SEASOFTH-Win32: SEASAVE
CTD Real-Time Data Acquisition Software for Windows 95/98/NT/2000/XP

User’s Manual
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Software Release 5.37 and later
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Section 1: Introduction

This section includes contact information and a brief description of SEASOFT-Win32 and its components.

How to Contact Sea-Bird

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Except from April to October, when we are on ‘summer time’
(1500 to 0000 Universal Time)

Summary

SEASOFT-Win32 consists of modular, menu-driven routines for acquisition, display, processing, and archiving of oceanographic data acquired with Sea-Bird equipment. SEASOFT-Win32 is designed to work with a PC running Win 95/98/NT/2000/XP.

SEASOFT-Win32 is actually several stand-alone programs:
• SEATERM and SeatermAF terminal programs that send commands to instrument for status, data acquisition setup, data retrieval, and diagnostics
• SEASAVE program that acquires real-time data
• SBE Data Processing program that converts, edits, processes, and plots data
• Plot39 program for plotting SBE 39 and SBE 48 data

This manual covers only SEASAVE, which:
• acquires real-time, raw data (frequencies and voltages) and saves the raw data to the computer for later processing
• displays selected raw and/or converted (engineering units) real-time or archived data in text and plot displays

Additional SEASAVE features include the ability to:
• send commands to close water sampler bottles
• save NMEA navigation data with the CTD data
• save user-input header information with the CTD data, providing information that is useful for identifying the data set
• output converted (engineering units) data to a computer COM port or file on the computer
• output data to a remote display
• set up alarm parameters
• mark real-time data to note significant events in a cast

Note:
The following SEASOFT-DOS calibration modules are not yet available in SEASOFT-Win32:
• OXFIT – compute oxygen calibration coefficients
• OXFITW – compute oxygen calibration coefficients using Winkler titration values
• OXSAT – compute oxygen saturation as a function of temperature and salinity
• PHFIT – compute pH coefficients
See the SEASOFT-DOS manual.
Section 1: Introduction

System Requirements

Sea-Bird recommends the following minimum system requirements for SEASOFT-Win32: Pentium 90 CPU, 64 Mbyte RAM, Windows 98 or later.

Products Supported

SEASAVE supports the following Sea-Bird instruments:

- SBE 911plus, 917plus, 911, and 911e CTD system
- SBE 16plus and 16 SEACAT C-T (optional pressure) Recorder
- SBE 19plus and 19 SEACAT Profiler
- SBE 21 SEACAT Thermosalinograph
- SBE 25 SEALOGGER CTD
- SBE 31 Multi-Channel Logger
- SBE 45 MicroTSG Thermosalinograph
- SBE 49 FastCAT CTD Sensor

Additionally, SEASAVE supports many other sensors / instruments interfacing with the instruments listed above, including Sea-Bird oxygen, pH, and ORP sensors; SBE 32 Carousel Water Sampler; and assorted equipment from third party manufacturers.

Differences from SEASOFT-DOS

SEASOFT was previously available in a DOS version. Following are the differences between SEASOFT-Win32 and SEASOFT-DOS, as they relate to SEASAVE:

1. SEASOFT-Win32 includes several stand-alone programs; you can install any or all of these programs as desired:
   - SEASAVE - Windows-based SEASAVE replaces SEASAVE and SEACON in SEASOFT-DOS
   - SBE Data Processing - replaces the data processing programs and SEACON in SEASOFT-DOS
   - Terminal Programs - Windows-based terminal programs SEATERM and SeatermAF replace the terminal programs in SEASOFT-DOS (TERM1621, TERM17, TERM19, TERM25, TERM37, TERMAFM, TERM11, and TMODEM).
   - Plot39 - Windows-based plotting program for SBE 39 and 48 data.

2. SEASAVE now supports use of serial ports COM1 through COM10.

3. Up to 10 displays can be active on the desktop at once. Displays can be added, deleted, and modified without interrupting data acquisition.

4. Each display in the SEASAVE window has its own display setup file. Save the file to a new name after modifying the display to build an accessible list of pre-configured displays. File extensions for display setup files vary, depending on the display type: .dso extension for overlay (X-Y) displays, .dsf extension for fixed displays, and .dss extension for scrolled displays.

5. Processing capability (for example, interfacing to additional auxiliary sensors) added to our software after November 2000 has been added only to the Windows version.
Section 2: Installation and Use

SEASAVE requires approximately 9 Mbytes of disk space during installation. Ensure there is room on your hard drive before proceeding. Sea-Bird recommends the following minimum system requirements for SEASOFT-Win32: Pentium 90 CPU, 64 Mbyte RAM, Windows 98 or later.

Installation

1. If not already installed, install SEASAVE and other Sea-Bird software programs on your computer using the supplied software CD:

A. Insert the CD in your CD drive.
B. Double click on Seasoft-Win32.exe.
C. Follow the dialog box directions to install the software.

The default location for the software is c:/Program Files/Sea-Bird. Within that folder is a sub-directory for each program. The installation program allows you to install the desired components. Install all the components, or just install SEASAVE.

Note:
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.
- You may not need the latest version. Our revisions often include improvements and new features related to one instrument, which may have little or no impact on your operation.
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.
SEASAVE Use

SEASAVE Window

To start SEASAVE:

- Double click on seasave.exe (default location c:/Program Files/Sea-Bird/Seasave-Win32), or
- (for Windows 98 and later) Left click on Start and follow the path Programs/Sea-Bird/Seasave-Win32

SEASAVE’s main window looks like this:

- Menus - The Menus contain options for setting up the instrument and the displays, as well as for starting data acquisition.

- Toolbar - The Toolbar contains buttons for adding and setting up the displays. To display or hide the Toolbar, select Toolbar in the View menu.

- Status Bar - The Status Bar is located at the bottom of the screen, and provides the following information:
  - If SEASAVE is storing data to disk (acquiring data) or reading archived data.
  - Output data file name.
  - Instrument configuration (.con) file name.

To display or hide the Status Bar, select Status bar in the View menu.

Note: SEASAVE can be run from the command line. See Appendix I: Command Line Operation.
Section 2: Installation and Use

Display Windows - SEASAVE can display up to ten windows. The windows can be set up to display real-time data (conductivity, temperature, pressure, etc.) as well as calculated parameters such as salinity and sound velocity. The three windows types - fixed, scrolled, and overlay (plot) - are briefly described below; their setup is described in detail in Section 6: ScreenDisplay Menu - Setting Up SEASAVE Displays.

- **The Fixed Display** window has a vertical list of the selected parameters to the left, and displays their current values to the right.

- **The Scrolled Display** window has a list of the selected parameters across the top, and displays the data in scrolling vertical columns.

- **The Overlay (plot) Display** window plots one parameter on the y-axis and up to four parameters on the x-axis.

Notes:

- The algorithms used to calculate derived parameters in SEASAVE are the same as used in SBE Data Processing’s Derive and Data Conversion modules (with the exception of the oxygen calculation). See the SBE Data Processing manual on our website or the SBE Data Processing Help files for details.

- Oxygen computed by SEASAVE and SBE Data Processing’s Derive module is somewhat different from values computed by SBE Data Processing’s Derive module, because the algorithm uses the derivative of the oxygen signal with respect to time. SEASAVE and Data Conversion compute the derivative looking backward in time, since they share common code and SEASAVE cannot use future values of oxygen while acquiring data in real time. Derive uses a centered window (equal number of points before and after the scan) to obtain a better estimate of the derivative. Use SEASAVE (or Data Conversion) to obtain a quick look at oxygen values; use Derive to obtain the most accurate values.

- If your data includes underwater and surface PAR data, you can select Corrected Irradiance [CPAR] as an output variable. SEASAVE calculates:

  \[
  \text{CPAR} = \frac{100 \times \text{ratio multiplier} \times \text{underwater PAR}}{\text{surface PAR}}
  \]

  where

  \[
  \text{ratio multiplier} = \text{scaling factor used for comparing light fields of disparate intensity; input in .con file entry for surface PAR sensor}
  \]

  underwater PAR = underwater PAR data

  surface PAR = surface PAR data

  For complete description of ratio multiplier, see Application Note 11S (11plus Deck Unit) or 47 (SBE 33 or 36 Deck Unit).
Getting Started

Displaying Archived Data - Sea-Bird Demo Files

SEASAVE can be used to display archived raw data in a .hex or .dat file. Sea-Bird provides example files with the software to assist you in learning how to use SEASAVE. These files are automatically installed on your hard drive when you install SEASAVE; the default location is:

C:\Program Files\Sea-Bird\SS-WIN32-DEMO

The demo files include:

- one data file - demo.dat
- one instrument configuration file - demo.con (defines instrument sensors, calibration coefficients, etc.)
- one or more display setup files for each type of display - fixed (.dsf extension), scrolled (.dss extension), and overlay (.dso extension)
- three SEASAVE configuration files - these have a .cfg extension. The .cfg file defines the size, placement, update rate, and setup file name for each display window; and all configuration information (instrument .con file name as well as setup for alarms, ASCII output, header, mark scans, NMEA interface, remote display, and water sampler).

Follow these steps to get started using SEASAVE to display archived data:

1. In the File menu, select Open SEASAVE Configuration. The Select SEASAVE Configure File to Use dialog box appears. Browse to the desired file (default location C:\Program Files\Sea-Bird\SS-WIN32-DEMO), select one of the .cfg files, and click OK. The display windows will now correspond to the selected .cfg file.

2. In the ArchivedData menu, select Start.

3. The Start Archived Data Display dialog box appears (see Section 8: Displaying Archived Data):
   A. Click Select Data File. The Select Data File dialog box appears. Browse to the desired file (default location C:\Program Files\Sea-Bird\SS-WIN32-DEMO\demo.dat) and click OK.
   B. Click Select .con File: The Select Instrument Configuration File dialog box appears. Browse to the desired file (default location C:\Program Files\Sea-Bird\SS-WIN32-DEMO\demo.con) and click OK.
   C. Click Start Display. The example data will display.

4. As desired, modify and save the setup of the display windows (see Section 6: ScreenDisplay Menu - Setting Up SEASAVE Displays). Save the modified .cfg file, and repeat Steps 2 and 3.

Note:
When modifying and saving the display window setup files and SEASAVE configuration (.cfg) file, use new file names to avoid overwriting the demo files.
Acquiring and Displaying Real-Time Data

Follow these steps to get started using SEASAVE to acquire and display real-time data:

1. Set up the instrument, and define SEASAVE operating parameters (see Sections 3, 4, and 5: Configure Menu):
   - Instrument Configuration (.con) File - define what sensors are integrated with the instrument, each sensor’s calibration coefficients, and what other data is integrated with the data stream from the instrument.
   - Alarms - enable and set up altimeter alarm in Deck Unit (if altimeter integrated with instrument) and/or SBE 14 Remote Display alarm (if SBE 14 connected to a computer COM port).
   - ASCII Output - enable and set up output of ASCII data (converted data in engineering units) to a COM port on your computer or to a shared file on your computer.
   - Header - create a customized header for the data.
   - Mark Variable Selection - set up format for marking of selected scans of data.
   - NMEA Lat/Lon Interface - define what navigation data is written to the data file.
   - Remote Display - enable and set up output of data to an SBE 14 Remote Display (if SBE 14 connected to a computer COM port).
   - Water Sampler Configuration - enable and set up control of bottle firing for a water sampler.

2. Define SEASAVE displays. SEASAVE can have up to ten displays total. Three types are available: fixed, scrolled, and overlay (plot) displays. See Section 6: ScreenDisplay Menu - Setting Up SEASAVE Displays.

3. Start real-time data acquisition. If applicable (and if enabled in Step 1), fire bottles, mark scans, and / or send Lat/Lon data to a file during acquisition. See Section 7: Real-Time Data Acquisition.
### File Formats

File extensions are used by SEASOFT to indicate the file type.

**Input files** for real-time data acquisition:

<table>
<thead>
<tr>
<th>Extension</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>.con</td>
<td>Instrument configuration - number and type of sensors, channel assigned to each sensor, and calibration coefficients. SEASAVE uses this information to interpret the raw data from the instrument. Latest version of .con file for your instrument is supplied by Sea-Bird when the instrument is purchased, upgraded, or calibrated. If you make changes to the instrument (add or remove sensors, recalibrate, etc.), you must update the .con file. The .con file can be viewed and/or modified in SEASAVE’s Configure menu (or in SBE Data Processing).</td>
</tr>
<tr>
<td>.cfg</td>
<td>SEASAVE configuration - size, placement of, and update rate for each display window, setup file (.dsf, .dso, and .dss files) name for each display window, and all configuration information (instrument .con file name as well as setup for alarms, ASCII output, header, mark scans, NMEA interface, remote display, and water sampler). The .cfg file can be selected and saved in SEASAVE’s File menu. Note that SEASAVE always opens to the configuration specified in seasave.cfg (default location C:\Program Files\Sea-Bird\Seasave-Win32).</td>
</tr>
<tr>
<td>.dsf</td>
<td>Fixed display window setup - desired parameters and number of digits for data display. The .dsf file setup can be viewed and/or modified in SEASAVE’s ScreenDisplay menu.</td>
</tr>
<tr>
<td>.dso</td>
<td>Overlay (plot) display window setup - desired parameters and number of digits for data display, and plot characteristics (labels, grids, etc.). The .dso file setup can be viewed and/or modified in SEASAVE’s ScreenDisplay menu.</td>
</tr>
<tr>
<td>.dss</td>
<td>Scrolled display window setup - desired parameters and number of digits for data display. The .dss file setup can be viewed and/or modified in SEASAVE’s ScreenDisplay menu.</td>
</tr>
</tbody>
</table>
Output files from real-time data acquisition:

<table>
<thead>
<tr>
<th>Extension</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>.bl</td>
<td>Bottle log information - output bottle file, containing bottle firing sequence number and position, date, time, and beginning and ending scan numbers for each bottle closure. Beginning and ending scan numbers correspond to approximately a 1.5-second duration for each bottle. Information is written to file by SEASAVE each time a bottle fire confirmation is received from a water sampler. File can be used by SBE Data Processing’s Data Conversion module.</td>
</tr>
<tr>
<td>.dat</td>
<td>Data file - binary raw data file created by SEASAVE from real-time data stream from SBE 911, 911e, or 911plus. File includes header information. File can be used by SBE Data Processing’s Data Conversion module.</td>
</tr>
</tbody>
</table>
| .hex      | Data file:  
- Hexadecimal raw data file created by SEASAVE from real-time data stream from SBE 16, 16plus, 19, 19plus, 21, 25, and 49. Data uploaded from instrument’s memory (not applicable to SBE 49) also has this extension.  
- Data uploaded from SBE 17plus (used with SBE 9plus).  
- Converted (engineering units) data file created by SEASAVE from real-time data stream from SBE 45. File includes header information. File can be used by SBE Data Processing’s Data Conversion module. |
| .hdr      | Header file – Includes same header information (software version, sensor serial numbers, instrument configuration, etc.) as in .hex or .dat data file. |
| .mrk      | Mark scan information - output marker file containing sequential mark number, system time, and data for selected variables. Information is written to file by SEASAVE when user clicks on Mark Scan during real-time data acquisition to mark significant events in the cast. File can be used by SBE Data Processing’s Mark Scan module. |
| .nav      | Navigation information - output navigation file (for system integrated with NMEA Lat/Lon device) containing latitude, longitude, time, scan number, and pressure. Information is written to file by SEASAVE when user clicks on Add to .nav File during real-time data acquisition to mark significant events in the cast. |
| .txt      | ASCII output - output file created if you configure SEASAVE to output ASCII data to a shared file. |
Section 3: Configure Menu, Part I - General System Setup

This section describes the setup of the following in the Configure menu:
- Alarms
- ASCII Output
- Header Form
- Mark Variable Selection
- NMEA Lat/Lon Interface
- Remote Display
- Water Sampler Configuration

For setup of the instrument configuration (.con) file, see Section 4: Configure Menu, Part II - Instrument .con File.

Alarms

SEASAVE can set up two types of alarms:
- Alarm in the Deck Unit for an altimeter integrated with the CTD, and/or
- Alarm on the SBE 14 Remote Display

Altimeter Alarm

1. In the Configure menu, set up the CTD configuration (.con) file as desired (see Section 4: Configure Menu, Part II - Instrument .con File). Select the altimeter as one of the auxiliary voltage sensors. Save the changes.

2. In the Configure menu, select Alarms / Altimeter Alarm. In the Altimeter Alarm Configuration dialog box, select Enable Altimeter Alarm. Enter the alarm parameters and click OK.
   - Sea-Bird recommends Minimum Pressure to Enable Altimeter Alarm > 20 decibars to prevent the alarm from turning on while on the ship deck or as the system is entering the water.
   - Set Alarm Hysteresis greater than the expected ship heave (swell) to prevent on-off-on-off sounding of the alarm caused by ship heave. Example: You want the alarm to turn on at 10 meters; set Alarm Setpoint = 10 meters. There is a 0.5 meter swell; set Alarm Hysteresis = 1 meter, which should be sufficient to account for possible 0.5 meter upward movement due to ship heave. The alarm will sound at 10 meters and will stay on until the altimeter goes above 11 meters, when it will shut off until it falls to 10 meters again.

<table>
<thead>
<tr>
<th>Sea Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm not on, regardless of altimeter reading</td>
</tr>
<tr>
<td>Minimum Pressure to Enable Altimeter Alarm</td>
</tr>
</tbody>
</table>

| Alarm Hysteresis |
| alarm stays on in this range after Alarm Setpoint is reached |
| Alarm Setpoint |
| alarm on when altimeter is in this range |

<table>
<thead>
<tr>
<th>Sea Bottom</th>
</tr>
</thead>
</table>

Note:
Setup of all parameters in the Configure menu is included in the SEASAVE configuration (.cfg) file. To save the setup, you must save the .cfg file (File menu / Save Seasave configuration as . . .) before exiting SEASAVE.
Remote Display Alarm

The SBE 14 Remote Display can be set up to turn an alarm on when pressure is less than and/or more than a specified amount.

To enable and set up the Remote Display Alarm:

1. In the Configure menu, select Remote Display.

2. In the Remote Display Configuration dialog box, select Send Data to SBE 14 Display. Make other selections as desired (see Remote Display below), and click OK.

3. In the Configure menu, select Alarms / Remote Display Alarm. In the Remote Display Alarm Configuration dialog box, select the desired alarm (minimum pressure alarm and/or maximum pressure alarm) and enter the alarm setpoints in decibars. Click OK.

Note:
Remote Display alarm setup in SEASAVE is applicable only for an SBE 14 connected to a computer COM port. If the SBE 14 is connected directly to an SBE 11plus Deck Unit, Remote Display alarm setup is done by sending commands to the SBE 11plus using SEATERM.
ASCII Output

SEASAVE can output ASCII data (converted data in engineering units) to a COM port on your computer or to a shared file on your computer.

If outputting ASCII data to a shared file, you can use Word, Notepad, or some other program to open and look at the data while SEASAVE continues to acquire more data. However, the data you are viewing will not refresh while the ASCII file is open; in other words, you must close the file and reopen it to view the latest data.

To enable and set up ASCII data output:

In the Configure menu, select ASCII Output. The ASCII Output Set Up dialog box appears:

Make the desired selections and click OK.

Controls how often data for selected variables is converted to engineering units and sent to COM port. Time between updates interacts with instrument’s data output baud rate and number of output variables selected. SEASAVE will not work properly if data is presented to COM port faster than COM port can transmit it at selected baud rate. For full rate data, set to 0.

If you select Generate Shared File, Shared File defines output file location and name.

If you select Output ASCII Data to COM, ASCII Data Output Port and Comm Settings define COM port (COM1 through COM10 are available), baud rate, data bits, and parity for output data.

Enter desired number of digits to right of decimal point for each variable’s data.

Make the desired selections and click OK.
Header Form

Note:
A header is automatically included in the data (.dat or .hex) file and in the header (.hdr) file. The header includes software version, sensor serial numbers, instrument configuration, date and time of start of data acquisition, etc. There can be up to two date/time listings in the header. The first, System Upload Time, is always the date and time from the computer. The second, UTC Time, is the date and time from an optional NMEA navigation device.

SEASAVE can write a user-input descriptive header to the data file, which is useful in identifying the data set. There are three choices for header use:

- **Prompt for header information** - The user will be prompted to fill out the header form at the start of data acquisition. Only the lines with text prompts on them will appear. The completed header, along with system time, instrument type, and serial numbers, will be written to the beginning of the data file and also output to a file with the same name as the data file but with a .hdr extension.

- **Include Default Header Information in File** - The user will not be prompted to add any header information at the start of data acquisition. The user-defined default header form will be written as-is to the beginning of the data file and also output to a file with the same name as the data file but with a .hdr extension.

- **Don’t Include Header Information in File** - User-input header information will not be added to the data file or placed in the .hdr file.

To set up the header:

1. In the Configure menu, select Header Form. The Header Form Setup dialog box appears.

2. Select the desired Header Choice and enter the header. Click OK.

Example:
Prompt for Header Information is selected in the Header Form Setup dialog box, and the Header Form prompts are filled in as shown.

![Header Form Setup](image)

Note:
A header is **automatically** included in the data (.dat or .hex) file and in the header (.hdr) file. The header includes software version, sensor serial numbers, instrument configuration, date and time of start of data acquisition, etc. There can be up to two date/time listings in the header. The first, System Upload Time, is always the date and time from the computer. The second, UTC Time, is the date and time from an optional NMEA navigation device.
When you begin data acquisition, (if you chose to store the data on disk) the header form appears for you to fill in. The user-selected prompts (Ship, Cruise, Station, Latitude, and Longitude) appear to the left of the blank fields.
Mark Variable Selection

Mark Scan allows you to copy the most recent scan of data to a mark (.mrk) file as desired. The .mrk file can be used to manually note water sampler bottle firings, to compare CTD data with data from a Thermosalinograph taken at the same time, or to mark significant events in the cast (winch problems, large waves causing ship heave, etc.) for later review and analysis of the data.

If a plot display is set up to show mark lines, SEASAVE will also draw a horizontal line in the plot each time you mark a scan.

To enable and set up Mark Variables:

1. In the Configure menu, select Mark Variable Selection. The Mark Variable Configuration dialog box appears:

![Mark Variable Configuration Dialog Box]

Select Mark Type (line can be labeled with sequential mark number or with pressure), Mark Line Style, and Mark Line Color, which are applicable only if you set up a plot display to show mark lines.

Enter desired number of digits to right of decimal point for each variable's data.

Make the desired selections and click OK.

2. To set up a plot display to show mark lines - Right click in the desired Overlay plot window, and select Setup. In the Display Setup dialog box, select Show Mark Lines. Change other settings as desired, and click OK.

See Marking Scans in Section 7: Real-Time Data Acquisition to mark the scans during data acquisition.
NMEA Lat/Lon Interface

Notes:
- There can be up to two date/time listings in the header. The first, System Upload Time, is always the date and time from the computer. The second, UTC Time, is the date and time from an optional NMEA navigation device.
- NMEA Lat/Lon Interface selections are not applicable to the SBE 45. The 90402 – SBE 45 Interface Box defines what navigation data is included in the data file.

If your instrument is connected to a deck unit that can integrate data from a NMEA navigation device with the CTD data, NMEA Lat/Lon Interface defines what navigation data is written to the data file. Note that NMEA data is written to the data file only if the instrument configuration (.con) file indicates that NMEA data is to be added (see Section 4: Configure Menu, Part II - Instrument .con File).

To set up the NMEA Interface:

1. In the Configure menu, set up the CTD configuration (.con) file as desired (see Section 4: Configure Menu, Part II - Instrument .con File). Select NMEA data added in the instrument Configuration dialog box. Save the changes.

2. In the Configure menu, select NMEA Lat/Lon Interface. The NMEA Interface Configuration dialog box appears.

Select how to store the data:
- **Add to Header Only**: Latitude, longitude, and time are automatically written to the header when data acquisition is started.
- **Append to Every Scan**: Latitude, longitude, and time are automatically written to the header when data acquisition is started. Additionally, 7 bytes of Lat/Lon data are appended to every scan of CTD data.
  - Note: For the SBE 21, if NMEA depth data added is selected in the .con file, 3 bytes of depth data is also appended to every scan of CTD data, after the Lat/Lon data.
- **Append to .nav File when <Ctrl F7> is Pressed**: Latitude, longitude, and time are automatically written to the header when data acquisition is started. And, latitude, longitude, time, scan number, and pressure are written to a .nav file every time Add to .nav File is selected (see Adding NMEA Data to .nav File in Section 7: Real-Time Data Acquisition).
- **Append to Every Scan and Append to .nav File when <Ctrl F7> is Pressed**: Latitude, longitude, and time are automatically written to the header when data acquisition is started. Additionally, 7 bytes of Lat/Lon data are appended to every scan of CTD data. And, latitude, longitude, time, scan number, and pressure are written to a .nav file every time Add to .nav File is selected (see Adding NMEA Data to .nav File in Section 7: Real-Time Data Acquisition).
  - Note: For the SBE 21, if NMEA depth data added is selected in the .con file, 3 bytes of depth data is also appended to every scan of CTD data, after the Lat/Lon data.

Click OK.
Remote Display

The SBE 14 Remote Display can display depth, pressure, and/or altimeter height for a CTD system.

To enable and set up the Remote Display:

1. In the Configure menu, select Remote Display. The Remote Display Configuration dialog box appears:

   - **Depth** - displays with 4 digits
   - **Pressure** - displays with 4 digits
   - **Altimeter Height with Depth** - altimeter height and depth alternate on display; altimeter height displays with 3 digits and depth displays with 4 digits
   - **Altimeter Height with Pressure** - altimeter height and pressure alternate on display; altimeter height displays with 3 digits and pressure displays with 4 digits

   Must be selected to enable sending data to SBE 14, and to enable Remote Display Alarm (see Alarms above).

   Fresh or Salt water - affects SEASAVE's depth calculation.

   Updates at a very fast rate could make display difficult to read. Additionally, time between updates interacts with data output baud rate (set internally in SBE 14 to 300 baud; cannot be changed) and number of variables transmitted. SEASAVE will not work properly if data is presented to COM port faster than COM port can transmit it to SBE 14 at 300 baud.

   Make the desired selections and click OK.

   Notes:
   - To set up the SBE 14’s alarm, see Alarms above.
   - Remote Display setup in SEASAVE is applicable only for an SBE 14 connected to a computer COM port. If the SBE 14 is connected directly to an SBE 11plus Deck Unit, Remote Display setup is done by sending commands to the SBE 11plus using SEATERM.
Water Sampler Configuration

For real-time data acquisition, a Sea-Bird CTD can be integrated with a water sampler when used with a deck unit. The water sampler bottles can be fired by command from SEASAVE (see Firing Bottles in Section 7: Real-Time Data Acquisition).

Bottle firings can be recorded in the data in several ways:

- SEASAVE automatically writes bottle sequence number, bottle position, date, time, and beginning and ending scan numbers to a bottle log (.bl) file each time a bottle fire confirmation is received from the water sampler. The beginning and ending scan numbers correspond to approximately a 1.5-second duration for each bottle.

- For a 911plus system, SEASAVE automatically sets the bottle confirm bit in the data (.dat) file for all scans within a 1.5-second period after a bottle firing confirmation is received from the water sampler.

- If desired, you can use SEASAVE’s Mark Scan feature to manually note when bottles are fired, creating a .mrk file.

SBE Data Processing can use the bottle firing information, in any of these forms, to assist you in processing the water bottle data.

To enable and set up the water sampler:

1. In the Configure menu, select Water Sampler Configuration. The Water Sampler Configuration dialog box appears:

   Make the desired selections and click OK.

   See Firing Bottles in Section 7: Real-Time Data Acquisition for details on firing the bottles during data acquisition.
Section 4: Configure Menu, Part II - Instrument .con File

Note:
Setup of all parameters in the Configure menu, including the name and location of the selected .con file, is included in the SEASAVE configuration (.cfg) file. To save the setup, you must save the .cfg file (File menu / Save Seasave configuration as ...) before exiting SEASAVE.

This section describes the setup of the instrument configuration (.con) file in the Configure menu.

For setup of other items in the Configure menu (Alarms, ASCII Output, Header Form, Mark Variable Selection, NMEA Lat/Lon Interface, Remote Display, and Water Sampler Configuration), see Section 3: Configure Menu, Part I - General System Setup.

Introduction

The instrument configuration (.con) file defines the instrument configuration (what sensors are integrated with the instrument and what channels are used by the sensors) and the sensor calibration coefficients. SEASAVE uses this information to convert the raw data stream into engineering units for display during real-time data acquisition.

Because Sea-Bird always tries to maintain support for old instrumentation, while continuously improving and expanding our product line, SEASAVE has two instrument configuration types:

- **Old Style Instrument Configuration** - does not support products or auxiliary sensors added to software after November 2000 (such as SBE 16plus or 19plus SEACAT, SBE 45 MicroTSG, SBE 49 FastCAT, SBE 43 Dissolved Oxygen Sensor, and Turner SCUFA).

- **New Style Instrument Configuration** - does not support older products: SBE 31, 911, or 911e (but does support 9plus with 11plus or 17plus, abbreviated in SEASAVE as 911/917plus). The new style has the same features / functions / dialog boxes used by the Configure module in our Windows data processing software (SBE Data Processing), and is the style required by SBE Data Processing.

Old and new styles are compatible, except for the instruments / sensors that are not supported. This allows you to open an existing old style .con file with the new style selection in the Configure menu, and vice versa, if the instrument and sensors are all supported by that style.

- Use the new style if your system does not include any of the older instruments and you plan to use SBE Data Processing to process the data after acquisition. Note that this .con file can be created / modified in SEASAVE or SBE Data Processing.

- Use the old style if your system includes any of the older instruments or you plan to use SEASOFT-DOS to process the data after acquisition. Note that this .con file can be created / modified in SEASAVE or in the SEACON module of SEASOFT-DOS.

Notes:
- Sea-Bird supplies a .con file with each instrument. The .con file must match the existing instrument configuration and contain current sensor calibration information.
- Appendix II: Configure (.con) File Format contains a line-by-line description of the contents of the .con file.
The .con file discussion is in several parts:

- **Instrument Configuration - New Style** (in this section):
  Configuration dialog box for each instrument available in the new style (SBE 911/917plus, 16, 16plus, 19, 19plus, 21, 25, 45, and 49).

- **Instrument Configuration - Old Style** (in this section):
  Configuration dialog box for each instrument available in the old style (SBE 911plus, 911e, 911, 16, 19, 21, 25, and 31).

- **Section 5: Configure Menu, Part III - Calibration Coefficients**: calculation of calibration coefficients for each type of frequency, A/D count, and voltage sensor.

**Instrument Configuration - New Style**

The discussion of new style instrument configuration is in two parts:

- General description of how to view, modify, or create a .con file
- Detailed description of the Configuration dialog box for each instrument

**Viewing, Modifying, or Creating .con File**

1. **To create a new .con file**: In the Configure menu, select New Style Instrument Configuration / Create New Instrument Configuration and select the desired instrument. Go to Step 3.

2. **To select and view or modify an existing .con file**:
   A. In the Configure menu, select New Style Instrument Configuration / Select Instrument Configuration. In the dialog box, browse to the desired file and click OK.
   B. In the Configure menu, select New Style Instrument Configuration / Modify Selected Instrument Configuration.

3. The Instrument Configuration dialog box appears. The selections at the top of the dialog box are different for each instrument. An example is shown below for the SBE 19plus.
Section 4: Configure Menu, Part II - Instrument .con File

All Instrument Configuration dialog boxes include:

- List of instrument configuration options at the top (instrument-specific), such as number of auxiliary channels, pressure sensor type, addition of Surface PAR and NMEA to the CTD data string.

- Channel/Sensor Table: This table reflects the options selected at the top (for example, the number of voltage sensors listed in the table agrees with the user-selection for External voltage channels). Shaded sensors cannot be removed or changed to another type of sensor. All others are optional.

➢ **To change a sensor type and input its calibration coefficients:**
After you specify the number of frequency and/or voltage channels at the top of the dialog box, click a (non-shaded) sensor and click **Select** to pick a different sensor for that channel. A dialog box with a list of sensors appears.

![Select New Voltage Sensor](image)

Double click on the desired sensor. The Calibration Coefficients dialog box appears. An example is shown below for a pH sensor:

![pH](image)

Enter the desired values and click OK.

➢ **To change a sensor’s calibration coefficients:**
In the Configuration dialog box, click a sensor and click **Modify** to change the calibration coefficients for that sensor (see *Section 5: Configure Menu, Part III - Calibration Coefficients*). The Calibration Coefficients dialog box appears (example shown above).
### New Style SBE 9plus Configuration

#### Channel/Sensor table

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

#### External Voltage

<table>
<thead>
<tr>
<th>Voltage words suppressed</th>
<th>Connector</th>
<th>Words to Keep</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUP</td>
<td>AUX 1</td>
<td>1</td>
</tr>
<tr>
<td>SUP</td>
<td>AUX 2</td>
<td>2</td>
</tr>
<tr>
<td>SUP</td>
<td>AUX 3</td>
<td>3</td>
</tr>
<tr>
<td>SUP</td>
<td>AUX 4</td>
<td>4</td>
</tr>
</tbody>
</table>

#### IEEE-488 or RS-232C for CTD data interface between Deck Unit and computer.

#### Frequency channels suppressed

- **RS-232C**

#### Scans to average

- Enter number of scans to average

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

#### Click a 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.

#### Open to select different .con file.

#### New to create new .con file for this CTD.

#### Save or Save As to save current .con file settings.

#### Exit or Cancel

---

**For full rate (24 Hz) data, set to 1. Example: If number of scans to average=24, SEASAVE averages 24 scans, saving data to computer at 1 scan/second.**

**Surface PAR - Select if Surface PAR sensor used; must agree with ADDSPAR= command programmed into Deck Unit. Adds 2 channels to Channel/Sensor table. Do not decrease Voltage words suppressed to reflect this; Voltage words suppressed reflects only external voltages going directly to 9plus from auxiliary sensors. See Application Note 11S.**

**NMEA - Select if NMEA navigation device used. If selected, SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE’s Configure menu to control how Lat/Lon data is incorporated.**

---

**Opens a .txt file (for viewing and printing only; cannot be modified) that shows all parameters in .con file.**

---

**New Style SBE 9plus Configuration**

<table>
<thead>
<tr>
<th>Channel</th>
<th>Sensor</th>
<th>New</th>
<th>Open</th>
<th>Save</th>
<th>Save As</th>
<th>Select</th>
<th>Modify</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Frequency</td>
<td>Temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Frequency</td>
<td>Conductivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Frequency</td>
<td>Pressure, Digiqush with TC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. A/D voltage 0</td>
<td>pH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. A/D voltage 1</td>
<td>Oxygen, SBE 43</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. A/D voltage 2</td>
<td>Fluorometer, Bioospherical Natural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. A/D voltage 3</td>
<td>Altimeter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. SPAR voltage</td>
<td>Unavailable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. SPAR voltage</td>
<td>SPAR/Surface Irradiance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Channel/Sensor table reflects this choice. Voltage channel 0 in .con file corresponds to sensor wired to channel 0 on end cap connector, voltage channel 1 to sensor wired to channel 1 on end cap connector, etc. Total number of voltage words is 4; each word contains data from two 12-bit A/D channels. Deck Unit and SEARAM suppress words above highest numbered voltage word used. Words to suppress = 4 - Words to Keep.**

**Channel/Sensor table reflects this choice.**

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

---

**Opens a .txt file (for viewing and printing only; cannot be modified) that shows all parameters in .con file.**

---

**Click to exit dialog box. If you made changes and did not Save or Save As, SEASAVE asks if you want to save changes.**
New Style SBE 16 SEACAT C-T Recorder Configuration

Section 4: Configure Menu, Part II - Instrument .con File

New Style SBE 16 SEACAT C-T Recorder Configuration

Time between scans. Used to calculate elapsed time, if you select time as a parameter for a display window. Must agree with number programmed into SBE 16 with SI command; see reply from status command (DS).

Select if using with a deck unit connected to a NMEA navigation device. If selected, SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE’s Configure menu to control how Lat/Lon data is incorporated.

Opens a .txt file (for viewing and printing only; cannot be modified) that shows all parameters in .con file.

Configuration for the SBE 16 Seacat CTD

ASCII file opened: None
Pressure sensor type
External voltage channels: 2
Firmware version: Version >= 4.0
Sample interval seconds: 15
NMEA position data added

Select strain gauge, Digiquartz with or without temperature compensation, or no pressure sensor. If no pressure sensor or Digiquartz without Temp Comp is selected, Data button accesses a dialog box to input additional parameter(s) needed to process data.

See reply from status command (DS): Used to determine strain gauge pressure sensor data format.

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

Select if using with a deck unit connected to a NMEA navigation device. If selected, SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE’s Configure menu to control how Lat/Lon data is incorporated.

Opens a .txt file (for viewing and printing only; cannot be modified) that shows all parameters in .con file.

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

Click to exit dialog box. If you made changes and did not Save or Save As, SEASAVE asks if you want to save changes.
New Style SBE 16\textit{plus} SEACAT C-T Recorder Configuration

The SBE 16\textit{plus} can interface with one SBE 38 secondary temperature sensor, one SBE 50 pressure sensor, or up to two Pro-Oceanus Gas Tension Devices (GTDs) through the SBE 16\textit{plus} optional RS-232 connector. Data from an SBE 50 pressure sensor is appended to the data stream, and does not replace the (optional) internally mounted pressure sensor data.

Channel/Sensor table reflects this choice (0, 1, 2, 3, or 4). Must agree with number programmed into 16\textit{plus} with \texttt{VOLTn=} commands (n=0, 1, 2, and 3); see reply from status command (DS). Voltage channel 0 in .con file corresponds to first external voltage in data stream, voltage channel 1 to second external voltage in data stream, etc.

Internally mounted pressure sensor: select strain gauge, Digiquartz with temperature compensation, or no pressure sensor. If no pressure sensor is selected, Data button accesses a dialog box to input additional parameter needed to process data. Must agree with setup programmed into 16\textit{plus} with \texttt{PTYPE=} command; see reply from status command (DS). Selection applies only to 16\textit{plus} internally mounted pressure sensor; if instrument has no internally mounted pressure sensor but is interfacing with SBE 50 pressure sensor, select No pressure sensor here and then select SBE 50 in Serial RS-232C sensor field below. Note: Digiquartz without temperature compensation is not applicable.

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

Select if using with a deck unit connected to a NMEA navigation device. If selected, SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE’s Configure menu to control how Lat/Lon data is incorporated.

Click a sensor and click \texttt{Select} to pick a different sensor for that channel. A dialog box with a list of sensors appears. Select sensors after number of voltage channels have been specified above.

Opens a .txt file (for viewing and printing only; cannot be modified) that shows all parameters in .con file.
New Style SBE 19 SEACAT Profiler Configuration

SEASAVE always treats the SBE 19 as if it is a Profiling instrument (i.e., it is in Profiling mode). If your SBE 19 is in Moored Mode, you must treat it like an SBE 16 (when setting up the .con file, select the SBE 16).

Select strain gauge or Digiquartz with temperature compensation.

Number of 0.5 second intervals between samples; used to compute time between samples. SEASAVE uses this to calculate elapsed time, if you select time as a parameter for a display window. Must agree with number programmed into SBE 19 with SR command; see reply from status command (DS).

- Surface PAR - Select if surface PAR voltage added by deck unit. Selecting Surface PAR voltage adds 2 channels to Channel/Sensor table. Do not increase External voltage channels to reflect this; External voltage channels reflects only external voltages going directly to SBE 19 from auxiliary sensor. See Application Note 47.
- NMEA - Select if using with a deck unit connected to a NMEA navigation device. If selected, SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE’s Configure menu to control how Lat/Lon data is incorporated.

ASCII file opened: None
Pressure sensor type: Strain Gauge
External voltage channels: 2
Firmware version: Version >= 3.0
0.5 second intervals: 1

- Surface PAR voltage added
- NMEA position data added

Channel/Sensor table reflects this choice. Must agree with number programmed into SBE 19 with SVn (n=0, 2, or 4) command; see reply from status command (DS). Voltage channel 0 in .con file corresponds to sensor wired to channel 0 on end cap connector, voltage channel 1 in .con file corresponds to sensor wired to channel 1 on end cap connector, etc.

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

Click a sensor and click Select to pick a different sensor for that channel. A dialog box with a list of sensors appears. Select sensors after number of voltage channels have been specified above.

Opens a .txt file (for viewing and printing only; cannot be modified) that shows all parameters in .con file.

Click to exit dialog box. If you made changes and did not Save or Save As, SEASAVE asks if you want to save changes.

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

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

Opens a .txt file (for viewing and printing only; cannot be modified) that shows all parameters in .con file.
**New Style SBE 19plus SEACAT Profiler Configuration**

### Configuration for the SBE 19 Seacat plus CTD

<table>
<thead>
<tr>
<th>Channel</th>
<th>Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Count</td>
<td>Temperature</td>
</tr>
<tr>
<td>2. Frequency</td>
<td>Conductivity</td>
</tr>
<tr>
<td>3. Count</td>
<td>Pressure, Strain Gauge</td>
</tr>
<tr>
<td>4. A/D voltage 0</td>
<td>Oxygen, SBE 43</td>
</tr>
<tr>
<td>5. A/D voltage 1</td>
<td>pH</td>
</tr>
<tr>
<td>6. A/D voltage 2</td>
<td>Transmissometer, Chelsea/Seatech/Wetlab C6603</td>
</tr>
<tr>
<td>7. A/D voltage 3</td>
<td>Altimeter</td>
</tr>
</tbody>
</table>

#### New
- Click to create new .con file for this CTD. **Open** to select different .con file. **Save** or **Save As** to save current .con file settings.

#### Edit
- Click a sensor and click **Modify** to change calibration coefficients for that sensor.

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

**ASCII file opened**: None

**Pressure sensor type**: Strain Gauge

**External voltage channels**: 4

**Mode**: Profile

**Sample interval seconds**: 10

**Scans to average**: 1

- **Surface PAR voltage added**: Must agree with 19plus setup (MP command for Profiling mode, MM command for Moored mode); see reply from status command (DS).

- **NMEA position data added**: Number of samples to average (samples at 4 Hz) in Profiling mode. Used to calculate elapsed time, if you select time as a parameter for a display window. Must agree with number programmed into 19plus with NAVG= command; see reply from status command (DS).

**Interval between scans in Moored mode**: SEASAVE uses this to calculate elapsed time, if you select time as a parameter for a display window. Must agree with number programmed into 19plus with SAMPLEINTERVAL= command; see reply from status command (DS).

- **Surface PAR - Select if surface PAR voltage added by deck unit. Selecting Surface PAR voltage adds 2 channels to Channel/Sensor table. Do not increase External voltage channels to reflect this; External voltage channels reflects only external voltages going directly to 19plus from auxiliary sensor. See Application Note 47.**

- **NMEA - Select if using with a deck unit connected to a NMEA navigation device. If selected, SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE's Configure menu to control how Lat/Lon data is incorporated.**

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

Opens a .txt file (for viewing and printing only; cannot be modified) that shows all parameters in .con file.

Click to exit dialog box. If you made changes and did not Save or Save As, SEASAVE asks if you want to save changes.
Section 4: Configure Menu, Part II - Instrument .con File

New Style SBE 21 Thermosalinograph Configuration

Channel/Sensor table reflects this choice. Must agree with number programmed into SBE 21 with SBE3= or SBE38= command; see reply from status command (DS). Voltage channel 0 in .con file corresponds to sensor wired to channel 0 on end cap connector, voltage channel 1 in .con file corresponds to sensor wired to channel 1 on end cap connector, etc.

Select if Interface Box connected to a NMEA navigation device. If selected, SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE’s Configure menu to control how Lat/Lon data is incorporated.

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

Open .txt file (for viewing and printing only; cannot be modified) that shows all parameters in .con file.

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

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

Click to exit dialog box. If you made changes and did not Save or Save As, SEASAVE asks if you want to save changes.

Select if Interface Box connected to a NMEA depth device. Select NMEA (Lat/Lon) Interface in SEASAVE’s Configure menu to control how depth data is incorporated.

Time between scans. Used to calculate elapsed time, if you select time as a parameter for a display window. Must agree with number programmed into SBE 21 with SI command; see reply from status command (DS).

If remote temperature is selected, SEASAVE (and Data Conversion and Derive in SBE Data Processing) uses remote temperature data when calculating density and sound velocity.

Channel/Sensor table reflects this choice (shows additional frequency-based temperature channel if SBE 3 selected, or RS-232 channel if SBE 38 selected). Must agree with SBE3= or SBE38= command programmed into SBE 21 to enable or disable external temperature sensor; see reply from status command (DS).
New Style SBE 25 SEALOGGER Configuration

Channel/Sensor table reflects this choice (0 - 7). Must agree with number programmed into SBE 25 with CC command; see reply from status command (DS). Voltage channel 0 in .con file corresponds to first external voltage in data stream, voltage channel 1 to second external voltage in data stream, etc.

1. Frequency
2. Conductivity
3. Pressure voltage
4. A/D voltage 0
5. A/D voltage 1
6. SPAR voltage
7. SPAR voltage

- Surface PAR - Select if Surface PAR voltage added by deck unit. Selecting Surface PAR voltage adds 2 channels to Channel/Sensor table. Do not increase External voltage channels to reflect this; External voltage channels reflects only external voltages going directly to SBE 25 from auxiliary sensor. See Application Note 47.
- NMEA - Select if using with a Deck Unit connected to a NMEA navigation device. SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE’s Configure menu to control how Lat/Lon data is incorporated.

Opens a .txt file (for viewing and printing only; cannot be modified) that shows all parameters in .con file.

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

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

Click to exit dialog box. If you made changes and did not Save or Save As, SEASAVE asks if you want to save changes.
New Style SBE 45 MicroTSG Configuration

The SBE 45 transmits ASCII converted data in engineering units. It converts the raw data internally to engineering units, based on the programmed calibration coefficients. See the SBE 45 manual.

Define data in SBE 45 data stream:
- Output conductivity with each scan. Must agree with OUTPUTCOND= command programmed into SBE 45.
- Output salinity with each scan – Must agree with OUTPUTSAL= command programmed into SBE 45.
- Output sound velocity with each scan – Must agree with OUTPUTSV= command programmed into SBE 45. See reply from status command (DS) for setup programmed into SBE 45.

- Use junction box - Select if SBE 45 data is transmitted to computer through optional 90402 – SBE 45 Interface Box. Interface Box can append optional SBE 38 and NMEA data to SBE 45 data stream.
- SBE 38 temperature added – Select if 90402 – SBE 45 Interface Box is connected to SBE 38 remote temperature sensor. Interface Box appends SBE 38 data to data stream. SEASAVE (and Data Conversion and Derive in SBE Data Processing) uses remote temperature data when calculating density and sound velocity.
- NMEA data added - Select if 90402 – SBE 45 Interface Box is connected to a NMEA navigation device. Interface Box appends NMEA data to data stream. SEASAVE adds current latitude, longitude, and universal time code to data header.

Time between scans. Must agree with number programmed into SBE 45 with INTERVAL= command; see reply from status command (DS).

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

Click to exit dialog box. If you made changes and did not Save or Save As, SEASAVE asks if you want to save changes.
New Style SBE 49 FastCAT Configuration

Number of samples to average per scan. SBE 49 samples at 16 Hz (0.0625 seconds), averages data, and transmits averaged data real-time. Must agree with number programmed into SBE 49 with \texttt{NAVG=} command; see reply from status command (\texttt{DS}).

Click a sensor and click \texttt{Modify} to change calibration coefficients for that sensor.

New to create new .\texttt{con} file for this CTD. Open to select different .\texttt{con} file. Save or \texttt{Save As} to save current .\texttt{con} file settings.

Click to exit dialog box. If you made changes and did not Save or \texttt{Save As}, \texttt{SEASAVE} asks if you want to save changes.

Opens a .\texttt{txt} file (for viewing and printing only; cannot be modified) that shows all parameters in .\texttt{con} file.
Section 4: Configure Menu, Part II - Instrument .con File

Instrument Configuration - Old Style

The discussion of old style instrument configuration is in two parts:

- General description of how to view, modify, or create a .con file
- Detailed description of the Configuration dialog box for each instrument

Note:
Unless noted otherwise, SEASAVE supports only one of each brand and type of auxiliary sensor interfacing with a CTD. For example, you cannot specify two Chelsea Minitracka fluorometers, but you can specify a Chelsea Minitracka and a Chelsea Aqua 3 fluorometer. SEASAVE’s Old Style Instrument Configuration will not give you an error message if you select two or more of the same sensor; however, it will use the calibration coefficients of the first sensor for all identical sensors. See the individual sensor descriptions in Section 5: Configure Menu, Part III – Calibration Coefficients for those sensors that SEASAVE does support in a redundant configuration (two or more of the same sensor interfacing with the CTD) when using the Old Style configuration.

Viewing, Modifying, or Creating .con File

1. In the Configure menu, select Old Style Instrument Configuration. The Select Instrument Configuration File dialog box appears:

2. To create a new .con file: Click Create New [.con] File. In the dialog box, browse to the desired location for the new .con file, enter the desired file name, and click OK. Go to Step 4.

3. To select and view or modify an existing .con file: Click Select [.con] File. In the dialog box, browse to the desired file and click OK.

4. Click Examine / Change [.con] File. The Examine / Change Instrument Configuration File dialog box appears. An example is shown below:

A. If creating a new .con file: Select the desired instrument type from the Instrument Type pull down menu.
B. Click Change Instrument Configuration to change or set up the configuration of the instrument (number and type of sensors, channel assigned to each sensor, etc.). The Instrument Configuration dialog box appears. This dialog box is different for each instrument. An example is shown below for the SBE 19.

![Instrument Configuration Dialog Box](image)

All Instrument Configuration dialog boxes include:

- **List of instrument configuration options at the top** (instrument-specific), such as number of auxiliary channels, pressure sensor type, addition of Surface PAR and NMEA to the CTD data string, etc.

- **Modify Data Format Button and List of Channels and Assigned Sensors**: This list reflects the options selected at the top (for example, the number of voltage sensors listed agrees with the user selection for External voltage channels). Click the button to modify the list of sensors assigned to the channels.

Make the desired selections and click OK.
C. After completing instrument configuration, click Change Calibration Coefficients (in the Examine / Change Instrument Configuration File dialog box) to change or enter sensors’ serial numbers, calibration dates, and/or calibration coefficients. The Change Calibration Coefficients dialog box appears, with a list of the sensors you defined for the configuration in Step 4B:

![Change Calibration Coefficients dialog box]

Double click on a sensor to bring up its calibration coefficient dialog box. An example is shown below for a pH sensor:

![pH sensor calibration box]

Enter or modify the information in the dialog box, and click OK.

D. In the Change Calibration Coefficients dialog box, click OK when done entering / modifying calibration coefficients for the sensors.

E. In the Examine / Change Instrument Configuration File dialog box, click Save [.con] File.
Section 4: Configure Menu, Part II - Instrument .con File

Old Style SBE 9plus Configuration

Listing of channels at bottom of dialog box reflects this choice. Total number of voltage words is 4, and each word contains data from two 12-bit A/D channels. SBE 11plus 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

<table>
<thead>
<tr>
<th>External Voltage</th>
<th>Connector</th>
<th>Words to Keep</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 or 1</td>
<td>AUX 1</td>
<td>1</td>
</tr>
<tr>
<td>2 or 3</td>
<td>AUX 2</td>
<td>2</td>
</tr>
<tr>
<td>4 or 5</td>
<td>AUX 3</td>
<td>3</td>
</tr>
<tr>
<td>6 or 7</td>
<td>AUX 4</td>
<td>4</td>
</tr>
</tbody>
</table>

- Surface PAR - Select if Surface PAR sensor used; must agree with ADDSPAR= command programmed into Deck Unit. Adds 2 channels to Channel/Sensor table. Do not decrease Voltage words suppressed to reflect this; Voltage words suppressed reflects only external voltages going directly to 9plus from auxiliary sensors.
- NMEA - Select if NMEA navigation device used. If selected, SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE’s Configure menu to control how Lat/Lon data is incorporated.
- IEEE-488 (GPIB) or RS-232C, based on how SBE 11plus is connected to computer.
Old Style SBE 911 Configuration

Select from standard or high resolution Digiquartz, with or without temperature compensation, or strain gauge. If pressure sensor calibration sheet contains only C, D, and T0 coefficients, you do not have temperature compensation. If pressure sensor calibration sheet contains C1, C2, C3, D1, T1, T2, and T3 coefficients, you do have temperature compensation. CTDs manufactured after December 1988 included a high-resolution period counter for pressure channel. If you have this option, configuration sheet will indicate high-resolution pressure.

NMEA - Select if NMEA interface option installed in SBE 11 and connected to NMEA navigation device. If selected, SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE's Configure menu to control how Lat/Lon data is incorporated.

Select to match your SBE 9 (8, 12, 24, or 33 1/3 scans per second).

Listing of channels at bottom of dialog box reflects this choice.

Click to modify list of sensors (after number of frequency channels and voltage words have been specified above). Data Format Definition dialog box with a list of sensors appears. Select sensors.

Click to return to Examine / Change Instrument Configuration File dialog box. In that dialog box, click Change Calibration Coefficients to view, modify, or enter coefficients.
Old Style SBE 911e Configuration

Section 4: Configure Menu, Part II - Instrument .con File

 Listing of channels at bottom of dialog box reflects this choice.
• 0 (dual redundant sensor configuration)
• 1 (single redundant sensor configuration)
• 2 (no redundant T or C sensors)

SBE 9 was configured to accept 0 to 5 volt (manufactured after February 1992) or -10 to 10 volt (before February 1992) inputs.

SBE 9 was available with 0, 1, 2, 3, or 4 voltage words.

IEEE-488 (GPIB) or RS-232C, based on how SBE 11 is connected to computer.

Click to modify list of sensors (after number of frequency channels and voltage words have been specified above). Data Format Definition dialog box with a list of sensors appears. Select sensors.

Click to return to Examine / Change Instrument Configuration File dialog box. In that dialog box, click Change Calibration Coefficients to view, modify, or enter coefficients.

Select from standard or high resolution Digiquartz, with or without temperature compensation, or strain gauge. If pressure sensor calibration sheet contains only C, D, and T0 coefficients, you do not have temperature compensation. If pressure sensor calibration sheet contains C1, C2, C3, D1, T1, T2, and T3 coefficients, you do have temperature compensation. CTDs manufactured after December 1988 included a high-resolution period counter for pressure channel. If you have this option, configuration sheet will indicate high-resolution pressure.
Old Style SBE 16 SEACAT C-T Recorder Configuration

- **Pressure Sensor Type (standard=none)**: Select strain gauge, Digiquartz with or without temperature compensation, or no pressure sensor.
- **Number of Ext. Freq. Sampled (standard=0)**: Used to calculate elapsed time, if you select time as a parameter for a display window. For calculation to be correct, this entry must agree with number programmed into SBE 16 with SVn(n=0, 1, 2, 3, or 4) command; see reply from status command (DS).
- **Number of Ext. Volt. Sampled (standard=0)**: Listing of channels at bottom of dialog box reflects this choice. Must agree with number programmed into SBE 16 with SVn(n=0, 1, 2, 3, or 4) command; see reply from status command (DS).
- **SEACAT Monitored Pressure (db)**: Voltage channel 0 in .con file corresponds to sensor wired to channel 0 on end cap connector, voltage channel 1 in .con file corresponds to sensor wired to channel 1 on end cap connector, etc.
- **Sample Interval (seconds)**: Must agree with setup of SBE 16; external frequency channels were a custom application for the SBE 16 - see configuration sheet.
- **Firmware Version**: Used to determine strain gauge pressure sensor data format.
- **NMEA Data Added by Deck Unit**: Select if using with a deck unit connected to a NMEA navigation device. If selected, SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE’s Configure menu to control how Lat/Lon data is incorporated.
- **NMEA Data Added by Deck Unit**: If None was selected for pressure sensor type, SEASAVE uses this pressure in calculations that are a function of pressure (conductivity, salinity, density, sound velocity, etc.).
- **Select if using with a deck unit connected to a NMEA navigation device. If selected, SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE’s Configure menu to control how Lat/Lon data is incorporated.**

Click to modify list of sensors (after number of frequency channels and voltage words have been specified above). Data Format Definition dialog box with a list of sensors appears. Select sensors.

Click to return to Examine / Change Instrument Configuration File dialog box. In that dialog box, click Change Calibration Coefficients to view, modify, or enter coefficients.
Old Style SBE 19 SEACAT Profiler Configuration

SEASAVE always treats the SBE 19 as if it is a Profiling instrument (i.e., it is in Profiling mode). If your SBE 19 is in Moored Mode, you must treat it like an SBE 16 (when setting up the .con file, select the SBE 16).

Listing of channels at bottom of dialog box reflects this choice. Must agree with number programmed into SBE 19 with SVn (n=0, 2, or 4) command; see reply from status command (DS). Voltage channel 0 in .con file corresponds to sensor wired to channel 0 on end cap connector, voltage channel 1 in .con file corresponds to sensor wired to channel 1 on end cap connector, etc.

Number of 0.5 second intervals between samples; used to compute time between samples. SEASAVE uses this to calculate elapsed time, if you select time as a parameter for a display window. For calculation to be correct, this entry must agree with number programmed into SBE 19 with SR command; see reply from status command (DS).

- Surface PAR - Select if surface PAR voltage added by deck unit. Selecting Surface PAR voltage adds 2 channels to Channel/Sensor table. See Application Note 47.
- NMEA - Select if using with a deck unit connected to a NMEA navigation device. If selected, SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE’s Configure menu to control how Lat/Lon data is incorporated.

Select strain gauge or Digiquartz with or without temperature compensation.

See reply from status command (DS). Used to determine strain gauge pressure sensor data format.

Click to modify list of sensors (after number of frequency channels and voltage words have been specified above). Data Format Definition dialog box with a list of sensors appears. Select sensors.

Click to return to Examine / Change Instrument Configuration File dialog box. In that dialog box, click Change Calibration Coefficients to view, modify, or enter coefficients.
Old Style SBE 21 Thermosalinograph Configuration

Time between scans. Used to calculate elapsed time, if you select time as a parameter for a display window. For calculation to be correct, this entry must agree with number programmed into SBE 21 with SI command; see reply from status command (DS).

Select if using with a deck unit connected to a NMEA navigation device. If selected, SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE’s Configure menu to control how Lat/Lon data is incorporated.

Listing of channels at bottom of dialog box reflects this choice (0 or 1). Must agree with XY or XN command programmed into SBE 21 to enable or disable external frequency (temperature) sensor; see reply from status command (DS). If external frequency is enabled, SEASAVE (and Data Conversion and Derive in SBE Data Processing) uses remote temperature data when calculating density and sound velocity.

SBE 21 Thermosalinograph

- Number of Ext Freq Sampled (standard=0)
- Number of Ext Volt Sampled (standard=0)
- Sample Interval (seconds)

- Lat/Lon Data Added by NMEA Interface

Modify Data Format

- Frequency 0: temperature
- Frequency 1: conductivity
- External Volt 0: pH

- External Volt 1: oxidation reduction potential
- External Volt 2: spare
- External Volt 3: spare

Click to modify list of sensors (after number of frequency channels and voltage words have been specified above). Data Format Definition dialog box with a list of sensors appears. Select sensors.

Click to return to Examine / Change Instrument Configuration File dialog box. In that dialog box, click Change Calibration Coefficients to view, modify, or enter coefficients.
Old Style SBE 25 SEALOGGER Configuration

Listing of channels at bottom of dialog box reflects this choice (0 - 7). Must agree with number programmed into SBE 25 with CC command; see reply from status command (DS). Voltage channel 0 in .con file corresponds to first external voltage in data stream, voltage channel 1 to second voltage in data stream, etc.

Used to determine strain gauge pressure sensor data format. See reply from status command (DS).

- Surface PAR - Select if Surface PAR voltage added by deck unit. Selecting Surface PAR voltage adds 2 channels to Channel/Sensor table. See Application Note 47.
- NMEA - Select if using with a deck unit connected to a NMEA navigation device. SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE's Configure menu to control how Lat/Lon data is incorporated.

Click to modify list of sensors (after number of frequency channels and voltage words have been specified above). Data Format Definition dialog box with a list of sensors appears. Select sensors.

Click to return to Examine / Change Instrument Configuration File dialog box. In that dialog box, click Change Calibration Coefficients to view, modify, or enter coefficients.
Old Style SBE 31 Configuration

Section 4: Configure Menu, Part II - Instrument .con File

Select if NMEA interface option installed in SBE 31 and SBE 31 is connected to a NMEA navigation device. SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE’s Configure menu to control how Lat/Lon data is incorporated.

Click to modify list of sensors (after number of frequency channels and voltage words have been specified above). Data Format Definition dialog box with a list of sensors appears. Select sensors.

IEEE-488 (GPIB) or RS-232C, based on how SBE 31 is connected to computer.

Select to match your system (6, 8, 12, 24, or 33 1/3 scans/second).

Listing of channels at bottom of dialog box reflects these choices.

Most SBE 31 CTD systems do not have a pressure sensor.

Click to return to Examine / Change Instrument Configuration File dialog box. In that dialog box, click Change Calibration Coefficients to view, modify, or enter coefficients.

Click to return to Examine / Change Instrument Configuration File dialog box. In that dialog box, click Change Calibration Coefficients to view, modify, or enter coefficients.
Section 5: Configure Menu, Part III - Calibration Coefficients

This section describes the calculation and/or source of the calibration coefficients for the configuration (.con) file, for each type of sensor supported by Sea-Bird CTDs. SEASAVE uses the sensor calibration coefficients to convert the raw data stream into engineering units for display during real-time data acquisition. This section covers:

- Accessing calibration coefficient dialog boxes
- Calibration coefficients for frequency sensors
- Calibration coefficients for A/D count sensors
- Calibration coefficients for voltage sensors

For all other details on the setup of the .con file, see Section 4: Configure Menu, Part II - Instrument .con File

For setup of the other items in the Configure menu (Alarms, ASCII Output, Header Form, Mark Variable Selection, NMEA Lat/Lon Interface, Remote Display, and Water Sampler Configuration), see Section 3: Configure Menu, Part I - General System Setup.

Accessing Calibration Coefficients Dialog Boxes

The method for accessing the calibration coefficients to view or modify them is dependent on whether you are using the Old Style Instrument Configuration or New Style Instrument Configuration, and is summarized below:

- Old Style Instrument Configuration - In the Configure menu, select Old Style Instrument Configuration. Click Select [.con] File; browse to the desired file. Click Examine/Change [.con] File. Click Change Calibration Coefficients. Double click on the desired sensor; the calibration coefficients dialog box for the sensor appears.

- New Style Instrument Configuration - In the Configure menu, select New Style Instrument Configuration / Select Instrument Configuration; browse to the desired file. In Configure menu, select New Style Instrument Configuration / Modify Selected Instrument Configuration. Double click on the desired sensor; the calibration coefficients dialog box for the sensor appears.
Calibration Coefficients for Frequency Sensors

For all calibration dialog boxes, enter the sensor serial number and calibration date. Many sensor calibration equations contain an offset term. Unless noted otherwise, use the offset (default = 0.0) to make small corrections for sensor drift between calibrations.

Calibration coefficients are discussed below for each type of sensor. Temperature, conductivity, and Digiquartz pressure sensors are covered first, followed by the remaining frequency sensor types in alphabetical order.

**Temperature Calibration Coefficients**

Enter g, h, i, j (or a, b, c, d), and f0 from the calibration sheet. Enter values for slope (default = 1.0) and offset (default = 0.0) to make small corrections for temperature sensor drift between calibrations:

\[
\text{Corrected temperature} = (\text{slope} \times \text{computed temperature}) + \text{offset}
\]

where

slope = true temperature span / instrument temperature span

offset = (true temperature – instrument reading) * slope; measured at 0 °C

**Temperature Slope and Offset Correction Example**

At true temperature = 0.0 °C, instrument reading = 0.0015 °C
At true temperature = 25.0 °C, instrument reading = 25.0005 °C
Calculating the slope and offset:

Slope = (25.0 – 0.0) / (25.0005 – 0.0015) = + 1.000040002
Offset = (0.0 – 0.0015) * 1.000040002 = - 0.001500060

Sea-Bird temperature sensors usually drift by changing offset, typically resulting in higher temperature readings over time for sensors with serial number less than 1050 and lower temperature readings over time for sensors with serial number greater than 1050. Sea-Bird’s data indicates that the drift is smooth and uniform with time, allowing users to make very accurate corrections based only on pre- and post-cruise laboratory calibrations. Calibration checks at sea are advisable to ensure against sensor malfunction; however, data from reversing thermometers is rarely accurate enough to make calibration corrections that are better than those possible from shore-based laboratory calibrations.

Sea-Bird temperature sensors rarely exhibit span errors larger than ± 0.005 °C over the range –5 to +35 °C (0.005 °C/(35 -[-5])C/year = 0.000125 °C/C/year), even after years of drift. A span error that increases more than ± 0.0002 °C/C/year may be a symptom of sensor malfunction.
Conductivity Calibration Coefficients

Enter g, h, i, j, Ctcor (or a, b, c, d, m) and Cpcor from the calibration sheet.

- Cpcor makes a correction for the highly consistent change in dimensions of the conductivity cell under pressure. The default is the compressibility coefficient for borosilicate glass (-9.57e-08). Some sensors fabricated between 1992 and 1995 (serial numbers between 1100 and 1500) exhibit a compression that is slightly less than pure borosilicate glass. For these sensors, the (hermetic) epoxy jacket on the glass cell is unintentionally strong, creating a composite pressure effect of borosilicate and epoxy. For sensors tested to date, this composite pressure coefficient ranges from -9.57e-08 to -6.90e-08, with the latter value producing a correction to deep ocean salinity of 0.0057 PSU in 5000 dbar pressure (approximately 0.001 PSU per 1000 dbar).

Before modifying Cpcor, confirm that the sensor behaves differently from pure borosilicate glass. Sea-Bird can test your cell and calculate Cpcor. Alternatively, test the cell by comparing computed salinity to the salinity of water samples from a range of depths, calculated using an AutoSal.

Enter values for slope (default = 1.0) and offset (default = 0.0) to make small corrections for conductivity sensor drift between calibrations:

Corrected conductivity = (slope * computed conductivity) + offset

where

slope = true conductivity span / instrument conductivity span
offset = (true conductivity – instrument reading) * slope; measured at 0 S/m

Conductivity Slope and Offset Correction Example

At true conductivity = 0.0 S/m, instrument reading = -0.00007 S/m
At true conductivity = 3.5 S/m, instrument reading = 3.49965 S/m
Calculating the slope and offset:
Slope = (3.5 – 0.0) / (3.49965 - [-0.00007]) = +1.000080006
Offset = (0.0 - [-0.00007]) * 1.000080006 = +0.000070006

The sensor usually drifts by changing span (slope of the calibration curve), typically resulting in lower conductivity readings over time. Offset error (error at 0 S/m) is usually due to electronics drift, and is typically less than ±0.0001 S/m per year. Because offsets greater than ±0.0002 S/m are a symptom of sensor malfunction, Sea-Bird recommends that drift corrections be made by assuming no offset error, unless there is strong evidence to the contrary or a special need.

Wide Range Conductivity Sensors

A wide range conductivity sensor has been modified to provide conductivity readings to 15 Siemens/meter by inserting a precision resistor in series with the conductivity cell. Therefore, the equation used to fit the calibration data is different from the standard equation. The sensor’s High Range Conductivity Calibration sheet includes the equation as well as the cell constant and series resistance to be entered in the program.

If the conductivity sensor serial number includes a w (an indication that it is a wide range sensor):
1. After you enter the calibration coefficients and click OK, the Wide Range Conductivity dialog box appears.
2. Enter the cell constant and series resistance (from the High Range Conductivity Calibration sheet) in the dialog box, and click OK.
Pressure (Paroscientific Digiquartz) Calibration Coefficients

Enter the sets of C, D, and T coefficients from the calibration sheet. Enter zero for any higher-order coefficients that are not listed on the calibration sheet. Enter values for slope (default = 1.0; do not change unless sensor has been recalibrated) and offset (default = 0.0) to make small corrections for sensor drift.

- For the SBE 9plus, also enter AD590M and AD590B coefficients from the configuration sheet.

Bottles Closed (HB - IOW) Calibration Coefficients

No calibration coefficients are entered for this parameter. The number of bottles closed is calculated by SBE Data Processing’s Data Conversion module based on frequency range.

Sound Velocity (IOW) Calibration Coefficients

Enter coefficients a0, a1, and a2.

Value = a0 + a1 * frequency + a2 * frequency^2
Calibration Coefficients for A/D Count Sensors

For all calibration dialog boxes, enter the sensor serial number and calibration date. Many sensor calibration equations contain an offset term. Unless noted otherwise, use the offset (default = 0.0) to make small corrections for sensor drift between calibrations.

Calibration coefficients are discussed below for each type of sensor: temperature and strain gauge pressure sensor.

Temperature Calibration Coefficients

For SBE 16+ plus, 19+ plus, and 49:
Enter \(a_0, a_1, a_2,\) and \(a_3\) from the calibration sheet.
Enter values for slope (default = 1.0) and offset (default = 0.0) to make small corrections for temperature sensor drift between calibrations:

\[
\text{Corrected temperature} = (\text{slope} \times \text{computed temperature}) + \text{offset}
\]

where

\[
\text{slope} = \frac{\text{true temperature span}}{\text{instrument temperature span}}
\]

\[
\text{offset} = (\text{true temperature} – \text{instrument reading}) \times \text{slope}; \text{measured at } 0 \, ^\circ\text{C}
\]

Temperature Slope and Offset Correction Example

At true temperature = 0.0 °C, instrument reading = 0.0015 °C
At true temperature = 25.0 °C, instrument reading = 25.0005 °C
Calculating the slope and offset:

\[
\text{Slope} = \frac{25.0 – 0.0}{25.0005 – 0.0015} = + 1.000040002
\]

\[
\text{Offset} = (0.0 – 0.0015) \times 1.000040002 = - 0.001500060
\]

Sea-Bird temperature sensors usually drift by changing offset, typically resulting in lower temperature readings over time. Sea-Bird’s data indicates that the drift is smooth and uniform with time, allowing users to make very accurate corrections based only on pre- and post-cruise laboratory calibrations. Calibration checks at sea are advisable to ensure against sensor malfunction; however, data from reversing thermometers is rarely accurate enough to make calibration corrections that are better than those possible from shore-based laboratory calibrations.

Sea-Bird temperature sensors rarely exhibit span errors larger than \(\pm 0.005 \, ^\circ\text{C}\) over the range \(-5 \text{ to } +35 \, ^\circ\text{C}\) \((0.005 \, ^\circ\text{C}/(35 - (-5))\text{C/year} = 0.000125 \, ^\circ\text{C}/\text{C/year})
\)
even after years of drift. A span error that increases more than
\(\pm 0.0002 \, ^\circ\text{C}/\text{C/year}\) may be a symptom of sensor malfunction.

Pressure (Strain Gauge) Calibration Coefficients

For SBE 16 plus and 19 plus configured with a strain gauge pressure sensor, and for all SBE 49s: Enter \(pA_0, pA_1, pA_2,\) pttempA0, pttempA1, pttempA2, pTCa0, pTCa1, pTCa2, pTCb0, pTCb1, and pTCb2 from the calibration sheet. Offset is normally zero, but may be changed for non-zero sea-surface condition. For example, if the in-air pressure reading is negative, enter an equal positive value.
Calibration Coefficients for Voltage Sensors

For all calibration dialog boxes, enter the sensor serial number and calibration date. Many sensor calibration equations contain an offest term. Unless noted otherwise, use the offset (default = 0.0) to make small corrections for sensor drift between calibrations.

Calibration coefficients are discussed below for each type of sensor. Strain gauge pressure sensors are covered first, followed by the remaining voltage sensor types in alphabetical order.

Pressure (Strain Gauge) Calibration Coefficients

Enter coefficients:
- Pressure sensor without temperature compensation
  - Enter A0, A1, and A2 coefficients from the calibration sheet
  - For older units with a linear fit pressure calibration, enter M (A1) and B (A0) from the calibration sheet, and set A2 to zero.
  - For all units, offset is normally zero, but may be changed for non-zero sea-surface condition. For example, if the in-air pressure reading is negative, enter an equal positive value.
- Pressure sensor with temperature compensation
  Enter ptempA0, ptempA1, ptempA2, pTCA0, pTCA1, pTCA2, pTCB0, pTCB1, pTCB2, pA0, pA1, and pA2 from the calibration sheet.

Altimeter Calibration Coefficients

Enter the scale factor and offset. 
\[ \text{Altimeter height} = [300 \times \text{voltage} / \text{scale factor}] + \text{offset} \]
where 
- scale factor = full scale voltage * 300/full scale range
- full scale range is dependent on the sensor (e.g., 50m, 100m, etc.)
- full scale voltage is from calibration sheet (typically 5V)

Fluorometer Calibration Coefficients

- Biospherical Natural Fluorometer
  Enter Cfn (natural fluorescence calibration coefficient), A1, A2, and B from calibration sheet.
  natural fluorescence \( Fn = Cfn \times 10^V \)
  production = \( A1 \times Fn / (A2 + PAR) \)
  chlorophyll concentration \( Chl = Fn / (B \times PAR) \)
where 
- \( V \) is voltage from natural fluorescence sensor

Note: See Calibration Coefficients for A/D Count Sensors above for information on strain gauge pressure sensors used on the SBE 16plus, 19plus, and 49. See Calibration Coefficients for Frequency Sensors above for information on Parascientific Digiquartz pressure sensors.

Note: To enter the altimeter alarm set point, alarm hysteresis, and minimum pressure to enable alarm, select Alarms in SEASAVE’s Configure menu.
**Chelsea Aqua 3**
Enter VB, V1, Vacetone, slope, offset, and SF.

Concentration (µg/l) = \( \text{slope} \times \frac{(10.0 \times \text{V/SF}) - 10.0 \times \text{VB}}{10.0 \times \text{V1} - 10.0 \times \text{Vacetone}} \) + offset

where

VB, V1, and Vacetone are from calibration sheet
Slope (default 1.0) and offset (default 0.0) adjust readings to conform to measured concentrations
Scale factor SF = 1.0 if CTD gain is 1; SF = 2 if CTD gain is 2.0
V is output voltage measured by CTD

Note: SEASAVE can process data for an instrument interfacing with up to two Chelsea Aqua 3 sensors when using the New Style configuration.

**Chelsea UV Aquatracka**
Enter A and B.

Concentration (µg/l) = A \times 10.0 V - B

where

A and B are from calibration sheet
V is output voltage measured by CTD

**Chelsea Minitracka**
Enter Vacetone, Vacetone100, and offset.

Concentration = \( \frac{100 \times \left( \text{V} - \text{Vacetone} \right)}{\text{Vacetone100} - \text{Vacetone}} \) + offset

where

Vacetone (voltage with 0 µg/l chlorophyll) and Vacetone100 (voltage with 100 µg/l chlorophyll) are from calibration sheet

**Dr Haardt Fluorometer - Chlorophyll a, Phycoerythrin, or Yellow Substance**
Enter A0, A1, B0, and B1.

These instruments may have automatic switching between high and low gains. Select the gain range switch:

- **Output Voltage Level** if the instrument indicates gain by output voltage level (< 2.5 volts is low gain, > 2.5 volts is high gain)
  - Low gain: value = A0 + (A1 \times V)
  - High gain: value = B0 + (B1 \times V)

- **Modulo Bit** if the instrument has control lines custom-wired to bits in the SBE 9+ modulo word
  - Bit not set: value = A0 + (A1 \times V)
  - Bit set: value = B0 + (B1 \times V)

- **None** if the instrument does not change gain
  - value = A0 + (A1 \times V)

where

V = voltage from sensor

**Dr Haardt Voltage Level Switching Examples**

*Example: Chlorophyll a*

<table>
<thead>
<tr>
<th>Low range scale = 10 mg/l</th>
<th>High range scale = 100 mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain = 10/2.5 = 4 mg/l/volt</td>
<td>Gain = 100/2.5 = 40 mg/l/volt</td>
</tr>
<tr>
<td>A0 = 0.0</td>
<td>B0 = -100</td>
</tr>
<tr>
<td>A1 = 4.0</td>
<td>B1 = 40.0</td>
</tr>
</tbody>
</table>
• **Seapoint**
Enter gain and offset.
Concentration = \(V \times \frac{30}{\text{gain}} + \text{offset}\)

where

Gain is dependent on cable used (see cable drawing, pins 5 and 6)

Note: SEASAVE can process data for an instrument interfacing with up to two Seapoint fluorometers when using the New Style configuration.

• **Seapoint Rhodamine** (New Style configuration only)
Enter gain and offset.
Concentration = \(V \times \frac{30}{\text{gain}} + \text{offset}\)

where

Gain is dependent on cable used (see cable drawing, pins 5 and 6)

• **WET Labs Flash Lamp Fluorometer (FLF) and Sea Tech**
Enter scale factor and offset.
Concentration = \(\text{voltage} \times \frac{\text{scale factor}}{5} + \text{offset}\)

where

Scale factor is dependent on fluorometer range

<table>
<thead>
<tr>
<th>Fluorometer</th>
<th>Switch-Selectable Range (milligrams/m³ or micrograms/liter)</th>
<th>Scale Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea Tech</td>
<td>0 – 3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>0 – 10 (default)</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>0 - 30</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>0-100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>0-300</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>0-1000</td>
<td>1000</td>
</tr>
<tr>
<td>WET Labs FLF</td>
<td>0 – 100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>0 – 300 (default)</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>0 - 1000</td>
<td>1000</td>
</tr>
</tbody>
</table>

Offset is calculated by measuring voltage output when the light sensor is completely blocked from the strobe light with an opaque substance such as heavy black rubber: \(\text{offset} = - \left( \frac{\text{scale factor} \times \text{voltage}}{5} \right)\)

• **Turner 10-005**
This sensor requires two channels - one for the fluorescence voltage and the other for the range voltage. Make sure to select both when configuring the instrument.

For the fluorescence voltage channel, enter scale factor and offset.

concentration = \(\left[ \text{fluorescence voltage} \times \frac{\text{scale factor}}{\text{range} \times 5} \right] + \text{offset}\)

where

range is defined in the following table

<table>
<thead>
<tr>
<th>Range Voltage</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.2 volts</td>
<td>1.0</td>
</tr>
<tr>
<td>&gt; 0.2 volts</td>
<td>&lt; 0.55 volts</td>
</tr>
<tr>
<td>&gt; 0.55 volts</td>
<td>&lt; 0.85 volts</td>
</tr>
<tr>
<td>&gt; 0.85 volts</td>
<td></td>
</tr>
</tbody>
</table>

• **Turner 10-AU-005**
Enter full scale voltage, zero point concentration, and full scale concentration from the calibration sheet.

concentration = \(\left[ \left(1.195 \times \text{voltage} \times (\text{FSC} - \text{ZPC}) \right) / \text{FSV} \right] + \text{ZPC}\)

where

voltage = measured output voltage from fluorometer
FSV = full scale voltage; typically 5.0 volts
FSC = full scale concentration
ZPC = zero point concentration
• **Turner SCUFA** (New Style configuration only)
Enter scale factor, offset, units, nx, my, and b from the calibration sheet.

\[
\text{corrected chlorophyll} = (\text{scale factor} \times \text{voltage}) + \text{offset}
\]

where

\[
\text{NTU} = \text{results from optional turbidity channel in SCUFA (see Turner SCUFA in OBS equations below)}
\]

Note: SEASAVE can process data for an instrument interfacing with up to two Turner SCUFA sensors when using the New Style configuration.

• **WET Labs AC3**
This sensor requires two channels - one for fluorometer voltage (listed under fluorometers in the dialog box) and the other for transmissometer voltage (listed under transmissometers). Make sure to select both when configuring the instrument.
Enter \(k_v\), \(V_{H2O}\), and \(A^X\).

\[
\text{concentration (mg/m}^3) = k_v \times (V_{out} - V_{H2O}) / A^X
\]

where

\(V_{out}\) = measured output voltage
\(k_v\) = absorption voltage scaling constant (inverse meters/volt)
\(V_{H2O}\) = measured voltage using pure water
\(A^X\) = chlorophyll specific absorption coefficient

• **WET Labs WetStar, ECO-AFL, and ECO-FL** (ECO-AFL and -FL in New Style configuration only)
Enter \(V_{blank}\) and scale factor.

\[
\text{Concentration (} \mu \text{g/l}) = (V_{sample} - V_{blank}) \times \text{scale factor}
\]

where

\(V_{sample}\) = in situ voltage output
\(V_{blank}\) = clean water blank voltage output
Scale factor = multiplier (\(\mu\)g/l/Volt)
The calibration sheet lists either:

- \(V_{blank}\) and scale factor, OR
- \(V_{blank}\) and \(V_{copro}\) (voltage output measured with known concentration of coproporphyrin tetramethyl ester). Determine an initial value for the scale factor by using the chlorophyll concentration corresponding to \(V_{copro}\):

\[
\text{scale factor} = \frac{\text{chlorophyll concentration}}{(V_{copro} - V_{blank})}
\]

Perform calibrations using seawater with phytoplankton populations that are similar to what is expected in situ.

Note: SEASAVE can process data for an instrument interfacing with up to two WET Labs WetStar sensors when using the New Style configuration.

• **WET Labs CDOM** (colored dissolved organic matter) (New Style configuration only)
Enter \(V_{blank}\) and scale factor.

\[
\text{Concentration (} \mu \text{g/l}) = (V_{sample} - V_{blank}) \times \text{scale factor}
\]

where

\(V_{sample}\) = in situ voltage output
\(V_{blank}\) = clean water blank voltage output
Scale factor = multiplier (\(\mu\)g/l/Volt)
The calibration sheet lists \(V_{blank}\) and \(V_{cdom}\) (voltage output measured with known concentration of colored dissolved organic matter). Determine an initial value for the scale factor by using the colored dissolved organic matter concentration corresponding to \(V_{cdom}\):

\[
\text{scale factor} = \frac{\text{cdom concentration}}{(V_{cdom} - V_{blank})}
\]

Perform calibrations using seawater with cdom types that are similar to what is expected in situ.

Notes:

- For complete description of calibration coefficient calculation, see Application Note 41 for WetStar and Application Note 62 for ECO-AFL, ECO-FL, and ECO-FL-NTU.
- For ECO-FL-NTU, a second channel is required for turbidity. Set up the second channel as a User Polynomial, with:

\[
a_0 = - V_{blank} \times \text{scale factor} \\
a_1 = \text{scale factor (NTU/volts)} \\
a_2 = a_3 = 0
\]

where scale factor and \(V_{blank}\) are for the turbidity measurement.
Methane Sensor Calibration Coefficients (New Style configuration only)

The **Capsum METS** sensor requires two channels – one for the methane concentration and the other for the temperature measured by the sensor. Make sure to select both when configuring the instrument.

For the concentration channel, enter D, A0, A1, B0, B1, and B2.

Methane concentration

\[
\text{Methane concentration} = \exp \left\{ D \ln \left[ (B_0 + B_1 \exp \left( -\frac{V_t}{B_2} \right)) \left( \frac{1}{V_m} - \frac{1}{A_0 - A_1 \cdot V_t} \right) \right] \right\} \quad [\mu \text{mol} / \text{l}]
\]

*Where*

- \( V_t \) = Capsum METS temperature voltage
- \( V_m \) = Capsum METS methane concentration voltage

For the temperature channel, enter T1 and T2.

\[
\text{Gas temperature} = (V_t \cdot T_1) + T_2 \quad [\degree \text{C}]
\]

OBS/Nephelometer Calibration Coefficients

In general, turbidity sensors are calibrated to a standard (formazin). However, particle size, shape, refraction, etc. in seawater varies. These variations affect the results unless field calibrations are performed on typical water samples.

- **Downing & Associates [D&A] OBS-3 Backscatterance**
  Enter gain and offset.
  \[
  \text{output} = (\text{volts} \times \text{gain}) + \text{offset}
  \]
  *where*
  - gain = range/5; see calibration sheet for range

- **Downing & Associates [D & A] OBS-3+ (New Style configuration only)**
  Enter A0, A1, and A2.
  \[
  \text{output} = A_1 + (A_1 \times V) + (A_2 \times V^2)
  \]
  *where*
  - \( V \) = voltage from sensor (milliVolts)
  - A0, A1, and A2 = calibration coefficients from D & A calibration sheet
  Note: SEASAVE can process data for an instrument interfacing with up to two OBS-3+ sensors.

- **Chelsea**
  Enter clear water value and scale factor.
  \[
  \text{turbidity [F.T.U.]} = \left( 10.0^V - \text{C} \right) / \text{scale factor}
  \]
  *where*
  - \( V \) = voltage from sensor
  See calibration sheet for C (clear water value) and scale factor

- **Dr. Haardt Turbidity**
  Enter A0, A1, B0, and B1. Select the gain range switch:
  - **Output Voltage Level** if the instrument indicates gain by output voltage level (< 2.5 volts is low gain, > 2.5 volts is high gain)
    - Low gain: value = A0 + (A1 \times V)
    - High gain: value = B0 + (B1 \times V)
  - **Modulo Bit** if the instrument has control lines custom-wired to bits in the SBE 9plus modulo word
    - Bit not set: value = A0 + (A1 \times V)
    - Bit set: value = B0 + (B1 \times V)
  - **None** if the instrument does not change gain
    - value = A0 + (A1 \times V)
  *where*
  - \( V \) = voltage from sensor
• **IFREMER**
  This sensor requires two channels - one for the direct voltage and the other for the measured voltage. Make sure to select both when configuring the instrument.
  For the direct voltage channel, enter \( v_{d0}, d_0, \) and \( k \).
  
  \[
  \text{diffusion} = \frac{k \times (v_m - v_{m0})}{v_d - v_{d0}} - d_0
  \]
  
  *where*
  
  \( k = \text{scale factor} \)
  
  \( v_{m0} = \text{measured voltage offset} \)
  
  \( v_d = \text{direct voltage} \)
  
  \( v_{d0} = \text{direct voltage offset} \)
  
  \( d_0 = \text{diffusion offset} \)
  
  **Note:**
  See Application Note 48 for complete description of calculation of Seapoint Turbidity calibration coefficients.

• **Seapoint Turbidity**
  Enter gain setting and scale factor.
  
  \[
  \text{output} = \frac{\text{volts} \times 500 \times \text{scale factor}}{\text{gain}}
  \]
  
  *where*
  
  Scale factor is from calibration sheet
  
  Gain is dependent on cable used (see cable drawing)
  
  Note: SEASAVE can process data for an instrument interfacing with up to two Seapoint Turbidity sensors when using the New Style or Old Style configuration.

• **Seatech LS6000**
  Enter gain setting, slope, and offset.
  
  \[
  \text{Output} = [\text{volts} \times (\text{range} / 5) \times \text{slope}] + \text{offset}
  \]
  
  *where*
  
  Slope is from calibration sheet.
  
  Range is based on sensor ordered (see calibration sheet) and cable-dependent gain (see cable drawing to determine if low or high gain):
  
<table>
<thead>
<tr>
<th>Range for High Gain</th>
<th>Range for Low Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.25</td>
<td>7.5</td>
</tr>
<tr>
<td>7.5</td>
<td>25</td>
</tr>
<tr>
<td>75</td>
<td>250</td>
</tr>
<tr>
<td>225</td>
<td>750</td>
</tr>
<tr>
<td>33</td>
<td>100</td>
</tr>
</tbody>
</table>
  
  Note: SEASAVE can process data for an instrument interfacing with up to two Seatech LS6000 sensors when using the New Style configuration.

• **Turner SCUFA** (New Style configuration only)
  Enter scale factor and offset.
  
  \[
  \text{corrected chlorophyll} = (m_x \times \text{chlorophyll}) + (m_y \times \text{NTU}) + b
  \]
  
  *where*
  
  \( m_x, m_y, \) and \( b \) = coefficients entered for Turner SCUFA fluorometer
  
  chlorophyll = results from fluorometer channel in SCUFA (see Turner SCUFA in fluorometer equations above)
  
  Note: SEASAVE can process data for an instrument interfacing with up to two Turner SCUFA sensors when using the New Style configuration.

**Oxidation Reduction Potential (ORP) Calibration Coefficients**

Enter \( M, B, \) and offset (mV).

\[
\text{Oxidation reduction potential} = [(M \times \text{voltage}) + B] + \text{offset}
\]

Enter \( M \) and \( B \) from calibration sheet.
Section 5: Configure Menu, Part III - Calibration Coefficients

**Oxygen Calibration Coefficients**

Enter the coefficients, which vary depending on the type of oxygen sensor, from the calibration sheet:

- **Beckman- or YSI-type sensor** *(manufactured by Sea-Bird or other manufacturer)* - These sensors require two channels - one for oxygen current (enter m, b, soc, boc, tcor, tau, and wt) and the other for oxygen temperature (enter k and c). Make sure to select both when configuring the instrument.
  
  Note: SEASAVE can process data for an instrument interfacing with up to two Beckman- or YSI-type oxygen sensors when using the New Style or Old Style configuration.

- **IOW sensor** - These sensors require two channels - one for oxygen current (enter b0 and b1) and the other for oxygen temperature (enter a0, a1, a2, and a3). Make sure to select both when configuring the instrument.
  
  Value = \( b0 + [b1 * (a0 + a1 * T + a2 * T^2 + a3 * T^3)] * C \)
  
  where
  
  \( T \) is oxygen temperature voltage, \( C \) is oxygen current voltage

- **Sea-Bird sensor (SBE 43)** *(New style configuration only)* - This sensor requires only one channel. Enter Soc, Boc, Voffset, tcor, pcor, and tau.
  
  \[ OX = [Soc * (V + Voffset) + (tau * \delta V/\delta t)] + Boc * exp(-0.03T) * exp(tcor * T + pcor * P) * Oxsat(T,S) \]
  
  where
  
  \( OX \) = dissolved oxygen concentration (ml/l)
  
  \( T \) = measured temperature from CTD (ºC)
  
  \( P \) = measured pressure from CTD (decibars)
  
  \( S \) = calculated salinity from CTD (PSU)
  
  \( V \) = temperature-compensated oxygen signal (volts)
  
  \( \delta V/\delta t \) = derivative of oxygen signal (volts/sec)
  
  \( Oxsat(T,S) \) = oxygen saturation (ml/l)
  
  Note: SEASAVE can process data for an instrument interfacing with up to two SBE 43 oxygen sensors when using the New Style configuration.

**PAR/Irradiance Calibration Coefficients**

**Underwater PAR Sensor**

Enter M, B, calibration constant, multiplier, and offset.

\[ \text{PAR} = [\text{multiplier} * (10^9 * 10^{V-B})/M] + \text{offset} \]

Where

- **Calibration constant, M, and B** are dependent on sensor type.

- **Biospherical PAR sensor** - *PAR sensor with built-in log amplifier* (QSP-200L, QSP-2300L, QCP-2300L, or MCP-2300):
  
  Typically, \( M = 1.0 \) and \( B = 0.0 \).
  
  Calibration constant
  
  \( = 10^5 \) / wet calibration factor from Biospherical calibration sheet.
  
  - **PAR sensor without built-in log amplifier** (QSP-200PD, QSP-2200 (PD), or QCP 2200 (PD)):
    
    M and B are taken from Sea-Bird calibration sheet.
    
    Calibration constant
    
    \( = C_5 \) calibration coefficient from Sea-Bird calibration sheet
    
    \( = 10^9 \) / calibration coefficient from Biospherical calibration sheet
  
  - **LI-COR PAR sensor**
    
    Calibration constant is LI-COR in water calibration constant.
    
    Enter calibration constant, M, and B from calibration sheet.
### Section 5: Configure Menu, Part III - Calibration Coefficients

- **Chelsea PAR sensor**
  Calibration constant
  \[ \text{Calibration constant} = \frac{10^9}{0.01} \text{ (for units of microEinstins/sec–m}^2\text{)} \text{ or} \]
  \[ \text{Calibration constant} = \frac{10^9}{0.04234} \text{ (for units of quanta/sec–m}^2\text{)} \]
  
  \[ M = 1.0 / (\log e \cdot A1 \cdot 1000) = 1.0 / (0.43429448 \cdot A1 \cdot 1000) \]
  \[ B = - M \cdot \log e \cdot A0 = - M \cdot 0.43429448 \cdot A0 \]
  
  where \( A0 \) and \( A1 \) are constants from Chelsea calibration sheet with an equation of form: \( \text{PAR} = A0 + (A1 \cdot \text{mV}) \)

  Multiplier can be used to scale output, and is typically set to 1.0.

  Note: SEASAVE can process data for an instrument interfacing with up to two PAR/irradiance sensors when using the New Style configuration.

- **Biospherical Surface PAR Sensor**
  A surface PAR sensor is selected by clicking **Surface PAR voltage added** in the Configure dialog box. Enter conversion factor and ratio multiplier.

- **pH Calibration Coefficients**

  Enter the slope and offset from the calibration sheet:
  \[
  \text{pH} = 7 + \frac{(\text{Vout} - \text{offset})}{(\circ K \cdot 1.98416e^{-4} \cdot \text{slope})}
  \]

  where

  \( \circ K \) = temperature in degrees Kelvin

- **Pressure/FGP (voltage output) Calibration Coefficients**

  Enter scale factor and offset.

  \[ \text{output [Kpa]} = (\text{volts} \cdot \text{scale factor}) + \text{offset} \]

  where:

  scale factor = 100 * pressure sensor range [bar] / voltage range [volts]

  Note: SEASAVE can process data for an instrument interfacing with up to eight pressure/fgp sensors when using the New Style or Old Style configuration.

- **Suspended Sediment Calibration Coefficients** (New Style configuration only)

  The **Sequoia LISST-25** sensor requires two channels – one for scattering output and the other for transmission output. Make sure to select both when configuring the instrument.

  For the scattering channel, enter Total volume concentration constant (Cal), Sauter mean diameter calibration (\( \alpha \)), Clean H\(_2\)O scattering output (\( V_{S0} \)), and Clean H\(_2\)O transmission output (\( V_{T0} \)) from the calibration sheet. For the transmission channel, no additional coefficients are required; they are all defined for the scattering channel.

  **Optical transmission**

  \[ \tau = V_T / V_{T0} \]
  \[ \text{Beam C} = - \ln (\tau) / 0.025 \text{ [1 / meters]} \]
  \[ \text{Total Volume Concentration} = TV = \text{Cal} \cdot \left[ \frac{(V_S / \tau) - V_{S0}}{} \right] \text{ [liters / liter]} \]
  \[ \text{Sauter Mean Diameter} = \text{SMD} = \alpha \cdot \left[ \frac{TV}{(-\ln(\tau))} \right] \text{ [microns]} \]

  where

  \( V_T \) = transmission channel voltage output
  \( V_S \) = scattering channel voltage output

  The calibration coefficients supplied by Sequoia are based on water containing spherical particles. Perform calibrations using seawater with particle shapes that are similar to what is expected in situ.

**Notes:**

- Selection of Par / Irradiance, Biospherical / Licor as the voltage sensor is also applicable to the Chelsea PAR sensor.
- For complete description of calculation of surface PAR calibration coefficients, see Application Note 11S (SBE 11 plus Deck Unit) or 47 (SBE 33 or 36 Deck Unit).

**Notes:**

- See Application Notes 18-1, 18-2, and 18-4 for complete description of calculation of pH calibration coefficients.
- SEASOFT-DOS < version 4.008 ignored temperature compensation of a pH electrode. The relationship between the two methods is:
  \[ \text{pH} = \text{pH old} + (7 - 2087/\circ K) \]
  For older sensors, run pHfit version 2.0 (in SEASOFT-DOS) using Vout, pH, and temperature values from the original calibration sheet to compute the new values for offset and slope.

**Notes:**

- Selection of Par / Irradiance, Biospherical / Licor as the voltage sensor is also applicable to the Chelsea PAR sensor.
- For complete description of calculation of surface PAR calibration coefficients, see Application Note 11S (SBE 11 plus Deck Unit) or 47 (SBE 33 or 36 Deck Unit).
Transmissometer Calibration Coefficients

- **Sea Tech, Chelsea (Alphatracka), and WET Labs Cstar**
  Enter M, B, and path length (in meters)
  Path length (distance between lenses) is based on sensor size
  (for example, 25 cm transmissometer = 0.25m path length, etc.).
  light transmission (%) = M * volts + B
  
  \[ M = \left( \frac{Tw}{W_0 - Y_0} \right) \left( \frac{A_0 - Y_0}{A_1 - Y_1} \right) \]
  \[ B = -M \times Y_1 \]
  
  and
  
  A0 = factory voltage output in **air** (factory calibration from transmissometer manufacturer)
  A1 = current (most recent) voltage output in **air**
  Y0 = factory **dark or zero** (blocked path) voltage (factory calibration from transmissometer manufacturer)
  Y1 = current (most recent) **dark or zero** (blocked path) voltage
  W0 = factory voltage output in pure **water** (factory calibration from transmissometer manufacturer)
  Tw = % transmission in pure water
  (for transmission **relative to water**, Tw = 100%; or
  for transmission **relative to air**, Tw is defined by table below.

<table>
<thead>
<tr>
<th>Wavelength</th>
<th>Tw = % Transmission in Pure Water (relative to AIR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>488 nm (blue)</td>
<td>99.8%</td>
</tr>
<tr>
<td>532 nm (green)</td>
<td>99.5%</td>
</tr>
<tr>
<td>660 nm (red)</td>
<td>96.0 - 96.4%</td>
</tr>
</tbody>
</table>

**Transmissometer Example**
(from calibration sheet) A0 = 4.743 volts, Y0 = 0.002 volts, W0 = 4.565 volts
Tw = 100%  (for transmission **relative to water**)
(from current calibration) A1 = 4.719 volts and Y1 = 0.006 volts
M = 22.046
B = -0.132

Note: SEASAVE can process data for an instrument interfacing
with up to two transmissometers in any combination of Sea Tech,
Chelsea Alphatracka, and WET Labs Cstar, when using the New
Style configuration.

- **WET Labs AC3**
  This sensor requires two channels - one for fluorometer voltage (listed
  under fluorometers in the dialog box) and the other for transmissometer
  voltage (listed under transmissometers). Make sure to select both when
  configuring the instrument.
  Enter Ch2o, Vh2o, VDark, and X from calibration sheet.
  Beam attenuation = \( \left\{ \log (Vh2o - VDark) - \log (V - VDark) \right\}/X \) + Ch2o
  Beam transmission (%) = exp ( -beam attenuation * X ) * 100

**Note:**
See Application Note 7 for complete description of computation of M and B.
**User Polynomial (for user-defined sensor) Calibration Coefficients**

The user polynomial allows you to define an equation to relate the sensor output voltage to calculated engineering units, if your sensor is not pre-defined in Sea-Bird software.

Enter \( a_0, a_1, a_2, \) and \( a_3. \)

\[
\text{Val} = a_0 + (a_1 \times V) + (a_2 \times V^2) + (a_3 \times V^3)
\]

*where:*

- \( V = \) voltage from sensor
- \( a_0, a_1, a_2, \) and \( a_3 = \) user-defined sensor polynomial coefficients

If desired, enter the sensor name. This name will appear in the data file header.

Note: SEASAVE can process data for an instrument interfacing with up to three sensors defined with user polynomials when using the New Style or Old Style configuration.

---

**Wet Labs ECO-FL-NTU Example**

For the turbidity channel, \( \text{NTU} = (V_{\text{sample}} - V_{\text{blank}}) \times \text{scale factor} \)

Set this equal to user polynomial equation and calculate \( a_0, a_1, a_2, \) and \( a_3. \)

\[
(V_{\text{sample}} - V_{\text{blank}}) \times \text{scale factor} = a_0 + (a_1 \times V) + (a_2 \times V^2) + (a_3 \times V^3)
\]

Expanding left side of equation and using consistent notation \( (V_{\text{sample}} = V); \)

scale factor \( \times V - \text{scale factor} \times V_{\text{blank}} = a_0 + (a_1 \times V) + (a_2 \times V^2) + (a_3 \times V^3) \)

Left side of equation has no \( V^2 \) or \( V^3 \) terms, so \( a_2 \) and \( a_3 \) are 0; rearranging:

\[
(\text{– scale factor} \times V_{\text{blank}}) + (\text{scale factor} \times V) = a_0 + (a_1 \times V)
\]

\[
a_0 = \text{– scale factor} \times V_{\text{blank}} \quad a_1 = \text{scale factor} \quad a_2 = a_3 = 0
\]

---

**Zaps Calibration Coefficients**

Enter \( M \) and \( B \) from calibration sheet.

\[
z = (M \times \text{volts}) + B \text{ [nmol]}
\]
Section 6: ScreenDisplay Menu - Setting Up SEASAVE Displays

This section describes how to set up and arrange SEASAVE display windows.

SEASAVE can have up to ten display windows. Edit a display window to select desired parameters, number of digits for data display, and plot characteristics (labels, grids, etc.). This information is saved in a setup file for each display window. File extensions vary, depending on display type: .dso for overlay plot displays, .dsf for fixed displays, and .dss for scrolled displays.

Adding a New Display Window

1. In the ScreenDisplay menu, select Add New Display Window and select the window type - fixed, scroll, or overlay (plot), OR
   In the Toolbar, click the New Fixed Display, New Scrolled Display, or New Overlay Display button.

2. The new window appears. Setup of the window display is detailed below.

Setting Up / Editing a Display Window

1. Click in the desired window.

2. In the ScreenDisplay menu, select Edit Selected Display Window, OR
   Right click in the desired window and select Setup. The Display Setup dialog box appears. The selections in the dialog box vary, depending on the display type (see Fixed or Scrolled Display and Overlay Plot Display below). All three dialog boxes have the following buttons:
   • Select Display File - select an existing display file for the window.
   • Modify Display Parameters - modify the existing display setup; brings up a Display Variables Set Up dialog box specific to the display type.
   • Save Display File - save any changes you make to the display setup. When you have completed the setup, click OK.

3. Right click in the desired window and select Update Rate. The Change Display Rate dialog box appears. The update rate is the time between each calculation of parameters for update of the display; each display window can have a different update rate. Enter the number of seconds between updates and click OK. Note that an update rate faster than 1 second can be difficult to view on a fixed or scrolled display.

4. If desired, change the display window size and location in the SEASAVE window:
   • In the ScreenDisplay menu, select Auto Arrange Display Windows and select the arrangement type - horizontal tiles, vertical tiles, or cascade (or, in the Toolbar, click the Horizontal Tile, Vertical Tile, or Cascade Button). SEASAVE automatically sizes (all the same size) and arranges all the windows. OR
   • Use standard Windows click-and-drag methods to resize and move the window(s) as desired.

Note:
The display window size and location in the SEASAVE window, and the window update rate, is not included in the display (.dsf, .dso, or .dss) file. This information, along with the names of the display files, is included in the SEASAVE configuration (.cfg) file. To save the entire setup, you must save the .cfg file (File menu, Save SEASAVE Configuration As).
Fixed Display or Scrolled Display

Setup for the Fixed and Scrolled Displays are similar.

The Fixed Display Setup dialog box looks like this:

Click on Modify Display Parameters to get the Fixed Display Variables Setup dialog box:

Select the desired variable for each row by clicking Select Variable. A dialog box with a list of variables appears; make your selection and click OK. Enter the number of desired digits after the decimal point for each variable’s data. When done, click OK.
Overlay Plot Display

The Display Setup dialog box looks like this:

The dialog box selections and buttons include:

- **Plot Label**: Label placed at top, center of plot.
- **Show Fire Sequence, Show Bottle Lines, and Bottle Line Configuration**: For a system integrated with a water sampler.
  - If **Show Fire Sequence** selected, SEASAVE lists the bottle closure order to the right of the plot.
  - If **Show Bottle Lines** selected, SEASAVE places a horizontal line in the plot to indicate the data associated with a bottle closure. **Bottle Line Configuration** defines the line - line color and style, and line label.
- **Auto Paging of the Display**: If selected, the display pages down if the y-axis data exceeds the selected y-axis maximum for the plot. For example, if you set up the y-axis for 0 to 1000 dbers, and the actual cast exceeds 1000 dbers, the y-axis minimum/maximum will adjust to 1000 to 2000 dbers so that it can continue to display data.
- **Display Downcast Only**: If selected, SEASAVE only plots data with pressure greater than the previous maximum pressure. It cannot differentiate between temporary upward movement due to ship movement and when the upcast actually begins, so data points where the CTD is moving upward due to ship heave will not display.
- **Show Mark Lines**: If selected, SEASAVE places a horizontal line in the plot to indicate the data associated with the user marking a scan. See **Mark Scans** in **Section 7: Real-Time Data Acquisition**.
Section 6: ScreenDisplay Menu - Setting Up SEASAVE Displays

Click on Modify Display Parameters to get the Overlay Display Parameters Setup dialog box:

The dialog box entries include:

- **Grid and Colors**: Select a background color for the plot, and select whether to show a grid, along with the grid style and color.

- **Variable selections and plotting parameters**: SEASAVE can plot one parameter on the y-axis and up to four parameters on the x-axis. For each parameter, select the desired variable by clicking Select Variable. A dialog box with a list of variables appears; make your selection and click OK. Then enter the label for the axis, number of major and minor divisions on the axis, line style and color, minimum and maximum value for the axis, and number of digits after the decimal point for the minimum/maximum value labels. Note that any data that falls below the minimum will plot at the minimum value; data that falls above the maximum will plot at the maximum value.

When done, click OK.
Section 7: Real-Time Data Acquisition

This section covers:
- Starting and stopping real-time data acquisition
- Firing bottles
- Marking scans
- Adding NMEA navigation data to a .nav file
- Manually turning an SBE 9plus pump on and off

Starting and Stopping Real-Time Data Acquisition

1. In the RealtimeData menu, select Start Acquisition.
2. The Acquire and Display Real-Time Data Setup dialog box appears:

   ![Acquire and Display Real-Time Data Setup dialog box](image)

   The dialog box selections include:
   - **Select .con File**: Click to select the instrument configuration file. The Select Instrument Configuration File dialog box appears. Browse to the desired file and click OK.
   - **Exam / Change .con File**: Click to view or modify the instrument configuration and calibration coefficients. See Section 4: Configure Menu, Part II - Instrument .con File.
   - **Output Data Options**: Select **Store on Disk** to store the raw (frequencies, A/D counts, and/or voltages) real-time data. If storing real-time data, click **Enter Output Data File Name**. Enter Output Data File Name dialog box appears; browse to the desired file location, enter the desired file name, and click OK.
   - **Number of Scans to Average in the Deck Unit**: Applicable to the SBE 911, 911e, 911plus, and 31 only. For full rate data, set to 1. **NOTE**: The SBE 911plus with a new style configuration (.con) file also has an entry for **Scans to Average**. The entry in this dialog box overrides the entry in the .con file.

   **Note:**
   - For SBE 16plus, 19plus, and 49: Instrument must be set up to output raw hex data (OUTPUTFORMAT=0) for SEASAVE to interpret the data. See the instrument user manual.

   **Note:**
   - To start acquisition without a mouse:
     - Windows 2000 / XP – Press the Alt key to show the keyboard shortcuts (underlines) on menus. Press the appropriate letter (for example, R for RealtimeData menu) and use the arrow and Enter keys to navigate.
     - Windows 95 / 98 / NT – Keyboard shortcuts (underlines) appear on menus at all times. Press the Alt key and appropriate letter and use the arrow and Enter keys to navigate.
- **COMM Port Configuration**: Click to configure the transfer of data. The COMM Port Configuration dialog box varies, depending on your system setup.
  - SBE 911, 911e, or 911plus, with or without water sampler, the dialog box looks like this:

![COMM Port Configuration dialog box](image)

- SBE 19, 19plus, or 25, with SBE 32 Carousel water sampler, the dialog box looks like this:

![COMM Port Configuration dialog box](image)

- SBE 16, 16plus, 19, 19plus, 21, 25, 45, or 49 without SBE 32 Carousel water sampler, the dialog box looks like this:

![COMM Port Configuration dialog box](image)

### Notes
- CTD with PDIM and SBE 36 deck unit: Computer port connected to SBE 36 Serial Data connector; sends commands to and receives replies from CTD (through PDIM).
- SBE 21 with Interface Box: Computer port connected to Interface Box RS-232C connector; sends commands to and receives replies from SBE 21 (through Box).
- SBE 45 with optional 90402 Interface Box: Computer port connected to Interface Box PC connector; sends commands to and receives replies from SBE 45 (through Box).
- Instrument connected directly to computer: Computer port connected to instrument; sends commands to and receives replies from instrument.
• **Start Acquire**: Begin processing and displaying data.

A. If you selected Store on Disk above, and selected Prompt for Header Information in the Header Form setup (Configure menu), the Header Information dialog box appears. Fill in the desired header and click OK.

B. A message similar to one of the following will appear (message dependent on the instrument and if CTD is connected to a water sampler):

For an instrument that is started by movement of a magnetic switch (such as SBE 19, 19plus, or 25) -

![Waiting...](image1)

SEASEAVE allows 60 seconds after you click Start Acquire for you to turn on the CTD magnetic switch. SEASEAVE will *time out* if data is not received from the instrument within this time. The time can be increased if needed (see *Appendix I: Command Line Operation*).

For other instruments (such as an SBE 16, 16plus, 21, 45, 49, or 911plus) -

![Waiting...](image2)

SEASEAVE will *time out* if data is not received from the instrument within 60 seconds.

• **Save and Exit**: Save the real-time data setup (.con and data file names, number of scans to average, and COMM port configuration). If saved, the next time you select Start Acquisition in the RealtimeData menu, the dialog box will appear with your saved selections.

3. **To stop data acquisition**: In the RealtimeData menu, select Stop Acquisition.
Firing Bottles

Water sampler bottles can be fired by command from SEASAVE. SEASAVE automatically writes bottle sequence number, bottle position, date, time, and beginning and ending scan numbers to a bottle log (.bl) file each time a bottle fire confirmation is received from the water sampler. The beginning and ending scan numbers correspond to approximately a 1.5-second duration for each bottle. For a 911plus system, SEASAVE also automatically sets the bottle confirm bit in the data (.dat) file for all scans within a 1.5-second duration after a bottle firing confirmation is received from the water sampler.

To fire bottles:

1. Set up the water sampler in the Configure menu (see Water Sampler Configuration in Section 3: Configure Menu, Part I - General System Setup).

2. Start real-time data acquisition.

3. In the View menu, select Fire Bottle Control. The Bottle Fire dialog box appears.

4. When desired, click Fire Bottle.
   - If you selected Sequential or Table driven in Water Sampler Configuration (Step 1), the dialog box displays the number of the fired bottle.
   - If you selected User Input in Water Sampler Configuration (Step 1), SEASAVE prompts you to enter the bottle number.

Note:
The .bl file has the same file name and is placed in the same directory as the data file. For example, if the data file is test1.hex, the .bl file is test1.bl.

Note:
If desired, you can fire bottles without using the Bottle Fire dialog box. Each time you want to fire a bottle, select Fire Bottle in the RealTimeData menu, or press Ctrl F3.

Marking Scans

Mark Scan allows you to copy the most recent scan of data to a mark (.mrk) file as desired. The .mrk file can be used to manually note water sampler bottle firings, compare CTD data with data from a Thermosalinograph taken at the same time, or to mark significant events in the cast (winch problems, large waves causing ship heave, etc.) for later review and analysis of the data.

If a plot display is set up to Show Mark Lines, SEASAVE also draws a horizontal line in the plot each time you mark a scan.

To mark scans:

1. Set up Mark Variable Selection in the Configure menu (see Mark Variable Selection in Section 3: Configure Menu, Part I - General System Setup).
2. Start real-time data acquisition.
3. In the View menu, select Mark Scan. The Mark Scan Control dialog box appears.
4. When desired, click Mark Scan. The dialog box displays how many scans have been marked (copied to .mrk file).

Adding NMEA Data to .nav File

NMEA Data Display allows you to view the latitude, longitude, and time during data acquisition, and to select scans to be written to a .nav file, if the NMEA Lat/Lon Interface has been set up. Each scan written to the .nav file contains latitude, longitude, time, scan number, and pressure.

To add data to a .nav file:

1. Set up the NMEA Interface in the Configure menu (see NMEA Lat/Lon Interface in Section 3: Configure Menu, Part I - General System Setup).
2. Start real-time data acquisition.
3. In the View menu, select NMEA Data Display. The NMEA Data dialog box appears.
4. When desired, click Add to .nav File.
Turning Pump On / Off

SEASAVE allows you to manually turn a 911plus’ pump on and off during data acquisition. This may be useful if your system is integrated with an acoustic instrument, to provide a quiet period during its data acquisition.

To manually turn SBE 911plus pump on / off:

1. Start SEASAVE from the command line (select Run in the Windows Start menu), using the -pc command line option:
   Path\seasave.exe -pc (path is location of seasave.exe on your computer)
2. SEASAVE opens. Set up the system and displays as desired.
3. Start real-time data acquisition.
4. When desired:
   In the RealTime Data menu, select Turn Pump On or Turn Pump Off, OR
   Press Ctrl F2 (pump on) or Ctrl F4 (pump off).

Note:
You must start SEASAVE from the command line, using the -pc command, to enable pump turn on / off from SEASAVE. If you do not, Turn Pump On and Turn Pump Off will remain grayed out and be unavailable after you start data acquisition.
Section 8: Displaying Archived Data

SEASAVE can be used to display and plot archived data:

1. In the ArchivedData menu, select Start. The Start Archived Data Display dialog box appears:

The dialog box selections include:

- **Select Data File**: Click to select an archived data file. The Select Data File dialog box appears. Browse to the desired file and click OK.

- **Select .con File**: Click to select the instrument configuration (.con) file. The Select Instrument Configuration File appears. Browse to the desired file and click OK.

- **Exam / Change .con File**: Click to view or modify the instrument configuration and calibration coefficients. See Section 4: Configure Menu, Part II - Instrument .con File.

- **Number of Scans to Skip Over**: Allows you to skip any number of scans at the beginning of the data, allowing you to skip data from before the cast actually began (i.e., when the instrument was on deck and initially soaking in the water).

- **Number of Seconds to Skip between Computations**: Allows you to skip data, speeding up the display. To calculate parameters for all data, set to 0. Note that this interacts with the Update Rate set for each display window, as illustrated by the examples below:
  
  **Example 1:**
  Number of Seconds to Skip between Computations = 5 seconds
  Display Update Rate = 10 seconds
  SEASAVE calculates parameters every 5 seconds, but updates the display only every 10 seconds.

  **Example 2:**
  Number of Seconds to Skip between Computations = 10 seconds
  Display Update Rate = 5 seconds
  SEASAVE calculates parameters every 10 seconds, and updates the display only every 10 seconds.

- **Start Display**: Begin processing and displaying data.

- **Save and Exit**: Save the archived data display setup (data and .con file names, number of scans to skip over, and number of seconds to skip between computations). If saved, the next time you select Start in the ArchivedData menu, the dialog box will appear with your saved selections.

**Note:**
To display archived data without a mouse:
- Windows 2000 / XP – Press the Alt key to show the keyboard shortcuts (underlines) on menus. Press the appropriate letter (for example, A for ArchivedData menu) and use the arrow and Enter keys to navigate.
- Windows 95, 98, and NT – Keyboard shortcuts (underlines) appear on menus at all times. Press the Alt key and appropriate letter and use the arrow and Enter keys to navigate.

**Note:**
Note that just above the Start Acquire button, the dialog box indicates if Output ASCII data (to a COM port, not to a shared file) and/or sending data to a Remote Display (through a COM port) was enabled in the Configure menu. These features are available for archived data as well as for real-time data. See ASCII Output and Remote Display in Section 3: Configure Menu, Part I - General System Setup.
2. **To pause and restart data display:** In the ArchivedData menu, select Pause. The data display stops, but SEASAVE retains information on where it stopped. In the ArchivedData menu, select Continue when ready to restart the display where it stopped.

3. **To adjust rate that data is displayed:** In the ArchivedData menu, select Faster, Slower, or No Wait. No Wait plays back data at the rate at which it was acquired.

4. **To stop data display:** In the ArchivedData menu, select Stop. The data display stops.
Section 9: Processing Data

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

However, sometimes users want to edit the raw .hex or .dat 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 or .dat 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.

**.hex Files**

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

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

2. Run WordPad.

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

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

   * Sea-Bird SBE 21 Data File:
   * FileName = C:\Odis\SAT2-ODIS\oct14-19\oc15_99.hex
   * Software Version Seasave Win32 v1.10
   * Temperature SN = 2366
   * Conductivity SN = 2366
   * System Upload Time = Oct 15 1999 10:57:19
   * Testing adding header lines
   * Must start with an asterisk
   * Place anywhere between System Upload Time & END of header
   * NMEA Latitude = 30 59.70 N
   * NMEA Longitude = 081 37.93 W
   * NMEA UTC (Time) = Oct 15 1999 10:57:19
   * Store Lat/Lon Data = Append to Every Scan and Append to .NAV File When <Ctrl F7> is Pressed
   ** Ship: Sea-Bird
   ** Cruise: Sea-Bird Header Test
   ** Station:
   ** Latitude:
   ** Longitude:
   *END*
5. In the File menu, select Save (not Save As). If you are running Windows 2000, the following message displays:

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

Ignore the message and click Yes.

6. In the File menu, select Exit.

.dat Files

Sea-Bird is not aware of a technique for editing a .dat file that will not corrupt it. Opening a .dat file with any text editor corrupts the file by leaving behind invisible characters (for example, carriage returns, line feeds, etc.) when the file is closed. These characters, inserted semi-randomly through the file, corrupt the data format. Sea-Bird distributes a utility program with our Windows software called Fixdat that may repair a corrupted .dat file.

- Fixdat.exe is installed with, and located in the same directory as, SBE Data Processing (the data processing software in our Windows suite of software).
Appendix I: Command Line Operation

SEASAVE has several command line parameters, for infrequently used options:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>-autostart=filename</td>
<td>Automatically start SEASAVE and data acquisition, saving data to filename. Filename must include path and extension (.dat for SBE 9plus, .hex for SBE 16, 16plus, 19, 19plus, 21, 25, or 31). SEASAVE uses .con file and display setup from last saved SEASAVE configuration (.cfg). This allows you to set up system ahead of time, and then have an untrained operator start acquisition without navigating through SEASAVE’s menus.</td>
</tr>
<tr>
<td>-diffd2</td>
<td>Add [(secondary sensor sigma-2) - (primary sensor sigma-2)] to list of variables for display.</td>
</tr>
<tr>
<td>-pc</td>
<td>Enable pump control for SBE 911plus from within SEASAVE. Turn Pump On and Turn Pump Off selections in RealtimeData menu remain grayed out if this parameter is not used.</td>
</tr>
<tr>
<td>-ss</td>
<td>Automatically start SEASAVE and data display, but do not save data until user responds to save prompt. SEASAVE uses .con file and display setup from last saved SEASAVE configuration (.cfg). This allows you to view, but not save, data acquired during soak time, eliminating the need to edit the data file later to remove these scans.</td>
</tr>
<tr>
<td>-nmeatime</td>
<td>For NMEA navigation device messages that contain time but not date, this parameter affects NMEA UTC Time in data file header and NMEA date/time in NMEA Data dialog box on screen during data acquisition. See description below.</td>
</tr>
</tbody>
</table>

Note: If specifying multiple parameters, insert a space between each parameter in the list.

For the -nmeatime command line parameter:

<table>
<thead>
<tr>
<th>If NMEA Message Includes</th>
<th>-nmeatime Included in Command Line?</th>
<th>Information in NMEA UTC Time in Header</th>
<th>Information in NMEA Data dialog box on screen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date &amp; time</td>
<td>(no effect)</td>
<td>NMEA time &amp; date</td>
<td>NMEA time &amp; date</td>
</tr>
<tr>
<td>Time only</td>
<td>No</td>
<td>(none)</td>
<td>NMEA time only</td>
</tr>
<tr>
<td>Time only</td>
<td>Yes</td>
<td>NMEA time</td>
<td>NMEA time &amp; computer date</td>
</tr>
<tr>
<td>No date or time</td>
<td>(no effect)</td>
<td>(none)</td>
<td>(none)</td>
</tr>
</tbody>
</table>

Notes:
- To view NMEA Data dialog box: in the View menu, select NMEA Data Display.
- System Upload Time in the data file header is always computer time and date, regardless of whether a NMEA navigation device is transmitting data.
To run SEASAVE with a Command Line Parameter:

1. In the Windows Start menu, select Run. The Run dialog box appears. Enter the command line parameter(s) as shown below:

   `Path\seasave.exe parameter1 parameter2 . . .`

   where Path is the location of seasave.exe on your computer, and one or more command line parameters are listed.

   **Examples**
   - “C:\Program Files\Sea-Bird\seasave.exe” –pc –diffd2 –ws180 (enables 3 parameters shown)
   - “C:\Program Files\Sea-Bird\seasave.exe” –pc (enables 1 parameter shown)
   - “C:\Program Files\Sea-Bird\seasave.exe” –autostart=“C:\Test Directory\testdata.hex” (automatically starts SEASAVE and data acquisition, saving data to C:\Test Directory\testdata.hex)

2. SEASAVE opens. Set up the system and displays as desired. The functions specified by the command line parameters are enabled.
### Appendix II: Configure (.con) File Format

Shown below is a line-by-line description of the .con file contents, which can be viewed in a text editor.

<table>
<thead>
<tr>
<th>Line</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conductivity sensor serial number</td>
</tr>
<tr>
<td>2</td>
<td>Conductivity M, A, B, C, D, PCOR</td>
</tr>
<tr>
<td>3</td>
<td>Conductivity cell_const, series_r, slope, offset, use GHIJ coefficients?</td>
</tr>
<tr>
<td>4</td>
<td>Temperature sensor serial number</td>
</tr>
<tr>
<td>5</td>
<td>Temperature F0, A, B, C, D, slope, offset, use GHIJ coefficients?</td>
</tr>
<tr>
<td>6</td>
<td>Secondary conductivity sensor serial number</td>
</tr>
<tr>
<td>7</td>
<td>Secondary conductivity M, A, B, C, D, PCOR</td>
</tr>
<tr>
<td>8</td>
<td>Secondary conductivity cell_const, series_r, slope, offset, use GHIJ coefficients?</td>
</tr>
<tr>
<td>9</td>
<td>Secondary temperature sensor serial number</td>
</tr>
<tr>
<td>10</td>
<td>Secondary temperature F0, A, B, C, D, slope, offset, use GHIJ coefficients?</td>
</tr>
<tr>
<td>11</td>
<td>Pressure sensor serial number</td>
</tr>
<tr>
<td>12</td>
<td>Pressure T1, T2, T3, T4, T5</td>
</tr>
<tr>
<td>13</td>
<td>Pressure C1 (A1), C2 (A0), C3, C4 (A2) – parameters in parentheses for strain gauge sensor</td>
</tr>
<tr>
<td>14</td>
<td>Pressure D1, D2, slope, offset, pressure sensor type, AD590_M, AD590_B</td>
</tr>
<tr>
<td>15</td>
<td>Oxygen (Beckman/YSI type) sensor serial number</td>
</tr>
<tr>
<td>16</td>
<td>Oxygen (Beckman/YSI type) M, B, K, C, SOC, TCOR</td>
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<td>Oxygen (Beckman/YSI type) WT, PCOR, TAU, BOC</td>
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<td>pH slope, offset, VREF</td>
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<td>PAR light sensor serial number</td>
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<td>21</td>
<td>PAR cal const, multiplier, M, B, surface_cc, surface_r, offset</td>
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<td>Transmissometer (SeaTech, Chelsea AlphaTracka, WET Labs Cstar) M, B, path length</td>
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<td>Fluorometer SeaTech sensor serial number</td>
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<td>25</td>
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<td>Tilt sensor serial number</td>
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<td>27</td>
<td>Tilt XM, XB, YM, YB</td>
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<td>ORP sensor serial number</td>
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<td>ORP M, B, offset</td>
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<td>OBS/Nephelometer D&amp;A Backscatterance sensor serial number</td>
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<td>OBS/Nephelometer D&amp;A Backscatterance gain, offset</td>
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<td>Altimeter scale factor, offset, hyst, min pressure, hysteresis</td>
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<td>Microstructure temperature sensor serial number</td>
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<td>Microstructure temperature pre_m, pre_b</td>
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<td>Microstructure temperature num, denom, A0, A1, A3</td>
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<td>Microstructure conductivity sensor serial number</td>
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<td>Microstructure conductivity A0, A1, A2</td>
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<td>Microstructure conductivity M, B, R</td>
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<td>Data format channels 0 – 9</td>
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<td>Data format channels 10 – 19</td>
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<td>Data format channels 20 – 39</td>
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<td>43</td>
<td>SBE 16: use water temperature?, fixed pressure, fixed pressure temperature</td>
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<td>Firmware version</td>
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<td>OBS/Nephelometer IFREMER VM0, VD0, D0, K</td>
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<td>OBS/Nephelometer Chelsea clear water voltage, scale factor</td>
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<td>ZAPS m, b</td>
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<td>Fluorometer (SeaTech) sensor calibration date</td>
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<td>Tilt sensor calibration date</td>
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<td>ORP sensor calibration date</td>
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<td>Microstructure conductivity sensor calibration date</td>
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<td>IFREMER OBS/nephelometer sensor calibration date</td>
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<td>Chelsea OBS/nephelometer sensor calibration date</td>
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<td>Dr. Haardt Chlorophyll fluorometer sensor serial number</td>
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<td>Dr. Haardt Chlorophyll fluorometer sensor calibration date</td>
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<td>Dr. Haardt Phycoerythrin fluorometer sensor calibration date</td>
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<td>Dr. Haardt Turbidity OBS/nephelometer sensor serial number</td>
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<td>Dr. Haardt Turbidity OBS/nephelometer sensor calibration date</td>
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<td>Biospherical natural fluorometer Cnf, A1, A2, B</td>
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<td>Fluorometer chelsea Aqua 3 sensor calibration date</td>
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<td>Fluorometer turner sensor calibration date</td>
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<td>WET Labs WETStar fluorometer Vblank, scale factor</td>
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<td>Primary conductivity sensor using g, h, i, j coefficients calibration date</td>
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<td>Secondary temperature sensor using g, h, i, j coefficients calibration date</td>
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<td>Line</td>
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<td>Fluorometer Dr. Haardt Yellow Substance sensor A0, A1, B0, B1, which modulo bit, gain range switching</td>
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<td>Seapoint Fluorometer gain, offset</td>
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<td>Secondary Oxygen (SBE 43) Soc, Tcor, offset</td>
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<td>Secondary Oxygen (SBE 43) Soc, Tcor, offset</td>
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<td>170</td>
<td>Secondary Oxygen (SBE 43) Pc0r, Tau, Boc</td>
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<td>Pressure (strain gauge with span TC) ptempA0, ptempA1, ptempA2, pTCP0, pTCP1, pTCP2</td>
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<td>Turner SCUFA fluorometer calibration date</td>
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<td>CAPSUM METS D, A0, A1, B0, B1, T1, T2</td>
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<td>Secondary PAR sensor cal const, multiplier, M, B, offset</td>
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<td>Line</td>
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<td>Secondary WET Labs WETStar Fluorometer Vblank, scale factor</td>
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<td>214</td>
<td>Secondary Seapoint Fluorometer sensor serial number</td>
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<td>Secondary Seapoint Fluorometer sensor calibration date</td>
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<td>Secondary Seapoint Fluorometer gain, offset</td>
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<td>WET Labs WETStar CDOM Vblank, scale factor</td>
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<td>Seapoint Rhodamine Fluorometer sensor serial number</td>
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<td>Seapoint Rhodamine Fluorometer sensor calibration date</td>
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<td>Seapoint Rhodamine Fluorometer gain, offset</td>
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<td>Primary Gas Tension Device sensor calibration date</td>
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<td>228</td>
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<td>Secondary Chelsea Aqua 3 fluorometer scale factor, slope, offset, vacetone, vb, v1</td>
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<tr>
<td>246</td>
<td>SBE 49 temperature sensor calibration date.</td>
</tr>
<tr>
<td>247</td>
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</tr>
<tr>
<td>248</td>
<td>Secondary Turner SCUFA OBS serial number</td>
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Appendix III: Software Problems

Considerable effort has been made to test and check this software before its release. However, because of the wide range of instruments that Sea-Bird produces (and interfaces with) and the many applications that these instruments are used in, there may be software problems that have not been discovered and corrected. If a problem occurs, please contact us via phone (425-643-9866), email (seabird@seabird.com), or fax (425-643-9954) with the following information:

- Instrument serial number
- Version of the software originally shipped with the instrument
- Version of the software you are attempting to run
- Complete description of the problem you are having

If the problem involves the configuration or setup of the software, in most cases a phone call to Sea-Bird will be sufficient to solve the problem. If you phone, we would appreciate it if you would be ready to run the software during the phone conversation.

If the problem involves data analysis or processing, you may be asked to send a sample of the data to Sea-Bird for evaluation.

Known Bugs/Compatibility Issues

1. SEASOFT-DOS’ terminal programs (TERM19, TERM25, etc.) may not run when SEASAVE is running.
   Solution: Use SEASOFT-Win32 terminal program (SEATERM), or close SEASAVE to run SEASOFT-DOS terminal program.

2. SEASAVE may not run when a DOS window (such as for SEASOFT-DOS) is open:
   Solution: Close DOS window. Use Windows software.
Appendix IV: Derived Parameter Formulas

For formulas for the calculation of conductivity, temperature, and pressure, see the calibration sheets for your instrument.

Formulas for the computation of salinity, density, potential temperature, specific volume anomaly, and sound velocity were obtained from "Algorithms for computation of fundamental properties of seawater", by N.P. Fofonoff and R.C Millard Jr.; Unesco technical papers in marine science #44, 1983.
- Temperature used for calculating derived variables is IPTS-68. Following the recommendation of JPOTS, T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C).

Equations are provided for the following oceanographic parameters:
- density (density, sigma-theta, sigma-1, sigma-2, sigma-4, sigma-t)
- thermosteric anomaly
- specific volume
- specific volume anomaly
- geopotential anomaly
- dynamic meters
- depth (salt water, fresh water)
- salinity
- sound velocity (Chen-Millero, DelGrosso, Wilson)
- average sound velocity
- potential temperature (reference pressure = 0.0 decibars)
- potential temperature anomaly
- specific conductivity
- derivative variables (descent rate and acceleration) - if input file has not been averaged into pressure or depth bins
- oxygen (if input file contains pressure, temperature, and either conductivity or salinity, and has not been averaged into pressure or depth bins) - also requires oxygen current and oxygen temperature (for SBE 13 or 23) or oxygen signal (for SBE 43)
- corrected irradiance (CPAR)

Note: Algorithms used for calculation of derived parameters in SEASAVE and in SBE Data Processing's Data Conversion, Derive, and SeacalcW modules are identical, except as noted.
Appendix IV: Derived Parameter Formulas

**Density calculation:**

Using the following constants -

- $B_0 = 8.24493 \times 10^{-1}$
- $B_1 = -4.0899 \times 10^{-3}$
- $B_2 = 7.64388 \times 10^{-5}$
- $B_3 = -8.2467 \times 10^{-7}$
- $B_4 = 5.3875 \times 10^{-9}$
- $C_0 = -5.72466 \times 10^{-3}$
- $C_1 = 1.02571 \times 10^{-4}$
- $C_2 = -1.65438 \times 10^{-6}$
- $D_0 = 4.8314 \times 10^{-4}$
- $A_0 = 999.842594$
- $A_1 = 6.793952 \times 10^{-2}$
- $A_2 = -9.095290 \times 10^{-3}$
- $A_3 = 1.001685 \times 10^{-4}$
- $A_4 = -1.120083 \times 10^{-6}$
- $A_5 = 6.536332 \times 10^{-9}$
- $FQ_0 = 54.6746$,
- $FQ_1 = -0.603459$,
- $FQ_2 = -1.0987 \times 10^{-2}$,
- $FQ_3 = -6.1670 \times 10^{-5}$,
- $G_0 = 7.944 \times 10^{-2}$,
- $G_1 = 1.6483 \times 10^{-2}$,
- $G_2 = -5.3009 \times 10^{-4}$,
- $H_0 = 3.239908$,
- $H_1 = 1.43713 \times 10^{-3}$,
- $H_2 = 1.16092 \times 10^{-4}$,
- $H_3 = -5.77905 \times 10^{-7}$,
- $K_0 = 8.50935 \times 10^{-5}$,
- $K_1 = 6.12293 \times 10^{-6}$,
- $K_2 = 5.2787 \times 10^{-8}$

**C Computer Code** -

```c
double Density(double s, double t, double p) 
// s = salinity PSU, t = temperature deg C ITPS-68, p = pressure in decibars 
{
    double t2, t3, t4, t5, s32;
    double sigma, k, kw, aw, bw;
    double val;
    t2 = t*t;
    t3 = t*t2;
    t4 = t*t3;
    t5 = t*t4;
    if (s <= 0.0)  s = 0.000001;
    s32 = pow(s, 1.5);
    p /= 10.0;   /* convert decibars to bars */
    sigma = A0 + A1*t + A2*t2 + A3*t3 + A4*t4 + A5*t5 + (B0 + B1*t + B2*t2 + B3*t3 + B4*t4)*s +
               (C0 + C1*t + C2*t2)*s32 + D0*s*s;
    kw = E0 + E1*t + E2*t2 + E3*t3 + E4*t4;
    aw = H0 + H1*t + H2*t2 + H3*t3;
    bw = K0 + K1*t + K2*t2;
    k = kw + (FQ0 + FQ1*t + FQ2*t2 + FQ3*t3)*s + (G0 + G1*t + G2*t2)*s32 + (aw + (i0 + i1*t +
                      i2*t2)*s + (J0*s32)) + (bw + (M0 + M1*t + M2*t2)*s)*p*p;
    val = 1 - p / k;
    if (val)  sigma = sigma / val - 1000.0;
    return sigma;
}
```

**Density** = $\rho = \rho (s, t, p) \quad [kg/m^3]$  
(density of seawater with salinity s, temperature t, and pressure p, based on the equation of state for seawater (EOS80))

**Sigma-theta** = $\sigma_{\theta} = \rho (s, \theta(t, p, 0), 0) - 1000 \quad [kg/m^3]$ 

**Sigma-1** = $\sigma_1 = \rho (s, \theta(s, t, p), 1000) - 1000 \quad [kg/m^3]$ 

**Sigma-2** = $\sigma_2 = \rho (s, \theta(s, t, p), 2000) - 1000 \quad [kg/m^3]$ 

**Sigma-4** = $\sigma_4 = \rho (s, \theta(s, t, p), 4000) - 1000 \quad [kg/m^3]$ 

**Sigma-t** = $\sigma_t = \rho (s, t, 0) - 1000 \quad [kg/m^3]$ 

thermosteric anomaly = $10^5 ((1000/(1000 + \sigma_i)) - 0.97266) \quad [10^{-8} m^3/kg]$ 

specific volume = $V(s, t, p) = 1/\rho \quad [m^3/kg]$ 

specific volume anomaly = $\delta = 10^8 (V(s, t, p) - V(35, 0, p)) \quad [10^{-8} m^3/kg]$ 

geopotential anomaly = $10^4 \sum_{\phi, p=0}^{p=p} (\delta \times \Delta p) \quad [J/kg] = [m^2/s^2]$ 

dynamic meters = geopotential anomaly / 10.0 
(1 dynamic meter = 10 J/kg; 
(Sverdup, Johnson, Flemming (1946), UNESCO (1991)))
Appendix IV: Derived Parameter Formulas

**Depth calculation:**

**C Computer Code** – 

```c
// Depth
double Depth(int dtype, double p, double latitude)
// dtype = fresh water or salt water, p = pressure in decibars, latitude in degrees
{
double x, d, gr;
if (dtype == FRESH_WATER) /* fresh water */
  d = p * 1.019716;
else { /* salt water */
  x = sin(latitude / 57.29578);
  x = x * x;
  gr = 9.780318 * (1.0 + (5.2788e-3 + 2.36e-5 * x) * x) + 1.092e-6 * p;
  d = (((-1.82e-15 * p + 2.279e-10) * p - 2.2512e-5) * p + 9.72659) * p;
  if (gr)  d /= gr;
}
return(d);
}
```

**Salinity calculation:**

**C Computer Code** – 

```c
using the following constants -
B4 = -3.107e-3, C0 = 6.766097e-1, C1 = 2.00564e-2, C2 = 1.104259e-4, C3 = -6.9698e-7,
C4 = 1.0031e-9
}
```

```c
double Salinity(double C, double T, double P) /* compute salinity */
// C = conductivity S/m, T = temperature deg C ITPS-68, P = pressure in decibars
{
  double R, RT, RP, temp, sum1, sum2, result, val;
  int i;
  if (C <= 0.0)
    result = 0.0;
  else {
    R = C / 42.914;
    if (val)
      RT = R / val;
    if (RT <= 0.0)  RT = 0.000001;
    for (i = 1; i < 6; i++) {
      temp = pow(RT, (double)i/2.0);
      sum1 += a[i] * temp;
      sum2 += b[i] * temp;
    }
    val = 1.0 + 0.0162 * (T - 15.0);
    if (val)
      result = sum1 + sum2 * (T - 15.0) / val;
    else
      result = -99.;
  }
return result;
}
```

**depth =** [m]

**salinity =** [PSU]

(Salinity is PSS-78.)
Appendix IV: Derived Parameter Formulas

sound velocity = \[ \text{m/sec} \]
(sound velocity can be calculated as Chen-Millero, DelGrosso, or Wilson)

Sound velocity calculation:

C Computer Code –

// Sound Velocity Chen and Millero
double SndVelC(double s, double t, double p0) /* sound velocity Chen and Millero 1977 */
/* JASA, 62, 1129–1135 */
// s = salinity, t = temperature deg C ITPS-68, p = pressure in decibars
{
double a, a0, a1, a2, a3;
double b, b0, b1;
double c, c0, c1, c2, c3;
double p, sr, d, sv;
p = p0 / 10.0; /* scale pressure to bars */
if (s < 0.0) s = 0.0;
sr = sqrt(s);
d = 1.727e-3 - 7.9836e-6 * p;
b1 = 7.367e-5 + 1.7945e-7 * t;
b0 = -1.922e-2 + 4.42e-5 * t;
b = b0 + b1 * p;
a3 = (-3.389e-13 * t + 6.649e-12) * t + 1.100e-10;
a2 = ((7.988e-12 * t - 1.6002e-10) * t + 9.1041e-9) * t - 3.9064e-7;
a1 = (((-2.012e-10 * t + 1.0507e-8) * t - 6.4885e-8) * t - 1.2580e-5) * t + 9.4742e-5;
a0 = (((-3.212e-9 * t + 2.006e-6) * t + 7.164e-9) * t - 1.262e-2) * t + 1.389;
a = (a3 * p + a2) * p + a1; /* p + a0;
c3 = (-2.3643e-12 * t + 3.850e-10) * t - 9.7729e-9;
c2 = ((1.0405e-12 * t - 2.5335e-10) * t + 2.5974e-8) * t - 1.7107e-6) * t + 3.1260e-5;
c1 = (((-6.1185e-10 * t + 1.3621e-7) * t - 8.1788e-6) * t + 6.8982e-4) * t + 0.153563;
c0 = (((3.1464e-9 * t - 1.47800e-6) * t + 3.3420e-4) * t - 5.80852e-2) * t + 5.03711) * t + 1402.388;
c = (c3 * p + c2) * p + c1) * p + c0;
sv = c + (a + b * sr + d * s) * s;
return sv;
}

// Sound Velocity DelGrosso
double SndVelD(double s, double t, double p) /* Delgrosso JASA, Oct. 1974, Vol 56, No 4 */
// s = salinity, t = temperature deg C ITPS-68, p = pressure in decibars
{
double c000, dct, dcs, dcp, dcstp, sv;
c000 = 1402.392;
p = p / 9.80665; /* convert pressure from decibars to KG / CM**2 */
dct = (0.501109398873e1 - (0.550946843172e-1 - 0.22153596924e-3 * t) * t) * t;
dcs = (0.112952290781e1 + 0.129855756844e-3 * s) * s;
dcp = (0.156059257041e0 + (0.24499868844e-4 - 0.8339232513e-8 * p) * p) * p;
dcstp = -0.127562783426e-1 * t * s + 0.635191613389e-2 * t * p + 0.26548471608e-7 * t * t * p * p - 0.159349479045e-5 * t * p + 0.52216437235e-9 * t * p * p - 0.438031096213e-6 * t * t * p + 0.16167449590e-8 * s * s * p + 0.968403156410e-4 * t * t * s + 0.485639620015e-5 * t * s * s * p - 0.340597039004e-3 * t * s * s * p;
sv = c000 + dct + dcs + dcp + dcstp;
return sv;
}

// Sound Velocity Wilson
double SndVelW(double s, double t, double p) /* Wilson JASA, 1960, 32, 1357 */
// s = salinity, t = temperature deg C ITPS-68, p = pressure in decibars
{
double pr, sd, a, v0, v1, sv;
pr = 0.1019716 * (p + 10.1325);
sd = s - 35.0;
a = (((7.9851e-6 * t - 2.6045e-4) * t - 4.6532e-2) * t + 4.5721) * t + 1449.14;
sv = (7.7717e-7 * t - 1.1244e-2) * t + 1.38999;
v0 = (1.69202e-3 * sd + sv) * sd + a;
a = (((4.5283e-8 * t + 7.4812e-6) * t - 1.8607e-4) * t + 0.16072;
sv = (1.579e-9 * t + 3.158e-8) * t + 7.7016e-5;
v1 = sv * sd + a;
a = (1.8563e-9 * t - 2.5294e-7) * t + 1.0268e-5;
sv = -1.2943e-7 * sd + a;
a = -1.9646e-10 * t + 3.5216e-9;
sv = (((-3.3603e-12 * pr + a) * pr + sv) * pr + v1) * pr + v0;
return sv;
}
Appendix IV: Derived Parameter Formulas

average sound velocity = \[ \frac{\sum_{\Delta p, p = \text{min}}^{\Delta p, p = \text{max}} d_i}{\sum_{\Delta p, p = \text{min}}^{\Delta p, p = \text{max}} d_i / v_i} \] [m/s]

Average sound velocity is the harmonic mean (average) from the surface to the current CTD depth. The average is calculated on the downcast only. The first window begins when pressure is greater than a minimum specified pressure and salinity is greater than a minimum specified salinity. Depth is calculated from pressure based on user-input latitude.

- In SEASAVE and in SBE Data Processing’s Data Conversion module, the algorithm also requires user input of a pressure window size and time window size. It then calculates:
  \[ d_i = \text{depth at end of window} - \text{depth at start of window} \] [meters]
  \[ v_i = (\text{sound velocity at start of window} + \text{sound velocity at end of window}) / 2 \] [m/sec]

- In SBE Data Processing’s Derive module, the algorithm is based on the assumption that the data has been bin averaged already. Average sound velocity is computed scan-by-scan:
  \[ d_i = \text{depth of current scan} - \text{depth of previous scan} \] [meters]
  \[ v_i = \text{sound velocity of this scan (bin)} \] [m/sec]
potential temperature [IPTS-68] = \( \theta (s, t, p, p_r) \) \[ ^\circ C \]
(Potential temperature is the temperature an element of seawater would have if raised adiabatically with no change in salinity to reference pressure \( p_r \). Sea-Bird software uses a reference pressure of 0 decibars).

Potential Temperature [IPTS-68] calculation:

\[ \text{Potential Temperature [IPTS-68] calculation:} \]

\[ \text{C Computer Code -} \]

// ATG (used in potential temperature calculation)
double ATG(double s, double t, double p) /* adiabatic temperature gradient deg C per decibar */ /* ref broyden,h. Deep-Sea Res.,20,401-408 */
{
    double ds;
    ds = s - 35.0;
    return((((-2.1687e-16 * t + 1.8676e-14) * t - 4.6206e-13) * p + ((2.7759e-12 * t - 1.1351e-10) * ds + ((-5.4481e-14 * t + 8.733e-12) * t - 6.7795e-10) * t + 1.8741e-8)) * p + (-4.2393e-8 * t + 1.8932e-6) * ds + ((6.6228e-10 * t - 8.5258e-8) * t + 3.5803e-5));
}

// potential temperature
double PoTemp(double s, double t0, double p0, double pr) /* local potential temperature at pr */ /* using atg procedure for adiabadic lapse rate */ /* Fofonoff,N.,Deep-Sea Res.,24,489-491 */
{
    double p, t, h, xk, q, temp;
    p = p0;
    t = t0;
    h = pr - p;
    xk = h * ATG(s,t,p);
    t += 0.5 * xk;
    q = xk;
    p += 0.5 * h;
    xk = h * ATG(s,t,p);
    t += 0.29289322 * (xk-q);
    q = 0.58578644 * xk + 0.121320344 * q;
    xk = h * ATG(s,t,p);
    t += 1.707106781 * (xk-q);
    q = 3.414213562 * xk - 4.121320344 * q;
    p += 0.5 * h;
    xk = h * ATG(s,t,p);
    temp = t + (xk - 2.0 * q) / 6.0;
    return(temp);
}

potential temperature [ITS-90] = \( \theta (s, t, p, p_r) / 1.00024 \) \[ ^\circ C \]

potential temperature anomaly = potential temperature - a0 - a1 x salinity

or

potential temperature - a0 - a1 x Sigma-theta

(a0, a1, and the selection of salinity or sigma-theta are user-input.)

specific conductivity = \((C \times 10,000) / (1 + A \times [T - 25])\) \[ \text{microS/cm} \]
(C = conductivity (S/m), T = temperature (°C),
A = thermal coefficient of conductivity for a natural salt solution
[0.019 - 0.020]; Sea-Bird software uses 0.020.)
Appendix IV: Derived Parameter Formulas

**Descent rate** and **acceleration** computed by SEASAVE and SBE Data Processing’s Data Conversion module are somewhat different from values computed by SBE Data Processing’s Derive module, because the algorithms calculate the derivative of the pressure signal with respect to time, using a linear regression to determine the slope. SEASAVE and Data Conversion compute the derivative looking backward in time, since they share common code and SEASAVE cannot use future values of pressure while acquiring data in real time. Derive uses a centered window (equal number of points before and after the scan; time window size is user-input) to obtain a better estimate of the derivative. Use SEASAVE and Data Conversion to obtain a quick look at descent rate and acceleration; use Derive to obtain the most accurate values.

**Oxygen** [ml/l] = (As applicable, see Application Note 64: SBE 43 Dissolved Oxygen Sensor or Application Note 13-1: SBE 13, 23, 30 Dissolved Oxygen Sensor Calibration & Deployment)

(Oxygen computed by SEASAVE and SBE Data Processing’s Data Conversion module is somewhat different from values computed by SBE Data Processing’s Derive module, because the algorithm calculates the derivative of the oxygen signal with respect to time, using a linear regression to determine the slope. SEASAVE and Data Conversion compute the derivative looking backward in time, since they share common code and SEASAVE cannot use future values of oxygen while acquiring data in real time. Derive uses a centered window [equal number of points before and after the scan; window size is user-input] to obtain a better estimate of the derivative. Use SEASAVE and Data Conversion to obtain a quick look at oxygen values; use Derive to obtain the most accurate values.)

\[
\text{oxygen [µmoles/kg]} = \frac{44660}{\Sigma-theta + 1000} \ \text{oxygen [ml/l]}
\]

**Corrected Irradiance [CPAR]** =

\[
100 \times \text{ratio multiplier} \times \text{underwater PAR} / \text{surface PAR} \quad [%]
\]

(Ratio multiplier = scaling factor used for comparing light fields of disparate intensity, input in .con file entry for surface PAR sensor;

Underwater PAR = underwater PAR data;

Surface PAR = surface PAR data)

**Note:**

For complete description of ratio multiplier, see Application Note 11S (SBE 11 plus Deck Unit) or 47 (SBE 33 or 36 Deck Unit).
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