User manual

SBE 19plus V2 SeaCAT Profiler

Conductivity, pressure, and temperature recorder

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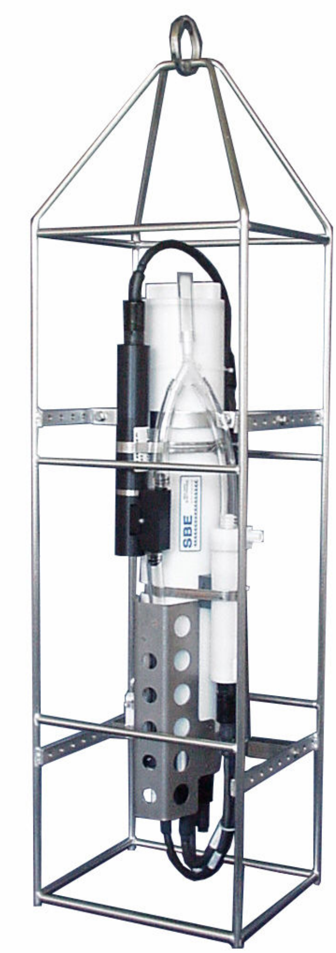
Version:	E



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seabird.com

Table of Contents

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

If the user thinks that the alkaline 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.

WARNING

If the user thinks that the NiMH 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

The pressure housing contains Electrostatic Discharge (ESD) sensitive parts and assemblies that are susceptible to damage from ESD. Follow ESD protocols:

- 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. *Do not wear a sweater, fleece or polyester-based clothing.*
- At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. *Do not use a workstation with a synthetic or polymeric-based tabletop.*

⚠ 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.

⚠ CAUTION

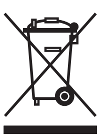
AF24173 anti-fouling devices contain bis(tributyltin) oxide. Wear rubber or latex gloves and eye protection to replace these devices on the sensor if it is so equipped. Wash hands with soap and water when finished.
Read the precautions on the product label.
It is a violation of US federal law to use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

NOTICE

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.

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.

	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.

	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.

	**ATTENTION!** **Remove sticker before deployment!** 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). 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.

Section 2 SBE 19plus V2 quick start guide

⚠ 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 alkaline 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.

⚠ WARNING

If the user thinks that the NiMH 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

The pressure housing contains Electrostatic Discharge (ESD) sensitive parts and assemblies that are susceptible to damage from ESD. Follow ESD protocols:

- 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. *Do not wear a sweater, fleece or polyester-based clothing.*
- At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. *Do not use a workstation with a synthetic or polymeric-based tabletop.*

This quick start guide gives the steps necessary to make sure that the SBE 19plus V2 SeaCAT sensor operates correctly and collects data before it is deployed.

What's in the box:

- SBE 19plus V2 with SBE 5M pump attached
- CD or USB drive with software, calibration files, documentation
- Dummy plugs and lock collars for each bulkhead connector
- Data I/O cable to connect the sensor to a PC
- Non-ionic surfactant to clean sensor flow path
- Conductivity cell tubing and storage kit
- Spare hardware and O-ring kit.

1. Install the manufacturer-supplied software on a PC. Refer to Install software and test sensor on page 21 for details.
2. Connect the data I/O cable to the sensor and the PC and start the software.
3. If necessary, install new batteries. Refer to Replace alkaline batteries on page 41 or Charge NiMH batteries on page 42 for details.

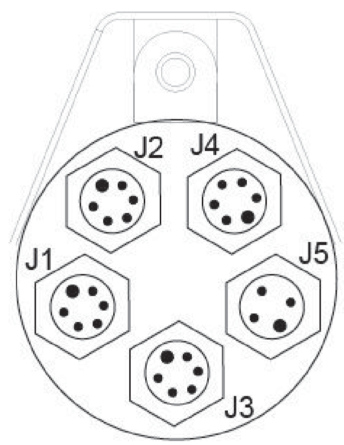
4. Make sure that all data stored in the sensor is transmitted to a PC.
5. Set the date and time and configure the data collection settings.
6. Install dummy plugs and lock collars on bulkhead connectors that are not used.
7. If necessary, remove the end-to-end loop of Tygon tubing from around the conductivity cell. It is used when the SeaCAT is in storage.
8. Connect the tubing from the pump to the conductivity cell.
9. Send the DS and DCal commands to verify status and calibration coefficients.
10. Moored Mode (MM): use StartNow to start data collection every SampleInterval= *x* seconds.
11. Moored Mode (MM): use StartDateTime= and StartLater to start data collection at a specified date and time, every SampleInterval=seconds.
12. Profile Mode (MP), as necessary:
    - Put the magnetic switch in the On position, **or**
    - If IgnoreSwitch=Y, send commands to start data collection now, with StartNow, or in the future, with StartDateTime= and StartLater to start data collection at a specified date and time, **or**
    - If AutoRun=Y, apply external power.
13. Deploy the sensor. For most applications, make sure the connector is at the bottom (lowest point).
14. Immediately after the sensor is recovered from a deployment:
    a. Transmit data from the sensor to a PC (refer to Transmit data on page 34 for details).
    b. Turn off the sensor.
    c. Flush the sensor with fresh water.
    d. Keep the SeaCAT out of direct sunlight between deployments.
15. Refer to CTD storage on page 44 for details to prepare the sensor for short- or long-term storage.

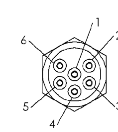
Section 3 Specifications

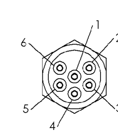
3.1 Mechanical

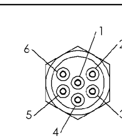
Weight, 600 m, plastic, no pump, in air, water	7.3, 2.3 kg
Weight, 10500 m, titanium, no pump, in air, water	13.7, 8.6 kg
Weight, 5M, plastic	0.3, 0.1 kg
Weight, 5M, titanium	0.3, 0.4 kg
Weight, 5P, plastic	0.3, 0.1 kg
Weight, 5T, titanium	0.4, 0.3 kg
Depth rating, acetyl plastic	600 m
Depth rating, 3AL–2.5V titanium	7000 m
Depth rating, 6AL–4V titanium	10500 m

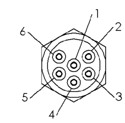
3.1.1 Connectors and cables



J1 auxiliary differential input 0,1				
Contact	**Function**	**Contact**	**Function**	**MCBH6MP**
1	Common	4	Voltage 1 signal	
2	Voltage 0 signal	5	Voltage 1 common	
3	Voltage 0 common	6	Auxiliary power out	

J2 auxiliary differential input 2, 3				
Contact	**Function**	**Contact**	**Function**	**MCBH6MP**
1	Common	4	Voltage 3 signal	
2	Voltage 2 signal	5	Voltage 3 common	
3	Voltage 2 common	6	Auxiliary power out	

J3 data I/O, pump, external power				
Contact	**Function**	**Contact**	**Function**	**MCBH6MP**
1	Common	4	Pump power common	
2	RS232 data RX	5	Pump power	
3	RS232 data TX	6	Auxiliary power in, 9–28 VDC	

J4 auxiliary differential input 4, 5				
Contact	**Function**	**Contact**	**Function**	**MCBH6MP**
1	Common	4	Voltage 5 signal	
2	Voltage 4 signal	5	Voltage 5 common	
3	Voltage 4 common	6	Auxiliary power out	

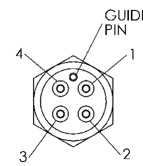
J5 auxiliary serial input *sensor and 19plus must be set to the same baud rate*		
Contact	**Function**	**MCBH4MP**
1	Common	
2	RS232 data transmit to RS232 sensor	
3	RS232 data receive from RS232 sensor	
4	Power to RS232 sensor	

Figure 1 Y cable

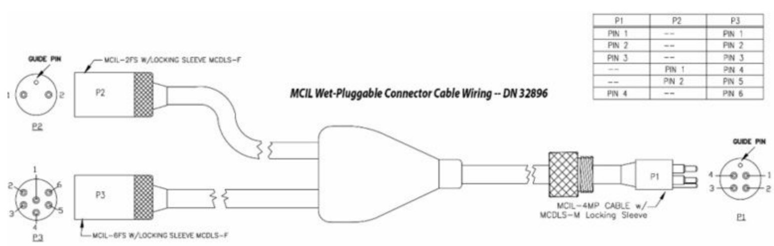


Figure 2 Data I/O cable

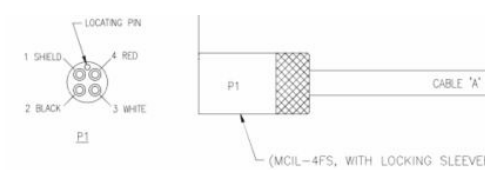
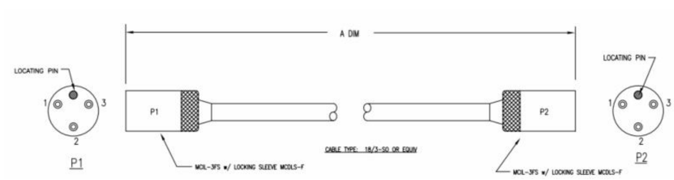
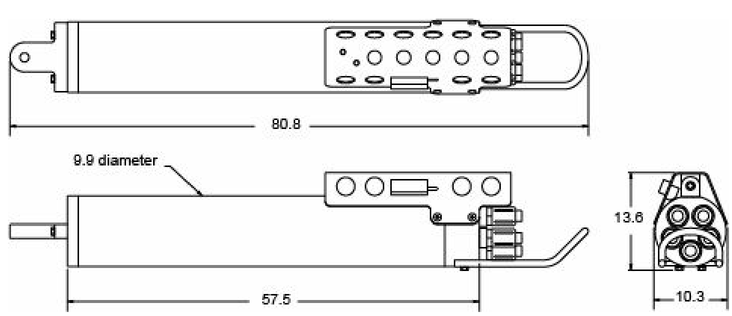


Figure 3 SBE 5 to CTD cable



3.1.2 Dimensions



3.2 Communications

Memory	64 MB Flash
Communication interface	RS232
Data collection rate	4 Hz

3.3 Electrical

Input from external power supply	9–28 VDC
Current draw from external power supply, 5M	3 A at 9V, 0.5 A at 12V and 19V
Current draw from external power supply, 5T, 5P	3 A at 12V, 1.5 A at 19V
Current draw, data collection	70 mA
Current draw, 5M pump	100 mA
Current draw, 5T, 5P	150 mA
Current draw, communications	65 mA
Current draw, low power (powered by internal batteries)	20 µA
Internal battery capacity, 9 alkaline D-cells	14 Ah
Internal battery capacity, NiMH pack	8 Ah
Auxiliary power out at 10.5–11 VDC	to 500 mA
Voltage A/D resolution	14 bits
Voltage sensor input range	0–5 VDC

3.4 Analytical

Parameter	**Range**	**Accuracy**	**Stability**	**Resolution**
Conductivity	0–9	±±0.005 V	0.0003 S/m/month	0.00007 S/m
Temperature	-5–35 °C	±0.005 V	0.0002 °C/mo	0.0001 °C
Pressure, strain gauge	Not more than the SBE 19plus V2 rated depth	±0.1% full scale range	±0.1% full scale range	0.002% full scale range
Pressure, quartz		± 0.02%	± 0.02%	0.0025% of full scale range

Section 4 Overview

4.1 System description

The SBE 19plus V2 SeaCAT Profiler measures conductivity, temperature, and pressure in both salt- and fresh water. The system operates in either profiling or moored modes.

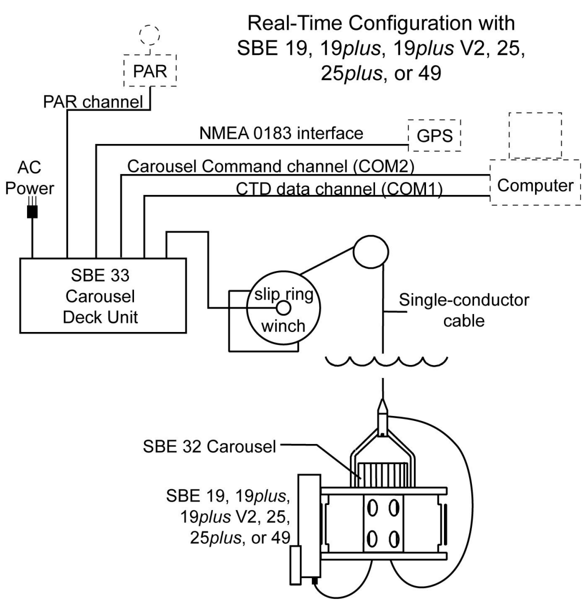
Profiling: the 19plus operates continuously, with a data collection rate of 4 Hz, or 2 Hz with a Digiquartz® pressure sensor. The 19plus can calculate the average of up to 32,767 samples, and store and transmit only that value.

Moored: takes a measurement once every 10 seconds to every 4 hours and can be adjusted in 1-second increments. The system goes into a low power mode between samples.

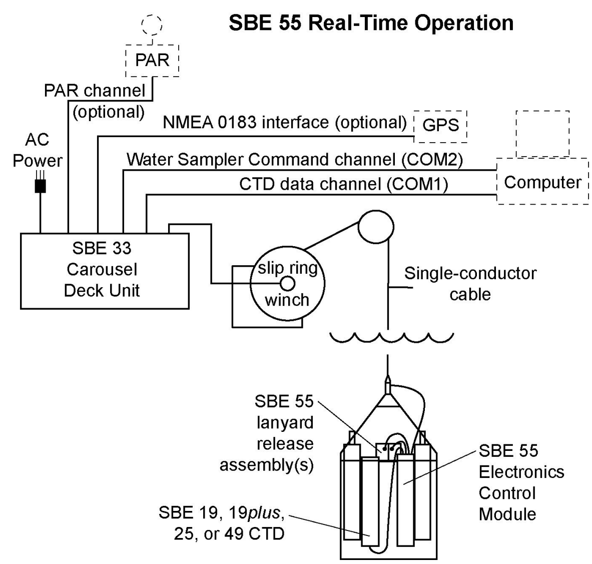
The 19plus V2 can be used with:

- SBE 32 carousel water sampler and SBE 33 carousel deck unit
- SBE 55 ECO water sampler and SBE 33 carousel deck unit
- SBE 36 CTD deck unit and Power Data Interface Module (PDIM)
- SBE 32 carousel water sampler and Auto Fire Module (AFM)
- SBE 55 ECO water sampler.

The water samplers can each provide +15 VDC power to the 19plus and auxiliary sensors. CTD data from the 19plus is converted into single-wire telemetry so it can be transmitted over 10,000 m sea cables. Bottles can be closed at any depth through the Seasave software, or from the front panel of the deck unit. CTD data collection is not affected.

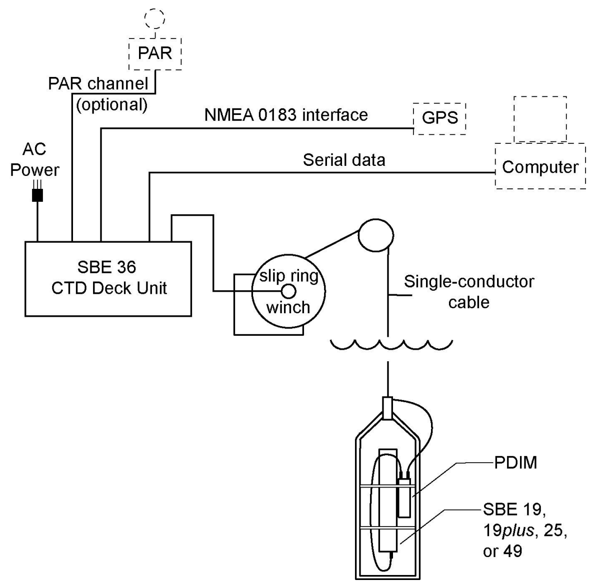


SBE 32 real-time operation



SBE 55 real-time operation

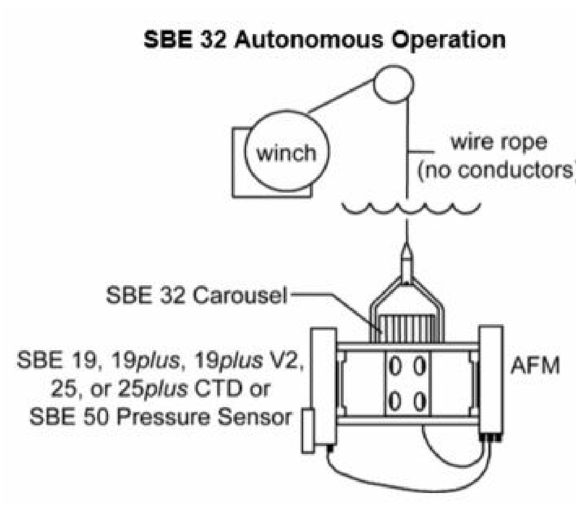
The PDIM provides 15 VDC power to the 19plus and is the interface for two-way RS232 communications from the 19plus to the telemetry used on the sea cable. The SBE 36 deck unit provides control over real-time data similar to the SBE 33.



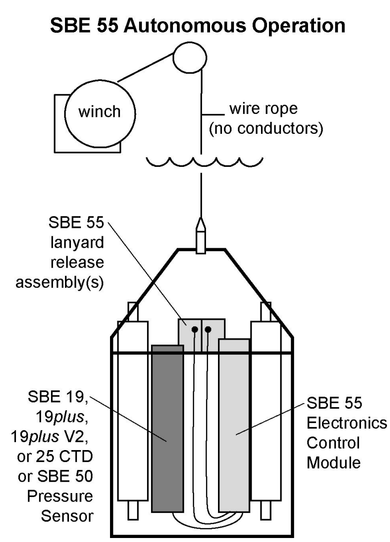
SBE 36 deck unit and PDIM real-time operation

The AFM that is mounted on or near the 19plus V2 lets the SBE 32 operate autonomously. The AFM supplies the power, logic, and control commands to operate the SBE 32. The AFM monitors the pressure data from the 19plus in real-time and closes the water sampler bottles at user-specified depths, or when the system is stopped for a specified period of time. The AFM records the bottle number, firing confirmation, and five measurements of CTD data for each bottle fired.

The SBE 55 is similar to a SBE 32 integrated with an AFM. The 55 thus operates autonomously. The SBE 55 monitors the pressure data from the 19plus in real-time and closes the water sampler bottles at user-specified depths, or when the system is stopped for a specified period of time. The SBE 55 records the bottle number, firing confirmation, and five measurements of CTD data for each bottle fired.



SBE 32 autonomous operation



SBE 55 autonomous operation

4.2 Battery pack

⚠ 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 alkaline 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

The pressure housing contains Electrostatic Discharge (ESD) sensitive parts and assemblies that are susceptible to damage from ESD. Follow ESD protocols:

- 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. *Do not wear a sweater, fleece or polyester-based clothing.*
- At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. *Do not use a workstation with a synthetic or polymeric-based tabletop.*

The SeaCAT uses 9 D-cell alkaline batteries for the main power supply (Duracell® MN1300, LR20).

Refer to the section on Replace alkaline batteries on page 41 for details about how to replace batteries. The batteries have a nominal capacity of 14 Ah. The manufacturer recommends a conservative value of 10 Ah. The available NiMH battery pack has a nominal capacity of 8 Ah.

Current consumption and data collection times vary as a result of instrument configuration and whether the 19plus V2 is moored or profiling. Examples are given below.

Profiling mode

Standard alkaline batteries, SBE 5M pump, no auxiliary sensors—
Data collection current draw = 70 mA

Pump current draw = 100 mA

Maximum data collection time = 10.5 Ah ÷ (0.070 A + 0.100A) = approximately 61 hours

Standard alkaline batteries, SBE 5T pump, auxiliary sensors with a total current draw of 100mA— Data collection current draw = 70 mA
Pump current draw = 150 mA
Maximum data collection time = 10.5 Ah ÷ (0.070 A + 0.150 A + 0.100 A) = approximately 32 hours

Moored mode

A 19plus V2 with strain-gauge pressure sensor and standard alkaline batteries is set up to sample autonomously every 10 minutes (6 samples/hour). How long can it be deployed?

SBE 5T pump on during sample, 15 second delay before sample is taken. Current draw of auxiliary sensors = 100 mA. 4 measurements per sample: Time on = 2.5 + 15 second delay + (4 - 1) × 0.25 additional measurements per sample = 18.25 seconds
Data collection current draw = 70 mA × 18.25 seconds = 1.28 A-seconds per sample
In one hour, data collection current draw = 6 × 1.28 A-seconds per sample = 7.7 A-seconds per hour
5T pump current draw = 150 mA ×18.25 seconds = 2.74 A-seconds per sample
In one hour, pump current draw = 6 × 2.74 A-seconds/sample = 16.4 A-seconds per hour
Auxiliary sensor current = 100 mA × 18.25 sec = 1.82 A-seconds per sample
In 1 hour, auxiliary sensor current = 6 × 1.82 A-seconds per sample = 10.9 A-seconds per hour
Quiescent current = 20 µA = 0.02 mA
In 1 hour, low power current draw ≈ 0.02 mA × 3600 seconds per hour = 0.072 A-secondd per hour
Current consumption per hour = 7.7 + 16.4 + 10.9 + 0.072 = 35.1 A-seconds per hour
Capacity = (10.5 A-hours × 3600 seconds per hour) ÷ (35.1 A-seconds per hour) = 1076 hours = 44 days = 0.12 years

Note:

- If the internal battery voltage is less than 9.5 V for 20 seconds OR the external power is less than the battery cutoff, the 19plus stops data collection. The data will show a low battery condition.

4.3 Cable length and external power

The sensor can use an external power source that supplies 9–28 VDC in addition to or instead of the internal batteries. The 19plus uses power from the source that supplies the highest voltage. It can also operate from the external power supply without the internal battery pack. On a ship, make sure that cables longer than 3 meters are installed by an electrician. These cables should be installed inside a grounded metal conduit. 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 the sensor will transmit data that does not meet the RS232 communication standard.
2. Supply enough power so that sufficient power is available to the sensor after IR loss is calculated.

Calculate communication IR loss

V_{limit} = 1 V = IR_{limit}

Maximum cable length = R_{limit} ÷ wire resistance/foot.

I = required communication current:

- profiling mode—use the total current draw required by the 19plus, pump, auxiliary sensor, communications.
- moored mode—65 mA

Profiling Mode for 19plus V2 with SBE 5M pump and no auxiliary sensors— For 20 gauge wire, what is maximum distance to transmit power to 19plus V2 with real-time data collection? Current draw = 70 mA (data collection) + 100 mA (pump) + 65 mA (communication) = 235 mA $R_{limit} = V_{limit} \div I$ = 1 volt ÷ 0.235 A = 4.3 ohms For 20 gauge wire, resistance is 0.0107 ohms/foot. Maximum cable length = 4.3 ohms ÷ 0.0107 ohms/foot = 402 feet = 122 meters

Moored Mode: 65 mA For 20 gauge wire, what is maximum distance to transmit power to 19plus V2 with real-time data? For 65 milliamp communications current, $R_{limit} = V_{limit} \div I$ = 1 volt ÷ 0.065 A = 15.4 ohms For 20 gauge wire, resistance is 0.0107 ohms/foot. Maximum cable length = 15.4 ohms ÷ 0.0107 ohms/foot = 1439 feet = 439 meters

Table 1 Common wire resistances

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

Supply sufficient power to 19plus V2

Supply enough power at the power source so sufficient voltage is available, after IR loss in the cable. The maximum 2-way resistance for various input supplies and pump configurations shows in the table below.

Power supply input, pump configuration	R_{limit} = maximum 2-way resistance, ohms
3 A @ 9V input, SBE 5M pump (cannot use SBE 5T or 5P pump with 9V input)	1
0.5 A @ 12V input, SBE 5M pump	10
0.5 A @ 12V input, SBE 5T or 5P pump	2
0.5 A @ 19V input, SBE 5M pump	30
0.5 A @ 19V input, SBE 5T or 5P pump	7

Maximum cable length = R_{limit} ÷ 2 × wire resistance per foot

Example What is the maximum cable length to supply power to the 19plus V2 with 20 gauge wire, a 12 V power supply, and SBE 5T pump? 2 ohms ÷ 2 × 0.0107 ohms/foot = 93 ft = 28 m

4.4 Data storage

The SBE 19plus V2 has a 64 MB flash memory for data. It can store a maximum of 1000 cast headers, which are added to memory each time a profile starts. The example below show the approximate number of samples that can be stored byt the 19plus V2.

Note that the data protocol is configured by the manufacturer for 9600 baud, 8 data bits, 1 stop bit, no parity.

Profiling mode no auxiliary sensors
strain-gauge pressure sensor = 5 bytes/sample
temperature and conductivity = 6 bytes/sample
Storage space ~ 64,000,000 ÷ (5 + 6) ~ 5,818,000 samples

Profiling mode strain-gauge pressure sensor = 5 bytes/sample
temperature and conductivity = 6 bytes/sample
External voltages = 2 bytes/sample × 6 voltages = 12 bytes/sample
Storage space ~ 64,000,000 ÷ (5 + 6 + 12) ~ 2,782,000 samples

Moored mode strain-gauge pressure sensor = 5 bytes/sample
temperature and conductivity = 6 bytes/sample
6 external voltages = 2 bytes/sample × 6 = 12 bytes/sample
SBE 38 sensor = 3 bytes/sample
date and time = 4 bytes/sample
Storage space ~ 64,000,000 ÷ (5 + 6 + 12 + 3 + 4) ~ 2,133,000 samples

4.5 Magnetic reed switch

Use the magnetic switch on the conductivity cell guard to start and stop the 19plus in Profiling mode. Make sure that the switch is in the Off position (closest to the bulkhead connector end) during setup and when data is transmitted.

If IgnoreSwitch=Y, the 19plus can be started and stopped with software commands. The position of the switch has no effect on data collection.

If AutoRun=Y, data collection starts and stops with external power is supplied and removed. The position of the switch has no effect on data collection. If the switch is to On, the 19plus draws an additional 15 µA from the battery when it is in a low power mode.

The magnetic switch is not used in Moored mode. Start and stop the 19plus with software commands.

4.6 Configuration options

The 19plus V2 can be configured with different auxiliary sensors. The three 6-contact bulkhead connectors are the input ports for the auxiliary sensor signal voltages and supply power to the sensors. The 4-contact bulkhead connector lets the user connect one of the RS232 sensors listed below:

- SBE 63 optical dissolved oxygen sensor
- SBE 38 secondary temperature sensor
- WET Labs' *ECO*, WETStar, C-Star, or SeaOWL UV-A sensors
- Pro-Oceanus Gas Tension Devices (2)
- Aanderaa Optode 4330 or 4835.

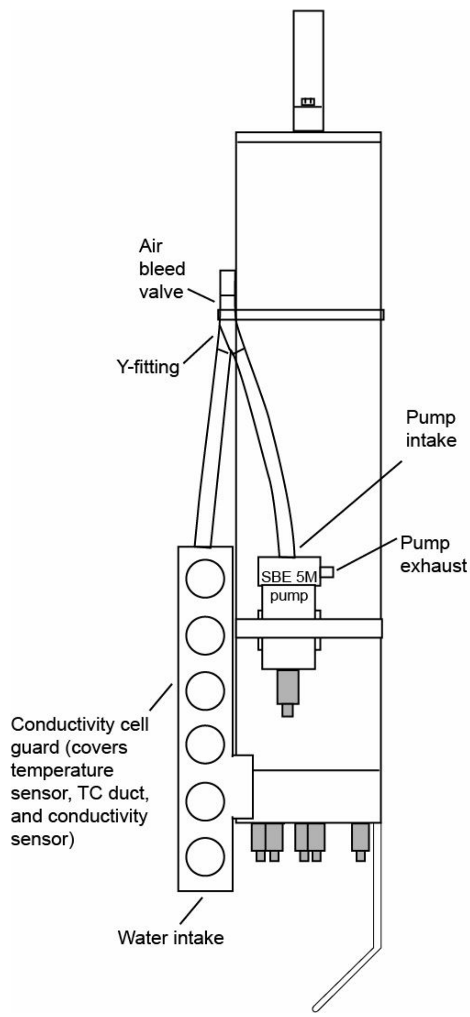
The 19plus V2 includes an external SBE 5M pump that supplies a constant flow rate through the conductivity cell at any rate of descent. The SBE 5 (T or P) is used if the 19plus V2 is configured with a dissolved oxygen sensor or pumped fluorometer. The system supplied by the manufacturer has the pump and plumbing set up as the user-specifies at the time of purchase. If the system is changed for a different application, **make sure that the pump and plumbing do not trap air, or the pump will not operate correctly.**

The 19plus V2 is typically deployed in a vertical position. If deployed with a SBE 32 carousel water sampler, the 19plus is deployed horizontally.

4.6.1 Vertical installation

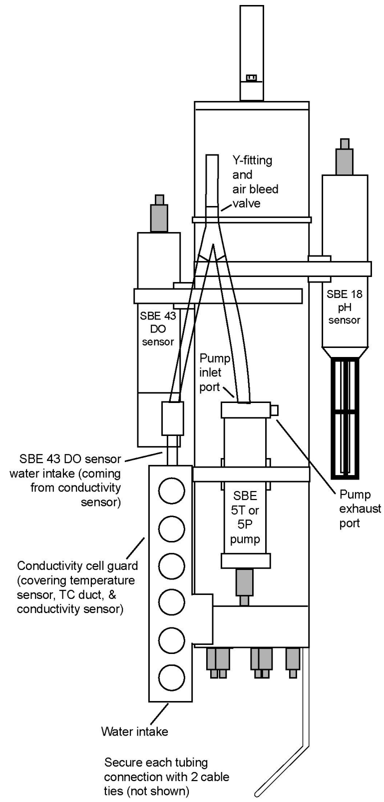
The figures below show the 19plus V2 with an SBE 5M pump, and the SBE 19 plus V2 with an SBE 5 (T or P) pump and auxiliary sensors.

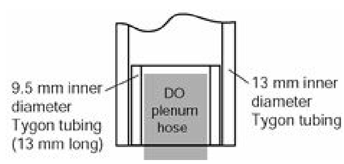
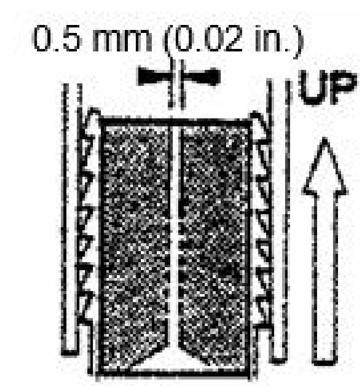
Figure 4 Vertical 19plus V2 with 5M pump



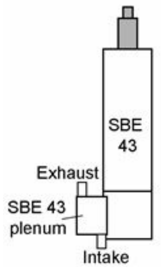
In the diagram below, the SBE 43 dissolved oxygen sensor is plumbed into the system between the conductivity outlet and the Y-fitting. An SBE 63 Optical Dissolved Oxygen sensor can be installed in place of the SBE 43. The manufacturer recommends that the user install the SBE 18 pH sensor for profiling applications only.

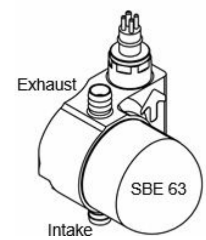
Figure 5 Vertical 19plus V2 with 5T or 5P pump and auxiliary sensors



<table>
<tr>
<td>
</td>
<td>
</td>
</tr>
<tr>
<td>DO sensor intake and exhaust detail</td>
<td>Air bleed valve detail</td>
</tr>
</table>

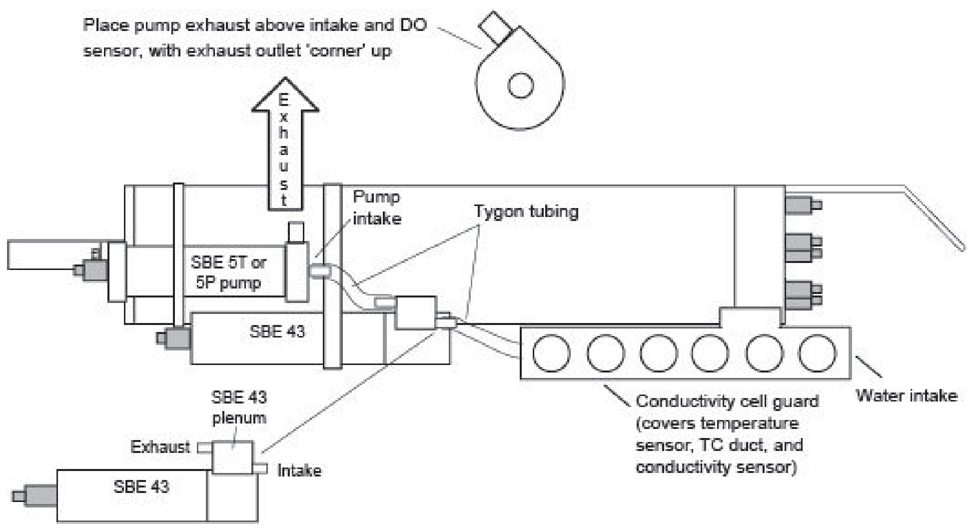
- Tygon tubing is 13 mm ID x 19 mm OD.
- Install a 13 mm long piece of 9.5 mm ID and put a 13 mm long, 13 mm ID piece of Tygon tubing over that on the conductivity cell exhaust for tight seals to the main plumbing—
  - when the optional antifouling fittings are installed on the 19plus V2.
  - on the SBE 43 intake and exhaust.





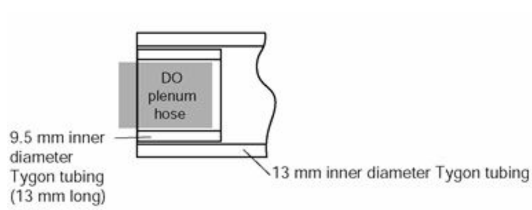
4.6.2 Horizontal installation

The figures below show the 19plus V2 with an SBE 5 (T or P), and an SBE 43 dissolved oxygen (DO) sensor. The SBE 43 is plumbed into the system between the conductivity cell outlet and the pump inlet. An (SBE 63 would attach in the same place.)



Details

- Attach the DO sensor intake above the conductivity sensor exhaust.
- Attach the pump intake above the DO sensor exhaust.
- Make sure the pump exhaust outlet is "corner" faces up.
- If the system does not have a DO sensor, connect the tubing from the conductivity cell directly to the pump intake.
- Attach the DO sensor with plenum intake closer to than exhaust to the SBE 43 housing.



- Tygon tubing for main plumbing is 13 mm ID and 19 mm OD.
- Install a 13 mm long section of Tygon tubing with a 9.5 mm ID and a 13 mm OD inside the main plumbing tubing at the SBE 43 intake and exhaust. This makes a tight seal.

Section 5 Deployment and recovery

5.1 Set up sensor and verify operation

Install the software for the sensor and configure the hardware to make sure that the system functions correctly before deployment.

5.1.1 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 software from the manufacturer-supplied CD or USB drive. The software is also available on the manufacturer's website.
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. Start the software. The software automatically connects at the default baud rate but will try others if necessary.

5.2 Set up for deployment

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.

1. If necessary, install new batteries or make sure that the installed batteries have enough capacity for the intended deployment. Refer to Replace alkaline batteries on page 41 for details.
2. Configure the 19plus V2.
   a. Set the date and time.
   b. If necessary transmit all stored data to a PC.
   c. Send InitLogging to make all of the memory available for data. If InitLogging is not sent, data will be stored after the last stored sample.
   d. Configure the data collection settings.
   e. Send GetCD or DS to verify the settings.
   f. Optional: use StartDateTime= and StartLater to set a future start date and time for Profiling Mode (if IgnoreSwitch=Y) or Moored mode.
3. Verify that the .xmlcon or .con configuration file agrees with the sensor configuration. The configuration file needs to be updated if the sensor has been re-calibrated or external sensors have been added.
4. Attach a cable or a dummy plug and lock collar to each connector on the 19plus V2.
5. Connect the cables to the applicable sensors
6. If necessary, remove the Tygon tubing looped end-to-end around the conductivity cell for storage. Connect the system plumbing again.
7. Immediately before deployment:
   Profiling mode—
   - If IgnoreSwitch=N, turn on the magnetic switch.
   - If IgnoreSwitch=Y, send StartNow, or StartDateTime= and StartLater.

- If AutoRun=Y, when the 19plus V2 is in low power mode, supply external power

Moored mode—

- Send StartNow or send StartDateTime= and StartLater.

5.3 Profiling operation mode

The SBE 19plus operates at 4 Hz, or one sample every 0.25 seconds and averages the data at user-selected intervals. Data is stored in the flash memory and is transmitted in real-time.

There are several methods to start and stop the 19plus:

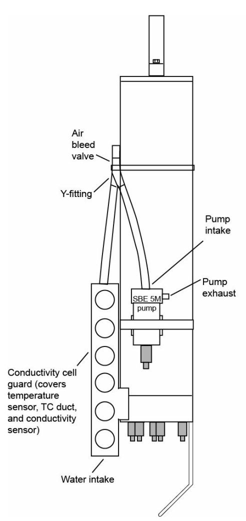
IgnoreSwitch=N	AutoRun=N	Start: slide magnetic switch on	Stop: slide magnetic switch off or send Stop
IgnoreSwitch=Y	AutoRun=N	Start: send StartNow or StartDateTime= and StartLater	Send Stop
IgnoreSwitch=Y or N	AutoRun=Y	Start: supply external power	Stop: remove external power

Operation notes:

- The 19plus operates at 2 Hz if equipped with a quartz pressure sensor.
- Profiling mode is not compatible with a Pro-Oceanus Gas Tension Device.
- The manufacturer ships the 19plus V2 with AutoRun=N. If you send AutoRun=Y, send QS to put the sensor in a low power mode, then turn the power off and then on again to start data collection, OR send StartNow to start sampling.

5.3.1 Pump operation

After the conductivity cell enters the water, there is a user-set interval before the pump turns on so that all of the air in the pump tubing can be released. If the pump turns on when there is air in the impeller housing, the pump may not prime correctly and the flow rate may be incorrect. The tubing that extends above the air-bleed hole has a small amount of water that keeps the pump primed for up to one minute, even if the cell inlet and pump outlet are just below the surface of the water.



Do not let the cell inlet and the pump outlet come above the surface of the water, or the pump prime will be lost.

If pump prime is lost, wait at least 5 seconds, then turn the 19plus on and submerge it completely. Wait for the pump interval time to pass and then start the profile.

5.4 Moored operation mode

At user-selected intervals, the SBE 19 V2 collects data and stores it flash memory, then returns to a low power mode. The 19plus V2 is in a low power mode for a minimum of 5 seconds between each sample.

Send StartNow or StartLater to start data collection. Send Stop to stop the 19plus V2. If MooredTxRealTime=Y, real-time data is transmitted after measurements are complete for the sample and before the next sample starts.

5.4.1 Sample times, moored mode

The time it takes for the 19plus V2 to collect a sample depends on several factors, such as the data collection mode, whether the optional pressure sensor is installed, pump setup, the number of characters of data transmitted and other factors.

Autonomous data collection

The 19plus V2 requires a minimum of 5 seconds from the end of one sample to the start of the next sample. If the sample interval is set to less than 5 seconds, the 19plus V2 sends an error message:

```
Error-->alarm time not far enough in the future, resetting alarm
to 5 sec from now.
```

The sensor takes the next sample in 5 seconds. The 19plus V2 does this check after each sample. Because of small variations in sample time, samples can be taken at irregular intervals. Make sure to verify that the sample time is long enough when the sensor is set up.

Examples:

MooredPumpMode=2
Pump on for 0.5 sec before each sample, with strain gauge pressure sensor and 1 measurement per sample.

Sample time = 0.5 seconds (pump on before sample) + 2.5 seconds (strain gauge sample time) = 3.0 seconds

Minimum sample interval = 3 seconds + 0.5 (seconds between samples) = 8.0 seconds < 10 second minimum, so minimum sample interval = 10.

MooredPumpMode=2
Pump on during each sample, with 15 second delay before next sample, quartz pressure sensor and 4 measurements per sample (NCycles=4).

Sample time = 15 seconds (delay before sample) + 2.45 seconds (quartz sample time) + (4 - 1) × 0.25 (additional measurements per sample for NCycles) = 18.2 seconds

Minimum sample interval = 18.2 seconds + 5 (seconds between samples) = 23.2 seconds, so minimum sample interval = 25 (round up by several seconds to account for small difference in sample time).

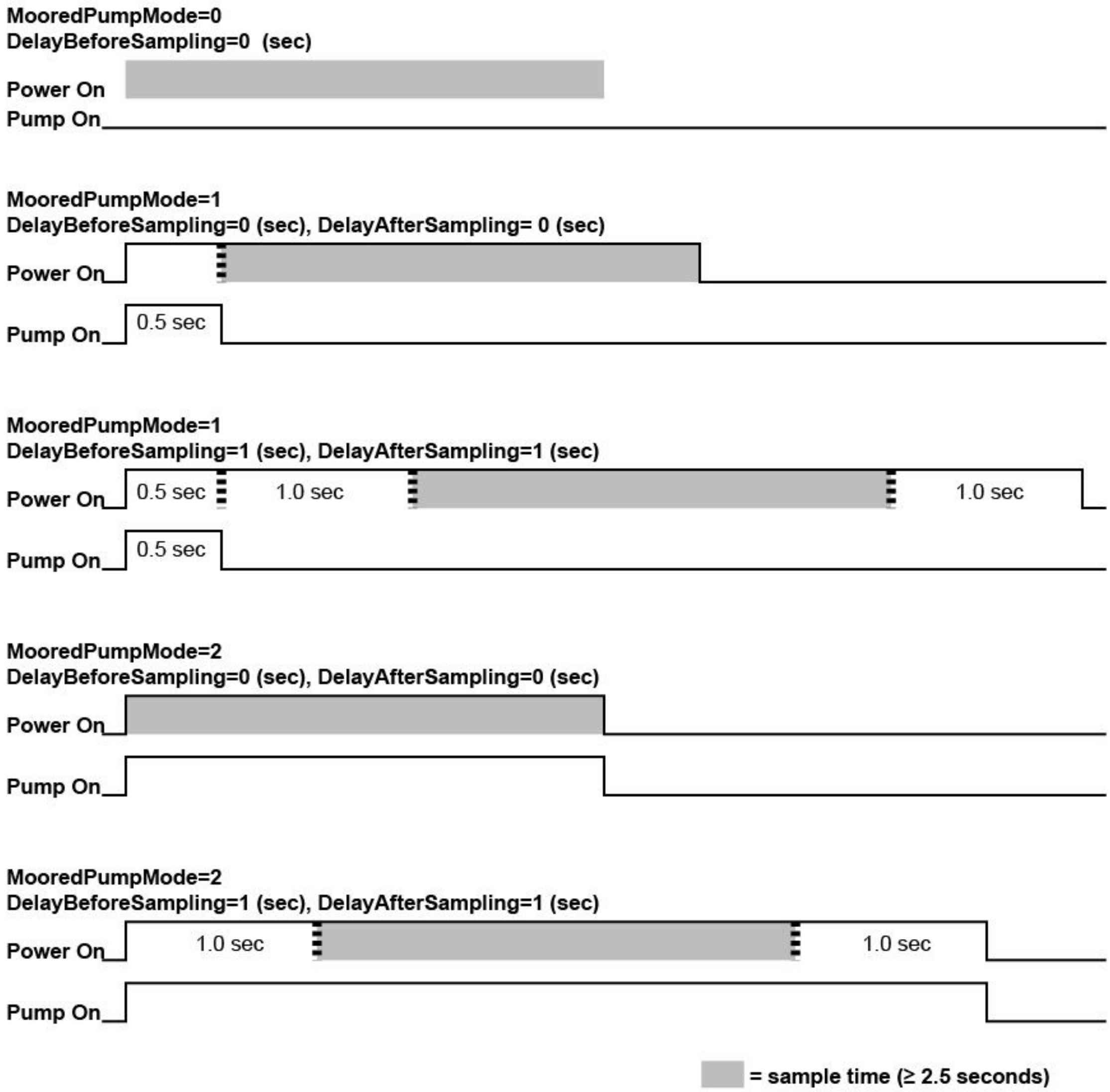
5.4.2 Pump operation

There are several user-selectable parameters to operate the 19plus V2 pump in Moored mode:

- **MooredPumpMode=0, 1, 2**
  Set up so that the pump does not operate (0)

  Set up so that the pump operates for 0.5 seconds before each sample (1)

  Set up so that the pump operates during each sample.
- **DelayBeforeSampling=**
  Set up so that data collection starts after power is supplied to external voltage and RS232 sensors: some require time to become stable after power is supplied, and WET Labs sensors with Bio-wipers require time for the wiper to open.
- **DelayAfterSampling=**
  Set up so that power is removed from the pump and external voltage and WET Labs sensors after data collection is complete so that the Bio-wiper closes.



Note: Sample time includes time for sensor to warm up as well as time to measure parameters. The 2.5 sec sample time is for 19*plus* V2 with strain gauge pressure sensor, and 1 measurement/sample (**NCycles=1**).

Pump setting recommendations

SBE 5M, 5P, or 5T through conductivity cell only:

For most deployments, use MooredPumpMode=1 and DelayBeforeSampling=0. The pump operates for 0.5 seconds before a conductivity measurement is made, so there is enough time for good airflow through the cell and to bring in a new sample of water.

If the 19plus V2 is moored in an area with large thermal gradients, it may be necessary to operate the pump longer to remove any cell thermal mass effects on the measurement. In this case, set MooredPumpMode=2 and DelayBeforeSampling= to a non-zero value for additional airflow time before the measurement is made.

SBE 5P or 5T through conductivity cell and SBE 43:

Set MooredPumpMode=2. As the pump brings new water into the SBE 43 plenum, time is required for the sensor to adjust to the new oxygen level. The time required is a function of membrane thickness and water temperature. For 1.0 mil SBE 43 membranes post-2007, DelayBeforeSampling= varies in a non-linear way from 25 seconds at 15 °C to 40 seconds at 0 °C.

SBE 5P or 5T through conductivity cell and SBE 63:

Set MooredPumpMode=2. As the pump brings new water into the SBE 63 plenum, time is required for the sensor to adjust to the new oxygen level. The time required is a function of water temperature. DelayBeforeSampling= varies in a non-linear way from 25 seconds at 15 °C to 40 seconds at 0 °C.

SBE 5P or 5T through conductivity cell and Beckman or YSI-type dissolved oxygen sensor:

Set MooredPumpMode=2. Set DelayBeforeSampling= to120–180 seconds to give the oxygen sensor time to polarize before the measurement is taken.

5.5 Real-time setup and data collection

Without a Deck Unit

The baud rate and the amount of data affect the rate that real-time data is transmitted from the 19plus V2:

time to transmit data = (# of characters × 10 bits/character) ÷ baud rate

- The carriage return and line feed at the end of each sample adds 2 characters.
- Include decimal points, commas, and spaces to the number of characters for OutputFormat=2, 3, 5.
- In Profiling mode, the time required to transmit data must be less than the real-time rate of output.
- In Moored mode, the time required to transmit data and the time required to make the measurement must be less than the interval between samples - 5 seconds (autonomous operation) because the 19plus V2 goes to a low power mode for a minimum of 5 seconds between each sample.
- When the 19plus V2 operates in moored mode with the setting MooredTxRealTime=Y, a # comes before the output for each sample.

Maximum cable lengths (m) and baud rates

cable	1600	800	400	200	100	50	25	16	8
baud	600	1200	2400	4800	9600	19200	38400	57600	115200

With a Deck Unit

Set the baud rate on the 19plus V2 to 4800 to use it with a Deck Unit:

- SBE 36 CTD Deck Unit and Power and Data Interface Module (PDIM)
- SBE 33 Carousel Deck Unit and SBE 32 Carousel Water Sampler or SBE 33 and SBE 55 ECO Water Sampler.

Systems that use Deck Units can support cables up to 10,000 m.

5.5.1 Set up for deployment

1. Make sure there are new batteries installed in the 19plus V2, or that the cells installed have sufficient power to complete the scheduled deployment.
2. Install the necessary cables or dummy plugs on each of the connectors on the 19plus V2 and the applicable sensors.
3. Verify that the .xmlcon configuration is the same as the 19plus V2 configuration. Update the configuration file if necessary.
4. Start the software.
5. Select the configuration settings for the deployment.
6. Make sure that the sensors are the same as the sensors attached to the 19plus V2, and that the channels are correct.
7. Start real-time data collection.
8. Stop the 19plus V2.
   The system is ready to deploy.

5.6 Data output formats

Data stored in the 19plus is converted and transmitted to a PC in the user-selected format, so it can be transmitted in more than one format until the user sends a command to overwrite it.

The output format is set by the user and by the command used to transmit the data. RS232 data is always in the same format:

- SBE 63 data is always phase delay and temperature voltage.
- SBE 38, GTD, and Optode data is always in engineering units.
- WET Labs sensor data is always in raw counts.

In Moored mode, the "time" is the time at the start of the sample, typically 1 to 2 seconds after a command to start data collection. If, for example, DelayBeforeSampling=20, the output time for the first sample is 20 + 1 or 2 seconds.

5.6.1 OutputFormat=0

Raw frequencies and voltages in hex

Data shows in the order listed, with no spaces or commas between parameters. Use the decimal equivalent of the hex data in the equations to calculate the parameter from the data.

- Set OutputFormat=0 if Seasave is used to collect real-time data.
- The raw output from the (absolute) pressure sensor includes the effect of atmospheric pressure (14.7 psi), as shown on the Calibration Sheet for the 19plus V2. If the output from the 19plus V2 is in engineering units, the pressure output shown is in decibars relative to the surface of the ocean.
  The 19plus V2 converts psia to decibars: (pressure, psia - 14.7) × 0.689476 = decibars.

Temperature A/D counts	ttttt
Conductivity frequency, Hz	cccccc ÷ 256
if PType=1, strain-gauge pressure sensor pressure A/D counts	pppppp
if PType=1, strain-gauge pressure sensor pressure compensation voltage	vvvv ÷ 13,107
if PType=3, quartz pressure sensor pressure frequency	pppppp ÷ 256
if PType=3, quartz pressure sensor temperature compensation voltage	vvvv ÷ 13,107
if Volt0=Y, external voltage 0	vvvv ÷ 13,107
if Volt1=Y, external voltage 1	vvvv ÷ 13,107
if Volt2=Y, external voltage 2	vvvv ÷ 13,107
if Volt3=Y, external voltage 3	vvvv ÷ 13,107
if Volt4=Y, external voltage 4	vvvv ÷ 13,107
if Volt5=Y, external voltage 5	vvvv ÷ 13,107
if SBE38=Y, SBE 38 temperature, °C	(ttttt ÷ 100,000) - 10
if WetLabs=Y, WET Labs RS232 sensor	wwwwxxxxyyyy
where wwww, xxxx, and yyyy are raw signal counts for each sensor. yyyy all 0's for dual sensor. xxxx and yyyy all 0's for single sensor.	
if GTD=Y or DualGTD=Y, GTD #1 pressure, millibars	pppppppp ÷ 100,000
if GTD=Y or DualGTD=Y, GTD #1 temperature, °C	(tttttt ÷ 100,000) - 10
if DualGTD=Y, GTD #2 pressure, millibars	pppppppp ÷ 100,000

if DualGTD=Y, GTD #2 temperature, °C	(tttttt ÷ 100,000) - 10
if Optode=Y, Optode oxygen, µmoles/L	(oooooo ÷ 10,000) - 10
if SBE 63=Y, SBE 63 oxygen phase, µsec	(oooooo ÷ 100,000) - 10
if SBE 63=Y, SBE 63 oxygen temperature voltage	(tttttt ÷ 1,000,000) - 1
Time, Moored mode only, seconds since Jan. 1, 2000	ssssssss

Example : profiling mode, strain-gauge pressure sensor, 2 external voltages = ttttttccccccppppppvvvvvvvvvvvv = 0A53711BC7220C14C17D8203050594			
temperature	tttttt	0A5371	676721 decimal A/D counts
conductivity	cccccc	1BC72	1820450 decimal; 1820450 ÷ 256 = 7111.113 Hz
pressure	pppppp	0C14C1	791745 decimal A/D counts
pressure sensor temperature compensation	vvvv	7D82	32,130 decimal; 32,130 ÷ 13,107 = 2.4514 volts
first external voltage	vvvv	0305	773 decimal; 773 ÷ 13,107 = 0.0590 volts
second external voltage	vvvv	0594	1428 decimal; 1428 ÷ 13,107 = 0.1089 volts

5.6.2 OutputFormat=1

Eengineering units in hex

Data shows in the order listed with no spaces or commas between parameters. Use the decimal equivalent of the hex data in the equations to calculate the parameter from the data.

Temperature, °C	(ttttt ÷ 100,000) - 10
Conductivity, S/m	(cccccc ÷ 1,000,000) - 1
if PType=1, strain-gauge pressure sensor or PType=3 quartz pressure sensor	(pppppp ÷ 1,000) - 100
if Volt0=Y, external voltage 0	vvvv ÷ 13,107
if Volt1=Y, external voltage 1	vvvv ÷ 13,107
if Volt2=Y, external voltage 2	vvvv ÷ 13,107
if Volt3=Y, external voltage 3	vvvv ÷ 13,107
if Volt4=Y, external voltage 4	vvvv ÷ 13,107
if Volt5=Y, external voltage 5	vvvv ÷ 13,107
if SBE38=Y, SBE 38 temperature, °C	(ttttt ÷ 100,000) - 10
if WetLabs=Y, WET Labs RS232 sensor	wwwwxxxxyyyy
where wwww, xxxx, and yyyy are raw signal counts for each sensor. yyyy all 0's for dual sensor. xxxx and yyyy all 0's for single sensor.	
if GTD=Y or DualGTD=Y, GTD #1 pressure, millibars	pppppppp ÷ 100,000
if GTD=Y or DualGTD=Y, GTD #1 temperature, °C	(tttttt ÷ 100,000) - 10
if DualGTD=Y, GTD #2 pressure, millibars	pppppppp ÷ 100,000
if DualGTD=Y, GTD #2 temperature, °C	(tttttt ÷ 100,000) - 10
if Optode=Y, Optode oxygen, µmoles/L	(oooooo ÷ 10,000) - 10
if SBE 63=Y, SBE 63 oxygen phase, µsec	(oooooo ÷ 100,000) - 10

if SBE 63=Y, SBE 63 oxygen temperature voltage	(tttttt ÷ 1,000,000) - 1
Time, Moored mode only, seconds since Jan. 1, 2000	ssssssss

Example : profiling mode, 2 external voltages = ttttttccccccppppppvvvvvvvv = 3385C40F42FE0186DE03050594			
temperature	tttttt	3385C4	3376580 decimal; 3376580 ÷ 100,000 = 23.7658 °C
conductivity	cccccc	0F42FE	10000190 decimal; (10000190 ÷ 1,000,000) -1 = 0.00019 S/m
pressure	pppppp	0186DE	100062 decimal; (100062 ÷ 1,000) -100 = 0.062 dbar
first external voltage	vvvv	0305	773 decimal; 773 ÷ 13,107 = 0.0590 volts
second external voltage	vvvv	0594	1428 decimal; 1428 ÷ 13,107 = 0.1089 volts

5.6.3 OutputFormat=2

Raw frequencies and voltages in decimal

Data shows in the order listed, with a comma and a space between parameters.

Temperature A/D counts	tttttt
Conductivity frequency, Hz	cccc.ccc
if PType=1, strain-gauge pressure sensor pressure A/D counts	pppppp
if PType=1, strain-gauge pressure sensor pressure compensation voltage	v.vvvv
if PType=3, quartz pressure sensor pressure frequency	ppppp.ppp
if PType=3, quartz pressure sensor temperature compensation voltage	v.vvvv
if Volt0=Y, external voltage 0	v.vvvv
if Volt1=Y, external voltage 1	v.vvvv
if Volt2=Y, external voltage 2	v.vvvv
if Volt3=Y, external voltage 3	v.vvvv
if Volt4=Y, external voltage 4	v.vvvv
if Volt5=Y, external voltage 5	v.vvvv
if SBE38=Y, SBE 38 temperature, °C	ttt.tttt
if WetLabs=Y, WET Labs RS232 sensor	wwwwxxxxyyyy
where wwww, xxxx, and yyyy are raw signal counts for each sensor. yyyy all 0's for dual sensor. xxxx and yyyy all 0's for single sensor.	
if GTD=Y or DualGTD=Y, GTD #1 pressure, millibars	pppppppp ÷ 100,000
if GTD=Y or DualGTD=Y, GTD #1 temperature, °C	tt.ttt
if DualGTD=Y, GTD #2 pressure, millibars	pppppppp ÷ 100,000
if DualGTD=Y, GTD #2 temperature, °C	tt.ttt
if Optode=Y, Optode oxygen, µmoles/L	oooo.ooo
if SBE 63=Y, SBE 63 oxygen phase, µsec	oo.ooo
if SBE 63=Y, SBE 63 oxygen temperature voltage	t.tttttt
Time, Moored mode only, date, time	dd Mmm yyyy, hh:mm:ss

Example : profiling mode, strain-gauge pressure sensor, 2 external voltages = tttttt, cccc.ccc, pppppp, v.vvvv, v.vvvv, v.vvvv = 676721, 7111.133, 791745, 2.4514, 0.0590, 0.1089		
temperature	tttttt	676721 A/D counts
conductivity	cccc.ccc	7111.113 Hz
pressure	pppppp	791745 A/D counts
pressure sensor temperature compensation	v.vvvv	2.4514 volts
first external voltage	v.vvvv	0.0590 volts
second external voltage	v.vvvv	0.1089 volts

5.6.4 OutputFormat=3

Engineering units in decimal

Data shows in the order listed, with a comma and a space between parameters.

Temperature °C	ttt.tttt
Conductivity frequency, S/m	cccc.ccc
if PType=1, strain-gauge pressure sensor dbars	pppp.ppp
if PType=3, quartz pressure sensor pressure frequency	pppp.ppp
if Volt0=Y, external voltage 0	v.vvvv
if Volt1=Y, external voltage 1	v.vvvv
if Volt2=Y, external voltage 2	v.vvvv
if Volt3=Y, external voltage 3	v.vvvv
if Volt4=Y, external voltage 4	v.vvvv
if Volt5=Y, external voltage 5	v.vvvv
if SBE38=Y, SBE 38 temperature, °C	ttt.tttt
if WetLabs=Y, WET Labs RS232 sensor	wwwwxxxxyyyy
where wwww, xxxx, and yyyy are raw signal counts for each sensor. yyyy all 0's for dual sensor. xxxx and yyyy all 0's for single sensor.	
if GTD=Y or DualGTD=Y, GTD #1 pressure, millibars	pppppppp ÷ 100,000
if GTD=Y or DualGTD=Y, GTD #1 temperature, °C	tt.ttt
if DualGTD=Y, GTD #2 pressure, millibars	pppppppp ÷ 100,000
if DualGTD=Y, GTD #2 temperature, °C	tt.ttt
if Optode=Y, Optode oxygen, µmoles/L	oooo.ooo
if SBE 63=Y, SBE 63 oxygen phase, µsec	oo.ooo
if SBE 63=Y, SBE 63 oxygen temperature voltage	t.tttttt
if OutputSal=Y, salinity, psu	sss.ssss
if OutputSV=Y, sound velocity, m/sec	vvvv.vvv
Time, Moored mode only, date, time	dd Mmm yyyy, hh:mm:ss

Example : profiling mode, strain-gauge pressure sensor, 2 external voltages = ttt.tttt, cc.ccccc, pppp.ppp, v.vvvv, v.vvvv = 23.7658, 0.00019, 0.062, 0.0590, 0.1089		
temperature	ttt.tttt	23.7658 °C

conductivity	cc.ccccc	0.00019 S/m
pressure	pppp.ppp	0.062 dbars
first external voltage	v.vvvv	0.0590 volts
second external voltage	v.vvvv	0.1089 volts

5.6.5 OutputFormat=4

Data shows in the order listed, with no spaces or commas between parameters. Use the decimal equivalent of the hex data in the equations to calculate the parameter from the data.

The 19plus V2 is automatically set to OutputFormat=4 when it communicates with:

- The Auto Fire Module (AFM) and SBE 32 Carousel Water Sampler. The AFM uses the pressure data from the 19plus V2 to close the SBE 32 water bottles.
- The SBE 55 ECO Water Sampler. The SBE 55 uses the pressure data from the 19plus V2 to close the water bottles if set up to collect data autonomously.

if PType=1 or 3, pressure in dbars	pppp - 100
Scan number=	ssssss

Example : 19plus V2 used with AFM and carousel = ppppssssss = 00C80001F0			
pressure	pppp	00C8	200 decimal; 200-100 = 100 dbar
scan number	ssssss	0001F0	496 = decimal scan number

5.6.6 OutputFormat=5

Data shows in the order listed, with no carriage return or line feed (CRLF) between parameters. The CRLF occurs the after </datapacket> tag.

	<?xml?>
	<datapacket>
	<hdr>
	<mfg>Sea-Bird</mfg>
	<model>19plus</model>
	<sn>nnnnnnn</sn>
	</hdr>
	<data>
Temperature °C	<t1>ttt.tttt</t1>
Conductivity frequency, S/m	<c1>cc.ccccc</c1>
if PType=1 or 3, pressure, dbars	<p1>pppp.ppp</p1>
if Volt0=Y, external voltage 0	<v0>v.vvvv</v0>
if Volt1=Y, external voltage 1	<v1>v.vvvv</v1>
if Volt2=Y, external voltage 2	<v2>v.vvvv</v2>
if Volt3=Y, external voltage 3	<v3>v.vvvv</v3>
if Volt4=Y, external voltage 4	<v4>v.vvvv</v4>
if Volt5=Y, external voltage 5	<v5>v.vvvv</v5>

	<ser1>
(RS232 sensor) <type>sbe38, wetlabs, gtd, Optode, sbe63, SeaFET</type>	
if SBE38=Y, SBE 38 temperature, °C	<t38>ttt.tttt</t38>
if WetLabs=Y	<wl0>wwww</wl0>
if WetLabs=Y	<wl1>wwww</wl1>
if WetLabs=Y	<wl2>wwww</wl2>
if GTD=Y or DualGTD=Y, GTD #1 pressure, millibars	<p1>pppppppp</p1>
if GTD=Y or DualGTD=Y, GTD #1 temperature, °C	<t1>tt.ttt</t1>
if DualGTD=Y, GTD #2 pressure, millibars	<p2>pppppppp</p2>
if DualGTD=Y, GTD #2 temperature, °C	<t2>tt.ttt</t2>
if Optode=Y, Optode oxygen, µmoles/L	<oox>oooo.ooo</oox>
if SBE 63=Y, SBE 63 oxygen phase, µsec	<oxph>oo.ooo</oxph>
if SBE 63=Y, SBE 63 oxygen temperature voltage	<oxtv>t.tttttt</oxtv>
if SeaFET=Y, internal reference voltage	<vint>ii.iiiiii</vint>
if SeaFET=Y, external reference voltage	<vext>ee.eeeeee</vext>
	</ser1>
if OutputSal=Y, salinity, psu	<sal>sss.ssss</sal>
if OutputSV=Y, sound velocity, m/sec	<sv>vvvv.vvv</sv>
Moored mode only, date, time	<dt>yyyy-mm-ddThh:mm:ss</dt>
	</data>
	</datapacket>

Example : profiling mode, 2 external voltages
= <?xml?><datapacket><hdr><mfg>Sea-Bird</mfg><model>19plus</model><sn>1906003</sn></hdr><data><t1>23.7658</t1><c1>0.00019</c1><p1>0.062</p1><v0>0.0590</v0><v1>0.1089</v1></data></datapacket>CRLF

= 23.7658, 0.00019, 0.062, 0.0590, 0.1089

temperature	ttt.tttt	23.7658 °C
conductivity	cc.ccccc	0.00019 S/m
pressure	pppp.ppp	0.062 dbars
first external voltage	v.vvvv	0.0590 volts
second external voltage	v.vvvv	0.1089 volts

Polled data

Commands SL, SLT, TS, TSS, or TSSOn: if OutputUCSD=Y and the 19plus V2 collects data autonomously, the data is followed by—
<dens>ddd.dddd</dens><vb>vv.v</vb><i>ccc.c</i>

where

density sigma-t, kg/m3 = ddd.dddd

battery voltage = vv.v

operational current draw, mA = ccc.c

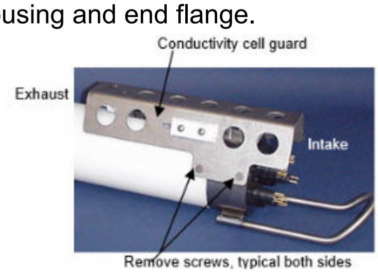
The rest of the data stream is as above for uploaded data.

5.7 Install optional anti-fouling devices

The SeaCAT is used primarily to profile, but can be deployed on a mooring. Anti-fouling caps and cups are available to prevent biofouling.

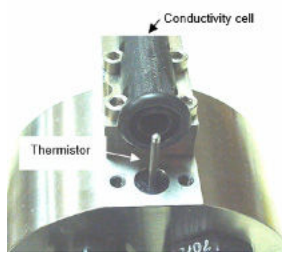
		
Device cups for intake and exhaust	Device cap for exhaust (with barbs for applications with pump)	Device cap for intake, and exhaust cap for applications without pump

1. Deployments with a pump: remove the Tygon tubing from the conductivity cell exhaust duct.
2. Remove the four Phillips-head screws that attach the conductivity cell guard to the pressure housing and end flange.

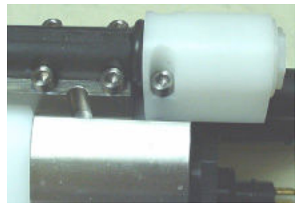


3. For exhaust:
   - **a.** Remove the two small screws that attach the exhaust duct to the guard.
   - **b.** Remove the exhaust duct and replace it with the exhaust anti-fouling cup and install the screws again.

   - **c.** Install the anti-fouling device cap to attach the device in the cup.
4. For intake:
   - **a.** Remove the two hex head screws that attach the intake duct to the end flange.
   - **b.** Pull the intake duct straight up to remove it, to prevent damage to the thermistor.

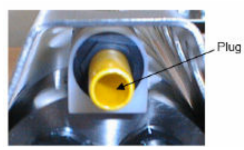


c. Make sure that the O-ring at the end of the conductivity cell is still in place.



d. Carefully put the intake anti-fouling cup over the thermistor and install the hex head screws again.

5. Make sure that the O-ring at the exhaust end of the conductivity cell is still in place.
6. Attach the conductivity cell guard on the pressure housing and end flange with the four Phillips-head screws.
7. If the sensor will not be deployed immediately, install a protective plug in the intake cap, and (for deployments without a pump) in the exhaust cap.



8. For deployments that use a pump, connect the tubing to the sensor again:

a. Put a 13 mm long piece of Tygon tubing on the barbed cap (ID = 9.5 mm; OD = 13 mm).

b. Install the tubing again.
(Tubing is 13 mm ID and 19 mm OD.)

5.8 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.

⚠ WARNING

If the user thinks that the alkaline 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.

⚠ WARNING

If the user thinks that the NiMH 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

The pressure housing contains Electrostatic Discharge (ESD) sensitive parts and assemblies that are susceptible to damage from ESD. Follow ESD protocols:

- 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. *Do not wear a sweater, fleece or polyester-based clothing.*
- At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. *Do not use a workstation with a synthetic or polymeric-based tabletop.*

⚠ 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.

1. Flush the sensor and conductivity cell with fresh water.
2. Make sure there is enough battery life to transmit data from the SeaCAT to a PC. Refer to Replace alkaline batteries on page 41 or Charge NiMH batteries on page 42 for details.
3. If so-equipped, remove and store the anti-fouling devices.
4. If so-equipped, install the protective plugs in the anti-fouling device cups.
5. If the SeaCAT will not be deployed immediately, put the sensor in a low power mode, which draws only 20 µA. If the sensor will be stored, remove the batteries.

5.9 Transmit data

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

1. If necessary, start the software.
2. Send a command to stop: push the **Enter** key, then enter **Stop**, then push **Enter** again. 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. Transmit data from the 19plus V2 to the PC
5. Make sure that all the data is uploaded to a PC, then send the InitLogging command to erase the memory.
   If this command is not sent, new data will be stored after the last stored sample until the memory is full.

Section 6 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.

6.1 Clean pressure housing

After every deployment, flush the pressure housing with clean fresh water. Make sure to keep the sensor out of direct sunlight between deployments.

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. Make sure that O-ring surfaces are clean, and monitor the pressure housing for deep scratches that can become a point of weakness during deep deployments or very cold temperatures.

For titanium and aluminum pressure housings: do not let the pressure housing come into direct with another type of metal. Wrap metal clamps and other hardware used to attach the sensor to a frame with electrical tape.

6.2 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.

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.
- Manufacturer-supplied tubing and syringe to clean the plumbing.

Procedure notes:

Use warm 30 °C (86 °F) 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 anti-fouling assembly if necessary.

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. 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.
2. Remove the copper assembly and anti-fouling devices from the sensor.
3. Use a 3/16-inch hex wrench to remove the flushing port plug, a ¼-20 x 1 inch socket head screw.
   Keep the plug to install again.
4. Put the instrument in a container with the bulkhead connector face-up.
5. If a cleaning solution is necessary, pull approximately 30 ml of DI water into the syringe.
6. Push the syringe plunger to fill the sensor flow path until 3–5 cm of solution shows in each tube.
7. Push and pull the plunger to mix the solution in the flow path. Do this 2–3 times.
8. Drain the solution from the sensor into a waste container. Push the syringe plunger to help remove all of the solution from the sensor.
9. Remove the tubing and shake the sensor.
10. If the flow path is still not clean, do the above steps again with the bleach solution.
11. Flush the flow path with DI water.
12. Install the flushing port plug again.
    The sensor is ready for a functional test in the laboratory or a deployment.

6.3 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.

6.4 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.

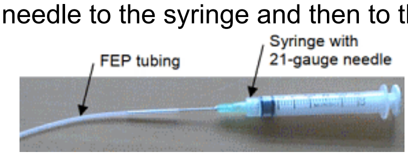
2. Flush the pressure port with warm DI water to remove any contamination.
3. Replace the pressure port plug. Do not over-tighten the nylon screw.

6.4.1 Refill the pressure sensor

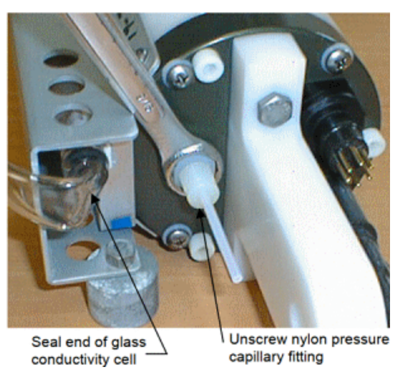
Fill the quartz pressure sensor with the appropriate oil when no oil can be seen in the capillary tube to the pressure sensor.

Part	Description	Qty
30419	Syringe	1
30420	21-gauge needle	1
30421	3 in. FEP tubing for syringe needle (1/32 in. ID; 1/16 in. OD)	1
30410	Dow Corning DC-200 oil	1 oz.
30322	Bottle for 30410 oil	1

1. Remove the tip of the needle so it is no longer sharp.
2. Remove any burrs.
3. Attach the needle to the syringe and then to the FEP tubing.



4. Cover the end of the glass conductivity cell with Tygon tubing or similar to prevent contamination with oil. Make sure not to hit the cell with the wrench or it can break.



5. Remove the nylon pressure capillary fitting from the pressure port. Oil may spill.
6. Optional: calibrate the pressure sensor.
   a. The pressure port is 5/16-24 straight thread to accept a pressure fitting such as a Swagelok-200-1-OR that has an O-ring.
   b. Do the calibration.
   c. Remove the pressure fitting.
7. Put the system in an upright position.

8. Fill the syringe with DC-200 oil.
9. Put the FEP tubing connected to the syringe into the internal capillary of the pressure port as far as it will go.
10. Fill the internal capillary with oil. Make sure to pull the syringe tubing out of the capillary as it fills, and keep the tip of the syringe tubing below the surface of the oil as the syringe is pulled out.
11. Install the nylon capillary fitting again. Make sure that it is not too tight.
    The oil should flow out of the external capillary tube as the fitting is installed. If it does not, add more oil.
12. Clean any spilled oil.
13. Remove the Tygon tubing or other material used to protect the glass conductivity cell.

6.5 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.

6.6 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 (approximately 1 cm in diameter) of silicone grease on the socket end of the connector and push as much of the lubricant as possible into each socket. 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.

6.7 Clean conductivity cell

⚠ CAUTION
Wear latex gloves, a lab coat, and safety glasses. Wash hands after use.

Clean the conductivity cell at regular intervals so that the sensor continues to collect accurate data.

Supplies:

- De-ionized or distilled water. If unavailable, use fresh tap water, used with a non-ionic surfactant, or bleach. 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.
- Manufacturer-supplied Tygon tubing and syringe to clean the conductivity cell.

- Use warm 30 °C (86 °F) 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 soaker tube with DI water for approximately 12 hours to loosen debris.

1. Attach a 10 cm length of ¼ inch OD Tygon tubing to the exhaust end of the conductivity sensor.
2. Attach the other end of the tubing to a 60 mL syringe that is filled with the bleach solution.
3. Push and pull the plunger to mix the solution in the flow path. Do this 2–3 times.
4. Drain the solution from the sensor into a waste container. Push the syringe plunger to help remove all of the solution from the sensor.
5. If the cell is still not clean, fill the syringe with the surfactant and steps 3 and 4.
   - Option: with the tubing filled with the surfactant solution, remove the syringe and attach the tubing to the other end of the sensor. Let it soak for one hour.

6. Flush the flow path with DI water.
7. Attach the soaker tube to store the sensor and keep the conductivity cell clean.

6.8 Replace alkaline batteries

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

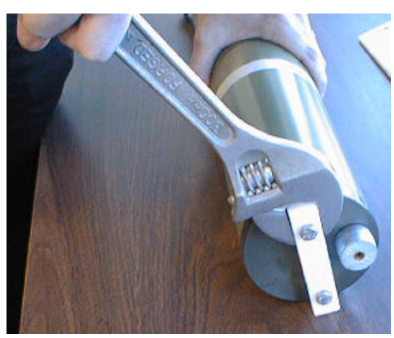
If the user thinks that the alkaline batteries have leaks, pressure may have built up inside of the pressure housing. Follow ESD protocols to release internal pressure. Put on safety glasses and protective gloves and make sure that the sensor is pointed away from the body and other people. In a well 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

The pressure housing contains Electrostatic Discharge (ESD) sensitive parts and assemblies that are susceptible to damage from ESD. Follow ESD protocols:

- 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. *Do not wear a sweater, fleece or polyester-based clothing.*
- At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. *Do not use a workstation with a synthetic or polymeric-based tabletop.*

1. Use a clean cloth to dry the outside of the battery end flange. Make sure to remove any water at the interface between the pressure housing and the end flange.
2. Use a wrench on the white plastic bar to turn the end flange counterclockwise to loosen.



3. Remove any water on all of the O-ring surfaces with a lint-free cloth or tissue.
4. Keep the end flange and make sure to protect the O-ring from contamination or other damage.
5. Remove the three Phillips-head screws and washers from the battery cover plate. The battery cover plate will pop out.

6. Remove the batteries.
7. Install new batteries. Make sure the + terminal is on the flat battery contacts and the - terminal is on the spring contacts.
8. Align the battery cover with the housing. The posts inside the housing are asymmetrical, to the cover fits into the housing only one way.
   One screw hole is closer to the edge than the others and aligns with the post that is closest to the housing.
9. Install the three Phillips-head screws and washers again: push firmly on the cover to make sure that the spring is fully in contact with the batteries.
   Make sure the screws are fully tightened or battery power will be intermittent.
10. Verify that the battery voltage at BAT + and BAT - on the battery cover is approximately 18 V.
11. Make sure all O-ring surfaces are clean and dry. Replace O-rings as necessary.
12. Apply a light coat of silicone-based Parker Super O Lube to the O-ring mating surfaces.
13. Carefully put the end flange onto the housing and screw the end flange into place. Use a wrench to make sure the cap is tightly installed.
14. Verify that the switch plunger is pulled out so that the Searam is in a low-power mode.

6.9 Charge NiMH batteries

⚠ 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 NiMH 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.

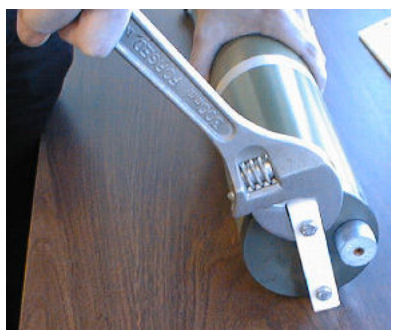
⚠ CAUTION


The pressure housing contains Electrostatic Discharge (ESD) sensitive parts and assemblies that are susceptible to damage from ESD. Follow ESD protocols:

- 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. *Do not wear a sweater, fleece or polyester-based clothing.*
- At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. *Do not use a workstation with a synthetic or polymeric-based tabletop.*

It is not necessary to remove the battery pack from the housing to charge the NiMH batteries (steps 5 and 12).

1. Use a clean cloth to dry the outside of the battery end flange. Make sure to remove any water at the interface between the pressure housing and the end flange.
2. Use a wrench on the white plastic bar to turn the end flange counterclockwise to loosen.



3. Remove any water on all of the O-ring surfaces with a lint-free cloth or tissue.
4. Keep the end flange and make sure to protect the O-ring from contamination or other damage.
5. Remove the battery pack from the housing:
    a. Unscrew each of the three cap screws **just until they reach the bottom of the protective plastic plate**.The battery pack will come out of the housing approximately 6 mm because of the spring contacts at the bottom of the battery compartment.
    b. Unscrew the cap screws again. The battery pack will come further out of the housing and should now be disconnected from the battery posts.
    c. Pull on the cord to remove the battery pack from the housing.
6. Connect the battery charger to a power source and turn on power to the charger.
7. Connect the charger cable to the battery pack and charger.
   The LED shows READY, and the display shows the battery type and voltage.

8. Push the DISCHARGE button on the charger.
   This starts the discharge cycle, so that any voltage in the batteries is discharged. This increases the life of the batteries. Discharge takes approximately 75 minutes. When complete, the LED shows EMPTY.
9. Push the CHARGE button.
   The LED shows FAST CHARGE (or WARM-UP CHARGE, or REFILL CHARGE, or TOP-OFF.) The FAST CHARGE cycle takes approximately 2 hours. The REFILL CHARGE takes approximately 15 hours. When the batteries are charged, the LED shows BATTERY FULL.
10. Turn off power to the charger.
11. Disconnect the charger cable from the battery pack and the power supply.
12. Install the battery pack into the housing again:
    a. The battery pack fits tightly in the housing. Align it carefully and slowly insert it straight into the housing. Be careful not to tear the shrink wrap on the battery pack.
    b. Install the three cap screws into the top plate.
    c. Push firmly on the protective plastic plate to make sure that the spring is fully in contact with the batteries.
    d. Make sure that the screws are fully tightened or the battery power will be intermittent.
13. Carefully put the end flange onto the housing and screw the end flange into place. use a wrench to make sure the cap is tightly installed.
14. Verify that the switch plunger is pulled out so that the Searam is in a low power mode.

6.10 CTD storage

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.

6.11 Spare parts and accessories

Part number	Description	Qty
50435	Spares kit with data I/O cable, bulkhead connectors, dummy plugs, non-ionic surfactant, O-ring lubricant, other mechanical spares and maintenance items	1
90087	Universal plumbing kit, pump air release valve, y-fitting, tubing (AN 64-1)	1

801511	9 Ni-MH D-cell batteries, Duracell MN 1300 (LR20), in rechargeable drop-in pack	1
90900S	Ni-MH battery charger for up to 12 cells, 8.0 Ah D-cells	1
20200.0	USB-to-serial port adapter, FTDI UC232R-10	1
801206	Data I/O cable, 2.4 m (DN 32366)	1
171883	Y-cable, pump and data I/O (DN 32896)	1
30411	500 ml bottle of non-ionic surfactant	1
50288.M	Moored mode conversion kit for antifouling holders, hardware and 172220 pump power-data-I/O cable to invert the pump	1
801542	AF24173 device pair	1

6.12 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.

6.12.1 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.

6.12.2 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.

6.12.3 Pressure

The SBE 19plus V2 has a strain-gauge pressure sensor or a quartz pressure sensor. 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 (db) = P (psi) = P (psia) - 14.7

P (dbar) = [P (psia) - 14.7] × 0.689476

The manufacturer recommends that the user use 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. Send TP to measure the 19plus V2 pressure 100 times and transmit converted data in engineering units (dbars).
5. Compare the sensor output to what a barometer at the same elevation as the pressure sensor port shows.

Example of offset correction

- Absolute pressure measured by a barometer is 1010.5 mbar.
- Pressure measured by the 19plus V2 is -2.5 dbar.
- Convert the barometer measurement: mbar × 0.01 dbar.
- = 1010.5 mbar × 0.01 = 10.1050 dbar.

The 19plus V2 uses the value of 14.7 psi for atmospheric pressure to show gage pressure. Convert the 19plus V2 output from gage to absolute:

- -2.5 dbar + (14.7 psi × 0.689476 dbar/psia) = -2.5 + 10.13 = 7.635 dbar
- 10.1050 - 7.635 = 2.47 dbar offset.

Enter this calculated offset in the 19plus V2 and in the configuration file.

Section 7 Reference: 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.
- When OutputExecutedTag=N and the SeaCAT does not show an `S>` prompt after a command is executed, push Enter to see the `S>` prompt.
- The argument Y and 1 are both "Yes" and N and 0 are both "No." For example, Volt0=y and Volt0=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 or push Enter.
- Push the **Esc** key or enter **^C**, then **Enter** to stop the sensor as it transmits data.
- Samples must have the same number of data fields. If the number of data fields is changed, the sensor must start data collection again. This sets the sample number and cast number to 0, so all of the memory is available to record data with the new number of data fields. **Make sure to transmit all stored data to a PC before the SeaCAT starts again, or data will be lost**. Commands that change the number of data fields are MM, MP, Ptype=,Volt0=, Volt1=, Volt2=, Volt3=, Volt4=, Volt5=, SBE63=, SBE38=, WetLabs=, GTD=, DualGTD=, Optode=. The user is prompted to verify the command so stored data is not overwritten.
- During data collection, the SeaCAT responds to GetCD, GetSD, GetCC, GetEC, ResetEC, GetHD, DS, DCal, TS, SL, SLT, GetLastSamples:x, QS, and Stop. If for example, the user sends DS while the sensor collects data, it will temporarily stop. In Moored mode, data collection starts again when the sensor goes into low power mode because QS was sent or 2 minutes have passed. In Profiling mode, the sensor starts data collection immediately. (The sensor does not respond to TS, SL, SLT or GetLastSamples:x during data collection.)
- If StartLater was sent and the SeaCAT has not yet started data collection, it will respond only to GetCD, GetSD, GetCC, GetEC, ResetEC, GetHD, DS, DCal, TS, SL, SLT, GetLastSamples:x, QS, and Stop.
- To send any other commands, send Stop, then send any commands to change the setup and then send StartLater.

7.1 Status

GetCD	Show configuration data

Example for 19plus V2 in Profiling mode, user entries in **boldface:**

```
GETCD
<ConfigurationData DeviceType='SBE19plus' SerialNumber='01906003'>
MP                      <ProfileMode>
MinCondFreq=            <MinCondFreq>3000</MinCondFreq>
PumpDelay=              <PumpDelay>60</PumpDelay>
AutoRun=                <AutoRun>no</AutoRun>
IgnoreSwitch=           <IgnoreSwitch>no</IgnoreSwitch>
                        </ProfileMode>
                        <Battery>
BatteryType=            <Type>alkaline</Type>
                        <CutOff>7.5</CutOff>
```

	</Battery>
	<DataChannels>
Volt0=	<ExtVolt0>yes</ExtVolt>
Volt1=	<ExtVolt1>no</ExtVolt>
Volt2=	<ExtVolt2>no</ExtVolt>
Volt3=	<ExtVolt3>yes</ExtVolt>
Volt4=	<ExtVolt4>no</ExtVolt>
Volt5=	<ExtVolt5>no</ExtVolt>
SBE38=	<SBE38>no</SBE38>
WetLabs=	<WETLABS>no</WETLABS>
Optode=	<OPTODE>no</OPTODE>
SBE63=	<SBE63>no</SBE63>
SeaFET=	<SeaFET>no</SeaFET>
GTD= or **DualGTD=**	<GTD>no</GTD>
	</DataChannels>
Echo=	<EchoCharacters>yes</EchoCharacters>
OutputExecutedTag=	<OutputExecutedTag>no</OutputExecutedTag>
OutputFormat=	<OutputFormat>converted decimal</OutputFormat>
OutputSal=	<OutputSalinity>no</OutputSalinity>>
OutputSV=	<OutputSoundVelocity>no</OutputSoundVelocity>
OutputUCSD=	<OutputSigmaT>no</OutputSigmaT>
	</ConfigurationData>

Example for 19plus V2 in Moored mode, user entries in **boldface:**

GETCD

<ConfigurationData DeviceType='SBE19plus' SerialNumber='01906003'>

MM	<MooredMode>
SampleInterval=	<SampleInterval>15</SampleInterval
NCycles=	<MeasurementsPerSample>3000</MeasurementsPerSample>
MooredPumpMode=	<Pump>run pump during sample</Pump>
DelayBeforeSampling=	<DelayBeforeSampling>0.0</DelayBeforeSampling>
DelayAfterSampling=	<DelayAfterSampling>0.0</DelayAfterSampling>
MooredTxRealTime=	<TransmitRealTime>no</TransmitRealTime>
	</MooredMode>
	<Battery>
BatteryType=	<Type>alkaline</Type>
	<CutOff>7.5</CutOff>
	</Battery>

	<DataChannels>
Volt0=	<ExtVolt0>yes</ExtVolt>
Volt1=	<ExtVolt1>no</ExtVolt>
Volt2=	<ExtVolt2>no</ExtVolt>
Volt3=	<ExtVolt3>yes</ExtVolt>
Volt4=	<ExtVolt4>no</ExtVolt>
Volt5=	<ExtVolt5>no</ExtVolt>
SBE38=	<SBE38>no</SBE38>
WetLabs=	<WETLABS>no</WETLABS>
Optode=	<OPTODE>no</OPTODE>
SBE63=	<SBE63>no</SBE63>
SeaFET=	<SeaFET>no</SeaFET>
GTD= or **DualGTD=**	<GTD>no</GTD>
	</DataChannels>
Echo=	<EchoCharacters>yes</EchoCharacters>
OutputExecutedTag=	<OutputExecutedTag>no</OutputExecutedTag>
OutputFormat=	<OutputFormat>converted decimal</OutputFormat>
OutputSal=	<OutputSalinity>no</OutputSalinity>>
OutputSV=	<OutputSoundVelocity>no</OutputSoundVelocity>
OutputUCSD=	<OutputSigmaT>no</OutputSigmaT>
	</ConfigurationData>

GetSD	Show status data
	Sensor model, S/N
	DateTime= format of date and time yyyy-mm-ddThh:mm:ss
	Data collection status
	Event counter, reset with ResetEC
	Voltages and current draw • main and back-up lithium • current draw during operation • pump current draw • external voltage sensor current for channels 0 and 1; shows if 1 or more channels are enabled • external voltage sensor current for channels 2, 3, 4, 5; shows if 1 or more channels are enabled • RS232 sensor current draw; shows if channel is enabled.
	Memory: number of bytes in memory, number of samples in memory, number of additional samples that can be saved in memory, number of bytes in each sample, number of casts in memory if in Profiling mode. Reset with InitLogging

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

GetEC	Show event counter. Some events include:
	Power fail: main batteries or external voltage below cutoff
	EEPROM read or EEPROM write: all power removed (main batteries removed, and back-up lithium batteries are dead)
	Alarm short: sample missed because "wake" command was sent during data collection in Moored mode
	Alarm long: StartLater was sent, but StartDateTime is more than 1 month in the future
	AD7730 timeout: delayed response from temperature and pressure A/D converter. Typical if a command is sent during data collection in Moored mode
	AD7714 timeout: delayed response from voltage channel A/D converter. Typical if a command is sent during data collection in Moored mode
Flash	Out of memory. Data collection continues but additional data is stored
	Correctable error: single bit error in a page that self-corrects. Does not affect data
	ECC error: does not affect data
	Timeout: problem with flash
	Ready: problem with flash, timeout error
	Erase failed: problem with flash
	Write failed: problem with flash
	Uncorrectable: problem with flash. 2 or more bits of errors on a page
	Block overrun: problem with flash
	New bad block: problem with flash. Write or Erase failed, or an uncorrectable error

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
	External voltage sensor models and S/N. Can be changed during a deployment.
	External RS232 sensor models and S/N. Can be changed during a deployment.

DS	Show operation status and setup parameters
	Firmware version, S/N, date and time. DateTime=
	Voltages and current draw
	Data collection status—not started, started, no data collection, or unknown
	NAvg= number of samples to average
	Number of samples saved and available space in memory
	Profiling mode—minimum conductivity frequency for pump to turn on (MinCondFreq=) and pump turn-on delay (PumpDelay=)

	AutoRun= start data collection when external power is supplied. IgnoreSwitch= ignore magnetic switch position that starts and stops operation.
	BatteryType= type of battery and cut-off voltage
	PType= pressure type and PRange= pressure range (set by manufacturer)
	SBE38= secondary temperature sensor WETLabs= WET Labs sensor Optode= optode SBE63= optical dissolved oxygen sensor GTD= gas tension device DualGTD- dual gas tension devices
	Volt0= through Volt5= sample external voltages 0, 1, 2, 3, 4, 5
	Echo= show commands as they are entered
	OutputFormat= format of data
	OutputSal= salinity output and OutputSV= sound velocity, if format of output is converted decimal or converted XML UVIC
	OutputUCSD= sigma-t, voltage, and current draw output with each sample if set to Y

Notes:

- The DS command is equivalent to the responses from GetSD and GetCD, with a different format.
- Send DS to briefly turn the pump on, so the 19plus V2 will measure and show the pump current draw. It will not cause damage to the pump to operate it for a **short** period of time.
- If a WET Labs sensor with a Bio-wiper (Biowiper=y) is used, the DS response shows `wait 4 seconds for biowiper to close` before it measures the enabled external voltage currents.

DCal	Calibration coefficients in a different format from GetCC

7.2 General setup

DateTime=x	Set real-time clock. Format is mmddyyyyhhmmss.
BaudRate=x	RS232 rates. 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200. Default is 9600. Send two times to change the rate. Refer to Transmit data on page 34 for the correct baud rate and cable length to use.
Echo=x	x=Y: show characters sent from PC as they are entered (default)
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.
BatteryType=x	x=alkaline: (can also be used for lithium batteries) operation stops when voltage is less than 7.5 V for 5 consecutive samples. Reduces load to low power state. x=nimh or lithium: operation stops when voltage is less than 7.8 V for 5 consecutive samples, or if voltage is less than 8.7 F and the voltage drop is more than 0.2 V/min (calculated by two 30-second moving averages.) Reduces load to low power state.
InitLogging*	**upload all stored data**, then initialize the sensor before data collection starts again. All of the memory is available. InitLogging sets the sample number (SampleNumber=) and header and cast number (HeaderNumber=) to 0. The first sample is 1 and the cast/header is 1. If not set to 0, data will be stored after the last recorded sample.

SampleNumber=x*	x= sample number for last sample in memory. Typically only used to recover data if InitLogging is accidently used before all stored data is transmitted to a PC. **Do not send SampleNumber=0 until all stored data has been transmitted**.
HeaderNumber=x*	x=header and cast number for last header or cast in memory. Typically only used to recover data if InitLogging is accidently used before all stored data is transmitted to a PC. **Maximum stored headers is 1000**. The 19plus V2 writes a new header— each time data collection starts in Profiling mode each time data collection starts and after every 2000 samples are stored in memory in Moored mode.
Biowiper=x	x=Y: used when the system includes a WET Labs sensor with Bio-wiper. The 19plus V2 is on longer for DS and GetSD so there is enough time for the wiper to open and then close if the wiper is set up to take 1 measurement for each sample. x=N: (default) no Bio-wiper.
QS	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 software.
- Make sure any RS232 sensor is set to the same baud rate as the 19plus V2.
- The Optode only uses 9600 baud, so the 19plus V2 must be set to 9600 if an Optode is connected.
- If GetSD or DS is sent when a WET Labs sensor with a Bio-wiper is installed and Biowiper=N, the Bio-wiper will open but there will not be enough time to close it with the supplied power. If the system is deployed with the Bio-wiper open and a delayed start time, the sensor may become fouled because the Bio-wiper will stay open until the first sample is complete.
- The sensor goes into a low power mode to save battery power if no command is received within 2 minutes.

* The 19plus V2 requires verification when InitLogging, SampleNumber=, or HeaderNumber= are sent. The sensor responds: `this command will change the scan length and/or initialize logging. Repeat the command to verify.` Enter the command again, then push **Enter**. The 19plus V2 responds: `Scan length has changed, initializing logging`. **Make sure all data has been transmitted to a PC before you send InitLogging**. These commands do not erase data; they reset the data pointer. If InitLogging is sent accidentally, do the steps below to recover data.

1. Set SampleNumber=a and HeaderNumber=b, where a and b are your estimate of the number of samples and casts in memory.
2. Transmit data. If **a** is more than the actual number of samples or **b** is more than the actual number of casts in memory, the data for the non-existent samples or casts will be nonsense. Examine the transmitted data and erase any bad, nonsense data.
3. You can increase **a** or **b** and transmit the data again to see if there is additional valid data in memory.

7.3 Pressure and voltage sensor setup

PType=x	x= type of pressure sensor, set by the manufacturer. x=1: strain gauge. x=3: quartz. Requires even NCycles= (2, 4, 6, etc) for Moored mode and even NAvg= for Profiling.
Volt0=x	x=Y: enable external voltage 0 x=N: do not
Volt1=x	x=Y: enable external voltage 1 x=N: do not

Volt2=x	x=Y: enable external voltage 2 x=N: do not
Volt3=x	x=Y: enable external voltage 3 x=N: do not
Volt4=x	x=Y: enable external voltage 4 x=N: do not
Volt5=x	x=Y: enable external voltage 5 x=N: do not

Notes:

- The 19plus V2 configuration file, .xmlcon or .con file must agree with the pressure sensor and external voltages to see real-time data in Seasave or to process data. Look at or edit the configuration file in Seasave or the SBE Data Processing software. These parameters are factory-set to agree with the system configuration that was purchased.
- External voltage numbers 0, 1, 2, 3, 4, and 5 are the same as the wiring of the sensors to a voltage channel on the 19plus V2. However, in the .xmlcon or .con file, voltage 0 is the first external voltage in the data, voltage 1 is the second, etc.

7.4 Set up RS232 sensors

In Moored mode, the setup requirements for the SBE 63, WET Labs, and GTD sensors are given below.

The 19*plus* V2 sample interval (**SampleInterval=**) must be greater than or equal to the sum of the times required to sample. **TxRealTime=**, **MooredPumpMode=**, **NCycles=**, **DelayBeforeSampling=**, and **DelayAfterSampling=** affect the time required to sample. If the time required to sample is too high, the 19*plus* V2 cannot make the required number of measurements and do the calculations within **SampleInterval=**.

7.4.1 Gateway

Thei 19plus V2 can communicate with the sensors listed below:

- SBE 63 optical dissolved oxygen sensor
- SBE 38 secondary temperature sensor
- WET Labs ECO, WETStar, C-Star, or SeaOWL UV-A
- Pro-Oceanus Gas Tension Devices (Moored mode only)
- Aanderaa oxygen Optode 4330 or 4835.

Send the GatewaySerial command to start direct communications with the RS232 sensor through the SBE 19plus V2. Send Ctrl-Shift-X (X must be upper case) for communications with the SBE 19plus V2. The serial sensor will go into low power mode if no command is received within 2 minutes.

The 19plus V2 requires verification when SBE63=, SBE38=, WETLABS=, GTD=, Dual GTD= or Optode= is sent. The response is `this command will change the scan length and/or initialize logging. Repeat command to verify`. Enter the command again. The response is `Scan length has changed, initializing logging`.

Make sure the .xmlcon or.con configuration files agree with the RS232 sensor to see real-time data or to process transmitted data. Edit the configuration file in Seasave or the Data Processing software. The manufacturer sets these to agree with the system that was purchased.

7.4.2 SBE 63 optical dissolved oxygen sensor

Connect the SBE 63 to a PC and supply power externally. Use the software to set the parameters below before it is connected to the 19plus V2.

- Use SetBaud= to set the baud rate to agree with the 19plus V2.
- Use SetEcho=1 to see the commands entered.
- Use SetAvg=2 to set the number of samples to be averaged. Values can be from 1-16; 2 (default) is recommended.
- Use SetFormat=1 so that the data format agrees with the 19plus V2.
- Use GetSD or GetHD to verify that <TxPwrSave> is 0.
- Use DelayBeforeSampling= to set the delay to 25 seconds at 15 °C, annd 40 seconds at 0 °C. This gives the SBE 63 enough time to equilibrate after the pump starts and before a measurement is made.

Connect the SBE 63 to the 19plus V2 *auxiliary RS232* connector. In the 19plus V2, set SBE63=Y to enable communications.

SBE63=x	x=Y: enable SBE 63 x=N: do not
Send63=command	Command the 19plus V2 to send [command] to the SBE 63 and get a response. The [command] is any command used by the SBE 63.

7.4.3 SBE 38 digital oceanographic thermometer

Connect the SBE 38 to a PC and external supply power. Use the software to set the parameters below before it is connected to the 19plus V2.

- Use Baud= to set the baud rate to agree with the 19plus V2.
- Use Interface=232 to set communications to RS232.
- Use AutoRun=Y to set data collection to start when power is supplied.
- Use Format=C to convert data.

Connect the SBE 38 to the SBE 19plus V2 *auxiliary RS232* connector. In the 19plus V2, set SBE38=Y to enable communications.

SBE38=x	x=Y: enable SBE 38 x=N: do not

7.4.4 WET Labs sensors

WARNING

Sensors that use ultraviolet light sources (< 400 nm): Do not look directly at a UV light source when it is on. It can cause damage to the eyes. Keep products that have UV light sources away from children, pets, and other living organisms. Wear polycarbonate UV-resistant safety glasses to protect the eyes when a UV light is on.

The 19plus V2 can communicate with ECO, WETStar, C-Star, or SeaOWL UV-A sensors. Connect the WET Labs sensor to the SBE 19plus V2 *auxiliary RS232* connector. In the 19plus V2, set WETLabs=Y to enable communications.

- Use BaudRate= to set the baud rate of the WET Labs sensor. The baud rate of the WET Labs RS232 sensor and the 19plus V2 must agree.
- Moored mode: use DelayBeforeSampling=2 (minimum). The 19plus V2 automatically sets this value to 2 if WetLabs=Y and DelayBeforeSampling= < 2.
- Moored mode, sensor with Bio-wiper: use DelayBeforeSampling=4. This gives the wiper enough time to open before a measurement and to close after a measurement.

The SBE 19plus V2 stores and show 6 bytes of data for each sample, with 2 bytes for each channel.

- For ECO Triplet or SeaOWL UV-A, each channel uses 2 bytes, for a total of 6.
- For ECO FLNTU, the first 4 bytes are data and the last 2 bytes are 0's.
- For single-channel sensors, the first 2 bytes are data and the last 4 bytes are 0's.

WetLabs=x	x=Y: enable WET Labs sensor x=N: do not

7.4.5 Gas Tension Device (GTD)

Connect the GTD to a PC and supply power externally. Use the software from Pro-Oceanus to set the parameters before it is connected to the 19plus V2.

- Use SetBaud= to set the baud rate to agree with the 19plus V2.
- Use **Output** set to millibars.
- Use the sum of the **pressure integration time** and **temperature integration time** so that the GTD responds to a *take pressure reading* command in 40 seconds or less so that the 19plus V2 does not go into low power mode before the reply is sent.

Connect the GTD to the 19plus V2 *auxiliary RS232 Input* connector. The manufacturer-supplied cable is labeled *Pro-Oceanus* to GTD at one end. The other is labeled *Sea-Bird*. In the 19plus V2, set

- GTD=Y or DualGTD=Y to enable communications.
- Send GTD= to change the ID if necessary.

The 19plus V2 samples the GTD last, after DelayBeforeSampling=, and after conductivity, temperature, pressure, and all voltage channels. The voltage to any other external sensors and the pump is turned off before the GTD sample is taken.

Each time a sample is to be taken, the 19plus V2 send the commands below to the GTD (ID= 01, 02, etc.)

- *ID00VR<CR><LF>: get GTD firmware version. Wait up to 3 seconds for response.
- ID00SN<CR><LF>: get GTD serial number. Wait up to 5 seconds for response.
- 9900P5<CR><LF>: command all GTDs to sample pressure. Hold data in the GTD.
- ID00DB<CR><LF>: get the held pressure data. Wait up to 90 seconds for response.
- 9900Q5<CR><LF>: command all GTDs to sample temperature. Hold data in the GTD.
- ID00DB<CR><LF>:get the held temperature data. Wait up to 90 seconds for response.

GTD=x	x=Y: enable GTD x=N: do not
DualGTD=x	x=Y: enable dual GTDs x=N: do not
TGTD	Measure GTD(s), show 1 sample from each GTD (firmware version, serial number, pressure, temperature).
SendGTD=command	Command 19plus V2 to send [command] to GTD and get response. [Command] can be any command used by the GTD (refer to GTD manual).

7.4.6 Aanderaa Optode

Connect the Optode to a PC and supply power externally. Do the steps supplied by Aanderaa to set the parameters below before it is connected to the 19plus V2.

- Use BaudRate=9600 and set the 19plus V2 to the same baud.
- **Communication** to RS232.
- **Sample interval** to 1 for Profiling mode. Set to 5 for Moored mode.

- **Output** to model number, serial number and oxygen concentration (µmol/L) in decimal format. Disable all other output (air saturation, temperature, raw data, and text).

Connect the Optode to the SBE 19plus V2 *auxiliary RS232 Input* connector. Set Optode=Y in the 19plus V2 to enable communications.

Optode=x	x=Y: enable Optode x=N: do not
SendOptode=command	Command 19plus V2 to send [command] to Optode and get response. [Command] can be any command used by the Optode (refer to the Optode manual). Response from the Optode is limited to one line.

Notes:

To set up the configuration (.xmlcon or .con) file in Seasave or SBE Data Processing software, select Oxygen, Optode for the Serial RS232C sensor. Enter the serial number, calibration date and information required for salinity and depth corrections. The *internal salinity* value must agree with the value entered into the Optode (ignored if *Salinity correction* is not enabled). If *Salinity correction* is enabled, the SBE software corrects the oxygen data from the Optode based on the actual salinity, which is calculated from the CTD data. If *Depth correction* is enabled, the SBE software corrects the oxygen data from the Optode based on the depth, which is calculated from the CTD data.

Send **stop** or **do stop** to the Optode to stop data collection before the SendOptode= command is sent. The stop command may need to be sent more than once. Refer to the Optode manual for the correct stop command for your Optode.

In Moored mode, the DelayBeforeSampling= command does not apply to the Optode. When power is supplied to the sensor it starts data collection. The 19plus V2 supplies power to the Optode when it is ready to get the Optode data, after it gets all CTD and other external sensor data.

7.5 Output format setup

OutputFormat=x	x=0: raw decimal data x=1: converted decimal data (default) x=2: converted decimal data in .xml format
OutputTime=x	x=Y: show date and time in output. Only applies if OutputFormat=0, 1, 2 x=N: do not
OutputTemp=x	x=Y: show temperature in units set by SetTempUnits= if OutputFormat=1 or 2 x=N: do not
SetTempUnits=x	x=0: °C; x=1: °F
OutputCond=x	x=Y: show conductivity in units set by SetCondUnits= if OutputFormat=1 or 2 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
OutputPress=x	x=Y: show pressure, value set by SetPressUnits= with OutputFormat=1 or 2 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/second x=N: do not
OutputDensity=x	x=Y: calculate and show local density, kg/m^3, based on salinity, temperature, and pressure. Applies to OutputFormat=1, 2, 4, 5. Local density = Sigma (s,t,p) - 1000. x=N: do not
OutputDepth=x	x=Y: calculate and show depth (meters) with latitude in calculation. Applies to OutputFormat=1, 2, 4, 5 x=N: do not.
Latitude=x	x=latitude, degrees to use in depth calculation. Applies if OutputDepth=Y.
OutputSC=x	x=Y: calculate and show specific conductivity, value set by SetCondUnits, with OutputFormat=1 or 2 x=N: do not
UseSCDefault=x (Applies if OutputSC=Y)	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 UseSCDefault=0
TxSampleNum=x	x=Y: show sample number in output x=N: no sample number shows

Note:

Specific conductivity = C ÷ (1 + A × [T - 25]) *where*

C = conductivity in same units as specific conductivity: µS/cm, mS/cm, S/m

T = temperature, °C

A = thermal coefficient of conductivity for natural sale ion solutions (default is 0.020).

7.6 Profiling mode

In Profiling mode, the 19plus V2 transmits real-time data and does not go into a low power mode between samples. Data is stored in the flash memory. If the flash memory is full, data collection continues and real-time data is transmitted, but not stored in memory, because the 19plus V2 does not overwrite stored data.

The first time data collection starts after the InitLogging command is sent, data is recorded at the start of memory. Any previously recorded data is overwritten. Each time data collection starts, the data is recorded, and a new header is written to identify the cast number, date, time, and sample numbers in the cast. Maximum casts is 1000.

MP	set to Profiling mode
NAvg=x	x= number of samples to average. Default is 1. Sample rate is 4 Hz. If the 19plus V2 has a quartz pressure sensor, NAvg must be an even number.
MinCondFreq=x	x= minimum conductivity frequency (Hz) to turn on the pump.
PumpDelay=x	x= time in seconds to wait after minimum conductivity frequency is reached before the pump turns on. Default is 60 seconds.
AutoRun=x	x=Y: automatically start data collection with external power is supplied. Stop data collection when power is removed. The magnetic switch position does not effect operation. x=N: do not automatically start data collection when external power is supplied. Manufacturer ships the 19plus V2 with AutoRun=N.
IgnoreSwitch=x	x=Y: ignore magnetic switch position when data collection is started or stopped. Send StartNow, StartLater and Stop to control operation. x=N: do not ignore magnetic switch position
StartNow	start data collection now. Set IgnoreSwitch=Y
StartDateTime=	data collection start. Format is mmddyyyyhhmmss

StartLater	start data collection at StartDateTime=. Set IgnoreSwitch=Y. If the start date and time has passed, the 19plus V2 does StartNow. If the start date and time is more than one month in the future, the 19plus V2 does StartNow.
Stop	stop data collection or stop the wait to collect data. Push **Enter** and then send Stop. Stop data collection before data is transmitted to a PC. May need to send Stop more than once. If IgnoreSwitch=N, the user must also turn the magnetic switch off to stop data collection.

Notes:

- If AutoRun=Y, send QS to put the 19plus V2 into a low power "quiescent" mode. Turn the power off and then on again to start data collection, or send StartNow to start data collection.
- When equipped with a quartz pressure sensor, the sample rate is 2 Hz.
- The Pro-Oceanus Gas Tension Device is not compatible with Profiling mode.

7.7 Moored mode

The first time data collection starts after the InitLogging command is sent, data is recorded at the start of memory. Any previously recorded is overwritten. When Stop is sent, data is not recorded. Each time StartNow or StartLater is sent, data is recorded, and new data is stored after the previously recorded data. A new header is written each time data collection starts and every 2000 samples after that. Maximum number of headers is 1000. If the maximum number of headers is reached but there is still memory available, the 19plus V2 continues to collect and store data with no additional headers written.

MM	set to Moored mode
SampleInterval=x	x= interval in seconds between samples (10–14,400)
NCycles=x	x= number of measurements to collect and average every SampleInterval seconds. Default is 1. If the 19plus V2 has a quartz pressure sensor, the interval must be an even number.
MooredPumpMode=x	x=0: no pump x=1: operate pump for 0.5 seconds before each sample x=2: operate pump during each sample
DelayBeforeSampling=x	x= x= time in seconds to wait after power is supplied to external voltage sensors and RS232 sensors before data collection starts (0–600). Default is 0.
DelayAfterSampling=x	x= time in seconds to wait after data collection is completed before power to external voltage sensors and RS232 sensors is turned off (0–600). Default is 0.
MooredTxRealTime=x	x=Y: transmit real-time data x=N: do not
StartNow=	start data collection now
StartDateTime=	data collection start. Format is mmddyyyyhhmmss
StartLater=	start data collection at StartDateTime=. If the start date and time has passed, the 19plus V2 does StartNow. If the start date and time is more than one month in the future, the 19plus V2 does StartNow.
Stop	stop data collection or stop the wait to collect data. Push **Enter** and then send Stop. Stop data collection before data is transmitted to a PC. May need to send Stop more than once.

7.8 Transmit data

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

To transmit data from the 19plus V2 to a PC, make sure to stop data collection first. Use the **Upload** menu in the SBE Data Processing software. A manually entered command does not have the required header information for the SBE software to process the data. Use the **Capture** menu to save data to a file.

GetSamples:b,e or DDb,e	transmit data from sample **b** to sample **e**. If b and e are not entered, all data is transmitted.
GetCast:x or DCx	transmit data from Profiling cast x or Moored header x. If x is not entered, data from cast or header 1 is transmitted.
GetHeaders:b,e or DHb,e	transmit header b to header e. If b and e are not entered, all headers are transmitted.

7.9 Polled data collection

Use these commands to collect one sample. The 19plus V2 always stores data for the most recent sample in its buffer. Some commands also store data in the flash memory: the 19plus V2 will not execute the *store data in flash memory* part of those commands during data collection.

SL	show data from the last data sample and leave power on.
SLT	show data from the last sample stored in buffer, then collect a new sample and store data in buffer.
TS	collect new sample, store data in buffer, show data, leave power on.
TSS	collect one sample, store data in buffer and flash memory, show data. Turn power off.
TSSOn	collect one sample, store data in buffer and flash memory, show data, and leave power on.
GetLastSamples:x	show the last *x* samples from flash memory. If *x* is more that the number of samples in memory, the sensor shows all the samples in memory. If *x* is not entered, the 19plus V2 shows only the last sample (it is not necessary to stop data collection to send this command.)

7.10 Test

The 19plus V2 collects and transmits 100 samples for each test. Data is not stored in the flash memory. Push **Esc** or send a break character to stop a test.

Test commands do not automatically turn the pump on. Sensors that have a pump attached collect water from the same area for all 100 measurements because the pump and its plumbing do not let water flow freely through the conductivity cell. To get data from fresh samples, send PumpOn and then send a test command. Then send PumpOff when the test is complete.

TC	measure conductivity with converted data as the output
TCR	measure conductivity with raw data as the output
TT	measure temperature with converted data as the output
TTR	measure temperature with raw data as the output
TP	measure pressure with converted data as the output
TPR	measure pressure with raw data as the output
TV	measure six external voltage channels with converted data as the output.
TVR	measure voltages read by A/D converter with raw data as the output columns 1–6: external voltages column 7: main battery voltage/11 column 8: back-up lithium battery voltage/3.741 column 9: external current/333.33 column 10: pressure temperature voltage
TF	measure frequency (quartz pressure sensor) with converted data as the output.
TFR	measure frequency (quartz pressure sensor) with raw data as the output.

T63	measure SBE 63 optical dissolved oxygen with aa.aaaa, b.bbbb, o.oooo, tt.tttt as the output. aa.aaa=phase in µsec b.bbbb=temperature voltage o.oooo=dissolved oxygen, ml/L tt.tttt=temperature, °C
T38	measure SBE 38 (secondary temperature) with converted data as the output.
TOptode	measure Aanderaa Optode, product number, serial number, and dissolved oxygen micromoles/L as the output
PumpOn	turn pump on. Use this command to get pumped data from sensors with a pump, or to test the pump
PumpOff	turn pump off

ECO Triplet or SeaOWL UV-A	
Column	**Output**
1–2	date and time
3	wavelength sensor 1
4	raw signal counts sensor 1
5	wavelength sensor 2
6	raw signal counts sensor 2
7	wavelength sensor 3
8	raw signal counts sensor 3
9	thermistor counts

ECO dual channel	
Column	**Output**
1–2	date and time
3	wavelength sensor 1
4	raw signal counts sensor 1
5	wavelength sensor 2
6	raw signal counts sensor 2
7	thermistor counts

ECO single channel	
Column	**Output**
1–2	date and time
3	wavelength sensor 1
4	raw signal counts sensor 1
5	thermistor counts

C-Star	
Column	**Output**
1	serial number
2	reference counts

3	signal counts
4	corrected signal raw counts
5	calculated beam c, inverse meters
6	internal thermistor counts

WETStar	
Column	**Output**
1	counts

7.11 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 19plus V2. Send GetCC or DCal to see all coefficients.

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
TOffset=F	F=temperature offset correction
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
CTCor=F	F=conductivity tcor
CPCor=F	F=conductivity pcor
CSlope=F	F=conductivity slope correction
Pressure	
PCalDate=S	S=pressure calibration date
PRange=F	F=pressure sensor full scale range, psia
POffset=F	F=pressure offset correction
PA0=F	F=strain-gauge pressure A0
iPA1=F	F=strain-gauge pressure A1
PA2=F	F=strain-gauge pressure A2
PTempA0=F	F=strain-gauge pressure temperature A0
PTempA1=F	F=strain-gauge pressure temperature A1
PTempA2=F	F=strain-gauge pressure temperature A2

PTCA0=F	F=strain-gauge pressure ptca0
PTCA1=F	F=strain-gauge pressure ptca1
PTCA2=F	F=strain-gauge pressure ptca2
PTCB0=F	F=strain-gauge pressure ptcb0
PTCB1=F	F=strain-gauge pressure ptcb1
PTCB2=F	F=strain-gauge pressure ptcb2
PC1=F	F=quartz pressure C1
PC2=F	F=quartz pressure C2
PC3=F	F=quartz pressure C3
PD1=F	F=quartz pressure D1
PD2=F	F=quartz pressure D2
PT1=F	F=quartz pressure T1
PT2=F	F=quartz pressure T2
PT3=F	F=quartz pressure T3
PT4=F	F=quartz pressure T4
PSlope=F	F=quartz pressure slope correction

7.12 Hardware configuration

Auxiliary sensor settings can be modified in the field to change sensors connected the 19plus V2.

SetVoltType0=, SetVoltSN0=
SetVoltType1=, SetVoltSN1=
SetVoltType2=, SetVoltSN2=
SetVoltType3=, SetVoltSN3=
SetVoltType4=, SetVoltSN4=
SetVoltType5=, SetVoltSN5=
SetSerialType=, SetSerialSN=

Section 8 Troubleshooting

8.1 No communications with sensor

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.

8.2 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*.

8.3 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.

8.4 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:

- 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 9 General information

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

9.1 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
Sea-Bird Electronics, Inc.
13431 NE 20th St.
Bellevue, WA 98005

EPA Registration No. 74489-1
EPA Establishment No. 74489-WA-1

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	• 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	• 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	• 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.

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.

9.2 Warranty

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

9.3 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.

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