HOBO® MX Water Level Logger (MX2001-0x) Manual

HOBO MX Water Level Logger

Models:

- MX2001-01 or MX2001-01-Ti (Titanium), 9-meter/30-foot depth)
- MX2001-02, 30-meter/100-foot depth
- MX2001-03, 76-meter/250-foot depth
- MX2001-04 or MX2001-04-Ti (Titanium), 4-meter/13-foot depth

Note: Each model consists of a sensor end (MX2001-0x-S or MX2001-0x-Ti-S) and a top end (MX2001-TOP).

Included Items:

- Two AA 1.5 V Batteries
- Logger consisting of a top end and sensor end connected by a cable in desired length (ordered separately)

Required Items:

- HOBOmobile® 1.4 or later
- Device with iOS or Android™ and Bluetooth
- Cable (CABLE-DR-xxx)

Accessory:

- Well cap (WELL-CAP-01)

The HOBO MX water level logger is used for monitoring changing water levels in a wide range of applications, including streams, lakes, wetlands, tidal areas, and groundwater. This Bluetooth® Low Energy-enabled logger is designed for wireless communication with a mobile device. Using the HOBOmobile® app, you can easily configure the logger and read it out—all from its deployed location—to your phone or tablet where you can view the logged data or share it for further analysis. With HOBOmobile, you can also set a reference water level and water density, configure up to 8 logging intervals, log statistics, configure an alarm to trip at thresholds you specify, or set up burst logging in which data is logged at a different interval when sensor readings are above or below certain limits. This logger features a ceramic pressure sensor, durable housing, and an integrated barometric pressure sensor for barometric compensation in the logger, which allows for direct water level readout without needing to do any post processing. An optional cap is also available for deployment in existing wells or stilling wells. Without cumbersome vent tubes or desiccants to maintain and convenient data retrieval to a phone or tablet, this easy-to-use logger is an ideal solution for water level studies and research.

Specifications

Pressure (Absolute) and Water Level Measurements MX2001-01-S and MX2001-01-Ti-S

Operation Range	0 to 207 kPa (0 to 30 psia); approximately 0 to 9 m (0 to 30 ft) of water depth at sea level, or 0 to 12 m (0 to 40 ft) of water at 3,000 m (10,000 ft) of altitude
Factory Calibrated Range	69 to 207 kPa (10 to 30 psia), 0° to 40°C (32° to 104°F)
Burst Pressure	310 kPa (45 psia) or 18 m (60 ft) depth
Water Level Accuracy*	Typical error: ±0.05% FS, 0.5 cm (0.015 ft) water Maximum error: ±0.1% FS, 1.0 cm (0.03 ft) water
Raw Pressure Accuracy**	±0.3% FS, 0.62 kPa (0.09 psi) maximum error
Resolution	<0.02 kPa (0.003 psi), 0.21 cm (0.007 ft) water
Pressure Response Time (90%)**	<1 second at a stable temperature

Pressure (Absolute) and Water Level Measurements MX2001-02-S

Operation Range	0 to 400 kPa (0 to 58 psia); approximately 0 to 30.6 m (0 to 100 ft) of water depth at sea level, or 0 to 33.6 m (0 to 111 ft) of water at 3,000 m (10,000 ft) of altitude
Factory Calibrated Range	69 to 400 kPa (10 to 58 psia), 0° to 40°C (32° to 104°F)
Burst Pressure	500 kPa (72.5 psia) or 40.8 m (134 ft) depth
Water Level Accuracy*	Typical error: ±0.05% FS, 1.5 cm (0.05 ft) water Maximum error: ±0.1% FS, 3.0 cm (0.1 ft) water
Raw Pressure Accuracy**	±0.3% FS, 1.20 kPa (0.17 psi) maximum error
Resolution	<0.04 kPa (0.006 psi), 0.41 cm (0.013 ft) water
Pressure Response Time (90%)**	<1 second at a stable temperature

Pressure (Absolute) and Water Level Measurements MX2001-03-S

Operation Range	0 to 850 kPa (0 to 123.3 psia); approximately 0 to 76.5 m (0 to 251 ft) of water depth at sea level, or 0 to 79.5 m (0 to 262 ft) of water at 3,000 m (10,000 ft) of altitude
Factory Calibrated Range	69 to 850 kPa (10 to 123.3 psia), 0° to 40°C (32° to 104°F)
Burst Pressure	1,200 kPa (174 psia) or 112 m (368 ft) depth
Water Level Accuracy*	Typical error: ±0.05% FS, 3.8 cm (0.125 ft) water Maximum error: ±0.1% FS, 7.6 cm (0.25 ft) water
Raw Pressure Accuracy**	±0.3% FS, 2.55 kPa (0.37 psi) maximum error
Resolution	<0.085 kPa (0.012 psi), 0.87 cm (0.028 ft) water
Pressure Response Time (90%)**	<1 second at a stable temperature

Specifications (continued)

Pressure (Absolute) and Water Level Measurements MX2001-04-S and MX2001-04-Ti-S

Operation Range	0 to 145 kPa (0 to 21 psia); approximately 0 to 4 m (0 to 13 ft) of water depth at sea level, or 0 to 7 m (0 to 23 ft) of water at 3,000 m (10,000 ft) of altitude
Factory Calibrated Range	69 to 145 kPa (10 to 21 psia), 0° to 40°C (32° to 104°F)
Burst Pressure	310 kPa (45 psia) or 18 m (60 ft) depth
Water Level Accuracy*	Typical error: ±0.075% FS, 0.3 cm (0.01 ft) water Maximum error: ±0.15% FS, 0.6 cm (0.02 ft) water
Raw Pressure Accuracy**	±0.3% FS, 0.43 kPa (0.063 psi) maximum error
Resolution	<0.014 kPa (0.002 psi), 0.14 cm (0.005 ft) water
Pressure Response Time (90%)***	<1 second at a stable temperature

Barometric Pressure (MX2001-TOP)

Operation Range	66 to 107 kPa (9.57 to 15.52 psia)
Temperature Calibrated Range	-20 to 50°C (-4 to 122°C)
Accuracy	±0.2 kPa (±0.029 psi) over full temperature range at fixed pressure; maximum error ±0.5% FS
Water Level Accuracy*	Typical error: ±0.075% FS, 0.3 cm (0.01 ft) water Maximum error: ±0.15% FS, 0.6 cm (0.02 ft) water
Resolution	<0.01 kPa (0.0015 psi)
Response Time	<1 second at stable temperature
Stability (Drift)	<0.01 kPa (0.0015 psi) per year

Temperature Measurements (All Sensor End Models MX2001-0x-S and MX2001-0x-Ti-S)

|	
Operation Range	-20° to 50°C (-4° to 122°F)
Accuracy	±0.44°C from 0° to 50°C (±0.79°F from 32° to 122°F), see Plot A
Resolution	0.1°C at 25°C (0.18°F at 77°F), see Plot A
Response Time (90%)	5 minutes in water (typical)
Stability (Drift)	0.1°C (0.18°F) per year

Logger

|	
Operating Range	-20° to 50°C (-4° to 122°F)
Radio Power	1 mW (0 dBm)
Transmission Range	Approximately 30.5 m (100 ft) line-of-sight
Wireless Data Standard	Bluetooth Low Energy (Bluetooth Smart®)
Logging Rate	1 second to 18 hours
Logging Modes	Fixed interval, multiple intervals with up to 8 user-defined logging intervals and durations, or burst
Memory Modes	Wrap when full or stop when full
Start Modes	Immediate, date & time, or next interval
Stop Modes	When memory full, stop with HOBOmobile, date & time, or after a set logging period
Time Accuracy	±1 minute per month 0° to 50°C (32° to 122°F)
Battery	Two AA, 1.5 V alkaline batteries, user replaceable
Battery Life	1 year, typical with logging interval of 1 minute. Faster logging and/or statistics sampling intervals, entering burst logging mode, excessive readouts, checking of Full Status Details, and remaining connected with HOBOmobile will impact battery life.
Memory	256 KB memory (30,000 sets of measurements)
Full Memory Download Time	Approximately 2 minutes; may take longer the further the device is from the top end of the logger
Dimensions	Top end (MX2001-TOP): 2.54 cm (1.0 inches) diameter, 28.9 cm (11.4 inches) length; mounting hole 7.6 mm (0.3 inches) diameter
	Sensor end (MX2001-0x-S and MX2001-0x-Ti-S): 2.54 cm (1.0 inches) diameter, 9.91 cm (3.9 inches) length
	Note: The length of the water level logger cable (CABLE-DR-xxx) can vary -0% to +3% +10 cm (3.9 inches) from the length ordered. The logger adds 38.8 cm (15.3) inches to the length of the cable ordered.

Specifications (continued)

Weight	Top end (MX2001-TOP): Approximately 136 g (4.78 oz) in air
	Stainless sensor end (MX2001-0x-S): Approximately 106 g (3.74 oz) in air; approximately 53.9 g (1.9 oz) in fresh water
	Titanium sensor end (MX2001-0x-Ti-S): Approximately 80 g (2.83 oz) in air; approximately 37 g (1.3 oz) in fresh water
Wetted Materials	Top end (MX2001-TOP): PVC housing, Polycarbonate end cap, Viton O-ring
	Stainless sensor end (MX2001-0x-S): Acetal housing, Viton and Buna-N O-rings, ceramic sensor in stainless steel end cap
	Titanium sensor end (MX2001-0x-Ti-S): Acetal housing, Viton and Buna-N O-rings, ceramic sensor in Titanium end cap
	Cable (CABLE-DR-XXX): Polycarbonate end cap, PVC end cap, polycarbonate collar nut, Viton O-rings, polyurethane jacket
Environmental Rating	NEMA 6, IP67 (top end)
CE	The CE Marking identifies this product as complying with all relevant directives in the European Union (EU).
FC	See last page

* Water Level Accuracy: With accurate reference water level measurement, known water density, and a stable temperature environment. System Water Level Accuracy equals the sum of the Barometric Water Level Accuracy plus the selected sensor end Water Level Accuracy.

** Raw Pressure Accuracy: Absolute pressure sensor accuracy includes all sensor drift, temperature, and hysteresis-induced errors.

*** Changes in Temperature: Allow 20 minutes in water to achieve full temperature compensation of the pressure sensor. There can be up to 0.5% of additional error due to rapid temperature changes. Measurement accuracy also depends on temperature response time.
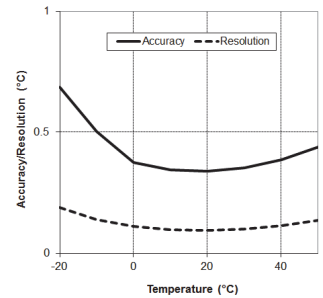
Plot A

Logger Components and Operation
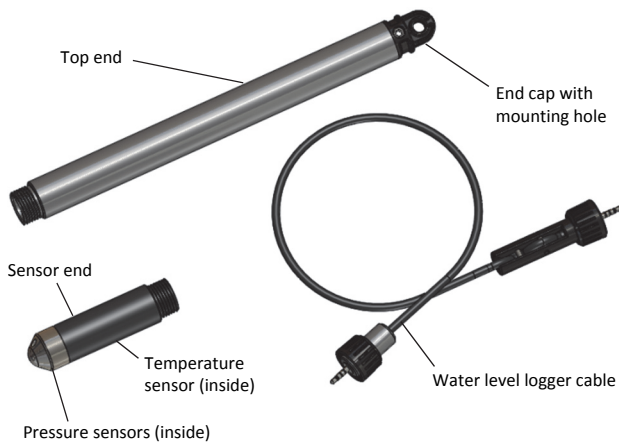
The MX water level logger consists of a top end and a sensor end that is connected by a water level logger cable. The three components work together to allow for wireless transfer of data to the HOBOmobile app on a mobile phone or tablet. This is an overview of each component:

- **Top end.** This contains the Bluetooth wireless communication and two AA batteries. This top end unit is suspended from the top of the well using the mounting hole in the end cap (see *Deploying the Logger*).

- **Sensor end.** This measures the pressure and temperature in the water. The nose cone on the sensor end houses the pressure sensors and the body of the sensor end houses the temperature sensor.

- **Water level logger cable.** This is the cable that connects the top end to the sensor end. Data measured by the sensor is transmitted through the cable to the top end where it is logged for later upload to a mobile phone or tablet (see *Getting Started with the Logger*).

When the three components are deployed together, you can then configure the logger or offload data to your mobile device without having to pull the logger up to the surface.

Factory Calibration

The pressure sensors in the sensor end are individually calibrated. During calibration, raw pressure sensor data is collected at multiple pressures and temperatures over the calibrated range of the logger (see *Specifications*). This data is used to generate calibration coefficients that are stored in the sensor end's non-volatile memory. The calibration coefficients are then checked to be sure that the logger meets its stated accuracy over the calibrated range. The pressure sensor can be used at pressures and temperatures that are outside of the calibrated range, but the accuracy cannot be guaranteed.
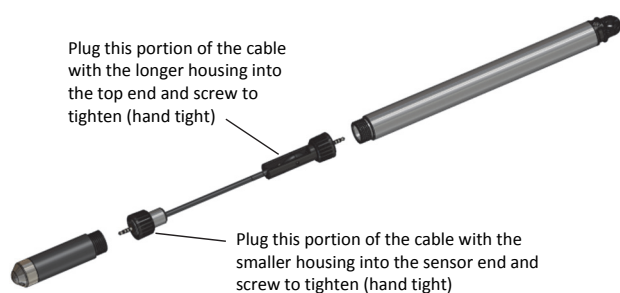
Important: Never exceed the burst pressure of the sensor!

Getting Started with the Logger

Follow these steps to begin using the logger. After completing steps 1–4, it is recommended that you perform a trial run of steps 5 through 12 before deploying the logger.

> **Important:** When assembling the logger or attaching the cable, make sure the O-rings and mating housing surfaces are clear of any debris. Any contamination of these surfaces can cause leaks that will lead to logger failure.

1. **Install the batteries in the top end.** See *Battery Information* for details.

2. **Connect the logger components.** Connect the top end to the sensor end with the water level logger cable as shown below. The end of the cable with the longer housing connects to the top end as shown below.
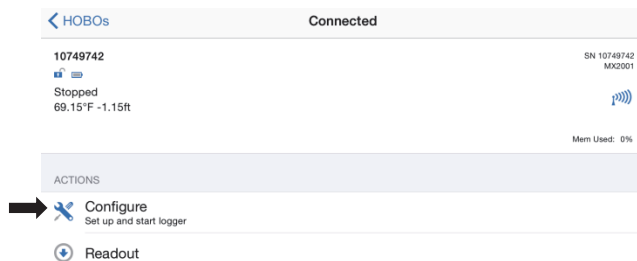
Plug this portion of the cable with the longer housing into the top end and screw to tighten (hand tight)

Plug this portion of the cable with the smaller housing into the sensor end and screw to tighten (hand tight)

3. **Download HOBOmobile.** Go to the App Store℠ or Google Play™ and download the HOBOmobile app to your phone or tablet.

4. **Open HOBOmobile.** Enable Bluetooth in your device settings if prompted.

5. **Determine the logger is within range.** In HOBOmobile, tap **HOBOs** at the bottom of the screen. The logger should appear in the In Range list in the HOBOs screen as shown below (note that the serial number shown in HOBOmobile is for the top end of the logger). If it does not appear in the list, make sure the logger is within range of your device. Note that sensor readings are displayed as "--" when the logger is stopped. Readings are updated every minute while the logger is logging and in range.

IN RANGE

SN 10749742   SN 10749742
                                      MX2001
Stopped
70.01°F 0.00ft
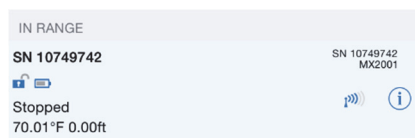
6. **Deploy the logger if ready.** If you are ready to deploy the logger, place it in the deployment location (see *Deploying the Logger* for deployment guidelines). Otherwise, skip deployment and complete the following steps as a test.

7. **Connect to the logger**. Tap a row in the In Range list to connect to the logger. Tips for connecting:

- Make sure the top end of the logger is within range of your mobile device. The range for successful wireless communication is approximately 30.5 m (100 ft) with full line-of-sight.
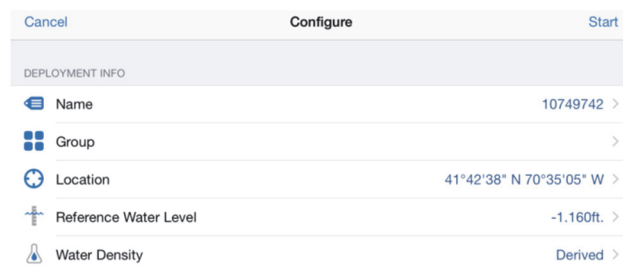
- If your device can connect to the logger intermittently or loses its connection, move closer to the top end of the logger, within sight if possible.

- If the logger appears in the In Range list, but you cannot connect to it or if you are experiencing persistent connection problems, close HOBOmobile and power cycle the mobile device (turn it off, wait a minute, and turn it back on). This forces the previous Bluetooth connection to close.

8. **Configure the logger.** Once connected to the logger, tap Configure to set up the logger.
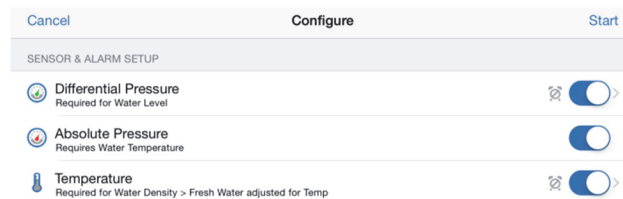
HOBOs   Connected

10749742   SN 10749742
                                           MX2001
Stopped
69.15°F -1.15ft

                                   Mem Used: 0%

ACTIONS

Configure
Set up and start logger

Readout

9. **Set the Reference Water Level and Water Density.**

a. In the Configure screen, tap Reference Water Level or Water Density and enter the current water level as the reference level in meters or feet. Water levels that are below the reference point should be entered as negative values. The reference water level entered will be associated with a data point taken upon tapping Start (step 12) to determine the correction factor to be used for water level data.

b. Select the water density for the deployment or enter your own value under Manual Input.

c. Tap Done to return to the Configure screen.

Cancel   Configure   Start

DEPLOYMENT INFO

Name   10749742 >

Group   >

Location   41°42'38" N 70°35'05" W >

Reference Water Level   -1.160ft. >

Water Density   Derived >

10. **Enable the desired sensors.** Differential pressure must be enabled to calculate water level. Temperature must be enabled to log absolute pressure. Temperature must also be enabled if you selected the water density option "Fresh Water adjusted for Temp" because the temperature values are used to calculate the water density.

Cancel   Configure   Start

SENSOR & ALARM SETUP

Differential Pressure
Required for Water Level

Absolute Pressure
Requires Water Temperature

Temperature
Required for Water Density > Fresh Water adjusted for Temp

11. **Finish configuring the logger.** Select any of the following logger settings as desired. The following table provides an overview of the settings. For complete details, see the *HOBOmobile User's Guide*. Note: If you are deploying multiple loggers and set the HOBOmobile time-saving options to Automatically Start, the configure screen still may be shown so that you can verify or enter the correct reference water level and water density values for each logger. See the *HOBOmobile User's Guide* for more details.

Logger Setting	Action
Name	Enter a name for the logger up to 20 characters. This name will be used as the title on the graph and in the file name. A name also helps identify the logger in the HOBOs screen in HOBOmobile. If no name is entered, the logger serial number is used.
Group	Add the logger to the Favorites group or a custom group to help identify the logger and its resulting data files.
Logging Interval	Select how often the logger will record data when in normal mode, from 1 second to 18 hours. When selecting a logging interval, keep in mind that data offload time is proportional to the amount of data logged. The faster the logging interval, the more data that will need to be offloaded and the longer it will take. **Multi-Rate Logging** You can set a total of 8 logging intervals. Click the plus icon to add a logging interval and select a rate from 1 second to 18 hours. Select the number of samples to be logged during this interval. If this is the last logging interval, then an approximation of samples that will occur before memory fills is shown instead.
Start Logging Options	Choose one of the following: • **Now.** Logging will begin immediately after selecting Start. • **On Next Logging Interval.** Logging will begin at the next even interval as determined by the selected logging interval. • **On Date/Time.** Logging will begin at a date and time you specify.
Stop Logging Options	Choose a memory option: • **When Memory Fills.** The logger will continue recording data until the memory is full. • **Never (Wrap When Full).** The logger will continue recording data indefinitely, with newest data overwriting the oldest. This option is not available if the Logging Mode is set to Burst (see *Burst Logging*) or if you set up multiple logging intervals. Choose a time-based option: • **Never.** Select this if you do not want the logger to stop at any predetermined time frame. • **On Date/Time.** Select this if you want the logger to stop logging on a specific date and time. Select the date and time and then tap Done. • **After.** Select this if you want to control how long the logger should continue logging once it

Logger Setting	Action
	starts. Choose the amount of time you want the logger to log data and then tap Done. For example, select 30 days if you want the logger to log data for 30 days after logging begins.
Alarms	Enable and configure sensor alarms. See *Setting up Alarms* for details.
Logging Mode and Statistics	Choose the logging mode and statistics (note that you cannot change the logging mode from Normal if you have multiple logging intervals configured): • **Fixed Interval.** Select this for the logger to record data at each logging interval or statistics sampling interval for all enabled sensors and/or selected statistics. Note that this is also the mode you need to select for multi-rate logging. • **Burst Logging.** Select this to enable burst mode in which logging can occur at a faster rate when a specified trigger level is exceeded. See *Burst Logging* for more information. • **Normal.** Select this to log current readings for enabled sensors. You must select this to log sensor data, including water level and barometric pressure data. • **Statistics.** Select any statistics you want to record (maximum, minimum, average, and standard deviation) and set the statistics sampling interval. Statistics are not available for water level and barometric pressure data. See *Statistics Logging* for more information.

12. **Start the logger.** Tap Start in the upper right corner of the Configure screen. The logger will begin logging data based on the settings you selected. After logging begins, you can read out the logger at any time (see *Reading Out the Logger* for details). You can update the reference water level or water density during the deployment if necessary (see *Updating the Reference Water Level and Water Density*).

Notes:

• When the logger is stopped, the water level reading shown while connected to the logger does not reflect any reference water level and water density values you have entered (it reverts to a reference water level of zero and a water density of "Fresh Water adjusted for Temperature"). Once logging begins, the readings shown in HOBOmobile will be based on the reference water level and water density you entered.

• If the logger is logging and you start a new deployment, the logger will take a current water level reading and use that as the default reference reading for the new deployment.

• HOBOmobile has time-saving options available in the Settings. If you select the "Previous Configuration" option under "Fill Configure Screen with Contents of," the

Configure screen will show the logging setup from the last logger configured and the reference level, water density, sensor, and alarm settings from the currently connected logger. Make sure the settings are correct for this deployment.

Deploying the Logger

The logger is designed to be easy to deploy in many environments. The logger includes an absolute pressure sensor and a barometric pressure sensor so no vent tube is required. Follow these guidelines when deploying the logger:

- The absolute pressure sensor is temperature compensated over the range of 0° to 40°C (32° to 104°F). The barometric pressure sensor is temperature compensated over the range of -20° to 50°C (-4° to 122°F). To obtain the highest level of accuracy, both the sensor end and top end units of the logger should be allowed to come to full temperature equilibrium (approximately 20 minutes) before the reference level is entered.

- Sudden temperature changes should be avoided.

- When deploying the logger in a well, make sure the well is vented to the atmosphere. Typically, a small hole can be drilled in the side of the well cap to ensure that the pressure inside and outside the well is at equilibrium. You can also use the Onset well cap (WELL-CAP-01).

- There is a vent for the barometric sensor at the top of the logger (in the top end). This vent must not collect water or it will block proper barometric pressure readings. To avoid collecting water, the logger should be hung vertically and the vent hole in the well cap should not be oriented directly above the vent in the top end of the logger. If the logger must be mounted at an angle, the vent in the top end should point down so that any water will drain out of it.

- Consider using slots for a mounting bolt at the top of the well rather than holes so that the logger can be pulled up easily for well access without having to remove nuts in the field. This can reduce the chances for small parts falling into the water and being lost.

- Any change in length of the logger cable will result in a 1-to-1 corresponding error in the depth measurement. Always pull-test a cable prior to deploying a logger in a well to make sure it does not stretch.

- The top of the logger must be close to the surface and not shielded in metal so that your phone or tablet can connect to it. The maximum range for communication is 30.5 m (100 ft) with full line-of-sight.

- If you are deploying the logger in a lake, river, or stream, you must first build a stilling well to protect the logger, sensor, and cable. A simple stilling well can be constructed with PVC or ABS pipe. A properly constructed stilling well holds the sensor in position and protects the logger components from currents, wave action, and debris. Suspend the sensor end in the stilling well so it is always underwater, but not on the bottom to be buried by silt.

- To prevent the sensor from moving in currents and to ensure the support cable is kept straight during deployment, you may need to add a weight to the suspension cable just above the sensor or hang a weight below the sensor. In some cases, you may need to both add a weight and use a stilling well.

- Be very careful not to exceed the burst pressure for the sensor. The pressure sensor will burst if the maximum depth is exceeded (see *Specifications*). The sensor should be positioned at a depth where it will remain in the water for the duration of the deployment, but not exceed the rated bursting depth.

To deploy the logger:

1. Make sure the top end is connected to the sensor end with the water level logger cable as described in *Getting Started with the Logger*.

2. Attach any small parts, such as bolts with nuts, before you go into the field so you don't risk losing them in the field.

3. Lower the logger into the well or stilling well.

4. Use the Onset well cap if it is a 5 cm (2 inch) well. Otherwise, use a 1/4-inch bolt of sufficient length to span the well top or washer. Mount the logger as follows:

   - The top end must be above any metal well to ensure good wireless transmission.

   - Make sure there is access for measuring the water level in the well. In some cases, such as when using the Onset well cap, it will be necessary to pull the top end of the logger out of the well to get a water level meter sensor into the well.

   - Make sure the logger cannot accidentally fall in the well.

   - If the cable is too long, loop the cable and secure the cable with multiple zip ties to ensure the loop does not slip. The looped cable should be tight enough that the cable can be easily pulled out of the well if necessary, but it must not bend the cable any tighter than a 1.25 cm (0.5 inch) radius to prevent damage to the cable.

5. Measure the water level from the desired reference point (top of pipe, ground level, or sea level) and enter it in HOBOmobile. Note that you may need to pull the top end out of the well to gain access for measuring the water level within the well. Follow these guidelines for determining the reference level:

   - To maximize accuracy, allow 20 minutes after deploying the logger before measuring water depth to allow the logger to reach temperature equilibrium with the water.

   - If the well is too small in diameter to measure the water depth while the logger is deployed, measure the water depth before deployment, then deploy the logger immediately.

- If the water level surface is below the reference point as shown below, enter the reference water level in HOBOmobile as a negative number.
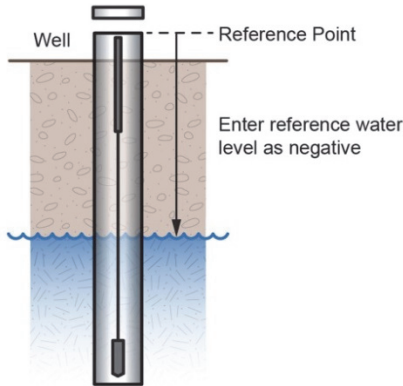
- If the water level surface is above the reference point as shown below, enter the reference water level in HOBOmobile as a positive number.
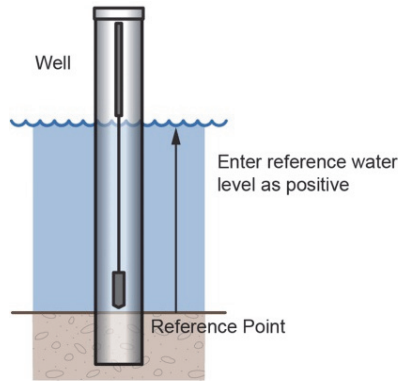

- If you are using the sensor as the reference point as shown below, enter the reference water level in HOBOmobile as zero and start the logger before the sensor is in the water. The logged water level readings will represent the height above the sensor.
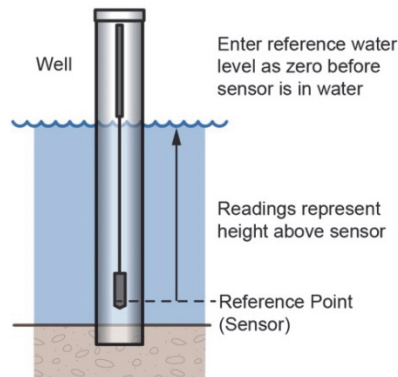
Setting up Alarms

You can set an alarm to trip on the logger when a sensor reading rises above or falls below a specified value. This can alert you to problems so you can take corrective action. To set an alarm:

1. Tap **HOBOs** and select a logger in the In Range list to connect to it.

2. Once connected, tap Configure.

3. If you are going to set up a water level alarm, you must enter the reference water level and water density before setting the alarm levels.

4. In Sensor & Alarm Setup, tap an enabled sensor. Tap Differential Pressure if you want to set a water level alarm. Tap Temperature to set a temperature alarm. You cannot configure alarms for absolute pressure. Note: The Normal logging mode must be enabled to configure a water level alarm.

5. Enable the High Alarm if you want an alarm to trip when the sensor reading rises above the high alarm value. Drag the slider to the reading that will trip the alarm or tap the value field and type a specific reading. In the example on the next page, an alarm will trip when the water temperature rises above 85°F. If you are configuring a water level alarm, enter the limit value for water level and HOBOmobile will show the differential pressure level that will be used to trigger the alarm in the logger.

6. Enable the Low Alarm if you want an alarm to trip when the sensor reading falls below the low alarm value. Drag the slider to the reading that will trip the alarm or tap the value field and type a specific reading. In the example on the next page, an alarm is configured to trip when the temperature falls below 32°F.

7. Under Raise Alarm After, select the duration before an alarm is tripped.
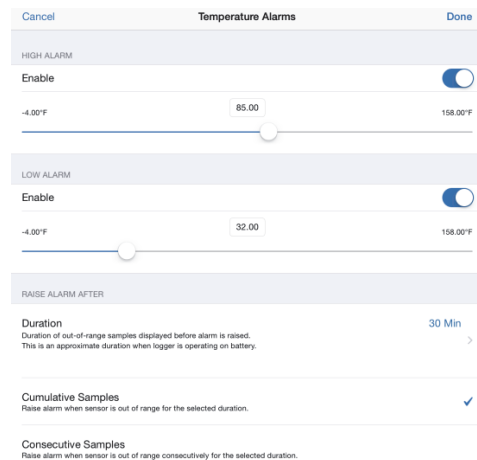
8. If you select Cumulative Samples, then the alarm will trip when the time the sensor is out of range over the course of the deployment is equal to the selected duration. If you select Consecutive Samples, then the alarm will trip when the time the sensor is continuously out of range is equal to the selected duration. For example, the high alarm for temperature is set to 85°F and the duration is set to 30 minutes. If Cumulative is selected, then an alarm will trip once a sensor reading has been at or above 85°F for a total of 30 minutes since the logger was configured; specifically, this could be 15 minutes above 85°F in the morning and then 15 minutes above 85°F again in the afternoon. If Consecutive is selected, then an alarm will trip only if all

sensor readings are 85°F or above for a continuous 30-minute period.

9. Tap Done and repeat steps 4–9 for the other sensor if desired.

10. Back in the Configure screen, the Sensor in Limits alarm option should be enabled. This indicates the alarm icon will remain visible in HOBOmobile until the sensor reading returns to the normal range between any configured high and low alarm limits.

11. Tap Start in the Configure screen to load the alarm settings onto the logger if you are ready to start.

Notes:

*   The actual values for the high and low alarm limits are set to the closest value supported by the logger. For example, the closest value to 85°F that the logger can record is 84.990°F and the closest value to 32°F is 32.043°F. In addition, alarms can trip or clear when the sensor reading is within the logger specifications of 0.1°C resolution. This means the value that triggers the alarm may differ slightly than the value entered. For example, if the High Alarm is set to 75.999°F, the alarm can trip when the sensor reading is 75.994°F (which is within the 0.1°C resolution).

*   When setting water level alarm limits, make sure that the water level remains constant from the time alarm limits are set until the time the logger is started.

*   If you need to change the reference water level during the deployment, you will also need to re-enter the alarm limits based on the new reference water level.

*   The alarm icon will appear in the HOBOs screen in HOBOmobile next to the logger name or serial number when the alarm trips if the device is within range of the logger.

*   Once an alarm condition clears, the alarm icon in HOBOmobile will go away. There is no option to keep the alarm icon visible until the logger is reconfigured.

*   When you read out the logger, alarm events can be displayed on the plot or in the data file. See *Internal Logger Events*.
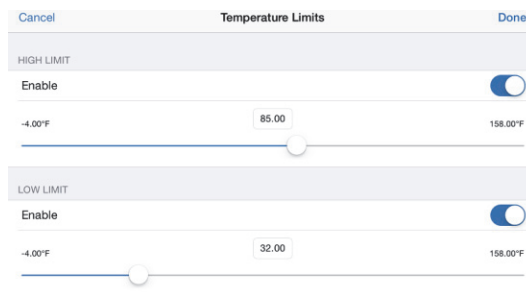
Burst Logging

Burst logging is a logging mode that allows you to set up more frequent logging when a specified condition is met. For example, a logger is recording data at a 5-minute logging interval and burst logging can be configured to log every 30 seconds when the water temperature rises above 85°F (the high limit) or falls below 32°F (the low limit). This means the logger will record data every 5 minutes as long as the water temperature remains between 85°F and 32°F. Once the water temperature rises above 85°F, the logger will switch to the faster logging rate and record data every 30 seconds until the temperature falls back to 85°F. At that time, logging then resumes every 5 minutes at the normal logging interval. Similarly, if the temperature falls below 32°F, then the logger would switch to burst logging mode again and record data every 30 seconds. Once the water temperature rises back to 32°F, the logger will then return to normal mode, logging every

5 minutes. **Note:** Sensor alarms, statistics, and the Stop Logging option "Wrap When Full" are not available in burst logging mode.

To set up burst logging:

1. Tap ⬚ HOBOs and select a logger in the In Range list to connect to it.

2. Once connected, tap Configure.

3. If you are going to set up burst logging for water level, you must enter the reference water level and water density before setting the burst limits.

4. Tap Logging Mode and then tap Burst Logging.

5. Tap a sensor under Burst Sensor Limits.

6. Enable High Limit if you want burst logging to occur when the sensor reading rises above a specific reading. Drag the slider to the reading that will trigger burst logging or tap the value field and type a specific reading. In this example, the logger will switch to burst logging when the water temperature rises above 85°F. If you are configuring burst logging for water level, enter the limit value for water level and HOBOmobile will show the differential pressure level that will be used to trigger burst logging in the logger.

7. Enable Low Limit if you want burst logging to occur when the sensor reading falls below a specific reading. Drag the slider to the reading that will trigger burst logging or tap the value field and type a specific reading. In the example, the logger will switch to burst logging when the water temperature falls below 32°F.

8. Tap Done and repeat steps 5–8 for the other sensor if desired.

9. Tap Burst Logging Interval and select an interval faster than the logging interval. Keep in mind that the more frequent the burst logging rate, the greater the impact on battery life and the shorter the logging duration. Tap Done.

10. Tap Done to exit the Logging Mode screen.

11. Tap Start in the Configure screen to load the burst settings onto the logger if you are ready to start.

Notes:

*   Once the logger is configured, the high and low burst limits are checked once every 15 seconds. Therefore, if you set the logging interval to less than 15 seconds and the sensor reading falls outside the levels, the burst logging will not begin until the next 15-second refresh cycle.

*   If high and/or low limits have been configured for more than one sensor, then burst logging will begin when any

high or low condition goes out of range. Burst logging will not end until all conditions on all sensors are back within normal range.

- The actual values for the burst logging limits are set to the closest value supported by the logger. For example, the closest value to 85°F that the logger can record is 84.990°F and the closest value to 32°F is 32.043°F.

- When setting water level limits for burst logging mode, make sure the water level remains constant from when the burst limits are set until when the logger is started.

- If you need to change the reference water level during the deployment, you will also need to re-enter the burst limits based on the new reference water level.

- Burst logging mode can begin or end when the sensor reading is within the logger specifications of 0.1°C resolution. This means the value that triggers burst logging may differ slightly than the value entered. For example, if the high limit for a water temperature alarm is set to 75.999°F, burst logging can start when the sensor reading is 75.994°F (which is within the 0.1°C resolution).

- Once the high or low condition clears, the logging interval time will be calculated using the last recorded data point in burst logging mode, not the last data point recorded in "normal mode." For example, let's assume the logger has a 10-minute logging interval and logged a data point at 9:05. Then, the high limit was surpassed and burst logging began at 9:06. Burst logging then continued until 9:12 when the sensor reading fell back below the high limit. Now back in normal mode, the next logging interval will be 10 minutes from the last burst logging point, or 9:22 in this case. If burst logging had not occurred, the next data point would have been at 9:15.

- A New Interval event is created each time the logger enters or exits burst logging mode. See *Internal Logger Events* for details on plotting and viewing the event. In addition, if the logger is stopped via HOBOmobile while in burst logging mode, then a New Interval event is automatically logged and the burst condition is cleared, even if the actual high or low condition has not cleared.

Statistics Logging

During fixed interval logging, the logger records data for enabled sensors and/or selected statistics at the logging interval selected. Statistics are calculated at a sampling rate you specify with the results for the sampling period recorded at each logging interval. The following statistics can be logged for each sensor:

- The maximum, or highest, sampled value,

- The minimum, or lowest, sampled value,

- An average of all sampled values, and

- The standard deviation from the average for all sampled values.

For example, a logger is configured with the absolute pressure, differential pressure, and water temperature sensors enabled, and the logging interval set to 5 minutes. The logging mode is set to fixed interval logging with Normal and all four statistics enabled and with a statistics sampling interval of 30 seconds.

Once logging begins, the logger will measure and record the actual absolute pressure, differential pressure, and water temperature sensor values every 5 minutes as well as calculate the water level and barometric pressure. In addition, the logger will take readings for the enabled sensors every 30 seconds and temporarily store them in memory. The logger will then calculate the maximum, minimum, average, and standard deviation using the samples gathered over the previous 5-minute period and log the resulting values. When reading out the logger, this would result in 17 data series: 5 sensor-related series (differential pressure, absolute pressure, barometric pressure, temperature, and water level with data logged every 5 minutes) plus 12 maximum, minimum, average, and standard deviation series (four for differential pressure, four for absolute pressure, and four for temperature with values calculated and logged every 5 minutes based on the 30-second sampling). Statistics are not available for barometric pressure and water level data.

To log statistics:

1. Tap HOBOs and select a logger in the In Range list to connect to it.

2. Once connected, tap Configure.

3. Tap Logging Mode and then select Fixed Interval Logging.

4. Select Normal to record the current reading for each enabled sensor at the logging interval shown at the top of the screen.

> **Important:** You must select Normal if you want to log water level and barometric pressure data. If you deselect Normal, the logger will not be able to calculate water level or barometric pressure.

5. Select the statistics you want the logger to record at each logging interval: Maximum, Minimum, Average, and Standard Deviation (average is automatically enabled when selecting Standard Deviation). Statistics will be logged for all enabled sensors. In addition, the more statistics you record, the shorter the logger duration and the more memory is required.

6. Tap Statistics Sampling Interval and select the rate to use for calculating statistics. The rate must be less than, and a factor of, the logging interval. For example, if the logging interval is 1 minute and you select 5 seconds for the sampling rate, then the logger will take 12 sample readings between each logging interval (one sample every 5 seconds for a minute) and use the 12 samples to record the resulting statistics at each 1-minute logging interval. Note that the more frequent the sampling rate, the greater the impact on battery life.

7. Tap Done.

8. Tap Done again to exit the Logging Mode screen.

9. Tap Start in the Configure screen to load the statistics settings onto the logger if you are ready to start.

You can plot the statistics series once you read out the logger. Note that the logger will always display the current sensor readings in HOBOmobile even if they are not being logged.

Updating the Reference Water Level and Water Density

The logger calculates data based on the reference water level and water density settings in HOBOmobile. You may need to update these settings during deployment. These are guidelines for when to update reference water level or water density.

- The reference water level may need to be adjusted to compensate for drift (see *Compensating for Drift*) or for cable stretch in water level logger cables longer than 30 meters (100 feet). Check the reference reading in the first couple of months of deployment when using a long cable and update the reference water level as necessary. Once stabilized, you should not need to reset the reference water level for several months.

- If you realize during a deployment that the reference water level and water density you entered are not as accurate as needed, then you will need to update them.

- If you update the water density, you will also need to enter a new reference water level reading. Once the new values are entered and you tap Update, a reading is taken and will be used to calculate a new calibration constant that will be applied to all data for the current deployment (both before and after the new values are entered).

- If you only want to change future data, then stop the current deployment, offload the data, and start a new deployment with the new water parameters.

To change the reference water level or water density:

1. Tap HOBOs and tap the logger to connect to it.

2. Once connected, tap Update Reference Water Level or Update Water Density.

3. Enter the current water level as the new reference water level, making sure you have selected the proper units.

4. Change the water density if needed, making sure you have selected the proper units.

5. Tap Update. The changes will take effect immediately. This will result in reference water level and water density events in the data file (see *Internal Logger Events*). **Note:** Saving the changes is a two-part process. If there is a failure during the first part of the process (during the update portion), these events are still logged, but the old water level and water density values are listed and still in use. You will need to re-enter the new reference water level and water density changes in this case. If there is a failure during the second part of the process (during the save portion), the changes will take effect as expected.

Reading Out the Logger

To read out the logger:

1. Tap HOBOs.

2. Find the logger you wish to offload in the In Range list and tap that row.

3. Once connected, tap Readout.

4. Tap Data Files to view a mini-graph of the offloaded data.

5. Tap the mini-graph to view a larger version of the graph or to share the file.

- To add or remove sensor data or events in the large graph, tap ☰ and select the sensors or events as desired (see *Internal Logger Events* for more details on events).

- To share the data file, tap ⬆ and select the type of data file you wish to share. Mail, copy the file, or open it in a supported app.

See the *HOBOmobile User's Guide* for details on viewing graphs and sharing data. Data can also be uploaded automatically to HOBOlink, Onset's web-based software. For details on working with data in HOBOlink, refer to the HOBOlink Help.

You can also change the reference water level, reference time, and water density in the data file as needed.

> **Important:** Editing the water parameters permanently changes the data file. If you need the original data, share the data file as described above before making the changes.

To change the water parameters:

1. Tap ⓘ at the top right corner of the large graph.

2. Tap Edit Reference Water Level, Edit Reference Time, or Edit Water Density.

3. In the Water Parameters screen, you can do the following:

- Enter a new reference water level value and/or change the water level units.

- Tap Reference Time and select a time associated with a logged data point for when the reference reading was taken. Tap Done to return to the Water Parameters screen.

- Change the water density used for the file and/or the units.

4. Tap Done to close the Water Parameters screen and then Done again to close the Data File Details screen. The graph and data file will be updated to include these changes. Note that the mini-graph will not be updated.

See the *HOBOmobile User's Guide* for additional details on viewing graphs and sharing data.

Internal Logger Events

The logger records the following internal events to track logger operation and status. To see these events on a plot in HOBOmobile, tap a mini-graph and then tap ☰. Select the events you wish to plot and then tap ☰ again. You can also view events in shared or exported data files.

Internal Event Name	Definition
Host Connected	The logger was connected to a mobile device.
Started	The logger received a command to start

Internal Event Name	Definition
	recording data from the software.
Stopped	The logger received a command to stop recording data from the software.
Reference Water Level	The reference water level for the logger has been updated. The new reference water level is listed with the event.
Water Density	The water density for the logger has been updated. The new water density value is listed with the event.
Chan <#> Alarm Tripped	A sensor alarm has tripped; <#> is the sensor number, where 1 is differential pressure (water level) and 2 is temperature.
Chan <#> Alarm Cleared	A sensor alarm has cleared; <#> is the sensor number, where 1 is differential pressure (water level) and 2 is temperature.
New Interval	The logger has entered or exited burst logging mode.
Safe Shutdown	The battery level dropped below 1.85 V; the logger performs a safe shutdown.

## Setting a Logger Password

You can assign the logger a password to prevent other devices from connecting to it. To set a password:

1. Tap HOBOs and tap the logger to connect to it.
2. Once connected, tap Logger Password.
3. Enter a password up to 10 characters and tap Done. Only the phone or tablet used to set the password can then connect to the logger without entering a password; all other mobile devices will be required to enter the password. For example, if you set the password for the logger with your tablet and then try to connect to the device later with your phone, you will be required to enter the password on the phone but not with your tablet. Similarly, if anyone else attempts to connect to the logger with a different device, then they would also be required to enter the password.

To reset a password, either repeat the steps above and select Reset to Factory Default. Or, press the reset button on the logger located between the two batteries in the top end as shown below.

Press this button to reset a logger password
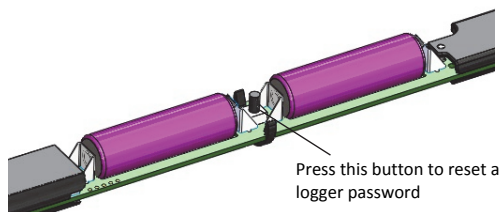
Maintenance

The logger requires the following periodic maintenance to ensure optimal operation:

- **Protect the logger. This logger can be damaged by shock.** Always handle the top end and sensor end with care. The sensors may lose their calibrated accuracy or can be damaged if dropped. Use proper packaging when transporting or shipping the logger.

> **Important: Do not attempt to open the sensor end housing!** Unscrewing the nose cone of the sensor end will cause serious damage to the pressure sensor and logger electronics. There are no user serviceable parts inside the sensor end. Contact Onset Technical Support if the sensor end requires servicing.

- **Periodically inspect the logger for biofouling**. Biological growth on the face of the pressure sensor will impact the pressure sensor's accuracy. Organisms that grow inside the sensor nose cone and on the sensor itself can interfere with the sensor's operation and eventually make the sensor unusable. If the deployment area is prone to biofouling, check the logger periodically for marine growth.

- **Be careful of solvents.** Check a materials-compatibility chart against the wetted materials listed in the Specifications table before deploying the logger in locations where untested solvents are present. The logger has Viton and Buna-N O-rings, which are sensitive to polar solvents (acetone, ketone), ammonia, chlorine, and brake fluids. The sensor is housed in an acetal end cap. Acetal is resistant to most solvents, fuels, and lubricants.

Compensating for Drift

All pressure sensors drift over time. The drift for the pressure sensors and electronics in the logger is less than 0.5% FS (worst case) per year. In most applications, drift is not a significant source of error because the offset created by any drift is zeroed out when you enter the reference water level in HOBOmobile at the beginning of each deployment. In effect, you are re-zeroing the sensor each time you apply a reference reading to the data file.

Pressure sensor drift matters more when absolute pressure values are needed, or if there are no recent reference level or depth measurements available. For example, if the logger is deployed for one year and no new reference level readings are taken during the deployment, it is possible that the sensor could have drifted as much as 0.5% FS by the end of the deployment.

It is possible to determine the actual amount of drift during a deployment if a reference level is taken at the beginning and the end of a long-term deployment. The results of applying the two different reference levels (once at the beginning of the data file and again at the end of the data file) can be compared. Any difference between the files indicates the amount of sensor drift (assuming accurate reference levels). See *Reading Out the Logger* for changing the reference water level in the data file.

Verifying Accuracy

You can check the differential accuracy of the logger for water level measurements by deploying the logger's sensor end at two depths and comparing the difference in level readings in the data files. When verifying the accuracy this way, be sure to allow the sensor's temperature to stabilize at each depth.

You can check the absolute pressure accuracy by using the two pressure sensors in the logger. Pull up the sensor end that is in the water so that both the absolute and differential sensors are in the air. Check the differential pressure with HOBOmobile. The differential pressure should be zero or less than the sum of the error for the two sensors.

Battery Information

The logger requires two user-replaceable AA 1.5 V alkaline batteries for operation at the extreme ends of the logger operating range. Expected battery life varies based on the ambient temperature where the logger is deployed, the logging or sampling interval, frequency of offloading and connection to the mobile device, number of channels that are active, alarm duration, use of burst mode or statistics logging, and battery performance. New batteries typically last 1 year with logging intervals greater than 1 minute. Deployments in extremely cold or hot temperatures, a logging interval faster than 1 minute, or a sampling interval faster than 15 seconds can impact battery life. Estimates are not guaranteed due to uncertainties in initial battery conditions and operating environment.

To install or replace the batteries:

1. Before changing the batteries, stop the logger and offload any data.

2. Disconnect the cable.

3. Unscrew the end cap on the top end. Push the board out from the cable end and then pull out the printed circuit board.

Unscrew end cap
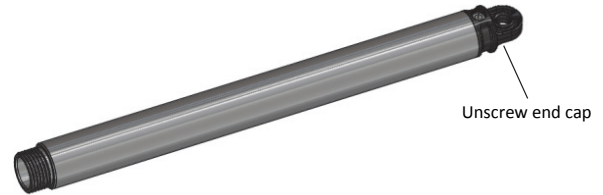
4. Insert two AA batteries observing polarity as shown on the board. A slight curvature in the printed circuit board is normal when the batteries are installed. Reinsert the board and place the desiccant back on the end of the board as shown.

Remove board and install batteries

Place desiccant on this end of board
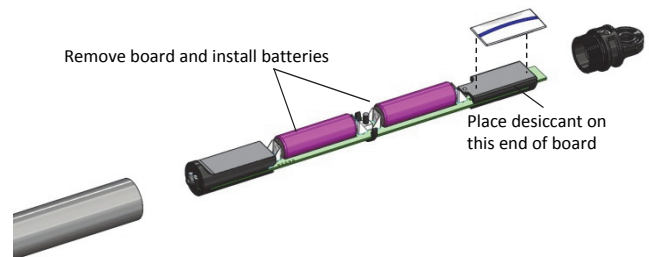
5. Screw the cap back on until hand tight.

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 HOBO MX 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.

KC Statement

해당 무선설비는 전파혼신 가능성이 있으므로 인명안전과 관련된 서비스는 할 수 없음

Translation:

The service related to human safety is not allowed because this device may have the possibility of the radio interference.