HOBO Data Loggers

This sensor measures soil moisture and temperature over multiple zones with a single probe using GroPoint™ TDT technology. It is designed to work with the HOBOnet (HOBO® RX) Wireless Sensor Network in which data is transmitted wirelessly from the sensor mote across the network to the station and then uploaded to HOBOlink® web-based software. With HOBOlink, you can monitor sensor readings, view graphs, set up alarms, download data, and more.

Specifications

Soil Moisture: Volumetric Water Content (VWC)

Measurement Range	0.000 to 1.000 m³/m³ in most soils
Accuracy	±0.02 m³/m³ (±2%) in most soils typical from 0° to 50°C (32° to 122°F)*
Resolution	0.001 m³/m³

Temperature

Measurement Range	-20° to 70°C (-4° to 158°F)
Accuracy	±0.5°C (0.9°F)
Resolution	0.1°C (0.18°F)

Depths Measured (see diagram on page 3)

RXW-GP3-xxx	45 cm (18 inches) total; three soil moisture zones, six temperature depths
RXW-GP4-xxx	60 cm (24 inches) total; four soil moisture zones, seven temperature depths
RXW-GP6-xxx	90 cm (35 inches) total; six soil moisture zones, eleven temperature depths

Wireless Mote

Operating Temperature Range	Sensor: -20° to 70°C (-4° to 158°F) Mote: -25° to 60°C (-13° to 140°F) with rechargeable batteries -40° to 70°C (-40° to 158°F) with lithium batteries
Radio Power	12.6 mW (+11 dBm) non-adjustable
Transmission Range	Reliable connection to 457.2 m (1,500 ft) line of sight at 1.8 m (6 ft) high Reliable connection to 609.6 m (2,000 ft) line of sight at 3 m (10 ft) high
Wireless Data Standard	IEEE 802.15.4
Radio Operating Frequencies	RXW-GPx-900: 904–924 MHz RXW-GPx-868: 866.5 MHz RXW-GPx-921: 921 MHz RXW-GPx-922: 916–924 MHz
Modulation Employed	OQPSK (Offset Quadrature Phase Shift Keying)
Data Rate	Up to 250 kbps, non-adjustable
Duty Cycle	<1%
Maximum Number of Motes	Up to 50 wireless sensors or 336 data channels per one HOBO RX station

Logging Rate

Maximum logging interval: 18 hours

Recommended minimum logging interval:

	Using Solar Power with Rechargeable Batteries	Using Non-Rechargeable Lithium Batteries
RXW-GP3-xxx:	5 minutes year round	10 minutes
RXW-GP4-xxx:	5 minutes summer, 10 minutes winter	15 minutes
RXW-GP6-xxx:	5 minutes summer, 10 minutes winter	15 minutes

See Battery Life specification for more details.

Number of Data Channels	RXW-GP3-xxx: 10 RXW-GP4-xxx: 12 RXW-GP6-xxx: 18

RXW Multi-Depth Soil Moisture Sensor

Models:

- RXW-GP3-900 (US)
  RXW-GP3-868 (Europe)
  RXW-GP3-921 (Taiwan)
  RXW-GP3-922 (Australia/NZ)

- RXW-GP4-900 (US)
  RXW-GP4-868 (Europe)
  RXW-GP4-921 (Taiwan)
  RXW-GP4-922(Australia/NZ)

- RXW-GP6-900 (US)
  RXW-GP6-868 (Europe)
  RXW-GP6-921 (Taiwan)
 RXW-GP6-922 (Australia/NZ)

Included Items:

- Cable ties
- Screws

Specifications (continued)

Battery Type/ Power Source	Two AA 1.2V rechargeable NiMH batteries, powered by built-in solar panel or two AA 1.5 V non-rechargeable lithium batteries for operating conditions of -40 to 70°C (-40 to 158°F)
Battery Life	With NiMH batteries: Typical 3–5 years when operated in the temperature range -20° to 40°C (-4°F to 104°F) and positioned toward the sun (see *Mounting and Positioning the Mote*), operation outside this range will reduce the battery service life
	With non-rechargeable lithium batteries: RXW-GP3-xxx: 1 year with a 10-minute logging interval RXW-GP4-xxx: 1 year with a 15-minute logging interval RXW-GP6-xxx: 7 months with a 15-minute logging interval
Memory	16 MB
Dimensions	RXW-GP3-xxx sensor length: 53.2 cm (20.9 inches) RXW-GP4-xxx sensor length: 68.2 cm (26.9 inches) RXW-GP6-xxx sensor length: 98.2 cm (38.7 inches) Sensor diameter: 3 cm (1.2 inches) Cable length: 3 m (9.8 ft) Mote: 16.2 x 8.59 x 4.14 cm (6.38 x 3.38 x 1.63 inches)
Weight	RXW-GP3-xxx sensor: 351 g (12.4 oz) RXW-GP4-xxx sensor: 408 g (14.4 oz) RXW-GP6-xxx sensor: 526 g (18.6 oz) Cable: 190 g (6.7 oz) Mote: 223 g (7.87 oz)
Materials	Sensor: Polycarbonate housing encasing epoxy sealed circuit board Cable: Polyurethane Mote: PCPBT, silicone rubber seal
Environmental Rating	Mote: IP67, NEMA 6
Compliance Marks	FC RXW-GPx-900: See last page
	CE RXW-GPx-868: The CE Marking identifies this product as complying with all relevant directives in the European Union (EU).
	RXW-GPx-921: See last page
	RXW-GPx-922: See last page

- Soil-specific calibration requires user post-processing in a spreadsheet program such as Microsoft® Excel® or a utility and connector as recommend by RioT Technology Corp., manufacturer of GroPoint sensors. Refer to *Performing a Soil-Specific Calibration* for details.

Mote Components and Operation

Sensor Mote Closed, Front

Sensor Mote Closed, Back

Sensor Mote Opened
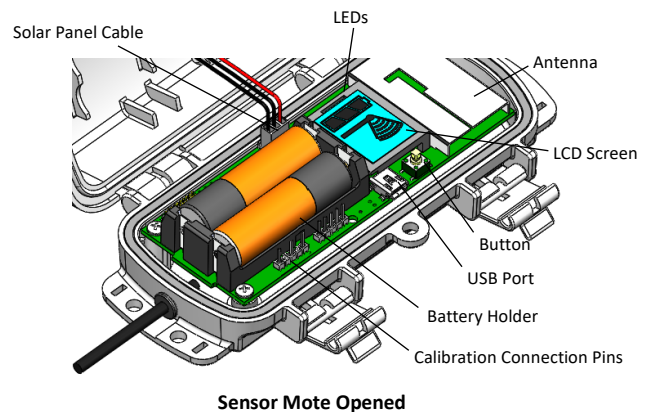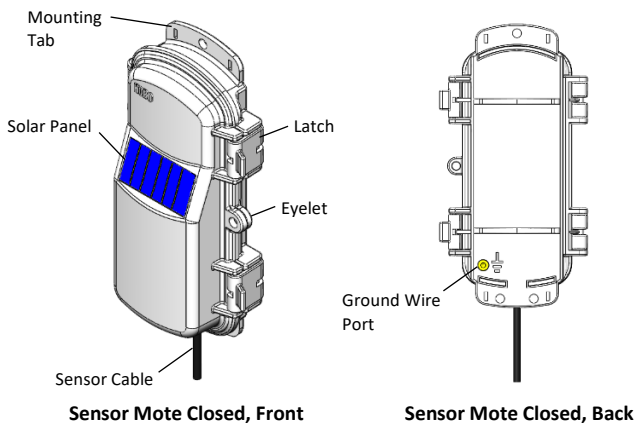
Mounting Tab: Use the tabs at the top and bottom of the mote to mount it (see *Mounting and Positioning the Mote*).

Solar Panel: Position the solar panel towards the sun to charge the mote batteries (see *Mounting and Positioning the Mote*).

Sensor Cable: This is the cable that connects the mote to the sensor.

Eyelet: Use this eyelet to attach a 3/16 inch padlock to the mote for security.

Latch: Use the two latches to open and close the mote door.

Ground Wire Port: Use this port to connect a ground wire (see *Mounting and Positioning the Mote*).

Antenna: This is the built-in antenna for the radio communications across the RX Wireless Sensor Network.

LEDs: There are two LEDs to the left of the LCD screen. The green LED blinks during the process of joining a network, blinking quickly while the mote searches for a network and then slowly as the mote registers with the network. Once the network registration process is complete, the blue LED blinks at 4 seconds to indicate normal operation. If the mote is not currently part of a network, the blue LED will be off. If the blue LED is on and not blinking, there is a problem with the mote. Contact Onset Technical Support.

Solar Panel Cable: This cable connects the built-in solar panel to the mote circuitry.
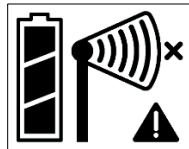
Battery Holder: The location where the batteries are installed as shown (see *Battery Information*).

Calibration Connection Pins: Use these pins to connect a programming tool. See *Performing a Soil-Specific Calibration* for details.

USB Port: Use this port to connect to the mote to a computer via USB cable if you need to update the firmware (see *Updating Mote Firmware*).

Button: Push this button for 1 second to illuminate the LCD or 3 seconds for the mote to search for a HOBOnet Wireless Sensor Network to join (see *Adding the Mote to the HOBOnet Wireless Sensor Network*).

LCD Screen: The mote is equipped with an LCD screen that displays details about the current status. The following example shows all symbols illuminated on the LCD screen followed by definitions of each symbol in the table.
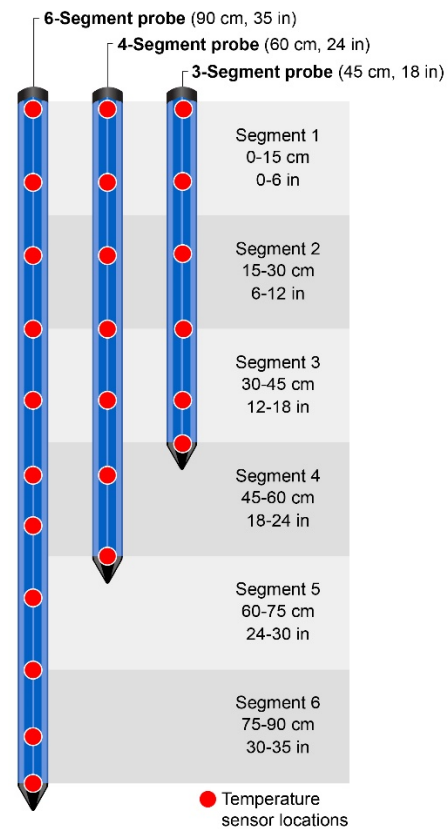
LCD Symbol	Description
	The battery indicator shows the approximate battery charge remaining.
	This is a signal strength indicator. The more bars, the stronger the signal between motes. If there is no x icon next to the signal strength indicator, then the mote is part of a HOBOnet Wireless Sensor Network.
	An empty signal strength icon plus the x icon indicates that the mote is not currently part of a network. See *Adding the Mote to the HOBOnet Wireless Sensor Network* for details on how to add a mote to the network.
	When the mote is in the process of joining a network, the signal strength icon will blink and then the bars in the icon will cycle from left to right. The x icon will blink during the last step in the network registration process (see *Adding the Mote to the HOBOnet Wireless Sensor* Network for details).
	This indicates a problem with the sensor itself (the mote is operational). Check the sensor and make any adjustments to it as needed. Contact Onset Technical Support if the problem persists.

Sensor Components and Operation

The sensor measures soil moisture and temperature over several zones using a single probe. Designed for vertical installation, the sensor takes measurements over multiple soil layers, with each measurement zone providing the average volumetric soil moisture content over a 15 cm (5.9 inch) zone. Water can be detected as much as 5 cm (2 inches) from the surface of the probe. However, moisture closest to the surface of the probe has more influence on the readings than moisture further away. Each 15 cm (5.9 inch) zone has a 2.78 L (169.6 in³) volume of influence.

Probes are divided into sensor segments as shown in the following diagram. Each segment measures soil moisture over the corresponding soil depth zone. Temperature sensors within the probe measure the soil temperature at different depths (refer to the tables later in this section for the specific depth of each temperature sensor).

6-Segment probe (90 cm, 35 in)
4-Segment probe (60 cm, 24 in)
3-Segment probe (45 cm, 18 in)

Segment 1
0-15 cm
0-6 in

Segment 2
15-30 cm
6-12 in

Segment 3
30-45 cm
12-18 in

Segment 4
45-60 cm
18-24 in

Segment 5
60-75 cm
24-30 in

Segment 6
75-90 cm
30-35 in

● Temperature sensor locations

The following table shows how many channels are logged for each of the three sensor models.

Part number	Channels logged
RXW-GP3-xxx	10 total channels: • 3 soil moisture (water content) • 6 soil temperature • 1 mote battery
RXW-GP4-xxx	12 total channels: • 4 soil moisture (water content) • 7 soil temperature • 1 mote battery
RXW-GP6-xxx	18 total channels: • 6 soil moisture (water content) • 11 soil temperature • 1 mote battery

In HOBOlink, measurement channels are listed as <sensor serial number>-<number>, where <number> represents the soil moisture zones followed by the temperature sensor depths in order from the top down to the tip of the probe. The following tables show the soil moisture zones and temperature sensor depths associated with each channel number for the three RXW-GPx models. It is recommended that you label each channel in HOBOlink for each soil moisture zone or temperature depth. To change the label for a channel, go to your RX station page in HOBOlink. Click next to a channel and then enter a label and click Save.

RXW-GP3 HOBOlink Channels

RXW GP3 Sensor Channel	Corresponding Channel Number in HOBOlink
Soil moisture (water content) measurement zone 1: 0 to 15 cm (0 to 5.91 inches)	<serial number>-1
Soil moisture (water content) measurement zone 2: 15 to 30 cm (5.91 to 11.81 inches)	<serial number>-2
Soil moisture (water content) measurement zone 3: 30 to 45 cm (11.81 to 17.72 inches)	<serial number>-3
Temperature at 3.5 cm (1.38 inches)	<serial number>-4
Temperature at 10 cm (3.94 inches)	<serial number>-5
Temperature at 20 cm (7.87 inches)	<serial number>-6
Temperature at 30 cm (11.81 inches)	<serial number>-7
Temperature at 40 cm (15.7 inches)	<serial number>-8
Temperature at 45 cm (17.72 inches)	<serial number>-9

RXW-GP4 HOBOlink Channels

RXW GP4 Sensor Channel	Corresponding Channel Number in HOBOlink
Soil moisture (water content) measurement zone 1: 0 to 15 cm (0 to 5.91 inches)	<serial number>-1
Soil moisture (water content) measurement zone 2: 15 to 30 cm (5.91 to 11.81 inches)	<serial number>-2
Soil moisture (water content) measurement zone 3: 30 to 45 cm (11.81 to 17.72 inches)	<serial number>-3
Soil moisture (water content) measurement zone 4: 45 to 60 cm (17.72 to 23.62 inches)	<serial number>-4
Temperature at 3.5 cm (1.38 inches)	<serial number>-5
Temperature at 10 cm (3.94 inches)	<serial number>-6
Temperature at 20 cm (7.87 inches)	<serial number>-7
Temperature at 30 cm (11.81 inches)	<serial number>-8
Temperature at 40 cm (15.7 inches)	<serial number>-9
Temperature at 50 cm (19.69 inches)	<serial number>-10
Temperature at 60 cm (23.62 inches)	<serial number>-11

RXW-GP6 HOBOlink Channels

RXW GP6 Sensor Channel	Corresponding Channel Number in HOBOlink
Soil moisture (water content) measurement zone 1: 0 to 15 cm (0 to 5.91 inches)	<serial number>-1
Soil moisture (water content) measurement zone 2: 15 to 30 cm (5.91 to 11.81 inches)	<serial number>-2
Soil moisture (water content) measurement zone 3: 30 to 45 cm (11.81 to 17.72 inches)	<serial number>-3
Soil moisture (water content) measurement zone 4: 45 to 60 cm (17.72 to 23.62 inches)	<serial number>-4
Soil moisture (water content) measurement zone 5: 60 to 75 cm (23.62 to 29.53 inches)	<serial number>-5
Soil moisture (water content) measurement zone 6: 75 to 90 cm (29.53 to 35.43 inches)	<serial number>-6
Temperature at 3.5 cm (1.38 inches)	<serial number>-7
Temperature at 10 cm (3.94 inches)	<serial number>-8
Temperature at 20 cm (7.87 inches)	<serial number>-9
Temperature at 30 cm (11.81 inches)	<serial number>-10
Temperature at 40 cm (15.7 inches)	<serial number>-11
Temperature at 50 cm (19.69 inches)	<serial number>-12
Temperature at 55 cm (21.65 inches)	<serial number>-13
Temperature at 65 cm (25.59 inches)	<serial number>-14
Temperature at 75 cm (29.53 inches)	<serial number>-15
Temperature at 85 cm (33.47 inches)	<serial number>-16
Temperature at 90 cm (35.43 inches)	<serial number>-17

## Adding the Mote to the HOBOnet Wireless Sensor Network

The mote must join a HOBOnet Wireless Sensor Network before it can begin measuring water potential and transmitting data. This requires accessing the station and the mote at the same time so it is recommended that you complete these steps before deploying the mote.

> **Important:** If you are setting up a new station, follow the instructions in the station quick start before setting up this mote (go to www.onsetcomp.com/support/manuals/24380-man-rx2105-rx2106-qsg for RX2105 and RX2106 stations or go to www.onsetcomp.com/support/manuals/18254-MAN-QSG-RX3000 for RX3000 stations).

To add a mote to the network:

1. If the LCD is blank on the station, press any button to wake it up.

2. Press the Select button once (which shows the number of smart sensors installed) and then press it again to switch to the module with the manager.
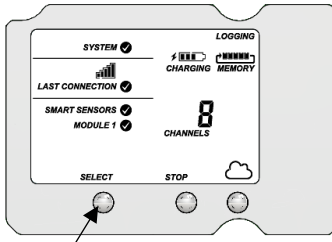

Press this button to view the module

3. Press the Search button (the magnifying glass). The magnifying glass icon will blink while the station is in search mode.
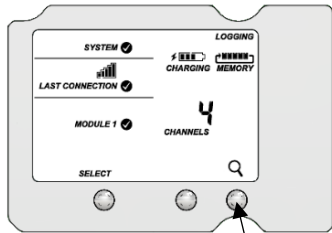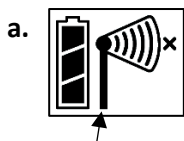

Press this button so the station is ready to have motes join the network

4. Open the mote door and install the batteries if you have not already done so.

5. Press the button on the mote for 3 seconds. The signal strength icon will flash and then cycle.
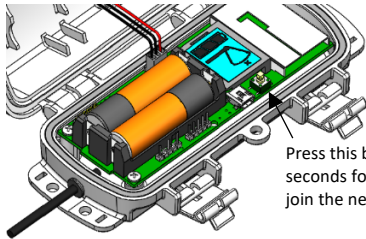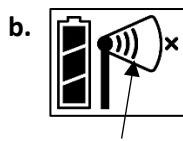

Press this button for 3 seconds for the mote to join the network

6. Watch the LCD on the mote.

a. This signal strength icon blinks while searching for a network.

b. Once a network is found, the icon will stop flashing and the bars will cycle from left to right.

c. This network connection "x" icon blinks while the mote completes the registration process, which may take up to five minutes.

d. Once the mote has finished joining the network, the "x" icon is removed and the channel count on the station LCD increases by the total channel count for that sensor model.

The green LED blinks quickly while the mote searches for a network to join and then blinks slowly while it completes the network registration. Once the mote has finished joining the network, the green LED turns off and the blue LED then blinks indefinitely while the mote is part of the network.

Note: If the mote cannot find the network or has trouble remaining connected during this process, make sure the mote is in a vertical, upright position and within range of the station.

7. Press the Search button (the magnifying glass) on the station to stop searching for motes.
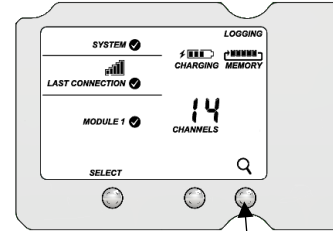
Press this button again to stop searching for motes

If you added more than one more mote to the network, then the total channel count on the station LCD for the manager module will represent all measurement channels plus a battery channel for each mote in the network.

Sensor measurements will be recorded at the logging interval specified in HOBOlink, transmitted to the station, and uploaded to HOBOlink at the next connection interval (readout).

Important: Because this sensor provides multiple soil moisture and temperature measurements, the battery usage can be too high at fast logging rates. It is recommended that you set the logging interval in HOBOlink for wireless sensors to be no faster than the following rates.

Part Number	Minimum Logging Interval Using Solar Power with Rechargeable Batteries*	Minimum Logging Interval Using Non-Rechargeable Lithium Batteries
RXW-GP3-xxx	5 minutes year round	10 minutes with a 1-year battery life
RXW-GP4-xxx	5 minutes summer, 10 minutes winter	15 minutes with a 1-year battery life
RXW-GP6-xxx	5 minutes summer, 15 minutes winter	15 minutes with a 7-month battery life

*Requires the solar panel is positioned directly toward the sun and without shade (see *Mounting and Positioning the Mote*)

Note that this logging interval will be applied to all wireless sensors in the HOBOnet® wireless network. For solar powered RXW-GPx motes, logging intervals faster than the recommended minimum can result in missing data because there will be insufficient charge for the batteries. For RXW-GPx motes with non-rechargeable lithium batteries, faster intervals will require more frequent battery replacement.

Use HOBOlink to monitor mote status and health. If a mote is temporarily offline, any logged data is saved until it is back online. In addition, if a mote is offline for 30 minutes, the

station will automatically connect to HOBOlink and report the mote as missing. Once the mote is back online, any logged data will be uploaded the next time the station connects to HOBOlink.

See the HOBOlink Help for details on how to change the logging and connection intervals, view data, check mote status, add the mote to a map, and more.

Installing the Sensor

To install the sensor, it is recommended that you use a slide hammer (Onset part number SLIDE-HAMMER) and pilot rod to form a hole to insert the sensor probe (use Onset part number PILOT-ROD4 with RXW-GP3 and RXW-GP4 models or use PILOT-ROD6 with the RXW-GP6 model). These tools will create a pilot hole that is the exact size and shape of the sensor without air gaps to ensure good soil contact with the sensor and accurate measurements. You may also need tape, two adjustable wrenches, a dead blow hammer, and water. There are also two alternate installation methods described later in this section if a slide hammer and pilot rod are not available.

⚠ **WARNING:** Follow these important safety guidelines when working with a slide hammer and pilot rod:

● Be careful when carrying and using the slide hammer as the bottom part of the slide may drop down, potentially causing injury. Steel-toed work shoes are recommended to prevent possible injury to toes and feet.

● Eye and ear protection are recommended at all times when using the slide hammer. When in use, the slide hammer generates harmful levels of acoustic energy. Hearing protection with a Noise Reduction Rating of 20 decibels should always be worn.

● Wear work gloves and keep both hands on the slide hammer when driving the pilot rod. Be careful to avoid getting fingers caught in the slide mechanism.

Sensor Installation Guidelines

Before installing the sensor, follow these guidelines.

- Install the probe when the soil is dry to minimize the air gaps that can form around the probe as wet soil dries out. Also avoid excessively rocky soil whenever possible as cavities may form when rocks are pushed out of the way when creating the pilot hole.

- The sensor probe must be installed vertically. Hold the slide hammer and pilot rod perfectly vertical to avoid making the hole larger than the size of the sensor.

- Always maintain control of the slide hammer with a firm grip to avoid wobbling or moving the hammer side-to-side. This is especially important while the first half of the pilot rod is being hammered in place.

- Check that the pilot rod is tightly screwed to the slide hammer during the insertion process as the threads may loosen during repeated impacts. Failure to check the connection may place excessive force on the threads and damage them.

- Drive the pilot rod only as far as needed for the length of probe being used. A hole that is too short may cause

damage to the probe during insertion. A hole that is too long may allow water to collect in the void below the probe and cause inaccurate readings.

- When extracting the pilot rod, make sure it remains vertical so the hole does not become enlarged, which may result in air gaps forming between the probe and soil and potentially incorrect soil moisture readings.

- Once the pilot rod is removed, insert the probe as soon as possible. Any delay may allow moisture to swell the sides of the hole or water to enter the hole.

- If the pilot hole is larger at the top than the bottom due to side-to-side movement of the slide hammer during installation, it may take a few days to a week for the soil to settle back and seal against the probe. You can also create a soil slurry at the surface to fill the hole. See *Maintenance* for more details on using a slurry.

- To reduce air gaps from forming over time as soil expands and contracts, limit the variation of moisture content of the soil if possible, such as by periodic irrigation.

- 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.

Slide Hammer and Pilot Rod Installation Method

1. For assembled pilot rods, skip to step 2. For disassembled pilot rods, select the appropriate number of middle rod segments based on the length of your probe: two segments for RXW-GP3 and RXW-GP4 models, or three for the RXW-GP6 model. Assemble the pilot rod by screwing one segment into the other, connecting each rod segment together to form the body of the pilot rod, making sure all edges are aligned. Screw in the pilot rod tip to one end of the pilot rod body and the top cap to the other end.

2. Lay the pilot rod down next to the sensor probe, with both tips aligned. Wrap a piece of tape around the pilot rod at the depth the rod should be driven into the soil (which should line up with the top of the sensor).

3. Screw the pilot rod into the slide hammer as shown. Use two adjustable wrenches to make sure the threads are tight. A loose connection can damage the threads as you are hammering.
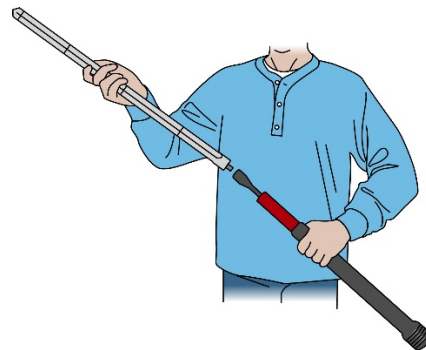
4. At the location where you want to install the probe, use a repetitive up-then-down motion on the slide hammer to vertically drive the pilot rod into the soil. Be sure to hold the slide hammer vertically without side-to-side movement. Drive the pilot rod in until it reaches the tape marking made in step 2.
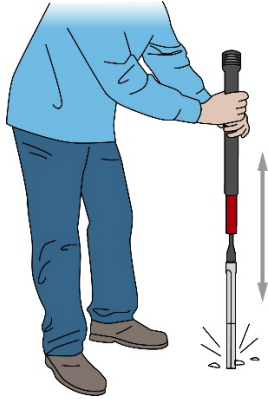
5. Once the pilot rod reaches the desired depth, extract the pilot rod by using the slide hammer in reverse, lifting it rapidly to hammer upwards. Be sure to hold the slide hammer vertically without side-to-side movement to extract the pilot rod straight up.

6. Once the pilot rod is extracted, clear away any loose soil at the top edges of the hole so that it doesn't fall into the hole.

7. Insert the sensor probe into the hole, pressing it in as far as possible by hand. Pour a bit of water around the probe at the top of the hole if the soil is very tightly packed to help it slide more smoothly into the hole. You can use a dead blow hammer to gently tap the top of the sensor if you are having trouble pushing in the sensor by hand.

> **Important:** Never use a regular hammer or other tool to push in the sensor because other tools can damage the internal electronics.
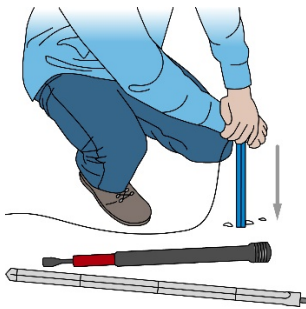
8. Once the probe is fully inserted in the hole, pack the soil around the top of the sensor to prevent water from entering the hole. The sensor should be completely covered with soil and only the sensor cable visible.

See *Checking Sensor Readings with HOBOlink* for details on verifying that you have consistent sensor readings.

Auger Installation Method

1. Drill a vertical hole with a 3 inch auger.

2. Insert the sensor into the hole, making sure the entire sensor body is in the hole.

3. Make a slurry of the soil from the hole and pour it down slowly so that it settles evenly around the sensor. Stop pouring every few inches and give it time for the water to drain from the soil and the soil to settle. Allow more time for soils that retain water, such as clay soils.

4. Make sure the sensor is completely covered with soil and only the sensor cable visible.

See *Checking Sensor Readings with HOBOlink* for details on verifying that you have consistent sensor readings.

Excavation Installation Method

1. Dig a hole deep enough for the sensor probe and save the soil on a plastic tarp or sheet. Lay out the soil on the tarp in a row for the different depths so that you will be able to easily return all the soil to the excavated hole in the correct order.

2. Place the sensor probe vertically in the hole.

3. While supporting the sensor at the top and bottom so that it does not move, backfill the hole with the soil that was removed from the hole, restoring the original soil at each depth as laid out on the tarp. To ensure the same soil density as before the probe was installed, return the soil to the hole in 8 to 10 cm (3 to 4 inch) layers. Tamp down each layer with a 2.54 cm (1 inch) diameter metal rod, making sure the soil is packed around and into the sensor so that there is good soil contact on all sensor surfaces. The accuracy depends on not having any air gaps around the sensor. Be sure to keep the sensor vertical while backfilling the hole.

4. Once all soil has been returned to the hole, make sure the excavation surface is level with the surrounding soil. The sensor should be completely covered with soil and only the sensor cable visible.

5. Water the soil thoroughly after installation to help ensure that the soil has filled in around the sensor.

See the next section for details on verifying that you have consistent sensor readings.

Checking Sensor Readings with HOBOlink

Use HOBOlink to check for consistent sensor readings, which can indicate that the installation was successful with minimal air pockets.

1. Temporarily set the logger interval in HOBOlink to 1 minute and Save.

2. Press the Connect button on the station.

3. Press the Start button if the station is not logging. Let the station log data for a few minutes.

4. Connect to HOBOlink again so that the station can upload the soil moisture data.

5. Export the data for the sensor and check that the readings are similar between adjacent segments (it is normal to have significant differences in readings from one end of the probe to the other). If any segments have significantly low readings compared to their adjacent segments, that could be a sign of an air gap. Try pouring water on the soil around the sensor and repeating steps 4 and 5. If that does not work, you may need to remove the sensor from the hole and redo the installation.

6. Once the readings are consistent, change the logging interval in HOBOlink back to your desired interval for the deployment.

Mounting and Positioning the Mote

- Mount the mote to a mast or pipe using cable ties or affix the mote to a wooden post or flat surface with screws. Insert the cable ties or screws through the holes on the mounting tabs.

- Consider using plastic poles such as PVC to mount the mote as certain types of metal could decrease signal strength.

- Make sure the mote remains in a vertical position once it is placed in its deployment location for optimal network communications.

- Make sure the mote door is closed, with both latches fully locked to ensure a watertight seal.

- Consider using a 3/16 inch padlock to restrict access to the mote. With the mote door closed, hook a padlock through the eyelet on the right side of the door and lock it.

- Position the mote towards the sun, making sure the solar panel is oriented so that it receives optimal sunlight throughout each season. It may be necessary to periodically adjust the mote position as the path of the sunlight changes throughout the year or if tree and leaf growth alters the amount of sunlight reaching the solar panel.

- Make sure the mote is mounted a minimum of 1.8 m (6 ft) from the ground or vegetation to help maximize distance and signal strength.

- Place the mote so there is full line of sight with the next mote. If there is an obstruction between two sensor motes or between the sensor mote and the manager, then use a repeater mounted on the obstruction. For example, if there is a hill between the sensor mote and the manager, place a repeater at the top of the hill between the sensor mote and the manager.

- There should not be more than five motes in any direction at their maximum transmission range from the manager. Data logged by a wireless sensor must travel or "hop" across the wireless network from one mote to the next until it ultimately reaches the manager connected to the station. To make sure the data can successfully travel across the network, the mote should not be more than five hops away from the manager.

- The HOBOnet Wireless Sensor Network can support up to 50 wireless sensors or 336 data channels per one HOBO RX station.

- Use a #4-40 screw to attach a ground wire to the port on the back of the mote if you are deploying the mote in a location where lightning is a concern.

Performing a Soil-Specific Calibration

The sensor is factory-calibrated for use in most soils. The GroPoint user manual provides instructions on how to perform soil-specific calibrations using a GP-USB Connect SDI-12 programming tool (GroPoint part number 6300 available from www.gropoint.com). Refer to Appendix A of the GroPoint manual available at https://www.gropoint.com/products/soil-sensors/gropoint-profile/ from the Downloads tab. Use wires with clips to connect to the pins on the mote pointed out in the following instructions. Connect the other ends of the wires to the screw terminals on the SDI-12 programming tool.

To connect an SDI-12 programming tool to the mote:

1. Remove the mote batteries (see *Battery Information*).

2. Connect the programming tool to the mote, using the three J2 connection pins labeled PWR, DATA, and GND on the mote circuit board.
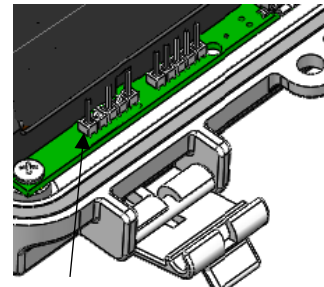
Connect the programming tool to these connection pins

Be sure to disconnect the programming tool before reinstalling the batteries in the mote.

Maintenance

The soil may pull away from the side of the probe over time, creating a crack in the soil. Use a slurry to fill it. Mix some of the soil in the immediate vicinity of the probe with water to make the slurry. Pour the slurry down the crack and allow it dry out and shrink. Repeat this process until the crack remains filled.

The mote is designed for outdoor use, but should be inspected periodically. When inspecting the mote, do the following:

- Verify the mote is free of visible damage or cracks.

- Make sure the mote is clean. Wipe off any dust or grime with a damp cloth.

- Wipe off any water before opening the mote.

- Make sure the interior seal is intact and free of any debris, and the latches are fully locked when the mote door is closed.

Removing the Sensor from the Soil

To remove a sensor probe from the soil:

1. Carefully dig out the soil around the top of the probe with a hand shovel, being sure not to damage the probe or cable. Dig out the hole until at least 30 cm (11.8 inches) of the probe is exposed.

2. Grasp the probe firmly with two hands as you pull it upwards. Do not grab onto the black probe head as it is not secured with enough strength for probe extraction. Do not pull the probe up by the sensor cable.

Updating Mote Firmware

If a new firmware version is available for the mote, use HOBOlink to download the file to your computer.

1. In HOBOlink, go to Devices, then RX Devices, and click your station name.

2. On the station page, click Overview and scroll down to Device Information.

3. Click the Wireless tab. This icon ⬚ appears next to the mote if there is a new version of firmware available.

4. Click the firmware ⬚ upgrade link. Click Download and save the firmware .bin file to your computer.

5. Connect the mote to the computer with a USB cable (open the mote door and use the USB port to the right of the LCD). The blue LED is illuminated while connected.

6. The mote appears as a new storage device in the computer's file storage manager. Copy the downloaded firmware file to the new storage device (the mote). The blue LED will blink slowly while the file is copying.

7. After the file is copied to the mote, the LED will stop blinking and remain a steady blue. Eject the storage device from the computer and disconnect the cable from the mote. The firmware installation process will begin automatically on the mote. The blue LED will blink rapidly while the firmware is installed. Once the firmware installation is complete, the LCD symbols return and the mote will automatically rejoin the network.

Notes:

- Mac® users: A message may appear indicating the disk has not ejected properly when disconnecting the mote from the computer. The mote is operational and you can ignore the message.

- If the blue LED turns off abruptly while copying the file or installing the firmware, a problem has occurred. Contact Onset Technical Support for help.

Battery Information

The mote uses two 1.2 V rechargeable NiMH batteries, charged by the built-in solar panel. The quality and quantity of solar light can affect whether the battery is sufficiently charged to last through the night and cloudy periods. Make sure the mote is placed in a location that will receive several hours of sunlight each day. If the mote does not receive enough sunlight to

recharge the batteries, the battery life is estimated at 3–4 months. When batteries are regularly recharged, expected battery life is estimated at 3–5 years. Battery life varies based on the ambient temperature where the mote is deployed, the logging interval, the number of tripped alarms, and other factors. Minimum recommended logging intervals as described in the specifications should be followed to keep the batteries charged. Deployments in extremely cold or hot temperatures can impact battery life. Estimates are not guaranteed due to uncertainties in initial battery conditions and operating environment.

Mote operation will stop when battery voltage drops to 1.8 V. Mote operation will return if the battery recharges to 2.3 V. If the batteries are unable to be recharged, replace them with fresh rechargeable batteries. **Note:** if you install used rechargeable batteries that together are less than 2.3 V, the mote will not resume operation.

To replace rechargeable batteries:

1. Open the mote door.

2. Remove the old batteries and install fresh ones observing polarity.

3. Make sure the solar panel cable is plugged in.
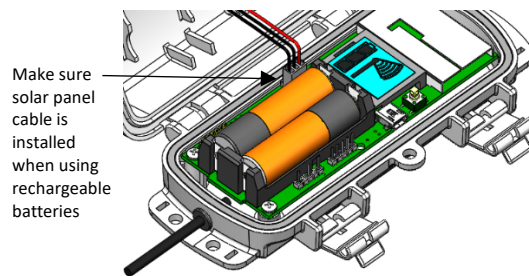
Make sure solar panel cable is installed when using rechargeable batteries

The mote contacts the network once the new batteries are installed. The green LED blinks quickly while the mote searches for a network to join and then blinks slowly while it completes the network registration. Once the mote has finished joining the network, the green LED turns off and the blue LED then blinks indefinitely while the mote is part of the network.

Lithium Batteries

You can use two 1.5 V non-rechargeable lithium batteries (HWSB-LI) for operation at the extreme ends of the mote operating range. The estimated battery life is one year with a minimum logging interval of 10 minutes for the RXW-GP3-xxx model or 15 minutes for the RXW-GP4-xxx model. The estimated battery life for the RXW-GP6-xxx model is seven months with a logging interval of 15 minutes. In addition, battery life is based on the ambient temperature where the mote is deployed, the number of tripped alarms, and other factors. Estimates are not guaranteed due to uncertainties in initial battery conditions and operating environment. When using lithium batteries, you must disconnect the solar panel cable because the batteries will not be recharged.

To install lithium batteries:

1. Open the mote door.

2. Remove any old batteries and install the new ones observing polarity.

3. Push in the side tab of the solar panel cable connector and pull the connector out of the cable port.

4. Place the connector in the slot on the inside of the mote door. Make sure the solar panel cables are tucked inside the door so that they do not interfere with the interior seal when the mote is closed.
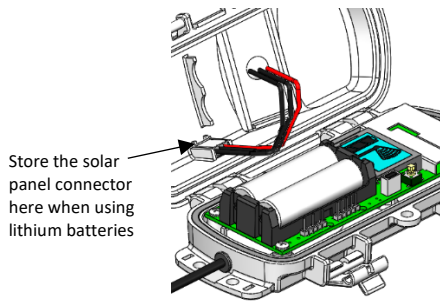
Store the solar panel connector here when using lithium batteries

The mote contacts the network once the new batteries are installed. The green LED blinks quickly while the mote searches for a network to join and then blinks slowly while it completes the network registration. Once the mote has finished joining the network, the green LED turns off and the blue LED then blinks indefinitely while the mote is part of the network.

⚠ **WARNING:** Do not cut open, incinerate, heat above 85°C (185°F), or recharge the lithium batteries. The batteries may explode if the mote is exposed to extreme heat or conditions that could damage or destroy the battery cases. Do not mix battery types, either by chemistry or age; batteries may rupture or explode. Do not dispose of the logger or batteries in fire. Do not expose the contents of the batteries to water. Dispose of the batteries according to local regulations for lithium batteries.

Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

Industry Canada Statements

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Avis de conformité pour l'Industrie Canada

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

To comply with FCC and Industry Canada RF radiation exposure limits for general population, the logger must be installed to provide a separation distance of at least 20cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

NCC Statement

經型式認證合格之低功率射頻電機，非經許可，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

低功率射頻電機之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。前項合法通信，指依電信法規定作業之無線電通信。低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

Translation:

Article 12

Without permission granted by the NCC, any company, enterprise, or user is not allowed to change frequency, enhance transmitting power or alter original characteristic as well as performance to an approved low power radio-frequency device.

Article 14

The low power radio-frequency devices shall not influence aircraft security and interfere with legal communications. If found, the user shall cease operating immediately until no interference is achieved. The said legal communications means radio communications is operated in compliance with the Telecommunications Act. The low power radio-frequency devices must be susceptible with the interference from legal communications or ISM radio wave radiated devices.

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