

Soil Moisture Smart Sensors (S-SMx-M005)

Soil moisture smart sensors are used for measuring soil water content and are designed to work with smart sensor-compatible HOBO[®] data loggers. They combine the innovative ECH₂O[®] Dielectric Aquameter probe from Decagon Devices, Inc. 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	S-SMD-M005*
Measurement Range	In soil: 0 to 0.550 m ³ /m ³ (volumetric water content)	In soil: 0 to 0.570 m ³ /m ³ (volumetric water content)
Extended range	-0.401 to 2.574 m ³ /m ³ ; see Note 1	-0.659 to 0.6026 m ³ /m ³ ; see Note 1
Accuracy	±0.031 m ³ /m ³ (±3%) typical 0 to 50°C (32° to 122°F) for mineral soils up to 8 dS/m ±0.020 m ³ /m ³ (±2%) with soil specific calibration; see Note 2	±0.033 m ³ /m ³ (±3%) typical 0 to +50°C (+32° to 122°F) for mineral soils up to 10 dS/m ±0.020 m ³ /m ³ (±2%) with soil specific calibration; see Note 3
Resolution	±0.0007 m ³ /m ³ (±0.07%)	±0.0008 m ³ /m ³ (±0.08%)
Volume of Influence	0.3 liters (10.14 oz)	1 liter (33.81 oz)
Sensor Frequency	70 MHz	70 MHz
Soil Probe Dimensions	89 x 15 x 1.5 mm (3.5 x 0.62 x 0.06 in.)	160 x 32 x 2 mm (6.5 x 1.25 x 0.08 in.)
Weight	180 grams (6.3 oz)	190 grams (6.7 oz)
Decagon ECH ₂ O Probe Part No.	EC-5	10HS

* HOBOware[®] 3.2.1 or greater is required for the S-SMD-M005 model only.

Specifications	Both models
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 tube (the white 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 when using the S-SMD-M005 smart sensor.
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)

** A single smart sensor-compatible HOBO logger 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 the S-SMD-M005 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 below for more details.

Note 2: This is a system level accuracy specification and is comprised of the probe's accuracy of $\pm 0.03 \text{ m}^3/\text{m}^3$ typical ($\pm 0.02 \text{ m}^3/\text{m}^3$ soil specific) plus the smart sensor adapter accuracy of $\pm 0.001 \text{ m}^3/\text{m}^3$ at 25°C (77°F). There are additional temperature accuracy deviations of $\pm 0.003 \text{ m}^3/\text{m}^3 / ^\circ\text{C}$ maximum for the probe across operating temperature environment, typical $< 0.001 \text{ m}^3/\text{m}^3 / ^\circ\text{C}$. (The temperature dependence of the smart sensor adapter is negligible.)

Note 3: This is a system level accuracy specification and is comprised of the probe's accuracy of $\pm 0.03 \text{ m}^3/\text{m}^3$ typical ($\pm 0.02 \text{ m}^3/\text{m}^3$ soil specific) plus the smart sensor adapter accuracy of $\pm 0.003 \text{ m}^3/\text{m}^3$ at 25°C (77°F). There are additional temperature accuracy deviations of $\pm 0.003 \text{ m}^3/\text{m}^3 / ^\circ\text{C}$ maximum for the probe across operating temperature environment, typical $< 0.001 \text{ m}^3/\text{m}^3 / ^\circ\text{C}$. (The temperature dependence of the smart sensor adapter is negligible.)

Inside this Package

- Soil Moisture Smart Sensor

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 surface and the S-SMD-005 sensor must be installed at least 10 cm (3.94 inches) from the surface to obtain accurate readings.

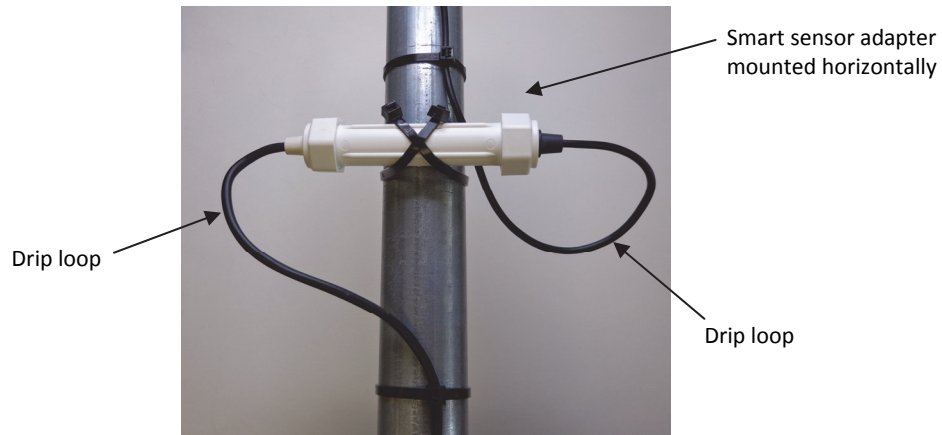
It is important to consider the particle size of the medium in which you are inserting the sensor because it is possible for sticks, tree bark, roots, or other materials to get stuck between the sensor prongs, which will adversely affect readings. Be careful when inserting these sensors into dense soil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

Soil Moisture Smart Sensor

- To provide long-term protection from moisture entry, the smart sensor adapter must be mounted horizontally and with the cable wires routed with drip loops so that water drains away from the cable entry point as shown in the example below. When mounted properly, the housing is weatherproof (but not waterproof).



- 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

To start using the Soil Moisture smart sensor, stop the logger and insert the sensor's modular jack into an available port on the logger. If a port is not available use a 1-to-2 adapter (Part # S-ADAPT), which allows you to plug two sensors into one port. The next time you use the logger, it will automatically detect the new smart sensor. Note that the logger supports a maximum of 15 data channels; this sensor uses one data channel. Launch the logger and verify that the sensor is functioning correctly. See the logger user's guide for more details about connecting smart sensors to the logger.

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 electronics (housed in the white tube on the sensor cable) are 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. (See your logger user's guide for more information about 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/files/support/pdfs/Soil_calibration.pdf

Verifying Sensor Functionality

To quickly check sensor functionality before deployment, perform the following two tests:

1. Wash the probe with water and let it dry.
2. Plug the sensor into the logger.
3. Open the logging software and go to the status screen.
4. Conduct an air test: Hold the sensor by the cable letting the sensor hang freely in the air, and compare the value in the status screen with the table below.

Sensor	Air	Water
S-SMC-M005	-0.193 to -0.139	+0.521 to +0.557
S-SMD-M005	-0.473 to -0.134	+0.474 to +0.692

5. Distilled water test: Insert the probe in a room temperature container of fresh water, completely covering the entire ECH₂O probe. Compare the value in the status screen with the table above.

If these tests pass, your sensor is working normally. If not, please contact Onset for assistance. If you believe your sensor is defective or broken, you can send the smart sensor back to Onset for testing if needed. Contact Onset or your place of purchase for a Return Merchandise Authorization (RMA) number and associated costs before sending it.