

HOBO® U24 Conductivity Logger (U24-002-C) Manual



The HOBO U24 Conductivity logger (U24-002-C) measures actual conductivity and temperature, and can provide specific conductance at 25°C and salinity with the HOBOWare® Conductivity Assistant. This easily deployable, rugged logger is ideal for environments with relatively small changes in salinity ($\pm 5,000 \mu\text{S/cm}$), such as saltwater bays, or to detect salinity events, such as upwelling, rainstorm, and discharge events. This logger can also be used to gather salinity data when deployed with a HOBO U26 Dissolved Oxygen logger. An optional U2X Protective Housing accessory (HOUSING-U2X) is available to further protect the logger, reduce fouling, and simplify mounting in harsh environments.

HOBO Conductivity Logger

Model: U24-002-C

Included Item:

- Communications window protective cap

Required Items:

- Coupler (COUPLER2-C) with USB Optic Base Station (BASE-U-4) or HOBO Waterproof Shuttle (U-DTW-1)
- HOBOWare Pro 3.2 or later with the Conductivity Assistant 2.1 or later
- Conductivity meter for calibration measurements

Accessories:

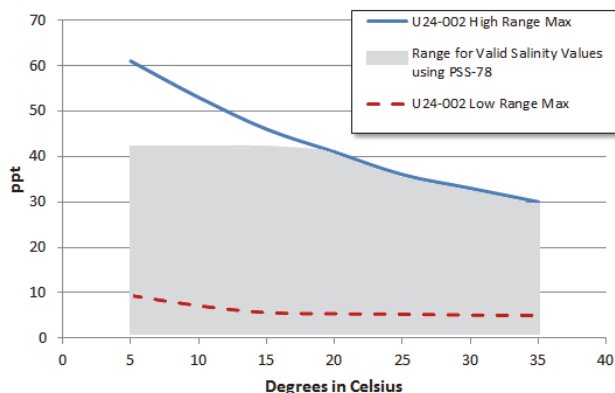
- U2X Protective Housing (HOUSING-U2X)
- Replacement communications window protective caps (U22-U24-CAP)

Specifications

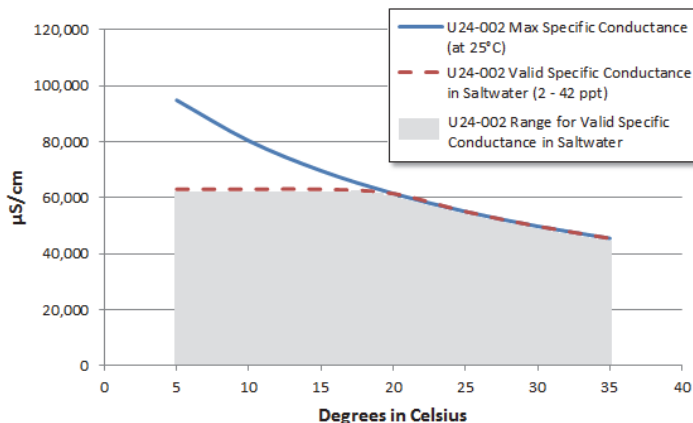
Measurements	Actual Conductivity, Temperature, Specific Conductance at 25°C (calculated), Salinity (calculated using PSS-78, the Practical Salinity Scale 1978)
Conductivity Measurement Ranges	Low Range: 100 to 10,000 $\mu\text{S/cm}$ High Range: 5,000 to 55,000 $\mu\text{S/cm}$; see Plots A and B on next page for salinity and specific conductance ranges
Conductivity Calibrated Range - Temperature Range	5° to 35°C (41° to 95°F)
Conductivity Extended Ranges	Low Range: 50 to 30,000 $\mu\text{S/cm}$ High Range: 1,000 to 55,000 $\mu\text{S/cm}$ (readings below these ranges reported as 0)
Temperature Measurement Range	-2° to 36°C (28° to 97°F)
Specific Conductance Accuracy (in Calibrated Range using Conductivity Assistant and Calibration Measurements)	Low Range: 3% of reading or 50 $\mu\text{S/cm}$, whichever is greater High Range: 5% of reading, in waters within a range of $\pm 3,000 \mu\text{S/cm}$ of the calibration point; waters with greater variation can have substantially greater error (see Plot C)
Conductivity Resolution	2 $\mu\text{S/cm}$ (typical)
Temperature Accuracy (in Calibrated Range)	0.1°C (0.2°F)
Temperature Resolution	0.01°C (0.02°F)
Conductivity Drift	Up to 12% sensor drift per month, exclusive of drift from fouling. Monthly start- and end-point calibration should be used with HOBOWare Conductivity Assistant to achieve the specified Specific Conductance accuracy
Response Time	1 second to 90% of change (in water)
Operating Range	-2° to 36°C (28° to 97°F) - non-freezing
Memory	18,500 temperature and conductivity measurements when using one conductivity range; 14,400 sets of measurements when using both conductivity ranges (64 KB total memory)
Sample Rate	1 second to 18 hrs, fixed or multiple-rate sampling with up to 8 user-defined sampling intervals
Clock Accuracy	± 1 minute per month
Battery	3.6 Volt lithium battery
Battery Life	3 years (at 1 minute logging)
Maximum Depth	70 m (225 ft)
Weight	193 g (6.82 oz), buoyancy in freshwater: -59.8 g (-2.11 oz)
Size	3.18 cm diameter x 16.5 cm, with 6.3 mm mounting hole (1.25 in. diameter x 6.5 in., 0.25 in. hole)
Wetted Housing Materials	Delrin®, epoxy, stainless steel retaining ring, polypropylene, Buna rubber O-ring, titanium pentoxide (inert coating over sensor); all materials are suitable for long-term use in saltwater
CE	The CE Marking identifies this product as complying with all relevant directives in the European Union (EU).

Specifications (continued)

Plot A: Salinity Range*



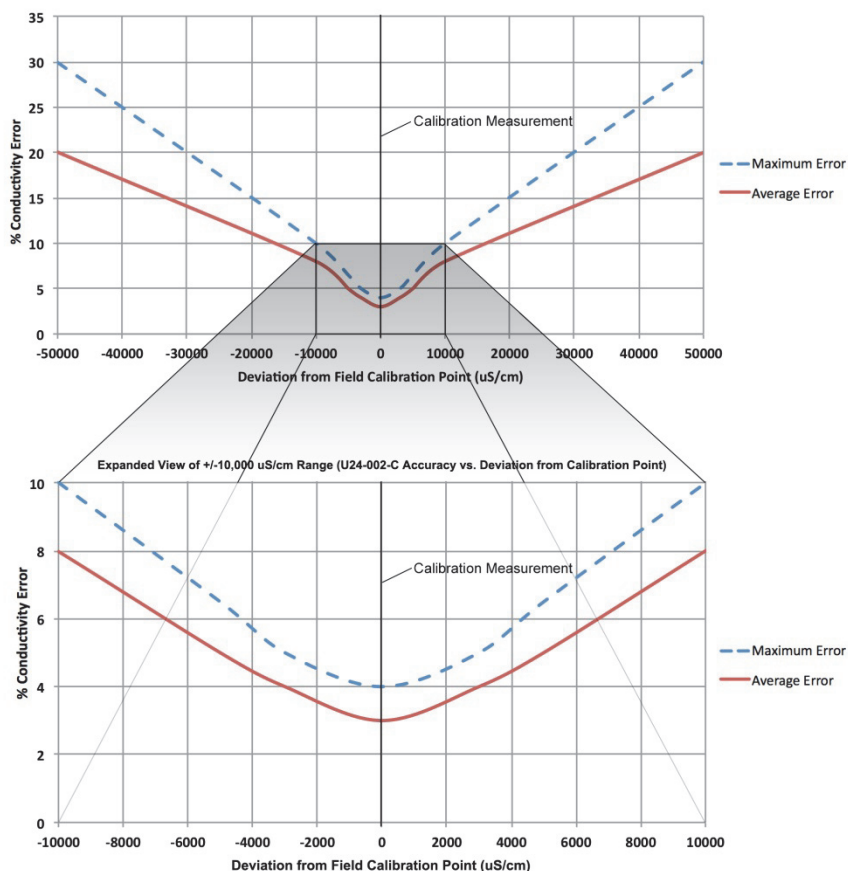
Plot B: Specific Conductance Range in Saltwater



* The Practical Salinity Scale 1978 (PSS-78) used to calculate salinity is valid for salinities in the range of 2 to 42 ppt. For salinities outside of this range, use the measured conductivity and temperature data from the logger with a calculation appropriate for your salinities.

Plot C: Specific Conductance High-Range Accuracy

U24-002-C Conductivity Accuracy vs. Deviation from Field Calibration Point

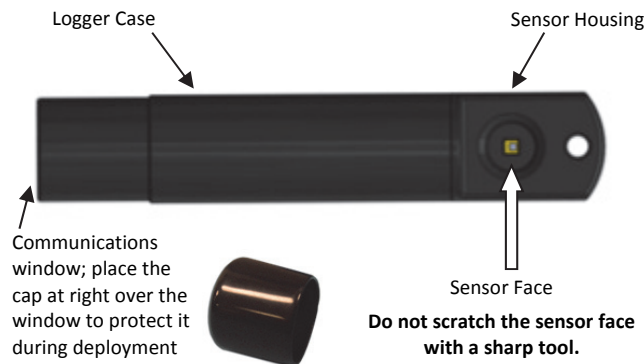


Note: The accuracy of the readings is relative to their proximity to the calibration point. The closer the conductivity reading is to the calibration point, the higher the accuracy. The calibration point is measured in actual conductivity (not specific conductance), while the calibrated data is provided in either specific conductance or salinity.

Protecting the Logger

IMPORTANT: This logger can be damaged by shock. Always handle the logger with care. The logger may be damaged if it is dropped. Use proper packaging when transporting or shipping the logger.

Do not attempt to open the logger case or sensor housing. Disassembling of the logger case or sensor housing will cause serious damage to the sensor and logger electronics. There are no user-serviceable parts inside the case. Contact Onset Technical Support at 1-800-LOGGERS (1-800-564-4377) or an authorized Onset dealer if your logger requires servicing.



Operation

An LED in the communications window of the logger confirms logger operation. When the logger is logging, the LED blinks once every one to four seconds (the shorter the logging interval, the faster the LED blinks). The LED also blinks when the logger is recording a sample. When the logger is awaiting a start because it was configured to start "At Interval," "On Date/Time," or "Using Coupler," the LED blinks once every eight seconds until logging begins.

The logger can record two types of data: samples and events. Samples are the sensor measurements recorded at each logging interval. Events are independent occurrences triggered by a logger activity, such as Bad Battery or Host Connected. Events help you determine what was happening while the logger was logging.

Communication

To connect the logger to a computer, use either the Optic USB Base Station (BASE-U-4) or HOBO Waterproof Shuttle (U-DTW-1) with a coupler (COUPLER2-C).

IMPORTANT: USB 2.0 specifications do not guarantee operation outside the range of 0°C (32°F) to 50°C (122°F).

To launch and read out the logger in the field, use one of these methods:

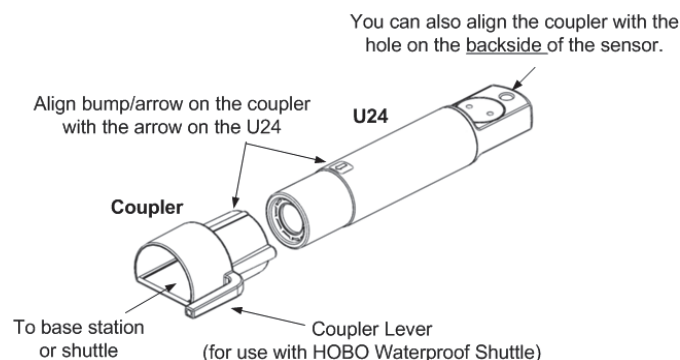
- Laptop computer with Optic USB Base Station (BASE-U-4) and a coupler (COUPLER2-C)
- HOBO Waterproof Shuttle (U-DTW-1, Firmware Version 3.2.0 or later) and a coupler (COUPLER2-C)
- HOBO U-Shuttle (U-DT-1, Firmware Version 1.14m030 or later) with Optic USB Base Station and coupler (COUPLER2-C)

The optical interface allows the logger to be offloaded without breaking the integrity of the seals. The USB compatibility allows for easy setup and fast downloads.

Connecting the Logger to a Computer or Waterproof Shuttle

1. Follow the instructions that came with your base station or Waterproof Shuttle to attach it to a USB port on the computer.
2. Attach the coupler to the base station or shuttle.
3. Wipe off any residue or slime from the area of the logger that will go into the coupler, including the communication window. This will help the logger slide in and out of the coupler more easily, and help with communication.
4. Insert the logger into the coupler, aligning the bump/arrow on the coupler with the arrow on the logger. Be sure that it is properly seated in the coupler. If the logger has never been connected to the computer before, it may take a few seconds for the new hardware to be detected by the computer.

Note: If you are using the HOBO Waterproof Shuttle as a base station with a computer, briefly press the Coupler Lever to put the shuttle into base station mode.



WARNING: Do not leave the logger in the coupler for extended periods of time. When connected to a coupler, the logger is "awake" and consumes significantly more power than when it is disconnected and considered "asleep." Always remove the logger from the Optic Base Station or HOBO Waterproof Shuttle as soon as possible after launching, reading out, or checking the status to avoid draining the battery.

Launching the Logger

Before deploying the logger in the field, perform the following steps in the office:

1. Start HOBOWare.
2. Connect the logger to the computer as described in the previous section.
3. Verify the status. Click the status button on the toolbar and observe that the temperature is near the actual temperature.
4. Launch the logger with the correct range. Refer to the specifications on page 1 for both calibrated and extended

ranges (the calibrated ranges are also printed on the logger housing). The logger will not record readings outside of the extended range selected. (For the U24-002-C, readings below the extended range are reported as 0.) If in doubt on the range needed for your deployment, or for environments with wide fluctuations, select both ranges. This will shorten the deployment duration from 18,500 samples to 14,400 samples per parameter (not logging battery voltage). See the *HOBOWare User's Guide* or online help for details on launching.

Note: Logging battery voltage is not essential because you can check the battery using the Status screen at launch or readout of the logger. Logging the battery voltage will reduce the number of conductivity and temperature readings you can log.

Taking Calibration Readings

It is important to take temperature and conductivity calibration readings with a portable conductivity meter at both the beginning (launchtime) and end of a deployment (readout) because these readings are necessary for data calibration and to compensate for any measurement drift during deployment. The conductivity calibration readings should be the *actual conductivity* without temperature compensation (*not* in specific conductance at 25°C), and should be recorded in a notebook with the time and location of the reading. You will use these readings in the HOBOWare Conductivity Assistant to calibrate the readings for the corresponding data series offloaded from the logger.

The calibration reading should be taken in the middle of the expected range in the environment. For example, if the range where the logger will be deployed is 20,000 $\mu\text{S}/\text{cm}$ to 40,000 $\mu\text{S}/\text{cm}$, then the calibration reading should be taken at 30,000 $\mu\text{S}/\text{cm}$, which is the midpoint of that range (see Method 2 at right for advice on how to get readings at the midpoint).

There are three methods for obtaining accurate calibration readings. The first method involves placing the meter's probe into the water next to the logger. The second method involves placing the logger and meter probe in a field water sample in a jar. In both methods, the conductivity meter probe must be close to the data logger—but not touching—so that it is measuring water at the same conductivity and salinity as the logger. The third method involves taking a sample back to the office to measure with a meter there.

If the conductivity and salinity in the water where the logger is deployed is stable and it is easy to reach the logger, then you can obtain calibration readings by placing the probe directly into the water next to the logger. However, taking calibration readings in areas that have tidal and freshwater mixing is more challenging due to the rapidly changing salinities. Similarly, taking calibration readings in wells can also be difficult because it may be hard to get the meter probe next to the logger. In these instances, you should fill a jar with a water sample from where the logger is deployed to take the calibration readings. To obtain the water sample from a well or stilling well, you can use a bailer with a diameter that is small enough to fit down the well.

Note: Some salt residue may remain on the logger from factory calibration. Carefully rinse the logger in distilled water or clean

freshwater to remove any residual salt before taking your first calibration readings.

Method 1:

Taking readings directly in the water (recommended for locations with access for the field meter probe and with conductivity that is stable)

1. If you have just deployed the logger, allow enough time for the logger temperature to stabilize for the best accuracy (approximately 15 minutes).
2. Gently tap the logger to remove any bubbles from the surface. Tug the cable if you cannot reach the logger itself.
3. Measure the temperature and actual conductivity with the field meter, making sure the meter probe readings stabilize per the meter's specification. Record the values, time, and location of the readings in a field notebook for use later in the HOBOWare Conductivity Assistant.

Method 2:

Taking readings in a jar (recommended for readings in wells or in water with rapidly changing conductivity, such as areas with saltwater and freshwater mixing)

1. Take a sample of water in a jar that is large enough to hold both the logger and the probe from a portable conductivity meter, leaving an inch of space between the probe and the logger. For wells, use a bailer to obtain the water sample.

IMPORTANT: For the best accuracy, use a calibration reading at the midpoint of the expected conductivity range. This can be done either by taking a sample in the middle of a tide cycle or by taking a sample at high tide and then adding freshwater to reach the expected midpoint. *Always be sure to stir thoroughly to fully mix the fresh and saltwater.*

2. Leave the logger and the meter probe submerged in this jar of water long enough so they reach temperature equilibrium and the logger has logged at least three readings (allow at least 15 minutes for the best accuracy). (Three readings are necessary because this will help you identify which readings were taken while the logger is in the jar.)
3. Measure the temperature and actual conductivity with the field meter. Record the values, time, and location of the reading in a field notebook for use later in the HOBOWare Conductivity Assistant.
4. When using the Conductivity Assistant, look for the spot in the data where there are three similar readings in a row and link the last of those readings to the meter reading. (The time you noted may be slightly different than the logger time so looking for the three similar readings will help identify the correct reading.) The Conductivity Assistant uses that value to calibrate the specific conductance and salinity readings for that data series.

Method 3:

Taking a sample back to the office in a sealable jar to measure there (recommended for locations with conductivity that is stable when you do not have a field meter or it is not convenient to access the logger)

1. Place a sample of the water taken from next to the logger in a jar and immediately seal it to ensure that none of the water evaporates. This allows the specific conductance and salinity of the sample to be maintained, which in turn results in usable temperature and conductivity readings when you measure it with the meter at a later time.
2. Write down the time you take the sample for use later in the HOBOWare Conductivity Assistant.
3. At the office, measure the temperature and actual conductivity of the sample with a meter and write down the values next to the time you noted in step 2.

Note: If you've taken the calibration readings in specific conductivity, you can convert the readings back to actual conductivity. Use the temperature readings from the meter or logger to convert the conductivity reading following the specific conductivity calculation used by your meter (consult the meter documentation). If the meter uses a standard linear compensation, you can use the following formula to convert it. This equation calculates the electrical conductivity (Y_e) from a measured water temperature (T) and from a measured specific conductance at 25°C (C_s) using the linear temperature coefficient entered into the meter.

$$Y_e = C_s * (1 - ((25-T) * a / 100))$$

Where: Y_e = Calculated Electrical Conductivity
 T = water temperature in degrees C measured by the meter
 C_s = Specific Conductance measured by the meter
 a = linear temperature coefficient (% / degrees C) entered into the meter to calculate specific conductance

Deploying the Logger

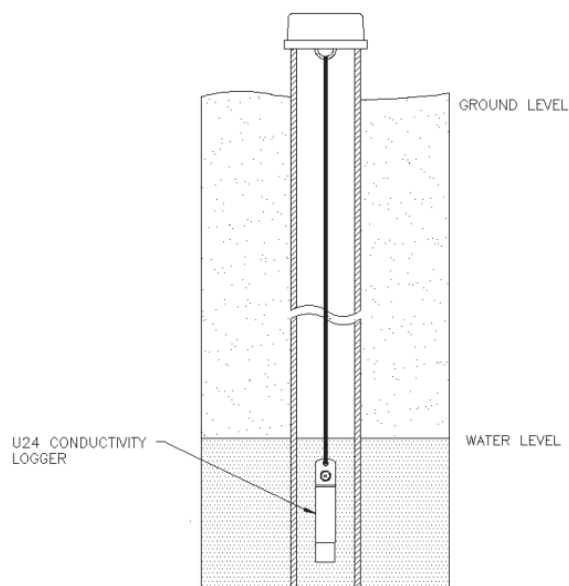
The HOBO U24 Conductivity logger is designed to be easy to deploy in many environments. The small size of the logger is convenient for use in small wells and allows the logger to be mounted and/or hidden in the field. Follow these guidelines when deploying the logger:

- Make sure the logger is located where it will receive a steady flow of the water that is being monitored.
- When deploying the logger in rivers, streams, and ponds, insert the logger in a PVC or ABS pipe if possible. The PVC pipe should have enough holes to ensure good circulation of water.
- To avoid bubbles collecting on the sensor, make sure the sensor face is vertical and avoid sudden temperature changes.
- Do not place any conductive materials or metals within 2.5 cm (1 in.) of the sensor.
- Avoid deploying the logger in freezing water with moving ice.
- Use the included cap to protect the communications window in the logger from fouling and abrasion. Place the protective cap over the communications window before deploying the logger.

- Use the U2X Protective Housing (HOUSING-U2X) for added protection to the logger in harsh environments or to reduce the amount of light reaching the logger, which helps to reduce fouling.

To deploy the logger at each site:

1. Launch the logger with a laptop or shuttle.
2. Take a calibration reading as described on page 4.
3. Deploy the logger in the water (if it hasn't already been placed in the water) following the guidelines recommended above.
4. Repeat steps 1 through 3 for each logger deployed. Be sure to take a new calibration reading for each logger that you deploy.



Reading Out the Logger and Maintenance

Your readout and maintenance schedule will be determined by the amount of fouling at the site, sensor drift, and your accuracy requirements. Two- to four-week maintenance schedules are typically required.

To read out the logger in the field:

1. Calibrate the field conductivity meter before using it to take field readings.
2. Measure the actual conductivity and temperature values with the field meter using one of the calibration methods on page 4 or 5.
3. Remove the logger from the water (if it hasn't already been removed for the calibration measurement). Remove the logger from the protective housing (if applicable) and remove the protective cap.
4. Read out the data from the logger using a shuttle.
5. Relaunch the logger.
6. Clean the sensor (see the next section for more details).
7. Place the protective cap back on the logger and remount the logger inside the protective housing (if applicable).

- Redeploy the logger in the water, and take another calibration measurement.

Maintenance

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

- **Clean the sensor.** Mix several drops of dish detergent or biodegradable soap in a cup of tap water with a clean cotton swab. Clean the sensor face using the cotton swab and then rinse the sensor with clean or distilled water. Do not scratch the sensor face with a sharp tool.
- **Check for biofouling.** Biofouling and excessive marine growth on the logger will compromise accuracy. Organisms that grow on the sensor 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 before deploying the logger in locations where untested solvents are present. Refer to the specifications for wetted housing materials on page 1.

Use HOBOWare to calibrate data and convert to specific conductance or salinity

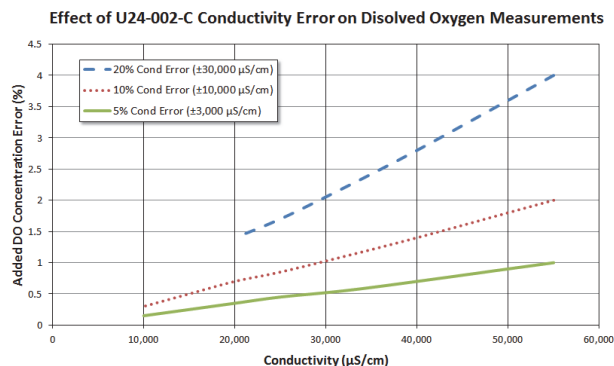
- Offload the most recent data files from the shuttle or loggers to your computer.
- Open a data file in HOBOWare.
- Use the HOBOWare Conductivity Assistant to calibrate the readings and adjust for drift. You will need to enter the field meter conductivity and temperature readings and times from the beginning and, optionally, the end of that segment of the logger's deployment. Refer to the Help for the Conductivity Assistant for more details. Save your changes to a project file.
- Repeat steps 1 through 3 for all data files.

Using the Logger with a HOBO U26 Dissolved Oxygen Logger

If you are deploying a HOBO U26 Dissolved Oxygen logger in a location with changing conductivity, you will need a data file with salinity or specific conductivity readings for the entire deployment. The U24-002-C provides a convenient source for this data, but it is not suitable for all environments. To determine if this logger is adequate for salinity-adjusted DO in your application:

- Determine the potential conductivity error based on maximum deviation from the field calibration point (see Plot C on page 2 for reference).
- Determine the effect of the conductivity error on the DO accuracy, referring to the plot on the next page. For conductivities within $\pm 30,000 \mu\text{S/cm}$, there will be less than 4% error added to the DO measurements (percent of the DO reading in mg/L).

- If the results of steps 1 and 2 indicate this logger will work for your application, then deploy this logger next to the DO logger and use the resulting data file for salinity data.



Battery Guidelines

- **Battery Life.** The battery life of the logger should be three years or more. Actual battery life is a function of the number of deployments, logging interval, and operation/storage temperature of the logger. Frequent deployments with logging intervals of less than one minute, continuous storage/operation at temperatures above 35°C (95°F), and keeping the logger connected to the coupler will result in significantly lower battery life. For example, continuous logging at a one-second logging interval will result in a battery life of approximately one month. To obtain a three-year battery life, a logging interval of one minute or greater should be used and the logger should be operated and stored at temperatures between 0° and 25°C (32° and 77°F).
- **Battery Voltage.** The logger can report and log its battery voltage. If the battery falls below 3.1 V, the logger will record a "bad battery" event in the datafile. If the datafile contains "bad battery" events, or if logged battery voltage repeatedly falls below 3.3 V, the battery is failing and the logger should be returned to Onset for battery replacement. Note that the logger does not have to be recording the battery channel for it to detect bad battery events. The logger will record these events regardless of what channels are logged.
- **Replacing the Battery.** To have your logger's battery and sensor replaced, contact Onset or your place of purchase for return arrangements. Do not attempt to replace the battery yourself. Severe damage to the logger will result if the case is opened without special tools, and the warranty will be voided.

WARNING: Do not cut open, incinerate, heat above 100°C (212°F), or recharge the lithium battery. The battery may explode if the logger is exposed to extreme heat or conditions that could damage or destroy the battery case. Do not dispose of the logger or battery in fire. Do not expose the contents of the battery to water. Dispose of the battery according to local regulations for lithium batteries.