SBE 19*plus* V2
SEACAT Profiler

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

User's Manual

Sea-Bird Electronics, Inc.
1808 136th Place NE
Bellevue, Washington 98005 USA
Telephone: 425/643-9866
Fax: 425/643-9954
E-mail: seabird@seabird.com
Website: www.seabird.com

Manual Version #002, 02/20/08
Firmware Version 2.0c and later
SEASAVE V7 Version 7.16 and later
SBE Data Processing Version 7.16 and later

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Section 1: Introduction

This section includes contact information, Quick Start procedure, and photos of a standard SBE 19*plus* V2 shipment.

About this Manual

This manual is to be used with the SBE 19*plus* 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 e-mail any comments or suggestions to seabird@seabird.com.

How to Contact Sea-Bird

Sea-Bird Electronics, Inc.
1808 136th Place Northeast
Bellevue, Washington 98005 USA

Telephone:	425-643-9866	Fax:	425-643-9954
E-mail:	seabird@seabird.com	Website:	http://www.seabird.com

Business hours:
Monday-Friday, 0800 to 1700 Pacific Standard Time
(1600 to 0100 Universal Time)
Except from April to October, when we are on *summer time*
(1500 to 0000 Universal Time)

Quick Start

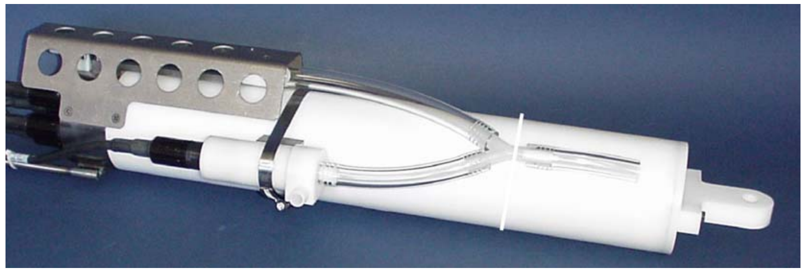
Follow these steps to get a Quick Start using the SBE 19*plus* V2.
The manual provides step-by-step details for performing each task:

1. Install batteries and test power and communications (see *Section 3: Power and Communications Test*).

2. Deploy the 19*plus* 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 and establish setup and logging parameters.
   D. **Moored mode** - Set 19*plus* V2 to start logging now or in the future.
   E. Install dummy plugs and/or cable connectors, and locking sleeves.
   F. If applicable, remove Tygon tubing that was looped end-to-end around conductivity cell for storage. Reconnect tubing from pump to conductivity cell.
   G. **Profiling mode** - Put magnetic switch in On position, send commands to start logging now or in the future, or apply external power, as appropriate for your instrument's setup.
   H. Deploy 19*plus* V2.

Unpacking SBE 19*plus* V2

Shown below is a typical SBE 19*plus* V2 shipment.



SBE 19*plus* V2 SEACAT with SBE 5M plastic pump

I/O Cable

25-pin to 9-pin adapter
(for use with computer
with DB-25 connector)

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

SBE 19*plus* V2 Manual

Software, and Electronic Copies of
Software Manuals and User Manual

Section 2: Description of SBE 19*plus* V2

This section describes the functions and features of the SBE 19*plus* 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 19*plus* V2 SEACAT Profiler is designed to measure conductivity, temperature, and pressure in marine or fresh-water environments at depths up to 7000 meters (22,900 feet). The 19*plus* V2 operates in two modes:

- **Profiling mode** for acquiring vertical profiles. The 19*plus* V2 runs continuously, sampling at 4 scans per second (4 Hz). 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 19*plus* V2 powers down, drawing only 20 microamps.

Self-powered and self-contained, the 19*plus* V2 features the proven Sea-Bird conductivity and temperature sensors and a precision, semiconductor, strain-gauge 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/setups vary). The 19*plus* 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 19*plus* 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.

A standard 19*plus* V2 is supplied with:

- Plastic housing for depths to 600 meters (1950 feet)
- 64 Mbyte FLASH RAM memory
- Internally mounted strain-gauge pressure sensor
- 9 D-size alkaline batteries (Duracell MN1300, LR20)
- Impulse glass-reinforced epoxy bulkhead connectors:
  - 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 38 secondary temperature sensor, or up to two Pro-Oceanus Gas Tension Devices)
- T-C Duct, which ensures that Temperature and Conductivity measurements are made on the same parcel of water
- SBE 5M miniature pump (with plastic housing for depths to 600 meters) 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.*

SBE 19*plus* V2 options / accessories include:

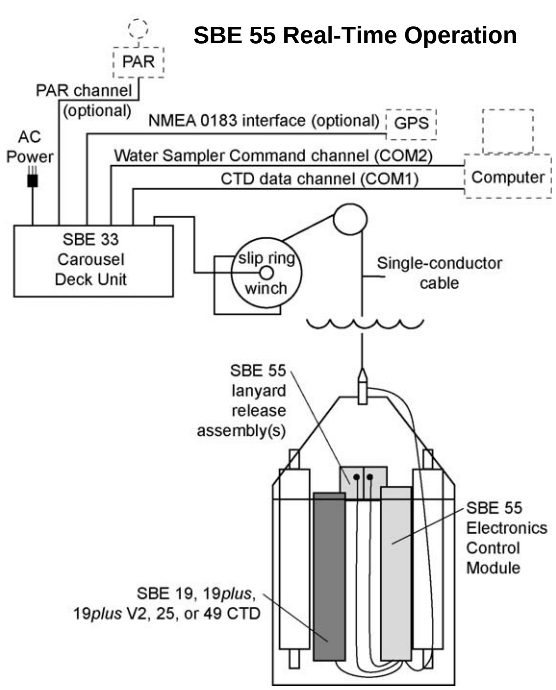
- Titanium housing for use to 7000 meters (22,900 feet)
- Internally mounted Quartz pressure sensor in place of strain-gauge sensor
- SBE 5M miniature pump with titanium housing in place of plastic housing
- SBE 5P (plastic) or 5T (titanium) pump in place of SBE 5M for use with dissolved oxygen and/or other pumped auxiliary sensors
- Sensors for dissolved oxygen, pH (Profiling mode only), fluorescence, light (PAR), light transmission, and turbidity
- Stainless steel cage
- Wet-pluggable (MCBH) connectors in place of standard connectors
- Nickel Metal Hydride (NiMH) batteries and charger
- Nickel Cadmium (Ni-Cad) batteries and charger
- Moored mode conversion kit with anti-foulant device fittings, for when 19*plus* V2 used on moorings

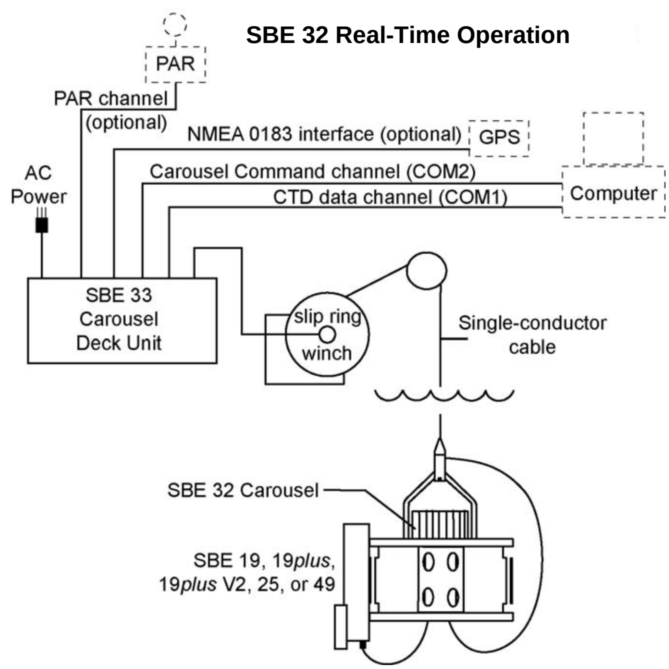
Future upgrades and enhancements to the SBE 19*plus* V2 firmware can be easily installed in the field through a computer serial port and the *Data I/O, Pump, and External Power* bulkhead connector on the 19*plus* V2, without the need to return the 19*plus* V2 to Sea-Bird.

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

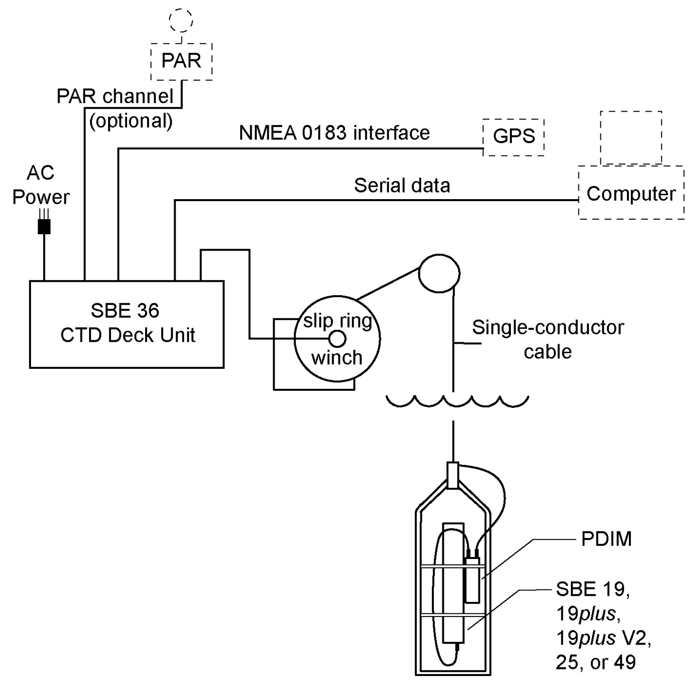
> **Note:**
> The SBE 32 Carousel is a 12-, 24-, or 36-bottle water sampler. The SBE 55 ECO is a 3- or 6-bottle water sampler.

- **SBE 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 19*plus* V2 and has ample power for auxiliary sensors not normally supported by battery-powered CTDs. CTD data from the 19*plus* 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.



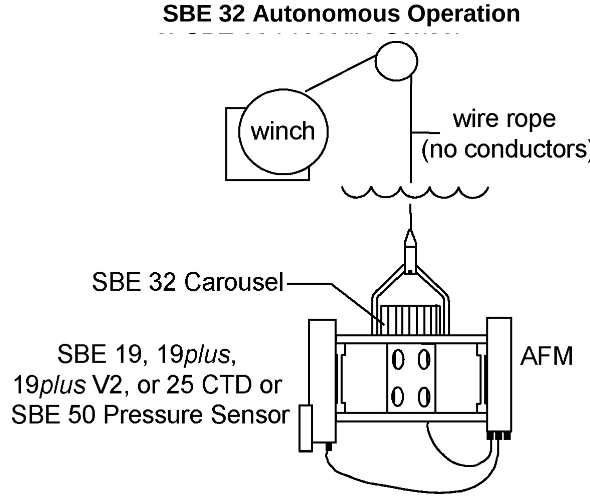


- **SBE 36 CTD Deck Unit and Power Data Interface Module (PDIM)** - These items provide power and real-time data handling capability over single-conductor sea cables using the same method employed in the SBE 32/SBE 33. The PDIM is a small pressure housing that is mounted on or near the 19*plus* V2. It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



- **SBE 32 Carousel Water Sampler and Auto Fire Module (AFM)** - The AFM, mounted on or near the 19*plus* 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 19*plus* 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.

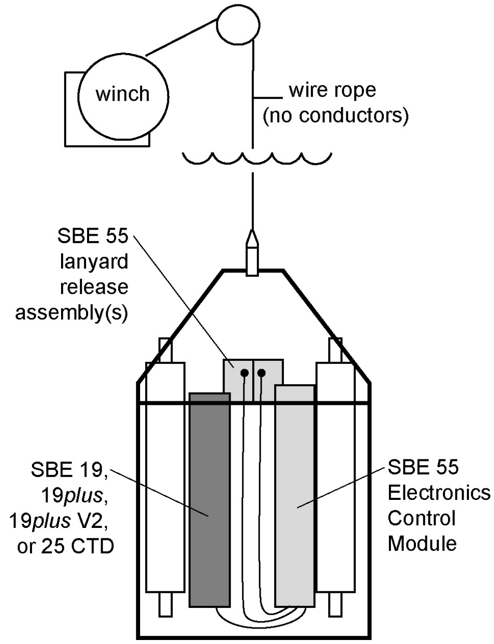
SBE 32 Autonomous Operation



> **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 19*plus* 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 and separate software manual provide detailed information on the use of SEASAVE V7 and SBE Data Processing.
> - Sea-Bird also supplies an older version of SEASAVE, SEASAVE-Win32. However, all SEASAVE instructions in this manual are written for SEASAVE V7. See SEASAVE-Win32's manual and/or Help files if you prefer to use the older software.

The 19*plus* V2 is supplied with a powerful Windows 2000/XP software package, SEASOFT-Win32, which includes:

- **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.

The SBE 19*plus* V2 is also supplied with a **terminal program**, **SCPlusV2_RS232.exe**, for easy communication and data retrieval.
The use of the terminal program is described in this manual, and in the software Help files.

Specifications

	Temperature (°C)	Conductivity (S/m)	Pressure
Measurement Range	-5 to +35	0 to 9	0 to full scale range: • *Strain-gauge sensor:* 20 / 100 / 350 / 600 / 1000 / 2000 / 3500 / 7000 meters • *Quartz sensor:* 20 / 60 / 130 / 200 / 270 / 680 / 1400 / 2000 / 4200 / 7000 / 10500 meters
Initial Accuracy	0.005	0.0005	• *Strain-gauge sensor:* 0.1% of full scale range • *Quartz sensor:* 0.02% of full scale range
Typical Stability	0.0002/month	0.0003/month	• *Strain-gauge sensor:* 0.1% of full scale range/year • *Quartz sensor:* 0.025% of full scale range/year
Resolution	0.0001	• 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).	• *Strain-gauge sensor:* 0.002% of full scale range • *Quartz sensor:* 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

***Notes on Quartz Pressure Sensor Resolution:**

Pressure Sensor Resolution = Sensitivity * Counter Resolution

- Sensitivity = Δ pressure / Δ frequency
  where Δ pressure is change in pressure in desired units (psia, db, meters, etc.) = pressure sensor full scale range
  Δ frequency is change in frequency in Hz ≈ 3000 Hz over sensor's full scale range
- Counter Resolution = pressure sensor output frequency / (integration time * 1,843,200)
  where pressure sensor output frequency ≈ 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: db = 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 db/Hz * Counter Resolution
= 2.333 db/Hz * 0.076 Hz = 0.18 db ≈ 0.18 m = 180 mm

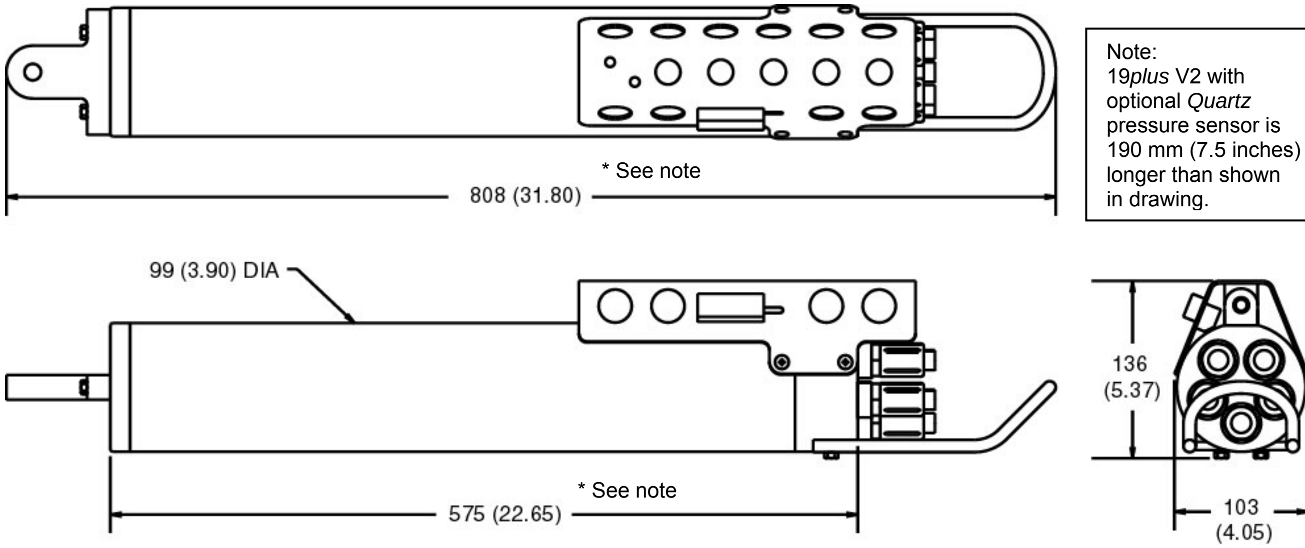
Continued from previous page

Memory	64 Mbyte non-volatile FLASH memory
Data Storage	**Recorded Parameter** — **Bytes/sample** Temperature & Conductivity — 6 (3 each) Strain-gauge or Quartz Pressure — 5 each external voltage — 2 SBE 38 secondary temperature — 3 each Pro-Oceanus GTD — 4 (pressure + 3 (temperature) date & time (Moored mode only) — 4
Real-Time Clock	32,768 Hz TCXO accurate to ±1 minute/year
Internal Batteries (nominal capacity)	*Standard 9 alkaline D-cells* (Duracell MN1300, LR20) - 14 amp-hours. *Optional NiMH battery pack* – 8 amp-hours. *Optional Ni-Cad battery pack* - 4.4 amp-hours.
External Power Supply	9 - 28 VDC; current requirement varies, depending on voltage and pump: • 3 Amps at 9V input - SBE 5M pump (cannot use SBE 5T or 5P pump with 9V input) • 0.5 Amps at 12V input – SBE 5M pump • 3 Amps at 12V input – SBE 5T or 5P pump • 0.5 Amps at 19V input – SBE 5M pump • 1.5 Amps at 19V input – SBE 5T or 5P pump
Power Requirements	*Sampling*: 70 mA *Pump:* Standard SBE 5M 100 mA; Optional SBE 5P or 5T 150 mA *Communications:* 65 mA *Quiescent:* 20 µA Moored Mode sampling time: • Minimum 2.5 seconds/sample [**strain-gauge** pressure, pump running while sampling (**MooredPumpMode=2**), 1 measurement/sample, and no delays]. • Minimum 2.45 seconds/sample [**Quartz** pressure, pump running while sampling (**MooredPumpMode=2**), 1 measurement/sample, and no delays]. • Add 0.25 seconds for each additional measurement/sample (**NCycles ≥ 2**). • Add pump on-time (0.5 second) if pump running before taking sample (**MooredPumpMode=1**). • Add time for user-programmed delay before sampling (**DelayBeforeSampling=**). Approximate Battery Endurance [1]: CTD & 5M pump, no auxiliary sensors: 60 hours Profiling Mode, 140,000 samples Moored Mode. [1] With Duracell MN 1300 (LR20) cells. Dependent on sampling scheme; see *Battery Endurance* for example calculations.
Auxiliary Voltage and RS-232 Sensors	*Auxiliary power out:* up to 500 mA at 10.5 - 11 VDC *Voltage sensor A/D resolution:* 14 bits *Voltage sensor input range:* 0 - 5 VDC
Housing Depth / Materials	*Standard:* 600 meter (1950 ft) - acetal copolymer (plastic). *Optional:* 7000 meter (22,900 ft) - 3AL-2.5V titanium
Weight	With plastic housing, no pump: *in air* 7.3 kg (16 lbs) — *in water* 2.3 kg (5 lbs) With titanium housing, no pump: *in air* 13.7 kg (30 lbs) — *in water* 8.6 kg (19 lbs) Pump adds (in air) 0.3 to 0.7 kg (0.6 to 1.5 lbs), depending on pump model selected. See pump brochures for details.
Optional Cage	For 19*plus* V2 with strain-gauge pressure: 1016 x 241 x 279 mm (40 x 9.5 x 11 in.), 6.3 kg (14 lbs) For 19*plus* V2 with Quartz pressure: 1219 x 241 x 279 mm (48 x 9.5 x 11 in.)

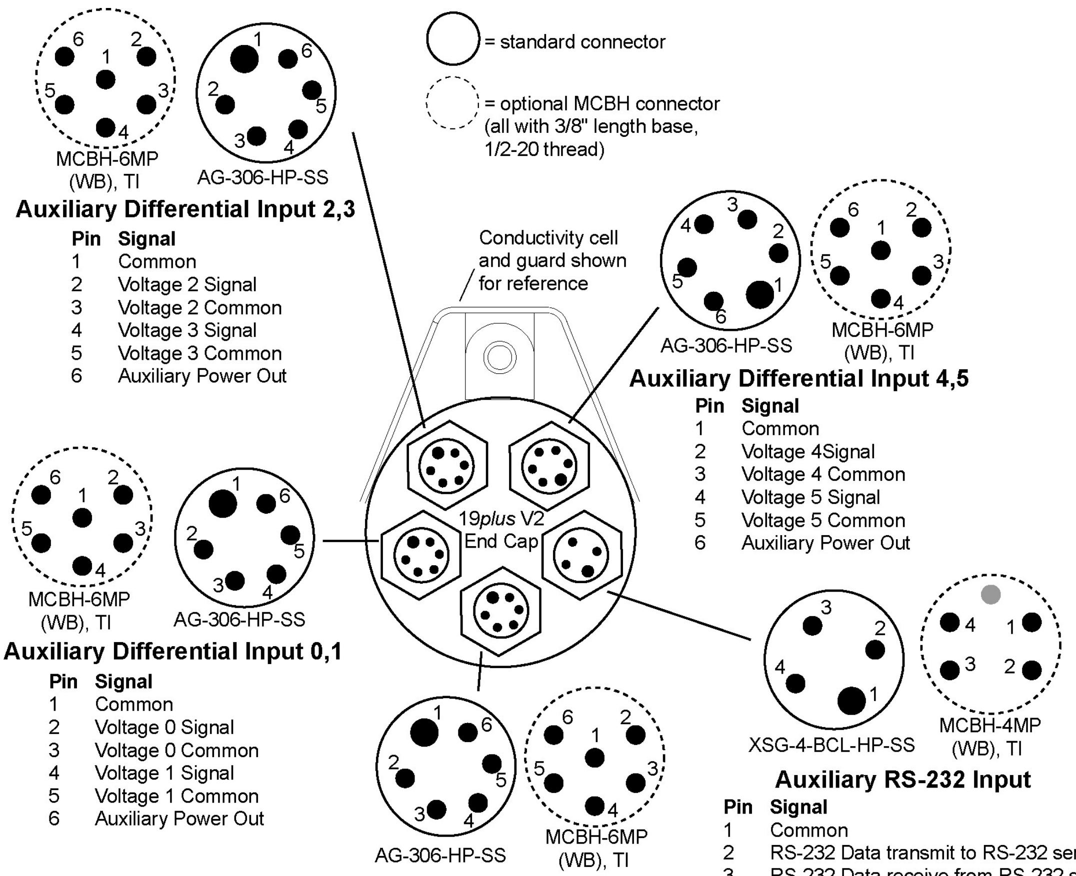
Note:
Battery packs for NiMH, Ni-Cad, and alkaline batteries differ – you cannot put alkalines in the NiMH or Ni-Cad battery pack or vice versa.

Dimensions and End Cap Connectors

Dimensions in millimeters (inches)



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



Auxiliary Differential Input 2,3

Pin	Signal
1	Common
2	Voltage 2 Signal
3	Voltage 2 Common
4	Voltage 3 Signal
5	Voltage 3 Common
6	Auxiliary Power Out

Auxiliary Differential Input 4,5

Pin	Signal
1	Common
2	Voltage 4Signal
3	Voltage 4 Common
4	Voltage 5 Signal
5	Voltage 5 Common
6	Auxiliary Power Out

Auxiliary Differential Input 0,1

Pin	Signal
1	Common
2	Voltage 0 Signal
3	Voltage 0 Common
4	Voltage 1 Signal
5	Voltage 1 Common
6	Auxiliary Power Out

Auxiliary RS-232 Input

Pin	Signal
1	Common
2	RS-232 Data transmit to RS-232 sensor
3	RS-232 Data receive from RS-232 sensor
4	Power to RS-232 sensor

Note: RS-232 sensor must be set to same baud rate as 19*plus*.

Data I/O, Pump, and External Power

Pin	Signal
1	Common
2	RS-232 data receive
3	RS-232 data transmit
4	Pump power common
5	Pump power
6	Auxiliary power in (9-28 VDC)

Note:
A Y-cable from this connector connects to the pump and to a data I/O - power cable.

Batteries

Note:
See *Replacing / Recharging Batteries* in *Section 5: Routine Maintenance and Calibration*.

For the main battery, the SBE 19*plus* 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 19*plus* V2 is logging data and the battery voltage is less than the battery cut-off, the 19*plus* 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 standard 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 optional NiMH battery pack has a nominal capacity of 8 amp-hours. The optional Ni-Cad battery pack 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.

Profiling Mode Examples

Example 1 - standard alkaline batteries, SBE 5M pump, no auxiliary sensors
Sampling current = 70 mA
Pump current = 100 mA
Maximum sampling time ≈ 10.5 amp-hours / (0.070 Amps + 0.100 Amps) ≈ 61 hours

Example 2 - standard alkaline batteries, optional SBE 5T pump, auxiliary sensors drawing 100 mA
Sampling current = 70 mA
Pump current = 150 mA
Auxiliary sensor current = 100 mA
Maximum sampling time ≈ 10.5 amp-hours / (0.070 Amps + 0.150 Amps + 0.100 Amps) ≈ 32 hours

Moored Mode Examples

A 19*plus* 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 amp-sec/sample
In 1 hour, sampling current = 6 * 0.21 amp-sec/sample = 1.26 amp-sec/hour

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

Quiescent current = 20 microamps = 0.02 mA
In 1 hour, quiescent current ≈ 0.02 mA * 3600 sec/hour = 0.0.072 amp-sec/hour

Current consumption / hour = 1.26 + 0.3 + 0.072 = 1.63 amp-sec/hour
Capacity = (10.5 amp-hours * 3600 sec/hr) / (1.63 amp-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 - optional 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 amp-sec/sample
In 1 hour, sampling current = 6 * 1.28 amp-sec/sample = 7.7 amp-sec/hour

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

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

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

Current consumption / hour = 7.7 + 16.4 + 10.9 + 0.072 = 35.1 amp-sec/hour
Capacity = (10.5 amp-hours * 3600 sec/hr) / (35.1 amp-sec/hour) = 1076 hours = 44 days = 0.12 years

External Power

The SBE 19*plus* 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 19*plus* 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.

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 19*plus* V2 externally:

- Limiting the communication IR loss to 1 volt **if transmitting real-time data**; higher IR loss will prevent the instrument from transmitting real-time data because of the difference in ground potential.
- 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.

Note:
Common wire resistances:

Gauge	Resistance (ohms/foot)
12	0.0016
14	0.0025
16	0.0040
18	0.0064
19	0.0081
20	0.0107
22	0.0162
24	0.0257
26	0.0410
28	0.0653

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, because the difference in ground potential of the 19*plus* V2 and ground controller prevents the 19*plus* V2 from transmitting real-time data.

V_{limit} = 1 volt = IR_{limit}

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

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

- Profiling mode – The 19*plus* 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 19*plus* V2 samples, and then transmits data. Use the communication current, 60 mA, in the calculation.

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

Example 1 – For 20 gauge wire, what is maximum distance to transmit power to 19*plus* V2 if transmitting real-time data?
Current = 65 mA (sampling) + 100 mA (pump) + 60 mA (communication) = 225 mA
R_{limit} = V_{limit} / I = 1 volt / 0.225 Amps = 4.4 ohms
For 20 gauge wire, resistance is 0.0107 ohms/foot.
Maximum cable length = 4.4 ohms / 0.0107 ohms/foot = 415 feet = 126 meters

Example 2 – Same as above, but there are 4 instruments powered from the same power supply.
R_{limit} = V_{limit} / I = 1 volt / (0.225 Amps * 4 instruments) = 1.1 ohms
Maximum cable length = 1.1 ohms / 0.0107 ohms/foot = 103 feet = 31 meters (to 19*plus* V2 *furthest* from power source).

Moored Mode Examples – use 60 mA communication current, regardless of 19plus V2 configuration

Example 1 – For 20 gauge wire, what is maximum distance to transmit power to 19*plus* V2 if transmitting real-time data?
For 60 milliamp communications current, R_{limit} = V_{limit} / I = 1 volt / 0.060 Amps = 16.7 ohms
For 20 gauge wire, resistance is 0.0107 ohms/foot.
Maximum cable length = 16.7 ohms / 0.0107 ohms/foot = 1557 feet = 474 meters

Example 2 – Same as above, but there are 4 instruments powered from the same power supply.
For 60 milliamp communications current, R_{limit} = V_{limit} / I = 1 volt / (0.060 Amps * 4 instruments) = 4.1 ohms
Maximum cable length = 4.1 ohms / 0.0107 ohms/foot = 389 feet = 118 meters (to 19*plus* 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 19*plus* 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:

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

Example 1 – For 20 gauge wire, what is maximum distance to transmit power to 19*plus* V2 if using 12 volt power source with SBE 5T pump?
Maximum cable length = R_{limit} / 2 * wire resistance per foot = 2 ohms / 2 * 0.0107 ohms/foot = 93 ft = 28 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_{limit} / 2 * wire resistance per foot * 4 instruments
= 2 ohms / 2 * 0.0107 ohms/foot * 4 = 23 ft = 7 meters (to 19*plus* V2 *furthest* from power source)

Data Storage

Note:
See *Battery Endurance* for power limitations.

The SBE 19*plus* V2 has a 64 Mbyte FLASH memory. 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 ≈ 64,000,000 / (6 + 5) ≈ 5,818,000 samples

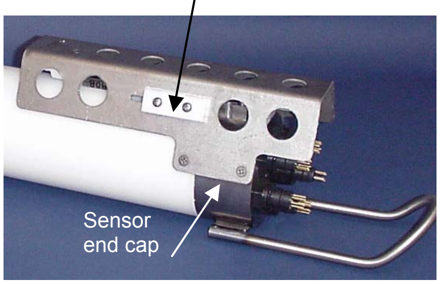
Example 2: Profiling mode, 6 external voltages, strain-gauge pressure
T & C = 6 bytes/sample   Strain-gauge P = 5 bytes/sample
External voltages = 2 bytes/sample * 6 voltages = 12 bytes/sample
Storage space ≈ 64,000,000 / (6 + 5 + 12) ≈ 2,782,000 samples

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 ≈ 64,000,000 / (6 + 5 + 12 + 3 + 4) ≈ 2,133,000 samples

Data I/O

The SBE 19*plus* 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. 19*plus* 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



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 19*plus* V2 draws an additional 15 μA from the battery while in quiescent state.

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 19*plus* 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 19*plus* 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.

Configuration Options and Plumbing

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

The standard SBE 19*plus* 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 19*plus* V2 can be configured with a wide range of auxiliary sensors. Three standard 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 standard 4-pin bulkhead connector on the sensor end cap is provided for interfacing with an RS-232 sensor, such as an SBE 38 secondary temperature sensor or Pro-Oceanus Gas Tension Devices (up to two GTDs can be integrated with the 19*plus* V2).

A 19*plus* V2 is typically deployed in a vertical position. However, when used with an SBE 32 (full size) Carousel Water Sampler, the 19*plus* 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.**

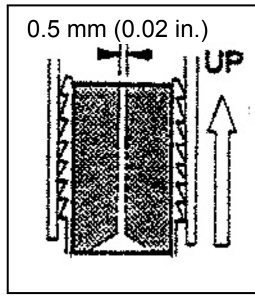
Shown below are schematics of the system configuration for vertical and horizontal deployment. In the schematics, cables are omitted for clarity. Secure each tubing connection with 2 cable ties.

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.

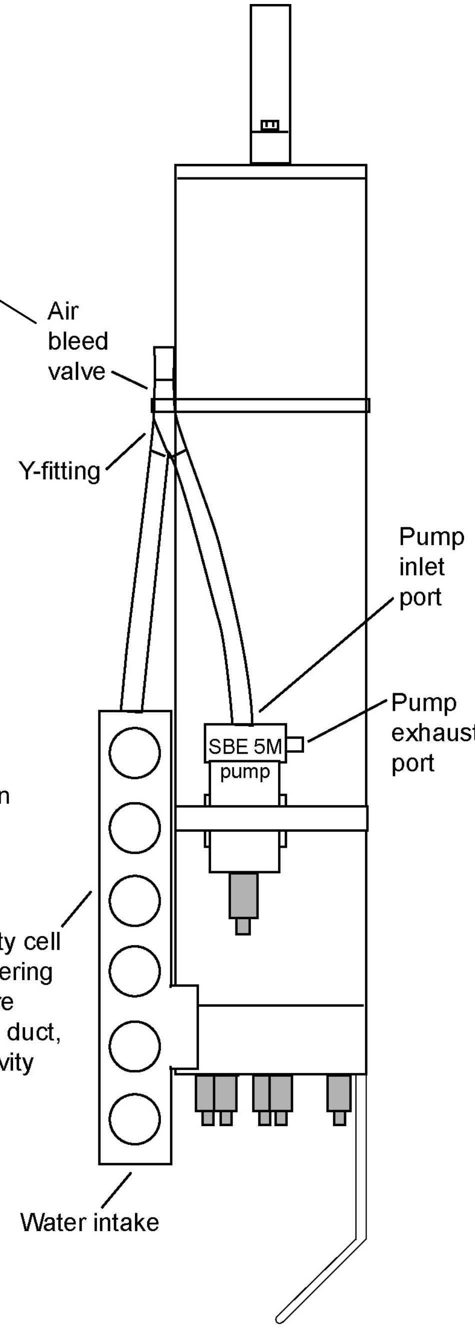
Shown below is the vertical mount plumbing arrangement of a 19*plus* V2 equipped with the standard SBE 5M miniature pump (standard plastic or optional titanium).

Air bleed valve detail



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

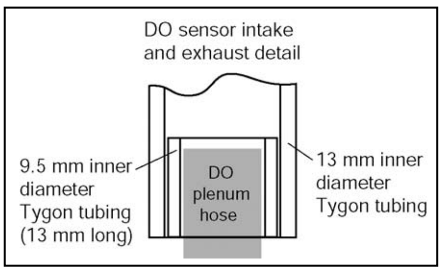
- Main plumbing is 13 mm ID x 19 mm OD (1/2 inch x 3/4 inch) Tygon tubing.
- A 13 mm (1/2 inch) long piece of 9.5 mm ID x 13 mm OD (3/8 inch x 1/2 inch) Tygon tubing is installed on the conductivity cell exhaust to provide tight seals to the main plumbing when optional anti-foul fittings are installed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

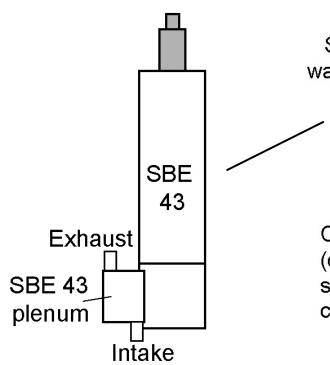


> **Note:**
> Sea-Bird recommends use of the pH sensor on the 19*plus* V2 only when the 19*plus* V2 is in Profiling mode (**MP**).

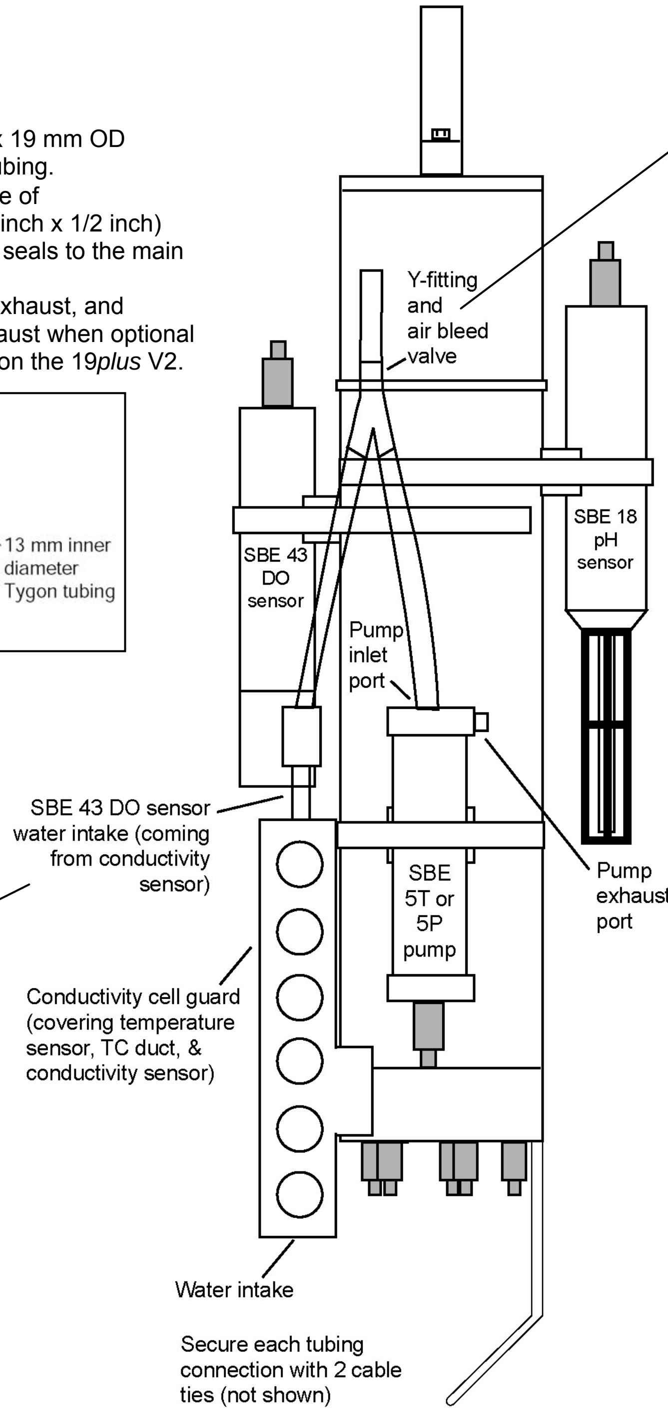
Shown below is the vertical mount plumbing arrangement of a 19*plus* V2 configured with the optional SBE 5T titanium or 5P plastic pump, SBE 43 dissolved oxygen (DO) sensor, and SBE 18 pH sensor. Note that the SBE 43 is plumbed into the system between the conductivity cell outlet and the Y-fitting. The SBE 18 is not connected to the plumbing.

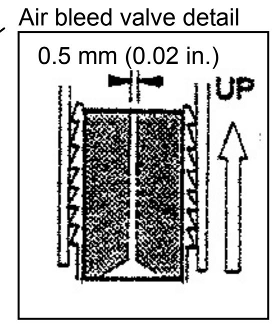
- Main plumbing is 13 mm ID x 19 mm OD (1/2 inch x 3/4 inch) Tygon tubing.
- A 13 mm (1/2 inch) long piece of 9.5 mm ID x 13 mm OD (3/8 inch x 1/2 inch) Tygon tubing to provide tight seals to the main plumbing is installed:
  - on the SBE 43 intake and exhaust, and
  - on the conductivity cell exhaust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



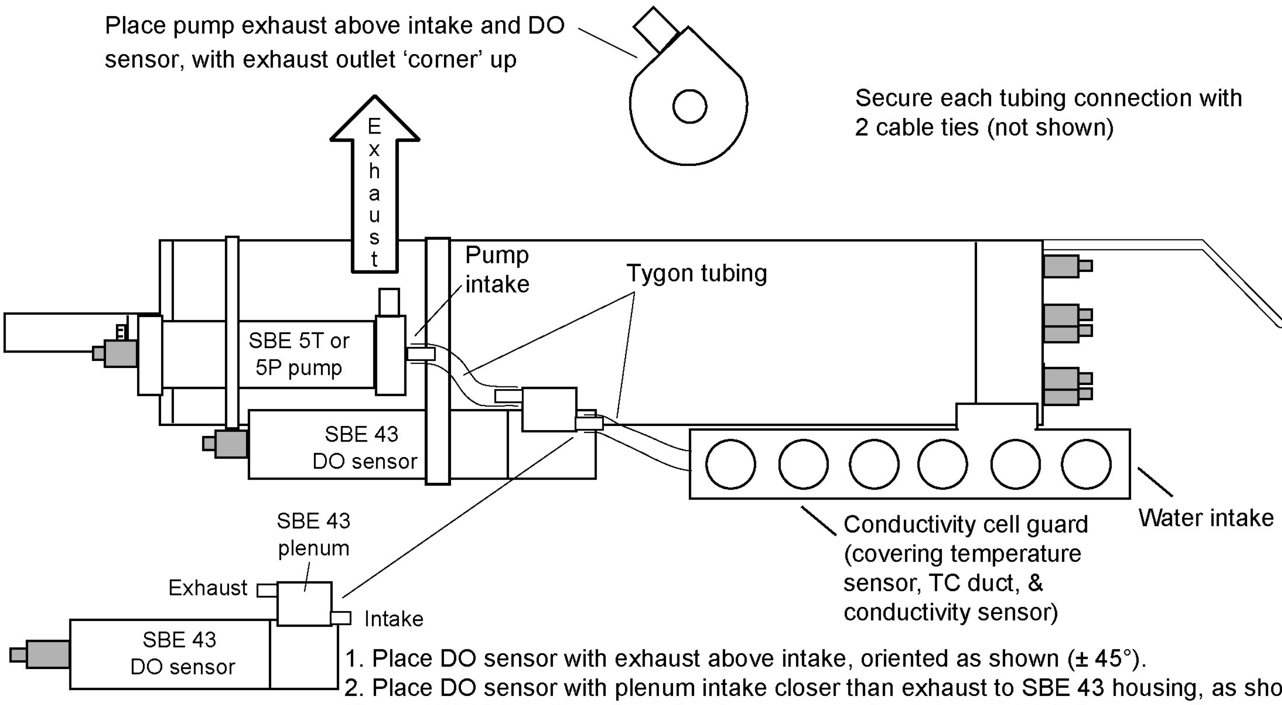


Note: Periodically clean air bleed valve to ensure proper functioning.

Horizontal Mount

Shown below is the horizontal mount plumbing arrangement of a 19*plus* V2 configured with the optional 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.

- 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.

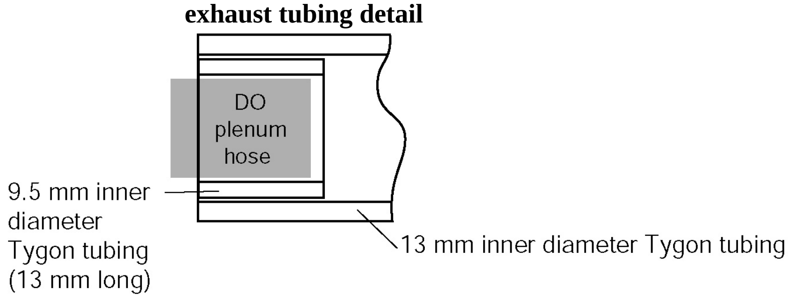


1. Place DO sensor with exhaust above intake, oriented as shown (± 45°).
2. Place DO sensor with plenum intake closer than exhaust to SBE 43 housing, as shown.

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

- 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 19*plus* V2.

DO sensor intake and exhaust tubing detail



Section 3: Power and Communications Test

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

Software Installation

Note:
It is possible to use the 19*plus* V2 without the included terminal program (SCPlusV2_RS232.exe) by sending direct commands from a dumb terminal or terminal emulator, such as Windows HyperTerminal.

Sea-Bird recommends the following minimum system requirements for installing the software: Windows 2000 or later, 500 MHz processor, 256 MB RAM, and 90 MB free disk space for installation.

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 terminal program software: Double click on **SCPlusV2_RS232_V*x_xx*.exe** (*x_xx* is the software version number). Follow the dialog box directions to install the software.
3. Install remaining software: Double click on **Seasoft-Win32_*date*.exe** (*date* is the date that version of the software was created). 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 SEASAVE V7 (real-time data acquisition), SBE Data Processing (data processing), SEATERM (terminal program for setting up SBE 38 auxiliary sensor), SeatermAF (terminal program for use with the Auto Fire Module).

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 19*plus* V2 housing. Note that the Y-cable is connected to the Data I/O, Pump, and External Power connector on the 19*plus* 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. **Standard 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.

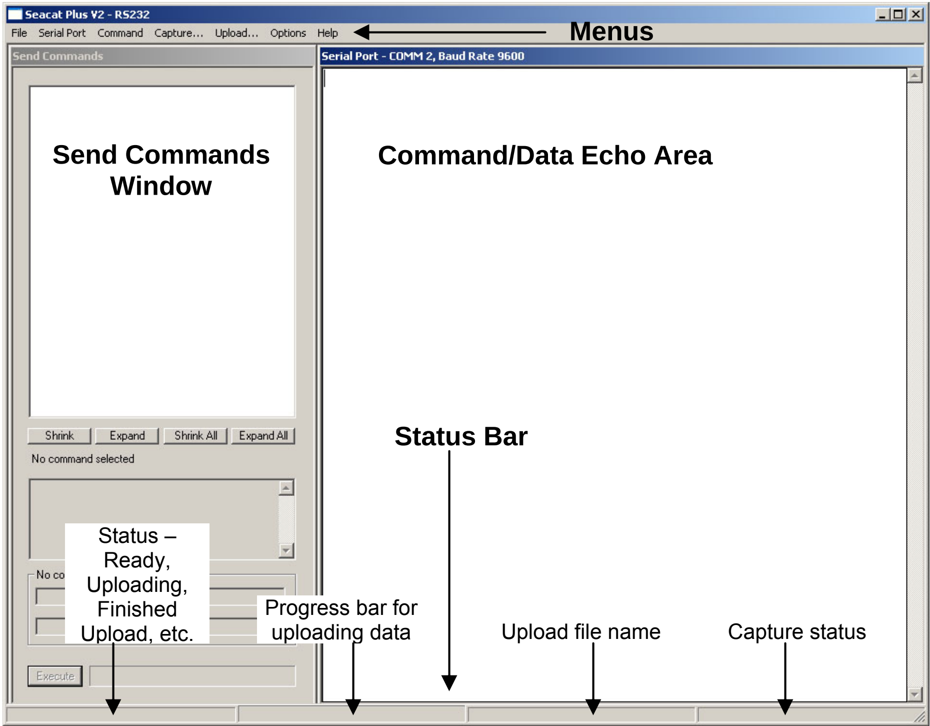
2. Connect the I/O cable connector to your computer's serial port.

Test

Note:
See terminal program's Help files.

Proceed as follows:

1. Double click on SCPlusV2_RS232.exe. The main screen looks like this:



- Menus – Contains tasks and frequently executed instrument commands.
- Send Commands window – Contains a list of commands applicable to your 19*plus* V2. This list automatically appears after you connect to the 19*plus* V2.
- Command/Data Echo Area – Title bar of this window shows the terminal program's current configuration of comm port and baud rate. Commands are echoed in this area, as well as the instrument's response to the commands. Additionally, a command can be manually typed or pasted (ctrl + V) in this area, from the list of available commands for the 19*plus* V2. Note that the 19*plus* V2 must be *connected* and *awake* for it to respond to a command.
- Status bar – Provides status information. To display or hide the Status bar, select View Status bar in the View menu.

Following is a description of the menus:

Menu	Description	Equivalent Command*
File	Exit program.	-
Serial Port	• Configure – Establish communication parameters (comm port and baud rate). • Connect – connect to comm port • Disconnect – disconnect from comm port	-
Command	• Abort – interrupt and stop 19*plus* V2's response • Set date and time – Set date and time to time sent by timekeeping software on your computer; accuracy ± 25 msec of time provided by computer.	• (press Esc key several times for Abort) • **DateTime=**
Capture	Capture instrument responses on screen to file, to save real-time data or may be useful for diagnostics. File has .cap extension. Press 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). 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**.	**GetSD**, **DH**, **GetHD**, **GetSD**, **GetCD**, **GetCC**, **GetEC**, 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)
Options	• Diagnostics - Keep a diagnostics log. • Convert .XML file to .HEX file – Using Upload menu automatically does this conversion; option is available in case there was a problem with the automatic conversion.	-

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

Note:
The terminal program's baud rate must be the same as the 19*plus* 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.

2. In the Serial Port menu, select Configure. The Serial Port Configuration dialog box appears. Select the Comm port and baud rate for communication, and click OK.

3. The terminal program should automatically connect to the 19*plus* 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. The terminal program also fills the Send Commands window with the correct list of commands for your 19*plus* V2. If there is no communication:
   A. In the Serial Port menu, select Connect (if Connect is grayed out, first select Disconnect and then select Connect).
   B. Check cabling between the computer and 19*plus* V2.
   C. If there is still no communication, repeat Step 2 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.

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

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

Notes:
- The 19*plus* 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 19*plus* V2 to sleep. If the system does not appear to respond, click Connect in the Serial Port menu to reestablish communications.
- Sending the status command causes the pump to turn on for a moment, so that the 19*plus* 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.

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

```
SeacatPlus V 2.0c  SERIAL NO. 4000    20 Feb 2008  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, 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
```

5. Command the 19*plus* 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 db
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).

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

The 19*plus* V2 is ready for programming and deployment.

Section 4: Deploying and Operating SBE 19*plus* V2

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.

This section includes discussions of:

- 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 19*plus* 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 19*plus* V2 has two sampling modes for obtaining data:

- Profiling mode
- Moored mode

Descriptions and examples of the sampling modes follow. Note that the 19*plus* 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.

Profiling Mode

The SBE 19*plus* 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 19*plus* 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.	• Turn off external power, or • (if you want to send commands to check or modify setup) Send **Stop**.

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

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

Example: 19*plus* V2 in **Profiling** mode

Wake up 19*plus* V2. Set date and time to October 1, 2007 at 9:05 am. Initialize logging to overwrite previous data in memory. Set up with strain-gauge pressure sensor and 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 terminal program's Serial Port menu to connect and wake up.)

```
DATETIME=09012007090500
INITLOGGING
PTYPE=1
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 19*plus* 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 terminal program's Serial Port menu to connect and wake up.)
(Click Upload– program leads you through screens to define data to be uploaded and where to store it.)

```
QS
```

Moored Mode

At pre-programmed intervals, the SBE 19*plus* V2 wakes up, samples data, stores the data in its FLASH memory, and enters quiescent (sleep) state. The 19*plus* V2 goes to sleep for a minimum of 3 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: 19*plus* V2 in **Moored** mode

Wake up 19*plus* V2. Set date and time to October 1, 2007 at 9:05 am. Initialize logging to overwrite previous data in memory. Set up with strain-gauge pressure sensor and 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, 2007 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 terminal program's Serial Port menu to connect and wake up.)

```
DATETIME=10012007090500
INITLOGGING
PTYPE=1
VOLT0=Y
SAMPLEINTERVAL=120
NCYCLES=4
MOOREDTXREALTIME=N
OUTPUTFORMAT=0
MOOREDPUMPMODE=1
STARTDATETIME=10152007110000
STARTLATER
GETCD       (to verify setup)
QS
```

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

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

(Click Connect in terminal program's Serial Port menu to connect and wake up.)

STOP

(Click Upload – program 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 19*plus* 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 19*plus* 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 19*plus* 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 19*plus* V2 Configuration Sheet), to prevent the pump from turning on when the 19*plus* 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 19*plus* 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 19*plus* V2 is submerged. Determine the turn-on delay by immersing the 19*plus* 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 our of the air bleed valve); 30 seconds is typical. Set the delay to approximately 1.5 times longer. When actually using the 19*plus* V2, be sure to *soak* the instrument just under the surface for at least the time required for pump turn-on.

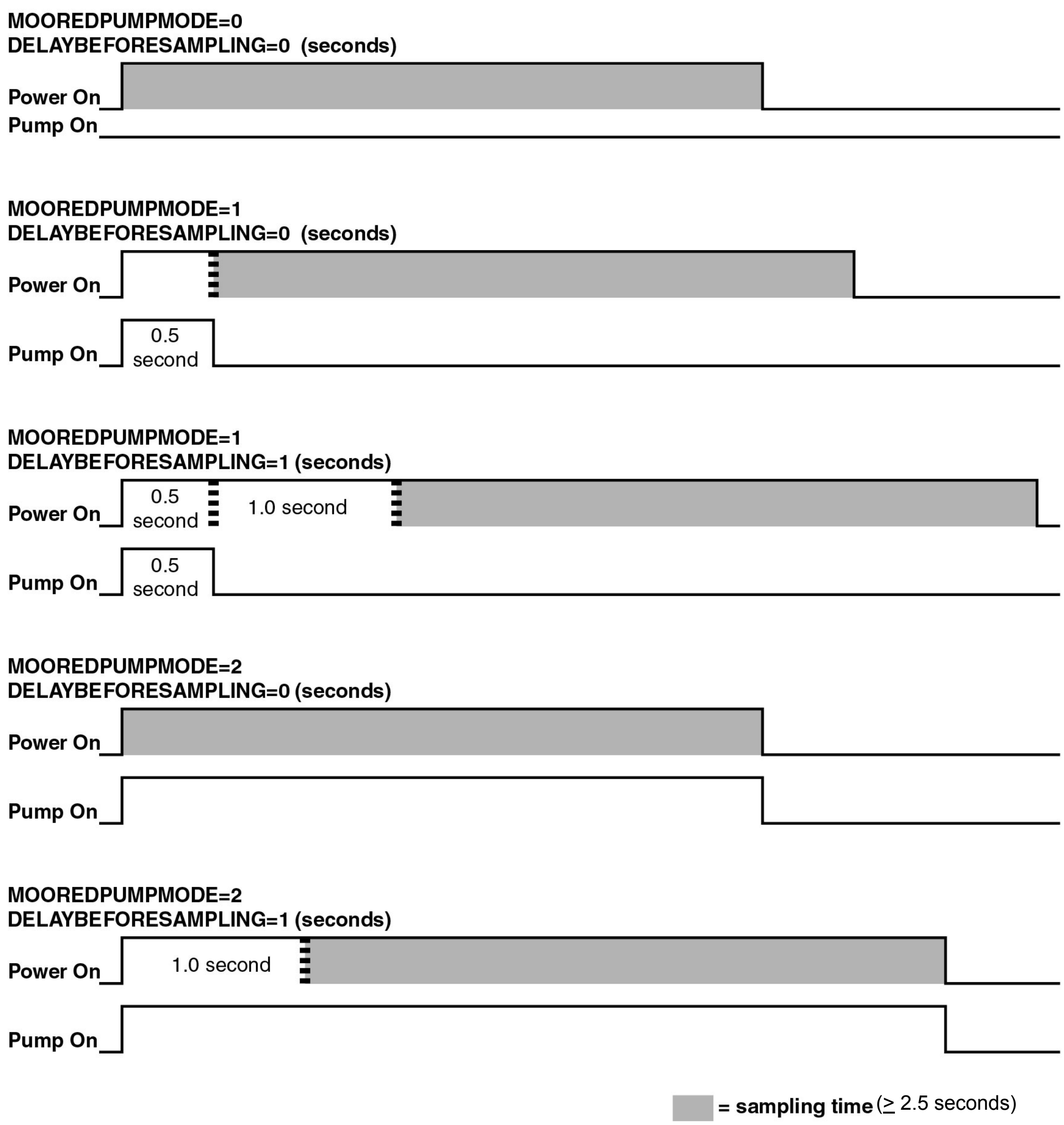
Pump turn-off occurs when the conductivity frequency drops below **MinCondFreq=**.

Pump Operation - Moored Mode

Pump operation is governed by two user-programmable parameters:

- **MooredPumpMode=0**, **1**, or **2**
  The 19*plus* 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 19*plus* V2 can be set up to delay sampling after turning on external voltage sensors. Some instruments require time to equilibrate or stabilize after power is applied, to provide good quality data.

MooredPumpMode= and **DelayBeforeSampling=** interact in the operation of the pump, as shown below. Recommendations for settings are provided on the next page.



Note:
Sampling time includes time for instrument to warm up as well as time to actually measure parameters. The 2.5 second sampling time is for 19*plus* 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

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

For most deployments, set **MooredPumpMode=1** and **DelayBeforeSampling=0**. The pump operates for 0.5 seconds before the conductivity measurement is made, providing enough time to ventilate the cell and bring in a new sample of water.

If the 19*plus* 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

Set **MooredPumpMode=2**.

As the pump brings new water into the SBE 43 plenum, some 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 were sold with a 0.5 mil thick membrane. Beginning 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).

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

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

Set **MooredPumpMode=2**. Set **DelayBeforeSampling=** to 120 to 180 seconds, allowing time for the oxygen sensor to polarize before taking the measurement.

Real-Time Setup

Notes:
- Set baud rate with **BaudRate=**.
- Set data storage and real-time output rate with **NAvg=** (for Profiling Mode) or **SampleInterval=** (for 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 19*plus* V2 is dependent on the amount of data to be transmitted per scan and the serial data baud rate:

Time required to transmit data =
(number of characters * 10 bits/character) / 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.

Time required to transmit data must be less than the real-time output rate.

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

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

Example 1 - 19*plus* 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 19*plus* V2 requires a baud rate of 1200 or less.
Number of characters for **OutputFormat=0** (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) / 1200 =
0.267 seconds > 0.25 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 - 19*plus* 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 19*plus* V2 requires a baud rate of 1200 or less.
Number of characters for **OutputFormat=0** (from *Data Output Formats*) =
6 (T) + 6 (C) + 6 (P) + 4 (P temperature compensation) + 4*4 (external voltages) + 8 (time) + 2 (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 seconds (delay after turning on power) + 2.5 second sampling time + [(10-1) * 0.25 seconds] +
0.4 seconds to transmit real-time + 3 seconds to go to sleep between samples = 23.15 seconds, round up to 24
Therefore, set **SampleInterval=24**, storing and transmitting one sample every 24 seconds.

With a Sea-Bird Deck Unit

Set the 19*plus* V2 baud rate to 4800 if using the 19*plus* 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 19*plus* V2 without a Deck Unit.

Example - 19*plus* 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 over 800 m with **OutputFormat=0** (raw hexadecimal data)?

With a Deck Unit, the 19*plus* 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 19*plus* 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 terminal program – Click the Capture menu; enter the desired file name in the dialog box, and click Save. Begin logging. The data displayed in the terminal program 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 19*plus* V2 has a timeout algorithm. If the 19*plus* V2 does not receive a command or sample data for 2 minutes, it powers down its main digital circuits. This places the 19*plus* V2 in quiescent state, drawing minimal current. **To re-establish control (wake up), click Connect in the Serial Port 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 19*plus* V2 in upper or lower case letters and register commands by pressing the Enter key.
- The 19*plus* V2 sends an error message if an invalid command is entered.
- (if **OutputExecutedTag=N**) If the 19*plus* 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 19*plus* V2 returns to the quiescent (sleep) state.
- If in quiescent state, re-establish communications by clicking Connect in the Serial Port menu or the Enter key.
- If the 19*plus* V2 is transmitting data and you want to stop it, press the Esc key or type ^C. Then press the Enter key.
- 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 19*plus* 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 19*plus* 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=**, **SBE38=**, **GTD=**, **DualGTD=**) prompt the user for verification before executing, to prevent accidental overwriting of existing data.
- The 19*plus* 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 19*plus* 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 19*plus* 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 19*plus* 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 19*plus* 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 19*plus* 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=**]
  - Pump turn-on delay [**DelayBeforeSampling=**]
  - 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 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: 19*plus* V2 in **Profiling** mode (user input in bold, command used to modify parameter in parentheses)

```
getcd
<ConfigurationData DeviceType='SBE19plus' SerialNumber='01906003'>
   <ProfileMode>                                                        [MP]
      <ScansToAverage>1</ScansToAverage>                                [NAvg=]
      <MinimumCondFreq>3000</MinimumCondFreq>                           [MinCondFreq=]
      <PumpDelay>60</PumpDelay>                                         [PumpDelay=]
      <AutoRun>no</AutoRun>                                             [AutoRun=]
      <IgnoreSwitch>no</IgnoreSwitch>                                   [IgnoreSwitch=]
   </ProfileMode>
   <Battery>
      <Type>alkaline</Type>                                             [BatteryType=]
      <CutOff>7.5</CutOff>
   </Battery>
   <DataChannels>
      <ExtVolt0>yes</ExtVolt0>                                          [Volt0=]
      <ExtVolt1>no</ExtVolt1>                                           [Volt1=]
      <ExtVolt2>no</ExtVolt2>                                           [Volt2=]
      <ExtVolt3>yes</ExtVolt3>                                          [Volt3=]
      <ExtVolt4>no</ExtVolt4>                                           [Volt4=]
      <ExtVolt5>no</ExtVolt5>                                           [Volt5=]
      <SBE38>no</SBE38>                                                 [SBE38=]
      <GTD>no</GTD>                                                     [GTD= or DualGTD=]
   </DataChannels>
   <EchoCharacters>yes</EchoCharacters>                                 [Echo=]
   <OutputExecutedTag>no</OutputExecutedTag>                            [OutputExecutedTag=]
   <OutputFormat>converted decimal</OutputFormat>                       [OutputFormat=]
   <OutputSalinity>no</OutputSalinity>                                  [OutputSal=]
   <OutputSoundVelocity>no</OutputSoundVelocity>                        [OutputSV=]
   <OutputSigmaT-V>no</OutputSigmaT-V>                                  [OutputUCSD=]
</ConfigurationData>
```

Example: 19*plus* 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>                                                         [MM]
      <SampleInterval>15</SampleInterval>                               [SampleInterval=]
      <MeasurementsPerSample>1</MeasurementsPerSample>                  [NCycles=]
      <Pump>run pump during sample</Pump>                               [MooredPumpMode=]
      <DelayBeforeSampling>0.0</DelayBeforeSampling>                    [DelayBeforeSampling=]
      <TransmitRealTime>no</TransmitRealTime>                           [MooredTxRealTime=]
   </MooredMode>
   <Battery>
      <Type>alkaline</Type>                                             [BatteryType=]
      <CutOff>7.5</CutOff>
   </Battery>
   <DataChannels>
      <ExtVolt0>yes</ExtVolt0>                                          [Volt0=]
      <ExtVolt1>no</ExtVolt1>                                           [Volt1=]
      <ExtVolt2>no</ExtVolt2>                                           [Volt2=]
      <ExtVolt3>yes</ExtVolt3>                                          [Volt3=]
      <ExtVolt4>no</ExtVolt4>                                           [Volt4=]
      <ExtVolt5>no</ExtVolt5>                                           [Volt5=]
      <SBE38>no</SBE38>                                                 [SBE38=]
      <GTD>no</GTD>                                                     [GTD= or DualGTD=]
   </DataChannels>
   <EchoCharacters>yes</EchoCharacters>                                 [Echo=]
   <OutputExecutedTag>no</OutputExecutedTag>                            [OutputExecutedTag=]
   <OutputFormat>converted decimal</OutputFormat>                       [OutputFormat=]
   <OutputSalinity>no</OutputSalinity>                                  [OutputSal=]
   <OutputSoundVelocity>no</OutputSoundVelocity>                        [OutputSV=]
   <OutputSigmaT-V>no</OutputSigmaT-V>                                  [OutputUCSD=]
</ConfigurationData>
```

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 19*plus* 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 19*plus* V2 is set up with a WET Labs ECO-FL fluorometer 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 19*plus* V2 (user input in bold, command used to modify parameter in parentheses)

```
getsd
<StatusData DeviceType = 'SBE19plus' SerialNumber = '01906003'>
   <DateTime>2007-10-05T10:53:03</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>        [only appear if in Profiling mode; 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 19*plus* V2.

Example: 19*plus* 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-Oct-07</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-Oct-07</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>01906003</SerialNum>
      <CalDate>27-Oct-07</CalDate>                          [PCalDate=]
      <PA0>-5.137085e-02</PA0>                              [PA0=]
      <PA1>1.550601e-03</PA1>                               [PA1=]
      <PA2>7.210415e-12</PA2>                               [PA2=]
      <PTCA0>5.154159e+05</PTCA0>                           [PTCA0=]
      <PTCA1>2.560262e-01</PTCA1>                           [PTCA1=]
      <PTCA2>-8.533080e-02</PTCA2>                          [PTCA2=]
      <PTCB0>2.426612e+01</PTCB0>                           [PTCB0=]
      <PTCB1>-7.750000e-04</PTCB1>                          [PTCB1=]
      <PTCB2>0.000000e+00</PTCB2>                           [PTCB2=]
      <PTEMPA0>-7.667877e+01</PTEMPA0>                      [PTempA0=]
      <PTEMPA1>4.880376e+01</PTEMPA1>                       [PTempA1=]
      <PTEMPA2>-4.555938e-01</PTEMPA2>                      [PTempA2=]
      <POFFSET>0.000000e+00</POFFSET>                       [POffset= (decibars)]
      <PRANGE>1.000000e+03</PRANGE>                         [PRange= (psia)]
   </Calibration>
   <Calibration format = 'VOLT0' id = 'Volt 0'>
      <OFFSET>0.000000e+00</OFFSET>                         [VOffset0=]
      <SLOPE>1.260977e+00</SLOPE>                           [VSlope0=]
   </Calibration>
   <Calibration format = 'VOLT0' id = 'Volt 1'>
      <OFFSET>-4.728750e-02</OFFSET>                        [Voffset1=]
      <SLOPE>1.259474e+00</SLOPE>                           [VSlope1=]
   </Calibration>
   <Calibration format = 'VOLT0' id = 'Volt 2'>
      <OFFSET>-4.715313e-02</OFFSET>                        [Voffset2=]
      <SLOPE>1.259946e+00</SLOPE>                           [VSlope2=]
   </Calibration>
   <Calibration format = 'VOLT0' id = 'Volt 3'>
      <OFFSET>-4.772396e-02</OFFSET>                        [Voffset3=]
      <SLOPE>1.260486e+00</SLOPE>                           [VSlope3=]
   </Calibration>
   <Calibration format = 'VOLT0' id = 'Volt 4'>
      <OFFSET>-4.765417e-02</OFFSET>                        [Voffset4=]
      <SLOPE>1.260014e+00</SLOPE>                           [VSlope4=]
   </Calibration>
   <Calibration format = 'VOLT0' id = 'Volt 5'>
      <OFFSET>-4.744167e-02</OFFSET>                        [Voffset5=]
      <SLOPE>1.260255e+00</SLOPE>                           [VSlope5=]
   </Calibration>
   <Calibration format = 'FREQ0' id = 'external frequency channel'>
      <EXTFREQSF>1.000000e+00</EXTFREQSF>                   [ExtFreqSF=]
   </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 19*plus* 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*)

> **Note:**
> External sensor types and serial numbers can be changed in the field, to accommodate changes in auxiliary sensors cabled to the 16*plus*-IM V2. Other hardware data is typically not changed by the user.

GetHD

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

- Device type, Serial number
- Manufacturer
- Firmware version
- Firmware date
- PCB serial number and assembly number
- Manufacture date
- Internal sensor types and serial numbers
- External sensor types (for example, dissolved oxygen, fluorometer, etc.) and serial numbers

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>2.0c</FirmwareVersion>
   <FirmwareDate>20 February 2008 13:00</FirmwareDate>
   <PCBAssembly PCBSerialNum = 'not assigned' AssemblyNum = '41054F'/>     [SetPcbSerialNum1=, SetPCBAssembly1=]
   <PCBAssembly PCBSerialNum = 'not assigned' AssemblyNum = '41580'/>      [SetPcbSerialNum2=, SetPCBAssembly2=]
   <PCBAssembly PCBSerialNum = 'not assigned' AssemblyNum = '41056E'/>     [SetPcbSerialNum3=, SetPCBAssembly3=]
   <PCBAssembly PCBSerialNum = 'not assigned' AssemblyNum = '41059D'/>     [SetPcbSerialNum4=, SetPCBAssembly4=]
   <MfgDate>03 october 2007</MfgDate>                                      [SetMfgDate=]
   <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>                                             [PType=]
         <SerialNumber>2580011</SerialNumber>
      </Sensor>
   </InternalSensors>
   <ExternalSensors>
      <Sensor id = 'volt 0'>
         <type>not assigned</type>                                         [SetVoltType0=]
         <SerialNumber>not assigned</SerialNumber>                         [SetVoltSN0=]
      </Sensor>
      <Sensor id = 'volt 1'>
         <type>not assigned</type>                                         [SetVoltType1=]
         <SerialNumber>not assigned</SerialNumber>                         [SetVoltSN1=]
      </Sensor>
      <Sensor id = 'volt 2'>
         <type>not assigned</type>                                         [SetVoltType2=]
         <SerialNumber>not assigned</SerialNumber>                         [SetVoltSN2=]
      </Sensor>
      <Sensor id = 'volt 3'>
         <type>not assigned</type>                                         [SetVoltType3=]
         <SerialNumber>not assigned</SerialNumber>                         [SetVoltSN3=]
      </Sensor>
      <Sensor id = 'volt 4'>
         <type>not assigned</type>                                         [SetVoltType4=]
         <SerialNumber>not assigned</SerialNumber>                         [SetVoltSN4=]
      </Sensor>
      <Sensor id = 'volt 5'>
         <type>not assigned</type>                                         [SetVoltType5=]
         <SerialNumber>hi there</SerialNumber>                             [SetVoltSN5=]
      </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 19*plus* 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 iext2345= (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 19*plus* V2 is set up for dual GTDs, the **DS** response shows: `Dual Gas Tension Device = Yes`
- If the 19*plus* V2 is set up with a WET Labs ECO-FL fluorometer 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 configuration parameters, 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=**]
- Sample RS-232 sensor - SBE 38 [**SBE38=**], 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 if output format = converted decimal or converted XML UVIC)
- Output sigma-t, voltage, and current with each sample? [**OutputUCSD=**] (only if output format = converted decimal or converted XML UVIC; and if set to Y)

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

```
DS
SeacatPlus V 2.0c  SERIAL NO. 4000    20 Feb 2008  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=]
SBE 38 = no, Gas Tension Device = no                                       [SBE38=, 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=**], and pump turn-on delay [**DelayBeforeSampling=**]
- Transmit data real-time? [**MooredTxRealTime=**]
- Battery type [**BatteryType=**] and battery cut-off voltage
- Pressure type [**PType=**] and range [**PRange=**]
- Sample RS-232 sensor - SBE 38 [**SBE38=**], 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)

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

```
DS
SeacatPlus V 2.0c  SERIAL NO. 4000    20 Feb 2008  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 = 1644953                                               [reset with InitLogging]
mode = moored, run pump for 0.5 sec, delay before sampling = 0.0 seconds  [MM, MOOREDPUMPMODE=, DELAYBEFORESAMPLING=]
transmit real-time = yes                                                  [MooredTxRealTime=]
battery type = alkaline, battery cutoff =  7.5 volts                      [BatteryType=]
pressure sensor = strain gauge, range = 2000.0                            [PType=, PRange=]
SBE 38 = no, Gas Tension Device = no                                      [SBE38=, 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 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 19*plus* V2.

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

dcal	
SeacatPlus V 2.0c SERIAL NO. 0003 20 Feb 2008 14:46:05	[**DateTime=**]
temperature: 20-jul-07	[**TCalDate=**]
TA0 = -3.178124e-06	[**TA0=**]
TA1 = 2.751603e-04	[**TA1=**]
TA2 = -2.215606e-06	[**TA2=**]
TA3 = 1.549719e-07	[**TA3=**]
TOFFSET = 0.000000e+00	[**TOffset=**]
conductivity: 20-jul-07	[**CCalDate=**]
G = -9.855242e-01	[**CG=**]
H = 1.458421e-01	[**CH=**]
I = -3.290801e-04	[**CI=**]
J = 4.784952e-05	[**CJ=**]
CF0 = 2.584100e+03	(not used in calculations; ignore)
CPCOR = -9.570000e-08	[**CPCor=**]
CTCOR = 3.250000e-06	[**CTCor=**]
CSLOPE = 1.000000e+00	[**CSlope=**]
pressure S/N , range = 2000 psia: 14-jul-07	[**PRange=** (psia), **PCalDate=**]
PA0 = 0.000000e+00	[**PA0=**]
PA1 = 0.000000e+00	[**PA1=**]
PA2 = 0.000000e+00	[**PA2=**]
PTEMPA0 = 0.000000e+00	[**PTempA0=**]
PTEMPA1 = 0.000000e+00	[**PTempA1=**]
PTEMPA2 = 0.000000e+00	[**PTempA2=**]
PTCA0 = 0.000000e+00	[**PTCA0=**]
PTCA1 = 0.000000e+00	[**PTCA1=**]
PTCA2 = 0.000000e+00	[**PTCA2=**]
PTCB0 = 0.000000e+00	[**PTCB0=**]
PTCB1 = 0.000000e+00	[**PTCB1=**]
PTCB2 = 0.000000e+00	[**PTCB2=**]
POFFSET = 0.000000e+00	[**POffset=** (decibars)]
volt 0: offset = 0.000000e+00, slope = 1.000000e+00	[**VOffset0=**, **VSlope0=**]
volt 1: offset = 0.000000e+00, slope = 1.000000e+00	[**Voffset1=**, **VSlope1=**]
volt 2: offset = 0.000000e+00, slope = 1.000000e+00	[**Voffset2=**, **VSlope2=**]
volt 3: offset = 0.000000e+00, slope = 1.000000e+00	[**Voffset3=**, **VSlope3=**]
volt 4: offset = 0.000000e+00, slope = 1.000000e+00	[**Voffset4=**, **VSlope4=**]
volt 5: offset = 0.000000e+00, slope = 1.000000e+00	[**Voffset5=**, **VSlope5=**]
EXTFREQSF = 1.000000e+00	[**ExtFreqSF=**]

Notes:
- The 19*plus* V2 baud rate (set with **BaudRate=**) must be the same as the terminal program's baud rate (set in the Serial Port menu).
- An RS-232 sensor (SBE 38 or GTD) integrated with the 19*plus* V2 must use the same baud rate as the 19*plus* V2. See the RS-232 sensor's manual to set its baud.
- **BaudRate=** must be sent twice. After the first entry, the 19*plus* V2 changes to the new baud, and then waits for the command to be sent again at the new baud. 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 rate.

General Setup Commands

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

Example: Set current date and time to 05 October 2007 12:05:00 (user input in bold).

```
datetime=10052007120500
```

BaudRate=x **x=** baud rate (600, 1200, 2400, 4800, 9600, 19200, 33600, 38400, 57600, or 115200). ***Default 9600.*** Check capability of your computer and terminal program before increasing baud rate. **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 19*plus* V2 response to a command requires additional time.

x=N: Do not.

Example: Set 19*plus* 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. 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 0.5 volts/minute as determined by two 30-second 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-second moving averages. This reduces battery load to quiescent current once first cell in battery pack is exhausted.

Notes:
- The 19*plus* V2 requires verification when **InitLogging**, **SampleNumber=**, or **HeaderNumber=** are sent. 19*plus* 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 19*plus* V2 responds:
  `Scan length has changed, initializing logging`
- **InitLogging** and **SampleNumber=0** have identical effects. Use either to initialize 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:
  1. Set **SampleNumber=a** and **HeaderNumber=b**, where **a** and **b** are your estimate of number of samples and casts in memory.
  2. 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.
  3. If desired, increase **a** and/or **b** and upload data again, to see if there is additional valid data in memory.

General Setup Commands (*continued*)

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. After all previous data has been uploaded, send **SampleNumber=0** (sets sample number and header / cast number to 0) before starting to sample to make entire memory available for recording (sampling will start with sample 1 and header 1). If not set to 0, data will be stored after last recorded sample. **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** or **SampleNumber=0**) before uploading all existing data. 19*plus* V2 can have a maximum of 1000 stored headers.
Note that 19*plus* 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:
The 19*plus* 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 19*plus* V2 to sleep.

QS

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

Notes:

- The 19*plus* V2 requires verification when these commands **(PType=** through **Volt5=**) are sent. The 19*plus* 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 19*plus* V2 responds:
  `Scan length has changed, initializing logging`
- The 19*plus* V2 configuration (.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 .con 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 19*plus* V2 end cap (see *Dimensions and End Cap Connectors* in *Section 2: Description of SBE 19plus V2*). However, in the .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.

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 .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.

Note:
If an ECO-FL 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 in Moored mode (**MM**) with the Bio-Wiper open and with a delayed start time, the ECO-FL may become fouled because the Bio-Wiper will remain open until the first sample is completed.

Biowiper=x **x=Y**: Configuration includes WET Labs ECO-FL fluorometer with Bio-Wiper. With this setup, 19*plus* V2 is powered longer for **DS** and **GetSD**, providing sufficient time for Bio-Wiper to open and then shut again if in Moored mode if Bio-Wiper is set up to take 1 measurement for each sample (see *Application Note 72*).

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

RS-232 Sensor Setup Commands

Notes:
- The 19*plus* V2 requires verification when **SBE38=**, **GTD=**, or **DualGTD=** is sent. The 19*plus* 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 19*plus* V2 responds:
  `Scan length has changed, initializing logging`
- The 19*plus* V2 configuration (.con) file must match this selection of RS-232 sensor when viewing real-time data or processing uploaded data. View and edit the .con file in SEASAVE or SBE Data Processing. These parameters are factory-set to match the ordered instrument configuration.
- See the SBE 38 or Pro-Oceanus GTD manual for command details for these instruments.

The SBE 19*plus* V2 can interface with an SBE 38 secondary temperature sensor, or up to 2 Pro-Oceanus Gas Tension Devices (GTDs).

Setup for SBE 38:

Set up SBE 38 to interface with SBE 19*plus* V2, **before** you connect it to 19*plus* V2. Connect SBE 38 directly to computer, power with an external power supply, and (using SEATERM) set:
- **Baud rate** to same baud rate as 19*plus* 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 19*plus* V2 RS-232 bulkhead connector, using provided cable. In the 19*plus* 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 19*plus* V2 sample interval (**SampleInterval=**) must be greater than or equal to the sum of the times required to sample. Total time is affected by the following:
- **Programmable pressure integration time for GTD**.
- **Programmable temperature integration time for GTD**.
- Minimum time required for 19*plus* V2 to take a sample (≈ 2.5 sec).
- Time required for 19*plus* V2 to take and average **NCycles=** samples; samples are taken 0.25 sec apart.
- Delay after providing power to external voltage sensors before sampling (**DelayBeforeSampling=**).
- Time required to run pump before sampling (0.5 sec if **MooredPumpMode=1**).

Setup for GTD:

SBE 19*plus* V2 must be in Moored mode (MM) to obtain GTD data; it cannot obtain GTD data in Profiling mode (**MP**). Set up GTD to interface with SBE 19*plus* V2, **before** you connect it to 19*plus* 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 19*plus* 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 seconds or less (required so that 19*plus* V2 does not *time out* while waiting for reply).

Connect GTD to SBE 19*plus* V2 RS-232 bulkhead connector, using provided cable (end labeled *Pro-Oceanus* to GTD and end labeled *Sea-Bird* to 19*plus* V2). In the 19*plus* V2, set:
- **GTD=Y** or **DualGTD=Y** to enable interface.
- **SendGTD=** to change IDs if necessary.

Each time a sample is to be taken, 19*plus* V2 sends following commands to GTD (ID= 01, 02, etc.):
- ***ID00VR** <CR><LF> - get GTD firmware version; wait up to 3 seconds for reply.
- ***ID00SN** <CR><LF> - get GTD serial number; wait up to 5 seconds 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 seconds 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 seconds for reply.

RS-232 Sensor Setup Commands (*continued*)

Notes:
- A 19*plus* 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 10^5)
GTD#2 pressure reply = *00021010.01580, p = 101001580   (millibars x 10^5)
GTD#1 temperature reply = *000123.49548, t = 23.4955   (°C)
GTD#2 temperature reply = *000223.0357038, t = 23.0357   (°C)
```

SendGTD=command

Command 19*plus* 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 the terminal program to view real-time data** - Set output format to converted decimal for ease in viewing real-time data.
> - After stopping sampling, use the terminal program'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 terminal program's Upload menu, terminal program always uploads data from memory in raw hex (compatible with SBE Data Processing and SEASAVE), 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.

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), 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 19*plus* V2 requires verification when **MP** is sent. 19*plus* 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 19*plus* V2 responds:
`Scan length has changed, initializing logging`

Note:
For a 19*plus* V2 with optional 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*.

Notes:
To start sampling immediately after you send **AutoRun=Y** (if you were performing setup on external power):
- Send **QS** to put 19*plus* V2 in quiescent (sleep) state, and then turn external power off and then on again. **or**
- Send **StartNow**.

Profiling Mode Setup Commands

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

MP — Set 19*plus* V2 to Profiling mode.

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

Example: 19*plus* V2 samples every 0.25 seconds. If **NAvg=2**, 19*plus* V2 averages data from 2 samples (= 1 averaged data sample per 0.5 seconds), 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 19*plus* V2 is in water. Pump stops when conductivity frequency drops below **MinCondFreq=**. 19*plus* 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 (seconds) 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 19*plus* V2 is submerged.
Pump starts **PumpDelay=** seconds after conductivity cell's frequency output is greater than **MinCondFreq=**.
Typical value 30 - 45 seconds; range 0 – 600 seconds. ***Default 60 seconds.***

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 **or** by commands. ***Default***.

Moored Mode Setup Commands

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

> **Note:**
> The 19*plus* V2 requires verification when **MM** is sent. 19*plus* 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 19*plus* V2 responds:
> `Scan length has changed, initializing logging`

MM — Set 19*plus* V2 to Moored mode.

SampleInterval=x — **x**= interval (seconds) between samples (10 - 14,400 seconds).

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

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

> *Example:* If **SampleInterval=10** and **NCycles=4**, every 10 seconds 19*plus* V2 takes 4 measurements (0.25 seconds 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 seconds 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 (seconds) to wait after switching on external voltage sensors before sampling (0-600 seconds). ***Default 0 seconds***. Typical values if using:

- SBE 43 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 seconds required to provide time for sensor to polarize.
Use with **MooredPumpMode=2**.

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

> **Notes:**
> - Pump operation is affected by both **DelayBeforeSampling=** and **MooredPumpMode=**. See *Pump Operation – Moored Mode*.
> - The 19*plus* V2 does the integration for the Quartz pressure sensor *after* **NCycles=** measurements have been taken.
> - **NCycles=** and **DelayBeforeSampling=** affect the time required to sample. If these are too high, the 19*plus* V2 is unable to take the required number of measurements and do the calculations within **SampleInterval=**. When it is beginning to log, the 19*plus* V2 checks all parameters, and if necessary it internally increases **SampleInterval=**.

MooredTxRealTime=x — **x=Y**: Output real-time data.

x=N: Do not.

Notes:
- In the terminal program, 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.
- If the 19*plus* V2 is sampling and the voltage is less than the cut-off voltage (see **BatteryType=** for cut-off values for various battery types), the 19*plus* V2 halts logging and displays `WARNING: LOW BATTERY VOLTAGE`.

Logging Commands

Logging commands direct the SBE 19*plus* V2 to sample data. When commanded to start sampling, the 19*plus* 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 19*plus* V2 transmits real-time data, and does not enter quiescent (sleep) state between samples. The 19*plus* V2 provides several methods for starting and stopping logging, depending on the settings for **IgnoreSwitch=** and **AutoRun=**. Logging starts approximately 1 - 2 seconds 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.	• Turn off external power, or • (if you want to send commands to check or modify setup) Send **Stop**.

Note:
Sea-Bird ships the 19*plus* V2 with **AutoRun=N** (it will not automatically start sampling when external power is applied). If you send **AutoRun=Y**:
- Send **QS** to put 19*plus* V2 n quiescent (sleep) state, then turn power off and then on again to start sampling, **or**
- Send **StartNow** to start sampling.

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.

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 19*plus* V2 is in quiescent state, the CPU enters the awake state, but logging does not begin. If no communications are established, the 19*plus* V2 times out and enters quiescent state after 2 minutes.

Moored Mode (MM)

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

To start logging, use **StartNow**; logging starts **SampleInterval=** seconds 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 19*plus* 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 19*plus* 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 19*plus* 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 19*plus* V2 executes **StartNow**.
- If the delayed start date and time is more then 1 month in the future when **StartLater** is received, the 19*plus* 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.

StartLater — Start logging at time set with **StartDateTime=**.

Example: Program 19*plus* V2 to start logging on 20 January 2008 12:05:00. (user input in bold)

STARTDATETIME=01202008120500
STARTLATER

Notes:
- You may need to send **Stop** several times to get the 19*plus* V2 to respond.
- If in Profiling mode and **IgnoreSwitch=N**, slide the magnetic switch off **or** send **Stop** to stop logging.
- You must stop logging before uploading data.

Stop — Stop 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**
Profiling mode only.
Upload data from cast **x**. If **x** is omitted, data from cast 1 is uploaded.
First cast 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, 19*plus* V2 responds:
> `cast 2 30 Oct 2007 12:30:33 samples 35 to 87, avg = 1, stop = mag switch`
>
> If in Moored mode, 19*plus* V2 responds:
> `hdr 2 30 Oct 2007 12:30:33 samples 35 to 87, int = 10, stop = stop cmd`

Polled Sampling Commands

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

Notes:

- The 19*plus* 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 19*plus* V2 is set to Profiling Mode (**MP**). Thus, the 19*plus* 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 19*plus* 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).

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, 19*plus* V2 outputs all samples in memory. If **x** is omitted, 19*plus* V2 outputs just the last sample.

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 19*plus* 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 optional Quartz), output converted data.

TPR Measure pressure (strain-gauge or optional 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 (optional Quartz pressure sensor), output converted pressure data.

TFR Measure frequency (optional Quartz pressure sensor), output raw data.

T38 Measure SBE 38 (secondary temperature), output converted data.

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

Notes:
- F = floating point number
  S = string with no spaces
- If using an SBE 38 secondary temperature sensor, its calibration coefficients are not stored in the 19*plus* V2 EEPROM. View and/or modify the instrument's calibration coefficients by connecting the instrument to the computer directly and using SEATERM.

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

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
CPCor=F	**F**=pcor
CTCor=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

Optional 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

External Frequency

ExtFreqSF=F	**F**=external frequency scale factor (applies to optional Quartz pressure sensor)

Note:
If using auxiliary A/D sensors (**Volt0=** through **Volt5=**), their calibration coefficients are not stored in the 19*plus* V2 EEPROM, but are stored in the 19*plus* V2 configuration (.con) file. View and/or modify the calibration coefficients using the Configure menu in SBE Data Processing or the Configure Inputs menu in SEASAVE.

Voltage Channels

The following commands set voltage channel offsets and slopes **at the factory**. These are properties of the 19*plus* V2's electronics, and are not calibration coefficients for the auxiliary sensors. These commands are included here for completeness, **but should never be used by the customer**.

VOffset0=	**VSlope0=**
VOffset1=	**VSlope1=**
VOffset2=	**VSlope2=**
VOffset3=	**VSlope3=**
VOffset4=	**VSlope4=**
VOffset5=	**VSlope5=**

Hardware Configuration Commands

The following commands are used to set manufacturing date, PCB serial numbers, PCB assembly numbers, and auxiliary channel sensor types and serial number, **at the factory**.

Factory Settings – do not modify in the field
SetMfgDate=
SetPcbSerialNum1=
SetPcbSerialNum2=
SetPcbSerialNum3=
SetPcbSerialNum4=
SetPcbAssembly1=
SetPcbAssembly2=
SetPcbAssembly3=
SetPcbAssembly4=

Auxiliary Sensor Settings – can be modified in the field to accommodate changes in auxiliary sensors cabled to the 19plus V2
SetVoltType0=
SetVoltSN0=
SetVoltType1=
SetVoltSN1=
SetVoltType2=
SetVoltSN2=
SetVoltType3=
SetVoltSN3=
SetVoltType4=
SetVoltSN4=
SetVoltType5=
SetVoltSN5=

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 19*plus* V2 to wake up and prepare to sample, and
- any programmed **DelayBeforeSampling=**.

For example, if the 19*plus* 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 19*plus* 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.

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 the terminal program's Upload menu, the terminal program always upload 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 19*plus* V2 outputs pressure relative to the ocean surface (i.e., at the surface the output pressure is 0 decibars). The 19*plus* V2 uses the following equation to convert psia to decibars: pressure (db) = [pressure (psia) - 14.7] * 0.689476
- Although **OutputFormat=0** outputs *raw* data for temperature, conductivity, etc., it outputs engineering units for SBE 38 and GTD data.

1. Temperature
   A/D counts = tttttt
2. Conductivity
   conductivity frequency (Hz) = cccccc / 256
3. Strain-gauge pressure sensor Pressure (if **PType=1**)
   A/D counts = pppppp
4. Strain-gauge pressure sensor temperature compensation (if **PType=1**)
   pressure temperature compensation voltage = vvvv / 13,107
5. Quartz pressure sensor pressure (if **PType=3**)
   pressure frequency (Hz) = pppppp / 256
6. Quartz pressure sensor temperature compensation (if **PType=3**)
   temperature compensation voltage = vvvv / 13,107
7. External voltage 0 (if **Volt0=Y**)
   external voltage 0= vvvv / 13,107
8. External voltage 1 (if **Volt1=Y**)
   external voltage 1 = vvvv / 13,107
9. External voltage 2 (if **Volt2=Y**)
   external voltage 2 = vvvv / 13,107
10. External voltage 3 (if **Volt3=Y**)
    external voltage 3 = vvvv / 13,107
11. External voltage 4 (if **Volt4=Y**)
    external voltage 4 = vvvv / 13,107
12. External voltage 5 (if **Volt5=Y**)
    external voltage 5 = vvvv / 13,107
13. SBE 38 secondary temperature (if **SBE38=Y**)
    SBE 38 temperature (°C, ITS-90) = (tttttt / 100,000) – 10
14. GTD #1 pressure (if **GTD=Y** or **DualGTD=Y**)
    GTD #1 pressure (millibars) = pppppppp / 100,000
15. GTD #1 temperature (if **GTD=Y** or **DualGTD=Y**)
    GTD #1 temperature (°C, ITS-90) = (tttttt / 100,000) – 10
16. GTD #2 pressure (if **DualGTD=Y**)
    GTD #2 pressure (millibars) = pppppppp / 100,000
17. GTD #2 temperature (if **DualGTD=Y**)
    GTD #2 temperature (°C, ITS-90) = (tttttt / 100,000) - 10
18. Time (**Moored mode [MM] only**)
    seconds since January 1, 2000 = ssssssss

Example: Profiling mode, strain-gauge pressure sensor, 2 external voltages sampled,
example scan = ttttttccccccppppppvvvvvvvvvvvv
= 0A53711BC7220C14C17D8203050594

- Temperature = tttttt = 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
   temperature (°C, ITS-90) = (tttttt / 100,000) - 10
2. Conductivity
   Conductivity (S/m) = (cccccc / 1,000,000) - 1
3. Pressure (strain-gauge or Quartz - **PType=1** or **3**)
   pressure (decibars) = (pppppp / 1,000) - 100
4. External voltage 0 (if **Volt0=Y**)
   external voltage 0= vvvv / 13,107
5. External voltage 1 (if **Volt1=Y**)
   external voltage 1 = vvvv / 13,107
6. External voltage 2 (if **Volt2=Y**)
   external voltage 2 = vvvv / 13,107
7. External voltage 3 (if **Volt3=Y**)
   external voltage 3 = vvvv / 13,107
8. External voltage 4 (if **Volt4=Y**)
   external voltage 4 = vvvv / 13,107
9. External voltage 5 (if **Volt5=Y**)
   external voltage 5 = vvvv / 13,107
10. SBE 38 secondary temperature (if **SBE38=Y**)
    SBE 38 temperature (°C, ITS-90) = (tttttt / 100,000) – 10
11. GTD #1 pressure (if **GTD=Y** or **DualGTD=Y**)
    GTD #1 pressure (millibars) = pppppppp / 100,000
12. GTD #1 temperature (if **GTD=Y** or **DualGTD=Y**)
    GTD #1 temperature (°C, ITS-90) = (tttttt / 100,000) – 10
13. GTD #2 pressure (if **DualGTD=Y**)
    GTD #2 pressure (millibars) = pppppppp / 100,000
14. GTD #2 temperature (if **DualGTD=Y**)
    GTD #2 temperature (°C, ITS-90) = (tttttt / 100,000) - 10
15. Time (**Moored mode [MM] only**)
    seconds since January 1, 2000 = ssssssss

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

- Temperature = tttttt = 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 = tttttt
2. Conductivity
   conductivity frequency (Hz) = cccc.ccc
3. Strain-gauge pressure (if **PType=1**)
   A/D counts = pppppp
4. Strain-gauge pressure sensor temperature compensation (if **PType=1**)
   pressure temperature compensation voltage = v.vvvv
5. Quartz pressure sensor pressure (if **PType=3**)
   Quartz pressure frequency (Hz) = ppppp.ppp
6. Quartz pressure sensor temperature compensation (if **PType=3**)
   Quartz temperature compensation voltage = v.vvvv
7. External voltage 0 (if **Volt0=Y**)
   external voltage 0= v.vvvv
8. External voltage 1 (if **Volt1=Y**)
   external voltage 1 = v.vvvv
9. External voltage 2 (if **Volt2=Y**)
   external voltage 2 = v.vvvv
10. External voltage 3 (if **Volt3=Y**)
    external voltage 3 = v.vvvv
11. External voltage 4 (if **Volt4=Y**)
    external voltage 4 = v.vvvv
12. External voltage 5 (if **Volt5=Y**)
    external voltage 5 = v.vvvv
13. SBE 38 secondary temperature (if **SBE38=Y**)
    SBE 38 temperature (°C, ITS-90) = ttt.tttt
14. GTD #1 pressure (if **GTD=Y** or **DualGTD=Y**)
    GTD #1 pressure (millibars) = ppppppppp / 100,000
15. GTD #1 temperature (if **GTD=Y** or **DualGTD=Y**)
    GTD #1 temperature (°C, ITS-90) = tt.ttt
16. GTD #2 pressure (if **DualGTD=Y**)
    GTD #2 pressure (millibars) = ppppppppp / 100,000
17. GTD #2 temperature (if **DualGTD=Y**)
    GTD #2 temperature (°C, ITS-90) = tt.ttt
18. Time (**Moored mode [MM] only**)
    date, time = dd Mmm yyyy, hh:mm:ss (day month year hour:minute:second)

Note:
Although **OutputFormat=2** outputs *raw* data for temperature, conductivity, etc., it outputs engineering units for SBE 38 and GTD data.

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

- Temperature = tttttt = 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
   temperature (°C, ITS-90) = ttt.tttt
2. Conductivity
   Conductivity (S/m) = cc.ccccc
3. Pressure (strain-gauge or Quartz - **PType=1** or **3**)
   pressure (decibars) = pppp.ppp
4. External voltage 0 (if **Volt0=Y**)
   external voltage 0= v.vvvv
5. External voltage 1 (if **Volt1=Y**)
   external voltage 1 = v.vvvv
6. External voltage 2 (if **Volt2=Y**)
   external voltage 2 = v.vvvv
7. External voltage 3 (if **Volt3=Y**)
   external voltage 3 = v.vvvv
8. External voltage 4 (if **Volt4=Y**)
   external voltage 4 = v.vvvv
9. External voltage 5 (if **Volt5=Y**)
   external voltage 5 = v.vvvv
10. SBE 38 secondary temperature (if **SBE38=Y**)
    SBE 38 temperature (°C, ITS-90) = ttt.tttt
11. GTD #1 pressure (if **GTD=Y** or **DualGTD=Y**)
    GTD #1 pressure (millibars) = ppppppppp / 100,000
12. GTD #1 temperature (if **GTD=Y** or **DualGTD=Y**)
    GTD #1 temperature (°C, ITS-90) = tt.ttt
13. GTD #2 pressure (if **DualGTD=Y**)
    GTD #2 pressure (millibars) = ppppppppp / 100,000
14. GTD #2 temperature (if **DualGTD=Y**)
    GTD #2 temperature (°C, ITS-90) = tt.ttt
15. Salinity (if **OutputSal=Y**)
    salinity (psu) = sss.ssss
16. Sound velocity (if **OutputSV=Y**)
    sound velocity (meters/second) = vvvv.vvv
17. 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 19*plus* V2 is logging (autonomous sampling is in progress), data is followed by density sigma-t in kg/m^3 (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 19*plus* 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 19*plus* 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 19*plus* V2 pressure data to determine when to close its water bottles if set up for autonomous water sampling.

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

> *Example*: 19*plus* 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

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

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

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>nnnnnnn</sn>	
</hdr>	
<data>	
<t1>ttt.tttt</t1>	
<c1>cc.ccccc</c1>	
<p1>pppp.ppp </p1>	(if **PType=1** or **3**)
<v0>v.vvvv</v0>	(if **Volt0=Y**)
<v1>v.vvvv</v1>	(if **Volt1=Y**)
<v2>v.vvvv</v2>	(if **Volt2=Y**)
<v3>v.vvvv</v3>	(if **Volt3=Y**)
<v4>v.vvvv</v4>	(if **Volt4=Y**)
<v5>v.vvvv</v5>	(if **Volt5=Y**)
<ser1>	
<type>*sbe38 or gtd*</type>	(indicates type of RS-232 sensor)
<t38>ttt.tttt</t38>	(if **SBE38=Y**)
<p1>ppppppppp</p1>	(if **GTD=Y** or **DualGTD=Y**)
<t1>tt.ttt</t1>	(if **GTD=Y** or **DualGTD=Y**)
<p2>ppppppppp</p2>	(if **DualGTD=Y**)
<t2>tt.ttt</t2>	(if **DualGTD=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
GTD pressure (millibars) = ppppppppp / 100,000 (for GTD #1 and #2)
GTD temperature (°C, ITS-90) = tt.ttt (for GTD #1 and #2)
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 19*plus* 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/m^3) = 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 19*plus* 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 19*plus* 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 19*plus* 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 19*plus* 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 19*plus* 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 19*plus* 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 19*plus* 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 19*plus* 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 19*plus* V2 has been stored, better results are obtained if the 19*plus* 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 19*plus* 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 9*plus*, which uses very fast sensors (0.07 second) and high speed (24 Hz) parallel signal acquisition. The 19*plus* V2 static accuracy is the same as that of the 9*plus*, 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 19*plus* V2 is intended primarily for use as a profiling instrument, and does not come standard with anti-foulant device cups and caps. Some customers, finding that they use the 19*plus* V2 in Moored mode on occasion, choose to install the optional moored mode conversion kit, which includes anti-foulant device cups and caps.

Intake anti-foulant device cup

Exhaust anti-foulant device cup

Hole for thermistor

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

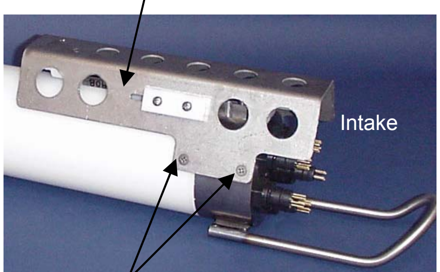
Intake anti-foulant device cap for all applications and exhaust cap for non-pumped applications

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.

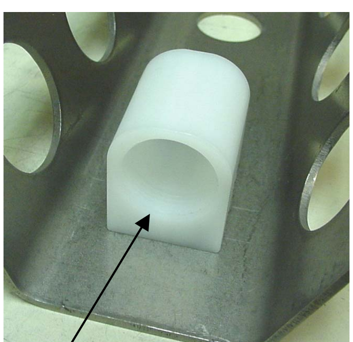
Conductivity cell guard

Exhaust



Remove screws, typical both sides

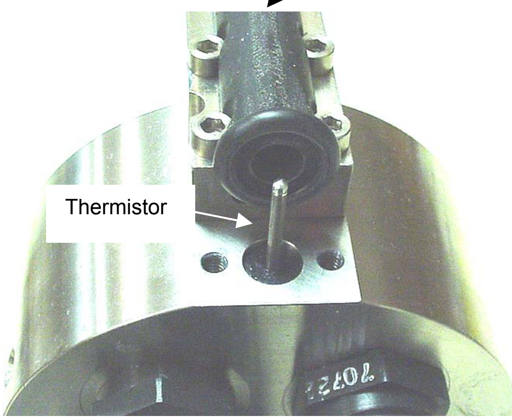
2. Remove the four Phillips-head screws attaching the conductivity cell guard to the housing and end cap. Carefully remove the conductivity cell guard.

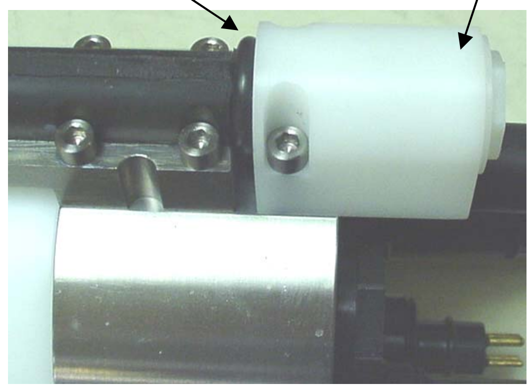


Exhaust anti-foulant device cup

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.

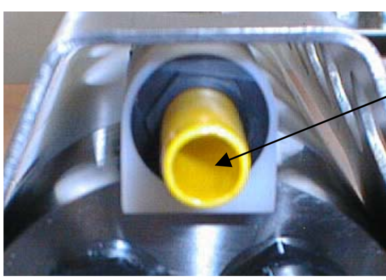
4. Intake –
   A. Remove the two hex head screws attaching the existing intake duct to the end cap.
   B. Remove the existing intake duct, pulling it straight up to avoid damaging the thermistor.
   C. Check to ensure that the o-ring at the end of the conductivity cell is still in place.
   D. Place 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 standard exhaust cap on the 19*plus* 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 19*plus* V2 for the intended deployment using the terminal program (see *Section 3: Power and Communications Test* for connection information; see this section for 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.

Note:
When we ship a new instrument, we include a .con file that reflects the current instrument configuration *as we know it*. The .con file is named with the instrument serial number, followed with the .con extension. For example, for an instrument with serial number 2375, Sea-Bird names the .con file *2375.con*. You may rename the .con file if desired; this will not affect the results.

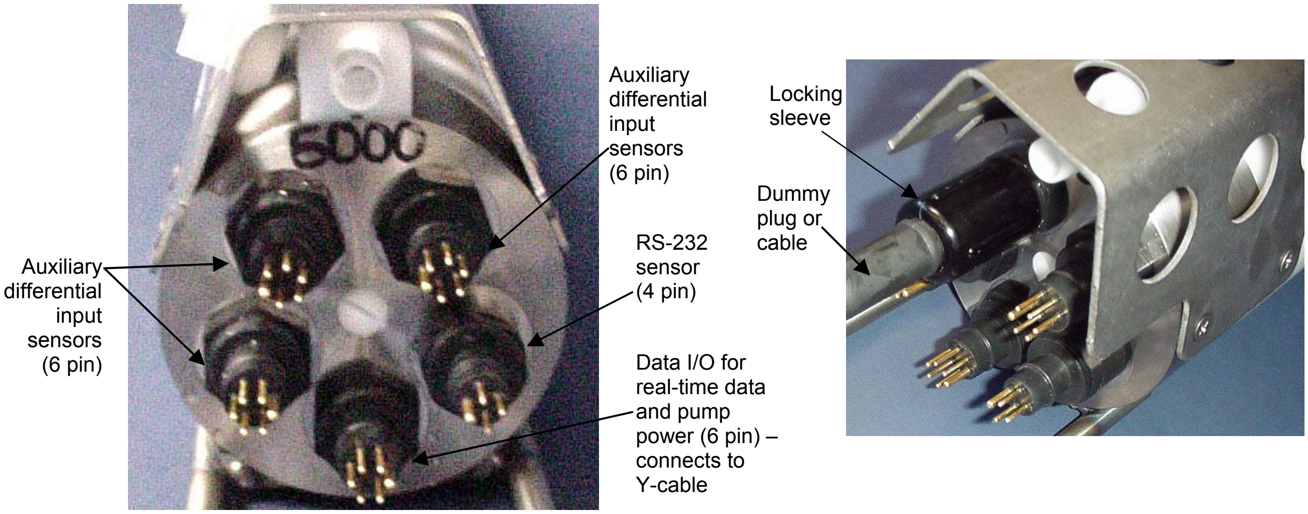
3. If you will be using SEASAVE to acquire and view real-time data, verify that the configuration (.con) file matches the instrument configuration. Sea-Bird supplies a .con file to match the factory configuration and calibrations. If the instrument is recalibrated or the configuration is changed (such as by adding external sensors), the .con file must be updated to reflect the current condition. See *Verifying Contents of .con File*.

4. If you will be using the terminal program 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.

Deployment

CAUTION:
Do not use WD-40 or other petroleum-based lubricants, as they will damage the connectors.

1. Install a cable or dummy plug for each connector on the 19*plus* V2 sensor end cap:
   A. Lightly lubricate the inside of the dummy plug/cable connector with silicone grease (DC-4 or equivalent).
   B. **Standard 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 19*plus* 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 19*plus* V2 in quiescent (sleep) state, apply external power.

6. **Moored mode** - If not already done, send **StartNow**, or send **StartDateTime=** and **StartLater**.

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

Acquiring Real-Time Data with SEASAVE

Notes:

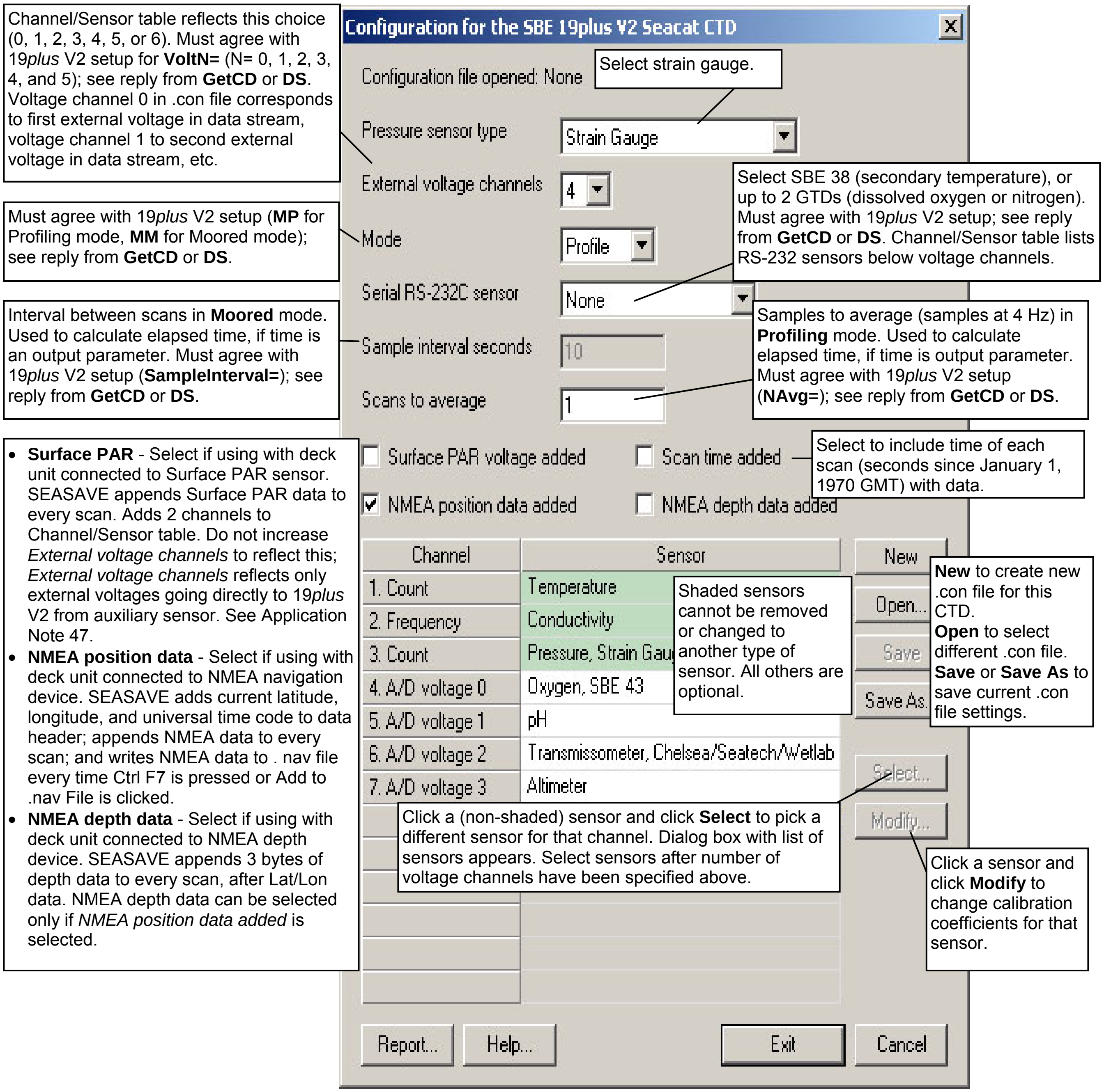
- When we ship a new instrument, we include a .con file that reflects the current instrument configuration *as we know it*. The .con file is named with the instrument serial number, followed with the .con extension. For example, for an instrument with serial number 2375, we name the .con file *2375.con*. You may rename the .con file if desired; this will not affect the results.
- In the 19*plus* 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 .con file, voltage 0 is the first external voltage in the data stream, voltage 1 is the second, etc.
- SEASAVE and SBE Data Processing use the same .con file.

Verifying Contents of .con File

SEASAVE, our real-time data acquisition and display program, requires a .con file, which defines the instrument – 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 .con file to interpret and process the raw data. **If the .con 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 .con file and click Open.

3. The configuration information appears on the Instrument Configuration tab. Verify that the sensors match those on your 19*plus* 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.



4. Click *Save* or *Save As* to save any changes to the .con file. Click Exit when done reviewing / modifying the .con file.

Acquiring Real-Time Data

Instructions below are for an SBE 19*plus* V2 with a conventional single-core armored cable, used without a Sea-Bird Deck Unit. **If using the 19*plus* 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 connector (19*plus* V2 with standard connectors) or MCIL-4FS (19*plus* V2 with optional wet-pluggable connectors). Wire the cable armor to pin 1 (large pin for 19*plus* V2 with standard connectors) and the inner conductor to pin 3 (opposite large pin) on the 19*plus* 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:

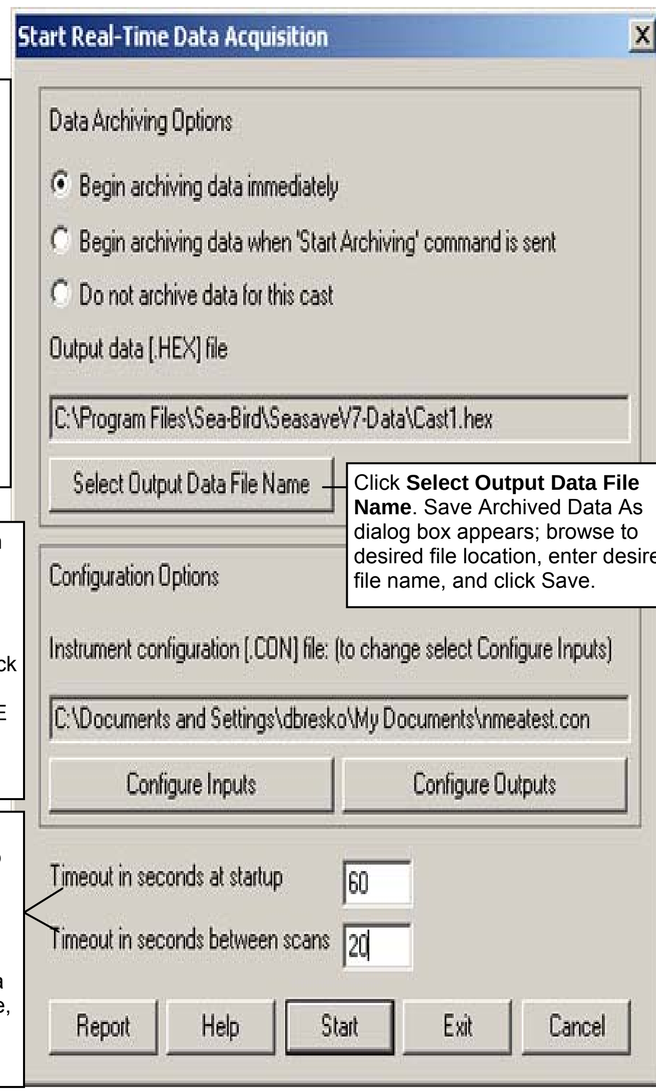
Slip-ring lead	25-pin serial port	9-pin serial port
from armor	Pin 7	Pin 5
from inner conductor	Pin 3	Pin 2

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

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: Currently selected instrument configuration (.con) file is shown, containing information on number and type of sensors interfacing with 19*plus* V2, calibration coefficients, and inclusion of NMEA and/or Surface PAR data with output from CTD. To select different .con file or modify input configuration (.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, header form, and/or diagnostics), click Configure Outputs.

- **Timeout in seconds at startup**: Time allowed before first data scan is received from 19*plus* V2. SEASAVE will *time out* and stop attempting to acquire data if data is not received from 19*plus* V2 within this time period.
- **Timeout in seconds between scans**: Maximum **gap** allowed between scans after first data scan is received from 19*plus* V2. SEASAVE will *time out* and stop attempting to acquire data if data is not received from 19*plus* 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).

Notes:
- If in **Moored** mode, the 19*plus* V2 must be sampling autonomously to use SEASAVE for real-time data acquisition. Start sampling by sending **StartNow** or **StartLater** in the terminal program before starting acquisition in SEASAVE.
- To prevent problems in the use of the COM port, click Disconnect in the Serial Port menu in the terminal program, and close the terminal program 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 *Check Scan Length* in the Options menu, SEASAVE checks the .con file to verify that the scan length defined by the .con file matches the 19*plus* V2 (i.e., number of sensors and inclusion of NMEA is as defined in the .con file). If a *Scan length error* appears, verify that:
      - You are using the correct .con file.
      - The .con file has been updated as necessary if you added or deleted sensors, added or deleted NMEA or Surface PAR inputs, etc.
   C. 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 19*plus* V2. SEASAVE *times out* if data is not received within *Timeout in seconds at startup*.
   D. 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 the **terminal program** and send **Stop**.
   - If **AutoRun=Y**: Remove external power.

Recovery

> ***WARNING!***
> **If the 19*plus* 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 then 85 psia; this force could still cause injury.
> If you suspect the 19*plus* V2 is flooded, point the 19*plus* 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 19*plus* 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 19*plus* V2 is to be stored for a long time, **replace the batteries yearly to prevent battery leakage** (which could damage the 19*plus* V2).

Uploading 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 SCPlusV2_RS232.exe. The main screen appears.

2. In the Serial Port menu, select Configure. The Serial Port Configuration dialog box appears. Verify/modify the Comm port and baud, and click OK.

3. The terminal program should automatically connect to the 19*plus* V2. As it connects, it sends **GetHD** and displays the response. The terminal program also fills the Send Commands window with the correct list of commands for your 19*plus* V2. If there is no communication:
   A. In the Serial Port menu, select Connect (if Connect is grayed out, first select Disconnect and then select Connect).
   B. Check cabling between the computer and 19*plus* V2.
   C. If there is still no communication, repeat Step 2 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.

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

4. Command the 19*plus* 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**)

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

```
SeacatPlus V 2.0c  SERIAL NO. 4000    20 Feb 2008  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 = 5000, free = 4381542, 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, 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
```

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

6. Click Upload to upload stored data. The terminal program responds as follows:
   A. The terminal program sends **GetSD** and displays the response. **GetSD** provides information on the instrument status, and number of samples in memory.
   B. The terminal program sends **DH** and displays the response. **DH** provides information on the headers in memory.
   C. An Upload Data dialog box appears:

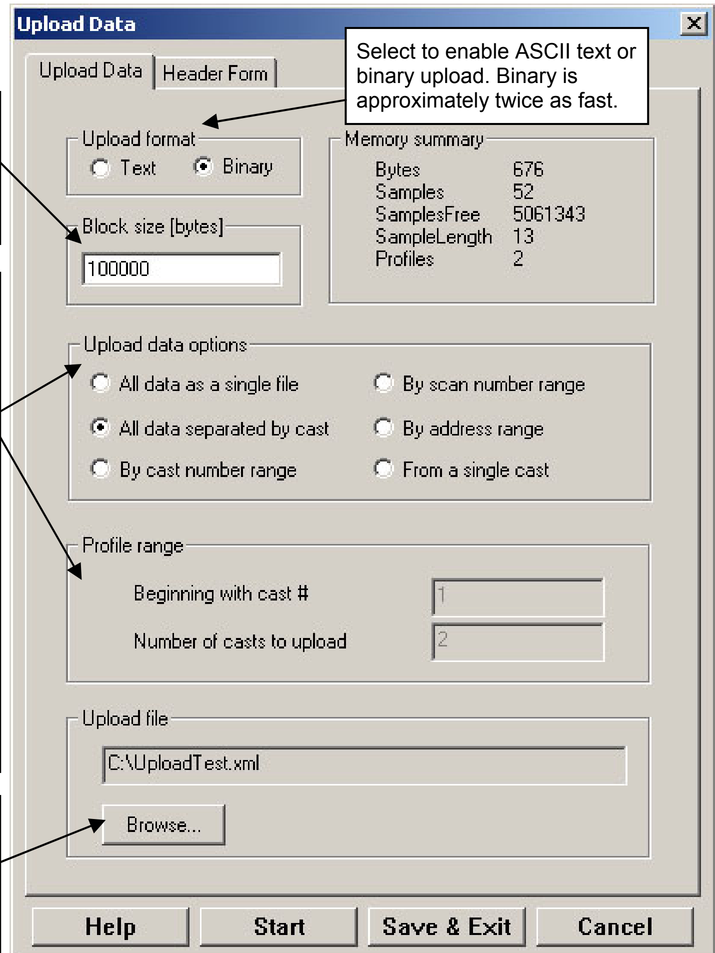
Note:
If binary upload is selected, the terminal program uploads the data in binary and then converts it to ASCII text, resulting in a data file that is identical to one uploaded in ASCII text.

Select to enable ASCII text or binary upload. Binary is approximately twice as fast.

Select number of bytes uploaded in each block. Terminal program uploads data in blocks, and calculates a check sum at end of each block. If block fails checksum verification, terminal programs 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.
- By address range – Enter beginning byte number and total number of bytes. Note that first byte in memory is byte 0. 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.

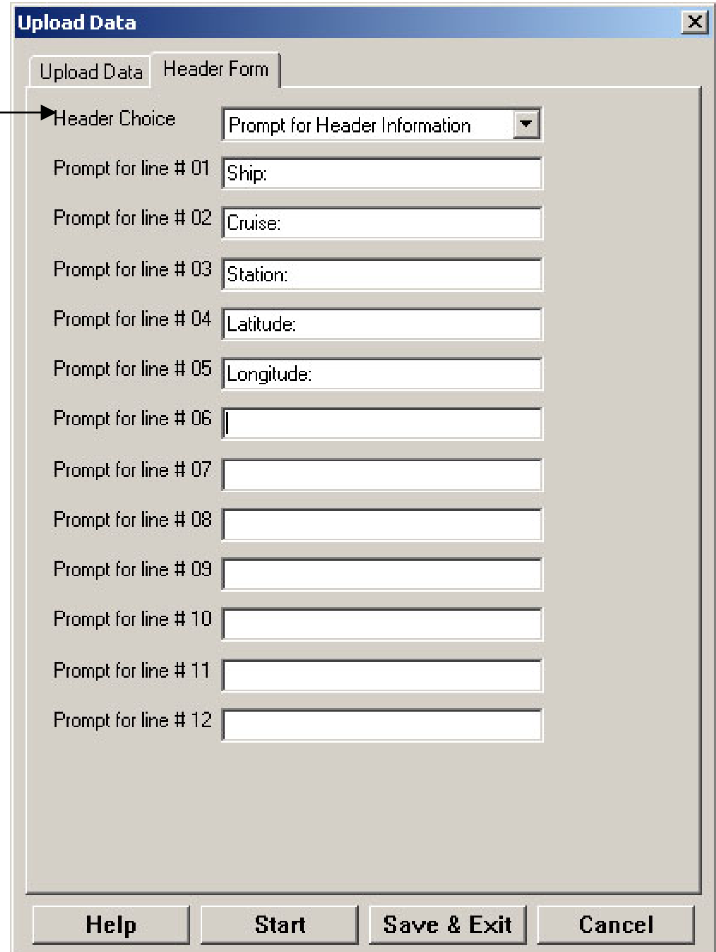
Click Browse to navigate to desired upload file path and name. Upload file has a .xml extension. After terminal program uploads data into .xml file(s), it automatically converts .xml file(s) to .hex file(s) (same file name, different extension), which is compatible with SEASAVE and SBE Data Processing.



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 Start; the Status bar at the bottom of the window displays the upload progress:
   A. The terminal program 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.
   B. **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. The terminal program writes the header information to the upload file.
   C. The terminal program 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.
   D. **If you selected *All data separated by cast* or *By cast number range* in the Upload Data dialog box** – The terminal program repeats Steps B and C for each cast.
   E. When the data has been uploaded, the terminal program shows the S> prompt (if **OutputExecutedTag=N**).

Note:
The commands and responses automatically sent by the terminal program 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 19*plus* 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 from by reviewing and processing the data:
   A. Use **SEASAVE** to display and plot the *raw* hexadecimal data in engineering units (see *Verifying Contents of .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:
- See the SBE Data Processing manual and/or Help files.
- When we ship a new instrument, we include a .con file that reflects the current instrument configuration *as we know it*. The .con file is named with the instrument serial number, followed with the .con extension. For example, for an instrument with serial number 2375, Sea-Bird names the .con file *2375.con*. You may rename the .con file if desired; this will not affect the results.
- In the 19*plus* 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 .con file, voltage 0 is the first external voltage in the data stream, voltage 1 is the second, etc.
- SEASAVE and SBE Data Processing use the same .con file.

1. Convert the .hex (raw data) file (real-time file from SEASAVE or uploaded from 19*plus* 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 (.con) File

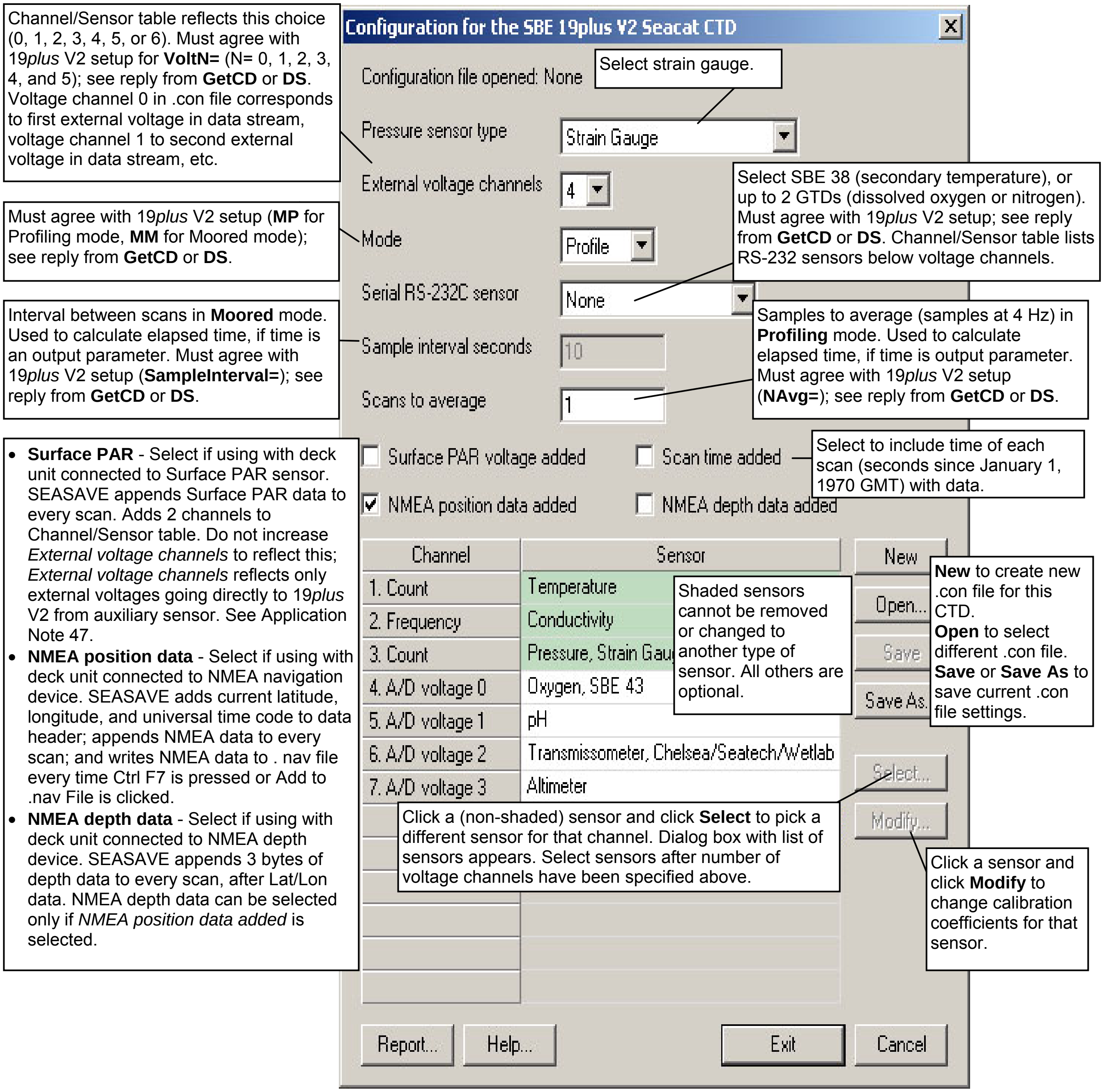
To convert the .hex (raw data) file, you need a .con file, which defines the instrument – integrated sensors, and channels, serial numbers, and calibration dates and coefficients for all sensors (C, T, and P as well as auxiliary sensors). SBE Data Processing (as well as our real-time data acquisition software) uses the .con file information to interpret and process the raw data. **If the .con 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 .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.

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



4. Click *Save* or *Save As* to save any changes to the .con file. Click Exit when done reviewing / modifying the .con file.

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, conductivity cell storage and cleaning, pressure sensor maintenance, replacement of optional Anti-Foulant Devices, and sensor calibration. The accuracy of the SBE 19*plus* V2 is sustained by the care and calibration of the sensors and by establishing proper handling practices.

Corrosion Precautions

Rinse the SBE 19*plus* 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*.

CAUTION:
Do not use WD-40 or other petroleum-based lubricants, as they will damage the connectors.

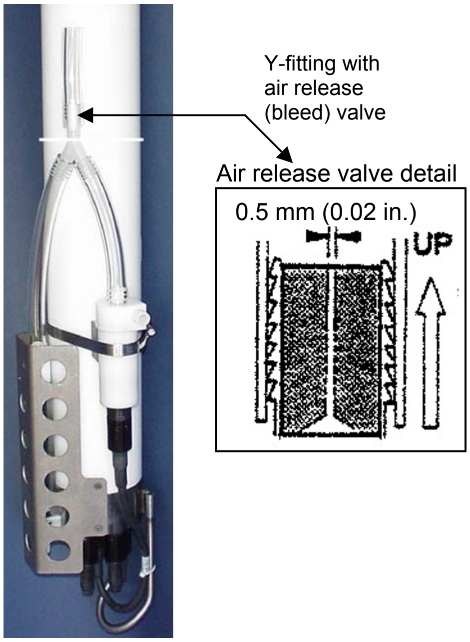
Clean and inspect connectors, cables, and dummy plugs before every cruise, during a cruise (good practice if you have a few days of down time between casts), after every cruise, and as part of your yearly equipment maintenance. Inspect connectors that are unmated for signs of corrosion product around 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. **Standard 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 19*plus* 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.

Plumbing Maintenance



For an SBE 19*plus* 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.

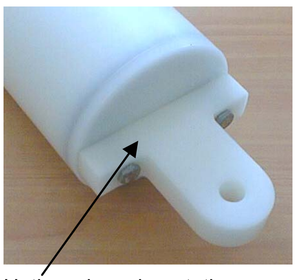
3. (if applicable) Replace the Tygon tubing above the air release valve.

Replacing / Recharging Batteries

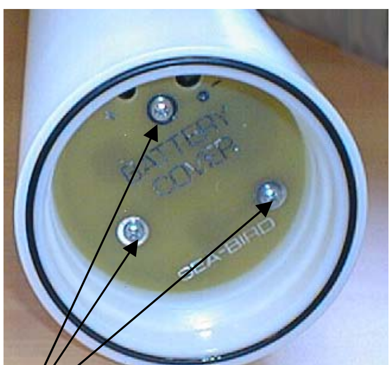
> **Note**:
> If changing from alkaline to Ni-Cad or NiMH batteries, or vice versa, send **BatteryType=** to indicate the new battery type.

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

Alkaline D-cell (MN1300, LR20)



Unthread cap by rotating counter-clockwise



Remove Phillips-head screws and washers

Replacing Alkaline Batteries

The 19*plus* 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 19*plus* 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**.

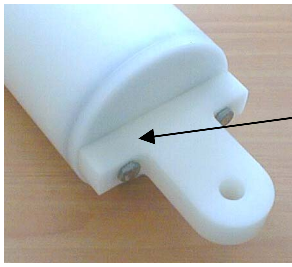
6. Check the battery voltage at BAT + and BAT - on the battery cover plate. It should be approximately 13.5 volts.

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.

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

Recharging Optional Nickel Metal Hydride Batteries

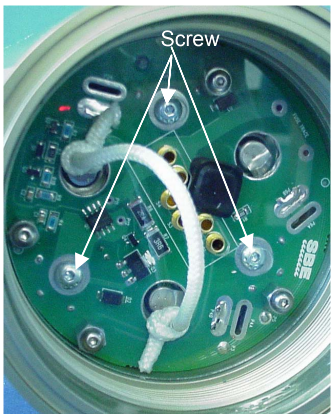
See the *NiMH Battery Charger and Battery Pack* manual for complete details on charging, error messages, battery specifications, etc.

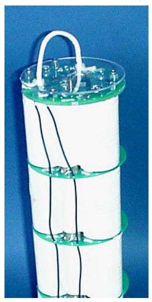


Unthread cap by rotating counter-clockwise

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.

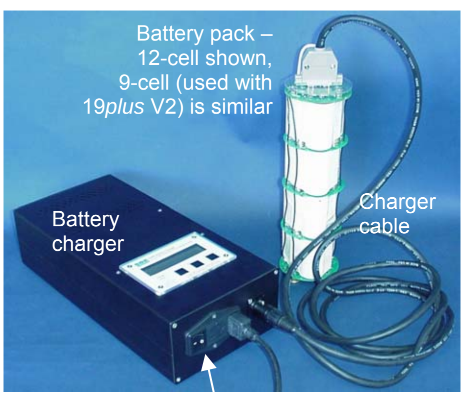
> **Note:**
> **If desired, you can recharge the NiMH battery pack while it is in the housing**. Skip Steps 2 and 4 if recharging in the housing.





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 19*plus* 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

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

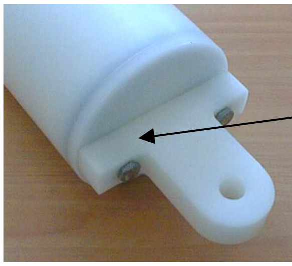
3. Recharge the batteries:
   A. Plug the battery charger into a suitable power source and turn on power to the charger.
   B. Connect the charger cable to the battery pack and charger. The LED should show `READY`, and display the battery type and measured voltage.
   C. Press the **Discharge** button. 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.

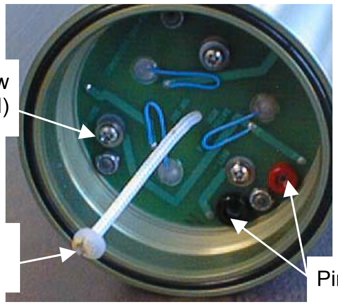
Note:
The NiMH battery pack fits tightly in the housing. When placing a battery pack in the housing, align it carefully and slowly insert it straight into the housing. If not careful, the battery pack shrink wrap can be torn.

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.

Verify that the magnetic switch is Off, so the SBE 19*plus* 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 19*plus* V2 electronics.

Recharging Optional Nickel-Cadmium Batteries

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.

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

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 19*plus* 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 19*plus* 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 19*plus* 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 bars **for cleaning and storage only**. Remember to reinstall the original cap(s) before deployment. **Deploying an SBE 19*plus* V2 with barbed anti-foulant device cap(s) in place of the installed caps is likely to produce undesirable results in your data.** See *Replacing Anti-Foulant Devices* for safety precautions when handling the AF24173 Anti-Foulant Devices

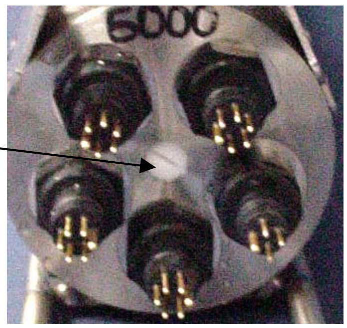
Pressure Sensor Maintenance

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 19*plus* V2.

Strain-Gauge Pressure Sensor

Pressure sensor port

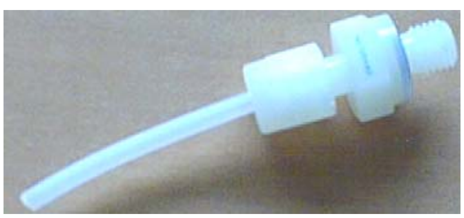


The pressure port plug has a small vent hole to allow hydrostatic pressure to be transmitted to the pressure sensor inside the instrument, while providing protection for the pressure sensor, keeping most particles and debris out of the pressure port.

Periodically (approximately once a year) inspect the pressure port to remove any particles, debris, etc:

1. Unscrew the pressure port plug from the pressure port.
2. Rinse the pressure port with warm, de-ionized water to remove any particles, debris, etc.
3. Replace the pressure port plug.

Quartz Pressure Sensor



Nylon pressure capillary fitting for 19*plus* 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 16*plus*, SBE 19*plus*)

AF24173
Anti-Foulant
Device

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.

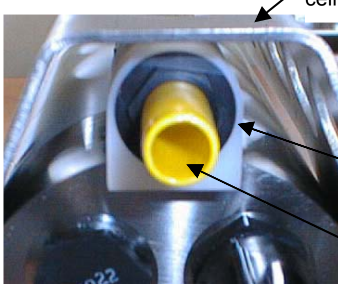
Read precautionary information on product label (see Appendix V) before proceeding.

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

The SBE 16*plus* and 19*plus* (moored option) have an anti-foulant device cup and cap on each end of the conductivity cell. A new SBE 16*plus* (or moored option 19*plus*) 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 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.



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 19*plus* V2 EEPROM, and ships the instrument back to the user with Calibration Certificates showing the new coefficients. The user must enter the coefficients in the instrument configuration (.con) file in the Configure menu in SEASAVE or SBE Data Processing.

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 19*plus* V2 are supplied fully calibrated, with coefficients stored in EEPROM in the 19*plus* V2 and printed on their respective Calibration Certificates.

We recommend that the 19*plus* 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 19*plus* V2 includes a standard strain-gauge pressure sensor or optional Quartz pressure sensor. These sensors are capable of meeting the 19*plus* 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 19*plus* V2 pressure output to readings from a barometer.

> **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 19*plus* V2 outputs pressure relative to the ocean surface (i.e., at the surface the output pressure is 0 decibars).
> The 19*plus* V2 uses the following equation to convert psia to decibars:
> pressure (db) =
> [pressure (psia) - 14.7] * 0.689476

Allow the 19*plus* 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 19*plus* V2 to equilibrate before starting will provide the most accurate calibration correction.

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

> *Offset Correction Example*
> *Absolute* pressure measured by a barometer is 1010.50 mbar. Pressure displayed from 19*plus* V2 is -2.5 dbars.
> Convert barometer reading to dbars using the relationship: mbar * 0.01 = dbar
> Barometer reading = 1010.50 mbar * 0.01 = 10.1050 dbar
> The 19*plus* V2's internal calculations and our processing software output gage pressure, using an assumed value of 14.7 psi for atmospheric pressure. Convert 19*plus* V2 reading from gage to absolute by adding 14.7 psia to the 19*plus* V2 output:
> -2.5 dbars + (14.7 psi * 0.689476 dbar/psia) = -2.5 + 10.13 = 7.635 dbars
> Offset = 10.1050 – 7.635 = + 2.47 dbars
> Enter offset in 19*plus* V2 and in .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 7/16-20 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 19*plus* 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 19*plus* V2 and computer have been established. Before proceeding with troubleshooting, attempt to establish communications again by clicking Connect in the Serial Port menu in the terminal program or pressing the Enter key several times.

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

Cause/Solution 2: The instrument communication settings may not have been entered correctly in the terminal program. Verify the settings in the Serial Port Configuration dialog box (Serial Port 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 19*plus* 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: 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 configuration in the 19*plus* V2. Send **GetCD** or **DS** to verify the 19*plus* 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 .con file. Verify the settings in the instrument .con file match the instrument Configuration Sheet.

Note:
Each 19*plus* 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 19*plus* V2. Send **GetCC** or **DCal** to verify the calibration coefficients in the 19*plus* V2 match the instrument Calibration Certificates. Note that calibration coefficients do not affect the raw data stored in 19*plus* 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 the terminal program'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 .con file. Verify the calibration coefficients in the .con file match the instrument Calibration Certificates.
- For RS-232 sensors interfacing to the 19*plus* 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 SEATERM to verify the calibration coefficients match the instrument Calibration Certificate.

Problem 4: Program Corrupted

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

Cause/Solution 1: In rare cases, the program that controls the 19*plus* 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 19*plus* 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

Batteries – Nine alkaline D-cells (Duracell MN1300, LR20) standard. Available with optional rechargeable NiMH or Ni-Cad battery pack.

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 Win 2000/XP 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.

SCPlusV2_RS232.exe – Win 2000/XP terminal program used to communicate with the SBE 19*plus* V2 and SBE 16*plus* V2. This terminal program is not yet incorporated in the SEASOFT-Win32 package.

SEACAT – High-accuracy conductivity, temperature, and pressure recorder. The SEACAT is available as the SBE 16*plus* (moored applications, RS-232 or -485 interface), SBE 16*plus*-IM (moored applications, inductive modem interface) and SBE 19*plus* (profiling or moored applications). Version 2 (V2) models of each of these instruments became available in late 2007 / early 2008, and have 2 additional A/D channels (for a total of 6), a standard channel for an RS-232 sensor, and larger memory (64 MB).
A *plus* version of the SBE 21 SEACAT (thermosalinograph) is under development.

SEASAVE V7 – Sea-Bird's Windows 2000/XP software used to acquire, convert, and display real-time or archived raw data.

SEASOFT-Win32– Sea-Bird's complete Win 2000/XP software package, which includes software for communication, real-time data acquisition, and data analysis and display. SEASOFT-Win32 includes ***SEATERM***, ***SeatermAF***, ***SEASAVE V7***, ***SBE Data Processing***.

SEATERM – Sea-Bird's Win 95/98/NT/2000/XP terminal program used to communicate with the SBE 38.

SeatermAF – Sea-Bird's Win 95/98/NT/2000/XP 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.

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 Mallinckrodt Baker (see http://www.mallbaker.com/changecountry.asp?back=/Default.asp for local distributors)

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. The19*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 Druck strain-gauge sensor or optional 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 ºC 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 ºC to 40 ºC).

Battery Wiring

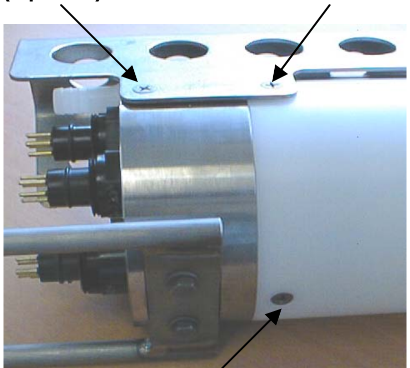
SBE 19*plus* V2 standard main battery is a series connection of D-cells that drop into the battery compartment as a cluster of end-to-end stacks, three batteries each (standard 9-cell battery pack has three stacks). The positive battery connections are contact areas on double-thick printed circuit disks 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



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.

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

> **Note:**
> See *Command Descriptions* in *Section 4: Deploying and Operating SBE 19plus V2* for detailed information and examples.

CATEGORY	COMMAND	DESCRIPTION
Status	**GetCD**	Get and display configuration data (setup parameters).
	GetSD	Get and display status data.
	GetCC	Get and display calibration coefficients.
	Get EC	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.
	DCal	Get and display calibration coefficients.
General Setup	**DateTime= mmddyyyyhhmmss**	Set real-time clock month, day, year, hour, minute, second.
	BaudRate=x	**x=** baud rate (600, 1200, 2400, 4800, 9600, 19200, 33600, 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 optional 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. Equivalent to **SampleNumber=0**.
	SampleNumber=x	**x=** sample number for last sample in memory. After all previous data has been uploaded, set to 0 before starting to log to make entire memory available for recording. If not reset to 0, data stored after last sample. **SampleNumber=0** is equivalent to **InitLogging**.
	HeaderNumber=x	**x=** header and cast number for last cast in memory.
	QS	Enter quiescent (sleep) state. Main power turned off, but data logging and memory retention unaffected.
Pressure and Voltage Sensor Setup	**PType=x**	**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 l voltage 1. **x=N**: Do not.
	Volt2=x	**x=Y**: Enable external l voltage 2. **x=N**: Do not.
	Volt3=x	**x=Y**: Enable external l voltage 3. **x=N**: Do not.
	Volt4=x	**x=Y**: Enable external l voltage 4. **x=N**: Do not.
	Volt5=x	**x=Y**: Enable external l voltage 5. **x=N**: Do not.
	Biowiper=x	**x=Y**: Configuration includes ECO-FL fluorometer with Bio-Wiper. **x=N**: Does not.
RS-232 Sensor Setup	**SBE38=x**	**x=Y**: Enable SBE 38. **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 19*plus* V2 to send **command** to GTD and receive response (**command** can be any command recognized by GTD).

CATEGORY	COMMAND	DESCRIPTION
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.
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. 19*plus* V2 samples at 4 Hz and averages **NAvg** samples. Default 1. Must be even number (2, 4, etc.) if 19*plus* V2 includes optional Quartz pressure sensor)
	MinCondFreq=x	**x=** minimum conductivity frequency (Hz) to enable pump turn-on.
	PumpDelay=x	**x=** time (seconds) to wait after minimum conductivity frequency is reached before turning pump on. Default 60 seconds.
	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 (seconds) between samples (10 - 14,400).
	NCycles=x	**x=** number of measurements to take and average every **SampleInterval** seconds. Default 1. Must be even number (2, 4, etc.) if 19*plus* V2 includes optional Quartz pressure sensor)
	MooredPumpMode=x	**x=0**: No pump. **x=1**: Run pump for 0.5 seconds before each sample. **x=2**: Run pump during each sample.
	DelayBeforeSampling=x	**x=** time (seconds) to wait after switching on external voltage before sampling (0-600 seconds). Default 0 seconds.
	MooredTxRealTime=x	**x=Y**: Output real-time data. **x=N**: Do not.
Logging	**StartNow**	Start logging now.
	StartDateTime= mmddyyyyhhmmss	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.

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
Data Upload Stop logging before uploading.	**GetSamples:b,e** or **DDb,e**	Upload data from scan **b** to scan **e**.
	GetCast:x or **DCx**	**Profiling mode only.** Upload data from cast **x**.
	GetHeaders:b,e or **DHb,e**	Upload header **b** to header **e**.
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 (optional Quartz pressure), output raw data.
	T38	Measure SBE 38, output converted data.
	PumpOn	Turn pump on for testing purposes.
	PumpOff	Turn pump off for testing purposes.

CATEGORY	COMMAND	DESCRIPTION
Calibration Coefficients (F=floating point number; S=string with no spaces) Dates shown are when calibrations were performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with 19*plus* V2. View all coefficients with **GetCC** or **DCal**.	**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.
	ExtFreqSF=F	**F=**External frequency (Quartz pressure sensor) scale factor.
	VOffset0=, **VSlope0=**, . . . **VSlope5=**, **VOffset5=**	Voltage channel offsets and slopes are all factory set, and should never be modified by customer. These are properties of 19*plus* V2 electronics, and are not calibration coefficients for auxiliary sensors. Enter calibration coefficients for auxiliary sensors in .con file in SEASAVE and/or SBE Data Processing.
Hardware Configuration	*Factory Settings – do not modify in the field* **SetMfgDate=** **SetPcbSerialNum1=, SetPcbSerialNum2=,** **SetPcbSerialNum3=, SetPcbSerialNum4=** **SetPcbAssembly1=, SetPcbAssembly2=,** **SetPcbAssembly3=, SetPcbAssembly4=** *Auxiliary Sensor Settings – can be modified in the field to accommodate changes in auxiliary sensors cabled to 19plus V2* **SetVoltType0=, SetVoltSN0=** **SetVoltType1=, SetVoltSN1=** **SetVoltType2=, SetVoltSN2=** **SetVoltType3=, SetVoltSN3=** **SetVoltType4=, SetVoltSN4=** **SetVoltType5=, SetVoltSN5=**	

Appendix IV: 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: ………………………………....	47.0%
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.
1808 - 136th Place Northeast
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	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for15-20 minutes. • Call a poison control center or doctor for treatment advice.
If swallowed	• Call poison control center or doctor immediately for treatment advice. • Have person drink several glasses of water. • Do not induce vomiting. • Do not give anything by mouth to an unconscious person.
If in eyes	• 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.
1808 - 136th Place Northeast
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 DISPOSAL: Dispose of in a sanitary landfill or by other approved State and Local procedures.

Sea-Bird Electronics/label revised 01-31-05

Appendix V: Replacement Parts

Part Number	Part	Application Description	Quantity in 19*plus* V2
22018	Alkaline D-cell batteries, Duracell MN 1300 (LR20)	Power 19*plus* 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	-
801641	Ni-Cad battery pack	Optional rechargeable 9-cell battery pack	-
90226	Ni-Cad battery charger	For Ni-Cad 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 19*plus* 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 19*plus* 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 standard bulkhead connectors

continued on next page

continued from previous page

Part Number	Part	Application Description	Quantity in 19*plus* V2
60021	Spare battery end cap hardware and o-rings	O-rings and hardware, including: • 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: • 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: • 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, ¼-20 x 1 ¼ 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 ¼-20 x 5/8 Hex, titanium (secures connector guard to sensor end cap) • 30633 Washer, ¼" 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 ¾ socket, titanium (secures conductivity cell and TC duct to sensor end cap) • 31225 Bolt, ¼-20 x 1¼ Hex, titanium (mount 19*plus* V2 to cage) • 31138 Bolt, ¼-20 x 3/4 Hex, stainless steel (mount cross bars to cage)	-
50434	Seaspares kit, standard connectors	Includes o-rings, hardware, bulkhead connectors, dummy plugs, etc.: • 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 • 801225 Data I/O cable, 4-pin RMG-4FS to 9-pin DB -9S cable, 2.4 m (8 ft) long • 171888 Cable adapter, DB-25 to DB-9 • 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, ¾" x ½" (main sensor plumbing tubing) • 30409 Teflon tape (for insides of hose clamps) • 30411 Triton X100 (for cell cleaning) • 30457 Parker O-Lube (o-ring lubricant)	-

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Part Number	Part	Application Description	Quantity in 19*plus* V2
50435	Seaspares kit, wet-pluggable connectors	Includes o-rings, hardware, bulkhead connectors, dummy plugs, etc.: • 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 • 171888 Cable adapter, DB-25 to DB-9 • 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 ½-20 bulkhead connector • 172022 6-pin MCBH-6MP(WB), TI ½-20 bulkhead connector • 30388 Vinyl tube, ¾” x ½” (main sensor plumbing tubing) • 30409 Teflon tape (for insides of hose clamps) • 30411 Triton X100 (for cell cleaning) • 30457 Parker O-Lube (o-ring lubricant)	-

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