EXO User Manual

ADVANCED WATER QUALITY MONITORING PLATFORM

Item# 603789REF
Revision E

THIS IS AN INTERACTIVE DOCUMENT

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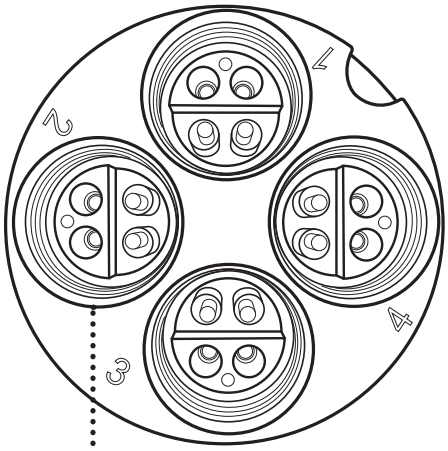
1.1 EXO1 Sonde Overview

The EXO1 sonde is a multiparameter instrument that collects water quality data. The sonde collects the data with up to four user-replaceable sensors and an integral pressure transducer. Each sensor measures its parameter via a variety of electrochemical, optical, or physical detection methods. Each port accepts any EXO sensor and automatically recognizes its type. Depending on user-defined settings, the EXO1 will collect data and store it onboard the sonde, transfer the data to a data collection platform (DCP), or relay it directly to a user's PC or EXO Handheld. *See section 7 for information specific to vented level sondes.*



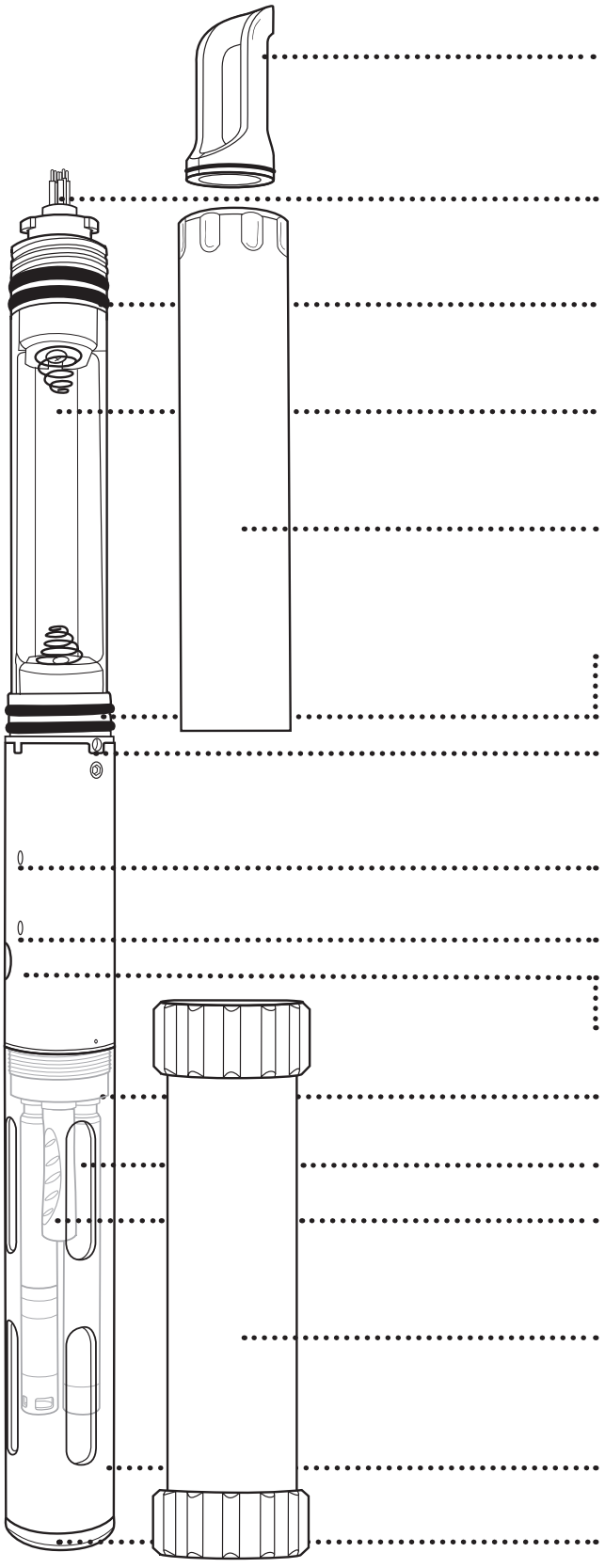
Universal Sensor Ports

NOTE: Starting early 2014, EXO sonde bulkhead material changed from bronze to titanium.

Users communicate with the sonde via a field cable to an EXO Handheld, Bluetooth® wireless connection to a PC or EXO Handheld, or a USB connection (via communications adapter) to a PC.

Specifications

Operating Environment	
Depth Rating	250 meters, 820 feet
Material	Xenoy®, Lexan®, bronze, titanium, 316 stainless steel
Internal Logging Memory Capacity	512 MB
Software	Kor Interface Software
Communications	Bluetooth, Field Cable,
Sonde	USB, RS-485;
Adapters	USB, SDI-12/RS-232
Power	
External	9-16 VDC
Internal	2 D-size batteries
Temperature	
Operating	-5 to 50°C
Storage	-20 to +80°C
Battery Life	90 days typically
Dimensions	
Diameter	4.70 cm,1.85 in
Length	64.77 cm, 25.50 in
Weight	1.42 kg, 3.15 lb w batt.



EXO1 Sonde
599501-xx

Removable Bail
599473

6-Pin Cable Connector

Upper Battery Compartment Seal
O-ring kit 599680

Battery Compartment

Battery Cover
599052

Lower Battery Compartment Seal

Pressure Transducer Opening

Red LED Indicator–Sonde Status

Blue LED Indicator–Bluetooth

On/Off Magnetic Switch for Power and Bluetooth

Bulkhead

Sensors

Port Plug
599475

Calibration Cup
599786

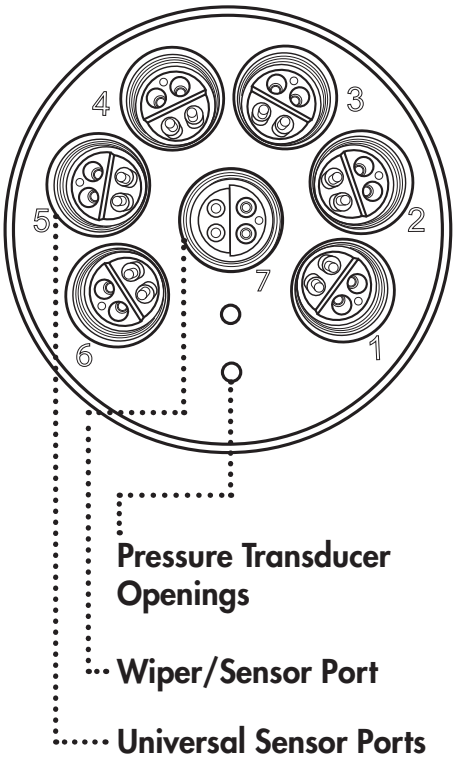
Sensor Guard
599666, 599563

Guard Weight
599471

1.2 EXO2 Sonde Overview

The EXO2 sonde is a multiparameter instrument that collects water quality data. The sonde collects the data with up to six user-replaceable sensors and an integral pressure transducer. Each sensor measures its parameter via a variety of electrochemical, optical, or physical detection methods. Each port accepts any EXO sensor and automatically recognizes the type of sensor. Depending on user-defined settings, the EXO2 will collect data and store it onboard the sonde, transfer the data to a data collection platform (DCP), or relay it to a user's PC or EXO Handheld via cable, USB connection, or Bluetooth connection.

In addition to six standard sensor ports, the EXO2 also has a bulkhead port for a central wiper (or an additional sensor) and an auxiliary port on top of the sonde. This auxiliary port will allow the user to connect the EXO2 to other EXO sondes. *See section 7 for information specific to vented level sondes.*

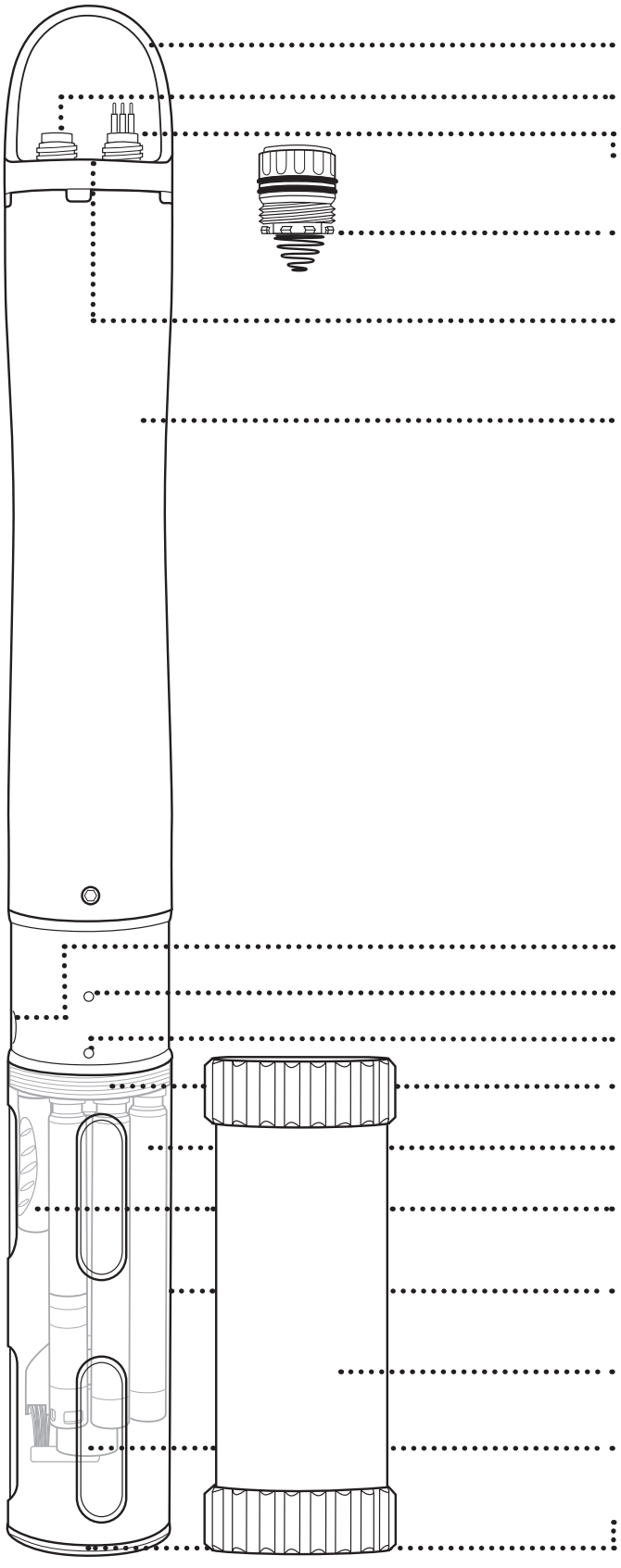


NOTE: Starting early 2014, EXO sonde bulkhead material changed from bronze to titanium.

Users communicate with the sonde via a field cable to an EXO Handheld, Bluetooth® wireless connection to a PC or EXO Handheld, or a USB connection (via communications adapter) to a PC.

Specifications

Operating Environment	
Depth Rating	250 meters, 820 feet
Material	Xenoy, Lexan, bronze, titanium, 316 stainless steel
Internal Logging Memory Capacity	512 MB
Software	Kor Interface Software
Communications	Bluetooth, Field Cable,
Sonde	USB, RS-485;
Adapters	USB, SDI-12/RS-232
Power	
External	9-16 VDC
Internal	4 D-size batteries
Temperature	
Operating	-5 to +50°C
Storage	-20 to +80°C
Battery Life	90 days typically
Dimensions	
Diameter	7.62 cm, 3.00 in
Length	71.1 cm, 28.00 in
Weight	3.60 kg, 7.90 lb w batt.



EXO2 Sonde
599502-xx

Removable Bail
599474

Auxiliary Port

6-Pin Cable Connector

Battery Cap/Pressure Relief Valve
O-ring kit 599681

Battery Compartment Opening

Battery Compartment

On/Off Magnetic Switch for Power and Bluetooth

Red LED Indicator–Sonde Status

Blue LED Indicator–Bluetooth

Bulkhead

Sensors

Port Plug
599475

Sensor Guard
599667, 599564

Calibration Cup
599316

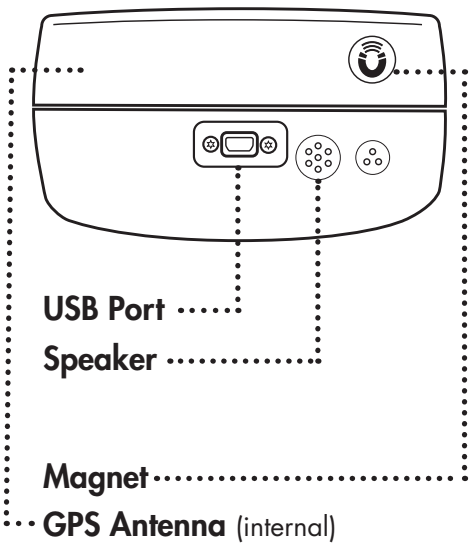
Central Wiper
599090-01

Guard Weight
599472

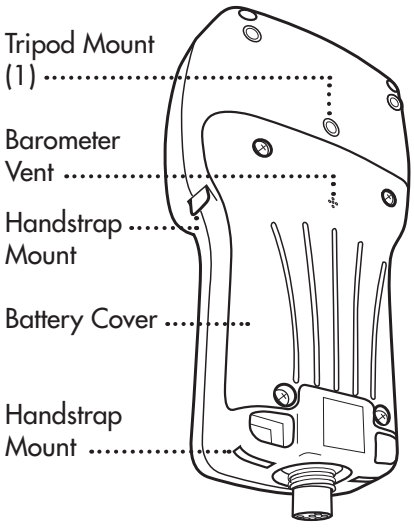
1.3 EXO Handheld Overview

The EXO Handheld (HH) is a rugged, microcomputer-based instrument that allows the user to display sonde readings, configure sondes, store and retrieve data, and transfer data from sondes to a computer. Equipped with GPS, barometer, and custom operating system, the Handheld communicates via Bluetooth wireless technology, field cable, or USB connector. (NOTE: The USB connection is only used when connecting the Handheld to a PC.) The unit utilizes an adjustable backlit screen for easy day or night viewing. Pre-installed KOR software facilitates all user interaction and provides powerful control over data collection.

Top View



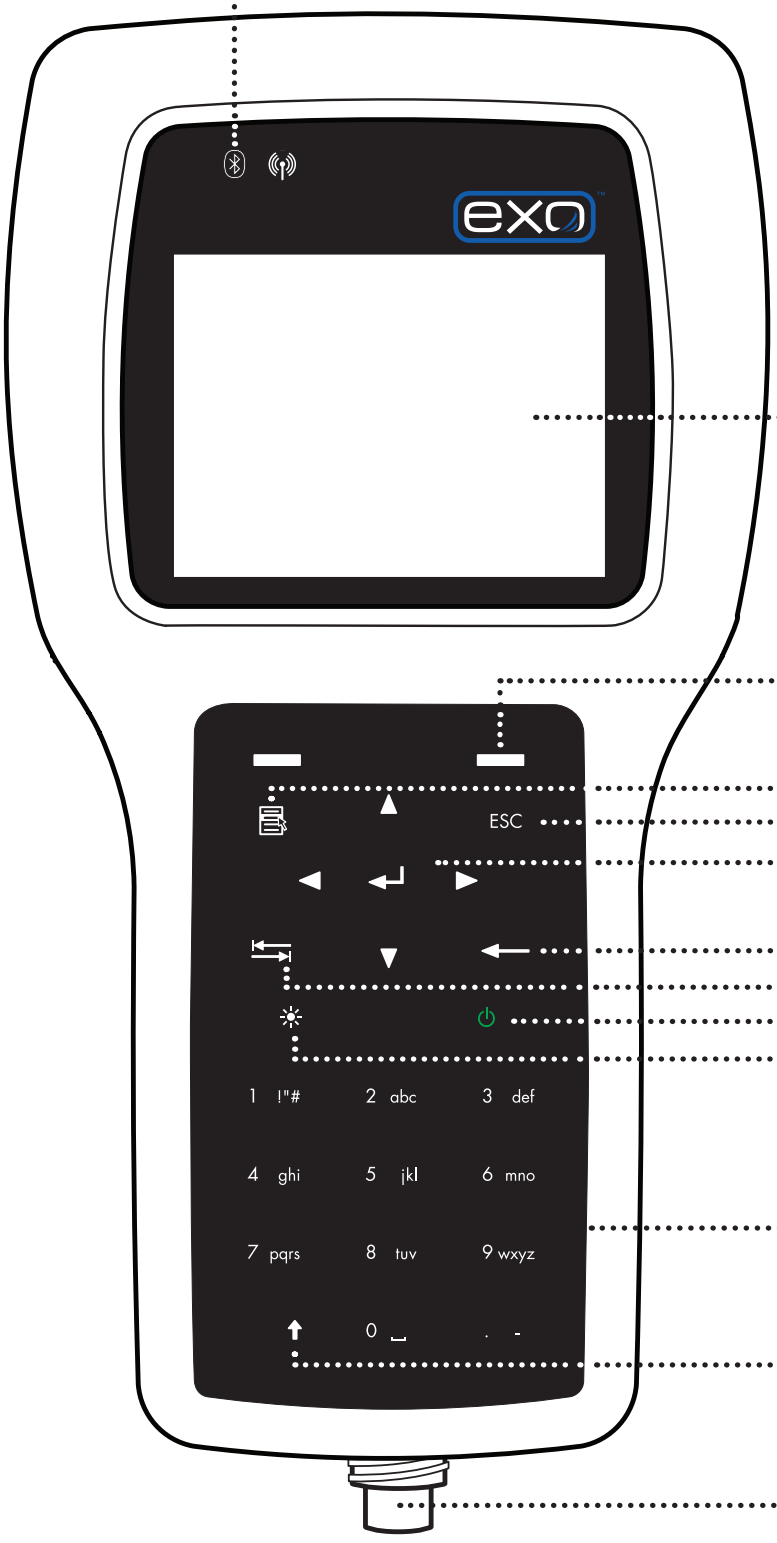
Back View



Specifications

Barometer	Yes
GPS	Yes
Audio Speaker	Yes
Operating System	Windows CE 5.0
Material	Polycarbonate/ABS housing,rated to IP-67 in factory tests; polycarbonate lens
Memory	2 GB
Software	Kor Interface Software
Communications	Bluetooth, Field Cable, USB
Power *Internal*	 4 C-size alkaline batteries or optional Li-Ion Pack
Temperature *Operating* *Storage*	 -5 to +50°C -20 to +80°C
Dimensions *Width* *Length* *Weight w. batt.*	 11.9 cm, 4.7 in 22.9 cm, 9.0 in 0.91 kg, 2.1 lb

EXO Handheld
599150



Bluetooth Indicator

Daylight-viewable LCD

Soft Keys (2)

Menu

Escape

Navigation Arrows (4) & Return

Backspace

Tab

Power

Brightness

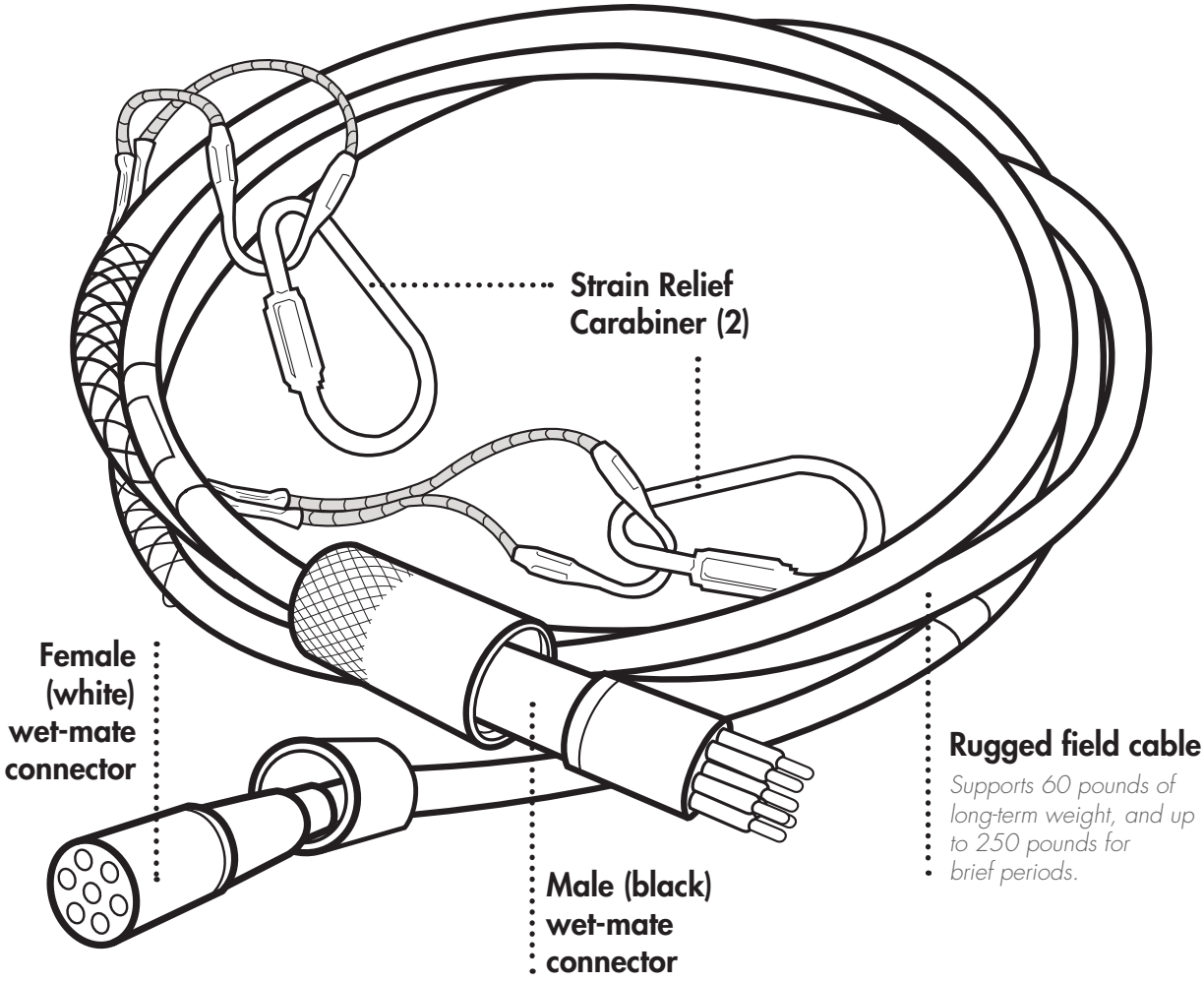
Alphanumeric Keypad

Shift

Cable Connector

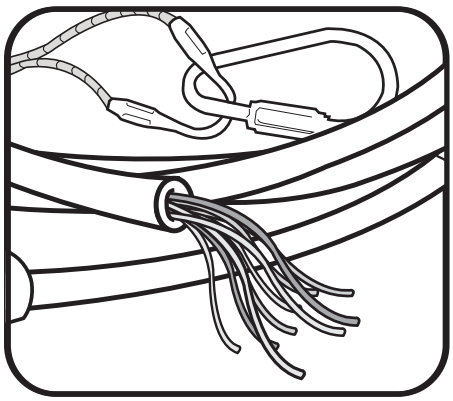
1.4 EXO Cables Overview

The EXO rugged field cable comes in many different lengths and options to meet the needs of your specific application. Selecting the correct cable length and coupler will ensure the best quality data for your project. For a full list of cable options and precautions for extended cables, please see the following page.



Flying Lead Cable Vented and Non-Vented

A flying lead cable option is available which is intended for wiring to a data collection platform (DCP) or a data logger. A vented flying lead option is for use with a vented sonde only.
See section 7 for more information.



Cable Options

599431-01	EXO Cable Coupler, Titanium
599431-02	EXO Cable Coupler, Brass
599040-2	EXO 2 meter Field Cable
599040-4	EXO 4 meter Field Cable
599040-10	EXO 10 meter Field Cable
599040-15	EXO 15 meter Field Cable
599040-33	EXO 33 meter Field Cable
599040-66	EXO 66 meter Field Cable
599040-100	EXO 100 meter Field Cable
599040-150	EXO 150 meter Field Cable
599040-200	EXO 200 meter Field Cable

599040-250	EXO 250 meter Field Cable
599040-300	EXO 300 meter Field Cable
599008-10	EXO 10 meter Flying Lead Cable
599008-15	EXO 15 meter Flying Lead Cable
599008-33	EXO 33 meter Flying Lead Cable
599008-66	EXO 66 meter Flying Lead Cable
599008-100	EXO 100 meter Flying Lead Cable
599210-4	EXO 4 meter VENTED Flying Lead Cable
599210-10	EXO 10 meter VENTED Flying Lead Cable
599210-15	EXO 15 meter VENTED Flying lead Cable
599210-33	EXO 33 meter VENTED Flying Lead Cable

Extended Field Cables Precaution

Be aware, longer cables are made to order and there is an **eight week lead time** to build the product. There are some limitations for applications using EXO cable lengths greater than 100 meters - whether by extended cables, or by means of cable-coupling.

⚠ To prevent system problems related to power and signal integrity, make sure you understand the system limitations if you plan to use cable couplers or extended cables.

Voltage drop through long cables can adversely affect the available power at the sonde.
Here are some techniques to prevent such problems:

- Use Alkaline or high-capacity NiMH batteries in the sonde. This serves a dual purpose of adding weight in the sonde for profiling applications, as well as preventing system reboots during period of high current demand.
- Do not use EXO's USB SOA or Handheld as the sole power source for systems with large payloads (many optical or high power sensors). These devices do not provide a voltage high enough for use with extended cables.
- Limit use of EXO's auxiliary port to lower power devices.
- Power the sondes with a regulated power supply (12V-14V) capable of supplying 1A. This will ensure sufficient power is reaching the sonde.

1.5 EXO Sensors Overview

The EXO product line includes nine sensors that detect a variety of physical, chemical, and biological properties of natural water. EXO sensors are designed to collect highly accurate data under ever-changing environmental conditions.

Data Filtering

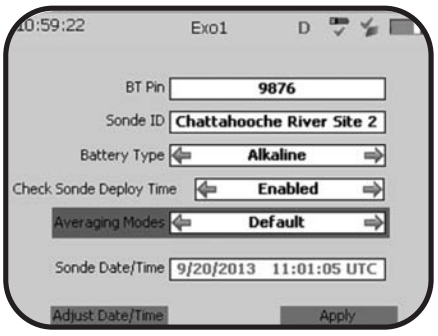
All EXO sensors share some common embedded software, including the filtering of real-time data. Sensors acquire environmental data at a constant rate, and use this stream of data as the input to the filtering algorithm that produces results seen by the user. EXO sondes collect data from the EXO sensors and are able to output data at rates up to 4 Hz. The EXO sensor data filtering process consists of four components (none of which is user selectable):

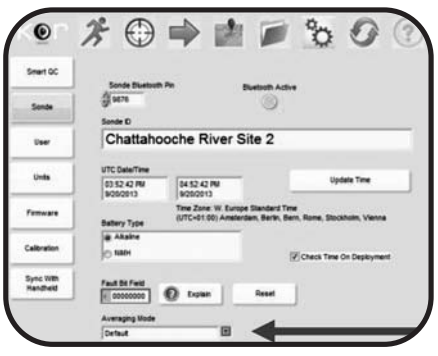
Basic Rolling Filter

The filter is fundamentally a rolling or window average of past acquired inputs to the filter, such that as a new data value is added to the summation, the oldest data value is removed, and the total summation is divided by the total number of data values. It is a simple average, just rolling or moving in time. Starting with the February 2014 software release, different rolling time windows for the filter are now supported.

Data Filtering Modes

Data filtering options are included in the handheld and desktop version of KOR. These settings can be modified within the Sonde Options menu (Options>Sonde) as well as within the deployment template settings. *NOTE: Making any changes to data filtering options will stop a deployment.* As a sonde takes measurements, it compares new readings to those taken in the previous 2-30 seconds (depending on the selected option). If the new reading is not significantly different than past measurements, then it merely factors into the rolling average with older data points to create a smooth curve. If the new reading is significantly different than past measurements, then it restarts the rolling average of data points.





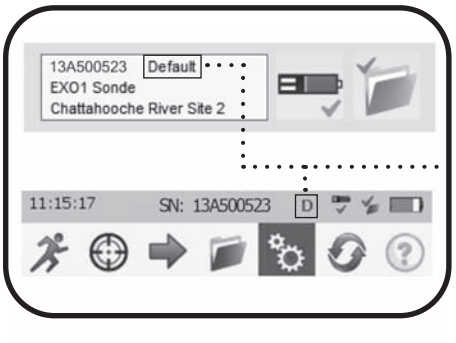
Averaging options

Default – This mode provides optimum data filtering for all sensors. Provides the highest accuracy, automatic averaging during unattended monitoring or fixed mooring. This mode has up to 40 seconds of filtering on the sensors.
NOTE: This is the mode all sensors ship in and how sensors filtered data prior to this update.

Accelerated* – This mode should be used for spot sampling and slow (or paused) depth profiles. The sensors are averaging 5-10 seconds of data in a rolling window, unless there are any outliers.

Rapid* – This mode should be used where the sonde is moving quickly through the water, such as with rapid profiling and unique applications like auvs, gliders, or towed applications. The data will be noisy and will never settle on a single steady number. This mode has 2-3 second filtering on the sensors.

*TIP: Enable the Vertical Position parameter in the Depth unit options to view the real-time position of the sonde in the water column. This is helpful in profiling applications to ensure the sonde is lowered to the desired depth without waiting for the Depth data to stabilize.



Confirm averaging settings

To quickly check a sonde's data filtering options, examine the summary information at the top of either the desktop or handheld versions of KOR. On the desktop software, the word Default, Accelerated, or Rapid will be adjacent to the sonde's serial number. Similarly, on the handheld, the letter D, A, or R will be listed at the top right of the screen.

Adaptive Filtering

The drawback to a basic rolling filter is that response time to an impulse event is delayed, and the more entries in the average summation, the longer the delay for the result to converge on the true value. To correct this, the filter algorithm monitors the new data arriving and compares it to the current averaged result, looking for indication of an impulse event. When new data deviates from the average by more than a predetermined tolerance, the number of data entries within the rolling average is reduced to a minimum count and the remaining values are flushed with the new data. The result is a snap to the new value, entirely eliminating the inherent delay caused by the rolling average.

Outlier Rejection

Every time a newly acquired data value is added, the rolling average entries are scanned for outlier data. Although such data has already been determined to fall within the tolerances defined above, the remaining worst offenders are removed from the rolling average calculation. This outlier rejection allows for smoother continuous data results.

Calibration Stability

During calibration, the filtering is active as described, plus an additional feature works to provide stability feedback to the user. When the user attempts to calibrate a sensor, the sudden changes in environment are perceived as impulses or plunge events and the filtering reacts accordingly. The results immediately show the value of the solution, and after a few moments, the filter incrementally engages fully and supplies the smoothest data. However, as the sensor and the calibration solution work towards equilibrium, the measurement may slowly drift. The sensor will monitor the results from the filter and determine if the measurement is stable. It watches the results and calculates a slope from each and every result to the next. Once the slope settles and is consistently flat for approximately 30 seconds, the sensor is considered stable. KOR is then notified and calibration can continue.

Sensor Response Times

Response times for EXO sensors are based on laboratory testing. This testing, though stringent, cannot mimic the actual response times in the field due to the wide variety of use cases. To characterize an EXO sensor's response time, a step change in the sensor's primary output parameter is applied, and the time to reach 63% of the final stimulus value is recorded. Repeated characterization of multiple sensors provides the T63 specification.

Sensor Accuracy Specifications

To maintain accuracy specifications for EXO sensor, we recommend that users calibrate sensors in the lab in standards with temperatures as close to the ambient temperature of the field water as possible.

1.6 Conductivity/Temperature Sensor Overview

The EXO combination conductivity and temperature sensor should be installed in a sonde in nearly all sonde applications. Not only will this sensor provide the most accurate and fastest response temperature data, but it will also provide the best data for the use in temperature compensation for the other EXO probes. The conductivity data is used to calculate salinity, non-linear function (nLF) conductivity, specific conductance, and total dissolved solids, and compensate for changes in density of water (as a function of temperature and salinity) in depth calculations if a depth sensor is installed.

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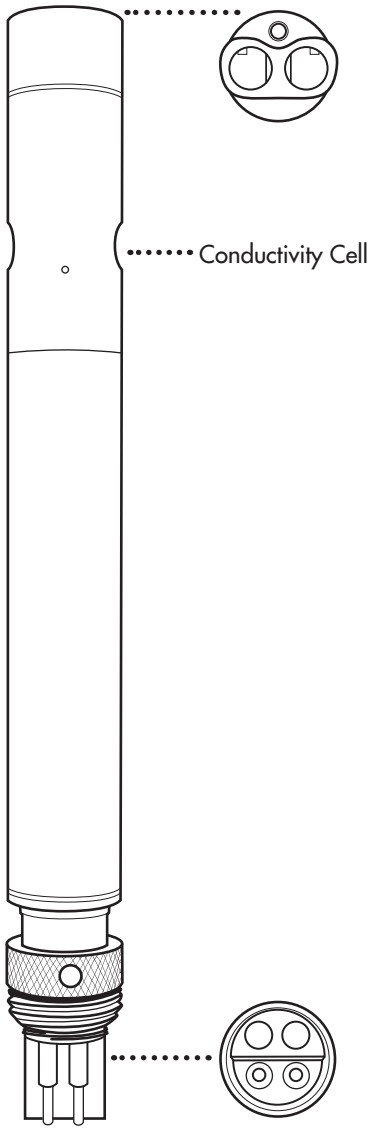


599870-01

Specifications

Conductivity

Default Units	microSiemens/centimeter
Temperature *Operating* *Storage*	 -5 to +50°C -20 to +80°C
Range	0 to 200 mS/cm
Accuracy	0-100 mS/cm: ±0.5% of reading or 0.001 mS/cm, whichever is greater; 100-200 mS/cm: ±1% of reading
Response	T63<2 sec
Resolution	0.0001 to 0.01 mS/cm range-dependent
Sensor Type	4-electrode nickel cell

Temperature

Default Units	°Celsius
Temperature *Operating* *Storage*	 -5 to +50°C -20 to +80°C
Accuracy	-5 to 35°C: ±0.01°C 35 to 50°C: ±0.05°C
Response	T63<1 sec
Resolution	0.001°C
Sensor Type	Thermistor

Temperature Thermistor

The temperature sensor uses a highly stable and aged thermistor with extremely low-drift characteristics. The thermistor's resistance changes with temperature. The measured resistance is then converted to temperature using an algorithm. The temperature sensor receives a multi-point NIST traceable wet calibration and the accuracy specification of 0.01˚C is valid for expected life of the probe. No calibration or maintenance of the temperature sensor is required, but accuracy checks can be conducted.

Conductivity Electrodes

The conductivity sensor uses four internal, pure-nickel electrodes to measure solution conductance. Two of the electrodes are current driven, and two are used to measure the voltage drop. The measured voltage drop is then converted into a conductance value in milliSiemens (millimhos). To convert this value to a conductivity value in milliSiemens per cm (mS/cm), the conductance is multiplied by the cell constant that has units of reciprocal cm (cm-1). The cell constant for the conductivity cell is approximately 5.5/cm ±10%. For most applications, the cell constant is automatically determined (or confirmed) with each deployment of the system when the calibration procedure is followed.

Temperature Compensation

EXO sensors have internal thermistors for quality assurance purposes. Turbidity uses the internal thermistor for temperature compensation, while all other EXO sensors reference the C/T probe for temperature compensation. To display and log temperature, a C/T probe must be installed in an EXO sonde. Thermistor readings are logged in the sonde's raw data–viewable in KOR software–but are not included in data exported to Excel.

Conductivity = This is a measurement of water conductance from the drive and sense electrodes on the conductivity electrode. The output is in mS/cm or µS/cm. Note that the conductivity of solutions of ionic species is highly dependent on temperature, and the conductivity output is NOT compensated for temperature.

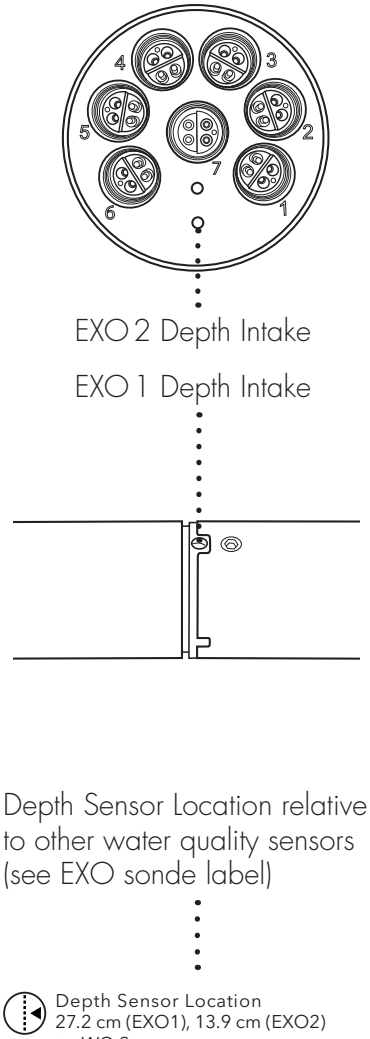
Specific Conductivity = When Specific Conductance is selected, the sonde uses the temperature and raw conductivity values associated with each determination to generate a specific conductance value compensated to 25∞C by default. Both the Temperature Coefficient and reference temperature can be adjusted in the advanced sensor menu under calibration.

nLF Conductivity = The non-linear function (nLF) is defined by the ISO 7888 standard and is applicable for the temperature compensation of electrolytic conductivity of natural waters. This convention is typically used in German markets.

Salinity = Salinity is determined automatically from the sonde conductivity and temperature readings according to algorithms found in Standard Methods for the Examination of Water and Wastewater (ed. 1989). The use of the Practical Salinity Scale results in values that are unitless, since the measurements are carried out in reference to the conductivity of standard seawater at 15 ∞C.

1.7 Depth and Level Sensor Overview

EXO measures depth of water with a non-vented strain gauge. (*See section 7 if your sonde is equipped with vented level.*) A differential strain gauge transducer measures pressure with one side of the transducer exposed to the water and the other side exposed to a vacuum. We calculate depth from the pressure exerted by the water column minus atmospheric pressure. Factors influencing depth measurement include barometric pressure, water density, and temperature. Calibration in the atmosphere "zeros" the sensor with respect to the local barometric pressure. A change in barometric pressure will result in a zero shift unless the transducer is recalibrated to the new pressure.



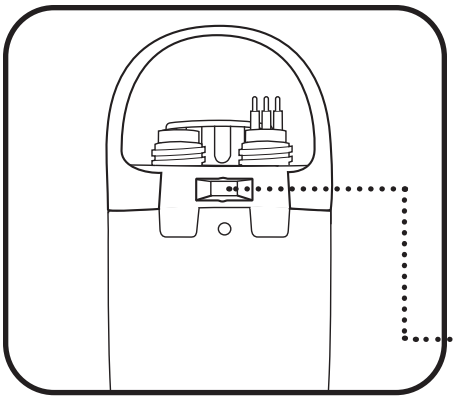
EXO sondes have intake openings to allow water to act on the strain gauge. The EXO1 intake is located in the yellow section between the battery compartment and label of the sonde.

The EXO2 intake openings are two small holes on the face of the sonde bulkhead.

(continued)

Specifications

Units	PSI, Depth (m, ft, bar)
Temperature *Operating* *Storage*	 -5 to +50°C -20 to +80°C
Range	*Shallow:* 0 to 33 ft (10 m) *Medium:* 0 to 328 ft (100 m) *Deep:* 0 to 820 ft (250 m) *Vented:* 0 to 33 ft (10 m)
Accuracy	*Shallow:* ±0.04% FS (±0.013 ft or ±0.004 m) *Medium:* ±0.04% FS (±0.13 ft or ±0.04 m) *Deep:* ±0.04% FS (±0.33 ft or ±0.10 m) *Vented:* ±0.03% FS (±0.010 ft or ±0.003 m)
Response	T63<2 sec
Resolution	0.001 ft (0.001 m)
Sensor Type	Stainless steel strain gauge



Location of Depth Sensor

Depth sensors on the EXO2 sondes are not on center. When deploying the sonde *vertically,* take care to ensure the sonde is redeployed in same position. Often a marker pin inside a PVC pipe is used. In *horizontal* deployments, take care to ensure the redeployments are always in the same orientation. This is especially important for the EXO2 sonde because the depth sensor is off-axis.

To assist with consistent horizontal orientation, the EXO2 sonde has an indentation at the top of the sonde for a marker or positioning pin.

The sonde should be installed with at least 1 cm of water above the intake ports.

If a conductivity sensor is installed, the depth will be compensated automatically for changes in the density of water as temperature and salinity change.

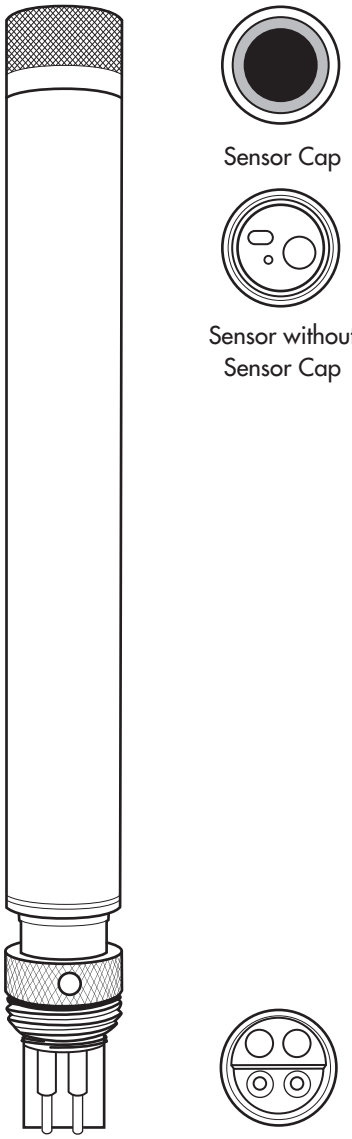
Depth Configuration

EXO sondes must be ordered with a specific depth option:
59950x-00 = no depth
59950x-01 = 0-10 m depth
59950x-02 = 0-100 m depth
59950x-03 = 0-250 m depth
59950x-04 = 0-10 m vented level
(*Reference section 7 for more detail on vented level.*)

The depth configuration must be chosen at time of ordering. Once a sonde is shipped with a depth configuration it cannot be changed by the user.

1.8 Dissolved Oxygen Sensor Overview

The principle of operation of the EXO optical dissolved oxygen sensor is based on the well-documented concept that dissolved oxygen quenches both the intensity and the lifetime of the luminescence associated with a carefully chosen chemical dye. The EXO DO sensor operates by shining a blue light of the proper wavelength on this luminescent dye which is immobilized in a matrix and formed into a disk. The blue light causes the immobilized dye to luminesce and the lifetime of this dye luminescence is measured via a photodiode in the probe. To increase the accuracy and stability of the technique, the dye is also irradiated with red light during part of the measurement cycle to act as a reference in the determination of the luminescence lifetime.



599100-01;
599110 sensor cap

When there is no oxygen present, the lifetime of the signal is maximal; as oxygen is introduced to the membrane surface of the sensor, the lifetime becomes shorter. Thus, the lifetime of the luminescence is inversely proportional to the amount of oxygen present and the relationship between the oxygen pressure outside the sensor and the lifetime can be quantified by the Stern-Volmer equation. For most lifetime-based optical DO sensors, this Stern-Volmer relationship

$$((Tzero/T) - 1) \text{ versus } O_2 \text{ pressure}$$

is not strictly linear (particularly at higher oxygen pressures) and the data must be processed using analysis by

(continued)

Specifications

Units	% Saturation, mg/L
Temperature *Operating* *Storage*	 -5 to +50°C -20 to +80°C
Range	0 to 500% air sat. 0 to 50 mg/L
Accuracy	0-200%: ±1% reading or 1% air sat., whichever is greater; 200-500%: ±5% reading 0-20 mg/L: ±1% of reading or 0.1 mg/L; 20-50 mg/L: ±5% reading
Response	T63<5 sec
Resolution	0.1% air sat. 0.01 mg/L
Sensor Type	Optical, luminescence lifetime

polynomial non-linear regression. Fortunately, the non-linearity does not change significantly with time so that, as long as each sensor is characterized with regard to its response to changing oxygen pressure, the curvature in the relationship does not affect the ability of the sensor to accurately measure oxygen for an extended period of time.

Variables that Affect DO Measurements

Variables that could affect dissolved oxygen measurements include temperature, salinity, and barometric pressure. Temperature and salinity are compensated for during instrument calibration and field use with the use of additional sensors and/or instrument software settings. Barometric pressure relates to the pressure of oxygen in the calibration environment, and barometric pressure changes due to a change in altitude or local weather. Generally the effect of barometric pressure is overcome by proper sensor calibration to a standard pressure. However, if the user measures dissolved oxygen in something besides per cent saturation, then the EXO DO sensor can store a local barometric reading put into the KOR software (DO % local) or the EXO handheld can take a live barometric reading with its internal barometer (ODO % EU).

ODO % Sat = Raw DO reading corrected with temperature and local barometric pressure at the time of calibration. (Local pressure/760 mmHg x 100 = % Sat.)

ODO % Local = Raw DO reading corrected with temperature and % Sat output fixed to 100% regardless of barometric pressure entry. (The entered local barometric pressure is used by KOR software for mg/L calculations.)

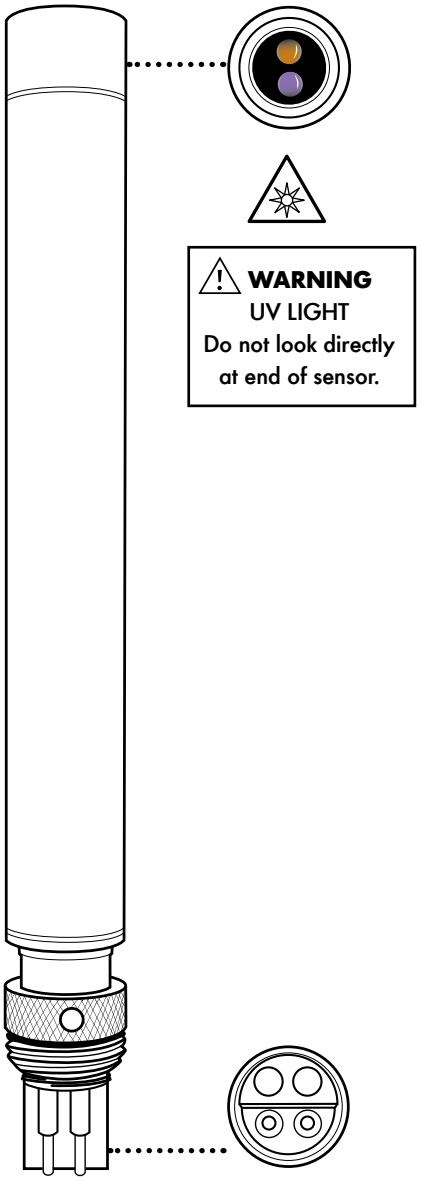
ODO % EU = ODO % Sat reading corrected with live barometric reading (available only on EXO Handheld). Fixes the % Sat output to 100%, and conforms to British and EU standards.

1.9 fDOM Sensor Overview

The EXO fDOM (Fluorescent Dissolved Organic Matter) sensor is a fluorescence sensor which detects the fluorescent component of DOM (Dissolved Organic Matter) when exposed to near-ultraviolet (UV) light.

Colored Dissolved Organic Matter

Users might wish to quantify *colored* dissolved organic matter (CDOM) in order to determine the amount of light which is absorbed by stained water and thus is not available for the photosynthesis process carried out by subsurface aquatic plants and algae. In most cases, fDOM can be used as a surrogate for CDOM.



599104-01

Quinine Sulfate

A surrogate for fDOM is Quinine Sulfate, which, in acid solution, fluoresces similarly to dissolved organic matter. The units of fDOM are quinine sulfate units (QSUs) where 1 QSU = 1 ppb quinine sulfate and thus quinine sulfate is really a double surrogate for the desired CDOM parameter.

The EXO fDOM sensor shows virtually perfect linearity (R^2=1.0000) on serial dilution of a colorless solution of quinine sulfate. However, on serial dilution of stained water field samples, the sensor shows some underlinearity. The point of underlinearity in field samples varies and is

(continued)

Specifications

Units	Quinine Sulfate Units (QSU), ppb
Temperature *Operating* *Storage*	 -5 to +50°C -20 to +80°C
Range	0 to 300 ppb QSU
Response	T63<2 sec
Resolution	0.01 ppb QSU
Sensor Type	Optical, fluorescence
Linearity	R^2>0.999 for serial dilution of 300 ppb Quinine Sulfate solution
Detection Limit	0.07 ppb QSU
Optics: **Excitation**	365±5 nm
Emission	480±40 nm

affected by the UV absorbance of the DOM in the water. Testing shows that underlinearity can occur at fDOM concentrations as low as 50 QSU. This factor means that a field sample with an fDOM reading of 140 QSU will contain significantly more than double the fDOM of a sample that reads 70 QSU. This effect—good linearity in colorless quinine sulfate solution, but underlinearity in stained field samples—is also exhibited by other commercially available fDOM sensors and thus the performance of the EXO sensor is likely to be equivalent or better than the competition while providing the advantages of easy integration into a multiparameter package and automatic mechanical cleaning when used in monitoring studies with an EXO2 sonde.

1.10 Ammonium, Nitrate, & Chloride Sensors Overview

⚠ Ammonium, nitrate, and chloride ion-selective electrodes (ISEs) should be used in *freshwater* applications only at depths of less than 55 feet (17 meters) and less than 25 psi.

The ammonium and nitrate sensors use a silver/silver chloride wire electrode in a custom filling solution. The internal solution is separated from the sample medium by a polymer membrane, which selectively interacts with ammonium or nitrate ions. When the sensor is immersed in water, a potential is established across the membrane that depends on the relative amounts of ions in the sample and the internal solution. This potential is read relative to the Ag/AgCl reference electrode.

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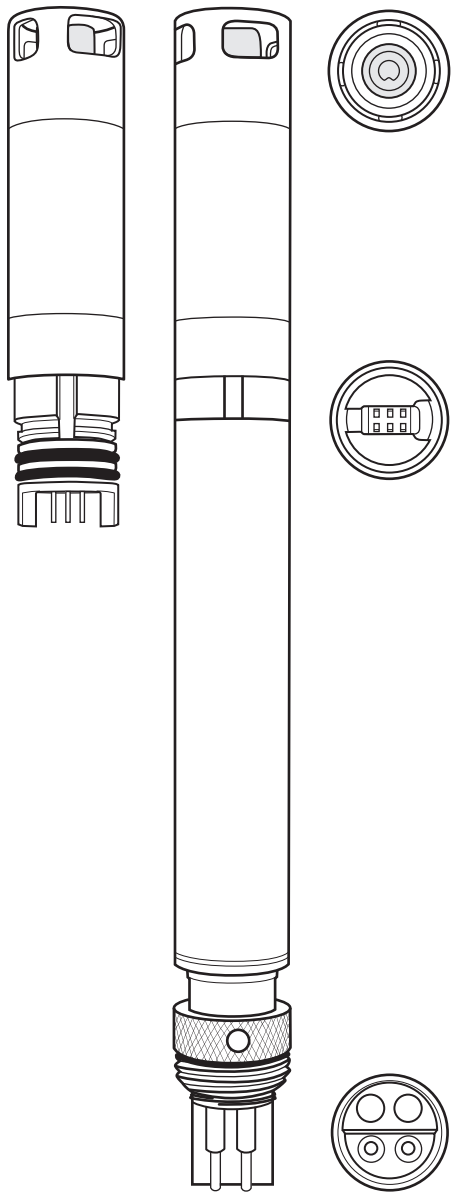

599709, 599710, 599711;
599743-01, 599744-01, 599745-01 modules

Specifications

Ammonium - NH_4

Units	mg/L-N, millivolts
Temperature *Operating* *Storage*	 0 to 30°C 0 to 30°C
Depth	0 to <55 ft (0 to <17 m)
Range	0 to 200 mg/L-N
Accuracy	±10% of reading or ±2 mg/L-N, whichever is greater
Response	T63<30 sec
Resolution	0.01 mg/L
Sensor Type	Ion-selective electrode
Conductivity	<1500 µS/cm

Nitrate - NO_3

Units	mg/L-N, millivolts
Temperature *Operating* *Storage*	 0 to 30°C 0 to 30°C
Depth	0 to <55 ft (0 to <17 m)
Range	0 to 200 mg/L-N
Accuracy	±10% of reading or ±2 mg/L-N, whichever is greater
Response	T63<30 sec
Resolution	0.01 mg/L
Sensor Type	Ion-selective electrode
Conductivity	<1500 µS/cm

Specifications *(continued)*

Chloride - Cl

Units	mg/L-Cl, millivolts
Temperature *Operating* *Storage*	 0 to 30°C 0 to 30°C
Depth	0 to <55 ft (0 to <17 m)
Range	0 to 18000 mg/L-Cl
Accuracy	±15% of reading or ±5 mg/L-Cl, whichever is greater
Response	T63<30 sec
Resolution	0.01 mg/L
Sensor Type	Ion-selective electrode
Salinity	30 psu

NOTE: Qualification testing for chloride was performed in a stirred calibration solution. Due to the solid state nature of the chloride ISE, the sensor exhibits moderate flow dependence. Mitigation can be achieved by stirring during calibration.

- The chloride sensor uses a solid-state membrane attached to a conductive wire. This sensor operates in a similar fashion to the ammonium and nitrate sensors.

- For all ISEs, the linear relationship between the logarithm of the ammonium, nitrate or chloride activity and the observed voltage, as predicted by the Nernst equation, is the basis for the determination.

- Ammonium is calculated from the pH, salinity, and temperature readings. If a pH sensor is not in use, the instrument will assume the sample is neutral (pH 7) for the calculation. If a conductivity sensor (salinity) is not in use, the instrument will use the salinity correction value entered in the ammonium sensor calibration screen for the calculation.

Replaceable Sensor Module

- The EXO ammonium, chloride, and nitrate sensors have a unique design that incorporates a user-replaceable sensor tip (module) and a reusable sensor base that houses the processing electronics, memory, and wet-mate connector. This allows users to reduce the costs associated with these sensors by only replacing the relatively inexpensive module periodically and not the more costly base.

- The connection of the module to the sensor base is designed for one connection only and the procedure must be conducted in an indoor and dry environment. Once installed the module cannot be removed until you are prepared to replace it with a new module. *See section 6.21 for detailed instructions.*

The typical life expectancy of an ISE sensor is three to six months, depending on use.

⚠ Precautions

- ISEs are intended for sampling purposes and **must** be calibrated frequently due to sensor drift.

- ISEs can be used in long-term deployments for qualitative trends. Use with an EXO wiper will deform the brush over time and may require more frequent brush replacement. The brush deformation may intensify with the fouling present in the monitored environment.

- ISE sensors only come in guarded configurations. Customers should not remove the plastic guard that protects the ISE membrane.

- For long-term deployments, sensor data should be compared to that of grab samples throughout the monitoring period to note drift.

For a full list of precautions see the end of section 5.10

1.11 pH and ORP Sensor Overview

Users can choose between a pH sensor or a combination pH/ORP sensor to measure these parameters. pH describes the acid and base characteristics of water. A pH of 7.0 is neutral; values below 7 are acidic; values above 7 are alkaline. ORP designates the oxidizing-reducing potential of a water sample and is useful for water which contains a high concentration of redox-active species, such as the salts of many metals and strong oxidizing (chlorine) and reducing (sulfite ion) agents. However, ORP is a non-specific measurement—the measured potential is reflective of a combination of the effects of all the dissolved species in the medium. Users should be careful not to overinterpret ORP data unless specific information about the site is known.

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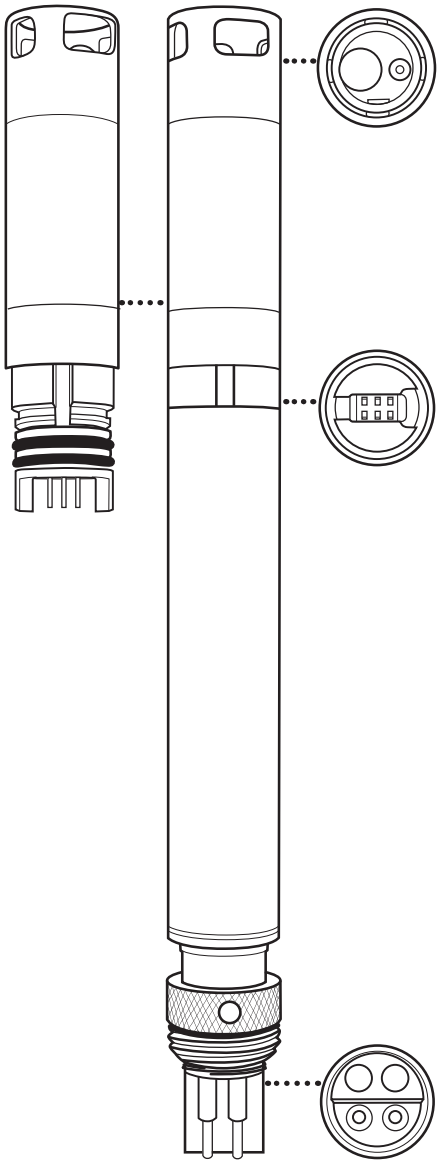

599701, 599702, 599705, 599706; 599795-01, 599795-02, 599797-01, 599797-02 modules

Specifications

pH

Units	pH units
Temperature *Operating* *Storage*	 -5 to +50°C 0 to 60°C
Range	0 to 14 units
Accuracy	±0.1 pH units within ±10°C of calibration temperature; ±0.2 pH units for entire temp range
Response	T63<3 sec
Resolution	0.01 units
Sensor Type	Glass combination electrode

ORP

Units	millivolts
Temperature *Operating* *Storage*	 -5 to +50°C 0 to 60°C
Range	-999 to +999 mV
Accuracy	±20 mV in Redox standard solution
Response	T63<5 sec
Resolution	0.1 mV
Sensor Type	Platinum button

Replaceable Sensor Module

The EXO pH and pH/ORP sensors have a unique design that incorporates a user-replaceable sensor tip (module) and a reusable sensor base that houses the processing electronics, memory, and wet-mate connector. This allows users to reduce the costs associated with pH and pH/ORP sensors by only replacing the relatively inexpensive module periodically and not the more costly base.

The connection of the module to the sensor base is designed for one connection only and the procedure must be conducted in an indoor and dry environment. Once installed the module cannot be removed until you are prepared to replace it with a new module. *See section 6.21 for detailed instructions.*

Users must order either a pH or pH/ORP sensor. Once ordered the sensor is *only* compatible with like-model sensor modules. For example, if a pH sensor is purchased initially, then the user must order a replaceable pH sensor module in the future; it cannot be replaced with a pH/ORP module.

Electrodes

EXO measures pH with two electrodes combined in the same probe: one for hydrogen ions and one as a reference. The sensor is a glass bulb filled with a solution of stable pH (usually 7) and the inside of the glass surface experiences constant binding of H^+ ions. The outside of the bulb is exposed to the sample, where the concentration of hydrogen ions varies. The resulting differential creates a potential read by the meter versus the stable potential of the reference.

The ORP of the media is measured by the difference in potential between an electrode which is relatively chemically inert and a reference electrode. The ORP sensor consists of a platinum button found on the tip of the probe. The potential associated with this metal is read versus the Ag/AgCl reference electrode of the combination sensor that utilizes gelled electrolyte. ORP values are presented in millivolts and are not compensated for temperature.

Signal Quality

Signal conditioning electronics within the pH sensor module improve response, increase stability, and reduce proximal interference during calibration. Amplification (buffering) in the sensor head is used to eliminate any issue of humidity in the front-end circuitry and reduce noise.

1.12 Total Algae (Chl & BGA) Sensor Overview

The EXO total algae sensor is a dual-channel fluorescence sensor that generates two independent data sets; one resulting from a blue excitation beam that directly excites the chlorophyll *a* molecule, present in all photosynthetic cells, and a second from an orange excitation beam that excites the phycocyanin accessory pigment found in blue-green algae (cyanobacteria). This orange excitation triggers a transfer of energy from the phycocyanin to the central chlorophyll *a*, where photosynthesis is initiated.

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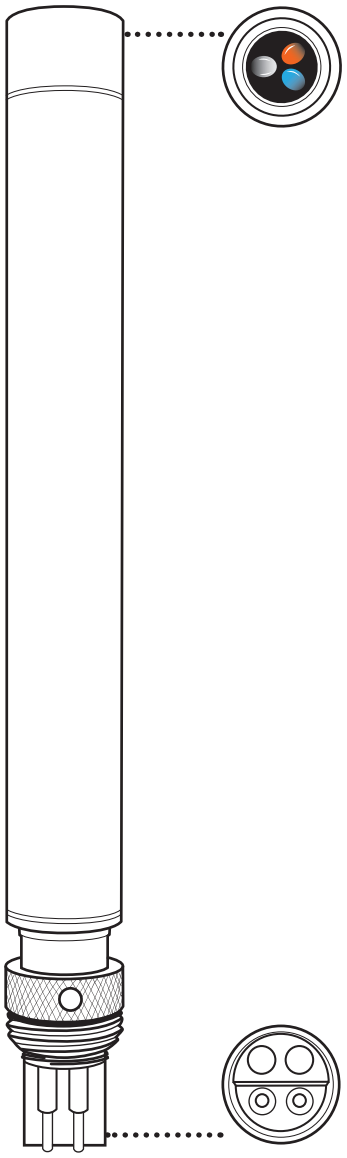


599102-01 (Phycocyanin)
599103-01 (Phycoerythrin)

Specifications

Units	
Chlorophyll	RFU, µg/L Chl
BGA-PC	RFU, µg/L PC
BGA-PE	RFU, µg/L PE
Temperature	
Operating	-5 to +50°C
Storage	-20 to +80°C
Range	*Chl:* 0-100 RFU, 0-400 µg/L Chl*; *BGA-PC:* 0-100 RFU, 0-100 µg/L*; *BGA-PE:* 0-100 RFU, 0-280 µg/L*
Response	T63<2 sec
Resolution	*Chl:* 0.01 RFU, 0.01 µg/L Chl; *BGA-PC:* 0.01 RFU, 0.01 µg/L; *BGA-PE:* 0.01 RFU, 0.01 µg/L
Sensor Type	Optical, fluorescence
Linearity	*Chl:* R^2>0.999 for serial dilution of Rhodamine WT solution from 0-400 µg/L Chl equivalents *BGA-PC:* R^2>0.999 for serial dilution of Rhodamine WT solution from 0-100 µg/L PC equivalents; *BGA-PE:* R^2>0.999 for serial dilution of Rhodamine WT solution from 0-280 µg/L PE equivalents
Optics: Chl Excitation	470±15 nm
PC Excitation	590±15 nm
PE Excitation	525±15 nm
Emission	685±20 nm

*Pigment concentration ranges of algae sensors were determined in monocultures of specific algae species. This range will vary depending on algae assemblage and environmental conditions. For accurate pigment concentration estimates at particular sites or samples, the user must determine the RFU to pigment concentration relationship on a site-by-site basis.

Although blue-green algae contain chlorophyll *a*, the chlorophyll fluorescence signal detected by *in situ* fluorometers is weaker than in eukaryotic phytoplankton. This results in an underestimate of algae biomass when using a single-channel chlorophyll sensor when blue-green algae are present. The EXO total algae sensor generates a more accurate total biomass estimate of the planktonic autotrophic community by exciting chlorophyll *a*, phycocyanin or phycoerythrin.

The sensor generates data in three formats: RAW, RFU, and an estimate of the pigment concentration in µg/L.

The RAW value is a value unaffected by user calibrations and provides a range from 0-100, representing the per cent of full scale that the sensor detects in a sample. This parameter is typically used for diagnostic purposes only.

RFU stands for Relative Fluorescence Units and is used to set sensor output relative to a stable secondary standard, such as Rhodamine WT dye. This allows users to calibrate sensors identically; for example, calibrating all sensors in a network to read 100 RFU in a concentration of Rhodamine WT dye. The sensors can then be deployed and generate data that is relative to all other sensors. Once a sensor is retrieved, it can be checked against that same standard to assess sensor performance, drift, or the potential effects of biofouling.

The µg/L output generates an estimate of pigment concentration. The relationship between µg/L and sensor's RAW signal should be developed through following standard operating procedures of sampling the water body of interest, collecting sensor data from sample, and then extracting the pigment to establish a correlation. The higher the temporal and spatial resolution of the sampling, the more accurate this estimate will be.

Chlorophyll

The EXO chlorophyll sensor operates on the *in vivo* fluorescence principle with no disruption of the cells required to obtain either spot readings or long-term data. The EXO sensor has an excellent detection limit as determined under laboratory conditions and this advantage should be realized in many field applications.

EXO chlorophyll readings show excellent linearity on serial dilution of a surrogate solution of Rhodamine WT (R^2>0.9999) and this should ensure relative accuracy of field chlorophyll readings, i.e., a chlorophyll reading of 100 units will represent twice the algal content of water with a chlorophyll reading of 50 units. Also, EXO chlorophyll readings show very low interference from turbidity, allowing for more accurate determination of algal content during rainfall events which release both sediment and algae into the water. The EXO chlorophyll sensor also exhibits very low interference from dissolved organics, increasing data accuracy.

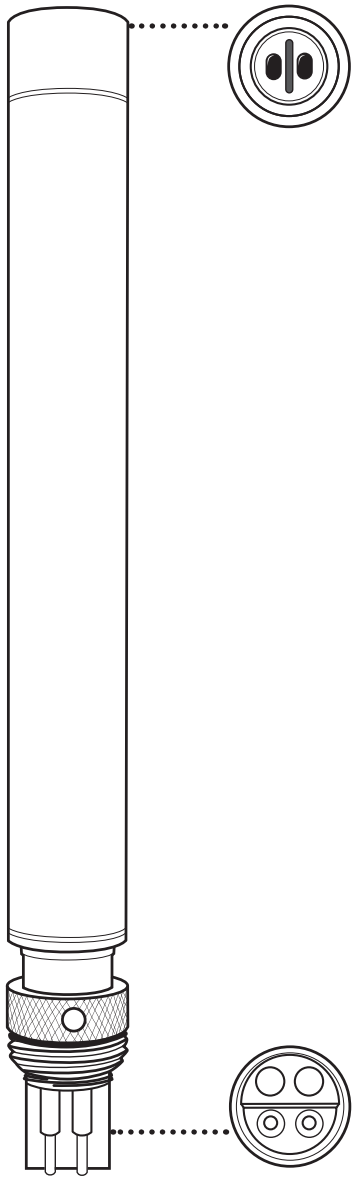
Blue-green Algae

The EXO BGA readings show excellent linearity on serial dilution of a surrogate solution of Rhodamine WT (R^2>0.9999) and this should ensure relative accuracy of field BGA readings, i.e., a BGA reading of 100 units will represent twice the algal content of water with a BGA reading of 50 units.

1.13 Turbidity Sensor Overview

Turbidity is the indirect measurement of the suspended solid concentration in water and is typically determined by shining a light beam into the sample solution and then measuring the light that is scattered off of the particles which are present. The suspended solid concentration is an important water quality factor and is a fundamental measure of environmental change. The source of the suspended solids varies in nature (examples include silt, clay, sand, algae, organic matter) but all particles will impact the light transmittance and result in a turbidity signal.

The EXO Turbidity sensor employs a near-infrared light source and detects scattering at 90 degrees of the incident light beam. According to ASTM D7315 method, this type of turbidity sensor has been characterized as a nephelometric near-IR turbidimeter, non-ratiometric[#]. This method calls for this sensor type to report values in formazin nephelometric units (FNU). FNU is the default calibration unit for the EXO sensor but users are able to change calibration units to nephelometric turbidity units (NTU), raw sensor signal (RAW), or total suspended solids (TSS) assuming the user enters the appropriate correlation data.



599101-01

The RAW value is a value unaffected by user calibrations and provides a range from 0-100, representing the per cent of full scale that the sensor detects in a sample. *(continued)*

Specifications

Default Units	FNU
Temperature *Operating* *Storage*	 -5 to +50°C -20 to +80°C
Range	0 to 4000 FNU
Accuracy	0-999 FNU: 0.3 FNU or ±2% of reading, whichever is greater; 1000-4000 FNU: ±5% of reading
Response	T63<2 sec
Resolution	0-999 FNU: 0.01 FNU 1000-4000 FNU: 0.1 FNU
Sensor Type	Optical, 90° scatter
Optics: Excitation	 860±15 nm

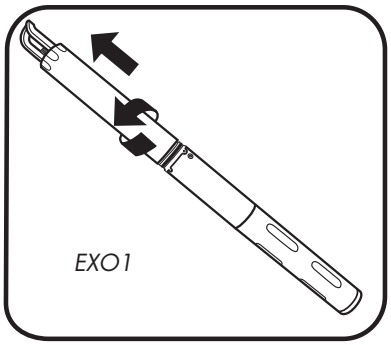
[#] *ASTM D7315-07a "Test Method for Determination of Turbidity Above 1 Turbidity Unit (TU) in Static Mode."*

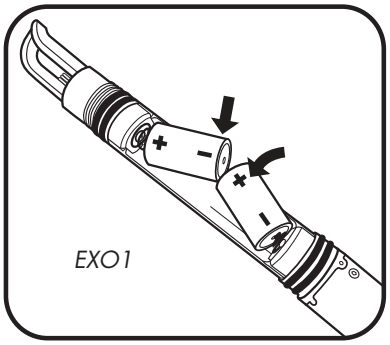
While all turbidity sensors will read consistently in formazin, other calibration solutions and field readings will vary between different models of turbidity sensors. These differences are thought to be a result of differing optical components and geometries and the resulting detection of varying suspended sediment characteristics. This effect is inherent in the nature of every turbidity sensor, and as a result readings between different model turbidity sensors are likely to show different field values even after calibration in the same standards.

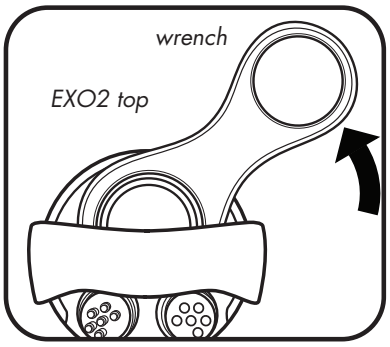
For long-term, *in situ* continuous monitoring of turbidity, the EXO2 sonde has a wiper to clean the turbidity sensor to avoid sensor fouling and maintain accuracy.

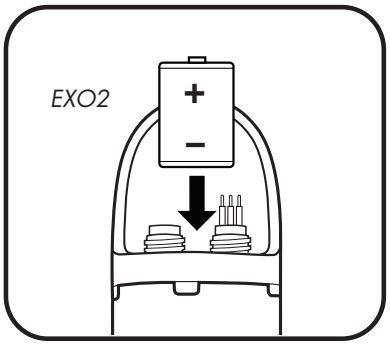
2.1 Install Batteries

The EXO1 Sonde uses two (2) D-cell alkaline batteries and the EXO2 Sonde uses four (4) D-cell alkaline batteries as the recommended power source. Alternatively, the sonde may use rechargeable 1.5V high-capacity NiMH D-cell batteries that you purchase. (Do not use Ni-Cad or Lithium batteries in the EXO sonde.) *For detailed installation instructions please see section 6.3 for EXO1 and 6.4 for EXO2.*









⚠ Do not use 3.6V Li batteries in the sondes.
Damage to the circuit board is not covered under warranty.

1. Remove battery cover.

EXO1: Twist the blue battery cover counterclockwise to loosen, lift up to remove. Use included wrench to loosen, if necessary.

⚠ Do not remove the screws on the sonde's electronics compartment.

EXO2: Unscrew and remove battery cap. Use included wrench to loosen, if necessary.

2. Install batteries.

EXO1: Lift up the rubber flaps *(not shown at left),* which help reduce vibration against the battery cover.

EXO1 and EXO2: Insert the batteries with positive terminals (+) facing up and negative terminals (-) facing down toward the probes.

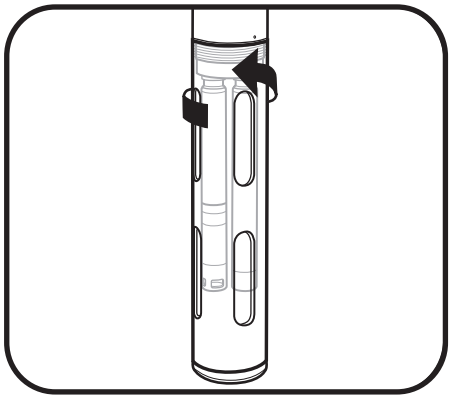
3. Replace battery cover.

NOTE: Before replacing the battery cover, inspect and service the o-rings. Ensure that the o-rings are not nicked or torn and that they have no contaminants or particles on them or the sealing surfaces inside the battery cover. Then apply a thin coat of Krytox® lubricant to each o-ring and sealing surface.

Replace the battery cover or cap and tighten until snug. Do not overtighten.

2.2 Install/Remove Guard or Calibration Cup

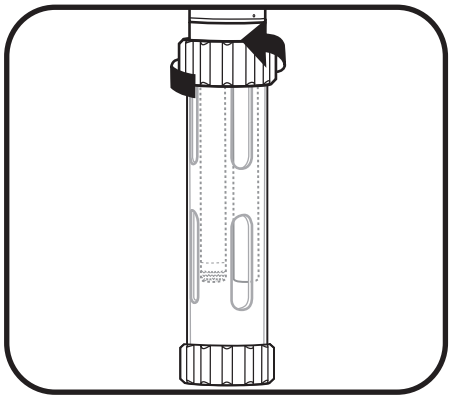
Sonde guards protect EXO sensors from impact throughout deployment. Users must install the guard prior to data collection. The calibration cup (cal cup) is used for storage and calibration. We recommend using two guards: one for field deployments and a second used exclusively for calibrations. Using a second guard will minimize calibration solution contamination (especially for turbidity). EXO calibration cups install over an installed sonde guard. This configuration reduces the amount of standards required for calibration and protects the sensors during calibration.



1 Install/remove sonde guard.

Install guard by threading it onto the sonde bulkhead threads. Rotate the guard clockwise on the bulkhead to install, taking care not to pinch your fingers. Rotate it counterclockwise to remove. Always use one guard for deployment/storage and the other for calibration only.

⚠ Take care not to let the guard damage unguarded pH or pH/ORP sensors when installing and removing.

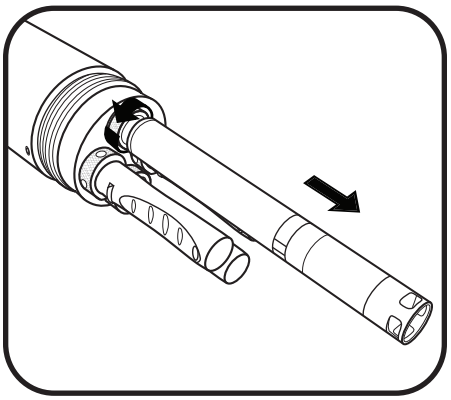


2 Install/remove calibration cup.

Before installation, loosen (but do not remove) the cup's clamping ring. Then, with the sonde guard already installed, slide the cal cup over the guard until the bottom of the guard rests against the bottom of the cal cup. Tighten the ring until snug. To remove the cal cup, loosen the ring by 1/4 turn and pull the guard free from the cup.

2.3 Install/Remove Sensors

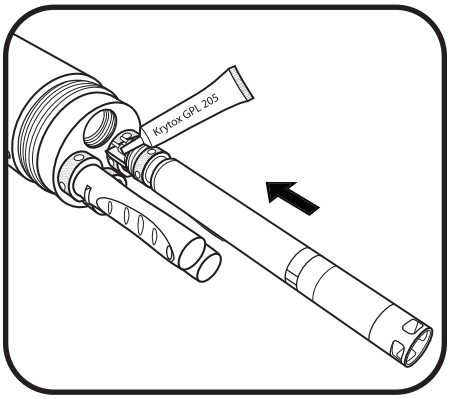
EXO sensors have identical connectors and identify themselves via onboard firmware; therefore, users can install any probe into any universal sonde port. The exception is the wiper for the EXO2 sonde, which must be installed in the central Port 7. Individual ports are physically identified by an engraved number on the sonde bulkhead. Although the probes are wet-mateable, users should clean, lubricate, and dry the sonde and sensors connectors prior to installation or service, when possible.



1 Remove probe or port plug.

Remove the calibration cup and sensor guard from the sonde. Place the sonde on a clean, flat surface and prevent it from rolling.

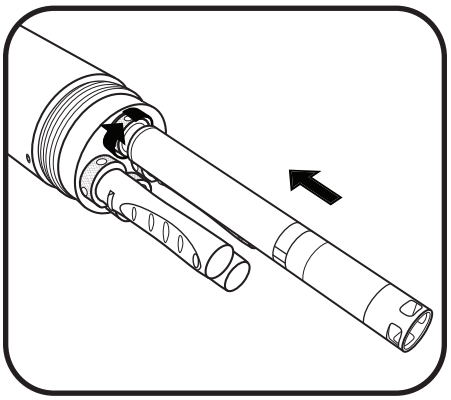
If removing a sensor or port plug, use the probe tool in the locking nut and rotate counterclockwise to loosen. Pull the probe straight out of the port and place on a clean surface. Remove hydration caps or buffer bottles on probes. Wipe dry with a clean, lint-free cloth.



2 Clean port and install sensor.

Visually inspect the port for contamination. If the port is dirty or wet, clean it with a clean, lint-free cloth or compressed air. Apply a light coat of Krytox grease to the rubber mating surfaces of the connector (not the -o-ring) and a small dab of Krytox grease on the threads of the locking nut.

Insert the sensor into the port by properly aligning the connectors' pins and sleeves (male and female contacts); then press them firmly together.



3 Tighten locking nut.

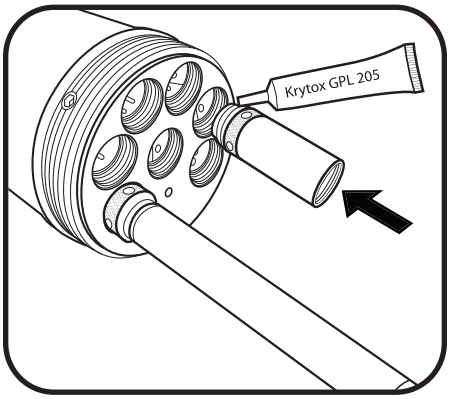
Taking care not to cross-thread the grooves, finger-tighten the locking nut clockwise. When the nut and o-ring are seated against the bulkhead, tighten the nut with probe tool 1/4 turn until snug. Once sensors or plugs are installed, reinstall the sensor guard to protect sensors from impact damage.

⚠ Take care not to twist the probe body when tightening and loosening the locking nut. Excessive twisting of the probe can damage the connector and is not covered under warranty.

2.4 Install Saltwater Sacrificial Anode

One of two EXO saltwater anode kits are required for sondes continuously deployed in corrosive media, particularly saltwater or brackish estuarine water. This section describes the anode that installs in a sensor port (#599595). The next section describes the anode that attaches to a metal sensor guard (#599520 or #599521).

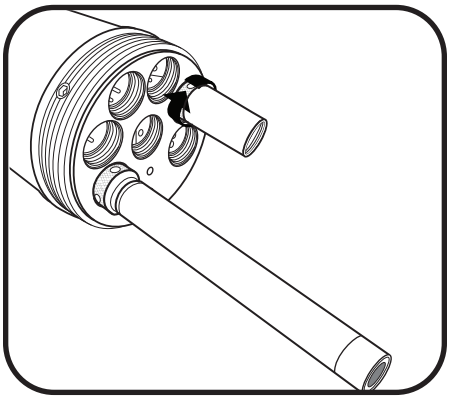
A "sacrificial anode" is commonly used in marine applications to minimize corrosion damage to all metallic parts of ships. Elemental zinc is used as the sacrificial anode because it is more easily oxidized than most other metals. A replaceable block of zinc is installed in electrical contact with other metals that are susceptible to saltwater corrosion, and the zinc is preferentially oxidized (or corroded), thus preventing damage to other metal components. The metal on the EXO's bulkhead, probe housings, and optional antifouling guard benefit from the use of a sacrificial anode.



NOTE: Early 2014 sonde models include a titanium bulkhead and connectors. This new feature eliminates the need to use an anode, however all older sondes with a bronze alloy do require an anode to prevent damage.

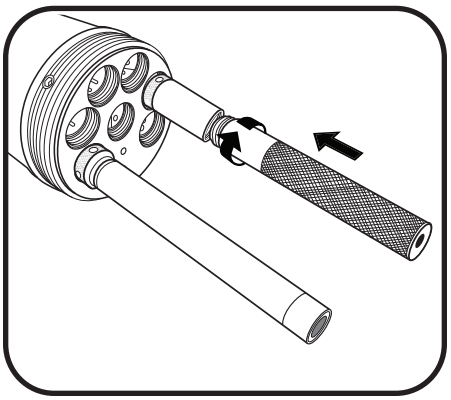
1 Grease threads.

Apply a light coating of lubricant to the connector threads to prevent binding. Apply a light coating of lubricant to the anode base's o-ring and threads.



2 Install the anode base.

Insert the anode base in an available sensor port and screw down the retaining ring until snug.



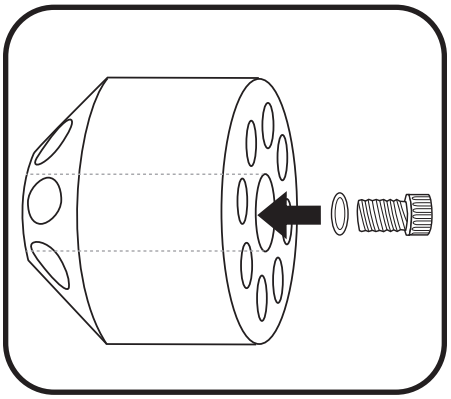
3 Install the anode.

Install the sacrificial anode in the anode base, twisting until anode is snug.

When the first anode deteriorates, replace with the second anode in the kit. When both anodes have been consumed, purchase a new anode kit.

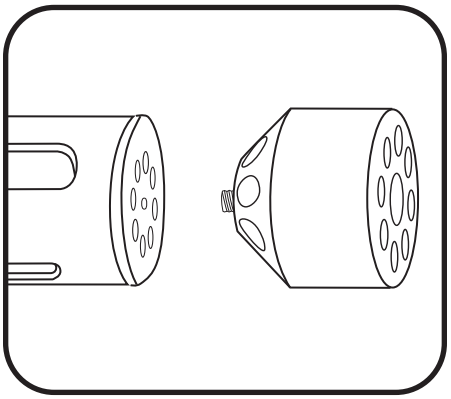
2.5 Install Coastal Anode Guard Weight

The EXO Coastal Anode Guard Weight is the alternative zinc solution that does not occupy a sensor port. The anode is available in two sizes—for EXO1 sondes (#599520) and for EXO2 sondes (#599521)—and attaches to the base of an antifouling sensor guard. As with the other anode solution, zincs are not required on early 2014 sonde models which feature a titanium bulkhead.



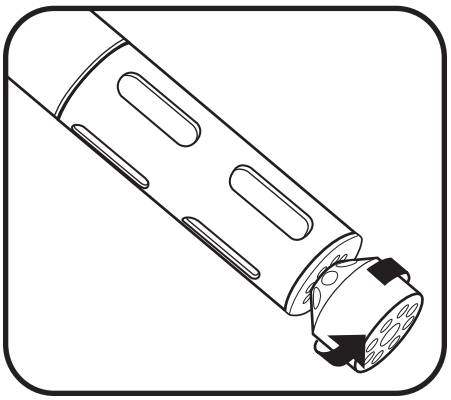
1 Attach hardware to anode.

Equip the end of the socket-head screw with the washer. Then insert the screw into the anode base.



2 Attach anode to sensor guard.

Attach the anode weight to the endcap of the antifouling guard.

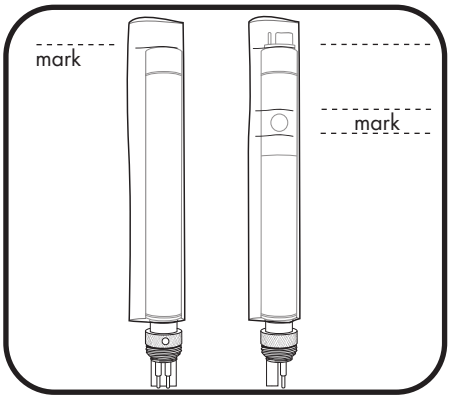


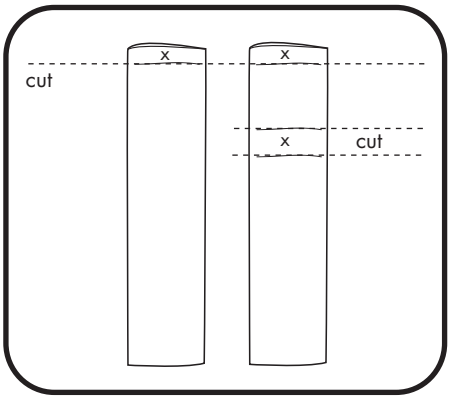
Use an Allen or torque wrench to turn the socket-head screw inside the anode weight. Turn clockwise, and tighten until snug (torque to 24-30 inch pounds).
Do not over tighten.

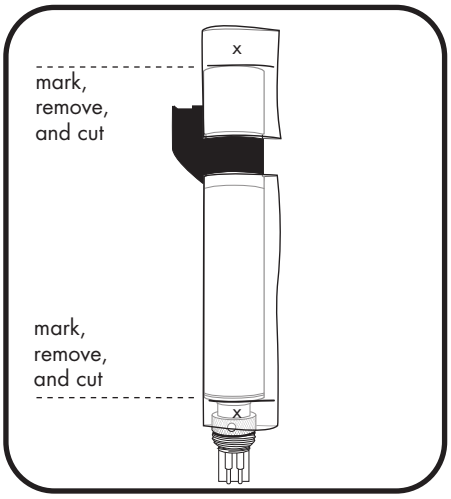
⚠ *Only use the anode weight in combination with the EXO antifouling guard.* If you attach the anode weight to a polymer EXO sensor guard, then the anode will lose all its protective qualities. (Order antifouling guards separately: EXO1, #599563 or EXO2, #599564.)

2.6 Install/Remove Anti-fouling Sleeves

The Anti-Fouling Protective Sleeve Kit (#599663) contains plastic sonde and probe covers used for long-term deployments. The kit includes sleeves for the sonde, individual sensors, and the central wiper that are heat shrunk to be form-fitting. Throughout a deployment, biofouling will collect on the sleeve rather than directly on the instrument, significantly reducing cleaning and maintenance. Review these instructions below for proper installation and removal of the protective sleeves.







1 Fitting the probe sleeves.

a. Prior to installation, ensure all probes are detached from the sonde body.

b. Insert a probe into a protective sleeve. Line up the edge of the plastic sleeve with the bottom edge of the probe housing nearest the connector; then use a marker to note where the sleeve begins to overhang the top edge of the probe head.

- For C/T, indicate two lines above and below the vent hole to ensure its exposure during deployment.

c. Remove the sleeve from the probe and cut it at the marked area(s) to remove excess plastic. Once appropriately sized, slide the anti-fouling sleeve back onto the probe.

- For C/T, slide both pieces of the sleeve back onto the probe and ensure the vent hole remains exposed.

d. Repeat this process with all probes except the EXO central wiper (see next instructions).

2 Fitting the EXO2 central wiper sleeve.

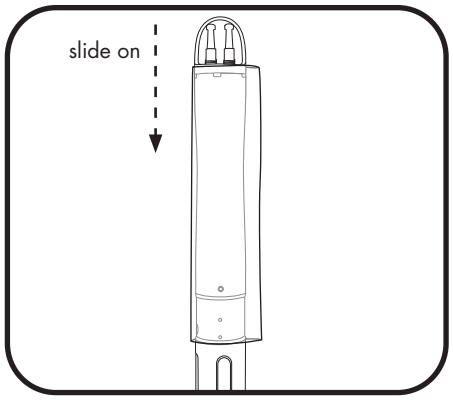
The central wiper sleeve is comprised of two pieces.

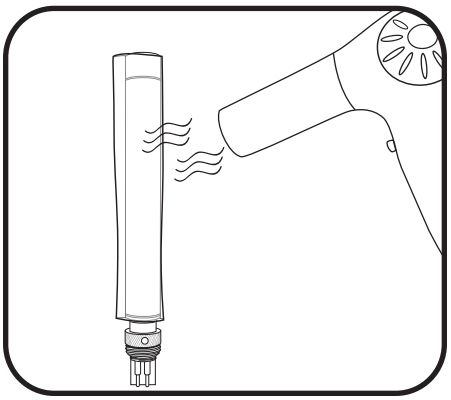
a. Loosen the set screw with a 0.05 in. Allen wrench and remove the wiper brush assembly.

b. Slide the large central wiper sleeve onto the wiper housing at the brush end until it fits snugly into the brush guard. The sleeve can be slipped between the guard and the housing by gently pulling the brush guard away from the housing. Use a marker to note where the sleeve begins to overhang the edge of the wiper housing.

c. Remove the sleeve from the wiper and cut it at the marked area to remove excess plastic.

d. Slide the remaining plastic onto the connector end of the wiper until it touches the bottom of the brush guard. Use a marker to note where the plastic begins to overhang the wiper housing.





e. Remove the sleeve from the probe and cut it at the marked area to remove the excess plastic.

f. Once both pieces of the sleeve are appropriately sized, slide them back onto the wiper.

3 Fitting the EXO2 sonde sleeve.

Install all probes and the guard onto the sonde. Equip the sonde with a protective sleeve starting at the bail end of the sonde for easiest installation. Line up the end of the plastic with the top of the sonde body (in yellow).

4 Heat-shrinking the sleeves.

To form-fit the plastic to the equipment, you must heat shrink the sleeves using one of two methods:

Heat Gun/Hair Dryer (Highest Setting)

Do not hold heat on any one spot for more than one second. Move the heat back and forth and continue to rotate the equipment until the plastic clings tightly to it. This process should take less than 5 seconds with a heat gun and 15-20 seconds with a hair dryer on its highest setting.

NOTE: If using the heat gun method, shrink the sleeves on the probes first, install the probes in the sonde, and install the guard. Then shrink the sonde sleeve.

Oven/Toaster Oven

Pre-heat oven to approximately 65-70°C.

⚠ DO NOT exceed 80°C or you will damage components of the sonde and sensors.

Insert the equipment by gripping the sonde by the bail and **not** by the sonde's sleeve. If possible, the sonde should be in the upright position when placed in the oven. Laying the sonde on its side, resting on a grate or rack, could cause inconsistencies in the shrinking process. Safely remove it with gloves once the sleeves visibly cling to the instrument.

NOTE: With either method, small air bubbles may appear in the sleeve. This is expected and will not affect the performance of the sleeve.

5 Removing the sleeves after use.

To remove the sleeves, find the perforation in the plastic. Pull down on this from the top. If unable to remove the sleeve with this approach, simply cut the plastic. Do so cautiously, so as to not damage the instrument.

⚠ DO NOT use a sharp instrument in an attempt to cut the sleeve off. This could cut through the sleeve and into your sonde or probe, causing damage to your equipment.

2.7 Sonde States and LED Descriptions

States

An EXO sonde is always in one of three operational states: *Off, Awake,* and *Asleep*. These states determine the sonde's current power usage and logging potential. When *Off* , the sonde is not powered and cannot collect data (no batteries installed, no topside power). Users can apply power to the sonde internally, using batteries, or externally with an EXO field cable attached from the topside port to an EXO Handheld, DCP or other approved power source. Once power is applied to a sonde, it is either *Awake* or *Asleep*.

States

Off: Not powered, no data collection.

Asleep: Low power. Waiting for command.

Awake: Full power. Ready to collect.

LED Indicators

Blue LED–Bluetooth

None: Off, not active.

On Solid: On, not linked.

2 Hz Blink: On, successfully linked.

Red LED–Sonde State

None: Sonde is *Off* or *Asleep* with logging disabled.

0.1 Hz Blink: Sonde is *Asleep* with logging enabled.

1 Hz Blink: Sonde is *Awake*.

On: Sonde is *Awake* with faults.

When in an *Asleep* state, the sonde remains in a very low power setting and waits for a user command or its next scheduled logging interval. An *Awake* sonde is fully powered and ready to collect data. Once awakened, a sonde remains *Awake* for five minutes after its last communication via Bluetooth or 30 seconds after its last communication via the topside port. The sonde also automatically awakens 15 seconds before its next scheduled logging interval.

LED Indicators

Each sonde has two LED indicators that show the sonde's status. The blue LED indicates the Bluetooth's wireless connection status. The red LED indicates the sonde's current state.

The Bluetooth light (blue) is activated by a magnet swipe at the magnetic activation area. When the blue LED is off, the Bluetooth is disabled. When the light is on continuously, the Bluetooth is enabled, but no link has been established. When the blue LED blinks at 2 Hz, the sonde's Bluetooth is on, and has established a link.

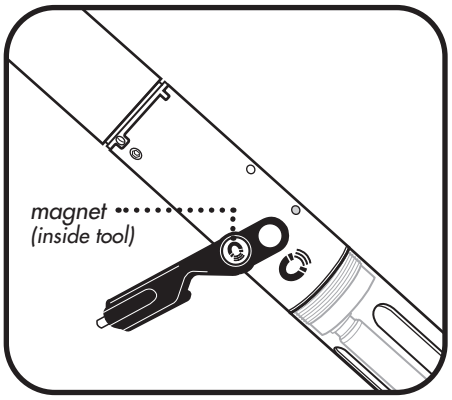
When the red sonde state LED is off, the sonde is either *Off* or *Asleep* and not logging. When it blinks at 0.1 Hz (once every 10 seconds), the sonde is *Asleep* and logging is enabled. When the red light blinks at 1 Hz, the sonde is *Awake* and has no faults. If the red light is lit continuously, the sonde is *Awake* and has detected faults, such as problems with the system that need to be fixed prior to use.

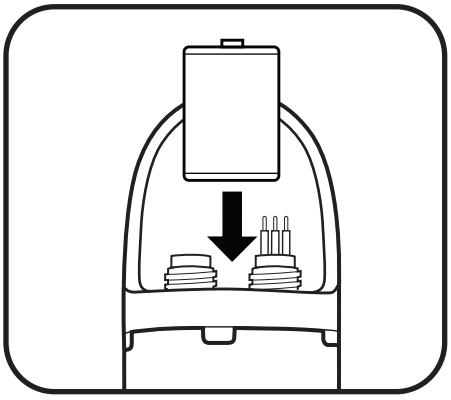
Modes

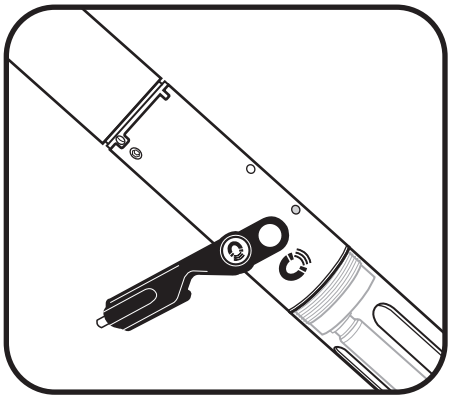
Within the *Awake* state, the sonde has three modes, which are activated via Kor software. When "Inactive (Off)," the sonde does not log any data. In "Real-Time" mode, the sonde continuously collects data at a user-specified interval (default is 2 Hz). "Sample/Hold" mode allows users to easily synchronize data between the sonde's data logger and an external data collection platform.

2.8 Awaken Sonde, Activate Bluetooth

Once power is applied to the sonde, internally or externally, users can awaken their sondes from *Sleep* state using any of several methods. Primarily, users activate EXO sondes and the Bluetooth connections via a magnetic switch installed in sonde's electronics compartment. The sonde will automatically disable the connection and go to sleep once it has not received a Bluetooth signal for 5 minutes or a signal from the topside connector for 30 seconds. In order to activate their sondes, users should keep a magnet with them when setting up and deploying sondes. *For more information on sonde states and LEDs, see section 2.7.*







1 Awaken sonde with magnet.

Users can make their sonde go to the Awake state by holding a magnet at the magnetic activation area on the sonde's bulkhead (identified by the illustrated magnet symbol on the label). Simply hold the magnet within one (1) cm of the symbol until the LEDs activate. EXO Handhelds and sensor tools contain embedded magnets identified by the same symbol.

NOTE: A new magnetic tool is available. Item #599469 "EXO Sensor Tool Kit".

2 Awaken sonde without magnet.

Users can also make their sonde go to the Awake state using any of the following methods.

- Cycling power to the sonde (uninstalling/installing batteries).
- Communicating via the topside port.
- Inserting a sensor.

In addition to these manual methods, the sonde also automatically awakens for scheduled unattended logging (programmed in KOR).

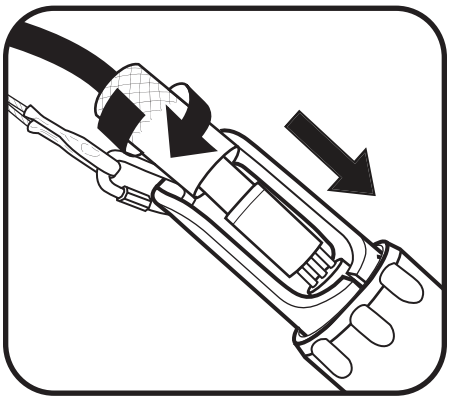
3 Activate sonde's Bluetooth.

Users activate Bluetooth by holding a magnet at the magnetic activation area in the same way as described in Step 1. In addition to magnetic activation, users can also activate Bluetooth by:

- Cycling power to the sonde (uninstalling/installing batteries).
- Enabling Bluetooth via a connection at the topside port in KOR.

2.9 Attach Sonde to Handheld Field Cable

All EXO cables have 6-pin and wet-mateable connectors. (Connectors on vented level cables have 5 pins and a vent pin.) Each cable also incorporates a strain relief mechanism to alleviate stress on the connector. Because Bluetooth wireless will not pass through water, users must use the cable to connect to the sonde when it is submerged and taking real-time field readings that are being viewed by the user or logged by a data collection platform.

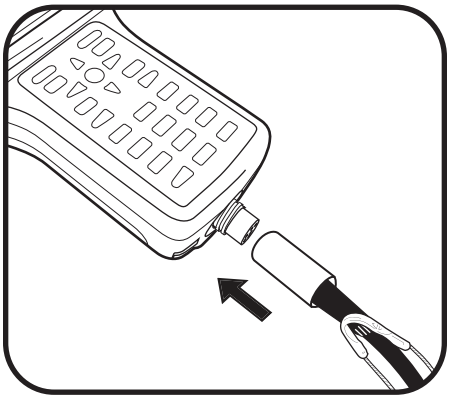


1 Attach cable to sonde.

Apply a light layer of Krytox grease to the male pins and rubber surface of the connector on the cable and the female connector on the sonde.

For the EXO1 sonde, first attach the cable's strain relief to the sonde's bail with a carabiner. Then press in the cable's male 6-pin connector, and screw down the retaining collar. (For the EXO2 sonde, the strain relief can be connected after the cable and collar.)

The cable's strain relief is designed to capture the sonde in case of failure of the connector.



2 Attach cable to handheld.

Apply a light layer of Krytox grease to the male pins on the handheld and the female connector on the cable. Press on the female 6-pin connector, then screw down the retaining collar. Connect the strain relief to the Handheld's strap.

3 Discover sonde in KOR.

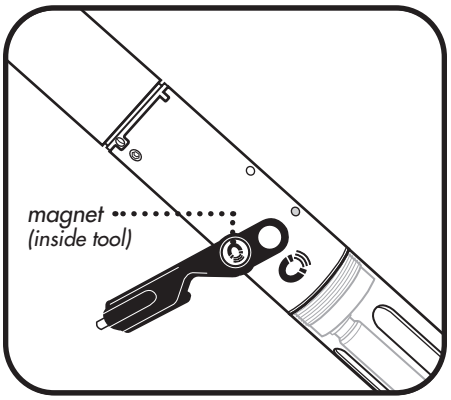
Upon startup of the Handheld, KOR software searches for a hard-wired connection to the sonde. If KOR discovers the sonde it will request to connect to it.

If the Handheld is already powered up go to the Connections menu. Then select Rescan and select Confirm. Locate your sonde in the menu and select Connect.

2.10 Attach Sonde to Handheld Bluetooth Wireless

Users can wirelessly connect EXO sondes (above water) to the EXO Handheld using Bluetooth wireless. With Bluetooth, users can reduce the amount of cables needed to operate their sonde. This wireless connection has a typical range of 10 meters, but this range will fluctuate depending on the operating environment. Users cannot wirelessly connect through water.

In order to connect via wireless, both devices must be powered on.



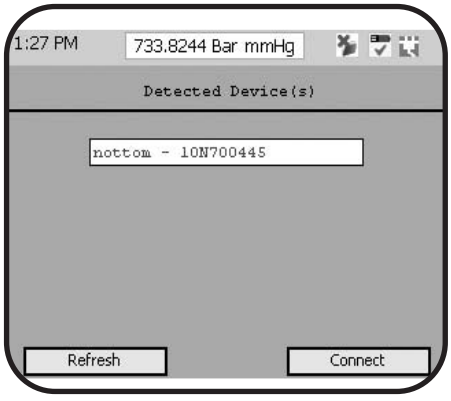
1 Activate sonde's Bluetooth.

Activate Bluetooth by holding a magnet at the magnetic activation area. NOTE: There is a magnet in the top of the Handheld as well. In addition to magnetic activation, users can also activate Bluetooth by cycling power to the sonde (remove/reinstall batteries).

NOTE: A new magnetic tool is available.
Item #599469 "EXO Sensor Tool Kit".

2 Discover sonde in KOR.

Every time the Handheld powers on, it automatically searches for a sonde via the hard-wired cable connection and will connect to the sonde if the Auto Discover option is enabled in the Connection | Settings menu.



3 Rescan sonde.

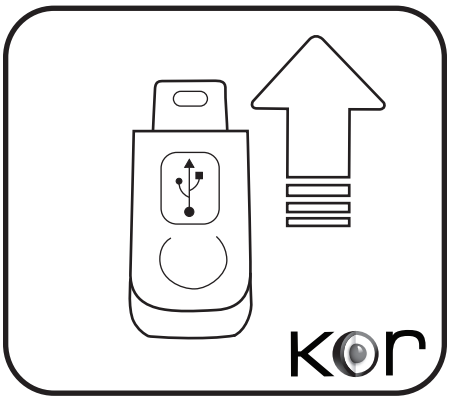
If a wired connection is not found, and to manually establish a connection to a sonde via Bluetooth, navigate to the Connections menu in KOR software on the Handheld. Select Rescan. KOR will rescan and detect Bluetooth-enabled sondes. Select the sonde from the list and then click the Connect button.

If no sonde is detected, click Refresh to scan again. It may take 2-3 scans to discover the sonde.

2.11 Install KOR Software

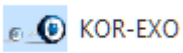
The desktop KOR software is supplied will all EXO sondes on a USB flash drive. Installing the software will require Administrative privileges on the local PC. It is important to install KOR software prior to using the USB Signal Adapter, as the required drivers for the adapter are installed along with KOR software.

NOTE: A "lite" version of KOR software on the EXO handheld does not require any installation.



1 Install KOR software and drivers.

Insert USB drive and install software using the startup.exe file. Select all these items to install: EXO-KOR software, National Instruments supporting software, and USB drivers for the EXO USB adapter. When complete, KOR will reside in the root Program menu (not in a subfolder) with the following icon:



Additionally, a folder called National Instruments will be created; however this information will not be accessed through the course of normal operation.

Reboot the computer after installation of the software.

Minimum requirements:

Minimum requirements on a computer for KOR software:

- Windows®XP (service pack 3) or newer Windows operating platform (Windows®7 recommended)
- Microsoft .NET (any version from 2.0 through 3.5 Service Pack 1)*
- 500 MB of hard disk space (1 GB recommended)
- 2 GB of RAM (4 GB recommended)
- Screen with resolution of 1280x800 or greater
- Available USB 2.0 port
- Internet access for software updates
- Optional: Integral Bluetooth or USB dongle Bluetooth adapter

2 Software updates

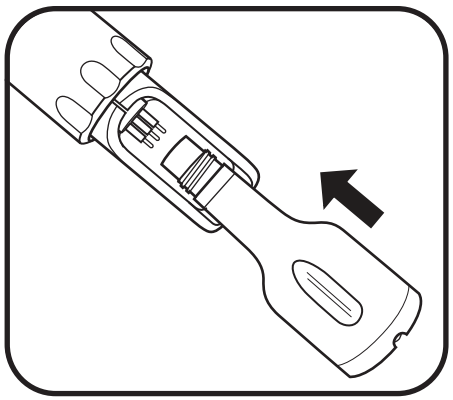
When they become available, updated versions of KOR software will be posted to **EXOwater.com**. Users will need to register a free account to access the software download.

**Download and install a Microsoft executable file that helps your computer run applications developed using the .NET framework: www.microsoft.com/download. Search for "dotnetfx.exe".*

2.12 Connect Sonde
USB

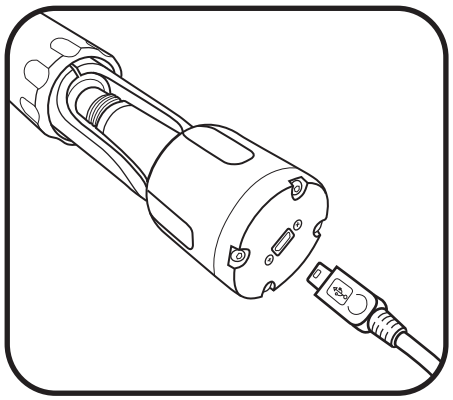
The USB signal output adapter (USB-SOA #599810) allows users to connect to an EXO sonde over a standard USB connection. Although the USB-SOA is rugged and water resistant, users should protect its connectors with the included cap when not in use. *The SOA should never be submerged.*

Prior to use, users must install KOR software and its drivers on the associated PC. The USB-SOA will not work without the drivers that accompany KOR. *See section 2.11.*



1 Connect SOA to sonde.

Remove the plug from the 6-pin connector on the sonde. Apply a light layer of Krytox grease to the male pins on the sonde and the female connector on the USB-SOA. Then align the connector's six pins and jackets, and press them firmly together so that no gap remains.



2 Connect USB cable to SOA and PC.

Remove the protective cap from the USB end of the SOA, and ensure that the connector is clean and dry. Then insert the small end of the provided USB cable into the SOA connector and the large, standard side into one of the PC's USB ports.

Attaching the adapter to the PC causes a new device to be recognized. Windows automatically installs the drivers and creates a new port. Each new adapter that is attached creates a new port.

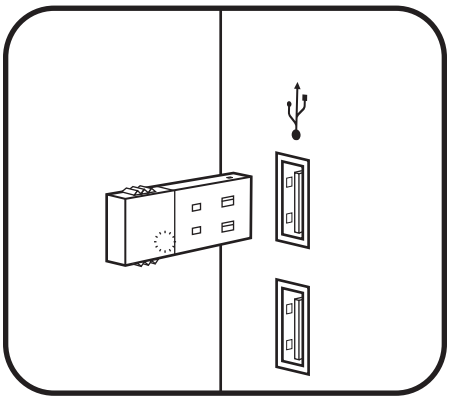
Ports

KOR automatically scans ports for both USB adapters and Bluetooth. To view the USB adapter and its associated comm port, go to the Control Panel on your computer, click Device Manager, then click Ports.

Next, open KOR, go to connections, rescan and select the adapter from the list and click connect.

2.13 Connect Sonde Bluetooth

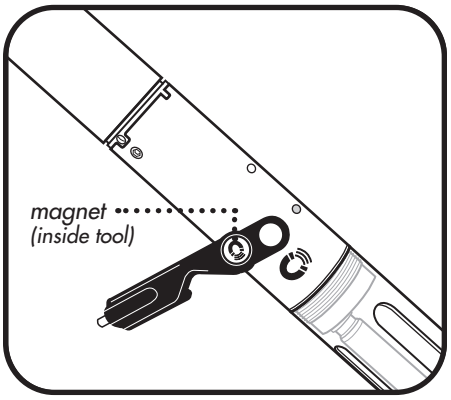
Before users can communicate wirelessly with their EXO sondes, they must establish a Bluetooth link. All EXO sondes are equipped with Bluetooth wireless. This technology provides a secure, two-way, reliable communication channel with which users can communicate with their sondes above water without cables. Many new computers are equipped with Bluetooth wireless installed internally; those without Bluetooth can use a Bluetooth dongle (not included). Follow the manufacturer's instructions for installing the dongle's software and hardware. Administrative permissions and IT support may be required depending on the adapter and your PC settings.



1 Install Bluetooth dongle (optional).

If your computer is not equipped with internal Bluetooth radio, insert a Bluetooth dongle (not provided) into any of the computer's USB ports. Wait for the computer to automatically install the device and its drivers. Once the installation is complete, the computer should indicate that the device is installed and ready to use.

The preferred Bluetooth configuration is Windows 7 with native Windows Bluetooth drivers and software.

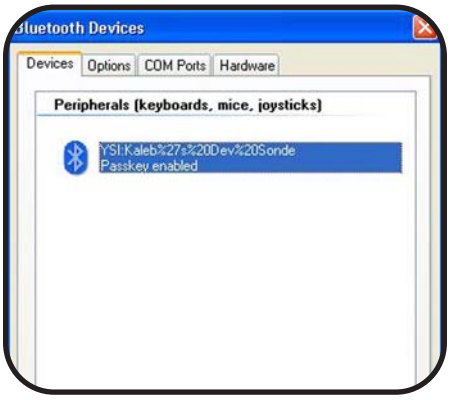


2 Activate sonde's Bluetooth.

Users activate Bluetooth wireless by holding a magnet at the magnetic activation area. In addition to magnetic activation, users can also activate Bluetooth by:

- Applying power to the sonde (remove and reinstall batteries)

See more information on sonde activation and LED conditions in sections 2.7 and 2.8.



3a Establish Bluetooth link–Search Bluetooth (Win 7 or Win XP).

1. Launch KOR software and click the Connections menu.
2. Click Rescan button.
3. Click Search Bluetooth button. This may take up to 40 seconds, and may require several attempts using the Refresh button.
4. Select the device from the list and click Connect.

When the connection is complete, KOR automatically displays the Dashboard screen with live data.

3b Establish Bluetooth link (Win XP).

1. Click the Bluetooth icon in the system tray (lower right), select "Add a Bluetooth Device" and complete the device wizard.
2. Activate your sonde's Bluetooth.
3. Check "My device is setup and ready to be found," then click "Next."
4. Locate the sonde name (starts with YSI) from the list and click Next. (If not found, click "Search Again.")
5. Select "Enter the device's pairing code" and click Next. Then enter the pairing code 9876. Click "Next."
6. Windows assigns an outgoing comm port. Select Finish.
7. See step 3a to complete the connection in KOR.

3c Establish Bluetooth link (Win 7).

1. Open the Windows Start menu and click Devices and Printers.
2. Select "Add a Device" from the top of the screen.
3. Locate the sonde name (starts with YSI) from the list and click Next.
4. Select "Enter the device's pairing code" and click Next. Then enter the pairing code 9876. Click "Next."
5. Windows will configure the device, install drivers, and assign a comm port.
6. See step 3a to complete the connection in KOR.

4 Confirm successful link.

Once the device has been added, confirm that the device appears in:

- Win XP - Devices tab of the BT Devices window
- Win 7 - Devices and Printers screen

If the device is not listed, attempt the establishment process again.

This process establishes a secure wireless link between the sonde and a PC. Once established, users will not need to perform this process again in order to link with the sonde.

Ports

KOR automatically scans ports for both USB adapters and Bluetooth. To view the comm port associated with Bluetooth:

- Win XP: Go to the Bluetooth menu on your computer, click Show Bluetooth Devices, click on the device you added, then click Properties > Services.
- Win 7: Go to the Devices and Printers screen, right-click your sonde, then click Properties > Hardware.

2.14 Connect Sonde
Data Collection Platform (DCP)

This signal output adapter (DCP-SOA #599800) allows users to connect an EXO sonde to a Data Collection Platform as well as power it via an external 12 V DC source (not included). Users wire a sonde cable with flying leads into one side of the SOA and an SDI-12 /RS-232 output and power source into the other. Mount the SOA in a humidity-controlled enclosure using the following recommended hardware, and never attempt to perform electrical work beyond your experience.

1 Configure sonde.

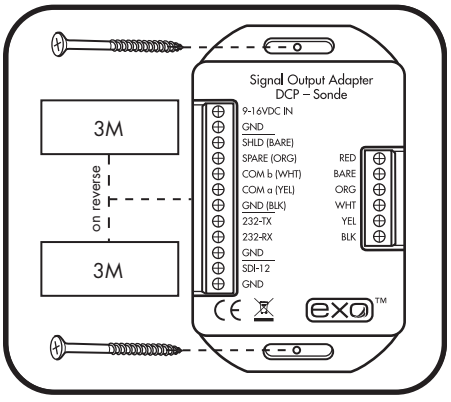
Using KOR software, go to the Deploy menu and choose to deploy by opening a template or starting a custom deployment. Click Edit, then go to the SDI-12 tab and select your parameters and the SDI address. The sonde's default address is zero (0). Click to save with one of these options: Save, deploy, start logging; Save, deploy, no logging; Save only.

Refer to section 4.4, KOR Software for more details. Alternatively, you can watch KOR Software orientation videos on our You Tube channel. (YouTube.com/YSIinc)

2 Route cable.

Determine the sonde cable routing to the DCP, and protect the cable from chafe damage and impact.

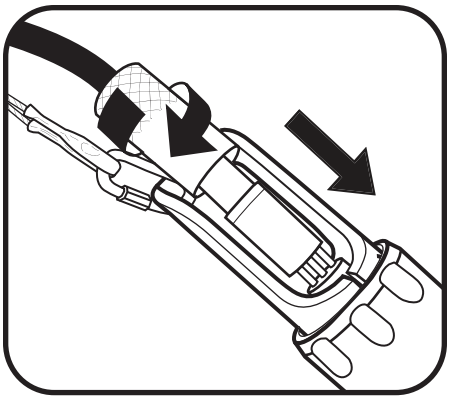
Route the cable through a sealing gland into the DCP, and ensure that the seal is air-tight and water-tight.



3 Mount SOA.

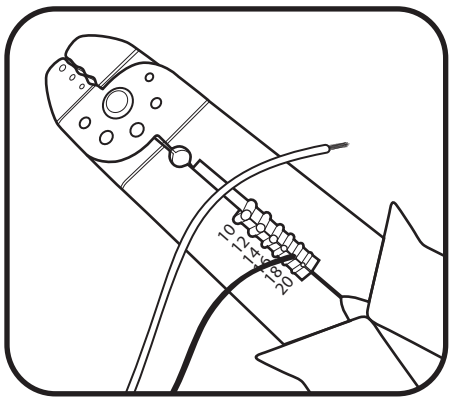
Users can mount the SOA horizontally or vertically either by the screw slots on the sides of the SOA or with the included 3M adhesive strips. The screw slots were designed to accept #4 wood screws but may accept other types and sizes.

If the user opts to use adhesive strips, first clean the application surface with a 50:50 mixture of isopropyl alcohol and water, then mount them in temperatures between 21° and 38°C (70˚ and 100˚F) and allow the bond to cure for 72 hours if possible before attaching wires.



4 Connect flying lead cable to sonde.

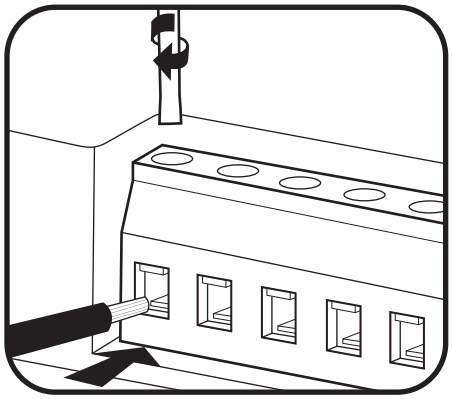
Press in the male 6-pin connector, then screw down the retaining collar. Attach the cable's strain relief to the sonde's bail with a carabiner. The cable's strain relief is designed to capture the sonde in case of failure of the connector.



5 Prepare wires.

⚠ *Always follow proper safety precautions when performing electrical work.*

Properly strip the ends of the wire. Remove 0.25 inches of insulation from each wire then twist the bared strands together. All wires should be 18-24 AWG and are not included with the SOA.



6 Insert wires into SOA.

Loosen the clamping screw with the supplied screwdriver, insert the indicated wire into the terminal strip, and tighten the clamping screw back down onto the exposed wire end. Ensure that all strands are inserted to avoid short circuits. Take care not to strip the slots in the heads of the screws.

- Connect DCP signal ground to SOA SDI ground terminal (recommend black wire)
- Connect DCP SDI-12 data terminal for SOA SDI-12 terminal (recommend violet wire)
- Connect DCP output ground terminal to SOA power ground terminal (recommend black wire)
- Connect DCP 12 VDC output to SOA 9-16 VDC input terminal (recommend red wire).

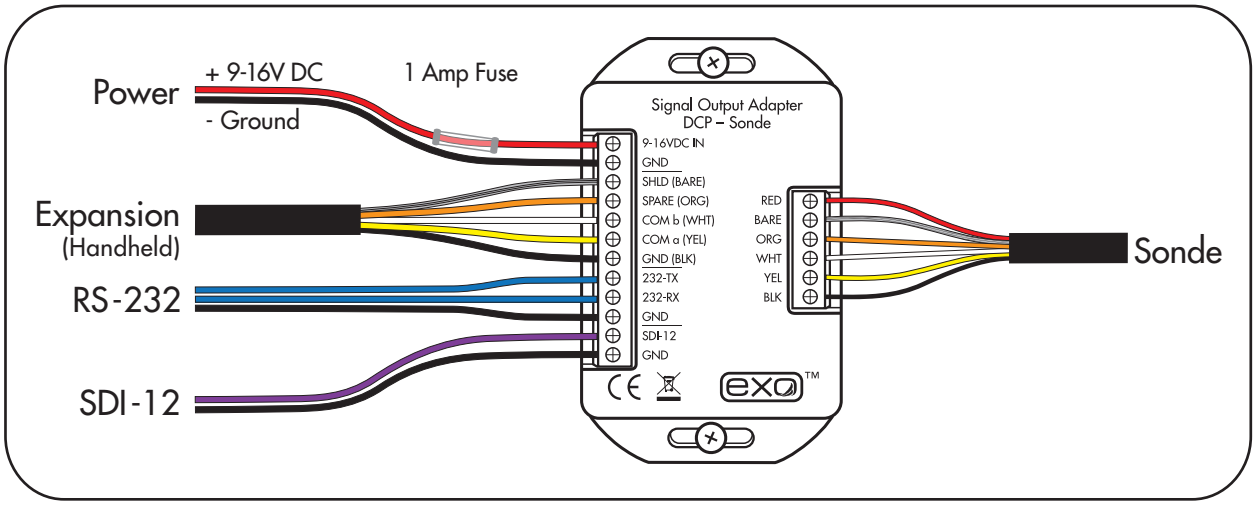
NOTE: Due to the tight accessibility of many enclosures, it may be more practical to complete Step 6 (Wiring) *prior* to Step 3 (Mounting).

Voltage

The sonde is designed to run with 12-volt batteries, with supply voltages between 9 and 16 V DC. These systems should be directly powered by a sealed battery or installed as part of a remote solar system. Power the SOA through a 1-amp slow-blow fuse for protection. Remove the fuse until all wiring is completed.

NOTE: External power to the DCP adapter is required even if you are putting batteries in the sonde.

When used with a solar system always ensure use of 12-volt solar regulator. Never connect the sonde directly to solar panel; voltages above 16.5 volts will cause the sonde to shut down and excessive voltage will permanently damage the sonde and is not covered under warranty.



Power Draw

	Asleep	Active
EXO1, full sensor payload	0.25 mA	45 mA
EXO2, full sensor payload	0.25 mA	100 mA
DCP SOA	1 mA	17 mA

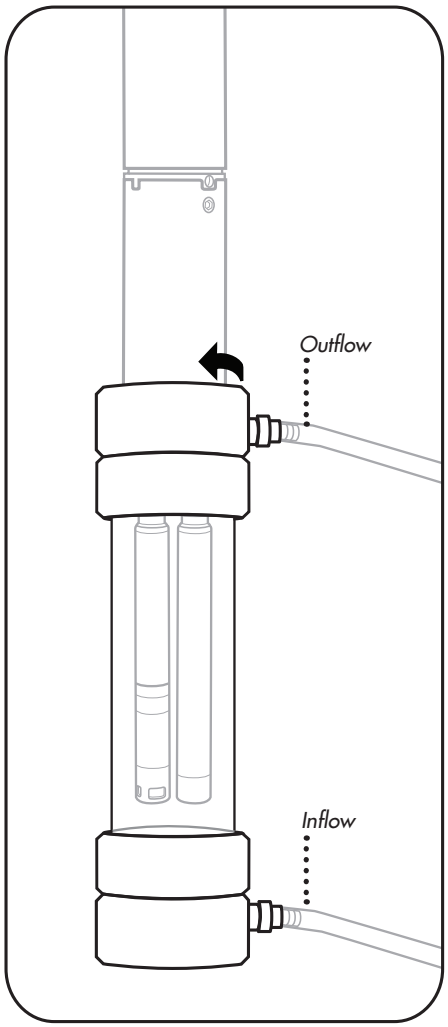
Command Sets

To program the DCP with SDI-12 or RS-232 commands, please see command sets in KOR software, section 4.11.

Advanced RS-232 interface commands are available from technical service for system integrators interested in connecting to EXO via RS-232.

2.15 Connect Sonde Flow Cell

There are two versions of the EXO flow cell: EXO1 flow cell (#599080) and EXO2 flow cell (#599201). Flow rate of the flow cell is typically between 100 mL and 1 L per minute. Maximum flow rate depends on tubing type, size, and length. Maximum pressure for each flow cell is 25 psi. Flow cell volumes (without sensors installed) are approximately 410 mL for EXO1, and 925 mL for EXO2.



1 Inspect sonde and flow cell.

Remove the sonde guard or calibration cup from the sonde so that the sensors are exposed.

Make sure that the threads of the sonde and flow cell as well as all o-rings are clean and free of any particles such as sand, grit, or dirt.

2 Insert sonde into flow cell.

Insert the sonde into the top of the flow cell. Be careful not to bump or scrape the sensors on the sides of the flow cell.

Screw the sonde into the flow cell by turning the sonde clockwise until it is hand-tightened into place; do not use a tool.

3 Connect tubing to flow cell.

Install the Quick Connect tube fittings onto the flow cell by inserting them into the Quick Connect coupling body. They should snap into place.

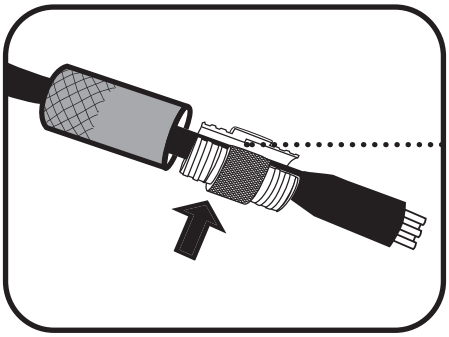
Connect the tubing from your pump (not included) to the Quick Connect tube fittings, making sure that the tubing is pushed securely onto the fittings. The inflow should be at the bottom of the flow cell and the outflow should be at the top.

Keep flow cell vertical to purge it and ensure air release from Conductivity/Temperature sensor.

⚠ Do not turn on water to the system *until* the flow cell is securely connected.

2.16 Connect Field Cables with Cable Coupler

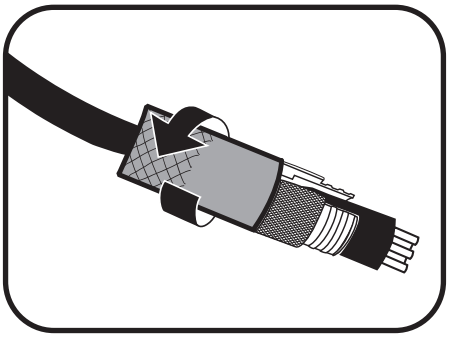
A cable coupler is required to join two EXO field cables together or a field cable to a flying lead cable. The cable coupler is available in either titanium (#599430-01) for deployment or brass (#599430-02) for laboratory and non-submerged use. Review these instructions for the proper installation of the cable coupler.



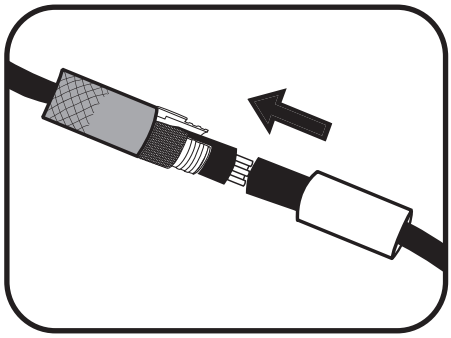
1 Position and install coupler on first cable.

Prior mating the cables together, install the coupler on the first cable. Pull the black retaining collar away from the male 6-pin connector and then install the coupler onto the exposed cable between the collar and the connector.

⚠ Align the coupler in the correct orientation, with the smaller interior diameter positioned toward the black collar. Incorrect orientation of the coupler does not allow it to slide over the connector later.

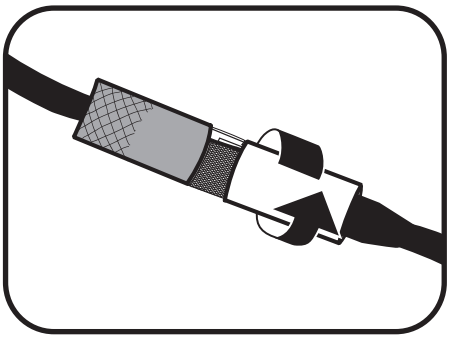


Screw the black retaining collar onto the end of the coupler.



2 Connect cables.

Apply small dabs of Krytox grease to the sockets of the connector on the second cable. Then align the 6-pin connector of the first cable with the sockets of the second cable and press them firmly together so that no gap remains.



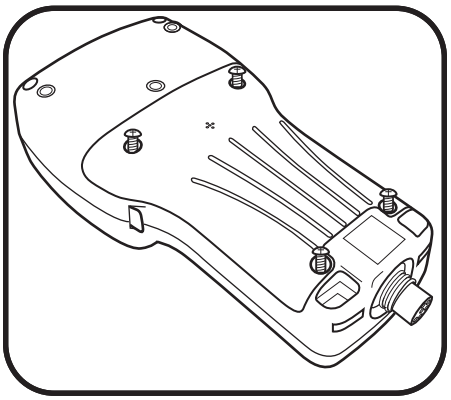
3 Connect coupler to second cable.

Slide the black collar and coupler toward the joined connectors. Slide the white retaining collar of the second cable to the coupler and twist to securely attach the two components together.

Attach the strain reliefs of each cable together via the carabiners.

3.1 Handheld
Install or Replace Batteries

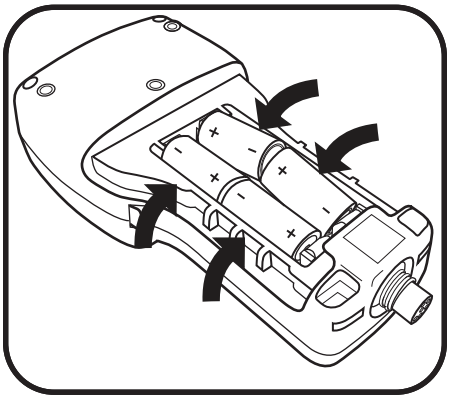
The EXO Handheld (HH) uses four (4) C-cell alkaline batteries as a power source. Alternatively, a rechargeable Li-Ion battery pack is an available option, as described in the next section. Users can extend battery life by putting the HH in "Sleep" mode, when convenient, by pressing and holding the power button for less than three seconds. 1.5V rechargeable high-capacity NiMH batteries can also be used. Battery life varies depending on GPS, power to sonde, and Bluetooth wireless use.



1 Remove battery cover panel.

The battery cover panel is located on the back of the HH. To remove the panel, unscrew (counter-clockwise) the four screws with a flat or Phillips head screwdriver.

NOTE: The retaining screws are captured into this panel and are not independently removable. If replacement is necessary, replace the entire assembly.

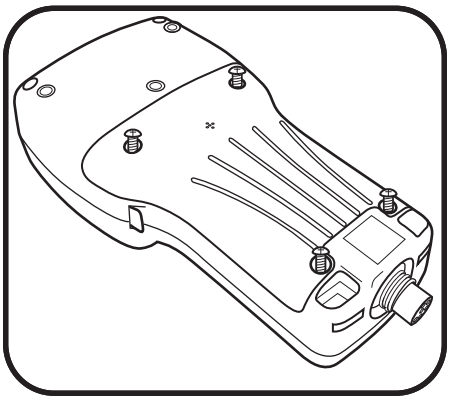


2 Insert/replace batteries.

⚠ Do not use 3.6V Li batteries in the handheld.
Damage to the circuit board is not covered under warranty.

Remove the old batteries and dispose of them according to local ordinances and regulations. Install the new batteries between the battery clips with their polarity (+/-) oriented as shown on the bottom of the battery compartment.

If you use your own rechargeable batteries, they cannot be charged inside the handheld; they should be charged outside the handheld. If using Ni-MH batteries we recommend high discharge type with 5,000 mAhr rating.



3 Reinstall battery cover panel.

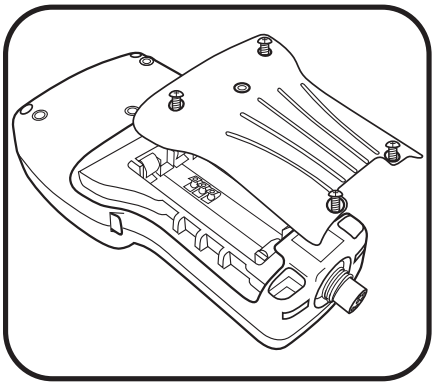
Ensure that the rubber battery cover gasket is seated properly, then replace the cover onto the back of the HH. Tighten the four retaining screws back into their holes.

⚠ **CAUTION**: Overtightening of the screws is likely to cause damage and require replacement of the battery pack.

3.2 Rechargeable Li-Ion Battery Pack
Overview

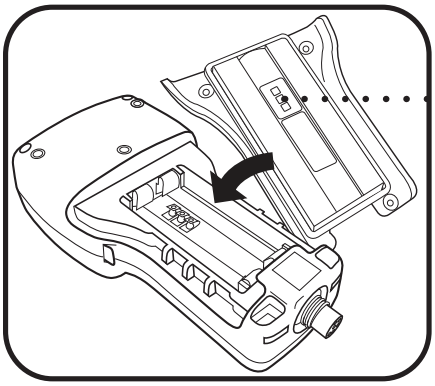
The EXO Handheld (HH) can use a rechargeable lithium-ion battery pack as a power source. Battery life varies depending on GPS and Bluetooth wireless use. Users can extend battery life by putting the HH in "Sleep" mode, when convenient, by pressing and holding the power button for less than three seconds.

⚠ **WARNING:** Be sure to reference the supplied *Safety Warnings and Precautions* sheet included with the battery pack. Failure to exercise care while using this product and to comply with the safety guidelines could result in product malfunction, excessive heat, fire, damage to your products not covered under warranty, property damage, and/or personal injury.



1 Before the first charge.

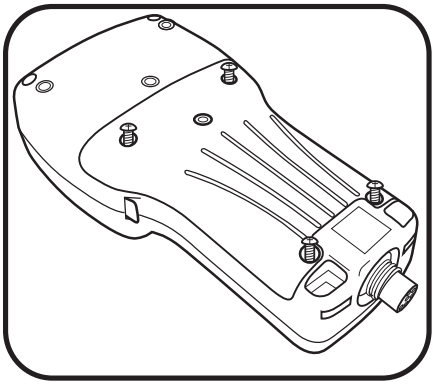
Make a visual and physical inspection of the pack for any damaged or loose leads or connectors, damaged packaging, or other irregularities which may cause a short circuit and eventual fire. Always charge the pack in an open area away from flammable materials, liquids and surfaces. **Do not** charge or handle batteries that are hot to the touch.



2 Remove battery cover panel.

The battery cover panel is located on the back of the HH. To remove the panel, unscrew (counter-clockwise) the four screws with a flat or Phillips head screwdriver.

NOTE: The retaining screws are captured into this panel and are not independently removable. If replacement is necessary, replace the entire assembly.



3 Insert the Li-Ion battery pack.

Remove existing batteries if necessary.

⚠ **WARNING:** Be sure to remove the clear plastic tape from the back of the battery pack before inserting. Failure to do so can cause damage to your equipment.

Install the pack by fitting it correctly into the battery compartment. Ensure that the rubber battery cover gasket is seated properly, then tighten the four retaining screws back into their holes.

⚠ **CAUTION**: Overtightening of the screws is likely to cause damage and require replacement of the battery pack.

Prior to first use, charge the Li-Ion battery pack with the approved YSI charger. See the FAQ's for more details.

Rechargeable Li-Ion Battery Pack Specifications

Battery Life	Dependent upon variables such as temperature, screen brightness, and feature use. Up to 9 hours under active use for a new Li-Ion battery pack. Performance can be expected to decline over time and use.		
Temperature	Charging 2°C to 45°C (35.6°F to 113°F)	Operating -20°C to 60°C (-4°F to 140°F)	Storage 0°C to 35°C (32°F to 95°F)
Charging Supply	Charging Supply Input 100 - 240V	Charging Supply Output 12VDC / 2.5A	
Software	For accurate battery gauge use KOR Interface Software: Operating System 1.0.2		

Battery Pack Handling

For information on how to handle a hot or damaged battery, please reference the supplied *Safety Warnings and Precautions* sheet included with the battery pack or *section 8.1* in this document.

Battery Pack Disposal

For information on how to prepare your battery for disposal, please reference the supplied *Safety Warnings and Precautions* sheet included with the battery pack or *section 8.6* in this document.

3.3 Power On/Off Handheld

Users can power on/off and awaken/put to sleep the EXO Handheld (HH) depending on use. In order to use the HH, users must first power it on. When finished with the HH, users should power it off to increase its battery life. When temporarily not using the HH, users should put it to sleep, and awaken it when next needed. The HH's sleep mode is a low-power mode designed to increase its battery life. When finished with the HH for a long period of time, users should power it off and remove the batteries.

1 Power on/awaken handheld.

With batteries installed, press and hold the power button for one second. The Bluetooth wireless indicator will then illuminate. Next the splash screen will appear then briefly go black (approximately 5 seconds) while the system starts up. The HH will then automatically start Kor.

If the HH is asleep, users should briefly press the power button to awaken it.

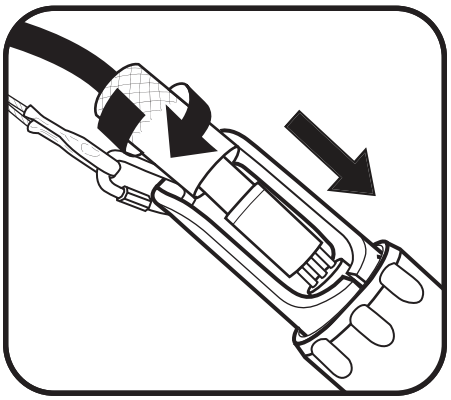
2 Power off/put to sleep.

To power off the HH, users must press and hold the power button for more than three seconds. Once the button has been held long enough, the screen will power down and go black.

To put the HH to sleep, press and hold the power button for less than three seconds, and release it. The screen will then go black.

3.4 Attach Handheld to Sonde Field Cable

All EXO cables have 6-pin and wet-mateable connectors. (Connectors on vented level cables have 5 pins and a vent pin.) Each cable also incorporates a strain relief mechanism to alleviate stress on the connector throughout deployment. Although the cables are wet-mateable, users should dry the connectors prior to installation when possible. Always protect connectors by leaving the cable or connector caps installed even when the connector is not in use. Always attach the cable's strain relief mechanism to the bail when the sonde is deployed.

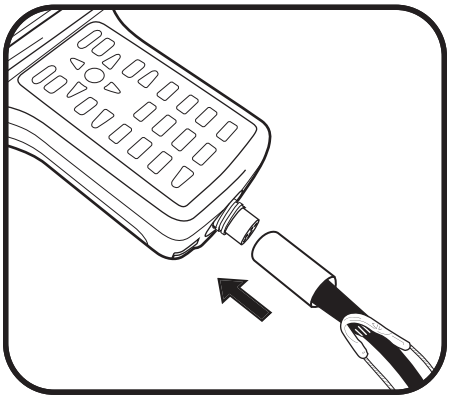


1 Attach cable to sonde.

Apply a light layer of Krytox grease to the male pins and rubber surface of the connector on the cable and the female connector on the sonde.

For the EXO1 sonde, first attach the cable's strain relief to the sonde's bail with a carabiner. Then press in the cable's male 6-pin connector, and screw down the retaining collar. (For the EXO2 sonde, the strain relief can be connected after the cable and collar.)

The cable's strain relief is designed to capture the sonde in case of failure of the connector.



2 Attach cable to handheld.

Apply a light layer of Krytox grease to the male pins on the cable and the female connector on the handheld. Press on the female 6-pin connector, then screw down the retaining collar. Connect the strain relief to the Handheld's strap.

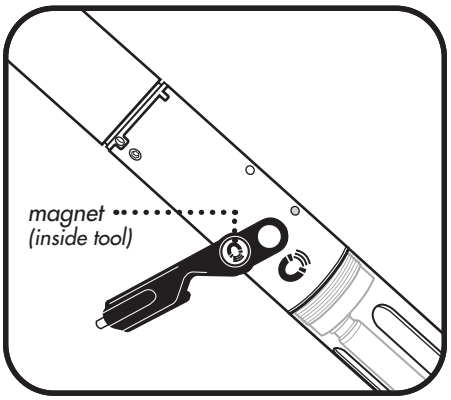
3 Discover sonde in KOR.

Upon startup of the Handheld, KOR software searches for a hard-wired connection to the sonde. If KOR discovers the sonde, it will request to connect to it.

3.5 Attach Handheld to Sonde
Bluetooth Wireless

Users can wirelessly connect their EXO sondes (above water) to the EXO Handheld using Bluetooth wireless communication. With Bluetooth, users can reduce the amount of cables needed to operate their sonde. The wireless connection has a typical range of 10 meters, but this range will fluctuate depending on the operating environment. Users cannot wirelessly connect through water.

In order to connect via wireless, both devices must be powered on.



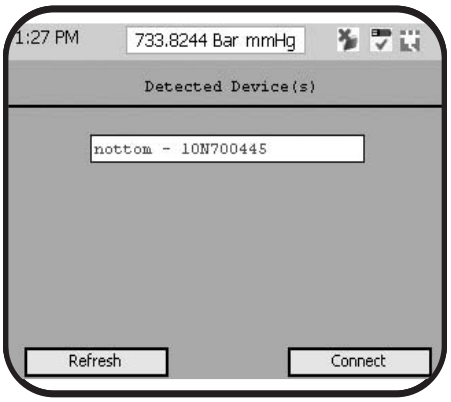
1 Activate sonde's Bluetooth.

Users activate Bluetooth by holding a magnet at the magnetic activation area. In addition to magnetic activation, users can also activate Bluetooth by cycling power to the sonde (remove/reinstall batteries).

NOTE: Starting 2014 a new magnetic tool is available. Item #599469 "EXO Sensor Tool Kit".

2 Discover sonde in KOR.

Every time the Handheld powers on, it automatically searches for a sonde via the hard-wired cable connection and will connect to the sonde if the Auto Discover option is enabled in the Connection | Settings menu.



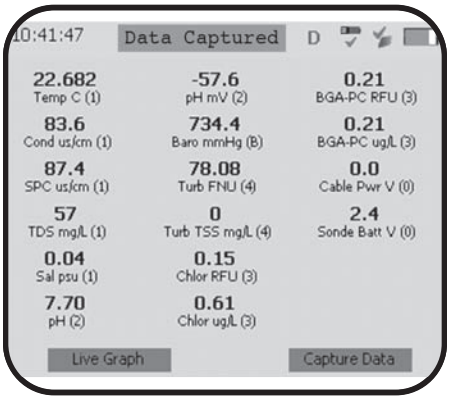
3 Rescan sonde.

If a wired connection is not found, and to manually establish a connection to a sonde via Bluetooth, navigate to the Connections menu in KOR software on the Handheld. Select Rescan. KOR will rescan and detect Bluetooth-enabled sondes. Select the sonde from the list and then click the Connect button.

If no sonde is detected, click Refresh to scan again. It may take 2-3 scans to discover the sonde.

3.6 Spot Sampling
View Live Data

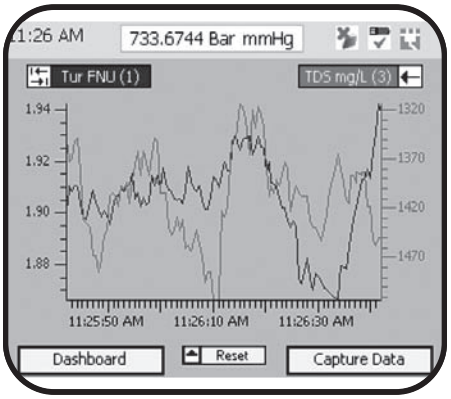
When connecting through the Handheld, KOR software attempts to automatically connect to an available sonde and start displaying current data in a live view. To manually access the live view from either the Handheld or Desktop, go to the Run menu and choose "Dashboard." Users can set view preference in the live view menu to display numeric live data (default) or a graph view, where a maximum of two parameters can simultaneously be plotted on the screen. *For overview of KOR menus, see section 4; for overview of Handheld keypad functions, see section 1.3*



Data dashboard and graph

Users can toggle between numeric Dashboard and Live Graph views using the soft key on the left. The Capture Data soft key may be used to log information displayed on the screen. (*See more detail, section 3.7.*)

Dashboard image at left; live graph image at middle left.



Parameter preference

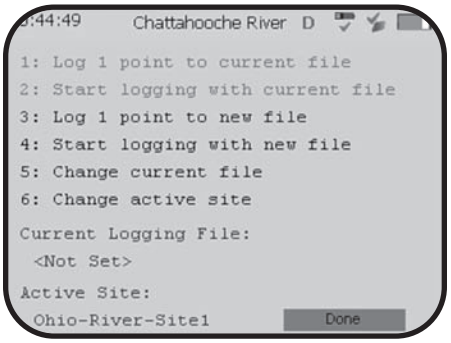
Users can select which parameters to display in graph mode by using the backspace and tab keys on the Handheld keypad. If an expected parameter is not available, first set the appropriate units preference from the Options | Units menu.

Advanced display settings

Adjust data display settings for both dashboard and live graph modes in the Run menu. Select Settings to change the settings for graph type (time series or vertical profile), sample interval (default is 1 sec), and default parameters to view.

3.7 Collecting Data with Handheld

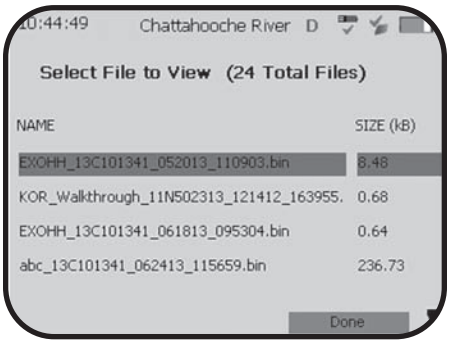
Collecting sampling data on the EXO Handheld is easy due to the array of logging options available via the Capture Data menu (Run>Dashboard>Capture Data).



1 Logging data.

Upon navigating to the Capture Data menu for the first time (and each time you reconnect to a sonde), you will need to set a logging file or start logging with a new file (options 3 or 4).

Logging to a new file will automatically generate and set a Current Logging File to which future data points will be appended.

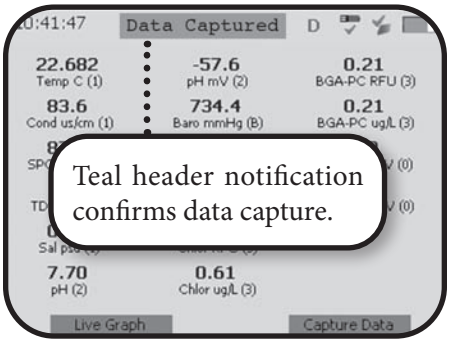


2 Appending data.

Once a logging file is set, you can append future data points to it. Use the keypad to select options 1 or 2 to add data points to the Current Logging File.

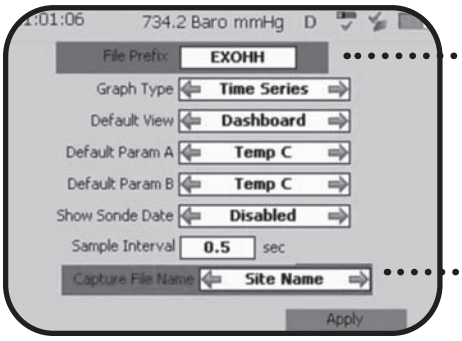
To append data to a different location, press 5 on the keypad. This will bring up a list of available files currently saved on the handheld that can be set instead.

NOTE: You can press 1 or 2 while on the dashboard to quickly append data to an existing file, avoiding the need to navigate to the Capture Data menu for each reading.



3 Continuous sampling.

Selecting options 2 or 4 on the Capture Data menu will cause the sonde to begin recording data continuously at the sampling interval set in the Run Settings (Run>Run Settings). To stop logging data, press Stop Capture.



4 File nomenclature.

With the addition of sites, options for file naming have been added in the Run Settings menu of the Handheld (Run>Run Settings). EXO data files are generated with the following naming structure by default:

FilePrefix_HandheldSerialNumber_MonthDateYear_HourMinuteSecond.bin

You can modify the File Prefix in the Run Settings menu using the Handheld's alpha-numeric keypad. Additionally, you can also include sites within file names by using the directional keys to select "Site Name" under Capture File Name. This naming structure is:

FilePrefix_SiteName_MonthDateYear_HourMinuteSecond.bin.

3.8 Managing Sites with Handheld

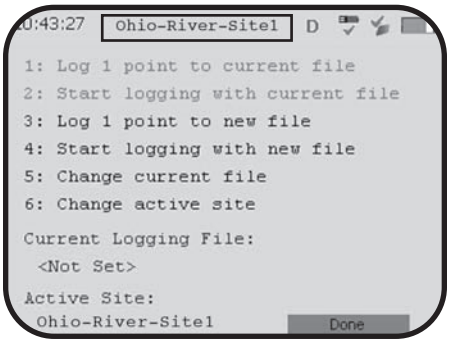
The desktop software and handheld firmware allows you to create/delete sites, as well as tag data files with site names.

1 Creating sites.

A new Create Site option exists under the Handheld's Run menu. Selecting this option will allow you to generate a new site using the Handheld's alpha-numeric keypad.

NOTE: To tag files with site information or to delete sites on the Handheld, you must be connected to an EXO sonde.

Tip: If entering a longer list of sites into the handheld it is easier to utilize KOR Desktops equivalent feature. When creating files on the desktop be sure to sync with the handheld.



2 Tagging sites to sampling data.

On the Capture Data menu (Run>Dashboard>Capture Data), all files will be tagged with whichever site is active while you record data.

To change the active site, press 6 on the Handheld keypad, and select any of the sites you have created. Your active site will be shown on the rotating header.

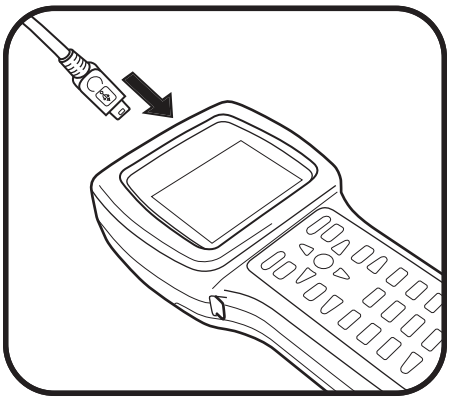
3 Deleting sites.

To delete a site on the Handheld, go to the Change active site menu, select the site you wish to delete and press the tab button on the keypad.

Tip: You can also create/delete sites on desktop KOR (Sites menu) and then sync this list with your Handheld (Options>Sync With Handheld). This is helpful when generating longer site lists..

3.9 Upload Data from Handheld to PC

The EXO Handheld stores two different sets of sensor data files: Files uploaded from the sonde and files manually logged into the Handheld from the live data mode. Both types of files can be sent to a PC via the USB cable. Note that KOR Desktop software must first be installed on a computer before transferring files from Handheld to PC.



1 Connect handheld to computer.

Power on the Handheld and allow up to three minutes for Windows to recognize the Handheld as a removable drive before the Handheld shows up in KOR software.

Plug the small end of the USB cable into the port on the top side of the EXO Handheld. Plug the other end of the USB cable into a port on your computer.

2 Transfer files.

When the Handheld is connected to the PC, go to the Options | Sync with Handheld menu in KOR Desktop software. Select Sync All and KOR will search all folders and synchronize the files automatically. Or users can select each folder separately and synchronize selected files manually. By checking the delete files box, data and calibration files will be removed from the Handheld after syncing.

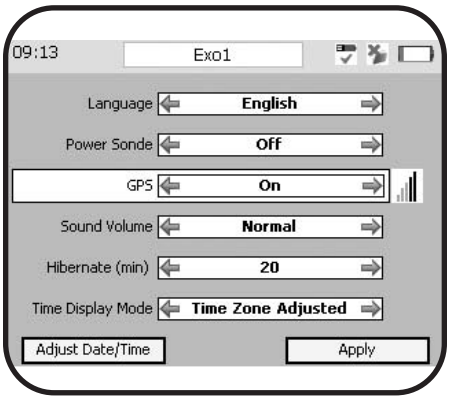
"Push Latest Firmware Package" button will transfer the most recent sensor and sonde firmware from the PC to the Handheld for updating sondes in the field with the Handheld.

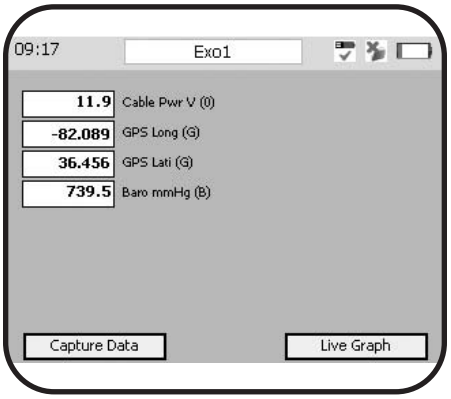
3 Delete files.

Directory Maintenance: Users can browse folders and select files to delete from the Handheld. Deleting files is optional.

3.10 Handheld Options

Upon startup of the Handheld, the GPS function automatically initiates a fix of the location. This may take some time. During this process, the Handheld should remain stationary and have a clear view of the sky. The first time a user powers on the Handheld, the GPS fix can take up to a maximum of 20 minutes to obtain.





1 Turn on/off GPS.

To manually enable GPS, go to the Options menu. Select Handheld | Enable GPS | On. Click Apply. When GPS is fixed, a signal strength icon with green bars will appear. If the bars are black, then no GPS signal is found.

The GPS consumes battery power and can be turned off to conserve battery life.

2 Display GPS units.

To display GPS units on screen, go to the Options | Units menu and select GPS Lati and GPS Long. When units are selected, GPS data is displayed on screen only if the GPS is turned on.

NOTE: If the Handheld is stored for more than 10 days without batteries installed, then the user will need to re-enter the date and time. Additionally, it will take longer for the unit to obtain a new GPS fix.

Additional Handheld Options on the next page.

3.10 Handheld Options Continued

Additional options in the Handheld menu and a brief description of their function. After making a change to a selection the field will be highlighted in green. Be sure to hit the top-right "Apply" button to confirm your changes.

Language.

Settings → Handheld → Language → Reboot
NOTE: Changing the language of the Handheld requires a restart to take effect.

Power Sonde.

Settings → Handheld → Power Sonde
Turn On or Off the ability for the Handheld battery to power the sonde.

⚠ WARNING: Powering the sonde via the Handheld is not recommended for typical use. Due to the rapid drain on the Handheld batteries in this mode it is suggested to only use this mode for short bursts.

Sound Volume.

Settings → Handheld → Sound Volume
Allows the user to select the volume of the Handheld speaker, including the ability to turn it off completely.

Hibernate.

Settings → Handheld → Hibernate (min)
Allows the user to select how much time, in minutes (min) the Handheld, will wait without input before going into a power saving sleep-mode.
NOTE: Selecting zero will keep the Handheld on continuously.

Time Display Mode.

Settings → Handheld → Time Display Mode
Allows the user to adjust the Handheld clock display to the selected time zone.
A universal time zone option is also available.

Adjust Date/Time

Settings → Handheld → Top-Left Button
Allows the user to change specific parameters of the time display.

4.1 KOR Software Introduction

Users interface with the EXO sondes and handheld via KOR software. Once the software is installed and a device is connected to a computer or an EXO handheld, launch the KOR software. *For KOR Installation instructions, see section 2.11.*

Navigation

Both versions of KOR—Desktop KOR for computers and KOR for the EXO handheld—have the same basic menu structure. The main menu items are:

Run: This menu is used to display live data from the EXO sonde either in numeric or graphical display.

Calibrate: This menu is used to calibrate the sensors installed in the EXO sonde, after the sonde is connected.

Deploy: Go to Deploy to set up the EXO sonde for logging deployments. Settings such as logging interval and SDI-12 configurations are in this menu, as well as starting and stopping autonomous logging on the sonde.

Sites: Used to manage sites, this optional menu helps users create site detail that may be associated with files logged in the sonde. NOTE: Only available on desktop KOR.

Data: This menu enables file transfers from the EXO sonde or handheld, and can also be used without a sonde to view and export data files that were previously transferred to the desktop or handheld.

Options: Application preferences, sonde settings, and software and firmware updates can be accessed through this menu. The user can change display units here.

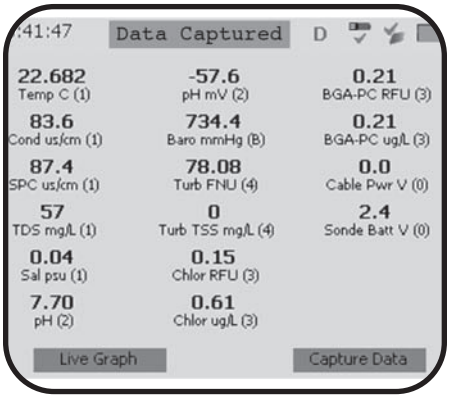
Connections: This menu allows the user to connect to other sondes and devices, identify which probes are installed in which ports, and update Bluetooth settings.

Help: This page links to support resources for using KOR.

Status icons: The icons in the top right of the KOR window are information-only displays. The white box shows the connected device by serial number and name. The sonde icons show if an EXO sonde is connected (check mark) or not connected (X). The folder icons show if the sonde is currently in logging mode (check mark) or not logging (X).

4.2 KOR Software
Run Menu

The Run menu displays real-time water quality data in numeric or graph formats, and has three main submenus.



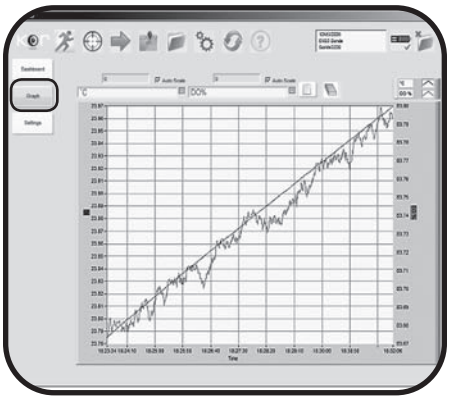
Dashboard.

This real-time display shows data from connected devices. The data appears in a default order of parameters in the list. In the RUN menu, data is automatically buffered up to 1000 points in desktop KOR.

Capture Data: Use the Capture Data button to save a snapshot of the data buffer to the computer. The captured data is automatically saved in the location and in a format specified in the Settings submenu *(see next page)*. When capturing data on the Handheld a new menu will appear with various options for sampling data.

Wipe Sensors: In the Dashboard menu, it is possible to manually activate the central wiper if the EXO2 sonde is equipped with one. This feature can be helpful when transferring the sensors into liquid; the wiper can help remove any bubbles that may be trapped at the sensor faces.

NOTE: Menu functionality is the same, although visual display differences are found between KOR's Desktop version (top) and Handheld version (bottom).

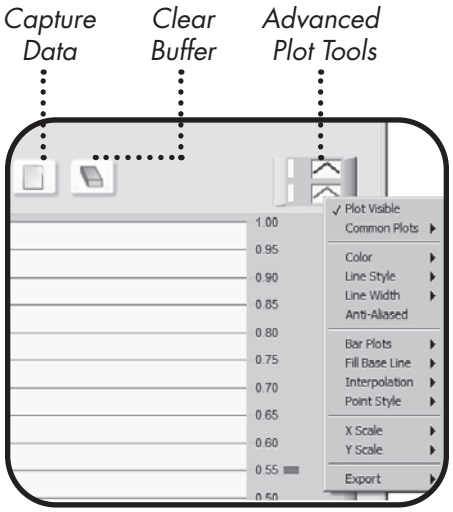


Graph.

This real-time display will graph one or two parameters from the attached EXO device. The parameters are chosen from the drop-down menu above the plot area (desktop KOR) or with the tab and backspace keys (handheld KOR). Only parameters currently active in the attached device will be available for plotting.

It is important to note the scale when viewing real-time data in Graph mode. Due to the precise nature of EXO sensors, very small micro-changes are visible in the graph.

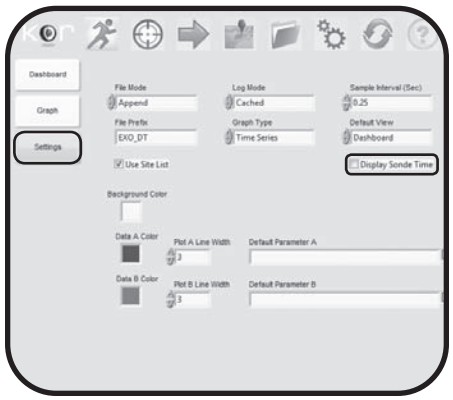
- Auto-scaling enables KOR to best fit data into the available window, even if the Y-axis extremes vary by less than a unit.
- To manually scale the plot, first deselect the Autoscale button(s), then click the upper-most and bottom-most numbers on either Y-axis. (Not available on handheld KOR.)



Clear Buffer: As in the Dashboard, the data buffer can manually be saved to a file using the Capture Data button. Alternatively the buffer data can be cleared using the Clear Buffer button. Once the buffer is cleared, it cannot be recovered.

Settings.

The Settings menu defines the preferences for the RUN mode. Plot line colors and width can be chosen, as well as the default plot parameters. While all parameters are available to set as default, the connected device must have the corresponding sensor installed in order to plot the data.



File Mode: When using the Capture Data button, data will be saved to a file. When the file mode is set to NEW, a new data file will be created.

Log Mode: Controls the amount of data saved to a file. Cached sends the entire real-time data buffer (up to 1000 points in desktop KOR), while Single records the most recent data set (1 point for every parameter).

Sample Interval: This option corresponds to the refresh rate of the graph and dashboard. 1 sample per second (1 Hz) is typical for most real-time display; once per second new readings are posted to the buffer and updated on the display. The sampling rate on the real-time display is limited to 4 samples per second (4 Hz) because of the processing effort of transferring the information to the PC.

File Prefix: This prefix is the file name that will appear at the beginning of the captured data file. KOR automatically applies a unique identifier name on all files generated. The user can change this setting, but the file prefix allows users to give the captured file a name.

Graph Type: Choose between Time Series or Profiling graph displays. The Profiling graph displays data versus depth.

Default View: The Default View allows the user to choose between Dashboard or Graph as the default display when KOR automatically opens the Run menu.

Apply: When a field is edited in the Settings menu, the user must click the Apply button to commit those changes. If you edit a field, then attempt to navigate away, a warning box appears to remind you to apply or discard your changes.

Display Sonde Time: Will add a new clock to dashboard with real-time clock from sonde, time will be displayed in UTC regardless of time zone settings.

4.3 KOR Software Calibrate Menu

This menu is the main interface for calibrating EXO sensors. Calibration and verification settings will vary by sensor. A device must be connected to access the Calibrate menu.

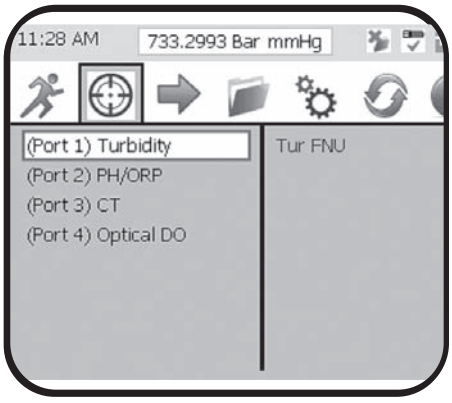
For detailed calibration procedures for individual sensors, reference Section 5, Calibration.

Calibration menu overview.

In the Calibrate menu, the list of installed sensors is shown on the left side of the window. If your sonde is configured with a depth sensor, Port D depth also appears in the list.

Sensor calibration menu.

Select a sensor from the list to bring up a sensor-specific menu of parameters. For example, selecting ODO (optical dissolved oxygen) from the list, brings up a menu for the enabled parameters ODO % sat, ODO mg/L, or ODO % Local. (To change the enabled parameters on desktop KOR, go to the Options | Units menu. Handheld KOR calibrates in base units regardless of user selections made in the Units menu.)



A typical calibration window shows 1, 2, or 3 calibration points, depending on the sensor. If the sensor supports only a single calibration point, then the other calibration points are not active (grayed out).

Temperature: This field displays current temperature, if a conductivity/temperature sensor is installed. If no sensor is installed, user can input data into this field.

Barometer: Displays for DO calibrations only.

Standard Value: User-input field for the calibration setpoint based on the value of the standard being used.

Type: Optional field for type of standard being used. Pre-populated for some calibrations; user-input field for other calibrations.

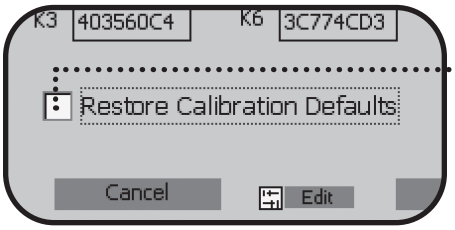
Manufacturer: Optional field to record manufacturer of calibration standard used. This data is logged in the calibration worksheet.

Lot number: Optional field for calibration standard lot number, used for traceability purposes.

Advanced calibration menu.

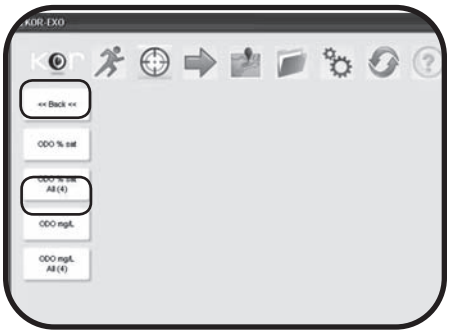
Each sensor calibration menu has an Advanced button to edit advanced features for the specific parameter. Unique sensor options include TSS input for Turbidity (not available on Handheld when performing multi-sensor calibration) and sensor cap coefficients for DO.

Uncalibrate.



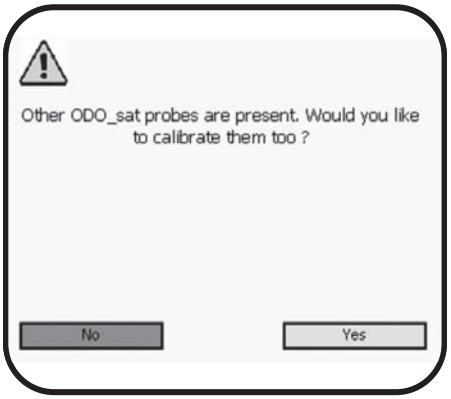
The Uncal function in the Advanced menu returns the probe back to factory calibration settings. Users may select this for troubleshooting if a calibration process on a probe is not working correctly. (On the Handheld version there is a checkbox “Restore Calibration Defaults” under the same Advanced Menu.)

Calibrating multiple sensors.



To calibrate multiple sensors of the same type concurrently, install all the sensors in the sonde. In the Calibration menu, click on the sensor, and new options are available in the second menu for calibrating ALL like sensors.

Follow the calibration instructions in KOR to calibrate all the sensors. Calibrations occur one after the other, not simultaneously. Sensors are turned on one at a time so the user can validate each sensor’s reading and to avoid the possibility of interference from the other sensors.



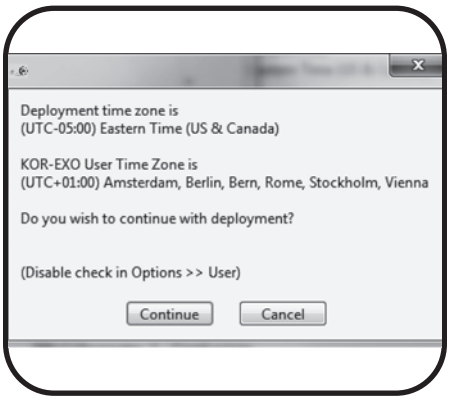
Once all like sensors have been calibrated, they can be removed from the sonde and installed in other EXO sondes. The sensor will retain its calibration.

Note: When calibrating multiple sensors with the Handheld, clicking the Restore Default Calibrations button will restore ALL like sensors to original settings.

Note: Menu functionality is the same, although visual display differences are found between KOR’s Desktop version (top and middle) and Handheld version (bottom), this page and previous page.

4.4 KOR Software Deploy Menu

The Deploy menu is used mainly to configure an EXO sonde to collect unattended data and to manage deployment templates. This menu is dynamic based on the mode of the attached device. Two or three submenu options are available: Read Current Settings, Open a Template, and, if a connected sonde is logging, a Stop Deployment button.



Read current sonde settings.

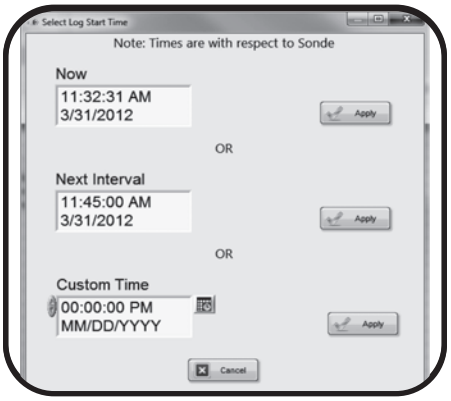
This menu scans the attached device and summarizes its current configuration, including battery life, sample count and when the next sample will be taken. The user can view the configuration, edit the configuration, or apply a saved template.

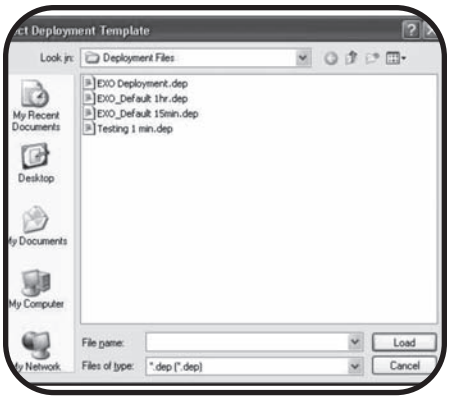
Time and Date: When reading the current sonde settings, KOR communicates with the EXO sonde and performs a number of system checks, including a date and time check. If the sonde clock and the computer clock differ, or if time zones differ, then KOR notifies the user. These prompts are informational only and can be disabled as noted on the screen.

Edit: Edit the existing settings using the Edit button.

Deploy: Redeploy the sonde by clicking the Deploy button, with these log start-time options:

- Start logging now. For example, a first sample logs at 11:32:31, and with a 15-minute logging interval the next sample will log at 11:47:31.
- Start logging at next even interval. For example, a first sample logs at 00:00:00, and with a 15-minute logging interval the next sample will log at 00:15:00, then 00:30:00, 00:45:00, etc. This set-up is typical. Logged data will be uniform.
- Set a custom start time. Choose the start date and time, which can vary from minutes to days in the future, then click the Apply button to prepare the sonde for deployment. Setting a start time in the past causes the sonde to start logging immediately.
- Apply or Cancel. Click the Apply button to apply the edits to the settings. Or click the Cancel button to update the sonde settings for SDI-12 but not actually start a log file.





Open a template.

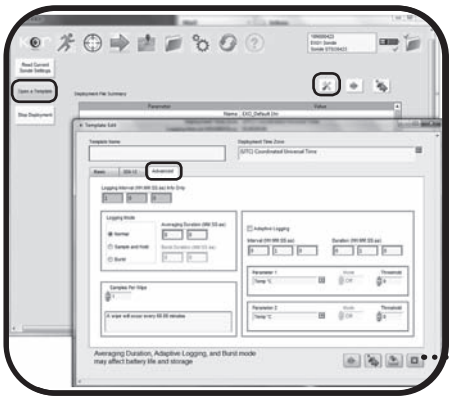
This submenu opens saved template files on the computer for configuration settings. Deploy immediately by opening default templates for 15-minute and one-hour logging intervals, which are stored in the KOR-EXO | Deployment Files folder located in the Program Files folder on the computer.

Template Edit: Open and edit a template with a new name before deploying to the sonde.

Basic: To set up logging based on a specific time interval.

SDI-12: To send data to a DCP. *See sections 2.14 and 4.11.*

Advanced: See below.



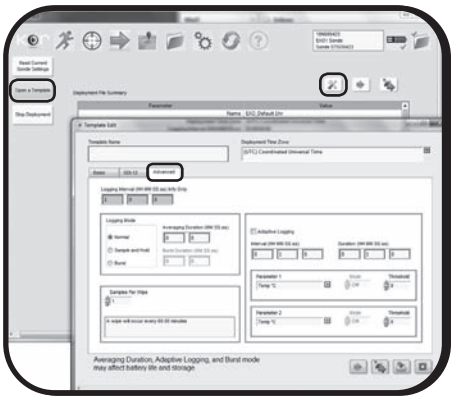
Save and deploy a template.

Save edited templates with these options:

- Save, deploy, start logging. Starts logging at interval specified for deployment.
- Save, deploy, no logging. Use with data logger and RS-232 settings.
- Save only. Save but do not deploy and log.
- Cancel.

Stop deployment.

This Stop Deployment button appears when an attached EXO device is actively logging. After stopping a deployment, the button disappears and the icon in the upper right changes state to indicate the sonde is not actively logging data.



Advanced sampling and logging.

Access the following functions in the Deploy | Open Template | Edit Template menu and click on the Advanced tab.

Logging Intervals

When deploying a sonde, data is logged and time-stamped at a routine sampling interval. A typical sampling interval for unattended logging is 15 minutes. If the sonde logs at 00:15:00, the sonde will wake up early to activate the sensors and start processing data. Typically this will be 12-15 seconds before the time-stamp. If an averaging interval were activated, then the sonde would wake up 15 seconds early plus the averaging interval to start averaging the data.

Samples Per Wipe - Wiping Interval

In most deployments the user will choose to use the EXO2 central wiper to wipe the sensors preceding each logging interval. We recommend a wiping interval of 1 for 15-minute and 30-minute sampling intervals; 1 wipe will occur just prior to a sample being taken. Set the wiping interval to 2 and one wipe will occur every other sample. If you have a short sampling interval, such as 5 minutes, and biofouling is not aggressive, then you may not need to wipe the sensors prior to every sampling interval. In this case, you can set the wiping interval to 4, in which case it will wipe every fourth time a sample is taken, or approximately every 20 minutes. This action can help conserve battery life.

Setting Samples Per Wipe to 0 will disable the central wiper.

Sampling Rates

The sensors output data to the EXO sonde in real time, this data transfer rate varies by sensor and processing conditions but generally it can be assumed the sensor transfers data to the sonde twice a second (2 Hz). In high speed unattended sampling applications, like vertical profiling, the sonde can be deployed to log data as fast as 4 times a second (4 Hz). The user can set the sampling interval, and the real time transfer between the sensors and sonde will automatically adjust to an appropriate output rate. The user can not manually control the output rate of the sensors themselves. RS-232 output via SOA-DCP is limited to 1 Hz.

Battery Consumption: Sampling rates can vary significantly depending on application, and a sampling rate will have a significant impact on memory usage and battery consumption. An EXO2 sonde with a full payload can be expected to log more than 90 days at a 30-minute sampling interval, but the same sonde set to profile at 4 Hz (four times per second) will have battery power for only one day. An estimate of this life is provided in the deployment summary screen, and should be considered when setting sampling intervals.

Burst Sampling

Burst sampling allows the user to collect a set of data at each logging interval. Activate Burst Sampling by clicking on Burst in the Logging Mode area of the Template Edit menu. Then select a time duration between 1 and 300 seconds. Data will be collected at a rate of 1 Hz during the specified duration. This data set will allow users to perform advanced data analysis and post processing. However, note that this increased data in the logged file may more rapidly fill the internal memory of the data logger and affect battery life.

Adaptive Logging

Adaptive or Event Logging allows the user to select one or two sensors as triggers for a higher resolution logging interval. The user can set the trigger to activate above or below a pre-determined threshold level for the given sensor. Activate the Adaptive Logging feature by clicking the box next to Adaptive Logging. Enter values for the logging interval and duration fields. Then select a trigger sensor for Parameter 1 from the drop-down list, set the Mode to Above, Below or Off, and set the threshold value. Repeat this process for Parameter 2, if desired. However, note that this increased data may affect battery life.

4.5 KOR Software
Sites Menu

Used to manage sites, this optional menu helps users create site detail that may be associated with files logged using the sonde or handheld. KOR is a dynamic software platform subject to additional development and future improvements. Software menus and features are subject to change.

NOTE: This feature was introduced in the February 2014 software update. If not available on your software please visit **EXOwater.com** to get the latest upgrades.

Add a Site.

Click "Add" to create and name a site.

Sites are displayed in the order they were created.

Remove a Site.

To remove a site, highlight an existing entry and click "Remove".

Sync Sites with Handheld.

For instructions on syncing your site list with the Handheld reference the instructions in *section 3.8*.

4.6 KOR Software Data Menu

The Data menu is used to transfer files from the sonde or handheld and manage data files on a local computer. The Transfer function will only work when connected to a sonde.

Transfer.

Clicking the Transfer submenu button initiates a scan of the attached EXO and lists all files on the sonde.

Upload/copy files: Select files to upload by clicking a file name in the list, clicking the Select All button, or clicking multiple files by holding down the Control key. Selected files are highlighted in blue. After files are selected, use the Selected button to copy the file to the PC. Click the Latest button to copy the most recent file. The uploaded file(s) are in binary format and are stored in the Program Files\KOR-EXO\Data Files folder on the computer. *See Data Files & File Locations section 4.10 for more detail.*

Delete files: After files have been copied to the PC, users can delete selected files. Select the files to be removed and use the Delete Selected button to remove them permanently from the sonde.

Quick View: Click a file in the list, and then click the Quick View button to view the last 50 data points of the file.

Storage space: The progress bar on the bottom will indicate memory usage on the sonde. We recommend users keep a back-up copy of the binary files on the sonde, unless storage space is needed.

View/export.

Use this submenu to review binary files transferred from the sonde and export the binary data to different format.

View: Select and open a saved file from the Data Files pop-up menu. Alternatively, click the Select File button to manually open a file. When a file is loaded in desktop KOR, you can view it one point at a time using the arrow buttons or change to a graph view using the Change View button. (Handheld KOR is limited to viewing 100 data points.)

Export: Click the Export Data button to export files to Excel format or delimited text file. For Excel format, a spreadsheet automatically opens with the data. Save other open files in Excel first, or the export will not work.

Settings.

This submenu allows the user to set the default file location, export format, and data display formatting.

View calibration worksheets.

This submenu in desktop KOR allows the user to open and view saved Calibration Worksheets from the Calibration Files folder on the computer. If you encounter errors viewing data files synced from the EXO Handheld, click the Update Directory button.

4.7 KOR Software Options Menu

Many preferences, settings, and updates for KOR can be accessed through the Options menu.

Smart QC: KOR performs quality checks on each connected sonde and sensor and provides an overall Network QC Score.

- **Check mark** (green)**:** OK.
- **X** (red)**:** Warning that part or all of the system is out of specification ranges.
- **Question mark** (black)**:** Unknown, not enough data to determine QC score.
- **Exclamation point** (yellow)**:** Caution. While OK now, part(s) of the system is close to being out of specification.

Sonde: Bluetooth pin number, activate Bluetooth, sonde ID/name, sonde date and time, battery type, and fault bit field.

KOR software on the EXO Handheld also has a **Handheld submenu** to set language, date and time, power, GPS, sound volume, Bluetooth pin number, and hibernate/sleep preferences on the Handheld itself.

User: Select settings for Language, Idle Timeout, and Time Zone and Time Format preferences, and turn on/off time zone check at deployment.

Units: Customize display units/parameters for each sensor, plus adjust wiper position and sonde cable and battery readings. While the sonde and sensors record data in fixed formats, KOR can adjust the displayed units. For example, the Temperature sensor outputs degrees C to the sonde; however the display units can be set to degrees F, and the temperature reading is converted. After the units are set, data viewed on the Run menu will be displayed in this format.

Firmware: Check and update firmware on connected devices. KOR automatically searches for connected sondes, sensors, and handhelds and loads the table with sensor names, serial numbers and current firmware revisions. *To update firmware, see instructions in sections 6.7 and 6.11.*

Calibration: To speed the calibration process, users can set default calibration settings for individual sensors and parameters here. Click the Apply button and changes take effect immediately.

Sync with Handheld: Upload files from Handheld to PC. *See section 3.8.*

4.8 KOR Software Connections Menu

This menu allows the user to connect to other sondes and devices, identify which probes are installed in which ports, and update Bluetooth settings.

Rescan.

This submenu allows the user to refresh and initiate connections to hard-wired devices, search for Bluetooth connections, or disconnect.

To reconnect to a sonde, wait for KOR to scan the devices, then select a device from the list. Click Connect.

Map.

This menu allows the user to view connected sondes, sensors, serial numbers and the ports assigned to the sensors.

Also, if a sonde is connected to the auxiliary port of an EXO2 sonde, then both sondes will be visible in this menu. However, the user can only communicate with one sonde at a time.

Settings.

This submenu allows the user to control Bluetooth settings including PIN number and auto-scanning.

Advanced.

This submenu allows the user to control settings for the Signal Output Adapter (SOA).

4.9 KOR Software
Help Menu

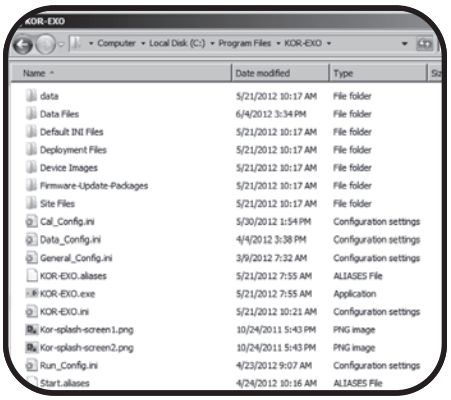
This menu connects the user to documentation resources for using KOR software and the EXO products, including videos.

4.10 KOR Software
Data Files and File Locations

KOR software is installed onto your computer's default hard drive, which is typically C:\ on most Windows-based PCs. The KOR program is then placed into the program file directory. On XP and Windows 7 32-bit systems, this folder is simply called Program Files. On 64-bit systems KOR is placed in the Program File (x86) folder. The two most common file paths are:

C:\Program Files\KOR-EXO\ *(XP and 32-bit Windows 7)*

C:\Program Files (x86)\KOR-EXO\ *(64-bit Windows 7)*



Data folders.

Data Files: These are the binary data files from EXO, which are only accessible via KOR. We strongly recommend you maintain all binary data files in this folder and also create a back-up copy.

Deployment Files: Templates for deployments are stored here. They may be moved to another computer to provide consistent deployments across your organization.

Site Files: These contain the site details used by KOR; *future functionality, not active yet.*

⚠ Do not edit, move, or rename other files. This could damage KOR and affect system reliability.

Data files.

Templates, binary data files, data files and configuration settings are in the KOR-EXO | Data Files folder. You can navigate to the KOR-EXO folder to access template and data files, if you want to copy them to another computer.

Data file names.

Data files are given unique names to ensure no duplication. The file name structure is:

AAAAAAAA_YYMBBBBBB_MMDDYY_HHMMSS.bin

Sample: EXODT_12N768062_033012_182618.bin

AAAAAAAA: User-defined file prefix up to 8 characters, set in the deployment template or Run | Settings menu.

YYMBBBBBB: EXO sonde serial number. YY represents the year the sonde was manufactured, M corresponds to the month of manufacture, and BBBBBB is a unique sequential number. For live data capture files, the serial number is a number assigned to the instance of Desktop KOR or the serial number of the Handheld.

MMDDYY: MM is the month the data file was created, DD is the day of the month, and YY is the year.

HHMMSS: UTC time stamp where HH is the hour the file was created in 24-hour format, MM the minute, and SS the second.

.bin: binary file extension. *To obtain a delimited file format or Excel format, see section 4.6.*

4.11 KOR Software
SDI-12

The sonde can be connected to an SDI-12 bus using a DCP Signal Output Adapter (SOA). The SOA provides the necessary SDI-12 electrical interface and communicates to the sonde via the topside RS-485 interface. The SOA will automatically recognize when a sonde is connected and retrieve the SDI-12 address and ID from the sonde. The SDI-12 data parameter list is set by the user in the Deploy menu. Go to Deploy | Open Template | Edit Template menu and click on the SDI-12 tab.

Add: Choose the SDI-12 parameters you want from the Available column and double-click or select and move them with the right arrow to the Selected column.
Remove: Remove parameters from Selected column by double-clicking or selecting and clicking the left arrow.
Order: Arrange the parameter output by using the up and down arrows.

Sensor parameter codes:

Temp	C	1
Temp	F	2
Temp	K	3
Cond	mS/cm	4
Cond	µS/cm	5
SpCond	mS/cm	6
SpCond	µS/cm	7
Sal	psu	12
pH	mV	17
pH		18
ORP	mV	19
Press	psia	20
Press	psig	21
Depth	meters	22
Depth	feet	23
Battery	volts	28
Turbidity	NTU	37
NH_3	N mg/L	47
NH_4^+	N mg/L	48
Date	DD/MM/YY	51
Date	MM/DD/YY	52
Date	YY/MM/DD	53
Time	HH:MM:SS	54
NO_3^-	N mV	101
NO_3^-	N mg/L	106
NH_4^+	N mV	108

Cl^-	mg/L	112
Cl^-	mV	145
TSS	mg/L	190
TSS	g/L	191
Chlorophyll	µg/L	193
Chlorophyll	RFU	194
ODO	% sat	211
ODO	mg/L	212
ODO	% local	214
BGA PC	RFU	216
BGA PE	RFU	218
Turbidity	FNU	223
Turbidity	RAW	224
BGA PC	µg/L	225
BGA PE	µg/L	226
fDOM	RFU	227
fDOM	QSU	228
Wiper Position	volts	229
Cable Power	volts	230
BGA PC	Raw	231
BGA PE	Raw	232
fDOM	Raw	233
Chlorophyll	Raw	234
nLF Cond	mS/cm	237
nLF Cond	µS/cm	238
Wiper Peak Current	mA	239
TDS	g/L	10
TDS	kg/L	95
TDS	mg/L	110

4.11 KOR Software RS-232

The EXO DCP Signal Output Adapter (SOA) supports limited RS-232 commands. The SOA supports both SDI-12 and RS-232 communications. The order of the RS-232 parameter output is controlled by the SDI-12 tab on the deployment menu.

See section 2.14 for instructions on mounting and wiring the DCP-SOA.

Commands:

Data	Returns sonde data as specified by SDI-12 parameter settings set by user in Deploy menu of KOR software
Para	Lists the parameter order using ID numbers, *(Parameter codes on previous page.)*
Time	Sets or gets current time in HH:MM:SS format
Twipeb	Starts a wiper event, responds with estimate of time in seconds to complete wiping sequence
Ver	Returns sonde firmware version number
Verdate	Returns sonde firmware version compilation date

Send these commands to the DCP via an RS-232 hyperterminal window configured with the following settings:

Bits per second	9600
Data bits	8
Parity	None
Stop bits	1
Flow control	None

4.12 Update Firmware and Software
Sonde and Sensors

Users can check and update sensor or sonde firmware through the KOR interface software. This process may take up to 30 minutes depending on the number of sensors that will be updated.

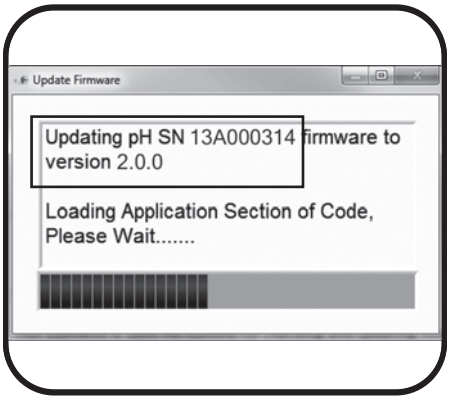
NOTE: For best power management, update firmware while a device is connected via USB, as this will provide power to the device. However, if you use Bluetooth, we recommend installing fully charged batteries in the sonde.

1 Connect to sonde.

Each device must be connected to a computer running the Desktop version of KOR, and the computer must have internet access.

2 Open firmware submenu in KOR.

Navigate to the Options menu in KOR, then to the Firmware submenu. Immediately after clicking the Firmware submenu button, KOR begins to search for connected sondes and sensors and loads the table with names, serial numbers, and current firmware versions.



3 Update sonde and sensor network.

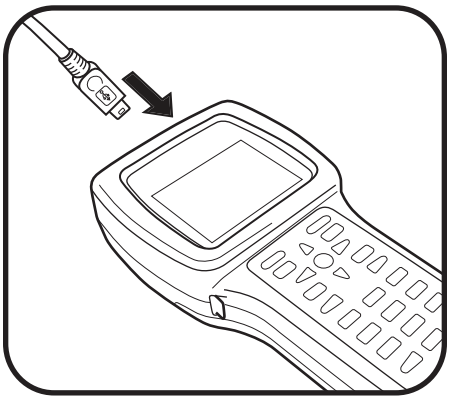
Click the update network button.

KOR then updates the device's firmware, which could take several minutes. If you experience problems with automatically downloading the latest firmware, please see the Troubleshooting section in this document.

⚠ NOTE: Firmware updates require all instrumentation (Handheld, sonde, sensors, and desktop software) be updated to function properly.

4.12 Update Firmware and Software
Handheld

To update the instrument firmware and KOR software on the EXO Handheld, use the Desktop version of KOR on a computer with internet access. KOR Desktop will go online and pull updated files for the Handheld, which are then transferred to the Handheld.



1 Connect handheld to computer.

Plug the small end of the USB cable into the port on the top side of the EXO Handheld. Plug the other end of the USB cable into a port on your computer. Wait for Windows to recognize the Handheld as a removable drive before the Handheld shows up in KOR software. This may take several minutes.

2 Update handheld.

When the Handheld is connected to the PC, go to the Options | Firmware menu in KOR Desktop software. Select the Update Handheld button from the bottom-right corner of the menu.

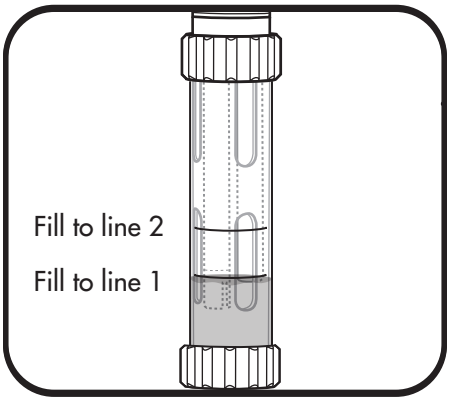
Handheld information will be displayed in this box when successfully connected. Follow the prompts for completing the update process and rebooting the Handheld.

⚠ NOTE: Firmware updates require all instrumentation (Handheld, sonde, sensors, and desktop software) be updated to function properly.

5.1 Calibration Basic

EXO sensors (except temperature) require periodic calibration to assure high performance. Calibration procedures follow the same basic steps with slight variations for particular parameters. Conduct calibrations in a temperature-controlled lab.

Calibration set-up.



For accurate results, thoroughly rinse the EXO calibration cup with water, and then rinse with a small amount of the calibration standard for the sensor you are going to calibrate. Two to three rinses are recommended. Discard the rinse standard, then refill the calibration cup with fresh calibration standard. Fill the cup to approximately the first line with a full sensor payload or the second line with small sensor payload. Volumes will vary, just make certain that the sensor is submerged. Be careful to avoid cross-contamination with other standards.

Begin with a clean, dry probe installed on the EXO sonde. Install the clean calibration guard over the probe(s), and then immerse the probe(s) in the standard and tighten the calibration cup onto the EXO sonde. We recommend using one sonde guard for calibration procedures only, and another sonde guard for field deployments. This ensures a greater degree of cleanliness and accuracy for the guard used in the calibration procedure.

Basic calibration in KOR software.

Go the Calibrate menu in KOR software. This menu's appearance will vary depending on the sensors installed in the sonde. Select the sensor you are going to calibrate from the list. Next select the parameter for the sensor you are going to calibrate. Some sensors have only one parameter option, while other sensors have multiple options.

In the next menu, select a 1-, 2-, or 3-point calibration, depending on your sensor. Enter the value of the standard you are using. Check that the value you enter is correct and its units match the units at the top of the menu (e.g., microSiemens versus milliSiemens). You may also enter optional information for type of standard, manufacturer of standard, and lot number.

Click the Start Calibration button. This action initiates the probe's calibration in the standard; initially the data reported will be unstable and then they will move to stable readings. Click the Graph Data button to compare the pre-cal and post-cal values in graph form. Users should confirm that the value is within their acceptable margin of error. Once readings are stable, click Apply to accept this calibration point. Repeat the process for each calibration point. **Click Complete when all points have been calibrated.**

A calibration summary appears with a QC score. View, export, and/or print the calibration worksheet. If a calibration error appears, repeat the calibration procedure.

5.2 Calibration
Conductivity / Temperature

Clean the conductivity cell with the supplied soft brush before calibrating *(see section 6.14).*
Also, review the basic calibration description in section 5.1.

This procedure calibrates conductivity, non-linear function (nLF) conductivity, specific conductance, salinity, and total dissolved solids.

Place the correct amount of conductivity standard into a clean and dry or pre-rinsed calibration cup. A variety of standards are available based on the salinity of your environment. Select the appropriate calibration standard for your deployment environment; we recommend using standards greater than 1 mS/cm (1000 µS/cm) for greatest stability.

Carefully immerse the probe end of the sonde into the solution, making sure the standard is above the vent holes on the conductivity sensor. Gently rotate and/or move the sonde up and down to remove any bubbles from the conductivity cell.

Allow at least one minute for temperature equilibration before proceeding.

In the Calibrate menu, select Conductivity and then a second menu will offer the options of calibrating conductivity, nLF conductivity, specific conductance, or salinity. Calibrating any one option automatically calibrates the other parameters. After selecting the option of choice (specific conductance is normally recommended), enter the value of the standard used during calibration. Be certain that the units are correct and match the units displayed in the second window at the top of the menu.

Click Start Calibration. Observe the readings under Current and Pending data points and when they are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

- If the data do not stabilize after 40 seconds, gently rotate the sonde or remove/reinstall the cal cup to make sure there are no air bubbles in the conductivity cell.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.

Rinse the sonde and sensor(s) in tap or purified water and dry.

5.3 Calibration Dissolved Oxygen

First review the basic calibration description in section 5.1.

ODO % sat and ODO % local – 1-point

Place the sonde with sensor into either saturated air or saturated water:
(a) Saturated air: Ensure there are no water droplets on the DO sensor or the thermistor. Place into a calibration cup containing about 1/8 inch of water that is vented by loosening the threads. (Do not seal the cup to the sonde.) Wait 10-15 minutes before proceeding to allow the temperature and oxygen pressure to equilibrate. Keep out of direct sunlight.
(b) Saturated water: Place into a container of water which has been continuously sparged with an aquarium pump and air stone for one hour. Wait approximately 5 minutes before proceeding to allow the temperature and oxygen pressure to equilibrate.

In the Calibrate menu, select ODO, then select ODO % sat or ODO % local. Calibrating in ODO % sat automatically calibrates ODO mg/L and ODO % local and vice versa.

Enter the current barometric pressure in mm of Hg (Inches of Hg x 25.4 = mm Hg).

> NOTE: Laboratory barometer readings are usually "true" (uncorrected) values of air pressure and can be used "as is" for oxygen calibration. Weather service readings are usually not "true", i.e., they are corrected to sea level, and therefore cannot be used until they are "uncorrected". An approximate formula for this "uncorrection" (where the BP readings MUST be in mm Hg) is:
> True BP = [Corrected BP] – [2.5 * (Local Altitude in ft above sea level/100)]

Click 1 Point for the Calibration Points. Enter the standard value (air saturated).

Click Start Calibration. Observe the readings under Current and Pending data points and when they are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.

mg/L – 1-point

Place the sonde with sensor in a container which contains a known concentration of dissolved oxygen in mg/L and that is within ±10% of air saturation as determined by one of the following methods:

- Winkler titration
- Aerating the solution and assuming that it is saturated
- Measurement with another instrument

⚠ Carrying out DO mg/L calibrations at values outside the range of ±10 % of air saturation is likely to compromise the accuracy specification of the EXO sensor. For highest accuracy, calibrate in % saturation.

In the Calibrate menu, select ODO, then select ODO mg/L. Calibrating in ODO mg/L automatically calibrates ODO % sat and vice versa.

Click 1 Point for Calibration Points. Enter the known mg/L concentration for the standard value. Click Start Calibration. Observe the readings under Current and Pending data points and when they are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point. Click Complete.

Rinse the sonde and sensor(s) in tap or purified water and dry.

ODO % sat, ODO % local or mg/L – 2-point (or zero point)

Normally it is not necessary to perform a 2-point calibration for the DO sensor, and the procedure is not recommended unless (a) you are certain that the sensor does not meet your accuracy requirements at low DO levels and (b) you are operating under conditions where you are certain to be able to generate a medium which is truly oxygen-free.

For ODO % sat or ODO % local, calibrate your sonde at zero oxygen and in water-saturated air or air-saturated water. For ODO mg/L, calibrate your sonde at zero oxygen and a known concentration of oxygen within ±10% of air-saturation. The key to performing a 2-point calibration is to make certain that your zero-oxygen medium is truly oxygen-free:

- If you use nitrogen gas for the zero-point calibration, make certain that the vessel you use has a small exit port to prevent back diffusion of air and that you have completely purged the vessel before confirming the calibration.
- If you use sodium sulfite solution for the zero-point calibration, prepare the solution at a concentration of approximately 2 g/L at least two hours prior to use and keep it sealed in a bottle which does not allow diffusion of oxygen through the sides of the container. Transfer the sodium sulfite solution rapidly from its container to the calibration cup, fill the cup as full as possible with solution to minimize head space, and seal the cup to the sonde to prevent diffusion of air into the vessel.

Place the sonde with DO and temperature sensors in a zero-oxygen medium.

In the Calibrate menu, select ODO, then select either ODO % sat, ODO % local or ODO mg/L.

Click 2 Point for the Calibration Points. Enter Zero Point as the value of the first standard.

Click Start Calibration. Observe the readings under Current and Pending data points and when they are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

- If you used sodium sulfite solution as your zero calibration medium, you must thoroughly remove all traces of the reagent from the probes and wiper prior to proceeding to the second point. We recommend that the second calibration point be in air-saturated water if you use sodium sulfite solution.

Next place the sensors in the medium containing a known oxygen pressure or concentration and wait at least 10 minutes for temperature equilibration. Click Proceed in the pop-up window. Then enter either the barometer reading in mm Hg (for ODO %) or the actual concentration of oxygen which was probably determined from a Winkler titration (for ODO mg/L). Observe the readings under Current and Pending data points and when they are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.

⚠ Carrying out DO mg/L calibrations at values outside the range of ±10 % of air saturation is likely to compromise the accuracy specification of the EXO sensor. For highest accuracy, calibrate in % saturation.

Rinse the sonde and sensor(s) in tap or purified water and dry.

5.4 Calibration
Depth and Level

NOTE: This calibration option is available only if your sonde is equipped with an integral depth sensor or a vented level sensor.

For the calibration, make certain that the depth sensor or vented level sensor is in air and not immersed in any solution. *Also, review the basic calibration description in section 5.1.*

In the Calibrate menu, select Port D-Depth, then select Depth or Level from the second menu.

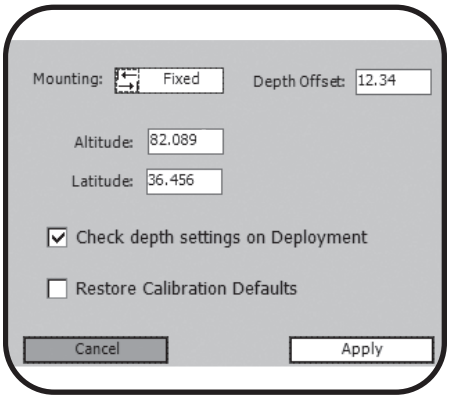
Click 1 Point for the Calibration Points. Enter 0 or go to the Advanced menu to enter a known sensor offset.

- If a depth offset is entered, the output value will shift by the value of the offset. Users may use an offset if referencing a water elevation against a known datum.

Click Start Calibration. Observe the readings under Current and Pending data points and when they are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point. This process zeros the sensor with regard to current barometric pressure.

Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.

For best performance of depth measurements, users should ensure that the orientation of the sonde remains constant while taking readings. This is especially important for vented level measurements. Keep the sonde still and in one position while calibrating.



Advanced

Mounting: Use the Advanced menu to select if a sonde will be mounted in a moving/profiling deployment instead of a fixed location.

Depth Offset: Enter a datum or barometric pressure offset at time of calibration. Barometric pressure offset allows the depth data to be post-processed for barometric pressure changes over the course of the deployment.

Altitude/Latitude: Enter the coordinates for the local altitude (in feet, relative to sea level) and latitude (in degrees) where the sonde is sampling. Latitude values are used in the calculation of depth or level to account for global variations in the gravitational field.

5.5 Calibration
pH

1-point
Select the 1-point option to calibrate the pH probe using one calibration standard.

2-point
Select the 2-point option to calibrate the pH probe using two calibration standards. In this procedure, the pH sensor is calibrated with a pH 7 buffer and a pH 10 or pH 4 buffer depending on your environmental water. A 2-point calibration can save time (versus a 3-point calibration) if the pH of the media to be monitored is known to be either basic or acidic.

3-point
Select the 3-point option to calibrate the pH probe using three calibration standards. In this procedure, the pH sensor is calibrated with a pH 7 buffer and two additional buffers. The 3-point calibration method assures maximum accuracy when the pH of the media to be monitored cannot be anticipated.

Review the basic calibration description in section 5.1.

Pour the correct amount of pH buffer in a clean and dry or pre-rinsed calibration cup. Carefully immerse the probe end of the sonde into the solution, making sure the sensor's glass bulb is in solution by at least 1 cm. Allow at least 1 minute for temperature equilibration before proceeding.

In the Calibrate menu, select pH or pH/ORP, then select pH.

Select the number of points desired for the calibration. Enter the value(s) of the pH buffer(s) that will be used for the calibration.

⚠ Observe the temperature reading above the standard value. The actual pH value of all buffers varies with temperature. Enter the correct value from the bottle label for your calibration temperature for maximum accuracy. For example, the pH of one manufacturer's pH 7 Buffer is 7.00 at 25˚C, but 7.02 at 20˚C.
- If no temperature sensor is installed, user can manually update temperature by entering a value.

Click Start Calibration. Observe the readings under Current and Pending data points and when they are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point. Confirm that the Pending data value is close to the Setpoint value. Click Proceed and wait for the software to prompt you to move the sensor to the next standard solution.

Rinse the sensor in deionized water. Pour the correct amount of an additional pH buffer standard into a clean, dry or pre-rinsed calibration cup, and carefully immerse the probe end of the sonde into the solution. Allow at least 1 minute for temperature equilibration before proceeding.

Repeat the calibration procedure and click Apply when the data are stable. Rinse the sensor and pour additional pH buffer, if necessary. Repeat calibration procedure for the third point and click Apply when data are stable.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.

Rinse the sonde and sensors in tap or purified water and dry.

5.6 Calibration ORP

Review the basic calibration description in section 5.1.

Pour the correct amount of standard with a known oxidation reduction potential value (we recommend Zobell solution) in a clean and dry or pre-rinsed calibration cup. Carefully immerse the probe end of the sonde into the solution.

In the Calibrate menu, select pH/ORP, then select ORP mV.

Click Start Calibration. Observe the readings under Current and Pending data points and when they are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

⚠ Do not leave sensors in Zobell solution for a long time. A chemical reaction occurs with the copper on the sonde (sonde bulkhead, central wiper assembly, copper tape). While the reaction does not impact calibration, it will degrade the sonde materials over time. Discard the used standard.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.

Rinse the sonde in tap or purified water and dry the sonde.

Effect of temperature on ORP

The oxidation reduction potential value shows an inverse relationship with temperature. This effect must be accounted for when calibrating the EXO ORP sensor with Zobell solution. Enter the mV value from the table below that corresponds to the temperature of the standard.

Temp (°C)	mV	Temp (°C)	mV
-5	270.0	25	231.0
0	263.5	30	224.5
5	257.0	35	218.0
10	250.5	40	211.5
15	244.0	45	205.0
20	237.5	50	198.5

5.7 Calibration Turbidity

Before calibrating, be certain that the probe is clean and free of debris. Solid particles, particularly those carried over from past deployments, will contaminate the standards during your calibration protocol and cause either calibration errors and/or inaccurate field data *(cleaning instructions, section 6.13)*. Use a clean, spare sonde guard. *Also, review the basic calibration description in section 5.1.*

For proper calibration, you must use standards that have been prepared according to details in *Standard Methods for the Treatment of Water and Wastewater* (Section 2130 B). Acceptable standards include (a) formazin prepared according to *Standard Methods,* especially for calibration points greater than 1010; (b) dilutions of 4000 NTU formazin concentrate purchased from Hach; (c) Hach StablCal™ standards in various NTU denominations; and (d) AMCO-AEPA standards prepared specifically for the EXO turbidity sensor by the manufacturer *(see table next page)*.

⚠ The use of standards other than those mentioned above will result in calibration errors and inaccurate field readings. It is important to use the same type of standard for all calpoints. (i.e. do not mix formazine and AMCO-AEPA standard for different points in a multi-point cal).

2-point

Pour the correct amount of 0 NTU standard (clear deionized or distilled water) into the calibration cup. Immerse the probe end of the sonde into the water.

In the Calibrate menu, select Turbidity, then select Turbidity FNU.

Click 2 Point for the Calibration Points. Enter 0 FNU for first standard value and 124 FNU for second standard value. (0 must be calibrated first.)

- If the water to be evaluated is known to be low in turbidity, an appropriate choice of standards might be 0 and 12.4. However, for general purpose measurements an appropriate choice of standards is usually 0 and 124.
- If deploying with a copper anti-fouling guard, use this guard during calibration to calibrate for any offset; input 0.5 or 1 instead of 0. The guard must be clean and free of sediment and debris.

Click Start Calibration. Observe the readings under Current and Pending data points. While stabilizing, click the Wipe Sensors button to activate the wiper to remove any bubbles. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

- If the temperature of your field site is substantially different from the lab temperature, allow the sensor to sample for 3-5 minutes at each calibration point before accepting it. This step ensures the best possible temperature compensation when deployed.

Next place the sensors in the second calibration standard. Click Proceed on the pop-up window. Observe the readings under Current and Pending data points. While stabilizing, click the Wipe Sensors button to activate the wiper to remove any bubbles. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.

Rinse the sonde in tap or purified water and dry the sonde.

3-point

Select the 3-point calibration option for maximum accuracy over a wider range. As for the 2-point procedure, the first standard must be 0 FNU. Because of the linearity characteristics of the sensors, we recommend that the other two standards have turbidity values of 124 and 1010 FNU. It is important to use a consistent type of standard for all calibration points. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to proceed to an additional solution to complete the 3-point procedure.

Calibration Limits

Due to the non-linear response of the turbidity sensor, calibration ranges may be limited. A 1-, 2-, or 3-point calibration may be completed, using the following limits:

1-point	2-point	3-point
0-1 FNU (or NTU)	5-199 FNU (or NTU)	200-4200 FNU (or NTU)

Calibration standards

The following standards are available for the EXO turbidity sensor:

608000	0 NTU (all turbidity sensors); 1 gallon
607200	12.4 FNU (EXO); 12.7 NTU (YSI 6-Series); 1 gallon
607300	124 FNU (EXO); 126 NTU (YSI 6-Series); 1 gallon
607400	1010 FNU (EXO); 1000 NTU (YSI 6-Series); 1 gallon

5.8 Calibration (Chl + BGA)
Total Algae

Review the basic calibration description in section 5.1.
Before calibrating, be certain that the sensing window is clean *(cleaning instructions, section 6.13)*.

Chlorophyll

This procedure calibrates Chlorophyll RFU or Chlorophyll µg/L. If the user has both units selected, then this procedure must be performed twice, once for each unit, to completely calibrate the parameter.

For 2-point calibrations, one standard must be clear water (0 µg/L), and this standard must be calibrated first. The other standard should be in the range of a known chlorophyll content of the water to be monitored. Two general types of standards can be used: (a) phytoplankton suspensions of known chlorophyll content, determined by employing the extractive analysis procedure described in *Standard Methods for the Examination of Water and Wastewater*, or by analyzing the suspension *in situ* using a laboratory fluorometer, and (b) dye solutions whose fluorescence can be correlated to that of chlorophyll.

For option (b), we recommend using a 625 µg/L Rhodamine WT dye solution *(for detailed instructions, see section 5.11)*, and the solution is used in the calibration steps below.

µg/L – 1- or 2-point

This procedure will zero your fluorescence sensor and use the default sensitivity for calculation of chlorophyll concentration in µg/L, allowing quick and easy fluorescence measurements that are only semi-quantitative with regard to chlorophyll. However, the readings will reflect changes in chlorophyll from site to site, or over time at a single site.

Pour the correct amount of clear deionized or distilled water into the calibration cup. Immerse the probe end of the sonde in the water.

In the Calibrate menu, select BGA-PC/Chlor, then select Chl µg/L. Select either a 1- or 2-point calibration. Enter 0 for first standard value and 66 for second standard value.

Click Start Calibration. Observe the readings under Current and Pending data points. While stabilizing, click the Wipe Sensors button to activate the wiper to remove any bubbles. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Next place the sensors in the Rhodamine WT standard. Click Proceed on the pop-up window. Observe the readings under Current and Pending data points. While stabilizing, click the Wipe Sensors button to activate the wiper to remove any bubbles. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.
Rinse the sonde in tap or purified water and dry the sonde.

RFU – 1- or 2-point

RFU is a percent full scale output; it outputs relative fluorescence from 0-100%. This calibration procedure is recommended if you are also using grab samples to post-calibrate *in vivo* chlorophyll readings.

The sonde will report relative values of fluorescence in the sample being measured. These values can be converted into actual chlorophyll concentrations in µg/L by using a post-calibration procedure, after the chlorophyll content of grab-samples taken during a deployment has been analyzed in a laboratory. This determination can involve conducting the extractive analysis procedure described for chlorophyll in *Methods for the Examination of Water and Wastewater* or by carrying out an *in situ* measurement of chlorophyll using a commercial benchtop fluorometer.

Pour the correct amount of clear deionized or distilled water into the calibration cup. Immerse the probe end of the sonde in the water.

In the Calibrate menu, select BGA-PC/Chlor, then select Chl RFU. Select either a 1- or 2-point calibration. Enter 0 for first standard value and 16.4 for second standard value.

Click Start Calibration. Observe the readings under Current and Pending data points. While stabilizing, click the Wipe Sensors button to activate the wiper to remove any bubbles. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Next place the sensors in the Rhodamine WT standard. Click Proceed on the pop-up window. Observe the readings under Current and Pending data points. While stabilizing, click the Wipe Sensors button to activate the wiper to remove any bubbles. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.

Rinse the sonde in tap or purified water and dry the sonde.

Blue-green Algae Phycocyanin

This procedure calibrates BGA RFU or BGA µg/L. If the user has both units selected, then this procedure must be performed twice, once for each unit, to completely calibrate the parameter.

For the 2-point calibration, one of the standards must be clear water (0 µg/L), and this standard must be calibrated first. The other standard should be in the range of the suspected BGA-PC content at the environmental site. Two general types of standards can be used: (a) phytoplankton suspensions of known BGA-PC content, and (b) dye solutions whose fluorescence can be correlated to that of BGA-PC. The user is responsible for determining the BGA-PC content of algal suspensions by using standard cell counting techniques.

For option (b), we recommend using a 625 µg/L Rhodamine WT dye solution *(for detailed instructions, see section 5.11)*, and the solution is used in the calibration steps below.

µg/L – 1- or 2-point

This procedure will zero your fluorescence sensor and use the default sensitivity for calculation of phycocyanin-containing BGA in µg/L, allowing quick and easy fluorescence measurements that are only semi-quantitative with regard to BGA-PC. However, the readings will reflect changes in BGA-PC from site to site, or over time at a single site.

Pour the correct amount of clear deionized or distilled water into the calibration cup. Immerse the probe end of the sonde in the water.

In the Calibrate menu, select BGA-PC/Chlor, then select BGA µg/L. Select either a 1- or 2-point calibration. Enter 0 for first standard value and 16 for second standard value.

Click Start Calibration. Observe the readings under Current and Pending data points. While stabilizing, click the Wipe Sensors button to activate the wiper to remove any bubbles. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Next place the sensors in the Rhodamine WT standard. Click Proceed on the pop-up window. Observe the readings under Current and Pending data points. While stabilizing, click the Wipe Sensors button to activate the wiper to remove any bubbles. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.
Rinse the sonde in tap or purified water and dry the sonde.

RFU – 1- or 2-point

RFU is a percent full scale output; it outputs relative fluorescence from 0-100%. This calibration procedure is recommended if you are also using grab samples to post-calibrate *in vivo* algae readings.

Pour the correct amount of clear deionized or distilled water into the calibration cup. Immerse the probe end of the sonde in the water.

In the Calibrate menu, select BGA-PC/Chlor, then select BGA RFU. Select either a 1- or 2-point calibration. Enter 0 for first standard value and 16 for second standard value.

Click Start Calibration. Observe the readings under Current and Pending data points. While stabilizing, click the Wipe Sensors button to activate the wiper to remove any bubbles. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Next place the sensors in the Rhodamine WT standard. Click Proceed on the pop-up window. Observe the readings under Current and Pending data points. While stabilizing, click the Wipe Sensors button to activate the wiper to remove any bubbles. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.

Rinse the sonde in tap or purified water and dry the sonde.

Blue-green Algae Phycoerythrin

This procedure calibrates BGA RFU or BGA µg/L. If the user has both units selected, then this procedure must be performed twice, once for each unit, to completely calibrate the parameter.

For the 2-point calibration, one of the standards must be clear water (0 µg/L), and this standard must be calibrated first. The other standard should be in the range of the suspected BGA-PE content at the environmental site. Two general types of standards can be used: (a) phytoplankton suspensions of known BGA-PE content, and (b) dye solutions whose fluorescence can be correlated to that of BGA-PE. The user is responsible for determining the BGA-PE content of algal suspensions by using standard cell counting techniques.

For option (b), we recommend using a 25 µg/L Rhodamine WT dye solution *(for detailed instructions, see section 5.11)*, and the solution is used in the calibration steps below.

µg/L – 1- or 2-point

This procedure will zero your fluorescence sensor and use the default sensitivity for calculation of phycoerythrin-containing BGA in µg/L, allowing quick and easy fluorescence measurements that are only semi-quantitative with regard to BGA-PE. However, the readings will reflect changes in BGA-PE from site to site, or over time at a single site.

Pour the correct amount of clear deionized or distilled water into the calibration cup. Immerse the probe end of the sonde in the water.

In the Calibrate menu, select BGA-PE/Chlor, then select BGA µg/L. Select either a 1- or 2-point calibration. When using Rhodamine WT enter 0 for the first standard value and 126 for the second standard value.

Click Start Calibration. Observe the readings under Current and Pending data points. While stabilizing, click the Wipe Sensors button to activate the wiper to remove any bubbles. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Next place the sensors in the Rhodamine WT standard. Click Proceed on the pop-up window. Observe the readings under Current and Pending data points. While stabilizing, click the Wipe Sensors button to activate the wiper to remove any bubbles. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.
Rinse the sonde in tap or purified water and dry the sonde.

RFU – 1- or 2-point

RFU is a percent full scale output; it outputs relative fluorescence from 0-100%. This calibration procedure is recommended if you are also using grab samples to post-calibrate *in vivo* algae readings.

Pour the correct amount of clear deionized or distilled water into the calibration cup. Immerse the probe end of the sonde in the water.

In the Calibrate menu, select BGA-PE/Chlor, then select BGA RFU. Select either a 1- or 2-point calibration. When using Rhodamine WT enter 0 for the first standard value and 45 for the second standard value.

Click Start Calibration. Observe the readings under Current and Pending data points. While stabilizing, click the Wipe Sensors button to activate the wiper to remove any bubbles. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Next place the sensors in the Rhodamine WT standard. Click Proceed on the pop-up window. Observe the readings under Current and Pending data points. While stabilizing, click the Wipe Sensors button to activate the wiper to remove any bubbles. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.

Rinse the sonde in tap or purified water and dry the sonde.

5.9 Calibration fDOM

Review the basic calibration description in section 5.1. Before calibrating, be certain that the sensing window is clean *(cleaning instructions, section 6.13)*.
This procedure calibrates fDOM RFU or fDOM QSU/ppb. If the user has both units selected, then this procedure must be performed twice, once for each unit, to completely calibrate the parameter.

For 2-point calibrations, the first standard must be clear water (0 µg/L). The second standard should be a 300 µg/L quinine sulfate solution. *(For detailed instructions for mixing this solution, see section 5.11.)*

⚠ Do not leave sensors in quinine sulfate solution for a long time. A chemical reaction occurs with the copper on the sonde (wiper assembly, sonde bulkhead, copper tape) that degrades the solution and causes it to drift. Also, start with very clean sensors, as the presence of chloride and halide ions (from estuarine or seawater, conductivity standards, and Zobell solution) can compromise QS fluorescence.

QSU – 1- or 2-point

Pour the correct amount of clear deionized or distilled water into the calibration cup. Immerse the probe end of the sonde in the water.

In the Calibrate menu, select fDOM, then select QSU/ppb. Select either a 1- or 2-point calibration. Enter 0 for first standard value and 300 µg/L for second standard value.

Click Start Calibration. Observe the readings under Current and Pending data points, and when they are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Remove the central wiper from the EXO2 sonde before proceeding to the next step.

Next place the sensors in the correct amount of 300 µg/L quinine sulfate standard in the calibration cup. Click Proceed on the pop-up window. Observe the readings under Current and Pending data points. While stabilizing, verify that no air bubbles reside on the sensing face of the sensor. If there are bubbles, gently shake or move the sensor to dislodge. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.

RFU – 1- or 2-point

Pour the correct amount of clear deionized or distilled water into the calibration cup. Immerse the probe end of the sonde in the water.

In the Calibrate menu, select fDOM, then select RFU. Select either a 1- or 2-point calibration. Enter 0 for first standard value and 100 RFU for second standard value.

Click Start Calibration. Observe the readings under Current and Pending data points, and when they are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Remove the central wiper from the EXO2 sonde before proceeding to the next step.

Next place the sensors in the correct amount of 300 µg/L quinine sulfate standard in the calibration cup. Click Proceed on the pop-up window. Observe the readings under Current and Pending data points. While stabilizing, verify that no air bubbles reside on the sensing face of the sensor. If there are bubbles, gently shake or move the sensor to dislodge. When data are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu. Rinse the sonde in tap or purified water and dry the sonde. Discard the used standard.

5.10 Calibration
ISEs: Ammonium, Nitrate, & Chloride

This procedure calibrates the EXO ammonium, chloride, or nitrate sensor. The sensors can be calibrated to one, two or three points. The 3-point calibration method assures maximum accuracy when the temperature of the media to be monitored cannot be anticipated; we strongly recommend a 3-point calibration for best performance of ISE sensors. *Review the basic calibration description in section 5.1.*

The temperature response of ion-selective electrodes is not as predictable as that of pH sensors. Therefore, be sure to carry out a 3-point calibration the first time you use the sensor. This will provide a default setting for the effect of temperature on your sensor. After this initial calibration, you can use the less time-consuming 2-point and 1-point routines to update the 3-point calibration. However, we strongly recommend a new 3-point calibration after each deployment of 30 days or longer.

Due to the nature of ion-selective electrodes, it is recommended that they be used for sampling purposes for the greatest accuracy. Using an ISE in long-term deployments is possible, but it's important to note that drift occurs over an extended period of time. Collecting grab samples from the site is encouraged to correct for drift. Additionally, sample readings should be taken after sensors have fully stabilized. Calibrating in a continuously stirred solution from 1 to 5 minutes has shown to improve sensor performance. For best performance sensors should be calibrated as close to the expected field conditions as possible.

For more ISE precautions, drift, and accuracy notes please see "ISE Precautions" at the end of this section.

1-point

Select the 1-point option only if you are adjusting a previous calibration. If a 2-point or 3-point calibration has been performed previously, you can adjust the calibration by carrying out a 1-point calibration.

2-point

Select the 2-point option to calibrate the ammonium sensor using only two calibration standard solutions. In this procedure, the ammonium sensor is calibrated using a 1 mg/L NH_4^+ -N and 100 mg/L NH_4^+ -N calibration standard solutions. A 2-point calibration procedure (as opposed to a 3-point procedure) can save time if the temperature range of the media being monitored is known and stable.

3-point

Select the 3-point option to calibrate the ammonium sensor using three calibration standard solutions, two at ambient temperature and one at a temperature substantially different from ambient. The 3-point calibration method should be used to assure maximum accuracy when the temperature of the media to be monitored cannot be anticipated. 3-point calibration temperatures should span the range of interest, for example 20°C and 2°C for "cold" and 20°C and 30°C for "hot". The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to place the sensor in the additional calibration standard solution to complete the 3-point procedure. Be certain that the calibration standard solution and sensor are thermally equilibrated prior to proceeding with the calibration. The recommended order of calibration standards is (1) 1 mg/L NH_4^+ -N standard at ambient temperature, (2) 100 mg/L NH_4^+ -N standard at ambient temperature, and (3) 1 mg/L NH_4^+ -N standard at a different temperature (usually lower) than ambient, ±10°C minimum.

- To save time during calibration, chill/heat a sufficient amount of 1 mg/L NH_4^+ -N calibration standard solution prior to the start of calibration.

Ammonium 3-point

⚠ Do not expose electrodes to high-conductivity solutions. Exposure will reduce data quality and response of the sensors. During calibration of other sensors, remove the ISEs to avoid exposing them to conductivity standards, Zobell solution, pH buffer, or any solution with significant conductivity.

In the Calibrate menu, select ISE, then select ammonium.

Click 3-point for the Calibration Points. Enter 1 mg/L as the value of the first standard, 100 mg/L as the value of the second standard, and 1 mg/L as the value of the third standard.

Click Start Calibration.

Pour a sufficient amount of 1 mg/L NH_4^+ -N calibration standard solution at ambient temperature in a clean and dry or pre-rinsed calibration cup. Carefully immerse the sensor end of the sonde into the solution, making sure the sensor's tip is in solution by at least 1 cm. Allow at least 1 minute for temperature equilibration before proceeding.

Observe the readings under Current and Pending data points and when they are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point. Confirm that the Pending data value is close to the Setpoint value. Click Proceed and wait for the software to prompt you to move the sensor to the next calibration standard solution.

Rinse the sensors in deionized water between changes of the calibration solutions. Pour a sufficient amount of 100 mg/L of NH_4^+ -N calibration standard solution at ambient temperature into a clean, dry or pre-rinsed calibration cup and carefully immerse the sensor end of the sonde into the solution. Allow at least 1 minute for temperature equilibration before proceeding.

Observe the readings under Current and Pending data points and when they are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point. Confirm that the Pending data value is close to the Setpoint value. Click Proceed and wait for the software to prompt you to move the sensor to the next calibration standard solution.

Rinse the sensors in deionized water between changes of the calibration solutions. Immerse the sensor end of the sonde in the pre-chilled 1 mg/L NH_4^+ -N calibration standard solution ensuring that the temperature is at least 10°C different than ambient. Allow at least 1 minute for temperature equilibration before proceeding.

Observe the readings under Current and Pending data points and when they are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point. Confirm that the Pending data value is close to the Setpoint value.

Click Complete. View the Calibration Summary screen and QC score. Click Exit to return to the sensor calibration menu

Rinse the sonde in tap or purified water.

Nitrate 3-point

The calibration procedure for nitrate is identical to the procedure for ammonium, except that the calibration standard solution values are in mg/L NO_3^- -N instead of NH4+ -N.

Chloride 3-point

The calibration procedure for chloride is identical to the procedure for ammonium and nitrate, except that the calibration standard solution values are in mg/L Cl^- instead of NH_4^+ -N or NO_3^- -N. YSI recommends that the user employ standards for chloride that are 10 times greater than for ammonium and nitrate and that span the expected deployment conditions. Typical calibration ranges are 10mg/L Cl^- and 1000mg/L Cl^- or 1000mg/L Cl^- and 18000mg/L Cl^-.

⚠ ISE Precautions

- Ion-selective electrodes may not stabilize as rapidly as pH sensors. Be sure to allow plenty of time for the readings to come to their final values during all calibration routines.

- Ion-selective electrodes generally drift more than pH sensors. To check for this drift, read the sensor's value in a calibration standard solution at the end of each deployment.

- Ammonium and nitrate standards are good growth media for a variety of organisms. This growth can significantly reduce the nitrogen content of your standards, an effect that is particularly important for the 1 mg/L solution. It is best to use new standards for each deployment, but if you decide to save your solutions for reuse, we recommend refrigerated storage to minimize the growth of these organisms.

- Remember that the ammonium, nitrate, and chloride sensors will take longer to stabilize after exposure to high conductivity solutions such as a pH calibration. To accelerate the recovery process, soak the sensor in 100 mg/L (ammonium or nitrate standard solution) or 1000mg/L Cl- standard solution for a few minutes after exposure. In addition, be particularly careful that readings are stable during subsequent calibrations.

Sensor Drift

The ion-selective electrodes have the greatest tendency to exhibit calibration drift over time. This drift should not be a major issue for sampling studies where the instrument can be frequently calibrated. However, if the sensor is used in longer-term deployments, drift is almost certain to occur. The extent of the drift will vary depending on the age of the probe, the flow rate at the site, and the quality of the water. For all monitoring studies using ion-selective electrodes, the user should acquire a few grab samples during the deployment for analysis in the laboratory or with another sensor that has been recently calibrated.

Sensor Accuracy Specifications

The typical accuracy specification for the sensors (+/-10% of reading or 2mg/L which ever is greater for ammonium and nitrate and ±15% of reading or 5mg/L which ever is greater for chloride) refer to sampling applications where only minimal time has elapsed between calibration and field use.

To maintain accuracy specifications for EXO sensor, we recommend that users calibrate sensors in the lab in standards with temperatures as close to the ambient temperature of the field water as possible.

All ion-selective electrodes are subject to the interaction of species with the sensor membrane, which are similar in nature to the analyte. These interfering species thus include other halide ions (fluoride, bromide, and iodide) as well as other anions.

Despite the potential problems with interference when using ISEs, it is important to remember that almost all-interfering species produce an artificially high reading. Thus, if the sensor indicates the presence of only small quantities, it is unlikely that the reading is erroneously low because of interference. Unusually high readings (which could be due to interfering ions) should be confirmed by laboratory analysis after collection of water samples.

5.11 Calibration
Calibration Standards

Quinine Sulfate Solution for fDOM Sensor

⚠ Before using a quinine sulfate reagent (solid or solution) or sulfuric acid reagent, read the safety instructions provided by the supplier. Take extra precautions when making dilutions of concentrated sulfuric acid, as this reagent is particularly dangerous. Remember that only trained personnel should handle chemicals.

Preparation

Use the following procedure to prepare a 300 µg/L solution of quinine sulfate (300 QSU) that can be used to calibrate the EXO fDOM sensor for field use:

1. Purchase solid quinine sulfate dihydrate with a high purity (>99%). (Recommended supplier: Fisher Scientific item #6119-70-6.) Purchase 0.1 N (0.05 M) sulfuric acid, to avoid the hazards of diluting concentrated sulfuric acid to make this reagent. (Recommended supplier: Fisher Scientific item # AA35651K7.)
2. Weigh 0.100 g of solid quinine sulfate dihydrate and quantitatively transfer the solid to a 100-mL volumetric flask. Dissolve the solid in about 50 mL of 0.05 M (0.1 N) sulfuric acid (H_2SO_4), dilute the solution to the mark of the volumetric flask with additional 0.05 M sulfuric acid, and mix well by repeated inversion. This solution is 1000 ppm in quinine sulfate (0.1%).
3. Transfer 0.3 mL of the 1000 ppm solution to a 1000 mL volumetric and then fill the flask to the top graduation with 0.05 M sulfuric acid. Mix well to obtain a solution of 300 µg/L (300 QSU or 100 RFU).
4. Store the concentrated standard solution in a darkened glass bottle in a refrigerator to retard decomposition. The dilute standard prepared in the previous step should be used within 5 days of preparation and should be discarded immediately after exposure to EXO's metal components.

Degradation of quinine fluorescence by copper and chloride

⚠ Exposure of the quinine sulfate solution to any copper-based component of the EXO sonde and sensors (primarily the wiper assembly) will begin to degrade the solution significantly within minutes. Quinine fluorescence is also degraded by the presence of chloride or halide ions, found in estuarine or seawater, conductivity standards, and Zobell solution. Thus, clean your sensors thoroughly and perform your calibration as quickly as possible on immersion of the sensors into the quinine sulfate solution. Discard the used standard. When quinine sulfate standards are required in the future, perform another dilution of the concentrated solution.

Effect of temperature on fluorescence

The intensity of the fluorescence of many dyes shows an inverse relationship with temperature. This effect must be accounted for when calibrating the EXO fDOM sensor with Quinine Sulfate Solution. Enter the QSU or RFU value from the table below that corresponds to the temperature of the standard.

Temp (˚C)	RFU	QSU	Temp (˚C)	RFU	QSU
30	96.4	289.2	18	101.8	305.4
28	97.3	291.9	16	102.7	308.1
26	98.2	294.6	14	103.6	310.8
24	99.1	297.3	12	104.6	313.8
22	100	300	10	105.5	316.5
20	100.9	302.7	8	106.4	319.2

Rhodamine WT Dye Solution for Total Algae Sensor

⚠ Read and follow all the safety instructions and MSDS documentation supplied with the dye before proceeding. Remember that only trained personnel should handle chemicals.

Preparation

Use the following procedure to prepare a Rhodamine WT solution for use as a sensor stability check reagent for the EXO Total Algae (Chlorophyll and Blue-green Algae) sensor:

1. Purchase Rhodamine WT dye in solution form, which can vary somewhat in nominal concentration. Recommended supplier for a solution that is approximately 2.5% in Rhodamine WT:
   Fluorescent FWT Red Dye (item #106023)
   Kingscote Chemicals
   3334 South Tech Blvd., Miamisburg, OH 45342 USA
   1-800-394-0678
2. Accurately transfer 5.0 mL of the Rhodamine WT solution into a 1000 mL volumetric flask. Fill the flask to the volumetric mark with deionized or distilled water and mix well to produce a solution that is approximately 125 mg/L of Rhodamine WT. Transfer this standard to a glass bottle and retain it for future use.
3. Accurately transfer 5.0 mL of the solution prepared in the above step to a 1000 mL volumetric flask and then fill the flask to the volumetric mark with deionized or distilled water. Mix well to obtain a solution, which is 0.625 mg/L in water (a 200:1 dilution of the concentrated solution).
4. For BGA-PE calibration, accurately transfer 0.2 mL of the 125 mg/L solution prepared in step 2 to a 1000 mL volumetric flask and then fill the flask to the volumetric mark with deionized or distilled water. Mix well to obtain a solution that is 25 µg/L or 0.025 mg/L of Rhodamine WT.
5. Store the concentrated standard solution in a glass bottle in a refrigerator to retard decomposition. The dilute standard prepared in the previous step should be used within 24 hours of its preparation.

Discard the used standard. When Rhodamine standards are required in the future, perform another dilution of the concentrated Rhodamine WT solution after warming it to ambient temperature.

Effect of temperature on fluorescence

The intensity of the fluorescence of many dyes shows an inverse relationship with temperature. This effect must be accounted for when calibrating the EXO Total-Algae sensor with Rhodamine WT. Enter the µg/L or RFU value from the table below that corresponds to the temperature of the standard.

Temp (°C)	RFU Chl	µg/L Chl	RFU BGA-PC	µg/L BGA-PC	RFU BGA-PE	µg/L BGA-PE
30	14.0	56.5	11.4	11.4	37.3	104.0
28	14.6	58.7	13.1	13.1	39.1	109.0
26	15.2	61.3	14.1	14.1	41.0	115.0
24	15.8	63.5	15.0	15.0	43.0	120.0
22	16.4	66	16.0	16.0	45.0	126.0
20	17.0	68.4	17.1	17.1	47.0	132.0
18	17.6	70.8	17.5	17.5	49.2	138.0
16	18.3	73.5	19.1	19.1	51.4	144.0
14	18.9	76	20.1	20.1	53.6	150.0
12	19.5	78.6	21.2	21.2	55.9	157.0
10	20.2	81.2	22.2	22.2	58.2	163.0
8	20.8	83.8	22.6	22.6	60.6	170.0

Chloride Standard for Chloride Sensor

⚠ Read and follow all the safety instructions and MSDS documentation supplied with the chemical before proceeding. Remember that only trained personnel should handle hazardous chemicals.

Preparation

Use the following procedure to prepare 10 and 1000 mg/L chloride reagents for the EXO Chloride sensor. (Nitrate and Ammonium standards can be purchased from YSI or other laboratory supply companies.)

1000 mg/L Standard

1. Purchase solid sodium chloride from a supplier.
2. Accurately weigh 1.655 grams of anhydrous sodium chloride and transfer into a 1000 mL volumetric flask.
3. Add 0.5 grams of anhydrous magnesium sulfate to the flask.
4. Add 500 mL of water to the flask, swirl to dissolve all of the reagents. Dilute to the volumetric mark with water. Mix well by repeated inversion and then transfer the 1000 mg/L standard to a storage bottle.
5. Rinse the flask extensively with water prior to its use in the preparation of the 10 mg/L standard.

Alternatively, simply add 0.5 grams of magnesium sulfate to a liter of a 1000 mg/L chloride standard from a certified supplier.

10 mg/L Standard

1. Accurately measure 10 mL of the above 1000 mg/L standard solution into a 1000 mL volumetric flask.
2. Add 0.5 grams of anhydrous magnesium sulfate to the flask.
3. Add 500 mL of water, swirl to dissolve the solid reagents, and then dilute to the volumetric mark with water. Mix well by repeated inversion and then transfer the 10 mg/L standard to a storage bottle.

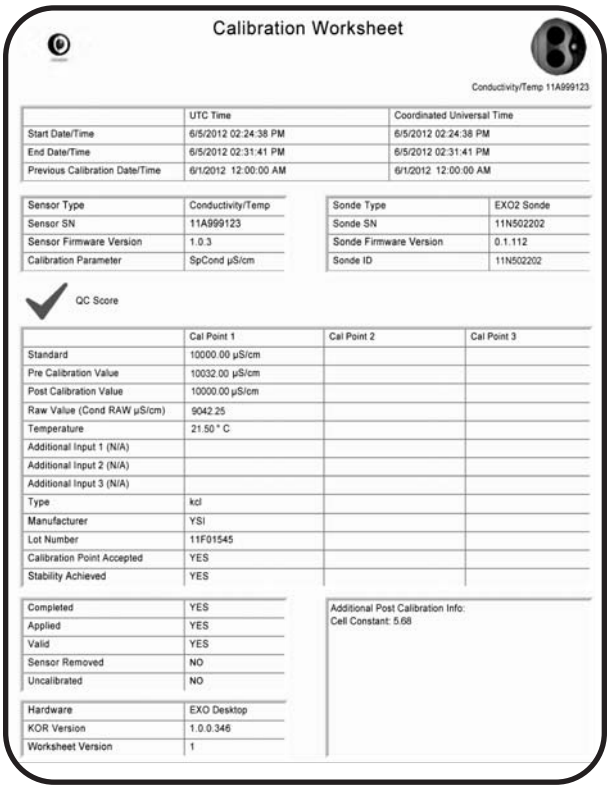
5.12 Calibration
Calibration Worksheet

The Calibration Worksheet is a record of the calibration for an EXO sensor. The worksheet contains quality assurance information including date and time of calibration, date of previous calibration, sensor firmware version, type of calibration performed, standard used, and QC score.

Calibration Worksheets are saved in the Calibration Files folder on the computer (not on the sonde). All saved Worksheets can be accessed and viewed through the Data menu in KOR software.

Sample Worksheets:

1-point calibration of specific conductance on EXO conductivity/temperature probe



Calibration Worksheet

Conductivity/Temp 11A999123

	UTC Time	Coordinated Universal Time
Start Date/Time	6/5/2012 02:24:38 PM	6/5/2012 02:24:38 PM
End Date/Time	6/5/2012 02:31:41 PM	6/5/2012 02:31:41 PM
Previous Calibration Date/Time	6/1/2012 12:00:00 AM	6/1/2012 12:00:00 AM

Sensor Type	Conductivity/Temp	Sonde Type	EXO2 Sonde
Sensor SN	11A999123	Sonde SN	11N502202
Sensor Firmware Version	1.0.3	Sonde Firmware Version	0.1.112
Calibration Parameter	SpCond µS/cm	Sonde ID	11N502202

QC Score

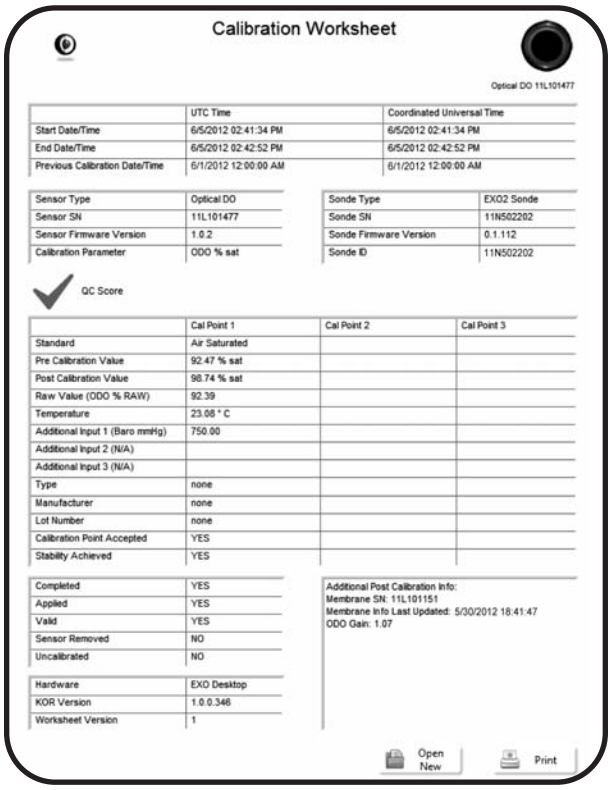
	Cal Point 1	Cal Point 2	Cal Point 3
Standard	10000.00 µS/cm		
Pre Calibration Value	10032.00 µS/cm		
Post Calibration Value	10000.00 µS/cm		
Raw Value (Cond RAW µS/cm)	9042.25		
Temperature	21.50 ° C		
Additional Input 1 (N/A)			
Additional Input 2 (N/A)			
Additional Input 3 (N/A)			
Type	kcl		
Manufacturer	YSI		
Lot Number	11F01545		
Calibration Point Accepted	YES		
Stability Achieved	YES		

Completed	YES
Applied	YES
Valid	YES
Sensor Removed	NO
Uncalibrated	NO

Additional Post Calibration Info:
Cell Constant: 5.68

Hardware	EXO Desktop
KOR Version	1.0.0.346
Worksheet Version	1

1-point calibration of percent saturation on EXO optical dissolved oxygen probe



Calibration Worksheet

Optical DO 11L101477

	UTC Time	Coordinated Universal Time
Start Date/Time	6/5/2012 02:41:34 PM	6/5/2012 02:41:34 PM
End Date/Time	6/5/2012 02:42:52 PM	6/5/2012 02:42:52 PM
Previous Calibration Date/Time	6/1/2012 12:00:00 AM	6/1/2012 12:00:00 AM

Sensor Type	Optical DO	Sonde Type	EXO2 Sonde
Sensor SN	11L101477	Sonde SN	11N502202
Sensor Firmware Version	1.0.2	Sonde Firmware Version	0.1.112
Calibration Parameter	ODO % sat	Sonde ID	11N502202

QC Score

	Cal Point 1	Cal Point 2	Cal Point 3
Standard	Air Saturated		
Pre Calibration Value	92.47 % sat		
Post Calibration Value	98.74 % sat		
Raw Value (ODO % RAW)	92.39		
Temperature	23.08 ° C		
Additional Input 1 (Baro mmHg)	750.00		
Additional Input 2 (N/A)			
Additional Input 3 (N/A)			
Type	none		
Manufacturer	none		
Lot Number	none		
Calibration Point Accepted	YES		
Stability Achieved	YES		

Completed	YES
Applied	YES
Valid	YES
Sensor Removed	NO
Uncalibrated	NO

Additional Post Calibration Info:
Membrane SN: 11L101151
Membrane Info Last Updated: 5/30/2012 18:41:47
ODO Gain: 1.07

Hardware	EXO Desktop
KOR Version	1.0.0.346
Worksheet Version	1

Open New

Print

Additional Post-Calibration Info

ODO Gain: The ODO gain is a diagnostic value recorded on the Calibration Worksheet and used for advanced diagnostic purposes. The nominal value is 1, and accurate calibrations of the DO sensor will only slightly deviate from this number.

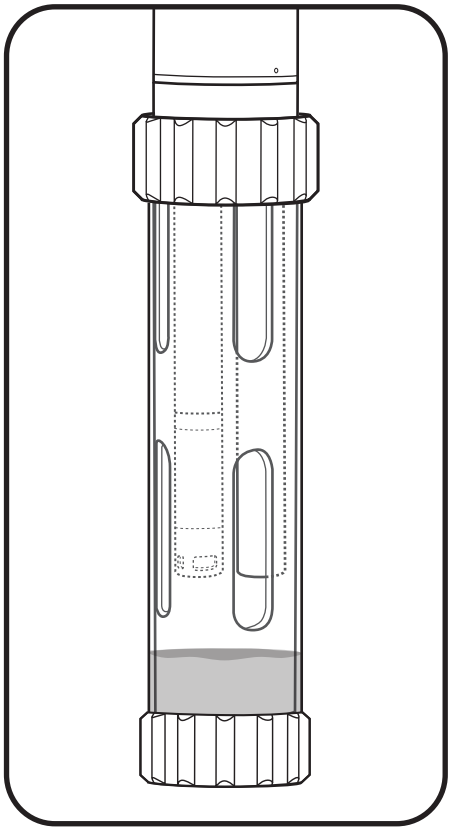
Cell Constant: The cell constant is the current value of the conductivity and is a function of the factory original cell constant and the most recent user calibration. The cell constant will drift over time based on the sensor's electrodes, and the cell constant can be used to track drift.

Slope: The slope for the pH sensor is the mV per decade (pH unit) where 59 is the typical value. Slope allows the user to track drift away from 59 to determine the life/aging of the sensor module.

Change mV: The change millivolts is the delta mV change between either 4 and 7 or 7 and 10 calibration values for the pH sensor. It is the mV deviation away from the middle calibration point number.

6.1 Sonde Storage

Proper sonde storage helps to ensure proper sonde operation. To keep sondes in their best working order, users must follow these instructions. This section will identify storage as "long-term" or "short-term."Long-term denotes storage during times of long inactivity (over winter, end of monitoring season, etc.). Short-term denotes storage during times the sonde will be used at a regular interval (daily, weekly, biweekly, etc.).



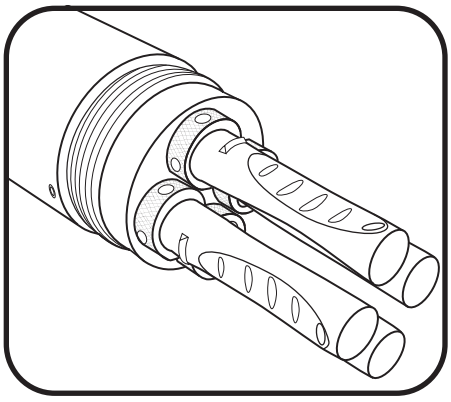
1 Short-term storage

For interim storage, users should keep sensors moist, but not submerged; submersion during storage may produce sensor drift. Users should aim for a storage environment of water-saturated air (100% humidity) for the sensors.

Place approximately 0.5 in (1 cm) of water (deionized, distilled, tap, or environmental) in the bottom of the calibration cup. Then place the sonde with all of its sensors into the cup and close it tightly to prevent evaporation. Users can also use a moist sponge to create a humid environment.

Ensure that unused sensor ports are properly protected with port plugs. The sonde itself should be stored in dry air.

To protect the cable connector, either leave the cable installed on the connector, or install the port plug. This is especially important for sondes with level; users should always keep the cable connector of vented sondes dry. (*See section 7.5)*



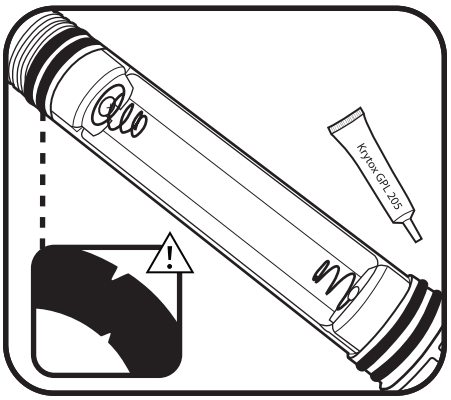
2 Long-term storage

Store all removed sensors according to the specific instructions in their sensor storage section. Plug all open ports, and store the sonde according the above instructions for short-term sonde storage.

⚠ Always remove batteries from sondes during long periods of inactivity to prevent potentially harmful battery leaks.

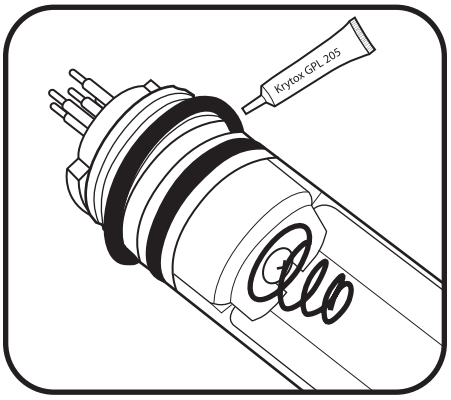
6.2 Sonde Maintenance

Like all precision equipment, EXO sondes work most reliably when users maintain them properly. A proper inspection and cleaning can prevent several issues, including leaks. When performing general maintenance on the sonde, also check this manual's depth and connector sections. Use only the recommended materials to service instruments. Each sonde comes with a maintenance kit, including proper lubricants and replacement o-rings. Users can order replacement o-ring kits (#599680 or #599681) or tool kit (#599594) from the manufacturer or an authorized distributor.



1 Inspect and service o-rings

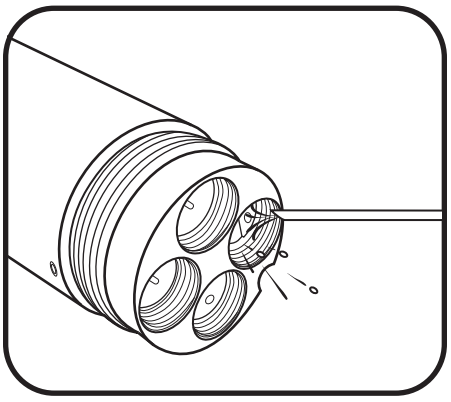
User-serviceable o-rings are located in the EXO sonde battery compartments. Perform a thorough visual inspection of o-rings each time they are exposed. Carefully look for grit, hair, etc. on the o-ring and mating surfaces and wipe away any contamination with a lint-free cloth. Without removing them from their grooves, *lightly* grease each o-ring with Krytox. Replace any damaged o-rings.



2 Replace o-rings.

If the above inspection reveals a damaged (split, cracked, or misshapen) o-ring, remove it. Wipe the groove clean with alcohol and a lint-free cloth. Grease the o-ring by drawing it between your *lightly* greased thumb and index fingers. Place the o-ring in its groove, being careful to not roll or twist it, and lightly grease the surface. Inspect the o-ring for contamination.

⚠ Do not apply excess grease to the o-rings. This can cause contamination and seal failure.



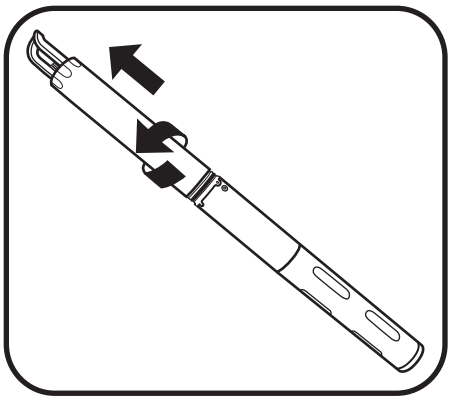
3 Inspect, clean, and grease ports.

Visually inspect each port for contamination (grit, hair, etc.). Should the user detect contamination, remove it with a blast of compressed air. When the port's rubber appears dry, lightly grease the sensor connector before insertion.

⚠ Never insert solid objects into the sonde ports. This could permanently damage the connectors.

6.3 Sonde
Install or Replace EXO1 Batteries

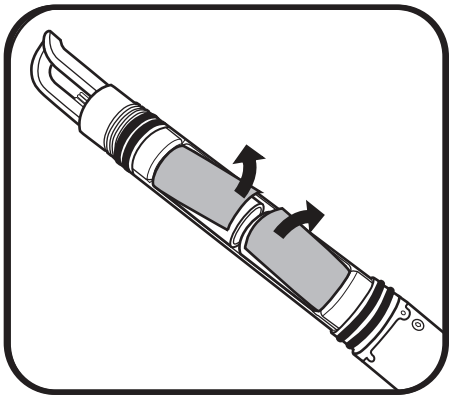
EXO1 water quality sondes use two (2) D-cell batteries as a power source. Using alkaline batteries, users can expect approximately 90 days of deployment from a fully loaded sonde that samples once every 15 minutes. However, deployment times may vary greatly depending on water temperature, sampling rate, sensor payload, and brand of battery. *See battery life specification, next page.* Do not use Ni-Cad rechargeable batteries in the EXO1 sonde.



1 Remove battery cover.

Start with a clean and dry sonde. Hold the sonde horizontally with the bail up and twist the battery cover counterclockwise until free. If necessary, slide the sonde tool's larger opening over the end of the battery compartment and use it as a lever to break the compartment free. Then slide off the battery cover.

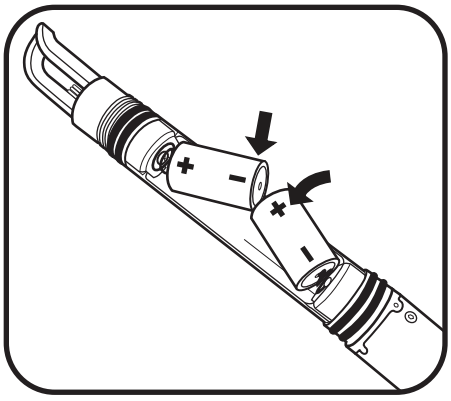
⚠ Do not remove the screws on the sonde.
Do not clamp the sonde in a vise.



2 Remove old batteries.

Expose the batteries by flipping the isolation flap up away from the batteries, and pull the batteries free of their compartment. Always dispose of used alkaline batteries according to local requirements and regulations.

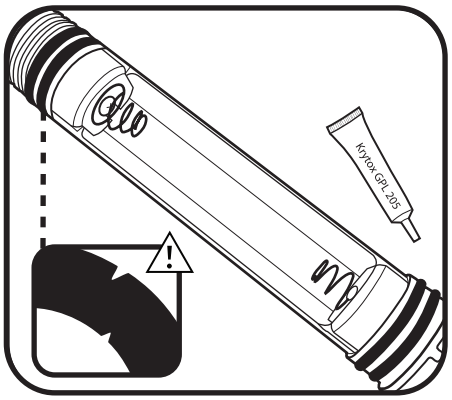
Clean the inside of the battery compartment with a lint-free cloth.



3 Install new batteries.

Install the new batteries so that the positive terminals point towards the bail (away from the sensor bulkhead). Replace the isolation flap over the batteries.

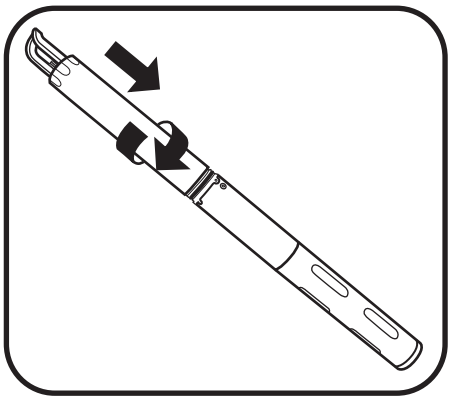
⚠ Do not use 3.6V Li batteries in the sondes.
Damage to the circuit board is not covered under warranty.



4 Check and service o-rings.

⚠ *Before replacing the battery cover, check and service the four o-rings.*

Ensure that the o-rings are not nicked or torn and that they have no contaminants or particles on them or the sealing surfaces inside the battery cover. Clean the o-rings with a lint-free cloth. Then apply a thin coat of Krytox® lubricant to each o-ring.



5 Replace battery cover.

Twist the battery cover clockwise until it stops at the rubber gasket. The gasket does not provide a seal and does not need to be compressed. Do not overtighten; overtightening will not create a strong seal and may damage the sonde.

The EXO1 sonde has a resealing battery relief valve; no maintenance is required.

If a battery failure occurs that results in battery acid leakage into the battery compartment, the sonde must be returned to a service center for evaluation. Some battery acid will damage the plastic in the battery compartment.

Battery life specification

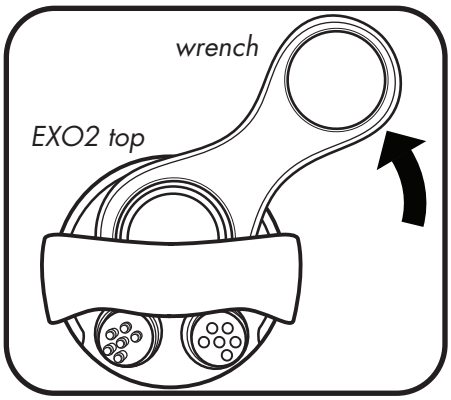
When using alkaline batteries: Approximately 90 days at 20˚C at a 15-minute logging interval, and temperature/conductivity, pH/ORP, Optical DO, and turbidity installed. Battery life is heavily dependent on sensor configuration and is given for a typical sensor ensemble.

Battery life is reduced in cold-water applications.

When using rechargeable nickel metal hydride (NiMH) batteries: Estimated battery life is not available because NiMH batteries vary greatly in manufacturer capacity and discharge curves. We recommend a NiMH D-cell battery with a minimum rating of 10,000 milliamp hours that are fully charged each time they are used.

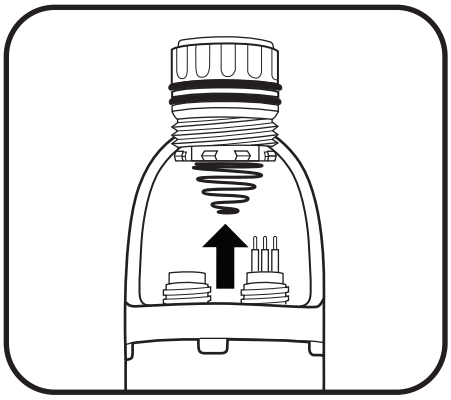
6.4 Sonde
Install or Replace EXO2 Batteries

EXO2 water quality sondes use four (4) D-cell batteries as a power source. Using alkaline batteries, users can expect approximately 90 days of deployment from a fully loaded sonde that samples once every 15 minutes. However, deployment times may vary greatly depending on water temperature, sampling rate, sensor payload, wiper frequency, and brand of battery. *See battery life specification, next page. Do not* use Ni-Cad rechargeable batteries in the EXO2 sonde.



1 Loosen battery cap.

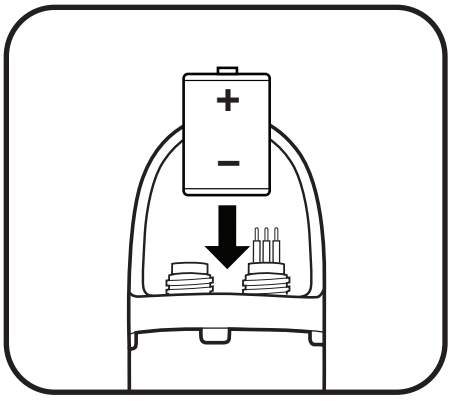
Start with a clean and dry sonde. Slide the sonde tool's smaller opening over the battery cap on top of the EXO2. Using the tool as a lever, firmly turn the tool counterclockwise until the battery cap is loose.



2 Remove battery cap and old batteries.

Once the cap is sufficiently loose, remove the cap and old batteries from the well. Always dispose of used alkaline batteries according to local requirements and regulations.

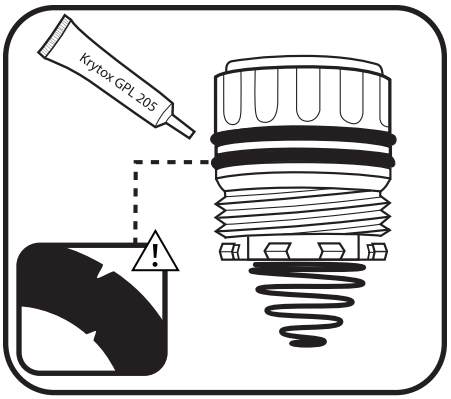
Clean the o-ring sealing surfaces with a lint-free cloth. Inspect down into the battery tube to make sure it is clean and dry.



3 Insert new batteries.

⚠ Do not use 3.6V Li batteries in the sondes.
Damage to the circuit board is not covered under warranty.

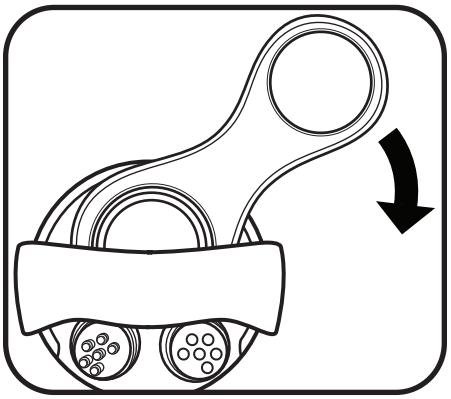
With the positive terminal facing up, insert four (4) new D-cell batteries into the battery well.



4 Check and service o-rings.

⚠ *Before replacing the battery cover, inspect and service the four o-rings.*

Ensure that the o-rings are not nicked or torn and that they have no contaminants or particles on them or the sealing surfaces inside the battery cover. Then apply a thin coat of Krytox® lubricant to each o-ring and sealing surface.



5 Replace battery cap.

After servicing the cap's o-rings, insert the cap in its recess. Then, using your thumb, press down on the pressure relief valve while turning the cap clockwise. Once the cap threads are engaged, use the tool to tighten until snug. Do not overtighten; overtightening will not create a strong seal and may damage the sonde. When completed, the top o-ring of the cap must be below the battery compartment opening.

If a battery failure occurs that results in battery acid leakage into the battery compartment, the sonde must be returned to a service center for evaluation. Some battery acid will damage the plastic in the battery compartment.

Pressure in Battery Compartment

The EXO2 sonde is equipped with a pressure relief valve to protect against catastrophic battery failure. If the valve is open (indicating an over-pressure situation), the battery cap must be replaced. Significant water leakage into battery compartment requires that your instrument be evaluated by the manufacturer or Authorized Service Center before the next deployment.

Battery Life Specification

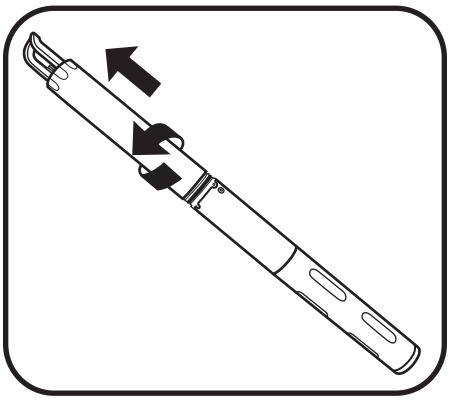
When using alkaline batteries: Approximately 90 days at 20˚C at a 15-minute logging interval, and temperature/conductivity, pH/ORP, Optical DO, turbidity, and Total Algae-PC installed along with a central wiper which rotates once every logging interval. Battery life is heavily dependent on sensor configuration and is given for a typical sensor ensemble.

Battery life is reduced in cold-water applications.

When using rechargeable nickel metal hydride (NiMH) batteries: Estimated battery life is not available because NiMH batteries vary greatly in manufacturer capacity and discharge curves. We recommend a NiMH D-cell battery with a minimum rating of 10,000 milliamp hours that are fully charged each time they are used.

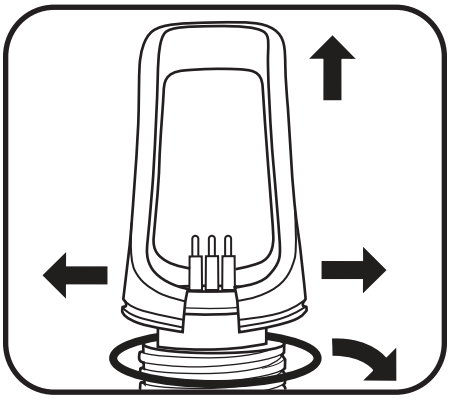
6.5 Sonde
Replace EXO1 Bail

Sonde bails provide users with a handle for convenient transport and an attachment point for cable strain reliefs. If an EXO1 bail breaks due to impact or standard wear and tear throughout the life of the sonde, a user can easily replace it. We also recommend attaching the cable's strain relief mechanism to the bail.



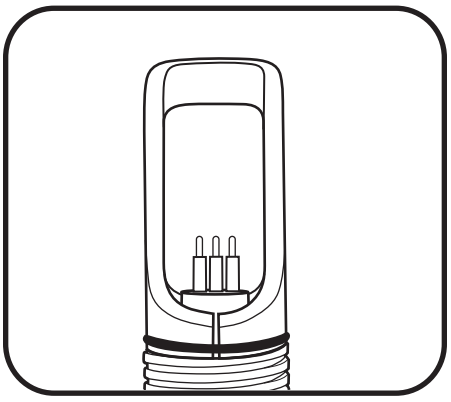
1 Remove battery cover.

Twist the battery cover counterclockwise until free. Then slide off the battery cover.



2 Remove bail.

Spread the sides of the bail away from the connector, pull the bail over the posts on top of the sonde, and remove the o-ring from its groove and discard.

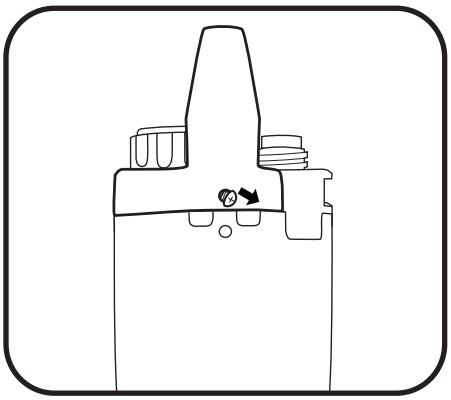


3 Install new bail.

Install a new o-ring in the groove at the base of the bail. Then carefully spread the bail open and seat its sockets over the posts around the connector.

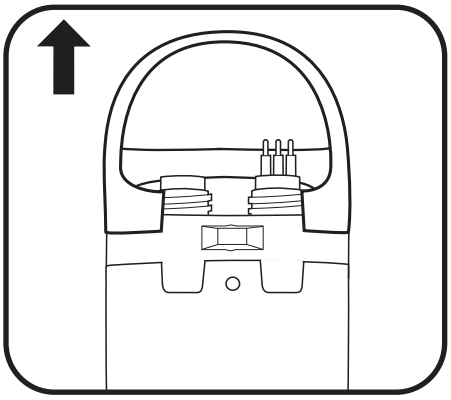
6.6 Sonde
Replace EXO2 Bail

Sonde bails provide users with a handle for convenient transport and an attachment point for cable strain reliefs. If an EXO2 bail breaks due to impact or standard wear and tear throughout the life of the sonde, a user can easily replace it. We also recommend attaching the cable's strain relief mechanism to the bail.

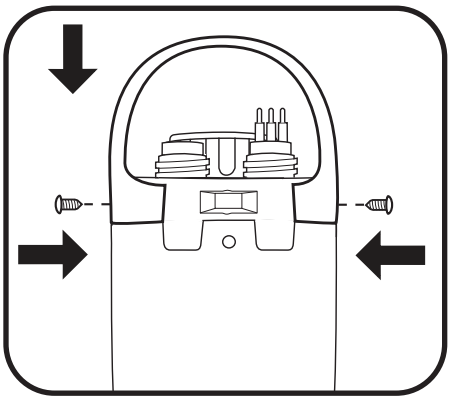


1 Remove bail.

Use a small screwdriver to remove two screws on the sides of the bail.



Once screws are removed, lift the bail off the sonde.



2 Install new bail.

Place the new bail onto the sonde, aligning holes for the screws. With one side of the bail aligned, push on the other side to snap it into place. Use a small screwdriver to insert two screws on the sides of the bail. Tighten until snug.

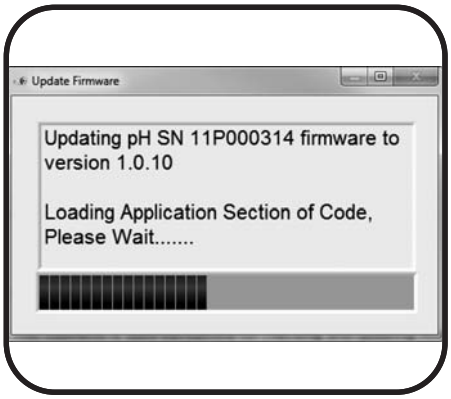
6.7 Sonde Update Firmware & KOR Software

Users can check for and download new versions of KOR software through the **EXOwater.com** website. Click on Support and then the Software tab for the latest information and complete installation instructions.

Users can check and update sensor or sonde firmware through the KOR interface software. Each device must be connected to the computer that is running the Desktop version of KOR, and the computer must have internet access. This process may take up to 30 minutes depending on the number of sensors updated.

1 Open firmware submenu in KOR.

Navigate to the Options menu in KOR, then to the Firmware submenu. Immediately after clicking the Firmware submenu button, KOR begins to search for connected sondes and sensors and loads the table with names, serial numbers, and current firmware versions.



2 Select device and update.

To update a device, click on the device's name in the table and then click the Update Selected button. KOR then updates the device's firmware, which could take several minutes.

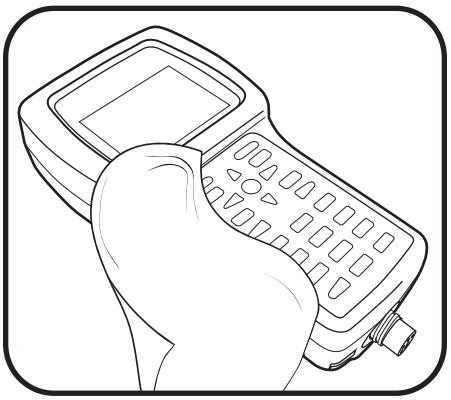
To update all connected devices (i.e., attached sonde and senors), click the Update Network button.

NOTE: For best power management, update firmware while a device is connected via USB, as this will provide power to the device. However, if you use Bluetooth, we recommend installing fully charged batteries in the sonde.

See section 6.11 for instructions on how to update sonde and sensor firmware using the EXO Handheld when the sonde is in the field.

6.8 Handheld Maintenance and Storage

EXO Handhelds (HH) are rugged field instruments that are tested to a rating of IP-67 in the factory. Follow the instructions below for the most reliable performance from the HH. This section will identify storage as "long-term" or "short-term." Long-term denotes storage during times of long inactivity (over winter, end of monitoring season, etc.). Short-term denotes storage during times the sonde will be used at a regular interval (daily, weekly, biweekly, etc.).

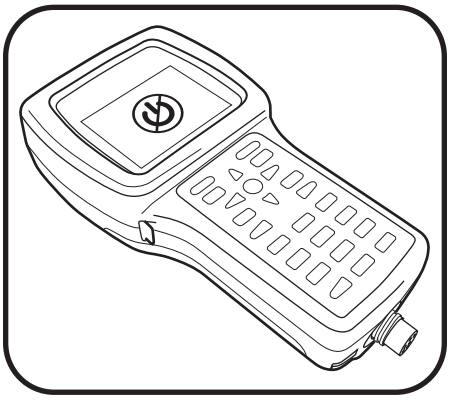


1 Clean handheld.

If the HH's USB connector is contaminated, rinse it with clean water and dry it.

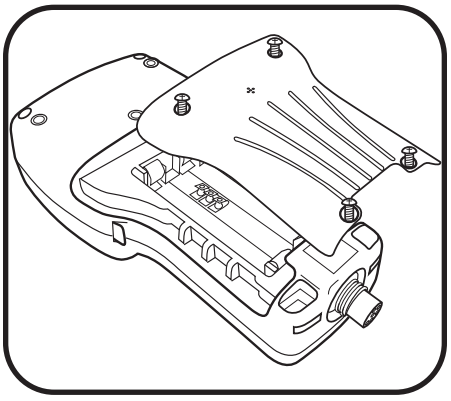
To clean the HH's cable connector, follow directions in section 6.24 for Connector Maintenance.

Wipe clean the HH's keypad, lens, and polymer case with a cloth soaked in clean water and a few drops of a dishwashing liquid that contains a degreaser. Take care not to scratch the lens.



2 Short-term storage.

Keep the HH in a safe storage location and power it down by pressing and holding the power button for more than three seconds. Pressing the power button for less than three seconds does not entirely power down the instrument (Sleep mode) and may cause unnecessary battery drain.



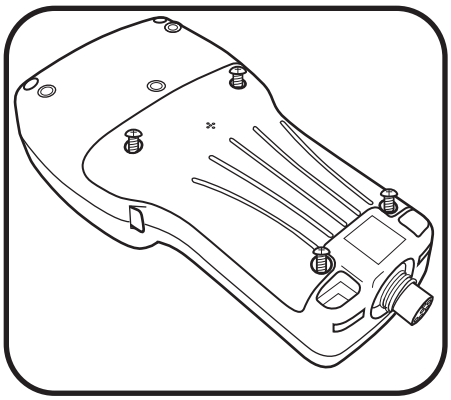
3 Long-term storage.

Keep the HH in a safe location and remove the batteries (and reinstall the battery compartment panel) to prevent potentially harmful battery leaks.

NOTE: If the HH is stored for more than several days without batteries, the GPS will take longer to obtain a location fix.

6.9 Handheld
Install or Replace Batteries

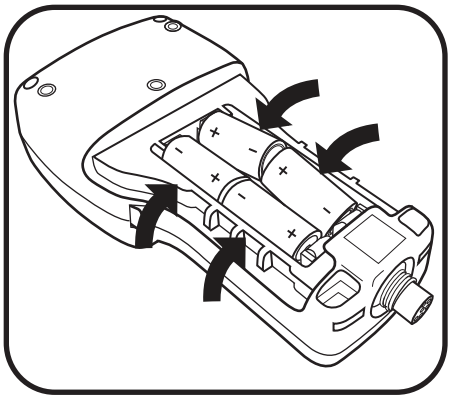
The EXO Handheld (HHs) uses four (4) C-cell alkaline batteries as a power source. Alternatively, a rechargeable Li-Ion battery pack is an available option (*see section 3.2*). Users can extend battery life by putting the HH in "Sleep" mode, when convenient, by pressing and holding the power button for less than three seconds. 1.5V Rechargeable Nickel Metal Hydride (NiMH) batteries can also be used. Battery life varies depending on GPS and Bluetooth wireless use. We recommend battery capacity of at least 5000 milliamp hours. *Do not* use Ni-Cad rechargeable batteries in the Handheld.



1 Remove battery cover panel.

The battery cover panel is located on the back of the HH. To remove the panel, unscrew (counter-clockwise) the four screws with a flat or Phillips head screwdriver.

NOTE: The retaining screws are captured into this panel and are not independently removable. If replacement is necessary, replace the entire assembly.



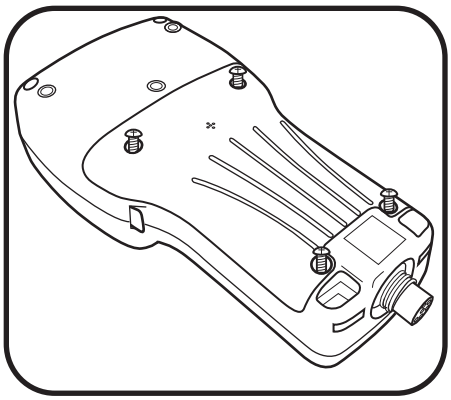
2 Insert/replace batteries.

⚠ Do not use 3.6V Li batteries in the handheld. Damage to the circuit board is not covered under warranty.

Remove the old batteries and dispose of them according to local ordinances and regulations. Install the new batteries between the battery clips with their polarity (+/-) oriented as shown on the bottom of the battery compartment.

If you use your own rechargeable batteries, they cannot be charged inside the handheld; they should be charged outside the handheld.

NOTE: A rechargeable Li-Ion battery pack specifically for EXO Handhelds is available from YSI (*see section 3.2*).



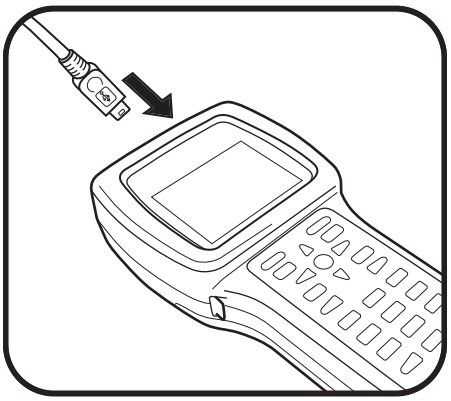
3 Reinstall battery cover panel.

Ensure that the rubber battery cover gasket is seated properly, then replace the cover onto the back of the HH. Tighten the four retaining screws back into their holes.

⚠ **CAUTION**: Overtightening of the screws is likely to cause damage and require replacement of the battery pack.

6.10 Handheld
Update Firmware and KOR Software

To update the instrument firmware and KOR software on the EXO Handheld, use the Desktop version of KOR on a computer with internet access. KOR Desktop will go online and pull updated files for the Handheld, which are then transferred to the Handheld via cable. (Bluetooth communication is not recommended for this process.)



1 Connect handheld to computer.

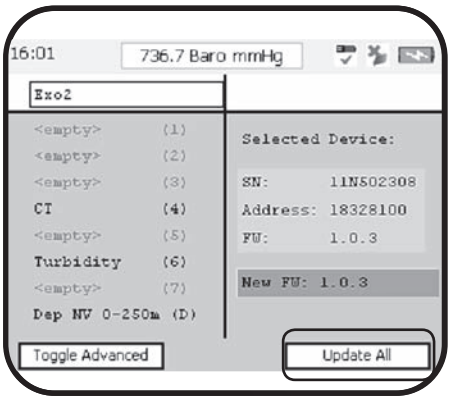
Plug the small end of the USB cable into the port on the top side of the EXO Handheld. Plug the other end of the USB cable into a port on your computer. Power on the Handheld and allow a minute for Windows to recognize the Handheld as a removable drive before the Handheld shows up in KOR software.

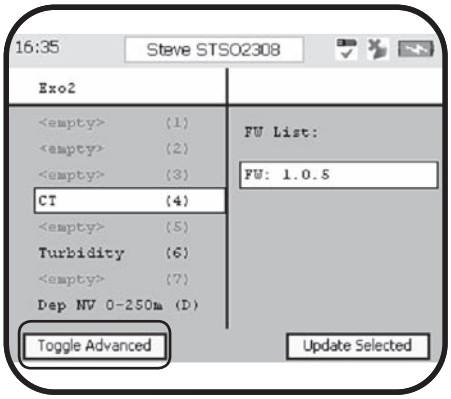
2 Update handheld.

When the Handheld is connected to the PC, go to the Options | Firmware menu in KOR Desktop software. Select the Update Handheld button from the bottom-right corner of the menu. Follow the prompts for completing the update process and rebooting the Handheld.

6.11 Handheld
Update Sonde Firmware

To update the instrument firmware when a sonde is in the field, you can use the EXO Handheld instead of a computer.





1 Download updates to handheld.

Connect the Handheld to a computer with internet access to retrieve the latest firmware updates *(see section 6.10)*. In KOR desktop software, go to the Options menu, select Sync with Handheld, and follow the prompts. When complete, your Handheld can be brought to the field to deliver updates to sondes and sensors.

2 Connect handheld to sonde.

Connect Handheld to sonde via Bluetooth *(see section 3.5)* or field cable *(see section 3.4)*.

3 Update sonde and sensors.

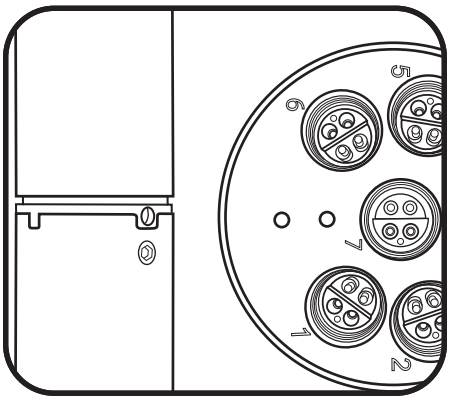
When the Handheld is connected to the sonde, go to the Options | Firmware menu on the Handheld. The list on the left side displays the connected device's current firmware and any new firmware available to install.

- To update the sonde and all sensors in the sonde, click the Update All soft key.
- To update an individual sensor, select the sensor from the list and click the Toggle Advanced soft key. Then select the firmware version from the list on the right and click the Update Selected soft key.
- Click OK to confirm that you would like to stop deployment and update firmware.

The Handheld will update the sonde and/or sensors one by one, and a progress screen will show when each is completed.

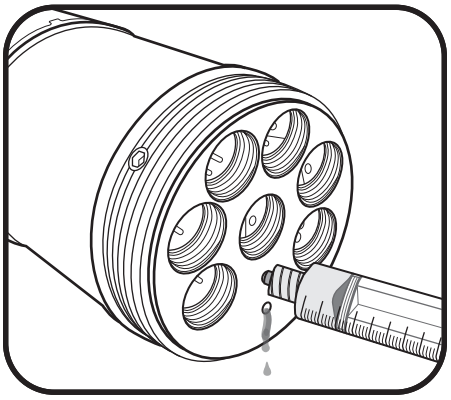
6.12 Depth and Level Sensor Maintenance and Storage

EXO depth and level sensors access the water through small holes (ports) located in the sonde body or bulkhead. Although users cannot access them directly, proper storage maintenance will help to ensure reliable operation. Depth sensors can be stored dry, in water-saturated air, or submerged in clean water. However, be sure that the water does not contain solutions that are corrosive. This can cause damage to the sensor's strain gauge.



1 Locate depth ports.

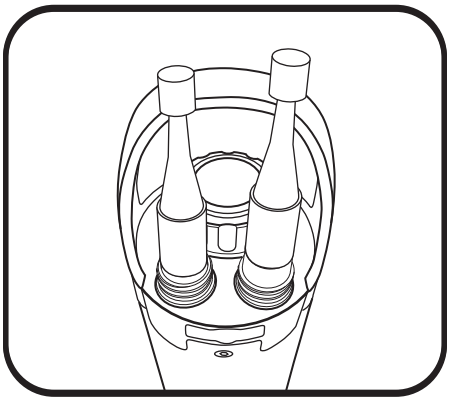
The two EXO1 depth ports are located in the yellow-plastic section between the bulkhead tube (labeled area) and the blue plastic battery cover. The EXO2 depth ports are located on the metal bulkhead face itself, in the largest open area between ports.



2 Clean depth ports.

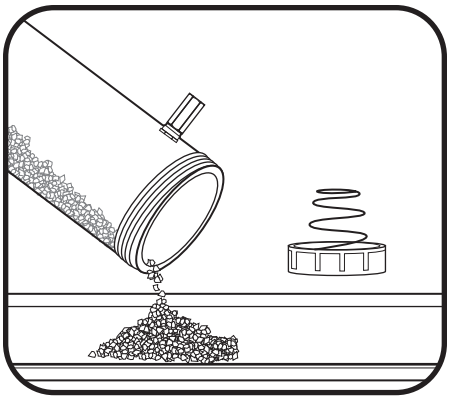
Although users cannot directly access the depth/level sensors, they should periodically clean them with the syringe included in the EXO tool kit (#599594). Fill the syringe with clean water and gently force water through one of the ports. Ensure that water flows from the other hole. Continue flushing the port until the water comes out clean.

⚠ Do not insert objects in the EXO2 depth ports, as this may cause damage to the transducer not covered under the warranty.



3 Level sensor storage.

Users can store these sensors either dry or submerged in clean water. However, regardless of storage method or length, ensure the vent tube remains dry. Always attach the port plug to the cable connector, or leave the cable installed with a cap over the desiccant's vent.

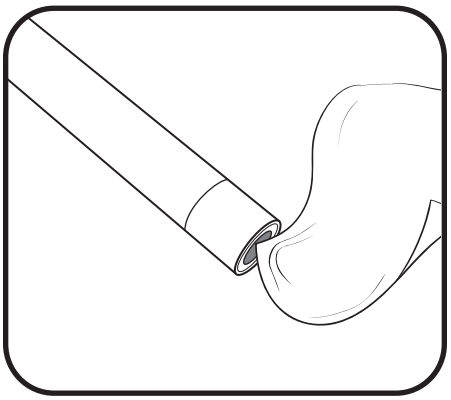


4 Level desiccant maintenance.

Active desiccant is blue; saturated desiccant is pink. When the desiccant closest to the sonde begins to turn pink, you should replace (YSI 6108), or regenerate (YSI 6109) the desiccant cartridge. To regenerate desiccant, remove it from the cartridge and heat it for one hour at 200°C (about 400°F); then cool it an airtight container before refilling. Also heat the felt filters at 100°C (about 200°F) for 30 minutes. The desiccant will turn blue following a successful recharge.

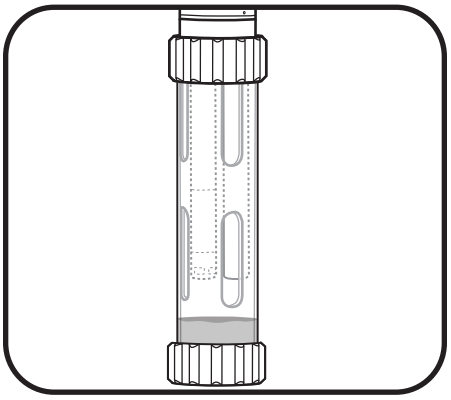
6.13 Standard Optical Sensor Maintenance and Storage

Standard optical sensors include Turbidity, Total Algae, and fDOM sensors; these optical sensors are very low maintenance. This section identifies storage as "long-term" or "short-term." Long-term denotes storage during times of long inactivity (over winter, end of monitoring season, etc.). Short-term denotes storage during times the sonde will be used at a regular interval (daily, weekly, biweekly, etc.). *Maintain connectors as instructed in section 6.24.*



1 Clean sensing window.

Turbidity, Total Algae, and fDOM require minimal maintenance. Users should periodically inspect the optical surface at the tip of the sensor and wipe it clean with a non-abrasive, lint-free cloth if necessary. As much as possible, prevent scratches and damage to the sensing window.



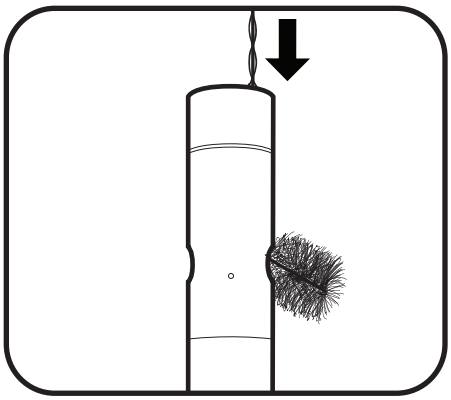
2 Long- and short-term storage.

Turbidity, Total Algae, and fDOM require minimal precautions. Users can either remove the sensors or leave them installed in the sonde for long- and short-term storage. If left installed on the sonde, follow guidelines for sonde storage. If users remove them from the sonde, the sensors may be stored in dry air in their shipping cap (to protect against physical damage).

⚠ Do not store any sensor in quinine sulfate solution.

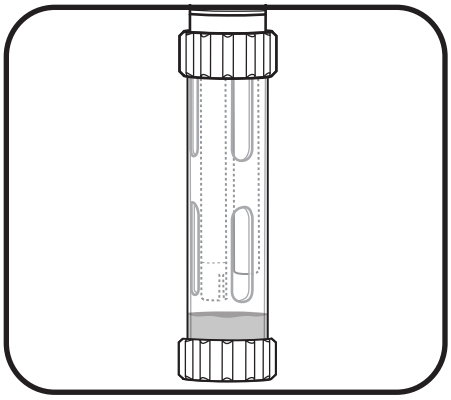
6.14 Conductivity/Temp Sensor Maintenance and Storage

EXO conductivity and temperature (CT) sensors require little maintenance or special attention for storage. As much as possible, prevent impact to the sensor's exposed thermistor. This section will identify storage as "long-term" or "short-term." Long-term denotes storage during times of long inactivity (over-wintering, end of monitoring season, etc.). Short-term denotes storage during times the sonde will be used at a regular interval (daily, weekly, biweekly, etc.). *Maintain connectors as instructed in section 6.24.*



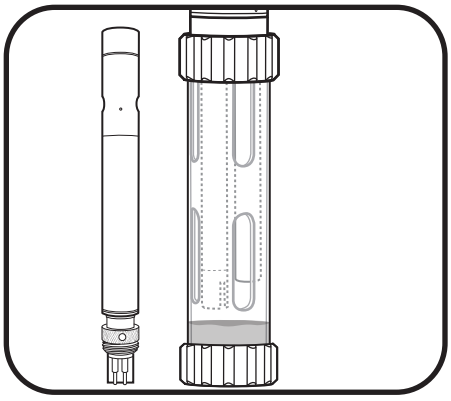
1 Clean electrode channels.

The only parts of the CT sensor that require special maintenance are the channels leading to the internal electrodes. Dip the sensor's cleaning brush (included in the sonde maintenance kit) in clean water, insert at top of channels, and sweep the channels 15-20 times. If deposits have formed on the electrodes, use a mild solution of dish soap and water to brush the channels. If necessary, soak in white vinegar to aid cleaning. Rinse the channels with clean water following the sweepings or soak.



2 Short-term storage.

When in regular field use, the sensor should remain installed on the sonde in an environment of water-saturated air. Place approximately 0.5 in (1 cm) of any water (deionized, distilled, tap, or environmental) in the bottom of the calibration cup. Insert the sonde and sensor into the cup and screw it on tightly to prevent evaporation. (*More information in "Short-Term Sonde Storage" section 6.1.*)

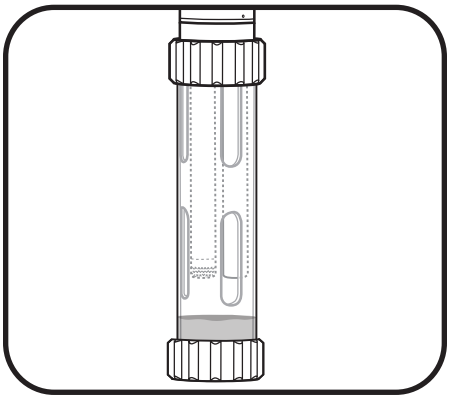


3 Long-term storage.

Store the sensors either dry or wet, installed on the sonde or detached. However, before storage, perform the recommended maintenance (above) to ensure the sensor is in good working order for the next deployment season. If the sensor is submerged for storage, ensure that the liquid is not corrosive.

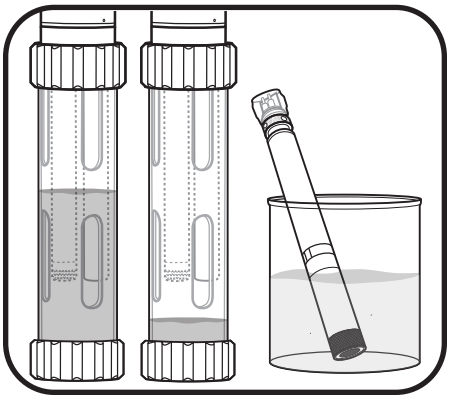
6.15 Dissolved Oxygen Sensor Storage

EXO DO sensors require separate storage instructions from other optical sensors due to their sensing membranes. This section will identify storage as "long-term" or "short-term." Long-term denotes storage during times of long inactivity (over winter, end of monitoring season, etc.). Short-term denotes storage during times the sonde will be used at a regular interval (daily, weekly, biweekly, etc.).



1 Short-term storage.

When in regular field use, the ODO sensor should remain installed on the sonde. Place approximately 0.5 in (1 cm) of any water (deionized, distilled, tap, or environmental) in the bottom of the calibration cup. Insert the sonde and sensor into the cup and screw it on tightly to prevent evaporation. (*More information in "Short-Term Sonde Storage" section 6.1.*)



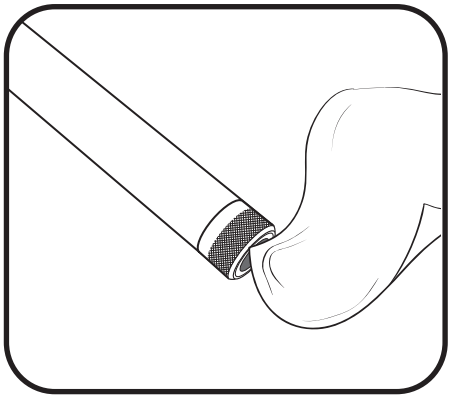
2 Long-term storage.

Leave the sensor installed in the sonde, and submerge it in clean water in the calibration cup. Screw the cup on tightly to prevent evaporation. Users may also store the ODO sensor by itself in two ways. One, submerge the sensing end of the sensor in a container of water; occasionally check the level of the water to ensure that it does not evaporate. Two, store the sensor in water-saturated air.

We do not recommend storing the sensor with the connector end unmated or exposed. If unmated, cover with plastic connector cap.

6.16 Dissolved Oxygen Sensor Maintenance and Rehydration

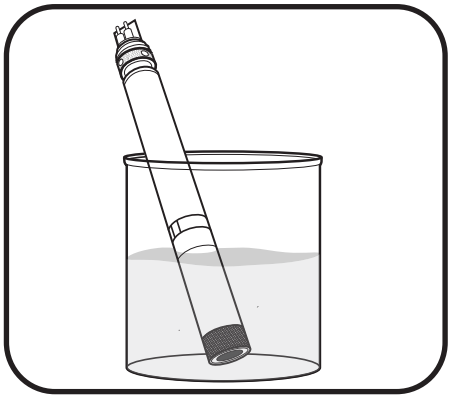
EXO optical Dissolved Oxygen (DO) sensors require unique maintenance instructions due to their sensing membranes. Users should routinely perform these instructions in order to achieve the highest levels of sensor accuracy. DO sensor caps have a typical life of 12 months. After this point, users should replace the DO membrane cap. As caps age, accuracy is reduced, ambient light rejection suffers, and response times can be affected. *Maintain connectors as instructed in section 6.24.*



1 DO membrane maintenance.

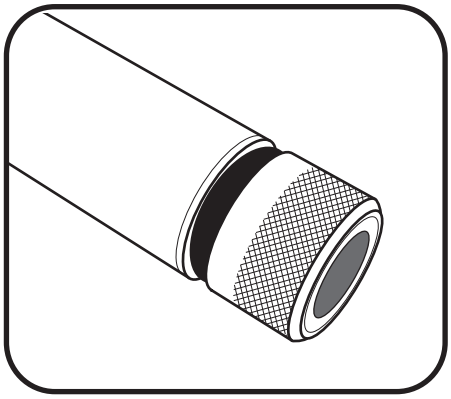
Users should periodically inspect the optical surface at the tip of the sensor and wipe it clean with a non-abrasive, lint-free cloth if necessary. Never use organic solvents to clean an EXO DO sensor.

As much as possible, prevent scratches and damage to the sapphire sensing window. Avoid getting fingerprints on the window. If necessary, wash with warm water and dish soap and rinse with DI water.



2 Sensor rehydration.

Users should always store DO sensors in a moist or wet environment in order to prevent sensor drift. However, should DO sensors be left in dry air for longer than eight hours, they must be rehydrated. To rehydrate, soak the DO sensor cap in warm (room temperature) tap water for approximately 24 hours. Following this soak, calibrate the sensor and store it in a moist environment.

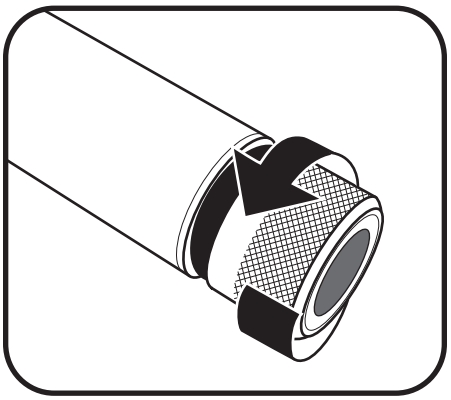


3 Sensor cap replacement.

Due to restrictions inherent to all DO sensors, DO sensor caps have a typical life of 12 months. After this point, users should replace the DO membrane cap. To replace this cap, follow the directions in the "Sensor Cap Replacement" section found on the next page.

6.17 Dissolved Oxygen Sensor
Sensor Cap Replacement

Follow these instructions to replace the sensor cap on an EXO optical dissolved oxygen sensor once the previous cap has exhausted its usable life (typically about one year). The DO sensor cap (#599110-01) is shipped in a humidified container, and should be stored in a 100% humid environment. If the sensor cap dries completely, follow instructions to rehydrate it.



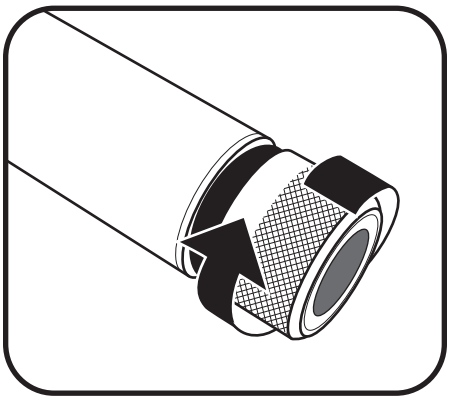
1 Remove current sensor cap.

Rotate the sensor cap with your fingers counterclockwise until free.

⚠ If possible, do not use any tools during this process. However, should the cap be immovable after use, carefully twist the sensor cap with pliers until it breaks loose. Do not use pliers on the sensor body, and take great care not to damage the sensor threads.

2 Replace o-ring.

Without using tools, remove the previous o-ring (pinch the o-ring out, then roll it upwards over the threads) and discard it. Visually inspect the new o-ring for nicks, tears, contaminants, or particles; discard damaged o-rings. Without twisting it, carefully install the new o-ring over the threads and into its groove, then apply a thin coat of Krytox lubricant to the o-ring only. Ensure the sensor cap's cavity is completely dry before installing the new cap.



3 Install new sensor cap.

After the o-ring is installed and lubricated, wipe the clear window at end of sensor with a lint-free cloth until clean. Then dry the inside cavity of the sensor cap with a lint-free cloth. With a clockwise motion, thread the new sensor cap onto the sensor until it is finger-tight. The o-ring should now be compressed between the sensor cap and sensor, and not pinched. If pinched, remove and discard the o-ring and repeat procedure.

⚠ Do not over-tighten the sensor cap. Do not use any tools for the installation process.

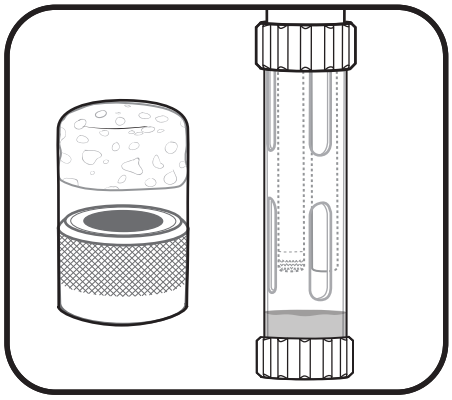
4 Configure sonde for new cap.

In KOR software, configure the sonde for the new sensor cap. Click the Calibrate button and then click the ODO button. Next click the ODO % sat button, and in the DO calibration window click the Advanced button.

In the Advanced menu, click the Edit button and enter the unique membrane cap coefficients found on the instruction sheet shipped with the DO sensor cap.

NOTE: Calibration coefficients are associated with specific individual sensor caps. They cannot be used for other ODO sensors.

Although measures are taken at the factory to ensure this, please check that the serial number with the calibration coefficients on the instruction sheet matches the serial number engraved on the outside of the sensor cap.



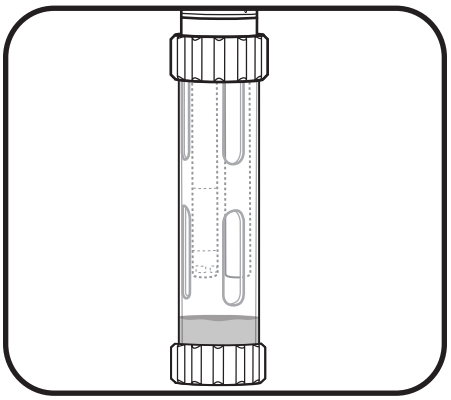
5 Store sensor cap.

The sensor cap is shipped in a humidified container, and should be consistently stored in a 100% humid environment. Prior to installation, ensure the cap's container remains moist. Once the sensor cap is installed on the sensor, maintain this environment by placing approximately 0.5 in (1 cm) of water (deionized, distilled, tap, or environmental) in the bottom of the calibration cup and screw it tightly onto the sonde to prevent evaporation. You may also store the sensor by submerging the cap end in water.

⚠ If pH sensor is also installed, do not submerge it in *distilled* water.

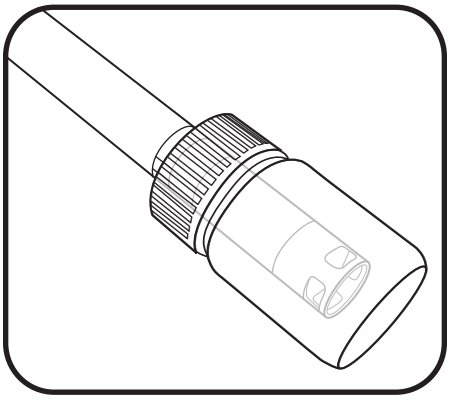
6.18 pH and pH/ORP Sensors
Storage and Rehydration

pH and pH/ORP sensors have two specific storage requirements: they should not be stored in distilled or deionized water and their reference electrode junction should never dry out. This section will identify storage as "long-term" or "short-term." Long-term denotes storage during times of long inactivity (over-wintering, end of monitoring season, etc.). Short-term denotes storage during times the sonde will be used at a regular interval (daily, weekly, biweekly, etc.).



1 Short-term storage.

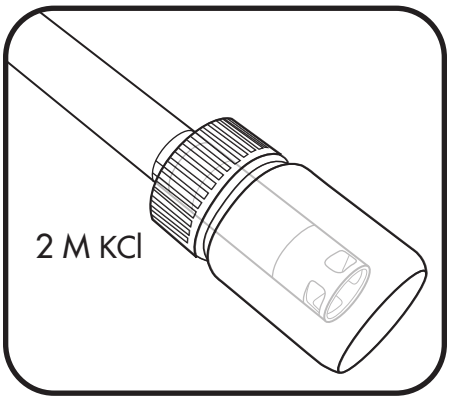
When in regular field use, the sensor should remain installed on the sonde in an environment of water-saturated air. Place approximately 0.5 in (1 cm) of any water (deionized, distilled, tap, or environmental) in the bottom of the calibration cup. Insert the sonde and sensor into the cup and screw it on tightly to prevent evaporation. (*More information in "Short-Term Sonde Storage" section 6.1.*)



2 Long-term storage.

Remove the sensor from the sonde and insert its sensing end into the bottle that the sensor was shipped in. Install the bottle's o-ring and cap then tighten. This bottle contains a 2 molar solution of pH 4 buffer. If this solution is unavailable, users may store the sensor in tap water.

⚠ Do not store the pH or pH/ORP sensor in Zobell solution or DI water.

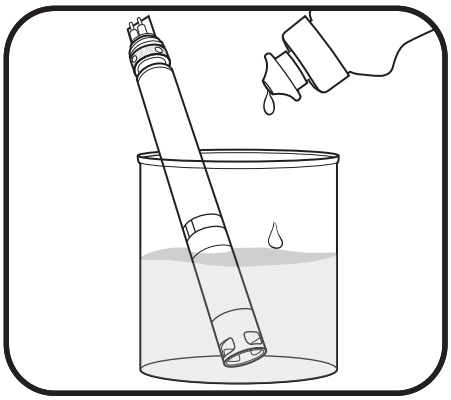


3 Rehydrate reference junction.

If the pH sensor has been allowed to dry, soak the sensor for several hours (preferably overnight) in a 2 molar (2 M) solution of potassium chloride (KCl). In order to create a 2 M KCl solution, dissolve 74.6 g of KCl in 500 mL of distilled or deionized water. If KCl is unavailable, a tap water or pH 4 buffer soak may restore function. If the sensor is irreparably damaged, users must replace the sensor module.

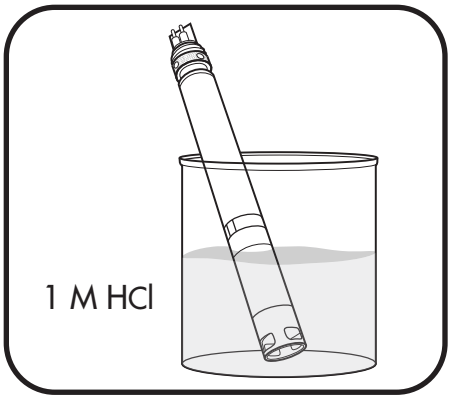
6.19 pH and pH/ORP Sensors Maintenance

pH and pH/ORP sensors will require occasional maintenance to clear contamination from the sensing elements. These contaminants can slow the sensor's response time. Clean the sensors whenever deposits, biofouling, or other contamination appear on the glass, or when the sensor's response time slows perceptibly. Remove the sensor from the sonde before performing the following cleaning steps. Do not attempt to physically scrub or swab the glass bulbs. The bulbs are very fragile and will break if pressed with sufficient force. *Maintain connectors as instructed in section 6.24. Replace depleted sensor module as instructed in section 6.21.*



1 Soak in dishwashing liquid solution.

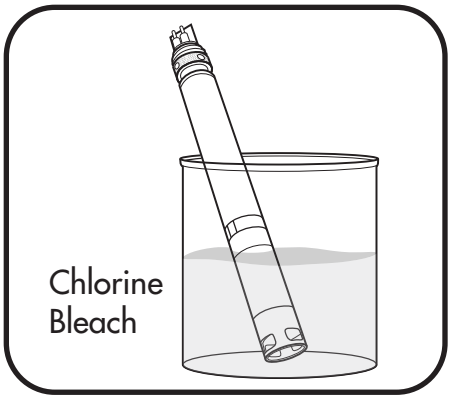
Soak the sensor for 10-15 minutes in a solution of clean water and a few drops of dishwashing liquid. Following the soak, rinse the sensor with clean water and inspect. If contaminants remain or response time does not improve, continue to the HCl soak.



2 Soak in HCl solution.

Soak the sensor for 30-60 minutes in one molar (1 M) hydrochloric acid (HCl). This reagent can be purchased from most distributors. Following the HCl soak, rinse the sensor in clean tap water and allow it to soak for an hour in clean water. Stir the water occasionally. Then, rinse the sensor again in tape water and test response time. If response time does not improve or you suspect biological contamination of the reference junction, continue to the next soak. If HCl is not available, soak in white vinegar.

⚠ Follow the HCl manufacturer's instructions carefully to avoid personal harm.

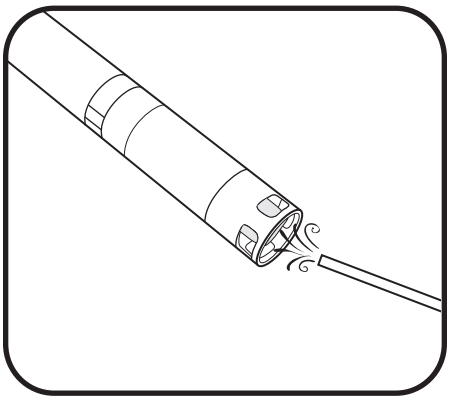


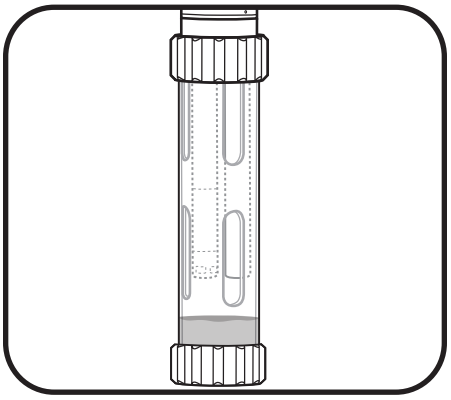
3 Soak in chlorine bleach solution.

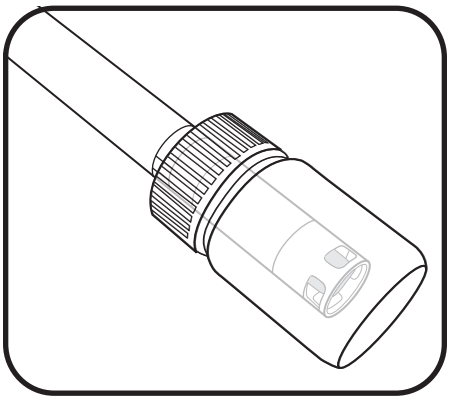
Soak the sensor for approximately one hour in a 1:1 dilution of chlorine bleach and tap water. Following the soak, rinse the sensor in clean tap water and allow it to soak for at least one hour in clean water (longer if possible). Then, rinse the sensor again in tap water and test response time.

6.20 ISE Sensors Maintenance and Storage

EXO ammonium, nitrate, and chloride sensors utilize ion-selective electrodes (ISEs) to monitor these parameters. One key requirement of storage, short or long-term, for these sensors is their reference electrode junctions should never dry out. This section will identify storage as "long-term" or "short-term." Long-term denotes storage during times of long inactivity (over-wintering, end of monitoring season, etc.). Short-term denotes storage during times the sonde will be used at a regular interval (daily, weekly, biweekly, etc.). *Replace depleted sensor module as instructed in section 6.21.*







1 Sensor maintenance.

Ammonium or Nitrate sensor: When deposits, biofouling, or other contamination appear on the membrane, users should *gently* remove them with a fine jet of deionized water or rinsing in alcohol followed by soaking in the high standard calibration solution. Gently dab dry with a lint-free tissue.

Chloride sensor: When deposits, biofouling, or other contamination appear on the membrane, users should *gently* remove them by washing with alcohol and/or gently polishing with fine emery paper in a circular motion to remove deposits or discoloration, then thoroughly washing with deionized water to remove any debris.

⚠ The ion-selective membranes are very fragile. Do not use coarse materials (e.g. paper towels) to clean the membranes, as these could permanently damage the sensor. The exception is fine emery paper for the chloride sensor, noted above.

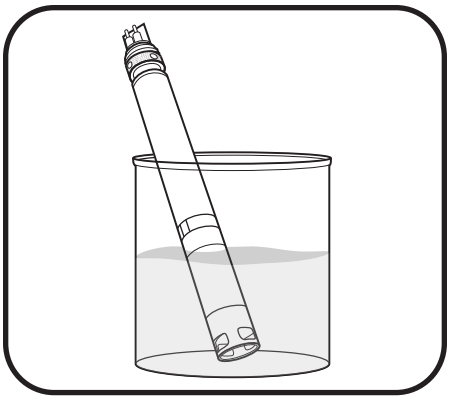
2 Short-term storage.

When in regular field use, the sensor should remain installed on the sonde in an environment of water-saturated air. Place approximately 0.5 in (1 cm) of any water (deionized, distilled, tap, or environmental) in the bottom of the calibration cup. Insert the sonde and sensor into the cup and screw it on tightly to prevent evaporation. (*More information in "Short-Term Sonde Storage" section 6.1.*)

3 Long-term storage.

Users should remove the sensors from the sonde and place them in their storage bottle (installed on sensor during shipping) with a small amount of tap water or calibration standard. The sensors should not be immersed in water.

⚠ Do not store the ISE sensors in conductivity standard, pH buffer, salt water, or any solution with significant conductivity.

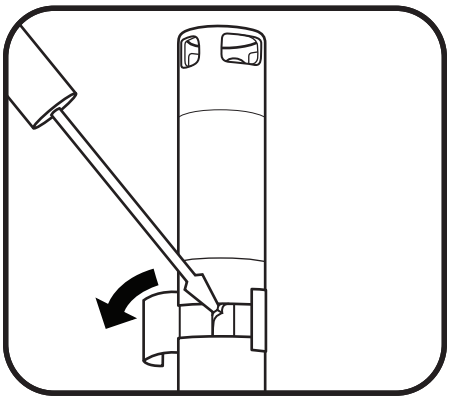


4 Rehydrate reference junction.

If an ISE sensor has been allowed to dry, soak the sensor for several hours (preferably overnight) in the sensor's high-calibration solution. If the sensor is irreparably damaged, users must replace the sensor module.

6.21 Sensor Module Replacement

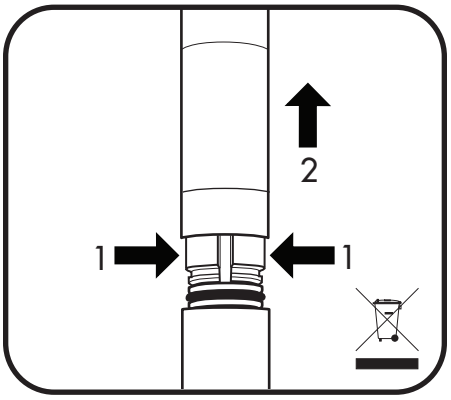
EXO pH, pH/ORP, ammonium, nitrate, and chloride sensors feature replaceable sensor modules (#599795, 599797, 599743-01, 599744-01, 599745-01) due to the electrolyte depleting characteristics necessary to make such measurements. We recommend that users replace these modules as necessary—typically 12 to 18 months for pH and ORP and three to six months for ISEs, if stored properly in a humid environment, wetting the sponge in the provided bottle when not in use. Working life will depend on the conditions of the deployment environment. Perform this procedure in a clean, dry laboratory environment.



1 Remove old sticker and plug.

Peel off and discard the old sticker that covers the junction of the sensor body and the module. Then, with a small, flat-blade screwdriver, remove the small rubber plug from the gap in the hard plastic ring at the base of the sensor module.

⚠ Caution: Always exercise extra care when using sharp or potentially harmful instruments.



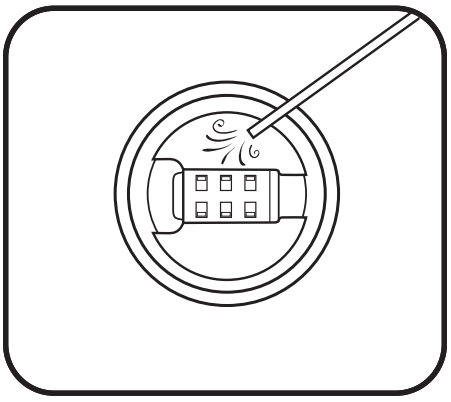
2 Remove and discard old sensor module.

To remove, perform two motions simultaneously.

1. With your fingers, squeeze the sensor module's hard plastic ring so that it compresses the gap left by the rubber plug.
2. Steadily pull the sensor module straight back from the sensor body, rocking slightly if necessary.

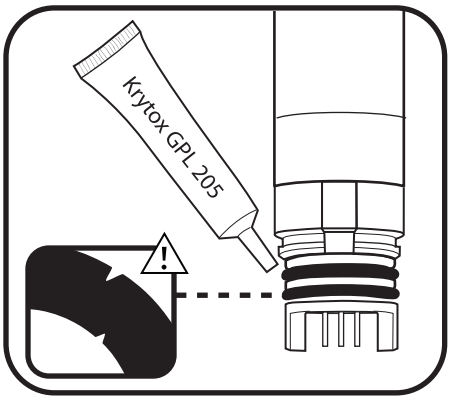
NOTE: The act of removing the old sensor module renders the o-rings on the module unusable. To prevent catastrophic leaks, do not attempt to reinstall a module with damaged o-rings.

Discard the module according to your organization's guidelines, or return it to manufacturer for recycling.



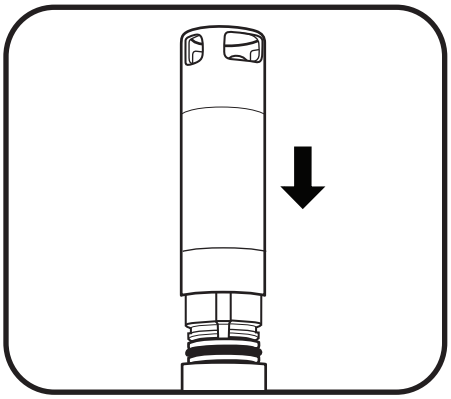
3 Inspect and service connector cavity.

Inspect the connector cavity of the probe body for debris or moisture. If detected, remove it with a lint-free cloth or a gentle blast of compressed air.



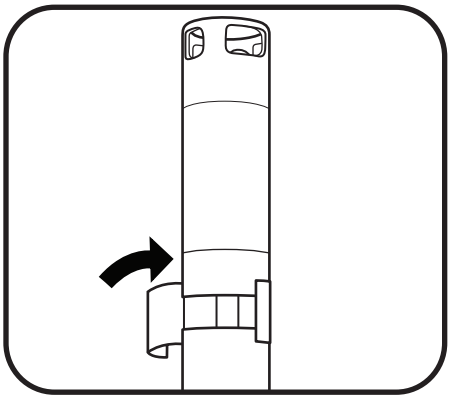
4 Inspect and service new sensor module's o-rings.

Ensure that the two o-rings are not nicked or torn and have no contaminants or particles on them. If the user detects damage, carefully replace them with the extras included in the sensor module kit. Then apply a thin coat of Krytox® lubricant to each o-ring. If a user removes a sensor module that is in good working order, replace the o-rings before use.



5 Insert new sensor module.

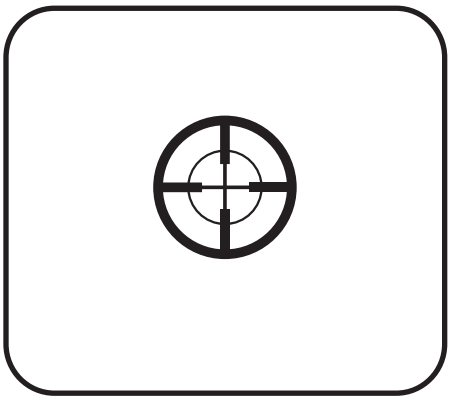
Align the prongs on the base of the module with the slots in the sensor body. The sensor module is keyed to insert in only one orientation. Once the module is aligned, press it firmly into position until it clicks. Wipe away any excess grease from the assembled components.



6 Apply new sticker.

Wrap the junction of the sensor module and the body with the new sticker included in the sensor module kit. This sticker helps keep the sensor module junction clean and retains the rubber plug throughout deployment.

On the sticker, mark the date the replacement module was installed, as a reminder.

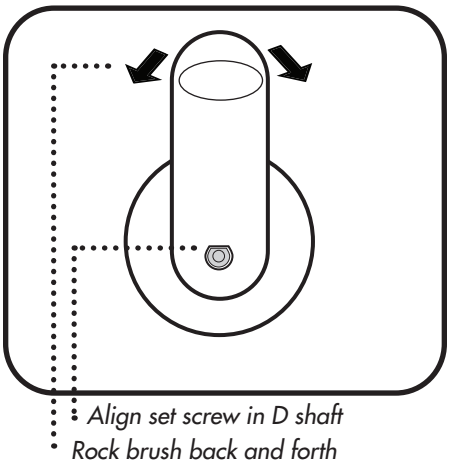


7 Re-calibrate the sensor.

Using KOR software, calibrate the sensor following each sensor module replacement. After calibration, the sensor is ready for field use.

6.22 Wiper Maintenance and Storage

Follow these instructions to replace the wiper brush assembly or brush guard component on the central wiper module on the EXO2 sonde. We recommend changing the wiper between deployments to avoid sediment carryover, which can compromise calibration and data collection. For long- and short-term storage, the wiper requires minimal precautions. Users can either remove the wiper or leave it installed in the sonde. If left installed on the sonde, follow guidelines for sonde storage. If users remove it from the sonde, the wiper may be stored in dry air in its shipping cap to protect against physical damage.



1 Replace wiper brush.

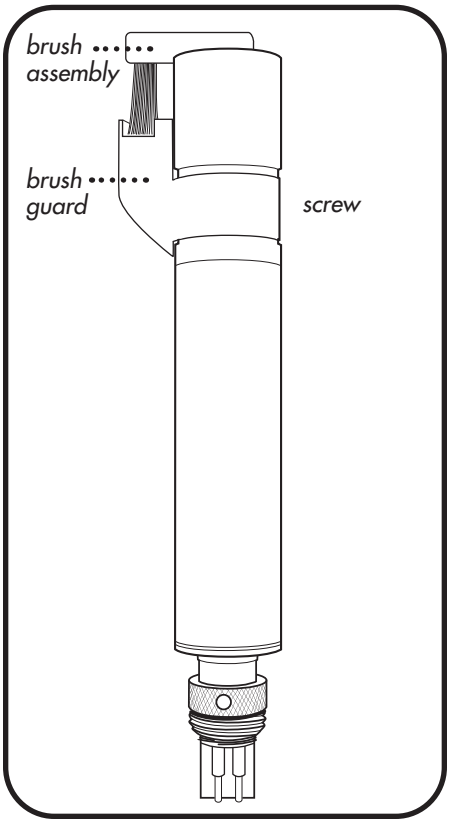
Loosen set screw with 0.050 inch Allen wrench.

Remove old brush assembly and clean any residue from wiper shaft and wiper end cap.

Install new brush assembly, gently pressing the wiper arm down against shoulder on wiper shaft.

Tighten set screw to a torque of 4 inch-pounds. While tightening, gently and slowly rock the brush to ensure a tight fit against the D shaft.

Check snugness of wiper by gently rocking 5 degrees in either direction.



2 Replace brush guard.

In KOR software, go to Run > Dashboard. Click the Wipe Sensors button to ensure proper wiper park position.

Mark the position of the old guard with a marker.

Loosen the #6 screw with a 7/64 inch Allen wrench, remove the ~~old~~ guard and clean any residue from motor housing.

Remove cover on adhesive strip on the inside of the new brush guard.

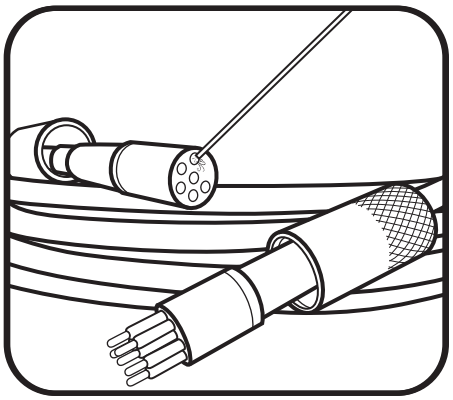
Carefully install new brush guard in same position as old guard—with brush centered in well. Tighten screw until snug, but do not overtighten. (The adhesive helps to hold the guard in place.)

If necessary, calibrate the position of the new wiper in the KOR Calibrate menu.

NOTE: The adhesive on the guard strap, which facilitates installation, may make it difficult to re-position the wiper guard after it's been installed. Take caution to mark the position of the old guard before removing it and install the new one in the same location. Confirm that the new guard is aligned with the 4-pin connector at the bottom of the probe as shown, and properly centered between ports 1 and 6 after the wiper has been installed in the sonde.

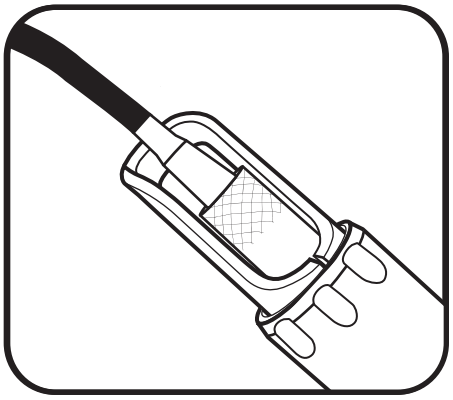
6.23 Field Cable Maintenance and Storage

EXO field cables are rugged and provide years of reliable service when properly maintained. As with all field cables, they are most vulnerable at their connectors. Take extra caution to protect the connectors from debris and physical harm.



1 Inspect and clean cables.

Inspect the cable's connectors for contamination and remove any detected debris with a blast of compressed air. Users should also apply a thin coat of Krytox grease to the male pins of the connectors when they appear dried out. However, it is better to apply too little grease than too much. Too much grease can encourage contamination. Periodically inspect the cable for nicks and tears to ensure best performance.



2 Cable storage.

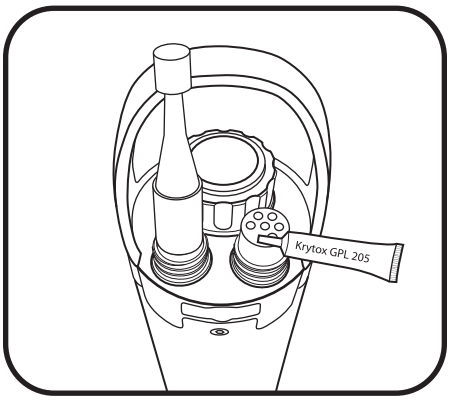
Users should leave the cable installed on the sonde to protect the connectors. If necessary users may remove it from the sonde, but extra care should be taken to protect the connectors. Store the cable in a safe location free from direct sunlight.

If the cable is vented, ensure the storage cap is affixed to the desiccant inlet. Store vented cables in a bag containing desiccant.

6.24 Connectors
Maintenance and Storage

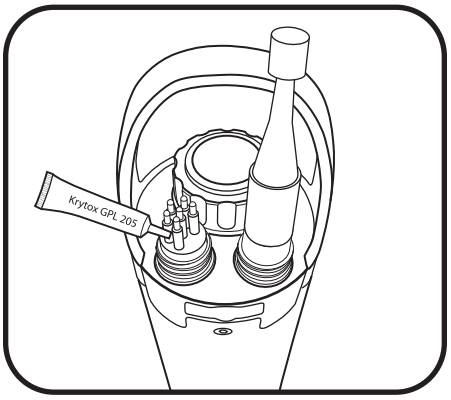
EXO sondes utilize wet-mate connectors that greatly reduce problems associated with traditional underwater connectors. However these connectors must be properly maintained to reap the full benefit of this design. Following these instructions will minimize most potential issues.

Never stick any foreign object into a female connector. Use only Krytox grease to lubricate the mating surfaces of the connectors.



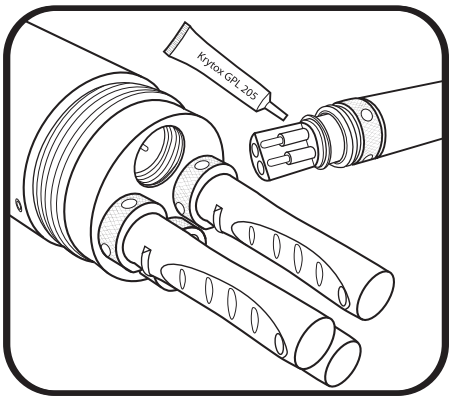
1 Female 6-pin connectors.

These connectors are located on field cables, EXO2 accessory connector, and EXO Handheld. Periodically inspect the connectors for signs of contamination. If you detect debris, remove it with a gentle blast of compressed air. Prior to initial installation, or when dry, apply a light coat of Krytox grease to the flat rubber mating surface on top of the connector. When not in use, always install the connector's plug.



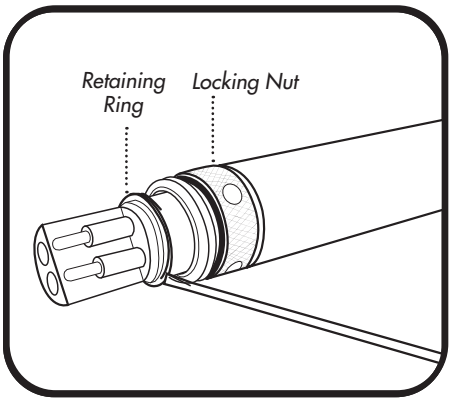
2 Male 6-pin connectors.

These connectors are located on field cables and topside sonde connectors. Periodically inspect the connectors for signs of contamination. If you detect debris, carefully remove it. Prior to initial installation, or when dry, apply a light coat of Krytox grease to the rubber mating surfaces of the connector (including the rubber portions of the pins). When not in use, always install the connector's plug.



3 Sensor connectors (4-pin).

These connectors are located on sonde bulkheads (sockets) and sensors. Periodically inspect the female portions of these hermaphroditic connectors and the entire socket for contamination, and remove any debris with a gentle blast of compressed air. Prior to initial installation, or when dry, apply a light coat of Krytox grease to the rubber area of the sensor's connector.



4 Replace locking nut.

If the locking nut near the sensor connector wears out, users can replace it with #599668 (sensor) or #599669 (EXO2 central wiper).

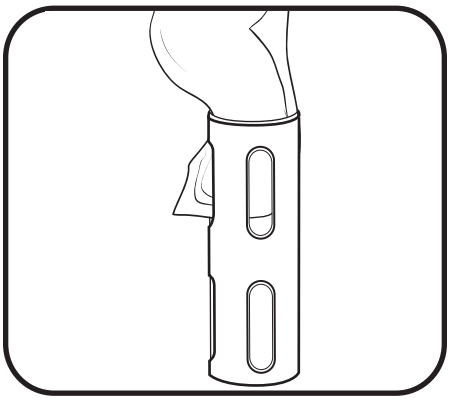
First remove the retaining ring by inserting the tip of a small, flat-blade screwdriver under the lip of the ring and pry upward. Pull ring out of groove.

Slide off locking nut and replace with new locking nut. Install new retaining ring by prying up one edge with screwdriver and fitting it into groove. Use the screwdriver to follow the diameter of the ring around the groove to seat it fully.

⚠ Wear eye protection when servicing the retaining ring.

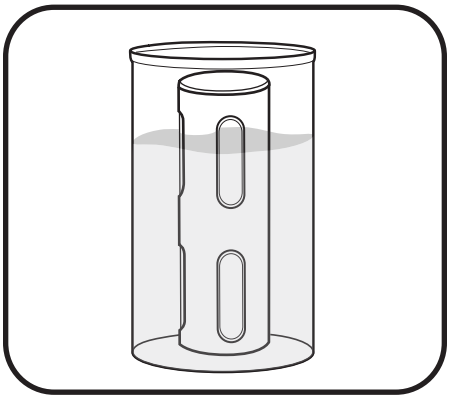
6.25 Antifouling Equipment Maintenance

Many components on EXO sondes are made of an anti-fouling copper-alloy material that discourages the growth of aquatic organisms. However, longer deployment intervals and highly productive waters can result in biofouling attachment to the equipment, which should be cleaned periodically. *See also instructions for cleaning individual sensors.*



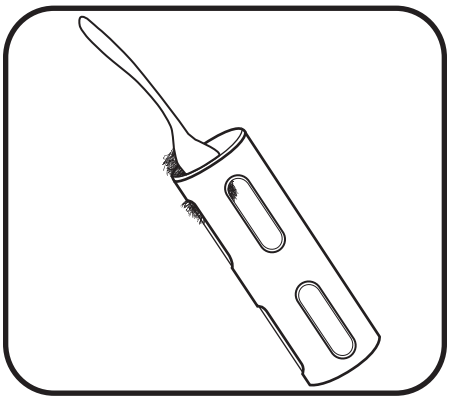
1 Remove minimal biofouling.

Remove the antifouling sonde guard from the sonde. If the guard is covered in a thin layer of slime or filaments, wipe away the biofouling with a cloth soaked in clean water and a few drops of a dishwashing liquid that contains a degreaser. Rinse the guard with clean water and inspect.



2 Soak to remove heavy biofouling.

Remove the antifouling sonde guard from the sonde. If the guard is covered in a thick layer of filaments or barnacles, soak the guard for 10-15 minutes in a solution of clean water and a few drops of a dishwashing liquid that contains a degreaser. Following the soak, rinse the guard with clean water and inspect.



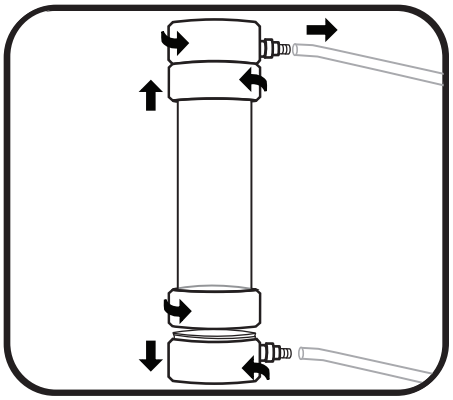
3 Scrub to remove heavy biofouling.

If biofouling remains, use a small plastic scrub brush or plastic scraper to gently scrub the biofouling off the guard. Then wipe the guard with a wet, soapy cloth and rinse.

Do not sand or polish the inside of the guard bottom, as this may effect turbidity readings. (The guard bottom has a black coating that will eventually wear off.)

6.26 Flow Cell Maintenance

There are two versions of the EXO flow cell: EXO1 flow cell (#599080) and EXO2 flow cell (#599201). Flow rate of the flow cell is typically between 100 mL and 1 L per minute. Maximum flow rate depends on tubing type, size, and length. Maximum pressure for each is 25 psi.

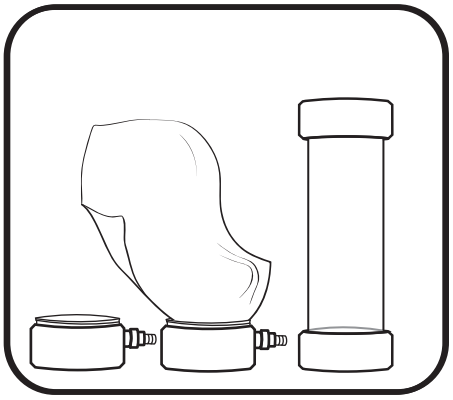


1 Disassemble flow cell.

To clean the flow cell after use, unscrew and remove the sonde from the flow cell.

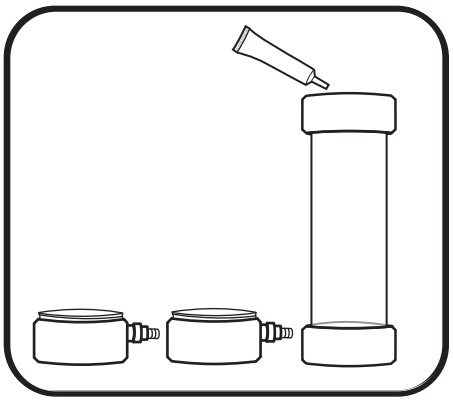
Take apart the flow cell by unscrewing the base from the locking ring. Remove the flow cell tube by gently pulling the base and the tube apart. The locking ring will remain on the tube due to the stainless steel retaining ring.

Repeat the same steps to remove the top of the flow cell from the flow cell tube.



2 Clean flow cell.

Use water and a mild detergent and water to wipe clean the flow cell parts.



3 Reassemble flow cell.

Make sure that the o-rings and threads are clean and free of any particles such as sand, grit, or debris. Apply a thin coat of Krytox grease to the two o-rings on the flow cell tube.

Make sure that the o-rings and stainless steel retaining rings are properly seated on the flow cell tube. Push the base of the flow cell onto the flow cell tube until it is firmly seated. This creates the watertight seal.

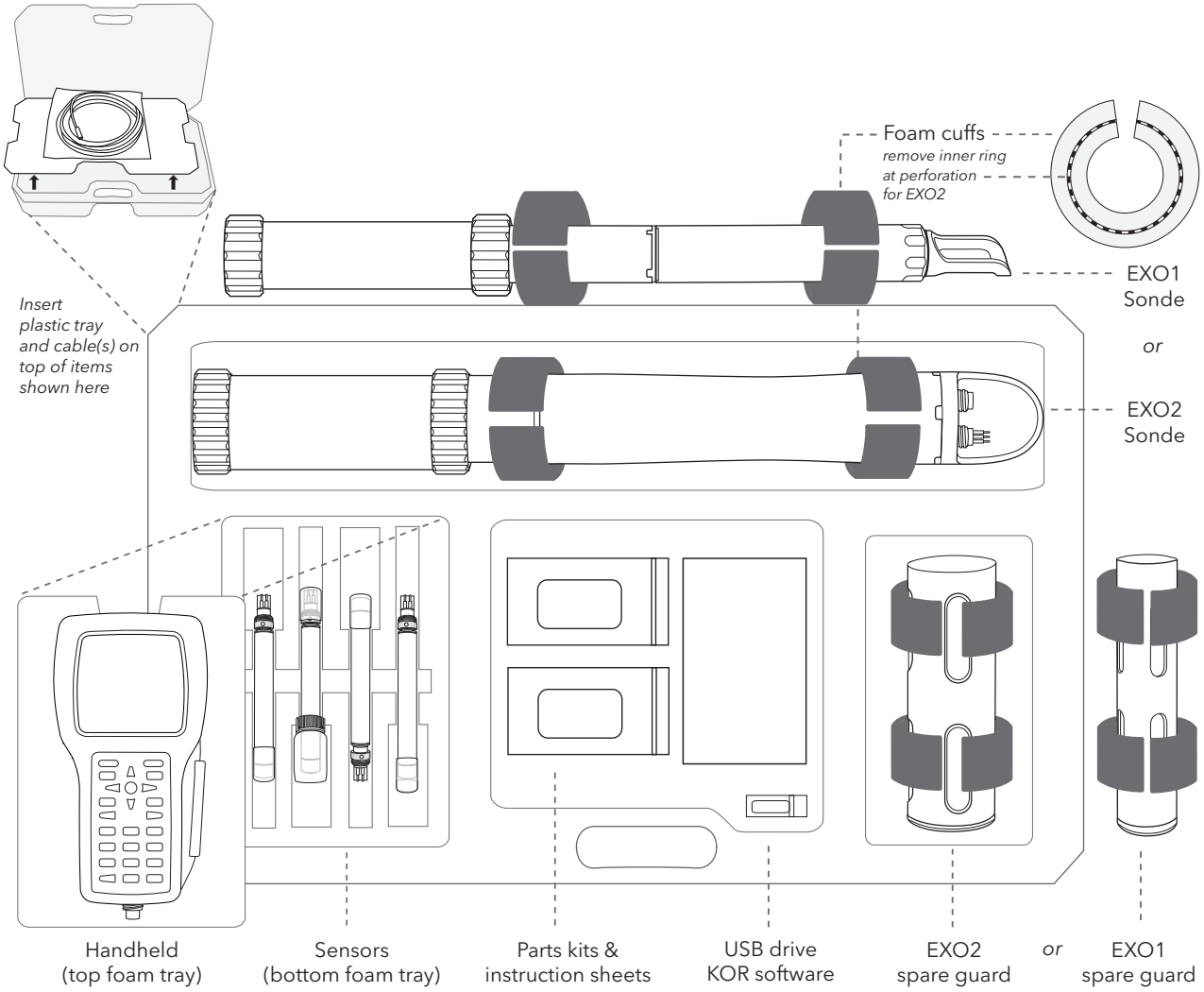
Screw the locking ring on to the base by turning it clockwise; do not use a tool and do not overtighten.

Repeat same steps to reconnect the top of the flow cell to the flow cell tube.

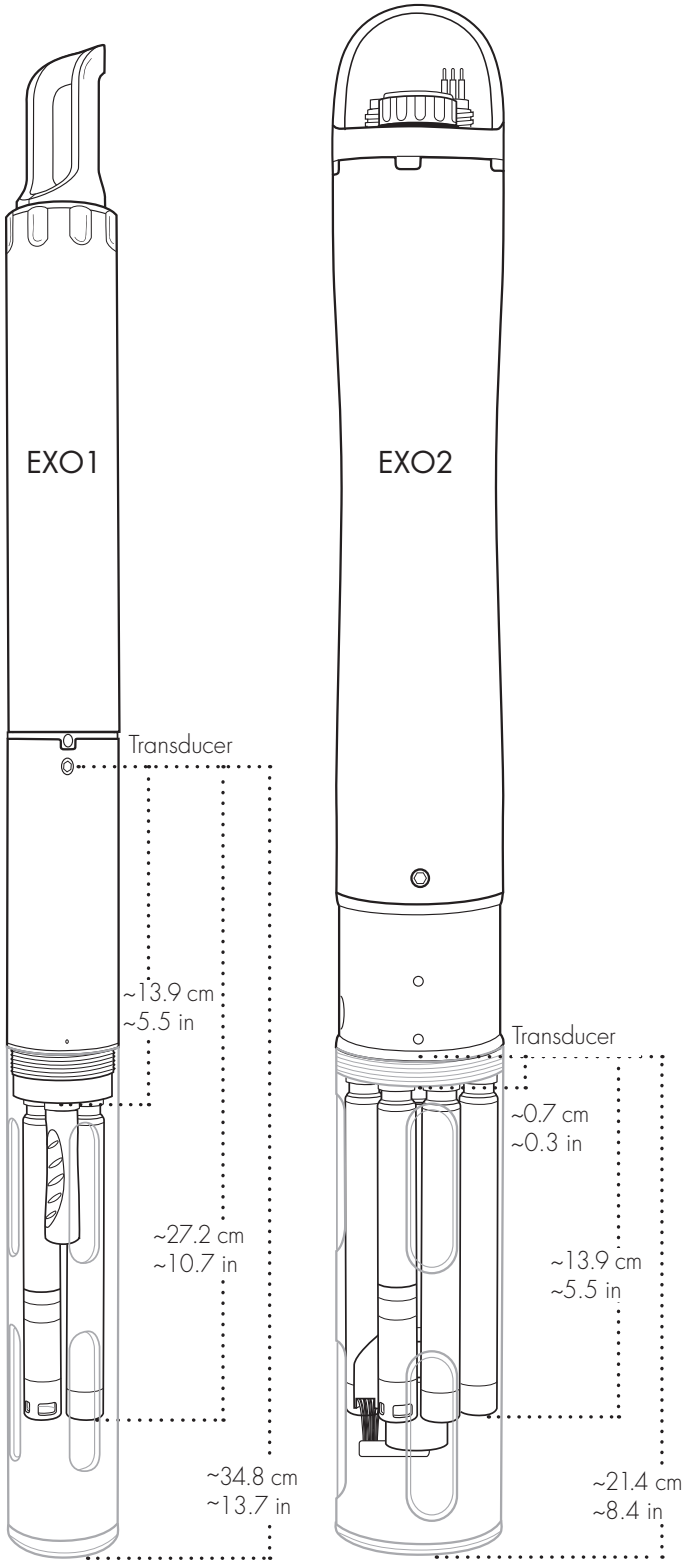
6.27 Storage Cases
Packing Equipment

In addition to the maintenance procedures for individual components of the EXO system detailed in this section, users can store all EXO components (sonde, sensors, handheld, cables, etc.) in a large, hard-sided carrying case (#599593-01), which measures 32x20 inches, for safe-keeping. Proper long-term storage helps to ensure proper equipment operation. Long-term denotes storage during times of long inactivity (over winter, end of monitoring season, etc.).

Also available from YSI is a soft-sided cloth carrying case (#605394). We also recommend Pelican® 1600 and 1700 cases, ordered from the manufacturer or reseller.



7.1 Vented Level Sonde Overview



Like EXO depth sensors, level sensors use a differential transducer with one side exposed to the water. However, unlike the depth sensors which have their back side sealed in a vacuum, the other side of the level transducer is vented to the atmosphere.

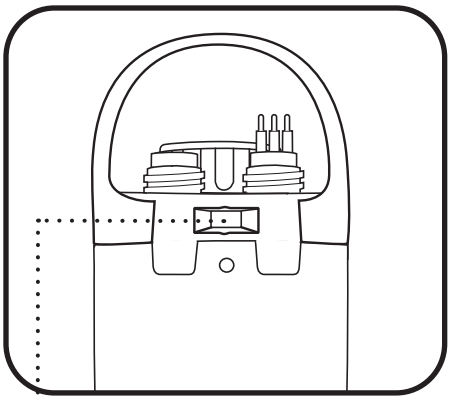
Because of this venting to the surface the transducer will only measure the water pressure exerted by the water column. Thus, the vented level option for depth measurement eliminates errors due to changes in barometric pressure because the barometric pressure is being seen on both sides of the pressure sensor. This is accomplished by using a special sensor that has been vented to the outside atmosphere by way of a tube that runs through the sonde and cable. This tube must remain open and vented to the outside atmosphere to function. No foreign objects can block the openings.

⚠ Never expose the sonde or the cable to the atmosphere for more than a few minutes without an active desiccant or connector dummy plug in place. Moisture or high humidity air entering the vent tubes can condense and block the tube, affecting accuracy; it could also cause damage to the transducer that is not covered by the warranty.

Special field cables are required for vented level measurements. These cables have a vent tube running through the center and connect to the EXO sonde at the connector near the bail. In the center of the sonde's connector is a matching vent hole. When attached, the vented cable allows the sonde to vent through the water column and thus gain a more accurate depth measurement.

7.2 Vented Level Sonde Installation

When installing a vented level sonde, users must ensure that the sonde never exceeds an operational depth of 10 meters. Provisions for floods, astronomical tides and severe storm events should be factored in. Exposing the depth sensor to depths greater than 10 meters could result in damage to the pressure sensor that is not covered by the warranty.



Indentation for location or positioning pin to ensure consistent horizontal orientation

Location of Depth Sensor

For best measurement accuracy when installing a sonde, the sonde's orientation and position must remain fixed.

When deploying the sonde vertically, take care to ensure the sonde is redeployed in the same position. Use a location pin or suspend the sonde using materials that cannot stretch (chain, wire rope) to ensure a fixed location.

Depth sensors on the EXO2 sondes are not on center. In horizontal deployments, take care to ensure the redeployments are always in the same orientation.

To assist with consistent horizontal orientation, the EXO2 sonde has an indentation at the top of the sonde for a location or positioning pin.

⚠ Never band clamp a sonde. This can lead to the sonde body becoming warped and taking on water.

EXO1 Depth Sensor Reference Points *(see diagram on previous page)*

- From bottom of sensor guard (metal or plastic) to transducer diaphragm: ~34.8 cm / ~13.7 inches
- From face of sensor endcap to transducer diaphragm: ~27.2 cm / ~10.7 inches
- From face of connector bulkhead to transducer diaphragm: ~13.9 cm / ~5.5 inches

EXO2 Depth Sensor Reference Points *(see diagram on previous page)*

- From bottom of sensor guard (plastic or metal) to transducer diaphragm: ~21.4 cm / ~8.4 inches
- From face of sensor endcap to transducer diaphragm: ~13.9 cm / ~5.5 inches
- From face of connector bulkhead to transducer diaphragm: ~0.7 cm / ~0.3 inches
- Horizontally positioned sonde, from outer case (location pin down) to transducer diaphragm: ~2.1 cm / ~0.8 inches

Ambient Light Interference

When deploying horizontally, it is best to keep the sonde's optical sensors out of direct sunlight. We suggest:

- Installing the sonde in a PVC pipe that has adequate openings for flow
- Aiming the sensors north in northern hemisphere or south in southern hemisphere
- Using a sun shield if the sonde is in the open

7.3 Cables and Desiccants Installation

Cables

Vented cables for EXO have a maximum length of 33 meters, so when connecting a sonde to a data logger, users should use a junction box to reach further distances. In the junction box, the EXO cable can connect to the desiccant, as well as another cable running to the data logger or DCP device.

- Avoid bending vented cables sharply to prevent the inner tube from kinking. (Min. bend radius 20.3 cm/8 in.)
- EXO vented cables have a reduced length to prevent tube damage from their own weight.
- EXO vented cables **do not** have wet-mate connectors—any water or humidity entering the vent tube will cause damage to the pressure sensor that is not covered by the warranty.
- EXO vented cables are not equipped with the barbed fitting for small desiccant cartridges.

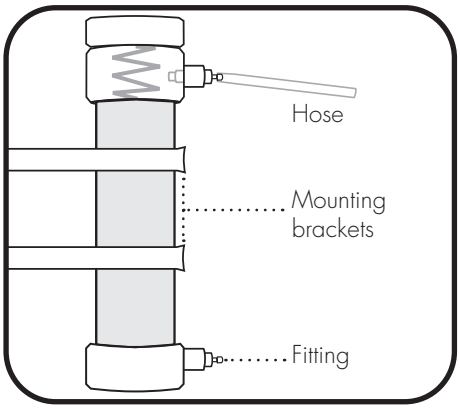
Dessicants

⚠ All EXO sondes with vented level require the use of a desiccant. Any damage to the sensor due to the lack of desiccant use is not covered under warranty.

Two desiccant systems are available, a cartridge kit (YSI 6108) and a canister kit (YSI 6109). *For all EXO sondes we strongly recommend the 6109 canister kit*. The 6109 desiccant canister contains a larger amount of desiccant and is intended for long-term deployments (can last up to 1 year in severe conditions). It also contains mounting brackets for mounting the canister to a nearby structure. The smaller 6108 kit requires replacement frequently in high humidity environments.

⚠ A desiccant or a connector dummy plug must always be attached to the sonde and cable to prevent moisture from entering into the vent tubes.

Users must also ensure that the desiccant always remains active. Active desiccant is a blue color, and when it can absorb no more moisture, it is a pink color. The end that is vented to the atmosphere will begin to change color first. As long as the desiccant closest to the sonde is blue, no maintenance is required. Local conditions will dictate how long the desiccant will last. In humid environments, the desiccant may need to be changed or regenerated before it is completely exhausted to ensure that it lasts the entire deployment.



Installing YSI 6109 Desiccant Canister

- Remove the 1/8" NPT plugs from the stainless steel fittings on the canister.
- Install the 1/8" NPT to 1/8" hose fittings into the stainless steel fittings located on the side of the desiccant canister. Do not over-tighten.
- Place the plugs over the fittings on the canister until you are ready to use the canister.
- Using suitable screws fasten the canister mounting brackets to an appropriate support structure. The spacing between the brackets must accommodate the length of the canister. The canister must be located within a few feet of the cable end.
- Remove the plug from the top fitting of the canister. Remove the plug from the barbed fitting on the end of the cable. Using the tubing provided in the kit, connect the canister to the fitting on the end of the cable. Remember to remove the remaining plug from the canister when ready to begin sampling. When putting the sonde into service, remove the plug to ensure that the sensor in the sonde is vented to the atmosphere.

7.4 Calibration

NOTE: This calibration option is available only if your sonde is equipped with a vented level sensor.

For the calibration, make certain that the vented level sensor is in air and not immersed in any solution. Orient the sonde in the same position as it will be deployed. Also, never calibrate a vented level depth sensor with a non-vented cable.

In the desktop KOR Calibrate menu, select Port D-Depth, then select Depth m from the second menu. In the Device Calibration menu, you should see Depth Vented 0-10m as the device name. (In the handheld KOR Calibrate menu, select Port D Dep V 0-10m, then select Depth m from the next menu.)

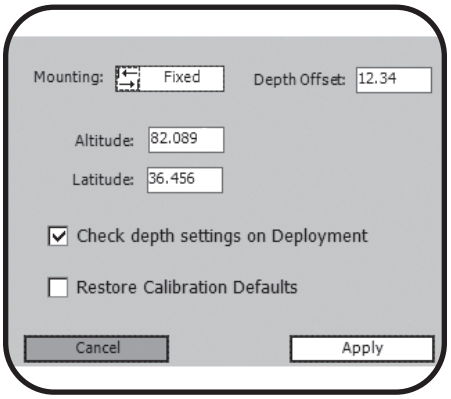
Click 1 Point for the Calibration Points. Enter 0 or go to the Advanced menu to enter a known sensor offset.

- If a depth offset is entered, the output value will shift by the value of the offset. Users may use an offset if referencing a water elevation against a known datum.

Click Start Calibration. Observe the readings under Current and Pending data points and when they are Stable (or data shows no significant change for approximately 40 seconds), click Apply to accept this calibration point. This process zeros the depth sensor.

Click Exit to return to the sensor calibration menu, and then the back arrows to return to main Calibrate menu.

For best performance of vented level measurements, users should ensure that the orientation of the sonde remains constant while taking readings. Keep the sonde still and in one position while calibrating.



Advanced

Mounting: Use the Advanced menu to select if a sonde will be mounted in a moving/profiling deployment instead of a fixed location.

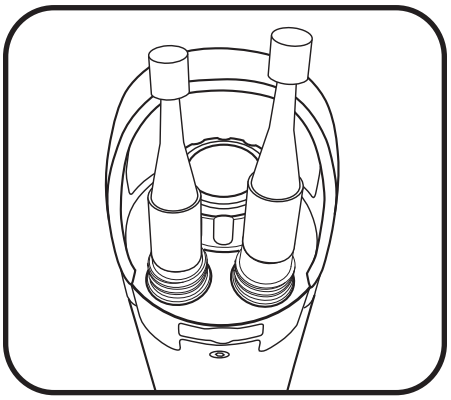
Depth Offset: Enter a positive or negative depth offset value if the sonde has been surveyed into a geodetic reference.

Altitude/Latitude: Enter the coordinates for the local altitude (in meters, relative to sea level) and latitude (in degrees) where the sonde is sampling. Latitude values are used in the calculation of depth and level to account for global variations in the gravitational field. NOTE: You must be within 500 feet and 1 degree, respectively.

7.5 Maintenance and Storage

Short-term Storage

⚠ It is important that the air in a sonde's vent tube remains dry at all times.



Level Sensor Storage

Users can store these sensors either dry or submerged in clean water. However, regardless of storage method or length, ensure the vent tube remains dry. Always attach the port plug to the cable connector, or leave the cable installed with a cap over the desiccant's vent.

Level Desiccant Maintenance

Active desiccant is blue; saturated desiccant is pink or rose red. When the desiccant closest to the sonde begins to turn pink, you should replace (YSI 6108), or regenerate (YSI 6109) the desiccant cartridge.

To regenerate desiccant, remove it from the cartridge and heat it for one hour at 200°C (about 400°F); then cool it an airtight container before refilling. Also heat the felt filters at 100°C (about 200°F) for 30 minutes. The desiccant will turn blue following a successful recharge.

Connectors Maintenance

Connectors on vented level cables have five pins and a vent pin. Periodically inspect the connectors for signs of contamination. If you detect debris, carefully remove it. Prior to initial installation, or when dry, apply a *light* coat of Krytox grease to the rubber mating surfaces of the connector (including the rubber portions of the pins).

⚠ Do not allow grease to enter or block the vent tube on the cable connector or the vent opening on the sonde connector.

When not in use, always install the sonde and cable dummy plugs.

Cable Storage

Users should leave the cable installed on the sonde to protect the connectors. If necessary users may remove it from the sonde, but extra care should be taken to protect the connectors. For vented cables, ensure the storage cap is affixed to the desiccant inlet. Store vented cables in a bag containing desiccant.

NOTE: Minimum bend radius for coiling cable is 8 inches.

8.1 Health and Safety
Chemicals

NOTE: For additional health, safety, and disposal information about reagents, download the MSDS documents for the chemical in question from the EXO manufacturers' websites: www.ysi.com or www.wtw.de.

First Aid for all solutions

Inhalation	Move to fresh air. If breathing is difficult, give oxygen. If symptoms persist, seek medical attention.
Skin Contact	Remove contaminated clothing and wash. Wash exposed area with soap and water for at least 15 minutes. If irritation persists, seek medical attention.
Eye Contact	Rinse eyes immediately with large amounts of water, also under eyelids, for at least 15 minutes. If irritation persists, seek medical attention.
Ingestion	Wash out mouth with water and then drink plenty of water. If symptoms persist, seek medical attention.

Ammonium Solutions

3841, 3842, and 3843

Ingredients: Water, Ammonium Chloride, Lithium Acetate Dihydrate, Sodium Azide, Hydrochloric Acid

Nitrate Solutions

3885, 3886, and 3887

Ingredients: Water, Potassium Nitrate, Magnesium Sulfate Heptahydrate, Gentamycin Sulfate

Inhalation:
Avoid breathing vapors or mists. Ensure adequate ventilation is available before handling.

Skin:
Wear lightweight protective clothing, gloves, and apron.

Eyes:
Wear safety glasses with side-shields or face shield. Contact lenses should not be worn when working with these solutions.

Ingestion:
May be harmful if swallowed. Wear a mouth cover or face shield when there is splashing. Keep away from food and drink.

First Aid: See box at left.

Conductivity Solutions

3161, 3163, 3165, 3167, 3168, and 3169

Ingredients: Water, Potassium Chloride

Inhalation:
Avoid breathing vapors or mists. Inhalation of dust may cause irritation of respiratory tissues. Ensure adequate ventilation is available before handling.

Skin:
Exposure may cause irritation with repeated exposure. Wear lightweight protective clothing, gloves, boots, and apron.

Eyes:
Can cause irritation and potential eye damage with repeated exposure. Wear safety glasses with side-shields or face shield.

Ingestion:
May cause irritation of mouth, throat, and an upset stomach. Wear a mouth cover or face shield when there is splashing. Keep away from food and drink. Do not swallow.

First Aid: See box on page 123.

pH 4.00, 7.00, 10.00 Buffer Solutions

3821, 3822, and 3823

pH 4 Ingredients: Water, Potassium Hydrogen Phthalate, Red food coloring

pH 7 Ingredients: Water, Potassium Phosphate Monobasic, Sodium Hydroxide, Yellow food coloring

pH 10 Ingredients: Water, Potassium Hydroxide, Disodium EDTA dihydrate, Potassium Borate, Potassium Carbonate, Bromphenol Blue Sodium Salt, Bromphenol Green Sodium Salt

Inhalation:
Avoid breathing vapors or mists. Inhalation of dust may cause irritation of respiratory tissues. Ensure adequate ventilation is available before handling.

Skin:
Exposure may cause irritation with repeated exposure. Wear rubber or neoprene gloves.

Eyes:
Can cause irritation and potential eye damage with repeated exposure. Wear safety glasses with side-shields or face shield. Contact lenses should not be worn when working with these solutions.

Ingestion:
May cause nausea, vomiting, or diarrhea. Wear a mouth cover or face shield when there is splashing. Do not swallow. Do not induce vomiting.

First Aid: See box on page 123.

Zobell Solution

3682

Ingredients: Potassium Chloride, Potassium Ferrocyanide Trihydrate, Potassium Ferricyanide

Inhalation:
Inhalation of dust may cause irritation of respiratory tissues. Ensure adequate ventilation is available before handling.

Skin:
Exposure may cause irritation. Wear lightweight protective clothing, gloves, boots, and apron.

Eyes:
May cause irritation. Wear safety glasses with side-shields or face shield.

Ingestion:
May cause an upset stomach. Wear a mouth cover or face shield when there is splashing. Keep away from food and drink. Do not swallow. If large amount is ingested and person is conscious, induce vomiting.

First Aid: See box on page 123.

Turbidity Standard

6073

Ingredients: Water, Styrene divinyl Benzene copolymer beads

The material is not volatile and has no known ill effects on skin, eyes, inhalation or ingestion. Therefore, no special precautions are required when using the standards. However, general precautions should be adopted as required with all materials to minimize unnecessary contact.

First Aid: See box on page 123.

Ultraviolet Light

The fDOM sensor radiates ultraviolet light (UV light) which can be harmful to the eyes even during brief periods of exposure. Do not look into the light at the tip of the probe and wear protective eyewear when handling UV LEDs.

Lithium-Ion Battery Handling

Failure to exercise care when handling this product and to comply with the following conditions and guidelines could result in product malfunction, excessive heat, fire, property damage, and ultimately injury.

- **DO NOT** alter, puncture, or impact battery or related components.
- **DO NOT** directly connect the terminals with metal objects.
- **DO NOT** expose the battery to extreme temperatures or direct extended exposure to sunlight.
- Always disconnect batteries when not in use and for long term storage.
- Store batteries in a non-conductive and fireproof container.
- For best results, store the battery at approximately 50% of the capacity.

If at any time the battery becomes damaged, hot, or begins to balloon or swell, discontinue charging (or discharging) immediately. Quickly and safely disconnect the charger. Then place the battery and/or charger in a safe, open area way from flammable materials. After one hour of observation, remove the battery from service. **DO NOT** continue to handle, attempt to use, or ship the battery. Failure to follow these procedures can cause damage to the battery, personal property or cause serious injury.

⚠ Damaged or swollen batteries can be unstable and very hot. **DO NOT** touch batteries until they have cooled. In the event of a fire use a Class A, B, or C fire extinguisher. **DO NOT** use water.

If the internal battery fluid comes into contact with your skin, wash the affected area(s) with soap and water immediately. If it comes into contact with your eye(s), flush them with generous amounts of water for 15 minutes and seek immediate medical attention.

8.2 Radio Frequency

Xylem certifies that the EXO product line has been tested and complies with the following radio frequency (RF) interference standards and are approved for use in the following countries:

- United States: FCC Part 15 compliant
- Canada: RSS compliant
- European Union (EU): CE compliant
- Australia: CISPR 11 compliant
- New Zealand: CISPR 11 compliant
- Republic of Korea: Radio Waves Act compliant
- People's Republic of China: Radio regulations compliant
- Japan: TELEC Radio Law compliant
- Brazil: Anatel certification compliant

Reference the Declaration of Conformity in the next section for further details.

Bluetooth wireless technology and similar approvals and regulations can be country-specific. Check local laws and regulations to insure that the use of wireless products purchased from Xylem or its subsidiaries are in full compliance.

8.3 Declarations of Conformity

The undersigned hereby declares that the products listed below conform with all applicable requirements of FCC Part 15 for the U.S. and Industry Canada (IC) ICES-003 for Canada, for intentional radiators.

Manufacturer:	YSI Incorporated, a Xylem brand 1725 Brannum Lane Yellow Springs, OH 45387 USA
Equipment name:	EXO Sondes (EXO1 and EXO2) and EXO Handheld Systems
Model numbers:	599501-xx, 599511-xx, 599502-xx, 599512-xx, 599150
Intentional Radiators:	EXO Sondes (EXO1 and EXO2) contain the LMX Bluetooth module: FCC ID ED9LMX9838; IC 1520A-LMX9838. Nemko certified body ID #CE 2302. EXO Handheld (599150) contains a Wi-Fi/Bluetooth module: FCC ID U9R-W2CBW003; IC 7089A-W2CBW003. Nemko certified body ID #CE 2302.
Regulations:	• FCC 47 CFR Part 15-2011, Radio Frequency Devices. • IC ICES-003-2004, Digital Apparatus.

Lisa M. Abel, Director, Quality
June 7, 2012

The undersigned hereby declares that the products listed below conform with all applicable Essential Requirements of the listed Directives and Standards and carry the CE mark accordingly.

Manufacturer:	YSI Incorporated, a Xylem brand 1725 Brannum Lane Yellow Springs, OH 45387 USA
Equipment name:	EXO Sondes (EXO1 and EXO2) and EXO Handheld Systems
Model numbers:	599501-xx, 599511-xx, 599502-xx, 599512-xx, 599150
Accessories/Sensors:	599090-xx, 599100-xx, 599101-xx, 599102-xx, 599104-xx, 599118-xx, 599800, 599810, 599870-xx, 599040-xx, 599008-xx, EXOISE0x
Intentional Radiators:	EXO Sondes (EXO1 and EXO2) contain the LMX Bluetooth module. EXO Handheld (599150) contains a Wi-Fi/Bluetooth module. Nemko certified body ID# CE 2302.

Directives:
- EMC 2004/108/EC
- R&TTE 1999/5/EC
- ROHS
- WEEE

Harmonized Standards:
- EN61326-1:2006, Electrical equipment for measurement, control, and laboratory use – EMC requirements – Part 1: General Requirements.
- EN61326-2-3:2006, Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 2-3: Particular Requirements – Test configuration, operational conditions, and performance criteria for transducers with integrated or remote signal conditioning.
- EN61000-3-2:2006+A1:2009+A2:2009, Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current <16A per phase).
- EN61000-3-3:2008, Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems for equipment with rated current < 16A per phase and not subject to conditional connection.
- EN 300 328, V1.7.1, Electromagnetic compatibility and Radio spectrum Matters (ERM); Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive.
- EN 301 489-1, V1.8.1, Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements.
- EN 301 489-17, V2.1.1, Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment; Part 17: Specific conditions for Broadband Data Transmission Systems.
- EN 60950-1: Information technology equipment – Safety – Part 1: General requirements.

Lisa M. Abel, Director, Quality
June 7, 2012

The undersigned hereby declares that the products listed below conform with the Australian and New Zealand Electromagnetic Compatibility (EMC) requirements for generic products to be used in residential, commercial, and light industrial environments, and carry the C-Tick mark accordingly.

Manufacturer:	YSI Incorporated, a Xylem brand 1725 Brannum Lane Yellow Springs, OH 45387 USA
Equipment name:	EXO Sondes (EXO1 and EXO2) and EXO Handheld Systems
Model numbers:	599501-xx, 599511-xx, 599502-xx, 599512-xx, 599150
Accessories/Sensors:	599090-xx, 599100-xx, 599101-xx, 599102-xx, 599104-xx, 599118-xx, 599800, 599810, 599870-xx, 599040-xx, 599008-xx, EXOISE0x
Intentional Radiators:	EXO Sondes (EXO1 and EXO2) contain the LMX Bluetooth module. Nemko certified body ID #CE 2302. C-Tick number N136. EXO Handheld (599150) contains a Wi-Fi/Bluetooth module. Nemko certified body ID #CE 2302. C-Tick number N136.

Directives:
- EMC 2004/108/EC
- Australian ACMA Standards for C-Tick mark, Section 182 of the Radiocommunications Act 1992.
- New Zealand RSM Standards, Radiocommunications Act 1992.
- Telecommunications Labeling, Notice 2001 under section 407 of the Australian Telecommunications Act 1997.

Standards:
- EN61326-1:2006, Electrical equipment for measurement, control, and laboratory use – EMC requirements – Part 1: General Requirements.
- ACMA Radio Communications (Short Range Devices), 2004.
- AS/NZ 4268, 2008.
- Radio Communications (Electromagnetic Radiation - Human Exposure) Standard, March 2003.

Lisa M. Abel, Director, Quality
June 7, 2012

The undersigned hereby declares that the products listed below conform with all applicable requirements of the Radio Waves Act of Korea, for intentional radiators.

Manufacturer:	YSI Incorporated, a Xylem brand 1725 Brannum Lane Yellow Springs, OH 45387 USA
Equipment name: Model numbers:	EXO Sondes (EXO1 and EXO2) and EXO Handheld Systems 599501-xx, 599511-xx, 599502-xx, 599512-xx, 599150
Intentional Radiators:	EXO Sondes (EXO1 and EXO2) contain the LMX Bluetooth module. Broadcasting and certification number KCC-CRM-XYL-EXOSonde1 (for EXO1) and KCC-CRM-XYL-EXOSonde2 (for EXO2). EXO Handheld (599150) contains a Wi-Fi/Bluetooth module. Broadcasting and certification number KCC-CRM-XYL-EXOHANDHELD (for EXO Handheld).
Type Identification:	LARN8-IO2Y2402/2480TR0.000003F1D79 (EXO1) LARN8-IO2Y2402/2480TR0.00001F1D79 (EXO2) LARN8-IO2Y2402/2480TR0.00003F1DG1D79 (EXO Handheld)
Regulation:	Radio Waves Act of the Republic of Korea.

A급 기기 (업무용 방송통신 기자재)
이 기기는 업무용 (A급) 전자파 적합기기로서
판매자 또는 사용자는 이 점을 주의하시기 바라
며, 가정 외의 지역에서 사용하는 것을 목적으 로 합니다.

Class A device (Broadcasting and communication equipment for office work).
Seller and user shall be noticed that this equipment is suitable for electromagnetic equipment for office work (Class A) and it can be used outside the home.

KCC notice 2012-12. Radio device using 2400-2483.5 MHz and 5725-5825 MHz.
해당 무선설비는 전파혼신
가능성이 있으므로 인명안전과
관련된 서비스는 할 수 없음.
Service related to human safety is not allowed because this device may have the possibility of the radio interference.

Lisa M. Abel, Director, Quality
December 13, 2012

The undersigned hereby declares that the products listed below conform with all applicable requirements of the Radio Regulations of China, for intentional radiators.

Manufacturer:	YSI Incorporated, a Xylem brand 1725 Brannum Lane Yellow Springs, OH 45387 USA
Equipment name:	EXO Sondes (EXO1 and EXO2) and EXO Handheld Systems
Model numbers:	599501-xx, 599511-xx, 599502-xx, 599512-xx, 599150
Intentional Radiators:	EXO Sondes (EXO1 and EXO2) contain the LMX Bluetooth module. EXO Handheld (599150) contains a Wi-Fi/Bluetooth module.
CMIIT ID:	CMIIT ID: 2012DJ7503 (EXO1) CMIIT ID: 2012DJ7504 (EXO2) CMIIT ID: 2012DJ7505 (EXO Handheld)
Regulation:	Radio Regulations of the People's Republic of China.

A级设备（办公用广播和通讯设备）
销售商和使用者应注意本设备适用于办公条件下的电磁环境（A级）并可以在室外使用。
Class A device (Broadcasting and communication equipment for office work).
Seller and user shall be noticed that this equipment is suitable for electromagnetic equipment for office work (Class A) and it can be used outside the home.

Lisa M. Abel, Director, Quality
December 13, 2012

The undersigned hereby declares that the products listed below conform with all applicable requirements of TELEC and Radio Law of Japan for intentional radiators.

Manufacturer:	YSI Incorporated, a Xylem brand 1725 Brannum Lane Yellow Springs, OH 45387 USA
Equipment name:	EXO Sondes (EXO1 and EXO2) and EXO Handheld Systems
Model numbers:	599501-xx, 599511-xx, 599502-xx, 599512-xx, 599150
Intentional Radiators:	Intentional radiators: EXO Sondes (Exo1 and Exo2) contain the LMX Bluetooth module. Exo1 TELEC certificate number 001-A00577. Exo2 TELEC certificate number 001-A00578. EXO Handheld contains a Wi-Fi/Bluetooth module; certificate number 001-A00579.
Regulations:	TELEC; Article 38-24 Paragraph 1 of the Radio Law.

Lisa M. Abel, Director, Quality
June 7, 2012

The undersigned hereby declares that the products listed below conform with all applicable requirements of the Anatel Regulations of Brazil for intentional radiators.

Manufacturer:	YSI Incorporated, a Xylem brand 1725 Brannum Lane Yellow Springs, OH 45387 USA
Equipment name:	EXO Sondes (EXO1 and EXO2) and EXO Handheld Systems
Model numbers:	599501-xx, 599511-xx, 599502-xx, 599512-xx, 599150
Intentional Radiators:	Intentional Radiators: EXO Sondes (EXO1 and EXO2) contain the LMX Bluetooth module: Certificate of Homologation No. 0657-13-8838; Certificate of Conformity No. 07473/13. EXO Handheld (599150) contains a Wi-Fi/Bluetooth module: Certificate of Homologation No. 1281-13-8838; Certificate of Conformity No. 07769/13.
Regulations:	Anatel; Transceptor de Radiacao Restrita - Categoria II

Lisa M. Abel, Director, Quality
June 7, 2012

8.4 Instrument Warranty

Warranty Card

Register your product with the online warranty card: www.EXOwater.com/warranty

- Warranted against defects in workmanship and materials when used for their intended purposes and maintained according to instructions and exclusive of batteries and any damage caused by defective batteries.

- **Two years**: cables; sondes (bulkheads); handheld; conductivity, temperature, depth, and optical sensors; electronics base for pH, pH/ORP, ammonium, chloride, and nitrate sensors; and accessories.

- **One year:** optical DO membranes and replaceable reagent modules for pH and pH/ORP.

- **Three months**: replaceable reagent modules for ammonium, chloride, and nitrate.

Regular maintenance of sondes and sensors, such as replacing damaged o-rings, is described in the Maintenance section of this manual. Users are expected to follow these guidelines to keep their equipment in good and proper working order and to protect the warranty on the product. Damage due to accidents, misuse, tampering, or failure to perform prescribed maintenance is not covered.

This warranty does not include batteries or damage resulting from defective batteries. As documented in the Maintenance section of this manual, batteries should be removed from all sondes and handheld when the product is not in use. Since many battery manufacturers will repair or replace any equipment that has been damaged by their batteries, it is essential that leaky or defective batteries be retained with the damaged product until the manufacturer has evaluated the claim.

The warranty period for chemicals and reagents is determined by the expiration date printed on their labels. Within the warranty period, we will repair or replace, at our sole discretion, free of charge, any product that we determine to be covered by this warranty.

To exercise this warranty, write or call your local representative, or contact Technical Support. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by the manufacturer. Repair or replacement will be made and the product returned transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

Limitation of Warranty

This Warranty does not apply to any EXO product damage or failure caused by (i) failure to install, operate or use the product in accordance with the written instructions, (ii) abuse or misuse of the product, (iii) failure to maintain the product in accordance with the written instructions or standard industry procedure, (iv) any improper repairs to the product, (v) use by you of defective or improper components or parts in servicing or repairing the product, or (vi) modification of the product in any way not expressly authorized by the manufacturer.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. YSI's LIABILITY UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AND THIS SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY. IN NO EVENT SHALL YSI BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY.

8.5 Instrument Service
Cleaning and Packing

EXO Authorized Service Centers are located in the United States and around the world. Please refer to the EXO website (**EXOwater.com**) for your nearest Authorized Service Center.

Product Return Form

Find the product return form online:
www.EXOwater.com/return

Cleaning Certificate

Find the cleaning certificate on the back of the online product return form:
www.EXOwater.com/return

Cleaning Instructions

Before they can be serviced, equipment exposed to biological, radioactive, or toxic materials must be cleaned and disinfected. Biological contamination is presumed for any instrument, probe, or other device that has been used with body fluids or tissues, or with wastewater. Radioactive contamination is presumed for any instrument, probe or other device that has been used near any radioactive source.

If an instrument, probe, or other part is returned or presented for service without a Cleaning Certificate, and if in our opinion it represents a potential biological or radioactive hazard, our service personnel reserve the right to withhold service until appropriate cleaning, decontamination, and certification has been completed. We will contact the sender for instructions as to the disposition of the equipment. Disposition costs will be the responsibility of the sender.

When service is required, either at the user's facility or at the manufacturer, the following steps must be taken to insure the safety of our service personnel.

- In a manner appropriate to each device, decontaminate all exposed surfaces, including any containers. 70% isopropyl alcohol or a solution of 1/4 cup bleach to 1 gallon tap water are suitable for most disinfecting. Instruments used with wastewater may be disinfected with .5% Lysol® if this is more convenient to the user.
- The user shall take normal precautions to prevent radioactive contamination and must use appropriate decontamination procedures should exposure occur.
- If exposure has occurred, the customer must certify that decontamination has been accomplished and that no radioactivity is detectable by survey equipment.
- Cleaning must be completed and certified on any product before returning.

Packing Instructions

- Clean and decontaminate items to insure the safety of the handler.
- Complete and include the Product Return Form, found online.
- Place the product in a plastic bag to keep out dirt and packing material.
- Use a large carton, preferably the original, and surround the product completely with packing material.

8.6 Instrument Service
Recycling

Batteries

The user must remove and dispose of alkaline batteries when they no longer power the EXO1 sonde, EXO2 sonde, or EXO Handheld. Disposal requirements vary by country and region, and users are expected to understand and follow the battery disposal requirements for their specific locale.

The circuit board in these instruments may contain a manganese dioxide lithium "coin cell" battery that must be in place for continuity of power to memory devices on the board. This battery is not user serviceable or replaceable. When appropriate, an authorized service center will remove this battery and properly dispose of it, per service and repair policies.

Rechargeable Li-Battery Pack

(1) When the battery is worn out, insulate the terminals with adhesive tape or similar materials before disposal.

(2) Dispose of batteries in the manner required by your city, county, state or country. For details on recycling lithium-ion batteries, please contact a government recycling agency, your waste-disposal service, or visit reputable online recycling sources such as **www.batteryrecycling.com.**

This product must not be disposed of with other waste. Instead, it is the user's responsibility to dispose of their waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment.

For more information about where you can drop off your waste equipment for recycling, please contact your local city office, or your household waste disposal service. **DO NOT ship batteries to YSI.**

Manufacturer

We are committed to reducing the environmental footprint of our products. While materials reduction is the ultimate goal, we also make a concerted effort to responsibly deal with materials after a long, productive life-cycle. Our recycling program ensures that old equipment is processed in an environmentally responsible way, reducing the amount of materials going to landfills.

- Printed circuit boards are sent to facilities that process and reclaim as much material for recycling as possible.
- Plastics enter a material recycling process and are not incinerated or sent to landfills.
- Batteries are removed and sent to battery recyclers for dedicated metals.

xylem
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