



SEA-BIRD
SCIENTIFIC

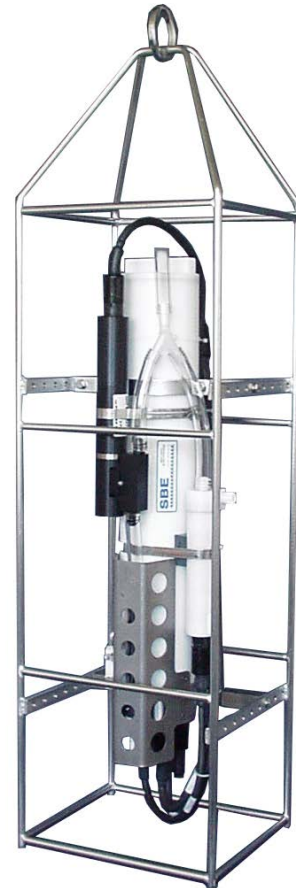
User Manual

Release Date: 06/13/2016

SBE Sea-Bird
Electronics

SBE 19plus V2 SeaCAT Profiler CTD

Conductivity, Temperature, & Pressure Recorder
with RS-232 Interface



*Shown with optional cage,
optional SBE 5P pump, &
optional SBE 43 Dissolved Oxygen Sensor*

Manual version
Firmware version
Software versions

- 013
- 3.1.8 & later
- Seaterm V2 2.6.1 & later
- Seasave V7 7.26.1 & later
- SBE Data Processing 7.26.1 & later



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Limited Liability Statement

Extreme care should be exercised when using or servicing this equipment. It should be used or serviced only by personnel with knowledge of and training in the use and maintenance of oceanographic electronic equipment.

SEA-BIRD ELECTRONICS, INC. disclaims all product liability risks arising from the use or servicing of this system. SEA-BIRD ELECTRONICS, INC. has no way of controlling the use of this equipment or of choosing the personnel to operate it, and therefore cannot take steps to comply with laws pertaining to product liability, including laws which impose a duty to warn the user of any dangers involved in operating this equipment. Therefore, acceptance of this system by the customer shall be conclusively deemed to include a covenant by the customer to defend, indemnify, and hold SEA-BIRD ELECTRONICS, INC. harmless from all product liability claims arising from the use or servicing of this system.

Declaration of Conformity

DECLARATION OF CONFORMITY

Manufacturer's Name: Sea-Bird Electronics
Manufacturer's Address: 13431 NE 20th St
Bellevue, WA 98005, USA

The Authorized Representative located within the Community is:

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Device Description: Various data acquisition Devices and Sensors

Model Numbers:

39plus 39plus-IM HydroCat-EP
16plusV2 16plusV2-IM 19pV2
NiMH Battery Charger and Battery Pack

Applicable EU Directives: Machinery Directive 98 / 37/ EC
EMC Directive 2004 / 108 / EC
Low Voltage Directive (73 / 23 / EEC) as amended by (93 / 68 / EEC)

Applicable Harmonized Standards:

EN 61326-2-3 (2013) Class C Electrical Equipment for Measurement, Control, and Laboratory Use, EMC Requirement – Part 1: General Requirements (EN 55011:2007 Group 1, Class A)

EN 61010-1:2001, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements

I, the undersigned, hereby declare that the equipment specified above conforms to the relevant sections of the above European Union Directives and Standards. The units comply with all applicable Essential Requirements of the Directives.

Authorized Signature / Date:

 3/23/2016

Name: Casey Moore
Title: President
Place: Bellevue, WA

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Section 1: Introduction

This section includes a Quick Start procedure, and photos of a typical SBE 19plus V2 shipment.

About this Manual

This manual is to be used with the SBE 19plus V2 SeaCAT Profiler Conductivity, Temperature, and Pressure Recorder. It is organized to guide the user from installation through operation and data collection. We have included detailed specifications, command descriptions, maintenance and calibration information, and helpful notes throughout the manual.

Sea-Bird welcomes suggestions for new features and enhancements of our products and/or documentation. Please contact us with any comments or suggestions (seabird@seabird.com or 425-643-9866). Our business hours are Monday through Friday, 0800 to 1700 Pacific Standard Time (1600 to 0100 Universal Time) in winter and 0800 to 1700 Pacific Daylight Time (1500 to 0000 Universal Time) the rest of the year.

Quick Start

Follow these steps to get a Quick Start using the SBE 19plus V2. The manual provides step-by-step details for performing each task:

1. Install batteries and test power and communications (see *Section 3: Power and Communications Test*).
2. Deploy the 19plus V2 (see *Section 4: Deploying and Operating SBE 19plus V2*):
 - A. Install new batteries if necessary.
 - B. Ensure all data has been uploaded, and then send **InitLogging** to make entire memory available for recording if desired.
 - C. Set date and time (**DateTime=**) and establish setup and logging parameters.
 - D. Check status (**DS**) and calibration coefficients (**DCal**) to verify setup.
 - E. **Moored mode (MM)** - Set 19plus V2 to start logging now (**StartNow**) or in the future (**StartDateTime=** and **StartLater**).
 - F. Install dummy plugs and/or cable connectors, and locking sleeves.
 - G. If applicable, remove Tygon tubing that was looped end-to-end around conductivity cell for storage. Reconnect tubing from pump to conductivity cell.
 - H. **Profiling mode (MP)** - As appropriate for your instrument's setup:
 - Put magnetic switch in On position, OR
 - (if **IgnoreSwitch=Y**) Send commands to start logging now (**StartNow**) or in the future (**StartDateTime=** and **StartLater**), OR
 - (if **AutoRun=Y**) Apply external power.
 - I. Deploy 19plus V2.

Unpacking SBE 19plus V2

Shown below is a typical SBE 19plus V2 shipment.



SBE 19plus V2 SeaCAT with SBE 5M plastic pump



I/O Cable



2-pin dummy plug and locking sleeve



Spare o-ring and hardware kit



Conductivity cell cleaning solution (Triton-X)



Conductivity cell filling and storage kit



Software, and Electronic Copies of Software Manuals and User Manual

Section 2: Description of SBE 19plus V2

This section describes the functions and features of the SBE 19plus V2 SeaCAT Profiler, including system description and auxiliary equipment, specifications, dimensions and end cap connectors, batteries and battery endurance, external power and cable length limitations, data storage, communication settings, magnetic reed switch, and configuration options and plumbing.

System Description

The SBE 19plus V2 SeaCAT Profiler is designed to measure conductivity, temperature, and pressure in marine or fresh-water environments at depths up to 10,500 meters (34,400 feet). The 19plus V2 operates in two modes:

- **Profiling mode** for acquiring vertical profiles. The 19plus V2 runs continuously, sampling at 4 scans per second (4 Hz) (2 Hz with Digiquartz[®] pressure sensor). It can average up to 32,767 samples, storing and transmitting only averaged data.
- **Moored mode** for acquiring time series measurements once every 10 seconds to every 4 hours, adjustable in 1-second increments. Between samples, the 19plus V2 powers down, drawing only 20 microAmps.

Self-powered and self-contained, the 19plus V2 features the proven Sea-Bird conductivity and temperature sensors and a precision, semiconductor, strain-gauge or quartz pressure sensor. Nine D-size alkaline batteries provide 60 hours operation in Profiling mode; the 64 Mbyte FLASH RAM records 400 hours of conductivity, temperature, and pressure data while sampling at four scans per second (other configurations/setup vary). The 19plus V2 three-wire RS-232C interface provides simultaneous, real-time monitoring. User-selectable output format is raw data or engineering units, in hexadecimal or decimal form; XML output is also available. Setup, diagnostics, and data extraction are performed without opening the housing. The 19plus V2 can power and acquire the outputs of external sensors.

Logging is started by sliding the On/Off switch, by command via the RS-232 interface, or by applying external power, depending on your instrument setup.

An SBE 19plus V2 is supplied with:

- Plastic housing for depths to 600 meters (1950 feet) or titanium housing for depths to 7000 meters (22,900 feet) or 10,500 meters (34,400 feet)
- 64 Mbyte FLASH RAM memory
- Internally mounted strain-gauge or Quartz pressure sensor
- 9 D-size alkaline batteries (Duracell MN1300, LR20)
- Bulkhead connectors (XSG / AG or wet-pluggable MCBH):
 - one 6-pin connector for data I/O, external power, and pump power;
 - three 6-pin connectors, for two differential auxiliary A/D inputs each;
 - one 4-pin connector, for RS-232 auxiliary sensor (SBE 63 optical dissolved oxygen sensor, SBE 38 secondary temperature sensor, WET Labs sensor [single, dual, or triple channel ECO sensor; WETStar; C-Star; or SeaOWL UV-A[™]], Satlantic SeaFET pH sensor, up to two Pro-Oceanus Gas Tension Devices, or Aanderaa Oxygen Optode 4330 or 4835)
- T-C Duct, which ensures that Temperature and Conductivity measurements are made on the same parcel of water
- SBE 5M miniature pump for pumped conductivity; by fixing the flow to a constant rate, the pump ensures a constant conductivity time response. *The T-C duct and pump combination results in dramatically lower salinity spiking.*

Note:

The 19plus V2 must be in moored mode (MM) to obtain SeaFET or Gas Tension Device (GTD) data.

SBE 19plus V2 options / accessories include:

- SBE 5P (plastic) or 5T (titanium) pump in place of SBE 5M for use with dissolved oxygen and/or other pumped auxiliary sensors
- Sensors for dissolved oxygen, pH, fluorescence, light (PAR), light transmission, and turbidity
- Stainless steel cage
- Nickel Metal Hydride (NiMH) batteries and charger
- Moored mode conversion kit with anti-foulant device fittings, for when 19plus V2 used on moorings

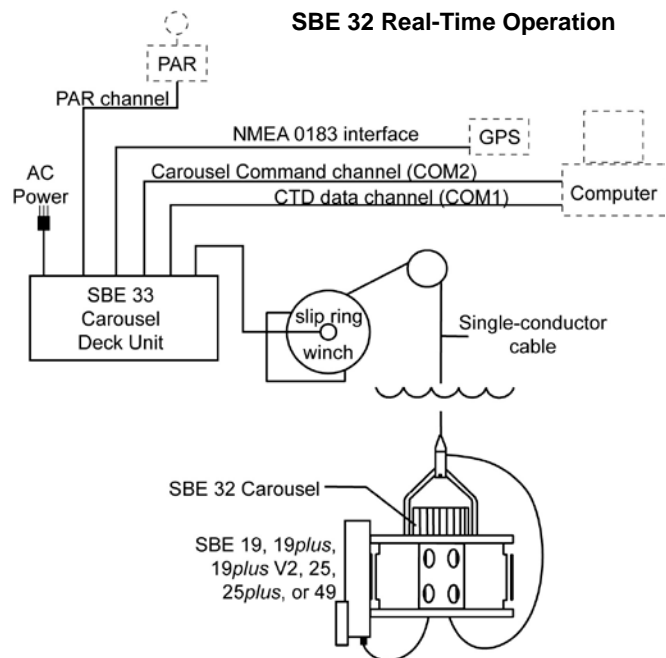
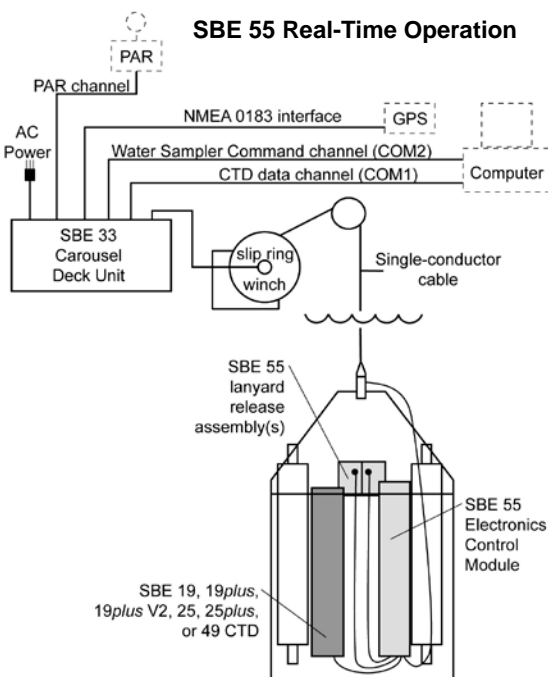
Future upgrades and enhancements to the SBE 19plus V2 firmware can be easily installed in the field through a computer serial port and the *Data I/O, Pump, and External Power* bulkhead connector on the 19plus V2, without the need to return the 19plus V2 to Sea-Bird.

Notes:

- The SBE 32 Carousel is a 12-, 24-, or 36-bottle water sampler. The SBE 55 ECO is a 3- or 6-bottle water sampler.
- Seasave 7.18 or later also supports acquisition of data from a NMEA device connected directly to the computer (instead of the deck unit).
- SBE 33's Surface PAR interface was optional prior to 2012.

The 19plus V2 can be used with the following Sea-Bird equipment:

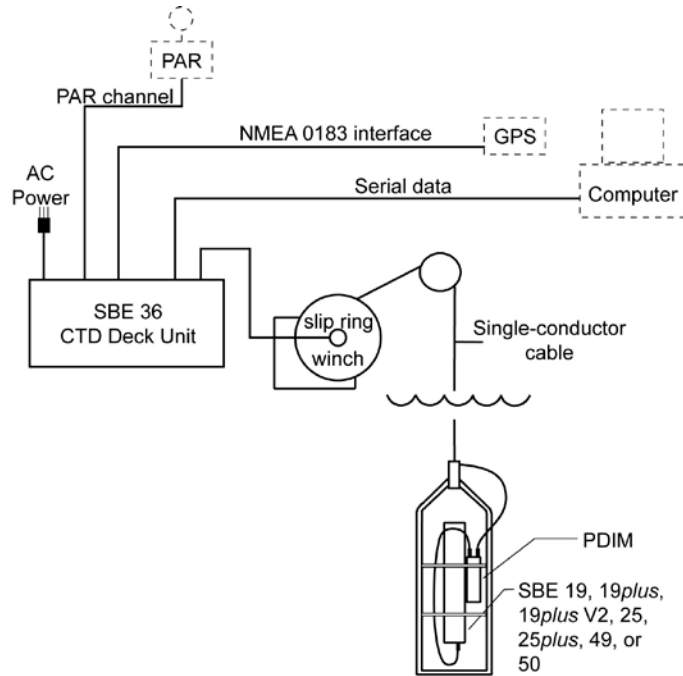
- **SBE 32 Carousel Water Sampler and SBE 33 Carousel Deck Unit OR SBE 55 ECO Water Sampler and SBE 33 Carousel Deck Unit** - The SBE 32 or SBE 55 provides +15 VDC power to the 19plus V2 and has ample power for auxiliary sensors not normally supported by battery-powered CTDs. CTD data from the 19plus V2 is converted into single-wire telemetry for transmission over long (10,000 meter [32,800 feet]) sea cables. Bottles may be closed at any depth without interrupting CTD data via software control using the Seasave program or from the front panel of the SBE 33 Deck Unit. See the SBE 33 manual for operating details.



- SBE 36 CTD Deck Unit and Power Data Interface Module (PDIM) -**
 These items provide power and real-time data handling capability over single-conductor sea cables using the same method employed in the SBE 32/SBE 33. The PDIM is a small pressure housing that is mounted on or near the 19plus V2. It provides +15 VDC power to the 19plus V2 and interfaces two-way RS-232 communications from the 19plus V2 to the telemetry used on the sea cable. See the SBE 36/PDIM manual for operating details.

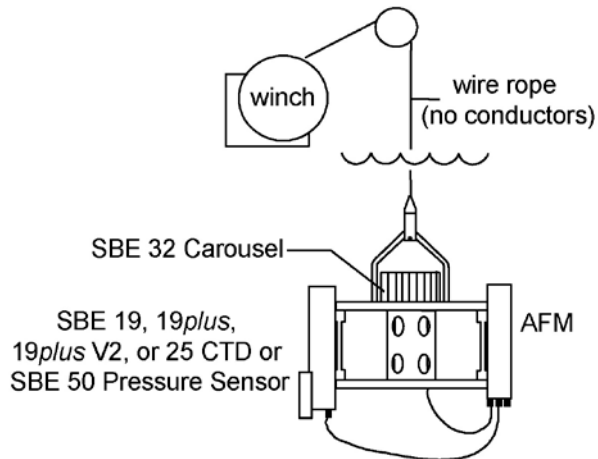
Notes:

- Seasave 7.18 or later also supports acquisition of data from a NMEA device connected directly to the computer (instead of the deck unit).
- SBE 36's Surface PAR interface was optional prior to 2012.



- SBE 32 Carousel Water Sampler and Auto Fire Module (AFM) -** The AFM, mounted on or near the 19plus V2, allows the SBE 32 to operate autonomously on non-conducting cables. The AFM supplies the power, logic, and control commands to operate the SBE 32. The AFM monitors the pressure data recorded by the 19plus V2 in real-time, closing water sampler bottles at predefined pressures (depths) or whenever the system is stationary for a specified period of time. Bottle number, firing confirmation, and five scans of CTD data are recorded in the AFM memory for each bottle fired. See the AFM manual for operating details.

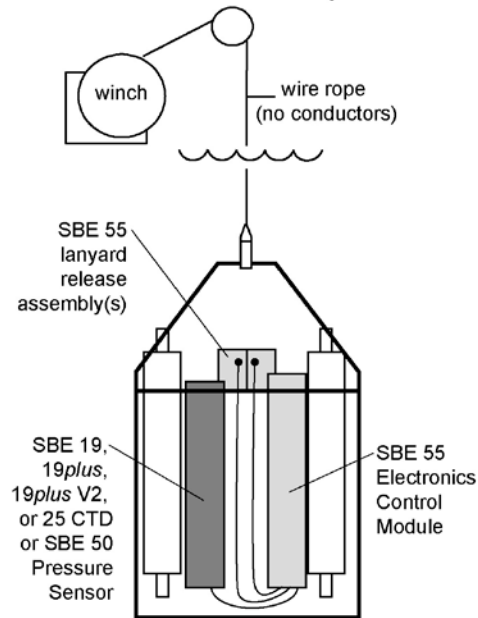
SBE 32 Autonomous Operation



Note:

The SBE 32 Carousel is a 12-, 24-, or 36-bottle water sampler. The SBE 55 ECO is a 3- or 6-bottle water sampler.

- **SBE 55 ECO Water Sampler** - The SBE 55 has built-in capabilities similar to that of an SBE 32 Carousel Water Sampler integrated with an Auto Fire Module, allowing the SBE 55 to operate autonomously on non-conducting cables. The SBE 55 monitors the pressure data recorded by the 19plus V2 in real-time, closing water sampler bottles at predefined pressures (depths) or whenever the system is stationary for a specified period of time. Bottle number, firing confirmation, and five scans of CTD data are recorded in the SBE 55 memory for each bottle fired. See the SBE 55 manual for operating details.

SBE 55 Autonomous Operation**Notes:**

- Help files provide detailed information on the software.
- Separate software manuals also provide information on Seasave V7 and SBE Data Processing.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our website. See our website for the latest software version number, a description of the software changes, and instructions for downloading the software.

The SBE 19plus V2 is supplied with a powerful Windows software package, Seasoft[®] V2, which includes:

- **Deployment Endurance Calculator** (for 19plus V2 in Moored mode) – program for determining deployment length based on user-input deployment scheme, instrument power requirements, and battery capacity.
- **SeatermV2** – terminal program for easy communication and data retrieval. SeatermV2 is a *launcher*. Depending on the instrument selected it launches **Seaterm232** (RS-232 instruments, such as the 19plus V2), **Seaterm485** (RS-485 instruments), or **SeatermIM** (inductive modem instruments).
- **Seasave V7** – program for acquiring, converting, and displaying real-time or archived raw data.
- **SBE Data Processing** – program for calculation and plotting of conductivity, temperature, pressure, auxiliary sensor data, and derived variables such as salinity and sound velocity.

Specifications

	Temperature (°C)	Conductivity (S/m)	Pressure																						
Measurement Range	-5 to +35	0 to 9	0 to full scale range: <ul style="list-style-type: none"> • <i>Strain-gauge sensor</i>: 20 / 100 / 350 / 600 / 1000 / 2000 / 3500 / 7000/10,500 meters • <i>Quartz sensor</i>: 20 / 60 / 130 / 200 / 270 / 680 / 1400 / 2000 / 4200 / 7000 / 10500 meters 																						
Initial Accuracy	± 0.005	± 0.0005	<ul style="list-style-type: none"> • <i>Strain-gauge sensor</i>: ± 0.1% of full scale range • <i>Quartz sensor</i>: ± 0.02% of full scale range 																						
Typical Stability	0.0002/month	0.0003/month	<ul style="list-style-type: none"> • <i>Strain-gauge sensor</i>: 0.1% of full scale range/year • <i>Quartz sensor</i>: 0.02% of full scale range/year 																						
Resolution	0.0001	<ul style="list-style-type: none"> • 0.00005 (most oceanic water; resolves 0.4 ppm in salinity). • 0.00007 (high salinity water; resolves 0.4 ppm in salinity). • 0.00001 (fresh water; resolves 0.1 ppm in salinity). 	<ul style="list-style-type: none"> • <i>Strain-gauge sensor</i>: 0.002% of full scale range • <i>Quartz sensor</i>: 0.0025% of full scale range for NAvg=2 (Profiling mode) or NCycles=2 (Moored mode) (see notes below) 																						
Sensor Calibration (measurement outside these ranges may be at slightly reduced accuracy due to extrapolation errors)	+1 to +32	0 to 9; physical calibration over range 2.6 to 6 S/m, plus zero conductivity (air)	Ambient pressure to full scale range in 5 steps																						
Real-Time Clock	32,768 Hz TCXO accurate to ±1 minute/year																								
Sampling Speed	4 Hz (4 samples/sec)																								
Memory	64 Mbyte non-volatile FLASH memory; maximum of 1000 cast headers																								
Data Storage	<table border="1"> <thead> <tr> <th>Recorded Parameter</th> <th>Bytes/sample</th> </tr> </thead> <tbody> <tr> <td>Temperature & Conductivity</td> <td>6 (3 each)</td> </tr> <tr> <td>Strain-gauge or Quartz Pressure</td> <td>5</td> </tr> <tr> <td>each external voltage</td> <td>2</td> </tr> <tr> <td>SBE 63 optical dissolved oxygen</td> <td>6</td> </tr> <tr> <td>SBE 38 secondary temperature</td> <td>3</td> </tr> <tr> <td>WET Labs RS-232 sensor</td> <td>6</td> </tr> <tr> <td>Satlantic SeaFET pH sensor</td> <td>6</td> </tr> <tr> <td>each Pro-Oceanus GTD</td> <td>4 (pressure) + 3 (temperature)</td> </tr> <tr> <td>Aanderaa Optode</td> <td>3</td> </tr> <tr> <td>date & time (Moored mode only)</td> <td>4</td> </tr> </tbody> </table>		Recorded Parameter	Bytes/sample	Temperature & Conductivity	6 (3 each)	Strain-gauge or Quartz Pressure	5	each external voltage	2	SBE 63 optical dissolved oxygen	6	SBE 38 secondary temperature	3	WET Labs RS-232 sensor	6	Satlantic SeaFET pH sensor	6	each Pro-Oceanus GTD	4 (pressure) + 3 (temperature)	Aanderaa Optode	3	date & time (Moored mode only)	4	
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*Notes on Quartz Pressure Sensor:

1. Maximum sampling rate in Profiling mode is 2 Hz when 19plus V2 is equipped with Quartz pressure sensor.

2. Resolution:

Pressure Sensor Resolution = Sensitivity * Counter Resolution

- Sensitivity = Δ pressure / Δ frequency

where Δ pressure is change in pressure in desired units (psia, dbar, meters, etc.) = pressure sensor full scale range

Δ frequency is change in frequency in Hz \approx 3000 Hz over sensor's full scale range

- Counter Resolution = pressure sensor output frequency / (integration time * 1,843,200)

where pressure sensor output frequency \approx 35,000 Hz

Integration time = 0.25 seconds

(requires **NAvg**= even number for Profiling mode; requires **NCycles**= even number for Moored mode)

- To convert pressure units: dbar = psia / 1.45
- Increasing **NAvg**= (Profiling mode) or **NCycles**= (Moored mode) reduces the measurement noise.

Example: What resolution can be obtained for a 7000 meter (10,000 psia) Quartz pressure sensor?

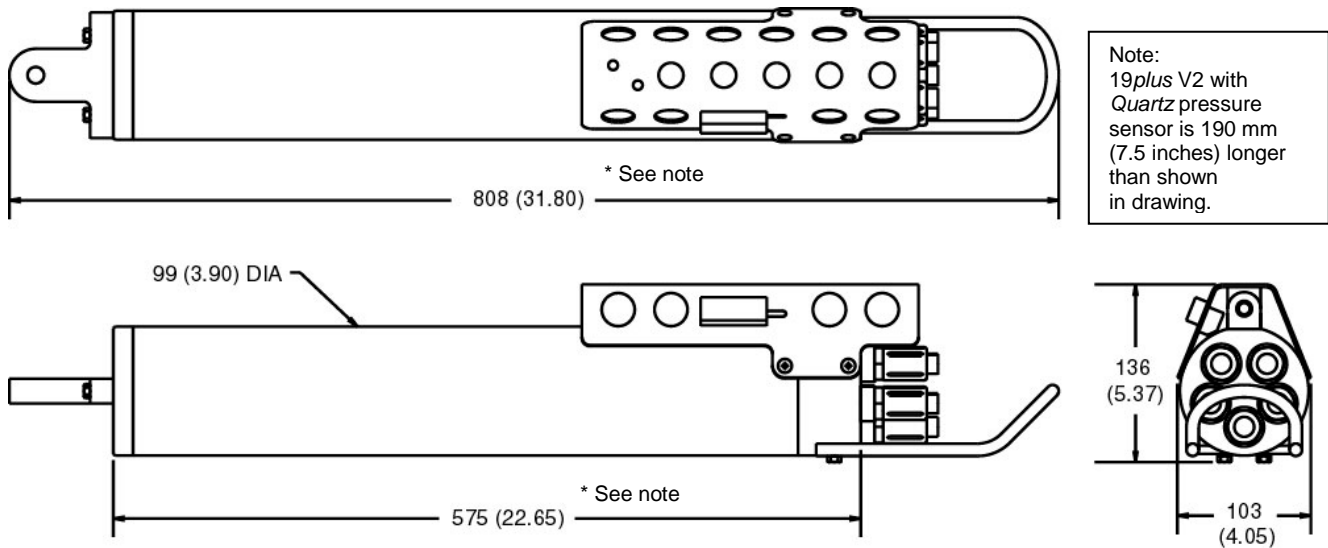
Sensitivity = Δ pressure / Δ frequency = 7000 m / 3000 Hz = 2.333 m / Hz

Counter Resolution = pressure sensor output frequency / (integration time * 1,843,200) = 35,000 Hz / (integration time * 1,843,200)
= 35,000 Hz / (0.25 seconds * 1,843,200) = 0.076 Hz

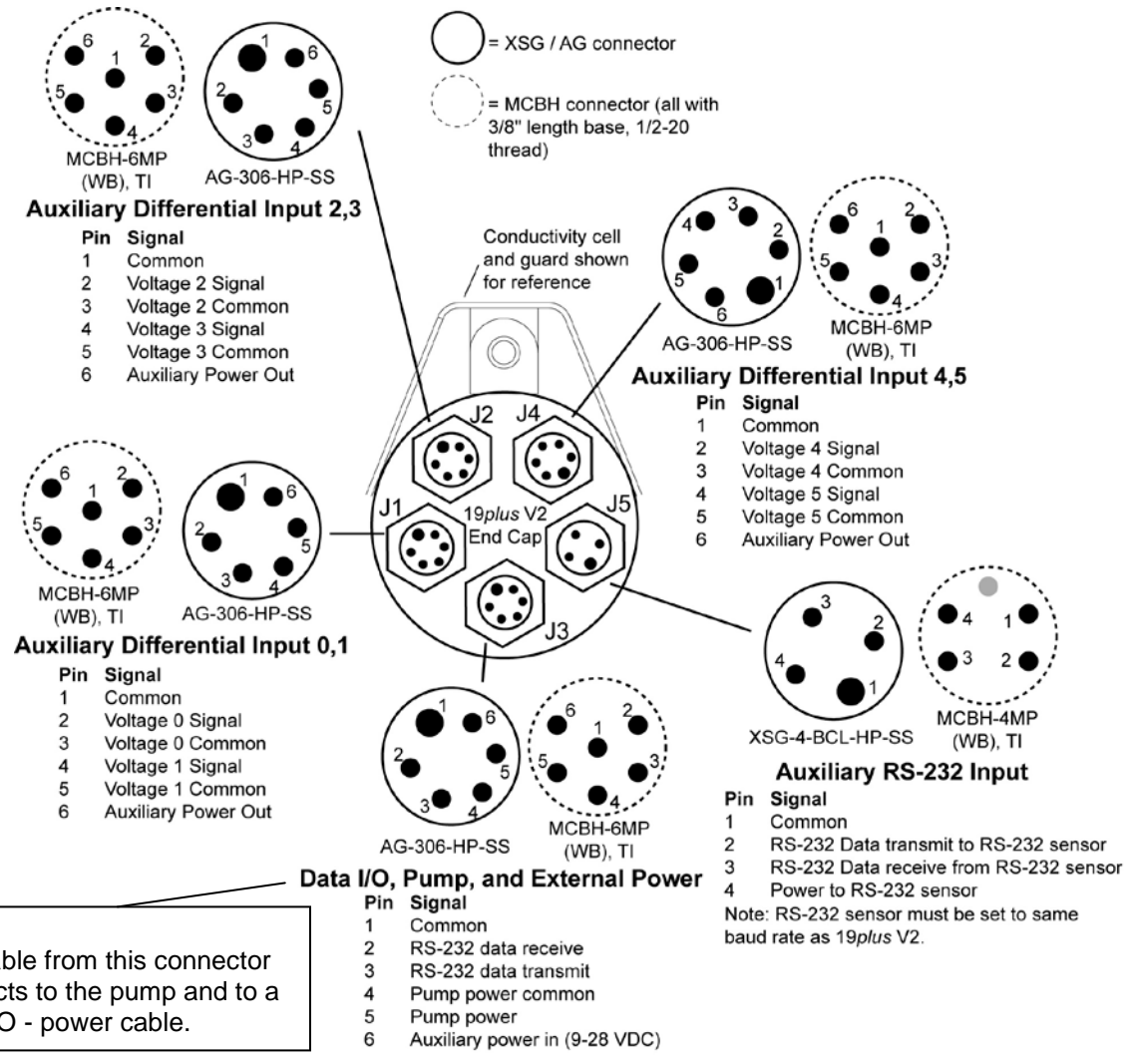
Resolution = Sensitivity * Counter Resolution = 2.333 dbar/Hz * Counter Resolution
= 2.333 dbar/Hz * 0.076 Hz = 0.18 dbar \approx 0.18 m = 180 mm

Dimensions and End Cap Connectors

Dimensions in millimeters (inches)

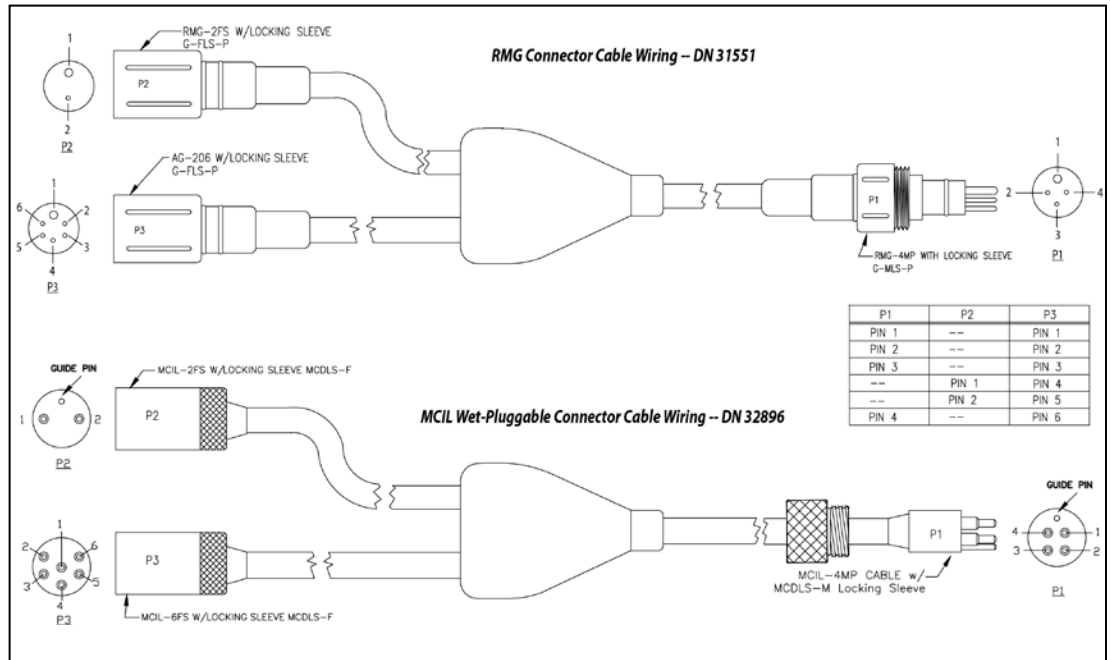


Note:
19plus V2 with Quartz pressure sensor is 190 mm (7.5 inches) longer than shown in drawing.

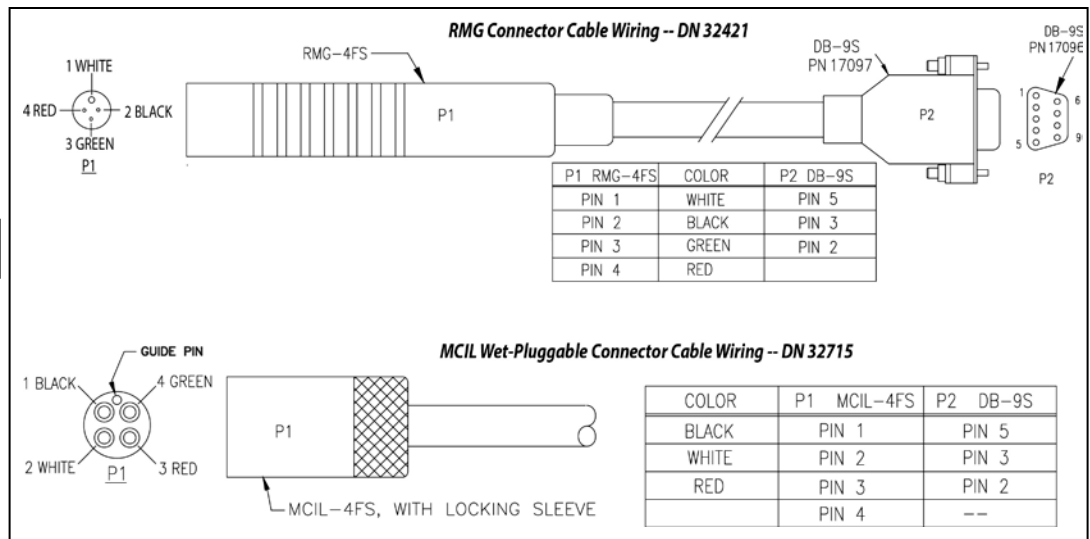


Cables

Y- cable –
 6-pin connects to 19plus V2 bulkhead connector;
 2-pin connects to pump;
 4-pin connects to data I/O cable



Data I/O cable



Sample Timing (Moored Mode)

Notes:

- See sampling times in *Specifications*.
- See moored mode sampling times in *Specifications*.
- Sample timing information is approximate.
- See *Battery Endurance* for power limitations.

Sample timing in **Moored Mode** is dependent on a number of factors, including the 19plus V2 pressure sensor type – strain gauge or Quartz, setup for the pump (**MooredPumpMode=**), and user-programmable sampling parameters for number of samples per measurement (**NCycles=**) and delay before sampling to allow time for auxiliary sensors to stabilize or for WET Labs auxiliary sensor bio-wipers to open (**DelayBeforeSampling=**), and delay after sampling to allow time for WET Labs auxiliary sensor bio-wipers to close (**DelayAfterSampling=**).

For autonomous sampling (logging), the 19plus V2 requires a minimum of 5 seconds from the end of one sample to the beginning of the next sample. After it takes each sample, it checks the time for the start of the next sample, based on the user-programmable sampling interval (**SampleInterval=**). If there is less than 5 seconds remaining until the programmed start of the next sample, the 19plus V2 provides a message:

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

The 19plus V2 takes the next sample in 5 seconds. The 19plus V2 performs this check after each sample; because of small variations in sampling time, this can cause samples to be taken at uneven intervals. Therefore, best practice is to check the sample timing before you set up the instrument, to ensure that the sample interval is long enough.

Examples are shown below:

Example 1 - pump on for 0.5 sec before each sample (**MooredPumpMode=1**), strain gauge pressure sensor, 1 measurement/sample (**NCycles=1**):

Sampling time = 0.5 sec (pump before sampling) + 2.5 sec (basic sampling time for strain gauge) = 3.0 sec
 Minimum sample interval (**SampleInterval=**) = 3.0 sec + 5 (sec between samples) = 8.0 sec < 10 sec minimum,
 so **minimum SampleInterval=10**.

Example 2 - pump on during sample (**MooredPumpMode=2**), 15 sec delay before sampling (**DelayBeforeSampling=15**), Quartz pressure sensor, and 4 measurements/sample (**NCycles=4**):

Sampling time = 15 (delay before sampling) + 2.45 (basic sampling time for Quartz) +
 (4 - 1) * 0.25 (additional measurements/sample for **NCycles**) = 18.2 sec
 Minimum sample interval (**SampleInterval=**) = 18.2 sec + 5 (sec between samples) = 23.2 sec,
 so **minimum SampleInterval=25** (round up by a few seconds, to account for any small differences in sample timing).

Batteries

Notes:

- See *Replacing / Recharging Batteries* in *Section 5: Routine Maintenance and Calibration*.
- The Ni-Cad battery pack and charger are no longer available.

For the main battery, the SBE 19plus V2 uses nine D-cell alkaline batteries (Duracell MN 1300, LR20), or rechargeable Nickel Metal Hydride (NiMH) or Nickel-Cadmium (Ni-Cad) batteries. If necessary, carbon-zinc or mercury cells can be used.

On-board lithium batteries (non-hazardous units that are unrestricted for shipping purposes) are provided to back-up the buffer and the real-time clock in the event of main battery failure or exhaustion. The main batteries may be replaced without affecting either the real-time clock or memory.

Battery Endurance

Notes:

- See *Specifications* for power requirements.
- If the 19plus V2 is logging data and the battery voltage is less than the battery cut-off, the 19plus V2 halts logging and displays a low battery indication in the data. See **BatteryType=** command in *Command Descriptions* in *Section 4: Deploying and Operating SBE 19plus V2* for cut-off values for various battery types.
- See *Data Storage and Specifications* for data storage limitations.

The included alkaline battery pack has a nominal capacity of 14 Amp-hours; for planning purposes, Sea-Bird recommends using a conservative value of 10.5 Amp-hours. The available NiMH battery pack has a nominal capacity of 8 Amp-hours. The Ni-Cad battery pack (no longer available) has a nominal capacity of 4.4 Amp-hours.

Current consumption and sampling times vary greatly, depending on:

- instrument configuration - inclusion of optional SBE 5T or 5P pump and/or auxiliary sensors, **and**
- user-programmed sampling parameters - Profiling or Moored mode; if in Moored mode, the pump mode, number of measurements per sample, and delay before sampling influence power consumption.

Examples are shown below for several sampling schemes for both Profiling and Moored mode. **For Moored mode, you can use the Deployment Endurance Calculator** to determine the maximum deployment length, instead of performing the calculations by hand.

Profiling Mode Examples

Example 1 - standard alkaline batteries, SBE 5M pump, no auxiliary sensors

Sampling current = 70 mA (from *Specifications*)

Pump current = 100 mA (from *Specifications*)

Maximum sampling time $\approx 10.5 \text{ Amp-hours} / (0.070 \text{ Amps} + 0.100 \text{ Amps}) \approx 61 \text{ hours}$

Example 2 - standard alkaline batteries, SBE 5T pump, auxiliary sensors drawing 100 mA

Sampling current = 70 mA (from *Specifications*)

Pump current = 150 mA (from *Specifications*)

Auxiliary sensor current = 100 mA

Maximum sampling time $\approx 10.5 \text{ Amp-hours} / (0.070 \text{ Amps} + 0.150 \text{ Amps} + 0.100 \text{ Amps}) \approx 32 \text{ hours}$

Moored Mode Examples

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?

Example 1 – SBE 5M pump on for 0.5 sec/sample (**MooredPumpMode=1**), no auxiliary sensors, 1 measurement/sample (**NCycles=1**):

Sampling current = 70 mA * (2.5 sec + 0.5 sec) = 0.21 A-sec/sample
In 1 hour, sampling current = 6 * 0.21 A-sec/sample = 1.26 A-sec/hour

Pump current = 100 mA * 0.5 sec = 0.05 A-sec/sample
In 1 hour, pump current = 6 * 0.05 A-seconds/sample = 0.3 A-sec/hour

Quiescent current = 20 microA = 0.02 mA
In 1 hour, quiescent current ≈ 0.02 mA * 3600 sec/hour = 0.072 A-sec/hour

Current consumption / hour = 1.26 + 0.3 + 0.072 = 1.63 A-sec/hour

Capacity = (10.5 A-hours * 3600 sec/hr) / (1.63 A-sec/hour) = 23190 hours = 966 days = 2.6 years

However, Sea-Bird recommends that batteries should not be expected to last longer than 2 years in the field.

Example 2 - SBE 5T pump on during sample (**MooredPumpMode=2**), 15 sec delay before sampling (**DelayBeforeSampling=15**), auxiliary sensors drawing 100 mA, 4 measurements/sample (**NCycles=4**):

On-time = 2.5 + 15 (delay before sampling) + (4 – 1) * 0.25 (additional measurements/sample) = 18.25 sec

Sampling current = 70 mA * 18.25 sec = 1.28 A-sec/sample
In 1 hour, sampling current = 6 * 1.28 A-sec/sample = 7.7 A-sec/hour

5T Pump current = 150 mA * 18.25 sec = 2.74 A-sec/sample
In 1 hour, pump current = 6 * 2.74 A-sec/sample = 16.4 A-sec/hour

Auxiliary sensor current = 100 mA * 18.25 sec = 1.82 A-sec/sample
In 1 hour, auxiliary sensor current = 6 * 1.82 A-sec/sample = 10.9 A-sec/hour

Quiescent current = 20 microA = 0.02 mA
In 1 hour, quiescent current ≈ 0.02 mA * 3600 sec/hour = 0.072 A-sec/hour

Current consumption / hour = 7.7 + 16.4 + 10.9 + 0.072 = 35.1 A-sec/hour

Capacity = (10.5 A-hours * 3600 sec/hr) / (35.1 A-sec/hour) = 1076 hours = 44 days = 0.12 years

External Power

The SBE 19plus V2 can be powered from an external source (9 - 28 volts DC) through the Y-cable connected to the Data I/O, Pump, and External Power bulkhead connector on the sensor end cap. The internal battery pack is diode-OR'd with the external source, so power will be drawn from whichever voltage source is higher. The 19plus V2 can also be operated from the external supply without having the internal battery pack installed. Electrical isolation of conductivity is retained in units powered externally, preventing ground loop noise contamination in the conductivity measurement.

On the ship, cables longer than 3 meters should be installed inside an earthed metal conduit by a qualified electrician. This minimizes the potential for external signals to disrupt communication and ensures that high voltage lines (such as the sea cable) are sufficiently protected. Cables shorter than 3 meters can be used without shielding when installing or bench testing the instrument.

Cable Length and External Power without Deck Unit

Note:

See *Real-Time Setup* in *Section 4: Deploying and Operating SBE 19plus V2* for baud rate limitations on cable length if transmitting real-time data.

There are two issues to consider if powering the 19plus V2 externally:

- Limiting the communication IR loss to 1 volt **if transmitting real-time data**; higher IR loss will cause the instrument to transmit data that does not meet the RS-232 communication standard.
- Supplying enough power at the power source so that sufficient power is available at the instrument after considering IR loss.

Each issue is discussed below.

Limiting Communication IR Loss to 1 Volt if Transmitting Real-Time Data

The limit to cable length is typically reached when the maximum current during **communication** times the power common wire resistance is more than 1 volt.

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

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

where I = current required by SBE 19plus V2 during communication. The current varies, depending on operating mode:

- Profiling mode – The 19plus V2 samples and transmits data continuously. Use the total current required for sampling (sampling, pump, auxiliary sensor current, and communication current) in the calculation.
- Moored mode – The 19plus V2 samples, and then transmits data. Use the communication current, 65 mA, in the calculation.

Profiling Mode Examples - for 19plus V2 with SBE 5M pump and no auxiliary sensors

Example 1 – For 20 gauge wire, what is maximum distance to transmit power to 19plus V2 if transmitting real-time data?

Current = 70 mA (sampling) + 100 mA (pump) + 65 mA (communication) = 235 mA

$R_{\text{limit}} = V_{\text{limit}} / I = 1 \text{ volt} / 0.235 \text{ Amps} = 4.3 \text{ ohms}$

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 Examples – use 65 mA communication current, regardless of 19plus V2 configuration

Example 1 – For 20 gauge wire, what is maximum distance to transmit power to 19plus V2 if transmitting real-time data?

For 65 milliamp communications current, $R_{\text{limit}} = V_{\text{limit}} / I = 1 \text{ volt} / 0.065 \text{ Amps} = 15.4 \text{ ohms}$

For 20 gauge wire, resistance is 0.0107 ohms/foot.

Maximum cable length = $15.4 \text{ ohms} / 0.0107 \text{ ohms/foot} = 1439 \text{ feet} = 439 \text{ meters}$

Example 2 – Same as above, but there are 4 instruments powered from the same power supply.

For 65 milliamp communications current, $R_{\text{limit}} = V_{\text{limit}} / I = 1 \text{ volt} / (0.065 \text{ Amps} * 4 \text{ instruments}) = 3.8 \text{ ohms}$

Maximum cable length = $3.8 \text{ ohms} / 0.0107 \text{ ohms/foot} = 355 \text{ feet} = 108 \text{ meters}$ (to 19plus V2 furthest from power source).

Supplying Enough Power to SBE 19plus V2

Another consideration in determining maximum cable length is supplying enough power at the power source so that sufficient voltage is available, after IR loss in the cable (*from the turn-on transient, two-way resistance*), to power the 19plus V2. The table summarizes the maximum 2-way resistance for various input supplies and pump configurations:

Power Supply Input and Pump Configuration	R_{limit} = Maximum 2-way Resistance (ohms)
3 Amps at 9V input, SBE 5M pump (cannot use SBE 5T or 5P pump with 9V input)	1
0.5 Amps at 12V input, SBE 5M pump	10
3.0 Amps at 12V input, SBE 5T or 5P pump	2
0.5 Amps at 19V input, SBE 5M pump	30
1.5 Amps at 19V input, SBE 5T or 5P pump	7

Calculate maximum cable length as:

$$\text{Maximum cable length} = R_{\text{limit}} / 2 * \text{wire resistance per foot}$$

Example 1 – For 20 gauge wire, what is maximum distance to transmit power to 19plus V2 if using 12 volt power source with SBE 5T pump?

Maximum cable length = $R_{\text{limit}} / 2 * \text{wire resistance per foot} = 2 \text{ ohms} / 2 * 0.0107 \text{ ohms/foot} = 93 \text{ ft} = 28 \text{ meters}$

Note that 28 meters < 173 meters and 474 meters (maximum distance if transmitting real-time data in examples above), so IR drop in power is controlling factor for this example. Using a higher voltage power supply or a different wire gauge would increase allowable cable length.

Example 2 – Same as above, but there are 4 instruments powered from same power supply.

Maximum cable length = $R_{\text{limit}} / 2 * \text{wire resistance per foot} * 4 \text{ instruments}$

$$= 2 \text{ ohms} / 2 * 0.0107 \text{ ohms/foot} * 4 = 23 \text{ ft} = 7 \text{ meters}$$
 (to 19plus V2 furthest from power source)

Data Storage

Note:

See *Battery Endurance* for power limitations.

The SBE 19plus V2 has a 64 Mbyte FLASH memory for data, and can store a maximum of 1000 cast headers (a header is written to memory each time a profile is started). Shown below are calculations of available data storage for several configurations. See *Specifications* for storage space required for each parameter.

Example 1: Profiling mode, no auxiliary sensors, strain-gauge pressure

T & C = 6 bytes/sample

Strain-gauge P = 5 bytes/sample

Storage space $\approx 64,000,000 / (6 + 5) \approx 5,818,000$ samples

Example 2: Profiling mode, 6 external voltages, strain-gauge pressure

T & C = 6 bytes/sample

Strain-gauge P = 5 bytes/sample

External voltages = 2 bytes/sample * 6 voltages = 12 bytes/sample

Storage space $\approx 64,000,000 / (6 + 5 + 12) \approx 2,782,000$ samples

Example 3: Moored mode (stores date and time), 6 external voltages, strain-gauge pressure, SBE 38 RS-232 sensor

T & C = 6 bytes/sample

Strain-gauge P = 5 bytes/sample

SBE 38 = 3 bytes/sample

External voltages = 2 bytes/sample * 6 voltages = 12 bytes/sample

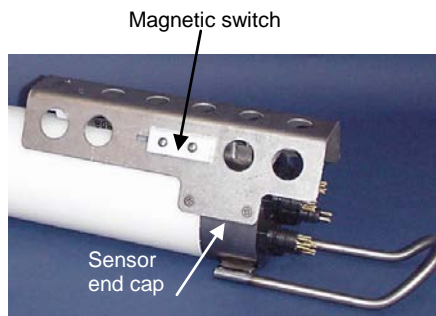
Date/Time = 4 bytes/sample

Storage space $\approx 64,000,000 / (6 + 5 + 12 + 3 + 4) \approx 2,133,000$ samples

Data I/O

The SBE 19plus V2 receives setup instructions and outputs diagnostic information or previously recorded data via a three-wire RS-232C link, and is factory-configured for 9600 baud, 8 data bits, 1 stop bit, and no parity. 19plus V2 RS-232 levels are directly compatible with standard serial interface cards (IBM Asynchronous Communications Adapter or equal). The communications baud rate can be changed using **BaudRate=** (see *Command Descriptions* in *Section 4: Deploying and Operating SBE 19plus V2*).

Magnetic Reed Switch



Profiling Mode

A magnetic switch, mounted on the conductivity cell guard, can be used to start and stop logging in Profiling mode. Sliding the switch to the On position wakes up the SBE 19plus V2 and starts logging. Sliding the switch to the Off position stops logging. The switch should be Off (towards the sensor end cap) when not logging data; i.e., during setup, diagnostics, and data extraction.

The 19plus V2 can be set up to ignore the switch position:

- If **IgnoreSwitch=Y**: logging is started and stopped with commands sent through the terminal program. Switch position has no effect on logging.
- If **AutoRun=Y**: logging is started and stopped when external power is applied and removed. Switch position has no effect on logging.

Moored Mode

In Moored mode, the magnetic switch position has no effect on logging. Logging is started and stopped with commands sent through the terminal program.

Notes:

- See *Command Descriptions* in *Section 4: Deploying and Operating SBE 19plus V2*.
- **Leave the switch in the Off position** if **IgnoreSwitch=Y** or **AutoRun=Y**, or in Moored mode. If the switch is On, the 19plus V2 draws an additional 15 μ A from the battery while in quiescent state.

Configuration Options and Plumbing

Note:

See *Section 4: Deploying and Operating SBE 19plus V2* for pump setup and operation.

The SBE 19plus V2 includes an externally mounted SBE 5M pump, which provides a constant flow rate through the conductivity cell regardless of descent rate. If configured with a dissolved oxygen sensor or pumped fluorometer, the more powerful SBE 5T (titanium) or 5P (plastic) pump is used. Any of these pumps is powered via a cable connected to the 2-pin leg of the Y-cable (which is connected to the Data I/O, Pump, and External Power bulkhead connector on the sensor end cap).

The 19plus V2 can be configured with a wide range of auxiliary sensors. Three 6-pin bulkhead connectors on the sensor end cap serve as the input ports for the auxiliary sensor signal voltages and provide power to the sensors.

Additionally, a 4-pin bulkhead connector on the sensor end cap is provided for interfacing with one of the following RS-232 sensors:

- SBE 63 optical dissolved oxygen sensor
- SBE 38 secondary temperature sensor
- WET Labs sensor - single, dual, or triple channel ECO sensor; WETStar; C-Star; or SeaOWL UV-A™
- Satlantic SeaFET pH sensor
- Pro-Oceanus Gas Tension Devices (up to two GTDs can be integrated)
- Aanderaa Optode 4330 or 4835

A 19plus V2 is typically deployed in a vertical position. However, when used with an SBE 32 (full size) Carousel Water Sampler, the 19plus V2 is deployed in a horizontal position in an extension stand below the Carousel. Pump placement and plumbing for a horizontal mount is different than that for a vertical mount.

Sea-Bird provides the system with pump placement and plumbing for the desired orientation at the time of purchase. However, you may reorient the system later as needed. **Failure to place the pump and plumbing properly can trap air, preventing the pump from working properly.**

Shown below are schematics of the system configuration for vertical and horizontal deployment. In the schematics, cables are omitted for clarity. Secure each tubing connection with 2 cable ties.

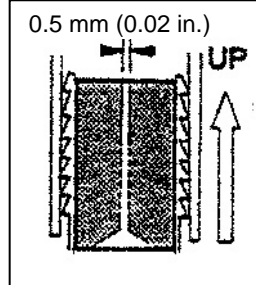
Vertical Mount

- Place the exhaust as far from the intake as possible, so that exhaust water is not pulled into the intake. Failure to place the exhaust away from the intake can lead to errors in temperature data, because the pump transfers heat to the exhaust water.

Shown below is the vertical mount plumbing arrangement of a 19plus V2 equipped with the SBE 5M miniature pump (plastic or titanium).

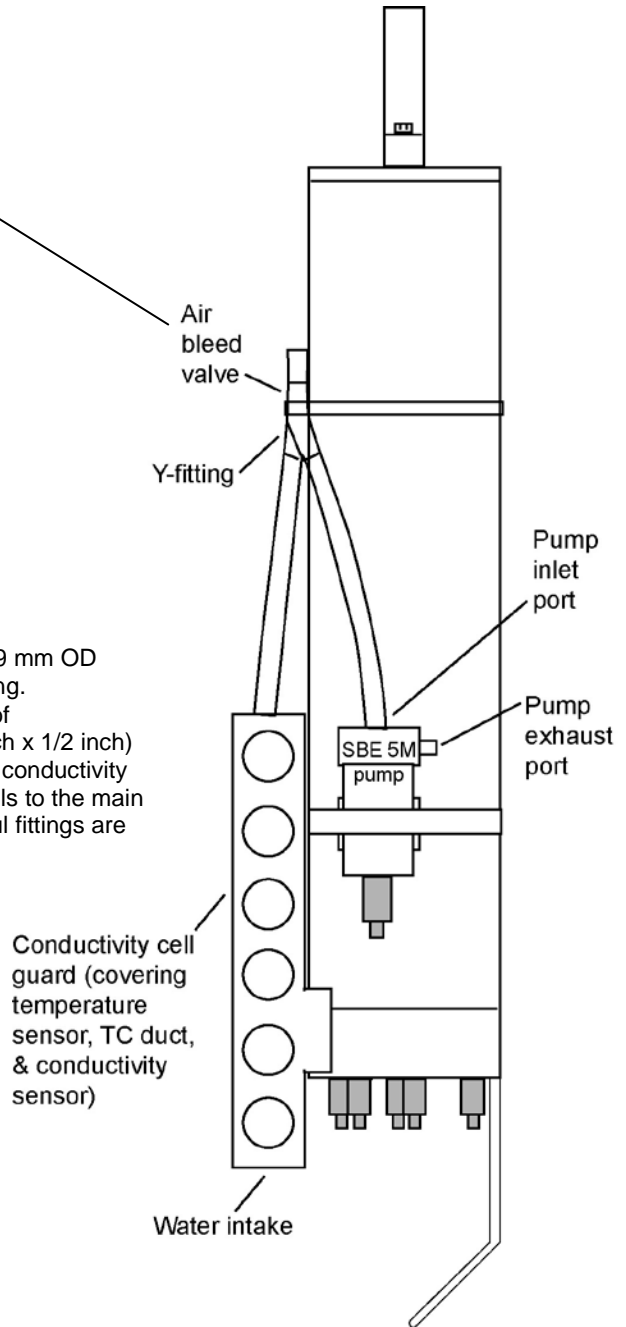


Air bleed valve detail



Note: Periodically clean air bleed valve to ensure proper functioning.

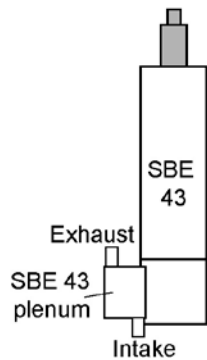
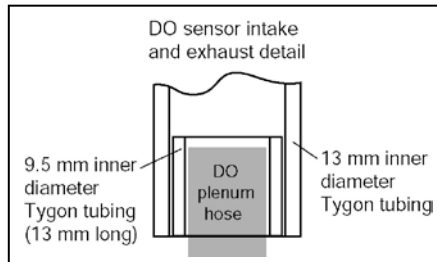
- Main plumbing is 13 mm ID x 19 mm OD (1/2 inch x 3/4 inch) Tygon tubing.
- A 13 mm (1/2 inch) long piece of 9.5 mm ID x 13 mm OD (3/8 inch x 1/2 inch) Tygon tubing is installed on the conductivity cell exhaust to provide tight seals to the main plumbing when optional anti-foul fittings are installed on the 19plus V2.



Shown below is the vertical mount plumbing arrangement of a 19plus V2 configured with the SBE 5T titanium or 5P plastic pump, SBE 43 dissolved oxygen (DO) sensor, and SBE 18 pH sensor. Note that the SBE 43 is plumbed into the system between the conductivity cell outlet and the Y-fitting (same configuration can be used with SBE 63 Optical DO sensor in place of SBE 43; see diagram below for mounting detail). The SBE 18 is not connected to the plumbing.

Notes:
Sea-Bird recommends use of the pH sensor on the 19plus V2 only when the 19plus V2 is in **Profiling mode (MP)**.

- Main plumbing is 13 mm ID x 19 mm OD (1/2 inch x 3/4 inch) Tygon tubing.
- A 13 mm (1/2 inch) long piece of 9.5 mm ID x 13 mm OD (3/8 inch x 1/2 inch) Tygon tubing to provide tight seals to the main plumbing is installed:
 - on the SBE 43 intake and exhaust, and
 - on the conductivity cell exhaust when optional anti-foul fittings are installed on the 19plus V2.

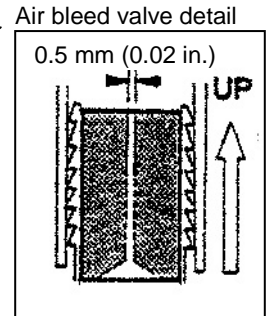
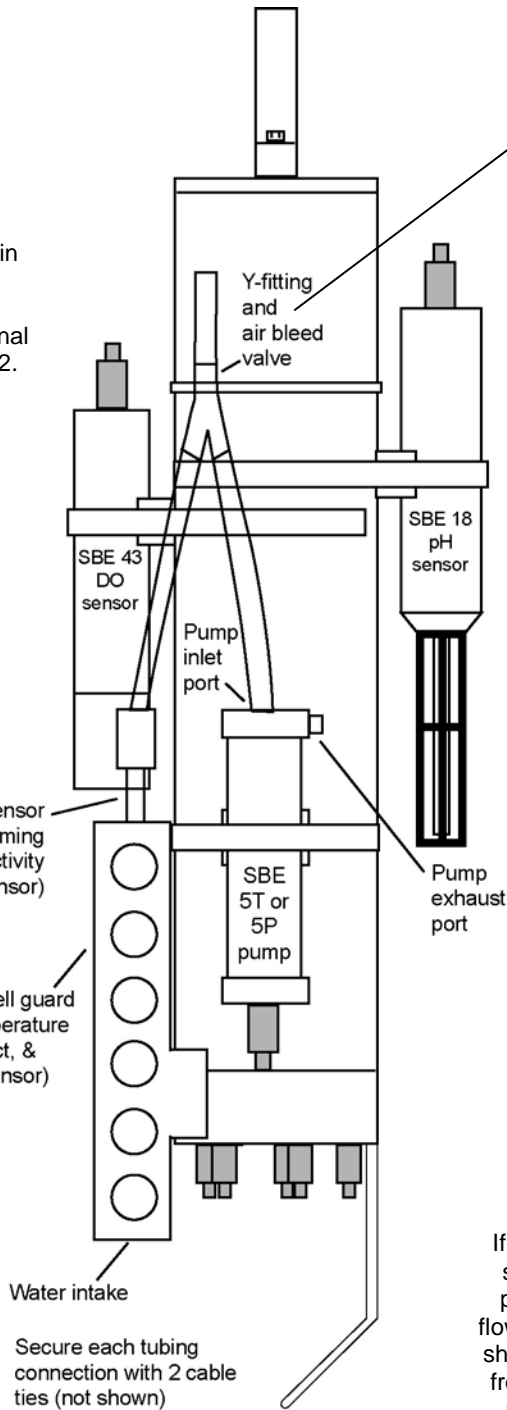


Place DO sensor with plenum intake closer than exhaust to SBE 43 housing, as shown.

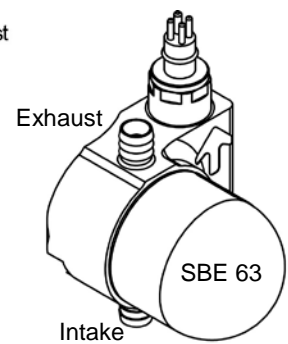
Note: SBE 43 housing orientation (connector end up or down) does not affect operation. Plenum can be reversed on housing by removing and replacing 2 screws.

SBE 43 DO sensor water intake (coming from conductivity sensor)

Conductivity cell guard (covering temperature sensor, TC duct, & conductivity sensor)



Note: Periodically clean air bleed valve to ensure proper functioning.

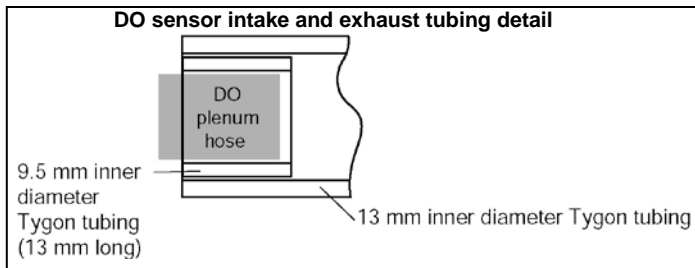
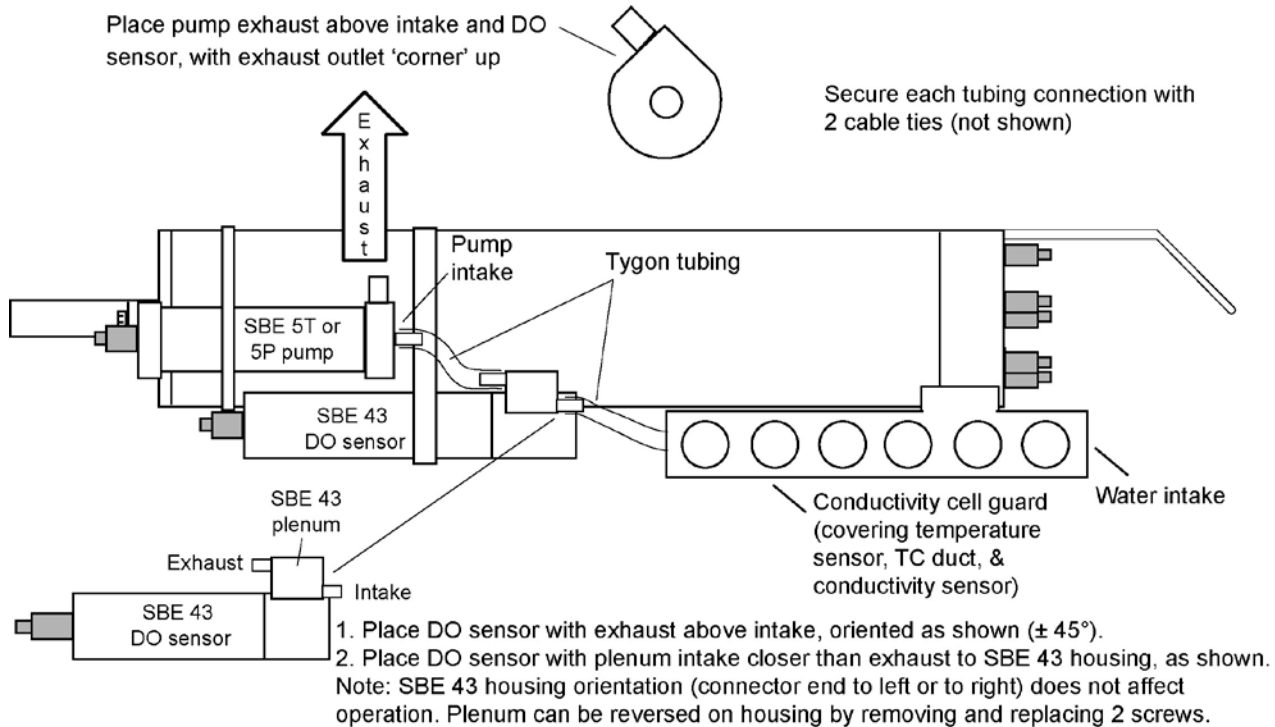


If using **SBE 63 Optical DO** sensor instead of SBE 43, place it in same location in flow path. Sensor mount arrow shows correct flow orientation from intake to exhaust. Main plumbing fits directly onto intake and exhaust barbs (no additional tubing required).

Horizontal Mount

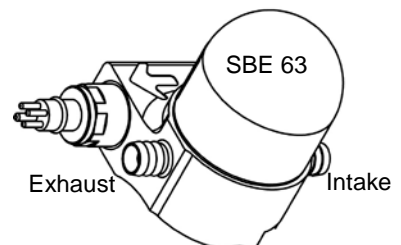
Shown below is the horizontal mount plumbing arrangement of a 19plus V2 configured with the SBE 5T titanium or 5P plastic pump, and SBE 43 dissolved oxygen (DO) sensor. Note that the SBE 43 is plumbed into the system between the conductivity cell outlet and the pump inlet (same configuration can be used with SBE 63 Optical DO sensor in place of SBE 43; see diagram below for mounting detail).

- Place the DO sensor intake above the conductivity sensor exhaust.
- Place the pump intake above the DO sensor exhaust.
- Orient the pump with the exhaust outlet *corner* up.
- If the system does not include a DO sensor, connect the tubing from the conductivity cell directly to the pump intake.



- Main plumbing is 13 mm ID x 19 mm OD (1/2 inch x 3/4 inch) Tygon tubing.
- A 13 mm (1/2 inch) long piece of 9.5 mm ID x 13 mm OD (3/8 inch x 1/2 inch) Tygon tubing to provide tight seals to main plumbing is installed:
 - on SBE 43 intake and exhaust, and
 - on conductivity cell exhaust when optional anti-foul fittings are installed on 19plus V2.

If using **SBE 63 Optical DO** sensor instead of SBE 43, place it in same location in flow path. Sensor mount arrow shows correct flow orientation from intake to exhaust. Main plumbing fits directly onto intake and exhaust barbs (no additional tubing required).



Section 3:

Power and Communications Test

This section describes software installation and the pre-check procedure for preparing the SBE 19plus V2 for deployment. The power and communications test will verify that the system works, prior to deployment.

Software Installation

Notes:

- Help files provide detailed information on the software. Separate software manuals on the CD-ROM contain detailed information on Seasave V7 and SBE Data Processing.
- It is possible to use the 19plus V2 without the SeatermV2 terminal program by sending direct commands from a dumb terminal or terminal emulator, such as Windows HyperTerminal.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our website. See our website for the latest software version number, a description of the software changes, and instructions for downloading the software.

Seasoft V2 was designed to work with a PC running Windows XP service pack 2 or later, Windows Vista, or Windows 7 (32-bit or 64-bit).

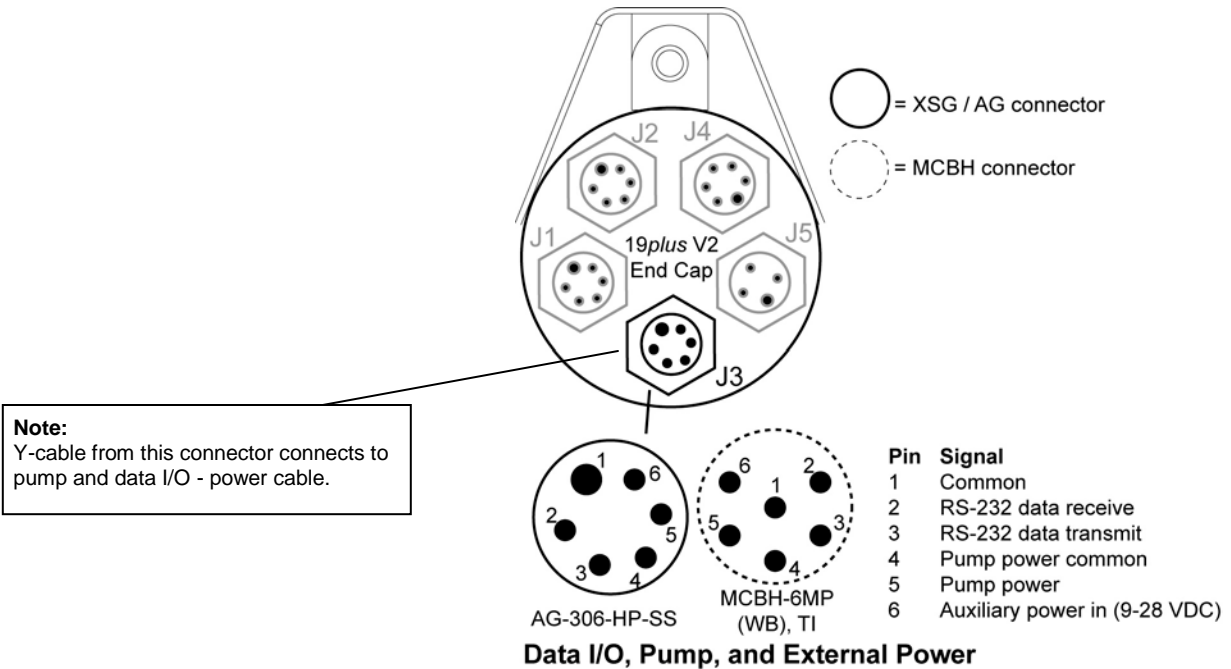
If not already installed, install Sea-Bird software programs on your computer using the supplied software CD:

1. Insert the CD in your CD drive.
2. Install software: Double click on **SeasoftV2.exe**. Follow the dialog box directions to install the software. The installation program allows you to install the desired components. Install all the components, or just install Deployment Endurance Calculator (battery endurance calculator for Moored mode), SeatermV2 (terminal program *launcher* for 19plus V2), Seasave V7 (real-time data acquisition), SBE Data Processing (data processing), and Seaterm (terminal program for setting up SBE 38 auxiliary sensor, if applicable to your system).

The default location for the software is c:\Program Files\Sea-Bird. Within that folder is a sub-directory for each program.

Test Setup

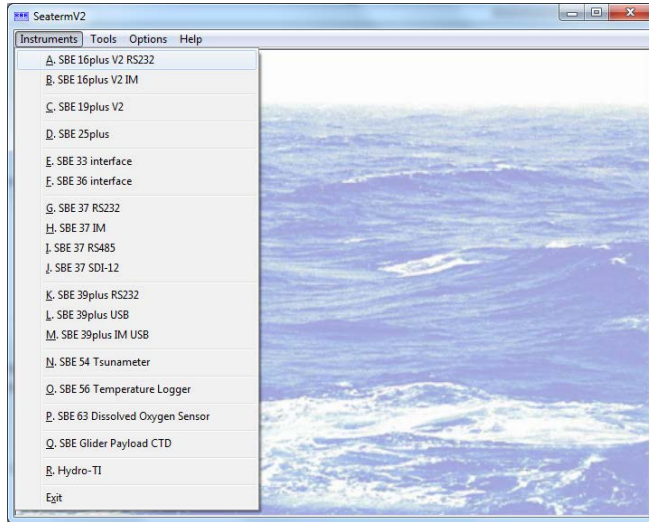
1. Remove the dummy plug from the Y-cable and install the I/O cable:
 - A. Pulling the plug firmly away from the connector, remove the dummy plug from the 4-pin connector on the Y-cable strapped to the 19plus V2 housing. Note that the Y-cable is connected to the Data I/O, Pump, and External Power connector on the 19plus V2 end cap, and provides power to the pump via the 2-pin connector as well as communications with the computer via the 4-pin connector.
 - B. **XSG / AG Connector** - Install the I/O cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the Y-cable. **OR**
MCBH Connector - Install the I/O cable connector, aligning the pins.
2. Connect the I/O cable connector to your computer's serial port.



Test

Note:
See SeatermV2's Help files.

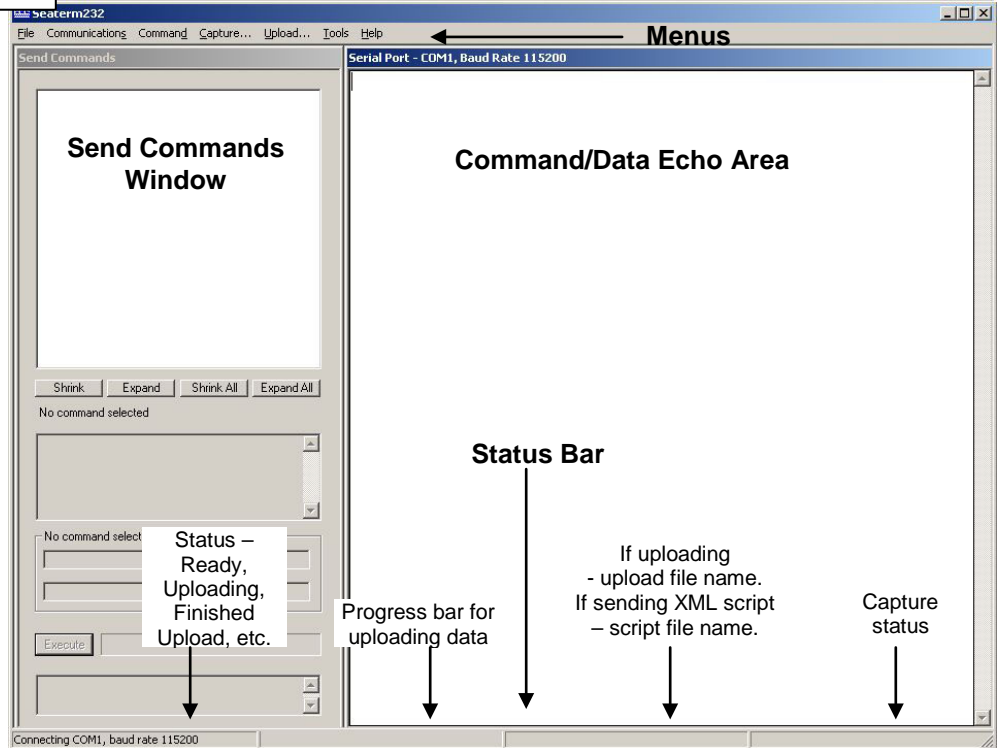
1. Double click on **SeatermV2.exe**. The main screen looks like this:



SeatermV2 is a *launcher*, and launches the appropriate terminal program for the selected instrument.

Note:
See Seaterm232's Help files.

2. In the Instruments menu, select *SBE 19plus V2*. **Seaterm232** opens; the main screen looks like this:



- **Menu** – For tasks and frequently executed instrument commands.
- **Send Commands window** – Contains commands applicable to your 19plus V2. The list appears after you connect to the 19plus V2.
- **Command/Data Echo Area** – Title bar of this window shows Seaterm232's current comm port and baud rate. Commands and the 19plus V2 responses are echoed here. Additionally, a command can be manually typed or pasted (Ctrl V) here. Note that the 19plus V2 must be *connected* and *awake* for it to respond to a command.
- **Status bar** – Provides connection, upload, script, and capture status information.

Following is a description of the menus:

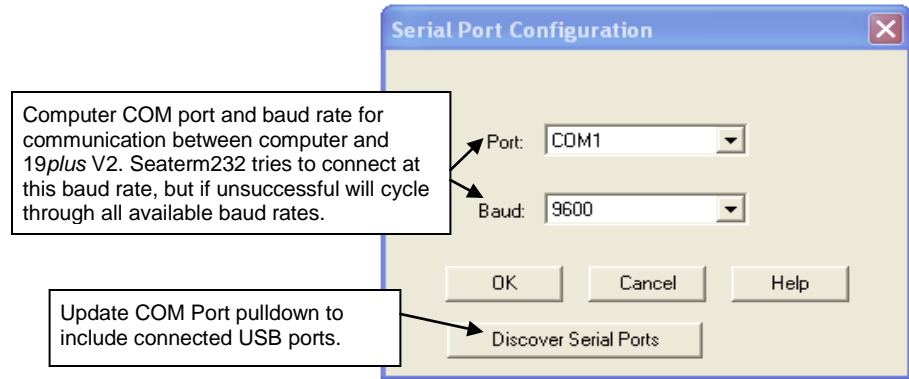
Menu	Description	Equivalent Command*
File	<ul style="list-style-type: none"> • Load command file – opens selected .XML command file, and fills Send Commands window with commands • Unload command file – closes command file, and removes commands from Send Commands window • Exit - Exit program. 	-
Communications	<ul style="list-style-type: none"> • Connect – connect to comm port • Disconnect – disconnect from comm port • Configure – Establish communication parameters (comm port and baud rate). • Disconnect and reconnect – may be useful if 19plus V2 has stopped responding 	-
Command	<ul style="list-style-type: none"> • Abort – interrupt and stop 19plus V2's response • Send 5 second break (not applicable to 19plus V2) • Send stop command • Set local time– Set date and time to time sent by timekeeping software on your computer; accuracy ± 25 msec of time provided by computer. • Set UTC Time (Greenwich Mean Time) – Set date and time to time sent by timekeeping software on your computer; accuracy ± 25 msec of time provided by computer. 	<ul style="list-style-type: none"> • (press Esc key several times for Abort) • Stop • DateTime= • DateTime=
Capture	Capture 19plus V2 responses on screen to file, to save real-time data or use for diagnostics. File has .cap extension. Click Capture again to turn off capture. Capture status displays in Status bar.	—
Upload	Upload data stored in memory, in format Sea-Bird's data processing software can use (raw hex). Uploaded data has .xml extension, and is then automatically converted to a file with .hex extension. Before using Upload: stop logging by sending Stop .	Several status commands and appropriate data upload command as applicable to user selection of range of data to upload (use Upload menu if you will be processing data with SBE Data Processing or viewing archived data with Seasave)
Tools	<ul style="list-style-type: none"> • Diagnostics log - Keep a diagnostics log. • Convert .XML data file – Using Upload menu automatically does this conversion; tool is available if there was a problem with the automatic conversion. • Send script – Send XML script to 19plus V2. May be useful if you have a number of 19plus V2s to program with same setup. 	-

Note:

Set local time and Set UTC time are disabled if the baud rate in Seaterm232 is set to 115200, because the software cannot reliably set the time at that baud.

*See Command Descriptions in Section 4: Deploying and Operating SBE 19plus V2.

3. If this is the first time Seaterm232 is being used, the Serial Port Configuration dialog box displays:



Make the desired selections, and click OK.

4. Seaterm232 tries to automatically connect to the 19plus V2. As it connects, it sends **GetHD** and displays the response, which provides factory-set data such as instrument type, serial number, and firmware version. Seaterm232 also fills the Send Commands window with the correct list of commands for your 19plus V2.

If there is no communication:

- A. In the Communications menu, select *Configure*. The Serial Port Configuration dialog box appears. Select the Comm port and baud rate for communication, and click OK. Note that the factory-set baud rate is documented on the Configuration Sheet.
- B. In the Communications menu, select *Connect* (if *Connect* is grayed out, select *Disconnect and reconnect*). Seaterm232 will attempt to connect at the baud specified in Step A, but if unsuccessful will then cycle through all other available baud rates.
- C. If there is still no communication, check cabling between the computer and 19plus V2, and try to connect again.
- D. If there is still no communication, repeat Step A with a different comm port, and try to connect again.

Note:

Seaterm232's baud rate must be the same as the 19plus V2 baud rate (set with **BaudRate=**). Baud is factory-set to 9600, but can be changed by the user (see *Command Descriptions* in *Section 4: Deploying and Operating SBE 19plus V2*). Other communication parameters – 8 data bits, 1 stop bit, and no parity – cannot be changed.

Note:

If **OutputExecutedTag=Y**, the 19plus V2 does **not** provide an S> prompt after the **<Executed/>** tag at the end of a command response.

After Seaterm232 displays the **GetHD** response, it provides an S> prompt to indicate it is ready for the next command.

Taking a look at the Send Commands window:

The screenshot shows the 'Send Commands' window for an SBE19plus device. The window has a tree view on the left under the heading 'SBE19plus Commands'. The tree includes: Status, General Setup, Pressure and Voltage Sensor Setup, RS-232 Sensor Setup, Output Format Setup, Profiling Mode Setup, Moored Mode Setup, Logging, Data Upload (expanded), Polled Sampling, Testing, Calibration Coefficients, and Hardware Configuration. The 'Data Upload' folder is expanded, showing several sub-items, with 'Upload data from FLASH memory' selected and highlighted in blue. Below the tree are buttons for 'Shrink', 'Expand', 'Shrink All', and 'Expand All'. A 'Help for command GetSamples:' section contains a text box with the following text: 'Upload selected data from FLASH memory in format specified by OutputFormat=. If starting and ending sample numbers are omitted, all data is uploaded. Equivalent to DD.' Below this is a section for 'Arguments for command GetSamples:' with two input boxes labeled 'Starting sample number' and 'Ending sample number'. At the bottom, there is an 'Execute' button and a 'GetSamples:' label. A large empty text area is at the very bottom of the window. Five callout boxes with arrows point to these elements: 1. 'Click on desired command description in list.' points to the 'Upload data from FLASH memory' item. 2. 'Help box describes selected command in more detail.' points to the help text box. 3. 'Enter any command arguments (such as starting and ending sample number for upload) in these boxes.' points to the two argument input boxes. 4. 'Click Execute when ready to send selected command.' points to the 'Execute' button. 5. 'This box shows selected command.' points to the 'GetSamples:' label.

You can use the Send Commands window to send commands, or simply type the commands in the Command/Data Echo area if desired.

Notes:

- The 19plus V2 automatically enters quiescent (sleep) state after 2 minutes without receiving a command. This timeout algorithm is designed to conserve battery energy if the user does not send **QS** to put the 19plus V2 to sleep. If the 19plus V2 does not appear to respond, click Connect in the Communications menu to reestablish communications.
- Sending the status command causes the pump to turn on for a moment, so that the 19plus V2 can measure and output the pump current. Because the pump is designed to be water lubricated, you may hear a noise when the impeller spins in air. Running the pump *dry* for **short** periods (for example, when sending the status command) will not harm the pump.

5. Display 19plus V2 status information by typing **DS** and pressing the Enter key. The display looks like this:

```
SBE 19plus V 3.1.8 SERIAL NO. 4000 13 Apr 2016 14:02:13
vbatt = 10.1, vlith = 8.9, ioper = 61.9 ma, ipump = 20.8 ma,
iext01 = 76.2 ma
status = not logging
number of scans to average = 1
samples = 10, free = 4386532, casts = 1
mode = profile, minimum cond freq = 3000, pump delay = 60 sec
autorun = no, ignore magnetic switch = no
battery type = alkaline, battery cutoff = 7.5 volts
pressure sensor = strain gauge, range = 1000.0
SBE 38 = no, WETLABS = no, OPTODE = no, SBE63 = no,
SeaFET = no, Gas Tension Device = no
Ext Volt 0 = yes, Ext Volt 1 = yes
Ext Volt 2 = no, Ext Volt 3 = no
Ext Volt 4 = no, Ext Volt 5 = no
echo characters = yes
output format = converted decimal
output salinity = no, output sound velocity = no
```

6. Command the 19plus V2 to take a sample by typing **TS** and pressing the Enter key. The display looks like this (if in Profiling mode, with converted decimal output format, no output salinity or sound velocity, and auxiliary voltage sensors on channels 0 and 1):

```
23.7658, 0.00019, 0.062, 0.5632, 2.3748
```

where 23.7658 = temperature in degrees Celsius
0.00019 = conductivity in S/m
0.062 = pressure in dbar
0.5632 = voltage for auxiliary sensor channel 0
2.3748 = voltage for auxiliary sensor channel 1

These numbers should be reasonable; e.g., room temperature, zero conductivity, barometric pressure (gauge pressure).

7. Command the 19plus V2 to go to sleep (quiescent state) by typing **QS** and pressing the Enter key.

The 19plus V2 is ready for programming and deployment.

Section 4: Deploying and Operating SBE 19plus V2

This section includes discussions of:

Note:

Separate software manuals on CD-ROM and Help files contain detailed information on installation, setup, and use of Sea-Bird's real-time data acquisition software and data processing software.

- Sampling modes (Profiling and Moored), including example sets of commands
- Pump operation
- Real-time setup
- Timeout description
- Command descriptions
- Data output formats
- Optimizing data quality for Profiling applications
- Installing anti-foul fittings for Moored applications
- Deployment
- Acquiring real-time data with Seasave
- Recovery - physical handling and uploading data
- Processing data

Sampling Modes

Notes:

- The 19plus V2 automatically enters quiescent state after 2 minutes without receiving a command.
- Set **OutputFormat=0** if you will be using Sea-Bird's real-time data acquisition software (Seasave) to view real-time data.

The SBE 19plus V2 has two sampling modes for obtaining data:

- Profiling mode
- Moored mode

Descriptions and examples of the sampling modes follow. Note that the 19plus V2 response to each command is not shown in the examples. Review the operation of the sampling modes and the commands described in *Command Descriptions* before setting up your system.

Notes:

- 19plus V2 samples at 2 Hz when equipped with Quartz pressure sensor.
- Profiling mode is **not** compatible with a Satlantic SeaFET pH sensor or Pro-Oceanus Gas Tension Device.

Note:

Use **Stop** to:

- Stop sampling
 - Stop waiting to start sampling (after **Startlater** has been sent)
- Once **Stop** is sent, the 19plus V2 accepts all commands again.

Note:

Sea-Bird ships the 19plus V2 with **AutoRun=N** (it will not automatically start sampling when external power is applied). If you send **AutoRun=Y**:

- Send **QS** to put 19plus V2 in quiescent (sleep) state, and then turn power off and then on again to start sampling. **or**
- Send **StartNow** to start sampling.

Profiling Mode

The SBE 19plus V2 samples data at 4 Hz (one sample every 0.25 seconds), averages the data at pre-programmed intervals, stores the averaged data in its FLASH memory, and transmits the averaged data real-time. The 19plus V2 provides several methods for starting and stopping logging, depending on the settings for **IgnoreSwitch=** and **AutoRun=**:

IgnoreSwitch=	AutoRun=	To Start Logging:	To Stop Logging:
N	N	Slide magnetic switch on.	Slide magnetic switch off, or send Stop .
Y	N	Send StartNow , or StartDateTime= and StartLater .	Send Stop .
Y or N	Y	Turn on external power.	<ul style="list-style-type: none"> • Turn off external power, or • (if you want to send commands to check or modify setup) Send Stop.

Example: 19plus V2 in Profiling mode

Wake up 19plus V2. Set date and time to October 1, 2016 at 9:05 am. Initialize logging to overwrite previous data in memory. Set up with 1 voltage sensor, average every 4 samples, and output data in raw hex format. Set up with a 60-second pump turn-on delay after pump enters water, to ensure pump is primed before turning on. Set up to initiate logging with the magnetic switch. After all parameters are entered, verify setup with status command. Send power-off command.

(Click Connect in Seaterm232's Communications menu to connect and wake up.)

DATETIME=10012016090500

INITLOGGING

VOLT0=Y

NAVG=4

OUTPUTFORMAT=0

PUMPDELAY=60

IGNORESWITCH=N

GETCD (to verify setup)

QS

Start logging by putting magnetic switch in On position. Put 19plus V2 in water, and allow to soak for at least time required for pump turn-on (**PumpDelay=60**) before beginning downcast. If desired, use Seasave to view real-time data. When cast is complete, stop logging by putting magnetic switch in Off position.

Upload data in memory, in format SBE Data Processing and Seasave can use. Send power-off command.

(Click Connect in Seaterm232's Communications menu to connect and wake up.)

(Click Upload– Seaterm232 leads you through screens to define data to be uploaded and where to store it.)

QS

Moored Mode

Note:

Use **Stop** to:

- Stop autonomous sampling
- Stop waiting to start autonomous sampling (after **Startlater** has been sent)

Once **Stop** is sent, the 19plus V2 accepts all commands again.

At pre-programmed intervals, the SBE 19plus V2 wakes up, samples data, stores the data in its FLASH memory, and enters quiescent (sleep) state. The 19plus V2 goes to sleep for a minimum of 5 seconds between each sample. Logging is started with **StartNow** or **StartLater**, and is stopped with **Stop**. If real-time data is to be transmitted (**MooredTxRealTime=Y**), data is transmitted after measurements are complete for that sample and before sampling begins for the next sample.

Example: 19plus V2 in Moored mode

Wake up 19plus V2. Set date and time to October 1, 2016 at 9:05 am. Initialize logging to overwrite previous data in memory. Set up with 1 voltage sensor, take a sample every 120 seconds, take and average 4 measurements for each sample, do not transmit real-time data, and output data in raw hex format. Set up pump to run for 0.5 seconds before each sample. Set up to start logging on October 15, 2016 at 11 am. Send command to start logging at designated date and time. After all parameters are entered, verify setup with status command. Send power-off command.

(Click Connect in Seaterm232's Communications menu to connect and wake up.)

```

DATETIME=10012016090500
INITLOGGING
VOLT0=Y
SAMPLEINTERVAL=120
NCYCLES=4
MOOREDTXREALTIME=N
OUTPUTFORMAT=0
MOOREDPUMPMODE=1
STARTDATETIME=10152016110000
STARTLATER
GETCD      (to verify setup)
QS

```

Deploy 19plus V2. Logging starts automatically at programmed date and time.

Upon recovering 19plus V2, stop logging. Upload data in memory, in format SBE Data Processing can use. Send power-off command.

(Click Connect in Seaterm232's Communications menu to connect and wake up.)

```

STOP
(Click Upload – Seaterm232 leads you through screens to define data to be uploaded and where to store it.)
QS

```

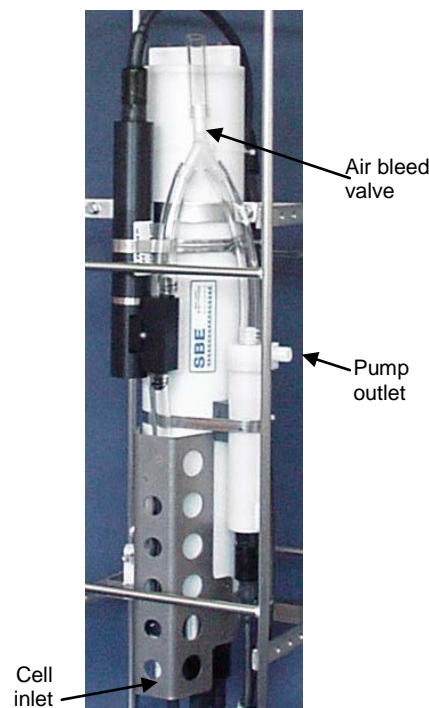
Pump Operation - General

Do not run the pump dry. The pump is water lubricated; running it without water will damage it. If briefly testing your system in dry conditions, fill the inside of the pump head with water via the pump exhaust port. This will provide enough lubrication to prevent pump damage during brief testing.

Pump Operation - Profiling Mode

Note:

The air bleed valve is used only when the 19plus V2 is deployed in a vertical orientation, as shown below. For horizontal orientation, ensure that the cell inlet and pump outlet remain below the surface for **PumpDelay=**; see horizontal schematic in *Configuration Options and Plumbing in Section 2: Description of SBE 19plus V2*.



Plumbing for Vertical Orientation
(see *Configuration Options and Plumbing* in *Section 2: Description of SBE 19plus V2* for plumbing for horizontal orientation)

After the conductivity cell enters the water, there is a user-programmable delay before pump turn-on so that all the air in the pump tubing can escape. If the pump motor turns on when there is air in the impeller housing, priming is uncertain and a proper flow rate cannot be ensured. The tubing extending above the air-bleed hole will contain a small reserve of water. This maintains the pump prime (for up to 1 minute, depending on the length of tubing above the air-bleed), even if the SBE 19plus V2 is lifted up so that the cell inlet and pump outlet are **just below** the water surface. This allows beginning the actual profile very near the top of the water. **The cell inlet and pump outlet must not come above the water surface or the prime will be lost.**

- If prime is lost: Stop logging. Wait at least 5 seconds, then start logging, submerge the 19plus V2 completely, and wait for the pump delay time before beginning the profile. (Start and stop logging with the magnetic switch, commands, or external power, depending on your setup.)

Pump turn-on occurs when two user-programmable conditions have been met:

- **Raw conductivity frequency exceeds the minimum conductivity frequency (MinCondFreq=)**
Set the minimum conductivity frequency for pump turn-on above the instrument's *zero conductivity raw frequency* (shown on the 19plus V2 Configuration Sheet), to prevent the pump from turning on when the 19plus V2 is in air.
 - For salt water and estuarine applications:
typical value = *zero conductivity raw frequency* + 500 Hz
 - For fresh/nearly fresh water:
typical value = *zero conductivity raw frequency* + 5 Hz
 If the minimum conductivity frequency is too close to the *zero conductivity raw frequency*, the pump may turn on when the 19plus V2 is in air, as a result of small drifts in the electronics. Some experimentation may be required, and in some cases it may be necessary to rely only on the pump turn-on delay time to control the pump. If so, set a minimum conductivity frequency lower than the *zero conductivity raw frequency*.
- **Pump turn-on delay time has elapsed (PumpDelay=)**
Set the pump turn-on delay time to allow time for the Tygon tubing and pump to fill with water after the 19plus V2 is submerged. Determine the turn-on delay by immersing the 19plus V2 (switch off, not running) just below the air-bleed hole at the top of the Tygon tubing. Measure the time needed to completely fill the tubing (by watching for when air bubbles stop coming out of the air bleed valve); 30 seconds is typical. Set the delay to approximately 1.5 times longer. When actually using the 19plus V2, be sure to *soak* the instrument just under the surface for at least the time required for pump turn-on.

Pump turn-off occurs when the conductivity frequency drops below **MinCondFreq=**.

Pump Operation - Moored Mode

Pump operation is governed by two user-programmable parameters:

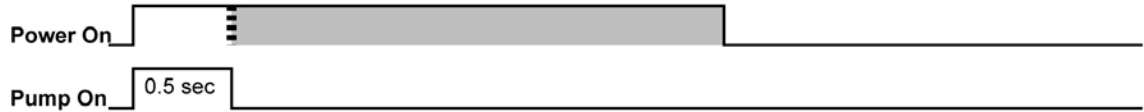
- MooredPumpMode=0, 1, or 2**
 The 19plus V2 can be set up to operate with no pump (0), with the pump running for 0.5 seconds before each sample (1), or with the pump running during each sample (2).
- DelayBeforeSampling=**
 The 19plus V2 can be set up to delay sampling after turning on external voltage and RS-232 sensors. Some instruments require time to equilibrate or stabilize after power is applied, to provide good quality data. WET Labs sensors with bio-wipers require time to allow the bio-wiper to open.
- DelayAfterSampling=**
 19plus V2 can be set up to delay turning off power to the pump and external voltage and RS-232 sensors. WET Labs sensors with bio-wipers require time to shut the bio-wiper after sampling is completed.

These parameters interact in the operation of the pump, as shown below. Recommendations for settings are provided on the next page.

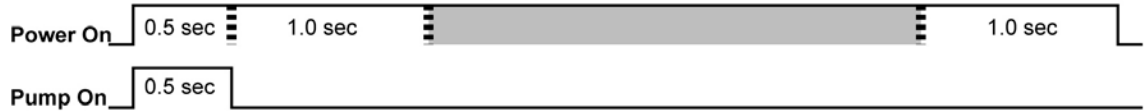
MooredPumpMode=0
DelayBeforeSampling=0 (sec)



MooredPumpMode=1
DelayBeforeSampling=0 (sec), DelayAfterSampling= 0 (sec)



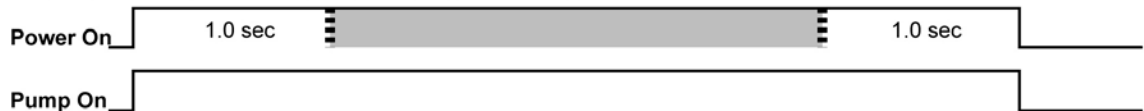
MooredPumpMode=1
DelayBeforeSampling=1 (sec), DelayAfterSampling=1 (sec)



MooredPumpMode=2
DelayBeforeSampling=0 (sec), DelayAfterSampling=0 (sec)



MooredPumpMode=2
DelayBeforeSampling=1 (sec), DelayAfterSampling=1 (sec)



= sampling time (≥ 2.5 seconds)

Note: Sampling time includes time for instrument to warm up as well as time to measure parameters. The 2.5 sec sampling time is for 19plus V2 with strain gauge pressure sensor, and 1 measurement/sample (NCycles=1). See Specifications in Section 2: Description of SBE 19plus V2 for sampling times for other setups.

Moored Mode Pump Setting Recommendations

Note:

DelayAfterSampling= is typically set to a non-zero value only if using a WET Labs sensor with a bio-wiper.

Sea-Bird provides the following recommendations for pump settings. Note that longer pump times increase power usage, reducing battery endurance. See *Battery Endurance* in *Section 2: Description of SBE 19plus V2* for sample battery endurance calculations.

Pump through Conductivity Cell Only (SBE 5M, 5P, or 5T pump)

For most deployments, set **MooredPumpMode=1** and **DelayBeforeSampling=0**. The pump operates for 0.5 sec before the conductivity measurement is made, providing enough time to ventilate the cell and 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 pump for a longer period of time, to eliminate any cell thermal mass effects on the measurement. In this case, set **MooredPumpMode=2** and set **DelayBeforeSampling=** to a non-zero value, providing additional ventilation time (allowing the conductivity cell temperature to equilibrate to the water temperature) before taking the measurement.

Pump through Conductivity Cell and SBE 43 Dissolved Oxygen Sensor (requires SBE 5P or 5T pump)

Set **MooredPumpMode=2**.

As the pump brings new water into the SBE 43 plenum, time is required for the sensor to equilibrate to the new oxygen level. The time required is dependent on the sensor's membrane thickness and on the water temperature. Prior to 2007, all SBE 43s had a 0.5 mil thick membrane. In 2007, Sea-Bird began offering two membrane thicknesses – 0.5 mil (faster response, typically for profiling applications) and 1.0 mil (slower response but more durable, typically for moored applications).

- **0.5 mil thick** membrane – Recommended **DelayBeforeSampling=** varies in a non-linear fashion, from 15 sec at 15 °C to 30 sec at 0 °C.
- **1.0 mil thick** membrane – Recommended **DelayBeforeSampling=** varies in a non-linear fashion, from 25 sec at 15 °C to 40 sec at 0 °C.

Note:

See *Application Note 64: SBE 43 Dissolved Oxygen Sensor – Background Information, Deployment Recommendations, and Cleaning and Storage* for the response time curves.

Note:

See the *SBE 63 manual*.

Pump through Conductivity Cell and SBE 63 Optical Dissolved Oxygen Sensor (requires SBE 5P or 5T pump)

Set **MooredPumpMode=2**.

As the pump brings new water into the SBE 63 plenum, time is required for the sensor to equilibrate to the new oxygen level. The time required is dependent on the water temperature. Recommended **DelayBeforeSampling=** varies in a linear fashion, from 25 sec at 15 °C to 40 sec at 0 °C.

Pump through Conductivity Cell and Beckman- or YSI-type Dissolved Oxygen Sensor

Set **MooredPumpMode=2**.

Set **DelayBeforeSampling=** to 120 to 180 sec, allowing time for the oxygen sensor to polarize before taking the measurement.

Pump through Conductivity Cell and Satlantic SeaFET pH Sensor

Set **MooredPumpMode=2**.

As the pump brings new water into the SeaFET, time is required for the sensor to equilibrate to the new pH level. Set **DelayBeforeSampling=** to 30 sec.

Real-Time Setup

Notes:

- See *External Power* in *Section 2: Description of SBE 19plus V2* for cable wiring on the ship.
- Set baud rate with **BaudRate=**.
- Set data storage and real-time output rate with **NAvg=** (Profiling Mode) or **SampleInterval=** (Moored Mode).
- Include auxiliary A/D sensors in the data stream with **VoltN=** commands. Include auxiliary RS-232 sensors in the data stream with **SBE38=**, **GTD=**, or **DualGTD=** commands.
- Set output format with **OutputFormat=**.
- Real-time data is automatically output in Profiling Mode. In Moored Mode, set **MooredTxRealTime=Y** to output real-time data.
- If using external power, see *External Power* in *Section 2: Description of SBE 19plus V2* for power limitations on cable length.

Baud Rate and Cable Length

Without a Sea-Bird Deck Unit

The rate that real-time data can be transmitted from the SBE 19plus V2 is dependent on the amount of data to be transmitted per scan and the serial data baud rate:

$$\text{Time required to transmit data} = \frac{\text{(number of characters * 10 bits/character)}}{\text{baud rate}}$$

where

Number of characters is dependent on the included data and output format (see *Data Output Formats*).

Add 2 to the number of characters shown in the output format, to account for the carriage return and line feed at the end of each scan.

For decimal output (**OutputFormat=2, 3, or 5**), include decimal points, commas, and spaces when counting the number of characters.

In Profiling Mode, the time required to transmit data must be less than the real-time output rate. In Moored Mode, the time required to transmit data plus the time required to make the measurements must be less than the (interval between samples – 5 seconds) for Autonomous Sampling, because the 19plus V2 goes to sleep for a minimum of 5 seconds between each sample.

The length of cable that the 19plus V2 can drive is also dependent on the baud rate. The allowable combinations are:

Maximum Cable Length (meters)	1600	800	400	200	100	50	25	16	8
Maximum Baud Rate*	600	1200	2400	4800	9600	19200	38400	57600	115200

* Check capability of your computer and terminal program before increasing baud rate; high baud rates require a short cable and good PC serial port with accurate clock.

Example 1 - 19plus V2 without a Deck Unit. Profiling Mode, strain-gauge pressure, configured with 2 external voltages. What is the fastest rate you can transmit real-time data over 800 m with **OutputFormat=0 (raw hexadecimal data)?**

With 800 meters of cable and no Deck Unit, the 19plus V2 requires a baud rate of 1200 or less.

Number of characters for **OutputFormat=0** (from *Data Output Formats*) =

$$6 \text{ (T)} + 6 \text{ (C)} + 6 \text{ (P)} + 4 \text{ (P temperature compensation)} + 2 * 4 \text{ (external voltages)} + 2 \text{ (carriage return \& line feed)} = 32$$

Time required to transmit data = (32 characters * 10 bits/character) / 1200 =

$$0.267 \text{ seconds} > 0.25 \text{ seconds (4 Hz, maximum sampling rate).}$$

Therefore, set **NAvg=2**, averaging 2 measurements/sample and storing and transmitting 1 sample every 0.5 seconds.

Example 2 - 19plus V2 without a Deck Unit. Moored Mode, strain-gauge pressure, configured with 4 external voltages, 10 measurements/sample (NCycles=10**), pump running during sampling (**MooredPumpMode=2**), and a 15-second delay before sampling (**DelayBeforeSampling=15**). What is the smallest sample interval you can use if you want to transmit real-time data over 800 m with **OutputFormat=0** (raw hexadecimal data)?**

With 800 meters of cable, the 19plus V2 requires a baud rate of 1200 or less.

Number of characters for **OutputFormat=0** (from *Data Output Formats*) =

$$6 \text{ (T)} + 6 \text{ (C)} + 6 \text{ (P)} + 4 \text{ (P temperature compensation)} + 4 * 4 \text{ (external voltages)} + 8 \text{ (time)} + 2 \text{ (carriage return \& line feed)} = 48$$

Time required to transmit data = (48 characters * 10 bits/character) / 1200 = 0.4 seconds

Minimum time required for each sample =

$$15 \text{ seconds (delay after turning on power)} + 2.5 \text{ second sampling time} + [(10-1) * 0.25 \text{ seconds}] +$$

$$0.4 \text{ seconds to transmit real-time} + 5 \text{ seconds to go to sleep between samples} = 25.15 \text{ seconds, round up to 27}$$

Therefore, set **SampleInterval=27**, storing and transmitting one sample every 27 seconds.

With a Sea-Bird Deck Unit

Set the 19plus V2 baud rate to 4800 if using the 19plus V2 with either of the following real-time data acquisition systems:

- 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 Carousel Deck Unit and SBE 55 ECO Water Sampler

The data telemetry link can drive 10,000 meters of cable while accepting 4800 baud serial data. The relationship between transmission rate, amount of data transmitted, and baud rate is as described above for a 19plus V2 without a Deck Unit.

*Example - 19plus V2 with an SBE 33 or 36 Deck Unit. Profiling Mode, strain-gauge pressure, configured with 2 external voltages. What is the fastest rate you can transmit data with **OutputFormat=0** (raw hexadecimal data)?*

With a Deck Unit, the 19plus V2 requires a baud rate of 4800.

Number of characters (from *Data Output Formats*) =

6 (T) + 6 (C) + 6 (P) + 4 (P temperature compensation) + 2*4 (external voltages) + 2 (carriage return & line feed) = 32

Time required to transmit data = (32 characters * 10 bits/character) / 4800 =

0.067 seconds < 0.25 seconds (4 Hz, maximum sampling rate).

Therefore, set **NAvg=1**, providing 4 Hz data (one sample every 0.25 seconds) for this configuration.

Real-Time Data Acquisition

Note:

If the FLASH memory is filled to capacity, data sampling and transmission of real-time data (if programmed) continue, but excess data is not saved in memory.

Real-time data can be acquired in either of the following ways:

- With Seasave (**typical method**) – When the 19plus V2 is set up for Profiling Mode or Autonomous Sampling Moored Mode, data can be viewed in Seasave in tabular form or as plots, as raw data or as converted (engineering units) data. Data acquired with Seasave can be processed with SBE Data Processing. See Seasave's Help files for details on setting up the program displays, baud rates, etc., and beginning data acquisition.
- With Seaterm232 – Click the Capture menu; enter the desired file name in the dialog box, and click Save. Begin logging. The data displayed in Seaterm232 will be saved to the designated file. Process the data as desired. Note that this file **cannot be processed by SBE Data Processing or displayed in Seasave, as it does not have the required headers and format for Sea-Bird's processing software.**

Timeout Description

The SBE 19plus V2 has a timeout algorithm. If the 19plus V2 does not receive a command or sample data for 2 minutes, it powers down its main digital circuits. This places the 19plus V2 in quiescent state, drawing minimal current. **To re-establish control (wake up), click Connect in Seaterm232's Communications menu or press the Enter key.**

Command Descriptions

This section describes commands and provides sample outputs.
See *Appendix III: Command Summary* for a summarized command list.

When entering commands:

- Input commands to the 19plus V2 in upper or lower case letters and register commands by pressing the Enter key.
- The 19plus V2 sends an error message if an invalid command is entered.
- (if **OutputExecutedTag=N**) If the 19plus V2 does not return an S> prompt after executing a command, press the Enter key to get the S> prompt.
- If a new command is not received within 2 minutes after the completion of a command, the 19plus V2 returns to the quiescent (sleep) state.
- If in quiescent state, re-establish communications by selecting *Connect* in Seaterm232's Communications menu or pressing the Enter key.
- If the 19plus V2 is transmitting data and you want to stop it, press the Esc key or type ^C. Then press the Enter key. Alternatively, select *Abort* in Seaterm232's Command menu.
- Commands to enable a parameter or output (such as enabling a voltage channel) can be entered with the *argument* as Y or 1 for yes, and N or 0 for no (for example, **Volt0=y** and **Volt0=1** are equivalent; both enable voltage channel 0).
- The 19plus V2 cannot have samples with different scan lengths (more or fewer data fields per sample) in memory. If the scan length is changed by commanding it to add or subtract a data field (such as an external voltage), the 19plus V2 must initialize logging. Initializing logging sets the sample number and cast number to 0, so the entire memory is available for recording data with the new scan length. **Initializing logging should only be performed after all previous data has been uploaded.** Therefore, commands that change the scan length (**MM**, **MP**, **PType=**, **Volt0=**, **Volt1=**, **Volt2=**, **Volt3=**, **Volt4=**, **Volt5=**, **SBE63=**, **SBE38=**, **WetLabs=**, **SeaFET=**, **GTD=**, **DualGTD=**, **Optode=**) prompt the user for verification before executing, to prevent accidental overwriting of existing data.
- The 19plus V2 responds only to **GetCD**, **GetSD**, **GetCC**, **GetEC**, **ResetEC**, **GetHD**, **DS**, **DCal**, **TS**, **SL**, **SLT**, **GetLastSamples:x**, **QS**, and **Stop** while logging. If you wake the 19plus V2 while it is logging (for example, to send **DS** to check on logging progress), it temporarily stops logging. In Moored mode, logging resumes when it goes to sleep (either by sending **QS** or after the 2-minute timeout). In Profiling mode, logging resumes immediately.
- The 19plus V2 responds only to **GetCD**, **GetSD**, **GetCC**, **GetEC**, **ResetEC**, **GetHD**, **DS**, **DCal**, **TS**, **SL**, **SLT**, **GetLastSamples:x**, **QS**, and **Stop** while *waiting to start logging* (if you sent **StartLater** but logging has not started yet). To send any other commands, send **Stop**, send the desired commands to modify the setup, and then send **StartLater** again.

Note:

In **Profiling** mode, the 19plus V2 does **not** respond to **TS**, **SL**, **SLT**, or **GetLastSamples:x** while logging or waiting to start logging.

Entries made with the commands are permanently stored in the 19plus V2 and remain in effect until you change them.

- The only exception occurs if the electronics are removed from the housing and disconnected from the battery Molex connector (see *Appendix II: Electronics Disassembly/Reassembly*). Upon reassembly, reset the date and time (**DateTime=**) and initialize logging (**InitLogging**).

Status Commands

Notes:

- **GetCD** output does not include calibration coefficients. To display calibration coefficients, use the **GetCC** command.
- The **DS** response contains similar information as the combined responses from **GetSD** and **GetCD**, but in a different format.

GetCD

Get and display configuration data, which includes all parameters related to setup of 19plus V2, including communication settings and sampling settings. Most of these parameters can be user-input/modified. List below includes, where applicable, command used to modify parameter:

- Device type, Serial number
- Profiling mode [**MP**]:
 - Number of scans to average [**NAvg**=]
 - Minimum conductivity frequency for pump turn-on [**MinCondFreq**=]
 - Pump turn-on delay [**PumpDelay**=]
 - Begin logging automatically when external power applied [**AutoRun**=]?
 - Ignore magnetic switch position for starting/stopping logging [**IgnoreSwitch**=]?
- Moored mode [**MM**]:
 - Sample interval [**SampleInterval**=]
 - Number of measurements to take and average per sample [**NCycles**=]
 - Pump turn-on parameter [**MooredPumpMode**=]
 - Turn-on delay [**DelayBeforeSampling**=]
 - Turn-off delay [**DelayAfterSampling**=]
 - Transmit data real-time? [**MooredTxRealTime**=]
- Battery type [**BatteryType**=] and cut-off voltage
- Sample external voltages 0, 1, 2, 3, 4, and 5? [**Volt0**= through **Volt5**=]
- Sample SBE 38 secondary temperature sensor [**SBE38**=]
- Sample WET Labs RS-232 sensor [**WetLabs**=]?
- Sample Optode [**Optode**=]?
- Sample SBE 63 optical dissolved oxygen sensor [**SBE63**=]?
- Sample Satlantic SeaFET pH sensor [**SeaFET**=]?
- Sample Gas Tension Device [**GTD**=], or dual Gas Tension Devices [**DualGTD**=]?
- Enable echoing? [**Echo**=]
- Output Executing and Executed tags? [**OutputExecutedTag**=]
- Output format [**OutputFormat**=]
- Output salinity? [**OutputSal**=]
(only appears if output format = converted decimal or converted XML UVIC)
- Output sound velocity? [**OutputSV**=]
(only appears if output format = converted decimal or converted XML UVIC)
- Output sigma-t, voltage, and current with each sample? [**OutputUCSD**=]
(only appears if output format = converted decimal or converted XML UVIC)

Status Commands *(continued)*

*Example: 19plus V2 in **Profiling** mode (user input in bold, command used to modify parameter in parentheses)*

getcd

```

<ConfigurationData DeviceType='SBE19plus' SerialNumber='01906003'>
  <ProfileMode>
    <ScansToAverage>1</ScansToAverage>
    <MinimumCondFreq>3000</MinimumCondFreq>
    <PumpDelay>60</PumpDelay>
    <AutoRun>no</AutoRun>
    <IgnoreSwitch>no</IgnoreSwitch>
  </ProfileMode>
  <Battery>
    <Type>alkaline</Type>
    <CutOff>7.5</CutOff>
  </Battery>
  <DataChannels>
    <ExtVolt0>yes</ExtVolt0>
    <ExtVolt1>no</ExtVolt1>
    <ExtVolt2>no</ExtVolt2>
    <ExtVolt3>yes</ExtVolt3>
    <ExtVolt4>no</ExtVolt4>
    <ExtVolt5>no</ExtVolt5>
    <SBE38>no</SBE38>
    <WETLABS>no</WETLABS>
    <OPTODE>no</OPTODE>
    <SBE63>no</SBE63>
    <SeaFET>no</SeaFET>
    <GTD>no</GTD>
  </DataChannels>
  <EchoCharacters>yes</EchoCharacters>
  <OutputExecutedTag>no</OutputExecutedTag>
  <OutputFormat>converted decimal</OutputFormat>
  <OutputSalinity>no</OutputSalinity>
  <OutputSoundVelocity>no</OutputSoundVelocity>
  <OutputSigmaT_V>no</OutputSigmaT_V>
</ConfigurationData>

```

[MP]
 [NAvg=]
 [MinCondFreq=]
 [PumpDelay=]
 [AutoRun=]
 [IgnoreSwitch=]
 [BatteryType=]
 [Volt0=]
 [Volt1=]
 [Volt2=]
 [Volt3=]
 [Volt4=]
 [Volt5=]
 [SBE38=]
 [WetLabs=]
 [Optode=]
 [SBE63=]
 [SeaFET=]
 [GTD= or DualGTD=]
 [Echo=]
 [OutputExecutedTag=]
 [OutputFormat=]
 [OutputSal=]
 [OutputSV=]
 [OutputUCSD=]

Status Commands *(continued)*

*Example: 19plus V2 in **Moored** mode, with strain-gauge pressure sensor (user input in bold, command used to modify parameter in parentheses)*

getcd

```

<ConfigurationData DeviceType='SBE19plus' SerialNumber='01906003'>
  <MooredMode>
    <SampleInterval>15</SampleInterval>
    <MeasurementsPerSample>1</MeasurementsPerSample>
    <Pump>run pump during sample</Pump>
    <DelayBeforeSampling>0.0</DelayBeforeSampling>
    <DelayAfterSampling>0.0</DelayAfterSampling>
    <TransmitRealTime>no</TransmitRealTime>
  </MooredMode>
  <Battery>
    <Type>alkaline</Type>
    <CutOff>7.5</CutOff>
  </Battery>
  <DataChannels>
    <ExtVolt0>yes</ExtVolt0>
    <ExtVolt1>no</ExtVolt1>
    <ExtVolt2>no</ExtVolt2>
    <ExtVolt3>yes</ExtVolt3>
    <ExtVolt4>no</ExtVolt4>
    <ExtVolt5>no</ExtVolt5>
    <SBE38>no</SBE38>
    <WETLABS>no</WETLABS>
    <OPTODE>no</OPTODE>
    <SBE63>no</SBE63>
    <SeaFET>no</SeaFET>
    <GTD>no</GTD>
  </DataChannels>
  <EchoCharacters>yes</EchoCharacters>
  <OutputExecutedTag>no</OutputExecutedTag>
  <OutputFormat>converted decimal</OutputFormat>
  <OutputSalinity>no</OutputSalinity>
  <OutputSoundVelocity>no</OutputSoundVelocity>
  <OutputSigmaT_V_I>no</OutputSigmaT_V_I>
</ConfigurationData>

```

[MM]
 [SampleInterval=]
 [NCycles=]
 [MooredPumpMode=]
 [DelayBeforeSampling=]
 [DelayAfterSampling=]
 [MooredTxRealTime=]

 [BatteryType=]

 [Volt0=]
 [Volt1=]
 [Volt2=]
 [Volt3=]
 [Volt4=]
 [Volt5=]
 [SBE38=]
 [WetLabs=]
 [Optode=]
 [SBE63=]
 [SeaFET=]
 [GTD= or DualGTD=]

 [Echo=]
 [OutputExecutedTag=]
 [OutputFormat=]
 [OutputSal=]
 [OutputSV=]
 [OutputUCSD=]

Status Commands (*continued*)**Notes:**

- The **DS** response contains similar information as the combined responses from **GetSD** and **GetCD**, but in a different format.
- Sending **GetSD** causes the pump to turn on for a moment, so that the 19plus V2 can measure and output the pump current. Because the pump is designed to be water lubricated, you will hear a noise when the impeller spins in air. Running the pump *dry* for such a **short** time will not harm the pump.
- In the example below, only voltage channel 0 is enabled, so external voltage current iext2345= (for channels 2, 3, 4, and 5) is not shown.
- In the example below, no RS-232 sensor is enabled, so RS-232 sensor current iserial= is not shown.
- If the 19plus V2 is set up with a WET Labs sensor with Bio-Wiper (**Biowiper=Y**) and if **OutputExecutedTag=Y**, the **GetSD** response shows: <Executing/> to allow time for the Bio-Wiper to close before it measures the enabled external voltage currents.

GetSD

Get and display status data, which contains data that changes while deployed. List below includes, where applicable, command used to modify parameter:

- Device type, Serial number
- Date and time [**DateTime=**] in ISO8601-2000 extended format (yyyy-mm-ddThh:mm:ss)
- Logging status (not logging, logging, waiting to start at . . ., or unknown status)
- Number of recorded events in event counter [reset with **ResetEC**]
- Voltages and currents -
 - Main battery voltage
 - Back-up lithium battery voltage
 - Operating current
 - Pump current
 - External voltage sensor current (channels 0 and 1) – displays only if 1 or more channels enabled
 - External voltage sensor current (channels 2, 3, 4, and 5) – displays only if 1 or more channels enabled
 - RS-232 sensor current – displays only if channel enabled
- Memory - [reset with **InitLogging**]
 - Number of bytes in memory
 - Number of samples in memory
 - Number of additional samples that can be placed in memory
 - Length (number of bytes) of each sample
 - Number of casts in memory if in Profiling mode

Example: Send **GetSD** to 19plus V2 (user input in bold, command used to modify parameter in parentheses)

get.sd

```
<StatusData DeviceType = 'SBE19plus' SerialNumber = '01906003'>
  <DateTime>2016-03-05T10:53:03</DateTime>                                [DateTime=]
  <LoggingState>not logging</LoggingState>
  <EventSummary numEvents = '0' />                                     [can clear with ResetEC]
  <Power>
    <vMain>10.1</vMain>
    <vLith>8.9</vLith>
    <iMain>61.9</iMain>
    <iPump>20.6</iPump>
    <iExt01>67.2</iExt01>
  </Power>
  <MemorySummary>
    <Bytes>150</Bytes>                                                [can clear with InitLogging]
    <Samples>10</Samples>                                           [can clear with InitLogging]
    <SamplesFree>4386532</SamplesFree>                               [can clear with InitLogging]
    <SampleLength>15</SampleLength>
    <Profiles>1</Profiles>                                          [can clear with InitLogging]
  </MemorySummary>
</StatusData>
```

Notes:

- **DCal** and **GetCC** responses contain similar information, but in different formats.
- Dates shown are when calibrations were performed.

Status Commands (*continued*)**GetCC**

Get and display calibration coefficients, which are initially factory-set and should agree with Calibration Certificates shipped with 19plus V2.

Example: 19plus V2 with strain-gauge pressure sensor (user input in bold, command used to modify coefficient in parentheses)

getcc

```

<CalibrationCoefficients DeviceType = 'SBE19plus' SerialNumber = '01906003'>
  <Calibration format = 'TEMP1' id = 'Main Temperature'>
    <SerialNum>01906003</SerialNum>
    <CalDate>19-Nov-15</CalDate> [TCalDate=]
    <TA0>1.155787e-03</TA0> [TA0=]
    <TA1>2.725208e-04</TA1> [TA1=]
    <TA2>-7.526811e-07</TA2> [TA2=]
    <TA3>1.716270e-07</TA3> [TA3=]
    <TOFFSET>0.000000e+00</TOFFSET> [TOffset=]
  </Calibration>
  <Calibration format = 'WBCOND0' id = 'Main Conductivity'>
    <SerialNum>01906003</SerialNum>
    <CalDate>19-Nov-15</CalDate> [CCalDate=]
    <G>-1.006192e+00</G> [CG=]
    <H>1.310565e-01</H> [CH=]
    <I>-2.437852e-04</I> [CI=]
    <J>3.490353e-05</J> [CJ=]
    <CPCOR>-9.570000e-08</CPCOR> [CPCor=]
    <CTCOR>3.250000e-06</CTCOR> [CTCor=]
    <CSLOPE>1.000000e+00</CSLOPE> [CSlope=]
  </Calibration>
  <Calibration format = 'STRAIN0' id = 'Main Pressure'>
    <SerialNum>10178581</SerialNum>
    <CalDate>11-Feb-16</CalDate> [PCalDate=]
    <PA0>7.600861e-02</PA0> [PA0=]
    <PA1>1.546746e-03</PA1> [PA1=]
    <PA2>6.195891e-12</PA2> [PA2=]
    <PTCA0>5.246582e+05</PTCA0> [PTCA0=]
    <PTCA1>3.954062e+00</PTCA1> [PTCA1=]
    <PTCA2>-7.760881e-02</PTCA2> [PTCA2=]
    <PTCB0>2.508687e+01</PTCB0> [PTCB0=]
    <PTCB1>1.750000e-04</PTCB1> [PTCB1=]
    <PTCB2>0.000000e+00</PTCB2> [PTCB2=]
    <PTEMPA0>-5.910866e+01</PTEMPA0> [PTempA0=]
    <PTEMPA1>5.332183e+01</PTEMPA1> [PTempA1=]
    <PTEMPA2>-4.048740e-01</PTEMPA2> [PTempA2=]
    <POFFSET>0.000000e+00</POFFSET> [POffset= (decibars)]
    <PRANGE>5.080000e+02</PRANGE> [PRange= (psia); factory set]
  </Calibration>
  <Calibration format = 'VOLT0' id = 'Volt 0'>
    <OFFSET>0.000000e+00</OFFSET> [factory set]
    <SLOPE>1.260977e+00</SLOPE> [factory set]
  </Calibration>
  <Calibration format = 'VOLT0' id = 'Volt 1'>
    <OFFSET>-4.728750e-02</OFFSET> [factory set]
    <SLOPE>1.259474e+00</SLOPE> [factory set]
  </Calibration>
  <Calibration format = 'VOLT0' id = 'Volt 2'>
    <OFFSET>-4.715313e-02</OFFSET> [factory set]
    <SLOPE>1.259946e+00</SLOPE> [factory set]
  </Calibration>
  <Calibration format = 'VOLT0' id = 'Volt 3'>
    <OFFSET>-4.772396e-02</OFFSET> [factory set]
    <SLOPE>1.260486e+00</SLOPE> [factory set]
  </Calibration>
  <Calibration format = 'VOLT0' id = 'Volt 4'>
    <OFFSET>-4.765417e-02</OFFSET> [factory set]
    <SLOPE>1.260014e+00</SLOPE> [factory set]
  </Calibration>
  <Calibration format = 'VOLT0' id = 'Volt 5'>
    <OFFSET>-4.744167e-02</OFFSET> [factory set]
    <SLOPE>1.260255e+00</SLOPE> [factory set]
  </Calibration>
  <Calibration format = 'FREQ0' id = 'external frequency channel'>
    <EXTFREQSF>1.000000e+00</EXTFREQSF> [factory set]
  </Calibration>
</CalibrationCoefficients>

```

Status Commands (*continued*)

GetEC

Get and display event counter data, which can help to identify root cause of a malfunction. Event counter records number of occurrences of common timeouts, power-on resets, etc. Can be cleared with **ResetEC**. Possible events that may be logged include:

- Power fail – main batteries and/or external voltage below voltage cutoff
- EEPROM read or EEPROM write – all power removed (main batteries removed, and back-up lithium batteries are dead)
- Alarm short – woke up 19plus V2 to send a command while logging in Moored mode
- Alarm long – sent **StartLater**, but **StartDateTime**= is more than 1 month in future
- AD7730 timeout – response from temperature and pressure A/D converter delayed; typically if woke up to send a command while logging in Moored mode
- AD7714 timeout – response from voltage channel A/D converter delayed; typically if woke up to send a command while logging in Moored mode
- FLASH out of memory – all available memory space is used; autonomous sampling continues, but no additional data written to FLASH (does not overwrite)
- FLASH correctable error – single bit error in a page, corrects itself, does not affect data
- FLASH ECC error – does not affect data
- FLASH timeout – problem with FLASH
- FLASH ready – problem with FLASH; timeout error
- FLASH erase failed – problem with FLASH
- FLASH write failed – problem with FLASH
- FLASH uncorrectable – problem with FLASH; 2 or more bits of errors in a page
- FLASH block overrun – problem with FLASH
- New bad block – problem with FLASH; FLASH write or erase failed, or a FLASH uncorrectable error

Example: (user input in bold, command used to modify parameter in parentheses)

getec

```
<EventCounters DeviceType = 'SBE19plus' SerialNumber = '01906003'>
```

```
  <EventSummary numEvents = '1' />
```

[can clear with **ResetEC**]

```
  <Event type='alarm short' count='1' />
```

```
</EventCounters>
```

ResetEC

Delete all events in event counter (number of events displays in **GetSD** response, and event details display in **GetEC** response).

Status Commands (continued)**GetHD**

Get and display hardware data, which is fixed data describing 19plus V2:

- Device type, Serial number
- Manufacturer
- Firmware version
- Firmware date
- Command set version
- PCB serial number and assembly number
- Manufacture date
- Internal sensor types and serial numbers
- External voltage sensor types (DO, fluorometer, etc.) and serial numbers
- External RS-232 sensor types (SBE 63, SBE 38, WET Labs, SeaFET, etc.) and serial numbers

Note:

External sensor types and serial numbers can be changed in the field, to accommodate changes in auxiliary sensors cabled to the 19plus V2. Other hardware data is typically not changed by the user.

Example: (user input in bold, command used to modify parameter in parentheses)

gethd

```

<HardwareData DeviceType = 'SBE19plus' SerialNumber = '01906003'>
  <Manufacturer>Sea-Bird Electronics, Inc.</Manufacturer>
  <FirmwareVersion>3.1.8</FirmwareVersion>
  <FirmwareDate>Mar 9 2016 16:22:00</FirmwareDate>
  <CommandSetVersion>1.4</CommandSetVersion>
  <PCBAssembly PCBSerialNum = 'not assigned' AssemblyNum = '41054F' />
  <PCBAssembly PCBSerialNum = 'not assigned' AssemblyNum = '41580' />
  <PCBAssembly PCBSerialNum = 'not assigned' AssemblyNum = '41056E' />
  <PCBAssembly PCBSerialNum = 'not assigned' AssemblyNum = '41059D' />
  <MfgDate>03 dec 2015</MfgDate>
  <InternalSensors>
    <Sensor id = 'Main Temperature'>
      <type>temperature0</type>
      <SerialNumber>01906003</SerialNumber>
    </Sensor>
    <Sensor id = 'Main Conductivity'>
      <type>conductivity-0</type>
      <SerialNumber>01906003</SerialNumber>
    </Sensor>
    <Sensor id = 'Main Pressure'>
      <type>strain-0</type>
      <SerialNumber>2580011</SerialNumber>
    </Sensor>
  </InternalSensors>
  <ExternalSensors>
    <Sensor id = 'volt 0'>
      <type>not assigned</type>
      <SerialNumber>not assigned</SerialNumber>
    </Sensor>
    <Sensor id = 'volt 1'>
      <type>not assigned</type>
      <SerialNumber>not assigned</SerialNumber>
    </Sensor>
    <Sensor id = 'volt 2'>
      <type>not assigned</type>
      <SerialNumber>not assigned</SerialNumber>
    </Sensor>
    <Sensor id = 'volt 3'>
      <type>not assigned</type>
      <SerialNumber>not assigned</SerialNumber>
    </Sensor>
    <Sensor id = 'volt 4'>
      <type>not assigned</type>
      <SerialNumber>not assigned</SerialNumber>
    </Sensor>
    <Sensor id = 'volt 5'>
      <type>not assigned</type>
      <SerialNumber>hi there</SerialNumber>
    </Sensor>
    <Sensor id = 'serial'>
      <type>not assigned</type>
      <SerialNumber> not assigned </SerialNumber>
    </Sensor>
  </ExternalSensors>
</HardwareData>

```

Status Commands (*continued*)

Notes:

- The **DS** response contains similar information as the combined responses from **GetSD** and **GetCD**, but in a different format.
- Sending **DS** causes the pump to turn on for a moment, so that the 19plus V2 can measure and output the pump current. Because the pump is designed to be water lubricated, you will hear a noise when the impeller spins in air. Running the pump *dry* for such a **short** time will not harm the pump.
- In the examples below, only voltage channel 0 is enabled, so external voltage current `ixt2345=` (for channels 2, 3, 4, and 5) is not shown.
- In the examples below, no RS-232 sensor is enabled, so RS-232 sensor current `iserial=` is not shown.
- If the 19plus V2 is set up for dual GTDs, the **DS** response shows:
Dual Gas Tension Device = Yes
- If the 19plus V2 is set up with a WET Labs sensor with Bio-Wiper (**Biowiper=Y**), the **DS** response shows:
wait
4 seconds for biowiper to
close before it measures the
enabled external voltage currents.

DS

Get and display operating status and setup, which vary depending on whether in Profiling or Moored mode.

List below includes, where applicable, command used to modify parameter.

Profiling Mode (MP)

- Firmware version, serial number, date and time [**DateTime=**]
- Voltages and currents (main and back-up lithium battery voltages, currents – operating, pump, external voltage sensors, RS-232 sensor)
- Logging status (not logging, logging, waiting to start at . . ., or unknown status)
- Number of scans to average [**NAvg=**]
- Number of samples, sample space, and number of casts in memory
- Profiling mode [**MP**], minimum conductivity frequency for pump turn-on [**MinCondFreq=**], and pump turn-on delay [**PumpDelay=**]
- Begin logging automatically when external power applied [**AutoRun=**]?
Ignore magnetic switch position for starting/stopping logging [**IgnoreSwitch=**]?
- Battery type [**BatteryType=**] and cut-off voltage
- Pressure type [**PType=**] and range [**PRange=**]; factory set
- Sample RS-232 sensor –SBE 38 secondary temperature sensor [**SBE38=**], WET Labs [**WetLabs=**], Optode [**Optode=**], SBE 63 optical dissolved oxygen sensor [**SBE63=**], Satlantic SeaFET pH sensor [**SeaFET=**], Gas Tension Device [**GTD=**], or dual Gas Tension Devices [**DualGTD=**]?
- Sample external voltages 0, 1, 2, 3, 4, and 5 [**Volt0=** through **Volt5=**]?
- Show entered commands as you type [**Echo=**]?
- Output format [**OutputFormat=**]
- Output salinity [**OutputSal=**] and sound velocity [**OutputSV=**] with each sample? (only if output format = converted decimal or converted XML UVIC)
- Output sigma-t, voltage, and current with each sample? [**OutputUCSD=**] (only if set to Y)

Status Commands (*continued*)

Example: Profiling mode (user input in bold, command used to modify parameter in parentheses)

DS

```

SBE 19plus V 3.1.8 SERIAL NO. 4000 13 Apr 2016 14:02:13 [DateTime=]
vbatt = 10.1, vlith = 8.9, ioper = 61.9 ma, ipump = 20.8 ma,
iext01 = 76.2 ma
status = not logging
number of scans to average = 1 [NAvg=]
samples = 10, free = 4386532, casts = 1 [can clear with InitLogging]
mode = profile, minimum cond freq = 3000, pump delay = 60 sec [MP, MinCondFreq=, PumpDelay=]
autorun = no, ignore magnetic switch = no [AutoRun=, IgnoreSwitch=]
battery type = alkaline, battery cutoff = 7.5 volts [BatteryType=]
pressure sensor = strain gauge, range = 1000.0 [PType=, PRange=; both factory set]
SBE 38 = no, WETLABS = no, OPTODE = no, SBE63 = no, SeaFET = no, Gas Tension Device = no
[SBE38=, WetLabs=, Optode=, SBE63=, SeaFET=, GTD=, DualGTD=]

Ext Volt 0 = yes, Ext Volt 1 = no [Volt0= and Volt1=]
Ext Volt 2 = no, Ext Volt 3 = no [Volt2= and Volt3=]
Ext Volt 4 = no, Ext Volt5 = no [Volt4= and Volt5=]
echo characters = yes [Echo=]
output format = converted decimal [OutputFormat=]
output salinity = no, output sound velocity = no [OutputSal=, OutputSV=]

```

Status Commands (*continued*)

Moored Mode (MM)

- Firmware version, serial number, date and time [**DateTime=**]
- Voltages and currents (main and back-up lithium battery voltages, currents – operating, pump, external voltage sensors, RS-232 sensor)
- Logging status (not logging, logging, waiting to start at . . ., or unknown status)
- Sample interval [**SampleInterval=**] and number of measurements to take and average per sample [**NCycles=**]
- Number of samples and available sample space in memory
- Moored mode [**MM**], pump turn-on parameter [**MooredPumpMode=**], turn-on delay [**DelayBeforeSampling=**], and turn-off delay [**DelayAfterSampling=**]
- Transmit data real-time? [**MooredTxRealTime=**]
- Battery type [**BatteryType=**] and battery cut-off voltage
- Pressure type [**PType=**] and range [**PRange=**]; factory set
- Sample RS-232 sensor - SBE 38 secondary temperature sensor [**SBE38=**], WET Labs [**WetLabs=**], Optode [**Optode=**], SBE 63 optical dissolved oxygen sensor [**SBE63=**], Satlantic SeaFET pH sensor [**SeaFET=**], Gas Tension Device [**GTD=**], or dual Gas Tension Devices [**DualGTD=**]?
- Sample external voltages 0, 1, 2, 3, 4, and 5 [**Volt0=** through **Volt5=**]?
- Show entered commands on screen as you type [**Echo=**]?
- Output format [**OutputFormat=**]
- Output salinity [**OutputSal=**] and sound velocity [**OutputSV=**] with each sample? (only appears if output format = converted decimal or converted XML UVIC)
- Output sigma-t, voltage, and current with each sample? [**OutputUCSD=**] (only appears if output format = converted decimal or converted XML UVIC; and if set to Y)

Status Commands (*continued*)

Example: Moored mode (user input in bold, command used to modify parameter in parentheses)

```

DS
SBE 19plus V 3.1.8 SERIAL NO. 4000 13 Apr 2016 14:02:13 [DateTime=]
vbatt = 10.1, vlith = 8.9, ioper = 61.9 ma, ipump = 20.8 ma,
iext01 = 76.2 ma
status = not logging
sample interval = 15 seconds, number of measurements per sample = 1 [SampleInterval=, NCycles=]
samples = 0, free = 3463060 [reset with InitLogging]
mode = moored, run pump for 0.5 sec, delay before sampling = 0.0 seconds,
delay after sampling = 0.0 seconds [MM, MooredPumpMode=, DelayBeforeSampling=, DelayAfterSampling=]
transmit real-time = yes [MooredTxRealTime=]
battery type = alkaline, battery cutoff = 7.5 volts [BatteryType=]
pressure sensor = strain gauge, range = 2000.0 [PType=, PRange=: both factory set]
SBE 38 = no, WETLABS = no, OPTODE = no, SBE 63 = no, SeaFET = no, Gas Tension Device = no
[SBE38=, Optode=, SBE63=, WetLabs=, SeaFET=, GTD=, DualGTD=]

Ext Volt 0 = yes, Ext Volt 1 = yes [Volt0= and Volt1=]
Ext Volt 2 = no, Ext Volt 3 = no [Volt2= and Volt3=]
Ext Volt 4 = no, Ext Volt 5 = no [Volt4= and Volt5=]
echo characters = yes [Echo=]
output format = converted decimal [OutputFormat=]
output salinity = no, output sound velocity = no [OutputSal=, OutputSV=]

```

Status Commands (*continued*)**Notes:**

- The **Dcal** and **GetCC** responses contain the same information, but in different formats.
- Dates shown are when calibrations were performed.

Dcal

Get and display calibration coefficients, which are initially factory-set and should agree with Calibration Certificates shipped with 19plus V2.

Example: 19plus V2 with strain-gauge pressure sensor (user input in bold, command used to modify coefficient in parentheses).

dcal

SBE 19plus V 3.1.8 SERIAL NO. 0003 13 Apr 2016 14:46:05

temperature: 20-nov-15

TA0 = -3.178124e-06

TA1 = 2.751603e-04

TA2 = -2.215606e-06

TA3 = 1.549719e-07

TOFFSET = 0.000000e+00

conductivity: 20-nov-15

G = -9.855242e-01

H = 1.458421e-01

I = -3.290801e-04

J = 4.784952e-05

CPCOR = -9.570000e-08

CTCOR = 3.250000e-06

CSLOPE = 1.000000e+00

pressure S/N 10178581, range = 508 psia: 11-Feb-16

PA0 = 7.600861e-02

PA1 = 1.546746e-03

PA2 = 6.195891e-12

PTCA0 = 5.246582e+05

PTCA1 = 3.954062e+00

PTCA2 = -7.760881e-02

PTCB0 = 2.508687e+01

PTCB1 = 1.750000e-04

PTCB2 = 0.000000e+00

PTEMPA0 = -5.910866e+01

PTEMPA1 = 5.332183e+01

PTEMPA2 = -4.048740e-01

POFFSET = 0.000000e+00

volt 0: offset = 0.000000e+00, slope = 1.000000e+00

volt 1: offset = 0.000000e+00, slope = 1.000000e+00

volt 2: offset = 0.000000e+00, slope = 1.000000e+00

volt 3: offset = 0.000000e+00, slope = 1.000000e+00

volt 4: offset = 0.000000e+00, slope = 1.000000e+00

volt 5: offset = 0.000000e+00, slope = 1.000000e+00

EXTFREQSF = 1.000000e+00

[DateTime=]

[TCalDate=]

[TA0=]

[TA1=]

[TA2=]

[TA3=]

[TOffset=]

[CCalDate=]

[CG=]

[CH=]

[CI=]

[CJ=]

[CPCor=]

[CTCor=]

[CSlope=]

[PRange= (psia), PCalDate=]

[PA0=]

[PA1=]

[PA2=]

[PTCA0=]

[PTCA1=]

[PTCA2=]

[PTCB0=]

[PTCB1=]

[PTCB2=]

[PTempA0=]

[PTempA1=]

[PTempA2=]

[POffset= (decibars)]

[factory set]

[factory set]

[factory set]

[factory set]

[factory set]

[factory set]

[factory set]

General Setup Commands

DateTime=mmddyyhhmmss Set real-time clock month, day, year, hour, minute, second.

Example: Set current date and time to 05 August 2016 12:05:00 (user input in bold).

datetime=08052016120500

Notes:

- The 19plus V2 baud rate (set with **BaudRate=**) must be the same as Seaterm232's baud rate (set in the Communications menu).
- An RS-232 sensor (SBE 63, SBE 38, WET Labs, SeaFET, GTD, or Optode) integrated with the 19plus V2 must use the same baud rate as the 19plus V2. See the RS-232 sensor's manual to set its baud. Note that the Optode only communicates at 9600 baud, so you must set the 19plus V2 baud to 9600 if interfacing with that sensor.
- **BaudRate=** must be sent twice. After the first entry, the 19plus V2 changes to the new baud, and then waits for the command to be sent again at the new baud (In the Communications menu, select *Configure*. In the dialog box, select the new baud rate and click OK. Then retype the command.). This prevents you from accidentally changing to a baud that is not supported by your computer. If it does not receive the command again at the new baud, it reverts to the previous baud.

BaudRate=x

x= baud rate (600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200). **Default 9600.** Check capability of your computer and terminal program before increasing baud rate; high baud rates require a short cable and good PC serial port with accurate clock. **Command must be sent twice to change rate.**

Echo=x

x=Y: Echo characters received from computer (**default**) - monitor will show entered commands as you type.

x=N: Do not.

OutputExecutedTag=x

x=Y: Display XML Executing and Executed tags (**default**). Executed tag displays at end of each command response; Executing tag displays one or more times if 19plus V2 response to a command requires additional time.

x=N: Do not.

Example: Set 19plus V2 to output Executed and Executing tags (user input in bold).

outputexecutedtag=y

<Executed/>**getcd**

. . . (GetCD response)

<Executed/>

(Note: <Executed/> tag at end of command response takes place of S> prompt.)

BatteryType=x

x=alkaline: Alkaline batteries (also use this setting for lithium batteries). Logging stops when voltage drops below 7.5 volts for 5 consecutive scans. This reduces battery load to quiescent current.

x=nicad: Ni-Cad batteries (no longer available). Logging stops when voltage drops below 7.5 volts for 5 consecutive scans or voltage is less than 10.9 volts and voltage drop is greater than 0.2 volts/minute as determined by two 30-sec moving averages. This reduces battery load to quiescent current once first cell in battery pack is exhausted.

x=nimh: NiMH batteries. Logging stops when voltage drops below 7.8 volts for 5 consecutive scans or voltage is less than 8.7 volts and voltage drop is greater than 0.2 volts/minute as determined by two 30-sec moving averages. This reduces battery load to quiescent current once first cell in battery pack is exhausted.

General Setup Commands (*continued*)

Notes:

- The 19plus V2 requires verification when **InitLogging**, **SampleNumber=**, or **HeaderNumber=** are sent. 19plus V2 responds:
this command will change the scan length and/or initialize logging. Repeat the command to verify.
Type the command again and press the Enter key to proceed. The 19plus V2 responds:
Scan length has changed,
initializing logging
- Do not initialize logging until all data has been uploaded.** These commands do not delete data; they reset the data pointer. **If you accidentally initialize logging before uploading**, recover data as follows:
 - Set **SampleNumber=a** and **HeaderNumber=b**, where **a** and **b** are your estimate of number of samples and casts in memory.
 - Upload data. If **a** is more than actual number of samples or **b** is more than actual number of casts in memory, data for non-existent samples/casts will be bad, random data. Review uploaded data file carefully and delete any bad data.
 - If desired, increase **a** and/or **b** and upload data again, to see if there is additional valid data in memory.

InitLogging

Initialize logging - after all previous data has been uploaded, initialize logging before starting to sample again to make entire memory available for recording. **InitLogging** sets sample number (**SampleNumber=**) and header and cast number (**HeaderNumber=**) to 0 (sampling will start with sample 1 and cast/header 1). If not set to 0, data will be stored after last recorded sample. **Do not send InitLogging until all existing data has been uploaded.**

SampleNumber=x

x= sample number for last sample in memory. Typically only used to recover data if you accidentally initialize logging (using **InitLogging**) before uploading all existing data. **Do not send SampleNumber=0 until all existing data has been uploaded.**

HeaderNumber=x

x= header and cast number for last cast or header in memory. Typically used to recover data if you accidentally initialize logging (using **InitLogging**) before uploading all existing data. **19plus V2 can have a maximum of 1000 stored headers.**

Note that 19plus V2 writes a new header:

- each time logging is started in Profiling Mode
- each time logging is started and after every 2000 samples are stored in memory in Moored Mode.

Note:

If a WET Labs sensor with Bio-Wiper is installed and **Biowiper=N**, sending **GetSD** or **DS** will open the Bio-Wiper, but not provide enough powered time to close it again. If you then deploy the instrument with the Bio-Wiper open and with a delayed start time, the sensor may become fouled because the Bio-Wiper will remain open until the first sample is completed.

Biowiper=x

x=Y: Configuration includes WET Labs sensor with Bio-Wiper (voltage or RS-232 auxiliary sensor). With this setup, 19plus V2 is powered longer for **DS** and **GetSD**, providing sufficient time for Bio-Wiper to open and then shut again if Bio-Wiper is set up to take 1 measurement for each sample (see *Application Note 72-V2*).

x=N (default): No ECO-FL with Bio-Wiper.

Note:

The 19plus V2 automatically enters quiescent (sleep) state after 2 minutes without receiving a command, conserving battery energy if the user does not send **QS** to put the 19plus V2 to sleep.

QS

Quit session and place 19plus V2 in quiescent (sleep) state. Main power turned off. Data logging and memory retention not affected.

Notes:

- The 19plus V2 requires verification when these commands are sent. The 19plus V2 responds: this command will change the scan length and/or initialize logging. Repeat the command to verify. Type the command again and press the Enter key to proceed. The 19plus V2 responds: Scan length has changed, initializing logging
- The 19plus V2 configuration (.xmlcon or .con) file must match this selection of pressure sensor and external voltages when viewing real-time data in Seasave or processing uploaded data. View and edit the configuration file in Seasave or SBE Data Processing. These parameters are factory-set to match the ordered instrument configuration.
- External voltage numbers 0, 1, 2, 3, 4, and 5 correspond to wiring of sensors to a voltage channel on the 19plus V2 end cap (see *Dimensions and End Cap Connectors* in Section 2: Description of SBE 19plus V2). However, in the .xmlcon or .con file, voltage 0 is the first external voltage in the data stream, voltage 1 is the second, etc.

Pressure and Voltage Sensor Setup Commands

PType=x	Pressure sensor type (set at factory; do not modify). x=1 : Strain-gauge. x=3 : Quartz with temperature compensation. Requires even NCycles= (2, 4, 6, etc.) for Moored mode and even NAvg= for Profiling mode.
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.

Example: Enable voltage sensors wired to channels 0 and 3 on end cap (user input in bold).

```
VOLT0=Y
VOLT1=N
VOLT2=N
VOLT3=Y
VOLT4=N
VOLT5=N
```

There will be 2 external sensor voltages in data stream. In .xmlcon or .con file (in SBE Data Processing or Seasave), indicate 2 external voltage channels. Voltage 0 corresponds to sensor wired to external voltage channel 0; voltage 1 corresponds to sensor wired to external voltage channel 3.

Notes:

- The 19plus V2 requires verification when **SBE63=**, **SBE38=**, **WetLabs=**, **SeaFET=**, **GTD=**, **DualGTD=**, or **Optode=** is sent. The 19plus V2 responds:
this command will change the scan length and/or initialize logging. Repeat the command to verify. Type the command again and press the Enter key to proceed. The 19plus V2 responds:
Scan length has changed,
initializing logging
- The 19plus V2 configuration (.xmlcon or .con) file must match this selection of RS-232 sensor when viewing real-time data or processing uploaded data. View and edit the configuration file in Seasave or SBE Data Processing. These parameters are factory-set to match the ordered instrument configuration.
- See the RS-232 sensor manual for its command details.

RS-232 Sensor Setup Commands

The SBE 19plus V2 can interface with one of the following RS-232 instruments (connected to the 4-pin *Auxiliary RS-232 Input* bulkhead connector on the 19plus V2 end cap):

- SBE 63 optical dissolved oxygen sensor
- SBE 38 secondary temperature sensor
- WET Labs single, dual, or triple channel ECO sensor; WETStar; C-Star; or SeaOWL UV-A™
- Satlantic SeaFET pH sensor (compatible only when 19plus V2 is in Moored mode)
- Pro-Oceanus Gas Tension Devices (compatible only when 19plus V2 is in Moored mode ; up to two GTDs can be integrated)
- Aanderaa Oxygen Optode 4330 or 4835

For any of these instruments, you can use the **GatewaySerial** command to open direct communications with the serial instrument through the SBE 19plus V2. To return to communicating with the SBE 19plusV2, send Ctrl Shift X (**'X' must be upper case**). If you do not send Ctrl Shift X, the connection to the serial instrument automatically times out after 2 minutes of 19plus V2 and serial instrument inactivity.

Example: Send a status command to SBE 63 connected to SBE 19plusV2.

```
gatewayserial
ds (this is directed to SBE 63)
getcd (this is directed to SBE 63)
(Ctrl Shift X)
getcd (this is directed to 19plus V2)
```

RS-232 Sensor Setup Commands (*continued*)**Note:**

You can use Seaterm232 to communicate directly with the SBE 63 when it is connected directly to the computer, or you can communicate with the SBE 63 *through* the 19plus V2 by using the **Send63=** command.

Note:

In Moored mode, the 19plus 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 19plus V2 is unable to take the required number of measurements and do the calculations within **SampleInterval=**. See *Sample Timing* in *Section 2: Description of SBE 19plus V2*. When integrating with SBE 63, note the following:

- Minimum time required for 19plus V2 to take a CTD sample and to request and receive a sample from SBE 63 is \approx 10 sec.
- When used with the SBE 63, minimum **DelayBeforeSampling=** is 25 sec at 15 °C to 40 sec at 0 °C (linear interpolation between those values). This provides enough time for the SBE 63 to equilibrate after pumping begins, before the measurement is made.

Setup for SBE 63:

Set up SBE 63 to interface with SBE 19plus V2, **before** you connect it to 19plus V2. Connect SBE 63 directly to computer, power with an external power supply, and (using Seaterm232) set the following parameters:

- Set baud rate to same baud rate as 19plus V2 (**SetBaud=**).
- Turn echoing on (**SetEcho=1**).
- Set samples averaged to 1 to 16; default value of 2 recommended (**SetAvg=2**).
- Set output format for compatibility with 19plus V2 (**SetFormat=1**).
- Disable automatic sampling when power applied (**SetAutoRun=0**).
- Verify that <TxPwrSave> in **GetSD** or **GetHD** response is 0 (factory set).
- If 19plusV2 in *Profiling* mode:
Set sample interval in SBE 63 to 10 sec or greater to minimize photo bleaching drift (**SetInterval=**).
Verify that <SerPause> in **GetSD** or **GetHD** response is 0 (factory set).

Connect SBE 63 to SBE 19plus V2 *Auxiliary RS-232 Input* connector, using provided cable. In the 19plus V2, set **SBE63=Y** to enable interface.

SBE63=x

x=Y: Enable SBE 63 optical dissolved oxygen sensor.

x=N: Do not enable SBE 63.

Send63=command

Command 19plus V2 to send **command** to SBE 63 and receive response; **command** can be any command recognized by SBE 63 (see SBE 63 manual).

RS-232 Sensor Setup Commands (*continued*)**Note:**

You can use Seaterm232 to communicate directly with the SBE 38 (when the sensor is connected directly to the computer). Alternatively, use the older Seaterm software, as documented in the manual for the SBE 38.

Setup for SBE 38:

Set up SBE 38 to interface with SBE 19plus V2, **before** you connect it to 19plus V2. Connect SBE 38 directly to computer, power with an external power supply, and (using Seaterm or Seaterm232) set:

- **Baud rate** to same baud rate as 19plus V2 (**Baud=**)
- **Interface** to RS-232 (**Interface=232**)
- **Sampling** to begin when power applied (**AutoRun=Y**)
- **Output** to converted data (**Format=C**)

Connect SBE 38 to SBE 19plus V2 *Auxiliary RS-232 Input* connector, using provided cable. In the 19plus V2, set **SBE38=Y** to enable interface.

SBE38=x**x=Y:** Enable RS-232 SBE 38 secondary temperature sensor.**x=N:** Do not enable SBE 38.**Note:**

In Moored mode, the 19plus 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 19plus V2 is unable to take the required number of measurements and do the calculations within **SampleInterval=**. See *Sample Timing* in *Section 2: Description of SBE 19plus V2*. When integrating with WET Labs sensor, note the following:

- **Minimum DelayBeforeSampling=** is 2 sec if using a WET Labs RS-232 sensor. *Typical* value is 4 sec if using a WET Labs RS-232 sensor with bio-wiper.
- **Typical DelayAfterSampling=** is 4 sec if using a WET Labs RS-232 sensor with bio-wiper.

Setup for WET Labs Sensor

(*single, dual, or triple ECO Sensor; WETStar, C-Star; or SeaOWL UV-A™*):

- **19plus V2** baud (**BaudRate=**) must match WET Labs RS-232 sensor baud.
- If in Moored mode: **19plus V2 DelayBeforeSampling=** must be ≥ 2 sec if using a WET Labs RS-232 sensor. If **WetLabs=Y** and **DelayBeforeSampling** < 2 sec, 19plus V2 automatically sets **DelayBeforeSampling=2**.
- If in Moored mode: If using a WET Labs sensor with a bio-wiper – set **19plus V2 DelayBeforeSampling=** and **DelayAfterSampling=** to enough time to allow bio-wiper to open before sampling and to close after sampling. Sea-Bird typically sets these parameters to **4.0 sec for use with a sensor with a bio-wiper** (sensor dependent).

Connect WET Labs sensor to SBE 19plus V2 *Auxiliary RS-232 Input* connector, using provided cable. In the 19plus V2, set **WetLabs=Y** to enable interface.

Note that the SBE 19plus V2 stores and outputs 6 bytes of WET Labs RS-232 data for each sample, with 2 bytes for each channel. If integrating an ECO Triplet or SeaOWL UV-A™, each sensor of the instrument uses 2 bytes (for a total of 6 bytes). If integrating a dual ECO sensor (such as the FLNTU), the first 4 bytes contain the sensor data; the remaining 2 bytes are 0's. For single WET Labs RS-232 sensors, the first 2 bytes contain the sensor data; the remaining 4 bytes are 0's.

WetLabs=x**x=Y:** Enable WET Labs RS-232 sensor.**x=N:** Do not enable WET Labs RS-232 sensor.

RS-232 Sensor Setup Commands (*continued*)**Note:**

In Moored mode, the 19plus 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 19plus V2 is unable to take the required number of measurements and do the calculations within **SampleInterval=**. See *Sample Timing* in *Section 2: Description of SBE 19plus V2*. When integrating with SeaFET, note the following:

- Minimum time required for 19plus V2 to request and receive a sample from SeaFET is ≈ 5 sec.
- Minimum **DelayBeforeSampling=** is 30 sec if using a SeaFET.

Setup for Satlantic SeaFET pH Sensor:

See *Appendix IV: Satlantic SeaFET Integration* for details on setup, testing, and data upload.

SBE 19plus V2 must be in Moored mode (MM) to obtain SeaFET data.

Set up SeaFET to interface with SBE 19plus V2, **before** you connect it to 19plus V2. Connect SeaFET directly to computer as described in its manual, and set the following:

- **Reset** – reset to factory defaults to start with a known state
- **Baud rate** - 9600, 19200, 38400, or 57600 (same baud rate as 19plus V2)
- **Frame** format - ‘SBE’
- **Mode** - ‘Polled’ mode
- **Navg** – 10 ADC samples
- **Output rate** - 1 frame/burst
- **Sample delay** – 0
- **Usectd on-the-fly temperature/salinity correction** – ‘false’ (disabled)

The following setup is required for the SBE 19plus V2:

- **19plus V2** must be set to same baud rate (**BaudRate=**) as SeaFET.
- **19plus V2 DelayBeforeSampling=** must be ≥ 30 sec if using a SeaFET.

Connect SeaFET to SBE 19plus V2 *Auxiliary RS-232 Input* connector, using provided cable. In the 19plus V2, set **SeaFET=Y** to enable interface.

Note that the SBE 19plus V2 stores and outputs 6 bytes of SeaFET RS-232 data for each sample.

SeaFET=x

x=Y: Enable Satlantic SeaFET pH sensor.

x=N: Do not enable Satlantic SeaFET pH sensor.

Note:

In Moored mode, the 19plus 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 19plus V2 is unable to take the required number of measurements and do the calculations within **SampleInterval=**. See *Sample Timing in Section 2: Description of SBE 19plus V2*. When integrating with GTD, note the following:

- Programmable pressure integration time for GTD.
- Programmable temperature integration time for GTD.

RS-232 Sensor Setup Commands (*continued*)**Setup for GTD:**

SBE 19plus V2 must be in Moored mode (MM) to obtain GTD data. Set up GTD to interface with 19plus V2, **before** you connect it to 19plus V2. Connect GTD directly to computer, power with an external power supply, and (using software provided by Pro-Oceanus) set:

- **Baud rate** to same baud rate as 19plus V2.
- **Output** to millibars.
- Sum of **pressure integration time** and **temperature integration time** so that GTD responds to a *take pressure reading* command in 40 sec or less (required so that 19plus V2 does not *time out* while waiting for reply).

Connect GTD to 19plus V2 *Auxiliary RS-232 Input* connector, using provided cable (end labeled *Pro-Oceanus* to GTD; end labeled *Sea-Bird* to 19plus V2). In the 19plus V2, set:

- **GTD=Y** or **DualGTD=Y** to enable interface.
- **SendGTD=** to change IDs if necessary.

The 19plus V2 samples the GTD last, after **DelayBeforeSampling=**, and after conductivity, temperature, and pressure, and all voltage channels have been sampled. To conserve power, the voltage to any other external sensors and the pump are turned off before acquiring the GTD sample.

Each time a sample is to be taken, 19plus V2 sends following commands to GTD (ID= 01, 02, etc.):

- ***ID00VR** <CR><LF> - get GTD firmware version; wait up to 3 sec for reply.
- ***ID00SN** <CR><LF> - get GTD serial number; wait up to 5 sec for reply.
- ***9900P5** <CR><LF> - command all GTDs to sample pressure; hold data in GTD.
- ***ID00DB** <CR><LF> - get held pressure; wait up to 90 sec for reply.
- ***9900Q5** <CR><LF> - command all GTDs to sample temperature; hold data in GTD.
- ***ID00DB** <CR><LF> - get held temperature; wait up to 90 sec for reply.

Notes:

- A 19plus V2 with dual GTDs is shipped with a Y-cable installed for the GTDs. The GTD ends are labeled GTD #1 and #2, and Sea-Bird set the GTD IDs to match.
- If **DualGTD=Y**, setting for **GTD=** has no effect.

GTD=x**x=Y:** Enable RS-232 GTD.**x=N:** Do not enable GTD.**DualGTD=x****x=Y:** Enable dual (2) GTDs.**x=N:** Do not enable dual GTDs.**TGTD**

Measure GTD(s), output 1 sample of data from each GTD (firmware version, serial number, pressure, and temperature).

Example: Output GTD data for system with dual GTDs (user input in bold):

TGTD

```
GTD#1 VR reply = *0001VR=s2.03 (GTD firmware version)
GTD#2 VR reply = *0002VR=s2.03 (GTD firmware version)
GTD#1 SN reply = *0001SN = 75524 (GTD serial number)
GTD#2 SN reply = *0002SN = 81440 (GTD serial number)
GTD#1 pressure reply = *00011010.04661, p = 101004661 (millibars x 105)
GTD#2 pressure reply = *00021010.01580, p = 101001580 (millibars x 105)
GTD#1 temperature reply = *000123.49548, t = 23.4955 (°C)
GTD#2 temperature reply = *000223.0357038, t = 23.0357 (°C)
```

SendGTD=commandCommand 19plus V2 to send **command** to GTD and receive response; **command** can be any command recognized by GTD (see GTD manual).

Examples: (user input in bold)

Send firmware version command to GTD #1:

SENDGTD=*0100vr

Sending GTD: **0100vr

GTD RX = *0001VR=s2.03

Send serial number command to GTD #2:

SENDGTD=*0200sn

Sending GTD: **0200sn

GTD RX = *0002SN=81440

Output Format Setup Commands

See *Data Output Formats* after the command descriptions for complete details on all the formats.

Note:

Output format does not affect how data is stored in FLASH memory.

Sea-Bird's real-time data acquisition (Seasave) and data processing (SBE Data Processing) software require data in raw hexadecimal (**OutputFormat=0**).

Typical use of the output format command is:

- Before beginning logging:
 - **If you will use Seasave to view real-time data** - Set output format to raw hex.
 - **If you will use Seaterm232 to view real-time data** - Set output format to converted decimal for ease in viewing real-time data.
- After stopping sampling, use Seaterm232's Upload menu to upload data from memory. This automatically uploads the data in raw hex (regardless of the **OutputFormat=** setting), so the uploaded data is compatible with SBE Data Processing for processing and with Seasave for viewing archived data.

OutputFormat=x

x=0: Output raw frequencies and voltages in hexadecimal. **Must use this format for acquiring and viewing real-time data in Seasave.** When using Seaterm232's Upload menu, Seaterm232 always uploads data from memory in raw hex (compatible with SBE Data Processing), regardless of user-programmed **OutputFormat=**.

x=1: Output converted (engineering units) data in hexadecimal.

x=2: Output raw frequencies and voltages in decimal.

x=3: Output converted (engineering units) data in decimal.

x=4: Output pressure and scan number only, in hexadecimal. Typically used only for interfacing with Auto Fire Module (AFM) and SBE 32 Carousel Water Sampler **or** with SBE 55 ECO Water Sampler (for autonomous water sampling).

x=5: Output converted (engineering units) data in decimal, in XML.

x=Y: Calculate and output salinity (psu). Only applies if **OutputFormat=3** or **5**.

x=N: Do not.

OutputSal=x**OutputSV=x**

x=Y: Calculate and output sound velocity (m/sec), using Chen and Millero formula (UNESCO Technical Papers in Marine Science #44). Only applies if **OutputFormat=3** or **5**.

x=N: Do not.

OutputUCSD=x

x=Y: Calculate and output density sigma-t (kg/m^3), battery voltage, and operating current (mA) with data polled while logging. Voltage and current measured after delay before sampling, but before sampling. Operating current measured and output only if in Moored mode. Only applies if **OutputFormat=3** or **5**.

x=N: Do not.

Note:

The 19plus V2 requires verification when **MP** is sent. 19plus V2 responds: this command will change the scan length and/or initialize logging. Repeat the command to verify.

Type the command again and press the Enter key to proceed.

The 19plus V2 responds:
Scan length has changed,
initializing logging

Note:

For a 19plus V2 with Quartz pressure sensor, **NAvg=** must be an even number (2, 4, etc.); increasing **NAvg=** reduces the measurement noise. See *Specifications* in *Section 2: Description of SBE 19plus V2* to determine resolution.

Note:

See *Pump Operation – Profiling Mode*.

Note:

To start sampling immediately after you send **AutoRun=Y** (if you were performing setup on external power):

- Send **QS** to put 19plus V2 in quiescent (sleep) state, and then turn external power off and then on again. **or**
- Send **StartNow**.

Note:

If **IgnoreSwitch=N**:

- Sending **Stop** only stops logging briefly, and then logging resumes. To stop logging, slide the magnetic switch off.
- An alternative for stopping logging is to send <Ctrl Z> through a terminal program; however, this will not work in Seaterm V2.

Profiling Mode Setup Commands

Profiling mode setup commands following MP apply to Profiling mode only, and have no effect on operation if the 19plus V2 is in Moored mode.

MP

Set 19plus V2 to Profiling mode.

NAvg=x

x= number of samples to average (**default 1**, maximum 32,767). 19plus V2 samples at 4 Hz (every 0.25 sec) and averages **NAvg** samples; averaged data is stored in FLASH memory and transmitted real-time.

Example: 19plus V2 samples every 0.25 sec. If **NAvg=2**, 19plus V2 averages data from 2 samples (= 1 averaged data sample per 0.5 sec), stores averaged data in FLASH memory, and transmits averaged data real-time.

MinCondFreq=x

x= minimum conductivity frequency (Hz) to enable pump turn-on, to prevent pump from turning on before 19plus V2 is in water. Pump stops when conductivity frequency drops below **MinCondFreq=**. 19plus V2 Configuration Sheet lists uncorrected (raw) frequency output at 0 conductivity. Typical value (and factory-set default) for **MinCondFreq=** for salt water and estuarine application is: (0 conductivity frequency + 500 Hz). Typical value for **MinCondFreq=** for fresh water applications is: (0 conductivity frequency + 5 Hz).

PumpDelay=x

x= time (sec) to wait after minimum conductivity frequency (**MinCondFreq=**) is reached before turning pump on. Pump delay time allows time for Tygon tubing and pump to fill with water after 19plus V2 is submerged. Pump starts **PumpDelay=** sec after conductivity cell's frequency output is greater than **MinCondFreq=**. Typical value 30 - 45 sec; range 0 – 600 sec. **Default 60 sec**.

AutoRun=x

x=Y: Start logging automatically when **external power** applied; stop logging when external power removed. Magnetic switch position has no effect on logging.

x=N: Wait for command when external power applied. **Default**.

IgnoreSwitch=x

x=Y: Do not start or stop logging based on position of magnetic switch. Use **StartNow**, **StartLater**, and **Stop** to control logging.

x=N: Do not ignore magnetic switch position. Logging controlled by switch position. **Default**.

Note:

19plus V2 requires verification when **MM** is sent. 19plus V2 responds: this command will change the scan length and/or initialize logging. Repeat the command to verify.

Type the command again and press the Enter key to proceed.

The 19plus V2 responds: Scan length has changed, initializing logging

Notes:

- 19plus V2 with Quartz pressure sensor: **NCycles=** must be even (2, 4, etc.); increasing **NCycles=** reduces measurement noise. See *Specifications in Section 2: Description of SBE 19plus V2* to determine resolution.
- 19plus V2 integrates for the Quartz pressure sensor *after NCycles=* measurements have been taken.

Moored Mode Setup Commands

Moored mode setup commands following MM apply to Moored Mode only, and have no effect on operation if the 19plus V2 is in Profiling mode.

MM

Set 19plus V2 to Moored mode.

SampleInterval=x

x= interval (sec) between samples (10 - 14,400 sec).

NCycles=x

x= number of measurements to take and average every **SampleInterval** sec. Range 1 – 100; **default 1**. 19plus V2 takes and averages **NCycles** samples (each 0.25 sec apart) each **SampleInterval** sec; averaged data is stored in FLASH memory and (if **MooredTxRealTime=Y**) transmitted real-time.

Example: If **SampleInterval=20** and **NCycles=4**, every 20 sec 19plus V2 takes 4 measurements (0.25 sec apart), averages data from 4 measurements, and stores averaged data in FLASH memory.

MooredPumpMode=x

x=0: No pump.

x=1: Run pump for 0.5 sec before each sample (typical for pumping through conductivity cell only, with no auxiliary sensors connected to plumbing).

x=2: Run pump during each sample (typical for pumping through conductivity cell and in-line auxiliary sensor).

DelayBeforeSampling=x

x= time (sec) to wait after switching on external voltage and RS-232 sensors before sampling (0-600 sec). **Default 0 sec**. Typical values if using:

- SBE 43 or 63 oxygen sensor – time is dependent on membrane thickness and on water temperature (see *Pump Operation – Moored Mode*). Use with **MooredPumpMode=2**.

- Beckman- or YSI-type oxygen sensor – 120 to 180 sec required to provide time for sensor to polarize. Use with **MooredPumpMode=2**.

- Sea Tech fluorometer - 15 sec required to provide time for sensor to stabilize.

DelayAfterSampling=x

x= time (sec) to wait after sampling is completed, before turning off power to external voltages and RS-232 sensors (0 – 600 sec). **Default 0 sec**.

Typical value if using WET Labs sensor with bio-wiper is 4 sec, to allow time for sensor to shut bio-wiper after sampling is completed (sensor dependent; see WET Labs documentation).

MooredTxRealTime=x

x=Y: Output real-time data.

x=N: Do not.

Notes:

- Pump operation is affected by **DelayBeforeSampling=**, **DelayAfterSampling=**, and **MooredPumpMode=**. See *Pump Operation – Moored Mode*.
- **NCycles=**, **DelayBeforeSampling=**, **DelayAfterSampling=**, **MooredPumpMode=**, and **MooredTxRealTime=** affect the time required to sample. If the time required to sample is too high, the 19plus V2 is unable to take the required number of measurements and do the calculations within **SampleInterval=**. See *Sample Timing in Section 2: Description of SBE 19plus V2*.
- Power turn-on defined by **DelayBeforeSampling=** does not apply to the RS-232 Aanderaa Optode, because turning on power to the Optode causes it to sample. The 19plus V2 turns on power to the Optode when the 19plus V2 is ready to acquire the Optode data.

Logging Commands

Notes:

- In Seaterm232, to save real-time data to a file, click the Capture menu before beginning logging.
- If the FLASH memory is filled to capacity, data sampling and transmission of real-time data continue, but excess data is not saved in memory. **The 19plus V2 will not overwrite data stored in memory.**
- If the 19plus V2 is sampling and the voltage is less than the cut-off voltage (see **BatteryType=** for cut-off values for various battery types), the 19plus V2 halts logging and displays WARNING: LOW BATTERY VOLTAGE.

Note:

Sea-Bird ships the 19plus V2 with **AutoRun=N** (it will not automatically start sampling when external power is applied). If you send **AutoRun=Y**:

- Send **QS** to put 19plus V2 n quiescent (sleep) state, then turn power off and then on again to start sampling, **or**
- Send **StartNow** to start sampling.
- 19plus V2 samples at 2 Hz when equipped with Quartz pressure sensor.
- Profiling mode is **not** compatible with a Satlantic SeaFET pH sensor or Pro-Oceanus Gas Tension Device.

Note:

For Moored mode, the magnetic switch should be left off, but it has no effect on logging. If the switch is turned on while the 19plus V2 is in quiescent state, the CPU enters the awake state, but logging does not begin. If no communications are established, the 19plus V2 times out and enters quiescent state after 2 minutes.

Logging commands direct the SBE 19plus V2 to sample data. When commanded to start sampling, the 19plus V2 takes samples and stores the data in its FLASH memory. Operation is dependent on the mode and setup.

Profiling Mode (MP)

While logging, the 19plus V2 transmits real-time data, and does not enter quiescent (sleep) state between samples. The 19plus V2 provides several methods for starting and stopping logging, depending on the settings for **IgnoreSwitch=** and **AutoRun=**. Logging starts approximately 1 - 2 sec after it is commanded.

IgnoreSwitch=	AutoRun=	To Start Logging:	To Stop Logging:
N	N	Slide magnetic switch on.	Slide magnetic switch off, or send Stop .
Y	N	Send StartNow , or StartDateTime= and StartLater .	Send Stop .
Y or N	Y	Turn on external power.	<ul style="list-style-type: none"> • Turn off external power, or • (if you want to send commands to check or modify setup) Send Stop.

The first time logging is started after receipt of the initialize logging command (**InitLogging**), data recording starts at the beginning of memory and any previously recorded data is written over. When logging is stopped, recording stops. Each time logging is started again, recording continues, with new data stored after the previously recorded data and a new header written to indicate the incremented cast number, date, time, and sample numbers contained in the cast. The maximum number of casts that can be taken is 1000.

Moored Mode (MM)

While logging, the 19plus V2 transmits real-time data if **MooredTxRealTime=Y**. The 19plus V2 enters quiescent (sleep) state between samples.

To start logging, use **StartNow**; logging starts **SampleInterval=** sec after receipt of **StartNow**. Alternatively, use **StartDateTime=** and **StartLater** to start logging at a designated date and time. The first time logging is started after receipt of the initialize logging command (**InitLogging**), data recording starts at the beginning of memory and any previously recorded data is written over. When **Stop** is sent, recording stops. Each time **StartNow** or **StartLater** is sent again, recording continues, with new data stored after the previously recorded data. A new header is written each time logging starts and every 2000 samples thereafter. A maximum of 1000 headers can be written; if the maximum number of headers is reached but there is still room for samples in FLASH memory, the 19plus V2 continues to sample and store sample data in FLASH memory without writing additional headers.

Logging Commands (continued)

Notes:

- If using **StartNow** or **StartLater** to start logging, the 19plus V2 must be set to Moored mode (**MM**), or if in Profiling mode (**MP**) must be set to ignore the magnetic switch (**IgnoreSwitch=Y**).
- After receiving **StartLater**, the 19plus V2 goes to sleep. Press the Enter key to wake it up if desired.
- After receiving **StartLater**, the 19plus V2 displays `waiting to start at . . .` in reply to **GetSD** or **DS**. Once logging starts, the **DS** reply displays `logging`.
- If the delayed start date and time has already passed when **StartLater** is received, the 19plus V2 executes **StartNow**.
- If the delayed start date and time is more than 1 month in the future when **StartLater** is received, the 19plus V2 assumes that the user made an error in setting the delayed start date and time, and it executes **StartNow**.

StartNow

Start logging now.

**StartDateTime=
mmddyyyyhhmmss**

Set delayed logging start month, day, year, hour, minute, and second.

StartLaterStart logging at time set with **StartDateTime=**. If you need to change 19plus V2 setup after **StartLater** has been sent (but before logging has started), send **Stop**, change setup as desired, and then send **StartLater** again.

Example: Program 19plus V2 to start logging on 20 January 2016 12:05:00. (user input in bold)

```
STARTDATETIME=01202016120500  
STARTLATER
```

Notes:

- You may need to send **Stop** several times to get the 19plus V2 to respond.
- If in Profiling mode and **IgnoreSwitch=N**:
Sending **Stop** only stops logging briefly, and then logging resumes. To stop logging, slide the magnetic switch off.
An alternative for stopping logging is to send <Ctrl Z> through a terminal program; however, this will not work in Seaterm V2.
- You must stop logging before uploading data.

StopStop logging or stop waiting to start logging (if **StartLater** was sent but logging has not begun yet). Press Enter key before sending **Stop**.

Data Upload Commands

Notes:

- **Use the Upload menu to upload data that will be processed by SBE Data Processing.** Manually entering a data upload command does not produce data with the required header information for processing by our software. These commands are included here for reference for users who are writing their own software.
- **If not using the Upload menu -** To save data to a file, click the Capture menu before entering a data upload command.
- See *Data Output Formats*.

Stop logging before uploading data. If manually sending a data upload command, data is uploaded in the format defined by **OutputFormat=**.

GetSamples:b,e or **DDb,e** Upload data from sample **b** to sample **e**.
If **b** and **e** are omitted, all data is uploaded.
First sample number is 1.

Examples: Upload samples 1 to 1000 to a file (user input in bold):
(Click Capture menu and enter desired filename in dialog box.)
GETSAMPLES : 1,1000
or
DD1,1000

GetCast:x or **DCx** Upload data from Profiling mode cast **x** or Moored mode header **x**. If **x** is omitted, data from cast/header 1 is uploaded.
First cast/header number is 1.

Example: Upload all data in second cast (cast 2) to a file (user input in bold):
(Click Capture menu and enter desired filename in dialog box.)
GETCAST : 2
or
DC2

GetHeaders:b,e or **DHb,e** Upload header **b** to header **e**. If **b** and **e** are omitted, all headers are uploaded. First header number is 1. Header includes:

- cast/header number
- month, day, hour, minute, and second when cast was started
- first and last sample in cast/header
- **Profiling mode only** - number of measurements to average per sample (**NAvg=**)
- **Moored mode only** - interval between samples (**SampleInterval=**)
- reason logging was halted
(batfail = battery voltage too low;
mag switch = switch turned off;
stop cmd = received **Stop** command
or Home or Ctrl Z character;
timeout = error condition;
unknown = error condition;
????? = error condition)

Examples:
Upload second header (header for cast 2) to a file (user input in bold):
(Click Capture menu and enter desired filename in dialog box.)
GETHEADERS : 2, 2
or
DH2, 2

If in Profiling mode, 19plus V2 responds:
cast 2 30 Oct 2016 12:30:33 samples 35 to 87, avg = 1, stop = mag switch

If in Moored mode, 19plus V2 responds:
hdr 2 30 Oct 2016 12:30:33 samples 35 to 87, int = 10, stop = stop cmd

Polled Sampling Commands

Notes:

- The 19plus V2 has a buffer that stores the most recent data samples. Unlike data in the FLASH memory, data in the buffer is erased upon removal or failure of power.
- Pump operation for polled sampling is defined by **MooredPumpMode=**, even if your 19plus V2 is set to Profiling Mode (**MP**). Thus, the 19plus V2 ignores the minimum conductivity frequency (**MinCondFreq=**) and pump delay (**PumpDelay=**) for polled sampling.
- *Leave power on* in **SL**, **SLT**, **TS**, and **TSSon** descriptions refers to power for the 19plus V2 as well as for the pump and any auxiliary sensors. Power remains on until **QS** is sent or the instrument times out (after 2 minutes).

These commands request a single sample. The 19plus V2 always stores data for the most recent sample in its buffer. Some polled sampling commands also store data in FLASH memory - the 19plus V2 will not execute the *store data in FLASH memory* portion of those commands while logging data.

SL	Output last sample from buffer (obtained with polled sampling, or latest sample from logging), and leave power on.
SLT	Output last sample from buffer, then take new sample and store data in buffer. Leave power on. Data is not stored in FLASH memory.
TS	Take new sample, store data in buffer, output data, and leave power on. Data is not stored in FLASH memory.
TSS	Take new sample, store data in buffer and FLASH memory , output data, and turn power off.
TSSon	Take new sample, store data in buffer and FLASH memory , output data, and leave power on.
GetLastSamples:x	Output last x samples from FLASH memory. If x is greater than the number of samples in memory, 19plus V2 outputs all samples in memory. If x is omitted, 19plus V2 outputs just the last sample. You do not need to stop logging (magnetic switch or Stop command) before sending GetLastSamples:x.

Testing Commands

Note:

Testing commands do not automatically turn the pump on. Thus, for instruments plumbed with the pump, they report data from essentially the same sample of water for all 100 measurements, because the pump does not run but the pump and associated plumbing prevent water from freely flowing through the conductivity cell and other plumbed sensors (for example, dissolved oxygen sensor). To get data from fresh samples, send **PumpOn** before sending a testing command, and then send **PumpOff** when the test is complete.

The 19plus V2 takes and outputs **100 samples** for each test (except as noted); data is **not** stored in FLASH memory. Press the Esc key (or send a break character) to stop a test.

- TC** Measure conductivity, output converted data.
- TCR** Measure conductivity, output raw data.
- TT** Measure temperature, output converted data.
- TTR** Measure temperature, output raw data.
- TP** Measure pressure (strain-gauge or Quartz), output converted data.
- TPR** Measure pressure (strain-gauge or Quartz), output raw data.
- TV** Measure 6 external voltage channels, output converted data.
- TVR** Measure voltages read by A/D converter, output raw data.

Column	Output
1 – 6	External voltages
7	Main battery voltage / 11
8	Back-up lithium battery voltage / 3.741
9	External current / 333.33
10	Pressure temperature voltage

- TF** Measure frequency (Quartz pressure sensor), output converted pressure data.
- TFR** Measure frequency (Quartz pressure sensor), output raw data.
- T63** Measure SBE 63 optical dissolved oxygen, output aa.aaaa, b.bbbb, o.oooo, tt.tttt
where
 aa.aaaa = phase (µsec)
 b.bbbb = temperature voltage
 o.oooo = dissolved oxygen (ml/l)
 tt.tttt = temperature in (°C)
- T38** Measure SBE 38 (secondary temperature), output converted data.

Testing Commands *continued*

TWetLabs

Measure WET Labs RS-232 sensor. Output varies, depending on sensor type.

ECO triple sensor or SeaOWL UV-A™:

Column	Output
1 – 2	Date and time
3	Wavelength sensor 1
4	Raw signal counts sensor 1
5	Wave length sensor 2
6	Raw signal counts sensor 2
7	Wave length sensor 3
8	Raw signal counts sensor 3
9	Thermistor counts

ECO dual sensor:

Column	Output
1 – 2	Date and time
3	Wavelength sensor 1
4	Raw signal counts sensor 1
5	Wave length sensor 2
6	Raw signal counts sensor 2
7	Thermistor counts

ECO single sensor:

Column	Output
1 – 2	Date and time
3	Wavelength sensor 1
4	Raw signal counts sensor 1
5	Thermistor counts

WETStar: Counts***C-Star:***

Column	Output
1	Sensor serial number
2	Reference counts
3	Signal counts
4	Corrected signal raw counts
5	Calculated beam c, inverse meters
6	Internal thermistor, counts

TSeaFET

Measure SeaFET, output internal reference voltage (ii.iiiiii) and external reference voltage (ee.eeeee).

TOptode

Measure Aanderaa Optode, output product number, serial number, and dissolved oxygen (micromoles/liter).

PumpOn

Turn pump on for testing purposes. Use this command:

- Before sending testing command to obtain pumped data from sensors plumbed with the pump, or
- To test pump.

PumpOff

Turn pump off for testing purposes.

Calibration Coefficients Commands

Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with the 19plus V2.

Notes:

- F = floating point number
S = string with no spaces
- Auxiliary sensor calibration coefficients are not stored in the 19plus V2 EEPROM.
 - Calibration coefficients for sensors that output raw data are stored in the 19plus V2 configuration (.xmlcon or .con) file. View and/or modify the calibration coefficients using the Configure menu in SBE Data Processing or the Configure Inputs menu in Seasave.
 - Some RS-232 auxiliary sensors store their calibration coefficients internally, and output data in engineering units. For the SBE 63, view and/or modify the instrument's calibration coefficients by sending **Send63=** to the SBE 63 *through* the 19plus V2. For other Sea-Bird auxiliary sensors such as the SBE 38, view and/or modify the instrument's calibration coefficients by connecting the instrument to the computer directly and using Seaterm, our older terminal program software (not Seaterm232).

Temperature

TCalDate=S	S=calibration date
TA0=F	F=A0
TA1=F	F=A1
TA2=F	F=A2
TA3=F	F=A3
TOffset=F	F=offset correction

Conductivity

CCalDate=S	S=calibration date
CG=F	F=G
CH=F	F=H
CI=F	F=I
CJ=F	F=J
PCor=F	F=pcor
TCor=F	F=tcor
CSlope=F	F=slope correction

Pressure - General

PCalDate=S	S=calibration date
PRange=F	F=sensor full scale range (psia)
POffset=F	F=offset correction (decibars)

Strain-Gauge Pressure

PA0=F	F=A0
PA1=F	F=A1
PA2=F	F=A2
PTempA0=F	F=pressure temperature A0
PTempA1=F	F=pressure temperature A1
PTempA2=F	F=pressure temperature A2
PTCA0=F	F=pressure temperature compensation ptca0
PTCA1=F	F=pressure temperature compensation ptca1
PTCA2=F	F=pressure temperature compensation ptca2
PTCB0=F	F=pressure temperature compensation ptcb0
PTCB1=F	F=pressure temperature compensation ptcb1
PTCB2=F	F=pressure temperature compensation ptcb2

Quartz Pressure

PC1=F	F=C1
PC2=F	F=C2
PC3=F	F=C3
PD1=F	F=D1
PD2=F	F=D2
PT1=F	F=T1
PT2=F	F=T2
PT3=F	F=T3
PT4=F	F=T4
PSlope=F	F=slope correction

Hardware Configuration Commands

The following commands are used to set auxiliary channel sensor types (description such as *oxygen, fluorometer, etc.*) and serial number.

Auxiliary Voltage Sensor Settings – can be modified in the field to accommodate changes in auxiliary voltage sensors cabled to the 19plus V2

SetVoltType0=

SetVoltSN0=

SetVoltType1=

SetVoltSN1=

SetVoltType2=

SetVoltSN2=

SetVoltType3=

SetVoltSN3=

SetVoltType4=

SetVoltSN4=

SetVoltType5=

SetVoltSN5=

Auxiliary RS-232 Sensor Settings – can be modified in the field to accommodate changes in auxiliary RS-232 sensors cabled to the 19plus V2

SetSerialType=

SetSerialSN=

Data Output Formats

Note:

Moored mode - For date and time output, time is the time at the **start** of the sample, after:

- a small amount of time (1 to 2 seconds) for the 19plus V2 to wake up and prepare to sample, and
- any programmed

DelayBeforeSampling=.

For example, if the 19plus V2 is programmed to wake up and sample at 12:00:00, and

DelayBeforeSampling=20, the output time for the first sample will be 12:00:21 or 12:00:22.

The SBE 19plus V2 stores data in a compact machine code. Data is converted and output in the user-selected format without affecting data in memory. Because memory data remains intact until deliberately overwritten, you can upload in one format, then choose another format and upload again.

Output format is dependent on **OutputFormat= (0, 1, 2, 3, 4, or 5)** and on the command used to retrieve the data, as detailed below. The inclusion of some data is dependent on the system configuration - if the system does not include the specified sensor, the corresponding data is not included in the output data stream, shortening the data string. RS-232 sensors always output data in the same format, regardless of **OutputFormat=**:

- SBE 63 data is always output as phase delay and temperature voltage
- SBE 38, GTD, and Optode data is always output in engineering units.
- WET Labs RS-232 sensor data is always output in raw counts.
- SeaFET sensor data is always output as two voltages – internal reference voltage and external reference voltage.

If in Moored mode and outputting real-time data (**MooredTxRealTime=Y**) while logging, a # sign precedes the real-time output for each sample.

OutputFormat=0 (raw frequencies and voltages in Hex)

Data is output in the order listed, with no spaces or commas between parameters. Shown with each parameter is the number of digits, and how to calculate the parameter from the data (use the decimal equivalent of the hex data in the equations).

Notes:

- If you will be using Seasave to acquire real-time data, you must set **OutputFormat=0**.
- When using Seaterm232's Upload menu, Seaterm232 always uploads data from memory in raw hex, regardless of the user-programmed format, providing the data in a format that SBE Data Processing can use.
- Our software uses the equations shown to perform these calculations; alternatively, you can use the equations to develop your own processing software.
- The pressure sensor is an absolute sensor, so its **raw** output includes the effect of atmospheric pressure (14.7 psi). As shown on the Calibration Sheet, Sea-Bird's calibration (and resulting calibration coefficients) is in terms of psia. However, when outputting pressure in **engineering units**, the 19plus V2 outputs pressure relative to the ocean surface (i.e., at the surface the output pressure is 0 decibars). The 19plus V2 uses the following equation to convert psia to decibars: pressure (dbar) = [pressure (psia) - 14.7] * 0.689476

1. Temperature A/D counts = ttttt
2. Conductivity frequency (Hz) = cccccc / 256
3. (if **PType=1**) Strain-gauge pressure sensor pressure A/D counts = pppppp
4. (if **PType=1**) Strain-gauge pressure sensor pressure temperature compensation voltage = vvvv / 13,107
5. (if **PType=3**) Quartz pressure sensor pressure pressure frequency (Hz) = pppppp / 256
6. (if **PType=3**) Quartz pressure sensor temperature compensation temperature compensation voltage = vvvv / 13,107
7. (if **Volt0=Y**) External voltage 0 = vvvv / 13,107
8. (if **Volt1=Y**) External voltage 1 = vvvv / 13,107
9. (if **Volt2=Y**) External voltage 2 = vvvv / 13,107
10. (if **Volt3=Y**) External voltage 3 = vvvv / 13,107
11. (if **Volt4=Y**) External voltage 4 = vvvv / 13,107
12. (if **Volt5=Y**) External voltage 5 = vvvv / 13,107
13. (if **SBE38=Y**) SBE 38 temperature (°C, ITS-90) = (ttttt / 100,000) - 10
14. (if **WetLabs=Y**) WET Labs RS-232 sensor = wwwxxxxxyyyy
where www, 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
15. (if **GTD=Y** or **DualGTD=Y**)
GTD #1 pressure (millibars) = pppppppp / 100,000
16. (if **GTD=Y** or **DualGTD=Y**)
GTD #1 temperature (°C, ITS-90) = (ttttt / 100,000) - 10
17. (if **DualGTD=Y**) GTD #2 pressure (millibars) = pppppppp / 100,000
18. (if **DualGTD=Y**)
GTD #2 temperature (°C, ITS-90) = (ttttt / 100,000) - 10
19. (if **Optode=Y**) Optode oxygen (micromoles/liter) = (oooooo / 10,000) - 10
20. (if **SBE63=Y**) SBE 63 oxygen phase (µsec) = (oooooo / 100,000) - 10
21. (if **SBE63=Y**) SBE 63 oxygen temperature voltage = (ttttt / 1,000,000) - 1
22. (if **SeaFET=Y**)
SeaFET internal reference cell voltage (V) = (iiiiiii / 1,000,000) - 8
SeaFET external reference cell voltage (V) = (eeeeeee / 1,000,000) - 8
23. Time (**Moored mode [MM] only**)
seconds since January 1, 2000 = ssssssss

Example: Profiling mode, strain-gauge pressure sensor, 2 external voltages sampled, example scan = tttttccccppppppvvvvvvvvvvvvvv

= 0A53711BC7220C14C17D8203050594

- Temperature = ttttt = 0A5371 (676721 decimal);
temperature A/D counts = 676721
- Conductivity = cccccc = 1BC722 (1820450 decimal);
conductivity frequency = 1820450 / 256 = 7111.133 Hz
- Pressure = pppppp = 0C14C1 (791745 decimal);
pressure A/D counts = 791745
- Pressure sensor temperature compensation =
vvvv = 7D82 (32,130 decimal);
Pressure temperature = 32,130 / 13,107 = 2.4514 volts
- First external voltage = vvvv = 0305 (773 decimal);
voltage = 773 / 13,107 = 0.0590 volts
- Second external voltage = vvvv = 0594 (1428 decimal);
voltage = 1428 / 13,107 = 0.1089 volts

OutputFormat=1 (engineering units in Hex)

Data is output in the order listed, with no spaces or commas between the parameters. Shown with each parameter is the number of digits, and how to calculate the parameter from the data (use the decimal equivalent of the hex data in the equations).

1. Temperature (°C, ITS-90) = (ttttt / 100,000) - 10
2. Conductivity (S/m) = (ccccc / 1,000,000) - 1
3. (strain-gauge or Quartz - **PType=1 or 3**)
pressure (decibars) = (pppppp / 1,000) - 100
4. (if **Volt0=Y**) External voltage 0 = vvvv / 13,107
5. (if **Volt1=Y**) External voltage 1 = vvvv / 13,107
6. (if **Volt2=Y**) External voltage 2 = vvvv / 13,107
7. (if **Volt3=Y**) External voltage 3 = vvvv / 13,107
8. (if **Volt4=Y**) External voltage 4 = vvvv / 13,107
9. (if **Volt5=Y**) External voltage 5 = vvvv / 13,107
10. (if **SBE38=Y**)
SBE 38 temperature (°C, ITS-90) = (ttttt / 100,000) - 10
11. (if **WetLabs=Y**) WET Labs RS-232 sensor = wwwwwwxyyyy
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
12. (if **GTD=Y or DualGTD=Y**)
GTD #1 pressure (millibars) = pppppppp / 100,000
13. (if **GTD=Y or DualGTD=Y**)
GTD #1 temperature (°C, ITS-90) = (ttttt / 100,000) - 10
14. (if **DualGTD=Y**)
GTD #2 pressure (millibars) = pppppppp / 100,000
15. (if **DualGTD=Y**)
GTD #2 temperature (°C, ITS-90) = (ttttt / 100,000) - 10
16. (if **Optode=Y**) Optode oxygen (micromoles/liter) = (oooooo / 10,000) - 10
17. (if **SBE63=Y**) SBE 63 oxygen phase (µsec) = (oooooo / 100,000) - 10
18. (if **SBE63=Y**) SBE 63 oxygen temperature voltage = (ttttt / 1,000,000) - 1
19. (if **SeaFET=Y**)
SeaFET internal reference cell voltage (V) = (iiiiiii / 1,000,000) - 8
SeaFET external reference cell voltage (V) = (eeeeeee / 1,000,000) - 8
20. Time (**Moored mode [MM] only**)
seconds since January 1, 2000 = ssssssss

Example: Profiling mode, 2 external voltages sampled,
example scan = tttttcccccpppppvvvvvvvv
= 3385C40F42FE0186DE03050594

- Temperature = ttttt = 3385C4 (3376580 decimal);
temperature (°C, ITS-90) = (3376580 / 100,000) - 10 = 23.7658
- Conductivity = cccccc = 0F42FE (1000190 decimal);
conductivity (S/m) = (1000190 / 1,000,000) - 1 = 0.00019
- Pressure = pppppp = 0186DE (100062 decimal);
pressure (decibars) = (100062 / 1,000) - 100 = 0.062
- First external voltage = vvvv = 0305 (773 decimal);
voltage = 773 / 13,107 = 0.0590 volts
- Second external voltage = vvvv = 0594 (1428 decimal);
voltage = 1428 / 13,107 = 0.1089 volts

OutputFormat=2 (raw frequencies and voltages in decimal)

Data is output in the order listed, with a comma followed by a space between each parameter. Shown with each parameter are the number of digits and the placement of the decimal point. Leading zeros are suppressed, except for one zero to the left of the decimal point.

1. Temperature A/D counts = ttttt
2. Conductivity frequency (Hz) = cccc.ccc
3. (if **PType=1**) Strain-gauge pressure A/D counts = pppppp
4. (if **PType=1**) Strain-gauge pressure sensor temperature compensation voltage = v.vvvv
5. (if **PType=3**) Quartz pressure sensor pressure frequency (Hz) = ppppp.ppp
6. (if **PType=3**) Quartz pressure sensor temperature compensation voltage = v.vvvv
7. (if **Volt0=Y**) External voltage 0 external voltage 0= v.vvvv
8. (if **Volt1=Y**) External voltage 1 = v.vvvv
9. (if **Volt2=Y**) External voltage 2 = v.vvvv
10. (if **Volt3=Y**) External voltage 3 = v.vvvv
11. (if **Volt4=Y**) External voltage 4 = v.vvvv
12. (if **Volt5=Y**) External voltage 5 = v.vvvv
13. (if **SBE38=Y**) SBE 38 temperature (°C, ITS-90) = ttt.ttt
14. (if **WetLabs=Y**) WET Labs RS-232 sensor = wwww, xxxx, yyyy 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
15. (if **GTD=Y** or **DualGTD=Y**) GTD #1 pressure (millibars) = pppppppp / 100,000
16. (if **GTD=Y** or **DualGTD=Y**) GTD #1 temperature (°C, ITS-90) = tt.ttt
17. (if **DualGTD=Y**) GTD #2 pressure (millibars) = pppppppp / 100,000
18. (if **DualGTD=Y**) GTD #2 temperature (°C, ITS-90) = tt.ttt
19. (if **Optode=Y**) Optode oxygen (micromoles/liter) = oooo.ooo
20. (if **SBE63=Y**) SBE 63 oxygen phase (µsec) = oo.ooo
21. (if **SBE63=Y**) SBE 63 oxygen temperature voltage = t.ttttt
22. (if **SeaFET=Y**) SeaFET internal reference cell voltage (V) = ii.iiiiii
SeaFET external reference cell voltage (V) = ee.eeeeee
23. Time (**Moored mode [MM] only**)
date, time = dd Mmm yyyy, hh:mm:ss (day month year hour:minute:second)

Example: Profiling mode, strain-gauge pressure sensor, 2 external voltages sampled, example scan = ttttt, cccc.ccc, pppppp, v.vvvv, v.vvvv, v.vvvv
= 676721, 7111.133, 791745, 2.4514, 0.0590, 0.1089

- Temperature = ttttt = 676721;
temperature A/D counts = 676721
- Conductivity = cccc.ccc = 7111.133;
conductivity frequency = 7111.133 Hz
- Pressure = pppppp = 791745;
Pressure A/D counts = 791745
- Pressure sensor temperature compensation = v.vvvv = 2.4514;
Pressure temperature = 2.4514 volts
- First external voltage = v.vvvv = 0.0590;
voltage = 0.0590 volts
- Second external voltage = v.vvvv = 0.1089;
voltage = 0.1089 volts

OutputFormat=3 (engineering units in decimal)

Data is output in the order listed, with a comma followed by a space between each parameter. Shown with each parameter are the number of digits and the placement of the decimal point. Leading zeros are suppressed, except for one zero to the left of the decimal point.

Uploaded Data (from GetSamples:b,e, or DDb,e)

1. Temperature (°C, ITS-90) = ttt.tttt
2. Conductivity (S/m) = cc.ccccc
3. (strain-gauge or Quartz - PType=1 or 3) Pressure (decibars) = pppp.ppp
4. (if Volt0=Y) External voltage 0 = v.vvvv
5. (if Volt1=Y) External voltage 1 = v.vvvv
6. (if Volt2=Y) External voltage 2 = v.vvvv
7. (if Volt3=Y) External voltage 3 = v.vvvv
8. (if Volt4=Y) External voltage 4 = v.vvvv
9. (if Volt5=Y) External voltage 5 = v.vvvv
10. (if SBE38=Y) SBE 38 secondary temperature (°C, ITS-90) = ttt.tttt
11. (if WetLabs=Y) WET Labs RS-232 sensor = wwwww, xxxx, yyyy
where wwwww, 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
12. (if GTD=Y or DualGTD=Y)
GTD #1 pressure (millibars) = ppppppppp / 100,000
13. (if GTD=Y or DualGTD=Y)
GTD #1 temperature (°C, ITS-90) = tt.ttt
14. (if DualGTD=Y)
GTD #2 pressure (millibars) = ppppppppp / 100,000
15. (if DualGTD=Y)
GTD #2 temperature (°C, ITS-90) = tt.ttt
16. (if Optode=Y) Optode oxygen (micromoles/liter) = ooooo.ooo
17. (if SBE63=Y) SBE 63 oxygen phase (µsec) = oo.ooo
18. (if SBE63=Y) SBE 63 oxygen temperature voltage = t.ttttt
19. (if SeaFET=Y)
SeaFET internal reference cell voltage (V) = ii.iiiiii
SeaFET external reference cell voltage (V) = ee.eeeee
20. (if OutputSal=Y) salinity (psu) = sss.ssss
21. (if OutputSV=Y) sound velocity (meters/second) = vvvv.vvv
22. Time (Moored mode [MM] only)
date, time = dd Mmm yyyy, hh:mm:ss (day month year hour:minute:second)

Example: Profiling mode, 2 external voltages sampled,

example scan = 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; temperature (°C, ITS-90) = 23.7658
- Conductivity = cc.ccccc = 0.00019; conductivity (S/m) = 0.00019
- Pressure = pppp.ppp = 0.062; pressure (decibars) = 0.062
- First external voltage = v.vvvv = 0.0590; voltage = 0.0590 volts
- Second external voltage = v.vvvv = 0.1089; voltage = 0.1089 volts

Polled Data from SL, SLT, TS, TSS, or TSSOn:

If OutputUCSD=Y and the 19plus V2 is logging (autonomous sampling is in progress), data is followed by density sigma-t in kg/m³ (ddd.dddd), battery voltage (vv.v), and operating current in mA (ccc.c), each separated by a comma and a space. The rest of the data stream is as described above for uploaded data.

OutputFormat=4 (pressure and scan number in Hex)

Note:

OutputFormat=4 is listed in the **GetCD** and **DS** response as converted HEX for AFM.

Data is output in the order listed, with no spaces or commas between parameters. Shown with each parameter is the number of digits, and how to calculate the parameter from the data (use the decimal equivalent of the hex data in the equations).

The 19plus V2 is automatically set to **OutputFormat=4** when communicating with:

- **Auto Fire Module (AFM) used with an SBE 32 Carousel Water Sampler** - This allows the AFM to use the 19plus V2 pressure data to determine when to close SBE 32 Carousel water bottles.
- **SBE 55 ECO Water Sampler** - This allows the SBE 55 to use the 19plus V2 pressure data to determine when to close its water bottles if set up for autonomous water sampling.

1. (strain-gauge or Quartz - **PType=1** or **3**) pressure (decibars) = pppp - 100
2. Scan number = ssssss

Example: 19plus V2 used with AFM and Carousel,
example scan = ppppssssss
= 00C80001F0

- Pressure = pppp = 00C8 (200 decimal);
pressure (decibars) = 200 - 100 = 100 decibars
- Scan number = ssssss = 0001F0 (496 decimal);
scan number = 496

Note:

OutputFormat=5 is listed in the **GetCD** and **DS** response as converted XML UVIC.

OutputFormat=5 (engineering units in decimal, in XML)

Data is output in the order listed, with **no** carriage return or line feed between each parameter (however, there is a carriage return and line feed at the end of the data stream, after the </datapacket> closing tag). Shown with each parameter is the number of digits and the placement of the decimal point. Leading zeroes are suppressed, except for one zero to the left of the decimal point.

Note:

For ease in reading, the data structure is shown with each XML tag on a separate line. However, there are no carriage returns or line feeds between tags (see example below).

Uploaded Data (from GetSamples:b,e or DDb,e):

```

<?xml?>
<datapacket>
<hdr>
<mfg>Sea-Bird</mfg>
<model>19plus</model>
<sn>nnnnnn</sn>
</hdr>
<data>
<t1>ttt.ttt</t1>
<c1>cc.cccc</c1>
<p1>pppp.ppp </p1> (if PType=1 or 3)
<v0>v.vvv</v0> (if Volt0=Y)
<v1>v.vvv</v1> (if Volt1=Y)
<v2>v.vvv</v2> (if Volt2=Y)
<v3>v.vvv</v3> (if Volt3=Y)
<v4>v.vvv</v4> (if Volt4=Y)
<v5>v.vvv</v5> (if Volt5=Y)
<ser1>
<type>sbe38, wetlabs, gtd, Optode, sbe63, or SeaFET</type> (RS-232 sensor)
<t38>ttt.ttt</t38> (if SBE38=Y)
<w10>www</w10> (if WetLabs=Y)
<w11>xxx</w11> (if WetLabs=Y)
<w12>yyy</w12> (if WetLabs=Y)
<p1>pppppppp</p1> (if GTD=Y or DualGTD=Y)
<t1>tt.ttt</t1> (if GTD=Y or DualGTD=Y)
<p2>pppppppp</p2> (if DualGTD=Y)
<t2>tt.ttt</t2> (if DualGTD=Y)
<oox>oooo.ooo</oox> (if Optode=Y)
<oxph>oo.ooo</oxph> (if SBE63=Y)
<oxtv> t.ttt</oxtv> (if SBE63=Y)
<vint>ii.iiii</vint> (if SeaFET=Y)
<vext>ee.eeeee </vext> (if SeaFET=Y)
</ser1>
<sal>sss.ssss</sal> (if OutputSal=Y)
<sv>vvvv.vvv</sv> (if OutputSV=Y)
<dt>yyyy-mm-ddThh:mm:ss</dt> (if in Moored [MM] mode)
</data>
</datapacket>

```


where

Serial number = nnnnnnn

Temperature (°C, ITS-90) = ttt.tttt

Conductivity (S/m) = cc.ccccc

Pressure (decibars) = pppp.ppp

External voltage = v.vvvv (for voltage 0, 1, 2, 3, 4, and 5)

SBE 38 temperature (°C, ITS-90) = ttt.tttt

WET Labs

sensor 0 (raw signal counts) = wwwww

sensor 1 (raw signal counts) = xxxx (= 0 unless using dual or triple sensor)

sensor 2 (raw signal counts) = yyyy (= 0 unless using triple sensor)

GTD pressure (millibars) = ppppppppp / 100,000 (for GTD #1 and #2)

GTD temperature (°C, ITS-90) = tt.ttt (for GTD #1 and #2)

Optode oxygen (micromoles/liter) = ooooo.ooo

SBE 63 oxygen phase (µsec) = oo.ooo

SBE 63 oxygen temperature voltage = t.ttttt

SeaFET internal reference voltage = ii.iiiiii

SeaFET external reference voltage = ee.eeeeeee

Salinity (psu) = sss.ssss

Sound velocity (meters/second) = vvvv.vvv

Date, time = year month day T hour:minute:second (yyyy-mm-ddThh:mm:ss)

Example: Profiling mode, with 2 external voltages sampled, example scan =

```
<?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
```

This data indicates Serial number = 1906003, Temperature (°C, ITS-90) = 23.7658, Conductivity (S/m) = 0.00019, Pressure (decibars) = 0.062, First external voltage = 0.0590 volts, Second external voltage = 0.1089 volts

Polled Data from SL, SLT, TS, TSS, or TSSOn:

If **OutputUCSD=Y** and the 19plus V2 is logging (autonomous sampling is in progress) and in Moored mode, 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

operating current (mA) = ccc.c

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

Optimizing Data Quality for Profiling Applications

Our deployment recommendations are only general guidelines, and are focused primarily on maximizing data quality. Actual sea state conditions, and winch and deck gear configurations, may require some adaptation in order to achieve best data quality and avoid mechanical problems.

The SBE 19plus V2 is optimized for profiling rates of 0.5 to 2 meters/second, with 1 meter/second generally providing the best compromise between data quality and profile resolution. The 19plus V2 pump maintains a constant and optimum flow rate, which ensures that the sensor response times are not dependent on the profiling rate. Adjust the profiling rate of the 19plus V2 based on the amount of ship motion (i.e., sea state) imparted to the cable, and the size, weight, and drag of the underwater package at the end of the cable. Generally, use a faster rate in rougher seas, allowing the 19plus V2 to stay clear of turbulent wakes that are shed downward when the ship heaves up; *shed wakes* are an error source from which all CTDs suffer. When the sea is very calm, the 19plus V2 can be lowered more slowly (for example, 10 to 20 cm/second) to give greater vertical resolution.

Like for other CTDs, the common configurations of the 19plus V2 are intended for obtaining downcast data, because the sensors are oriented so that the T-C Duct inlet passes through relatively undisturbed water as the CTD is lowered. As the CTD is raised (upcast), the sensors sample the turbulent wake of the package, resulting in lower quality data. If planning to sample on the upcast, consider the following:

- Vertical orientation – In the typical, sensors-down configuration, the sensors are in the wake of the housing on the upcast, providing poor data quality. If you must have good quality upcast data, invert the 19plus V2 so that the T-C Duct is at the top (ignore the downcast data for this configuration).
- Horizontal orientation (for example, under SBE 32 Carousel Water Sampler) - Position other instruments, sample bottles, etc. so that they are not directly above the T & C sensors and do not thermally contaminate the water that flows to the sensors at the T-C Duct inlet.

When a 19plus V2 is installed on a water sampler, good conductivity and optional dissolved oxygen data can be collected, even when stopped to collect a water sample, because water continues to flow through the sensors at a fixed and optimal rate.

Whether sampling on the upcast and/or downcast, position the T-C Duct inlet so that other instruments, sample bottles, etc. do not thermally contaminate the water that flows past the sensors.

Note:

See *Pump Operation – Profiling Mode* for information on the minimum soak time required to ensure proper pump operation.

Where the water temperature is very different from the temperature at which the 19plus V2 has been stored, better results are obtained if the 19plus V2 is allowed to equilibrate to the water temperature at the surface (soak) for several (3 – 5) minutes before beginning the profile. The reason is not that the electronics are temperature sensitive - they are not - but that the thermal influence of the instrument housing on the water entering the cell will be reduced. If the difference between water and storage temperature is extreme, allow more *soak time*.

When very heavy seas cause severe ship motion, the 19plus V2 descent can actually stop or reverse direction if the ship heaves upward faster than the package can descend. These occurrences can often be seen as loops in the real-time temperature trace. If the winch payout rate is too high, a loop of wire can form under water when the package descent is slowed or reversed by ship heave and the winch is still paying out wire. Inevitably, the loop formation gets out of phase with the heave and the loop closes on itself when the ship heaves, causing a kink. If the package includes a Carousel Water Sampler as well as the CTD, the package creates much more drag than with only the CTD, further increasing the possibility that a loop will form in the cable. After 1000 to 2000 meters of cable are paid out, it can be difficult or impossible to detect a loop in the cable. Adding 100 to 200 kg (maybe more by experimentation) of lead weights to the Carousel frame will help overcome the effect of drag, and allow the package to descend faster and stay more in line directly below the overboarding sheave.

Spiking is sometimes seen in the derived values for salinity, density, or sound velocity. Spiking results largely from a response time mismatch of the conductivity and temperature sensors, especially when the profiling descent rate is non-uniform. The greatest reduction in spiking is found by using premium CTD equipment such as the SBE 9plus, which uses very fast sensors (0.07 second) and high speed (24 Hz) parallel signal acquisition. The 19plus V2 static accuracy is the same as that of the 9plus, but its dynamic responses are not as ideal, as a result of its simpler, less costly, and more compact design. Much of the spiking can be removed from the data set by aligning the data in time. This alignment can be performed when post-processing the data in SBE Data Processing.

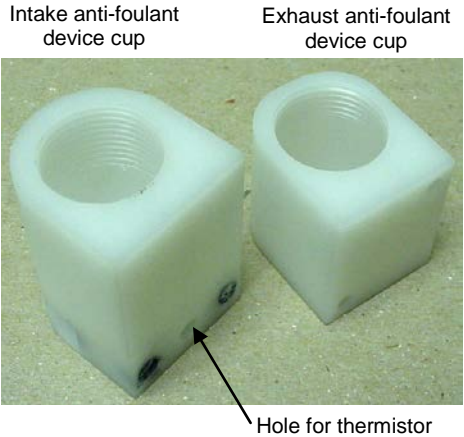
Note:

See the SBE Data Processing manual for information on data processing modules that can correct data for the influences of ship motion and minimize salinity spiking.

The amount of spiking depends on the temperature gradient, and is much worse when coupled surface motion causes the instrument to stop - or even reverse - its descent. In the event of heavy ship motion, it may be worth letting the instrument *free-fall*. When very heavy seas cause severe ship motion and result in periodic reversals of the instrument descent, the data set can be greatly improved by removing scans taken when the pressure is not increasing, using SBE Data Processing.

Installing Anti-Foul Fittings for Moored Applications

The SBE 19plus V2 is intended primarily for use as a profiling instrument, and does not come typically with anti-foulant device cups and caps. Some customers, finding that they use the 19plus V2 in Moored mode on occasion, choose to install a moored mode conversion kit, which includes anti-foulant device cups and caps.



Exhaust anti-foulant device cap (barbed) for pumped applications

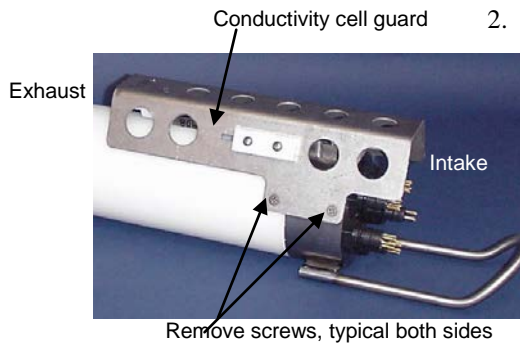


Intake anti-foulant device cap for all applications and exhaust cap for non-pumped applications

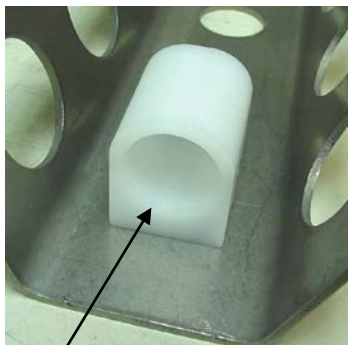


Note: The larger diameter of the intake cap / non-pumped application exhaust cap helps maintain good flow through the conductivity cell and reduces growth of biological material. **Do not use the barbed cap in its place.**

1. On pumped applications, remove the Tygon tubing from the existing conductivity cell exhaust duct.



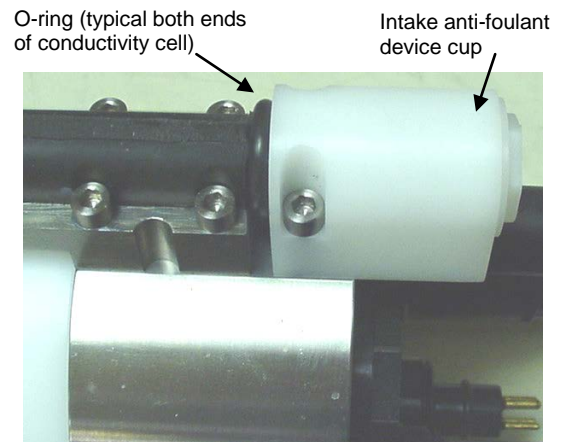
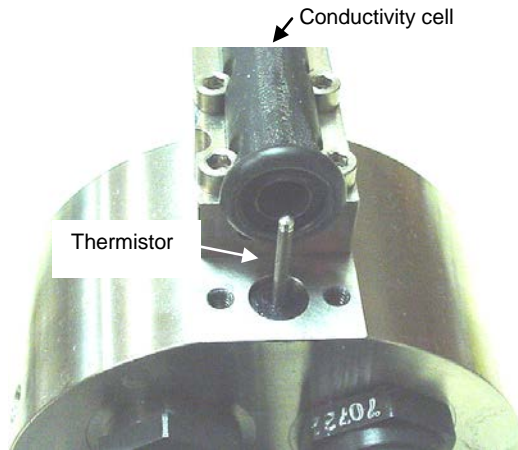
2. Remove the four Phillips-head screws attaching the conductivity cell guard to the housing and end cap. Carefully remove the conductivity cell guard.



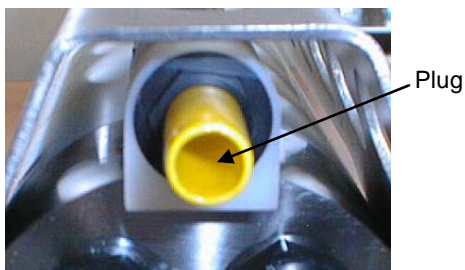
Exhaust anti-foulant device cup

3. Exhaust –
 - A. On the conductivity cell guard, remove the two small screws attaching the exhaust duct to the guard.
 - B. Remove the existing exhaust duct and replace with the exhaust anti-foulant device cup, reinstalling the two screws.
 - C. See *Replacing Anti-Foulant Devices* in *Section 5: Routine Maintenance and Calibration* for details on handling and installing the AF24173 Anti-Foulant Device.
 - D. Install the anti-foulant device cap to secure the Anti-Foulant Device in the cup.

4. Intake –
 - A. Remove the two hex head screws attaching the existing intake duct to the end cap.
 - B. Remove the existing intake duct, pulling it straight up to avoid damaging the thermistor.
 - C. Check to ensure that the O-ring at the end of the conductivity cell is still in place.
 - D. Place the intake anti-foulant device cup over the thermistor and reinstall the hex head screws.
 - E. See *Replacing Anti-Foulant Devices* in *Section 5: Routine Maintenance and Calibration* for details on handling and installing the AF24173 Anti-Foulant Device.
 - F. Install the anti-foulant device cap to secure the Anti-Foulant Device in the cup.



5. Check the exhaust end of the conductivity cell to ensure that the o-ring is still in place.
6. Carefully reinstall the conductivity cell guard on the housing and end cap using the four Phillips-head screws.
7. If not deploying immediately, install a protective plug:
 - In the intake cap, and
 - (for a non-pumped application) In the exhaust cap.
8. (for a pumped application) Reconnect the plumbing to the exhaust. Note that the barbed exhaust cap has a smaller diameter than the usual exhaust cap on the 19plus V2 (which does not accommodate Anti-Foulant Devices). When reconnecting the plumbing, place a 13 mm (0.5 inch) long piece of Tygon tubing, 9.5 mm ID x 13 mm OD (0.375 inch x 0.5 inch), on the barbed cap. Then reinstall the existing plumbing, 13 mm ID x 19 mm OD (0.5 inch x 0.75 inch OD) over the Tygon.



Setup for Deployment

1. Install new batteries or ensure the existing batteries have enough capacity to cover the intended deployment (see *Replacing/Recharging Batteries* in *Section 5: Routine Maintenance and Calibration*).
2. Program the 19plus V2 for the intended deployment using Seaterm232 (see *Section 3: Power and Communications Test* for connection information; see this section for setup/configuration, sampling modes, pump operation, and commands):
 - A. Set the date and time (**DateTime=**).
 - B. Ensure all data has been uploaded, and then send **InitLogging** to make the entire memory available for recording. If **InitLogging** is not sent, data will be stored after the last recorded sample.
 - C. Establish the setup and logging parameters.
If you will be using Seasave to acquire and view real-time data, you must set OutputFormat=0 (raw hexadecimal).
 - D. Send **GetCD** or **DS** to verify the setup.
 - E. If desired, use **StartDateTime=** and **StartLater** to establish delayed start date and time for Profiling mode (if **IgnoreSwitch=Y**) or Moored mode.
3. If you will be using Seasave to acquire and view real-time data, verify that the configuration (.xmlcon or .con) file matches the instrument configuration. Sea-Bird supplies a configuration file to match the factory configuration and calibrations. If the instrument is recalibrated or the configuration is changed (such as by adding external sensors), the configuration file must be updated to reflect the current condition. See *Verifying Contents of Configuration (.xmlcon or .con) File*.
4. If you will be using Seaterm232 to view real-time data, click the Capture menu to save the data to a file. Enter the desired capture file name in the dialog box, and click Save.

Note:

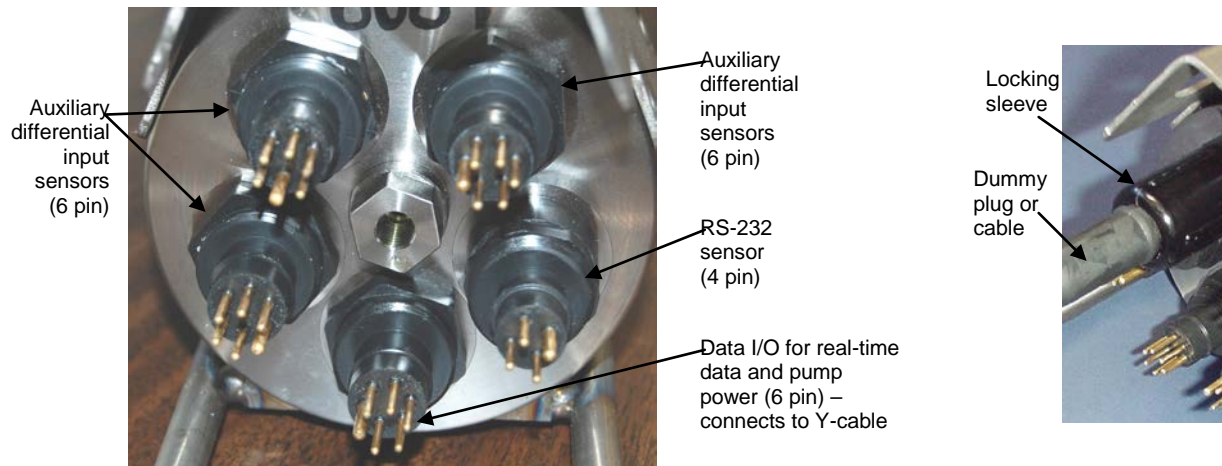
A new or recalibrated CTD ships with a configuration file that reflects the current configuration as we know it. The file is named with the instrument serial number, followed by a .xmlcon extension. For example, for a CTD with serial number 2375, Sea-Bird names the file 2375.xmlcon. You may rename the file (but not the extension) if desired; this will not affect the results.

Deployment

CAUTIONS:

- Do not use WD-40 or other petroleum-based lubricants, as they will damage the connectors.
- For wet-pluggable MCBH connectors: **Silicone lubricants in a spray can** may contain ketones, esters, ethers, alcohols, or glycols in their propellant. **Do not use these sprays, as they will damage the connector.**

1. Install a cable or dummy plug for each connector on the 19plus V2 sensor end cap:
 - A. Lightly lubricate the inside of the dummy plug/cable connector with silicone grease (DC-4 or equivalent).
 - B. **XSG / AG Connector** - Install the plug/cable connector, aligning the raised bump on the side of the plug/cable connector with the large pin (pin 1 - ground) on the 19plus V2. Remove any trapped air by *burping* or gently squeezing the plug/connector near the top and moving your fingers toward the end cap. **OR** **MCBH Connector** – Install the plug/cable connector, aligning the pins.
 - C. Place the locking sleeve over the plug/cable connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**



2. Connect the other end of the cables installed in Step 1 to the appropriate sensors.
3. Verify that the hardware and external fittings are secure.
4. If applicable, remove the Tygon tubing that was looped end-to-end around the conductivity cell for storage. Reconnect the system plumbing (see *Configuration Options and Plumbing* in Section 2: Description of SBE 19plus V2).
5. **Profiling mode** - Immediately prior to deployment:
 - (if IgnoreSwitch=N) Turn on the magnetic switch, **or**
 - (if IgnoreSwitch=Y) If not already done, send **StartNow**, or send **StartDateTime=** and **StartLater**, **or**
 - (if AutoRun=Y) With the 19plus V2 in quiescent (sleep) state, apply external power.
6. **Moored mode** - If not already done, send **StartNow**, or send **StartDateTime=** and **StartLater**.

The SBE 19plus V2 is ready to go into the water.

Acquiring Real-Time Data with Seasave

Notes:

- Seasave and SBE Data Processing versions 7.20a introduced .xmlcon files (in XML format). Versions 7.20a and later allow you to open a .con or .xmlcon file, and to save it to a .con or .xmlcon file. Seasave and SBE Data Processing use the same file.
- A new or recalibrated CTD ships with a configuration file that reflects the current configuration as *we know it*. The file is named with the instrument serial number, followed by a .con extension. For example, for a CTD with serial number 2375, Sea-Bird names the file *2375.con*. You may rename the file (but not the extension) if desired; this will not affect the results.
- In the 19plus V2 setup commands, external voltage numbers 0, 1, 2, 3, 4, and 5 correspond to wiring of sensors to a voltage channel on the end cap (see *Dimensions and End Cap Connectors* in *Section 2: Description of SBE 19plus V2*). However, in the .xmlcon or .con file, voltage 0 is the first external voltage in the data stream, voltage 1 is the second, etc.
- Some RS-232 auxiliary sensors (SeaFET pH sensor, Pro-Oceanus Gas Tension Device) are only compatible when the 19plus V2 is in Moored mode. Therefore, they are not available in the software configuration file if the 19plus V2 is in Profile mode.

Verifying Contents of Configuration (.xmlcon or .con) File

Seasave, our real-time data acquisition and display program, requires a configuration file, which defines the CTD – integrated auxiliary sensors, and channels, serial numbers, and calibration dates and coefficients for all the sensors (conductivity, temperature, and pressure as well as auxiliary sensors). Seasave (as well as our data processing software) uses the information in the configuration file to interpret and process the raw data. **If the configuration file does not match the actual instrument configuration, the software will not be able to interpret and process data correctly.**

1. Double click on Seasave.exe.
2. Click Configure Inputs. On the Instrument Configuration tab, click *Open*. In the dialog box, select the .xmlcon or .con file and click Open.

- The configuration information appears on the Instrument Configuration tab. Verify that the sensors match those on your 19plus V2, and that auxiliary sensors are assigned to the correct channels. Click Modify to bring up a dialog box (shown below) to change the configuration and/or to view / modify calibration coefficients.

Configuration for the SBE 19plus V2 Seacat CTD

Configuration file opened: None

Pressure sensor type: Strain Gauge

External voltage channels: 4

Mode: Profile

Serial RS-232C sensor: None

Sample interval seconds: 10

Scans to average: 1

NMEA position data added NMEA depth data added

NMEA device connected to deck unit NMEA time added

NMEA device connected to PC

Surface PAR voltage added Scan time added

Channel	Sensor	New
1. Count	Temperature	Open...
2. Frequency	Conductivity	Save
3. Count	Pressure, Strain Gauge	Save As...
4. A/D voltage 0	Oxygen, SBE 43	Select...
5. A/D voltage 1	pH	Modify...
6. A/D voltage 2	Transmissometer, Chelsea/Seatech/Wetlab	
7. A/D voltage 3	Altimeter	

Report... Help... Exit Cancel

Channel/Sensor table reflects this choice (0, 1, 2, 3, 4, 5, or 6). Must agree with 19plus V2 setup for VoltN= (N= 0, 1, 2, 3, 4, and 5); see reply from GetCD or DS. Voltage channel 0 in .xmlcon or .con file corresponds to first external voltage in data stream, voltage channel 1 to second, etc.

Strain gauge or Digiquartz with temperature compensation.

Must agree with 19plus V2 setup (MP for Profiling mode, MM for Moored mode); see reply from GetCD or DS.

SBE 38 (secondary temperature), SBE 63 (optical DO), WET Labs sensor (up to 3 channels), WET Labs SeaOWL UV-A, SeaFET pH, up to 2 GTDs (dissolved oxygen or nitrogen), or Optode. Must agree with 19plus V2 setup; see reply from GetCD or DS. Channel/Sensor table lists RS-232 sensors below voltage channels.

Interval between scans in Moored mode. Used to calculate elapsed time, if time is an output parameter. Must agree with 19plus V2 setup (SampleInterval=); see reply from GetCD or DS.

Number of samples to average (samples at 4 Hz) in Profiling mode. Used to calculate elapsed time, if time is output parameter. Must agree with 19plus V2 setup (NAvg=); see reply from GetCD or DS.

NMEA - Select if NMEA navigation device used, and select whether NMEA device is connected directly to Deck Unit or to computer. You can also append NMEA depth data (3 bytes) and NMEA time data (4 bytes) after Lat/Lon data. Seasave adds current latitude, longitude, and universal time code to data header; appends NMEA data to every scan; and writes NMEA data to .nav file every time Ctrl F7 is pressed or Add to .nav File is clicked.
 Notes:
 1. NMEA time can only be appended if NMEA device connected to computer.
 2. NMEA depth can only be appended if NMEA device connected to computer or if using 19plus V2 with PN 90488 or 90545 Interface Box.

Surface PAR - Select if using with deck unit connected to Surface PAR sensor. Seasave appends Surface PAR data to every scan. Adds 2 channels to Channel/Sensor table. Do not increase External voltage channels to reflect this; External voltage channels reflects only external voltages going directly to 19plus V2 from auxiliary sensor. See Application Note 47.

Scan time added - Select to have Seasave append time (seconds since January 1, 1970 GMT) to each data scan.

New to create new .xmlcon or .con file for this CTD. Open to select different .xmlcon or .con file. Save or Save As to save current .xmlcon or .con file settings.

Shaded sensors cannot be removed or changed to another type of sensor. All others are optional.

Click a (non-shaded) sensor and click Select to pick a different sensor for that channel. Dialog box with list of sensors appears. Select sensors after number of voltage channels have been specified above.

Click a sensor and click Modify to change calibration coefficients for that sensor.

- Click Save or Save As to save any changes to the .xmlcon or .con file. Click Exit when done reviewing / modifying the configuration.

Acquiring Real-Time Data

Instructions below are for an SBE 19plus V2 with a conventional single-core armored cable, used without a Sea-Bird Deck Unit. **If using the 19plus V2 with the SBE 33 or 36 Deck Unit or the SeaCAT/Sealogger RS-232 and Navigation Interface Box, see the Deck Unit or Interface Box manual.**

1. Wiring - Terminate the single-core armored cable with an RMG-4FS or MCIL-4FS connector, as applicable. Wire the cable armor to pin 1 (large pin for 19plus V2 with XSG / AG connectors) and the inner conductor to pin 3 (opposite pin 1) on the 19plus V2 data I/O - power connector (4-pin leg on Y-cable connected to Data I/O, Pump, and External Power bulkhead connector). On deck, wire:

Slip-ring lead	25-pin serial port	9-pin serial port
from armor	Pin 7	Pin 5
from inner conductor	Pin 3	Pin 2

Note:

The baud rate between the 19plus V2 and computer (defined in Configure Inputs, on the Serial Ports tab) must match the baud rate set in the 19plus V2 with **BaudRate=**.

2. Double click on **Seasave.exe**.
3. Perform any desired setup in the Configure Inputs, Configure Outputs, and Display menus..
4. In the Real-Time Data menu, select *Start*. The dialog box looks like this:

Data Archiving Options:

- **Begin archiving data immediately** to store raw (frequencies, A/D counts, and/or voltages) real-time data as soon as Start button is clicked and communication is established.
- **Begin archiving data when 'Start Archiving' command is sent** to control when data begins to be written to file. This allows you to eliminate scans associated with deploying CTD from ship deck and soaking instrument near surface (alternatively, remove these scans later in SBE Data Processing). If you make this selection, when you click Start button and communication is established, a dialog box with Start Archiving button appears. Click this button when ready to begin saving scans to file, or select Start Archiving in Real-Time Data menu.
- **Do not archive data for this cast** to not save data to a file. Real-time data will still appear in displays.

Configuration Options: Currently selected instrument configuration (.xmlcon or .con) file is shown, containing information on number and type of sensors interfacing with 19plus V2, calibration coefficients, and inclusion of NMEA and/or Surface PAR data with output from CTD. To modify input configuration (.xmlcon or .con file, serial ports, water sampler, TCP/IP ports, and/or miscellaneous), click Configure Inputs. To modify outputs (serial data output, serial ports, shared file output, mark variables, TCP/IP output, TCP/IP ports, SBE 14 remote display, PC alarms, header form, and/or diagnostics), click Configure Outputs.

- **Timeout in seconds at startup:** Time allowed before first data scan is received from 19plus V2. Seasave will *time out* and stop attempting to acquire data if data is not received from 19plus V2 within this time period.
- **Timeout in seconds between scans:** Maximum **gap** allowed between scans after first data scan is received from 19plus V2. Seasave will *time out* and stop attempting to acquire data if data is not received from 19plus V2 within this time period (for example, if a shark bites cable and interrupts data acquisition, Seasave stops attempting to acquire data after this gap).

Start Real-Time Data Acquisition

Data Archiving Options

Begin archiving data immediately

Begin archiving data when 'Start Archiving' command is sent

Do not archive data for this cast

Output data [.HEX] file

C:\Documents and Settings\vbresko\My Documents\test.hex

Select Output Data File Name

Click **Select Output Data File Name**. Save Archived Data As dialog box appears; browse to desired file location, enter desired file name, and click Save.

Configuration Options

Instrument configuration [.xmlcon or .con] file: (to change select Configure Inputs)

C:\Documents and Settings\vbresko\My Documents\test.xmlcon

Configure Inputs

Configure Outputs

Timeout in seconds at startup: 60

Timeout in seconds between scans: 20

Report Help Start Exit Cancel

Notes:

- If in **Moored** mode, the 19plus V2 must be sampling autonomously to use Seasave for real-time data acquisition. Start sampling by sending **StartNow** or **StartLater** in Seaterm232 before starting acquisition in Seasave.
- To prevent problems in the use of the COM port, click Disconnect in the Communications menu in Seaterm232, and close Seaterm232 before starting real-time acquisition in Seasave.

5. In the Start Real-Time Data Acquisition dialog box, click *Start*.
 - A. If you selected *Begin archiving data immediately* or *Begin archiving data when 'Start Archiving' command is sent* above, and selected *Prompt for Header Information* in the Header Form setup (Configure Outputs), the Header Information dialog box appears. Fill in the desired header and click OK.
 - B. If you selected *NMEA position data added* in the .xmlcon or .con file, Seasave initializes NMEA communications.
 - C. If you selected *Check Scan Length* in the Options menu, Seasave checks the .xmlcon or .con file to verify that the scan length defined by the configuration file matches the 19plus V2 (i.e., number of sensors and inclusion of NMEA is as defined in the file). If a *Scan length error* appears, verify that:
 - You are using the correct .xmlcon or .con configuration file.
 - The configuration file has been updated as necessary if you added or deleted sensors, added or deleted NMEA or Surface PAR, etc.
 - D. Seasave sends a message: *Waiting for data. . .* If you have already started logging data, ignore the message; otherwise, slide the magnetic switch to the On position or apply external power, as applicable to your setup of the 19plus V2. Seasave *times out* if data is not received within *Timeout in seconds at startup*.
 - E. Real-time data then starts appearing in the screen displays.
6. To stop real-time data acquisition: In the Real-Time Data menu, select *Stop*.
7. Stop logging:
 - If **IgnoreSwitch=N** and **AutoRun=N**: Put the magnetic switch in the Off position.
 - If **IgnoreSwitch=Y** and **AutoRun=N**: Close Seasave, then open **Seaterm232** and send **Stop**.
 - If **AutoRun=Y**: Remove external power.

Recovery

WARNING!

If the 19plus V2 stops working while underwater, is unresponsive to commands, or shows other signs of flooding or damage, carefully secure it away from people until you have determined that abnormal internal pressure does not exist or has been relieved. Pressure housings may flood under pressure due to dirty or damaged o-rings, or other failed seals. When a sealed pressure housing floods at great depths and is subsequently raised to the surface, water may be trapped at the pressure at which it entered the housing, presenting a danger if the housing is opened before relieving the internal pressure. Instances of such flooding are rare. However, a housing that floods at 5000 meters depth holds an internal pressure of more than 7000 psia, and has the potential to eject the end cap with lethal force. A housing that floods at 50 meters holds an internal pressure of more than 85 psia; this force could still cause injury.

If you suspect the 19plus V2 is flooded, point the 19plus V2 in a safe direction away from people, and loosen 1 end cap bulkhead connector very slowly, at least 1 turn. This opens an o-ring seal under the connector. Look for signs of internal pressure (hissing or water leak). If internal pressure is detected, let it bleed off slowly past the connector o-ring. Then, you can safely remove the end cap.

Physical Handling

1. Rinse the instrument and conductivity cell with fresh water. (See *Section 5: Routine Maintenance and Calibration* for cell cleaning and storage.)
2. If the batteries are exhausted, new batteries must be installed before the data can be extracted. Stored data will not be lost as a result of exhaustion or removal of batteries. (See *Section 5: Routine Maintenance and Calibration* for replacement of batteries.)
3. If immediate redeployment is not required, it is best to leave the 19plus V2 with batteries in place and in a quiescent state (**QS**). Because the quiescent current required is only 20 microAmps, the batteries can be left in place without significant loss of capacity. If the 19plus V2 is to be stored for a long time, **replace the batteries yearly to prevent battery leakage** (which could damage the 19plus V2).

Uploading Data

*Note: For best performance and compatibility, Sea-Bird recommends that customers set their computer to English language format and the use of a period (.) for the decimal symbol. Some customers have found corrupted data when using the software's **binary upload** capability while set to other languages. To update your computer's language and decimal symbol (instructions are for a Windows 7 operating system):*

1. In the computer Control Panel window, select Region and Language.
2. In the Region and Language window, on the Formats tab, select English in the Format pull down box.
3. In the Region and Language window, click the Additional settings . . . button. In the Customize Format window, select the period (.) in the Decimal symbol pull down box, and click OK.
4. In the Region and Language window, click OK.

Follow the procedure below to upload data:

Note:

Data may be uploaded during deployment or after recovery. If uploading after recovery, connect the I/O cable as described in Section 3: Power and Communications Test.

1. Double click on **SeatermV2.exe**. The main screen appears.
2. In the Instruments menu, select *SBE 19plus V2*. **Seaterm232** opens.
3. Seaterm232 will try to automatically connect to the 19plus V2. As it connects, it sends **GetHD** and displays the response. Seaterm232 also fills the Send Commands window with the correct list of commands for your 19plus V2. **If there is no communication:**
 - A. In the Communications menu, select *Configure*. The Serial Port Configuration dialog box appears. Select the Comm port and baud rate for communication, and click OK.
 - B. In the Communications menu, select *Connect* (if *Connect* is grayed out, select *Disconnect and reconnect*).
 - C. If there is still no communication, check cabling between the computer and 19plus V2.
 - D. If there is still no communication, repeat Step A with a different baud rate and/or comm port, and try to connect again. Note that the factory-set baud rate is documented on the Configuration Sheet.
4. Command the 19plus V2 to stop data logging by the method applicable to your instrument's setup:
 - Pressing the Enter key, typing **Stop**, and pressing the Enter key again, or
 - Moving the magnetic switch to the Off position (only applicable in Profiling mode, if **IgnoreSwitch=N**)

Note:

You may need to send **Stop** several times to get the 19plus V2 to respond.

5. Display 19plus V2 status information by typing **DS** and pressing the Enter key. The display looks like this (if in Profiling mode):

```
SBE 19plus V 3.1.8 SERIAL NO. 4000 13 Apr 2016 14:02:13
vbatt = 10.1, vlith = 8.9, ioper = 61.9 ma, ipump = 20.8 ma,
iext01 = 76.2 ma
status = not logging
number of scans to average = 1
samples = 1939488, free = 4042161, casts = 22
mode = profile, minimum cond freq = 3000, pump delay = 60 sec
autorun = no, ignore magnetic switch = no
battery type = alkaline, battery cutoff = 7.5 volts
pressure sensor = strain gauge, range = 1000.0
SBE 63 = no, SBE 38 = no, WETLABS = no, OPTODE = no, SBE 63 = no,
SeaFET = no, Gas Tension Device = no
Ext Volt 0 = no, Ext Volt 1 = no
Ext Volt 2 = no, Ext Volt 3 = no
Ext Volt 4 = no, Ext Volt 5 = no
echo characters = yes
output format = converted decimal
output salinity = no, output sound velocity = no
```

Verify that the status shows `status = not logging`.

6. Click Upload to upload stored data. Seaterm232 responds as follows:
 - A. Seaterm232 sends **GetSD** and displays the response. **GetSD** provides information on the number of samples in memory.
 - B. Seaterm232 sends **DH** and displays the response. **DH** provides information on the headers in memory.
 - C. In the Save As dialog box, enter the desired upload file name and click Save. The upload file has a .XML extension.
 - D. An Upload Data dialog box appears:

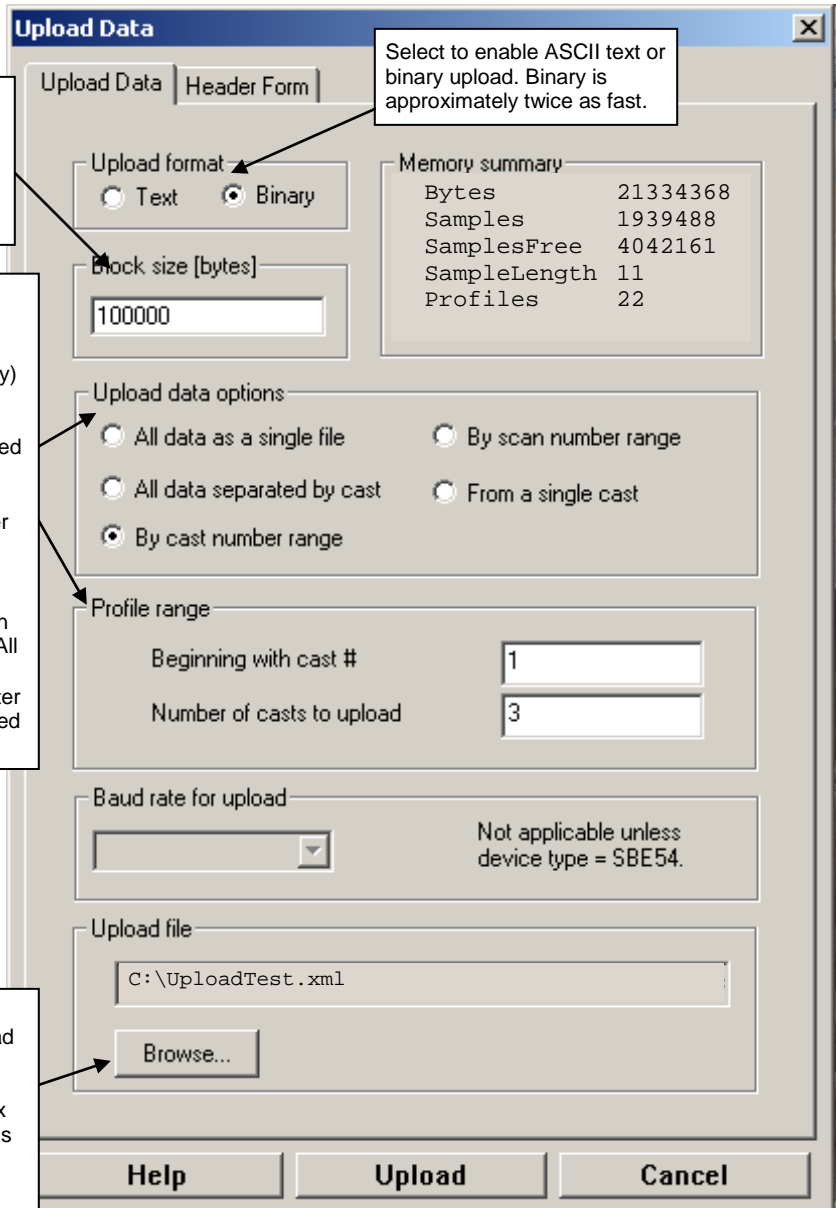
Note:
 If binary upload is selected, Seaterm232 uploads the data in binary and then converts it to ASCII text, resulting in a data file that is identical to one uploaded in ASCII text.

Select number of bytes uploaded in each block. Seaterm232 uploads data in blocks, and calculates a checksum at end of each block. If block fails checksum verification, Seaterm232 tries to upload block of data again, cutting block size in half.

Defines data upload type and range:

- All data as a single file – All data is uploaded into 1 file.
- All data separated by cast (Profiling mode only) - All data uploaded. Separate file is written for each cast, with 3-digit cast identification number (001 to 301) appended to user-selected file name.
- By cast number range (Profiling mode only) – Enter beginning cast number and total number of casts. Separate file is written for each cast, with 3-digit cast identification number (001 to 301) appended to user-selected file name.
- By scan number range – Enter beginning scan (sample) number and total number of scans. All data within range is uploaded into 1 file.
- From a single cast (Profiling mode only) – Enter cast number. All data from that cast is uploaded into 1 file.

To change upload file name selected in Step C above, click Browse to navigate to desired upload file path and name. Upload file has a .xml extension. After Seaterm232 uploads data into .xml file, it automatically converts .xml file to .hex file (same file name, different extension), which is compatible with Seasave and SBE Data Processing.



Make the desired selections.

7. Click the Header Form tab to customize the header:

Defines header information included with uploaded data:

- Prompt for header information – Each time data is uploaded, user is prompted to fill out user-defined header form.
- Include default header form in upload file – User-defined default header form included in upload file. User is not prompted to add any information when data is uploaded.
- Don't include default header form in upload file – Header information not included in upload file.

The entries are free form, 0 to 12 lines long. This dialog box establishes:

- the header prompts that appear for the user to fill in when uploading data, if *Prompt for header information* was selected
- the header included with the uploaded data, if *Include default header form in upload file* was selected

Enter the desired header/header prompts.

8. Click Upload; the Status bar at the bottom of the window displays the upload progress:

- Seaterm232 sends **GetHD** (get hardware data), **GetSD** (get status data), **GetCD** (get configuration data), **GetCC** (get calibration coefficients), and **GetEC** (get event counter), and writes the responses to the upload file. These commands provide information regarding the number of samples in memory, mode, header/cast numbers, calibration coefficients, etc.
- If you selected *Prompt for header information* in the Upload Data dialog box** – a dialog box with the header form appears. Enter the desired header information, and click OK. Seaterm232 writes the header information to the upload file.
- Seaterm232 sends the data upload command, based on your selection of upload range in the Upload Data dialog box, writes the data to the upload .xml file, and then creates the .hex file from the .xml file. The .hex file contains the data in raw hexadecimal, for compatibility with Seasave and SBE Data Processing.
- If you selected *All data separated by cast* or *By cast number range* in the Upload Data dialog box** – Seaterm232 repeats Steps B and C for each cast.
- When the data has been uploaded, Seaterm232 shows the S> prompt (if **OutputExecutedTag=N**).

Note:

The commands and responses automatically sent by Seaterm232 during the upload do not appear in the Command/Data Echo Area.

Notes:

To prepare for redeployment:

1. After all data has been uploaded, send **InitLogging**. If this command is not sent, new data will be stored after the last recorded sample, preventing use of the entire memory capacity.
 2. Send **QS** to put the 19plus V2 in quiescent (sleep) state until ready to redeploy. Quiescent current is only 20 microAmps, so the batteries can be left in place without significant loss of capacity.
9. Ensure all data has been uploaded by reviewing and processing the data:
 - A. Use **Seasave** to display and plot the *raw* hexadecimal data in engineering units (see *Verifying Contents of Configuration (.xmlcon or .con) File* and Seasave's manual/Help files).
 - B. Use **SBE Data Processing** to process and plot the data (see *Processing Data Using SBE Data Processing* and SBE Data Processing manual/Help files).

Processing Data Using SBE Data Processing

Notes:

- Seasave and SBE Data Processing versions 7.20a introduced .xmlcon files (in XML format). Versions 7.20a and later allow you to open a .con or .xmlcon file, and to save it to a .con or .xmlcon file. Seasave and SBE Data Processing use the same file.
- A new or recalibrated CTD ships with a configuration file that reflects the current configuration as *we know it*. The file is named with the instrument serial number, followed by a .con extension. For example, for a CTD with serial number 2375, Sea-Bird names the file *2375.con*. You may rename the file (but not the extension) if desired; this will not affect the results.
- In the 19plus V2 setup commands, external voltage numbers 0, 1, 2, 3, 4, and 5 correspond to wiring of sensors to a voltage channel on the end cap (see *Dimensions and End Cap Connectors* in *Section 2: Description of SBE 19plus V2*). However, in the .xmlcon or .con file, voltage 0 is the first external voltage in the data stream, voltage 1 is the second, etc.
- Some RS-232 auxiliary sensors (SeaFET pH sensor, Pro-Oceanus Gas Tension Device) are only compatible when the 19plus V2 is in Moored mode. Therefore, they are not available in the software configuration file if the 19plus V2 is in Profile mode.

1. Convert the .hex (raw data) file (real-time file from Seasave or uploaded from 19plus V2 memory) to a .cnv (engineering units) file in SBE Data Processing's Data Conversion module.
2. Once the data is converted: perform further processing (align, filter, remove bad data, etc.), calculate derived variables, and plot data using SBE Data Processing's other modules.

Verifying Contents of Configuration (.xmlcon or .con) File

To convert the .hex (raw data) file, you need a .xmlcon or .con configuration file, which defines the instrument – integrated sensors, and channels, serial numbers, and calibration dates and coefficients for all sensors (C, T, and P as well as auxiliary sensors). SBE Data Processing (as well as our real-time data acquisition software) uses the configuration file information to interpret and process the raw data. **If the configuration file does not match the actual instrument configuration, the software will be unable to interpret and process the data correctly.**

To view or modify the .xmlcon or .con file:

1. Double click on SBEDataProc.exe.
2. In the Configure menu, select *SBE 19plus V2 Seacat CTD*. The configuration dialog box appears; click Open.

- In the Open dialog box, select the .xmlcon or .con file and click Open. Verify that the sensors match those on your 19plus V2, auxiliary sensors are assigned to the correct voltage channels, and calibration coefficients for all sensors are up-to-date.

Configuration for the SBE 19plus V2 Seacat CTD

Configuration file opened: None

Pressure sensor type: Strain Gauge

External voltage channels: 4

Mode: Profile

Serial RS-232C sensor: None

Sample interval seconds: 10

Scans to average: 1

NMEA position data added NMEA depth data added

NMEA device connected to deck unit NMEA time added

NMEA device connected to PC

Surface PAR voltage added Scan time added

Channel	Sensor
1. Count	Temperature
2. Frequency	Conductivity
3. Count	Pressure, Strain Gauge
4. A/D voltage 0	Oxygen, SBE 43
5. A/D voltage 1	pH
6. A/D voltage 2	Transmissometer, Chelsea/Seatech/Wetlab
7. A/D voltage 3	Altimeter

Buttons: New, Open..., Save, Save As..., Select..., Modify..., Report..., Help..., Exit, Cancel

Callout Boxes:

- Channel/Sensor table reflects this choice (0, 1, 2, 3, 4, 5, or 6). Must agree with 19plus V2 setup for VoltN= (N= 0, 1, 2, 3, 4, and 5); see reply from GetCD or DS. Voltage channel 0 in .xmlcon or .con file corresponds to first external voltage in data stream, voltage channel 1 to second, etc.
- Strain gauge or Digiquartz with temperature compensation.
- Must agree with 19plus V2 setup (MP for Profiling mode, MM for Moored mode); see reply from GetCD or DS.
- SBE 38 (secondary temperature), SBE 63 (optical DO), WET Labs sensor (up to 3 channels), WET Labs SeaOWL UV-A, SeaFET pH, up to 2 GTDs (dissolved oxygen or nitrogen), or Optode. Must agree with 19plus V2 setup; see reply from GetCD or DS. Channel/Sensor table lists RS-232 sensors below voltage channels.
- Interval between scans in Moored mode. Used to calculate elapsed time, if time is an output parameter. Must agree with 19plus V2 setup (SampleInterval=); see reply from GetCD or DS.
- Number of samples to average (samples at 4 Hz) in Profiling mode. Used to calculate elapsed time, if time is output parameter. Must agree with 19plus V2 setup (NAvg=); see reply from GetCD or DS.
- NMEA - Select if NMEA navigation device used, and if NMEA depth data and NMEA time data were also appended. Seasave adds current latitude, longitude, and universal time code to data header; appends NMEA data to every scan; and writes NMEA data to .nav file every time Ctrl F7 is pressed or Add to .nav File is clicked. Note: Whether NMEA device was connected to a deck unit or directly to computer during data acquisition in Seasave has no effect on data file used by SBE Data Processing, and therefore has no effect on data processing.
- Surface PAR - Select if using with deck unit connected to Surface PAR sensor. Seasave appends Surface PAR data to every scan. Adds 2 channels to Channel/Sensor table. Do not increase External voltage channels to reflect this; External voltage channels reflects only external voltages going directly to 19plus V2 from auxiliary sensor. See Application Note 47.
- Scan time added - Select if Seasave appended time (seconds since January 1, 1970 GMT) to each data scan.
- Shaded sensors cannot be removed or changed to another type of sensor. All others are optional.
- New to create new .xmlcon or .con file for this CTD. Open to select different .xmlcon or .con file. Save or Save As to save current .xmlcon or .con file settings.
- Click a (non-shaded) sensor and click Select to pick a different sensor for that channel. Dialog box with list of sensors appears. Select sensors after number of voltage channels have been specified above.
- Click a sensor and click Modify to change calibration coefficients for that sensor.

- Click Save or Save As to save any changes to the .xmlcon or .con file. Click Exit when done reviewing / modifying the configuration.

Editing Raw Data File

Sometimes users want to edit the raw .hex data file before beginning processing, to remove data at the beginning of the file corresponding to instrument *soak* time, to remove blocks of bad data, to edit the header, or to add explanatory notes about the cast. **Editing the raw .hex file can corrupt the data, making it impossible to perform further processing using Sea-Bird software.** Sea-Bird strongly recommends that you first convert the data to a .cnv file (using the Data Conversion module in SBE Data Processing), and then use other SBE Data Processing modules to edit the .cnv file as desired.

Note:

Although we provide this technique for editing a raw .hex file, **Sea-Bird's strong recommendation, as described above, is to always convert the raw data file and then edit the converted file.**

The procedure for editing a .hex data file described below has been found to work correctly on computers running Windows 98, 2000, and NT. **If the editing is not performed using this technique, SBE Data Processing may reject the edited data file and give you an error message.**

1. **Make a back-up copy of your .hex data file before you begin.**
2. Run **WordPad**.
3. In the File menu, select Open. The Open dialog box appears. For *Files of type*, select *All Documents (*.*)*. Browse to the desired .hex data file and click Open.
4. Edit the file as desired, **inserting any new header lines after the System Upload Time line**. Note that all header lines must begin with an asterisk (*), and *END* indicates the end of the header. An example is shown below (for an SBE 21), with the added lines in bold:

```
* Sea-Bird SBE 21 Data File:
* FileName = C:\Odis\SAT2-ODIS\oct14-19\oc15_99.hex
* Software Version Seasave Win32 v1.10
* Temperature SN = 2366
* Conductivity SN = 2366
* System UpLoad Time = Oct 15 1999 10:57:19
* Testing adding header lines
* Must start with an asterisk
* Place anywhere between System Upload Time & END of header
* NMEA Latitude = 30 59.70 N
* NMEA Longitude = 081 37.93 W
* NMEA UTC (Time) = Oct 15 1999 10:57:19
* Store Lat/Lon Data = Append to Every Scan and Append to .NAV
File When <Ctrl F7> is Pressed
** Ship:          Sea-Bird
** Cruise:       Sea-Bird Header Test
** Station:
** Latitude:
** Longitude:
*END*
```

5. In the File menu, select Save (**not Save As**). If you are running Windows 2000, the following message displays:

```
You are about to save the document in a Text-Only
format, which will remove all formatting. Are you sure
you want to do this?
```

Ignore the message and click *Yes*.

6. In the File menu, select Exit.

Section 5: Routine Maintenance and Calibration

This section reviews:

- corrosion precautions
- connector mating and maintenance
- plumbing maintenance
- replacement/recharging batteries
- O-ring maintenance
- conductivity cell storage and cleaning
- pressure sensor maintenance
- replacement of optional AF24173 Anti-Foulant Devices
- sensor calibration

The accuracy of the SBE 19plus V2 is sustained by the care and calibration of the sensors and by establishing proper handling practices.

Corrosion Precautions

Rinse the SBE 19plus V2 with fresh water after use and prior to storage.

For both the plastic and titanium housing, all exposed metal is titanium (the plastic housing has a titanium end cap). No corrosion precautions are required, but avoid direct electrical connection of the titanium to dissimilar metal hardware.

Connector Mating and Maintenance

Note:

See *Application Note 57: Connector Care and Cable Installation*.

Clean and inspect connectors, cables, and dummy plugs before every cruise, during a cruise (good practice if you have a few days of down time between casts), after every cruise, and as part of your yearly equipment maintenance. Inspect connectors that are unmated for signs of corrosion product around the pins, and for cuts, nicks or other flaws that may compromise the seal.

When remating:

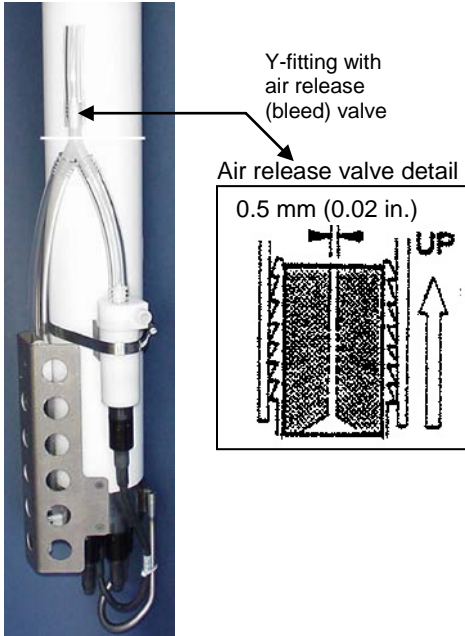
1. Lightly lubricate the inside of the dummy plug/cable connector with silicone grease (DC-4 or equivalent).
2. **XSG / AG Connector** - Install the plug/cable connector, aligning the raised bump on the side of the plug/cable connector with the large pin (pin 1 - ground) on the 19plus V2. Remove any trapped air by *burping* or gently squeezing the plug/connector near the top and moving your fingers toward the end cap. **OR**
MCBH Connector – Install the plug/cable connector, aligning the pins.
3. Place the locking sleeve over the plug/cable connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

Verify that a cable or dummy plug is installed for each connector on the system before deployment.

CAUTIONS:

- **Do not use WD-40** or other petroleum-based lubricants, as they will damage the connectors.
- For wet-pluggable MCBH connectors: **Silicone lubricants in a spray can** may contain ketones, esters, ethers, alcohols, or glycols in their propellant. **Do not use these sprays, as they will damage the connector.**

Plumbing Maintenance



For an SBE 19plus V2 with plumbing configured for vertical orientation - **A clogged air release valve can trap air, preventing the pump from functioning properly**; this will affect the data quality. Periodically clean the air release valve:

1. Use a 0.4 mm (0.016 inches) diameter wire (you can use #26 AWG wire) to clean the valve. The easiest way to do this is to remove the Tygon tubing above the air release valve, and use needle-nosed pliers to force the wire through the hole.
2. Blow through the air release valve to ensure it is open.
3. (if applicable) Replace the Tygon tubing above the air release valve.

Replacing / Recharging Batteries

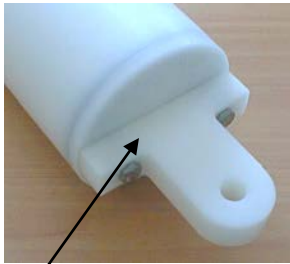
Note:

If changing from alkaline to Ni-Cad or NiMH batteries, or vice versa, send **BatteryType=** to indicate the new battery type.

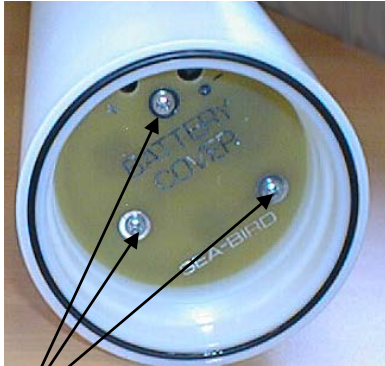
Leave the batteries in place when storing the SBE 19plus V2 to prevent depletion of the back-up lithium batteries by the real-time clock. Even *exhausted* main batteries will power the clock (20 microAmps) almost indefinitely. If the 19plus V2 is to be stored for long periods, **replace the batteries yearly to prevent battery leakage** (which could damage the 19plus V2).



Alkaline D-cell
(MN1300, LR20)



Unthread cap by rotating counter-clockwise



Remove Phillips-head screws and washers

Replacing Alkaline Batteries

The 19plus V2 uses alkaline D-cells (Duracell MN1300, LR20), dropped into the battery compartment.

1. Remove the battery end cap (end cap without connectors):
 - A. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.
 - B. Unthread the end cap by rotating counter-clockwise (use a wrench on the white plastic bar if necessary).
 - C. Remove any water from the O-ring mating surfaces inside the housing with a lint-free cloth or tissue.
 - D. Put the end cap aside, being careful to protect the O-ring from damage or contamination.
2. Remove the battery cover plate from the housing:
 - A. Remove the three Phillips-head screws and washers from the battery cover plate inside the housing.
 - B. The battery cover plate will pop out. Put it aside.
3. Turn the 19plus V2 over and remove the batteries.
4. Install the new batteries, with the + terminals against the flat battery contacts and the - terminals against the spring contacts.
5. Reinstall the battery cover plate in the housing:
 - A. Align the battery cover plate with the housing. The posts inside the housing are not placed symmetrically, so the cover plate fits into the housing only one way. Looking at the cover plate, note that one screw hole is closer to the edge than the others, corresponding to the post that is closest to the housing.
 - B. Reinstall the three Phillips-head screws and washers, while pushing hard on the battery cover plate to depress the spring contacts at the bottom of the battery compartment. **The screws must be fully tightened, or battery power to the circuitry will be intermittent.**
6. Check the battery voltage at BAT + and BAT - on the battery cover plate. It should be approximately 13.5 volts.
7. Reinstall the battery end cap:
 - A. Remove any water from the O-rings and mating surfaces with a lint-free cloth or tissue. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-rings and mating surfaces.
 - B. Carefully fit the end cap into the housing and rethread the end cap into place. Use a wrench on the white plastic bar to ensure the end cap is tightly secured.

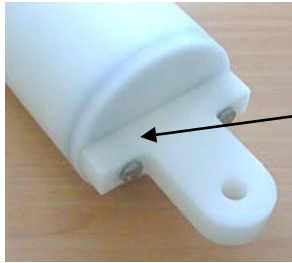
CAUTION:

Do not use Parker O-Lube, which is petroleum based; use only Super O-Lube.

Verify that the magnetic switch on the conductivity cell guard is in the Off position, so the 19plus V2 will be in quiescent (sleep) state.

Recharging Optional Nickel Metal Hydride Batteries

See the *NiMH Battery Charger and Battery Pack* manual for complete details on charging, error messages, battery specifications, etc.

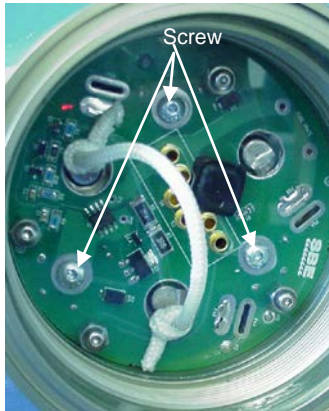


Unthread cap
by rotating
counter-
clockwise

1. Remove the battery end cap (end cap without connectors):
 - A. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.
 - B. Unthread the end cap by rotating counter-clockwise (use a wrench on the white plastic bar if necessary).
 - C. Remove any water from the O-ring mating surfaces inside the housing with a lint-free cloth or tissue.
 - D. Put the end cap aside, being careful to protect the O-ring from damage or contamination.

Note:

If desired, you can recharge the NiMH battery pack while it is in the housing. Skip Steps 2 and 4 if recharging in the housing.



9-cell
Battery pack

2. Remove the battery pack from the housing:
 - A. The protective plastic plate over the battery cover plate prevents you from completely removing the cap screws that connect the battery pack to the 19plus V2 battery posts in one step. Each of the screws is 12 mm (1/2 inch) long, but the clearance between the cover plate and plastic plate is only 6 mm (1/4 inch). Unscrew each of the three cap screws **just until they hit the bottom of the protective plastic plate**. The battery pack will *walk* out of the housing approximately 6 mm (1/4 inch) because of the spring contacts at the bottom of the battery compartment. Unscrew the cap screws again. The battery pack will *walk* out of the housing again, and should now be disconnected from the battery posts.
 - B. Pull on the cord to remove the battery pack from the housing.



Power
switch

3. Recharge the batteries:
 - A. Plug the battery charger into a suitable power source and turn on power to the charger.
 - B. Connect the charger cable to the battery pack and charger. The LED should show READY, and display the battery type and measured voltage.
 - C. Press the **Discharge** button. The LED should show DISCHARGE. This starts the discharge cycle, which discharges any remaining battery capacity. Repeatedly charging without discharging may damage the battery pack. The Discharge cycle takes approximately 110 minutes. When discharging is complete, the LED should show EMPTY.
 - D. Press the **Charge** button. The LED should show Fast Charge (it may also show WARM-UP CHARGE, REFILL CHARGE, and/or TOP OFF during the charge cycle). The Charge cycle takes approximately 2 hours. When charging is complete, the LED should show BATTERY FULL.
 - E. Turn off power to the charger.
 - F. Disconnect the battery pack from the charger and the charger from the power source.

WARNING!

Do not disconnect the battery while the Charger Active lamp is on. Doing so may cause a small spark.

Note:

The NiMH battery pack fits tightly in the housing. When placing a battery pack in the housing, align it carefully and slowly insert it straight into the housing. If not careful, the battery pack shrink wrap can be torn.

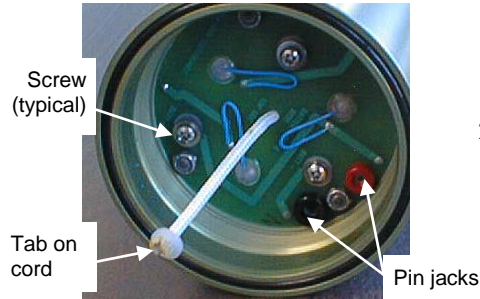
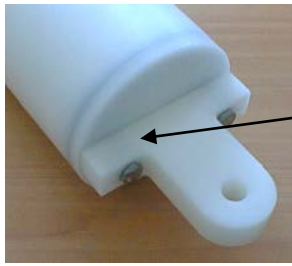
4. Reinstall the battery pack in the housing:
 - A. Align the battery pack with the housing. The posts inside the housing are not placed symmetrically, so the battery pack fits into the housing only one way. Looking at the bottom of the battery pack, note that one tube is closer to the edge than the others, corresponding to the post that is closest to the housing.
 - B. Reinstall the three cap screws until they are snug against the top plate. While pushing hard on the protective plastic plate to depress the spring contacts at the bottom of the compartment, continue to tighten the cap screws. Repeat until all three cap screws are tightened and the battery pack cannot be pushed further into the housing. **The screws must be fully tightened, or battery power to the circuitry will be intermittent.**

5. Reinstall the battery end cap:
 - A. Remove any water from the O-rings and mating surfaces with a lint-free cloth or tissue. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-rings and mating surfaces.
 - B. Carefully fit the end cap into the housing and rethread the end cap into place. Use a wrench on the white plastic bar to ensure the end cap is tightly secured.

CAUTION:

Do not use Parker O-Lube, which is petroleum based; use only Super O-Lube.

Verify that the magnetic switch is Off, so the SBE 19plus V2 will be in quiescent (sleep) state.



CAUTION:
Do not recharge the Ni-Cad battery pack while it is in the housing. If you do so, you may damage the 19plus V2 electronics.

Recharging Optional Nickel-Cadmium Batteries

The Ni-Cad battery pack and charger are no longer available.

1. Remove the battery end cap (end cap without connectors):
 - A. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.
 - B. Unthread the end cap by rotating counter-clockwise (use a wrench on the white plastic bar if necessary).
 - C. Remove any water from the O-ring mating surfaces inside the housing with a lint-free cloth or tissue.
 - D. Put the end cap aside, being careful to protect the O-ring from damage or contamination.
2. Remove the battery pack from the housing:
 - A. Remove the three Phillips-head machine screws and washers from the battery cover plate inside the housing.
 - B. Pull on the plastic tab on the center cord to remove the battery pack from the housing.
3. Recharge the batteries:
 - A. Connect the battery charger leads to the battery cover pin jacks, matching black-to-black and red-to-red (the pin jacks are different sizes to prevent cross-wiring).
 - B. Plug the battery charger into a suitable AC mains power source.
 - C. The red **Charge** LED on the charger comes on. Recharging takes approximately 15 hours. When recharging is complete, the yellow **Trickle** LED comes on, indicating the charger is providing a maintenance level charge.
 - D. Disconnect the battery pack from the charger and the charger from the power source.
 - E. Check the voltage at BAT + and BAT – on the battery cover. It should be approximately 10.8 volts.
4. Reinstall the battery pack in the housing:
 - A. Align the battery pack with the housing. The posts inside the housing are not placed symmetrically, so the battery pack fits into the housing only one way. Looking at the battery bottom cover, note that one circular cutout is closer to the edge than the others, corresponding to the post that is closest to the housing.
 - B. Reinstall the three Phillips-head screws and washers, while pushing hard on the top of the battery pack to depress the spring contacts at the bottom of the compartment. **The screws must be fully tightened, or the battery power to the circuitry will be intermittent.**
5. Reinstall the battery end cap:
 - A. Remove any water from the O-rings and mating surfaces with a lint-free cloth or tissue. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-rings and mating surfaces.
 - B. Carefully fit the end cap into the housing and rethread the end cap into place. Use a wrench on the white plastic bar to ensure the end cap is tightly secured.

CAUTION:
Do not use Parker O-Lube, which is petroleum based; use only Super O-Lube.

Verify that the magnetic switch on the conductivity cell guard is in the Off position, so the 19plus V2 will be in quiescent (sleep) state.

O-Ring Maintenance

Note:

For details on recommended practices for cleaning, handling, lubricating, and installing O-rings, see the *Basic Maintenance of Sea-Bird Equipment* module in the Sea-Bird training materials on our website.

CAUTION:

Do not use Parker O-Lube, which is petroleum based; use only Super O-Lube.

Recommended inspection and replacement schedule:

- For battery end cap O-rings – inspect each time you open the housing to replace the batteries; replace approximately once a year.
- For O-rings that are not normally disturbed (for example, on the connector end cap) – replace approximately every 3 to 5 years.

Remove any water from the O-rings and mating surfaces in the housing with a lint-free cloth or tissue. Inspect O-rings and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-rings and mating surfaces.

Conductivity Cell Maintenance

CAUTIONS:

- **Do not put a brush or any object inside the conductivity cell to dry it or clean it.** Touching and bending the electrodes can change the calibration. Large bends and movement of the electrodes can damage the cell.
- **Do not store the 19plus V2 with water in the conductivity cell.** Freezing temperatures (for example, in Arctic environments or during air shipment) can break the cell if it is full of water.

The SBE 19plus V2's conductivity cell is shipped dry to prevent freezing in shipping. Refer to *Application Note 2D: Instructions for Care and Cleaning of Conductivity Cells* for conductivity cell cleaning and storage procedures and materials.

The 19plus V2 is shipped with a kit for cell filling and storage. The kit includes:

- Syringe and tubing assembly, and
- Two anti-foulant device caps with hose barbs. These caps are used during cleaning and storage only if you installed anti-foul fittings for a moored application, because the tubing cannot attach to an anti-foulant device cap that is not barbed. The cap used during deployment on one or both ends of the conductivity cell may not be barbed, depending on your system configuration (see *Installing Anti-Foul Fittings for Moored Applications* in *Section 4: Deploying and Operating SBE 19plus V2*). As needed, remove the installed, non-barbed anti-foulant device cap(s) and replace them with the caps with hose barbs **for cleaning and storage only**.

Remember to reinstall the original cap(s) before deployment. **Deploying a 19plus V2 with a barbed anti-foulant device cap on the intake is likely to produce undesirable results in your data.**

See *Replacing Anti-Foulant Devices* for safety precautions when handling the AF24173 Anti-Foulant Devices



Pressure Sensor Maintenance

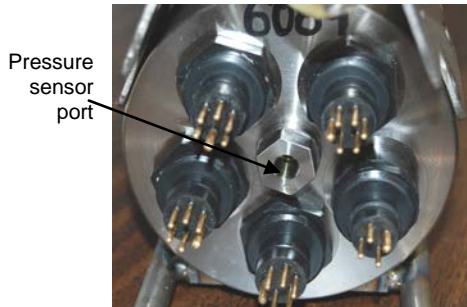
CAUTION:

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

Pressure sensor maintenance varies, depending on the type of pressure sensor in your SBE 19plus V2.

Strain-Gauge Pressure Sensor

Periodically (approximately once a year) inspect the pressure port for particles and debris. Rinse the pressure port with warm, de-ionized water to remove any particles, debris, etc.



Quartz Pressure Sensor



Nylon pressure capillary fitting for 19plus V2 with Quartz pressure sensor

At the factory, the pressure sensor and pressure port were filled with a silicon oil, and a nylon pressure capillary fitting – which includes a pressure port fitting and an external capillary tube – were used to retain the oil. The oil transmits hydrostatic pressure via internal, stainless steel, capillary tubing to the pressure sensor inside the instrument, and prevents corrosion that might occur if the sensor diaphragm was exposed to water. The internal tubing and nylon capillary fitting are vacuum back-filled at the factory.

Because of the viscosity of the silicone oil and capillary action, the silicone oil does not run out of the external capillary tube. However, due to temperature and pressure cycling over long periods, it is normal for some oil to slowly leak out of the external capillary tube. **When the oil is not visible or is receding inside the translucent tube, or if the fitting has been damaged, refill the oil** using the supplied pressure sensor oil refill kit. See *Application Note 12-1: Pressure Port Oil Refill Procedure & Nylon Capillary Fitting Replacement*.

Pump Maintenance

See *Application Note 75: Maintenance of SBE 5T, 5P, and 5M Pumps*.

Replacing Anti-Foulant Devices (SBE 16plus, SBE 19plus)



AF24173
Anti-Foulant
Device

The SBE 16plus and 19plus (moored option) have an anti-foulant device cup and cap on each end of the conductivity cell. A new SBE 16plus (or moored option 19plus) is shipped with an Anti-Foulant Device and a protective plug pre-installed in each cup.

Wearing rubber or latex gloves, follow this procedure to replace each Anti-Foulant Device (two):

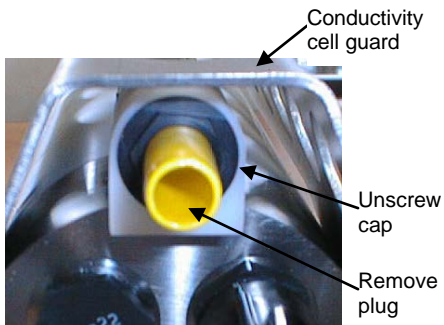
1. Remove the protective plug;
2. Unscrew the cap with a $\frac{5}{8}$ -inch socket wrench;
3. Remove the old Anti-Foulant Device. If the old Anti-Foulant Device is difficult to remove:
 - Use needle-nose pliers and carefully break up material;
 - If necessary, remove the conductivity cell guard to provide easier access;
4. Place the new Anti-Foulant Device in the cup;
5. Rethread the cap onto the cup. Do not over tighten;
6. Replace the protective plug if not ready to redeploy.

WARNING!

AF24173 Anti-Foulant Devices contain bis(tributyltin) oxide. Handle the devices only with rubber or latex gloves. Wear eye protection. Wash with soap and water after handling.

Read precautionary information on product label (see Appendix V) before proceeding.

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



CAUTION:

One of the anti-foulant device cups is attached to the guard and connected to the conductivity cell. **Removing the guard without disconnecting the cup from the guard will break the cell.** If the guard must be removed:

1. Remove the two screws connecting the anti-foulant device cup to the guard;
2. Remove the four Phillips-head screws connecting the guard to the housing and sensor end cap;
3. Gently lift the guard away.

Sensor Calibration

Note

After recalibration, Sea-Bird enters the new calibration coefficients in the 19plus V2 EEPROM, and ships the instrument back to the user with Calibration Certificates showing the new coefficients. We also ship a new instrument configuration (.con) file, which includes the new coefficients.

Sea-Bird sensors are calibrated by subjecting them to known physical conditions and measuring the sensor responses. Coefficients are then computed, which may be used with appropriate algorithms to obtain engineering units. The conductivity, temperature, and pressure sensors on the SBE 19plus V2 are supplied fully calibrated, with coefficients stored in EEPROM in the 19plus V2 and printed on their respective Calibration Certificates.

We recommend that the 19plus V2 be returned to Sea-Bird for calibration.

Conductivity Sensor

The conductivity sensor incorporates a fixed precision resistor in parallel with the cell. When the cell is dry and in air, the sensor's electrical circuitry outputs a frequency representative of the fixed resistor. This frequency is recorded on the Calibration Certificate and should remain stable (within 1 Hz) over time.

The primary mechanism for calibration drift in conductivity sensors is the fouling of the cell by chemical or biological deposits. Fouling changes the cell geometry, resulting in a shift in cell constant.

Accordingly, the most important determinant of long-term sensor accuracy is the cleanliness of the cell. We recommend that the conductivity sensors be calibrated before and after deployment, but particularly when the cell has been exposed to contamination by oil slicks or biological material.

Temperature Sensor

The primary source of temperature sensor calibration drift is the aging of the thermistor element. Sensor drift will usually be a few thousandths of a degree during the first year, and less in subsequent intervals. Sensor drift is not substantially dependent upon the environmental conditions of use, and — unlike platinum or copper elements — the thermistor is insensitive to shock.

Pressure Sensor

The SBE 19plus V2 includes a strain-gauge pressure sensor or Quartz pressure sensor. These sensors are capable of meeting the 19plus V2 error specification with some allowance for aging and ambient-temperature induced drift.

Pressure sensors show most of their error as a linear offset from zero. A technique is provided below for making small corrections to the pressure sensor calibration using the *offset* (**POffset=**) calibration coefficient term by comparing 19plus V2 pressure output to readings from a barometer.

Allow the 19plus V2 to equilibrate (with power on) in a reasonably constant temperature environment for at least 5 hours before starting. Pressure sensors exhibit a transient change in their output in response to changes in their environmental temperature. Sea-Bird instruments are constructed to minimize this by thermally decoupling the sensor from the body of the instrument. However, there is still some residual effect; allowing the 19plus V2 to equilibrate before starting will provide the most accurate calibration correction.

Note:

The pressure sensor is an absolute sensor, so its **raw** output includes the effect of atmospheric pressure (14.7 psi). As shown on the Calibration Sheet, Sea-Bird's calibration (and resulting calibration coefficients) is in terms of psia. However, when outputting pressure in **engineering units**, the 19plus V2 outputs pressure relative to the ocean surface (i.e., at the surface the output pressure is 0 decibars). The 19plus V2 uses the following equation to convert psia to decibars:
 pressure (dbar) =
 [pressure (psia) - 14.7] * 0.689476

1. Place the 19plus V2 in the orientation it will have when deployed.
2. In Seaterm232:
 - A. Set the pressure offset to 0.0 (**POffset=0**).
 - B. Send **TP** to measure the 19plus V2 pressure 100 times and transmit converted data in engineering units (decibars).
3. Compare the 19plus V2 output to the reading from a good barometer at the same elevation as the 19plus V2 pressure sensor.
 Calculate *offset* = barometer reading – 19plus V2 reading
4. Enter the calculated offset (positive or negative) in two places:
 - In the 19plus V2 EEPROM, using **POffset=** in Seaterm232, **and**
 - In the configuration (.xmlcon or .con) file, using Seasave or SBE Data Processing.

Offset Correction Example

Absolute pressure measured by a barometer is 1010.50 mbar. Pressure displayed from 19plus V2 is -2.5 dbar.

Convert barometer reading to dbar using the relationship: mbar * 0.01 = dbar

Barometer reading = 1010.50 mbar * 0.01 = 10.1050 dbar

The 19plus V2's internal calculations and our processing software output gage pressure, using an assumed value of 14.7 psi for atmospheric pressure. Convert 19plus V2 reading from gage to absolute by adding 14.7 psia to the 19plus V2 output:

$-2.5 \text{ dbar} + (14.7 \text{ psi} * 0.689476 \text{ dbar/psia}) = -2.5 + 10.13 = 7.635 \text{ dbar}$

Offset = 10.1050 – 7.635 = + 2.47 dbar

Enter offset in 19plus V2 and in .xmlcon or .con file.

For demanding applications, or where the sensor's air ambient pressure response has changed significantly, calibration using a dead-weight generator is recommended. The end cap's 5/16-24 straight thread permits mechanical connection to the pressure source. Use a fitting that has an O-ring tapered seal, such as Swagelok-200-1-4ST, which conforms to MS16142 boss.

Section 6: Troubleshooting

This section reviews common problems in operating the SBE 19plus V2, and provides the most common causes and solutions.

Problem 1: Unable to Communicate

If **OutputExecutedTag=N**, the S> prompt indicates that communications between the SBE 19plus V2 and computer have been established. Before proceeding with troubleshooting, attempt to establish communications again by clicking *Connect* in the Communications menu in Seaterm232 or pressing the Enter key several times.

Cause/Solution 1: The I/O cable connection may be loose. Check the cabling between the 19plus V2 and computer for a loose connection.

Cause/Solution 2: The instrument communication settings may not have been entered correctly in Seaterm232. Verify the settings in the Serial Port Configuration dialog box (Communication menu -> *Configure*). The settings should match those on the instrument Configuration Sheet.

Cause/Solution 3: The I/O cable may not be the correct one. The I/O cable supplied with the 19plus V2 permits connection to standard 9-pin RS-232 interfaces. See *Dimensions and End Cap Connectors* in Section 2: *Description of SBE 19plus V2* for cable pinouts.

Problem 2: No Data Recorded

Cause/Solution 1: The memory may be full; once the memory is full, no further data is recorded. Verify that the memory is not full using **GetSD** or **DS** (*free = 0* or *1* if memory is full). Sea-Bird recommends that you upload all previous data before beginning another deployment. Once the data is uploaded, use **InitLogging** to reset the memory. After the memory is reset, **GetSD** or **DS** will show *samples = 0*.

Problem 3: Unable to View Data in Seasave (Real-Time Data Acquisition program)

Note:

If *Check scan length* is enabled in Seasave's Options menu, Seasave checks the data scan length against the expected length (based on the configuration file setup), and provides a warning that there is an error. Sea-Bird recommends using this setting.

Cause/Solution 1: If the scan length does not match the selected .xmlcon or .con configuration file (for example, the configuration file indicates that NMEA position data is added through a NMEA device connected to the computer, but you did not connect the NMEA device to the computer), **Seasave continues with real-time data acquisition (saving the raw data to a file for later processing), but does not show or plot data in the Seasave displays.** The data quality is not affected; you can correct the configuration file error in SBE Data Processing (post-processing), and process the data as required. Verify that the settings in the configuration file match the current CTD configuration - number and type of auxiliary sensors, sensors assigned to correct channels, NMEA and Surface PAR selected if applicable.

Problem 4: Scan Length Error in SBE Data Processing

Note:

To view the Diagnostics file, select *Diagnostics* in Data Conversion's Options menu. In the Diagnostics dialog box, click on *Display Log File*.

Cause/Solution 1: If the scan length in the data file does not match the selected .xmlcon or .con configuration file (for example, the configuration file indicates that NMEA position data was added, but the data file does not contain NMEA data), SBE Data Processing's Data Conversion module will not process the data. If you look in the Diagnostics file, you will see a *scan length error*. Check the configuration file against the header in the data file, and correct the configuration file as required.

Problem 5: Nonsense or Unreasonable Data

The symptom of this problem is a data file that contains nonsense values (for example, 9999.999) or unreasonable values (for example, values that are outside the expected range of the data).

Cause/Solution 1: A data file with nonsense values may be caused by incorrect instrument configuration:

- Bad data may be caused by incorrect setup in the 19plus V2. Send **GetCD** or **DS** to verify the 19plus V2 setup matches the instrument Configuration Sheet (correct pressure sensor, voltage sensors assigned to correct channels, etc.).
- Bad data may be caused by incorrect configuration in the instrument .xmlcon or .con configuration file. Verify the settings in the configuration file match the instrument Configuration Sheet.

Note:

Each 19plus V2 is shipped with a configuration (.con) file that matches the configuration of the instrument (number and type of auxiliary sensors, etc.) and includes the instrument calibration coefficients.

Cause/Solution 2: A data file with unreasonable (i.e., out of the expected range) values for temperature, conductivity, etc. may be caused by incorrect calibration coefficients:

- If you manually uploaded data in engineering units (**OutputFormat=1, 3, or 5**) – Bad data may be caused by incorrect calibration coefficients in the 19plus V2. Send **GetCC** or **DCal** to verify the calibration coefficients in the 19plus V2 match the instrument Calibration Certificates. Note that calibration coefficients do not affect the raw data stored in 19plus V2 memory. If you have not yet overwritten the memory with new data, you can correct the coefficients and then upload the data again.
- If you are viewing real-time data in Seasave, manually uploaded data in raw hexadecimal (**OutputFormat=0**), or used Seaterm232's Upload menu to upload data and are processing the data in Seasave or SBE Data Processing - Bad data may be caused by incorrect calibration coefficients in the instrument .xmlcon or .con configuration file. Verify the calibration coefficients in the configuration file match the instrument Calibration Certificates.
- For RS-232 sensors interfacing to the 19plus V2: Bad data may be caused by incorrect calibration coefficients programmed into the RS-232 sensor. Connect the sensor directly to the computer and use Seaterm232 of Seaterm to verify the calibration coefficients match the instrument Calibration Certificate.

Problem 6: Less Data than Expected

Cause/Solution 1: If there is less data than expected, look at the cast header (**GetHeaders:b,e** or **DHb,e**). An example is shown below:

```
cast 4 3 Mar 2016 08:01:03 samples 438 to 865,  
avg = 1, stop = stop cmd
```

If the header shows *stop = stop cmd*, this indicates that the **Stop** command was sent from a terminal program. If you didn't send the Stop command, moisture on the data I/O connector may have created a short on the receive and transmit pins (pins 2 and 3 on the Data I/O, Pump, and External Power connector), which could be misinterpreted by the 19plus V2 as a command to stop logging. Check the I/O connector on the end cap, the Y-cable connecting to it, and the data I/O - power cable connecting to the Y-cable for moisture or corrosion.

Problem 7: Program Corrupted

Note:

Using the reset switch does not affect the 19plus V2 memory - data in memory and user-programmable parameter values are unaffected.

Cause/Solution 1: In rare cases, the program that controls the 19plus V2 microprocessor can be corrupted by a severe static shock or other problem. This program can be initialized by using the reset switch. Proceed as follows to initialize:

1. Open the battery end cap and remove the batteries
(see *Replacing /Recharging Batteries* in *Section 5: Routine Maintenance and Calibration*).
2. There is a small, pushbutton switch on the battery compartment bulkhead, which is visible after the batteries are removed. The switch is used to disconnect the internal lithium batteries from the electronics. Push the switch in for 1 second.
3. Reinstall or replace the batteries, and close the battery end cap.
4. Establish communications with the 19plus V2 (see *Section 3: Power and Communications Test*). Send **GetSD** or **DS** to verify that the date and time and sample number are correct.

Glossary

Note:

All Sea-Bird software listed was designed to work with a computer running Windows XP service pack 2 or later, Windows Vista, or Windows 7 (32-bit or 64-bit).

Batteries – Nine alkaline D-cells (Duracell MN1300, LR20). Available with rechargeable NiMH. Ni-Cad battery pack is no longer available.

Deployment Endurance Calculator – Sea-Bird’s Windows software used to calculate deployment length for moored instruments, based on user-input deployment scheme, instrument power requirements, and battery capacity.

Fouling – Biological growth in the conductivity cell during deployment. Typically a concern when SBE 19*plus* V2 is used in a moored application; install moored mode conversion kit with AF24173 Anti-Foulant Devices for these applications.

PCB – Printed Circuit Board.

SBE Data Processing – Sea-Bird’s Windows data processing software, which calculates and plots temperature, conductivity, and pressure, data from auxiliary sensors, and derives variables such as salinity and sound velocity.

Scan – One data sample containing temperature, conductivity, pressure, date and time (Moored mode only), and optional auxiliary inputs.

SeaCAT – High-accuracy conductivity, temperature, and pressure recorder. The SeaCAT is available as the SBE 16*plus* V2 (moored applications, RS-232 interface), SBE 16*plus*-IM V2 (moored applications, inductive modem interface), SBE 19*plus* V2 (profiling or moored applications), and SBE 21 (thermosalinograph).

Seasave V7 – Sea-Bird’s Windows software used to acquire, convert, and display real-time or archived raw data.

Seasoft V2 – Sea-Bird’s complete Windows software package, which includes software for communication, real-time data acquisition, and data analysis and display. Seasoft V2 includes *Deployment Endurance Calculator*, *SeatermV2*, *Seaterm*, *Seasave V7*, and *SBE Data Processing*.

Seaterm – Sea-Bird’s Windows terminal program used to communicate with the SBE 38.

SeatermAF – Sea-Bird’s Windows terminal program used to communicate with the SBE 19*plus* V2 when it is used with a water sampler operated autonomously (SBE 32 Carousel Water Sampler with Auto Fire Module (AFM) or SBE 55 ECO Water Sampler). See the AFM manual or SBE 55 manual.

SeatermV2 – Windows terminal program *launcher*. Depending on the instrument selected, it launches Seaterm232 (RS-232 instruments), Seaterm485 (RS-485 instruments), or SeatermIM (inductive modem instruments).

Seaterm232 – Windows terminal program used with Sea-Bird instruments that communicate via an RS-232 interface, and that were developed or redesigned in 2006 and later. The common feature of these instruments is the ability to output status information in XML.

CAUTION:
Do not use Parker O-Lube, which is petroleum based; use only Super O-Lube.

Super O-Lube – Silicone lubricant used to lubricate O-rings and O-ring mating surfaces. Super O-Lube can be ordered from Sea-Bird, but should also be available locally from distributors. Super O-Lube is manufactured by Parker Hannifin (www.parker.com/ead/cm2.asp?cmid=3956).

TCXO – Temperature Compensated Crystal Oscillator.

Triton X-100 – Reagent grade non-ionic surfactant (detergent), used for cleaning the conductivity cell. Triton can be ordered from Sea-Bird, but should also be available locally from chemical supply or laboratory products companies. Triton is manufactured by Avantor Performance Materials (www.avantormaterials.com/commerce/product.aspx?id=2147509608).

Appendix I: Functional Description and Circuitry

Sensors

The SBE19*plus* V2 embodies the same sensor elements (3-electrode, 2-terminal, borosilicate glass cell, and pressure-protected thermistor) previously employed in Sea-Bird's modular SBE 3 and SBE 4 sensors and in the original SeaCAT design. The 19*plus* V2 differs from the SBE 19 in that it uses three independent channels to digitize temperature, conductivity, and pressure concurrently. Multiplexing is not used for these channels.

The pressure sensor is a strain-gauge or Quartz sensor.

Sensor Interface

Temperature is acquired by applying an AC excitation to a bridge circuit containing an ultra-stable aged thermistor with a drift rate of less than 0.002 °C per year. The other elements in the bridge are VISHAY precision resistors. A 24-bit A/D converter digitizes the output of the bridge. AC excitation and ratiometric comparison avoids errors caused by parasitic thermocouples, offset voltages, leakage currents, and reference errors.

Conductivity is acquired using an ultra-precision Wein-Bridge oscillator to generate a frequency output in response to changes in conductivity.

Strain-gauge pressure is acquired by applying an AC excitation to the pressure bridge. A 24-bit A/D converter digitizes the output of the bridge. AC excitation and ratiometric comparison avoids errors caused by parasitic thermocouples, offset voltages, leakage currents, and reference errors. A silicon diode embedded in the pressure bridge is used to measure the temperature of the pressure bridge. This temperature is used to perform offset and span corrections on the measured pressure signal.

The six external 0 to 5 volt DC voltage channels are processed by differential amplifiers with an input resistance of 50K ohms and are digitized with a 14-bit A/D converter.

Real-Time Clock

To minimize power and improve clock accuracy, a temperature-compensated crystal oscillator (TCXO) is used as the real-time-clock frequency source. The TCXO is accurate to ± 1 minute per year (0 °C to 40 °C).

Battery Wiring

SBE 19plus V2 main battery is a series connection of alkaline D-cells that drop into the battery compartment as a cluster of end-to-end stacks, three batteries each (9-cell battery pack has three stacks). The positive battery connections are contact areas on double-thick printed circuit disks that form the internal bulkhead and battery retainer plates. Battery negative contacts are heavy beryllium-copper springs. The three cell stacks are aligned by plastic insulated aluminum spacers which also serve as electrical interconnects. The battery-to-circuit card connection is made by means of a Molex-type 3-pin pc board connector (JP3 on the power PCB).

The Power PCB contains three series-connected Panasonic BR-2/3A lithium cells (non-hazardous) which are diode OR'd with the main battery (and external power source, if used). The back-up lithium supply is capable of maintaining the buffer and the real-time clock if the main batteries and/or external power are removed. If the back-up lithium battery voltage (*Vlith* in the **GetSD** or **DS** response) falls below 7 volts, replace the back-up batteries.

Appendix II: Electronics Disassembly/Reassembly

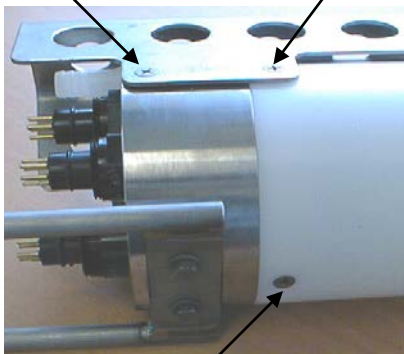
CAUTION:

Use caution during disassembly and reassembly to avoid breaking the conductivity cell.

Disassembly

Do not remove screw attaching guard to sensor end cap (2 places)

Remove screw (2 places)



Remove screw

1. As a precaution, upload any data in memory before beginning.
2. Remove the two Phillips-head screws holding the conductivity cell guard to the housing. **Do not remove the two screws holding the conductivity cell guard to the sensor end cap.**
3. Remove the Phillips-head screw holding the sensor end cap to the housing on the side opposite the conductivity cell guard.
4. Remove the sensor end cap (with attached conductivity cell and cell guard) and electronics:
 - A. Wipe the outside of the sensor end cap and housing dry, being careful to remove any water at the seam between them.
 - B. Slide the end cap and attached electronics out of the housing.
 - C. The electronics are electrically connected to the battery compartment bulkhead with a Molex connector. Disconnect the Molex connector.
 - D. Remove any water from the O-rings and mating surfaces inside the housing with a lint-free cloth or tissue.
 - E. Be careful to protect the O-rings from damage or contamination.

Reassembly

Note:

Before delivery, a desiccant package is inserted in the electronics chamber, and the chamber is filled with dry Argon gas. These measures help prevent condensation. **If the electronics are exposed to the atmosphere, dry gas backfill with Argon and replace the desiccant package.** See *Application Note 71: Desiccant Use and Regeneration (drying)* for desiccant information.

Battery replacement does not affect desiccation of the electronics, as no significant gas exchange is possible unless the electronics PCBs are actually removed from the housing.

CAUTION:

Do not use Parker O-Lube, which is petroleum based; use only Super O-Lube.

1. Reinstall the sensor end cap, conductivity cell and guard, and electronics:
 - A. Remove any water from the O-rings and mating surfaces in the housing with a lint-free cloth or tissue. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to the O-rings and mating surfaces.
 - B. Plug the Molex connector onto the pins on the battery compartment bulkhead. Verify the connector holes and pins are properly aligned.
 - C. Carefully fit the end cap and electronics into the housing until the O-rings are fully seated.
2. Reinstall the three screws to secure the end cap.
3. Reset the date and time (**DateTime=**) and initialize logging (**InitLogging**) before redeploying. No other parameters should have been affected by the electronics disassembly (send **GetSD** or **DS** to verify).

Appendix III: Command Summary

CATEGORY	COMMAND	DESCRIPTION
Status	GetCD	Get and display configuration data (setup parameters).
	GetSD	Get and display status data.
	GetCC	Get and display calibration coefficients.
	GetEC	Get and display event counter data.
	ResetEC	Delete all events in event counter.
	GetHD	Get and display hardware data.
	DS	Get and display configuration data (setup parameters) and status data.
General Setup	DCal	Get and display calibration coefficients.
	DateTime= mmddyyhhmmss	Set real-time clock month, day, year, hour, minute, second.
	BaudRate=x	x= baud rate (600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200). Default 9600.
	Echo=x	x=Y: Echo characters as you type. x=N: Do not.
	OutputExecutedTag=x	x=Y: Display XML Executing and Executed tags. x=N: Do not.
	BatteryType=x	x= alkaline : Alkaline (or lithium) batteries. x= nicad : Nickel-Cadmium batteries. x= nimh : Nickel Metal Hydride batteries.
	InitLogging	After all previous data has been uploaded, send this before starting to log to make entire memory available for recording. If not sent, data stored after last sample.
	SampleNumber=x	x= sample number for last sample in memory.
	HeaderNumber=x	x= header and cast number for last cast in memory.
	Biowiper=x	x=Y: Configuration includes WET Labs sensor with Bio-Wiper (voltage or RS-232 auxiliary sensor). x=N: Does not.
Pressure and Voltage Sensor Setup	QS	Enter quiescent (sleep) state. Main power turned off, but data logging and memory retention unaffected.
	PType=x	Pressure sensor type (set at factory; do not modify) x=1: Strain-gauge pressure sensor. x=3: Quartz with temperature compensation.
	Volt0=x	x=Y: Enable external voltage 0. x=N: Do not.
	Volt1=x	x=Y: Enable external 1 voltage 1. x=N: Do not.
	Volt2=x	x=Y: Enable external 1 voltage 2. x=N: Do not.
	Volt3=x	x=Y: Enable external 1 voltage 3. x=N: Do not.
	Volt4=x	x=Y: Enable external 1 voltage 4. x=N: Do not.
Volt5=x	x=Y: Enable external 1 voltage 5. x=N: Do not.	

Note:
See *Command Descriptions* in Section 4: *Deploying and Operating SBE 19plus V2* for detailed information and examples.

CATEGORY	COMMAND	DESCRIPTION
RS-232 Sensor Setup	GatewaySerial	Open direct communications with serial instrument through 19plus V2. To return to communicating with 19plusV2, send Ctrl Shift X ('X' must be upper case). If you do not send Ctrl Shift X, connection to serial instrument automatically times out after 2 minutes of inactivity.
	SBE63=x	x=Y: Enable SBE 63. x=N: Do not.
	Send63=command	Command 19plus V2 to send command to SBE 63 and receive response (any command recognized by SBE 63).
	SBE38=x	x=Y: Enable SBE 38. x=N: Do not.
	WetLabs=x	x=Y: Enable WET Labs RS-232 sensor. x=N: Do not.
	SeaFET=x	x=Y: Enable Satlantic SeaFET pH sensor. x=N: Do not.
	GTD=x	x=Y: Enable GTD. x=N: Do not.
	DualGTD=x	x=Y: Enable dual (2) GTD x=N: Do not.
	TGTD	Measure GTD(s), output 1 converted data sample for each GTD.
	SendGTD=command	Command 19plus V2 to send command to GTD and receive response (any command recognized by GTD).
	Optode=x	x=Y: Enable Aanderaa Optode. x=N: Do not.
	SendOptode=command	Command 19plus V2 to send command to Optode and receive response (any command recognized by Optode).
Output Format Setup	OutputFormat=x	x=0: output raw frequencies and voltages in Hex (required if using Seasave or SBE Data Processing). x=1: output converted data in Hex. x=2: output raw frequencies and voltages in decimal. x=3: output converted data in decimal. x=4: output pressure and scan number in Hex. X=5: output converted data in decimal, in XML.
	OutputSal=x	x=Y: Calculate and output salinity (psu). Only applies if OutputFormat=3 or 5 . x=N: Do not.
	OutputSV=x	x=Y: Calculate and output sound velocity (m/sec). Only applies if OutputFormat=3 or 5 . x=N: Do not.
	OutputUCSD=x	x=Y: Calculate and output density sigma-t (kg/m ³), battery voltage, and operating current (mA) with data polled while logging. Only applies if OutputFormat=3 or 5 . x=N: Do not.

CATEGORY	COMMAND	DESCRIPTION
Profiling Mode Setup (commands after MP do not affect Moored mode operation)	MP	Set to Profiling mode.
	NAvg=x	x = number of samples to average. <i>19plus</i> V2 samples at 4 Hz and averages NAvg samples. Default 1. Must be even number (2, 4, etc.) if <i>19plus</i> V2 includes Quartz pressure sensor.
	MinCondFreq=x	x = minimum conductivity frequency (Hz) to enable pump turn-on.
	PumpDelay=x	x = time (sec) to wait after minimum conductivity frequency is reached before turning pump on. Default 60 sec.
	AutoRun=x	x=Y : Automatically wake up and start logging when external power is applied; stop logging when external power is removed. Magnetic switch position has no effect on logging. x=N : Do not automatically start logging when external power is applied.
	IgnoreSwitch=x	x=Y : Ignore magnetic switch position for starting or stopping logging. Use StartNow , StartLater , and Stop to control logging. x=N : Do not ignore magnetic switch position.
Moored Mode Setup (commands after MM do not affect Profiling mode operation)	MM	Set to Moored mode.
	SampleInterval=x	x = interval (sec) between samples (10 - 14,400).
	NCycles=x	x = number of measurements to take and average every SampleInterval sec. Default 1. Must be even number (2, 4, etc.) if <i>19plus</i> V2 includes Quartz pressure sensor)
	MooredPumpMode=x	x=0 : No pump. x=1 : Run pump for 0.5 sec before each sample. x=2 : Run pump during each sample.
	DelayBeforeSampling=x	x = time (sec) to wait after switching on external voltages and RS-232 sensors before sampling (0-600 sec). Default 0.
	DelayAfterSampling=x	x = time (sec) to wait after sampling is completed, before turning off power to external voltages and RS-232 sensors (0 – 600 sec). Default 0.
	MooredTxRealTime=x	x=Y : Output real-time data. x=N : Do not.
Logging	StartNow	Start logging now.
	StartDateTime=mmddyyhhmmss	Delayed logging start: month, day, year, hour, minute, second.
	StartLater	Start logging at StartDateTime= .
	Stop	Stop logging or stop waiting to start logging. Press Enter key before sending Stop . Must stop logging before uploading data. If in Profiling mode and IgnoreSwitch=N , can also turn magnetic switch Off to stop logging.
Data Upload Stop logging before uploading.	GetSamples:b,e or DDb,e	Upload data from scan b to scan e .
	GetCast:x or DCx	Upload data from Profiling cast x or Moored header x .
	GetHeaders:b,e or DHb,e	Upload header b to header e .

Note:
Use the Upload menu to upload data that will be processed by SBE Data Processing. Manually entering the data upload command does not produce data with the required header information for processing by SBE Data Processing.

CATEGORY	COMMAND	DESCRIPTION
Polled Sampling	SL	Output last sample from buffer and leave power on.
	SLT	Output last sample from buffer, then take new sample and store data in buffer. Leave power on.
	TS	Take sample, store data in buffer, output data, and leave power on.
	TSS	Take sample, store in buffer and FLASH memory , output data, and turn power off.
	TSSOn	Take sample, store in buffer and FLASH memory , output data, and leave power on.
	GetLastSamples: x	Output last x samples from FLASH memory.
Testing Takes and outputs 100 samples for each test. Press Esc key (or send break character) to stop test.	TC	Measure conductivity, output converted data.
	TCR	Measure conductivity, output raw data.
	TT	Measure temperature, output converted data.
	TTR	Measure temperature, output raw data
	TP	Measure pressure, output converted data.
	TPR	Measure pressure, output raw data.
	TV	Measure 6 external voltage channels, output converted data.
	TVR	Measure 6 external voltage channels, main battery voltage, back-up lithium battery voltage, external current, pressure temperature; output raw data.
	TF	Measure frequency (Quartz pressure), output converted data.
	TFR	Measure frequency (Quartz pressure), output raw data.
	T63	Measure SBE 63, output data.
	T38	Measure SBE 38, output converted data.
	TWetLabs	Measure WET Labs RS-232 sensor, output raw data.
	TSeaFET	Measure Satlantic SeaFET pH sensor, output internal and external reference voltages.
TOptode	Measure Aanderaa Optode, output converted data.	
PumpOn	Turn pump on for testing purposes.	
PumpOff	Turn pump off for testing purposes.	

CATEGORY	COMMAND	DESCRIPTION
<p>Calibration Coefficients (F=floating point number; S=string with no spaces)</p> <p>Dates shown are when calibrations were performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with 19plus V2. View all coefficients with GetCC or DCal.</p>	TCalDate=S	S=Temperature calibration date.
	TAO=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.
	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.
	CPCor=F	F=Conductivity pcor.
	CTCor=F	F=Conductivity tcor.
	CSlope=F	F=Conductivity slope correction.
	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.
	PA1=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 temperature compensation ptca0.
	PTCA1=F	F=Strain-gauge pressure temperature compensation ptca1.
	PTCA2=F	F=Strain-gauge pressure temperature compensation ptca2.
	PTCB0=F	F=Strain-gauge pressure temperature compensation ptcb0.
	PTCB1=F	F=Strain-gauge pressure temperature compensation ptcb1.
	PTCB2=F	F=Strain-gauge pressure temperature compensation 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.	
<p>Hardware Configuration</p>	<p><i>Auxiliary Sensor Settings – can be modified in the field to accommodate changes in auxiliary sensors cabled to 19plus V2</i></p>	
	<p>SetVoltType0=, SetVoltSN0=</p>	
	<p>SetVoltType1=, SetVoltSN1=</p>	
	<p>SetVoltType2=, SetVoltSN2=</p>	
	<p>SetVoltType3=, SetVoltSN3=</p>	
	<p>SetVoltType4=, SetVoltSN4=</p>	
	<p>SetVoltType5=, SetVoltSN5=</p>	
<p>SetSerialType=, SetSerialSN=</p>		

Appendix IV: Satlantic SeaFET Integration

Note:

The SeaFET is not compatible with an SBE 19plus V2 in Profiling mode.

This Appendix describes integration of a SeaFET pH sensor with a SeaCAT CTD (SBE 16plus V2 or 19plus V2). The SeaCAT can retrieve indirect pH measurements from the SeaFET in autonomous (SBE 16plus V2), moored (SBE 19plus V2), polled (SBE 16plus V2/19plus V2), and serial line sync (16plus V2) sampling modes. The indirect pH measurements are reported to the SeaCAT as two cell voltages, corresponding to the two SeaFET pH-sensitive cells (ISFET|internal reference, ISFET|external reference). The SeaCAT stores the pH voltages in memory and (optionally) transmits them in real-time along with its own measurements. pH in the total scale is calculated in post-processing from the SeaFET cell voltages, temperature and salinity from the SeaCAT, and SeaFET calibration coefficients. A less accurate pH measurement is logged internally in the SeaFET along with other SeaFET related parameters, and can be retrieved after deployment without reprocessing.

Use this Appendix with the SeaFET manual (firmware 3.6.0 and later).

Setup

The SeaCAT and SeaFET must be correctly set up for proper interoperation; setup is dependent on the SeaCAT sampling mode. Before starting:

- Activate the SeaFET with its magnetic switch.
- Verify that SeaFET and SeaCAT baud rates match (≤ 57600).

The SeaCAT provides a method of direct communication with the SeaFET via the **GatewaySerial** command. This is particularly useful when the SeaFET port is not accessible. In the example below, after sending **GatewaySerial**, a soft-break was sent to wake up the SeaFET by pressing '\$' repeatedly.

```
S>gatewayserial
Initializing serial instrument gateway. TAB to abort

SeaFET Command Console.
Serial - 0000
Firmware - DEV3.6.3 (Variant: RC1, Build: Jan 9 2015-14:59:37)
2015/02/04 17:34:18

Type 'help' for a list of available commands.

SeaFET>
```

The gateway is aborted automatically after two minutes of inactivity or by sending Ctrl Shift X ('X' **must be upper case**) from the terminal emulator.

Operational Modes

The SeaCAT operates in one of four modes: autonomous (16plus V2), moored (19plus V2), polled (16plus V2 and 19plus V2), and serial line sync (16plus V2). Autonomous and moored modes are equivalent and can be used to acquire time series measurements every 10 seconds to 4 hours. In polled or serial line sync mode, a controller can request a new sample on demand.

Autonomous (16plus V2) and Moored (19plus V2) Modes

The SeaCAT sample interval (**SampleInterval=**) must be greater than or equal to the sum of the times required to sample. **TxRealTime=**, **PumpMode=** (16plus V2 only), **MooredPumpMode** (19plus V2 only) **NCycles=**, **ParosIntegration=** (16plusV2 only), **DelayBeforeSampling=**, and **DelayAfterSampling=** affect the time required to sample. If the time required to sample is too high, the SeaCAT is unable to take the required number of measurements and do the calculations within **SampleInterval=**. See *Sample Timing* in *Section 2*. When integrating with SeaFET, note the following:

- Minimum time required for SeaCAT to request and receive a sample from SeaFET is ≈ 5 sec.
- Minimum **DelayBeforeSampling=** is 30 sec if using a SeaFET.
- This results in a **minimum sample interval of 43 sec**, assuming that **TxRealTime=N**, **PumpMode** or **MooredPumpMode =2** (16plus V2 or 19plus V2, respectively), **NCycles=1**, **DelayAfterSampling=0**, and the SeaCAT does not include a Quartz pressure sensor.

Configure the instruments as shown below:

SeaFET pH Sensor Configuration

(First send **GatewaySerial** to establish communications, then send commands shown; SeaFET responses omitted for clarity)

SeaFET>freset --force	(Return SeaFET to known state; no need to reboot when prompted)
SeaFET>set --opermode polled	(Configure SeaFET in polled mode)
SeaFET>set --outfrtyp sbe	(Set SeaFET to output SBE frames)
SeaFET>set --navg 10	(Average 10 ADC samples)
SeaFET>set --samdelay 0	(Set sample delay to 0)
SeaFET>set --msgtotlm false	(Do not output diagnostic messages)
SeaFET>set --brstsize 1	(Output 1 frame per sampling event)
SeaFET>set --usectd false	(Disable on-the-fly TS corrections)
SeaFET>exit	(Put SeaFET back to sleep)

SeaCAT CTD Configuration

S>mm	(19plus V2 only: configure SeaCAT in moored mode)
S>datetime=mmddyyyyhhmmss	(Configure system time if needed)
S>seafet=y	(Enable SeaFET integration)
S>sampleinterval=s	(Sample interval in seconds)
S>ncycles=n	(Number of measurements to take and average* per sample)
S>mooredpumpmode=2	(19plus V2 only: pump during sampling)
S>pumpmode=2	(16plus V2 only: pump during sampling)
S>delaybeforesampling=30	(Pump for 30 sec before sampling)
S>startdatetime=mmddyyyyhhmmss	(Configure sampling start date and time)
S>startlater	(Start logging at designated time)
S>getcd	(Verify setup)
S>qs	(Power off SeaCAT)

* *NCycles* does not apply to SeaFET measurement. SeaFET averaging is configured with 'set --navg' as shown above.

Polled Sampling (16plus V2 and 19plus V2) and Serial Line Sync Modes (16plus V2)

Configure the instruments as shown below.

SeaFET pH Sensor Configuration

(First send **GatewaySerial** to establish communications, then send commands shown; SeaFET responses omitted for clarity)

```
SeaFET>freset --force           (Return SeaFET to known state; no need to reboot when prompted)
SeaFET>set --opermode polled   (Configure SeaFET in polled mode)
SeaFET>set --outfrtyp sbe      (Set SeaFET to output SBE frames)
SeaFET>set --navg 10           (Average 10 ADC samples)
SeaFET>set --samdelay 0        (Set sample delay to 0)
SeaFET>set --msgtotlm false    (Do not output diagnostic messages)
SeaFET>set --brstsize 1        (Output 1 frame per sampling event)
SeaFET>set --usectd false      (Disable on-the-fly TS corrections)
SeaFET>exit                    (Put SeaFET back to sleep)
```

SeaCAT CTD Configuration

```
S>seafet=y                       (Enable SeaFET integration)
S>ncycles=n                       (Number of measurements to take and average* per sample)
S>mooredpumpmode=2                (19plus V2 only: pump during sampling)
S>pumpmode=2                      (16plus V2 only: pump during sampling)
S>delaybeforesampling=30          (Pump for 30 sec before sampling)
```

**NCycles* does not apply to SeaFET measurement. SeaFET averaging is configured with 'set --navg' as shown above.

Pre-deployment Test

A pre-deployment test is highly recommended to ensure that the package is ready for deployment.

1. Establish a connection with the SeaCAT.
2. (19plus V2 only) Ensure the instrument is in moored mode (**MM**).
3. Set the SeaCAT data output format to an easy-to-read format (*Example: **OutputFormat=3***).
4. Take a sample (**TS**, or initiate a sample via serial line sync).
5. Examine the output data for reasonable SeaFET electrode voltages (~ -0.5V to -1.5V). A value of -9.999999V indicates data transmission issues from the SeaFET to the SeaCAT.

Example good data (with SeaFET and no other auxiliary sensors):

```
21.1146, 4.79201, 0.649, -0.974981, -0.922549, 03 Feb 2016 10:38:34
```

Example bad data (with SeaFET and no other auxiliary sensors):

```
21.1146, 4.79201, 0.649, -9.999999, -9.999999, 03 Feb 2016 10:38:34
```

Likely causes for the integration not to work:

- SeaFET misconfiguration (not in 'polled' mode, output frame not 'sbe', wrong baud rate, etc.).
- SeaFET not activated (from SeaFET magnetic switch) or not connected to the SeaCAT serial port.

Deployment Termination

Autonomous and moored deployments are stopped by sending the SeaCAT **Stop** command. When the SeaCAT deployment is terminated, the SeaFET is automatically put in low power sleep mode. See the SeaFET Manual for instructions on completely de-activating the SeaFET and preparing it for storage.

Real-Time Data and Data Processing

During deployment both the SeaFET and the SeaCAT log samples internally.

- The SeaCAT logs temperature, conductivity, pressure, and the pH cell voltages.
- The SeaFET logs temperature, cell voltages, and calculated pH for both cells plus instrument diagnostics information.

Note:

The data logged in the **SeaFET** is not required by Seasave V7 or SBE Data Processing, but may be useful for diagnostic purposes.

Sea-Bird real-time data acquisition software (Seasave V7) and data processing software (SBE Data Processing) calculate pH from the temperature, conductivity, pressure, and pH cell voltages in the SeaCAT. See either of the software manuals for details on the calculation.

References

- SeaFET pH Sensor, Operation Manual. Firmware v3.6.0 and later, SeaFETCom v1.2.3. (see www.satlantic.com)
- Technical note SAT-TN-DAS-1301: 'pH Calculation Brief' (available on request from Satlantic)

Appendix V: 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 IN SEA-BIRD ELECTRONICS' CONDUCTIVITY SENSORS TO CONTROL THE GROWTH OF AQUATIC ORGANISMS WITHIN ELECTRONIC CONDUCTIVITY SENSORS.

ACTIVE INGREDIENT:

Bis(tributyltin) oxide.....	53.0%
OTHER INGREDIENTS:	<u>47.0%</u>
Total.....	100.0%

DANGER

See the complete label within the Conductivity Instrument Manual for Additional Precautionary Statements and Information on the Handling, Storage, and Disposal of this Product.

Net Contents: Two anti-foulant devices

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

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

AF24173 Anti-Foulant Device

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

ACTIVE INGREDIENT:

Bis(tributyltin) oxide.....	53.0%
OTHER INGREDIENTS:	47.0%
Total.....	100.0%

DANGER

See Precautionary Statements for additional information.

FIRST AID	
If on skin or clothing	<ul style="list-style-type: none"> • Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
If swallowed	<ul style="list-style-type: none"> • Call poison control center or doctor immediately for treatment advice. • Have person drink several glasses of water. • Do not induce vomiting. • Do not give anything by mouth to an unconscious person.
If in eyes	<ul style="list-style-type: none"> • Hold 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.
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 Street
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. Harmful if swallowed. Harmful if absorbed through the skin or inhaled. Prolonged or frequently repeated contact may cause allergic reactions in some individuals. Wash thoroughly with soap and water after handling.

PERSONAL PROTECTIVE EQUIPMENT

USER SAFETY RECOMMENDATIONS

Users should:

- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Wear protective gloves (rubber or latex), goggles or other eye protection, and clothing to minimize contact.
- Follow 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.
- Wash hands with soap and water before eating, drinking, chewing gum, using tobacco or using the toilet.

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.

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 to 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 purpose. Offer for recycling, if available.

Appendix VI: Replacement Parts

Part Number	Part	Application Description	Quantity in 19plus V2
22018	Alkaline D-cell batteries, Duracell MN 1300 (LR20)	Power 19plus V2	9
41124B	Battery cover plate	Retains alkaline batteries	1
801511	NiMH battery pack	Optional rechargeable 9-cell battery pack	-
90504	NiMH battery pack charger	For NiMH batteries	-
30411	Triton X-100	Octyl Phenol Ethoxylate – Reagent grade non-ionic cleaning solution for conductivity cell (supplied in 100% strength; dilute as directed)	1
50288	Moored Mode Conversion Kit	Anti-foulant device fittings for moored applications (order AF24173 Anti-Foulant Devices separately)	-
801542	AF24173 Anti-Foulant Device	bis(tributyltin) oxide device inserted into anti-foulant device cup, for moored applications	1 (set of 2)
17709*	6-pin AG-206 to 2-pin RMG-2FS and 4-pin RMG-4MP Pump / Data I/O-Power Y-cable	From SBE 19plus V2 bulkhead connector to pump (2-pin) and data I/O - power (4-pin)	1
801225*	4-pin RMG-4FS to 9-pin DB-9S I/O cable, 2.4 m (8 ft)	From 4-pin connector on Y-cable 17709 to computer	1
171888	25-pin DB-25S to 9-pin DB-9P cable adapter	For use with computer with DB-25 connector	1
17080*	2-pin RMG-2FS to 2-pin RMG-2FS cable, 0.4 m (1.2 ft)	From 2-pin connector on Y-cable 17709 to pump	1
17044.1*	2-pin RMG-2FS dummy plug with locking sleeve	For 2-pin connector on Y-cable 17709, when pump not used	1
17046.1*	4-pin RMG-4FS dummy plug with locking sleeve	For 4-pin connector on Y-cable 17709, when I/O cable not used. Also, for 4-pin RS-232 auxiliary sensor connector when not used.	2
17047.1*	6-pin AG-206 dummy plug with locking sleeve	For when auxiliary differential input sensors not used	3
171883	6-pin MCIL-6FS to 2-pin MCIL-2FS and 4-pin MCIL-4MP Pump / Data I/O Y-cable	From SBE 19plus V2 bulkhead connector to pump (2-pin) and data I/O - power (4-pin)	1
801374	4-pin MCIL-4FS (wet-pluggable) to 9-pin DB-9S I/O cable, 2.4 m (8 ft)	From 4-pin connector on Y-cable 171883 to computer	1
171502	2-pin MCIL-2FS to 2-pin MCIL-2FS (wet-pluggable) cable, 0.4 m (1.2 ft)	From 2-pin connector on Y-cable 171883 to pump	1
171497.1	2-pin MCDC-2-F wet-pluggable dummy plug with locking sleeve	For 2-pin connector on Y-cable 171883 when pump not used	1
171398.1	4-pin MCDC-4-F wet-pluggable dummy plug with locking sleeve	For 4-pin connector on Y-cable 171883 when I/O cable not used. Also, for 4-pin RS-232 auxiliary sensor connector when not used.	2
171498.1	6-pin MCDC-6-F wet-pluggable dummy plug with locking sleeve	For when auxiliary differential input sensors not used	3
50275	Spare magnetic switch assembly	For starting/stopping logging in Profiling mode	-
90087	Pump air bleed valve assembly	Y fitting, air bleed valve, cable ties, vinyl tubing	1
30388	Tygon tube, ½ inch ID x ¾ inch OD	Main plumbing tubing	-
30579	Tygon tube, 3/8 inch ID x ½ inch OD	13 mm (0.5 inch) long pieces used on conductivity cell exhaust cap used with optional Anti-Foulant Devices and for SBE 43 intake and exhaust to fit to main plumbing	-
22009	Panasonic BR-2/3A lithium batteries	Back-up lithium cells on Power PCB	3

* For XSG / AG bulkhead connectors

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Part Number	Part	Application Description	Quantity in 19plus V2
50062	Pump O-ring kit	Includes: <ul style="list-style-type: none"> • 30010 Pump thrust washer (insulates each end of impeller against pump shaft) • 30095 Parker 2-002N674-70 (pump impeller retainer) • 30571 Parker 2-124N674-70 (pump head to impeller housing) • 30082 Parker 2-213N1000-70 (pump end cap to housing, 5T pump with retaining ring) • 31011 Parker 2-026 N674-70 (pump end cap to housing, all 5M/5P pumps, and 5T pump without retaining ring) 	-
50391	Pump impeller replacement kit	Includes: <ul style="list-style-type: none"> • 30009 Pump impeller • 30010 Pump thrust washer (insulates each end of impeller against pump shaft) • 30095 Parker 2-002N674-70 (pump impeller retainer) • 30571 Parker 2-124N674-70 (pump head to impeller housing) • 30082 Parker 2-213N1000-70 (pump end cap to housing, 5T pump with retaining ring) • 31011 Parker 2-026 N674-70 (pump end cap to housing, all 5M/5P pumps, and 5T pump without retaining ring) 	-
60021	Spare battery end cap hardware and o-rings	O-rings and hardware, including: <ul style="list-style-type: none"> • 30145 Screw, 6-32 x 1/2 Phillips-head, stainless steel (secures battery cover plate to battery posts) • 30242 Washer, #6 flat, stainless steel (for screw 30145) • 30816 Parker 2-234E603-70 (battery end cap to housing piston seal, sensor end cap to housing seals) • 30090 Parker 2-153N674-70 (battery end cap to housing face seal) 	-
50274	Spare o-ring kit	Assorted o-rings, including: <ul style="list-style-type: none"> • 30816 Parker 2-234E603-70 (battery end cap to housing piston seal, sensor end cap to housing seals) • 30090 Parker 2-153N674-70 (battery end cap to housing face seal) • 30507 Parker 2-206N674-70 (each end of conductivity cell) • 30802 Parker 2-110DUR070, ethylene (titanium conductivity cell tray face seal, groove surface) • 30809 Morrison seal, .047" hole, NIT (temperature probe Morrison seal) • 30072 Parker 2-017N674-70 (bulkhead connector seal) • 30070 Parker 3-904N674-70 (pressure sensor mounting seal) • 30087 Parker 2-232N674-70 (buffer for top retainer for PCB sandwich assembly) • 30801 Parker 5-374E603-70 (base of battery bulkhead seal) 	-
50273	Spare hardware kit	Assorted hardware, including: <ul style="list-style-type: none"> • 30163 Screw, 8-32 x 1 Phillips-head, stainless steel (for magnetic switch) • 30145 Screw, 6-32 x 1/2 Phillips-head, stainless steel (secures battery cover plate to battery posts) • 30242 Washer, #6 flat, stainless steel (for 30145) • 30414 Washer, #12, internal tooth (secures battery bulkhead retainer) • 30954 Screw 4-40 x 3/16 Phillips-head, stainless steel (securing screw for PCB retainer rod) • 31119 Screw 6-32 x 5/8 Truss Head (secures battery bulkhead retainer to bulkhead bottom plate) • 30176 Screw, 10-24 x 3/4, Phillips-head, stainless steel (secures Celcon threaded ring inside titanium battery end cap) • 30249 Washer #10, Flat, stainless steel (used with 30176) • 30447 Bolt, 1/4-20 x 1 1/4 Hex, titanium (secures lift eye to battery end cap) • 31089 Screw, 10-32 x 1/2 flat Phillips-head, titanium (secures sensor end cap to housing - side opposite conductivity cell guard) • 31090 Screw, 10-32 x 5/8 flat Phillips-head, titanium (secures conductivity cell guard to housing) • 31118 Screw, 10-32 x 3/8 Phillips-head, titanium (secures conductivity cell guard to sensor end cap) • 30875 Bolt 1/4-20 x 5/8 Hex, titanium (secures connector guard to sensor end cap) • 30633 Washer, 1/4" split ring lock, titanium (for 30875) • 30919 Screw, 6-32 x 3/8 flat slotted, titanium (secures anti-foulant device cup to conductivity cell guard) • 31066 Screw, 8-32 x 3/4 socket, titanium (secures conductivity cell and TC duct to sensor end cap) • 31225 Bolt, 1/4-20 x 1 1/4 Hex, titanium (mount 19plus V2 to cage) • 31138 Bolt, 1/4-20 x 3/4 Hex, stainless steel (mount cross bars to cage) 	-

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Part Number	Part	Application Description	Quantity in 19plus V2
50434	Seaspares kit, XSG / AG connectors	Includes o-rings, hardware, bulkhead connectors, dummy plugs, etc.: <ul style="list-style-type: none"> • 50087 Conductivity cell filling and storage kit • 50273 Spare hardware kit (see above) • 50274 Spare o-ring kit (see above) • 50275 Spare magnetic switch assembly • 41124 Battery cover plate • 801385 Data I/O cable, 4-pin RMG-4FS to 9-pin DB -9S cable, with power leads, 2.4 m (8 ft) long • 17046.1 4-pin RMG-4FS dummy plug with locking sleeve • 17047.1 6-pin AG-206 dummy plug with locking sleeve • 17654 4-pin XSG-4-BCL-HP-SS bulkhead connector • 17628 6-pin AG-306-HP-SS bulkhead connector • 30388 Vinyl tube, 3/4" x 1/2" (main sensor plumbing tubing) • 30409 Teflon tape (for insides of hose clamps) • 30411 Triton X100 (for cell cleaning) • 30457 Parker Super O-Lube (o-ring lubricant) 	-
50435	Seaspares kit, wet-pluggable connectors	Includes o-rings, hardware, bulkhead connectors, dummy plugs, etc.: <ul style="list-style-type: none"> • 50087 Conductivity cell filling and storage kit • 50273 Spare hardware kit (see above) • 50274 Spare o-ring kit (see above) • 50275 Spare magnetic switch • 41124 Battery cover plate • 801374 Data I/O cable, 4-pin MCIL-4FS (wet-pluggable connector) to 9-pin DB-9S I/O cable, 2.4 m (8 ft) long • 171192 Locking sleeve • 171398 4-pin MCDC-4-F wet-pluggable dummy plug • 171498 6-pin MCDC-6-F wet-pluggable dummy plug • 172021 4-pin MCBH-4MP(WB), TI 1/2-20 bulkhead connector • 172022 6-pin MCBH-6MP(WB), TI 1/2-20 bulkhead connector • 30388 Vinyl tube, 3/4" x 1/2" (main sensor plumbing tubing) • 30409 Teflon tape (for insides of hose clamps) • 30411 Triton X100 (for cell cleaning) • 30457 Parker Super O-Lube (o-ring lubricant) 	-
801269	SeaCAT plus cage, type 1, 40"	Cage for 19plus V2 with strain-gauge pressure, 40 inches tall	-
801270	SeaCAT plus cage, type 1, 48"	Cage for 19plus V2 with Digi quartz pressure, 48 inches tall	-
23892	SBE 25/19 cage	Cage for mounting 19plus V2 horizontally in SBE 32 Carousel Extension Stand, 38 inches tall	-
232012	SeaCAT ice cage	Cage with small footprint, for deploying through ice	-

Appendix VII: Manual Revision History

Manual Version	Date	Description
001	11/07	<ul style="list-style-type: none"> Release of firmware version 2 (19plus V2).
002	02/08	<ul style="list-style-type: none"> Firmware 2.0c: now available with Quartz pressure sensor (PType=3). Add note to dimension drawing for longer housing if using Quartz. Add taller cage to specifications, for use with 19plus V2 with Quartz. Change pressure stability specifications to per year instead of per month. Add more detail on cleaning air bleed valve. Update configuration drawings (with 36/pdim, 32/33, 32/AFM, 55/33, 55) to include 19plus V2 There were still a few references to Toolbar (Seaterm's toolbar, new software does not have it), remove them. Correct TVR (said columns 1–16 for external voltage, should be 1–6). Add new V2 Seaspares kits in replacement parts list. Add explanation for Hardware configuration commands: customer may change voltage sensor types and serial numbers. Correct XML output in Output Format section, for OutputUCSD=Y and OutputFormat=5 (closing tag for voltage was incorrect).
003	11/08	<ul style="list-style-type: none"> Delete SCPlusV2_RS232 software, add SeatermV2 software. Firmware 2.1 – add CommandSetVersion tag in GetHD reply; change StartLater limitation from 1 month to 90 days in future. Update for Seasave/SBE Data Processing 7.18, configuration file now allows selection of NMEA connected directly to the computer. Remove CF0 from DCal response. Remove 33600 from valid baud rates. Expand on how to change baud. Update schematic of SBE 55 autonomous sampling, add SBE 50. Add J1, J2, etc. labeling on internal wiring showing what goes to what connector. Strain gauge pressure sensor maintenance: – design change, no port plug anymore.
004	07/09	<ul style="list-style-type: none"> Firmware 2.2: add information related to use of Aanderaa Optode as auxiliary RS-232 sensor. Clarify and correct sleep time between samples. Remove PType= from setup examples, mention that factory-set. Add information about Deployment Endurance Calculator, which is installed with Seasoft. Update SeatermV2 screen capture to show SBE 33 and 36 in instrument list. Update software name. Add statement about compatibility with Vista.
005	12/09	<ul style="list-style-type: none"> Seasave and SBE Data Processing 7.20a: Add information about .xmlcon file. Add more information about operation with GTD auxiliary sensor. Add more information about DelayBeforeSampling: does not apply to Optode. Add more information about GetLastSamples:x; do not need to stop logging before sending command. Correct external power examples to incorporate 19plus V2 current draws (was still showing 19plus current draws). Add information required for CE certification. Add CE mark. Update SBE address. Update anti-foul label in Appendix with new Container Handling requirement and new address

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006	04/11	<ul style="list-style-type: none"> • Firmware 2.3: Add compatibility with WET Labs RS-232 sensors (WetLabs=, TWetLabs). Add commands for RS-232 sensor type and serial number (SetSerialType=, SetSerialSN=). StartLater limitation is 1 month in future. • Correct explanation of SampleNumber=; does not reset HeaderNumber=. • Clarify use of DelayBeforeSampling=; applies to all auxiliary sensors except Optode. • Clarify how to stop logging if in profiling mode and IgnoreSwitch=N; must use switch or send <CTRL Z>; Stop command only stops logging briefly, and then logging resumes. • Correct Diquartz pressure sensor stability specification to 0.02% of full scale range/year. • Clarify that in Moored mode, Optode data is acquired after all CTD and other external sensor data. • Replacement parts list: add ice cage, update Seaspares kit contents • Update SeatermV2 screen. • Remove references to Druck pressure sensors. • Add information that Ni-Cad battery pack and charger no longer available. • Correct typos.
007	05/12	<ul style="list-style-type: none"> • Firmware version 2.5: Add compatibility with SBE 63 Optical Dissolved Oxygen Sensor (SBE63=, Send63=, T63), and add DelayAfterSampling= command. • Update BioWiper= description to make it more generic (applies to all WET Labs sensors with bio-wipers, not just to ECO-FL). • Update DelayBeforeSampling= description to include recommended value for use with WL sensor with bio-wiper. • Add information that maximum sampling rate for profiling is 2 Hz if using Quartz pressure sensor. • Correct information about SampleNumber=0 resetting header number. • Clarify that barbed cap used on intake end for conductivity cell maintenance should never be used for deployment. • Update schematics showing CTD use with deck units and water samplers, to include SBE 25<i>plus</i> in list of CTDs, and show Surface PAR as standard in SBE 33 and 36 Deck Units (was optional). • Add more troubleshooting information. • Add pump replacement parts to replacement parts list. • Add graphic in Test Setup showing connection of I/O cable to Y-cable. • Add information about software compatibility with Windows 7. • Update Triton website information. • Remove commands that should only be used at the factory. • Correct typos.
008	08/12	<ul style="list-style-type: none"> • Add information on use with SBE 63 in profiling mode – set interval (SetInterval=) in SBE 63 to 10 seconds or higher to minimize photo bleaching. • Delete sentence on disabling update of blue LED counter in SBE 63 (SetBlueTUp= was removed from SBE 63 manual, Sea-Bird sets it at factory). • Add Declaration of Conformity to manual.
009	02/13	<ul style="list-style-type: none"> • Add cable drawings for y-cable and data I/O cable. • Add recommended pump operation setup when integrated with SBE 63 optical DO sensor. • Add SBE 63 mounting information in Configuration Options and Plumbing. • Add information on high baud rates limitations, and disabling of automatic time setting tools in Seaterm232 if baud is set to 115200. • Add range for DelayAfterSampling=. • Remove references to <i>plus</i> version of SBE 21. • Remove references to RS-485 version of 16<i>plus</i> V2. • Update software compatibility information. • Update Upload dialog box. • Update Serial Port Configuration dialog in Seaterm232. • Fix typos.
010	03/13	<ul style="list-style-type: none"> • Firmware 2.5.2: - Update GetCD response for XML compliance (caused upload failure if OutputFormat=3 or 5). - Update interface to Aanderaa Optode for recent Aanderaa changes; update documentation.

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011	09/13	<ul style="list-style-type: none"> • Add more information on required settings in SBE 63. • Update SeatermV2 screen capture and Upload dialog box. • Update reference to Application Note 72; version specific to V2 SeaCATs is 72-V2. • Clarify that accuracy specifications are \pm. • Update Declaration of Conformity. • Add O-ring maintenance section. • Remove references to Seasave-Win32 (old software).
012	02/16	<ul style="list-style-type: none"> • Firmware 3.1.8: <ul style="list-style-type: none"> - Add compatibility with Satlantic SeaFET pH RS-232 sensor (SeaFET=, TSeaFET); - Add GatewaySerial command to allow direct communications with integrated RS-232 sensor. - New electronics. • Add compatibility with SeaOWL UV-ATM in-situ oil-in-water sensor with RS-232 output. • Add higher depth rating and strain gauge pressure sensor depth rating availability. • Update SBE 63 oxygen sensor mount drawing. • Update information on baud rate required if integrating with WET Labs sensor. • Correct information on pressure fitting size. • Add caution on using spray can lubricants on MCBH connectors. • Add caution regarding using Parker Super O Lube, not Parker O Lube (which is petroleum based). • Remove <i>standard</i> and <i>optional</i> language. • Add weight for cage used with 19plus with Quartz pressure. • Add note in <i>Section 2</i> that GTD is only supported in moored mode. • Add information on PC settings for binary upload. • Correct description of battery drop cutoff for Ni-Cad batteries. • Add information that Ctrl Z sequence to stop logging does not work in SeatermV2. • Update parts listing in PN 50434 kit. • Document that 19plusV2 goes to sleep after receiving StartLater. • Correct information on GetCast:x and DCx; previously said 'profiling mode only', but these commands also work in moored mode. • Correct example output from DCal command; order of response did not match actual output. • Correct information on GetSD response (number of headers in moored mode not shown). • Correct information on OutputUCSD listing in DS response. • Add more references to 1000 cast limit. • Update language on where to find updated software on website. • Add sampling rate to specifications table. • Update Declaration of Conformity. • Update SeatermV2 main screen. • Switch to Sea-Bird Scientific cover.
013	06/16	<ul style="list-style-type: none"> • Update software configuration file description to show selection for WET Labs SeaOWL UV-ATM and Satlantic SeaFET pH sensor, which were added in Seasave and SBE Data Processing 7.26.0. • Correct range for DelayAfterSampling=. • Update Declaration of Conformity.

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