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Special Documentation
SONO-VIEW

Standalone display and configuration for reliable process control with SONO or TRIME moisture sensors

Endress+Hauser
People for Process Automation

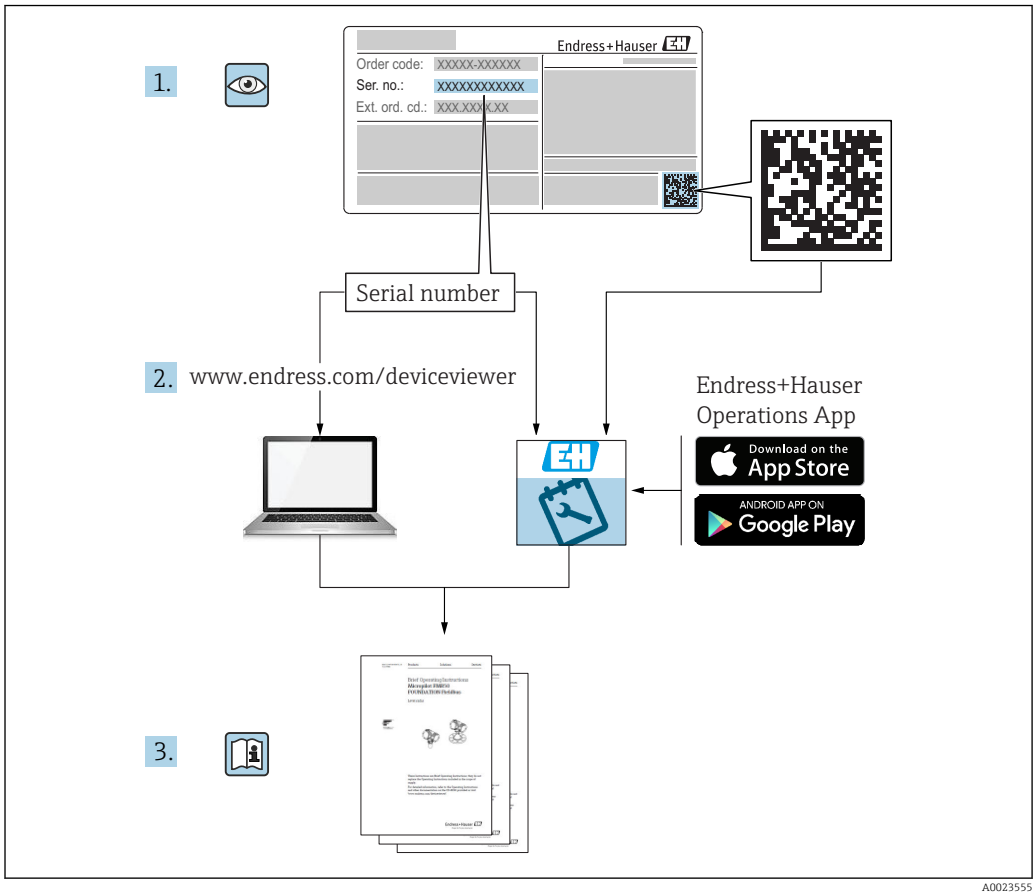

1.
Endress+Hauser
Order code: XXXXX-XXXXXX
Ser. no.: XXXXXXXXXXX
Ext. ord. cd.: XXX XXX XX XX
Serial number
2. www.endress.com/deviceviewer
Endress+Hauser
Operations App
Download on the App Store
ANDROID APP ON Google Play
3.
A0023555

Table of contents

1. Introduction

Up to four SONO or TRIME probes can be captured online via a serial interface and the measured values displayed on the LCD. In addition, SONO-VIEW allows users to operate SONO or TRIME probes on a PC with Windows via the USB interface. The following actions can be taken or parameter settings made with SONO-VIEW:

1. Selection of a calibration curve saved in the probe
2. Configuration of the analog outputs of the probe
3. Configuration of the operating mode of the probe
4. Configuration of the averaging times
5. Zero point adjustment
6. Analysis and optimization for new applications with SONO moisture probes
7. Logging and saving of measured data via a PC

2. Documentation

The following types of documentation are available in the Download area of the Endress+Hauser website (www.endress.com/downloads):
For an overview of the Technical Documentation pertaining to the device, please refer to the following:
- *W@M Device Viewer* (www.endress.com/deviceviewer): enter the serial number on the nameplate

- *Endress+Hauser Operations App*: enter the serial number on the nameplate or scan the 2D matrix code (QR code) on the nameplate

2.1. Supplementary documentation

SD02334M
Application Manual MMP40, MMP41, MMP42, MMP60

3. Basic safety instructions

3.1. Requirements for personnel

Personnel must meet the following requirements for the tasks they perform:

- Trained specialist staff. Have a relevant qualification for their specific role and task.
- Are authorized by the plant owner/operator.
- Are familiar with federal/national regulations.
- Prior to commencing work: read and understand the instructions in the manual and supplementary documentation as well as in the certificates (depending on the application).
- Follow instructions and comply with general policies and conditions.

3.2. Designated use

Application and media

The device described in this manual is designed for connecting SONO or TRIME probes to a Windows PC in compliance with the limit values specified in the "Technical Data" and the conditions listed in the manual and supplementary documentation.

Incorrect use

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

Remaining risks

Due to the transfer of heat from the process and power dissipation of the electronics, the temperature of the electronics housing and the assemblies contained therein can increase to up to 80 °C (176 °F).

Possible burn hazard from touching surfaces!

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

3.3. Workplace safety

When working on and with the device:

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

3.4. Operational safety

Risk of injury!

- Only operate the device 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 necessary, consult with the manufacturer.

Repairs

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.
- Only use 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 equipment 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.

3.5. Product safety

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

3.5.1. CE mark

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

4. Incoming acceptance and product identification

4.1. Incoming acceptance

On receipt of the goods, check the following:
- Are the order codes on the delivery note and the product label identical?
- Are the goods free from damage?
- Do the data on the nameplate match the order specifications on the delivery note?
- Where applicable (see nameplate): are Safety Instructions (XA) provided with the device?

If you can answer "no" to one of these questions, please contact your
Endress+Hauser Sales Office.

4.2. Product identification

The device can be identified in the following ways:
- Specifications on the nameplate
- Extended order code with a breakdown of the device features on the delivery note
- Enter the serial number on the nameplate in *W@M Device Viewer* (www.endress.com/deviceviewer): all the information about the device is displayed.
- Enter the serial number on the nameplate into the *Endress+Hauser Operations App* or scan the 2-D matrix code (QR code) on the nameplate with the *Endress+Hauser Operations App*: all the information about the device is displayed.

4.3. Manufacturer's address

Endress+Hauser SE+Co. KG
Hauptstraße 1
79689 Maulburg, Germany
Address of the manufacturing plant: see nameplate.

5. Operating elements / connection ports

5.1. Operating elements

5.2. Connection ports

USB (Mini B type)
-USB-IMP-Bridge
-firmware update

-Supply voltage
-bus interface

6. Technical data

Power supply	+12V to 24V_{DC} / 0.7W, stabilized
Operating temperature	0 to 50°C
Dimensions	145mm × 75mm × 34 mm
Weight	153g
Installation	DIN rail (optional)
Interfaces	IMP-Bus (rt / com) USB Mini B (galvanically isolated)
Protection class	IP20

7. Commissioning

7.1. Safety instructions

Note: Before you commission the device, make sure to read the general information at the start of these Operating Instructions. Improper use can damage this device.

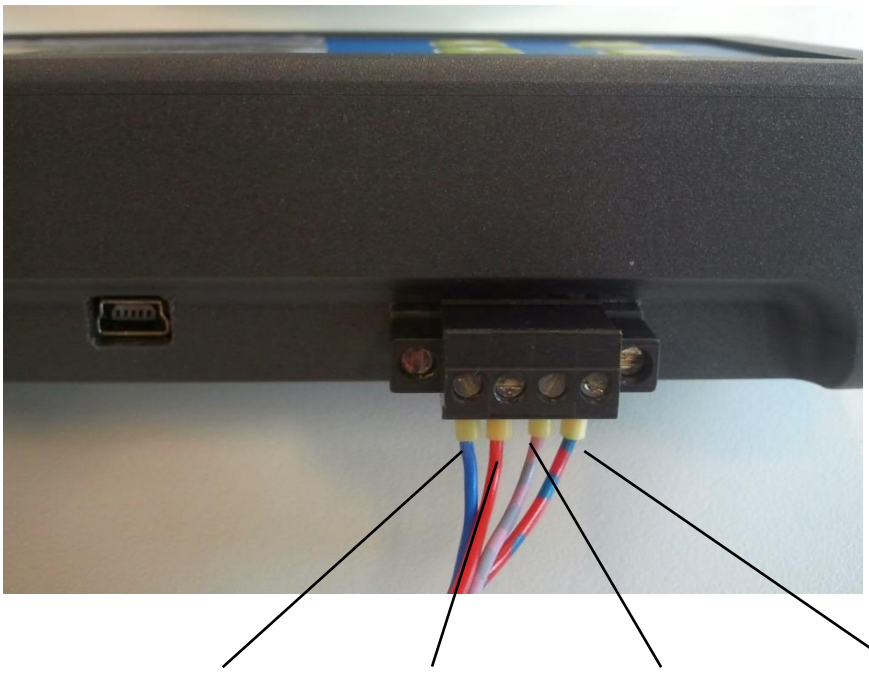
7.2. Checking the packaging contents

1. SONO-VIEW
2. Terminal block
3. USB cable (Type A → Mini B)

7.3. Connection

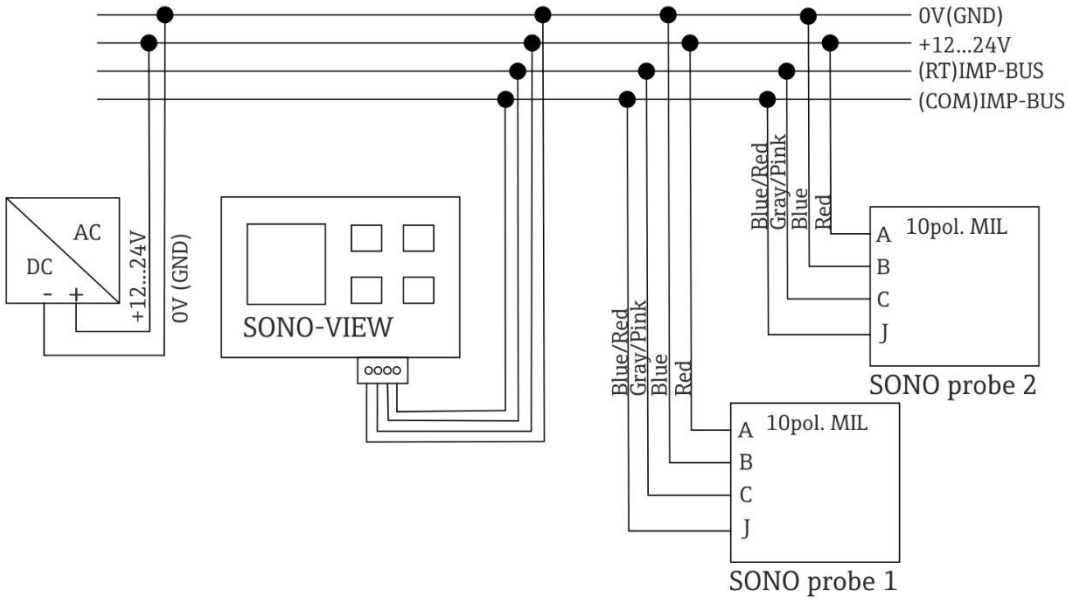
A supply voltage of 7 to 24V (approx. 80 to 30mA) is needed to operate the SONO-VIEW. A common ground line with the probes is not required. To connect to the probes, it suffices to connect the two bus lines "RT" and "COM".

Note: It is possible to display and configure up to four probes with SONO-VIEW. If more than four probes are connected, an error message is displayed and the device cannot function correctly.

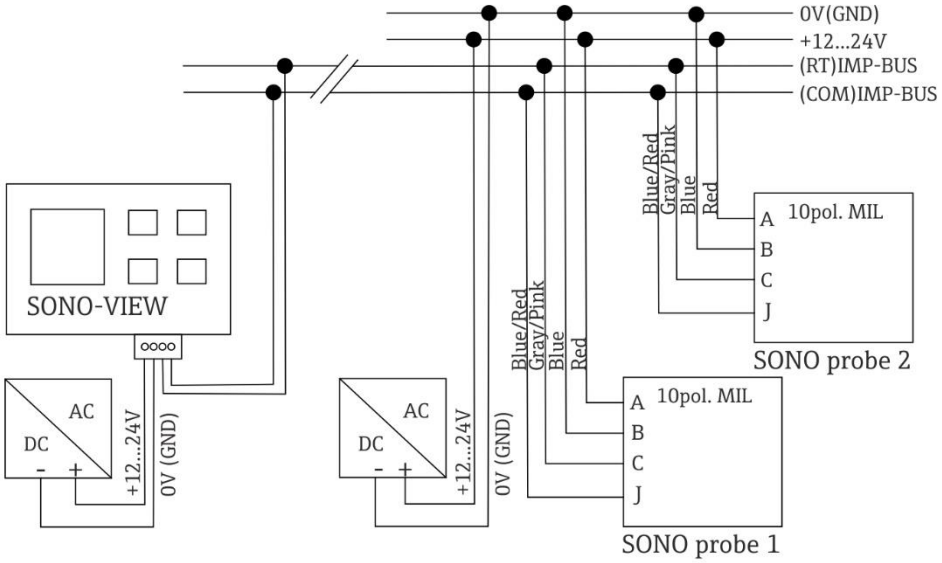


7.3.1. Connection examples

Example 1: Connection of the SONO-VIEW with two SONO or TRIME probes and a common power supply.



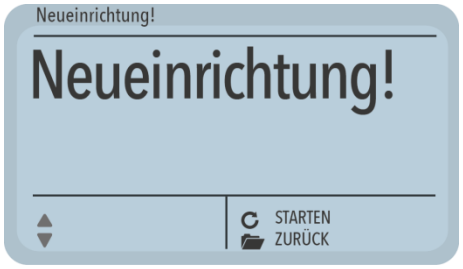
Example 2: Connection of the SONO-VIEW with 2 SONO or TRIME probes only via the IMP-Bus. The SONO-VIEW and the probes each have their own power supply. This may be useful if there are large distances between the measuring system and the display.



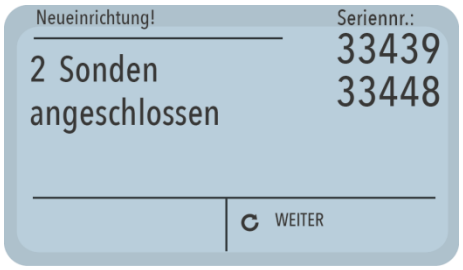
8. Operation

8.1. Initial/new setup

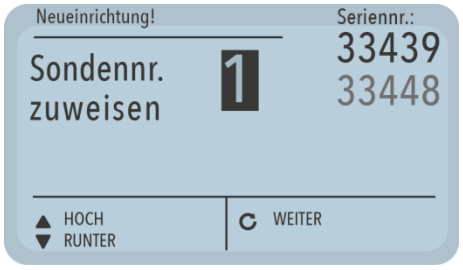
You must set up SONO-VIEW the first time you connect it to the probe network.



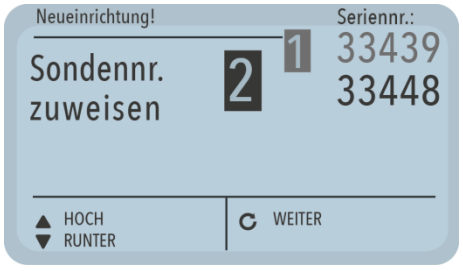
Here, the device searches the IMP-Bus for connected probes.
Press the key to start the setup.



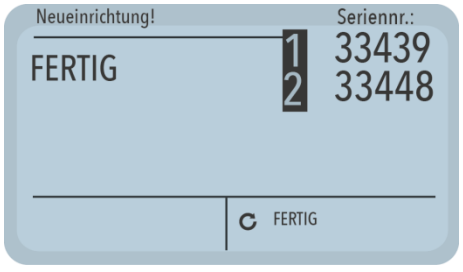
After a brief moment, the serial numbers of all the connected sensors are displayed on the screen.



SONO-VIEW uses probe numbers (1 - 4) to make it easier to manage the probes.
In the next step, you must assign these probe numbers to the serial numbers found. Using the / keys, select a serial number for each probe number and press to confirm.



Repeat this process until all the serial numbers are assigned to a probe number.



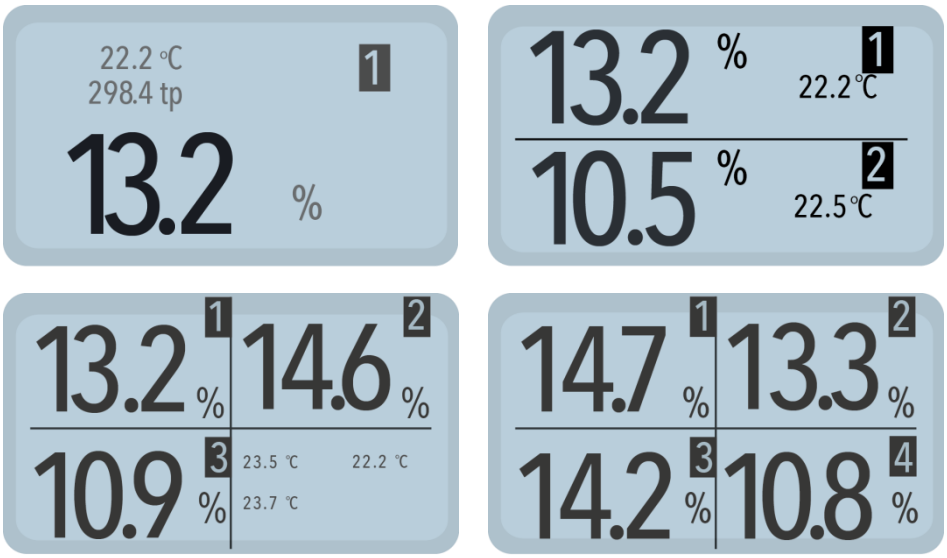
At the end all the probe numbers are displayed again in ascending order with the assigned serial numbers.
Press the key to complete the process.

Note: **It is possible to display and configure up to four probes with SONO-VIEW. If more than four probes are connected, an error message is displayed and the device cannot function correctly.**

At the end of the setup routine, SONO-VIEW reboots, checks the connected probes and immediately starts retrieving the measured data.

8.2. Measured value display

SONO-VIEW starts retrieving and displaying the measured values of the probes immediately after startup. It does so every 500ms. One of the following screens appears depending on whether one, two, three or four probes are connected.



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

It is possible to switch measuring screens if more than one probe is connected to SONO-VIEW. To do so, press the ▲ / ▼ keys. With each press of the key, all the connected probes are displayed in succession as individual probes. The probe number is always displayed in the top right of the screen so users know which probe the values refer to. If the user remains on a particular screen for longer, this screen is then set as the "Default" screen. Following a restart, SONO-VIEW will then start on the set default measuring screen.

8.3. Settings

Pressing the key while you are in the measuring screen takes you to the Settings menu. You can make a variety of settings in this menu and call up information about SONO-VIEW.

The Settings menu has the following structure:

Setting	***Description***
New setup	Allows users to scan for connected probes again
Language	Set the language
Display contrast	Set the contrast
About SONO-VIEW	Serial number and other information about your SONO-VIEW
Info	Support information
USB-IMP Bridge	Enables the convenient configuration of your probes using the PC

Press the / keys to select the desired setting. Pressing the key then takes you to the selected setting. Press the key again to exit the Settings menu.

8.3.1. New setup

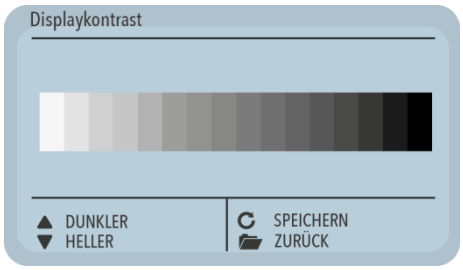
See Section "8.1 Initial/new setup"

8.3.2. Language

Press the / keys to select the desired language. Pressing the key sets the selected language as the default language. Press the key to exit the "Language" menu item.

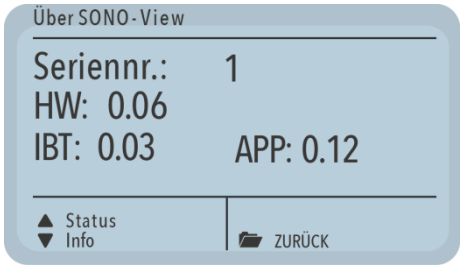
8.3.3. Display contrast

A bar with a gray scale appears on the display.



Use the ▲ / ▼ keys to set the contrast in such a way that you can see as many gradations as possible. Press the ↻ key to save your setting. You can exit the display contrast menu item by pressing the 🗁 key.

8.3.4. About SONO-VIEW



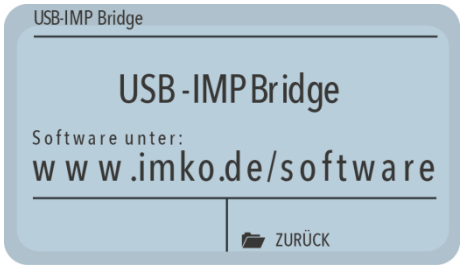
The serial number, HW version, IBT version and firmware version are displayed. Press the ▲ key to call up additional status information, such as connected probes and system voltages. Press the 🗁 key to exit the "About SONO-VIEW" menu item.

8.3.5. Info

Links to the Manufacturer-Homepage and the e-mail address for support questions.

8.3.6. USB-IMP Bridge

SONO-VIEW switches to a transparent data mode as soon as this menu item is opened. All data packages are now redirected from the USB interface directly to the IMP-Bus and vice versa. This enables easy probe configuration using a connected PC without the need for any additional hardware. For this, please download the free "SonoConfig" software and associated Operating Instructions from the Manufacturer-Homepage.



Connect SONO-VIEW to the PC using the USB cable supplied. SONO-VIEW connects to the PC as a virtual serial interface (COM port). The necessary driver is normally installed automatically by all recent Windows versions. If the driver is not installed automatically, please download the driver here: http://www.ftdichip.com/Drivers/VCP.htm.

Note: **No measured values are queried from the probe while SONO-VIEW is in the USB-IMP Bridge mode. However, the probes continue to measure and present their measured values at the analog output.**

Press the 🗁 key to exit the "USB-IMP Bridge" menu item.

8.4. Probe settings

With SONO-VIEW it is also possible to fully configure the connected probes without a PC. Settings such as the offset or the choice of a material-specific calibration can be easily configured with the ▲ / ▼ keys.

The "Probe settings" menu gives users the following options in this context:

Setting	***Description***
Probe info	Displays information about the connected probe
Material cal.	Choice of a material-specific calibration, 1-point calibration and 2-point calibration
Offset adjustment	Offsets the measured value
Average mode	Sets the averaging mode
Average parameters	Set the parameters for the configured averaging mode
Basic calibration	"Zero value" calibration of the probe in air

To access the "Probe settings", use the ▲ / ▼ keys on the measuring screen to select the single probe display for the probe to be configured (see also Section 4.2). Pressing the C key calls up the probe setting for the current probe.

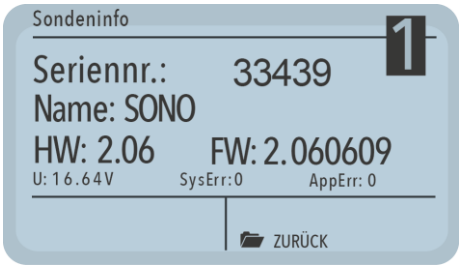
Note: **Only one probe can be configured at any one time. If the settings for more than one probe need to be modified, the process must be repeated for the other probes.**

Caution: **Make sure that the correct probe is set before you change the parameters.**

Caution: **SONO-VIEW allows users access to the measurement parameters of the probe. Before changing a parameter, please read the probe manual to find out exactly how this parameter works and the function it has. Changing a parameter can affect the reading, the accuracy and the measuring rate.**

8.4.1. Probe info

If this menu item is called, a range of information is retrieved from the probe and displayed.



You can exit the "Probe info" menu item again by pressing the key.

8.4.2. Material calibration

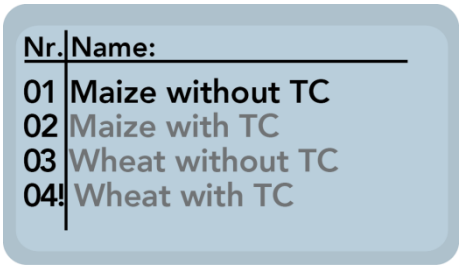
The "Material calibration" menu item allows users to set a material-specific calibration saved in the probe. In addition, you also have the option of programming and performing your own calibrations here in order to be able to measure special materials.

Note: **Pressing the key briefly takes you to the previous menu item. Pressing the key for longer takes you back to the "Probe settings" menu, irrespective of which "Material calibration" subitem is currently active.**

Once you have selected the "Material cal." menu item use the / keys to choose either the "Select" option to set one of the 15 material-specific calibrations saved in the device or the "Customize" option to program a new calibration to one of the 15 calibrations saved in the memory. Press the key to select the corresponding subitem in the menu. Pressing the key exits this menu item.

8.4.3. Select

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



Use the / keys to select the material-specific calibrations. The "!" symbol in front of a calibration indicates the current standard calibration. Press the key to save the selected calibration as the standard calibration in the probe. The set calibration is then saved to the non-volatile memory in the probe. You can exit this "Select" subitem again by pressing the key.

8.4.4. Customize

The "Customize" subitem allows you to perform a 1-point calibration or a 2-point calibration.

Use the ▲ / ▼ keys to switch between 1-point calibration and 2-point calibration. Pressing the C key executes the selected item and pressing the 🗁 key exits this subitem in the menu.

8.4.5. 1-point calibration

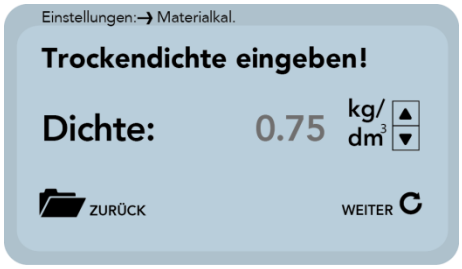
With this material calibration option, a linear equation (f(x)=mx+b) is calculated using the dry density, a reference moisture and the tp value (radar signal transit time) which can be measured or set at the point of the reference moisture. While a higher-value polynomial is useful to achieve better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

Note: **You require a sample of the material being measured and its dry density to perform a 1-point calibration. The moisture value must be determined with another method (kiln-dry method or similar) before the calibration.**

Procedure:

At the start of the calibration, the calibration memory (01 – 15) to be overwritten must be selected with the ▲ / ▼ keys. Press the C key to accept the setting. Pressing the 🗁 key takes you back to the previous item.

Then the percentage reference moisture of the material being measured must be set with the ▲ / ▼ keys. Press the C key to accept the setting. Pressing the 🗁 key takes you back to the previous item.



The dry density of the material being measured must be set in the next step with the ▲ / ▼ keys. Press the C key to accept the setting. Pressing the 🗁 key takes you back to the previous item.

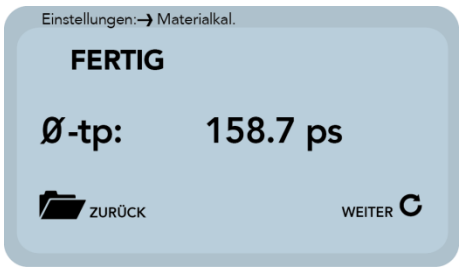
In the next step, the tp value (transit time of the radar signal) is determined by taking a measurement (with the connected probe) or by setting the value manually.

Use the ▲ / ▼ keys to switch between "Measure" and "Set".
Press the C key to select the relevant subitem in the menu.
Pressing the 🗁 key takes you back to the previous item.

Measure:

Press the C key to start the measurement.
Pressing the 🗁 key takes you back to the previous item.

Once you start measuring by pressing the C key, the average of 10 measured values is calculated.
SONO-View does not respond to any entries made during this time.



The tp average value is displayed when the device is finished measuring. Press the C key to accept the measured value. Pressing the 🗁 key takes you back to the previous item.

Set:

Use the ▲ / ▼ keys to manually set the tp value.
Press the C key to accept the setting.
Pressing the 🗁 key takes you 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".

Note: **Once you select "Save", the word "OWN:" is displayed in front of the original material calibration to indicate that this is a material calibration that the user has programmed on their own.**

Use the ▲ / ▼ keys to switch between "Save" and "Discard". Press the C key to select the relevant subitem in the menu. Pressing the 🗁 key takes you back to the previous item.

8.4.6. 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.

Note: **You require two material samples with different moisture values to perform a 2-point material calibration. The moisture values must be determined with another method (kiln-dry method, or similar) before the calibration. Make sure to adhere to the following sequence: first "lower moisture value" (drier material) and then "upper moisture value" (wetter material).**

Procedure:

At the start of the calibration, the calibration memory (01 – 15) to be overwritten must be selected with the ▲ / ▼ keys. Press the C key to accept the setting. Pressing the 🗁 key takes you back to the previous item.

Then the percentage moisture at the lower point of the material being measured must be set using the ▲ / ▼ keys. Press the C key to accept the setting. Pressing the 🗁 key takes you 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 probe) or by setting the value manually.

Use the ▲ / ▼ keys to switch between "Measure" and "Set". Press the C key to select the relevant subitem in the menu. Pressing the 🗁 key takes you back to the previous item.

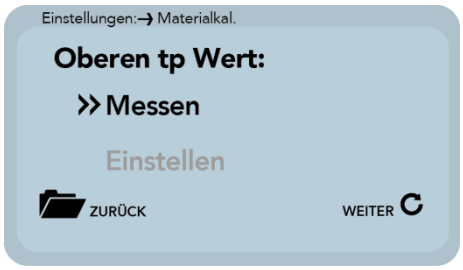
Measure: See Section "8.4.5 1-point calibration (Measure)".

Set:

Use the ▲ / ▼ keys to manually set the tp value at the lower moisture point. Press the C key to accept the setting. Pressing the 🗁 key takes you back to the previous item.

Then the percentage moisture at the upper point of the material being measured must be set using the ▲ / ▼ keys. Press the C key to accept the setting. Pressing the 🗁 key takes you 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 probe) or by setting the value manually.



Use the ▲ / ▼ keys to switch between "Measure" and "Set". Press the C key to select the relevant subitem in the menu. Pressing the 🗁 key takes you back to the previous item.

Measure: See Section "8.4.5 1-point calibration (Measure)".

Set:

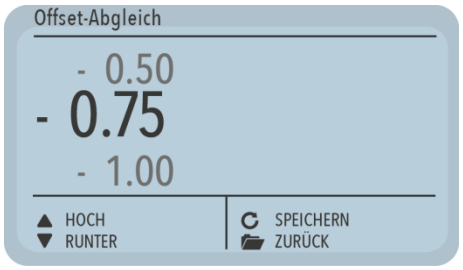
Use the ▲ / ▼ keys to manually set the tp value at the upper moisture point. Press the C key to accept the setting. Pressing the 🗁 key takes you back to the previous item.

In the next step, the calibration settings you have made can be saved to the calibration memory previously selected by selecting "Save". Here, the word "OWN:" is displayed in front of the original material calibration to indicate that this is a material calibration that the user has programmed on their own.

Use the ▲ / ▼ keys to switch between "Save" and "Discard". Press the C key to select the relevant subItem in the menu. Pressing the 🗁 key takes you back to the previous item.

8.4.7. Offset adjustment

It is possible to offset the measured value linearly to compensate for measured errors caused by density variations in the material or by installation conditions. 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 probe and will subsequently also affect the analog output. The setting is maintained in a traceable manner.



Adjust the offset to the desired setting using the ▲ / ▼ keys. Then press the C key to save the set value in the probe. Press the 🗁 key to exit this menu item.

8.4.8. Average mode

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

Mode CS: (Cyclic-Successive) For very short measurement processes in the seconds range (e.g. 5 to 20 seconds) without averaging and with up to 100 measurements per second internally and a cycle time of 250 milliseconds at the analog output. The CS operating mode is also used to record raw values without averaging and filtering.

Mode CA: (Cyclic Average Filter) Standard averaging for relatively fast but continuous measurement processes, with filtering and an accuracy of up to 0.1%.

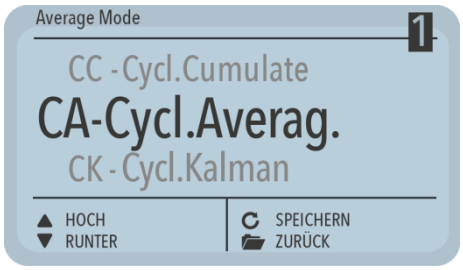
Mode CF: (Cyclic Floating Average with Filter) Floating average for very slow and continuous measurement processes, with filtering and an accuracy of up to 0.1%. Suitable for applications in fluidized bed dryers, on a conveyor belt etc.

Mode CK: (Cyclic with Kalman Filter) For complex applications.

Mode CC: (Cyclic Cumulated) With automatic totalization of moisture quantity measurements in one batch process.

Mode CH: (Cyclic Hold) Like Mode CC but without totalization

Note: Please also read the detailed information provided in your Probe User Guide.



Set the desired "Average mode" with the ▲ / ▼ keys and then set this mode as the standard mode by pressing the C key. The setting is then saved in the probe. You can exit the "Average mode" menu item again by pressing the 🗁 key.

8.4.9. Average parameters

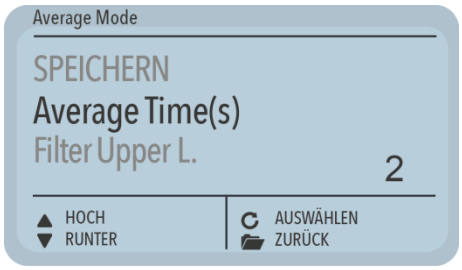
Different average parameters are available to control the device, depending on the "Average mode" selected.

Average mode	***Available parameters***
CA – Cyclic Average	Average Time
	Filter Upper Limit Offset
	Filter Lower Limit Offset
	Upper Limit Keep Time
	Lower Limit Keep Time
CK – Cyclic Kalman	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	Average Time
	Filter Upper Limit Offset
	Filter Lower Limit Offset
	Upper Limit Keep Time
	Lower Limit Keep Time
CC - Cyclic Cumulate	Moisture Threshold
	No Material Delay

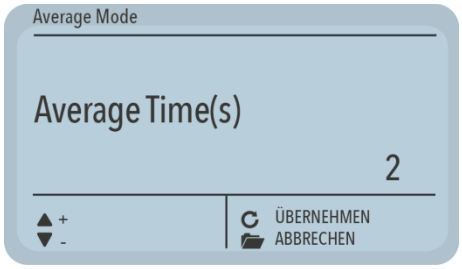
Note: **Please also read the detailed information provided in your Probe User Guide.**

Caution: **Before changing a parameter, please 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.**

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

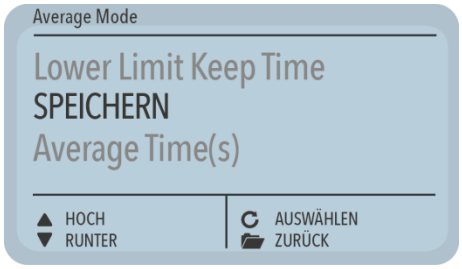


Use the ▲ / ▼ keys to navigate through the individual parameters. The current value of the selected parameter is displayed on the bottom right. Press the ↻ key to change the value.



The value now appears enlarged on the display. Press the ▲ / ▼ keys to change the value and press the ↻ key to accept this value. You can also exit the entry mode without changing the value by pressing the 🗁 key.

Repeat the process for all the parameters to be modified.

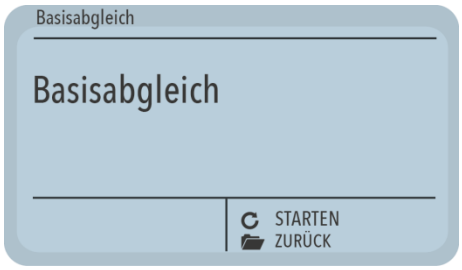


Once you have changed all the parameters to suit your preferences, select "SAVE" and press the ↻ key to confirm. The parameters are now written to the probe and apply immediately.

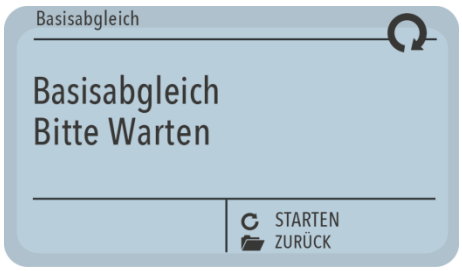
You can exit the "Average parameters" menu item without saving the changes by pressing the 🗁 key. All changes made are lost!

8.4.10. Basic calibration

If a sensor head is replaced, it may be necessary to perform a basic calibration in air due to different cable lengths. Here, the probe's moisture measured value is re-adjusted to the correct "zero value".



Press the 🗁 key to start the basic calibration. The calibration is then performed.



The message "Please wait" appears on the screen.
The calibration process takes around 30s.

Caution: To ensure a correct air calibration is performed, the sensor must be dry and free from any material during the basic calibration.

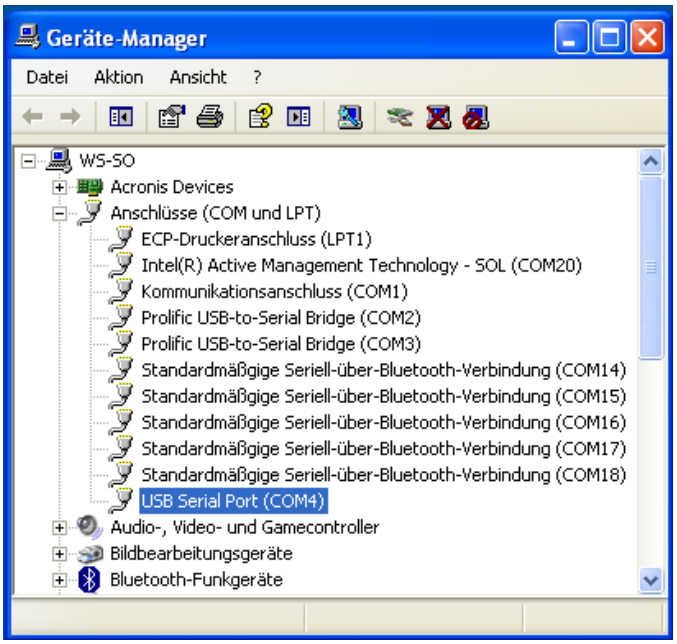
9. Installing SONO-VIEW on the PC

1. Install the USB driver from the USB stick.
2. The installation is performed automatically when SONO-VIEW is connected to the USB port of the PC.
3. Install the **SONO Config-SetUp.msi** software from the USB stick.
4. Connect the SONO or TRIME probe on SONO-VIEW to the operating voltage and the IMP-Bus (or RS485).
5. Check the COM port in the Windows Device Manager. (see **Note 1** on the next page)
6. Set up the COM port in SONOConfig. In the "**Configuration**" window under the "**Bus**" menu item, the PC can be set to an available **COMx-Port** and the baud rate **9600 Baud** can be configured for the SONO or TRIME probe. (COM1-COM15 are supported).
7. Start "**Scan Probes**" in SONOConfig.
8. After 30 seconds (max.) the serial number of the SONO or TRIME probe appears in the "**Probe List**" window.

Note 1:

The Device Manager is accessed as follows:

Control Panel → System → Hardware → Device Manager

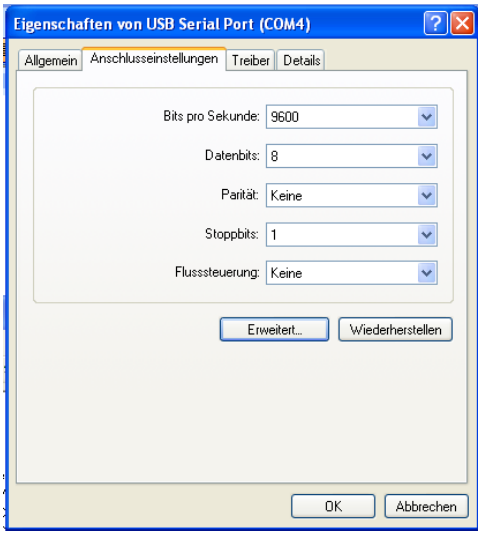


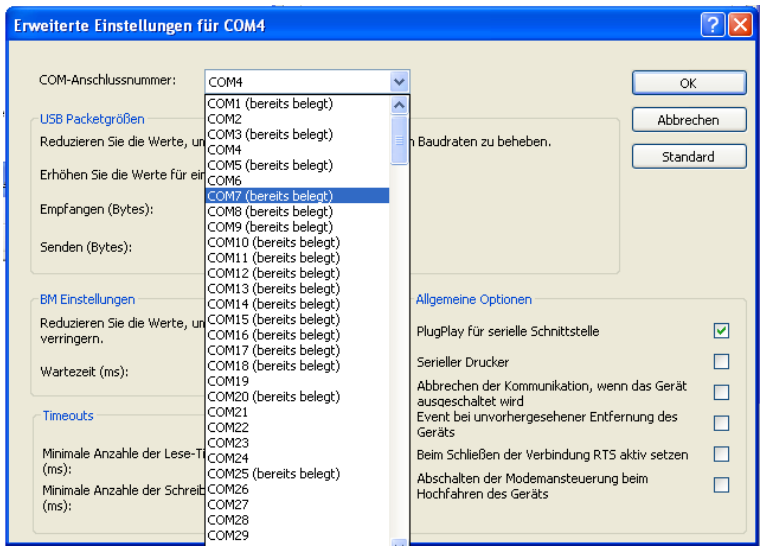
The subitem "**USB Serial Port (COMx)**" now appears under the "Ports (COM and LPT)" item.

COMx must be set in the range from COM1 to COM15 and the same port may not be used twice.

If a serial port conflict occurs or if SONO-VIEW is found at a higher COM port, the COM port number can also be changed manually:

Double-clicking the "USB Serial Port" entry takes you to the Properties menu where you can set the COM port number to a free number under "Port settings" – "Advanced".



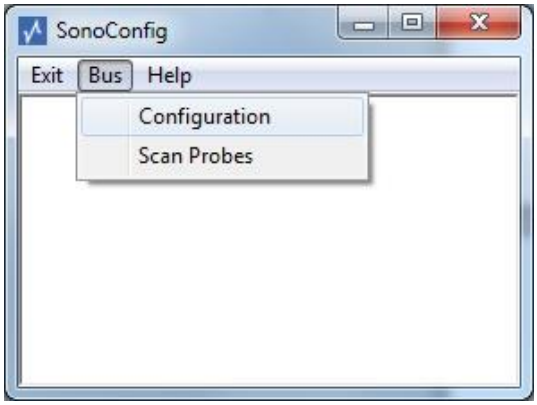


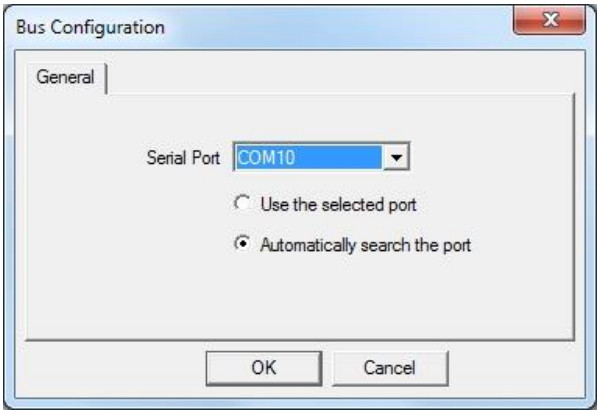
SONO-CONFIG must be restarted after these settings are changed.

10. Quick Guide for commissioning the SONO-CONFIG software

With SONO-CONFIG it is possible to make process-specific settings and to optimize individual probe parameters. In addition, with the SONO-CONFIG software the measured values of the SONO or TRIME probe can be read out serially, displayed on the PC and saved. For this purpose, the SONO or TRIME probe can be directly connected to the USB port of a PC via the USB module, which is available from the manufacturer.

In the "**Configuration**" window under the "**Bus**" menu item, the PC can be set to an available **COMx-Port** (which you may have specified or configured earlier) with the "Use the selected port" option and the baud rate **9600 Baud** can be configured for the SONO or TRIME probe. With the "Automatically search the port" option, the PC is automatically set to a COMx port with 9600 Baud.

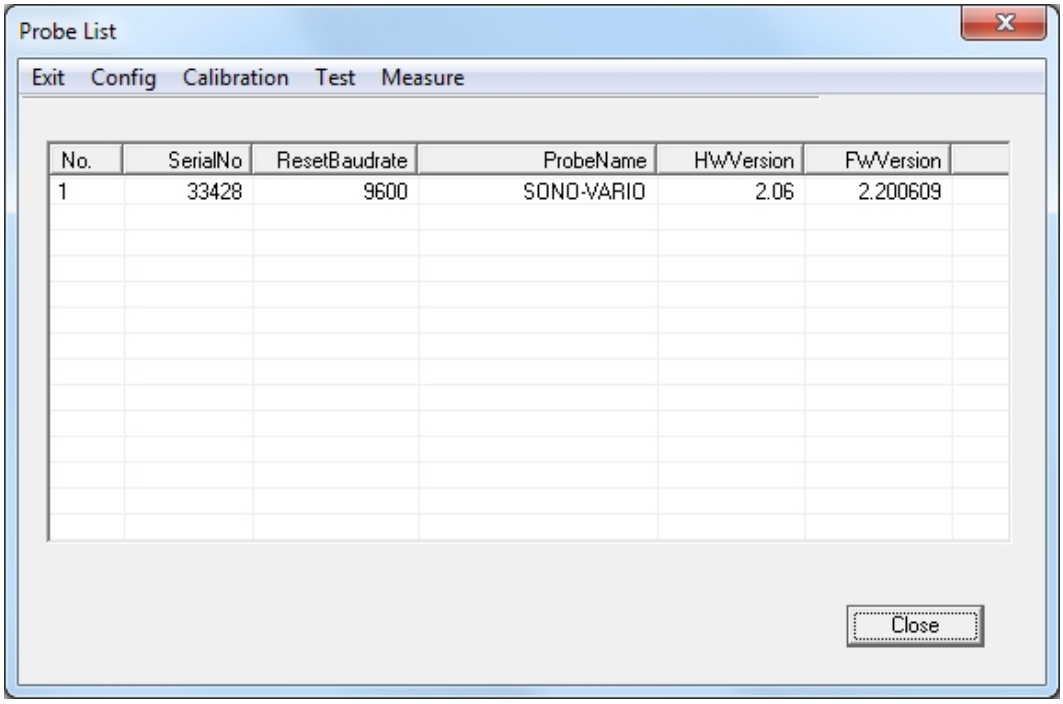




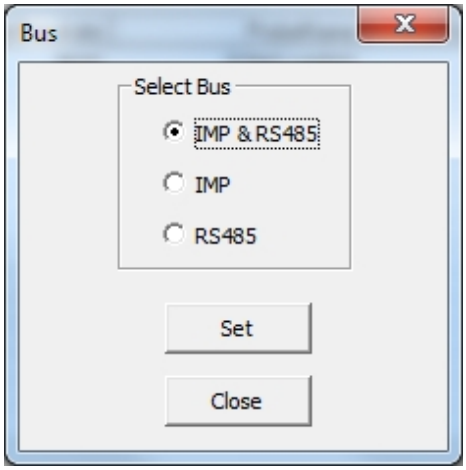
10.1.1. Scanning SONO or TRIME probes at the serial interface

In the "**Scan Probes**" window under the "**Bus**" menu item, the serial bus can be scanned for multiple connected SONO or TRIME probes (takes max. 30 seconds).

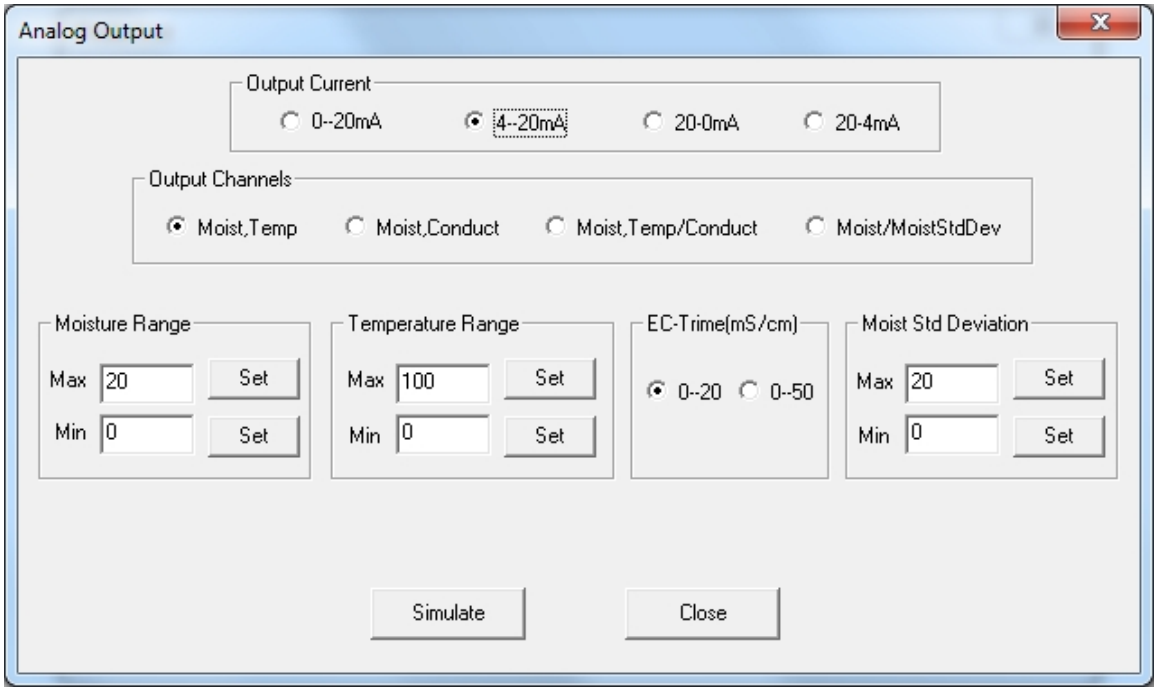
If SONO or TRIME probes are found, SONO-CONFIG displays the serial number of one or more probes in the "**Probe List**" window. Click a SONO or TRIME probe to select it.



10.1.2. Setting the probe operating mode and the serial SONO interface



In the "**Probe List**" window, the user can set the SONO or TRIME probe to the desired operating mode (CA to CH, see the "Measuring mode configuration" section) in the "**Measure Mode & Parameters**" window under the "**Config**" menu item. In addition, the serial interface in the SONO or TRIME probe can be set to IMP-Bus, RS485 or both interfaces. The robust IMP-Bus is the recommended setting.

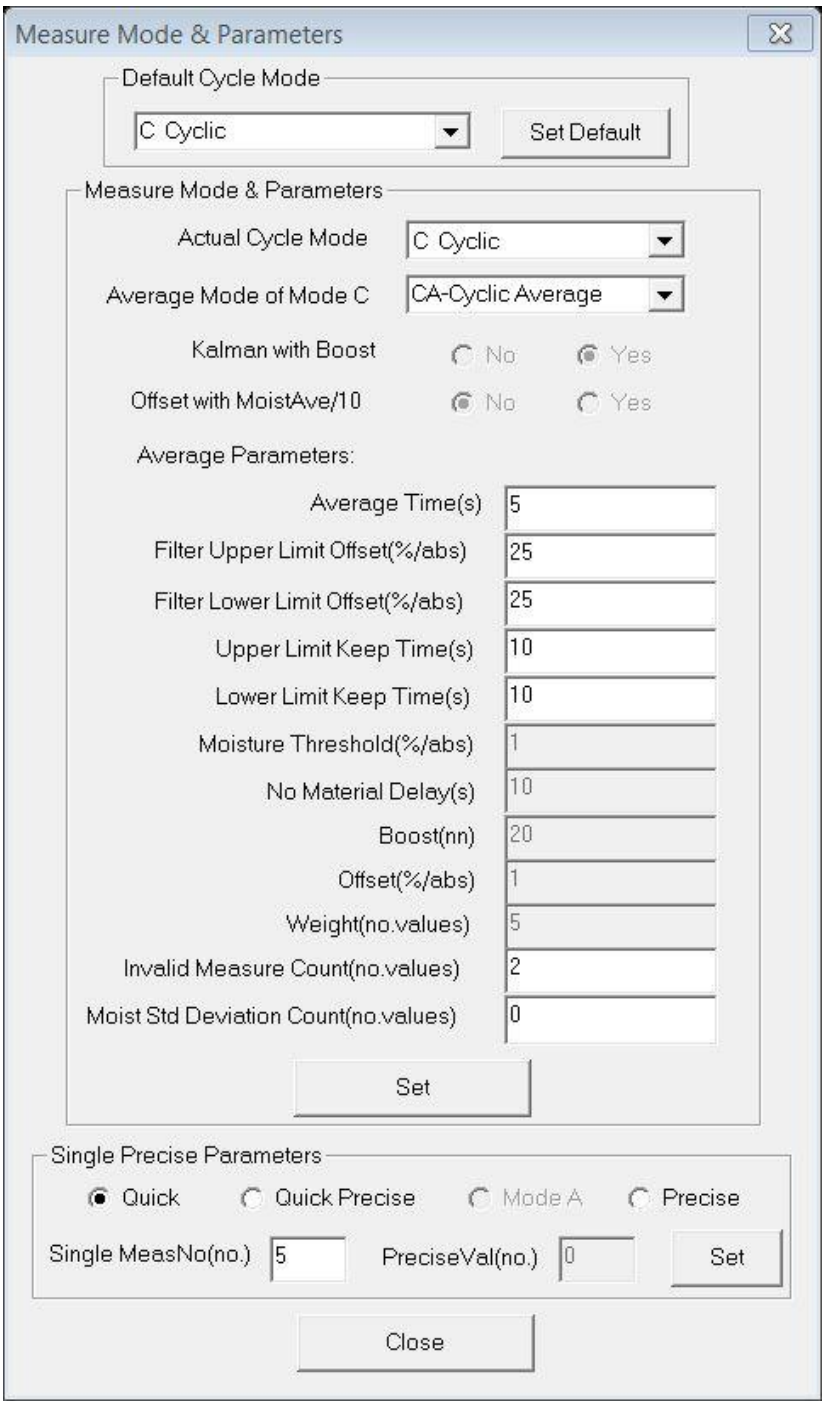


10.1.3. Analog outputs of the SONO or TRIME probe

The analog outputs of the SONO or TRIME probe can be configured in the "**Analog Output**" window under the "**Config**" menu item, (see the Section "Analog outputs for outputting the measured value").

10.1.4. Configuring the probe operating (measurement) mode

In the "**Probe List**" under "**Config**" and "**Measure Mode & Parameters**", the SONO or TRIME probe can be set to the measurement mode required in the specific application (CA, CF, CS, CK, CC or CH, see the "Measuring mode configuration" section).



The choice of operating mode specifies how the SONO or TRIME probe calculates an average value from several single values, filters data and executes other functions.

(See the **"Measuring mode configuration"** section in this manual).

In addition, a SONO or TRIME probe can be set to the precision level of a single moisture measurement "**Single Precise Parameters"** required in the respective application. This specifies how the TDR radar pulse is set and evaluated for the measurement.

The following section explains how this is done.

10.1.5. Setting the precision of a single value measurement

It must first be noted that SONO or TRIME probes are delivered with preconfigured parameters that should suit the intended applications of the probes.

Optionally, the SONO or TRIME probe can be configured with regard to the precision of a single measurement via **"Single Precise Parameters"**. Please note that the more precisely the SONO or TRIME probe is to measure the moisture value, the longer the amount of time that is needed for a single value measurement. There are applications where the SONO or TRIME probe installed under a silo discharge hatch only has 2 to 4 seconds to take several measurements and calculate an average. As a precise single value measurement would take too long here, the "Quick" setting with a single measurement time of 280ms is recommended here. Average values are already calculated internally during this 280ms period. If the flow of material under a silo discharge hatch fluctuates greatly,

conditions are not constant enough anyway to perform a highly accurate single measurement.

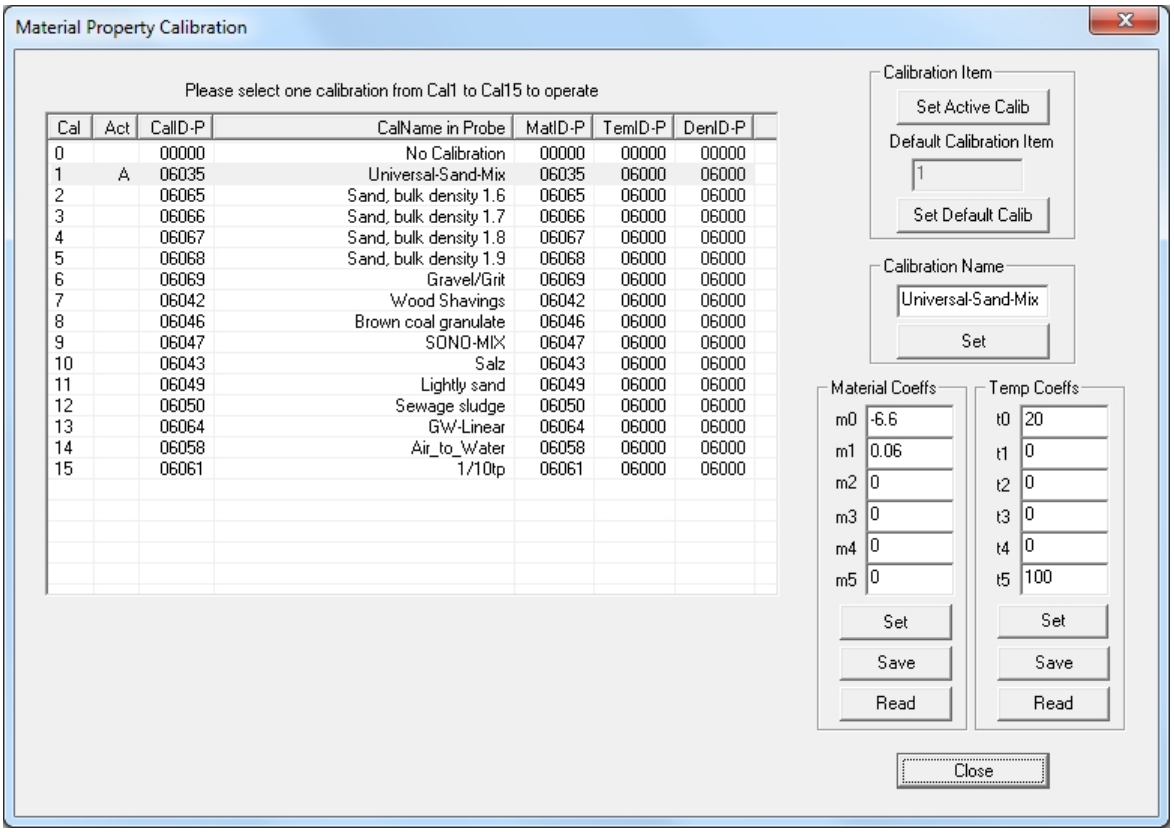
On the other hand, there are also applications with very stable and constant material flow conditions where accuracy levels of up to +-0.05% moisture must be achieved. Examples include the measurement of liquids with amounts of water in oil and also the measurement of emulsions.

The following table provides an overview of the configuration options for single value moisture measurements in the SONO or TRIME probe

Probe setting for single value measurement	**Probe operating mode**	**Parameter function**	**Application**
Quick:	Mode C i.e. CS, CF, etc.	Very quick TDR pulse evaluation and very fast single measurement time of approx. 280ms	e.g. Under a silo discharge hatch with a measuring time of just 2-4 seconds.
Quick Precise:	Mode C i.e. CS, CF, etc.	Quick and more precise TDR pulse evaluation with a single measurement time of approx. 350ms.	Similar to "Quick" but only if somewhat longer response times are possible in the process, e.g. 10 seconds.
Mode A:	Mode A	i.e. only if the SONO sensor readings are queried serially, e.g. for calibrations.	Mode A for mobile moisture probes with manual operation for use with the HD2 or SONO-DIS handheld device.
Precise: **PreciseVal:** Input value 1 to 4	Mode C and Mode A	Very precise single value measurements, i.e. very precise TDR pulse triggering and pulse evaluation. The higher the input value, the more precise the pulse evaluation but the longer the individual measuring time.	Only for process environments where a continuous flow of material is guaranteed, the measuring time is not a very critical factor and maximum precision is required.
Single MeasNo Default value: 4 10 is the max.	Mode C and Mode A	Additional averaging of single measurement values. If "10" is entered, a single value measurement can take up to one second.	Only for process environments where a continuous flow of material is guaranteed, the measuring time is not a very critical factor and maximum precision is required.

10.1.6. Selecting individual calibrations in the SONO or TRIME probe

SONO moisture probes are delivered with 15 different calibrations (Cal.1 to 15). In the "**Material Property Calibration**" window under the "**Calibration**" menu item, calibration curves Cal1 to Cal15 which are saved in the SONO or TRIME probe are retrieved from the probe and displayed on screen (takes 1 minute max.).



To pre-test the compatibility of a calibration curve, one of the 15 calibration curves (Cal 1 to 15) can be selected with the cursor, activated with the "**Set Active Calib**" button and tested with the material to be measured. By pressing the "**Set Default Calib**" button, the user can set the desired - and possibly modified - calibration curve Cal1 to Cal15 which is automatically activated for measurement once the probe power supply is switched on. The calibration name can be changed in the "Calibration-Name" window. In addition, the calibration coefficients m0 to m1 (for linear curves) and m0 to m5 (for non-linear curves) can be adjusted or modified for the individual calibration curves Cal1 to Cal15 using the **"Set"** and "**Save**" buttons.

Non-linear calibrations are possible with polynomials up to degree 5 (coefficients m0-m5).

Caution: A period must be used as the separator for coefficients m0 to m5. Do not use a comma!

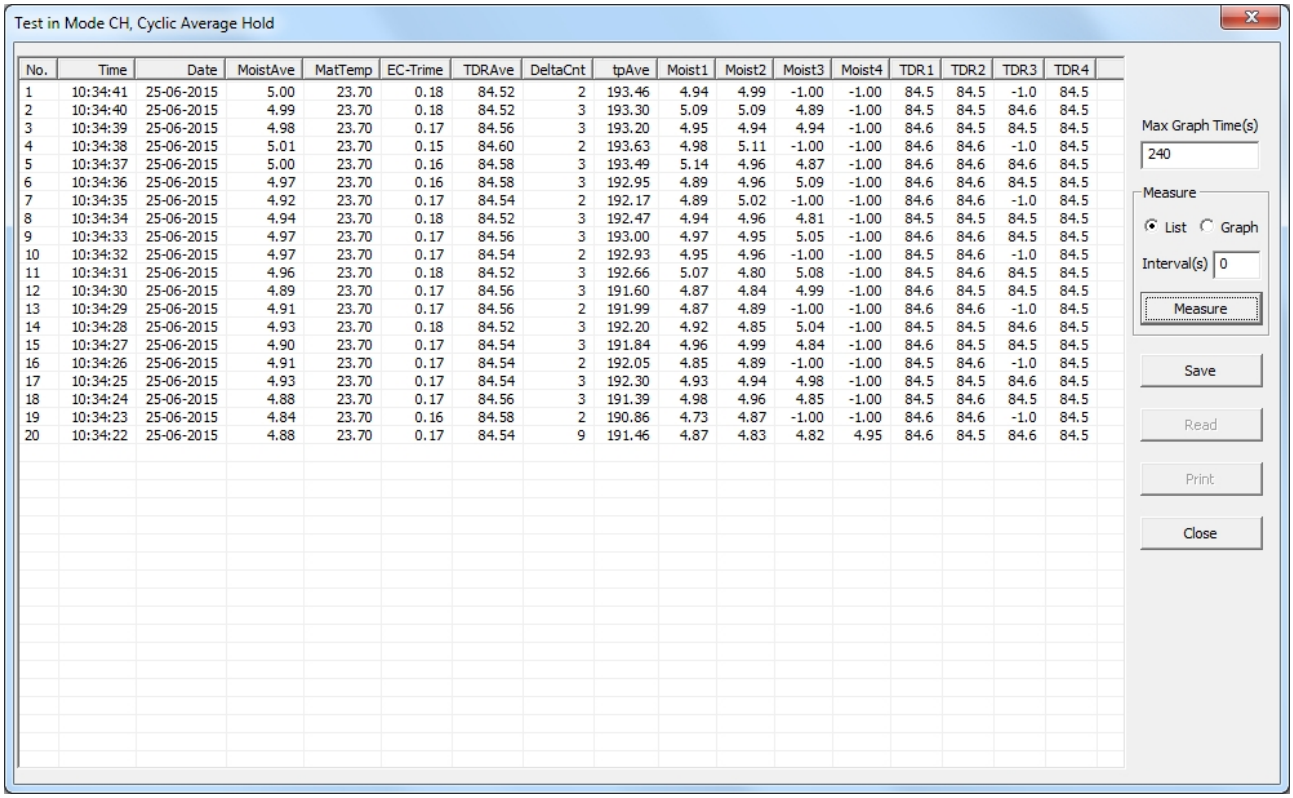
In the case of a linear material calibration, the two parameters m0 and m1 can be determined with the "SONO_LinearCalibration_Calculation" Excel sheet provided by the manufacturer (see also the "Calibration curve calculation" section):

1. Download the "SONO_LinearCalibration_Calculation" Excel sheet from the "Support Software" section of the manufacturer website.
2. Enter the two TP values with the moisture reference values in the Excel sheet.
3. Read the two parameters m0 and m1 from the Excel sheet.
4. Using the "SONO-CONFIG" program, save the two parameters m0 and m1 to the selected calibration curve.

10.1.7. Performing a test measurement in the selected operating mode

In the "**Test**" menu item, the moisture measured values determined by the probe are called up in the "**Test in Mode CA or CS**" window at short scanning frequencies and presented on the screen.

Caution: When performing a test run in Mode C (CA, CH, etc.), please ensure that the SONO or TRIME probe has also been set to this operating mode (Measure Mode C...). If this is not ensured, the probe will return zero values!



No.	Time	Date	MoistAve	MatTemp	EC-Trime	TDRAve	DeltaCnt	tpAve	Moist1	Moist2	Moist3	Moist4	TDR1	TDR2	TDR3	TDR4
1	10:34:41	25-06-2015	5.00	23.70	0.18	84.52	2	193.46	4.94	4.99	-1.00	-1.00	84.5	84.5	-1.0	84.5
2	10:34:40	25-06-2015	4.99	23.70	0.18	84.52	3	193.30	5.09	5.09	4.89	-1.00	84.5	84.5	84.6	84.5
3	10:34:39	25-06-2015	4.98	23.70	0.17	84.56	3	193.20	4.95	4.94	4.94	-1.00	84.6	84.5	84.5	84.5
4	10:34:38	25-06-2015	5.01	23.70	0.15	84.60	2	193.63	4.98	5.11	-1.00	-1.00	84.6	84.6	-1.0	84.5
5	10:34:37	25-06-2015	5.00	23.70	0.16	84.58	3	193.49	5.14	4.96	4.87	-1.00	84.6	84.6	84.6	84.5
6	10:34:36	25-06-2015	4.97	23.70	0.16	84.58	3	192.95	4.89	4.96	5.09	-1.00	84.6	84.6	84.5	84.5
7	10:34:35	25-06-2015	4.92	23.70	0.17	84.54	2	192.17	4.89	5.02	-1.00	-1.00	84.6	84.6	-1.0	84.5
8	10:34:34	25-06-2015	4.94	23.70	0.18	84.52	3	192.47	4.94	4.96	4.81	-1.00	84.5	84.5	84.5	84.5
9	10:34:33	25-06-2015	4.97	23.70	0.17	84.56	3	193.00	4.97	4.95	5.05	-1.00	84.6	84.6	84.5	84.5
10	10:34:32	25-06-2015	4.97	23.70	0.17	84.54	2	192.93	4.95	4.96	-1.00	-1.00	84.5	84.6	-1.0	84.5
11	10:34:31	25-06-2015	4.96	23.70	0.18	84.52	3	192.66	5.07	4.80	5.08	-1.00	84.5	84.6	84.5	84.5
12	10:34:30	25-06-2015	4.89	23.70	0.17	84.56	3	191.60	4.87	4.84	4.99	-1.00	84.6	84.5	84.5	84.5
13	10:34:29	25-06-2015	4.91	23.70	0.17	84.56	2	191.99	4.87	4.89	-1.00	-1.00	84.6	84.6	-1.0	84.5
14	10:34:28	25-06-2015	4.93	23.70	0.18	84.52	3	192.20	4.92	4.85	5.04	-1.00	84.5	84.5	84.6	84.5
15	10:34:27	25-06-2015	4.90	23.70	0.17	84.54	3	191.84	4.96	4.99	4.84	-1.00	84.6	84.5	84.5	84.5
16	10:34:26	25-06-2015	4.91	23.70	0.17	84.54	2	192.05	4.85	4.89	-1.00	-1.00	84.5	84.6	-1.0	84.5
17	10:34:25	25-06-2015	4.93	23.70	0.17	84.54	3	192.30	4.93	4.94	4.98	-1.00	84.5	84.5	84.6	84.5
18	10:34:24	25-06-2015	4.88	23.70	0.17	84.56	3	191.39	4.98	4.96	4.85	-1.00	84.5	84.6	84.5	84.5
19	10:34:23	25-06-2015	4.84	23.70	0.16	84.58	2	190.86	4.73	4.87	-1.00	-1.00	84.6	84.6	-1.0	84.5
20	10:34:22	25-06-2015	4.88	23.70	0.17	84.54	9	191.46	4.87	4.83	4.82	4.95	84.6	84.5	84.6	84.5

The measured values determined by the SONO or TRIME probe are displayed in the individual columns:

MoistAve Moisture as an average value

MatTemp Temperature in °C

EC-TRIME Radar-based conductivity in dS/m or mS/cm

TDRAve TDR signal level (for special applications)

DeltaCount Number of single measurements used to calculate the average

tpAve The radar transit time "tp Average" associated with the moisture value

By clicking **"Save"**, the recorded measured data are saved in a text file to the following path:
\SONO-CONFIG.exe-path\MD\file name

The text file Statis**+SN+yyyymmddHHMMSS.sts** is automatically assigned a name consisting of the serial number and date/time. Here, SN refers to the serial number of the SONO or TRIME probe. The measured data can then be evaluated and analyzed in Windows-EXCEL.

10.1.8. Measurement in data logging mode

In the **"Data logging"** menu item, it is possible to log and save the measured data of multiple SONO or TRIME probes with variable and longer cycle rates in the data logger mode. This is useful to record the measured data of the probe during an extended drying process, for example.

10.1.9. Basic calibration in air and water

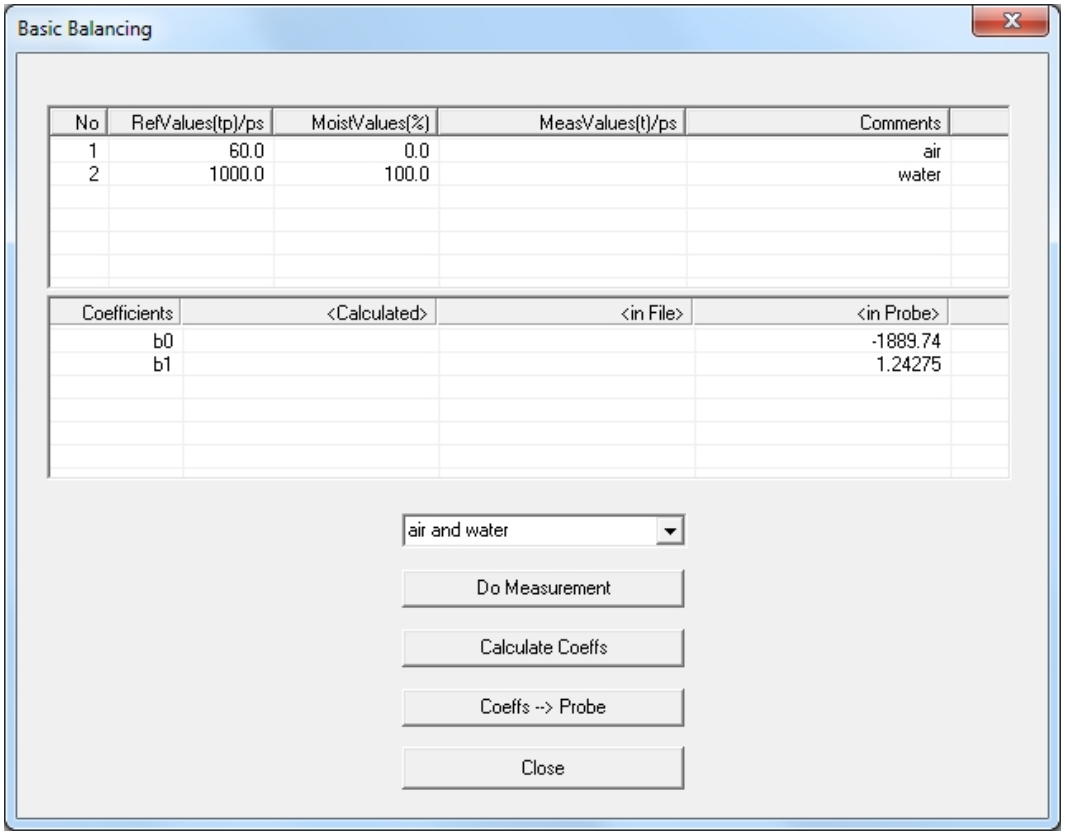
Even though SONO or TRIME probe heads have a precise, identical design, it is recommended to check the calibration after replacing a probe head and to correct it with a basic calibration.

In a basic calibration, two reference measurements are taken in media with known target values ("RefValues") and any deviation of the probe from these reference values is corrected. Different media are used as the reference medium, depending on the probe type. These media are air and water (tap water) for standard SONO or TRIME probes with a ceramic measuring field. For special SONO or TRIME probes, such as SONO-GS1 for instance, glass beads with different measuring points are used for the calibration (available on request).

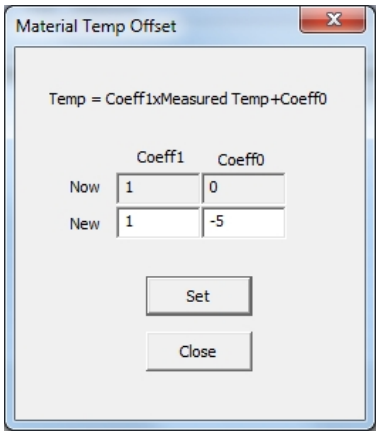
Caution: When performing a basic calibration, make sure that the SONO or TRIME probe has been set to operating mode A. If this is not ensured, the probe will return zero values! After the basic calibration, the SONO or TRIME probe must be reset to the C operating mode for online operation, as it would not perform continuous measurements otherwise.

In the "**Basic Balancing**" window under the "**Calibration**" menu item, the two reference values of the radar transit time **tp** are displayed with 60ps and 1000ps:

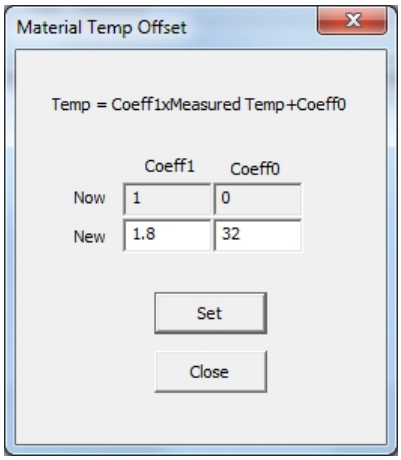
1. Reference target value A: tp=60ps in air (the surface of the probe must be dry here)
   Once reference value 60 is clicked, the SONO or TRIME probe is set to the first basic reference value when you press the "**Do Measurement**" button. The measured raw value for the radar transit time **t** is displayed in ps (e.g. 1532.05 picoseconds) in the "MeasValues" column.
2. Reference target value B: tp=1000ps in water. The SONO or TRIME probe must be immersed in tap water here and at least 5cm of water should cover the probe head.
   Once reference value 1000 is clicked, the SONO or TRIME probe is set to the second basic reference value when you press the "**Do Measurement**" button. Here too, the measured radar transit time **t** is displayed as a raw value in ps in the "MeasValues" column.
3. The calibration data are calculated automatically and saved in the non-volatile memory in the probe when you click the "**Calculate Coeffs**" and "**Coeffs → Sample**" button. In a test measurement (in operating mode A), the radar transit times **tp** of the SONO or TRIME probe should now be 60ps in air and 1000ps in water. In the "**Basic Balancing**" window under the "**Calibration**" menu item, the two reference values of the radar transit time **tp** are displayed with 60ps and 1000ps:



10.1.10. Adjustment of the material temperature sensor in the probe

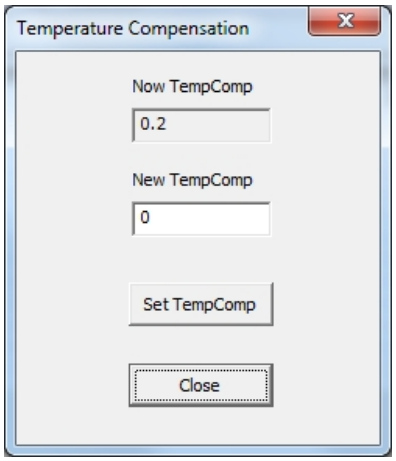


In the "**Material Temp Offset**" submenu of the "**Calibration**" menu, a zero-point adjustment can be performed for the material temperature sensor installed in the SONO or TRIME probe. In this example, a temperature drift of +5°C - which is caused by the sensor self-heating - is to be corrected by entering -5 in the Coeff0 field.



The following example shows the parameters for temperature displayed in ° Fahrenheit.

10.1.11. Adjustment of the electronics temperature



This temperature compensation function can compensate for a temperature drift of the SONO electronics. As the SONO electronics are generally not easily affected by temperature, the standard parameter **TempComp**=0.2 is preset in every SONO or TRIME probe for "normal" ambient temperature ranges. This TempComp parameter can be set to values up to **TempComp**=0.75 for operation at high temperatures, which can be up to 80°C depending on the SONO or TRIME probe type. However, if the parameter TempComp is changed by >0.2, it is recommended to perform a basic calibration in water and air with the SONO or TRIME probe. The TempComp parameter can be set with the SONO-CONFIG software tool in the "Calibrations" item and the "Electronic-Temperature-Compensation" menu.

11. Measured value pre-processing in SONO or TRIME probes

11.1.1. Measured value acquisition: physical preliminary check, averaging and filtering

SONO or TRIME probes measure internally at very high cycle rates in the 10kHz range but output the measured value at the analog output with a cycle time of 280 milliseconds. During these 280 milliseconds, the moisture value undergoes a preliminary check in the probe, i.e. only plausible individual measured values that are already physically checked and already averaged to an extent 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 milliseconds. 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 around the probe head. SONO or TRIME probes 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.

11.1.2. Auto-correction in event of abrasion

In the event of abrasion on the SONO probe head, an automatic measured value correction function in the probe enables far longer operating times without the need for recalibration. Most probes for material moisture measurement use a dielectric covering (ceramic or plastic plate). If this cover wears down and a regular recalibration is not performed, these probes deliver incorrect measured values because the intensity of the measuring field increases or decreases. In the SONO series with the TRIME TDR radar-based
method, the innovative probe design ensures the sensor is calibrated automatically if the dielectric covering changes due to abrasion. As a result any measured value deviations are only minor, which translates to continuous reliability and longer maintenance intervals for SONO probes.

11.1.3. Determination of the mineral concentration

With the radar-based TRIME measurement method, for the first time ever it is now possible not only to measure moisture but also to draw conclusions about the conductance or mineral concentration. Here, the system determines the attenuation of the radar pulse in the measured volume fraction of a material. This novel and innovative measurement method delivers a radar-based conductance value (RbC – **R**adar-**b**ased-**C**onductivity) in dS/m as the characteristic value, which is determined depending on the mineral concentration and is output as an unscaled value. The conductivity measuring range of the SONO or TRIME probe here is 0 to 12dS/m.

11.1.4. Material temperature measurement

The SONO or TRIME probe contains an integrated temperature sensor, which determines the housing temperature 3mm below the surface of the probe head. The temperature can optionally be output at analog output 2. As the probe electronics operate with a power of approx. 1.5W, the probe housing heats up slightly. Therefore a very precise measurement of the material temperature is not possible, or is only possible to a certain degree. 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 self-heating.
The temperature offset value resulting from the self-heating can be adjusted using the SONO-CONFIG program.

11.1.5. Temperature compensation when used at elevated temperatures

SONO or TRIME probes are generally not easily affected by temperature. Nevertheless, there are applications where temperature compensation is necessary. SONO or TRIME probes offer two ways to perform temperature compensation.

11.1.6. Temperature compensation of internal SONO electronics

This temperature compensation function can compensate for a temperature drift of the SONO electronics. As the SONO electronics are generally not easily affected by temperature, the standard parameter **TempComp**=0.2 is preset in every SONO or TRIME probe for "normal" ambient temperature ranges. This TempComp parameter can be set to values up to **TempComp**=0.75 for operation at high temperatures, which can be up to 80°C depending on the SONO or TRIME probe type. However, if the parameter TempComp is changed by >0.2, it is recommended to perform a basic calibration in water and air with the SONO or TRIME probe. The TempComp parameter can be set with the SONO-CONFIG software tool in the "Calibrations" item and the "Electronic-Temperature-Compensation" menu.

Caution: If the TempComp parameter is changed, the basic calibration of the probe also changes, which is why a new basic calibration of the SONO probe or TRIME probe is then needed!

11.1.7. Compensation of the temperature of the material being measured

When used in higher temperature ranges, the dielectric constant (DC) of water and certain materials being measured shows a temperature dependency. Moisture is determined using the dielectric constant, i.e. the DC is the actual parameter measured during moisture measurement with SONO or TRIME probes. If materials being measured, such as maize, show a very special temperature dependency of the DC, such as a temperature dependency only in very specific moisture ranges, it may be necessary to perform much more complex temperature compensation which involves a considerable amount of work in the laboratory. For this, the temperature of the material must be measured with the temperature sensor integrated in the SONO or TRIME probe, in addition to the measurement of the moisture. Parameters t0 to t5 can be set in each of the 15 calibration stages Cal1 to Cal15 (see the "Selecting the individual calibrations" section). If necessary, please contact the Service Department of the manufacturer if you require assistance with this very complex material-specific temperature compensation process.

11.2. The analog outputs for outputting the measured values

The measured values are output as a current signal via the analog output. Using the **SONO-CONFIG** service program, the SONO or TRIME probe can be set to two versions: 0-20mA or 4-20mA.
In addition, with **SONO-CONFIG** it is also possible to individually configure the moisture range for the analog output, e.g. 0-10%, **0-20%** or 0-30%, depending on the specific requirements.

Output 1: moisture in % (variable setting)
Output 2: conductivity (EC-TRIME) 0-12dS/m or optionally the temperature 0-70°C, or optionally the standard deviation for moisture measurement.
It is also possible to divide analog output 2 into two ranges to output both the conductance and the temperature, namely the 4-11mA range for temperature and the 12-20mA range for conductivity. Analog output 2 automatically switches between these two current windows every 5 seconds.

The two analog outputs can be individually adjusted with the SONO-CONFIG software. A 500R resistor can be used for a 0-10Vdc voltage output.

Therefore, there are several possible settings for analog outputs 1 and 2 with the SONO or TRIME probe:

Analog output: choice of 0-20mA or 4-20mA

0-20mA **4-20mA**

The current output can also be set inversely for special controllers and applications:
20mA-0mA and **20mA-4mA**

Analog output channels: The two analog outputs of the SONO or TRIME probe can be set differently to one of four possible options.

1.	**Moist, Temp**	Analog output 1 for moisture, output 2 for material temperature.
2.	**Moist, Conduct**	Analog output 1 for moisture, output 2 for conductivity from 0 to 20dS/m or 50dS/m
3.	**Moist, Temp/Conductivity**	Analog output 1 for moisture, output 2 for material temperature and EC-TRIME conductivity with automatic current window changeover.
4.	**Moist / MoistSTdDev**	Analog output 1 for moisture, output 2 for standard deviation with moisture measurement (for use in fluidized bed dryers, for example).

The moisture range and the material temperature output range can be individually configured for analog output 1 and 2. The moisture range may not exceed 100%.

Moisture Range in %
Maximum: e.g. 20 for sand (set in %)
Minimum: 0

Temp. Range in °C:
Maximum: 70°C
Minimum: 0 °C

Conductivity Range: 0 to 20dS/m or 0 to 50dS/m
Depending on the probe type and moisture, SONO or TRIME probes can measure the EC-TRIME pore water conductivity in the range from 5dS/m to 50dS/m.

12. The individual operating modes of SONO or TRIME probes

The SONO or TRIME probe is preconfigured at the factory before it is delivered. This device setting can be optimized to suit the process. For this purpose, the SONO or TRIME probe can be directly connected to the USB port of a PC via the **SM-USB module** or **SONO-VIEW**, which is available from the manufacturer.

The following SONO or TRIME probe settings can be changed.

Measure mode and parameters:

1. Measure mode A - OnRequest (only in network operation for calling up measured values via the serial interface for calibration purposes).
2. Measure mode **C** - Cyclic (default setting for SONO or TRIME probes with cyclic measurement).
3. Operating modes: SONO or TRIME probes are supplied from the factory with the **CH mode** for applications in the construction industry, and with **mode CA** for general process applications. Six different operating modes are available in the C-Mode, depending on the application.

   Mode CS: (Cyclic-Successive) For very short measurement processes in the seconds range (e.g. 1 to 10 seconds) without averaging and without filter functions, with up to 100 measurements per second internally and a cycle time of 250 milliseconds at the analog output.
   Mode CA: (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 then be able to analyze the measured data and identify the best operating mode.
   Mode CF: (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 in fluidized bed dryers, on a conveyor belt etc.
   Mode CK: (Cyclic with Boost Filter) For complex applications in mixers and dryers.
   Mode CC: (Cyclic Cumulated) With automatic totalization of moisture quantity measurements in one batch process if no PLC controller is used.
   Mode CH: (Cyclic Hold) Standard operating mode for applications in the construction industry. Like Mode CC but with filtering and without totalization. Mode CH is ideal for very short batch times as low as 2 seconds if the SONO or TRIME probe is installed under the silo discharge hatch. Mode CH performs filtering automatically, allowing drip water formed in the silo to be filtered out of the measured value, for example.
4. Average time, reaction speed of the measured values
5. Calibration (when different materials are used)
6. Filter function
7. Precision of a single value measurement (see the "Setting the precision of a single value measurement" section of the "SONO-CONFIG software" chapter.

Each of these settings are retained even after the probe is switched off, i.e. the setting is saved to the non-volatile memory of the SONO or TRIME probe.

12.1. Operating modes CA, CF, CH, CC and CK of the SONO or TRIME probe

The SONO or TRIME probe is delivered from the factory preconfigured with suitable parameters for the averaging time and a universal filter function for common systems.

The configuration options and special functions of the SONO or TRIME probe described in this chapter are only needed on rare occasions. Please note that changing the settings or executing this special function can result in a probe malfunction!

The settings described below in this context can be modified with the **SONO-CONFIG** 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 set with the ***Average-Time*** parameter.

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

Parameters in measurement modes CA, CC, CF, CH and CK	***Function***
Average-Time Standard setting: 2s *Range of adjustment: 1-20s* ***Unit: seconds***	**CA/CF:** The time for the 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**).
Filter-Upper-Limit Offset Standard setting: 25% *Range of adjustment: 1-100%* ***Unit: % absolute***	**CA/CC/CF/CH/CK:** Filters out excessively high measured values caused by metal scrapers or vanes around the probe head, for example. The offset value in % is added to the dynamic current average value.
Filter-Lower-Limit Offset Standard setting: 25% *Range of adjustment: 0-100%* ***Unit: % absolute***	**CA/CC/CF/CH/CK:** Filters out excessively low measured values caused by insufficient material or material flow around the probe head. The offset value in % is subtracted from the dynamic current average value.
Upper-Limit-Keep-Time Standard setting: 10s *Range of adjustment: 1-100s* ***Unit: seconds***	**CA/CC/CF/CH/CK:** The duration of the filter function for upper limit interference (e.g. caused by metal scrapers) can be limited with this parameter to avoid the risk of undefined states.
Lower-Limit-Keep-Time Standard setting: 10s *Range of adjustment: 1-100s* ***Unit: seconds***	**CA/CC/CF/CH/CK:** The duration of the filter function for lower limit interference (e.g. caused by insufficient material flow or longer "gaps in material") can be limited with this parameter to avoid the risk of undefined states, or to define the hold time at the end of a batch.
Moisture Threshold **(starting threshold) in % moisture** Standard setting: **0.1%** *Range of adjustment: 0-100%* ***Unit: % absolute***	**CA/CF/CK:** Inactive **CC/CH:** The probe starts the measurement process when the set threshold is exceeded. If the probe value drops below this threshold again, the measured value "**freezes**" and the ***No-Material-Delay*** time starts. This is used to eliminate interruptions in the material flow as a disturbance variable.

No-Material-Delay* (expiration time)** Standard setting: 10s *Range of adjustment: 1-100s* ***Unit: seconds	**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 probe. The last average value measured is then "**frozen**" and presented 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!
Boost Standard setting: 35nn *Range of adjustment: 0-100nn* ***Unit: None!***	**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%).
Offset Standard setting: 0.5% *Range of adjustment: 0-5%* ***Unit: % absolute***	**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 higher 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.
Weight Standard setting: 5 values *Range of adjustment: 0-50* ***Unit: Measured values*** *with SONO or TRIME probe scanning cycles of approx. 3 measured values per second, wherein each individual value is already pre-averaged.*	**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!
Invalid Measure Count Standard setting: 2 values *Range of adjustment: 0-10* ***Unit: Measured values*** *(with approx. 3 individual values per second)*	**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!

Moisture Std. Deviation Count Standard setting: 5 values *Range of adjustment: 0-20* ***Unit: Measured values*** *(with approx. 3 individual values per second)*	**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. Note: 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!
Quick and Quick-Precision *with Meas Time (no. values)* ***Unit: None!*** See also the "Setting the precision of a single value measurement" section of the "SONO-CONFIG software" chapter.	**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. 280ms, but instead increases by 60 milliseconds per step. Older SONO or TRIME probes do not support the Quick Precision function.

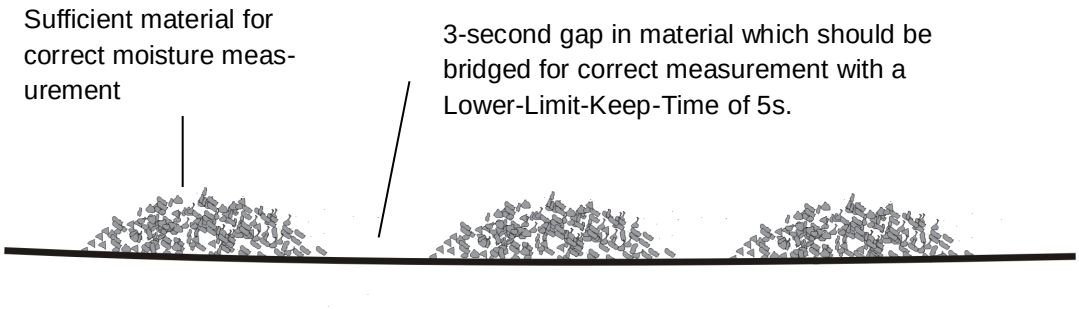
12.1.1. Averaging in the CA and CF measurement mode

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

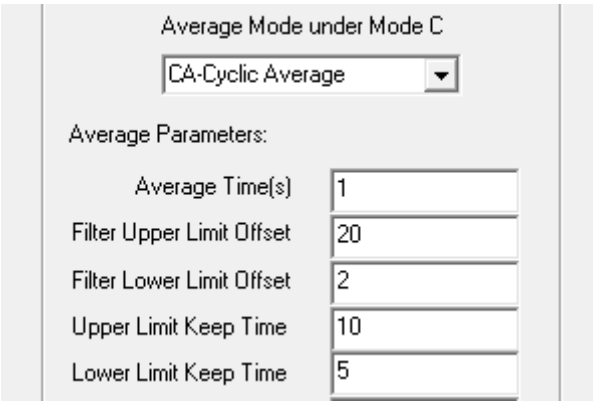
The ***Average-Time*** is set to 5 seconds in the default factory setting. This value has proven to be effective in many systems. A lower value can be set in applications that require a faster response time. A higher value should be selected if the display is too "unstable". Please note that the ***Average-Time***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

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

SONO or TRIME probes can filter out incorrect individual measured values using an advanced algorithm. The probe recognizes when there is little or no material around the probe head. Particular attention must be given to times when the probe'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 probe head. During such times, the probe reading would be too low. On the other hand, if metal vanes or scrapers strike the probe head, the measured value that the probe 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 seconds for example. If, during a gap in material flow, the SONO or TRIME probe now detects a moisture value that is 2% below the average value of, say, 8% (i.e.<6%), then the average value is "frozen" for 5 seconds, making it possible to bridge the gap in material. This powerful function in the SONO or TRIME probe acts as a kind of high-pass filter, where the higher moisture values are used to calculate an average value and smaller or incorrect measured values are filtered out. This function is illustrated with parameters below.



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.



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 seconds if the moisture value is 2% below the average. After these 5 seconds, the average value is deleted and a new averaging cycle starts. The filter function is reset if measured values are within the limit.

12.1.3. 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. Microwave moisture probes already established on the market have two disadvantages in this regard:

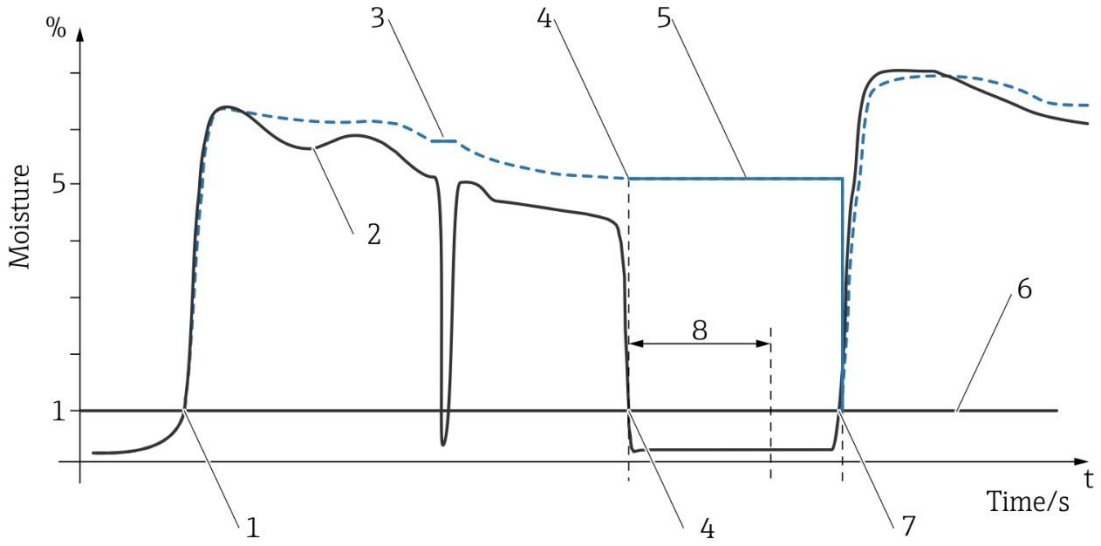
1. These microwave probes require an additional cable to transmit the switching signal from the controller to the probe in order to calculate the average value. This increases the wiring effort.
2. If a short-term gap in material occurs during a batch process, these zero measured values are also totalized and falsify the totalized measuring signal considerably, which then results in recipe errors.

In contrast to the microwave moisture probes available to date, SONO or TRIME probes in the CC mode automatically only totalize the times where material really is present around the probe. This increases the reliability of moisture calculation in a batch process.
Due to precise moisture measurement even in the lower moisture range, SONO or TRIME probes 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 SONO or TRIME probes recalibrate automatically, the zero point is maintained precisely in SONO or TRIME probes. 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, the user can specify a time as of which the SONO or TRIME probe is ready to start a new batch process. If short-term 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 around the probe - then the probe only briefly pauses the totalization. If the pause is longer than the "No-Material-Delay" then the probe is ready to start a new batch process.

How can the CC mode be used if material cannot be drained above the probe, i.e. if material is always present at the probe or for a longer time before material is transported:
In such cases, the probe cannot independently detect the start of material transportation.
The SONO or TRIME probe can be reset here by briefly interrupting the operating voltage of the SONO or TRIME probe (e.g. 0.5 seconds using a relay contact of the PLC). As soon as the operating voltage is reapplied, the probe starts totalizing and averaging immediately.

Please note: It is important to ensure that no material sticks or cakes to the probe as this would move up the moisture zero point between the batches and the probe 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 probe.

Time chart for the CC mode:



1 Start of the 1st batch process. The SONO probe detects that the adjustable start threshold of e.g. 1% has been exceeded and automatically starts the summation of measured values (blue curve).

2 Moisture curve in sand

3 Short-term interruptions are bridged

4 Analog output
End of the 1st batch process. The SONO probe detects that the threshold of 1% has been fallen below and automatically stops the summation of measured values (blue curve)

5 The last calculated average value remains at the analog output until a new batch process starts after the adjustable "No-Material-Delay" of e.g. 5 seconds.

6 Adjustable start threshold (Moisture Threshold)

7 Start of the 2nd batch process. The SONO probe detects after the "No-Material-Delay" of e.g. 5 seconds has elapsed that the threshold of 1% has been exceeded again.
The previously stored measured value is deleted and the SONO probe automatically starts again with the summation of measured values (blue curve).

8 Adjustable "No-Material-Delay" e.g. 5 seconds

12.1.4. CH operating mode

Automatic moisture measurement in one batch.

The **CH mode** is **the standard operating mode for probes installed under a silo discharge hatch** and is ideal for relatively short batch times as low as 5 seconds if the SONO or TRIME probe has been installed under the silo discharge hatch. In the CH mode, the probe filters automatically, allowing drip water formed 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.

12.2. Overview of the individual operating modes in different applications

The following table provides an overview of the possible parameter settings in the various operating modes.

Applications and parameters	**Sand/ gravel under the silo discharge hatch**	**On a conveyor belt**	**Inside a concrete mixer**	**In a fluid bed dryer**	**General simple applica-tions**	**In a screw conveyor with dis-turbance caused by spiral**	**In a screw conveyor without disturb-ance from spiral**
Operating mo-de	CH	CH	CH	CK	CA	CK	CF
Average-Time	2	2	5	5	10	10	10
Filter-Upper-Limit Offset	Inactive 100	Inactive 100	Inactive 100	Inactive 100	e.g. 20	Inactive 100	e.g. 20
Filter-Lower-Limit Offset	Inactive 100	Inactive 100	Inactive 100	Inactive 100	e.g. 10	Inactive 100	e.g. 5
Upper-Limit-Keep-Time	Inactive 10	Inactive 10	Inactive 10	Inactive 10	e.g. 10	Inactive 10	e.g. 10
Lower-Limit-Keep-Time	Inactive 10	Inactive 10	Inactive 10	Inactive 10	e.g. 10	Inactive 10	e.g. 10
Moisture Threshold	0.1	0.1	0.1	0.1	-	0.1	-
No-Material-Delay	10	10	10	10	-	Inactive	-
Boost	35	35	20	20	-	20	-
Offset	0.5	0.5	1	1	-	1	-
Weight	5	5	25	25	-	50	-
Invalid Mea-sure Count	2	2	Inactive	Inactive	-	Inactive	-

For very difficult applications where it is not yet clear which operating mode is best suited for the application, we recommend selecting the CA mode and setting an averaging time = 1 second. A data record can then be recorded under process conditions with the SONO-CONFIG software and saved. If this data record is forwarded to the manufacturer, he would be happy to assist in identifying the optimum operating mode with the optimum parameters.

Caution: If the TempComp parameter is changed, the basic calibration of the probe also changes, which is why a new basic calibration of the SONO probe or TRIME probe is then needed!

13. 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 **SONO-CONFIG** software. Two reference measuring points must be determined for this purpose, namely **point P1 for dry material** and **point P2 for moist material**, wherein there should be a sufficient distance between points P1 and P2 to obtain the best possible calibration curve.
The material moisture values at points P1 and P2 can be determined using a laboratory measurement procedure (drying cupboard etc.). However, it is important to ensure that sufficient material is measured so that a representative value is obtained.

In the "**Material Property Calibration**" window under the "**Calibration**" menu item, calibration curves Cal1 to Cal15 which are saved in the SONO or TRIME probe are retrieved from the probe and displayed on screen (takes 1 minute max.). Individual calibration curves can be selected with the cursor and activated using the "**Set Active Calib**" button. Using the **SONO-CONFIG** program, measurement of the sensor moisture value **MoistAve** with the associated radar transit time **tpAve** at point P1 and P2 is started in the "**Test**" submenu, "**Test in Mode CA**" function (see the "Quick Guide to the SONO-CONFIG software" chapter).

Step 1: The radar transit time **tpAve** of the probe is measured with dry material. Ideally, this is done while the mixer/dryer is in operation so that any fluctuations in the density of the material are factored in. It is recommended to take several **tpAve** measurements so that an optimum average for **tpAve** can be calculated from these values. The result is the first calibration point P1 (e.g. 70.0), i.e. a radar transit time **tpAve** of 70ps corresponds to 0% material moisture content. A higher point P1` would also be possible (e.g. 190.7). In this case, 190ps would then correspond to a moisture content of 7%. The gravimetric actual moisture value of the material - e.g. 7% - must be determined using a laboratory measurement method (drying oven).

Step 2: The radar transit time **tpAve** of the probe is measured with moist material. Ideally, this is also done while the mixer/dryer is in operation. Again, it is recommended to take several measurements and use these to calculate an average for **tpAve**. The result is the second calibration point P2 with X2/Y2 (e.g. 500.25), i.e. a radar transit time **tpAve** of 500ps corresponds to 25% material moisture content. The gravimetric actual moisture value of the material - e.g. 25% - must be determined using a laboratory measurement method (drying oven).

Step 3: The calibration coefficients m0 and m1 can be determined for the material under analysis with the two calibration points P1 and P2 (see the next page).

Step 4: The coefficients m1 = 0.0581 and m0 = -4.05 for the calibration curve (e.g. Cal15) are individually entered directly by hand using the **SONO-CONFIG** program and saved in the probe. The name of the calibration can also be entered manually. The selected calibration curve (e.g. Cal15), which is automatically activated once the probe power supply is switched on, is set with the "**Set Default Calib**" button.

Caution: When entering values using the SONO-CONFIG software, a period must be used as the separator for coefficients m0 to m5. Do not use a comma!

13.1.1. Calibration curves: calculation for a 2-point calibration

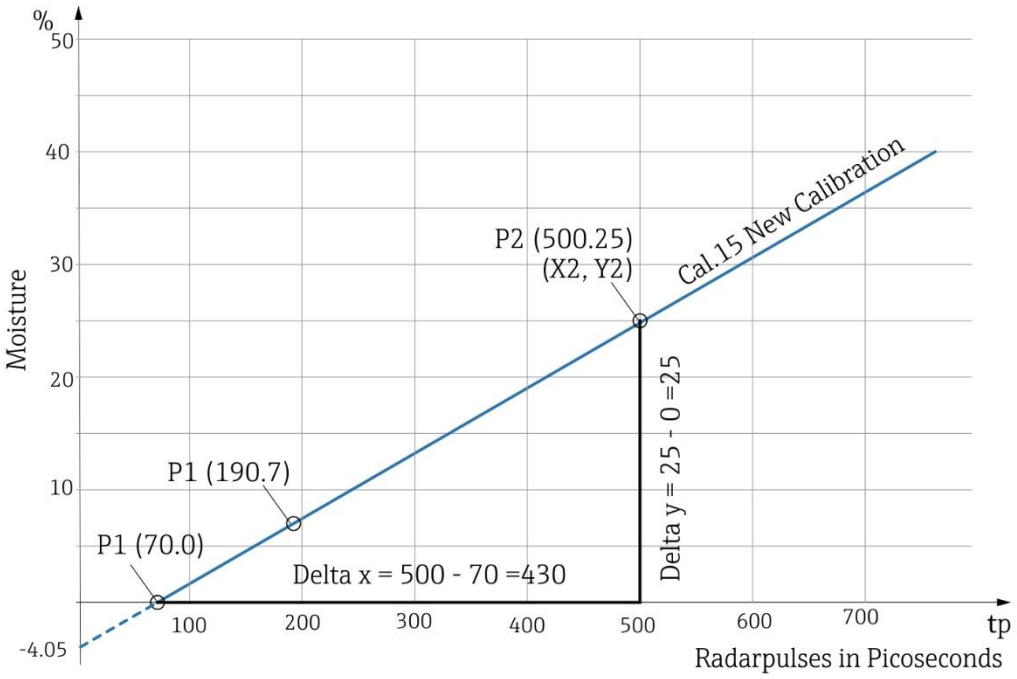
SONO or TRIME probes can work with linear and non-linear calibration curves with polynomials of up to degree 5. An Excel tool from the manufacturer can be used to calculate the coefficients for non-linear polynomials up to degree 5. It is also possible to use mathematical programs like MATLAB to calculate suitable non-linear calibration curves and the matching coefficient parameters m0 to m5, which can be entered into the probe using SONO-CONFIG.

The following chart shows a sample calculation for a linear calibration curve with coefficients m0 and m1 for a specific material.

Determining the two parameters m0 and m1 using the "SONO 2-Point LinearCalibration_Calculation" Excel sheet available fromthe manufacturer:

1. Download the **"SONO 2-Point LinearCalibration_Calculation"** Excel sheet from the "Support Software" section of the manufacturer website.
2. Enter the two TP values with the moisture reference values in the Excel sheet.
3. Read the two parameters m_0 and m_1 from the Excel sheet.
4. Using the "SONO-CONFIG" program, save the two coefficients or parameters m_0 and m_1 in the selected calibration curve with the "Set and Save" function in the "**Calibration**" menu item, "**Material Property Calibration**" window.

The chart below illustrates a classic calculation of parameters m_0 and m_1 "by hand":



The coefficient m_1 is calculated from the increase of the curve Cal.15:

$$\text{Coefficient } m_1 = \frac{\text{Delta y}}{\text{Delta x}} = \frac{25 - 0}{500 - 70} = 0.0581$$

The coefficient m_0 is the offset on the y-axis with x=0 and is calculated as follows:

$$\text{Coefficient } m_0 = Y2 - (m1 \times X2) = 25 - (0.0581 \times 500) = -4.05$$

14. Calibration curves Cal1 to Cal15

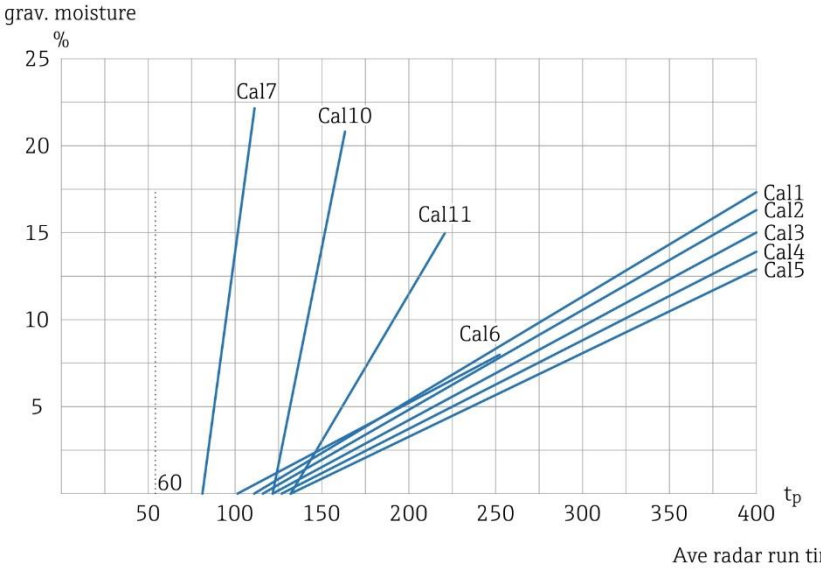
SONO or TRIME probes are supplied with a calibration that suits the application. A maximum of 15 different calibrations (Cal1 to Cal15) can be saved in the SONO or TRIME probe and can be activated via the **SONO-VIEW** display module or the **SONO-VIEW** module with the **SONO-CONFIG** service program.

To pre-test the compatibility of a calibration curve, using SONO-CONFIG the user can select individual calibration curves (Cal 1 to 15) in the "**Calibration**" menu item (using the mouse) and in the "**Material Property Calibration**" window, activate them with the "**Set Active Calib**" button and then test the curves with the material to be measured. The user can set the desired - and possibly modified - calibration curve by clicking the "**Set Default Calib**" button. This curve is activated for measurement once the probe power supply is switched on.

Non-linear calibrations are possible with polynomials up to degree 5 (coefficients m0-m5).

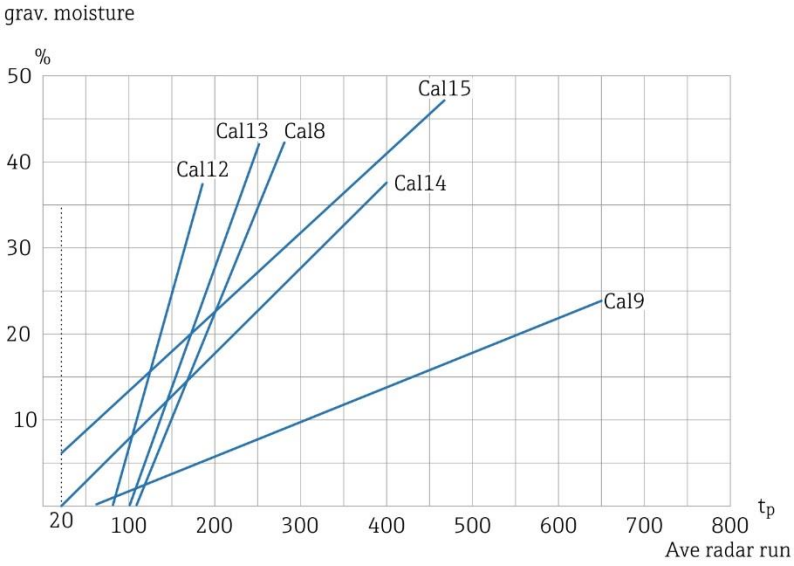
The graphics illustrated on the following pages (Cal.1 to 15) show the choice of linear calibration curves that are saved in the probe for different materials. The gravimetric moisture (**MoistAve**) is indicated on the y-axis, and the radar transit time **tpAve** in picoseconds is displayed on the x-axis, depending on the specific calibration curve. During moisture measurement, the radar transit time **tpAve** is displayed on the screen along with the moisture value (**MoistAve**) with the SONO-CONFIG software (see the SONO-VIEW manual and SONO-VIEW in the "Quick Guide to the SONO-CONFIG software" section). SONO or TRIME probes generally measure at a radar transit time of 60 picoseconds in air, and 1000 picoseconds in water.

SONO Calibration curves



Cal1 Universal Sand/Gravel/Grit
Cal2 Sand 1.6
Cal2 Sand 1.7
Cal2 Sand 1.8
Cal2 Sand 1.9
Cal7 Wood shavings
Cal10 Wheat grains
Cal11 Ligtht sand

SONO Calibration curves



Cal8 Brown coal
Cal9 SONO-MIX
Cal12 Sewage sludge
Cal13 GW-Linear
Cal14 Air/Water 0...100%
Cal15 1/10 tp Ave radar run time

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