

RXW EC-5 or 10H Soil Moisture Sensor (RXW-SMx-xxx) Manual

RXW 10HS model shown

This sensor measures soil moisture and is designed to work with the HOBONet Wireless Sensor Network in which data is transmitted wirelessly from the sensor mote across the network to the RX3000 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

	RXW-SMC-xxx	RXW-SMD-xxx
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 (±3.1%) 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	±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 4 and 5
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
METER ECH2O Probe Part No.	EC-5	10HS
Sensor Operating Temperature Range	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), the soil moisture data collected at these extreme temperatures is outside of the sensor's accurate measurement range.	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), 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 mote battery life.

RXW EC-5 or 10H Soil Moisture Sensor**Models:**

- RXW-SMC-900 and RXW-SMD-900 (US)
- RXW-SMC-868 and RXW-SMD-868 (Europe)
- RXW-SMC-922 and RXW-SMD-922 (Australia/NZ)




Included Items:

- Protective cap
- Cable ties
- Screws

Wireless Mote

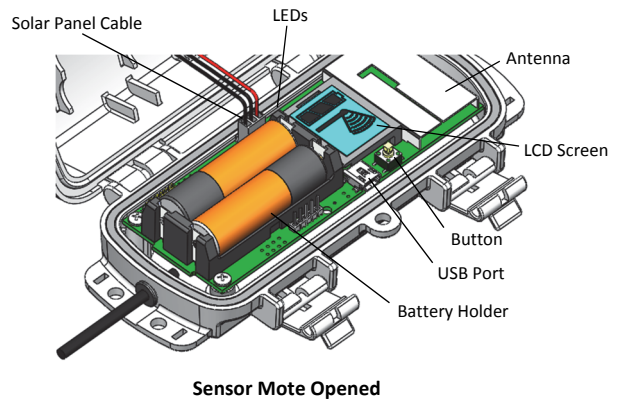
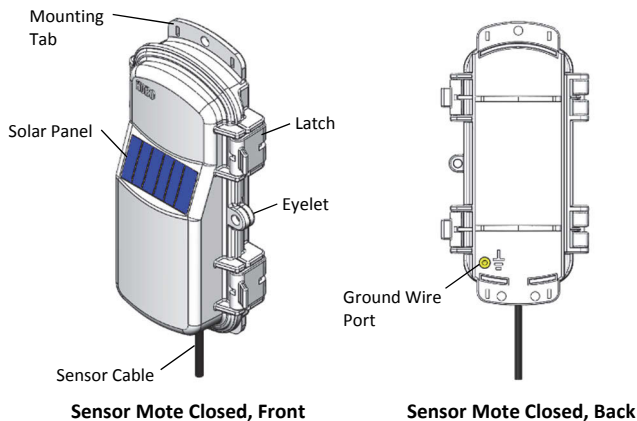
Operating Temperature Range	-25° to 60°C (-13° to 140°F) with rechargeable batteries -40 to 70°C (-40 to 158°F) with lithium batteries
Radio Power	12.6 mW (+11 dBm) non-adjustable
Transmission Range	Reliable connection to 457.2 m (1,500 ft) line of sight at 1.8 m (6 ft) high Reliable connection to 609.6 m (2,000 ft) line of sight at 3 m (10 ft) high
Wireless Data Standard	IEEE 802.15.4
Radio Operating Frequencies	RXW-SMC-900 and RXW-SMD-900: 904–924 MHz RXW-SMC-868 and RXW-SMD-868: 866.5 MHz RXW-SMC-922 and RXW-SMD-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	50 motes per one RX Wireless Sensor Network
Battery Type/Power Source	Two AA 1.2V rechargeable NiMH batteries, powered by built-in solar panel or two AA 1.5 V 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 <i>Deployment and Mounting</i>), operation outside this range will reduce the battery service life With lithium batteries: 1 year, typical use

Specifications (continued)

Memory	16 MB
Dimensions	RXW-SMC-xxx soil probe: 89 x 15 x 1.5 mm (3.5 x 0.62 x 0.06 in.) RXW-SMD-xxx soil probe: 160 x 32 x 2 mm (6.5 x 1.25 x 0.08 in.) Cable length: 5 m (16.4 ft) Mote: 16.2 x 8.59 x 4.14 cm (6.38 x 3.38 x 1.63 inches)
Weight	RXW-SMC-xxx sensor and cable: 180 grams (6.3 oz) RXW-SMD-xxx sensor and cable: 190 grams (6.7 oz) Mote: 223 g (7.87 oz)
Materials	Sensor: Weatherproof Mote: PCPBT, silicone rubber seal
Environmental Rating	Mote: IP67, NEMA 6
Compliance Marks	 RXW-SMC-900 and RXW-SMD-900: See last page  RXW-SMC-868 and RXW-SMD-868: The CE Marking identifies this product as complying with all relevant directives in the European Union (EU).  RXW-SMC-922 and RXW-SMD-922: See last page

- Note 1: (RXW-SMC-xxx and RXW-SMD-xxx) 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 *Sensor Operation* section for more details.
- Note 2: (RXW-SMC-xxx) 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 mote 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 mote is negligible.)
- Note 3: (RXW-SMC-xxx) 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 $0.061 \text{ m}^3/\text{m}^3$.
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.
- Note 4: (RXW-SMD-xxx) 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 mote 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 mote is negligible.)
- Note 5: (RXW-SMD-xxx) 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.

Mote Components and Operation



- Sensor Mote Opened**
- Mounting Tab:** Use the tabs at the top and bottom of the mote to mount it (see *Deploying and Mounting*).
- Solar Panel:** Position the solar panel towards the sun to charge the mote batteries (see *Deploying and Mounting*).

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 *Deploying and Mounting*).

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

Solar Panel Cable: This cable connects the built-in solar panel to the mote circuitry.

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.

Battery Holder: The location where the batteries are installed as shown (see *Battery Information*).

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 an RX Wireless Sensor Network to join (see *Adding the Mote to the RX Wireless Sensor Network*).

LCD Screen: The mote is equipped with an LCD screen that displays details about the current status. This 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 an RX Wireless Sensor Network.
	An empty signal strength icon plus the x icon indicates that the mote is not currently part of a network. See <i>Adding the Mote to the RX Wireless Sensor Network</i> 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 <i>Adding the Mote to the RX Wireless Sensor Network</i> for details).

LCD Symbol	Description
	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 Operation

The soil moisture 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.

The soil moisture 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. Readings outside the sensor frequency range may result in errors in HOBOLink.

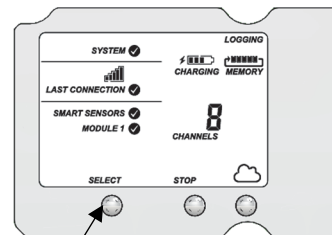
Adding the Mote to the RX Wireless Sensor Network

The mote must join an RX Wireless Sensor Network before it can begin measuring soil moisture and transmitting data. This requires accessing the RX3000 station and the mote at the same time so it is recommended that you complete these steps before deploying the mote.

Important: If you have not configured the RX3000 station with the RXW Manager, follow the instructions in the RX3000 Quick Start before continuing.

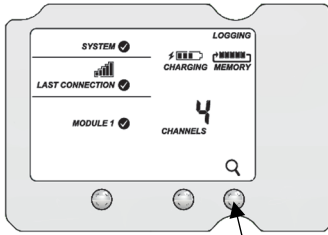
To add a mote to the RX Wireless Sensor Network:

1. If the LCD is blank on the RX3000 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 once if the HOBOLink RXW Manager is installed in the left slot (module 1) or twice if it is installed on the right slot (module 2).



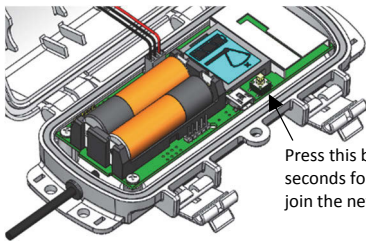
Press this button to view the module where the RXW Manager is installed

- Press the Search button (the magnifying glass). The magnifying glass icon will blink while the RX3000 is in search mode.



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

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

- Watch the LCD on the mote.



This signal strength icon blinks while searching for a network.



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



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

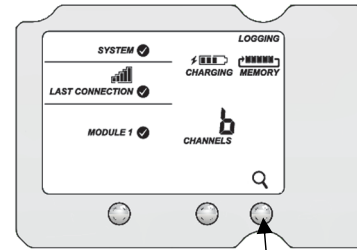


Once the mote has finished joining the network, the "x" icon is removed and the channel count on the station LCD increases by two (one for soil moisture and one for the mote battery).

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.

- Press the Search button (the magnifying glass) on the RX3000 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 RX3000 station LCD for the RXW Manager module will represent all measurement channels plus a battery channel for each mote in the RX Wireless Sensor Network.

Sensor measurements will be recorded at the logging interval specified in HOBOLink, transmitted to the RX3000 station, and uploaded to HOBOLink at the next connection interval (readout). 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 RX3000 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 RX3000 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.

Deployment and Mounting

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 RXW Manager, then use an RXW Repeater (RXW-RPTR-xxx). For example, if there is a hill between the sensor mote and the RXW Manager, place a repeater at the top of the hill between the sensor mote and the RXW Manager.
- There should not be more than five motes in any direction at their maximum transmission range from the RXW 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 RXW Manager at the RX3000 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 RX Wireless Sensor Network can support a maximum of 50 motes.
- 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.

Sensor Installation Guidelines

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 RXW-SMC sensor must be installed at least 3 cm (1.18 inches) from the soil surface and the RXW-SMD 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 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.

Maintenance

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

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 the latches are fully locked when the mote door is closed.

Calibration

The soil moisture 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.

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 > List 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

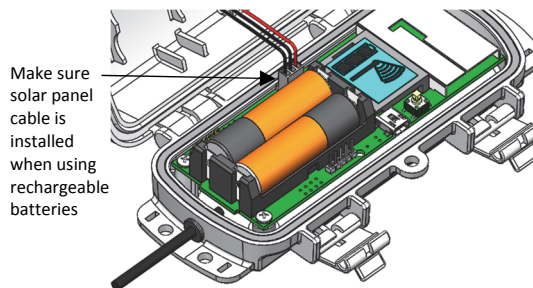
The mote uses two 1.2 V rechargeable NiMH batteries, charged by the built-in solar panel. The quality and quantity of solar light can affect whether the battery is sufficiently charged to last through the night and cloudy periods. Make sure the mote is placed in a location that will receive several hours 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. 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.



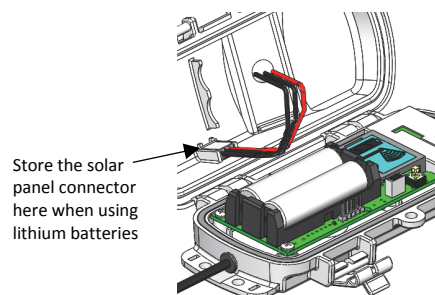
The mote contacts the network once the new batteries are installed. The green LED blinks quickly while the mote searches for a network to join and then blinks slowly while it completes the network registration. Once the mote has finished joining the network, the green LED turns off and the blue LED then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

Lithium Batteries

You can use two 1.5 V lithium batteries (HWSB-LI) for operation at the extreme ends of the mote operating range. Lithium battery life is estimated at 1 year, but varies based on the ambient temperature where the mote is deployed, the logging interval, 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.



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.