



SEA-BIRD
SCIENTIFIC

SBE 37 SMP, SMP-ODO SDI12

MicroCAT conductivity and temperature sensor

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ODO SDI12

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Section 1 Safety information

Please read this entire manual before this equipment is unpacked, set up, or operated. Pay attention to all danger, warning, and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, may cause damage to equipment. Information that requires special emphasis.

1.1 Hazard information

WARNING

This product can expose the user to chemicals with silica, crystalline (airborne particles of respirable size), which is known to the State of California to cause cancer and birth defects or other reproductive harm. For more information, go to www.P65Warnings.ca.gov.

WARNING





If the user thinks that a sensor has water in the pressure housing: Disconnect the sensor from any power supply. Put on safety glasses and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, use the purge port (if the sensor is so equipped), or very SLOWLY loosen the bulkhead connector to let the pressure release.

WARNING



If the user thinks that the batteries have leaks, pressure may have built up inside of the pressure housing. Follow ESD protocols to release internal pressure. Put on safety glasses and protective gloves and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, very SLOWLY loosen the bulkhead connector to release the pressure. Keep away from heat, sparks, flame, and other sources of ignition. Do not smoke.


⚠ CAUTION	
 	<p>The pressure housing contains Electrostatic Discharge (ESD) sensitive parts and assemblies that are susceptible to damage from ESD. Follow ESD protocols:</p> <ul style="list-style-type: none"> • Put on protective eye wear before you open the pressure housing. • Any electrostatic charge on the body of the human operator must be released before the pressure housing is opened: put a hand on a grounded surface, or better, wear a grounded antistatic wrist strap. • At a minimum, wear short-sleeved antistatic clothing, such as cotton, or better, wear an antistatic smock for this service activity. <i>Do not wear a sweater, fleece or polyester-based clothing.</i> • At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. <i>Do not use a workstation with a synthetic or polymeric-based tabletop.</i>


⚠ CAUTION
<p>AF24173 anti-fouling devices contain bis(tributyltin) oxide. Wear rubber or latex gloves and eye protection to replace these devices on the sensor if it is so equipped. Wash hands with soap and water when finished.</p> <p>Read the precautions on the product label.</p> <p>It is a violation of US federal law to use this product in a manner that is inconsistent with its label.</p>


NOTICE
<p>The manufacturer is not responsible for any damages due to misapplication of misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect process during a possible equipment malfunction.</p>

1.2 Equipment labels

Read all labels and tags attached to the equipment. Personal injury or damage to the equipment could occur if not observed. A symbol on the equipment is referenced in the manual with a precautionary statement.

	<p>Electrical equipment marked with this symbol may not be disposed of in European domestic or public disposal systems. Return old or end-of-life equipment to the manufacturer at no charge to the user.</p>
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	<p>EFUP e: No hazardous material exists over the threshold of GB/T 26572-2011 standard, China's Requirements for Concentration Limits for Certain Hazardous Substances in Electrical and Electronic Products. This product should be recycled after its environmentally friendly use period.</p>
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	<p style="text-align: center;">ATTENTION! Remove sticker before deployment!</p> <p>This sticker protects your instrument during shipping. REMOVE BEFORE DEPLOYMENT; if it is not removed, your instrument will not operate properly and you may cause severe damage to the conductivity cell. The conductivity cell is made of glass and will break if mishandled or frozen while filled with water. Apply new sticker to protect instrument when not in use (see spares kit).</p> <p>NOTICE: Sticker may have come in contact with the AF24173 Anti-foulant device, which contains TBTO. Dispose of the removed sticker. See SDS for handling precautions.</p>
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Section 2 MicroCAT quick start guide

This quick start guide gives the steps necessary to make sure that the SBE 37 MicroCat sensor operates correctly and collects data before it is deployed.

This quick start guide and user manual applies to the SBE 37 SMP and SBE 37 SMP-ODO models that use the SDI12 communications protocol. Refer to the [Feature summary](#) on page 7 for more details about each model.

What's in the box:

- CD or USB drive—has software, calibration files, documentation
 - Dummy plug and lock collar
 - Data I/O cable to connect the sensor to a PC
 - Plumbing kit and non-ionic surfactant to clean sensor flow path
 - Spare hardware and O-ring kit.
1. Install the manufacturer-supplied batteries. Refer to [Install batteries](#) on page 18 for details.
 - a. Remove the end flange of the sensor.
 - b. Disconnect the battery holder and remove it from the sensor.
 - c. Install new batteries.
 - d. Connect the battery pack to the sensor again and install the end flange again.
 2. Install the manufacturer-supplied software on a PC. Refer to [Install software](#) for details.
 3. Connect the data I/O cable to the sensor and the PC and start the software.
 4. Set up the sensor for deployment. Refer to [Set up sensor and verify operation](#) on page 15 for details.
 - a. If necessary, make sure that all data stored in the sensor is transmitted to a PC.
 - b. Set the date and time and configure the data collection settings.
 - c. Send the DS and DC commands to verify setup.
 - d. For SDI12 deployments **see XXXX for details:**
 - Set the address for SDI12 communications. This is aAb!
 - Set up the controller to send requests to operate the pump and take samples, then transmit.
 5. Remove the yellow protective label from the plumbing intake and exhaust.
 6. Verify that the antifouling devices are installed. Refer to [Verify anti-fouling devices](#) for details.
 7. Install the dummy plug or cable connector and lock collar.
 8. Deploy the sensor. For most applications, make sure the connector is at the bottom (lowest point).
 9. Immediately after the sensor is recovered from a deployment:
 - a. Transmit data from the sensor to a PC. Refer to [Transmit data to PC](#) on page 31 for details.
 - b. Use the software to turn off the sensor.
 - c. Flush the sensor with fresh water.
 - d. Keep the sensor out of direct sunlight between deployments
 10. Refer to [Store CTD](#) on page 39 for details to prepare the sensor for short- or long-term storage.

Section 3 Specifications

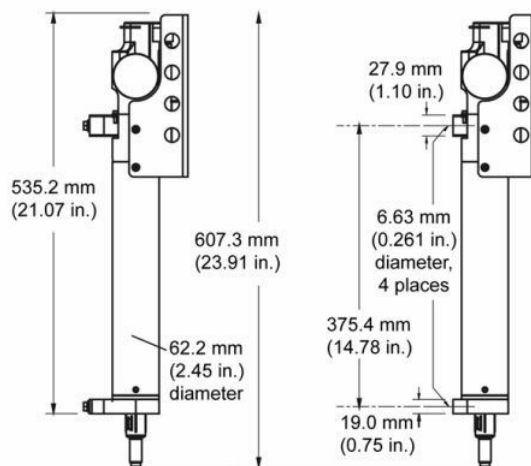
3.1 Feature summary

Model	Available hardware				Available communication interfaces			
	Pressure	Internal batteries	Pump	Optical Dissolved Oxygen	RS232	RS485	SDI12	Inductive Modem
37-SM	X	X			X	X		
37-SMP	X	X	X		X	X	X	
37-SMP-ODO	X	X	X	X	X	X	X	
37-SI	X				X	X		
37-SIP	X		X		X	X		
37-IM	X	X						X
37-IMP	X	X	X					X
37-IMP-ODO	X	X	X	X				X

3.2 Mechanical

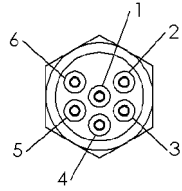
	37-SMP	37-SMP-ODO
Weight in air, water 350 m, plastic	3.4, 1.5 kg	
Length	53.5 cm	
Rated depth	350 m	
Optional strain gauge pressure sensor ranges	20, 100, 350 m	

3.2.1 Dimensions

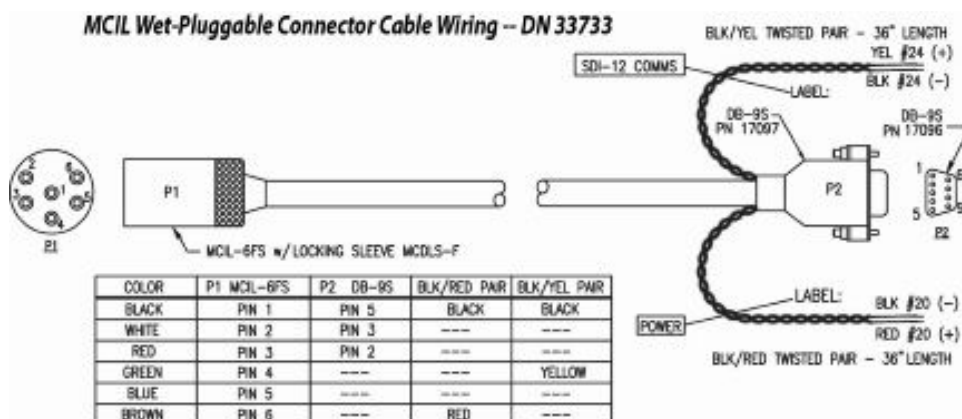


Specifications

3.2.2 Connector

Contact	Function	MCBH-6-MP
1	Ground	
2	RS232 Rx	
3	RS232 Tx	
4	SDI12 Tx	
5	N/C	
6	9–24 VDC external power	

3.2.3 Data I/O cable



3.3 Electrical

	37-SMP	37-SMP-ODO
Internal batteries	Saft LS-14500 (included), 3.6 V, 2.6 Ah Tadiran TL-4903, 3.6 V, 2.4 Ah Electrochem BCX85 series, 3.9 V, 2.0 Ah	
Current draw, low power	78 μ A	
Current draw, data collection	33.2 mA (RS232 TxRealTime off) 34.4 mA (RS232 TxRealTime on)	xx mA (TxRealTime off) xx mA (TxRealTime on)
Current draw, communication	4.3 mA, RS232 2.0 mA, SDI12	0.065 watts, RS232 0.024 watts, SDI12
Current draw, pump	25.3 mA	
External power	0.25 A at 9–24 VDC The sensor uses the higher voltage between the internal batteries and external power	

3.4 Communications

	37-SMP	37-SMP-ODO
Memory	8 Mb	
Communication interface	SDI12 or RS232	
RS232 baud rate	user-selectable, 600–115200, 8 data bits, 1 stop bit, no parity; SDI12 is 1200 only	

	37-SMP	37-SMP-ODO
Data storage	533,000 samples	381,000 samples
Firmware version	6.3.x and newer	

3.5 Analytical

Parameter	Range	Accuracy	Stability	Resolution
Conductivity	0–7 S/cm	±0.0003 S/cm	0.0003 S/cm	0.00001 S/cm
Temperature	-5–45 °C	±0.002 °C (-5–35 °C)	0.0002 °C/mo	0.0001 °C
Pressure	Determined by range of pressure gauge	±0.1% full scale range	0.05% full scale range/yr	0.002% full scale range

Section 4 Overview

4.1 Operation

The SBE 37 MicroCAT measures conductivity (C) and temperature (T).

Optional equipment includes:

- Pressure (depth, D)
- Internal pump
- Optical Dissolved Oxygen (ODO)

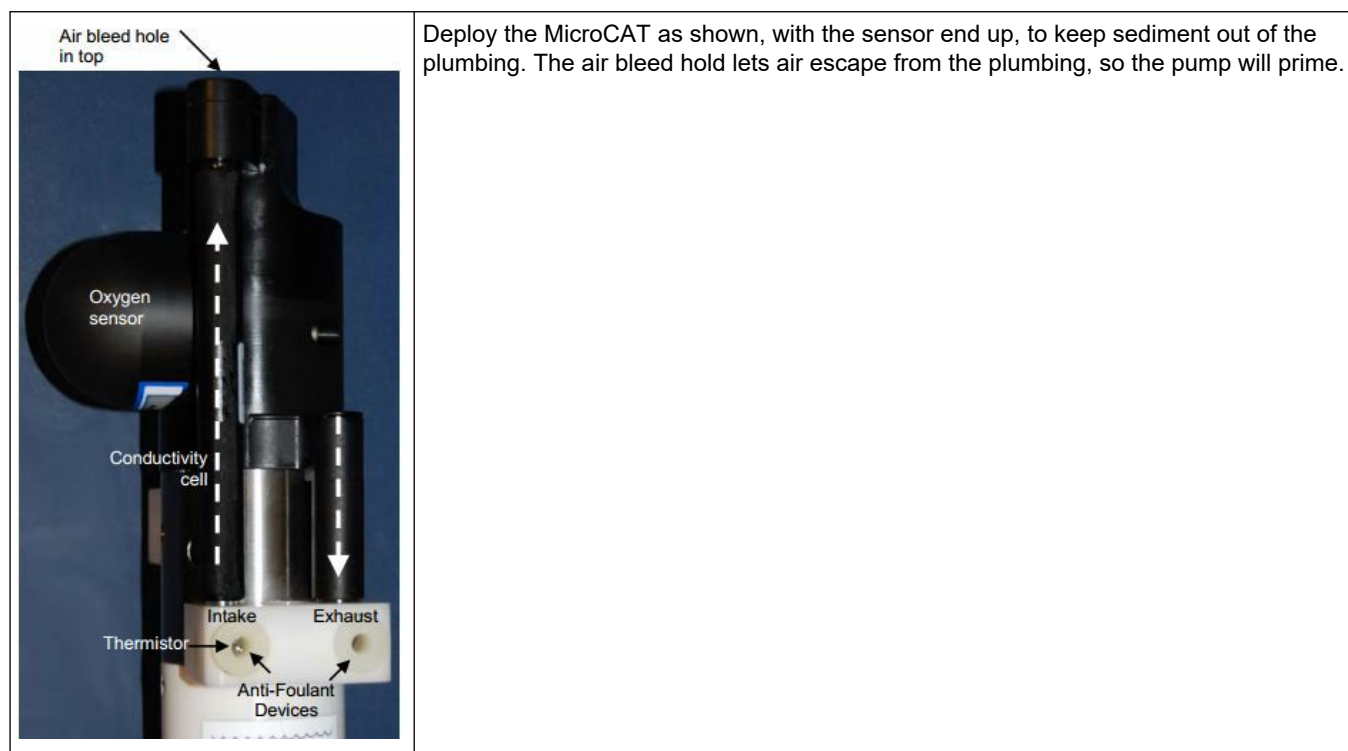
The sensor can operate as a standalone or is easily integrated with other platforms.

The optional internal pump operates for one second each time the sensor collects a sample. The internal pump has several advantages over sensors without pumps:

- The pump flushes the water from the flow path after each sample and quickly moves a new sample into the flow path so that conductivity and oxygen measurements are more accurate.
- Water does not flow freely through the flow path so it stays saturated with the anti-fouling chemicals.
- The ODO sensor (SMP-ODO only) is integrated in the flow path to better align with the CTD measurement.

Polled operation

- Polled data collection is useful when the sensor is integrated with satellite, radio, or wire telemetry equipment. The sensor is connected to a remote controller and can be externally powered.
- Operation sequence:
 1. The pump operates on command for one second
 2. The sensor makes one measurement
 3. The sensor sends the data to the controller
 4. The sensor goes into a low power mode until the next command to operate.



4.2 Sample times

The time it takes for the MicroCAT to collect a sample depends on several factors, such as the data collection mode, and whether the optional pressure sensor is installed. The pump operates for 1.0 second before each measurement. Data collection time does not include the time it takes to transmit real-time data, which depends on the baud rate and the number of characters transmitted.

The time that shows with the data is the time at the start of the sample. For example, if the sensor is set to sample at 12:00:00, the stored time shown in the data will be 12:00:01 or 12:00:02.

Sample times to operate the pump and take a sample in polled mode: Add pump time before sample (refer to [Set up pump for ODO accuracy](#) on page 21 for details.)

Condition	SMP	SMP-ODO
No pressure sensor	1.9 sec	2.7 sec
Pressure sensor	2.6 sec	3.1 sec

4.3 Battery life

The battery pack is four 3.6 V AA lithium cells in series of three parallel strings, or 12 total battery cells. The battery holder has a yellow cover plate. It is NOT compatible with the older battery holder that has a red cover plate. The manufacturer recommends the user uses a conservative capacity value of 6.0 amp-hours, even though the nominal capacity is calculated at 7.8 A-hours (2.6 A-hours × 3).

The current draw varies if the sensor is set to transmit data in real-time (9.1 mA) or not (7.9 mA). The current draw of the pump is 0.025 μ A-seconds per pulse (1.0 second pulse). Low power current draw is 30 μ A (0.26 amp-hours/year).

The time required for each sample depends on the user-set data collection mode, and whether the MicroCAT has a pressure sensor. The MicroCAT is shipped with Deployment Endurance Calculator software to calculate the maximum deployment time. An example of a manual calculation is shown below.

Example: A 37-SMP with pressure sensor is set up to take a sample every 5 minutes, or 12 samples/hour. Data is not transmitted in real-time. How long can it be deployed?

Sample time = 2.6 seconds

Current draw for data collection = 0.0079 A × 2.6 seconds = 0.021 A-seconds/sample

12 × 0.021 = **0.25 A-seconds/hour**

Pump operation current draw = 0.025 A-seconds/pulse

12 × 0.025 = **0.3 A-seconds/hour**

Low power current draw = 30 μ A, or 0.03 mA

in 1 hour, 0.03 mA × 3600 seconds/hour = **0.11 A-seconds/hour**

Total current draw/hour = 0.25 + 0.3 + 0.11 = **0.66 A-seconds/hour**

Capacity = (6.0 A-hours × 3600 seconds/hour) ÷ 0.66 A-seconds/hour = 32727 hours = 1363 days = 3.7 years

The manufacturer recommends that batteries should be replaced every 2 years in the field

Number of samples = 32,000 hours × 12 samples/hour = 380,000 samples

4.4 Cable length and external power

The sensor can use an external power source that supplies 0.25 amps at 9–24 VDC in addition to or instead of the internal batteries. The MicroCAT uses power from the source that supplies the highest voltage.

Make sure to calculate IR loss for real-time data collection with external power:

1. The communication IR loss should be 1 V or less or it will not meet the RS232 communication standard.
2. Supply sufficient power to the sensor after IR loss is calculated.

Calculate communication IR loss

$$V_{\text{limit}} = 1 \text{ V} = IR_{\text{limit}}$$

$$\text{Maximum cable length} = R_{\text{limit}} \div \text{wire resistance/foot.}$$

$$I = \text{required communication current} = 4.3 \text{ mA.}$$

Example for SBE 37 SM, SMP:

What is the maximum cable length that can supply power to the MicroCAT to transmit real-time data with 20 gauge wire?

$$1 \text{ V} \div 0.0043 \text{ A} = 232 \text{ ohms}$$

$$\text{Maximum cable length} = 232 \text{ ohms} \div 0.0107 = 21734 \text{ ft, or } 6626 \text{ m}$$

Example for SBE 37-SMP-ODO:

What is the maximum cable length that can supply power to the MicroCAT with 20 gauge wire?

$$1 \text{ V} \div 0.005 \text{ A} = 200 \text{ ohms}$$

$$\text{Maximum cable length} = 200 \text{ ohms} \div 0.0107 = 18691 \text{ ft, or } 6568 \text{ m}$$

Supply sufficient power to MicroCAT

The power requirement depends on whether any power is supplied from the internal batteries:

- Supply a minimum of 16 V, after IR loss, so the MicroCAT does not get **any** power from the internal batteries. $V - IR > 16 \text{ V}$.
- Supply a minimum of 9 V, after IR loss, if the MicroCAT uses the internal batteries, or if no batteries are installed. $V - IR > 9 \text{ V}$.

$$I = \text{turn-on transient, } 0.25 \text{ A.}$$

Example for SBE 37 SM, SMP, SMP-ODO

What is the maximum cable length to supply power to the MicroCAT with 20 gauge wire, a 12 V power supply, and no internal batteries?

$$12 \text{ V} - 0.25 \text{ A} \times (0.0107 \times 2 \times \text{cable length}) = 560 \text{ ft, or } 170 \text{ m.}$$

170 m < 6568 m (or 6626 m), so the IR drop in power determines the maximum cable length.

Table 1 Common wire resistances

Gauge	Ohms/ft.
12	0.0016
14	0.0025
16	0.0040
18	0.0064
19	0.0081
20	0.0107
22	0.0162
24	0.0257
26	0.0410
28	0.0653

Section 5 Set up sensor and verify operation

⚠ CAUTION

AF24173 anti-fouling devices contain bis(tributyltin) oxide. Wear rubber or latex gloves and eye protection to replace these devices on the sensor if it is so equipped. Wash hands with soap and water when finished.

Read the precautions on the product label.

It is a violation of US federal law to use this product in a manner that is inconsistent with its label.

Set up the hardware and install the software for the sensor to make sure that it functions correctly before deployment.

- If so equipped, install the internal batteries.
- If so equipped, set up the pump.
- Install the manufacturer-supplied software.
- Verify operation.

5.1 Install software and test sensor

Make sure that the sensor is connected to a power supply and PC through the serial connector on the supplied cable. Most PCs no longer have serial ports, and a serial-to-USB adapter is necessary. Make sure that the USB driver software is installed on the PC so that there is communication between the sensor and the PC.

1. Install the Seasoftware V2 software from the manufacturer-supplied CD or USB drive.
 - The software includes **SeatermV2**, a terminal program to communicate with and get data from the selected sensor.
 - **SeasaveV7**, to collect, convert, and show real-time or saved data.
 - **SBE Data Processing**, to calculate and make plots of conductivity, temperature, pressure, and other data, as well as derived data.
2. Remove the dummy plug from the sensor.
3. Connect the I/O cable to the sensor and to the PC and a power supply (9–24 VDC).
4. Supply power to the sensor.
5. Select **SeatermV2** to start the launcher.
6. At the **Instruments** menu item, select the sensor model.

The main window opens. If this is the first time the software is opened, a Serial Port Configuration window opens. The software automatically connects at the default baud rate but will try others if necessary. The software automatically looks for the serial port number of the connected sensor.

The area on the left shows available commands. The large area on the right shows commands and the responses from the sensor to those commands.
7. Push **OK** to close this window.
8. In the **Communications** menu, select *Connect*.
9. In the **File** menu, select *Load Command file* and select the connected sensor.
10. In the "Commands" area, select "Sampling," then "Take Sample" to make sure the sensor operates and collects data.

5.1.1 Software menu items

Note that the sensor will "time out" if it does not receive a command for two minutes. To start the sensor again, select *Connect* in the software **Communications** menu or push **Enter**.

Set up sensor and verify operation

Menu item	Description
File	<i>Load command file</i> opens the selected .xml command file in the "Send Commands" area. <i>Unload command file</i> closes the file and removes the commands from the "Send Commands" area. <i>Exit</i> closes the program.
Communications	<i>Connect</i> connects to the COM port. <i>Disconnect</i> disconnects from the COM port. <i>Configure</i> sets the COM port and baud rates. <i>Disconnect and reconnect</i> turns communications off then on. Useful if a sensor is non-responsive.
Command	<i>Abort</i> stops the sensor. (The Esc key is equivalent.) <i>Send 5-second break</i> is used with Serial Line Sync Mode. Does not apply to 37 SMP-ODO. <i>Send stop command</i> stops sensor operation. <i>Set local time/Set UTC time</i> sets the clock in the sensor to the time from the PC.
Capture	<i>Capture</i> sensor responses to save real-time data or for diagnostics. Select <i>Capture</i> again to turn it off. Capture status shows in the "Status" bar.
Upload	<i>Upload</i> data from the sensor to a PC. Data is in an .xml format and is automatically converted to .hex and .xmlcon files for the Data Conversion software module.
Tools	<i>Diagnostics log</i> saves diagnostic data. Use <i>Convert .xml data file</i> to manually convert data if the automatic Upload does not convert the data. <i>Send script</i> sends the same setup information to a number of MicroCAT sensors.

5.2 Verify conductivity cell devices

⚠ CAUTION



AF24173 anti-fouling devices contain bis(tributyltin) oxide. Wear rubber or latex gloves and eye protection to replace these devices on the sensor if it is so equipped. Wash hands with soap and water when finished.

Read the precautions on the product label.

It is a violation of US federal law to use this product in a manner that is inconsistent with its label.

Sensors equipped with conductivity cells have a subassembly with a holder for either an anti-fouling device or a blank device and a yellow protective label.

Table 2 Conductivity cell devices

	
AF24173 anti-fouling device	Blank device






1. Remove the yellow label.
Keep the label to attach again to protect the intake and exhaust ports when the sensor is not deployed.
2. Remove the copper conductivity cell guard.



3. Use a toothpick to lift each of the devices out of the holder. If necessary, use needle-nose pliers to carefully break up the AF24173 device.

Option	Procedure
To deploy sensor	Insert new devices into the holders, then install the cap onto the cup. Do not tighten too tight. Attach the copper assembly to the sensor again.
To clean or store sensor	Do not install new anti-fouling devices. Do install the blank device. Install the protective plug. Make sure to remove the plug before the next deployment or pressurization of the sensor. Damage to the conductivity cells can be caused if the plugs are not removed.

5.3 Install batteries

⚠ WARNING	
	Explosion hazard. If the batteries are not installed correctly, explosive gases can be released. Make sure that the batteries are of the same approved chemical type and are inserted in the correct orientation.
⚠ WARNING	
	If the user thinks that a sensor has water in the pressure housing: Disconnect the sensor from any power supply. Put on safety glasses and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, use the purge port (if the sensor is so equipped), or very SLOWLY loosen the bulkhead connector to let the pressure release.
⚠ WARNING	
	If the user thinks that the batteries have leaks, pressure may have built up inside of the pressure housing. Follow ESD protocols to release internal pressure. Put on safety glasses and protective gloves and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, very SLOWLY loosen the bulkhead connector to release the pressure. Keep away from heat, sparks, flame, and other sources of ignition. Do not smoke.
⚠ CAUTION	
 	<p>The pressure housing contains Electrostatic Discharge (ESD) sensitive parts and assemblies that are susceptible to damage from ESD. Follow ESD protocols:</p> <ul style="list-style-type: none"> • Put on protective eye wear before you open the pressure housing. • Any electrostatic charge on the body of the human operator must be released before the pressure housing is opened: put a hand on a grounded surface, or better, wear a grounded antistatic wrist strap. • At a minimum, wear short-sleeved antistatic clothing, such as cotton, or better, wear an antistatic smock for this service activity. <i>Do not wear a sweater, fleece or polyester-based clothing.</i> • At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. <i>Do not use a workstation with a synthetic or polymeric-based tabletop.</i>

The manufacturer ships the 12 lithium batteries for the sensor separately. Do the steps below to install or replace the batteries. Also see the "how to" video on the manufacturer's website to do this procedure.


	
Do not ship assembled battery packs	Lithium batteries are packaged in heat-sealed plastic and bubble-wrap.

Table 3 Recommended lithium battery brands

SAFT LS-14500 (included)	3.6 V, 2.6 Ah
Tadiran TL-4903	3.6 V, 2.4 Ah
Electrochem BCX85 series	3.9 V, 2.0 Ah

1. Make sure that the end flange and pressure housing are dry.
2. Use a 9/64" hex key to remove the two screws on the sides of the pressure housing.
3. Install these two screws into the sides of the end flange to start to loosen the end flange.

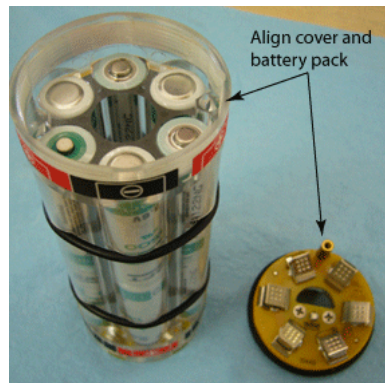


4. Turn the end flange counter-clockwise to loosen it from the pressure housing.
5. Pull gently to disconnect the battery wires in the end flange from the battery pack.
6. Use a lint-free tissue to remove any water from the O-ring surfaces inside the pressure housing and end flange.
7. Use a 7/64" hex key to loosen the captured screw in the battery cover plate.
8. Remove the battery pack from the pressure housing.
9. Turn the yellow cover plate counterclockwise to remove it from the battery pack body.
10. Move each of the two O-rings on the outside of the battery holder from the grooves. It makes it easier to remove or insert batteries.

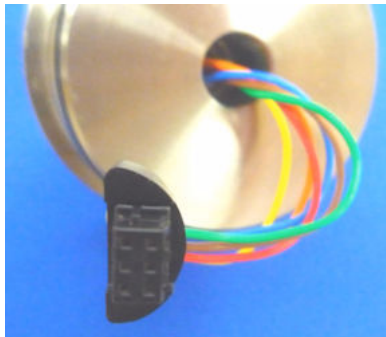


11. If necessary, remove the size AA batteries in the pack.
12. Insert new batteries.
Make sure to alternate the positive (+) and the negative (-) ends on the size AA batteries to agree with the labels on the pack as they are installed.
13. Move the O-rings back into the grooves.
14. Align the pin on the yellow battery cover with the post hole in the battery pack assembly.

Set up sensor and verify operation



15. Align the "D"-shaped part of the battery pack with the pins on the shaft.
16. Slowly move the assembly onto the housing. Push gently to connect the battery assembly with the circuit board in the pressure housing.
17. Use a 7/64" hex key to tighten the captured screw on the yellow battery cover onto the shaft in the pressure housing.
18. Attach the Molex connector on the end flange to the connector in the pressure housing.



19. Examine the O-rings on the end flange. They must be pristine, with no lint or scratches or chips.
 - Apply a small quantity of Parker Super O Lube® to any new O-rings.
20. Align the end flange holes with the holes in the pressure housing.
21. Carefully push the end flange into the pressure housing.
It may help to rotate the end flange so that the wires do not bend too much.
22. If necessary, use a 9/64" hex key to remove the two screws from the end flange.
23. Use a 9/64" hex key to install the two screws into the pressure housing of the sensor again.

5.4 Set up pump

NOTICE

Do not operate the pump of a CTD without water. It will cause damage to the pump.

The integrated pump (models with "P" in their serial number) of the sensor is water-lubricated. The pump will be damaged if it is operated dry for an extended period of time. Operation of the integrated pump depends on the minimum conductivity frequency, the value in the Adaptive Pump Control setting, and the pressure and temperature of a scheduled deployment.

Set the **MinCondFreq**= to an appropriate value greater than the zero conductivity frequency from the Calibration Sheet to make sure that the pump does not operate in air. The sensor will still operate and collect data.

Pump operation time + data collection time + 5 seconds = sample interval.

5.4.1 Set up pump for ODO accuracy

Applies only to MicroCATS with Optical Dissolved Oxygen (ODO) sensors.

The pump operates before and during data collection to flush the system. The length of time it operates depends on the value for the Adaptive Pump Control command.

AdaptivePumpControl=Y is the default setting. The sensor calculates the time the pump must operate for best oxygen accuracy based on the temperature and pressure from the previous sample. Pump operation time increases as pressure increases and temperature decreases. The pump operates during data collection.

Adaptive Pump Control can affect the interval between samples: if the time required to operate the pump is too large, the sensor will not be able to collect data at the user-selected **SampleInterval**=. If this happens, the sensor starts the next interval 5 seconds after the previous interval. The manufacturer recommends that the sample interval be set to a minimum of:

Pumping time + data collection time + 5 seconds = sample interval

- **AdaptivePumpControl=N**: Used only for testing and calibration.
The pump operates for a user-set length of time before each sample and during the sample collection.
- The pump operates for $OxNTau \times OxTau20$
where
 $OxTau20$ = oxygen calibration coefficient, $OxTau20=$
 $OxNTau$ = pump operation time multiplier, $OxNTau=$
- To test or to remove sediment from the plumbing, use PumpOn and PumpOff commands to manually turn the pump on and off.

Operation and algorithm for Adaptive Pump Control

Notes:

- $OxTau20$ is set by the manufacturer.
- If the MicroCAT does not have a pressure sensor, the Adaptive Pump Control algorithm uses **ReferencePressure**= as an alternative.
- The calculated Pump Time does not include the time that the pump operates during data collection.

$$ft = A + (B \times T) + (C \times T^2)$$

$$fp = e^{(pcor \times P)}$$

$$\tau = OxTau20 \times ft \times fp \text{ (minimum } \tau \text{ is 2.0; maximum } \tau \text{ is 30.0)}$$

$$\text{pump time} = OxNTau \times \tau \text{ (minimum pump time} = 3.0)$$

where

$$A = 2.549$$

$$B = -1.106 \times 10^{-1}$$

$$C = 1.571 \times 10^{-3}$$

$$pcor = 1.45 \times 10^{-4}$$

$OxTau20$ = oxygen calibration coefficient

$OxNTau$ = pump time multiplier

P = measured pressure, decibars

T = measured temperature, °C

Set up sensor and verify operation

Variables for the algorithm above, with a typical OxTau 20 value of 5.5, and an OxNTau value of 7.0:

T, °C	P, dbars	ft	fp	Tau	Pump time, seconds before sample
-3	1500	2.89	1.24	19.7	138
-3	0	2.89	1.0	15.9	111
0	0	2.549	1.0	14.0	98
0	1500	2.549	1.24	17.3	121
4	0	2.132	1.0	11.7	82
4	1500	2.132	1.24	14.5	102
20	0	0.9654	1.0	5.3	37
20	1500	0.9654	1.24	6.6	46

The total time for each sample is the calculated pump time plus the time to collect a sample. The MicroCAT requires a minimum of 3 seconds between samples. If the time required to operate the pump is too long, the MicroCAT will not be able to collect samples at the user-set SampleInterval. The MicroCAT will start the next sample interval 5 seconds after the end of the previous sample interval. The manufacturer recommends that the pump-on time is based on the algorithm above, the deployment pressure, and the coldest expected temperature. Do not set the sample interval (SampleInterval=) to less than

pump-on time + sample time + 5 seconds.

Section 6 Deployment and recovery

⚠ WARNING



If the user thinks that a sensor has water in the pressure housing: Disconnect the sensor from any power supply. Put on safety glasses and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, use the purge port (if the sensor is so equipped), or very SLOWLY loosen the bulkhead connector to let the pressure release.

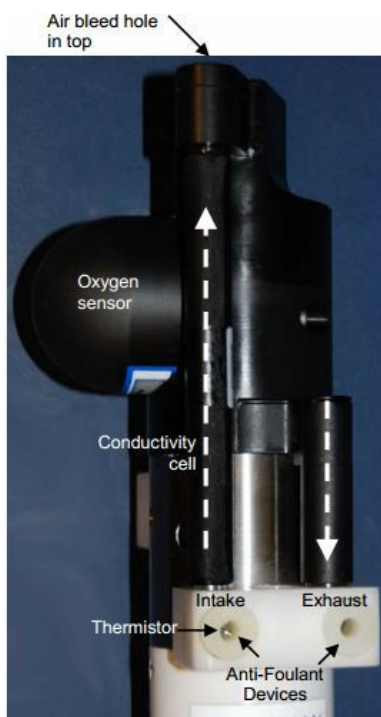
NOTICE

Examine, clean, and lubricate bulkhead connectors each time they are connected. Connectors that are not lubricated cause damage to the rubber that seals the connector contacts.

NOTICE

Do not operate the pump of a CTD without water. It will cause damage to the pump.

Make sure that the sensor is ready to deploy with the correct hardware and settings for the specific deployment. The manufacturer recommends that the sensor is deployed with the plumbing in a "U" to reduce intake of sediment and air. A small bleed hole in the duct releases air from the plumbing so that the pump will prime and operate.



The amount of air in the water column can have an effect on pump operation:

- The top ± 2 m of the water column may have a continuous supply of bubbles from breaking waves. It is important to be able to continuously remove air from the system.
- The next ± 30 m is not typically affected by bubbles. Without a bleed hole, it could take days to weeks for the air to be removed from the system. Once it is removed, no more air would get into the plumbing.
- Below ± 30 m, without a bleed hole, it can take hours to a day for the air to be removed from the system. Once it is removed, no more air would get into the plumbing.

The bleed hole lets air exit the plumbing and gives a little more ventilation. This ventilation will cause a slight decrease in the concentration of the anti-fouling function in the water held in the plumbing between samples. The risk of poor data because of sediment accumulation is usually greater than the risk of slightly reduced effectiveness of the anti-fouling function.

For most deployments, the plumbing of the sensor should be in an inverted U-shape to prevent the intake of sediment, and the bleed hole should be sealed. There are some conditions to consider:

Deployments in which severe biofouling applies but sediment intake does not:

- If accurate data is necessary immediately, seal the bleed hole and deploy the sensor in an upright U-shape.
- If it is not necessary to have accurate data immediately and there is time to let trapped air bleed from the system so the pump can prime correctly, seal the bleed hole and deploy the sensor in an inverted U-shape.

This deployment method will give good data within a day if the deployment is deeper than ± 30 m. Look at the conductivity data. Small changes in conductivity are a sign that the pump flow is not correct because air in the plumbing prevented the pump from priming.

Deployments in which air bubbles apply but sediment intake does not:

- Seal the bleed hole and deploy the sensor in an upright U-shape. Air will bleed from the plumbing but sediment intake is possible.

The manufacturer does not recommend horizontal mounting for deployments. If this is necessary, mount the sensor at a minimum 10 degree slope and point the intake and exhaust down.

1. Make sure that new lithium batteries are installed on sensors equipped with internal batteries. Refer to [Install batteries](#) on page 18 for details.
2. If necessary, remove the yellow protective label that covers the intake and exhaust ports.
3. If necessary, verify that the conductivity cell devices, either the AF24173 anti-fouling or the plastic dummy cylinder, are installed.
Refer to [Remove or replace conductivity cell devices](#) on page 33 for details.
4. Make sure that the bulkhead connectors are clean and lubricated. Refer to [Clean bulkhead connectors](#) on page 38 for details.
5. Attach the dummy plug or I/O cable to the sensor.
6. Optional: connect the sensor to a PC and or an external power supply.
7. If necessary, start the software.
8. Make sure all stored data has been transmitted to a PC. Send **InitLogging** to clear the memory. If this command is not sent, data will be stored after the last collected sample.
9. Set the date and time with **DateTime**.
10. Configure the data collection parameters.
11. Attach the mounting clamp and guide to the deployment cable.
12. Send the StartNow or StartLater command to start data collection (autonomous operation only).

6.1 Data collection modes

The MicroCAT can collect data in either polled or autonomous modes. Commands can be used in various combinations and in one or more modes. Note that sensors without internal batteries do not have real-time capability.

To prevent errors when data is written to memory, do not send polled data collection commands during autonomous operation.

6.1.1 Polled (controlled) mode

On command, the sensor collects one sample and transmits the data to the PC. Other options are available with different commands.

Example, user input in bold:

Supply power to the sensor. Set up to wait for a command each time it goes into standby mode. Send data in converted decimal format. Send date and time and salinity with data, then send power-off command. Keep power supplied to sensor. Connect to and start the sensor.

Enter **AUTORUN=N**

Enter **OUTPUTFORMAT=1**

Enter **OUTPUTTIME=Y**

Enter **OUTPUTSAL=Y**

Enter **GETCD** to verify setup

Enter **QS**

To collect a sample:

Enter **TS** Take Sample. Pump operates for 1.0 second.

Enter **QS** Command sensor to low power mode.

6.1.2 Autonomous mode

Interval, **SampleMode=2**: at user-selected intervals, the pump operates (if the conductivity frequency from the last sample is greater than MinCondFreq=), the sensor collects one sample, stores that data in the flash memory, and goes into a low power state.

Continuous, **SampleMode=3**: the sensor collects data at the fastest rate possible for the selected parameters. The pump operates continuously, if the conductivity frequency from the last sample is greater than MinCondFreq=. Data is transmitted to the PC.

Keep the signal line open circuit or within ± 0.3 V in relation to ground to minimize power consumption between commands.

Example, user input in bold:

Autonomous, continuous operation—AutoRun=N.

Set up to collect data every 20 seconds. Store data in memory. Transmit data in converted decimal format, send date and time with data. Send power-off command.

Connect to and start the sensor.

Enter **SAMPLEMODE=2**

Enter **SAMPLEINTERVAL=20**

Enter **STOREDATA=Y**

Enter **OUTPUTFORMAT=1**

Enter **OUTPUTTIME=Y**

Enter **AUTORUN=N**

Enter **GETCD** to verify setup

Enter **QS**

Enter **START**. Every 20 seconds, the pump operates, the sensor collects a sample, stores it in memory, and transmits it to the PC.

To stop data collection and put sensor in low power mode, push any key, then enter **STOP**. Optional: save the data to the PC.

Enter **QS**

Deployment and recovery

Autonomous, continuous operation—AutoRun=Y.

Set up to collect data every 20 seconds. Store data in memory. Transmit data in converted decimal format, send date and time with data. Remove power.

Connect to and start the sensor.

Enter **SAMPLEMODE=2**

Enter **SAMPLEINTERVAL=20**

Enter **STOREDATA=Y**

Enter **OUTPUTFORMAT=1**

Enter **OUTPUTTIME=Y**

Enter **AUTORUN=Y**

Enter **GETCD** to verify setup

Remove power.

Enter **START**. Every 20 seconds, the pump operates, the sensor collects a sample, stores it in memory, and transmits it to the PC.

To stop data collection, remove power.

To change the setup: supply power. Push any key, then enter **STOP**. Optional: save the data to the PC.

Remove power.

6.2 Data output formats

OutputFormat=	Description
OutputFormat=0	raw decimal, used by manufacturer for diagnostics
OutputFormat=1	converted decimal
OutputFormat=2	converted decimal, XML
OutputFormat=3	converted decimal, binary. MicroCATs with older firmware versions, SDI12-compatible format
OutputFormat=4	converted decimal, alternate. Date is mm-dd-yyyy
OutputFormat=5	converted decimal, compatible. Date is dd-mm-yyyy

Model	Supported output formats	
	RS232	RS485
37 SI	0, 1, 2	0, 1, 2, 3
37 SIP	0, 1, 2	0, 1, 2, 3
37 SM	0, 1, 2	0, 1, 2, 3
37 SMP	0, 1, 2, 3	0, 1, 2, 3
37 SMP-ODO	0, 1, 2	0, 1, 2
37 SMP-ODO SDI12	0, 1, 2, 3	N/A
37 IM	0, 1, 2, 4, 5	N/A
37 IMP	0, 1, 2, 4, 5	N/A
37 IMP-ODO	0, 1, 2, 4, 5	N/A

6.2.1 Raw decimal data

OutputFormat=0 is data in raw decimal format used by the manufacturer for diagnostics.

tttt=temperature, A/D counts

ccccccc=conductivity frequency, Hz

ppppp=pressure sensor pressure, sent if pressure sensor is installed. Units in A/D counts.

vvvv=pressure sensor pressure temperature compensation, sent if pressure sensor is installed. Units in A/D counts.
 dd mmm yyyy=day, month, year
 hh:mm:ss=hour, minute, second

<i>Example output in response to OutputFormat=0.</i>
ttttt, ccccc.ccc, ppppppp, vvvv, oo.ooo, t.tttt, dd mmm yyyy, hh:mm:ss
1722523, 93818, 23833, 20 Jun 2018, 10:16:44
temperature counts, pressure sensor counts, pressure sensor temperature compensation counts, date, time

Notes:

- Time = time at the start of the sample.
- Salinity, sound velocity, specific conductivity, and sample number are not sent, even if they are set to on. All data is separated with a comma and a space.
- The pressure sensor is an absolute sensor. The raw output, OutputFormat=0, includes the effect of atmospheric pressure (14.7 psi). When the output is in engineering units, pressure data is relative to the ocean surface, at 0 decibars. The sensor uses the equation:

$$\text{pressure, dbar} = (\text{pressure, psia} - 14.7) \times 0.689476$$

6.2.2 Converted decimal data

OutputFormat=1 is data in decimal format, converted to engineering units.

tt.tttt	temperature, sent if OutputTemp=y with units specified by SetTempUnits= .
c	conductivity, sent if OutputCond=y with units specified by SetCondUnits= .
	c.ccccc in S/m, if SetCondUnits=0
	cc.cccc in mS/cm, if SetCondUnits=1
	cccc.c in μ S/cm, if SetCondUnits=2
p.ppp	pressure, sent if pressure sensor is installed. OutputPress=y with units specified by SetPressUnits= . Digits left of the decimal specified by range of pressure sensor.
sss.ssss	salinity in psu, sent if OutputSal=y
vvvv.vvv	sound velocity in m/sec, sent if OutputSV=y
x	specific conductivity, sent if OutputSC=y with units specified by SetCondUnits=
	x.xxxxx in S/m, if SetCondUnits=0
	xx.xxxx in mS/cm, if SetCondUnits=1
	xxxx.x in μ S/cm, if SetCondUnits=2
oo.oooo	if SBE 63 is installed. Oxygen, sent if OutputOx=y, in units set by SetOxUnits=.
dd mmm yyyy	day, month, year
hh:mm:ss	hour, minute, second
n	sample number in flash memory, sent if TxSampleNum=y and autonomous data collection or polled commands that store data in flash memory or get the last sample from flash memory

Note: Only one zero to the left of the decimal point shows.

Deployment and recovery

Output format, SM-RS232
tt.tttt, c.ccccc, p.ppp, sss.ssss, vvvv.vvv, x, dd mmm yyyy, hh:mm:ss, n
temperature, conductivity (S/m), pressure, salinity, sound velocity, specific conductivity, date, time, sample number
<i>Example output:</i>
24.2724, 0.15269, 9.316, 0.57981, 1491.560, 0.57981, 20 Oct 2016, 09:01:34, 3

Output format, SMP-RS232
ttt.tttt, c.ccccc, ppppp.ppp, ssss.ssss, vvvvv.vvv, ccc.ccccc, dd mmm yyyy, hh:mm:ss
temperature, conductivity (S/m), pressure, salinity, sound velocity, specific conductivity (S/m), date, time
<i>Example output:</i>
24.2724, 0.15269, 9.316, 0.57981, 1491.560, 0.57981, 20 Oct 2016, 09:01:34

Output format, SMP-ODO-RS232
tt.tttt, c.ccccc, p.ppp, oo.ooo, sss.ssss, vvvv.vvv, x, dd mmm yyyy, hh:mm:ss, n
temperature, conductivity (S/m), pressure, oxygen, salinity, sound velocity, specific conductivity (S/m), date, time, sample number
<i>Example output:</i>
24.2724, 0.15269, 9.316, 5.954, 0.57981, 1491.560, 0.57981, 20 Oct 2016, 09:01:34, 3

6.2.3 Converted decimal data, compatible alternate

OutputFormat=2 is converted decimal data, compatible alternate

```
<?xml version="1.0"?>
```

```
<datapacket>
```

```
<hdr>
```

```
<mfg>Sea-Bird</mfg>
```

```
<model>37SM-RS232</model>
```

```
<sn>nnnnnnnn</sn>
```

```
</hdr>
```

```
<data>
```

```
<t1>ttt.tttt</t1>
```

```
<c1>cc.ccccc</c1>
```

```
<p1>p.ppp</p1>
```

```
<sal>sss.ssss</sal>
```

```
<sv>vvvv.vvv</sv>
```

```
<sc>x</sc>
```

```
<smpl>n</smpl>
```

```
<dt>yyyy-mm-ddThh:mm:ss</dt>
```

```
</data>
```

```
</datapacket>
```

037nnnnn	MicroCAT serial number
t.tttt	temperature, sent if OutputTemp=Y . Units in SetTempUnits= , °C or °F.
c	conductivity, sent if OutputCond=Y . Units in SetCondUnits= .
	c.ccccc if SetCondUnits=0 . Units in S/m.

	cc.cccc if SetCondUnits=1 . Units in mS/cm.
	cccc.c if SetCondUnits=2 . Units in μ S/cm.
p.ppp	pressure, sent if installed on sensor and OutputPress=Y , Units in SetPressUnits= , in dbar or psi. Number of digits left of decimal is a function of pressure sensor range.
s.ssss	salinity, sent if OutputSal=Y . Units in psu.
v.vvv	sound velocity, sent if OutputSV=Y . Units in m/sec.
x	specific conductivity, sent if OutputSC=Y . Units in SetCondUnits= .
	x.xxxxx if SetCondUnits=0 . Units in S/m.
	xx.xxxx if SetCondUnits=1 . Units in mS/cm.
	xxxxx.x if SetCondUnits=2 . Units in μ S/cm.
dd mmm yyyy	day, month, year
mm-dd-yyyy	month, day, year
hh:mm:ss	hour, minute, second
n	sample number in FLASH memory, sent if TxSampleNum=Y and autonomous mode or with commands that store data in FLASH memory or get the last sample from FLASH memory.

Example:

OutputFormat=2, OutputTemp=Y, SetTempUnits=0, SetCondUnits=0, SetPressUnits=0, SetOxUnits=0

temperature, conductivity, pressure, oxygen, salinity, sound velocity, specific conductivity, sample number, date, time

```
<?xml version="1.0"?> datapacket<hdr><mfg>Sea-Bird</mfg><model>SBE
39plus</model><sn>03720132</sn></hdr><data><t1>23.1258</t1><c1>0.00001</c1><p1>0.05
16</p1><ox63r>6.107</ox63r><sc>0.00001</sc><dt>2018-06-13T15:00:36</dt></data></dat
apacket> CRLF
```

6.2.4 Converted binary data

OutputFormat=3 is converted binary data in SDI-12 format. Used with SBE 37-SMP and 37-SMP-ODO sensors. Refer to [SDI12 command descriptions](#) on page 51 for details about SDI12 commands.

a	SDI12 address
+ or -	polarity sign, comes before each parameter
ttt.tttt	temperature, sent if OutputTemp=Y . Units in SetTempUnits= , °C or °F.
c	conductivity, sent if OutputCond=Y . Units in SetCondUnits= .
	cc.ccccc if SetCondUnits=0 . Units in S/m.
	ccc.cccc if SetCondUnits=1 . Units in mS/cm.
	cccc.c if SetCondUnits=2 . Units in μ S/cm.
pppp.ppp	pressure, sent if installed on sensor and OutputPress=Y , Units in SetPressUnits= , in dbar or psi. Number of digits left of decimal is a function of pressure sensor range.
oo.ooo	oxygen, sent if OutputOx=Y . Units in SetOxUnits= .
sss.ssss	salinity, sent if OutputSal=Y . Units in psu.
vvvv.vvv	sound velocity, sent if OutputSV=Y . Units in m/sec.
x	specific conductivity, sent if OutputSC=Y . Units in SetCondUnits= .
	xx.xxxxx if SetCondUnits=0 . Units in S/m.
	xxx.xxxx if SetCondUnits=1 . Units in mS/cm.

Deployment and recovery

	xxxxxx.x if SetCondUnits=2 . Units in $\mu\text{S/cm}$.
n	sample number in flash memory, sent if TxSampleNum=Y , with autonomous or polled commands that store data in flash memory or get the last sample from flash memory.

Example: 37-SMP-ODO, with pressure sensor installed, **OutputFormat=3**, **SetTempUnits=0**, **SetCondUnits=0**, **SetPressUnits=0**, **SetOxUnits=0**.

SDI12 address, temperature, conductivity, pressure, oxygen, salinity, sound velocity, specific conductivity, sample number

Example output:

0+23.1258+0.00002-0.267+0.838+0.0115+1492.967+0.00002+1

Example: 37-SMP, with pressure sensor installed, **OutputFormat=3**, **SetTempUnits=0**, **SetCondUnits=0**, **SetPressUnits=0**.

SDI12 address, temperature, conductivity, pressure, salinity, sound velocity, specific conductivity, sample number

Example output:

0+23.1258+0.00002-0.267+0.0115+1492.967+0.00002+1

6.3 Transmit real-time data

Cable length and baud rate

Use the **TxRealTime=Y** command to transmit data in real-time, and set the **BaudRate=** to agree with the cable length. Permitted combinations are listed below.

Maximum cable length, m	Maximum baud rate
200	4800
100	9600
50	19200
25	38400
16	57600
8	115200

To use the software to process the data, transmit stored data from the sensor memory.

6.4 Recover sensor from deployment

⚠ WARNING



If the user thinks that a sensor has water in the pressure housing: Disconnect the sensor from any power supply. Put on safety glasses and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, use the purge port (if the sensor is so equipped), or very SLOWLY loosen the bulkhead connector to let the pressure release.

1. Loosen the lock collar and move it up the cable so that the inside of the collar and the still-connected connector can be flushed with fresh water.
2. Flush the sensor with fresh water.
3. If necessary, install new batteries before data from the sensor is transmitted to a PC. Refer to [Install batteries](#) on page 18 for details.
Data stored in the sensor is not affected if the batteries are removed or replaced.

4. If necessary, connect the sensor to the PC and send the command to stop data collection.
5. Transmit the data stored in the sensor to the PC.
Look at the data to make sure it was transmitted and not corrupted. If there is any problem with the data, transmit the data again; the next deployment will overwrite this data.
6. Put the sensor in a low power state (**PwrOff**) and keep the battery pack in the sensor even if it will not be deployed soon.
The current draw in this state is 30 μ A, which reduces battery capacity by approximately 5% per year.
7. If the sensor is equipped with a pressure sensor, record the atmospheric pressure with a barometer.
This information can be used to compare with the sensor output in air to verify and correct for pressure sensor drift.
8. Carefully flush the conductivity cell with clean de-ionized water, then drain, and carefully blow through the cell to remove larger water drops.
9. Flush all internal plumbing to prevent salt crystal formation.

6.5 Transmit data to PC

Data can be transmitted during deployment or after the sensor is recovered from a deployment.

1. If necessary, start the software.
2. If the sensor mode is autonomous, send a command to stop: press any key, then type **Stop** and push **Enter**. It may be necessary to send the "Stop" command several times.
3. Type **DS** and look for the output to show `not logging, stop command at` approximately the fourth line.
4. Select the options to transmit data.
Data is transmitted from the sensor to the PC. The software makes a .hex data file and a .xmlcon configuration file that can be used to process data.

Section 7 Maintenance

⚠ WARNING



If the user thinks that a sensor has water in the pressure housing: Disconnect the sensor from any power supply. Put on safety glasses and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, use the purge port (if the sensor is so equipped), or very SLOWLY loosen the bulkhead connector to let the pressure release.

The manufacturer recommends that the user returns the sensor for calibration at regular intervals. The measurement accuracy of the sensor may decrease if the sensor is stored unused for long periods of time.

7.1 Maintain plastic sensor

Sensors with plastic or acetyl pressure housings are lighter and less expensive than the more durable titanium or aluminum housings, but require extra care.

- Plastic can become brittle in cold environments. It is possible for cracks to form around screw holes. Make sure that screws are tightened to 15 in-lbs., or finger-tight, then 45 degrees more.
- Plastic scratches easily. Do not use screwdrivers or metal tools to remove the end flange. Monitor the pressure housing for deep scratches that can become a point of weakness during deep deployments or very cold temperatures. Make sure that the O-ring surfaces are clean.

7.2 Remove or replace conductivity cell devices

⚠ CAUTION



AF24173 anti-fouling devices contain bis(tributyltin) oxide. Wear rubber or latex gloves and eye protection to replace these devices on the sensor if it is so equipped. Wash hands with soap and water when finished.

Read the precautions on the product label.

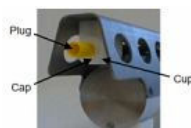
It is a violation of US federal law to use this product in a manner that is inconsistent with its label.

Sensors equipped with conductivity cells have a subassembly with a holder for either an anti-fouling device or a blank device. Make sure to remove the device to thoroughly flush the conductivity cell. Install the device again after the cell is clean so that the conductivity cell operates correctly. (The steps below are from the SBE-37 MicroCAT.)

Table 4 Conductivity cell devices

	
AF24173 anti-fouling device	Blank device

1. If necessary, remove the yellow protective plugs.
2. Remove the two screws that connect each device cup to the conductivity cell guard.



3. Remove the four Phillips screws that attach the conductivity cell guard to the pressure housing and carefully remove the cell guard.



4. Remove the protective plug from the device holder.
5. Use a 5/8-inch socket wrench to unscrew the device cap from the device cup.



6. Remove the AF24173 or the blank device from the cup.
7. Use a toothpick to lift each of the devices out of the holder. If necessary, use needle-nose pliers to carefully break up the AF24173 device.

Option	Procedure
To deploy sensor	Insert new devices into the holders, then install the cap onto the cup. Do not tighten too tight. Attach the copper assembly to the sensor again.
To clean or store sensor	Do not install new anti-fouling devices. Do install the blank device. Install the protective plug. Make sure to remove the plug before the next deployment or pressurization of the sensor. Damage to the conductivity cells can be caused if the plugs are not removed.

8. Attach the conductivity cell guard again.

7.3 Clean flow path

⚠ WARNING

Bleach is caustic. Wear nitrile gloves and safety glasses and work in a well ventilated area to use bleach. Wash hands after use.

⚠ CAUTION

Do not mix bleach with water > 1 PSU salinity or let bleach into a sensor that has not been flushed with clean, fresh (< 1 PSU) water.

The manufacturer recommends that the user thoroughly clean the flow path before and after a deployment to make sure that the sensor continues to collect accurate, high-quality data. Correct maintenance of the flow path is critical for the multi-parameter measurement capabilities.

1. Remove the pH sensor (if so-equipped) and store it in the white plastic holder with KCl solution or de-ionized (DI) water if non-ionic surfactant or bleach is necessary to

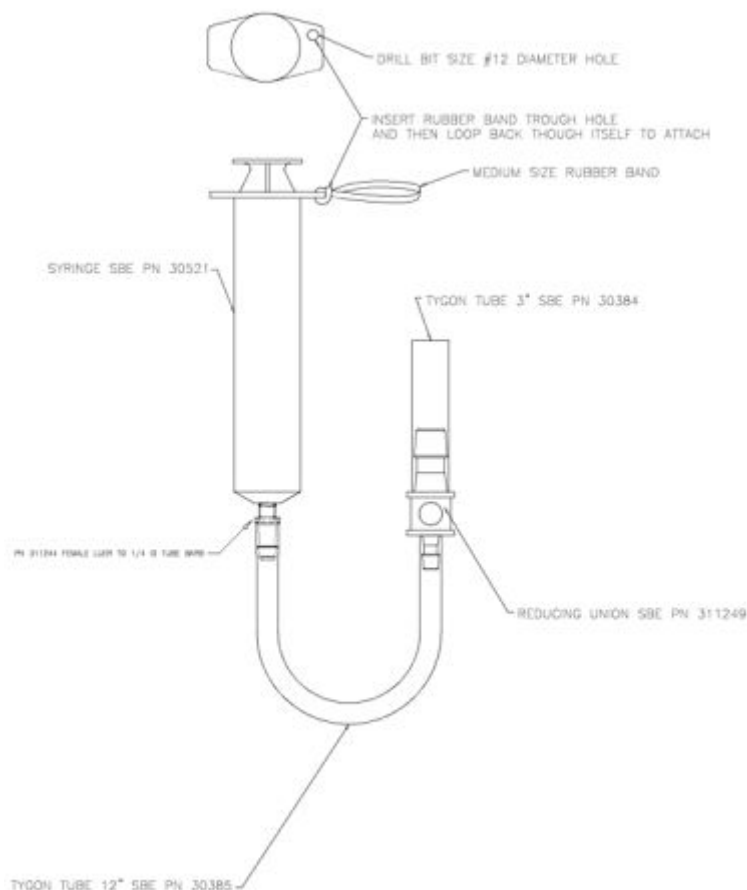
clean the flow path. The pH sensor can stay installed on the sensor if DI water is used.

2. Do not expose the pH sensor to air for longer than a few minutes. Refer to "Prepare pH sensor for storage" for details to remove the pH sensor.
3. If necessary, remove the copper assembly and anti-fouling or blank devices from the sensor.
4. Use a 3/16-inch hex wrench to remove the flushing port plug, a ¼-20 x 1 inch socket head screw.

Supplies:

- 500 ml bottle of DI water
- Container for waste water
- Container for sensor
- De-ionized or distilled water. If unavailable, use fresh tap water. Do not use shipboard fresh water because it can have traces of oil in it.
- Non-ionic surfactant. The manufacturer supplies this with each sensor. It is a secondary alcohol ethoxylate, a non-ionic detergent that is biodegradable. Make sure that any alternative detergent that is used is scientific grade, with no colors, perfumes, glycerins, lotions, etc.
- Bleach mixed 50:1—Household bleach is usually 4–7% (40,000–70,000 ppm) sodium hypochlorite with stabilizers.
- Part number 50087, the manufacturer-supplied kit to clean the plumbing.

Part number	Description
30384	Tygon tube, 7/16 inch ID, 1/16 inch wall
30385	Tygon tube, ¼ inch ID, 3/8 inch OD, 1/16 inch wall
30521	60 cc syringe
311244	Female Luer thread to ¼ inch ID tubing barb
311249	Nylon reducer union, ½ to ¼ inch



Procedure notes:

Use warm, 40 °C water and 1% non-ionic surfactant to flush the flow path for one minute.

It may be necessary to do these steps up to five times to clean the flow path.

If there is bio-fouling on the sensor it may be necessary to fill the flow path with the non-ionic surfactant solution for approximately 12 hours to loosen debris.

Make sure to remove the blank or anti-fouling device if necessary.

Keep the plug to install again.

5. Put the instrument in a container with the bulkhead connector face-up.
6. If a cleaning solution is necessary, pull approximately 30 ml into the syringe.
7. Attach the syringe to the tubing, PN 30385.
8. Push the syringe plunger to fill the sensor flow path until 3–5 cm of solution shows in each tube.
9. Push and pull the plunger to mix the solution in the flow path. Do this 2–3 times.
10. Drain the solution from the sensor into a waste container. Push the syringe plunger to help remove all of the solution from the sensor.
11. Remove the tubing and shake the sensor.
12. If the flow path is still not clean, do the above steps again with the bleach solution.
13. Flush the flow path with DI water.
14. Install the flushing port plug again.
15. Install either the blank or AF24173 device again.

The sensor is ready for a functional test in the laboratory or a deployment.

7.4 Remove and replace internal batteries

Refer to [Install batteries](#) on page 18 for details to change the internal lithium batteries.

7.5 Maintain pump

Sediment in the pump can cause data from the sensor to be of poor quality. To clean and maintain the pump, put the sensor in clean water and operate the pump for 15 minutes.

7.6 Clean pressure sensor

NOTICE

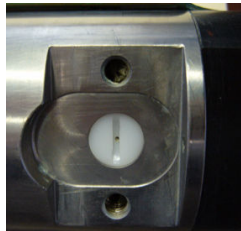
Do not put a brush or any object in the pressure port. It may damage or break the pressure sensor.

The nylon pressure capillary fitting has a pressure port fitting and an external capillary tube that is filled with silicone oil. The oil transmits hydrostatic pressure from the capillary tubing to the pressure sensor. The oil also prevents corrosion if the sensor is exposed to water.

Because of temperature and pressure changes over long time periods, some oil will slowly leak out of the external capillary tube. Use P/N 50025, Pressure Sensor Oil Refill Kit to refill the oil in the tube if no oil can be seen in the tube.

At regular intervals, or annually, inspect and clean the pressure port of sensors that are so equipped.

1. Use a flathead screwdriver to remove the pressure port plug.



2. Flush the pressure port with warm DI water to remove any contamination.
3. Replace the pressure port plug. Do not over-tighten the nylon screw.

7.7 Examine O-rings

NOTICE

Do not use petroleum-based lubricants on O-rings. It will cause damage to the O-rings. Damaged O-rings can cause the sensor to flood and make it unserviceable.

Examine the O-rings on the sensor every time they are exposed—on the connector end flange and other parts. O-rings must be pristine. If there is any question about whether an O-ring is clean and undamaged, replace it with a new one.

1. Dry the O-rings and O-ring grooves with a lint-free cloth or tissue.
2. Examine each O-ring to make sure there is no damage, dirt, lint or hair on it.
3. Replace an O-ring if necessary.
4. Apply a small quantity of silicone-based Parker Super O Lube® or Dow Corning® high vacuum grease to each O-ring.
 - The lubricant helps the O-ring move into its groove with no twist, which can compromise the seal.

- Do NOT use petroleum-based lubricants on any O-ring.






7.8 Clean bulkhead connectors

NOTICE

Do not use WD-40® or petroleum-based lubricant on bulkhead connectors. It will cause damage to the rubber.
 Damaged connectors can cause a loss of data and additional costs for service.
 Damaged connectors can cause damage to the sensor and make it unserviceable.
 Use silicone-based lubricants only.

Examine, clean, and lubricate bulkhead connectors at regular intervals. Connectors that are not lubricated increase the damage to the rubber that seals the connector contacts. The incorrect lubricant will cause the failure of the bulkhead connector.

1. Apply isopropyl alcohol (IPA) as a spray or with a nylon brush or lint-free swab or wipes to clean the contacts.
2. Flush with additional IPA.
3. Shake the socket ends and wipe the pins of the connectors to remove the IPA.
4. Blow air into the sockets and on the pins to make sure they are dry.
5. Use a flashlight and a magnifying glass to look for:

Any corrosion.		
Cracks, scratches, or other damage on the rubber pins or in the sockets.		
Separation of the rubber from the pins.		
Swelled or bulging rubber pins.		

6. Use a silicone-based lubricant on each of the contacts of the bulkhead connector. The manufacturer recommends any of the products listed below.
 - 3M™ Spray Silicone Lubricant (3M ID# 62-4678-4930-3). Make sure to let it dry.
 - Dow Corning Molykote® III Compound (DC III)
 - Dow Corning High Vacuum Grease® (DC 976 V)
 - Dow Corning 4 Electrical Insulating Compound® (DC 4)
 - Dow Corning Molykote 44 High Temperature Grease® (DC 44)

Use a finger to put a small quantity of 100% silicone grease or spray in the sockets or on the pins. Use the mating plug or cable to help distribute the lubricant. Do not use too much lubricant, as that will prevent a good seal.

7. Connect the connectors.
8. Use a lint-free wipe to clean any unwanted lubricant from the sides of the connectors.

7.9 Store CTD

When the plumbing is clean, the sensor can be prepared for storage:

- Make sure the anti-fouling devices are not installed.
- Make sure there is a dummy plug and lock collar attached to the bulkhead connector.

For short-term storage up to a week, make sure to put the manufacturer-supplied colored plugs on the intake and exhaust plumbing ports.

For long term storage:

- Attach one end of a Tygon hose section to the exhaust port, and the other end to the intake port to isolate the conductivity cell plumbing.
- Attach the yellow protective label over the intake and exhaust ports.



7.10 Calibration

The manufacturer calibrates every sensor to known conditions and measures the response of the sensor. Calibration coefficients are calculated and are used to get engineering units.

7.10.1 Conductivity

The conductivity sensor has a fixed resistor in parallel with the cell. When the cell is dry and in air, the output of the sensor is a frequency that is a reflection of the fixed resistor. This value is on the Calibration Certificate and should remain stable (within 1 Hz) over time.

The calibration changes as a result of fouling in the cell by chemical or biological deposits. Because of this, the long-term accuracy depends on how clean the cell is. The manufacturer recommends that the user has the conductivity sensor calibrated before and after a deployment, but also after the sensor has been deployed in contaminated water.

7.10.2 Temperature

As the thermistor element ages during the first year, the calibration of temperature sensor changes by a few thousandths of a degree. Change is less in subsequent years. Environmental conditions do not have much effect on the calibration.

7.10.3 Pressure

The strain-gauge pressure sensor has an initial static error band of 0.05%. Pressure sensors show most of their error as a linear offset from zero. Note that the pressure sensor is an "absolute" sensor, so the raw data includes the effect of atmospheric pressure of 14.7 psi. Engineering units, however, are relative to the ocean surface. The sensor uses the equations below to convert psia:

$$P \text{ (db)} = P \text{ (psi)} = P \text{ (psia)} - 14.7$$

$$P \text{ (dbar)} = [P \text{ (psia)} - 14.7] \times 0.689476$$

The manufacturer recommends that the user applies the offset calibration coefficient to make small corrections to the pressure sensor calibration. Compare the pressure values to a barometer.

1. Let the sensor equilibrate in a constant temperature bath for at least 5 hours in the orientation in which it will be deployed.
2. Start the software.
3. Set the pressure offset to 0.0 (POffset=0).
4. Set the output format to converted decimal (OutputFormat=1).
5. Set the pressure output to yes (OutputPress=y), and pressure units to decibars (SetPressUnits=0).
6. Take 100 samples and transmit data (TSN:100).
7. Compare the sensor output to what a barometer at the same elevation as the pressure sensor port shows.
 - Calculate the offset: the barometer value - pressure sensor value.
8. Set the calculated offset (POffset=).

7.10.4 Optical Dissolved Oxygen

The primary cause for a change in calibration in the optional ODO sensors is bio-fouling of the optical window from chemical or biological contamination. The manufacturer recommends that the user cleans the optical window at regular intervals and sends the ODO for calibration when it has been contaminated by oil or biological material.

The secondary cause of ODO calibration change is photobleaching of the sensor film. If the ODO sensor is disconnected from the main sensor body, make sure to keep the sensor film out of direct sunlight. Every measurement puts short wavelength light on the film that degrades the film over time. The manufacturer recommends that the user send the ODO for calibration when the memory in the main sensor is full, approximately 300,000–500,000 samples.

Section 8 RS232 command descriptions

This is a reference for advanced users. The values of these commands are stored in the sensor until the user changes them. Notes about terminal commands are listed below.

- Commands are not case-sensitive. Push **Enter** to store a command.
- The sensor sends an error message if a command is invalid.
- The argument Y and 1 are both "Yes" and N and 0 are both "No." For example, OutputSal=y and OutputSal=1 are equivalent.
- The sensor will go into a low power mode if no command is sent for 2 minutes. Select *Connect* in the **Communications** menu to start communication again.
- Push the **Esc** key or enter **^C**, then **Enter** to stop the sensor as it sends data.
- During autonomous operation, the sensor will only respond to commands that do not change the setup or interrupt data collection.
- If the user sent StartNow (autonomous mode) and the sensor is in operation or in standby, the user can use the Status commands, TS, TPS, SL, QS, and Stop. For example, if the user sends a DS to see status data, the sensor completes the current measurement and then responds to the command. If OutputExecuted=Y, the sensor will send "executing" messages until the measurement is complete.
- If the user sent StartLater (autonomous mode) and the sensor is operation or in standby, the user can use the Status commands, TS, TPS, SL, QS, and Stop. To send other commands, enter the Stop command, then enter any other commands, and send StartLater again.
- IMM-equipped sensors: Set up or transfer data from the sensor with the internal RS232 connector. Do not use the #i prefix. Use Seaterm232 instead of SeatermIM.

8.1 Status

GetCD	Show configuration data
	Model, SerialNumber=
	PressureInstalled= Y or N
	SampleDataFormat= 1, converted engineering, or 2, converted decimal in XML.
	TemperatureUnits= temperature output, set by SetTempUnits=
	ConductivityUnits= conductivity output, set by SetCondUnits=
	PressureUnits= pressure output, set by SetPressUnits=
SMP-ODO	OxygenUnits= oxygen output, set by SetOxUnits=
	OutputOxygen= Y or N
	OutputTemperature= Y or N
	OutputSalinity= Y or N
	OutputSV= Y or N, sound velocity output
	OutputSC= Y or N, specific conductivity output
	UseSCDefault= SetSCA= set specific conductivity temperature coefficient
	TxSampleNumber= Y or N, transmit sample number with real-time autonomous data and polled from memory
	SampleInterval= interval between samples for autonomous data collection
	TxRealTime= Y or N, transmit autonomous and serial line sync data in real-time
	SyncMode= Y or N, serial sync mode state
	If sensor is equipped with pump:
SMP, SMP-ODO	MinCondFreq= value of minimum conductivity frequency for pump to turn on

RS232 command descriptions

SMP-ODO	AdaptivePumpControl= Y or N, enable or disable adaptive pump control
	NTau= value for pump time multiplier
	PumpOnTime= value for pump-on time for each measurement, $OxNTau \times OxTau20$, sent only if Adaptive Pump Control is disabled.
	LegacyMode= Y or N

Example output for 37SMP-ODO-RS232, Serial Number 03723855:

```
S>getcd
<ConfigurationData DeviceType='SBE37SMP-ODO-RS232' SerialNumber='03723855'>
<PressureInstalled>yes</PressureInstalled>
<SampleDataFormat>converted engineering</SampleDataFormat>
<TemperatureUnits>Celsius</TemperatureUnits>
<ConductivityUnits>S/m</ConductivityUnits>
<PressureUnits>Decibar</PressureUnits>
<OxygenUnits>ml/L</OxygenUnits>
<OutputTemperature>yes</OutputTemperature>
<OutputConductivity>yes</OutputConductivity>
<OutputPressure>yes</OutputPressure>
<OutputOxygen>yes</OutputOxygen>
<OutputSalinity>yes</OutputSalinity>
<OutputSV>yes</OutputSV>
<OutputSC>no</OutputSC>
<SCCoeff>0.0200</SCCoeff>
<TxSampleNumber>no</TxSampleNumber>
<SampleInterval>10</SampleInterval>
<TxRealTime>yes</TxRealTime>
<SyncMode>no</SyncMode>
<MinCondFreq>4000.0</MinCondFreq>
<AdaptivePumpControl>no</AdaptivePumpControl>
<nTau>10.0</nTau>
<PumpOnTime>55.0</PumpOnTime>
<LegacyMode>no</LegacyMode>
```

GetSD	Show status data
	Sensor model, S/N
	DateTime= format of date and time yyyy-mm-ddThh:mm:ss
	Event counter, reset with ResetEC
	Voltages, main and back-up lithium
	Memory: number of bytes in memory, number of samples in memory, number of additional samples that can be saved in memory
	Data collection status, Y or N (if applicable, the reason data collection stopped)

GetCC	Show calibration coefficients. Same as the Calibration Certificates from the manufacturer.
-------	--

GetEC	Show event counter. Some events include:
	WDT reset: unexpected reset

	PON reset: power turned on
	ErrorADC12TimeOut: response delayed from A/D converter that measures main power and backup lithium cell power
	ErrorUART0TimeOut: timeout for transmitter to complete transmission of previous character
	ErrorAD7714TimeOut: response delayed from temperature and pressure A/D converter
	ErrorInvWakeUpFlag: unexpected wakeup
	ErrorFLASHTimeOut: problem with data sent to flash memory
	Alarm long: time to take next sample is too far in the future
	Alarm short: sample missed because "wake" command sent during data collection
	LoggingRestartNoAlarm: no sample taken for 8 hours. Data collection started again.
	LoggingRestartPON: power turned off then on during data collection. Data collection started again.
	ErrorSBE63Timeout: DO sensor does not respond within 1.5 seconds of power supplied to MicroCAT (37 SMP-ODO only)

ResetEC	Erase all events in the event counter
---------	---------------------------------------

GetHD	Show hardware data
	Sensor model, S/N
	Manufacturer
	Firmware version
	Firmware data
	PCB S/N and assembly numbers
	Manufacture date
	Sensor types and S/Ns

DS	Show operation status and setup parameters
	model, firmware version, S/N, date and time
	voltages, main and back-up lithium
	sample number= number of samples stored, number of available samples
	data collection status (not started, started, no data collection, or unknown)
	sample interval= time between samples for autonomous operation
	data format= 1, converted engineering, or 2, converted decimal in XML.
	output temperature= temperature output, value set by SetTempUnits=
	output conductivity= conductivity output, value set by SetCondUnits=
	output pressure= pressure output, value set by SetPressUnits=
	output oxygen= oxygen output, value set by SetOxUnits=
	output salinity= salinity output
	output sound velocity= sound velocity output
	transmit real time data= Y or N, transmit autonomous and serial line sync data in real-time
	sync mode= Y or N, serial sync mode state
	If sensor is equipped with pump:

RS232 command descriptions

	minimum conductivity frequency= minimum conductivity frequency for pump to turn on, value set by MinCondFreq=
	adaptive pump control= Y or N, pump-on time for each measurement, OxNTau × OxTau20, sent only if Adaptive Pump Control is disabled.

Example output for 37SMP-ODO-RS232, Serial Number 03723855:

S>ds
SBE37SMP-ODO-RS232 v6.3.2 SERIAL NO. 23855 18 Feb 2025 09:33:33
vMain = 13.42, vLith = 3.04
samplenum = 93190, free = 306267
not logging, stop command
sample interval = 10 seconds
data format = converted engineering
output temperature, Celsius
output conductivity, S/m
output pressure, Decibar
output oxygen, ml/L
output salinity, PSU
output sound velocity, m/s
transmit real time data = yes
sync mode = no
minimum conductivity frequency = 4000.0
adaptive pump control disabled, pump on time 10.0 * 5.5 = 55.0 sec

Note:

If OutputFormat=0, the DS response stays the same whether parameters are enabled or disabled.

DC	Calibration coefficients in a different format from GetCC
----	---

8.2 General setup

DateTime=x	Set real-time clock. Format is mmddyyyyhhmmss.
BaudRate=x	RS232 rates. 4800, 9600, 19200, 57600, 115200. Default is 9600. Send two times to change the rate. Refer to Transmit real-time data on page 30 for the correct baud rate and cable length to use.
OutputExecutedTag=x	x=Y: show XML tags during and after execution. x=N: do not show XML tags. Tags show one or more times during execution if the response to the command requires additional time.
ReferencePressure=x	Reference pressure in decibars. Used for conductivity, salinity, and sound velocity calculations in Adaptive Pump Control algorithm (if enabled) and oxygen calculation when sensor does not have a pressure sensor.
TxRealTime=x	x=Y: show real-time data for RS232 during autonomous data collection. Data is transmitted immediately after it is collected. x=N: do not show real-time data.
QS	RS232 only. Puts sensor in low power mode. Sensor continues to collect and store data.

Notes:

- The baud rate of the sensor must be the same as the baud rate in the Seaterm232 software.
- Send the baud rate command twice. The sensor changes to the new baud after the first entry, then waits for the command to be sent again. In Seaterm232, go to the **Communications** menu, then *Configure*. Select the new baud rate then push **OK**.
- The MicroCAT always transmits real-time data in polled mode.
- TxRealTime does not affect data stored in memory, but the current draw and sample time increase slightly.
- **Before data collection**—to save real-time data to a file, select the **Capture** menu, then enter your selection of file name. The *capture* status shows in the status bar at the bottom of the window.
- The sensor goes into a low power mode to save battery power if no command is received within 2 minutes.

8.3 Pump setup

NOTICE

Do not operate the pump of a CTD without water. It will cause damage to the pump.

Applies to 37-SMP and 37 SMP-ODO only.

MinCondFreq=x	Minimum conductivity frequency for pump to operate, Hz, to prevent pump from operation before the MicroCAT is in water. The Configuration Sheet lists the raw frequency output at 0 conductivity. Typical (manufacturer-set default) for salt water = 0 conductivity frequency + 500 Hz.
PumpOn	Turn pump on to test or to flush sediment. The pump operates continuously. Send PumpOff to stop the pump. PumpOn has no effect on pump operation during data collection.
PumpOff	Stop pump, if started with PumpOn. PumpOff has no effect on pump operation during data collection.
OxNTau=x (SMP-ODO only)	x=pump time multiplier, 0–100. Default is 7.0.
AdaptivePumpControl=x (SMP-ODO only)	x=Y: operate pump before each sample based on Adaptive Pump Control. Pump operates for $OxNTau \times OxTau20 \times ft \times fp$. Default. x=N: do not use; operate pump for $OxNTau \times OxNTau20$ before each sample. Turn off AdaptivePumpControl only to calibrate and test.

Notes:

- To test in dry conditions, make sure the plumbing is in a upright U position. Fill the internal plumbing with water through the pump exhaust so that there is enough water in the plumbing to prevent damage to the pump for a short period of operation.
- OxTau20= is the SBE 63 ODO sensor response time. If Adaptive Pump Control is turned off, the pump operates for a multiple OxNTau= of the response time before each sample.

8.4 Memory setup

Initlogging	Sets the SampleNumber= to 0. Do not send SampleNumber=0 or InitLogging until all stored data is transmitted. Makes all memory available for storage. If not set to 0, data is stored after the last stored sample number. Send command two times to confirm.
SampleNumber=x	Sample number for last sample in memory. SampleNumber=0 is the same as InitLogging. Send command two times. Do not send SampleNumber=0 or InitLogging until all stored data is transmitted.

Notes:

- If the flash memory is full, data collection continues but no data is saved: the MicroCAT does not overwrite the data in memory.
- **Make sure that all stored data is transmitted to a PC before you send InitLogging or SampleNumber=0 commands.** If one of these commands is sent by accident, recover the data with the steps below:
 1. Set SampleNumber=x, where **x** is your estimate of the number of samples in memory.
 2. Upload data. If **x** is more than the number of samples in memory, data for the non-existent samples will be bad, random data. Look at the transmitted data file carefully and erase any bad data.
 3. Optional: increase **x** and transmit data again, to see if there is additional valid data in memory.

8.5 Output format setup

OutputFormat=x	x=0: raw decimal data x=1: converted decimal data x=2: converted decimal data in .xml format
CompatibleMode=x	x=Y: Change to data format for older sensors x=N: do not
TxSampleNum=x	x=Y: show sample number in output x=N: no sample number shows
Legacy=x	x=Y: reset units to °C, S/m, dbar, ml/L, enable temperature, conductivity, pressure, oxygen. Disable sound velocity, specific conductivity, sample number. Do not let user change output units. Change DS to match firmware < 2.0, for older SMP-ODO sensors and < 4.0 for SM and SMP sensors x=N: enable all commands
OutputTemp=x	x=Y: show temperature x=N: do not
SetTempUnits=x	x=0: °C x=1: °F
OutputCond=x	x=Y: show conductivity x=N: do not
SetCondUnits=x	x=0: conductivity, specific conductivity S/m x=1: conductivity, specific conductivity mS/cm x=2: conductivity, specific conductivity µS/cm
OutputSC=x	x=Y: calculate and show specific conductivity, value set by SetCondUnits, with OutputFormat=1 or 2 x=N: do not
UseSCDefault=x	x=0: Do not use default. Use value set by SetSCA=. x=1: Use default value of 0.020 for thermal coefficients of conductivity for natural salt ion solutions (specific conductivity calculation).
SetSCA=x	x=Thermal coefficients of conductivity for natural salt ion solutions (specific conductivity calculation). Applies if OutputSC=Y and Use SCDefault=0.
OutputPress=x	x=Y: show pressure x=N: do not
SetPressUnits=x	x=0: decibars x=1: psi (gauge)
OutputSal=x	x=Y: calculate and show salinity, psu, if OutputFormat=1 or 2 x=N: do not

OutputSV=x	x=Y: calculate and show sound velocity, m/sec, with OutputFormat=1 or 2 x=N: do not
	When SBE 63 ODO is installed:
OutputOx=x	x=Y: show oxygen x=N: do not
SetOxUnits=x	x=0: oxygen in ml/L x=1: oxygen in mg/L

Notes:

- The MicroCAT does not store salinity, sound velocity, or specific conductivity. The software calculates and transmits these derived parameters in real-time, when polled, or as data is transmitted. When these parameters are included in the output, there is no effect on the number of samples that can be stored in memory.
- Salinity, sound velocity, and specific conductivity, and other derived parameters can also be calculated in the Data Processing software when data is transmitted from the MicroCAT.
- The pressure sensor is an absolute sensor, so the raw output, when OutputFormat=0, includes the effect of atmospheric pressure, 14.7 psi.
- When the output of pressure is in psi or dbars, the sensor transmits pressure relative to the ocean surface. The MicroCAT uses the equations below to convert psia:
 - $P(\text{psi}) = P(\text{psia}) - 14.7$
 - $P(\text{dbar}) = [P(\text{psia}) - 14.7] \times 0.689476$

8.6 Autonomous operation with data storage

Autonomous operation is not compatible with the SDI12 protocol.

SampleInterval=x	x=interval between samples, 6–21600 seconds when used with StartNow, StartLater. Sensor collects a sample, stores data in flash memory, transmits data, and turns off at x intervals.
StartNow	Start data collection at a rate defined by SampleInterval. Data is stored.
StartDateTime=	Start data collection at mmddyyyyhhmmss
StartLater	Start data collection at a set time in the future
Stop	Stop data collection or stop countdown for StartLater. Send Stop before data is transmitted to a PC. Send twice.

Notes

- If the battery voltage is less than 7.1 V for 10 consecutive samples, the sensor stops data collection and sets status to "low battery."
- If the memory in the sensor is full, data is not stored. The sensor does not overwrite the data in memory.
- After StartLater, the sensor shows `not logging: waiting to start`. The sensor shows `logging` when data collection starts.
- If the delayed start date and time has passed when StartLater is sent, the sensor executes StartNow.
- If the delayed start date and time is more than 30 days in the future, the sensor executes StartNow.

8.7 Polled data collection, model without pump

Use these commands to collect one or more samples. Unless stated otherwise, the sensor does **not** store data in flash memory.

RS232 command descriptions

TS	Collect one sample, store data, show data in the format specified by OutputFormat=.
TSR	Collect one sample, store in buffer, show data in raw decimal format.
TSH	Collect one sample, store data in buffer.
TSS	Collect one sample, store data in buffer and flash memory, show data. Sensor ignores this command if StartNow or StartLater has been sent.
TSN:x	Collect x samples, show data. To stop, push Esc . Sensor ignores this command if StartNow or StartLater has been sent.
SL	Show data from the last data sample.
SLT	Show data from the last sample stored in buffer. Collect one sample, store data in buffer.

8.8 Polled data collection, models with pump

Use these commands to collect one or more samples from the 37 SIP, 37 SMP, 37 SMP-ODO. Unless stated otherwise, the MicroCAT does **not** store data in flash memory.

Pump operation for polled commands is affected by three factors:

- Conductivity frequency from the last sample, and the setting for MinCondFreq=
- Setting for AdaptivePumpControl=
- Temperature and pressure of the previous sample.

TS	Pump does not operate. Collect a sample, store data, show data in the format specified by OutputFormat=.
TSR	Pump does not operate. Raw decimal format.
TPS	Pump operates. Collect a sample, store data in buffer, transmit data.
TPSH	Pump operates, collect a sample, store data in buffer
TPSS	Pump operates, collect a sample, store data in buffer and flash memory, show data. MicroCAT ignores this command if StartNow or StartLater has been sent.
TSN:x	Pump does not operate. Collect x samples, show data. To stop, push Esc . MicroCAT ignores this command if StartNow or StartLater has been sent.
TPSN:x	Pump operates continuously, collect x data samples, show data. To stop, push Esc . MicroCAT ignores this command if StartNow or StartLater has been sent.
T63	Pump does not operate. The DO sensor collects a sample, shows data in the format specified by SetFormat= <i>in SBE 63</i> .
SL	Show data from the last data sample
SLTP	Show data from the last sample stored in buffer. Pump operates, one sample is collected, data is stored in buffer.

8.9 Transmit data

These commands are included for reference for users that write their own software.

GetSamples:b,e	Transmit sample b to sample e, in format specified by OutputFormat= . First sample number is 1. As data is transmitted, the screen shows start time = start sample number = to show the start time and start sample number of data.
DDb,e	Transmit sample b to sample e, in converted decimal format specified by OutputFormat=1. The first sample is number 1. As data is transmitted, the screen shows start time = start sample number = to show the start time and start sample number of data.

Example: Transmit samples 1-200 to a file.

GetSamples:1,200

or

DD1,200

8.10 Calibration coefficients

F = floating point number. S = String with no spaces.

Calibration coefficients are set by the manufacturer and should be the same as the Calibration Certificates that ship with the MicroCAT.

Temperature	
TCalDate=S	S=temperature calibration date
TA0=F	F=temperature A0
TA1=F	F=temperature A1
TA2=F	F=temperature A2
TA3=F	F=temperature A3
Conductivity	
CCalDate=S	S=conductivity calibration date
CG=F	F=conductivity G
CH=F	F=conductivity H
CI=F	F=conductivity I
CJ=F	F=conductivity J
WBOTC=F	F=conductivity wbotc
CTCor=F	F=conductivity ctcor
CPCor=F	F=conductivity cpcor
Pressure	
PCalDate=S	S=pressure calibration date
PA0=F	F=pressure A0
iPA1=F	F=pressure A1
PA2=F	F=pressure A2
PTCA0=F	F=pressure ptca0
PTCA1=F	F=pressure ptca1
PTCA2=F	F=pressure ptca2
PTCB0=F	F=pressure ptcb0
PTCB1=F	F=pressure ptcb1
PTCB2=F	F=pressure ptcb2
PTempA0=F	F=pressure temperature a0
PTempA0=F	F=pressure temperature a1
PTempA0=F	F=pressure temperature a2
POffset=F	F=pressure offset, decibars

RS232 command descriptions

Dissolved Oxygen (SMP-ODO only)	
OxCalDate	S= oxygen calibration date
OxTau20=F	F= oxygen Tau20, sensor response time
OxA0=F	F= oxygen A0 coefficient
OxA1=F	F= oxygen A1 coefficient
OxA2=F	F= oxygen A2 coefficient
OxB0=F	F= oxygen B0 coefficient
OxB1=F	F= oxygen B1 coefficient
OxC0=F	F= oxygen C0 coefficient
OxC1=F	F= oxygen C1 coefficient
OxC2=F	F= oxygen C2 coefficient
OxTA0=F	F= oxygen TA0 coefficient
OxTA1=F	F= oxygen TA1coefficient
OxTA2=F	F= oxygen TA2 coefficient
OxTA3=F	F= oxygen TA3 coefficient
OxE=F	F= oxygen E coefficient

Notes:

- The coefficients stored in the SBE 63 are used to transmit converted oxygen data in response to the Send63= command. Refer to the SBE 63 manual for those commands.
- The coefficients stored in the MicroCAT are used to transmit converted oxygen data in response to all other commands. They are also in the configuration file, .xmlcon, that is automatically made when data is transmitted from the MicroCAT memory. The .xmlcon file is used by the SBE Data Processing software to post-process the transmitted data.

Section 9 SDI12 command descriptions

The sensor supports all basic SDI12 commands. Refer to the SDI12 specification at www.sdi-12.org for details of the command protocol.

Definitions:

- ttt = maximum seconds until data is ready
- n = 1 digit for M commands
- n = 2 digits for C commands
- Manufacturer ID = 8 characters
- <CR> = Carriage Return character
- <LF> = Line Feed character.

Notes on SDI12 commands:

- Are case-sensitive
- End with "!" except as noted
- Start with the SDI12 address "a"
- End with <CR><LF> except as noted
- Always sent with polarity sign (+ or -)
- Have optional decimal point
- Maximum digits for a value is 7, even without a decimal point
- Minimum digit for a value is 1
- Maximum characters in a data value is 9 (polarity sign 7 digits, decimal point)
- Only one zero to the left of the decimal point shows.

9.1 Setup commands

SetAddress=x	x=address: 0–9, a–z, A–Z for SDI12 communications. Send command twice to change address
SetSDI12Flag=x	<p>x= out-of-range value, -9999999 to +9999999. Must include + or - sign. For SDI12 OutputFormat=3. Default is +9999999</p> <p>If the MicroCAT calculates data that is out-of-range for a specific parameter, this value is included in the data for that parameter.</p> <p>The out-of-range value does not apply if OutputFormat=0, 1, or 2; it is set by the manufacturer to <i>nan</i>.</p>

9.2 Standard commands

Break	
Response	None; start search for valid mark
Purpose	12 ms space on the line: put all connected sensors into standby mode (! and <CR><LF> do not apply)

Acknowledge Active = a!	
Response	a<CR><LF>
Purpose	verifies communication with sensor

Send identification = a!!	
Response	allccccccmmmmmmvvnnnnnoooooooooo<CR><LF>
	a = sensor address
	ll (lowercase "l") = 2-character SDI-12 version. For example, "13" for version 1.3

SDI12 command descriptions

	ccccccc = 8-character manufacturer identification. For example, "SeaBird"
	mmmmmm = 6-character sensor model. For example, "37SMP"
	vvv = 3-character firmware version. For example, "500"
	_nnnnnn = up to 6-character serial number field.
	optional sensors. Up to 8 characters. P = pressure, O = DO
Example	address = 0. serial number = 32345. The firmware version is 2.42
	recorder sends 0!
	sensor sends 013SeaBird37SMP2.432345PO<CR><LF>

Address query = ?!	
Response	a<CR><LF>
Purpose	shows the sensor's SDI-12 address (if only one sensor is online)

Change address = aAb!	
Response	b<CR><LF>
Purpose	changes the sensor's SDI-12 address to "b". The default address is 0.
Example	address = 0
	recorder sends 0A1!
	sensor sends 1<CR><LF>
	address now = 1

This is the start of your concept.

9.3 Measurement commands

Send **TPPS** = operate the pump, take a measurement, store the data in flash memory and in the buffer until the next sample.

Command	Response	Function
aM!	atttn<CR><LF> then	start measurement
aMC!	a<CR><LF> n values available after ttt seconds	start measurement and request CRC
aC!	atttnn<CR><LF> then	start concurrent measurement
aCC!	a<CR><LF> nn values available after ttt seconds	start concurrent measurement and request CRC

Send **TPS** = operate the pump, take a measurement, store the data in the buffer until the next sample.

Command	Response	Function
aM1!	atttn<CR><LF> then	start measurement
aMC1!	a<CR><LF> n values available after ttt seconds	start measurement and request CRC
aC1!	atttnn<CR><LF> then	start concurrent measurement
aCC1!	a<CR><LF> nn values available after ttt seconds	start concurrent measurement and request CRC

Send **TS** = take a measurement, store the data in the buffer until the next sample.

Command	Response	Function
aM2!	atttn<CR><LF> then	start measurement
aMC2!	a<CR><LF> n values available after ttt seconds	start measurement and request CRC
aC2!	atttnn<CR><LF> then	start concurrent measurement
aCC2!	a<CR><LF> nn values available after ttt seconds	start concurrent measurement and request CRC

Send the data from the buffer.

Data output from an aM! or aMC! command

Send Data = aD0!–aD1!	
Response	a<values><CRC><CR><LF> <values>=T, C, P, DO, salinity, sound velocity, specific conductivity, sample number (function of which values are enabled)
Purpose	sends data to the SDI-12 recorder
Notes	aD0! after aM! or aMC!
	35 characters are permitted for non-concurrent string. The response is the first 6 values in the SDI-12 data format in response to an aM! Command. If a subsequent aD1! command is sent, the sensor will send the rest of the values.

Sample of data output from an aM! command

0M!00449<CR><LF>
0<CR><LF>
0D0!0+23.4679-0.085+8.057+7.5 -0.104<CR><LF> 0D1!0+3.504+0.0009+95.03+13.8<CR><LF>
SDI-12 address + temperature + pressure + oxygen + pH + fluorescence + turbidity + specific conductivity + percent oxygen saturation + voltage from main power supply

Data output from an aC! or aCC! command

Send Data = aD0!–aD1!–aD2!	
Response	a<values><CR><LF> or a<values><CRC><CR><LF>
Purpose	sends data to the SDI-12 recorder
Notes	aD0! after aC!
	75 characters are permitted. There is space in the 75-character field for 12 values. The recorder needs to send an aD1! command to get the rest of the values.

Sample of data output from an aC! command

0C!004416<CR><LF>
0D0!0+23.4563+0.005-0.084+8.054+7.75-0.097+3.409+1492.497<CR><LF> 0D1!0+0.006+95.00+13.8+1+0<CR><LF>
SDI-12 address + temperature + conductivity + pressure + oxygen + salinity + sound velocity + specific conductivity

9.4 Extended commands

The extended command, defined by "X," lets the user make common setup changes in the field without a PC.

SDI12 command descriptions

aXV!	
Response	av.v.v, mm dd yyyy hh:mm:ss<CR><LF>
Purpose	Get full sensor firmware version string, where: a = SDI-12 address, v.v.v = firmware version, mm dd yyyy hh:mm:ss = date and time of firmware version

aXPx!	
Response	ax<CR><LF>
Purpose	Sends PumpOn=1 PumpOff=0. Operate pump to test or to remove sediment. The pump operates continuously. Pump stops after 2 minutes with no communication or if PumpOff is sent.

aXMCFx!	
Response	ax<CR><LF>
Purpose	Send MinCondFreq=x. Range = 0–5000. The minimum conductivity frequency for pump to operate, so that the pump does not operate in air.

aXMRx!	
Response	n<CR><LF> Send twice to stop accidental reset of memory. First command shows the current number of samples in memory. Second command shows the number of samples reset to 0.
Purpose	Send InitLogging. If this command is not sent, data is stored after the last sample.

aXUTx!	
Response	ax<CR><LF>
Purpose	Send SetTempUnits=x. x=0 for °C; x=1 for °F

aXUCx!	
Response	ax<CR><LF>
Purpose	Send SetCondUnits=x. x=0 for conductivity in S/m; x=1 for mS/cm; x=2 for µS/cm

aXUPx!	
Response	ax<CR><LF>
Purpose	Send SetPressUnits=x. x=0 for pressure in decibars; x=1 for psi

aXUOx!	
Response	ax<CR><LF>
Purpose	Send SetOxUnits=x. x=0 for oxygen in ml/L; x=1 for mg/L

aXOxxxxxxx!	
Response	axxxxxxxx<CR><LF>
Purpose	Send SetOxUnits=x. x=0 disable output; x= 1 enable output
Example	a11111000 (enable T, C, P, O, salinity, disable sound velocity, specific conductivity, TXSampleNumber)

Section 10 Troubleshooting

10.1 No communication

If the `OutputExecutedTag=N`, the `S>` prompt shows that there was communication between the sensor and PC. Push **Enter** several times.

Cause: The I/O cable is not connected correctly.

Solution: Make sure the cable is connected at the PC and the sensor.

Cause: The sensor communication settings were not entered correctly in the software.

Solution: Make sure that the settings match the values on the Configuration Sheet that shipped with the sensor.

Cause: The I/O cable is not the correct cable.

Solution: Make sure the cable is a standard 9-pin RS232 cable.

10.2 No data recorded

Cause: The memory is full. No additional data can be recorded.

Solution: Send `GetSD` or `DS` to verify that the memory is not full. If full, *free = 0 or 1*. Transmit all stored data to a PC before the next deployment. Then send `InitLogging` to set the memory to 0. Send `GetSD` or `DS` to show that *samples = 0*.

10.3 Data looks incorrect

Cause: Data that looks incorrect, with values out of range, for example, may be caused by incorrect calibration coefficients in the sensor.

Solution: Send `GetCC` to verify that the calibration coefficients in the sensor are the same as the Calibration Sheet from the manufacturer. This does not affect the raw data stored in the sensor.

- If the memory is not overwritten with new data, correct the coefficients and upload the data again.
- If the memory is overwritten with new data, manually correct the coefficients in the `.xmlcon` configuration file.

Cause: Small changes in conductivity are an indication that the pump flow is incorrect. There are several causes, such as a clogged air bleed hole, sediment, or an incorrect `MinCondFreq` setting.

Solutions:

- Clean the air bleed hole.
- Make sure that the pump is oriented correctly.
- Use a wash bottle to flush the plumbing to remove sediment.
- Make sure `MinCondFreq` is not set too high.

10.4 Salinity spikes

Salinity is a derived value from conductivity, pressure, and depth. It is calculated by the sensor if `OutputSal=Y`.

In profiling applications, salinity spikes can be the result of temperature and conductivity measurements that are not aligned because of conditions with sharp gradients. The differences in response times for temperature and conductivity measurements can be corrected for post-processing if the response times are known.

In moored applications, the pump flushes the conductivity cell faster than the environment changes, so temperature and conductivity measurements stay aligned. Typical **causes** of salinity spikes include:

Troubleshooting

- External biofouling that limits the flow through the conductivity cell will cause the conductivity measurement to occur after the temperature measurement.
- Solar heating at shallow depths can cause the actual temperature inside the conductivity cell to be different from the temperature measured by the thermistor.
- Air bubbles from breaking waves can cause the conductivity cell measurement to read low.

Section 11 General information

Revised editions of this user manual are on the manufacturer's website.

11.1 Warranty

Refer to the manufacturer's website for warranty information (seabird.com/warranty).

11.2 Service and support

The manufacturer recommends that sensors be sent back to the manufacturer annually to be cleaned, calibrated, and for standard maintenance.

Refer to the website for FAQs and technical notes, or contact the manufacturer for support at support@seabird.com. Do the steps below to send a sensor back to the manufacturer.

1. Complete the online Return Merchandise Authorization (RMA) form or contact the manufacturer.
Note: The manufacturer is not responsible for damage to the sensor during return shipment.
2. Remove all batteries from the sensor, if so equipped.
3. Remove all anti-fouling treatments and devices.
Note: The manufacturer will not accept sensors that have been treated with anti-fouling compounds for service or repair. This includes AF 24173 devices, tri-butyltin, marine anti-fouling paint, ablative coatings, etc.
4. Use the sensor's original ruggedized shipping case to send the sensor back to the manufacturer.
5. Write the RMA number on the outside of the shipping case and on the packing list.
6. Use 3rd-day air to ship the sensor back to the manufacturer. Do not use ground shipping.
7. The manufacturer will supply all replacement parts and labor and pay to send the sensor back to the user via 3rd-day air shipping.

11.3 Lithium battery shipment

⚠ WARNING

Do not ship the sensor with the batteries installed. Do not ship the battery pack for the sensor with the batteries installed.


The information below is general. It gives guidance only to appropriately trained shipping personnel. Refer to the IATA Dangerous Goods Regulations for complete information about shipping lithium batteries.

The manufacturer ships the lithium cells with the sensor in a separate box. Each of the 12 cells is packed in heat-sealed plastic. All batteries are packed in bubble wrap in a sturdy box.



General information

Batteries that are shipped without the sensor are Dangerous Goods. They can only be shipped by personnel with the appropriate training from an organization that has a Dangerous Goods program.

	Sensor, no spares	Sensor, 1 or 2 spare cell sets	Cells only
UN #	3091		3090
PI #	969		968
Passenger aircraft	yes	no	
Cargo aircraft	yes		
Label requirements	<div></div>		
	--	<div><div>LITHIUM METAL BATTERIES - FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT</div><div>677-275-2235 www.AsiLabeled.com</div></div>	

11.4 AF24173 anti-foulant device

AF24173 Anti-Foulant Devices supplied for user replacement are supplied in polyethylene bags displaying the following label:

AF24173 ANTI-FOULANT DEVICE	
FOR USE ONLY WITH SEA-BIRD ELECTRONICS' CONDUCTIVITY SENSORS TO CONTROL THE GROWTH OF AQUATIC ORGANISMS WITHIN ELECTRONIC CONDUCTIVITY SENSORS.	
ACTIVE INGREDIENT: Bis(tributyltin) oxide	52.1%
OTHER INGREDIENTS:	47.9%
TOTAL	100.0%
DANGER	
Refer to conductivity sensor manual for the complete label and additional precautionary statements and information on the handling, storage and disposal of these devices.	
Net contents: Two anti-foulant devices	EPA Registration No. 74489-1
Sea-Bird Electronics, Inc.	EPA Establishment No. 74489-WA-1
13431 NE 20 th St.	
Bellevue, WA 98005	

AF24173 ANTI-FOULANT DEVICE

FOR USE ONLY WITH SEA-BIRD ELECTRONICS CONDUCTIVITY SENSORS TO CONTROL THE GROWTH OF AQUATIC ORGANISMS WITHIN ELECTRONIC CONDUCTIVITY SENSORS.

ACTIVE INGREDIENT: Bis(tributyltin) oxide 52.1%

OTHER INGREDIENTS: 47.9%

TOTAL 100.0%

DANGER

See Precautionary Statements for additional information.

FIRST AID	
If in eyes	<ul style="list-style-type: none"> • Hold the eye open and rinse slowly and gently with water for 15–20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
If on skin or clothing	<ul style="list-style-type: none"> • Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15–20 minutes. • Call a poison control center or doctor for treatment advice.
If swallowed	<ul style="list-style-type: none"> • Call poison control center or doctor immediately for treatment advice. • Have person drink several glasses of water. • Do not induce vomiting. • Do not give anything by mouth to an unconscious person.
HOT LINE NUMBER	
Note to Physician	Probable mucosal damage may contraindicate the use of gastric lavage.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For further information, call National Pesticide Telecommunications Network (NPTN) at 1-800-858-7378.	

Net contents: Two anti-foulant devices

Sea-Bird Electronics, Inc.

13431 NE 20th St.

Bellevue, WA 98005

EPA Registration No. 74489-1

EPA Establishment No. 74489-WA-1

PRECAUTIONARY STATEMENTS

HAZARD TO HUMANS AND DOMESTIC ANIMALS

Danger:

Corrosive—Causes irreversible eye damage and skin burns. May be fatal if swallowed or absorbed through the skin. Do not get in eyes, on skin, or on clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco, or using the toilet. Remove and wash contaminated clothing before reuse.

PERSONAL PROTECTIVE EQUIPMENT

Users must wear: protective gloves (rubber or latex), goggles or other eye protection, long-sleeved shirt, long pants, and shoes plus socks.

USER SAFETY RECOMMENDATIONS

Users should:

- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Follow the manufacturer's instructions for cleaning and maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

ENVIRONMENTAL HAZARDS

Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of EPA. This material is toxic to fish. Do not contaminate water when cleaning equipment or disposing of equipment washwaters.

General information

PHYSICAL OR CHEMICAL HAZARDS

Do not use or store near heat or open flame. Avoid contact with acids and oxidizers.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

For use only in Sea-Bird Electronics conductivity sensors. Read installation instructions in the applicable Conductivity Instrument Manual.

Intended for professional use by military, government, academic, commercial, and scientific personnel.

STORAGE AND DISPOSAL

PESTICIDE STORAGE: Store in original container in a cool, dry place. Prevent exposure to heat or flame. Do not store near acids or oxidizers. Keep container tightly closed.

PESTICIDE SPILL PROCEDURE: In case of a spill, absorb spills with absorbent material. Put saturated absorbent material into a labeled container for treatment or disposal.

PESTICIDE DISPOSAL: Pesticide that cannot be used according to label instructions must be disposed of according to Federal or approved State procedures under Subtitle C of the Resource Conservation and Recovery Act.

CONTAINER HANDLING: Nonrefillable container. Do not reuse this container for any other purpose. Offer for recycling, if available.

Sea-Bird Electronics
13431 NE 20th Street
Bellevue WA 98005 U.S.A.
(425) 643-9866

