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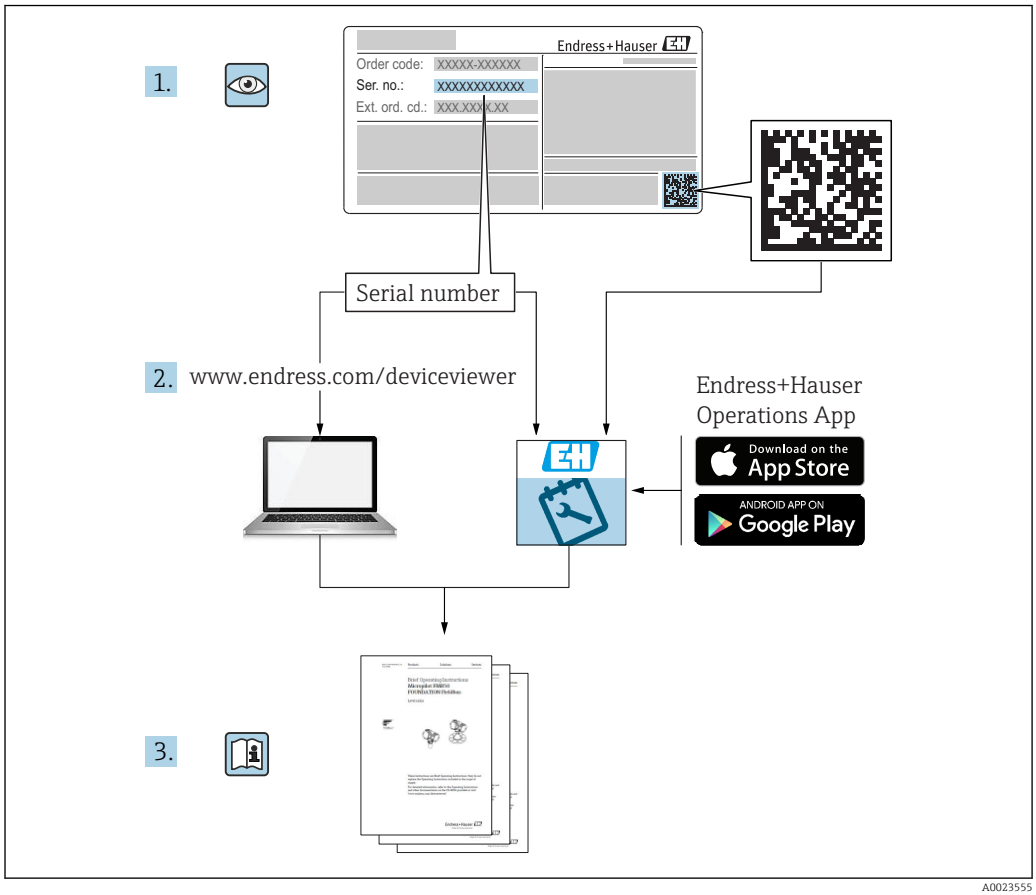
Operating Instructions
MMP20 SONO Mobil HD2 (option E)

Moisture measurement

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
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1 Introduction

MMP20 SONO-HD2 is a robust, battery-powered mobile display unit for a variety of probes: SONO-M1, SONO-M1C, SONO-M2.

The HD2 is a handheld device for displaying the measured values of TRIME moisture sensors, and has been specifically designed for mobile use in the field.

1.1 Area of application

- IP68 protection for robust use in the field
- Measuring range: 0% to 100% water content
- Depending on the hand probe used, material conductivity range: max. 12mS/cm
- Accuracy: up to +-0.1%

1.2 Your benefits

High-tech, mobile measurement of the moisture content of hard-to-measure materials at the speed of light directly onsite, with the following performance characteristics:

- Mobile moisture measurement of abrasive materials of average conductivity, such as sand, gravel, grit and other base materials.
- TDR moisture measurement technique for precise measured values with a representative measuring field and "slice-by-slice" radar scanning
- Up to 15 different material calibration curves are saved directly in the probe.
- The handy two-rod probe with solid rods can be easily inserted into sand, gravel, expanded clay and other aggregates.
- The two-rod probes can be connected to the PC for calibration and data logging via the SM-USB module.

2 General information

Please read these Operating Instructions carefully.

If you have any questions, please contact our Service Department at the address above. Do not, under any circumstances, open the device yourself, or make any attempt to repair the device. In the event of warranty claims, please contact your dealer.

In the interest of product improvement, we reserve the right to make technical and optical modifications to the device.

2.1 Designated use

This handheld device has been developed as a reader for a variety of IMKO probes. Only probes specially designed for this device may be connected to it. If a probe that is not designed for the device is connected to it, this may damage the device and/or the connected probe.

2.2 Rechargeable battery

Never replace the in-built rechargeable battery yourself.

The maximum operating times indicated apply under ideal conditions. The ambient temperature and recharging cycle can significantly reduce the performance times. In addition, the recharging capacity drops over time for technical reasons or if the unit is stored at very high or low temperatures.

2.3 Charging the HD2 handheld device

Only use the charger supplied or a comparable voltage source to charge the HD2 handheld device. A different charging voltage can damage the device.

If the device heats up while it is charging, this is normal behavior and is not dangerous.

If the HD2 only works briefly or not at all despite being charged repeatedly, the integrated battery is defective and must be replaced. Should this occur, please contact your dealer or IMKO directly.

2.4 Temperatures and ambient conditions

The HD2 handheld device has been developed for use in heavy-duty environments.

The operation of this device outside the conditions indicated can damage the device.

3 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

3.1 Standard documentation

BA01948M

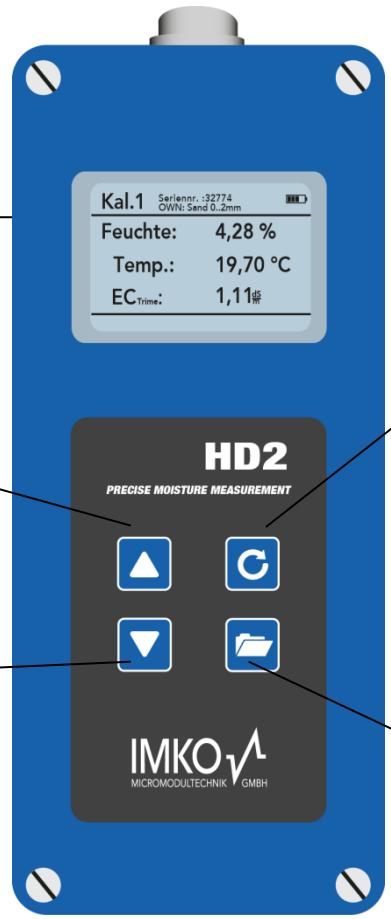
Operating Instructions for MMP20 SONO-HD2 mobile, battery-powered display unit

3.2 Supplementary documentation

SD02332M
SM-USB
Connection and configuration of SONO and TRIME probes on a PC with Windows via the SM-USB module

SD02333M
SONO-VIEW
Stand-alone display and configuration unit for reliable process control with SONO or TRIME moisture sensors

4 Operating elements



Connection for probe or charger

Display

"Up"

- Select item or setting
- Quick dial "Calibration selection"

"Down"

- Select menu item or setting
- Clear the value memory
  ➔ (only "Average" operating mode)

"Measure"

- Switch on/off
- Take a measurement
- Select a menu item
- Save and activate a setting

"Settings"

- Exit "Settings"
- Call menu
- Go back from the menu items

5 Commissioning

5.1 Safety instructions

Caution: Before you commission the device, make sure to read the general information under Point 1 at the start of these Operating Instructions. Improper use can damage this device.

5.2 Checking the packaging contents

- HD2 handheld device
- Power adapter (12 V/2 A)
- Charging adapter
- Protection cap
- Manual

5.3 Charging the battery

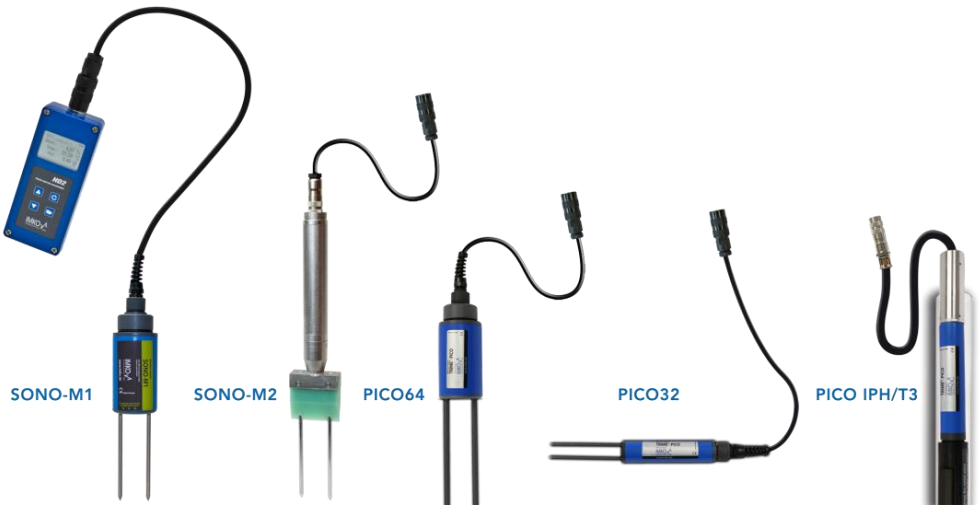
The installed battery should be charged before the device is used for the first time. To do so, insert the charging adapter provided into the 7-pin socket on the HD2. Then connect the power adapter to the charging adapter. Charging commences immediately if the HD2 handheld device is already switched on or the battery is over-discharged. Otherwise, switch on the HD2 by pressing and holding the "Measure" key  for approximately 1 second. An animated battery symbol on the display indicates that charging is active.

The built-in charging electronics charge the battery until it is fully charged. Charging takes around 2 hours if the battery was fully discharged. As soon as the battery is finished charging, all 4 "battery bars" appear permanently on the display screen and trickle charging commences.

Caution: **Only charge the battery at room temperatures (approx. 10°C to approx. 30°C)! If the temperature is too low, end-of-charge cutoff might not work correctly and the battery may be overcharged. If ambient temperatures are too high, the HD2 can be damaged by the heat generated during charging.**

5.4 Connecting the probe

The HD2 handheld device can be operated with the following IMKO moisture probes:



Connect the moisture probe to the HD2 by inserting the 7-pin plug into the socket provided on the HD2 and tighten the union nut.

6 Operation

Key function:

Key	Description
	**Measure** • Switch on/off → press and hold for 1s • Take a measurement → press briefly • Select a menu item → press briefly • Save a setting → press briefly
	**Settings** • Exit "Settings" • Switch to the menu • Go back from the menu items
	**Up** • Previous menu item or setting • For selection – material calibration (Single Value/ Average mode) • Access to density setting (Water Calculation mode)
	**Down** • Next menu item or setting • Clear the value memory (Average mode)

Symbols on the display:

Symbol	Description
	Remaining battery
	Measurement active
	Setting saved
	Brightness of background lighting
	Time until switchoff (lighting / APO)
	Press the "Up" key
	Press the "Down" key

Meaning of displayed text:

Text	Meaning
Cal.:	Number of the active calibration in the probe
Moisture:	Moisture measured value Note: the measured value can be %vol, %grav, ε or tp, depending on the calibration configured.
Temp.:	Temperature
EC-Trime	Electrical Conductivity - electrical conductivity based on TDR measurement
Serial No.:	Serial number of the probe or HD2
HW:	Hardware version
FW:	Firmware version

6.1 Switching on the HD2 handheld device

Press and hold the "Measure" key for about 1 second to switch on the HD2.

The HD2 attempts to communicate with the connected probe during the power-up process. This takes around 4 seconds. If no probe is connected or if the probe cannot be found for some other reason, an error message appears on the screen.

If the HD2 managed to successfully find the probe, the measurement background appears on the screen depending on the specific operating mode and the HD2 is ready for operation.

Note: If it is not possible to connect to the probe even after several attempts, check whether the probe is connected correctly. If this does not rectify the problem, please contact our Service Department.

6.2 Switching off the HD2 handheld device

To switch off the HD2 handheld device, press and hold the "Measure" key for approximately 1 second.

Note: It is not possible to switch off the HD2 when it is in "Settings". Please exit "Settings" first of all by pressing the "Settings" key until the measurement screen appears.

6.3 Measurement

The HD2 handheld device has three operating modes:

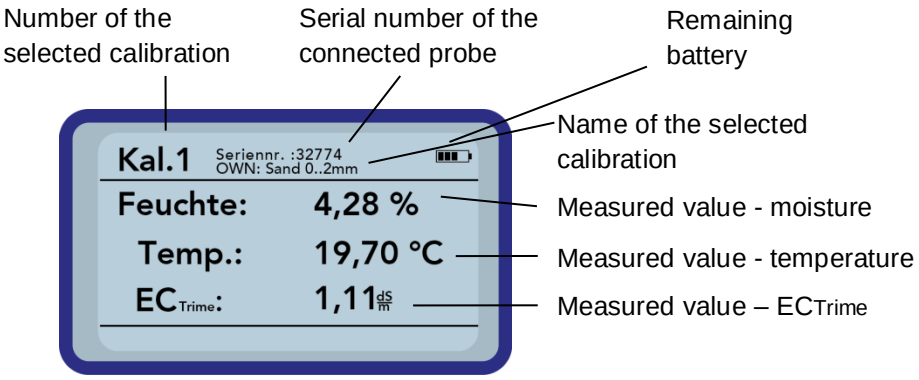
1. Single value → single value display - displays the measured variables "moisture", "temperature" and "EC-Trime"
2. Average → displays the average moisture value calculated from up to 6 individual measurements
3. Water calculation → calculates the water content in l/m^3

Note: No additional actions are possible during a measurement. The user must wait until the measurement is finished.

6.3.1 "Single values" operating mode

The "Single values" operating mode is the ideal mode for determining all the soil parameters that can be measured with a TRIME probe. The unit displays the moisture as a "%", the soil temperature in "°C" or "°F" and the measured conductivity EC_{TRIME} in "dS/m".

Once the HD2 handheld device is switched on, the following screen is displayed after the initial start-up screen:

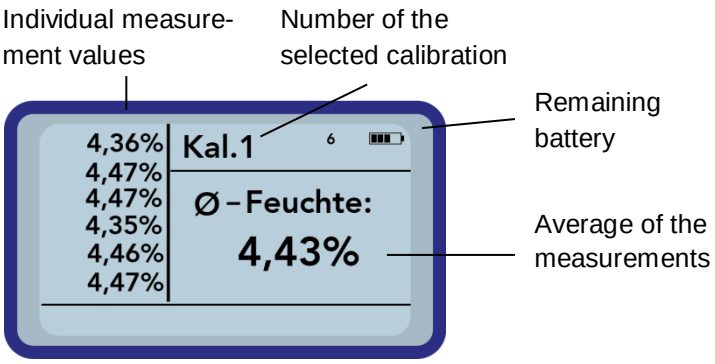


To start measuring, press the "Measure" key briefly. The device starts measuring and a rotating symbol appears in place of the battery in the top right-hand corner for the duration of the measurement process. No other actions can be performed during this time. The measurement takes around 4-5 seconds. Once the measurement is finished, the battery symbol appears on the display again along with the measured values. The values continue to be displayed on the screen until a new measurement is carried out.

6.3.2 "Average" operating mode

In this mode, only the moisture is determined and an arithmetic average is calculated from up to six individual values. The volumetric or the gravimetric moisture is displayed depending on the set calibration. This operating mode is suitable for measuring the moisture values of large volumes of material (e.g. sand, gravel etc.).

Once the HD2 handheld device is switched on, the following screen is displayed in the "Average" operating mode after the initial start-up screen:

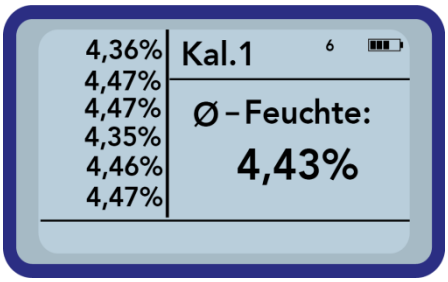


To start measuring, press the "Measure" key briefly. The device starts measuring and a rotating symbol appears in place of the battery in the top right-hand corner for the duration of the measurement process. No other actions can be performed during this time. The measurement takes around 4-5 seconds. Once the measurement is finished, the battery symbol appears on the display again. The individual measurements are displayed on the left of the screen. The last measured value appears at the top of the list, and older values are displayed one position down. The arithmetic average is displayed on the right of the screen. The average value is calculated from the existing individual values (maximum of six).

Note: Only a maximum of 6 values can be saved in the list. Older values are removed from the list and are no longer used to calculate the average.

To delete the series of measurements, press the "Down" key.

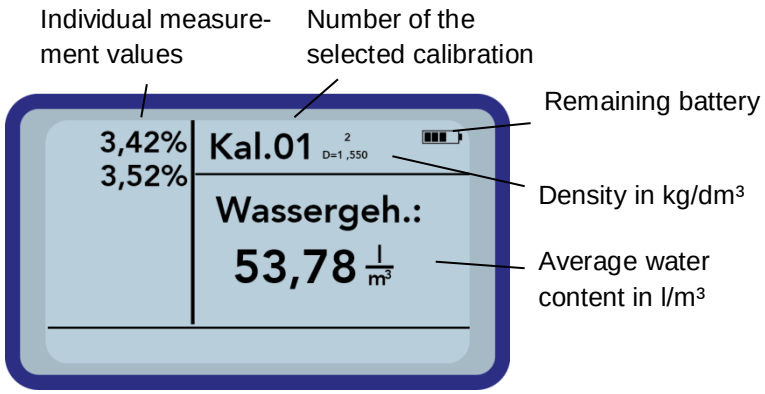
TIP:



With only six measurements in the "mean value" operating mode, you already receive a representative measurement result from all measuring points over a large quantity of material.

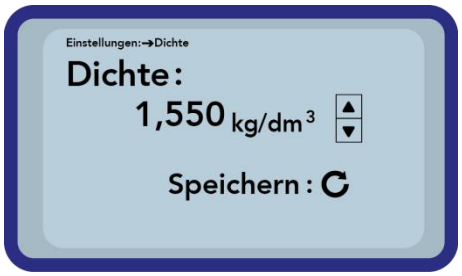
6.3.3 "Water calculation" operating mode

Only the moisture is measured in this mode. A mean value is calculated from up to six individual values. The water quantity per m³ is calculated from this mean. The density of the material being measured must be set to ensure the value is calculated correctly.



To delete the measurement series, press the "Down" key .

To set the density, press the "Up" key in the measurement window. The following screen then appears:

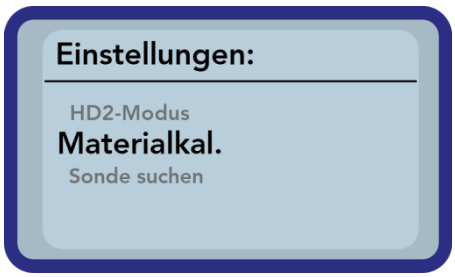


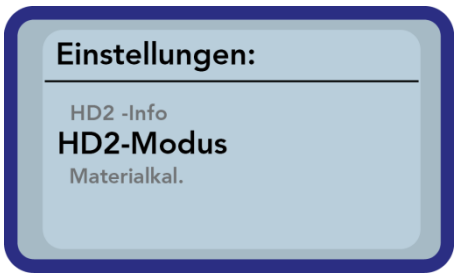
Set the density of your material with the "Up" and "Down" keys and press the "Measure" key to confirm your entries.

You return automatically to the measurement window. You can exit the density setting with the "Settings" key without changing the old density value.

6.4 Settings

The settings for the HD2 handheld device can be changed and adjusted in a variety of ways. Pressing the "Settings" key takes you to the following menu structure:





Press the "Up" and "Down" keys to highlight the desired entry and press the "Measure" key to select it. Press the "Settings" key to exit the current menu item and the "Settings" menu.

Overview of the configuration options

Setting	Description
HD2 mode	Change the operating mode • "Normal" → measure the parameters "moisture", "temperature" and EC-Trime • "Average" → get an average of up to 6 moisture measured values • "Water calculation" → calculates the water content in l/m³
Material cal.	• Select the desired material calibration in the probe • Customize a material calibration
Find probe	Search again for a connected probe (if an error occurred during power-up)
Language	Change the system language • German • English
Auto-power-off	Setting for automatic switch-off
Display lighting	Setting for background lighting • Switch-off time • Brightness
Display contrast	Setting for the optimum contrast
Probe info	Display information about the probe
HD2 info	Display information about the HD2 handheld device

6.4.1 HD2 mode

The operating mode of the HD2 handheld device can be changed in this menu item.

With the "Single value" option, the user selects an individual measurement of the three probe parameters: moisture, temperature and EC-Trime.

Depending on the selected calibration, the "moisture" parameter displays the moisture as a volumetric or gravimetric percent or can output the transit time of the TDR pulse. If the transit time is displayed, the percentage sign is understood as "Raw value tp".

If the "Average" option is selected, only the moisture is determined - in %vol or %grav depending on the calibration selected - or the transit time in tp. The measured value is saved in a list of up to six measured values. The arithmetic average is calculated from this list.

Note: Only a maximum of 6 values can be saved in the list. Older values are removed from the list and are no longer used to calculate the average.

The "Water calculation" setting activates a mode that indicates the water quantity in the material being measured in l/m³. To be able to measure larger volumes of material, a material sample can be taken at several points and an average calculated.

Press the "Up" and "Down" keys to highlight the desired entry and press the "Measure" key to select it. Once the entry has been selected, the symbol appears in the top right-hand corner of the display indicating that the option has been activated and saved.

6.4.2 Material calibration

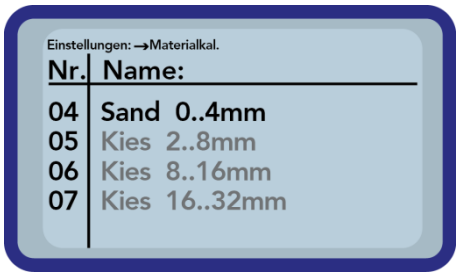
Different calibrations are saved in the probe depending on the intended application of the probe. This can be volumetric calibrations for soils of different densities, gravimetric calibrations for sand moisture measurements or also transit time calibrations.

You can select the calibration needed for your application in the "Material calibration" menu item. This makes it possible to use the same probe for different applications. In addition, you also have the option of programming and performing your own calibrations here in order to be able to measure special materials.

Once you have selected the "Material cal." menu item, choose either "SELECT" to set one of the 15 calibrations or "CUSTOMIZE" to program a new calibration to one of the 15 calibrations saved in the memory.

Menu item: "SELECT":

The 15 calibrations, and the names of the calibrations, appear on the display. This may take a moment. Then a screen similar to that shown below appears:

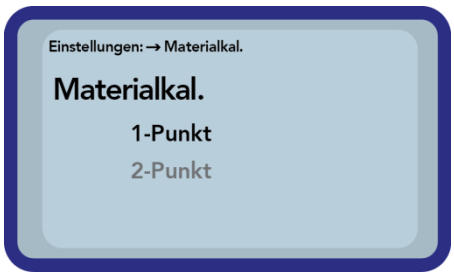


Press the "Up" and "Down" keys to scroll through the list and select the desired calibrations. The "!" symbol in front of a calibration indicates the currently active calibration. Press the "Measure" key to set the selected calibration as the active calibration. After a brief moment, the symbol appears in the top right-hand corner of the display, indicating that the option has been activated. In addition, the "!" symbol appears in front of the active calibration.

TIP: You can also access this menu item directly from the measurement window by pressing the "Up" key.

Menu item: "CUSTOMIZE":

Here, you have the option of performing your own material calibrations or of customizing existing calibrations to suit your particular needs. Two options are available for this:



1-point calibration:

- Adjusts the calibration curve to the selected point.
- The slope is not changed.
- Just one material sample is required.

2-point calibration:

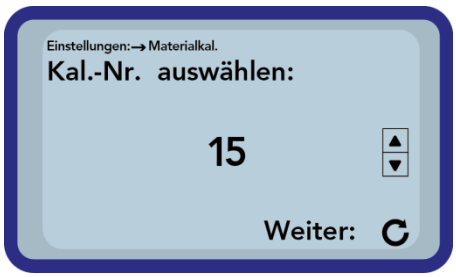
- Creation of a linear calibration between two measured points
- Two material samples with different moisture values are required

1-point calibration:

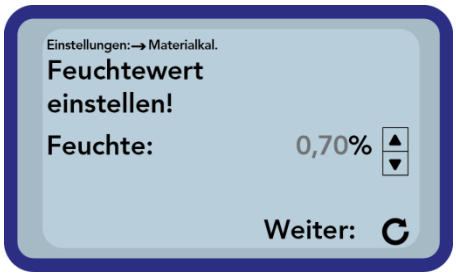
This material calibration option merely adjusts (offsets) the configured calibration. As the slope is not changed, it is important at the start to select a calibration curve that suits the material.

NOTE: You require a sample of the material being measured to perform a 1-point material calibration. The moisture value must be determined with another method (weighing and drying, or similar) before the calibration.

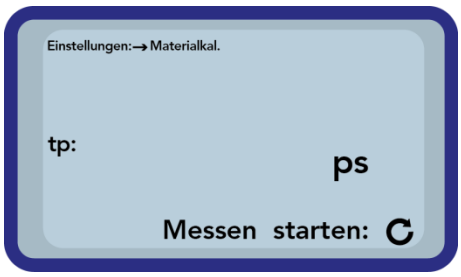
Procedure:



At the start of the calibration, the calibration memory (01 – 15) to be overwritten must be selected with the "Up" ▲ and "Down" ▼ keys. Press the "Measure" key C to accept the setting.



Then set the percentage moisture using the "Up" ▲ and "Down" ▼ keys, and again press the "Measure" key C to confirm your entries.



To start measuring the material, press the "Measure" key again. Four measurements are taken to increase the accuracy. An average of these measurement values is then calculated. The measuring time is approximately 20 seconds. When the measurement is finished, the measured pulse transit time is displayed briefly.

NOTE: Before you start measuring, make sure that the rods of the probe are fully immersed in the material to be measured. The probe must remain in the material for the entire duration of the measurement and should not be moved.

CAUTION: If you select "SAVE" at the end of the calibration, you overwrite one of the pre-configured calibrations (or one you may have already modified) in the probe! The original calibrations can only be restored with a PC and the Pico-Config software, as well as an RS485 adapter (e.g. SM-USB).

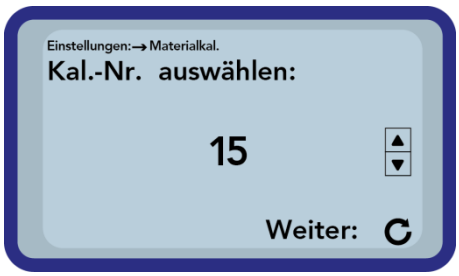
After this, the calibration can be saved to the calibration memory set at the start ("Save"). The selected memory is only overwritten once the "Measure" key is pressed. The word "OWN:" now appears in front of the original memory name to clearly indicate which memory has been overwritten.

2-point calibration:

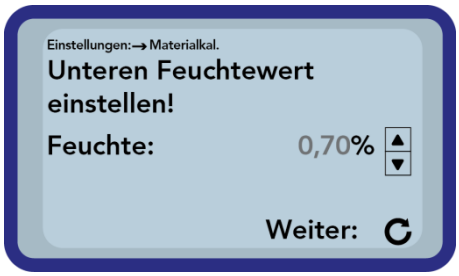
In a 2-point calibration, two material samples of different moisture content are measured and a linear equation (f(x)=mx+b) is then calculated from this information. While a higher-value polynomial is useful to achieve better accuracy, the linear equation often suffices, particularly in the lower moisture range, and delivers 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 (weighing and drying, 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).

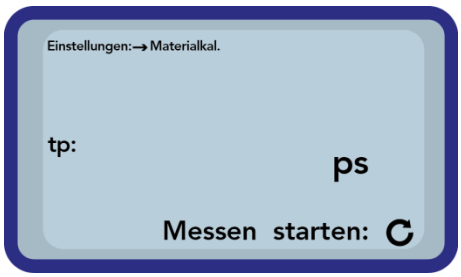
Procedure:



At the start of the calibration, the calibration memory (01 – 15) to be overwritten must be selected with the "Up" ▲ and "Down" ▼ keys. Press the "Measure" key ↻ to accept the setting.

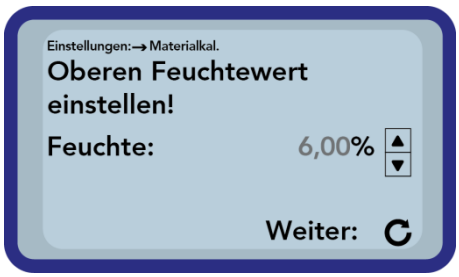


Then set the percentage moisture of the lower moisture value using the "Up" ▲ and "Down" ▼ keys, and again press the "Measure" key ↻ to confirm your entries.

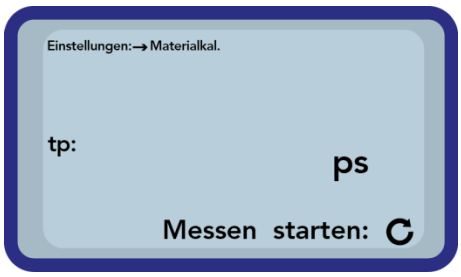


To start measuring the material, press the "Measure" key ↻ again. Four measurements are taken to increase the accuracy. An average of these measurement values is then calculated. The measuring time is approximately 20 seconds. When the measurement is finished, the measured pulse transit time is displayed briefly.

NOTE: Before you start measuring, make sure that the rods of the probes are fully immersed in the material to be measured. The probe must remain in the material for the entire duration of the measurement and should not be moved.



Then set the percentage moisture of the upper moisture value using the "Up" ▲ and "Down" ▼ keys, and again press the "Measure" key ↻ to confirm your entries.



To start measuring the material, press the "Measure" key again. Four measurements are taken to increase the accuracy. An average of these measurement values is then calculated. The measuring time is approximately 20 seconds. When the measurement is finished, the measured pulse transit time is displayed briefly.

NOTE: Before you start measuring, make sure that the rods of the probe are fully immersed in the material to be measured. The probe must remain in the material for the entire duration of the measurement and should not be moved.

CAUTION: If you select "SAVE" at the end of the calibration, you overwrite one of the pre-configured calibrations (or one you may have already modified) in the probe! The original calibrations can only be restored with a PC and the Pico-Config software, as well as an RS485 adapter (e.g. SM-USB).

After this, the calibration can be saved to the calibration memory set at the start ("Save"). The selected memory is only overwritten once the "Measure" key is pressed. The word "OWN:" now appears in front of the original memory name to clearly indicate which memory has been overwritten.

Tip: Back-up the calibrations you have saved on the probe to your PC using the "Pico-Config" software and an RS485 adapter (e.g. SM-USB). This allows you to transfer calibrations that you created to other probes.

6.4.3 Find probe

This menu item can be selected if there were problems communicating with the probe when the HD2 handheld device was switched on, or if a probe had not yet been connected when the device was switched on, or if the probe is to be changed during operation. Once this item has been selected, the HD2 makes another attempt to establish a connection to the connected probe. The serial number of the probe appears on the display as soon as the connection has been established successfully.

"Probe not found" appears on the display if a connection cannot be established.

NOTE: If it is not possible to connect to the probe even after several attempts, check whether the probe is connected correctly. If this does not rectify the problem, please contact our Service Department.

6.4.4 Language

The language of the HD2 handheld device can be changed in this menu item. Users can currently choose between German and English. Press the "Up" and "Down" keys to select the desired language and press the "Measure" key to activate it. Once the language has been activated, the symbol appears in the top right-hand corner of the display.

6.4.5 Auto-power-off

In the "Auto-power-off" menu item, you can select automatic device switch-off after different time intervals.

You can choose from the following times:

- -- minutes (switch-off function disabled)
- 1 minute
- 2 minutes
- 5 minutes
- 10 minutes
- 20 minutes

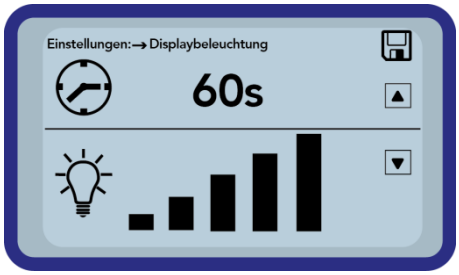
Press the "Up" and "Down" keys to select the desired switch-off time and press the "Measure" key to activate it. Once the setting has been activated, the symbol appears in the top right-hand corner of the display.

Note: The HD2 only switches off automatically if a key has not been pressed within the set time interval. Pressing a key restarts the countdown to switch-off.

6.4.6 Display lighting

The background lighting of the display can be customized if necessary. This allows the user to save energy and achieve a longer service life.

The following screen is displayed once the entry has been selected in the menu:

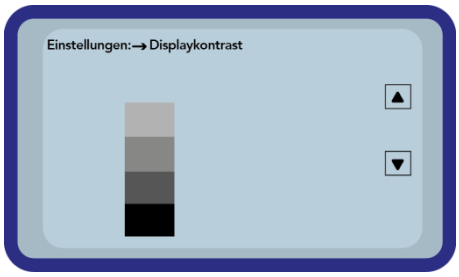


Press the "Up" key repeatedly to select the automatic switch-off function for background lighting or the time to switch-off.

Use the "Down" key to set the brightness of the display light or to switch the lighting off entirely. Press the "Measure" key to activate your settings. The symbol appears in the top right-hand corner of the display following activation.

6.4.7 Display contrast

At extreme temperatures, it may be necessary to change the contrast setting to improve screen readability.



After selecting the "Display contrast" menu item, change the contrast setting for the display with the "Up" or "Down" key. Set the contrast so that you can clearly see all the gray gradations in the bar chart. Press the "Measure" key to activate and save your settings. Once the setting has been activated, the symbol appears in the top right-hand corner of the display.

6.4.8 Probe info

Information about the probe is displayed shortly after selecting this menu item.

This information includes:

- Serial number
- Probe type
- Hardware revision (HW)
- Firmware revision (FW)

6.4.9 HD2 info

Information about your HD2 handheld device is displayed if this menu item is selected.

This information includes:

- Serial number
- Hardware revision (HW)
- Firmware revision (FW)
- Battery capacity
- Battery voltage

7 Technical data of HD2

Height			36mm
Width			64mm
Length			150mm
Weight			(with battery) approx. 437g
Power consumption	Power down		Approx. 35µA
	Idle	- background lighting off - background lighting on	Approx. 26mA Approx. 56mA
	Probe switched on		Approx. 100mA
	Measurement		Approx. 350 mA
Measurements per charge	20°C / background lighting max.		Up to approx. 5000
Connectable sensors			SONO-M1, SONO-M2, PICO64, PICO32, PICO-IPH
Storage temperature			-30°C to 80°C
Operating temperature			-20°C to 70°C
Charging temperature			10°C to 30°C
Charging voltage			Nom. 12V, max. 15V, min. 12V
Charging current			Approx. 1A
Charging time			Approx. 2h if battery fully discharged
Accumulator battery			Ni-MH (4 x 1.2V) (AA), 2000mAh, >1500 measurements
Physical BUS			RS485
Bus protocol			IMP-BUS protocol II
IMP-Bus port settings			8 data bits, 2 stop bits, odd parity

8 Using SONO-M1 probes

8.1 Introduction

Time-domain reflectometry (TDR) is a widely used technique to determine material moisture. In the past, efforts to measure the moisture content were complex and laborious, and the results obtained were not precise. Since the development of TRIME-TDR technology, there is almost no reason for businesses to rely on inaccurate and complicated technology to measure moisture.

8.2 Measuring volume of SONO-M1 probes

In theory, the electric and magnetic field lines penetrate the material to be measured to an infinite depth. However, the SONO-M1 probes' effective penetration depth, which is relevant for measurement, is approximately twice the distance between the rods. The effective measuring volume captured with this probe is illustrated in the graphic below (green waves).

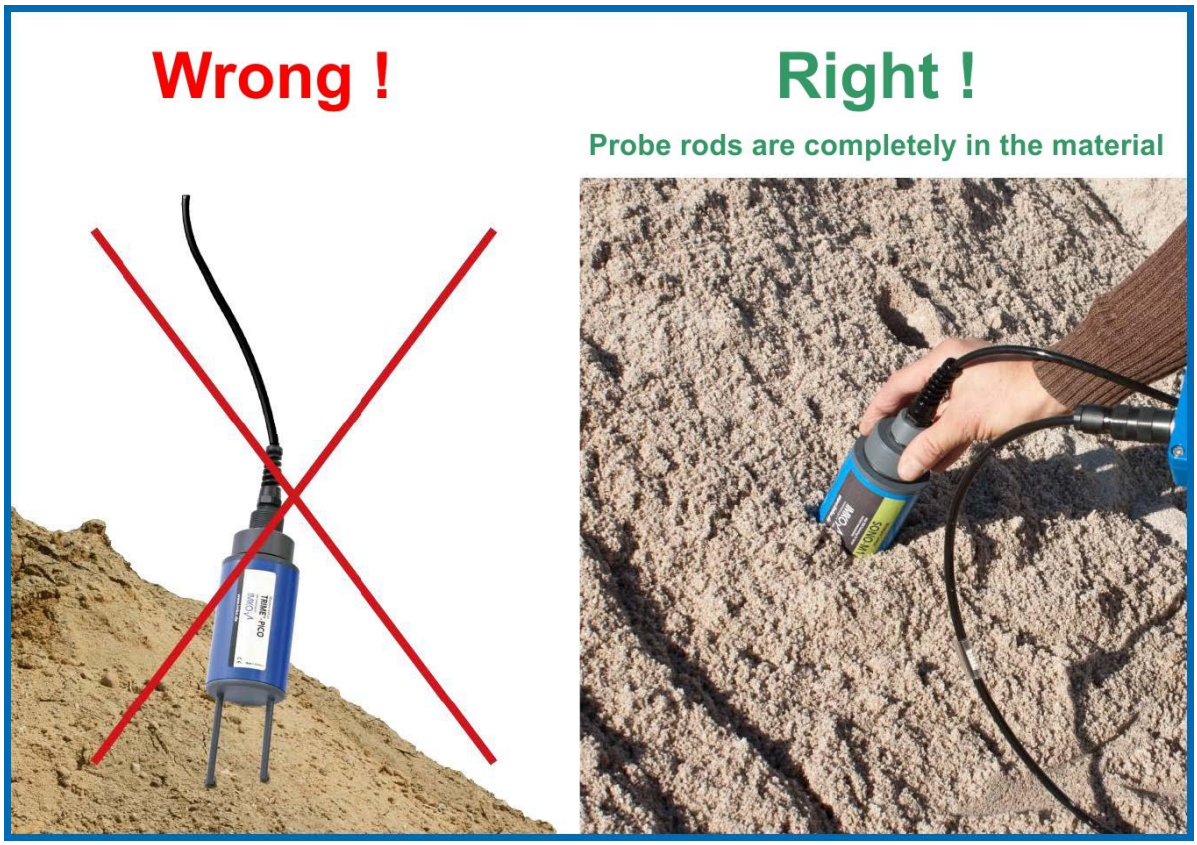
9 Best possible accuracy with HD2

Recommended approach to achieve the best possible accuracy with HD2

9.1 Measurements directly in piles of sand and gravel

When taking measurements in piles of sand, it is important to ensure that the probe is immersed in the material up to the blue probe body. To get a representative moisture value for your material, select the "Average" operating mode and take the measurements at different points in the pile.

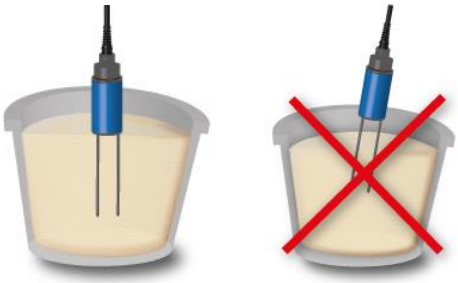
Please note that your material will be drier at the surface than in lower layers after a longer period of dry weather. However, if it has recently rained after a longer dry spell, the material at the surface will be wetter. For the best measurement result, measure the moisture at different points and at different depths.



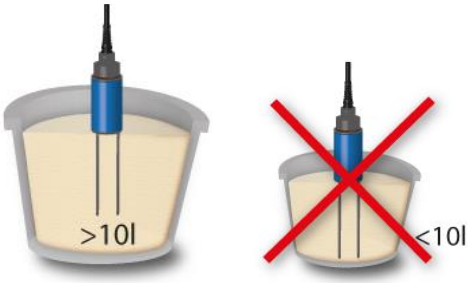
9.2 Measurement of laboratory samples in a bucket

The following conditions must be met to achieve the best possible accuracy with the measuring system:

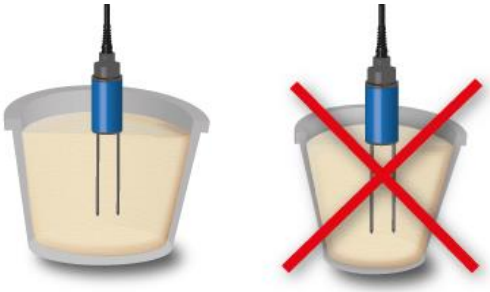
- The **entire length** of the rod probes must be immersed in the material to be measured



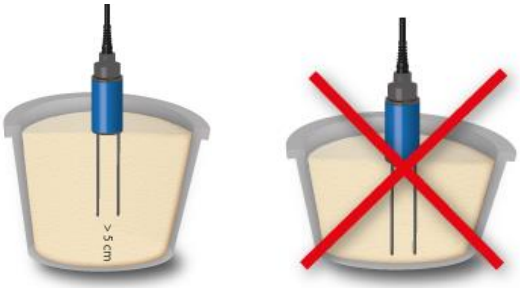
- The container must have a volume of **10 liters** or more and must be of a **non-metal** material



- The container must be roughly **cylindrical**



- The **level** of product in the container must be at least **5 centimeters greater** than the probe rod length



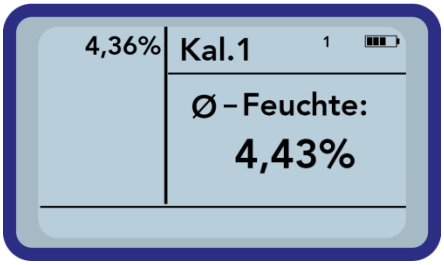
The best quality measurement results are guaranteed if readings are taken according to the procedure explained below

1. Fill the container with sand

2. Lift the container approximately 5cm and then drop it onto the ground to pack (compress) the sand. Do this five times. **(If it looks like the sand can be packed further after dropping the container for the fifth time, repeat the procedure another few times)**

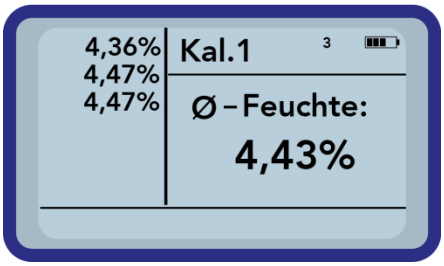
3. Insert the probe into the sand. Once the base of the probe reaches the sand surface push the probe in slightly further **(do not jiggle the probe or turn it while inserting it!)**
    a. **In the case of gravel and grit, shake the container while introducing the probe. Otherwise it is very difficult to introduce the probe into the material. Shaking the container places the material optimally around the probe rods.**

4. Take the measurement with the HD2 handheld device



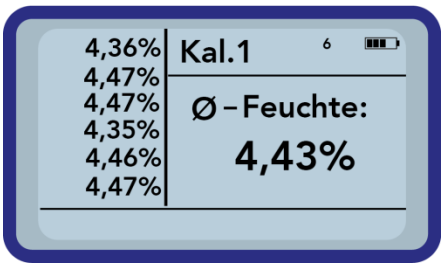
5. Remove the probe from the sand and shake the sand to loosen it again

6. Repeat steps 2 to 4 two more times so that you have 3 measured values in total



7. Pour the sand into a second bucket so you can take readings from the sand at the bottom **(this is particularly relevant for gravel and if the sand is close to saturation as any water can settle in the bottom of the container!)**

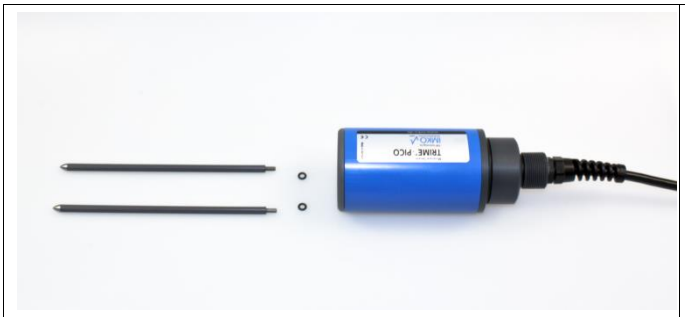
8. Repeat steps 2 to 4 three more times so that you have 6 measured values in the end



9. Document the average of the 6 measurements

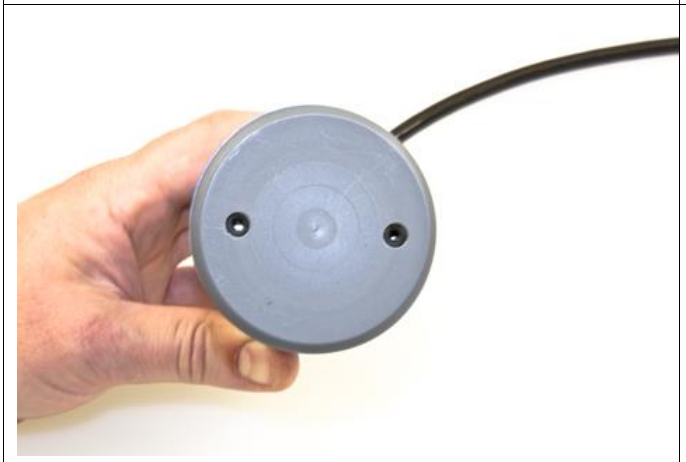
10 Replacing the probe rods

If the probe rods break, they can be easily replaced.



1) Lay out the probe rods, seal and probe body

2) Push the sealing rings into the boreholes



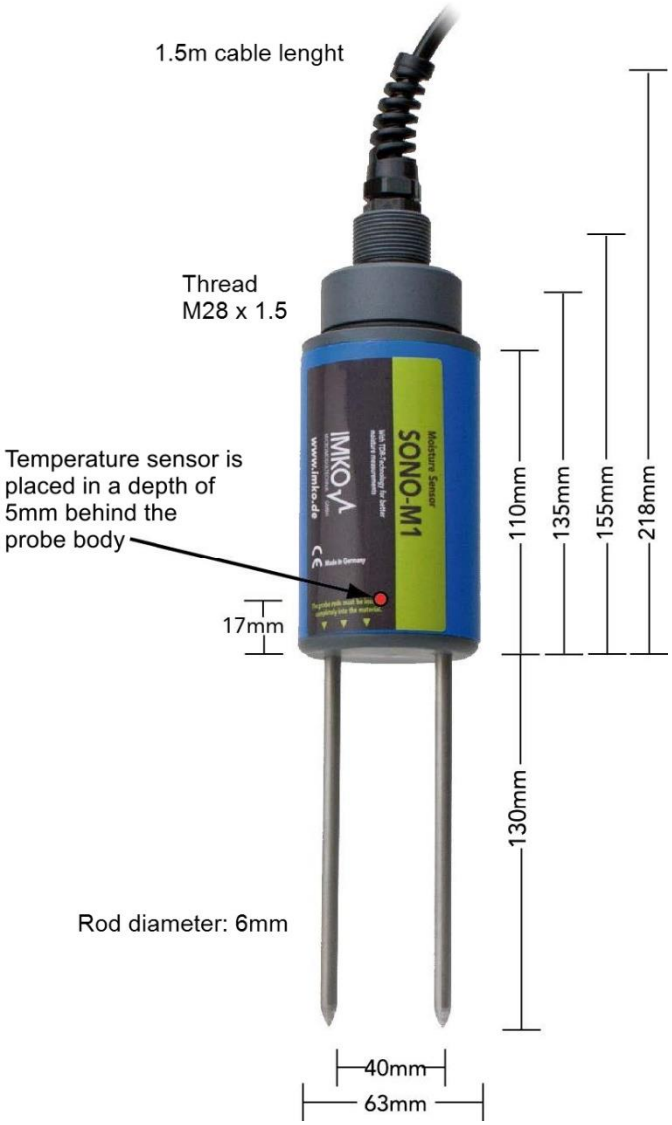
3) Push the seal in as far as the thread

4) Screw the rods into the probe body

11 Technical data for the SONO-M1 probe

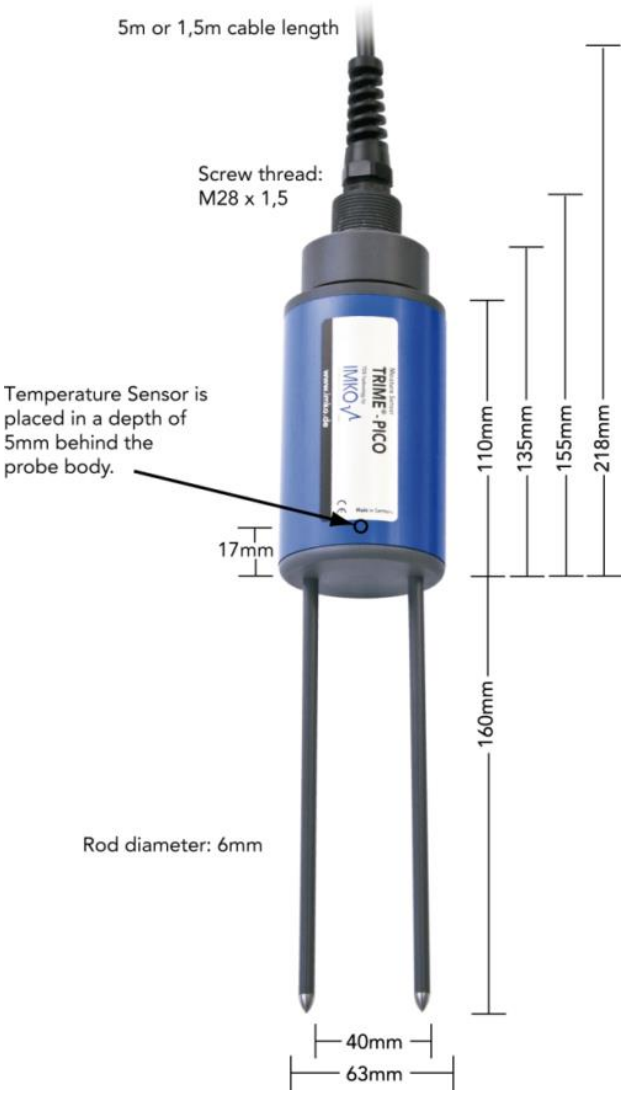
For moisture measurement in sand and gravel

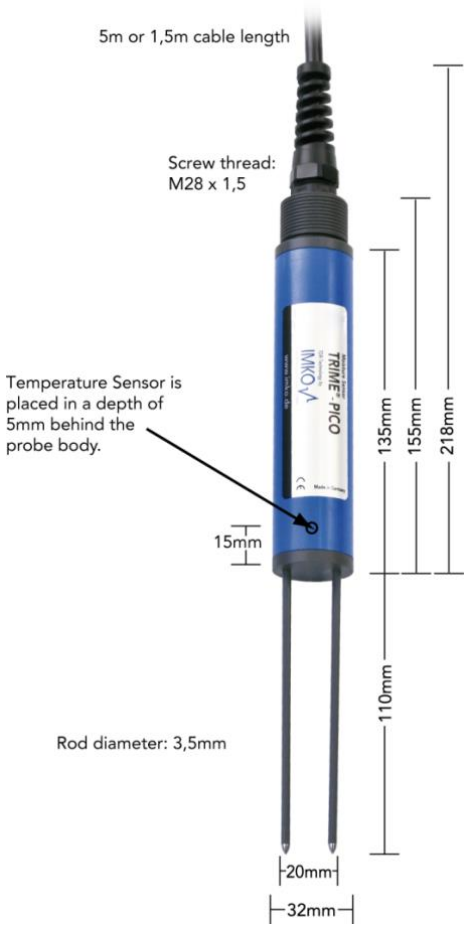
- High-tech sensor with integrated TDR electronics
- Measured value range from 0 to 40 vol.%
- Integrated temperature sensor
- Can be used for total conductivity values of up to max. 5dS/m (bulk-soil conductivity).
- Measuring volume ≙ 1000ml
- Robust (IP68), time-tested and suitable for long-term use



Power supply:	7V to 24V-DC
Current consumption:	100mA @ 12V/DC during 2-3 sec. measuring cycle time
Measuring range:	0 to 40% vol. water content
Accuracy (in % vol. water content):	±0.2%
Conductivity range:	0 to 5dS/m
Repeatability:	±0.3%
Temperature drift:	±0.3%
Material temperature measuring range:	-15°C to 50°C
Material temperature accuracy:	±0.5°C (when fully and permanently in material)
Measuring volume:	1.0L ≅ 130x100mm diameter
Probe temperature range:	-15°C to 50°C
Calibration:	Pre-programmed calibrations for sand, gravel and grit
	Own calibrations possible, Memory capacity for up to 15 calibration curves, Calibration curve *possible* for the dielectric constant
Probe degree of protection:	Water-tight potted, IP68 protection
Probe dimensions:	155 x Ø63mm
Rod length:	130mm
Rod diameter:	6mm
Interfaces:	1.5m cable with 7-pin coupling socket

11.1 PICO64 and PICO32 probe dimensions





11.2 **SONO-M2 probe dimensions**

Telescopic extension

12 Safety instructions

Sections of this document that require particular attention are highlighted and marked accordingly.

CAUTION:
The warning triangle with an exclamation mark warns against bodily injury or material damage.

Designated use
Sensors and measuring systems made by IMKO GmbH may only be used for the described purpose in compliance with the specified technical data. Use for purposes other than the originally intended purpose is not permitted. The correct functioning and operational safety of a sensor or measuring system can only be guaranteed if the standard safety procedures, national regulations and special safety instructions outlined in these Operating Instructions are adhered to fully.

Moisture sensors and measuring systems made by IMKO GmbH are used for the measurement of moisture as per the measurement purpose and measuring range defined and specified in the Technical Data.

Only compliance with the instructions in the manual is considered designated use.

The manual describes how to connect, use and maintain IMKO sensors and IMKO measuring systems.

Read the manual before you connect and operate a sensor or measuring system.

The manual is an integral part of the product and must be kept in an easily accessible location near the sensor or measuring system.

Safety is compromised
The sensor or measuring system is designed according to EN 61010 safety requirements for electrical equipment, has been tested, and left the factory in a condition in which it is safe to operate. If the sensor or measuring system can no longer be operated safely, it must be taken out of service and labeled accordingly to ensure it is not put back into operation. In case of doubt, the sensor or measuring system must be returned to the manufacturer or the manufacturer's trade partner for repair or maintenance.

Modifications

For safety reasons, it is not permitted to modify or alter the sensor or measuring system without the prior approval of the manufacturer.

The sensor or handheld device may only be opened, calibration and repair work may only be performed and all maintenance work apart from the maintenance work described in this manual may only be carried out by one of our authorized specialists. The sensor or measuring system must be disconnected from the power supply before any installation work or maintenance work is performed.

The handheld device and the power unit may not be opened or repaired!

Hazard warning

Danger from incorrect operation

The sensor or measuring system may only be operated by trained personnel. The operating personnel must have read and understood the Operating Instructions.

Electrical hazard

Never immerse the handheld device in water or other liquids. The sensor is not sensitive to moisture contained in the products typically measured with the sensor.

Connect the handheld device to a correctly installed socket whose voltage specifications meet the specifications in the Technical Data section using the supplied power supply cable only.

Make sure that the socket is easily accessible so that you can

quickly unplug the power adapter if necessary.

Only use the adapter that suits your socket.

Only operate the measuring device with the original accessories included in the scope of supply. Contact the manufacturer if you require additional accessories or a replacement.

Do not use the measuring device:

– If the measuring device, sensor, power adapter or accessories are damaged,

– The sensor or measuring system does not work as intended,

– The power cable or plug are damaged,

– The sensor or measuring system has been dropped.

Plug out the power adapter:

– If you will not use the sensor or measuring system for a long time,

– Before you clean, put away or move the sensor or measuring system;

– If you are performing work on the sensor or device, e.g. connecting the devices,

– If a malfunction clearly occurs during operation,

– In a thunderstorm.

Caution - material damage

Make sure to keep a sufficient distance from strong sources of heat, such as hot plates, heaters etc.

Disconnect the sensor or handheld device from other devices before moving or transporting the device. Plug out the plugs on the device.

Do not use any aggressive chemical cleaning agents,

abrasive cleaners, hard sponges or similar to clean the device.

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