SBE 17*plus* V2 SEARAM

Memory and Auto Fire Module for SBE 9plus CTD

Note:
New address (mid-January 2010; check website for exact date)
13431 NE 20th Street
Bellevue, WA 98005 USA

User's Manual

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

Manual Version #009, 12/30/2009
Firmware Version 1.6
SBE Data Processing Version 7.20a and later

Limited Liability Statement

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

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Table of Contents

Section 1: Introduction

This section includes contact information, Quick Start procedure, and photos of a standard SEARAM shipment.

About this Manual

This manual is to be used with the SBE 17*plus* V2 SEARAM memory and auto fire module. It is organized to guide the user from installation through operation and data collection. We have included detailed specifications, command descriptions, maintenance information, and helpful notes throughout the manual.

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

Quick Start

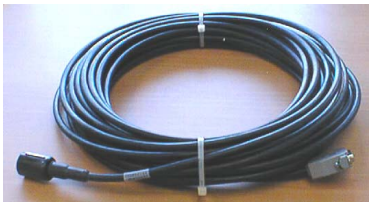
Follow these steps to get a Quick Start using the SEARAM.
The manual provides step-by-step details for performing each task:

1. Perform pre-check procedures:
   A. Test Power and Communications (see *Power and Communications Test* in *Section 3: Preparing SEARAM for Deployment).*
2. Deploy the SEARAM:
   A. Set the time and date, set memory and auto fire parameters, and program and arm the auto fire (see *Setup for Deployment* and *Command Descriptions* in *Section 4: Deploying and Operating SEARAM*).
   B. Replace the I/O cable with the dummy plug and locking sleeve, and verify all other cables and hardware are secure (see *Deployment* in *Section 4: Deploying and Operating SEARAM*).
   C. Deploy the system.

Unpacking SEARAM

Shown below is a typical SEARAM shipment.

SBE 17plus V2 SEARAM



Data I/O cable
(connection to computer serial port)

9*plus* /SEARAM cable
(connection to SBE 9*plus*)

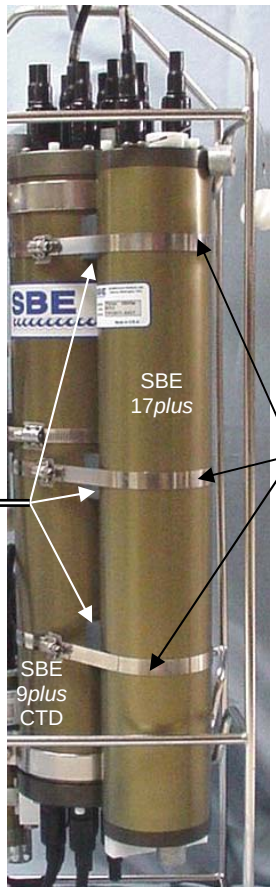
4-pin dummy plug
& locking sleeve

Carousel/SEARAM cable
(optional, connection to
SBE 32 Carousel Water Sampler)

6-pin dummy plug
& locking sleeve
(2 of each)

Spare magnetic
switch plunger

Jackscrew Kit



Mounting Kit (shown installed on 17*plus*); kit also
includes Teflon tape for preventing contact of
stainless steel clamps to aluminum housing

NiMH battery charger, battery pack, battery
charger cable, & AC power cable

Spare fuses (2) for
NiMH battery charger –
stored in compartment
inside charger

Spare o-ring &
hardware kit

Spare battery end
cap o-ring &
hardware kit

SEARAM User Manual

Software, & electronic
copies of software
manuals & user manual

Section 2: Description of SEARAM

This section describes the functions and features of the SBE 17*plus* V2 SEARAM, including specifications and dimensions.

System Description

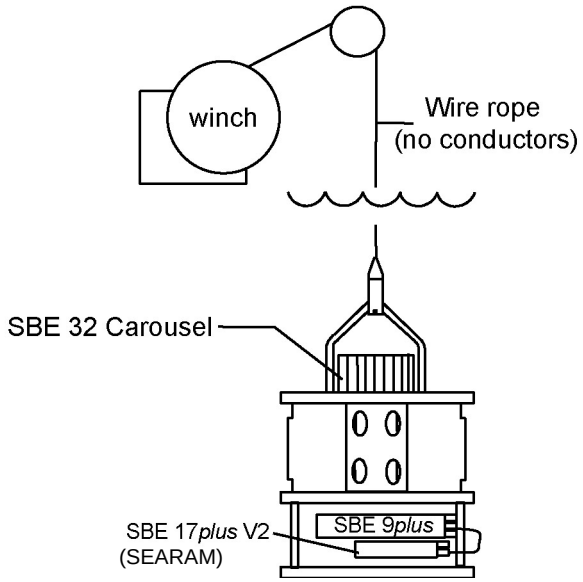
Notes:
- When the 9*plus* CTD is used with the 17*plus* V2 SEARAM, the system is often referred to as the **917*plus***.
- It is possible to use the SEARAM to record 9*plus* data in memory at the same time as 9*plus* data is transmitted real-time through the 11*plus* V2 Deck Unit. This provides a data back-up in case there are data transmission problems over the sea cable. See the 9*plus* manual for wiring and deployment details.

The SBE 9*plus* CTD is used with the SBE 11*plus* V2 Deck Unit for real-time data acquisition, or with the SBE 17*plus* V2 SEARAM for in-situ recording. **This manual covers the use of the 17*plus* V2 SEARAM with the 9*plus*.**

The SBE 17*plus* V2 SEARAM is an *in-situ* battery pack and data recorder for use with the **SBE 9*plus* CTD** underwater unit when an electrical cable and slip ring equipped winch is not available. The SEARAM supplies power to the SBE 9*plus*. The serial data stream from the SBE 9*plus* is decoded and optionally averaged by the SEARAM, allowing the user to trade memory duration for CTD resolution. Unused channels are stripped out, further increasing memory duration, and the resulting data is stored in non-volatile memory in the SEARAM for later retrieval and analysis.

The SEARAM also powers and operates the **SBE 32 Carousel Water Sampler** to close water sample bottles on upcast. Using the pressure data from the SBE 9*plus* and a user-input table of bottle closure pressures, the SEARAM signals the SBE 32 to close a bottle. Built-in logic and user-input parameters provide control in determining when the upcast begins, preventing accidental bottle closure caused by temporary upward movements during the downcast. A bottle confirm bit is set in the 9*plus* data stream stored in the SEARAM to mark scans associated with each bottle closure.

Notes:
- Winch and cable are not supplied by Sea-Bird.
- When used without a Carousel, the 9*plus* is deployed in a vertical orientation.
- Standard and optional auxiliary sensors for the 9*plus* are not shown.
- A 9*plus* with optional serial data uplink cannot be used with the SEARAM.



The SEARAM is mounted parallel to the SBE 9*plus* main housing. Nickel Metal Hydride (rechargeable, standard), Nickel-Cadmium (rechargeable, optional), or alkaline batteries provide power. The SEARAM's non-volatile memory preserves recorded data in the event of failure or exhaustion of the main battery pack. A low power *watch* crystal is used as the real-time-clock frequency source. An external magnetic reed switch plunger allows recording to be started and stopped without hooking up a terminal or computer to the SEARAM.

The standard SEARAM shipment includes:

- 16M byte of non-volatile FLASH RAM, providing memory endurance of over 6 hours at the full data rate of 24 Hz with all channels stored
- Aluminum housing, for depths to 6800 meters (22,300 feet)
- Mounting kit
- Nickel Metal Hydride (NiMH) rechargeable batteries in a removable battery pack, and battery charger and associated cables
- Short jumper cable (6-pin to 6-pin) for connection to the SBE 9*plus* SEARAM/modem bulkhead connector
- 20 meter data I/O cable for connection to the computer for setup and data upload

SEARAM options/accessories include:

- Titanium housing for use to 7000 or 10500 meters (23,000 or 34,400 feet)
- Wet-pluggable MCBH connectors in place of standard glass-reinforced epoxy connectors
- AC-powered junction box for supplying external power to the SEARAM for testing
- Rechargeable Ni-Cad battery pack and charger
- Cable (6-pin to 6-pin) for connection to the SBE 32 Carousel Water Sampler 6-pin connector

The SEARAM is supplied with a powerful Windows 2000/XP software package, SEASOFT V2, which includes:

- **SeatermAF** - terminal program for easy communication and data retrieval.
- **SBE Data Processing** - program for calculation, display, and plotting of temperature, conductivity, pressure, auxiliary sensor data, and derived variables such as salinity and sound velocity.
- **Seasave V7** –program for converting and displaying real-time (not applicable to SEARAM) or archived raw data.

Notes:

- Help files provide detailed information on the software.
- A separate software manual on CD-ROM contains detailed information on SBE Data Processing and Seasave V7.
- Sea-Bird also has an older version of Seasave, Seasave-Win32. However, all Seasave instructions in this manual are written for Seasave V7. See Seasave-Win32's manual and/or Help files if you prefer to use the older software.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our FTP site. See our website (www.seabird.com) for the latest software version number, a description of the software changes, and instructions for downloading the software from the FTP site.

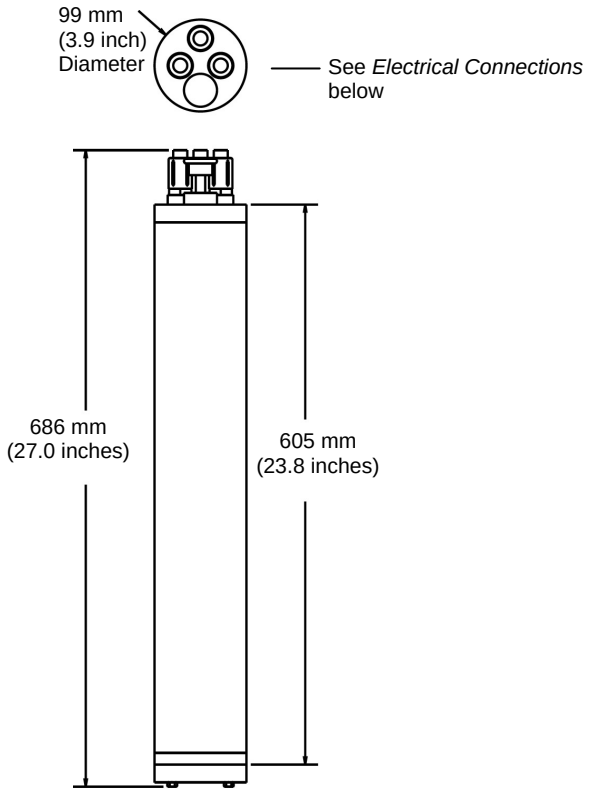
Specifications

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

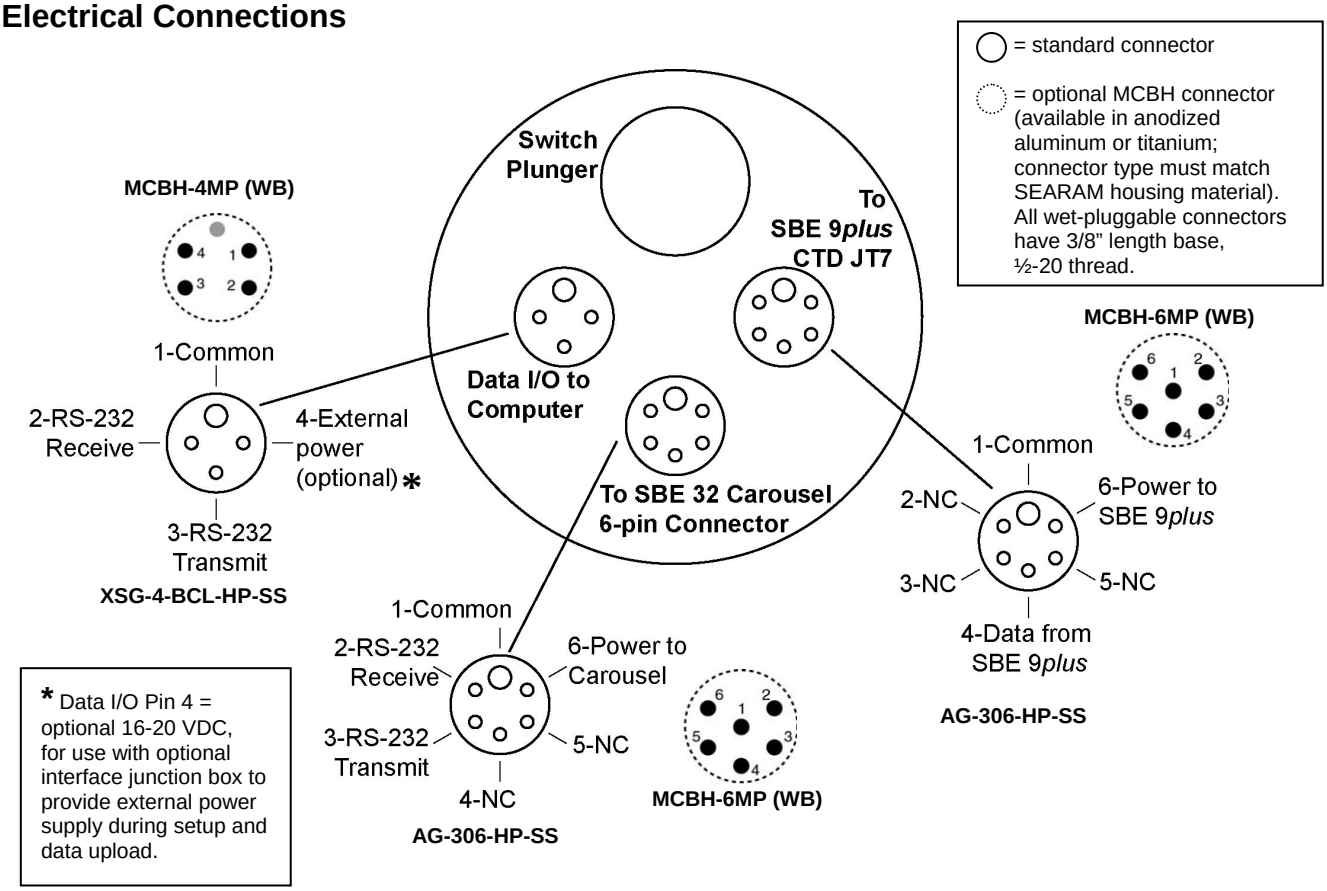
Memory	16M byte non-volatile FLASH RAM
Real-Time Clock	Watch-crystal type 32,768 Hz
Internal Batteries	*Standard*: 12 rechargeable, Nickel Metal Hydride (NiMH), D-cell batteries, nominal 8 amp-hours capacity. Provides sufficient energy to power a standard 9*plus* (without auxiliary sensors) for 10 hours, 9*plus* with auxiliary sensors for 7 hours. *Optional:* 12 alkaline D-cells or rechargeable Ni-Cad battery pack.
Housing Materials	*Standard*: 7075-T6 anodized aluminum pressure case rated at 6800 meters (22,300 feet), with zinc anode protection. *Optional*: Titanium pressure case rated at 7000 or 10500 meters (22,900 or 34,400 feet)
Interface	3-wire RS-232C link, factory-configured for 9600 baud, 8 data bits, 1 stop bit, and no parity
Weight (with standard aluminum housing)	In water: 4.5 kg (10 lbs) In air: 9.0 kg (20 lbs)

Dimensions

Note:
For the standard aluminum housing, the zinc anode projects 19 mm (0.75 inches) from the side of the connector end cap.



Electrical Connections



Magnetic Reed Switch Plunger

A plunger with a magnet is mounted to the top end cap. Pushing in the plunger closes a magnetic reed switch, signaling the CPU to power the SBE 9*plus* and record data. If the battery voltage is greater than the low power cut-off voltage (nominally 10 volts; depends on battery type) and there is room in memory for data, SEARAM supplies power to the 9*plus*, writes a header containing real time and cast number, and begins storing 9*plus* data in memory. When the plunger is pulled out, SEARAM removes power from the 9*plus* and enters its low power, quiescent (sleep) state. If the plunger is left pushed in, the SEARAM runs until the memory is filled or the batteries are used up.

The plunger must be pulled out when the SEARAM is not acquiring data from the SBE 9*plus*, i.e., during storage, setup, diagnostic tests, and data uploading.

Real-Time Clock

An independently-powered real-time clock provides a time stamp for each cast.

Memory

Note:
The SEARAM's full scan rate is 24 Hz. The actual scan rate is:
24 Hz / # of scans to average

(# of scans to average is set up with the **Ave=** command)

The SEARAM's standard memory is 16M byte. SEARAM sample capacity and memory endurance may be **estimated** by:

 # scans recorded (samples) = M / (B x W)
Memory endurance = # scans recorded/(scan rate)

where:
M = memory size
B = bytes per word = 3
W = # words stored per 9*plus* scan =
10 - # frequency words suppressed – # voltage words suppressed

Example: Estimate the sample capacity and memory endurance for a SEARAM with no auxiliary sensors and full rate data (24 Hz, **Ave=1**):

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

$$\text{\# scans recorded} = \frac{16{,}000{,}000}{(3 \times 4)} = 1{,}333{,}333$$

$$\text{memory endurance} = \frac{1{,}333{,}333 \text{ scans}}{24 \text{ Hz} \times 3600 \text{ seconds/hour}} = 15 \text{ hours}$$

With all channels (10 words per scan) stored, the SEARAM provides approximately 6 hours of memory endurance at the full data rate of 24 Hz.

Note:
Battery endurance for NiMH batteries is approximately 10 hours for a 9*plus* with no auxiliary sensors, or approximately 7 hours for a 9*plus* with auxiliary sensors. Memory endurance is longer at the full data rate of 24 Hz, as shown in the example. **To take full advantage of the memory endurance, recharge or replace the batteries between deployments, or provide external power.**

Data I/O

The SEARAM receives setup instructions and outputs diagnostic information or previously recorded data via a 3-wire RS-232C link, and is factory-configured for 9600 baud, 8 data bits, 1 stop bit, and no parity.
SEARAM RS-232 levels are directly compatible with standard serial interface cards (IBM Asynchronous Communications Adapter or equal).

Batteries

The SEARAM is shipped from the factory with the batteries installed, with the SEARAM in quiescent (sleep) state, drawing less than 50 microamps.

To preserve battery life, the SEARAM enters quiescent (sleep) state when:
- logging is halted by pulling out the switch plunger, or
- the SEARAM is not logging and more than 2 minutes has elapsed without receiving a command.

An internal A/D converter monitors the battery supply to permit orderly shut-down in the case of battery failure or exhaustion. The SEARAM's non-volatile memory retains all data in memory, regardless of battery failure or exhaustion.

Battery Pack

The standard battery pack consists of twelve NiMH, rechargeable, D-cell batteries. NiMH batteries are recommended for most applications.
An SBE 9*plus* without auxiliary sensors can typically operate in excess of 10 hours with NiMH batteries; a system with auxiliary sensors can typically operate for at least 7 hours.

A Ni-Cad, rechargeable, D-cell battery pack or alkaline D-Cell batteries can be substituted for the NiMH batteries.
- An SBE 9*plus* without auxiliary sensors can typically operate in excess of 6 hours with Ni-Cad batteries; a system with auxiliary sensors can typically operate for at least 4 hours.
- An SBE 9*plus* without auxiliary sensors can typically operate for approximately 12 hours with alkaline batteries, depending on temperature.

Back-Up Power

An auxiliary power source may be connected to the main I/O bulkhead to permit testing and data retrieval without affecting battery capacity.

Section 3:
Preparing SEARAM for Deployment

This section describes software installation and the pre-check procedure for preparing the SEARAM for deployment.

Software Installation

Note:
It is possible to use the SEARAM without SeatermAF by sending direct commands from a dumb terminal or terminal emulator, such as Windows HyperTerminal.

Sea-Bird recommends the following minimum system requirements for SEASOFT V2: Windows 2000 or later, 500 MHz processor, 256 MB RAM, and 90 MB free disk space for installation. Although SEASOFT V2 was designed to work with a PC running Win 2000/XP; extensive testing has not shown any compatibility problems when using the software with a PC running Windows Vista.

If not already installed, install SeatermAF and other Sea-Bird software on your computer using the supplied software

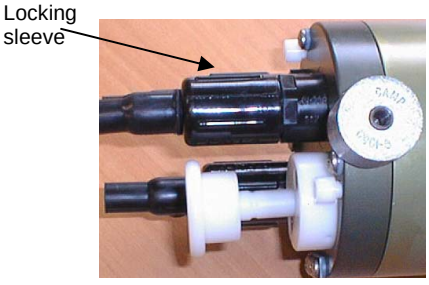
1. Insert the CD in your CD drive.

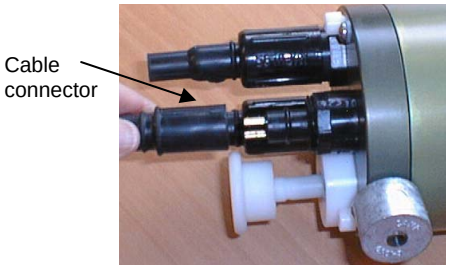
2. Double click on **SeasoftV2_*date*.exe** (*date* is the date that version of the software was created). Follow the dialog box directions to install the software. Install all the components, or as a minimum install SeatermAF (terminal program for setting up auto fire parameters), Seasave V7 (for viewing uploaded data), and SBE Data Processing (data processing).

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

Power and Communications Test

The power and communications test will verify that the system works, prior to deployment.





Setup

1. By hand, unscrew the locking sleeve from the I/O (4-pin) bulkhead connector. **If you must use a wrench or pliers, be careful not to loosen the bulkhead connector instead of the locking sleeve**.

2. Remove the dummy plug from the I/O bulkhead connector by pulling the plug firmly away from the connector.

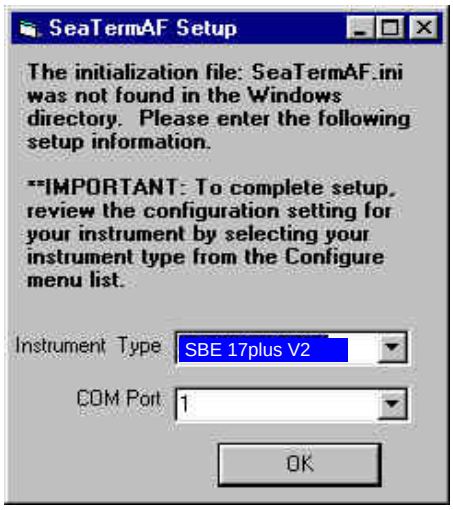
3. **Standard Connector** - Install the I/O cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the SEARAM. **OR**
MCBH Connector – Install the I/O cable connector, aligning the pins.

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

Test and Establish Operating Parameters

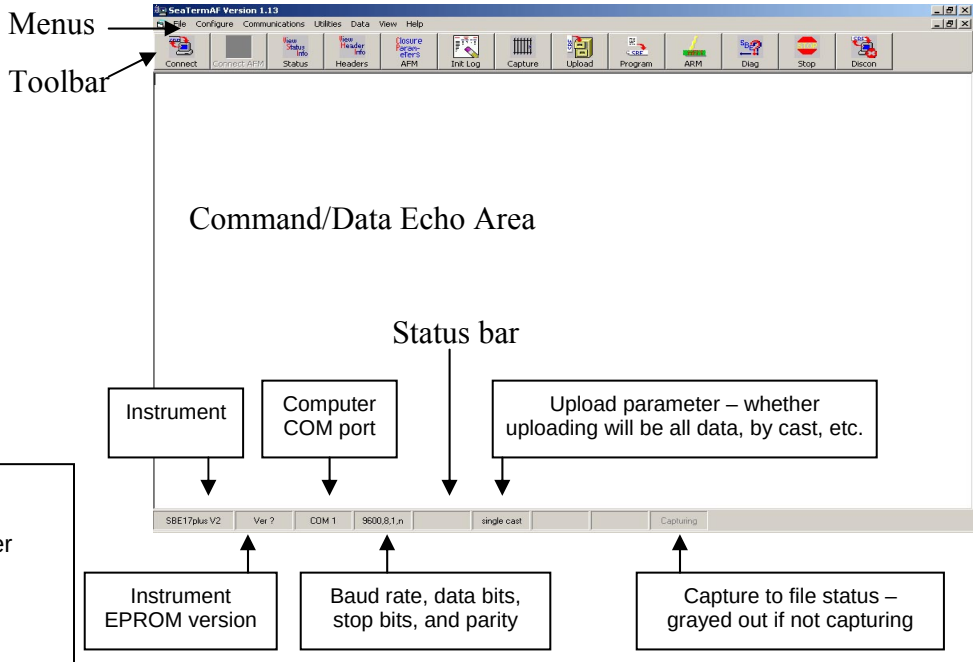
Notes:
- SeatermAF's initialization file, SeaTermAF.ini, includes information on the last instrument used when the program was closed, and the location of that instrument's settings (.ini) file. As a default, the instrument's .ini file is saved to the same directory as SeatermAF.exe.
- See SeatermAF's Help files for detailed information on the use of the program.

1. Double click on SeatermAF.exe. If this is the first time the program is used, the setup dialog box appears:



Select the instrument type (SBE 17plus V2) and the computer COM port for communication with the SEARAM. Click OK.

2. The main screen looks like this:



Note:
There is at least one way, and as many as three ways, to enter a command:
- Manually type command in Command/Data Echo Area.
- Use a menu to automatically generate a command.
- Use a Toolbar button to automatically generate a command.

Note:
To update Status bar:
- on the Toolbar, click Status; or
- from the Utilities menu, select Instrument Status.

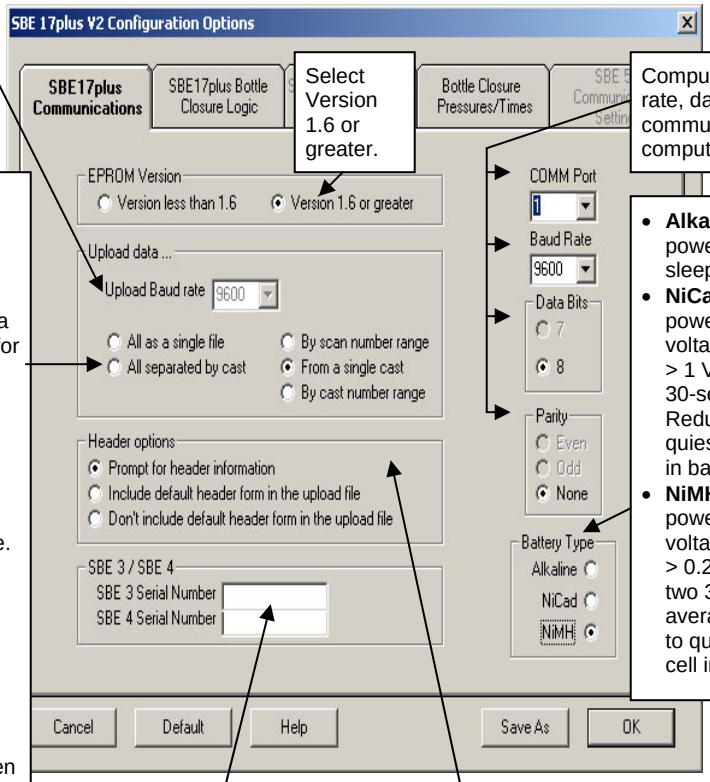
SeatermAF sends the status command, which displays in the Command/Data Echo Area, and updates the Status bar.

- Menus – Contains tasks and frequently executed instrument commands.
- Toolbar – Contains buttons for frequently executed tasks and instrument commands. All tasks/commands accessed through the Toolbar are also available in the Menus. To display or hide the Toolbar, select View Toolbar in the View menu.
- Command/Data Echo Area – Echoes a command executed with a Menu or Toolbar button, as well as the instrument's response. Additionally, a command can be manually typed in this area, from the available commands for the instrument. Note that the instrument must be *awake* for it to respond to a command (use the Toolbar's Connect button to wake up the instrument).
- Status bar – Provides status information. To display or hide the Status bar, select View Status bar in the View menu.

Toolbar Buttons	Description	Equivalent Command*
Connect	Re-establish communications with SEARAM. Computer responds with S> prompt. SEARAM *goes to sleep* after 2 minutes without communication from computer have elapsed.	(press Enter key)
Status	Display instrument status — provide information on instrument setup and current status.	**DS**
Headers	View data headers (cast number, date and time, number of samples in cast, etc.). A new header is generated for each 9*plus* cast.	**DH**
Closure Parameters AFM	Display all auto fire parameters and auto fire status.	**CP**
Init Log	Reset data pointers and cast numbers. This should be performed after existing data has been uploaded from SEARAM and prior to recording new data.	**SampleNum=0**
Capture	Capture instrument responses on screen to file; may be useful for diagnostics. File has .cap extension. Press Capture again to turn off capture. Capture status displays in Status bar.	**—**
Upload	Upload data from SEARAM, in format post-processing software can use. Before using upload: • Configure upload and header parameters in Configure menu. • Pull out switch plunger to stop logging.	**DC**
Program	Send auto fire information input in Configure menu to SEARAM. Must send this information before deployment for auto fire capability to function.	**—**
ARM	Enable auto fire algorithm to close bottles. Must arm SEARAM before deployment for auto fire capability to function.	**Arm**
Diag	Perform one or more diagnostic tests on SEARAM. Test(s) accessed in this manner are non-destructive – they do not write over any existing instrument settings.	**DS, VR, Flash Map**
Stop	Halt current command.	(press Esc key or Ctrl C)
Disconnect	Free computer COM port used to communicate with SEARAM. COM port can then be used by another program.	**—**

*See *Command Descriptions* in *Section 4: Deploying and Operating SEARAM*.

3. In the Configure menu, select SBE 17plus V2. The dialog box looks like this:



Baud rate for uploading data from SEARAM to computer (automatically set to same baud as for general communications).

Select Version 1.6 or greater.

Computer COM port, baud rate, data bits, and parity for communication between computer and SEARAM.

Defines data upload type when using Upload on Toolbar or Upload Data in Data menu:
- **All as single file** – All data uploaded into one file.
- **All separated by cast** – All data uploaded. Separate file written for each cast, with 3-digit cast ID (001, etc.) appended to user-selected file name.
- **By scan number range** – SeatermAF prompts for beginning and ending scan (sample) numbers, and uploads all data within range into one file.
- **From single cast** (default) – SeatermAF prompts for cast number, and uploads data from that cast into one file.
- **By cast number range** – SeatermAF prompts for beginning and ending cast numbers, and uploads data within range. Separate file written for each cast, with 3-digit cast ID (001, etc.) appended to user-selected file name.

- **Alkaline** – SEARAM turns off power (stops logging, goes to sleep) when voltage < 10.3 V.
- **NiCad** – SEARAM turns off power when voltage < 10.3 V *or* voltage < 15 V and voltage drop > 1 V/minute (calculated by two 30-second moving averages). Reduces battery load to quiescent current once first cell in battery pack is exhausted.
- **NiMH** – SEARAM turns off power when voltage < 10.8 V *or* voltage < 12 V and voltage drop > 0.2 V/minute (calculated by two 30-second moving averages). Reduces battery load to quiescent current once first cell in battery pack is exhausted.

Temperature and conductivity sensor serial numbers required for post-processing of data (SBE 3 and SBE 4 are sensors on 9*plus*). Enter these numbers **exactly** as they appear in configuration (.con) file.

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

Make the selections in the Communication and Upload Settings dialog box. Note that the SEARAM requires 8 data bits, no parity.

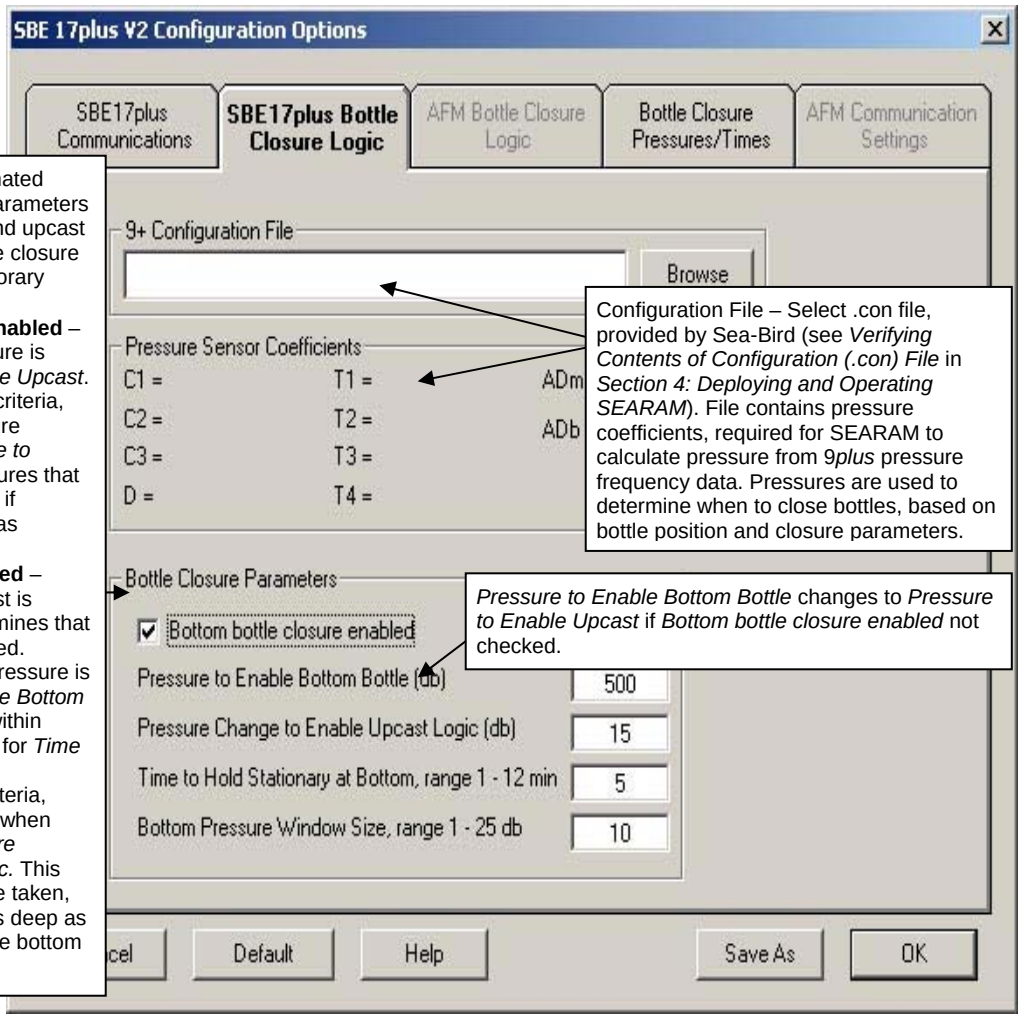
Note:
Only the Communication Settings (COMM Port, Baud Rate, Data Bits, and Parity) and Battery Type need to be entered to test communications. Upload Data, Header Options, SBE 3/4 Serial Numbers, and information on the SBE 17 Auto Fire and Bottle Positions and Closure Parameters tabs (Steps 4 through 6 below) are not needed to test communications. These items can be entered now, or can be entered just before deployment, if desired.

Note:
Seasave and SBE Data Processing versions 7.20a introduced .xmlcon files (in XML format). Versions 7.20a and later allow you to open a .con or .xmlcon file, and to save it to a .con or .xmlcon file. **However, SeatermAF is not currently compatible with a .xmlcon file; continue to use .con files with the SEARAM for compatibility with SeatermAF**.

4. Click the SBE 17plus Bottle Closure Logic tab. The dialog box looks like this:

SEARAM closes bottles at designated pressures on upcast. Auto Fire parameters define when bottom is reached and upcast begins, preventing incorrect bottle closure during downcast caused by temporary upward movement.

- **Bottom Bottle Closure not Enabled** – Upcast is enabled when pressure is greater than *Pressure to Enable Upcast*. If instrument never meets this criteria, upcast is enabled when pressure decreases by *Pressure Change to Enable Upcast Logic*. This ensures that water samples are taken, even if instrument did not go as deep as anticipated.
- **Bottom Bottle Closure Enabled** – Bottom bottle closes and upcast is enabled when SEARAM determines that bottom of cast has been reached. Bottom bottle is closed when pressure is greater than *Pressure to Enable Bottom Bottle*, and pressure remains within *Bottom Pressure Window Size* for *Time to Hold Stationary at Bottom*. If instrument never meets this criteria, SEARAM closes bottom bottle when pressure decreases by *Pressure Change to Enable Upcast Logic.* This ensures that water samples are taken, even if instrument did not go as deep as anticipated or did not stay at the bottom for as long as anticipated.



Configuration File – Select .con file, provided by Sea-Bird (see *Verifying Contents of Configuration (.con) File* in *Section 4: Deploying and Operating SEARAM*). File contains pressure coefficients, required for SEARAM to calculate pressure from 9*plus* pressure frequency data. Pressures are used to determine when to close bottles, based on bottle position and closure parameters.

Pressure to Enable Bottom Bottle changes to *Pressure to Enable Upcast* if *Bottom bottle closure enabled* not checked.

Make the selections in the dialog box.

These examples use the setup shown in the dialog box above, except as noted.

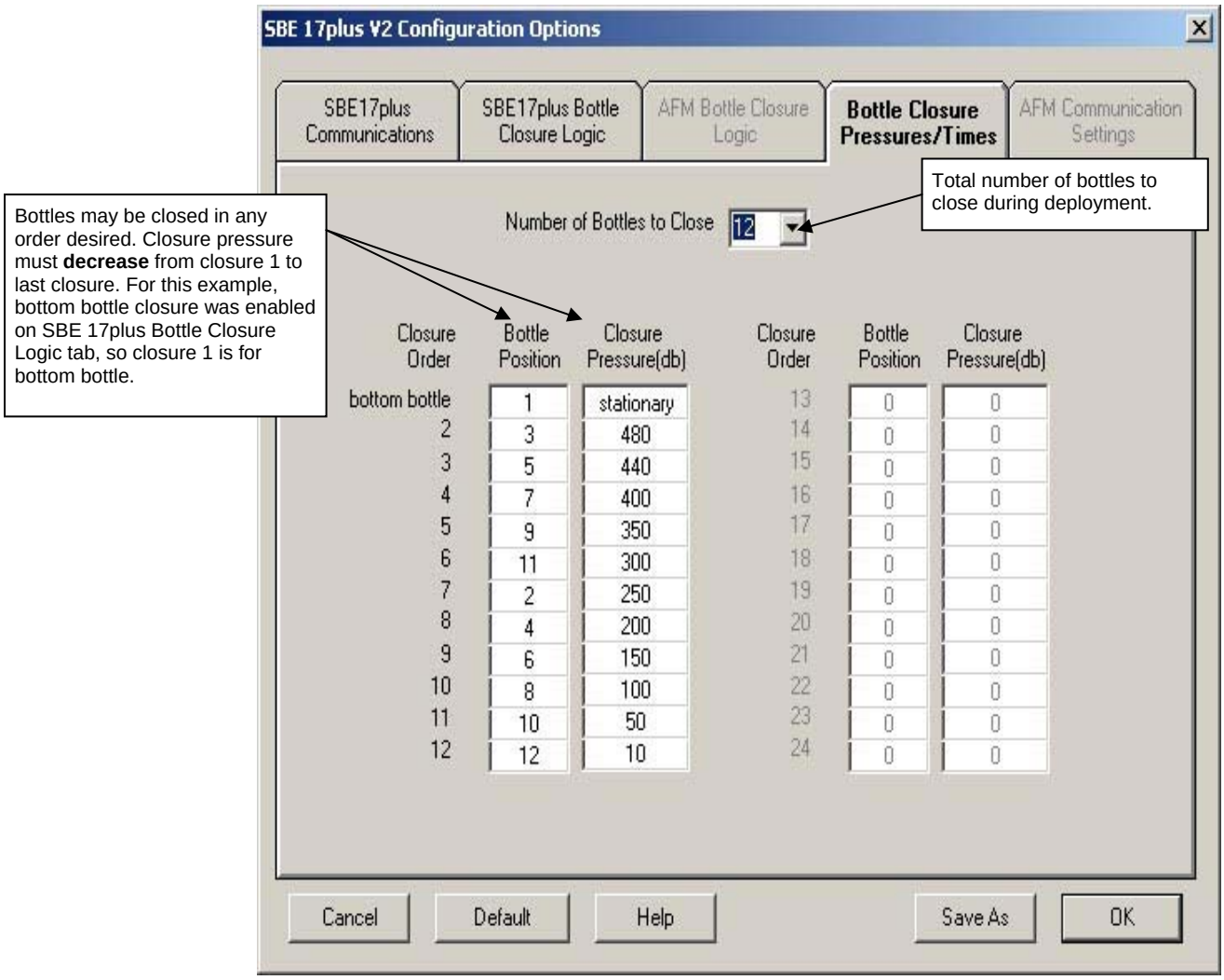
Example 1 – **Bottom Bottle Closure Enabled:** 9*plus* descends to 550 db (>500 db), and stays within 10 db window for 10 minutes. After 5 minutes, SEARAM closes bottom bottle.

Example 2 – **Bottom Bottle Closure Enabled:** 9*plus* descends to 450 db (<500 db), and stays within 10 db window for 10 minutes. Because it has not reached enable pressure (500 db), bottom bottle does not close. 9*plus* begins to ascend. When pressure decreases by 15 db to 435 db, SEARAM closes bottom bottle and any other bottles that were meant to close at depths below 435 db.

Example 3 – **Bottom Bottle Closure Disabled:** 9*plus* descends to 550 db (>500 db), begins to ascend. When it reaches pressure for first bottle to close, SEARAM closes first bottle.

Example 4 – **Bottom Bottle Closure Disabled:** 9*plus* descends to 450 db (<500 db), and begins to ascend. When pressure decreases by 15 db to 435 db, SEARAM closes any bottles that were meant to close at depths below 435 db.

5. Click the Bottle Closure Pressures/Times tab. The dialog box looks like this:



Make the selections in the dialog box. Click OK to overwrite an existing .ini file, or click Save As to save the file as a new filename.

6. Click Connect on the Toolbar. The display looks like this:

```
SBE 17plus version 2 SEARAM 1.6
S>
```

This shows that correct communications between the computer and the SEARAM has been established.

If the system does not respond as shown above:

- Click Connect again to attempt to establish communications.
- Check cabling between the computer and the SEARAM.
- Verify the correct instrument was selected and the COM settings were entered correctly in the Configure menu.

7. Display SEARAM status information by clicking Status on the Toolbar. The display looks like this:

```
S>ds
SBE17plus version 2 SEARAM V1.6 09/12/2004 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>
```

8. Command the SEARAM to go to sleep (quiescent state) by typing **QS** and pressing the Enter key.

The SEARAM is ready for programming and deployment.

Section 4: Deploying and Operating SEARAM

This section provides detailed command descriptions, data output formats, Carousel testing procedures, deployment instructions, and uploading and data processing instructions.

Command Descriptions

This section describes commands and provides sample outputs. Commands can be used in various combinations to provide a high degree of operating flexibility. Review the operation of the SEARAM and commands before setting up your system. See *Appendix III: Command Summary* for a summarized command list.

When entering commands:

Note:
Commands to the Carousel (typically used only if you are not using our software or for testing) must be input in UPPER CASE (capital letters).

- Input commands in upper or lower case letters and register commands by pressing the Enter key. Verify that the command was accepted by using the status commands (**DS** for general status, **CP** for auto fire status).
- The SEARAM sends `? CMD` if an invalid command is entered.
- If the system does not return an `S>` prompt after executing a command, press the Enter key to get the `S>` prompt.
- If a new command is not received within 2 minutes after completion of a command, the SEARAM returns to quiescent (sleep) state to prevent exhaustion of its batteries.
- **If in quiescent (sleep) state, re-establish communications by pressing Connect on the Toolbar or the Enter key to get an S> prompt.**
- Commands marked with ***** (* is not part of the command) alter the SEARAM's memory and require verification before executing, to prevent accidental modifications.
  After the command entry, the SEARAM responds:
  `This command will clear the memory, enter command again.`
  Type in the command again, and press the Enter Key.
- Braces [ ] indicate optional command parameters. Items in braces need not be entered.
- Use Upload on the Toolbar or Upload Data in the Data menu to upload data that will be processed by SBE Data Processing. Manually entering the data upload (**DC**) command does not produce data with the required header information for processing by our software.
- If the instrument is transmitting data and you want to stop it, type ^C or press the Esc key. Press the Enter key to get the `S>` prompt.

Status Commands

DS

Display operating status and setup parameters. List below includes, where applicable, command used to modify parameter.
Equivalent to Status on Toolbar.

- firmware version, date [**MMDDYY=** or **DDMMYY=**], time [**HHMMSS=**], battery type [**BatteryType=**]
- number of stored casts and samples, and available sample space in memory
- number of frequency channels to suppress [**SF=**]
- number of voltage channels to suppress [**SV=**]
- number of scans to average [**Ave=**]
- number of scans to advance primary conductivity [**AC0=**]
- number of scans to advance secondary conductivity [**AC1=**]
- auto fire status (armed or not) [**Arm** or **Disarm**]

Example: Display status (user input in bold).

```
S>ds
SBE17plus version 2 SEARAM V1.6 09/12/2004 17:09:16 batt type = NIMH      [MMDDYY=, HHMMSS=, BatteryType=]
Ncasts = 7  samples = 22128  free bytes = 16771072
Number of frequency channels suppressed = 0                                                    [SF=]
Number of voltage channels suppressed = 0                                                      [SV=]
Number of scans averaged = 1                                                                   [Ave=]
Primary conductivity advanced 0 scans                                                          [AC0=]
Secondary conductivity advanced 0 scans                                                        [AC1=]

Auto fire not armed                                                                [Arm or Disarm]
```

CP

Display bottle closure parameters. Equivalent to Closure Parameters AFM on 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

Example: Display bottle closure parameters (user input in bold).

```
S>CP
Auto fire armed
Pressure Coefficients:
C1 = -47027.81  C2 = -3.17762e-01  C3 = 1.41507e-02
D = 0.040116
T1 = 30.03788  T2 = -4.05515e-04  T3 = 4.15151e-06  T4 = 2.66753e-09
Adm = 0.011560  Adb = -7.898880

Bottom bottle closure enabled
Bottom bottle time 5
Bottom pressure window 20
Pressure to enable up cast 200
Pressure change to enable up cast 10
4 bottle(s) enabled for closure

   Sequence #      Bottle #   Closure Pressure
        1              1             200
        2              2             150
        3              3             100
        4              4              50
```

Notes:
- **DDMMYY=** and **MMDDYY=** are equivalent. Either can be used to set the date.
- **It is always necessary to set date and then time.** If a new date is entered but not a new time, the new date will not be saved. If a new time is entered without first entering a new date, the date will reset to the last date it was set for with **MMDDYY=** or **DDMMYY=**.
- If the SEARAM battery pack has been removed, date and time must be reset.

Note:
The SEARAM's baud rate (set with **Baud=**) must be the same as SeatermAF's baud rate (set in the Configure menu).

Note:
SampleNum=0 and **CastNum=0** do not delete the data; they just reset the data pointers and cast number. **If you accidentally send one of these commands before uploading**, recover the data as follows:
1. Send **CastNum=x**, where **x** is your estimate of the number of casts in memory.
2. Send **DH**, which displays the headers. If you overestimated the number of casts, all headers beyond the valid ones will be *garbage* or will have sample numbers that are inconsistent with the previous headers. If that occurs, send **CastNum=x** again, with the correct number of casts.
3. Send **SampleNum=y**, where **y** is determined from the valid **DH** output, and is (last sample number + 1).
4. Upload the data. If **SampleNum** is more than the actual number of samples in memory, data for the non-existent samples will be *garbage*. Review the uploaded data file and delete any *garbage* data.

General Setup Commands

MMDDYY=mmddyy Set real-time clock month, day, and year. Must be followed by **HHMMSS=** to set time.

DDMMYY=ddmmyy Set real-time clock day, month, and year. Must be followed by **HHMMSS=** to set time.

HHMMSS=hhmmss Set real-time clock hour, minute, and second.

Example: Set date and time to September 23, 2004 19:10:26 (user input in bold).

```
S>MMDDYY=092304
Setting date: 092304
S>HHMMSS=191026
04/23/2000 19:10:26
```

Baud=x **x**= baud rate for communication with computer and for uploading data (300, 600, 1200, 2400, 4800, 9600, 19200, or 38400).

BatteryType=x

x=nimh: Set battery type to NiMH. SEARAM turns off power (stops logging and goes to sleep) when voltage < 10.8 volts *or* voltage < 12 volts and voltage drop > 0.2 volt/minute (calculated by two 30-second moving averages). This reduces battery load to quiescent current (50 microamps) once first cell in battery pack is exhausted.

x=nicad: Set battery type to Ni-Cad. SEARAM turns off power (stops logging and goes to sleep) when voltage < 10.3 volts *or* voltage < 15 volts and voltage drop > 1 volt/minute (calculated by two 30-second moving averages). This reduces battery load to quiescent current (50 microamps) once first cell in battery pack is exhausted.

x=alkaline: Set battery type to alkaline. SEARAM turns off power (stops logging and goes to sleep) when voltage < 10.3 volts.

SampleNum=0 * or CastNum=0 *

Initialize logging. Use one of these commands to reset data pointers and cast number **after existing data has been uploaded from SEARAM** and prior to recording new data. Sending *either* command sets both **SampleNum** and **CastNum** to 0.

When switch plunger is pushed in, recording begins immediately. First time switch is pushed in after receipt of **SampleNum=0** or **CastNum=0**, recording starts at beginning of memory and any previously recorded data is written over, whether memory has been erased (see **Erase Memory**) or not. When plunger is pulled out, recording stops. Each time plunger is pushed in again, recording continues with new data stored after previously recorded data and a new header written to indicate time, date, incremented cast number, and sample numbers contained in cast. Up to 100 casts can be taken or until memory is full.

General Setup Commands (*continued*)

Erase Memory * Erase memory, **destroying all data in SEARAM**. All data bits are set to 1; sample number, header number, and data pointers are set to 0. Erasing memory is optional, as SEARAM writes over previously recorded information when **SampleNum=0** or **CastNum=0** is used. Knowledge of initial memory contents (i.e., all 1s) can be a useful cross check when data is uploaded.

QS Quit session and place SEARAM in quiescent (sleep) state. Main power is turned off; memory retention is unaffected.

Note:
SEARAM automatically enters sleep state after 2 minutes have elapsed without receiving a command.

SBE 9*plus* Setup Commands

Ave=x **x=** number of 9*plus* scans to average in SEARAM (1 - 96). Averaging reduces data storage requirements, but also reduces resolution.

Example: Set number of scans to average to 12, providing effective scan rate of 2 Hz (=24 Hz / 12) (user input in bold).

S>**AVE=12**

Notes:
For **Ave=**, **SF=**, and **SV=**:
- See *Data Output Formats* after these *Command Descriptions* for details on how these parameters affect data storage in the SEARAM.
- The 9*plus* configuration (.con) file must match these selections when processing uploaded data. View and edit the .con file in SBE Data Processing. Note that these parameters are factory-set to match the ordered instrument configuration.

SF=x **x=** number of 9*plus* frequency channels to suppress in SEARAM. Unused channels are not stored in memory, providing more data space. Frequency channels store temperature (T), conductivity (C), and pressure (P) sensor frequency output. P and primary T and C cannot be suppressed. Secondary T and C can be suppressed if desired.

x= 0: SBE 3 or 4 connected to JB5 on 9*plus* bottom end cap (dual redundant sensor configuration).

x= 1: SBE 3 or 4 connected to JB4 on 9*plus* bottom end cap and not using JB5 (single redundant sensor configuration).

x= 2: Not using redundant sensors.

SV=x **x=** number of 9*plus* voltage channels to suppress in SEARAM (**x** = 0, 2, 4, 6, or 8). Unused channels are not stored in memory, providing more data space. Voltage channels store output from auxiliary voltage sensors, such as dissolved oxygen, pH, altimeters, transmissometers, fluorometers, etc.

9*plus* has 4 voltage words; each word contains data from two 12-bit A/D channels (8 channels total). SEARAM can suppress voltage channels above highest numbered channel being used.

9*plus* Connector	Uses Channels
JT2 (AUX1)	0 and 1
JT3 (AUX2)	2 and 3
JT5 (AUX3)	4 and 5
JT6 (AUX4)	6 and 7

Example: 9*plus* has pH sensor connected to AUX2, with no other voltage sensors. With sensor connected to AUX2, channels 2 and 3 are used. Suppress channels 4 through 7 (4 channels) (user input in bold).

S>**SV=4**

Note that if sensor is connected instead to AUX1, channels 2 through 7 (6 channels) could be suppressed.

SBE 9*plus* Setup Commands (*continued*)

Note:
9*plus* systems with atypical flow paths (for example, supporting flow-through fluorometers) may require different settings. See the Align CTD module in the SBE Data Processing manual and Application Note 38 for calculation of optimal advance values.

AC0=x

x= number of 9*plus* scans (**x** = 0-3) to advance *primary* conductivity from *primary* temperature in SEARAM, to align conductivity and temperature data. Conductivity measurement on a water parcel is delayed because 9*plus* TC duct presents water to conductivity sensor after water has passed temperature sensor. Since pump sets a constant flow speed, delay is constant. To nullify delay so salinity can be computed with minimum spiking, SEARAM can advance conductivity measurement in time to coordinate it with appropriate temperature measurement. This advance occurs *before* any averaging, so a bias error is not introduced in salinity calculated when processing uploaded data. For most applications, correct setting (and factory default) is 2 scans (≈ 0.073 seconds * 24 scans/second). See Configuration Sheet for setting for your unit. If saving full rate (24 Hz) data, you can correct any residual time misalignment in post-processing (Align CTD module in SBE Data Processing).

AC1=x

x= number of 9*plus* scans (**x** = 0-3) to advance *secondary* conductivity from *secondary* temperature in SEARAM, to align conductivity and temperature data. See discussion above for **AC0=**.

Note:
Start logging by pushing in SEARAM's switch plunger. Stop logging by pulling out SEARAM's switch plunger.

Fx

Turn SEARAM power to 9*plus* on or off, instead of using SEARAM's switch plunger. This may be convenient for testing purposes. Note that this command **does not start logging**.

x=O: Turn power to 9*plus* on.

x=F: Turn power to 9*plus* off.

SBE 32 Carousel Setup Commands

Cx

Turn SEARAM power to Carousel on or off, instead of using SEARAM's switch plunger. This may be convenient for testing purposes. Note that this command **does not start logging**.

x=O: Turn power to Carousel on.

x=F: Turn power to Carousel off.

Note:
Commands to the Carousel must be input in UPPER CASE (capital letters).

#XXX

Relay character string defined by **XXX** to Carousel. **XXX** can be any command recognized by Carousel. See Carousel manual for list of commands. See *Testing SBE 32 Carousel Water Sampler Operation* below for an example of how to use this command for testing system before deployment.

Auto Fire Arm/Disarm Commands

Arm before deploying to enable the Carousel to take water samples. Disarm before deploying to disable the Carousel from taking water samples; the SBE 9*plus* can still take samples and log data in the SEARAM.

Arm — Arm (enable) auto fire to close bottles. Equivalent to ARM on Toolbar.

Disarm — Disarm (disable) auto fire.

Data Upload Commands

These commands upload data from the SEARAM's memory. Pull out the SEARAM's switch plunger to stop logging before uploading data.

Notes:
- **Use Upload on the Toolbar or Upload Data in the Data menu to upload data that will be processed by SBE Data Processing.** Manually entering a data upload command does not produce data with the required header information for processing by our software. These commands are included for reference for users who are writing their own software.
- To save data to a file, press Capture on the Toolbar before entering a data upload command.
- The first cast is cast 0.
- See *Data Output Formats* after these *Command Descriptions*.

DC [x] — Display raw data in hex from cast **x**. If **x** omitted, data from cast 0 displays.

Example: Upload data for cast 2 (user input in bold)

```
S>DC 2
Y                                   indicates valid cast number
aaaaaabbbbbbccccccccdddddd  (cast # 2, scan 0 data)
aaaaaabbbbbbccccccccdddddd  (cast # 2, scan 1 data)
...
aaaaaabbbbbbccccccccdddddd  cast # 2, scan x data
                    (x+1 is total number of scans of data stored in cast 2)
```

DD [x1,x2] — Display raw data in hex from scan **x1** through **x2**.

If **x1** and **x2** omitted, data displays from every scan.

Example: Upload data for scans 2 through 3 (user input in bold)

```
S>DD 2,3
aaaaaabbbbbbccccccccdddddd      (scan 2 data)
aaaaaabbbbbbccccccccdddddd      (scan 3 data)
```

Note:
A new header is written each time logging starts or resumes.

DH — Display headers from all casts.

Example: Display headers (user input in bold).

```
S>DH
cast 0 09/09/2004 08:01:15 avg=4 nfs=2 nvs=4 smpls 0 to 3540 stop=switch off v=15.23
cast 1 09/09/2004 12:30:33 avg=4 nfs=2 nvs=4 smpls 3541 to 8795 stop=switch off v=14.50
cast 2 09/09/2004 15:45:11 avg=4 nfs=2 nvs=4 smpls 8796 to 9801 stop=battery low v=13.33
```

where:
cast n = cast number.
mm/dd/yyyy hh:mm:ss = month day hour minute second when cast started.
avg = number of scans averaged by SEARAM.
nfs = frequency channels suppressed. nvs = voltage words suppressed.
x to y = first to last sample (scan) in cast.
stop = reason logging stopped (*switch off* if switch plunger pulled out, *battery low* if voltage dropped below minimum allowed, *bfrate* if voltage drops too rapidly [indicating failure of at least 1 battery], *memory full*, *memory failure*, *unknown*).
v = battery voltage when SEARAM stopped logging.

Diagnostic Commands

BV	Display main battery voltage.
BI	Display main battery current (amps).
VR	Continuously display power – main battery voltage and operating current (amps). SEARAM switches on power to 9*plus* and Carousel, so operating current is total current drawn by SEARAM, 9*plus*, and Carousel. Press Esc key to stop test.
TestEE	Test EEPROM
Flash Initialize *	Perform memory test, **destroying all data in SEARAM**. This test maps any bad data blocks in memory, allowing SEARAM to avoid using those blocks when recording data. Test requires approximately 20 minutes to perform, and cannot be stopped once it begins.
Flash Map	Display results of mapping from **Flash Initialize**. Press Esc key to abort at any time.

Commands Not Typically Sent by User

The user does not typically send the remaining commands. These involve setting up auto fire parameters, which are more easily set up in the Configuration Options dialog box (select the SBE 17plus V2 in the Configure menu). SeatermAF automatically sends these commands (with values based on entries in the dialog box) to the SEARAM when the user clicks Program on the Toolbar. The commands are included here for reference only. **Sea-Bird highly recommends using the Configuration Options dialog box to set up the SEARAM instead of using these commands.** See *Test and Establish Operating Parameters* in *Section 3: Preparing SEARAM for Deployment*.

Note:
Verify auto fire parameters - auto fire general setup, bottom bottle closure and upcast logic setup, and pressure coefficients - with the **CP** command before deploying the system.

Auto Fire General Setup

NB=x — **x** = total number of bottles to be closed during deployment. Maximum 24 bottles.

BC n,m — Define bottle closure pressure – bottle closure **n** occurs at pressure **m** (decibars). Repeat **NB** times, providing each closure pressure. Default 0 decibars for each bottle.

BS n,m — SEARAM allows bottles to be fired out of numerical sequence. Bottle closure **n** causes bottle number **m** to close. Repeat **NB** times, providing closure sequence for each bottle. Default is **n** equals **m** (bottles close in order of bottle number).

Auto Fire Bottle Bottom Closure and Upcast Logic Setup

The SEARAM closes bottles at designated pressures on upcast. However, the package sometimes moves upward during downcast, due to ship movement. These commands establish when upcast begins, preventing bottle closure during downcast caused by temporary upward movement. There are two cases:

- Bottom bottle closure not enabled – Upcast is enabled when pressure is greater than **BUP** decibars, or has decreased by **BUD** decibars from its maximum value.
- Bottom bottle closure enabled – Bottom bottle closure and upcast are enabled when pressure is greater than **BUP** decibars and remains within a window of **BBP** decibars for **BBT** minutes. If 9*plus* never meets these criteria, SEARAM closes bottom bottle when pressure decreases by **BUD** decibars.

BBx	**x**= Y (default): Enable bottom bottle closure – close a bottle when pressure remains within **BBP** decibars for **BBT** minutes. **x**= N: Disable bottom bottle closure.
BBP=x	**x** = bottom bottle pressure window (decibars).
BBT=x	**x** = bottom bottle time (minutes).
BUP=x	**x** = pressure (decibars) to enable upcast.
BUD=x	**x** = pressure decrease (decibars) from maximum to enable upcast.

The examples all use the following parameters: **BBP=**10 decibars**, BBT=**5 minutes**, BUP=**500 decibars**, BUD=**15 decibars

Example 1 – **BBY** (bottom closure enabled): 9*plus* descends to 550 db (> 500db) and stays within a 10 db window for 10 minutes. After 5 minutes, SEARAM closes bottom bottle.

Example 2 – **BBY** (bottom closure enabled): 9*plus* descends to 450 db (< 500 db) and stays within a 10 db window for 10 minutes. Because it has not reached enable pressure (500 db), bottom bottle does not close. Package begins to ascend. When pressure decreases by 15 db to 435 db, SEARAM closes bottom bottle and any other bottles that were meant to close at depths below 435 db.

Example 3 – **BBN** (bottom closure disabled): 9*plus* descends to 550 db (> 500 db) and begins to ascend. When it reaches pressure for first bottle to close, SEARAM closes first bottle.

Example 4 – **BBN** (bottom closure disabled): 9*plus* descends to 450 db (< 500 db) and begins to ascend. When pressure decreases by 15 db to 435 db, SEARAM closes any bottles that were meant to close at depths below 435 db.

SBE 9plus Pressure Coefficients

Note:
See the 9*plus* pressure sensor calibration sheet or the configuration (.con) file for the calibration coefficients.

These commands set up the 9*plus* pressure sensor calibration coefficients, used by the SEARAM to calculate pressures from the pressure sensor frequency data. Those pressures are used to determine when to close bottles.

PC1=x	**x** = C1 coefficient
PC2=x	**x** = C2 coefficient
PC3=x	**x** = C3 coefficient
PD=x	**x** = D coefficient
PT1=x	**x** = T1 coefficient
PT2=x	**x** = T2 coefficient
PT3=x	**x** = T3 coefficient
PT4=x	**x** = T4 coefficient
PADM=x	**x** = Adm coefficient
PADB=x	**x** = Adb coefficient

Data Output Formats

Notes:
- 9*plus* output format differs from the SEARAM's in several respects:
  - The SEARAM changes the order of the output.
  - The SEARAM strips 9*plus* bytes 31-36 (unused and marker bytes) and any unused frequency or voltage channels from the data.
  - The SEARAM overwrites the bottle confirm bit from the 9*plus* to record each Carousel bottle closure (9*plus* only sets the bottle confirm bit when used with a G.O. 1015 Rosette, not with an SBE 32 Carousel Water Sampler). The SEARAM sets the bit high for 1.5 seconds to record each closure.

  See the 9*plus* manual.
- 9*plus* data uploaded from the SEARAM is in a .hex file. Real-time 9*plus* data, acquired through an SBE 11*plus* Deck Unit with Seasave, is in one of the following file types:
  - SEASOFT (versions < 6.0) saved data coming from the Deck Unit as a .dat file.
  - Seasave V7 (versions ≥ 7.0), save data coming from the Deck Unit as a .hex file.

  See the SBE 11*plus* manual.

Data Storage

Data uploaded from the SEARAM as a .hex file. Data is stored 3 bytes per SBE 9*plus* word, except for the pressure word (4 bytes). When uploaded, the binary data is converted to ASCII hex and a carriage return and line feed is sent after the last byte in the scan. The SEARAM automatically suppresses any unused words from the 9*plus*. When no frequency or voltage channels are suppressed, data storage in the SEARAM is:

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 (8 LSBs)
byte 28	Pressure sensor temperature MSBs
byte 29	4 LSB = 9*plus* status (pump, bottom contact, water sampler bottle confirm bit, and 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:

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 suppressed and 8 voltage channels suppressed. The data format is:

SEARAM	Sensor
byte 0-2	Primary temperature
byte 3-5	Primary conductivity
byte 6-9	Pressure
byte 10	Pressure sensor temperature MSBs
byte 11	4 LSB = 9*plus* status, 4 MSB = pressure sensor temperature LSBs
byte 12	Modulo count (EOI line asserted)

Detailed Description of Data Formats

Notes:
- See the SBE Data Processing or Seasave V7 manual or Help files for instructions on converting the ASCII hex data.
- See the sensor calibration certificates for conversion of temperature and conductivity frequencies to engineering units.
- See the auxiliary sensor manual or the auxiliary sensor calibration certificates for conversion of voltages to engineering units.

The formats for each type of data are:

Format Type	Type of Data
1	Temperature or Conductivity frequency, if number of scans averaged is less than 8 (**Ave** < 8)
2	Pressure frequency, if number of scans averaged is less than 8 (**Ave** < 8)
3	Modulo
4	Voltage (channels for auxiliary sensors)
5	Temperature, Conductivity, or Pressure frequencies, if number of scans averaged is greater than or equal to 8 (**Ave** ≥ 8)

A detailed description of each type of data follows. To convert the ASCII hex data to a frequency or voltage (as applicable), use the Data Conversion module in SBE Data Processing or use Seasave V7.

Format Type 1:
Unconverted temperature and conductivity frequency, if Ave < 8
ASCII hex data (uploaded) = 6 characters c1,c2,c3,c4,c5,c6
SBE Data Processing or Seasave V7 perform the following calculations:
- Convert ASCII hex data to decimal = d1,d2,d3,d4,d5,d6
- Calculate -
  p = 288000 * number of scans averaged
  nr = d1 * 256 + d2 * 16 + d3
  nz = d4 * 256 + d5 * 16 + d6
  frequency = nz * 6912000 / (p + nr - nrFromPreviousScan)

Example of Calculation performed in Data Conversion (in SBE Data Processing) or Seasave V7:

ASCII hex data sample 0 = 1AE3B5
ASCII hex data sample 1 = 2C33B5
number of scans 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) + 3 = 707
nz = (3*256) + (11*16) + 5 = 949
frequency sample 1 = 949 * 6912000 / [(288000 * 2) + 707 - 430]
= 11382.526 Hz

Format Type 2: Unconverted pressure frequency, if Ave < 8

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

SBE Data Processing or Seasave V7 perform the following calculations:

- Convert ASCII hex data to decimal = d1,d2,d3,d4,d5,d6,d7,d8
- *Standard Resolution Pressure Frequency Calculations* -
  p = 288,000 * number of scans averaged
  nr = d1 * 4096 + d2 * 256 + d3 * 16 + d4
  nz = d5 * 4096 + d6 * 256 + d7 * 16 + d8
  frequency = nz * 6,912,000 / (p + nr - nrFromPreviousScan)

Example of Calculation performed in Data Conversion (in SBE Data Processing) or Seasave V7:

ASCII hex data sample 0 = 004510B5
ASCII hex data sample 1 = 00AB10B4
number of scans 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 * 6,912,000 / [(288,000 * 3) + 171 - 69]
= 34203.962 Hz

- *High Resolution Pressure Frequency Calculations* -
  p = 1,152,000 * number of scans averaged
  nr = d1 * 4096 + d2 * 256 + d3 * 16 + d4
  nz = d5 * 4096 + d6 * 256 + d7 * 16 + d8
  frequency = nz * 27,648,000 / (p + nr - nrFromPreviousScan)

Example of Calculation performed in Data Conversion (in SBE Data Processing) or Seasave V7:

ASCII hex data sample 0 = 034510B5
ASCII hex data sample 1 = 15AB10B4
number of scans 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 = 4
nr = (1 * 4096) + (5 * 256) + (10 * 16) + 11 = 5547
nz = (1 * 4096) + (0 * 256) + (11 * 16) + 4 = 4276
frequency sample 1 = 4276 * 27,648,000 / [(1,152,000 * 3) + 837 - 5547]
= 34254.684 Hz

Format Type 3: Modulo word
ASCII hex data (uploaded) = 6 characters c1,c2,c3,c4,c5,c6
SBE Data Processing or Seasave V7 perform the following calculations:

- 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 incrementing modulo count.

Example of Calculation performed in Data Conversion (in SBE Data Processing) or Seasave V7:

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

Format Type 4: Voltages (two 12 bit A/D channels)
ASCII hex data (uploaded) = 6 characters c1,c2,c3,c4,c5,c6
SBE Data Processing or Seasave V7 perform the following calculations:

- 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 of Calculation performed in Data Conversion (in SBE Data Processing) or Seasave V7:

ASCII hex data = 4510B5
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

Format Type 5:
Converted temperature, conductivity, or pressure frequency if Ave $\geq$ 8
ASCII hex data (uploaded) = 6 characters c1,c2,c3,c4,c5,c6
SBE Data Processing or Seasave V7 perform the following calculations:

- Convert ASCII hex data to decimal = d1,d2,d3,d4,d5,d6
- Calculate -
  frequency = d1 * 4096 + d2 * 256 + d3 * 16 + d4 + d5/16 + d6/256

One byte with the value 0 follows the converted pressure frequency.

Example of Calculation performed in Data Conversion (in SBE Data Processing) or Seasave V7:

ASCII hex data = 4510B5
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

Frequency Limitations Imposed by Averaging

To prevent internal overflow when SEARAM is averaging frequency data, limits are placed on maximum sensor frequency. Note that the SEARAM operates at 24 Hz (24 SBE 9*plus* scans per second).

Note:
Ave = number of scans to average

Format Type 1 (Unconverted temperature and conductivity frequency, if **Ave** < 8):

Maximum output frequency ≤
(4095 * # of 9*plus* scans per second) / **Ave**

Frequencies up to 14,040 Hz can be accommodated with **Ave** = 7, and higher frequencies can be accommodated with smaller values of **Ave**. Sea-Bird temperature and conductivity sensors have frequency outputs in the range of 2800 to 12,000 Hz.

Format Type 2 (Unconverted pressure frequency, **Ave** < 8) and
Format Type 5 (Converted temperature, conductivity, or pressure frequency, **Ave** ≥ 8) for ***Standard Resolution Digiquartz***

Maximum output frequency ≤
(65535 * # of 9*plus* scans per second) / **Ave**

Frequencies up to 65,535 Hz can be accommodated with **Ave** up to 24, sufficient to acquire the relatively high frequencies (up to 42,000 Hz) generated by standard resolution Paroscientific Digiquartz pressure sensors. For an SBE 9*plus* not using a Digiquartz sensor, frequencies up to 16,384 Hz can be accommodated with **Ave** = 96 (maximum value for this parameter).

Format Type 5 (Converted temperature, conductivity, or pressure frequency, **Ave** ≥ 8) *for* ***High Resolution Digiquartz***

Maximum output frequency ≤
(39768 * # of 9*plus* scans per second) / **Ave**

Testing SBE 32 Carousel Water Sampler Operation

Notes:
- **Enter Carousel commands using UPPER CASE (capital letters).**
- See the SBE 32 Carousel Water Sampler manual.

Test the SBE 32 Carousel Water Sampler in the lab, before deployment, to ensure that the Carousel responds to commands and that the firing mechanism functions properly. **CO** allows you to provide power to the Carousel without logging data to the SEARAM, and **#XXX** (**XXX** is any valid Carousel command) allows you to send commands to the Carousel through the SEARAM.

1. Connect the Carousel to the SEARAM.

2. Connect the SEARAM to the computer, start SeatermAF, and configure it for the SEARAM (see *Power and Communications Test* in *Section 3: Preparing SEARAM for Deployment*).

3. In SeatermAF, click Connect on the Toolbar to establish communications with the SEARAM.

4. Type **CO** and press the Enter key to turn on power from the SEARAM to the Carousel.

5. Type **#SR** and press the Enter key to send the reset command to the Carousel.

6. **To manually simulate sequential firing**:
   Type **#SF** (fire first or next bottle) and press the Enter key. Repeat as desired.

7. **To manually simulate firing in user-specified order**:
   Type **#SNx** (where **x**= bottle position number in ASCII; first bottle position number is 1) and press the Enter key. Repeat as desired.

Position #	Command	Position #	Command
1	**#SN1**	19	**#SNC**
2	**#SN2**	20	**#SND**
3	**#SN3**	21	**#SNE**
4	**#SN4**	22	**#SNF**
5	**#SN5**	23	**#SNG**
6	**#SN6**	24	**#SNH**
7	**#SN7**	25	**#SNI**
8	**#SN8**	26	**#SNJ**
9	**#SN9**	27	**#SNK**
10	**#SN:**	28	**#SNL**
11	**#SN;**	29	**#SNM**
12	**#SN<**	30	**#SNN**
13	**#SN=**	31	**#SNO**
14	**#SN>**	32	**#SNP**
15	**#SN?**	33	**#SNQ**
16	**#SN@**	34	**#SNR**
17	**#SNA**	35	**#SNS**
18	**#SNB**	36	**#SNT**

8. Type **CF** to turn off SEARAM power to the Carousel. **Failure to send this command will drain the SEARAM batteries**.

Testing system firing of bottles in response to changes in pressure is more difficult, and requires connecting a variable pressure source to the SBE 9*plus* pressure port to simulate ocean pressure during downcast and upcast. **Do not use pressures greater than the capacity of the 9*plus* pressure sensor, or you will damage the pressure sensor.**

Setup for Deployment

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

Note:
It is always necessary to set date and then time.

Set the time and date, establish memory and auto fire parameters, and program and arm the auto fire before deployment:

1. Connect the SEARAM to the computer, start SeatermAF, and configure it for the SEARAM (see *Power and Communications Test* in *Section 3: Preparing SEARAM for Deployment*).

2. Press Connect on the Toolbar to wake up the SEARAM and get an S> prompt.

3. **Set Up SEARAM:**
   A. Set up the SEARAM and its interface with the 9*plus*, after reviewing the information in this section on instrument commands.
   B. Set the date and time in the format you desire. The commands are:
      - **MMDDYY=mmddyy** set real-time clock month, day, year
      - **DDMMYY=ddmmyy** set real-time clock day, month, year
      - **HHMMSS=hhmmss** set real-time clock hour, minute, second

      MMDDYY and **DDMMYY** are equivalent; either can be used to set the date.
   C. Click Status on the Toolbar to verify the setup.

4. **Program and Arm Auto Fire:**
   A. Select the SBE 17plus V2 in the Configure menu. Make the desired selections on the SBE 17plus Bottle Closure Logic and Bottle Closure Pressures/Times tabs (see *Power and Communications Test* in *Section 3: Preparing SEARAM for Deployment*).
      Click OK or Save As to save the selections.
   B. Click Program on the Toolbar to send the input auto fire parameters to the SEARAM.
   C. Click Closure Parameters AFM on the Toolbar to verify the auto fire parameters were entered and transmitted correctly to the SEARAM.
   D. Click ARM on the Toolbar to arm the auto fire module, enabling the SEARAM to command the Carousel to take water samples.

Deployment

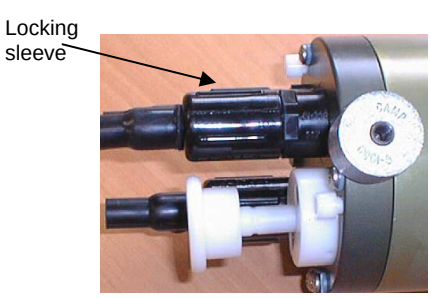
Note:
It is possible to use the SEARAM to record 9*plus* data in memory at the same time as 9*plus* data is transmitted real-time through the SBE 11*plus* V2 Deck Unit. This provides a data back-up in case there are data transmission problems over the sea cable. See the 9*plus* manual for wiring and deployment details.

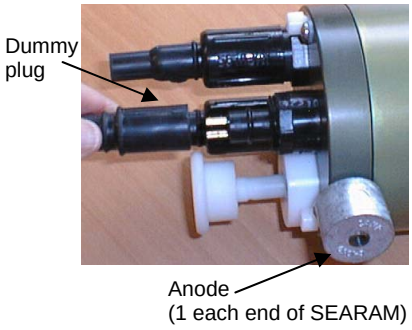
CAUTION:
Do not use WD-40 or other petroleum-based lubricants, as they will damage the connector.

1. By hand, unscrew the locking sleeve from the I/O (4-pin) bulkhead connector. **If you must use a wrench or pliers, be careful not to loosen the bulkhead connector instead of the locking sleeve**.

2. Remove the cable connector from the I/O bulkhead connector by pulling the cable connector firmly away from the bulkhead connector.

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





4. *Aluminum housing*: Verify that the anodes have not eroded away.

5. Verify that the hardware and external fittings are secure.

6. Verify that the cable connections from the SEARAM to the 9*plus* and the Carousel are secure. If not, follow the procedure described in Steps 1 through 3 to remove and reinstall the cables.

7. Push in the SEARAM's switch plunger.

The SEARAM is ready to go in the water. Note that the 9*plus* pump only runs when there is salt water in the conductivity cell.

Note:
If powering the SEARAM externally (optional), install the SBE 17 junction box:
1. Connect the box to the SEARAM using the 4-pin to MS cable provided.
2. Connect the box to the computer serial port using the supplied cable.
3. Connect AC mains power.
4. Press the red power button to provide power to the SEARAM.

The junction box supplies approximately 17 volts, so SEARAM batteries will not be drawn down when the junction box is in use.

Recovery

WARNING!
If the SEARAM, CTD, or Carousel stop working while underwater, are unresponsive to commands, or show other signs of flooding or damage, carefully secure the instruments away from people until you have determined that abnormal internal pressure does not exist or has been relieved. Pressure housings may flood under pressure due to dirty or damaged o-rings, or other failed seals. When a sealed pressure housing floods at great depths and is subsequently raised to the surface, water may be trapped at the pressure at which it entered the housing, presenting a danger if the housing is opened before relieving the internal pressure. Instances of such flooding are rare. However, a housing that floods at 5000 meters depth holds an internal pressure of more than 7000 psia, and has the potential to eject the end cap with lethal force. A housing that floods at 50 meters holds an internal pressure of more then 85 psia; this force could still cause injury. If you suspect the SEARAM is flooded, point the SEARAM in a safe direction away from people, and loosen the 4 screws on the connector end cap about ½ turn. If there is internal pressure, the end cap will *follow* the screws out, and the screws will not become easier to turn. In this event, loosen 1 bulkhead connector very slowly, at least 1 turn. This opens an o-ring seal under the connector. Look for signs of internal pressure (hissing or water leak). If internal pressure is detected, let it bleed off slowly past the connector o-ring. Then, you can safely remove the end cap.

Physical Handling

1. Rinse the SEARAM with fresh water.

2. If the batteries are exhausted, before data uploading:
   - Charge NiMH or Ni-Cad batteries, or
   - Install new alkaline batteries, or
   - Connect the SEARAM to an external power source.

   Stored data will not be lost as a result of exhaustion or removal of batteries. See *Section 5: Routine Maintenance* for battery charging or replacement.

3. By hand, unscrew the locking sleeve from the I/O bulkhead connector. **If you must use a wrench or pliers, be careful not to loosen the bulkhead connector instead of the locking sleeve**.

4. Remove the dummy plug from the I/O bulkhead connector by pulling the plug firmly away from the connector.

5. **Standard Connector** - Install the I/O cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the SEARAM. **OR**
   MCBH Connector – Install the I/O cable connector, aligning the pins.

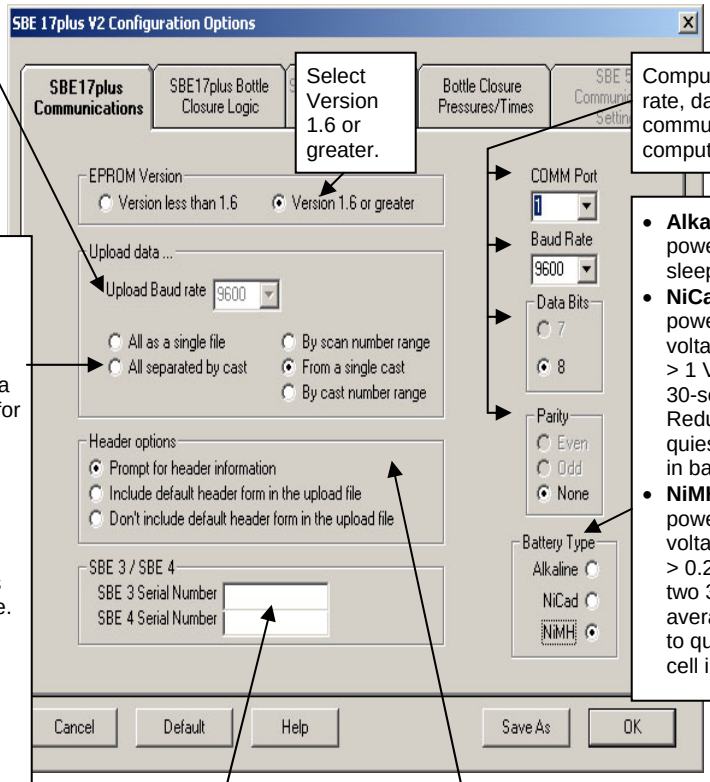
6. Connect the other end of the I/O cable to the computer serial port.

Note:
Set up **Upload Data**, **Header Information**, and/or **Header Form** (Steps 2 through 3):
- The first time you upload data, and
- If you want to change upload or header parameters.

Uploading Data

1. Double click on the SeatermAF icon. The display shows the main screen.

2. In the Configure menu, select SBE 17plus V2. The dialog box looks like this:



Baud rate for uploading data from SEARAM to computer (automatically set to same baud as for general communications).

Select Version 1.6 or greater.

Computer COM port, baud rate, data bits, and parity for communication between computer and SEARAM.

Defines data upload type when using Upload on Toolbar or Upload Data in Data menu:
- **All as single file** – All data uploaded into one file.
- **All separated by cast** – All data uploaded. Separate file written for each cast, with 3-digit cast ID (001, etc.) appended to user-selected file name.
- **By scan number range** – SeatermAF prompts for beginning and ending scan (sample) numbers, and uploads all data within range into one file.
- **From single cast** (default) – SeatermAF prompts for cast number, and uploads data from that cast into one file.
- **By cast number range** – SeatermAF prompts for beginning and ending cast numbers, and uploads data within range. Separate file written for each cast, with 3-digit cast ID (001, etc.) appended to user-selected file name.

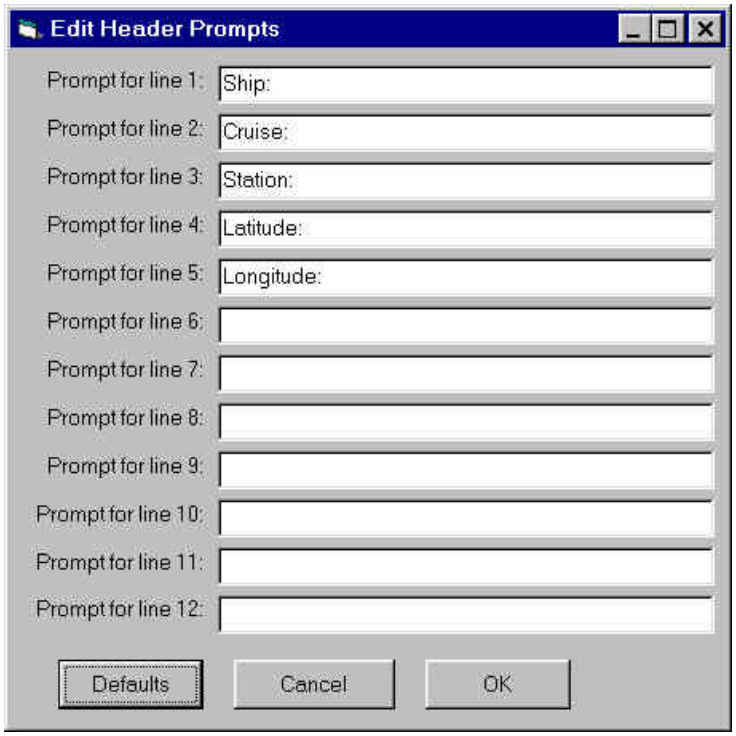
- **Alkaline** – SEARAM turns off power (stops logging, goes to sleep) when voltage < 10.3 V.
- **NiCad** – SEARAM turns off power when voltage < 10.3 V *or* voltage < 15 V and voltage drop > 1 V/minute (calculated by two 30-second moving averages). Reduces battery load to quiescent current once first cell in battery pack is exhausted.
- **NiMH** – SEARAM turns off power when voltage < 10.8 V *or* voltage < 12 V and voltage drop > 0.2 V/minute (calculated by two 30-second moving averages). Reduces battery load to quiescent current once first cell in battery pack is exhausted.

Temperature and conductivity sensor serial numbers required for post-processing of data (SBE 3 and SBE 4 are sensors on 9*plus*). Enter these numbers **exactly** as they appear in configuration (.con) file.

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

Make the selections/enter data. Click OK to overwrite an existing .ini file, or click Save As to save the file as a new filename.

3. In the Configure menu, select Header Form to customize the header. The dialog box looks like this (default prompts are shown):



The entries are free form, 0 to 12 lines long. This dialog box establishes:
- the header prompts that appear for the user to fill in when uploading data, if *Prompt for header information* was selected in the Configuration Options dialog box (Step 2)
- the header included with the uploaded data, if *Include default header form in upload file* was selected in the Configuration Options dialog box (Step 2)

Enter the desired header/header prompts. Click OK.

4. Click Connect on the Toolbar to begin communications with the SEARAM. The display looks like this:

```
SBE 17plus version 2 SEARAM 1.6
S>
```

This shows that correct communications between the computer and SEARAM has been established.
If the system does not respond as shown above:
- Click Connect again to attempt to establish communications.
- Check cabling between the computer and the SEARAM.
- Verify the correct instrument was selected and the COM settings were entered correctly in the Configure menu.

5. Display SEARAM status information by clicking Status on the Toolbar. The display looks like this:

```
S>ds
SBE17plus version 2 SEARAM V1.6 09/12/2004 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>
```

7. If you have not already done so, command the SEARAM to stop logging by pulling out the switch plunger.

8. Click Upload on the Toolbar to upload stored data. SeatermAF responds as follows before uploading the data:
   A. SeatermAF sends status (**DS**) and display headers (**DH**) commands, and displays the responses. These commands provide you with information regarding the number of scans and casts in memory.
   B. **If you selected *By scan number range, From a single cast,* or *By cast number range* in the Configuration Options dialog box (Configuration menu)** – a dialog box requests the cast or range. Enter the desired value(s), and click OK.
   C. **If you selected *Prompt for header information* in the Configuration Options dialog box (Configure menu)** – a dialog box with the header form appears. Enter the desired header information, and click OK.
   D. In the Open dialog box, enter the desired upload file name and click OK (the upload file has a .hex extension). Note that if you selected *All separated by cast* or *By cast number range* in the Configuration Options dialog box (Configuration menu), SeatermAF automatically appends a 3-digit cast number (000 to 999) for each cast to the user-selected file name.

9. Ensure all data has been uploaded from the SEARAM by:
   - Processing and reviewing the data in SBE Data Processing, or
   - Viewing the raw data in Seasave V7.

Notes:
To prepare the SEARAM for re-deployment:
1. Send **Erase Memory** to erase the memory and set the number of casts to 0, or send **SampleNum=0** or **CastNum=0** to reset the data pointers and cast numbers. If one of these commands is not sent, new data will be stored after the last recorded sample, preventing use of the entire memory capacity.
2. Push in the switch plunger to begin logging immediately, or send **QS** to put the SEARAM in quiescent (sleep) state until ready to redeploy.

Processing Data Using SBE Data Processing

Notes:
- 9*plus* data uploaded from the SEARAM is in a .hex file. Real-time 9*plus* data, acquired through an SBE 11*plus* Deck Unit with Seasave, is in one of the following file types:
  - SEASOFT (versions < 6.0) saved data coming from the Deck Unit as a .dat file.
  - Seasave V7 (versions ≥ 7.0), save data coming from the Deck Unit as a .hex file.
- *Basic* instructions are provided for processing the data using SBE Data Processing. See the SBE Data Processing manual and/or Help files for details.

Sea-Bird provides software, SBE Data Processing, for converting the raw .hex data file into engineering units, editing (aligning, filtering, removing bad data, etc.) the data, calculating derived variables, and plotting the processed data.

A bottle confirm bit in the SEARAM's data file was set for all scans within a 1.5-second duration after each bottle fire confirmation was received by the SEARAM from the Carousel. SBE Data Processing can use this information to develop a separate water bottle file for comparison to physical testing of the water bottle samples.

Data uploaded from the SEARAM is processed in SBE Data Processing in several steps:

1. **Data Conversion** module – From the raw .hex file from the SEARAM, Data Conversion creates:
   - .cnv file – 9*plus* data converted from raw hexadecimal to engineering units.
   - .ros water bottle file – data converted from raw hexadecimal to engineering units. The .ros file contains the 9*plus* data for 1.5 seconds after each bottle firing as well as additional data for a user-selected range of scans before and after each bottle firing.

2. **Bottle Summary** module – The .ros file created by Data Conversion is processed by Bottle Summary, which creates a bottle data summary .btl file. The .btl file includes:
   - Bottle position, optional bottle serial number, and date and time.
   - User-selected derived variables, computed for each bottle from mean values of input variables (temperature, pressure, conductivity, etc.).
   - User-selected averaged variables, computed for each bottle from input variables.

3. Additional processing of .cnv data – align, filter, remove bad data, etc., calculate derived variables, and plot data using SBE Data Processing's other modules.

Verification of the instrument configuration (.con) file, and the use of Data Conversion and Bottle Summary is described below (see the SBE Data Processing manual / help files for details).

Notes:

- Seasave and SBE Data Processing versions 7.20a introduced .xmlcon files (in XML format). Versions 7.20a and later allow you to open a .con or .xmlcon file, and to save it to a .con or .xmlcon file. **However, SeatermAF is not currently compatible with a .xmlcon file; continue to use .con files with the SEARAM for compatibility with SeatermAF**.
- A new or recalibrated CTD ships with a configuration file that reflects the current configuration *as we know it*. The file is named with the instrument serial number, followed by a .con extension. For example, for a CTD with serial number 2375, Sea-Bird names the file *2375.con*. You may rename the file (but not the extension) if desired; this will not affect the results.

Verifying Contents of Configuration (.con) File

Verify the contents of the .con file by clicking 911/917plus in SBE Data Processing's Configure menu, and then clicking Open in the dialog box to select the desired file. The .con file defines the instrument – integrated auxiliary sensors, and channels, serial numbers, and calibration dates and coefficients for all the sensors (conductivity, temperature, and pressure as well as auxiliary sensors). SBE Data Processing uses the information in the .con file to interpret and process the raw data. **If the .con file does not match the actual instrument configuration, the software will not be able to interpret and process the data correctly.**

Channel/Sensor table reflects this choice; must be consistent with **SF=** programmed into SEARAM. Typically:

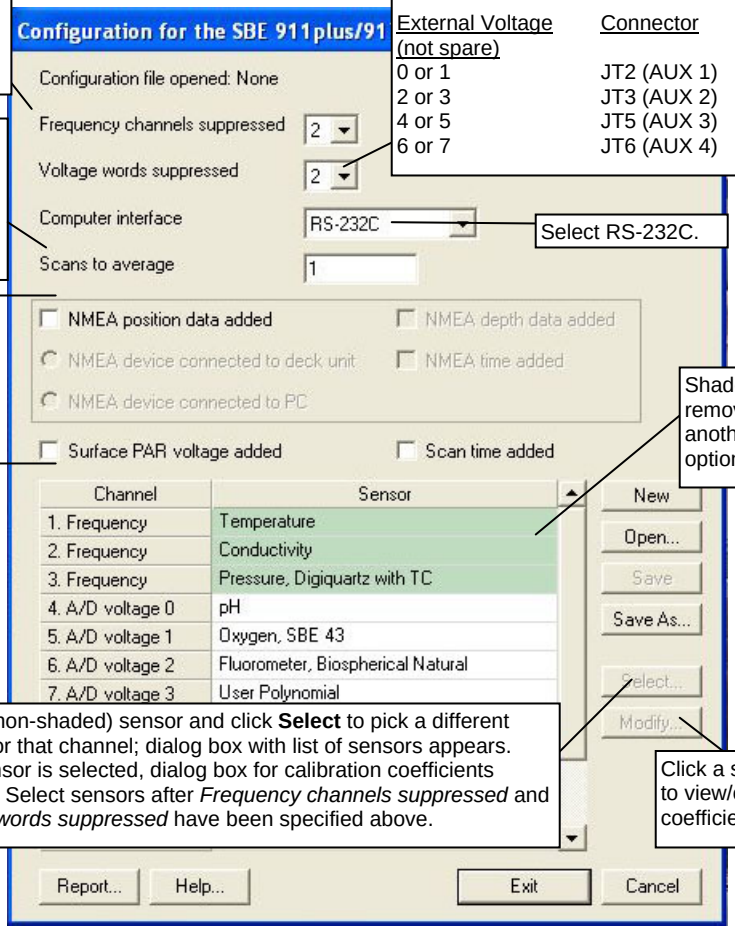
- **0** = SBE 3 or 4 plugged into JB5 (COND 2) on 9*plus* (dual redundant sensor configuration)
- **1** = SBE 3 or 4 plugged into JB4 (TEMP 2) on 9*plus* and not using JB5 (COND 2) connector (single redundant sensor configuration)
- **2** = no redundant T or C sensors

Channel/Sensor table reflects this choice; must be consistent with **SV=** programmed into SEARAM. Total voltage words is 4; each word contains data from two 12-bit A/D channels. SEARAM suppresses words starting with highest numbered word. Number of words to keep is determined by highest numbered external voltage input that is not a spare: Words to suppress = 4 - Words to Keep

External Voltage (not spare)	Connector	Words to Keep
0 or 1	JT2 (AUX 1)	1
2 or 3	JT3 (AUX 2)	2
4 or 5	JT5 (AUX 3)	3
6 or 7	JT6 (AUX 4)	4

Number of scans averaged in SEARAM; must be consistent with **Ave=** programmed into SEARAM. *Example*: If **Ave=24**, SEARAM averaged 24 scans, saving data to computer at 1 scan/second.

NMEA position data, *Surface Par voltage*, and *Scan time added* are not applicable to 9*plus* used with SEARAM.



Select RS-232C.

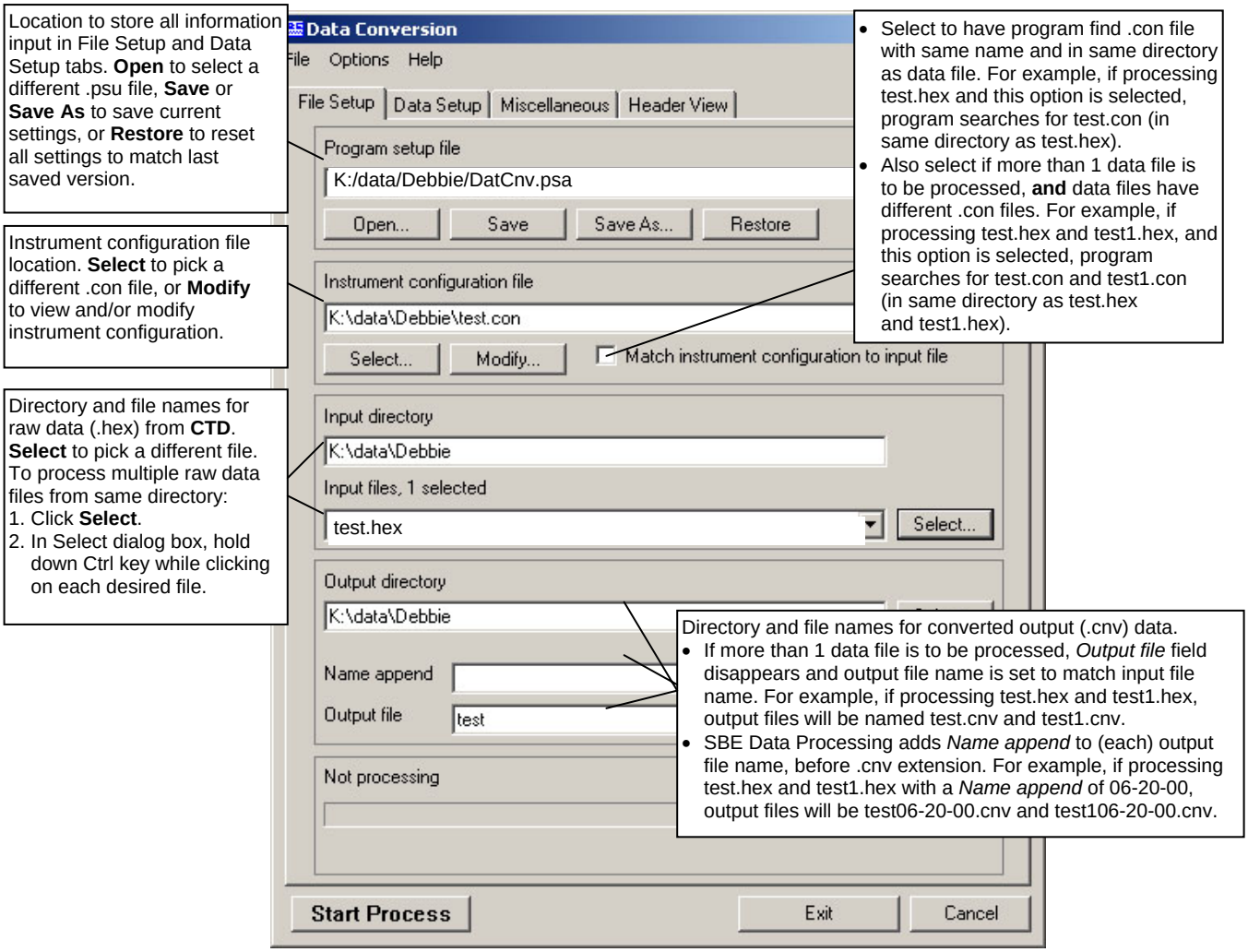
Shaded sensors cannot be removed or changed to another type; others are optional.

Click a (non-shaded) sensor and click **Select** to pick a different sensor for that channel; dialog box with list of sensors appears. After sensor is selected, dialog box for calibration coefficients appears. Select sensors after *Frequency channels suppressed* and *Voltage words suppressed* have been specified above.

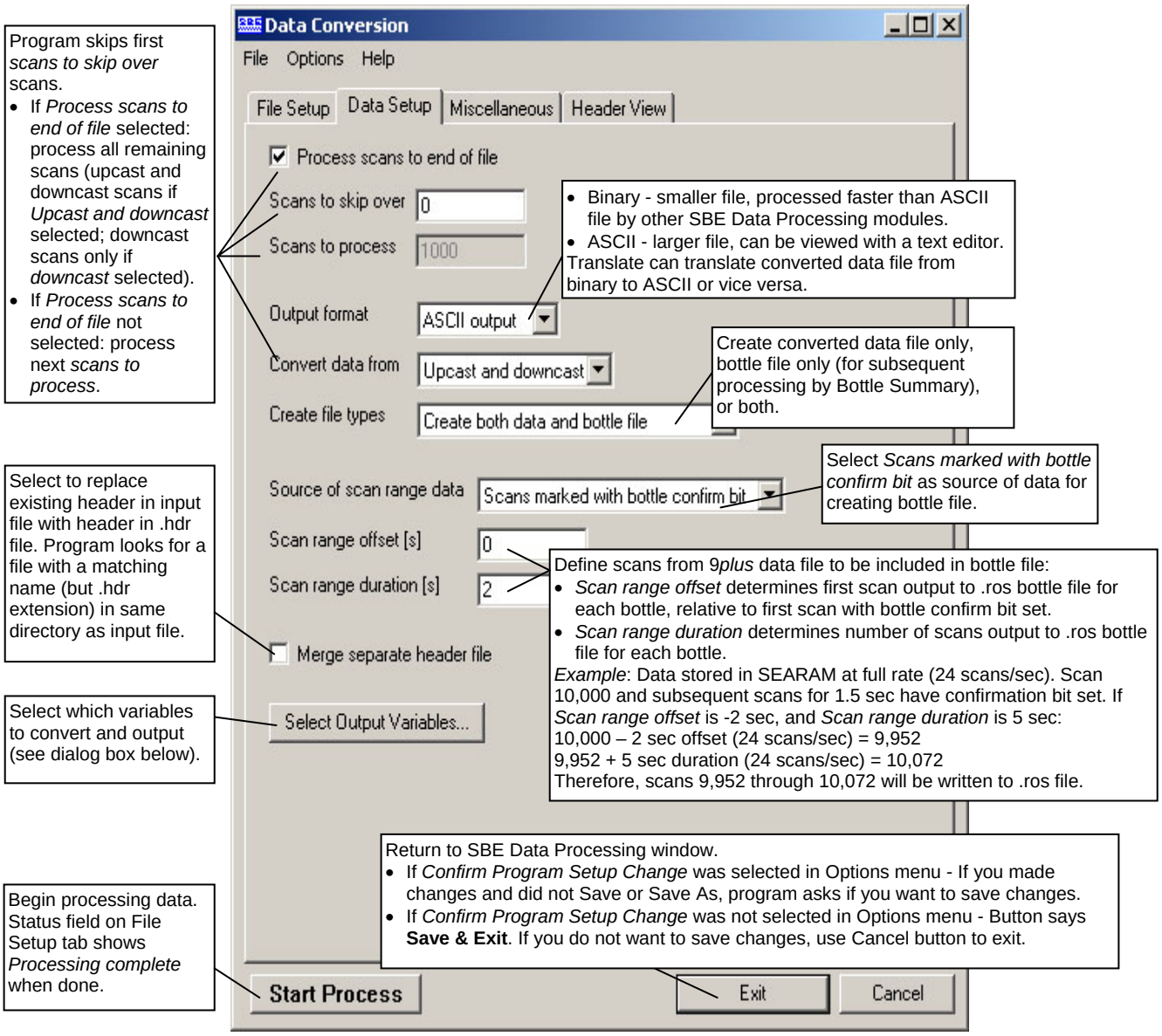
Click a sensor and click **Modify** to view/change calibration coefficients for that sensor.

Data Conversion

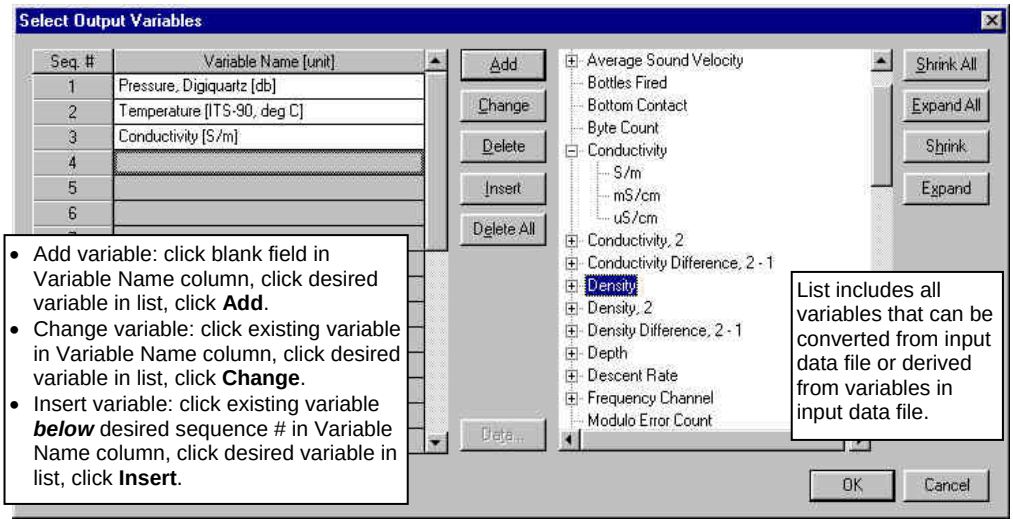
In SBE Data Processing's Run menu, select Data Conversion. The input files for Data Conversion are the .hex file from the SEARAM and the CTD configuration .con file. The File Setup tab in the dialog box looks like this:



The Data Setup tab in the dialog box looks like this:



The Select Output Variables dialog box (which appears when you click **Select Output Variables** on the Data Setup tab) looks like this:



Output variables selected here will be put in both the .cnv and .ros files.

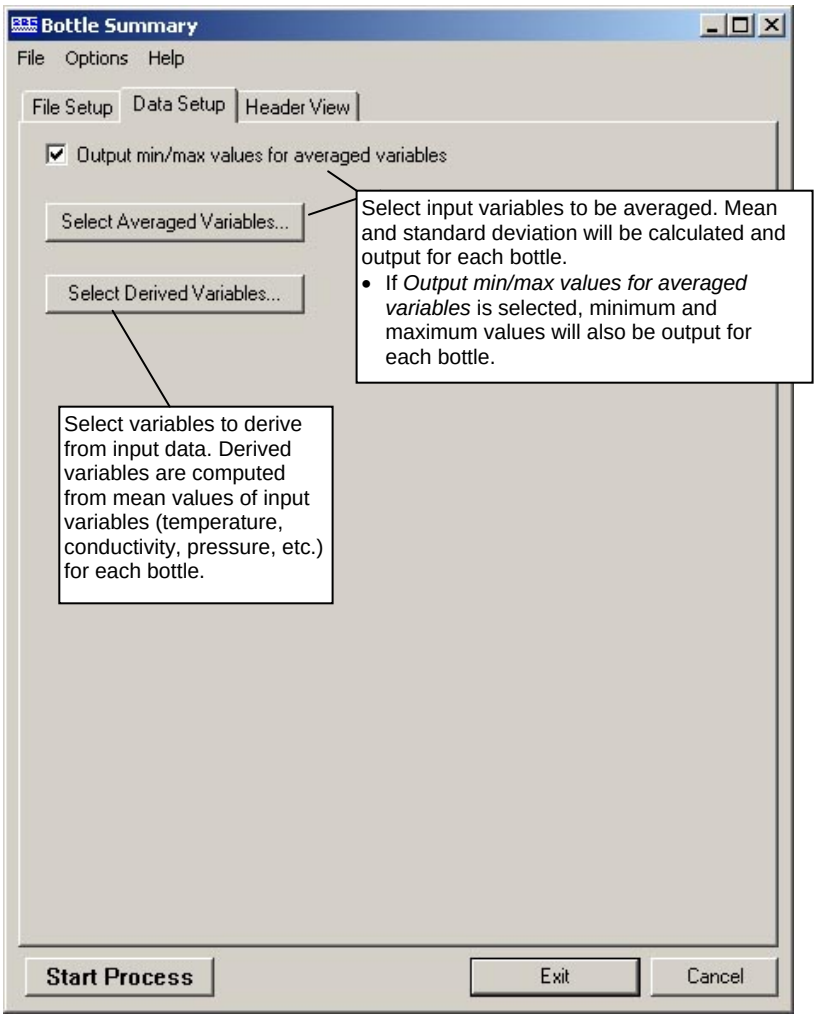
Bottle Summary

In SBE Data Processing's Run menu, select Bottle Summary. The File Setup tab in the dialog box is similar to the one shown and described for Data Conversion above. The input files for Bottle Summary are the .ros file (created in Data Conversion) and the CTD configuration .con file.

Note:
You can create a .sn file in a text editor.

- Additionally, if a .sn file (same name as input .ros file, with .sn extension) is found in the input file directory, bottle serial numbers are inserted between the bottle position and date/time columns in the .btl file output. The format for the .sn file is:
  Bottle position, serial number (with a comma separating the two fields)

The Data Setup tab in the dialog box looks like this:



Other Processing Modules

See the SBE Data Processing manual / Help files for information on additional processing that can be performed o the converted CTD data (.cnv) file.

Editing Raw Data File

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

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

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

1. **Make a back-up copy of your .hex data file before you begin.**

2. Run **WordPad**.

3. In the File menu, select Open. The Open dialog box appears. For *Files of type*, select *All Documents (*.*)*. Browse to the desired .hex data file and click Open.

4. Edit the file as desired, **inserting any new header lines after the System Upload Time line**. All header lines must begin with an asterisk (*), and *END* indicates the end of the header. An example is shown below, with the added lines in bold:

```
* Sea-Bird SBE17 Data File:
* FileName = C:\term17af\cast000.hex
* Software Version 5.0
* Temperature SN =
* Conductivity SN =
* System UpLoad Time = Aug 17 2004 3:45:12 PM
* Testing adding header lines
* Must start with an asterisk
* Place anywhere between System Upload Time & END of header
* ds
* SBE17plus SEARAM V1.4 08/17/2004 15:47:26 batt type = NICAD
* ncasts = 6  samples = 541078 free bytes = 16777216
* 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>
* dh
* cast 0  08/05/2004  10:36:34 avg = 1 nfs = 0 nvs = 0 smpls 0 to
163 stop = switch off v = 15.4
* S>
*END*
```

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

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

   Ignore the message and click *Yes*.

6. In the File menu, select Exit.

Section 5: Routine Maintenance

This section reviews corrosion precautions, connector maintenance, battery charging, and battery replacement.

Corrosion Precautions

Rinse the SEARAM with fresh water after use and prior to storage.

Aluminum Housing

All stainless steel screws which are exposed to salt water have been generously lubricated at the factory with Blue Moly™. After each use, remove these screws and re-lubricate them. **This compound is electrically conductive, so use care to ensure it does not get on circuit boards.**

There is a large zinc anode screwed in each end cap. Check these anodes periodically to verify that they are securely fastened and have not been eaten away.

Titanium Housing

All exposed metal is titanium; other materials are plastic. No corrosion precautions are required, but direct electrical connection of the SEARAM housing to dissimilar metal hardware should be avoided.

Connector Mating and Maintenance

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

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

Clean and inspect connectors, cables, and dummy plugs before every deployment and as part of your yearly equipment maintenance. Inspect connectors that are unmated for signs of corrosion product around the pins, and for cuts, nicks or other flaws that may compromise the seal.

When remating:

1. Lightly lubricate the inside of the cable/dummy plug connector with silicone grease (DC-4 or equivalent).

2. **Standard Connector** - Install the cable/dummy plug connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the SEARAM. Remove any trapped air by *burping* or gently squeezing the connector near the top and moving your fingers toward the end cap. **OR**
   MCBH Connector – Install the cable/dummy plug connector, aligning the pins.

3. Place the locking sleeve over the cable/dummy plug connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

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

Replacing/Recharging Batteries

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

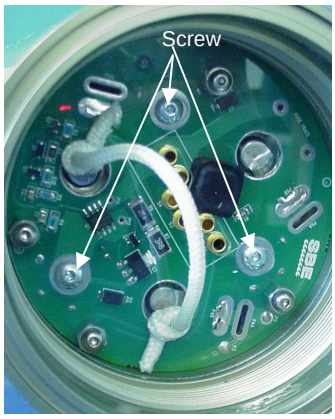
Leave the batteries in place when storing the SEARAM. If the SEARAM is to be stored for long periods, **replace alkaline batteries yearly to prevent battery leakage** (which could damage the SEARAM).

Recharging NiMH Batteries

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

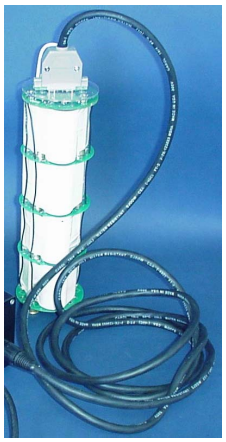
1. Remove the bottom end cap:
   A. Wipe the outside of the bottom end cap (end cap without any connectors) and housing dry, being careful to remove any water at the seam between them.
   B. Using a wrench on the white plastic bar, unthread the bottom end cap, rotating counter-clockwise.
   C. Remove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

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




Battery pack

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



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

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

3. Recharge the batteries:
   A. Plug the battery charger into a suitable power source and turn on power to the charger.
   B. Connect the charger cable to the battery pack and charger. The LED should show `READY`, and display the battery type and measured voltage.
   C. Press the **Discharge** button. The LED should show `DISCHARGE`. This starts the discharge cycle, which discharges any remaining battery capacity. Repeatedly charging without discharging may damage the battery pack. The Discharge cycle takes approximately 75 minutes. When discharging is complete, the LED should show `EMPTY`.
   D. Press the **Charge** button. The LED should show `Fast Charge` (it may also show `WARM-UP CHARGE`, `REFILL CHARGE`, and/or `TOP OFF` during the charge cycle). The Charge cycle takes approximately 2 hours. When charging is complete, the LED should show `BATTERY FULL`.
   E. Turn off power to the charger.
   F. Disconnect the battery pack from the charger and the charger from the power source.

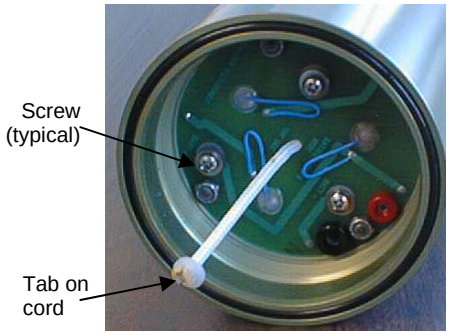
4. Reinstall the battery pack in the housing:
   A. Align the battery pack with the housing. The posts inside the housing are not placed symmetrically, so the battery pack fits into the housing only one way. Looking at the bottom of the battery pack, note that one tube is closer to the edge than the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

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

6. Verify that the switch plunger on the top end cap is pulled out, so the SEARAM will be in quiescent (sleep) state.

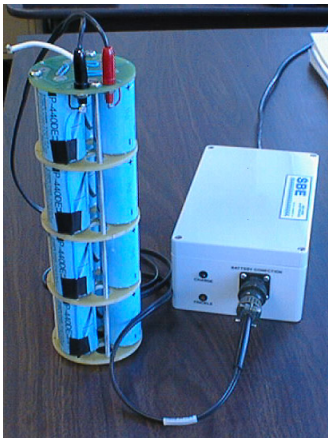
Recharging Ni-Cad Batteries

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



2. Remove the battery pack from the housing:
   A. Remove the three Phillips-head machine screws and washers from the battery cover plate inside the housing.
   B. Pull on the plastic tab on the center cord to remove the battery pack from the housing.

CAUTION:
Do not recharge the battery pack while it is in the housing. If you do so, you may damage the SEARAM electronics.



3. Recharge the batteries:
   A. Connect the battery charger leads to the battery cover pin jacks, matching black-to-black and red-to-red (the pin jacks are different sizes to prevent cross-wiring).
   B. Plug the battery charger into a suitable AC mains power source.
   C. The red **Charge** LED on the charger comes on. Recharging takes approximately 15 hours. When recharging is complete, the yellow **Trickle** LED comes on, indicating the charger is providing a maintenance level charge.
   D. Disconnect the battery pack from the charger and the charger from the power source.
   E. Check the voltage at BAT + and BAT – on the battery cover. It should be approximately 14.4 volts.

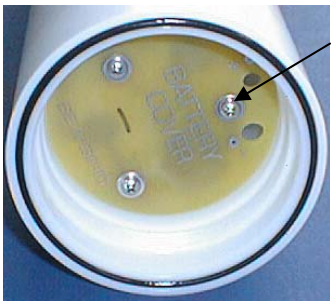
4. Reinstall the battery pack in the housing:
   A. Align the battery pack with the housing. The posts inside the housing are not placed symmetrically, so the battery pack fits into the housing only one way. Looking at the battery bottom cover, note that one circular cutout is closer to the edge than the others, corresponding to the post that is closest to the housing.
   B. Reinstall the three Phillips-head screws and washers, while pushing hard on the top of the battery pack to depress the spring contacts at the bottom of the compartment. **The screws must be fully tightened, or the battery power to the circuitry will be intermittent.**

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

6. Verify that the switch plunger on the top end cap is pulled out, so the SEARAM will be in quiescent (sleep) state.

Replacing Alkaline Batteries

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



2. Remove the battery cover from the housing:
   A. Remove the three Phillips-head screws and washers from the battery cover plate inside the housing.
   B. The battery cover will pop out. Put it aside.

3. Turn the SEARAM over and remove the batteries. Install the new batteries, with the + terminal against the flat battery contacts and the – terminal against the spring contacts.

4. Reinstall the battery cover in the housing:
   A. Align the battery cover with the housing. The posts inside the housing are not placed symmetrically, so the cover fits into the housing only one way. Looking at the cover, note that one screw hole is closer to the edge than the others, corresponding to the post that is closest to the housing.
   B. Reinstall the three Phillips-head screws and washers, while pushing hard on the battery cover to depress the spring contact. **The screws must be fully tightened, or the battery power to the circuitry will be intermittent.**

5. Check the battery voltage at BAT + and BAT - on the battery cover. It should be approximately 18 volts.

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

7. Verify that the switch plunger on the top end cap is pulled out, so the SEARAM will be in quiescent (sleep) state.

Glossary

Battery pack – Battery pack assembly includes twelve D-cell (nominal 8 Amp-hour) rechargeable Nickel Metal Hydride (NiMH) batteries (alkaline batteries or rechargeable Ni-Cad batteries can be substituted).

Carousel Water Sampler – Sea-Bird's SBE 32.

SEARAM – Memory and auto fire module for use with any Sea-Bird SBE 9*plus* CTD unit to permit *in-situ* recording of CTD data without the need for conductive wire and a slip-ring equipped winch.

PCB – Printed Circuit Board.

SBE Data Processing – Sea-Bird's Win 2000/XP data processing software, which calculates and plots temperature, conductivity, pressure, auxiliary sensor parameters, and derived variables such as salinity and sound velocity.

Scan – One data sample containing temperature, conductivity, pressure, and optional auxiliary sensor data.

Seasave V7 – Sea-Bird's Windows 2000/XP software used to acquire, convert, and display real-time or archived raw data. Seasave V7 can be used with the uploaded (archived) data from the SEARAM.

SEASOFT V2 –Sea-Bird's complete Windows 2000/XP software package, which includes software for communication, real-time data acquisition, and data analysis and display. SEASOFT V2 includes **SeatermAF**, **Seasave V7**, **SBE Data Processing**.

SeatermAF – Sea-Bird's Win 95/98/NT/2000/XP software used to communicate with the SEARAM. SeatermAF can send commands to the SEARAM to provide status display, data acquisition and auto fire setup, data display and capture, data upload, and diagnostic tests.

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

Appendix I: Functional Description

SEARAM circuitry is contained on one PCB:

- **Battery Wiring and Power Supply**
  SEARAM's main battery is 12 D-cells. The positive battery connections are contact areas on double-thick printed circuit disks that form the internal bulkhead and battery retainer plates. Battery negative contacts are heavy beryllium-copper springs.
  When the battery-circuit card connection is made, a low-power regulator chip supplies 5 volts (+ 5C) to the wake-up circuits. When a character is received from the RS-232 interface or the magnetic reed switch plunger is pushed in, the CPU powers on by switching on Q3 and Q5. The CPU checks that main battery voltage is adequate (minimum 10 volts at the input of Q3 and Q5) before proceeding.

- **9*plus* Power Supply**
  MOSFET Q1 switches 9*plus* power to the unregulated +15 volt supply of the 9*plus*.

- **9*plus* Receiver**
  The microcontroller U12 decodes serial data from the 9*plus*.

- **Carousel Power Supply**
  MOSFET Q9 switches Carousel power to the unregulated +15 volt supply of the Carousel.

- **A/D Converter (Internal Diagnostics)**
  A 12-bit A/D converter measures main supply voltage and operating current.

- **CPU and Data I/O**
  SEARAM's CPU is configured around a CMOS 16-bit microprocessor (U19), with program storage in CMOS EPROM. Communication with the SEARAM is via RS-232 interface to the UART (U23), while level conversion is handled by U14.

- **Real-Time Clock**
  Real-time clock functions are provided by U15.

- **Memory**
  Two 8 MB FLASH RAM chips (U20 and 21) provide main data memory.

Appendix II: Electronics Disassembly/Reassembly

Jackscrew kit

Sea-Bird provides a jackscrew kit with the SEARAM, to assist in removal of the connector end cap. The kit contains:

- 2 Allen wrenches
- 3 jackscrews
- 2 spare plastic socket hex-head screws

Disassembly

Note:
Wire (not shown) connects plunger to grounding strap to prevent accidental loss of plunger.

Remove the connector end cap and attached electronics PCB assembly as follows:

1. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.

2. Remove the four Phillips-head screws securing the end cap to the housing. Do not remove the fifth screw, which is an electrical connector.

3. Remove the three plastic hex head screws from the end cap using the larger Allen wrench. Insert the three jackscrews in theses three holes in the end cap. When you begin to feel resistance, use the smaller Allen wrench to continue turning the screws. Turn each screw ½ turn at a time. As you turn the jackscrews, the end cap will push away from the housing. When the end cap is loosened, pull it and the PCB assembly out of the housing. Wires from the electronics are connected to the bottom of the electronics compartment – do not tear these connections out when removing the end cap.

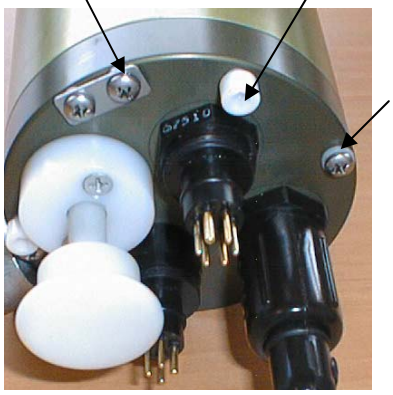
4. Remove any water from the O-ring mating surfaces inside the housing with a lint-free cloth or tissue. Protect the O-ring from damage or contamination.

5. The electronics are electrically connected to the bottom of the electronics compartment with a 3-pin Molex connector on the PCB. Holding the wire cluster near the connector, gently detach the connector from the pins.

6. Remove the jackscrews from the end cap.

Do not remove this screw.

Remove plastic hex head screws and install jackscrews in their place.



Remove 4 Phillips-head screws.

Detach wires at connector on PCB

Reassembly

Note:
Before delivery, a desiccant package is inserted in the housing and the electronics chamber is filled with dry Argon gas. These measures help prevent condensation. To ensure proper functioning:

1. Install a new desiccant bag each time you open the electronics chamber. If a new bag is not available, see *Application Note 71: Desiccant Use and Regeneration (drying)*.
2. If possible, dry gas backfill each time you open the housing. If you cannot, wait at least 24 hours before redeploying, to allow the desiccant to remove any moisture from the housing.

Note that opening the battery compartment does not affect desiccation of the electronics.

1. Reinstall the end cap:
   A. Remove any water from the O-ring and mating surfaces with a lint-free cloth or tissue. Inspect the O-ring and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-ring and mating surfaces.
   B. Plug the 3-pin Molex connector onto the pins on the PCB.
   C. Carefully fit the end cap into the housing, aligning the holes in the end cap and housing, until the O-ring is fully seated.
   D. Reinstall the four Phillip-head screws to secure the end cap.
   E. Reinstall the 3 plastic hex head screws in the end cap.

2. Verify that the switch plunger on the top end cap is pulled out, so the SEARAM will be in quiescent (sleep) state.

Appendix III: Command Summary

FUNCTION	COMMAND	DESCRIPTION
Status	**DS**	Display operating status.
	CP	Display bottle closure parameters.
General Setup	**MMDDYY= mmddyy**	Set real-time clock month, day, year. Follow with **HHMMSS=** or it will not set date.
	DDMMYY= ddmmyy	Set real-time clock day, month, year. Follow with **HHMMSS=** or it will not set date.
	HHMMSS= hhmmss	Set real-time clock hour, minute, second.
	Baud=x	**x**= baud rate for general communication and uploading (300, 600, 1200, 2400, 4800, 9600, 19200, or 38400)
	BatteryType=x	**x=nimh**: Set battery type to NiMH. **x=nicad**: Set battery type to Ni-Cad. **x=alkaline**: Set battery type to alkaline.
	SampleNum=0 * or **CastNum= 0 ***	Initialize logging – use to reset data pointers and cast number **after existing data has been removed from SEARAM** and prior to recording new data. Sending *either* sets both **SampleNum** and **CastNum** to 0. When switch plunger is pushed in, recording begins immediately. First time switch is pushed in after receipt of **SampleNum=0** or **CastNum=0**, data recording starts at beginning of memory and any previously recorded data is written over, whether memory has been erased (**Erase Memory**) or not. When switch is pulled out, recording stops. Each time switch is pushed in again, recording continues with new data stored after previously recorded data and a new header written to indicate time, date, incremented cast number, and sample numbers contained in cast. Up to 100 casts may be taken or until memory is full.
	Erase Memory *	Erase memory, **destroying all data in SEARAM**. All data bits are set to 1; sample number, header number, and data pointers are set to 0. Erasing memory is optional, as SEARAM writes over previously recorded information when **SampleNum=0** or **CastNum=0** is used. Knowledge of initial memory contents (i.e., all 1's) can be a useful cross check when data is uploaded.
	QS	Quit session and place SEARAM in quiescent (sleep) state. Main power is turned off; memory retention is unaffected. (SEARAM automatically enters quiescent state after 2 minutes have elapsed without receiving a command.)

FUNCTION	COMMAND	DESCRIPTION
SBE 9*plus* Setup	**Ave=x**	**x=** number of scans to average in SEARAM (1 to 96). Averaging reduces data storage requirements, but also reduces measurement resolution.
	SF=x	**x**= number of 9*plus* frequency channels to suppress in SEARAM. Unused channels are not stored in memory. **x** = 0 if SBE 3 or 4 connected to JB5 on 9*plus* bottom end cap connector (dual redundant sensor configuration). **x** = 1 if SBE 3 or 4 connected to JB4 on 9*plus* bottom end cap connector and not using JB5 (single redundant sensor configuration). **x** = 2 if not using redundant sensors.
	SV=x	**x=** number of 9*plus* voltage channels to suppress in SEARAM (**x** = 0, 2, 4, 6, or 8). Unused channels are not stored in memory. SEARAM can suppress voltage channels above highest numbered channel being used. **Connector** / **Uses Channels** / **Connector** / **Uses Channels** JT2 (AUX1) 0 and 1 JT5 (AUX3) 4 and 5 JT3 (AUX2) 2 and 3 JT6 (AUX4) 6 and 7
	AC0=x	**x=** number of 9*plus* scans (**x**=0 - 3) to advance *primary* conductivity to align conductivity and temperature data.
	AC1=x	**x=** number of 9*plus* scans (**x**=0 - 3) to advance *secondary* conductivity to align conductivity and temperature data.
	Fx	Turn SEARAM power to 9*plus* power on/off, instead of using SEARAM's switch plunger. **x=O**: turn power to 9*plus* on. **x=F**: turn power to 9*plus* off.
Carousel Setup	**Cx**	**x=O**: Turn SEARAM power to Carousel on. **x=F**: Turn SEARAM power to Carousel off.
	#xxx	Relay character string defined by **xxx** to Carousel. **xxx** can be any command recognized by Carousel – see Carousel manual for list of commands.
Auto Fire Arm/Disarm Arm before launching to take water samples. Disarm to log data but not take water samples.	**Arm**	Arm (enable) auto fire.
	Disarm	Disarm (disable) auto fire.
Data Upload Pull out switch plunger before uploading data.	**DC [x]**	Display raw data in hex from cast **x**. If **x** omitted, data from cast 0 displays.
	DD [x1,x2]	Display raw data in hex from scan **x1** through **x2**. If **x1** and **x2** omitted, data from every scan displays.
	DH	Display all headers.
Diagnostics	**BV**	Display SEARAM main battery voltage.
	BI	Display SEARAM main battery current (amps).
	VR	Continuously display SEARAM voltages – main battery voltage and operating current (amps). SEARAM switches on power to 9*plus* and Carousel, so operating current is total current drawn by SEARAM, 9*plus*, and Carousel. Press Esc key to stop test.
	TestEE	Test SEARAM EEPROM.
	Flash Initialize *	Perform memory test, **destroying all data in SEARAM**. Maps bad data blocks, allowing SEARAM to avoid using those blocks when recording data. Requires approximately 20 minutes, and cannot be stopped once it begins.
	Flash Map	Display results of mapping from **Flash Initialize**. Press Esc key to abort at any time.

Note:
Start logging by pushing in SEARAM switch plunger. Stop logging by pulling out SEARAM switch plunger.

Notes:
- The first cast is cast 0.
- Use Upload on the Toolbar or Upload Data in the Data menu to upload data that will be processed by SBE Data Processing. Manually entering data upload commands does not produce data with the required header information for processing by our software.

FUNCTION	COMMAND	DESCRIPTION
Commands not typically sent: ***Auto Fire General Setup***	**NB=x**	**x=** total number of bottles to be closed during deployment (maximum 24).
	BC n,m	Perform bottle closure **n** at pressure **m** (decibars). Repeat **NB** times, providing each closure pressure. Default 0 decibars for each bottle.
	BS n,m	SEARAM allows bottles to be fired out of numerical sequence. Bottle closure **n** closes bottle number **m**. Repeat **NB** times, providing closure sequence for each bottle. Default is **n** equals **m** (bottles close in order of bottle number).
Commands not typically sent: ***Bottle Bottom Closure and Upcast Logic Setup***	**BBx**	**x=Y**: Enable bottom bottle closure – close a bottle when pressure remains within **BBP** decibars for **BBT** minutes. **x=N**: Disable bottom bottle closure.
	BBP=x	**x=** bottom bottle pressure window (decibars).
	BBT=x	**x=** bottom bottle time (minutes).
	BUP=x	**x=** pressure (decibars) to enable upcast.
	BUD=x	**x=** pressure decrease (decibars) from maximum to enable upcast.
Commands not typically sent: ***Pressure Coefficients*** Used to calculate pressure from pressure sensor frequency data, to determine when to close bottles. Should agree with Calibration Certificate shipped with SEARAM.	**PC1=x**	**x**=C1 coefficient
	PC2=x	**x**=C2 coefficient
	PC3=x	**x**=C3 coefficient
	PD=x	**x**=D coefficient
	PT1=x	**x**=T1 coefficient
	PT2=x	**x**=T2 coefficient
	PT3=x	**x**=T3 coefficient
	PT4=x	**x**=T4 coefficient
	PADM=x	**x**=Adm coefficient
	PADB=x	**x**=Adb coefficient

Appendix IV: Replacement Parts

Part Number	Part	Application Description	Quantity in SEARAM
50092	SBE 16/19 Jackscrew Kit	For removing connector end cap	1
801642	NiMH battery pack (standard)	12-cell rechargeable battery pack	1
90504	NiMH battery pack charger (standard)	Includes NiMH charger, 17015 AC power cord, and 801509 charger cable	-
20165	Fuse, 5 x 20 mm, 3.0A, 250V, Fast Blow	For NiMH battery pack charger	
80259	Ni-Cad battery pack	12-cell rechargeable battery pack	-
90226	Ni-Cad battery pack charger	Includes Ni-Cad charger, 17015 AC power cord, and 80844 charger cable	-
90059	115 VAC power/test junction box	Junction box and cables for external power to SEARAM	-
90046	230 VAC power/text junction box	Junction box and cables for external power to SEARAM	
41124B	Cover plate	For optional alkaline batteries	1
801380	4-pin RMG-4FS to DB-9S data I/O cable, 20 m (66 ft)	From SEARAM to computer	1
171888	25-pin DB-25S to 9-pin DB-9P cable adapter	For use with computer with DB-25 connector	-
17043	Locking sleeve	Locks I/O cable or dummy plug in place	1
17132	6-pin AG-206 to 6-pin AG-206 cable, 0.3 m (1.1 ft)	SEARAM to 9*plus* interface cable	1
17198	6-pin AG-206 to 6-pin AG-206 cable, 2 m (6.6 ft)	SEARAM to Carousel interface cable	1
17046.1	4-pin RMG-4FS dummy plug with locking sleeve	For use when I/O cable not being used	1
17047.1	6-pin AG-206 dummy plug with locking sleeve	For use when 9*plus* or Carousel cable not being used	2
801421	4-pin MCIL-4FS to DB-9S data I/O wet-pluggable cable, 20 m (66 ft)	From SEARAM to computer	1
171192	MCDLS-F wet-pluggable locking sleeve	Locks I/O cable or dummy plug in place	1
171796	6-pin MCIL-6FS to 6-pin MCIL-6FS wet-pluggable cable, 0.3 m (1.1 ft)	SEARAM to 9*plus* interface cable	1
171741	6-pin MCIL-6FS to 6-pin MCIL-6FS wet-pluggable cable, 2 m (6.6 ft)	SEARAM to Carousel interface cable	1
171398.1	4-pin MCDC-4-F wet-pluggable dummy plug with locking sleeve	For use when I/O cable not being used	1
171498.1	6-pin MCDC-6-F wet-pluggable dummy plug with locking sleeve	For use when 9*plus* or Carousel cable not being used	2

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Part Number	Part	Application Description	Quantity in SEARAM
50051	Small hardware and o-ring kit (aluminum housing)	Assorted hardware and o-rings, including: • 30072 Parker 2-017N674-70 (for bulkhead connectors) • 30080 Parker 2-204N674-70 (for switch assembly) • 30090 Parker 2-153N674-70 (battery end cap face seal) • 30815 Parker 2-233E603-70 (for connector end cap) • 30816 Parker 2-234E603-70 (battery end cap radial seal) • 30145 Machine screw 6-32 x ½ PH SS (secure battery endplate) • 30154 Machine screw 8-32 x 3/8 PH SS (for groundstrap) • 30160 Machine screw 8-32 x 7/8 FH Al (secure SEARAM switch to housing - aluminum screw) • 30164 Machine screw 8-32 x 1-1/8 PH SS (connector end cap hardware) • 30236 Washer, #8 nylon (for groundstrap) • 30242 Washer, #6 flat (secure battery endplate) • 30267 Screw insulator, #8 x ½ (for 30164) • 30362 Nut, 6-32 nylon stop (secure boardset to end cap through threaded rod)	-
50140	Small hardware and o-ring kit (titanium housing)	Assorted hardware and o-rings, including: • 30072 Parker 2-017N674-70 (for bulkhead connectors) • 30080 Parker 2-204N674-70 (for installing switch assembly) • 30090 Parker 2-153N674-70 (battery end cap face seal) • 30815 Parker 2-233E603-70 (for connector end cap) • 30816 Parker 2-234E603-70 (battery end cap radial seal) • 30145 Machine screw 6-32 x ½ PH SS (secure battery endplate) • 30654 Machine screw 8-32 x ¾ FH TT (secure SEARAM switch to housing) • 30346 Bolt, 10-24 x 1” Hex TT (connector end cap hardware) • 30242 Washer, #6 flat (secure battery endplate) • 30362 Nut, 6-32 nylon stop (secure boardset to end cap through threaded rod) • 30447 Bolt, ¼-20 x 1-1/4, Hex TT (secure battery end cap handle to end cap)	-

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Part Number	Part	Application Description	Quantity in SEARAM
50105	Spares kit (aluminum housing, standard connectors)	Assorted cables, connectors, dummy plugs, and hardware, including: • 50051 Small hardware & o-ring Kit (see above) • 50092 Jackscrew kit (see above) • 17043 Plastic locking sleeve (for dummy plugs) • 17046 4-pin female dummy plug (for 4-pin bulkhead connector) • 17047 6-pin female dummy plug (for 6-pin bulkhead connector) • 17132 13" 6-pin to 6-pin cable (SEARAM to 9*plus* interface cable) • 17628 6-pin bulkhead connector (Carousel or 9*plus* connector) • 17654 4-pin bulkhead connector (I/O connector) • 23155.1 Switch (magnetic switch assembly) • 30044 Anode, 1" (for corrosion prevention) • 41124B Battery cover PCB (battery compartment cover plate for alkaline batteries)	-
50141	Spares kit (titanium housing, standard connectors)	Assorted cables, connectors, dummy plugs, and hardware, including: • 50092 Jackscrew kit (see above) • 50140 Small hardware & o-ring kit (see above) • 17043 Plastic locking sleeve (for dummy plugs) • 17046 4-pin female dummy plug (for 4-pin bulkhead connector) • 17047 6-pin female dummy plug (for 6-pin bulkhead connector) • 17132 13" 6-pin to 6-pin cable (SEARAM to 9*plus* interface cable) • 17628 6-pin bulkhead connector (Carousel or 9*plus* connector) • 17654 4-pin bulkhead connector (I/O connector) • 23155.1 Switch (magnetic switch assembly) • 41124B Battery cover PCB (battery compartment cover plate for alkaline batteries)	-

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Part Number	Part	Application Description	Quantity in SEARAM
50328	Spares kit (aluminum housing, wet-pluggable connectors)	Assorted cables, connectors, dummy plugs, and hardware, including: • 50051 Small hardware & o-ring Kit (see above) • 50092 Jackscrew kit (see above) • 171192 Plastic locking sleeve, (for dummy plugs) • 171398 4-pin female dummy plug (for 4-pin bulkhead connector) • 171498 6-pin female dummy plug (for 6-pin bulkhead connector) • 171796 13” 6-pin to 6-pin cable (SEARAM to 9*plus*) • 172025 4-pin bulkhead connector (I/O connector) • 172026 6-pin bulkhead connector (Carousel or 9*plus* connector) • 23155.1 Switch (magnetic switch assembly) • 30044 Anode, 1” (for corrosion prevention) • 41124B Battery cover PCB (battery compartment cover plate for alkaline batteries)	-
50329	Spares kit (titanium housing, wet-pluggable connectors)	Assorted cables, connectors, dummy plugs, and hardware, including: • 50092 Jackscrew kit (see above) • 50140 Small hardware & o-ring kit (see above) • 171192 Plastic locking sleeve (for dummy plugs) • 171398 4-pin female dummy plug (for 4-pin bulkhead connector) • 171498 6-pin female dummy plug (for 6-pin bulkhead connector) • 171796 13” 6-pin to 6-pin cable (SEARAM to 9*plus* cable) • 172021 4-pin bulkhead connector (I/O connector) • 172022 6-pin bulkhead connector (Carousel or 9*plus* connector) • 23155.1 Switch (magnetic switch assembly) • 41124B Battery cover PCB (battery compartment cover plate for alkaline batteries)	-

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