SEA-BIRD SCIENTIFIC

User manual

SBS 17plus V2 Searam

Recorder and auto fire module

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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

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 very SLOWLY loosen the bulkhead connector to release the pressure. Keep away from heat, sparks, flame, and other sources of ignition. Do not smoke.

⚠CAUTION

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

- Put on protective eye wear before you open the pressure housing.
- Any electrostatic charge on the body of the human operator must be released before the pressure housing is opened: put a hand on a grounded surface, or better, wear a grounded antistatic wrist strap.
- At a minimum, wear short-sleeved antistatic clothing, such as cotton, or better, wear an antistatic smock for this service activity. *Do not wear a sweater, fleece or polyester-based clothing.*
- At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. *Do not use a workstation with a synthetic or polymeric-based tabletop.*

NOTICE

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

1.2 Equipment labels

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

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

	EFUP: 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 17plus V2 Searam quick start guide

This quick start guide gives the steps necessary to make sure that the SBE 17plus V2 operates correctly and records data before it is deployed.

What's in the box:

- SBE 17plus V2 Searam, batteries installed
- Data I/O cable
- 9plus to 17plus cable
- Two dummy plugs and lock collars
- Spare magnetic switch plunger
- Jackscrew kit
- NiMH battery charger and cable
- Two spare fuses for battery charger
- Spare O-ring and hardware kit
- Spare battery end flange O-ring and hardware kit
- CD or USB drive with software and documentation

1. Install the manufacturer-supplied software on a PC. Refer to Set up and test on page 11 for details.
2. If necessary, install new batteries. Refer to Charge NiMH batteries on page 27 for details.
3. Connect the 17plus V2 to a PC and start the software.
4. Set up the 17plus V2 for deployment. Refer to SeatermAF configuration options on page 12 for details.
5. Immediately after the system is recovered from a deployment, use the magnetic switch to turn off the 17plus V2 and rinse the system with fresh water.
6. Transmit the recorded data to a PC.
7. Store the 17plus V2.

Section 3 Specifications

3.1 Searam

Memory	16 MB non-volatile flash RAM
Clock	Crystal type 32,768 Hz
Batteries	12 rechargeable Nickel Metal Hydride (NiMH) D-cells, 14.4 V
	12 alkaline D-cells, 18 V
Alkaline batteries cannot be used in a NiMH holder. NiMH batteries cannot be used in an alkaline holder.	
Battery capacity	10 hours for a 9plus 7 hours for 9plus with auxiliary sensors
Housing, rated depth	Anodized aluminum, 6800 m Titanium, 7000 or 10500 m
Communication interface	3-wire RS232C link
Carousel compatibility	Up to 24 bottles
Weight in air, water	Aluminum: 9.0 kg, 4.5 kg
Dimensions	68.6 cm high, 9.9 cm diameter

3.2 Connectors and cables

Table 1 9plus CTD (JT7)

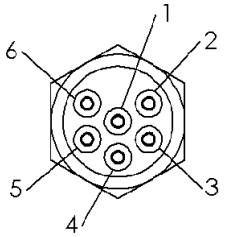
Contact	Function	MCBH-6-MP
1	Ground	
2	No connect	
3	No connect	
4	Data from 9plus	
5	No connect	
6	Power to 9plus	

Table 2 32 Carousel

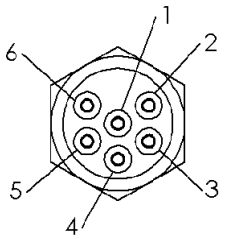
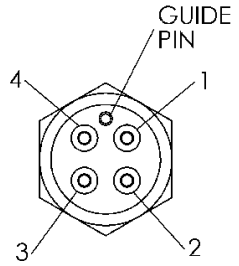
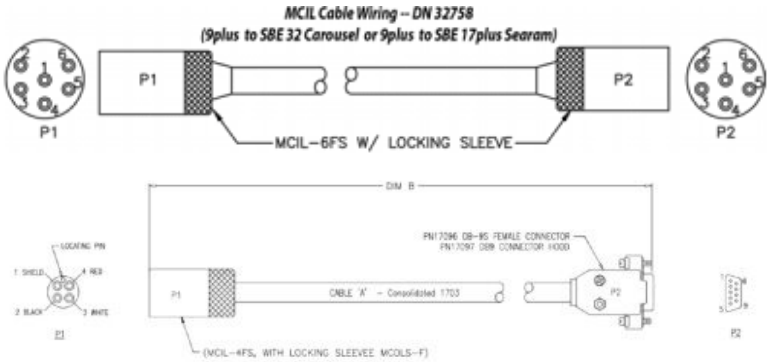
Contact	Function	MCBH-6-MP
1	Ground	
2	No connect	
3	No connect	
4	No connect	
5	No connect	
6	Power to Carousel	

Table 3 PC

Contact	Function	MCBH-4-MP
1	Ground	
2	RS232 RX	
3	RS232 TX	
4	External power (optional)	



Section 4 Description

The SBE 17plus V2 Searam is an *in-situ* battery pack and data recorder for use with the SBE 9plus CTD when an electrical cable and slip ring-equipped winch is not available. The Searam supplies power to the SBE 9plus. The serial data from the SBE 9plus is decoded and can be averaged by the Searam. Unused data channels are removed so there is more memory capacity.

The Searam also powers and operates the SBE 32 Carousel Water Sampler to close water sample bottles on upcast. The Searam uses pressure data from the 9plus and user-entered bottle closure pressures to close a bottle. Built-in logic and user-entered parameters control when the upcast starts. This prevents accidental bottle closure caused by temporary upward movements during the downcast. The Searam can close up to 24 bottles.

The non-volatile memory saves recorded data if the main battery pack fails. A low-power watch crystal is used for the real-time-clock frequency source. The Searam can be started and stopped with the external magnetic reed switch plunger.

4.1 Magnetic reed switch plunger

The top end flange of the Searam has a plunger attached to turn power on and off.

- When the plunger is pushed in, power is supplied to the 9plus and it collects data. If the battery voltage is more than the lower power cut-off of approximately 10 V, and there is sufficient space in the memory, the Searam will store data from the 9plus. This data will have a header and a cast number. If the plunger is left pushed in, the Searam operates until the memory is full or the batteries are drained.
- When the plunger is pulled out, no power is supplied to the 9plus and the Searam enters a low power mode. The plunger must be pulled out for storage, setup, diagnostic tests, and to transmit data.

4.2 Memory

The number of samples the Searam memory can store can be estimated:

Number of samples recorded = M ÷ B × W

Memory life = number of samples recorded ÷ sample rate

where:

M = memory size

B= bytes per word = 3

W = number of words stored per sample = 10 - number frequence of words suppressed - number of voltage words suppressed.

Example

Make an estimate of sample capacity and sample life for a Searam with no auxiliary and the full data rate of 24 Hz.

W = 10 - 2 frequency words suppressed - 4 voltage words suppressed = 4 words (C, T, D, and Modulo)

number of samples recorded = 16,000,000 ÷ (3 × 4) = 1,333,333

memory life = 1,333,333 ÷ (24 Hz × 3600 seconds per hour) = 15 hours.

With all channels (at 10 words per sample) stored, the Searam has approximately 6 hours of memory life at the full data rate of 24 Hz. Note that the actual rate is 24 Hz ÷ number of samples to average.

4.3 Data standard

The Searam receives setup commands and transmits recorded data through a 3-wire RS232 connection. The manufacturer has configured communication for 9600 baud, 8 data bits, 1 stop bit, no parity.

4.4 Batteries

The Searam is shipped from the manufacturer with 12 NiMH batteries installed. The current draw in this low power mode is less than 50 µA. The unit enters a low power mode when the plunger is pulled out, or when it is in standby mode for more than 2 minutes.

An A/D converter monitors the batteries for shutdown in the case of battery failure. All of the data in the non-volatile memory is saved.

The user can connect an auxiliary power source to the Searam to test and to transmit data.

Verify that the Searam turns on and communicates before a deployment. Install SeatermAF and other components supplied by the manufacturer on a PC.

1. Double-click on SeasoftV2.exe to install the software.
2. Connect the I/O cable to the 4-contact bulkhead connector and a PC.
3. Double-click on SeatermAF.exe. The first time the software is used, a setup window shows.
4. Select "SBE 17plus V2 SEARAM with SBE 9plus" from the dropdown menu.
5. Select the serial port. Push **OK**.
6. In the window that shows, select **Configure** and select "SBE 17plus with SBE 9plus."
7. Select the *SEARAM Battery & Firmware* tab. Select the type of battery installed in the Searam (nickel-cadmium "Ni-Cad" is no longer supported.)
8. Select 1.6 or greater in the "Firmware Version" dropdown.
9. Push **OK.**
10. Push **Connect SEARAM**. The display shows:
    ```
    SBE 17plus version 2 SEARAM 1.6
    S>
    ```
11. Push **Status** in the toolbar to see the status information:
    ```
    S>ds
    SBE17plus version 2 SEARAM V1.6 05/12/2020 12:30:43 batt
    type=NiMH
    ncasts = 7 samples = 22128 free bytes = 16771072
    number of frequency channels suppressed = 0
    number of voltage channels suppressed = 0
    number of scans averaged = 1
    primary conductivity advanced 0 scans
    secondary conductivity advanced 0 scans
    Auto fire not armed
    S>
    ```
12. Enter **QS** ("quiescent state"), then **Enter** to put the Searam in low power mode.

The Searam is ready to configure and deploy.

5.1 SeatermAF main window

This information applies to step 6, Set up and test on page 11.

The main window has four basic areas:

- Menus at the top of the window.
- 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 window 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 Searam.

Table 4 Toolbar button descriptions

Button	Description	Equivalent command
Connect SEARAM	Start communications with Searam. Response is S> prompt.	**Enter** key

Table 4 Toolbar button descriptions (continued)

Status	Show current status of Searam	**DS**
Headers	Information about cast number, date and time, number of samples in a cast, etc. Each cast has new header information.	**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	**MMDDYY= HHMMSS=**
Initialize Logging	Reset data pointers and cast numbers. Start data collection after stored data has been transmitted from Searam.	**SampleNum=0**
Capture	Look at and save Searam responses to a file with a .cap extension. Helps for diagnostics. Push **HHMMSS=Capture** again to turn off this function.	—
Upload	Get data from Searam in the format post-processing software can use. Be sure to pull out the switch plunger first to stop data collection, and use the **Configure** menu to set upload and header parameters. Then push **Upload**.	**DC**
Program	Send auto fire information entered under the **Configure** menu to the Searam. Make sure to send this before deployment so the auto fire functions correctly.	—
Arm	Enable 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 Searam. Tests do not write over current settings.	**DS, VR, Flash Map**
Stop	Stop the current process.	**Esc** key or **Ctrl C**
Disconnect	Release the PC serial port that communicates with the Searam.	—
Cancel	Stop the current process.	—

5.2 SeatermAF configuration options

This information applies to step 7 in Set up and test on page 11. There are six tabs on this window:

- Setup File
- Communication Setup
- Bottle Closure Logic
- Bottle Closure Pressures
- Upload & Header Options
- SEARAM Battery & Firmware

Settings for Communication Setup and SEARAM Battery & Firmware are necessary to set up and test the Searam. Other settings can be entered just before deployment.

5.2.1 *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 Searam to calculate pressure from the 9plus 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 and SBE 3 and SBE 4 serial numbers.

5.2.2 *Communication Setup* tab

Select the "Serial port" used by the connected PC to communicate with the Searam.

Baud rate default = 9600.

Data bits default = 8.

Parity default = none.

5.2.3 *Bottle Closure Logic* tab

The Searam closes bottles at selected pressures on the upcast. The Auto Fire parameters calculate when the upcast starts after the Searam is at the bottom.

If there is a check at "Bottom bottle closure enabled" the bottom bottle closes and upcast starts when the Searam 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 Searam is outside these parameter values, the Searam 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 Searam 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 Searam 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 Searam did not go as deep as specified.

Examples, based on:

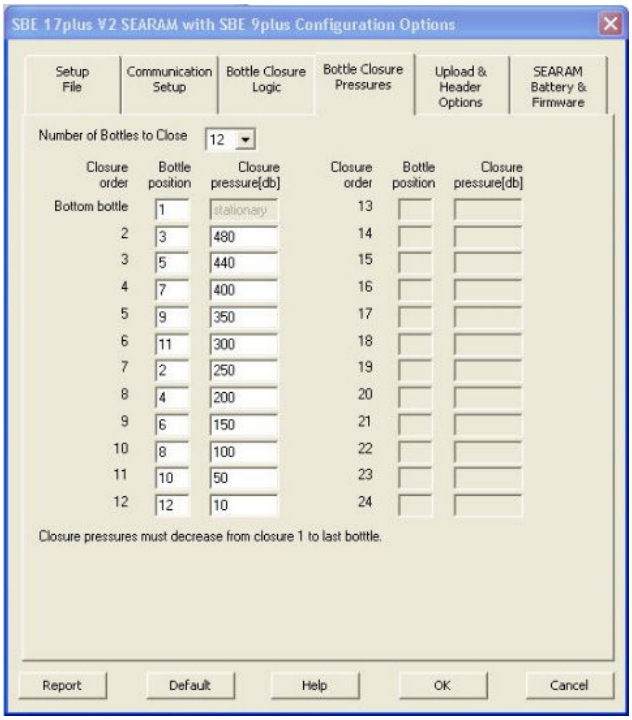
- Pressure to enable bottom bottle—500 dbar
- Pressure decrease to determine upcast—15 dbar
- Stationary time on bottom, 1–12 minutes—5
- Bottom pressure window in 1–25 dbar—10

1. Bottom bottle closure enabled: 9plus descends to 550 db (>500 db) and stays in 10 db range for 10 minutes. After 5 minutes the Searam closes the bottom bottle.
2. Bottom bottle closure enabled: 9plus descends to 450 db (<500 db) and stays in 10 db range for 10 minutes. Bottom bottle does not close. 9plus starts to ascend. When pressure decreases by 15 db to 435 db, Searam closes bottom bottle and any other bottles set to close at 435 db.
3. Bottom bottle closure disabled: 9plus descends to 550 db (>500 db), then starts to ascend. The Searam closes the first bottle at the specified pressure.
4. Bottom bottle closure disabled: 9plus descends to 450 db (<500 db), then starts to ascend. When pressure decreases by 15 db to 435 db, Searam closes any bottles set to close at depths below 435 db.

5.2.4 *Bottle Closure Pressures* tab

Bottles can be set to close in any order. The closure pressure must decrease from the first closure to the last.

Select the total number of bottles to close, then the "Bottle position" and the "Closure pressure." For example:



5.2.5 *Upload and Header Options* tab

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

In the Upload options for CTD data upload file area, there are five options.

- "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.

Push **Configure Header Form** to enter information about a deployment such as latitude, longittude, date, name of ship, etc.

In the Header options for CTD data upload area, select one of three options for header information.

- "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.

5.2.6 *Battery and Firmware* tab

Select either "Alkaline" or "Nickel Metal Hydride (NiMH)" battery type. Note that the battery holders are specific to the type and are not compatible. Alkaline batteries cannot be used in the NiMH holder and NiMH batteries cannot be used in the alkaline battery holder. Nickel-cadmium (NiCad) batteries are not supported.

The Searam turns off power when the alkaline battery voltage is less than 10.3.

The Searam turns off power when the voltage is less than 10.8, *or* when the voltage is less than 12 and the voltage drop is more than 0.2 V/minute. The Searam goes into low power mode when the first cell in the battery pack is drained.

Select the appropriate "Firmware Version," typically 1.6 or greater unless the system is old.

5.3 Test SBE 32 Carousel water sampler

Test the Carousel before deployment to make sure it responds to commands and that the firing mechanism works correctly. The **CO** command lets the user supply power to the Carousel but not collect data. **#XXX**, where **XXX** is any valid Carousel command, lets the user send commands to the Carousel through the Searam. All Carousel commands must be UPPER CASE.

1. Connect the Carousel to the Searam.
2. Connect the Searam to the PC, start SeatermAF and configure it for the Searam (refer to SeatermAF details for information about setup.
3. In SeatermAF, push **Connect SEARAM** on the Toolbar.
4. Enter **CO**, then push **Enter** to turn on power from the Searam to the Carousel.
5. Enter **#SR**, then push **Enter** to send the reset command to the Carousel.
6. To manually simulate sequential bottle firing, enter **#SF**, then push **Enter**. Do this as many times as necessary.
7. To manually simulate bottle fire in a user-specified sequence, enter **#SNx**, then push **Enter**. Do this as many times as necessary.
   x = bottle position number in ASCII. The first bottle position is 1.

Position	Command	Position	Command
1	#SN1	13	#SN=
2	#SN2	14	#SN>
3	#SN3	15	#SN?
4	#SN4	16	#SN@
5	#SN5	17	#SNA
6	#SN6	18	#SNB
7	#SN7	19	#SNC
8	#SN8	20	#SND
9	#SN9	21	#SNE
10	#SN:	22	#SNF
11	#SN;	23	#SNG
12	#SN<	24	#SNH

8. **Important!** Enter **CF** to turn off Searam power to the Carousel.
   If this command is not sent, the Searam batteries will drain.
9. Optional: The Carousel can be tested with a variable pressure source to simulate ocean pressure during downcast and upcast. **Do not use pressures greater than the rated depth of the 9plus pressure sensor. That will cause damage to the pressure sensor.**

Section 6 Deployment and recovery

6.1 Deployment

Set the date and time. Configure the memory, auto fire parameters, and auto fire for a deployment. The Searam can record 9plus data at the same time it is transmitted real-time through the 11plus Deck Unit. This gives a data back-up in case there are data transmission problems over the sea cable.
If the Searam will be externally powered, install the SBE 17 junction box: connect the box to the 4-contact cable and to the serial port of the PC. Connect AC mains power and push the red power button to supply power to the Searam. The junction box supplies approximately 17 volts.

1. Connect the Searam to a PC and start the SeatermAF software. Refer to SeatermAF configuration options on page 12 for details about the settings.
2. Push **Connect SEARAM** on the Toolbar to put the Searam in standby mode to send commands.
   The `S>` prompt shows.
3. Set up the Searam and the 9plus.
4. Set the date and time in the Searam.
5. Push **Status** on the Toolbar to verify the setup.
6. Select *SBE 17plus V2 Searam with SBE 9plus* in the **Configure** menu.
7. Make the necessary selections in the *Bottle Closure Logic* and *Bottle Closure Pressures* tabs.
8. Push **OK** to exit the **Configuration Options** window.
9. Push **Program** on the Toolbar to send the bottle closure information from the **Configuration Options** window to the Searam. SeatermAF sends a number of commands to the Searam and transmits the bottle closure parameters to the Searam.
10. Push **Closure Parameters SEARAM** on the Toolbar to verify the auto fire parameters were entered and transmitted correctly to the Searam.
11. Push **Arm** on the Toolbar to enable the Searam to command the Carousel to take water samples.

6.2 Recovery

⚠WARNING

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

⚠WARNING

If the user thinks that the 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 very SLOWLY loosen the bulkhead connector to release the pressure. Keep away from heat, sparks, flame, and other sources of ignition. Do not smoke.

⚠WARNING

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

1. Flush the Searam with fresh water.
2. Transmit data to the PC.
   If the batteries are drained, charge them or install new batteries or connect the Searam to an external power supply.
3. Remove the dummy plug from the I/O bulkhead and install the I/O cable to the Searam and to the serial port of the PC.
4. Start the SeatermAF software.
5. In the **Configure** menu, select *SBE 17plus V2 SEARAM with 9plus.*
6. In the **Configuration Options** window, select the *Upload & Header Options* tab. Refer to Upload and Header Options tab on page 14 for details about configuration options.
7. Push **Connect SEARAM** on the Toolbar. The display shows:
   ```
   SBE 17plus version 2 SEARAM 1.6
   S>
   ```
8. Push **Status** to see the Searam status information.
9. If necessary, pull the switch plunger to stop data collection.
10. Push **Upload** on the Toolbar.
    a. SeatermAF sends status (**DS**) and header (**DH**) commands, and shows the responses that give information about the number of samples and casts in memory.
    b. In the **Open** window, enter the file name to use, then **OK**. SeatermAF automatically adds a 3-digit cast number from 000–999 for each cast to the user-selected file name.
11. Use SBE Data Processing to look at the data and make sure it has all been transmitted from the Searam.
12. To prepare the Searam for the next deployment, send Erase Memory, SampleNum=0, or CastNum=0 to erase all of the data and set the data pointers and cast numbers to zero.
13. Store or deploy the Searam:
    - Send **QS** to put the Searam into low power mode.
    - Push the switch plunger in to start data collection.

Section 7 Process data

The SBE Data Processing software lets the user convert .hex files into engineering units, edit data, calculate derived variables, and make plots of the processed data.
The software uses a bottle confirm bit in the data file of the Searam to make a separate water bottle file. This lets the user compare the data with a physical test of the water bottle samples.

Data from the Searam is processed in three main steps.

1. Data conversion, where the raw .hex file from the 9plus is converted to a .cnv file and the raw .hex file from the water bottles is converted to a .ros file. The .ros file contains the 9plus data for 1.5 seconds after each bottle fires, and additional data for a user-selected range of scans before and after each bottle fires.
2. Bottle Summary, where the .ros file is converted to a .btl file that includes:
   - bottle position, optional bottle serial number, date and time.
   - user-selected derived variables, calculated for each bottle from mean values of input variables.
   - user-selected averaged variables, calculated for each bottle from input variables.
3. Additional changes to .cnv data. Align, filter, edit, calculate derived variables, make plots of the data.

7.1 Convert data

Some users want to edit the raw .hex file before it is processed, to remove "soak time" data at the start of the file, or edit the header, or to add notes about the cast.

The manufacturer recommends that the user first convert the data to a .cnv file with the other SBE Data Processing software modules, and then edit the .cnv file. **Edits to the .hex file can corrupt the data so that it cannot be processed further with the SBE software.**

1. Start the software and in the **Run** menu, select *Data Conversion*. Select the *File Setup* tab.
2. The Program setup file area is the location in which all of the File Setup and Data Setup information is stored.
   - Push **Open** to select a different file.
   - Push **Save** or **Save As** to save the current settings.
   - Push **Restore** to set all settings to the last saved version.
3. In the Instrument configuration file area:
   - Push **Select** to select a different .xmlcon or .con file.
   - Push **Modify** to look at or change the .xmlcon or .con file.
   - Put a check in "Match instrument configuration to input file" for the software to find the .xmlcon or .con file with the same name and in the same directory as the data file.
   - Put a check in this box if more than one data file will be processed, AND the data files have different configuration files.
4. In the Input directory:
   - Push **Select** to get the .hex file to convert. Hold the Ctrl key down to select more than one file.
5. In the Output directory:
   - If more than one file is to be processed, the "Output file" field goes out of view and the output file name is set to be the same as the input file name.
   - The user can enter additional information such as a date or cruise number in the "Name append" field. If, for example, test.hex and test1.hex are processed with

an appended name of 11-20-21, the output files will be test11-20-21.cnv and test111-20-21.

6. In the **Data Conversion** window, select the *Data Setup* tab.
7. At "Process scans to end of file":
   - Put a check in the box to process all scans.
   - Do not put a check in the box if there is a specific number of scans to process.
   - Enter the number of scans to skip, if any.
   - Select the "Output format": ASCII (larger file), or binary (smaller file, processed faster.)
   - At "Convert data from" select upcast, downcast, or both.
8. At "Create file types" select data only, bottle file only, or both.
9. At "Source of scan range data" select Scans marked with bottle confirm bit.
10. At "Scan range offset" and "Scan range duration," calculate the scans from the 9plus data file that will be included in the bottle file. Offset is the first scan output to the .ros bottle file for each bottle in relation to the first scan with the bottle confirm bit. Duration is the number of scans transmitted to the .ros bottle file for each bottle. Example: Data is stored in Searam at full rate of 24 scans/second. Confirmation bit is set from scan 10,000 for 1.5 seconds. If the offset is -2 seconds and duration is 5 seconds:
    10,000 - 2 second offset × 24 scans/second = 9,952

    9,952 + 5 second duration × 24 scans/second = 10,072

    So scans 9,952 through 10,072 will be written to the .ros file.
11. At "Merge separate header file" put a check in the box to replace the current header in the input file with the header in .hdr file.
12. Push **Select Output Variables**.
    A new window shows for the user to select the variables to convert. The user can add, change, insert, or delete variables that will be added to both the .cnv and .ros files.
13. At Source for start time in output .cnv header select either the time stamp of the first data scan in the Searam, or the time from the PC at the first scan, or the time that the data was transmitted from the Searam.
14. Push **Start Process.**
    Conversion of .hex data to .cnv format starts. The status field at the bottom of the *File Setup* tab shows "Processing complete" when the conversion is complete.
15. Go back to SBE Data Processing window:
    - If *Confirm Program Setup Change* was selected in the **Options** menu, the software prompts you to save changes.
    - If that option was not selected, the button shows **Save and Exit.**
    - Push **Cancel** to exit and not save changes.

7.2 Data storage

Data is stored 3 bytes per 9plus word, except for pressure (4 bytes). When transmitted, binary data is converted to ASCII hex and a carriage return (<CR>) line feed (<LF>) is sent after the last byte in the sample. When no frequency or voltage channels are suppressed, data is stored in the Searam as shown below.

Use the Data Conversion module in the SBE Data Processing software to convert the ASCII hex data to a frequency or voltage.

Searam	Sensor
bytes 0-2	frequency channel, primary temperature
bytes 3-5	frequency channel, primary conductivity
bytes 6-9	frequency channel, pressure
bytes 10–12	frequency channel, secondary temperature
bytes 13–15	frequency channel, secondary conductivity
byte 16	voltage channel 0, 8 MSBs
byte 17	voltage channel 0, 4 LSBs 4-7; voltage channel 1, 4 MSBs 0-3
byte 18	voltage channel 1, 8 LSBs
byte 19	voltage channel 2, 8 MSBs
byte 20	voltage channel 2, 4 LSBs 4-7; voltage channel 3, 4 MSBs 0-3
byte 21	voltage channel 3, 8 LSBs
byte 22	voltage channel 4, 8 MSBs
byte 23	voltage channel 4, 4 LSBs 4-7; voltage channel 5, 4 MSBs 0-3
byte 24	voltage channel 5, 8 LSBs
byte 25	voltage channel 6, 8 MSBs
byte 26	voltage channel 6, 4 LSBs 4-7; voltage channel 7, 4 MSBs 0-3
byte 27	voltage channel 7, 8LSBs
byte 28	pressure sensor temperature MSBs
byte29	4 LSB = 9plus status for pump, bottom contact, water sampler bottle confirm bit, modem 4 MSB = pressure sensor temperature LSBs
byte 30	modulo count, EOI line asserted

When frequency or voltage channels are suppressed, the suppressed bytes are shown below.

Channel type	Number of channels suppressed	Bytes suppressed
Frequency	1	13-15
	2	10-15
Voltage, 2 channels per word	2	25-27
	4	22-27
	6	19-27
	8	16-27

Example: Stored data for a CTD-only system (no secondary or auxiliary sensors) has 2 frequency channels and 8 voltage channels suppressed—

Searam	Sensor
byte 0-2	primary temperature
byte 3-5	primary conductivity
byte 6-9	pressure

byte 10	pressure sensor temperature LSBs
byte 11	4 LSB = 9plus status, 4 MSB = pressure sensor temperature LSBs
byte 12	modulo count, EOI line asserted

7.3 Data formats

The 9plus and Searam data is different in several ways.

- The Searam changes the order of the data.
- The Searam takes out 9plus bytes 31–36, which are unused and marker bytes, and any unused frequency or voltage channels.
- The Searam overwrites the bottle confirm bit from the 9plus to record each Carousel bottle closure. The 9plus only sets the bottle confirm bit when it is used with a G.O. 1015 rosette, not with a SBE 32 Carousel. The Searam sets the bit high for 1.5 seconds to record each closure.
- 9plus data transmitted from the Searam is in a .hex file. Real-time 9plus data collected through an 11plus Deck Unit with Seasave software is either a .dat file (versions older than 6.0), or a .hex file (versions equal to or newer than 7.0).

7.3.1 Data format 1: Unconverted temperature and conductivity frequency

ASCII hex data = 6 characters c1,c2,c3,c4,c5,c6

In the Data Processing software:

- Convert ASCII hex data to decimal = d1,d2,d3,d4,d5,d6
- Ave < 8
- Calculate—
  p = 288000 × number of samples averaged

  nr = d1 × 256 + d2 × 16 + d3

  nz = d4 × 256 + d5 × 16 + d6

  frequency = nz × 6912000 ÷ (p + nr - nrFromPreviousScan)

Example:
ASCII hex data sample 0 = 1AE3B5

ASCII hex data sample 1 = 2C33B5

number of samples to average = 2

sample 0:

d1 = 1, d2 = 10, d3 = 14

d4 = 3, d5 = 11, d6 = 5

nr = (1 × 256) + (10 × 16) + 14 = 430

nz = (3 × 256) + (11 × 16) + 5 = 949

sample 1:

d1 = 2, d2 = 12, d3 = 3

d4 =3, d5 = 11, d6 = 5

nr = (2 × 256) + (12 × 16) + 14 = 430

nz = (3 × 256) + (11 × 16) + 5 = 949

frequency sample 1 = 949 × 6912000 ÷ [(288000 × 2) + 707 - 430] = 11382.525 Hz

7.3.2 Data format 2: Unconverted pressure frequency

ASCII hex data = 8 characters c1,c2,c3,c4,c5,c6,c7,c8

In the Data Processing software:

- Convert ASCII hex data to decimal = d1,d2,d3,d4,d5,d6,d7,d8
- Ave < 8
- Calculate standard resolution—
  p = 288000 × number of samples averaged
  nr = d1 × 4096 + d2 × 256 + d3 × 16 + d4
  nz = d5 × 4096 + d6 × 256 + d7 × 16 + d8
  frequency = nz × 6912000 ÷ (p + nr - nrFromPreviousScan)

Example:
ASCII hex data sample 0 = 004510B5
ASCII hex data sample 1 = 00AB10B4
number of samples to average = 3
sample 0:
d1 = 0, d2 = 0, d3 = 4, d4 = 5
d5 = 1, d6 = 0, d7 = 11, d8 = 5
nr = (0 × 4096) + (0 × 256) + (4 × 16) + 5 = 69
nz = (1 × 4096) + (0 × 256) + (11 × 16) + 5 = 4277
sample 1:
d1 = 0, d2 = 0, d3 = 10, d4 = 11
d5 =1, d6 = 0, d7 = 11, d8 = 4
nr = (0 × 4096) + (0 × 256) + (10 × 16) + 11 = 171
nz = (1 × 4096) + (0 × 256) + (11 × 16) + 4= 4276
frequency sample 1 = 4276 × 6912000 ÷ [(288000 × 3) + 171 - 469] = 34203.962 Hz

In the Data Processing software:

- Calculate high resolution—
  p = 1152000 × number of samples averaged
  nr = d1 × 4096 + d2 × 256 + d3 × 16 + d4
  nz = d5 × 4096 + d6 × 256 + d7 × 16 + d8
  frequency = nz × 27648000 ÷ (p + nr - nrFromPreviousScan)

Example:
ASCII hex data sample 0 = 034510B5
ASCII hex data sample 1 = 15AB10B4
number of samples to average = 3
sample 0:
d1 = 0, d2 = 3, d3 = 4, d4 = 5
d5 = 1, d6 = 0, d7 = 11, d8 = 5
nr = (0×4096) + (3×256) + (4×16) + 5 = 837
nz = (1×4096) + (0×256) + (11×16) + 5 = 4277
sample 1:
d1 = 1, d2 = 5, d3 = 10, d4 = 11
d5 =1, d6 = 0, d7 = 11, d8 = 5
nr = (0×4096) + (5×256) + (10×16) + 11 = 5547
nz = (1×4096) + (0×256) + (11×16) + 4= 4276
frequency sample 1 = 4276 × 27648000 ÷ [(1152000 × 3) + 837 - 5547] = 34254.684Hz

7.3.3 Data format 3: Modulo word

ASCII hex data = 6 characters c1,c2,c3,c4,c5,c6

In the Data Processing software:

- Convert ASCII hex data to decimal = d1,d2,d3,d4,d5,d6
- Calculate—
  m0 = d1 × 16 + d2

  m1 = d3 × 16 + d4

  m2 = d5 × 16 + d6

  m0 and the first four bits of m1 is the pressure sensor temperature compensation information. m2 is the modulo count increment.

Example:
ASCII hex data = A500C7

d1 = 10, d2 = 5, d3 = 0, d4 = 0, d5 = 12, d6 = 7

m0 = (10 × 16) + 5 = 165

m1 = (0 × 16) + 0 = 0

m2 = (12 × 16) + 7 = 199

7.3.4 Data format 4: Voltages, two 12-bit A/D channels

ASCII hex data = 6 characters c1,c2,c3,c4,c5,c6

In the Data Processing software:

- Convert ASCII hex data to decimal = d1,d2,d3,d4,d5,d6
- Calculate—
  N(a) = d1 × 256 + d2 ×16 +d3

  N(b) = d4 × 256 +d5 + 16 + d6

  V(a) = 5[1 - (N(a) ÷ 4095)] volts

  V(b) = 5[1 - (N(b) ÷ 4095)] volts

Example:
ASCII hex data = 4510B6

d1 = 4, d2 = 5, d3 = 1, d4 = 0, d5 = 11, d6 = 5

N(a) = (4 × 256) + (5 × 16) + 1 = 1105

N(b) = (0 × 256) + (11 × 16) + 5 = 181

V(a) = 5[1 - (1105 ÷ 4095)] = 3.651 volts

V(b) = 5[1 - (181 ÷ 4095)] = 4.779 volts

7.3.5 Data format 5: Converted temperature, conductivity, or pressure frequency

ASCII hex data = 6 characters c1,c2,c3,c4,c5,c6

In the Data Processing software:

- Convert ASCII hex data to decimal = d1,d2,d3,d4,d5,d6
- Ave >/= 8
- Calculate—
  frequency = d1 × 4096 + d2 × 256 + d3 × 16 + d4+ (d5 ÷ 16) + (d6 ÷ 256)

  One byte with the value 0 comes after the converted pressure frequency.

Example:
ASCII hex data = 4510B6

d1 = 4, d2 = 5, d3 = 1, d4 = 0, d5 = 11, d6 = 5

frequency = (4 × 4096) + (5 × 256) + (1 × 16) + 0 + (11 ÷ 16) + (5 ÷ 256) = 17680.707 Hz

7.4 Frequency limits

To prevent internal overflow when the Searam averages frequency data (**Ave**, number of scans to average), limits are put on the maximum sensor frequency.

Format type 1

Maximum output frequency is less than or equal to (4095 × # of 9plus samples per second) ÷ **Ave**.

Frequencies up to 14,040 Hz can work with **Ave** = 7, and higher frequencies will work with smaller values of **Ave**. The manufacturer's temperature and conductivity sensors have frequency output in the range of 2800 to 12000 Hz.

Format type 2 and type 5, standard resolution Digiquartz

Maximum output frequency is less than or equal to (65535 × # of 9plus samples per second) ÷ **Ave**.

Frequencies up to 65535 Hz can work with **Ave**up to 24, which is sufficient to acquire higher frequencies up to 42000 Hz that the Paroscientific Digiquartz® pressure sensors supply. For a 9plus that does *not* use a Digiquartz sensor, frequencies up to 16384 Hz will work with an **Ave** = 96 (maximum value for this parameter).

Format type 5, high resolution Digiquartz

Maximum output frequency is less than or equal to (39768 × # of 9plus samples per second) ÷ **Ave**.

7.5 Bottle summary

In the SBE Data Processing software, select the **Run** menu, then *Bottle Summary*, then the *Data Setup* tab. The input files for the bottle summary are the .ros file and the .xmlcon or .com file.

If there is a .sn file in the input file directory, the bottle serial numbers are added between the bottle position and the date and time columns in the .btl file output.

If the user puts a check in "Output min/max values for averaged variables," the minimum and maximum values will show for each bottle.

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

Push **Select Derived Variables** to select the variables that are derived from the input data.

Oxygen: Ignored if oxygen is not calculated in derived variables.

⚠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.

8.1 Corrosion precautions

Make sure to rinse all of the sensors and flush the SBE 9plus system with fresh water after each deployment and before it is put in storage.

Aluminum pressure housing

The pressure housing is insulated from the stainless steel cage and sea cable power circuits, which prevents corrosion. Do not attach metal objects to the pressure housing. All stainless steel screws that are exposed to salt water have a molybdenum lubricant (Blue Moly™) that has nickel powder and zinc oxide in it. After each cruise, remove these screws and apply more lubricant to them. Note that this lubricant is electrically conductive. Make sure it does not get on circuit boards.

The 9 plus has three large zinc anodes attached to the top end flange of the pressure housing. Make sure they are secure and have no corrosion. Replace the zinc anodes when there is less than 50% remaining.

Remove the stainless steel hose clamps and PVC mounting brackets annually to clean the entire surface of the pressure housing. The manufacturer recommends that the user replace the clamps at regular intervals. Apply Teflon™ tape or equivalent between the clamps and the anodized pressure housing.

Titanium pressure housing

No corrosion precautions are required, but do not let different types of metal contact the titanium pressure housing.

Attached sensors and auxiliary equipment

The temperature, conductivity, and auxiliary sensors from the manufacturer that have an aluminum pressure housing also have a zinc anode ring. Make sure to look at the anodes at regular intervals to make sure they are secure and have no corrosion.

The CTD power and signal common lines can be connected to the pressure housings of auxiliary sensors. Do not connect the auxiliary sensor housings to the 9 plus 15 V power supply. This can cause damage to the conductivity cell electrodes.

8.2 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 very SLOWLY loosen the bulkhead connector to release the pressure. Keep away from heat, sparks, flame, and other sources of ignition. Do not smoke.

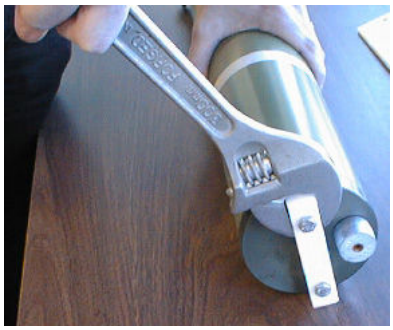
⚠CAUTION

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

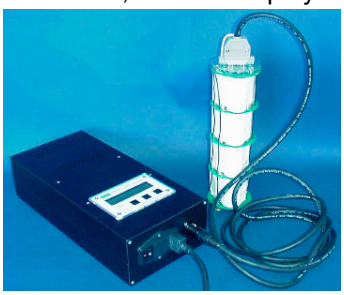
- Put on protective eye wear before you open the pressure housing.
- Any electrostatic charge on the body of the human operator must be released before the pressure housing is opened: put a hand on a grounded surface, or better, wear a grounded antistatic wrist strap.
- At a minimum, wear short-sleeved antistatic clothing, such as cotton, or better, wear an antistatic smock for this service activity. *Do not wear a sweater, fleece or polyester-based clothing.*
- At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. *Do not use a workstation with a synthetic or polymeric-based tabletop.*

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

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



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



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

8.3 Replace alkaline batteries

⚠WARNING

Explosion hazard. If the batteries are not installed correctly, explosive gases can be released. Make sure that the batteries are of the same approved chemical type and are inserted in the correct orientation.

⚠WARNING

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

⚠CAUTION

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

- Put on protective eye wear before you open the pressure housing.
- Any electrostatic charge on the body of the human operator must be released before the pressure housing is opened: put a hand on a grounded surface, or better, wear a grounded antistatic wrist strap.
- At a minimum, wear short-sleeved antistatic clothing, such as cotton, or better, wear an antistatic smock for this service activity. *Do not wear a sweater, fleece or polyester-based clothing.*
- At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. *Do not use a workstation with a synthetic or polymeric-based tabletop.*

NOTICE

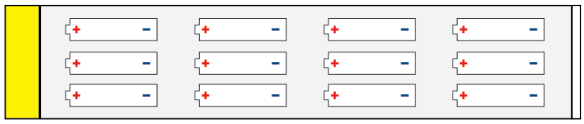
Blue Moly™ and Dow Corning®4 lubricants are electrically conductive. Keep away from electrical components.

The instrument uses 12 Duracell® MN1300, LR20 D-cell alkaline batteries.

Remove the batteries if the sensor will be stored for longer than 3 months. Store batteries at a temperature between 5 °C and 30 °C.

1. Remove the battery end flange (opposite the end with connectors):
   a. Clean the outside of the end flange and the housing. Make sure all parts are dry.
   b. Remove the three flat Phillips-head screws from the end of the 16plus V2.
   c. Pull firmly on the plastic bracket to remove the end flange. It may be necessary to turn the end flange or use a tool that will not cause damage to the plastic housing to loosen the end flange.
   d. Use a lint-free cloth or tissue to remove any water from the O-ring surfaces inside the housing.
   e. Make sure to protect the O-ring from damage or contamination.
2. Remove the three Phillips-head screws and washers from the green battery cover-plate inside the housing.
   a. Turn the battery pack over and remove the batteries.
   b. Install new batteries with the + terminals up. Refer to the marks on the side of the battery pack.

3. Turn the sensor over and remove the batteries.
4. Install new batteries. Make sure the polarity is correct.



5. Install the cover on the battery pack again:
   a. The cover fits onto the battery pack only one way: one screw hole is closer to the edge than the others, which aligns with the post that is closest to the housing.
   b. Push hard on the battery cover to compress the spring contacts and install the three Phillips-head screws and washers again.
   c. Tighten the cover completely, or power to the sensor will be intermittent.
   d. Use the **BAT +** and **BAT -** contacts to verify that the battery voltage is approximately 13.5 volts.
6. Carefully install the end flange again:
   a. Make sure there is no water on any surface.
   b. Connect the Molex connectors.
   c. The O-rings must be pristine. Apply a small quantity of Parker Super O-Lube on any new O-rings, then carefully install the new ones.

d. Carefully push the end flange into the housing until it is against the O-rings.
e. Install the three flat Phillips-head screws in the sensor end flange.

8.4 Examine O-rings

NOTICE

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

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

1. Dry the O-rings and O-ring grooves with a lint-free cloth or tissue.
2. Examine each O-ring to make sure there is no damage, dirt, lint or hair on it.
3. Replace an O-ring if necessary.
4. Apply a small quantity of silicone-based Parker Super O Lube® or Dow Corning® high vacuum grease to each O-ring.
   - The lubricant helps the O-ring move into its groove with no twist, which can compromise the seal.
   - Do NOT use petroleum-based lubricants on any O-ring.

8.5 Clean bulkhead connectors

NOTICE

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

Damaged connectors can cause damage to the sensor and make it unserviceable.

Use silicone-based lubricants only.

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

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

Any corrosion.		
Cracks, scratches, or other damage on the rubber pins or in the sockets.		

Separation of the rubber from the pins.	
Swelled or bulging rubber pins.	

6. Use a silicone-based lubricant on each of the contacts of the bulkhead connector. The manufacturer recommends any of the products listed below.

   - 3M™ Spray Silicone Lubricant (3M ID# 62-4678-4930-3). Make sure to let it dry.
   - Dow Corning Molykote® III Compound (DC III)
   - Dow Corning High Vacuum Grease® (DC 976 V)
   - Dow Corning 4 Electrical Insulating Compound® (DC 4)
   - Dow Corning Molykote 44 High Temperature Grease® (DC 44)

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

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

8.6 Spare parts and accessories

Part number	Description	Quantity
801512	NiMH battery pack, 12-cell rechargeable	
90900s	NiMH battery charger, AC power cord, charging cable	
801206	MCIL4FS to DB9S data I/O cable, Searam to PC, 8'	
801421	MCIL4FS to DB9S data I/O cable, Searam to PC, 66'	
20200.0	USB to serial port adapter	
50328	Spares kit, aluminum Searam	
	171398 MCDC4F dummy plug	
	171498 MCDC6F dummy plug	2
	171796 MCIL6FS to MCIL6FS, 13", Searam to 9plus	
	172025 MCBH4M connector, I/O	
	172026 MCBH6M connector, Carousel or 9plus	
	23155.1 switch plunger	

	30044 anode, 1"	
	41124 battery compartment cover plate	
	50051 small hardware and O-ring kit (details below)	
	50092 jack screw kit (details below)	
50051	small hardware and O-ring kit	
	30072 O-ring, 2-017 for hulkhead connector	
	30080 O-ring, 2-204 for switch assembly	
	30090.0 O-ring, 2-153 for battery end flange	
	30815 O-ring, 2-233 for connector end flange	
	30816 O-ring, 2-234, battery end flange radial seal	
	30145 Phillips head machine screw, 6-32x½" for battery end plate	
	30154 Phillips head machine screw, 8-32x3/8" for ground strap	
	30162 flat head machine screw, 8-32x7/8" for Searam switch to housing	
	30164 Phillips head machine screw, 8-32x1 1/8" for connector end flange	
	30236 #8 nylon washer for ground strap	
	30242 #6 flat washer for battery end plate	
	30267 #8 screw insulator, ½"	
	30362 nylon nut stop, 6-32 for boardset to end flange	
50092	jack screw kit	
	30515 set screw, nylon tip, ¼-20x1"	
	30520 hex wrench, 1/8"	
	30530 hex wrench, 3/16"	
	30526 cap screw, ¼-20x¾"	

Section 9 Reference: command descriptions

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

- Commands are not case-sensitive. Push **Enter** to store a command. Enter DS for general status, and CP for auto fire status to verify that the command is valid
- The Searam sends `? CMD` if a command is invalid.
- If the Searam does not send `S>` after a command is executed, push **Enter** to get the `S>` prompt.
- The sensor will go into a low power mode if no command is sent for 2 minutes. Select *Connect Searam* in the toolbar or push **Enter** for `S>`.
- Commands with an asterisk (*) change the Searam memory. Each command must be verified to prevent accidental changes. After the command is entered, the Searam sends `This command will clear the memory, enter the command again.` Enter the command again and push **Enter**.
- Brackets [ ] identify optional command parameters and do not need to be entered.
- Use *Upload* on the toolbar or the **Upload** menu to transmit data to be processed by the SBE Data Processing software. Use of the **DC** command does not supply data with the header information that is required by the SBE Data Processing software.
- Enter ^C or push **Esc** to stop data transmission. Push **Enter** to see the `S>`prompt.

9.1 Status

DS	Show status

`S>`**ds**

MMDDYY=, HHMMSS=, BatteryType=	`SBE17plus version 2 SEARAM V1.6 05/12/2018 17:09:16 batt type = NIMH`
SF=	`Number of frequency channels suppressed = 0`
SV	`Number of voltage channels suppressed = 0`
Ave=	`Number of scans averaged = 1`
AC0=	`Primary conductivity advanced 0 scans`
AC1=	`Secondary conductivity advanced 0 scans`
Arm or **Disarm**	`Auto fire not armed`

CP	Show bottle closure parameters. Equivalent to *Closure Parameters SEARAM* on software toolbar.
	auto fire status (armed or not armed)
	pressure coefficients
	bottom bottle closure status
	bottom bottle time, minutes
	bottom pressure window, db
	pressure to enable upcast, db
	pressure change to enable upcast, db
	number of bottles enabled
	bottle closure sequence and pressures

9.2 SBE 17plus setup

MMDDYY	Set real-time clock month, day, year. Must be followed by HHMMSS= to set time. mmddyy and ddmmyy are equivalent
DDMMYY	Set real-time clock month, day, year. Must be followed by HHMMSS= to set time. mmddyy and ddmmyy are equivalent
HHMMSS	Set real-time clock hour, minute, second. hhmmss is equivalent.
Baud=x	x=baud rate for communication with PC, 300, 600, 1200, 2400, 4800, 9600, or 38400. Must be the same as SeatermAF baud rate, set in **Configuration** menu
BatteryType=x	x=nimh: set to NiMH.
SampleNum=0* or CastNum=0	Either command sets data pointers and cast number to 0 and starts dat collection. Make sure to transmit stored data to a PC first. When the switch plunger is pushed in, data collection starts immediately. If the switch is pushed in after SampleNum=0 or CastNum=0 is sent, all stored data is overwritten. Data collection stops when the switch is pulled out. When the plunger is pushed in again, data collection continues, with new data saved after the stored data, with a new header. Up to 100 casts can be taken, or until memory is full.
Erase Memory	Erase all data from Searam. All data bits are set to 1. Sample number, header number, and data pointers are set to 0. This is optional because the Searam overwrites stored data when SampleNum=0 or CastNum=0 are sent.
QS	Quit session and put Searam in low power mode. The Searam automatically goes into low power if no command is sent for 2 minutes.

Notes:

- Alkaline batteries supply up to 18 V and can cause damage to auxiliary sensors, such as ECOs, which are limited to 15 V.
- If SampleNum=0 or CastNum=0 is sent accidentally, do the steps below to get the stored data:
  1. Send **CastNum=x**, where x is the estimate of the number of casts in memory.
  2. Send **DH** to see the headers. if the number of casts is overestimated, all headers after the valid ones will be invalid or have sample numbers that do not agree with the stored headers. Send **CastNum=x** again, with the correct number of casts.
  3. Send **SampleNum=y**, where y is calculated from the valid header information and is (last sample number + 1).
  4. Transmit the data. If **SampleNum** is more than the actual number of samples in memory, those values are invalid and can be erased.

9.3 SBE 9plus setup

Ave=x	x=number of 9plus samples to average, 1–96. Set the number of samples to average to 12, for example, for a rate of 2 Hz.
SF=x	x=number of frequency channels to suppress in Searam. These channels store temperature (T), conductivity (C), and pressure (P) data. P and primary T and C cannot be suppressed. Secondary T and C can be suppressed. x=0: SBE 3 or 4 connected to JB5, dual redundant sensor configuration. x=1: SBE 3 or 4 connected to JB4, no use of JB5, single redundant sensor configuration. x=2: No redundant sensors.

SV=x	x=number of voltage channels to suppress in Searam: x=0, 2, 4, 6, or 8. These channels store data from auxiliary sensors such as, pH, altimeters, fluorometers, etc. the 9plus has 4 voltage words. Each has data from two 12-bit A/D channels (8 total). The Searam can suppress voltage channels above the highest numbered channel used. JT2, AUX1 uses channels 0 and 1 JT3, AUX2 uses channels 2 and 3 JT5, AUX3 uses channels 4 and 5 JT6, AUX4 uses channels 6 and 7
AC0=x	x=number of samples, 0–3, to advance primary conductivity from primary temperature in Searam, to align the data. The conductivity measurement on a water parcel comes after temperature. Since the pumps operates at a constant flow speed, the interval is constant. To compute salinity with minimum spikes, Searam synchronizes the conductivity measurement with the appropriate temperature measurement before samples are averaged, so there is no bias error in salinity that is calculated when transmitted data is processed. For most applications the correct setting is 2 samples (default) (approximately 0.073 seconds × 24 samples/second). For full rate (24 Hz) data, time misalignment can be corrected in the data processing software.
AC1=x	x=number of samples, 1–3, to advance secondary conductivity from secondary temperature in Searam to align conductivity and temperature data.
Fx	Turn Searam power to 9plus on or off without the switch plunger. This command does not start data collection. x=O: turn on power to 9plus. x=F: turn off power to 9plus.

9.4 SBE 32 Carousel setup

All commands to the Carousel must be in UPPER CASE.

CX	Turn Searam power to Carousel on or off without the switch plunger. This command does not start data collection. X=O: turn on power to Carousel X=F: turn off power to Carousel
#XXX	Relay character string to Carousel. Refer to the Carousel manual for a list of commands.

Make sure to arm the Carousel before deployment to enable the Carousel to take water samples. The 9plus can collect samples and transmit data to the Searam whether the Carousel is armed or disarmed.

ARM	Enable auto fire to close bottles. Equivalent to "Arm" on the toolbar of the software.
DISARM	Disable auto fire

9.5 Diagnostics

BV	Show main battery voltage
BI	Show main battery current, amps
VR	Continuously show power for main battery voltage and operation current. Searam turns on power to the 9plus and Carousel. Total current draw for the Searam, 9plus, and Carousel shows. Push **Esc** to stop test.
TestEE	Test EEPROM
Flash Initialize*	Memory test. **All data in the Searam is erased**. This test identifies any bad data blocks in memory so Searam does not store data in them. This test takes approximately 20 minutes and cannot be stopped once it is started.
Flash Map	Show the results from Flash Initialize. Push **Esc** to stop at any time.

Section 10 General information

⚠WARNING

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

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

10.1 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.

10.2 Warranty

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

10.3 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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