



SEA-BIRD
SCIENTIFIC

User manual

SBE 55 ECO Water Sampler

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Section 1 Safety information

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

1.1 Hazard information

⚠ WARNING

Dangerous voltages over 75 volts are present inside the instrument even after external power is removed. Only qualified personnel may do the servicing.

⚠ WARNING

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

NOTICE

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

1.2 Equipment labels

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



Electrical equipment marked with this symbol may not be disposed of in European domestic or public disposal systems. Return old or end-of-life equipment to the manufacturer at no charge to the user.

Safety information

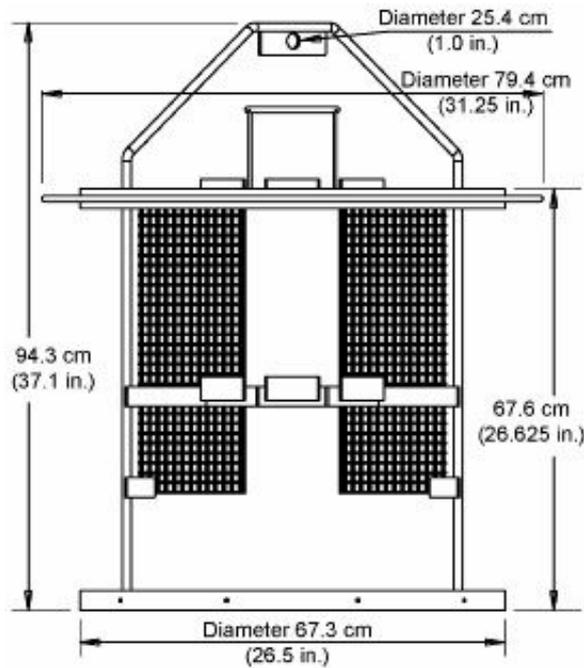


EFUP: Hazardous material exists over the threshold of GB/T 26572.2011. The number in the center of the symbol is the Environmentally Friendly Use Period as specified by SJ/T 11364-2014, China's marking for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products. This product should be recycled after its environmentally friendly use period.

Section 2 Specifications

2.1 Mechanical and electrical

Rated depth	Plastic: 600 m Optional titanium: 3500 m
Materials	Frame: 316 stainless steel Latch assembly: titanium, plastic, other corrosion-resistant components
Number of bottles	3 or 6, four liter capacity
Dimensions	Diameter: 67.3 cm, height: 94.2 cm
Weight in air	30 kg 19plus, 6 empty bottles: 60 kg 19plus, 6 full bottles: 84 kg
Winch cable compatibility	single- or multi-core armored cable to 10,000 m with inner core resistance of 0–350 ohms
Power requirement	100–375 VDC, 50 W
Current draw	<ul style="list-style-type: none"> • Low power: 15 μA • not armed, connected to PC: 2.5 mA • armed, capacitor during charge: 150 mA for 90 seconds after Arm command is sent
Internal batteries	Nickel-Metal Hydride (NiMH), 8 Ah nominal
Data storage	1 cast



2.2 Cables and connectors

Table 1 Electronics Control Module Connectors

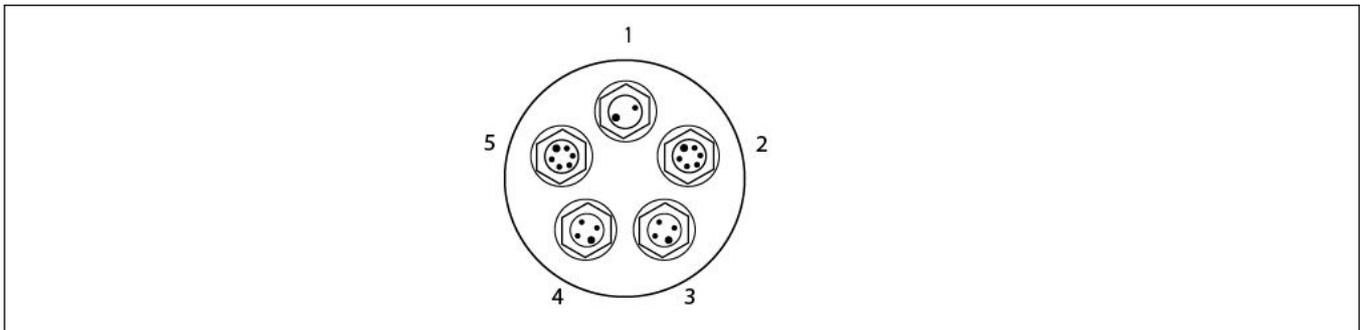


Table 2 Connector 1

Contact	Function	MCBH2MP
1	Ground (-)	<p>A diagram of a hexagonal connector with two contacts labeled 1 and 2. Contact 1 is on the right and contact 2 is on the left. A central pin is labeled 'GUIDE PIN'.</p>
2	Power (+)	

Table 3 Connector 2

Contact	Function	MCBH6MP
1	Ground	<p>A diagram of a hexagonal connector with six contacts labeled 1 through 6. Contact 1 is at the top, contact 2 is at the top-right, contact 3 is at the bottom-right, contact 4 is at the bottom, contact 5 is at the bottom-left, and contact 6 is at the top-left. A central pin is labeled 'GUIDE PIN'.</p>
2	TX from PC	
3	RX to PC	
4	DTR	
5	N/C	
6	N/C	

Table 4 Connectors 3 and 4

Latch connector 1	Contact	Function	MCBH4MP
	1	Common	<p>A diagram of a hexagonal connector with four contacts labeled 1 through 4. Contact 1 is at the top, contact 2 is at the top-right, contact 3 is at the bottom-right, and contact 4 is at the top-left. A central pin is labeled 'GUIDE PIN'.</p>
	2	Latch 1	
	3	Latch 2	
Latch connector 2	4	Latch 3	
	1	Common	
	2	Latch 4	
	3	Latch 5	
	4	Latch 6	

Table 5 Connector 5

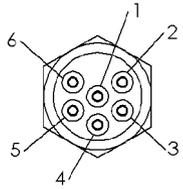
Contact	Function	MCBH6MP
1	Ground	
2	TX from sensor	
3	RX to sensor	
4	N/C	
5	+ 15 V in	
6	N/C	

Table 6 Data I/O cable

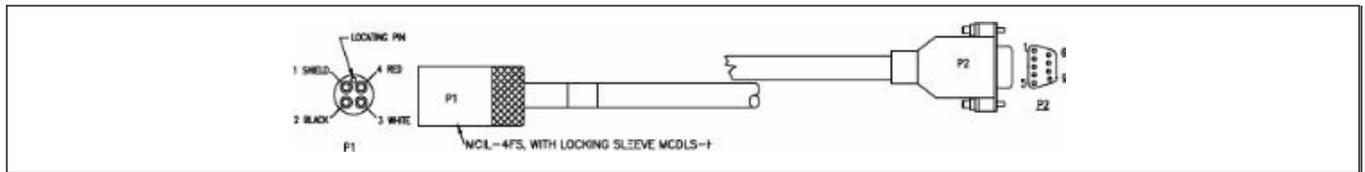


Table 7 Data I/O extension cable

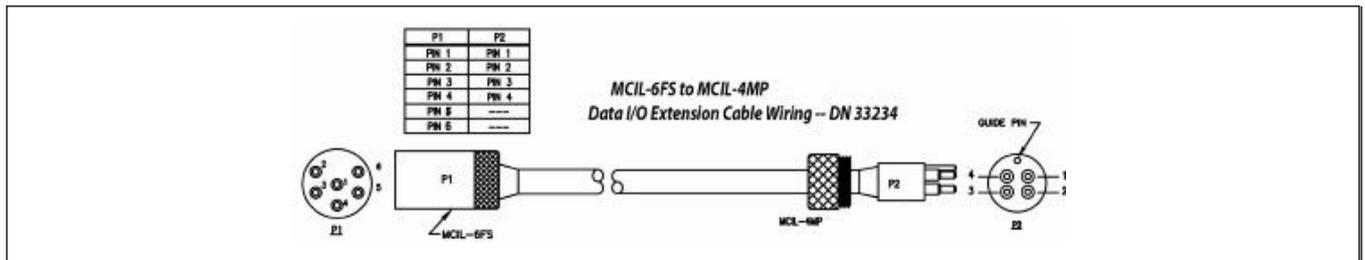


Table 8 Test cable, SBE 33 to SBE 55

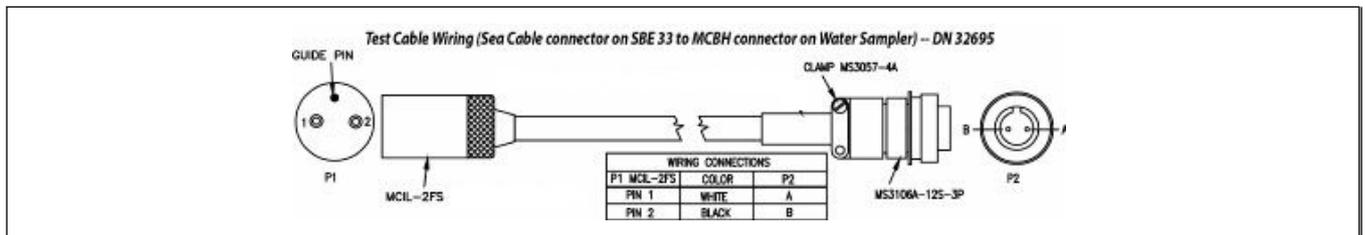
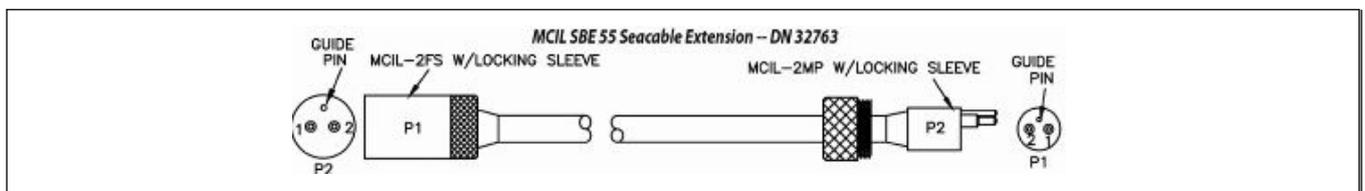


Table 9 SBE 55 sea cable extension



Specifications

Table 10 SBE 55 to CTD cable

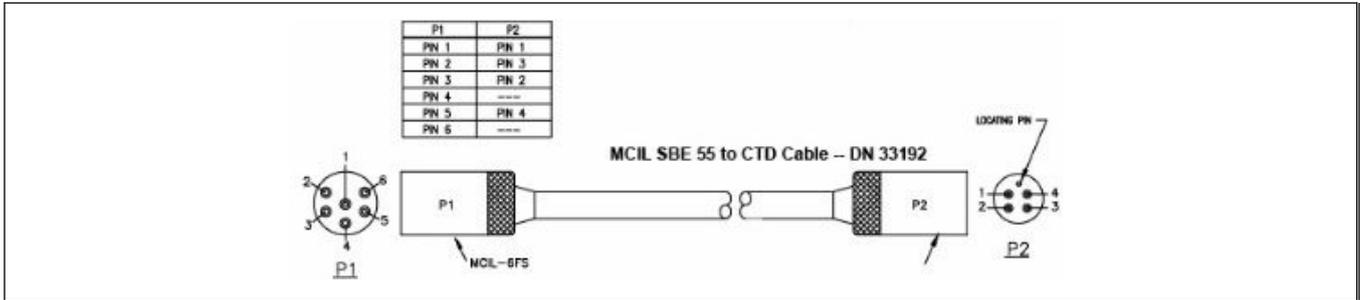
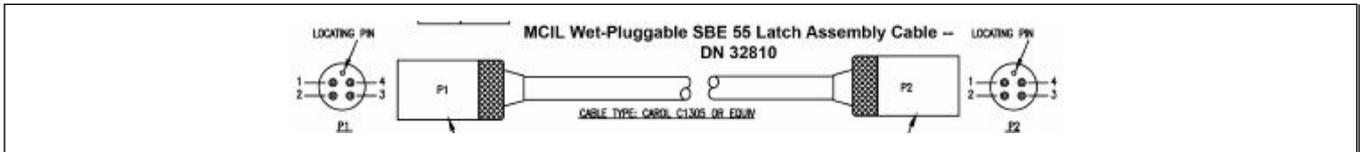


Table 11 SBE 55 to latch cable



Section 3 System description

The ECO Water Sampler includes:

- Electronics Control Module (ECM) with aluminum end flange or titanium end flange
- Nickel Metal Hydride (NiMH) rechargeable batteries in a removable battery pack, battery charger, and associated cables
- One or two 3-position lanyard release assemblies
- Latches with plastic side bars or optional titanium side bars
- Seasoft V2 software
- Stainless steel guard frame, lifting bail, and sturdy mesh panels to attach the ECM, CTD, and other sensors that may be integrated with the CTD (e.g., dissolved oxygen sensor, fluorometer, turbidity sensor, etc.). Band clamps are used to attach the bottles.

The SBE 55 ECO Water Sampler is designed for continuous data collection in coastal and estuarine waters, and large lakes. The SBE 55 can be used with an SBE 19, 19plus, 19plus V2, 25, 25plus, or 49 CTD. The primary use of the SBE 55 is for self-contained autonomous operation. Bottles can be configured to close at selected depths. The SBE 55 can also be used for real-time CTD data and water sampling operation with an SBE 33 Carousel Deck Unit, which requires an electro-mechanical cable and a slip-ring-equipped winch.

The SBE 49 can be used for real-time data collection only because it does not store data.

The SBE 19, 19plus, 19plus V2, 25, and 25plus record and transmit data at the same time. Data can be transmitted to the ECO or a Deck Unit.

Magnetically actuated lanyard release

A pressure-proof electromagnet at each bottle position is energized on command to release a latch that holds the bottle lanyard. Bottles can be fired in sequence or randomly. The lanyard release mechanism can be set with a touch of a finger before the lanyards are secured, so that setup is fast, convenient, safe, and reliable. The ECO is available with one or two three-position release assemblies, each connected to a separate connector on the Electronics Control Module (ECM), so it is easy to expand from a three-bottle to a six-bottle system.

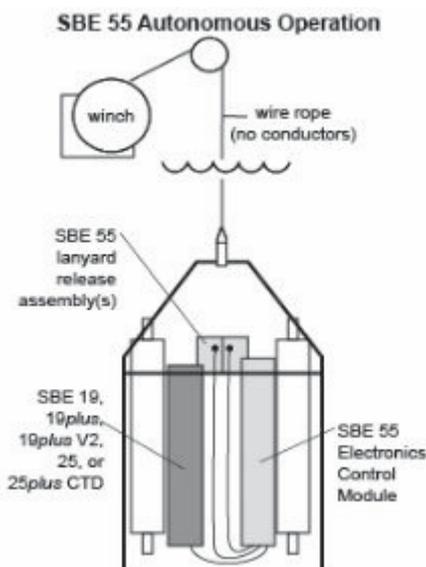
The energy used to release the magnetic trigger that controls each latch is stored in an internal capacitor. When a fire command is received, the ECO switches the capacitor to the selected magnetic trigger for 20 ms. A fire-confirm circuit senses the current flow through the circuit. Receipt of a fire-confirm message from the ECO verifies the bottle position selected that energy was sent to the magnetic trigger. The capacitor is charge to 70 V with a current-limited DC-DC converter. Recharge time is approximately 4 seconds.

3.1 Autonomous operation

The ECO can operate autonomously on non-conducting cables with or without a CTD. Power is supplied to the ECO by its internal batteries.

Used **with** a CTD, the ECO monitors the pressure data in real-time and fires bottles at predefined pressures. The bottle number, firing confirmation and five scans of CTD data are recorded in ECO memory for each bottle that is fired. At the end of a cast, the bottle data file (.afm) is transmitted from the ECO, and the CTD data is transmitted from the CTD through the Auto Fire Module (AFM).

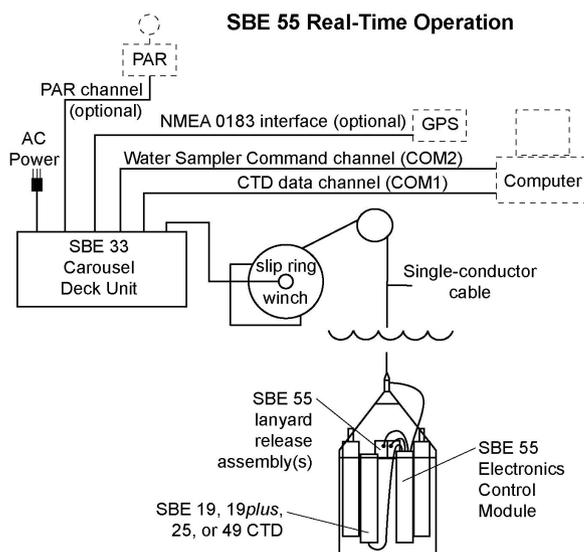
Used **without** a CTD, the ECO fires bottles at predefined intervals of time. Monitor the cable payout and time to determine the point at which samples are taken. At the end of a cast, the bottle data file (.afm) is transmitted from the ECO.



3.2 Real-time operation

The Electronics Control Module (ECM) includes a winch cable connector for real-time use. To change from autonomous to real-time operation, connect the winch cable to the ECM and the SBE 33 Carousel Deck Unit to AC power and winch slip rings. The ECO is then powered and controlled by the SBE 33. The system can be used with or without a CTD.

The system has real-time data telemetry capability and surface power for the CTDs and other auxiliary sensors. Control is through the SBE 33 or Seasave software. The SBE 33 has an NMEA interface for the NMEA 0183 protocol and an interface for a surface PAR sensor.



Notes:

- Real-time operation requires connection to two serial ports on the PC. COM1 is the CTD data channel and COM2 is the Water Sampler command channel. Any two ports in any order can be used; use Seasave to set these up.
- Seasave also supports data collection from an NMEA device connected directly to the PC instead of the deck unit.

Section 4 Assemble carousel

This section gives details to attach bottles, the Electronics Control Module (ECM), and other sensors to the SBE 55 frame, and how to set lanyards.

4.1 Attach bottles

Do the steps below to attach the four-liter water bottles to the SBE 55 frame. The frame has top and bottom attach points for each bottle.



1. Use the manufacturer-provided band clamps to attach each bottle to the frame. Make sure the D-ring is on the top band clamp so the middle lanyard goes through it.
2. Place the drain fittings on the end bottles approximately parallel to the frame to prevent interference with the lower end cap when it is set.
3. Place the drain fitting for the middle bottle parallel with the drain fitting on one of the outside bottles.



4.2 Attach ECM, CTD, auxiliary sensors

1. Attach the ECM in the space between the bottles at the top of the frame.
2. Attach the white plastic spacer blocks to the mesh panel of SBE 55 for the CTD.



Assemble carousel

3. Make sure to put a layer of Teflon® or electrical tape on the inside of the band clamps to isolate the clamps from the sensor housing.
4. Use two band clamps to attach the CTD to the blocks.



For a three-bottle system, mount the ECM and CTD off-center to more equally distribute the weight.

4.3 Assemble lanyards

Do not use aircraft wire on latches with plastic side bars. The wire will cause damage to the plastic.

1. Make sure that the bottles are correctly attached to the frame and that the internal bands on the end caps are straight.



2. Disconnect the lower lanyard from the middle lanyard.



3. Push on the white plastic latch to release the mechanism.



4. Pull the bottle top cap toward the latch. Thread the upper lanyard over the oblong-shaped frame, and attach the upper lanyard to the latch.



5. Push against the trigger until there is a click, which sets the release mechanism.
6. Push on the outer part of the white plastic trigger release, then push the trigger until it makes a "click" into place.
Sometimes the trigger may not set into place because of residual magnetic force in the trigger release mechanism.
7. Pull the middle lanyard up and over the top of the oblong-shaped frame and through the D-ring on the outside of the top band clamp on the bottle.



Section 5 Get high quality data

5.1 Water samples on upcast

For typical applications, CTD data from a downcast is recommended because the CTD is pointed so that the intake can sample water before the rest of the package causes the water to mix and can have an effect on water temperature. If water samples are collected on the downcast, the pressure on an already closed bottle increases as the system continues through the downcast. If there is a small leak, the outside water is forced into the bottle so that it is contaminated.

If water samples are collected on the upcast, the pressure on an already closed bottle decreases, so if there is a leak, water will leave the bottle, so the integrity of the sample is not affected. The standard procedure is to monitor real-time downcast data to select where to take water samples, and then take water samples on the upcast.

5.2 Stop the ECO to take samples

If the system is not stopped before a bottle is fired on an upcast, the water in the bottle is a mixture of water from many meters below. The standard procedure is to stop the system to let the bottle(s) flush freely for several minutes before each is closed.

Note: if the system moves at 1 meter/second, the *flushing constant* is typically five to eight volumes. Water flushes slowly at the inside wall of the bottle, and faster toward the center of the bottle. For a 4-liter bottle, the sample contains a mixture of water from a cylinder in the water column with a diameter equal to the bottle inner diameter and a volume of 20 to 32 liters; the height of the cylinder is five to eight times the bottle height.

5.3 Collect samples to measure calibration drift

Oceanographic conditions such as internal waves and currents result in density surfaces that move continuously, which causes water of a given salinity to move up and down. Therefore, the standard procedure is to monitor the real-time temperature, salinity, and density structure during the downcast, so the water sampler can be stopped on the upcast at depths where gradients are small. The bottles can then be closed and used to measure calibration drift. The data associated with each bottle that was fired to measure drift can be compared to data from the CTD or auxiliary sensors to laboratory measurements made on the water in the bottles.

5.4 Real-time control

The ECO can be configured to take samples when it is stopped, which prevents the flushing problem, but the real-time data is not sufficient, because samples may still be taken in areas with large gradients, and the user can only estimate the depth of the system from the cable payout.

Because of the above, the manufacturer recommends that the ECO is used with an SBE 33 Deck Unit to control the system, so data is collected in real-time.

Autonomous data collection is intended for use on vessels that do not have the function of real-time data collection.

Section 6 Real-time operation

⚠ WARNING

Dangerous voltages over 75 volts are present inside the instrument even after external power is removed. Only qualified personnel may do the servicing.

⚠ WARNING



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

Real-time operation requires the SBE 33 Deck Unit as a controller for the SBE 55. The SBE 19, 19plus, 19plus V2, 25, 25plus, or 49 CTD are supported.

If a SBE 49 is used, Seasave does not support Surface PAR. The SBE 49 is not set to **AutoRun=Y**. Send the **Start** command in Seaterm and then start Seasave.

Make sure to transmit data from the system to the PC between deployments. The SBE 55 will write over any stored data.

The ECO will go into a low power mode after 2 hours without a command. It automatically disarms after 24 hours.

On the ship, cables longer than three meters should be installed inside an grounded metal conduit by a qualified electrician. This minimizes the potential for external signals to disrupt communication and ensures that high voltage lines (such as the sea cable) are sufficiently protected.

1. In Seaterm, set up the SBE 33 and the CTD.
If a SBE 19plus V2 is used, connect the CTD directly to the PC instead of the ECO and use SeatermV2, not Seaterm, to more easily set up the CTD.
2. In Seasave, select **Configure Inputs** menu, then select the *Instrument Configuration tab*.
3. Select the *Serial Ports* tab to set up the CTD and water sampler communication parameters.
 - **CTD**: Select the serial port connected to the SBE 33 serial data connector and the baud rate between the SBE 33 and the PC. The baud rate must agree with the dip switch setting on the SBE 33. Set data bits to 7 and parity to even.
 - **Water Sampler**: Select the *Water Sampler* tab. Select SBE ECO, the total number of bottles to be closed, and the firing sequence. If applicable, enter bottle positions for table-driven firing or auto fire pressure and positions.
4. Select any other configurations and push **OK**.
5. Make sure that every connector on the ECO and CTD has a cable connector or dummy plug attached.
6. In the **Real Time Data** menu, push **Start**.
7. Make a name and select the location for the data file.
8. Make any other selections.
9. Push **Start**.
If the CTD is not already on, Seasave sends a prompt to turn on the CTD.
10. To fire a bottle from Seasave:
 - Enter **Ctrl F3** OR
 - From the **Real Time Control** menu, select *Fire Bottle Control*. The "Bottle Fire" box shows. Select **Fire Bottle** (this box can be left open during the cast).
11. To fire a bottle from the SBE 33:

Real-time operation

- Set the "Bottle to Fire" switch to 00 then push **Reset**.
 - To fire bottles in random order, set the "Bottle to Fire" switch to the bottle to fire and push **Fire**.
 - To fire bottles in sequential order, set the "Bottle to Fire" switch to 99 and then fire the first bottle. Push **Fire**. The ECO fires bottle 1 and then fires in sequential order each time **Fire** is pushed.
- 12.** To stop real-time data collection, go to the **Real-time Data** menu and select *Stop*. The ECO goes into a low power mode after 2 hours without a command. The current draw in this state is 15 μ A.
- 13.** To stop the CTD, use the method that applies to the deployed CTD.
- 14.** When the system is recovered, make sure to rinse the ECO, CTD, and auxiliary sensors with fresh water and dry fully.
- 15.** Data can be transmitted from the CTD to compare it to the real-time data saved by the Seasave software.
- Connect the ECO to the PC and use SeatermAF to transmit the CTD data, OR
 - Connect the CTD to the PC and use the appropriate Seaterm software to transmit the data from the CTD.
Seaterm for SBE 19, 19plus, 25.
SeatermV2 for SBE 19plus V2 and 25plus.

Section 7 Autonomous operation

⚠ WARNING

Dangerous voltages over 75 volts are present inside the instrument even after external power is removed. Only qualified personnel may do the servicing.

⚠ WARNING



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

7.1 Connect system sensors

1. Connect the DB9S cable to the extender cable. This connects the Electronics Control Module (ECM) to the PC. The SeatermAF software communicates with the ECO (DTR line high) and the CTD (DTR line low). The data I/O cable from the CTD cannot be used to communicate with the ECO.
2. Use the 6-contact to 4-contact CTD cable to connect the CTD to the ECO.
3. SBE 19plus V2 and 25plus are supplied with a Y-cable: connect to the CTD and use the data I/O cable to connect to the pump.
4. Connect each of the 4-contact Latch Array connector to the 4-contact ECM connector: each Latch Array connector controls one latch assembly of three bottles.

7.2 Install and start software

The manufacturer ships SeatermAF software to configure and communicate with the ECO 55 and CTD.

1. Double-click on SeatermAF.exe. The first time the software is used, a setup window shows.
2. Select the "Firing controller & CTD" for the deployment.
3. Select the serial port. Push **OK**.
4. Select **Configure** from the SeatermAF main screen and select the combination of ECO 55 and CTD to be deployed.
5. Push **OK**.
6. Select one of the saved .psa files.
7. In the Instrument Configuration area, browse to the CTD configuration file, .xml or .xmlcon.
8. Push **OK**.
9. Select the *Communication Setup* tab.
10. In the Communications between computer and SBE 55 area, select the serial port.
11. In the Communications between computer and CTD through SBE 55 area, select transmit ("upload") baud rate.
The communication baud rate, data bits and parity are pre-set, and must be the same as the CTD.
12. If the deployment will close bottles on upcast, downcast, or when the system is stationary, the "Real-time baud rate" is required.
For most CTDs, this value must agree with the baud rate set in the CTD.
13. Push **OK**.
14. Select the *Bottle Closure Logic* tab and select the bottle closure option applicable for the deployment.

Autonomous operation

15. Select the *Bottle Closure Pressure or Times* tab and select the "Number of Bottles to Close" and select the "Closure order."
16. Push **OK**.
17. Exit SeatermAF.
18. Disconnect the I/O cable from the SBE 55 extender cable and attach a dummy plug and lock collar on the end of the extender cable.

7.2.1 Seaterm software

Use Seaterm to set up the SBE 33 Deck Unit and CTD. If a 19plus V2 is used, it can be connected directly to the PC so that Seaterm V2 can be used for easier setup.

7.2.2 Seasave software

1. Select **Configure Inputs** in Seasave.
2. Select the *Serial Ports* tab and select the CTD and Water Sampler communication parameters.
 - CTD: select the serial port connected to the SBE 33 Serial Data connector. Select the baud rate, which must agree with the SBE 33 dip switch setting. Set data bits to 7 and parity to even.
 - Water Sampler: select the serial port connected to the SBE 33 Carousel Data connector.
3. Select the *Water Sampler* tab. Select the SBE ECO, the number of bottles to be closed, and firing sequence.
4. Select any other setup options in the "Configure Inputs" box, then push **OK**.
5. Make sure that there is a dummy plug or cable installed on every connector on the ECO and CTD.

7.2.3 SeatermAF main screen

SeatermAF main screen has four basic areas:

- Menus at the top of the screen.
- Toolbar buttons for frequently used tasks and commands. Most of the options in the toolbar are also in the menus. The toolbar can be on the top of the screen or on the left. To change its location, select the **Options** menu.
- Command display shows the commands entered and the Searam response. Commands can be entered manually in this area, from the toolbar buttons, or the menu items.
- Status bar shows status information about the connected sensor.

Button	Description	Equivalent command
Connect CTD	Start communications with the CTD. Response is S> prompt. Note that the CTD goes into a low power mode if there is no communication after two minutes.	—
Connect ECO	Start communications with the ECO. Response is A> prompt. Note that the ECO goes into a low power mode if there is no communication after two hours.	—
View CTD	Look at the data transmitted from the CTD to the ECO to make sure that data collection has started before the system is deployed.	—
Status	Show current status of the CTD or ECO.	DS
Headers	Information about cast number, date and time, number of samples in a cast, etc. Each cast has new header information. Note that this function does not work with the SBE 25plus.	DH

Closure Parameters	Show all auto fire parameters and auto fire status.	CP
Set Time	Set date and time. Accuracy is ± 25 milliseconds of time on connected PC. Note that this function does not work with SBE 19 or 25. Use the ST command to set the date and time.	19plus: MMDDYY= HHMMSS= 19plus V2 or ECO: DateTime=
Initialize Logging	Reset data pointers and cast numbers for CTD. Start data collection after stored data has been transmitted from CTD.	19 or 25: IL 19plus, 19plus V2, 25plus: InitLogging
Capture	Look at and save the ECO or CTD responses to a file with a .cap extension. Helps for diagnostics. Push Capture again to turn off this function. Capture status shows in the Status bar.	—
Upload	Get data from ECO or CTD in the format that the post-processing software can use. Stop data collection and configure the upload and header parameters in the Configure menu <i>before</i> you send this command.	—
Program	Send auto fire information entered under the Configure menu to the ECO. Make sure to send this before deployment so the auto fire functions correctly.	—
Arm	Enable the auto fire algorithm to close bottles. Make sure to do this before deployment so the auto fire functions correctly.	Arm
Diagnostics	Do one or more diagnostic tests on the CTD. Tests do not write over current settings. Note that this does not work with the SBE 25plus.	19 or 25: DS, J, VR, FR 19plus, 19plus V2: DS, DCal, TS
Stop	Stop the current process.	Esc key or Ctrl C
Disconnect	Release the PC serial port that communicates with the ECO or CTD.	—
Cancel	Stop the current process.	—

7.3 Configuration options

There are five tabs in this window:

- Setup File
- Communication Setup
- Bottle Closure Logic
- Bottle Closure Pressures or Times
- Upload & Header Options

7.3.1 Setup File tab

The Program Setup File area has all of the settings that were entered in the *Configuration Options* tabs. The software saves a .psa file to the last location and with the last file name that was used for a specific application. The manufacturer recommends that the user save each file with a unique name or location so they can be used for future deployments.

The Instrument Configuration File area has the .xmlcon or .con file made by the manufacturer. This file has pressure coefficients that are required for the ECO to calculate pressure from the CTD pressure frequency data. Pressure values are used to determine with to close the bottles, based on position and closure parameters.

Push **Browse** to find the file to look at or change, then **Modify** to change the file. The software will then list pressure sensor coefficients. For the SBE 19plus, 19plus V2, and 25plus, the coefficients are stored in the CTD, so a configuration file is unnecessary.

Notes:

- For SBE 19: SeatermAF uses the pressure sensor coefficients to calculate raw pressure output from the user's closure pressure entries in the Configuration Options

area. These pressures determine when to close bottles. The configuration file must agree with the actual sensor configuration, or the ECO cannot process data correctly.

- A new or manufacturer-calibrated CTD has a configuration file *as known* by the manufacturer.
- For ECO: Do not enable NMEA, Surface PAR voltage added, or Scan time added. These options are for real-time operation and do not apply to the autonomous operation of the ECO.

7.3.2 Communication Setup tab

In the Communications between computer and SBE 55 area:

- Select the "Serial port" used by the connected PC to communicate with the ECO.
- Baud rate default = 4800.
- Data bits = 7
- Parity = even.

In the Communications between computer and CTD through SBE 55 area:

- Baud rate must agree with the user-set baud rate for the CTD.
- Upload baud rate default = 19200.
- Data bits = 7.
- Parity = even.

In the Communication of pressure data from CTD to SBE 55 area:

- Real-time baud rate must agree with the baud rate set in the CTD.
Does not apply if "Close on elapsed time, do not record CTD data" is selected in the *Bottle Closure Logic* tab.

Push OK to save settings.

7.3.3 Bottle Closure Logic tab

The user has five options to choose how ECO bottles close:

- Close on upcast
- Close on downcast
- Close when stationary
- Close on elapsed time, record CTD data
- Close on elapsed time, do not record CTD data.

The associated *Bottle Closure Pressures or Times* tab lets the user select number and order in which bottles close from the logic in the *Bottle Closure Logic* tab.

7.3.3.1 Close on upcast

The ECO closes bottles at selected pressures on the upcast if "Close on Upcast" is selected in the Bottle closure options area.

If there is a check at "Bottom bottle closure enabled" the bottom bottle closes and upcast starts when the ECO calculates that it is at the bottom of the cast. The bottom bottle closes when the pressure is greater than the value in "Pressure to enable bottom bottle," and the pressure stays in the value for "Bottom pressure window" for the time set in "Stationary time on bottom."

If the ECO is outside these parameter values, the ECO closes the bottom bottle when the pressure decreases by the value in "Pressure decrease to determine upcast" so that water samples are collected even if the ECO did not go as deep as specified or did not stay at the bottom as long as specified.

If there is no check at "Bottom bottle closure enabled," the upcast is enabled when pressure is greater than the value in "Minimum pressure to determine upcast." If the ECO is outside of this value, the upcast is enabled when pressure decreases by the value in

"Pressure change to enable upcast logic," so that samples are collected even if the ECO did not go as deep as specified.

7.3.3.2 Close on downcast

If "Close on downcast" is selected **and** there is a check in the box for "Bottom bottle closure enabled," the ECO closes bottles on the downcast only. Selections in the Upcast /downcast logic area define the conditions of pressure and time that identify when the bottom has been reached and upcast has started. This occurs when pressure is at least "Pressure to enable bottom bottle" **and** the pressure stays within "Bottom pressure window" for "Stationary time on bottom."

If there is no check in the box for "Bottom bottle closure," the Upcast / downcast logic parameters do not apply.

7.3.3.3 Close when stationary

If "Close when stationary" is selected, the Stationary logic parameters apply. The ECO closes bottles on the upcast.

When the ECO reaches the "Enable pressure for first bottle," a bottle closes each time the pressure stays within the "Pressure window size" for the "Time to hold in pressure window."

The "Minimum change between bottles" is the minimum pressure change between two consecutive bottles to enable the next bottle to close. The ECO will not close multiple bottles at approximately the same pressure. If you **want** to close all bottles at the same pressure, set this value to 0. There is a delay between each bottle close to let the ECO collect five scans of data.

- For SBE 19, 19plus and 19plus V2, the delay is 1.5 seconds.
- For SBE 25 and 25plus, the delay is 1 second.

7.3.3.4 Close on elapsed time

If "Close on elapsed time" is selected, the ECO closes bottles based on the elapsed time from when the ECO is armed (select Arm on the Toolbar and select the **Arm** menu, or type **Arm** from the keyboard.)

Close on elapsed time, record CTD data

The ECO records five scans of CTD data each time a bottle is closed, for a CTD record of each water sample.

Close on elapsed time, do not record CTD data

The ECO does not record CTD data. This option is typically used when an ECO operates without a CTD.

In the *Bottle Closure Pressures or Times* tab, select the "Number of Bottles to Close" and the order in which they are to be closed. The elapsed time must increase from the first closure to the last.

For example:

closure 1, bottle position 1, 10 minutes
closure 2, bottle position 3, 12 minutes
closure 3, bottle position 5, 14 minutes
closure 4, bottle position 2, 16 minutes
closure 5, bottle position 4, 18 minutes
closure 6, bottle position 6, 20 minutes.

7.3.4 Bottle Closure Pressures or Times tab

Select the order and pressure for bottles to be closed.

1. Select the *Bottle Closure Pressures or Times* tab.
2. Enter the "Number of Bottles to Close."

3. Enter the "Bottle position."
These values can be in any order.
4. Enter the "Closure pressure (db)" values.
 - If bottles are closed on upcast, the pressures must **decrease** from closure 1 to the last closure.
 - If bottles are closed on downcast, the pressures must **increase** from closure 1 to the last closure.
5. Push **OK**

7.3.5 Upload and Header Options tab

Select the way that data is transmitted to a PC, and any header information to be included.

1. Select one of the five options in the Upload options for CTD data upload file area:
 - "All data separated by cast" (default): a separate file is written for each cast, with a 3-digit ID appended to the user-selected file name.
 - "Single cast": the software prompts for the cast number and transmits the data in one file.
 - "By cast number range": the software prompts for start and end cast numbers and transmits data in that range.
 - "All data as a single file": all data is transmitted in one file.
 - "By scan number range": The software prompts for start and end sample numbers and transmits data in that range.
2. Push **Configure Header Form** to enter information about a deployment such as latitude, longitude, date, name of ship, etc.
3. Select one of three options in the Header options for CTD data upload area.
 - "Prompt for header information" (default): the software prompts the user to enter header information each time data is transmitted.
 - "Include default header information": user-entered default header information.
 - "Do not include header information": no header information is in the transmitted file.

The software transmits CTD data in blocks, and calculates a checksum at the end of each block. If the data does not pass the checksum verification, the software tries to transmit half the block size again. Default block size is 200.

4. Push **OK** to temporarily save the settings.
5. Exit the software.
A prompt shows to store the configuration settings so that they are saved to a .psa file for future use.
6. Select **Connect** on the toolbar. The display shows `A>`.
This shows that the communications between the PC and the ECO are correct.
7. On the **Toolbar** menu, select *Status* to see the status of the ECO 55. The display shows

```
SBE 55 V 1.4.1 15 Jun 2016 16:40:11
main battery = 11.86 volts
lithium battery = 2.92 volts
SBE 55 is NOT ARMED
```

 - Verify that the main battery voltage is > 7.5. If not, replace or recharge the batteries.
 - Verify that the lithium battery voltage is > 2.25. If not, return the ECM to the manufacturer for replacement.

- Verify that the date and time are correct. If not, enter `DateTime=mmddyyyyhhmmss` and push **Enter**. Select *Status* on the **Toolbar** menu to make sure the new date and time were transmitted to the ECO.
 - Verify that the SBE 55 is not armed. If it is, enter **DA** (disarm) and push **Enter**. The ECO must be disarmed before the bottle closure information from the **Configuration Options** is accepted.
8. Select *Connect CTD*. The display shows
`Connected successfully . . .`
`S>`
 This shows that the communications between the PC and the ECO are correct.
 9. Look at the status information:
 - For SBE 25plus, send **GetCD** and **GetSD** to see the status information.
 - For all other CTDs, select *Status* to see the status information.
 10. Look at the information in the status display. Send commands to change settings as necessary.

7.4 Configure and verify system operation

1. Select **Connect ECO** on the toolbar. An `A>` prompt shows, which shows that the PC and the ECO communicate correctly.
2. Select **Status** on the toolbar.
 The display shows:
`SBE 55 v. 1.4.1 15 Jun 2016 16:40:11`
`main battery = 11.86 volts`
`lithium battery = 2.92 volts`
`SBE 55 is NOT ARMED`
3. Verify this information:
 - Main battery voltage is > 7.5 volts. If not, replace or recharge the batteries.
 - Lithium battery voltage is > 2.25 volts. The manufacturer recommends that the user send the ECM to the factory to replace the backup lithium battery.
 - Date and time are correct. If not, enter `DateTime=mmddyyyyhhmmss`, then push **Enter**.
 - The SBE 55 is not armed. If it is armed, enter **DA**, then push **Enter**. The SBE 55 must be disarmed to accept the user-entered bottle closure information.
4. Select **Program** on the toolbar to send all of the bottle closure information to the ECO.
5. Select **Connect** on the toolbar.
 The display will show
`Connected successfully . . .`
`S>`
 This shows that the PC and CTD communicate directly, through the ECO. If the CTD does not show the above, select **Connect** again, and verify the correct CTD was selected in the **Configure** menu and the CTD settings were entered correctly on the *Communication Setup* tab in the *Configuration Options* area. Make sure the cables are attached correctly and that the battery voltage is sufficient.
6. SBE 25plus: send **GETCD** and **GETSD** to see the configuration and status information.
 If the 25plus is set to close bottles on upcast, make sure the configuration entered with **CC** is "Stop CTD on upcast (y/n)?=NO"
7. Exit **SeatermAF**.

The software will prompt the user to save the system settings to the .psa file if they were changed.

- 8.
- 9.
- 10.
- 11.

7.5 Deploy system

Deployment notes:

- Make sure to transmit data from the ECO before each deployment, because the ECO overwrites any data in the memory.
 - The ECO automatically disarms itself after 24 hours.
 - If a 19plus or 19plus V2 are used, SeatermAF automatically sets **OutputFormat=4** in the CTD. This is required for real-time communication of pressure information to the ECO.
 - If a 25plus is used, SeatermAF automatically sets **OutputFormat=1** in the CTD. This is required for real-time communication of pressure information to the ECO.
1. Start the SeatermAF software.
 2. Prepare the ECO for deployment:
 - a. In the **File** menu, select *Open Setup File*. Select the previously saved .psa file, then **Open**.
 - b. Push **Connect ECO** on the toolbar to start communications with the ECO.
 - c. Push **Program** on the toolbar to send the input closure parameters to the ECO.
 - d. Push **Arm** on the toolbar to enable the ECO to close bottles.
 3. Prepare the CTD for deployment with its **switch**:
 - a. Push **Connect** on the toolbar to start communications with the CTD.
 - b. Verify that the switch on the CTD is in the OFF position.
 - c. Send **QS** to put the CTD in a low power ("quiescent state") mode.
 - d. Turn on the switch on the CTD to start data collection. Data will be recorded after any data already stored in the CTD.
 - e. Optional: deploy the CTD with commands from the PC when data collection has started:
 - SBE 19 or 25—turn on the CTD's switch, then send **GL** to overwrite data, or **RL** to append stored data.
 - SBE 19plus, 19plus V2, or 25plus—send **StartNow**. Stored data will not be overwritten.
 - f. Optional: push **View CTD** on the toolbar to see the data that is transmitted from the CTD to the ECO. Verify that the pressure values from Each CTD scan show on the screen.
 - SBE 19 or 25— pressure shows as raw values. For the 19, the first pressure number does not show until the reference scans are received.
 - SBE 19plus or 19plus V2—The ECO automatically sets the CTD to **OutputFormat=4**. Pressure is shown in decibars.
 - SBE 25plus—The ECO automatically sets the CTD to **OutputFormat=1**. Pressure is shown in decibars.
 - g. Exit SeatermAF.
 - h. Disconnect the I/O cable from the extender cable and attach a dummy plug and lock collar on the extender cable.

4. Make sure that the hardware and cables are attached correctly.
5. Deploy the system.

7.6 Transmit data

Make sure that the data stored in the ECO is transmitted between deployments because any stored data will be overwritten.

1. If necessary, stop the CTD:
 - SBE 19 or 25—move the switch to the Off position.
 - SBE 19plus or 19plus V2—move the switch to the Off position OR, if the CTD is set up to start and stop on command and ignore the switch position, connect the ECO to the PC and start communications with the CTD through the ECO and send **Stop**.
 - SBE 25plus—move the switch to the Off position OR connect the Auto Fire Module (AFM) to the PC, start communications with the CTD through the AFM, and send **Stop**.
2. If necessary, connect the ECO to the PC: Connect the DB9S cable to the extender cable and the PC.
3. From the **File** menu in SeaterMAF, select *Open Setup File* then select the saved .psa file and push **Open**.
4. Select the **Configure** menu and then the SBE 55 with the applicable CTD.
5. Select the *Upload & Header Options* tab. Refer to [Upload and Header Options tab](#) on page 24 for details about the settings in this tab.
6. Select the *Communication Setup* tab. Refer to [Communication Setup tab](#) on page 22 for details about the settings in this tab.
7. Push **OK** to temporarily save the settings in the Configuration Options window.

7.6.1 Transmit data from the ECO

1. Push **Connect ECO** on the toolbar to start communications with the ECO. The display shows `A>`.
This shows that the PC and ECO are in communication. If the ECO does not respond with `A>`, push **Connect ECO** again, and verify that the correct auto fire instrument was selected from the **Configure** menu and that the communication setting were entered correctly on the *Communication Setup* tab in the *Configuration Options* dialog box.
2. Send **DA** to disarm the ECO.
The ECO responds with `#A` if it is already disarmed.
3. Select **Status** on the toolbar to look at the status of the ECO. The display will show

```
SBE 55 V 1.4.4 15 June 2016 16:40:11
main battery = 11.86 volts
lithium battery = 2.92 volts
SBE 55 is NOT ARMED
```
4. Push **Upload** on the toolbar to transmit data from the ECO. SeaterMAF responds:
 - a. **DS** to show the status response, and writes the command and response to the file to be transmitted.
 - b. If "Prompt for header information" is selected on the *Upload & Header Options* tab, a dialog box with the header form shows. Enter and header information and push **OK**.
 - c. In the open dialog box, enter the name of the file to transmit and push **OK**.

Autonomous operation

SeatermAF automatically adds the .afm file extension, sends the **DD** command to transmit data, and writes the response to that file.

7.6.2 ECO data formats

Use **Upload** on the toolbar or from the menu to transmit data from the ECO. Data is written to a file with an .afm extension. The data has a header with the .afm file name, the SeatermAF software version, transmit time, and ECO status. Each line of the header starts with *.

For each bottle that was fired, the bottle close information is in this format:

a b dd mmm yyyy hh:mm:ss.s xxxxxxxx cc.c dd

Parameter	Description
a	bottle sequence
b	bottle position (first bottle position is 0)
dd mmm yyyy	date
hh:mm:ss.s	time
xxxxxxx	Closure confirmation message: confirmed=OK user cmd=disarm command received low volt=low battery voltage no confirm=current through the latch magnet is insufficient invalid bn=bottle number received was not valid no reply= no response from the ECO latch array
cc.c	main battery voltage
dd	scan number of the first of five CTD scans recorded with this bottle. Starts from the time the ECO was armed. May not agree with the actual scan number in the CTD file, where the scan number is the number of scans since the last time the memory pointer was set to the start of memory. If no CTD was used, dd=1.

For SBE 19 or 25: The ECO records the entire data scan from the CTD, which includes any auxiliary sensor data.

For SBE 19plus, 19plus V2 or 25plus: The ECO records only the pressure and scan number, ppppssssss, *where* pressure in decibars = pppp, converted from hex to decimal, - 100. ssssss = scan number, converted from hex to decimal.

The first scan number, dd, for each bottle may not agree with the scan number ssssss because of differences in how scans are counted.

- dd is the number of scans counted by the ECO since the ECO was armed.
- ssssss is the number of scans counted by the CTD since the last time **InitLogging** or **SampleNumber=0** was sent to the CTD to set data collection to the start of memory.

7.6.3 Transmit data from SBE 19, 19plus, 19plus V2, or 25 CTD

Refer to [Transmit data from the SBE 25plus](#) on page 29 for details about this model.

1. Push **Connect CTD** on the toolbar to start communications with the CTD. The display shows

```
Connected successfully . . .
```

```
S>
```

This shows that the PC and CTD are in communication. If the CTD does not respond with S>, push **Connect CTD** again, and verify that the correct CTD was selected from

the **Configure** menu and that the communication setting were entered correctly on the *Communication Setup* tab in the *Configuration Options* dialog box.

2. Push **Upload** on the toolbar to transmit data from the CTD.
SeatermAF sends **DS** and **DH** commands, shows the responses, and writes this information to the transmitted file.
3. If "single cast," by cast number range," or "By scan number range" are selected on the *Upload & Header Options* tab, a dialog box asks for the range or cast number. Select, then enter those values and push **OK**.
SBE 19plus or 19plus V2: SeatermAF sends **OutputFormat=0** to the CTD, to set the data to raw hexadecimal, required for the SBE Data Processing software.
4. If "Prompt for header information" is selected on the *Upload & Header Options* tab, a dialog box with the header form shows. Enter and header information and push **OK**.
5. In the open dialog box, enter the name of the file to transmit and push **OK**.
SeatermAF automatically adds the .hex file extension, sends the **DDb,e** command to the CTD through the ECO to transmit data, and writes the response to that file.
SBE 19plus or 19plus V2: SeatermAF sends **OutputFormat=4** to the CTD, to set the data format back to pressure in decibars, so it will send real-time pressure data to the ECO on the next deployment.

7.6.4 Transmit data from the SBE 25plus

Note that files transmitted from the ECO and CTDs must have the same name and be in the same directory for the SBE Data Processing software. The file extensions will be different.

1. Push **Connect CTD** on the toolbar to start communications with the CTD. The display shows

```
Connected successfully . . .
S>
```

This shows that the PC and CTD are in communication. If the CTD does not respond with `S>`, push **Connect CTD** again, and verify that the correct CTD was selected from the **Configure** menu and that the communication setting were entered correctly on the *Communication Setup* tab in the *Configuration Options* dialog box.
2. Push **Upload** on the toolbar to transmit data from the CTD.
SeatermAF sends **SetOutputExecutedTag=Y** so data from the 25plus is transmitted correctly. SeatermAF sends **GetSD** and **GetFiles** and shows those responses.
3. In the *Upload Data* window, select the files to transmit from the 25plus. There are two file types, .xml and .txt
 - .xml data files from the CTD include UTC from start of cast, the 25plus serial number. Serial sensor data is included if **SetEnableSer1=Y**, and or **SetEnableSer2=Y**, and **SetInlineSer1=Y**, and or **SetInlineSer2=Y**
 - If the 25plus is set up with one or more serial sensors (**SetEnableSer1=Y** and or **SetEnableSer2=Y**) and serial sensor data is not stored in the CTD data file (**SetEnableSer1=N** and or **SetEnableSer2=N**), a .txt file is made with serial sensor data for each cast.
4. In the Destination options area, push **Select Folder...** to navigate to the necessary file path.
The files to transmit have .xml or .txt extensions. the .xml files are in raw hexadecimal, which is compatible with the Seasave and SBE Data Processing software.
5. Optional: group data files into sub-folders at the "Sub-folder options" dropdown.
6. Optional: append a name before the file extension to more easily identify files.
7. Set the "Block size," the number of bytes transmitted in each block.

SeatermAF transmits data in blocks and calculates a checksum at the end of each block. If a block fails the checksum verification, SeatermAF reduces the block size by half and tries to transmit the data again.

8. Push **Upload**.

The status bar at the bottom of the window shows the transmit status. SeatermAF sends the data transmit command and writes data to the .xml or .txt file as applicable. SeatermAF sends the transmit command for each cast, and when the data has all been transmitted, the `S>` prompt shows.

7.7 CTD data formats

When data is transmitted from the CTD, either through the ECO or directly from the CTD with the **Upload** command, the data is written to a file with a .hex extension or, for the SBE 25plus, an .xml extension. The data has header information and the CTD data. Each line of the CTD header starts with a *.

Section 8 Recover system and process data

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

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

Flush the ECO, the CTD, auxiliary sensors and frame with fresh water and then dry thoroughly.

The SBE Data Processing software uses two modules to process data from the ECO:

1. Data conversion
2. Bottle summary

The data conversion module makes a .cnv file, in engineering units, from the CTD data, and a .ros water bottle file. The .ros file comes from CTD and .afm data from autonomous operation, or from CTD and .bl data from real-time operation.

The bottle summary module uses the .ros file to make a bottle data summary .btl file. This file includes:

- Bottle position, optional bottle serial number, date and time
- User-selected variables calculated for each bottle from input variables, such as temperature, pressure, conductivity, etc.
- User-selected averaged variables, calculated for each bottle from input variables.

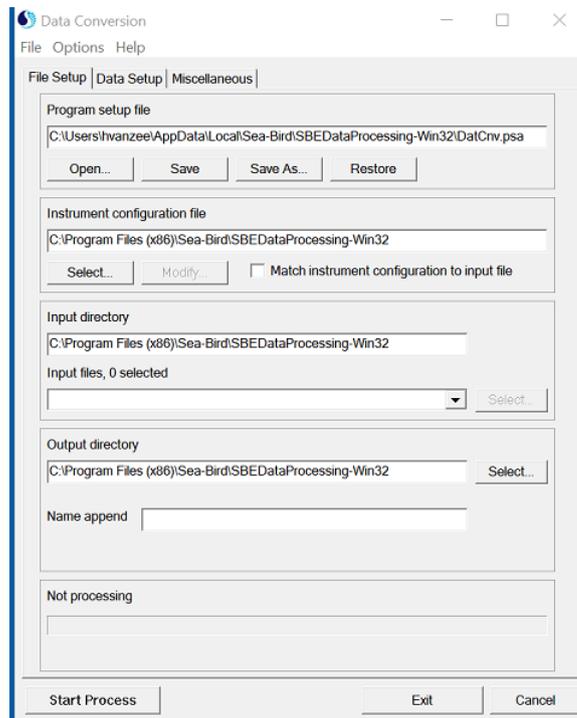
8.1 Data conversion module

In the **Run** menu of the Data Processing software, select "Data Conversion." Use the *File Setup* and *Data Setup* tabs to enter details for data conversion. The software uses the .hex file from the CTD, the .xmlcon or .con file for the CTD, and either the .afm (autonomous) or .bl (real-time) file as the input files.

Note that the Data Processing software looks for the .afm and .bl files in the same directory as the CTD data (.hex or .xml), with the same name as the data file but different extension.

8.1.1 File setup tab

The Program setup file, Input configuration file, and Output directory areas are auto-filled when "Data Conversion" is selected.



Program setup file

This is the directory in which all information from the *File setup* tab and the *Data Setup* tab is stored.

- Push **Open** to select a different .psa file.
- Push **Save** or **Save As** to save the current settings.
- Push **Restore** to set all settings to agree with the last saved version.

Instrument configuration file

- Push **Select** to select a different file.
- Push **Modify** to look at or change the configuration.
- Put a check in the "Match instrument configuration to input file" to have the software find the configuration file with the same name as the data file.
- Put a check in this box if more than one data file is to be processed, **and** the data files have different configuration files. For example, if test.hex and test1.hex are to be processed, the software looks for test.xmlcon and test1.xmlcon in the same directory as test.hex and test1.hex. If it does not find .xmlcon files, it looks for .con files.

Input directory

Directory and file names for .hex or .xml raw data. Push **Select** to see a different file. To process more than one data file from the same directory, push **Select** and in the dialog box, push the **Ctrl** while you select each file.

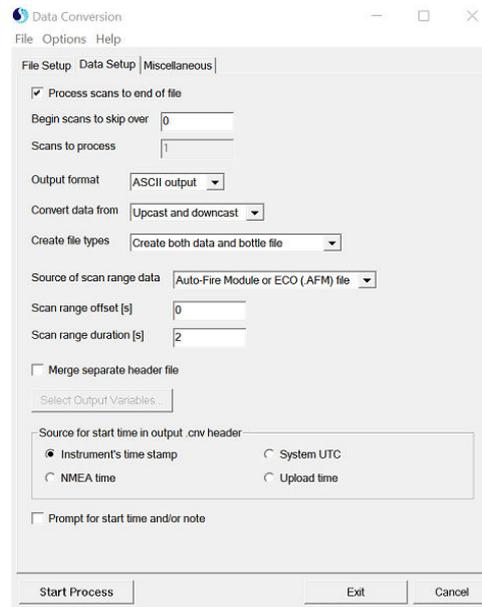
Output directory

This is the directory and file names for converted data.

"Name append": Append characters to the file name. For example, if "Name append" for "test" is 11-6-22, the output file will be test11-6-22.cnv.

"Output file": If test.hex and test1.hex will be processed, the "Output file" box goes away and the output file name is set to agree with the input file name. For example, test.hex and test1.hex output files will be named test.cnv and test1.cnv

8.1.2 Data setup tab



Put a check in "Process scans to end of file" box to process all data. If there is no check in this box, enter the "Scans to process." Enter the number of "Scans to skip over" to exclude the first scans of a file.

In "Output format" select either binary or ASCII. Binary makes a smaller file and is processed faster than ASCII. ASCII is human-readable. The SBE Data Processing Translate module can translate the converted data from binary to ASCII or from ASCII to binary.

Select the data to convert in "Convert data from" dropdown.

Select the type of file to make from the "Create file types dropdown.

Select the "Source of scan range data": to make the .ros file. Use .afm for autonomous or .bl for real-time data.

Enter any "Scan range offset" or "Scan range duration" of data to be included in the .ros file.

- Offset is the first scan transmitted to the .ros file.
- Duration is the number of scans transmitted to the .ros file for each bottle.

.afm example: Scan range offset = 2 seconds, Scan range duration = 5 seconds
 Scans 1,000–1,004 written to .afm for first bottle on ECO with 19plus, 4 Hz sample rate = 4 scans/second
 $1,000 - (2 \text{ second offset} \times 4 \text{ scans/second}) = 992$
 $992 + (5 \text{ second duration} \times 4 \text{ scans/second}) = 1,012$
 Scans 992 through 1,012 written to the .ros file for first bottle

.bl example: Scan range offset = 2 seconds, Scan range duration = 5 seconds
 Scans 1,000–1,005 written to .bl for first bottle on ECO with 19plus, 4 Hz sample rate = 4 scans/second; 1.5 seconds of data in .bl is 6 scans
 $1,000 - (2 \text{ second offset} \times 4 \text{ scans/second}) = 992$
 $992 + (5 \text{ second duration} \times 4 \text{ scans/second}) = 1,012$
 Scans 992 through 1,012 written to the .ros file for first bottle

Select the "Source for start time in output .cnv header."

Push **Select Output Variables** to see a new window from which to select variables.

Select the blank field in the "Variable Name" column, then select the variable to see from the list and push **Add**. These variables will be included in the .cnv and .ros files.

8.2 Bottle summary module

In the **Run** menu of the Data Processing software, select "Bottle Summary." The *File Setup* tab is similar to the tab in "Data Conversion." The input files for the bottle summary are the .ros file and the .xmlcon or .con file.

If there is an .sn file with the same name as the .ros file in the input file directory, the bottle serial numbers are inserted between the bottle position and date-time columns in the .btl file. A text editor can be used to make an .sn file.

Data Setup tab

Push **Select Derived Variables** to select the variables to be averaged. The mean and standard deviation are calculated and show for each bottle.

If there is a check in the box at "Output min/max values for averaged variables, the output will include minimum and maximum values for each bottle.

Push **Select Derived Variables** to see variables calculated from input data. Oxygen can be derived if oxygen data is in the .ros file.

- For SBE 13 or 23, this is oxygen current and temperature
- For SBE 43, this is oxygen signal
- For SBE 63, this is oxygen phase and temperature voltage.

The Bottle Summary uses a least squares fit to calculate the derivative of the oxygen signal or current for each bottle. Oxygen is calculated with mean values for temperature, pressure, and salinity, the derivative, and scan-by-scan values of oxygen current and temperature.

Put a check in the box at **Apply Tau correction** to improve the response of the measured signal in regions with large oxygen gradients. This can amplify signal noise, and in some application this negative consequence is greater than any gain in signal response. Applies to SBE 43, Beckman, and YSI sensors only.

Section 9 Maintenance

Flush the entire ECO with fresh water after each cast, and flush the inside and outside of all the bottles to prevent salt deposits on the tubing that closes the bottles. Some ECO systems have a zinc anode attached to prevent corrosion. Examine the anode at regular intervals and replace when it is worn.

Examine the tubing at regular intervals to make sure there are no tears and that each tube has the correct amount of tension.

Examine the O-rings on the end flange, air bleed valve, and drain of the bottles at regular intervals. The manufacturer recommends that these O-rings are replaced every three to four years.

9.1 Charge NiMH batteries

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

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

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



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



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

- d. Make sure that the screws are fully tightened or the battery power will be intermittent.
- 13. Carefully put the end flange onto the housing and screw the end flange into place. use a wrench to make sure the cap is tightly installed.
- 14. Verify that the switch plunger is pulled out so that the Searam is in a low power mode.

9.2 Clean bulkhead connectors

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

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

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

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

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

Use a finger to put a small quantity (approximately 1 cm in diameter) of silicone grease on the socket end of the connector and push as much of the lubricant as possible into each socket. Do not use too much lubricant, as that will prevent a good seal.



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

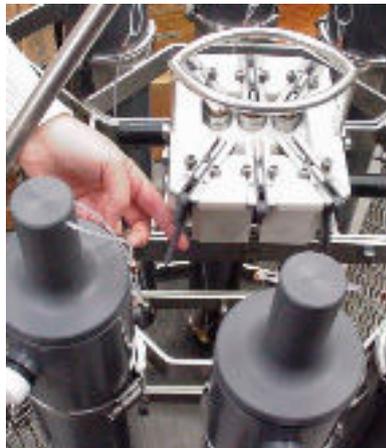
9.3 Remove and replace latches

The typical ECO has plastic sidebars. Titanium sidebars are available for some applications. It is not necessary to do these steps unless a latch is not working correctly.

1. Remove the latch assembly from the frame:
 - a. Remove the screws and washers from the sides of the latch assembly.
 - b. Pull straight up on the oblong-shaped frame to remove it.
 - c. Lift the latch assembly off of the frame.



2. If necessary, remove the individual triggers:
 - a. Remove the two socket-head screws from the trigger.



- b. Pull the trigger horizontally from the latch assembly. Put a mark on the trigger to make it easier to assemble again.



- 3. To install the trigger on the latch assembly, insert the trigger on the assembly.
- 4. Install the two socket-head screws to attach each trigger to the latch assembly.
- 5. Put the latch assembly on the frame.
- 6. Install the oblong frame and the washers and screws.

9.4 Storage

Store the ECO with the bottles closed to keep the correct amount of tension in the tubing. The manufacturer recommends that the ECO is covered if it is stored on the deck of a vessel. This will keep salt spray off of the system and protect the plastic parts from UV rays. At a minimum, cover the latch assembly.

9.5 Spare parts list

Part Number	Part description
801511	NiMH battery pack, rechargeable 9-cell
171743	MCIL2FS to MCIL2MP sea cable extension, from ECM to winch cable, 2 m
802039	3-position latch array
50496	Spare plastic latch
801714	ECO 4-L water sample bottle
50427	Bottle repair kit for 801714 bottle, includes
	50426 O-ring kit, includes
	30390 Parker 2-012 N674-70, seals drain fitting
	31649 Parker 2-012 N674-70, seals air vent valve
	31188 Parker 2-336 N674-70, seals bottle caps to bottle
	50425 air vent valve kit for 801714 bottle, includes
	233588 air vent port
	31649 Parker 2-012 N674-70, seals air vent valve
	50424 drain valve assembly kit for 801714 bottle, includes
	233589 drain fitting barb
	233590 drain fitting ring, attaches to barb and guide pin
	30390 Parker 2-012 N674-70, seals drain fitting
	30773 plastic lanyard ball
	30772 brass snap hook for lanyard
	31690 0.80 in. OD monofilament for lanyard
	30664 Nicopress oval sleeves for lanyard
	233650 latex rubber power cord, keeps cap on bottle

Maintenance

	233587 water bottle cap
	233575 lanyard guide D-ring, attaches to band clamp and routes middle lanyard
30379	ECO sampler bottle clamp, 2 per bottle
50430	ECO attachment and lanyard kit for 801714 bottle, includes
	233575 lanyard guide D-ring, attaches to band clamp and routes middle lanyard
	30664 Nicopress oval sleeves for lanyard
	311396 2 mm OD monofilament for lanyard
	30772 brass snap hook for lanyard
	233681 plastic lanyard ball
	30379 hose clamps to attach bottle to frame
50422	Spare CTD/electronics attachment kit, required to attach SBE 19, 19plus, 19plus V2, 25, or 25plus on ECO, includes
	233364.01 attachment blocks for 4-in. housing
	30379 stainless steel #80 hose clamps to attach CTD to ECO 55
	31138, bolts, 1/4-20 x 3/4 hex head, stainless steel, 1-in. OD, to attach block to wire mesh
	30253 washers, 1/4 Fender, stainless steel, 1-in. OD, to use with 31138
	30409 Teflon tape, 1 in. wide, for electrical insulation for hose clamps
90929	SBE 55 3-bottle to 6-bottle upgrade kit, includes latch array, bottles, cable and rigging

Section 10 Reference

10.1 Command descriptions

Verify that the PC communicates with the ECO, not the CTD. When connected to the ECO, SeatermAF shows an `A>` prompt. When connected to the CTD through the ECO, SeatermAF shows an `S>` prompt. If necessary, select **Connect ECO** on the toolbar in SeatermAF.

Enter commands to the ECO in upper or lower case letters. Push the `Enter` key to send commands. If the ECO does not return to an `A>` prompt after a command is executed, push `Enter` again to see an `A>` prompt.

If a new command is not received within two minutes, the "Command/Data Echo" area shows "time out" and the ECO goes into a low power mode to save battery power. Select **Connect ECO** on the toolbar to see an `A>` prompt.

10.1.1 Status

GetCD	Show configuration data
-------	-------------------------

Example, user entries in **boldface**:

GetSD	Show status data
	Firmware version, date and time DateTime=
	Main battery voltage
	Back-up lithium battery voltage
	ECO armed status, Arm or DA

DS	Same as GetSD
----	----------------------

GetEC	Show event counter and transmit a list of events and the number of times they occurred. Events can be unexpected conditions that should be seen as errors, as well as device power-up, invalid commands, or low-battery conditions.
-------	---

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

GetHD	Show hardware data
-------	--------------------

DC	Show bottle closure parameters
	CTD model and firmware version. SBE 19plus applies to 19plus, 19plus V2, or 25plus.
	CTD pressure sensor polarity
	CTD baud rate
	Number of bottles to fire
	Bottle closure sequence, with first bottle position = 0
	Closure mode, downcast, upcast, stationary, elapsed time with no CTD data, elapsed time with CTD data
	Upcast/downcast logic: bottom bottle enabled, pressure to enable upcast, stationary time on bottom, bottom pressure window
	Stationary logic: the minimum time to hold in pressure window to enable bottle closure, pressure window size, minimum change in pressure between bottles to enable next bottle closure, enable pressure for first bottle

Reference

10.1.2 Other commands

Table 12 Date and time

DateTime=x	x=realtime clock date and time, mmddyyhhmmss
------------	--

Arm before deployment to enable the ECO to take water samples. Disarm to disable water samples. The CTD can still collect data.

Table 13 Autofire

Arm	Enable auto fire to close bottles. ECO automatically disarms after 24 hours. Same as Arm on toolbar.
DA	Disable auto fire to close bottles

Use the **Upload** command on the toolbar to transmit data. If the upload command is entered manually the data does not have the correct header information for the SBE Data Processing software. To save data to a file, select **Capture** and then enter DD. Make sure to stop data collection before data is transmitted.

Table 14 Data upload

DD	Bottle sequence and number, date and time, firing confirmation, battery voltage, scan number of first of five CTD scans, and five scans of CTD data, or, if no CTD is used, bottle sequence and number, date and time, firing confirmation, battery voltage.
----	--

Table 15 Low power

QS	Stop (quit) session and put ECO in a low power mode. Main power is turned off. Memory is not affected.
----	--

Before the system is armed and deployed, make sure that the ECO operates correctly. Push against each trigger to set the release mechanisms. The triggers will make a click sound and lock into place.

Bottles close rapidly with great force and can cause injury. Make sure no one is near the ECO when it is tested.

Table 16 Test

DCDCOn	Turn on power to test ECO, use to change the ECO storage capacitor before firing. Wait for 1 minute after you send DCDCOn and then test fire a bottle.
DCDCOff	Turn off power to ECO after test. If this command is not sent, the ECO automatically turns off after 2 hours.
FireX	x= bottle number to fire for test. ECO will respond "fire confirmed" or "no confirm." If DCDCOn was not sent before this command, the ECO responds "wait 10 seconds for capacitor to charge" and then fires the bottle after 10 seconds. If the ECO is operated this way, it may not respond with "fire confirmed."

EETest	Test ECO EEPROM
--------	-----------------

10.1.3 ECO commands

During normal operation, commands are sent automatically to the ECO by the system that controls its operation. These commands are included for reference. All command characters must be upper case.

Command to ECO	Description
#SR	Go to home position (position #10

Command to ECO	Description
#SF	Fire next position (in sequence)

Command to ECO	Description			
#SNx	Fire position x, where x is in ASCII			
	Position #	Command	Position #	Command
	1	#SN1	4	#SN4
	2	#SN2	5	#SN5
	3	#SN3	6	#SN6

Command to ECO	Description	
	Set ECO to CTD communication baud rate x	
#SBx	Baud rate	Command
	600	#SB0
	1200	#SB1
	2400	#SB2
	4800	#SB3

Reply from ECO	Description			
!				
#				
\$				
x	Fired bottle x, where x is in ASCII			
	Position #	Reply	Position #	Reply
	1	*1*	*4*	*4*
	2	*2*	*5*	*5*
	3	*3*	*6*	*6*

The * characters are decimal 6, which is not a printable ASCII character. They may not show in the terminal program in use.

10.2 Make lanyards

All carousels have lanyards installed by the manufacturer if water bottles are ordered at the same time. Refer to the next section for steps to make lanyards for a specific carousel.

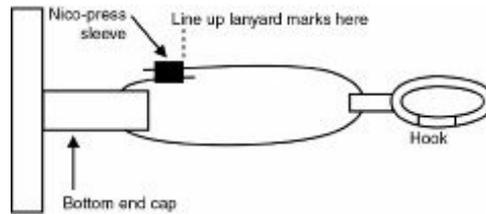
Use heavy-weight nylon monofilament to make lanyards. The 0.80 inch monofilament used for line trimmers is available at most home and garden stores. Make the lanyard loops with Nicopress crimped copper sleeves, available from the manufacturer or industrial suppliers. Install the sleeves with pliers made to crimp soldered electrical connections. If copper sleeves are not available, make a knot in the monofilament.

10.2.1 Make lower lanyard

1. Cut an 8 inch length of monofilament and make two marks 1 inch from each end.
2. Put the monofilament through the hole in the bottom end cap.
3. Put the monofilament through the hole in a brass snap hook.



- Put one end of the monofilament through the Nicopress sleeve. Put the other end through the sleeve from the opposite direction. Align the marks of one side of the sleeve

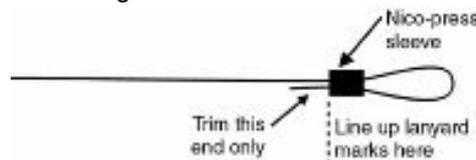


- Crimp the sleeve in two places.
- Cut any extra length of monofilament at a 45 degree angle for a smooth end.
- Move the loop around on the lower end cap until the sleeve is next to the end cap. Pull straight out on the brass hook to move the lanyard to the correct place.

10.2.2 Make middle lanyard

The middle lanyard connects the upper and lower lanyards. It may take several tries to make the correct length.

- Cut a length of monofilament to the approximate length and make two marks 1 inch from each end:
 - For a 12-bottle carousel, 12 inches (31 cm) longer than the bottle.
 - For a 24-bottle carousel, 24 inches (61 cm) longer than the bottle.
- Put both ends of the monofilament through one end of a Nicopress sleeve and keep a loop to connect to the bottom end cap hook.
- Align the marks on the side of the sleeve opposite the loop.
- Crimp the sleeve.
- Cut any extra length of monofilament next to the sleeve at a 45 degree angle.



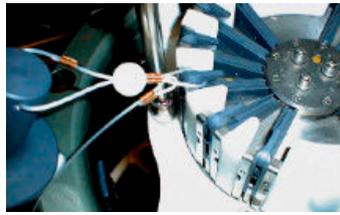
- Open both bottle end caps:
 - Put the loop of the upper lanyard on the trigger hook so that it is in the "set" position. Put a 2-inch wide wood spacer in the top bottle mouth for safety.
 - Put another wood spacer in the bottom bottle mouth. Make sure the handle on the end cap is pointed away from the center of the carousel.
 - Verify that the bottle end caps are set at the correct positions.
- Connect the middle lanyard loop into the lower lanyard snap hook.



8. If the bottle has a handle, put the end of the middle lanyard through the handle to prevent the loss of either end cap if the rubber tubing between the end caps breaks.
9. Put the end of the middle lanyard through a Nicopress sleeve.
10. Put the end of the middle lanyard through the loop on the upper lanyard.
11. Bring the end of the middle lanyard back through the Nicopress sleeve so that it makes a loop through the upper lanyard.



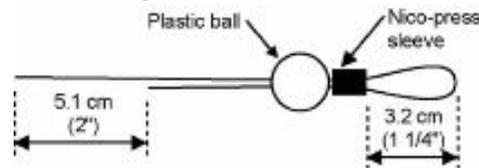
12. Adjust the middle lanyard length so that it takes up the tension on the bottom end cap.
13. Adjust the position of the Nicopress sleeve so that the upper loop is approximately 1 inch long.
14. Crimp the sleeve.
15. Cut any extra length of monofilament at a 45 degree angle.
16. Remove the wood spacers.
Both end caps should be in the correct "set" position. If they are not, make another lanyard and adjust the measurements as necessary.



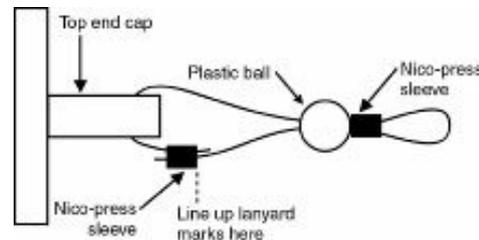
10.2.3 Make upper lanyard

The length of the upper lanyard depends on the size and type of bottle used on the carousel. It may take several tries to make the correct length.

1. Cut a length of monofilament and make two marks 1 inch from each end.
2. Put both ends of the monofilament through one end of a Nicopress sleeve and keep a loop of 1¼ inches to hook onto the pylon for the rigging. Adjust the ends so that one end is 2 inches longer than the other. **Do not crimp the sleeve.**



3. The plastic lanyard ball has a hole drilled through it. One side is slightly larger. Put both ends of the monofilament through the larger hole and move the ball up on the monofilament until it touches the Nicopress sleeve.
4. Put the longer end of the monofilament through the hole on the top end cap.
5. Put the ends of the monofilament through the Nicopress sleeve in opposite directions.
6. Crimp this sleeve.



7. Cut any extra length of monofilament at a 45 degree angle for smooth ends.
8. Adjust the ball and other sleeve so that the tension equal on both lengths of the monofilament.
9. Crimp the sleeve.
10. To test the lanyard assembly, put the loop over the appropriate trigger hook. The end cap should be in the correct set position. If it is not, make another lanyard and adjust the lengths as required.

Section 11 General information

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

11.1 Service and support

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

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

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

11.2 Warranty

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

11.3 China RoHS disclosure table

Name of Part	Hazardous substance or element in product					
	Pb	Hg	Cd	Cr(VI)	PBB	PBDE
PCBs	X	O	O	O	O	O
This table is compiled to the SJ/T 11364 standard.						
O: This hazardous substance is below the specified limits as described in GB/T 26572. X: This hazardous substance is above the specified limits as described in GB/T 26572.						

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