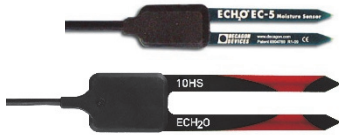


Soil Moisture Smart Sensor (S-SMx-M005) Manual



Soil moisture smart sensors are used for measuring soil water content and are designed to work with smart sensor-compatible HOBO® stations. They combine the innovative ECH₂O® Dielectric Aquameter probe from METER Group with Onset's smart sensor technology. All sensor conversion parameters are stored inside the smart sensor adapter so data is provided directly in soil moisture units without any programming or extensive user setup.

Specifications

S-SMC-M005

Measurement Range	In soil: 0 to 0.550 m ³ /m ³ (volumetric water content)
Extended Range	-0.401 to 2.574 m ³ /m ³ ; see Note 1
Accuracy	±0.031 m ³ /m ³ (±3.1%) typical 0 to 50°C (32° to 122°F) for mineral soils up to 8 dS/m and ±0.020 m ³ /m ³ (±2%) with soil specific calibration; see Notes 2 and 3
Resolution	0.0007 m ³ /m ³ (0.07%)
Volume of Influence	0.3 liters (10.14 oz)
Sensor Frequency	70 MHz
Soil Probe Dimensions	89 x 15 x 1.5 mm (3.5 x 0.62 x 0.06 in.)
Weight	180 grams (6.3 oz)
METER ECH₂O Probe Part No.	EC-5
Sensor Operating Temperature	0° to 50°C (32° to 122°F). Although the sensor probe and cable can safely operate at below-freezing temperatures (to -40°C/F) and the smart sensor adapter housing (the portion of the sensor cable that houses the electronics) can be exposed to temperatures up to 70°C (158°F), the soil moisture data collected at these extreme temperatures is outside of the sensor's accurate measurement range.
Bits per Sample	12
Number of Data Channels*	1
Measurement Averaging Option	No
Cable Length Available	5 m (16 ft)
Length of Smart Sensor Network Cable*	0.5 m (1.6 ft)
CE	The CE Marking identifies this product as complying with all relevant directives in the European Union (EU).

* A single HOBO station can accommodate 15 data channels and up to 100 m (328 ft) of smart sensor cable (the digital communications portion of the sensor cables).

Note 1: The sensor is capable of providing readings outside the standard volumetric water content range. This is helpful in diagnosing sensor operation and installation. See the *Operation* section for more details.

Note 2: This is a system level accuracy specification and is comprised of the probe's accuracy of ±0.03 m³/m³ typical (±0.02 m³/m³ soil specific) plus the smart sensor adapter accuracy of ±0.001 m³/m³ at 25°C (77°F). There are additional temperature accuracy deviations of ±0.003 m³/m³ / °C maximum for the probe across operating temperature environment, typical <0.001 m³/m³ / °C. (The temperature dependence of the smart sensor adapter is negligible.)

Note 3: Given the nature of the sensor design and sensor operating frequency, the system has inherent susceptibilities to Radio Frequency signals. The accuracy specification when subjected to certain RFI environments, such as those outlined in IEC 61000-4-3 and IEC 61000-4-6, is reduced to 0.061 m³/m³.

The system level accuracy will be particularly affected when placed in an electric field of 3 V/m or greater in the 70 MHz range. RFI mitigation practices and physical deployment changes may reduce the systems susceptibility.


Soil Moisture Smart Sensor

Models: S-SMC-M005
S-SMD-M005

Item included:

- Protective cap

Specifications (continued)

S-SMD-M005*	
Measurement Range	In soil: 0 to 0.570 m ³ /m ³ (volumetric water content)
Extended Range	-0.659 to 0.6026 m ³ /m ³ ; see Note 1
Accuracy	±0.033 m ³ /m ³ (±3.3%) typical 0 to 50°C (32° to 122°F) for mineral soils up to 10 dS/m and ±0.020 m ³ /m ³ (±2%) with soil specific calibration; see Notes 2 and 3
Resolution	0.0008 m ³ /m ³ (0.08%)
Volume of Influence	1 liter (33.81 oz)
Sensor Frequency	70 MHz
Soil Probe Dimensions	160 x 32 x 2 mm (6.5 x 1.25 x 0.08 in.)
Weight	190 grams (6.7 oz)
METER ECH₂O Probe Part No.	10HS
Sensor Operating Temperature	0° to 50°C (32° to 122°F). Although the sensor probe and cable can safely operate at below-freezing temperatures (to -40°C/F) and the smart sensor adapter housing (the portion of the sensor cable that houses the electronics) can be exposed to temperatures up to 70°C (158°F), the soil moisture data collected at these extreme temperatures is outside of the sensor's accurate measurement range. Extended temperatures above 50°C (122°F) will decrease logger battery life.
Bits per Sample	12
Number of Data Channels**	1
Measurement Averaging Option	No
Cable Length Available	5 m (16 ft)
Length of Smart Sensor Network Cable**	0.5 m (1.6 ft)
	The CE Marking identifies this product as complying with all relevant directives in the European Union (EU).

* HOBOWare® 3.2.1 or greater is required for the S-SMD-M005 model only (if using HOBOWare).

** A single smart sensor-compatible HOBO station can accommodate 15 data channels and up to 100 m (328 ft) of smart sensor cable (the digital communications portion of the sensor cables). Note that the S-SMD-M005 smart sensor uses more battery power than other models. Therefore, when connecting this smart sensor to H21-00x loggers that use 4 AA batteries, attach no more than 6 of these sensors to maintain battery life of one year.

Note 1: The sensor is capable of providing readings outside the standard volumetric water content range. This is helpful in diagnosing sensor operation and installation. See the *Operation* section for more details.

Note 2: This is a system level accuracy specification and is comprised of the probe's accuracy of ±0.03 m³/m³ typical (±0.02 m³/m³ soil specific) plus the smart sensor adapter accuracy of ±0.003 m³/m³ at 25°C (77°F). There are additional temperature accuracy deviations of ±0.003 m³/m³ / °C maximum for the probe across operating temperature environment, typical <0.001 m³/m³ / °C. (The temperature dependence of the smart sensor adapter is negligible.)

Note 3: Given the nature of the sensor design and sensor operating frequency, the system has inherent susceptibilities to Radio Frequency signals. The accuracy specification when subjected to certain RFI environments, such as those outlined in IEC 61000-4-3 and IEC 61000-4-6, may be significantly reduced.

The system level accuracy will be particularly affected when placed in an electric field of 3 V/m or greater in the 150 KHz to 1000 MHz range. RFI mitigation practices and physical deployment changes may reduce the systems susceptibility, however will yield reduced system accuracy. If deployments are planned in high RFI energy environments, Onset recommends on-site testing to determine system level accuracy.

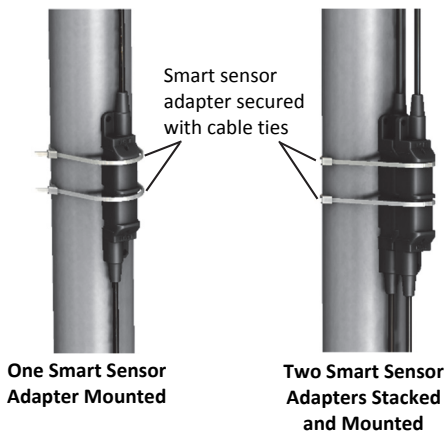
Installation

This sensor measures the water content in the space immediately adjacent to the probe surface. Air gaps or excessive soil compaction around the probe can profoundly influence soil water content readings. Do not mount the probes adjacent to large metal objects, such as metal poles or stakes. Maintain at least 8 cm (3 inches) of separation between the probe and other objects. Any objects, other than soil, within 8 cm (3 inches) of the probe can influence the probe's electromagnetic field and adversely affect output readings. The S-SMC-005 sensor must be installed at least 3 cm (1.18 inches) from the soil surface and the S-SMD-005 sensor must be installed at least 10 cm (3.94 inches) from the soil surface to obtain accurate readings.

It is important to consider the particle size of the medium in which you are inserting the sensor because it is possible for sticks, tree bark, roots, or other materials to get stuck between the sensor prongs, which will adversely affect readings. Be careful when inserting these sensors into dense soil as the prongs can break if excessive sideways force is used to push them into the soil.

To install the soil moisture sensors, follow these guidelines:

- Good soil contact with the sensor probes is required.
- Install the sensor probes into undisturbed soil where there aren't any pebbles in the way of the probes.
- Use a soil auger to make a hole to the desired depth (an angled hole is best) and push the probes into undisturbed soil at the bottom of the hole. Alternatively, dig a hole and push the probes into the side of the hole.
- If the probe has a protective cap on the end, remove it before placing the probe into the hole.
- To push the probe into the soil, use a PVC pipe with slots for the sensor and a longer slot for the cable.
- Thoroughly water the soil around the sensor after it is installed with the hole partially backfilled to cause the soil to settle around the sensor.
- As the hole is back-filled, try to pack the soil to the same density as the undisturbed soil.
- Secure the smart sensor adapter to the mast with the cable ties as shown. Multiple smart sensor adapters can be stacked as shown in the example below on the right.



One Smart Sensor Adapter Mounted

Two Smart Sensor Adapters Stacked and Mounted

Alternatively, mount the smart sensor adapter to a flat surface using two screws (no larger than a #6) and two washers as shown in the example below.



- Secure the sensor cable to the mounting pole or tripod with cable ties.
- Use conduit to protect the cable against damage from animals, lawn mowers, exposure to chemicals, etc.

If you need to calibrate your probe for the soil, you may want to gather soil samples from each sample depth at this time.

When removing the probe from the soil, **do not pull it out of the soil by the cable!** Doing so may break internal connections and make the probe unusable.

Connecting the Sensor to a Station

To connect the sensor to a station, stop the station from logging and insert the smart sensor's modular jack into an available smart sensor port on the station. See the station manual for details on operating stations with smart sensors.

Operating Environment

The soil moisture smart sensor provides accurate readings for soil between 0 and 50°C (32° and 122°F). The sensor will not be damaged by temperatures as low as -40°C (-40°F); it is safe to leave the sensor in the ground year-round for permanent installation. The smart sensor adapter housing (the portion of the sensor cable that houses the electronics) is rated to 70°C (158°F) and are mounted outside the logger enclosure and secured to the mounting pole. The cable and smart sensor adapter are weatherproof.

Operation

The soil moisture smart sensor measures the dielectric constant of soil in order to determine its volumetric water content. The dielectric constant of water is much higher than that of air or soil minerals, which makes it a sensitive measure of the water content. During operation, values of 0 to 0.5 m³/m³ are possible. A value of 0 to 0.1 m³/m³ indicates oven-dry to dry soil respectively. A value of 0.3 or higher normally indicates a wet to saturated soil. Values outside the operating range may be a sign that the sensor is not properly installed (poor soil contact or foreign objects are adjacent to the sensor) or that a soil-specific calibration is required. Note that sudden changes in value typically indicate that the soil has settled or shifted, which are signs that the sensor may not be installed properly or that it has been altered or adjusted during deployment. This sensor does not support measurement averaging.

Maintenance

The soil moisture smart sensor does not require any regular maintenance. If cleaning, rinse the sensor with mild soap and fresh water.

Calibration

The soil moisture smart sensor comes pre-calibrated for most soil types. If, however, your soil type has high sand or salt content, the standard calibration will not be accurate. In such cases, you will need to convert the data provided by the probe with a specific calibration for your individual soil type. To determine the soil specific calibration formula, refer to the *Calibrating ECH₂O Soil Moisture Probes* application note, available at <http://www.onsetcomp.com/support/tech-notes/calibrating-ech2o-soil-moisture-sensors-application-note>.

Verifying Sensor Performance

If you need to check the performance of your sensor over time, you can perform the following two tests. Note that these tests are intended to verify the sensor is functioning as expected; they are not tests of the accuracy of the sensor. If you need to test the accuracy, you can perform a soil calibration check using a standard mineral soil. Refer to the *Calibrating ECH₂O Soil Moisture Probes* application note for details, available at <http://www.onsetcomp.com/support/tech-notes/calibrating-ech2o-soil-moisture-sensors-application-note>.

1. Wash the probe with water and let it dry.
2. Plug the sensor into the logger.
3. Check the status of the device in HOBOWare®. If you are only using HOBOLink®, check the Latest Conditions for your device. You may need to press the connect button on your HOBO station to upload the latest readings to HOBOLink if the connection interval is long.
4. Conduct an air or water test to check the actual readings against the expected readings.

To conduct an air test, suspend the sensor by the cable so that it is hanging freely in the air and not near any objects.

To conduct a distilled water test, suspend the probe in a room temperature container of fresh water. Make sure the container is large enough to completely cover the entire probe and that it does not touch the bottom or sides of the container.

For both of these tests, it is important that the sensor's entire volume of influence is in air or water. For the volume of influence for the S-SMC-M005 probe, see <http://www.onsetcomp.com/support/tech-notes/ec-volume-sensitivity-application-note>.

For the volume of influence for the S-SMD-M005 probe, see <http://www.onsetcomp.com/support/tech-note/10hs-volume-sensitivity-application-note>.

5. Compare the value in HOBOWare or HOBOLink while running the test with the expected values in the table below. The

value should be within the specified range for the air or water test.

Sensor	Air	Water
S-SMC-M005	-0.26 to -0.13	+0.47 to +0.57
S-SMD-M005	-0.48 to -0.13	+0.46 to +0.70

If these tests pass, your sensor is working normally. If not, then it may be damaged and should be replaced.