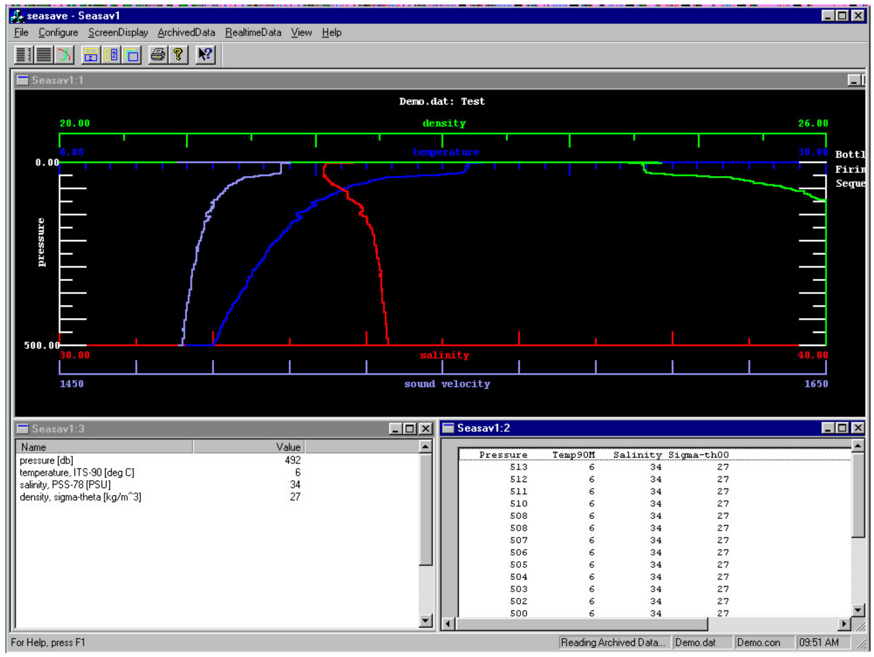
SEASOFT-Win32:
SEASAVE

CTD Real-Time Data Acquisition Software for Windows 95/98/NT/2000/XP



User's Manual

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

10/24/05
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

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

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

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

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.

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.

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

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 911*plus*, 917*plus*, 911, and 911e CTD system
- SBE 16*plus* and 16 SEACAT C-T (optional pressure) Recorder
- SBE 19*plus* 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

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.

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.

SEASAVE Use

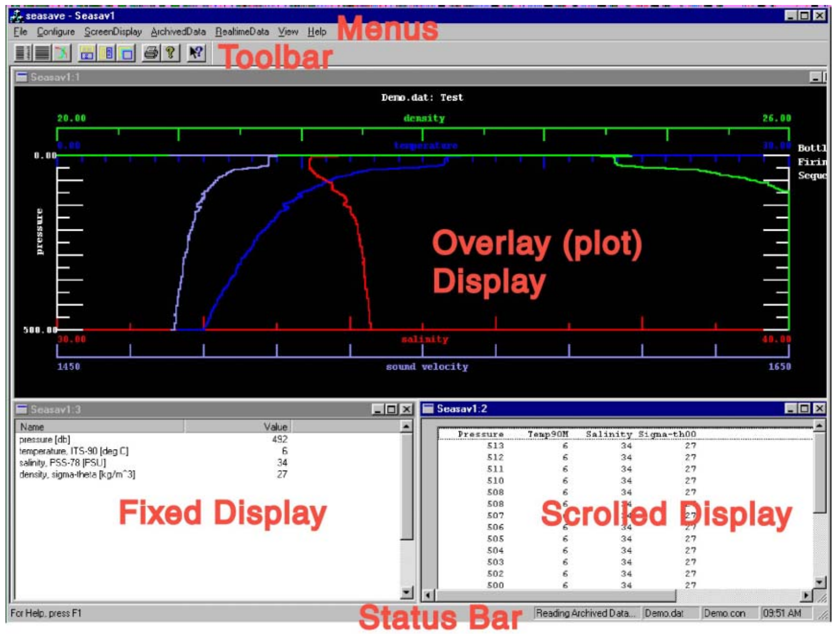
> **Note:**
> SEASAVE can be run from the command line. See *Appendix I: Command Line Operation*.

SEASAVE Window

To start SEASAVE:

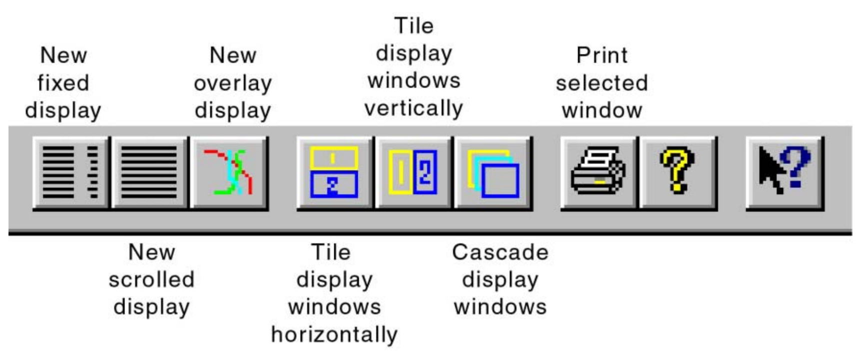
- Double click on seasave.exe
  (default location c:/Program Files/Sea-Bird/Seasave-Win32), **or**
- (for Windows 98 and later) Left click on Start and follow the path Programs/Sea-Bird/Seasave-Win32

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.

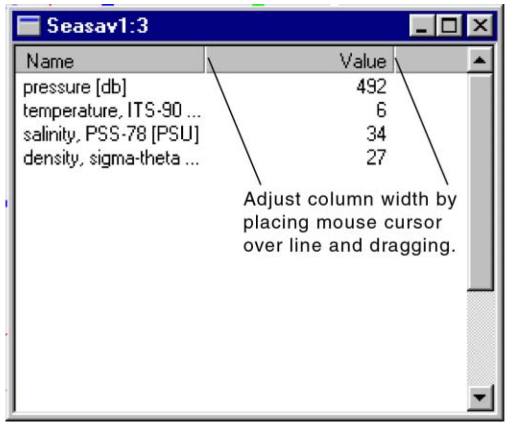
  To display or hide the Status Bar, select Status bar in the View menu.

Notes:

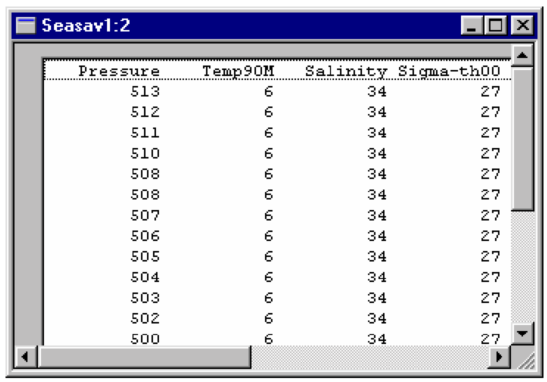
- The algorithms used to calculate derived parameters in SEASAVE are the same as used in SBE Data Processing's Derive and Data Conversion modules (with the exception of the oxygen calculation). See the SBE Data Processing manual on our website or the SBE Data Processing Help files for details.
- Oxygen computed by SEASAVE and SBE Data Processing's Data Conversion 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:
  CPAR = (100 * ratio multiplier * underwater PAR) / surface PAR
  where
  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
  For complete description of ratio multiplier, see Application Note 11S (11*plus* Deck Unit) or 47 (SBE 33 or 36 Deck Unit).

- 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*.

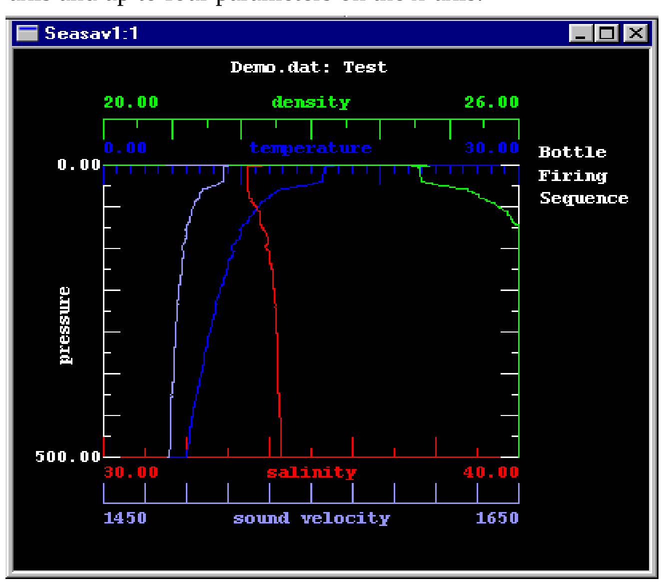
  ➢ The **Fixed Display** window has a vertical list of the selected parameters to the left, and displays their current values to the right.



  ➢ 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.



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:

Extension	Description
.con	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).
.cfg	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 seasavew.cfg (default location C:\Program Files\Sea-Bird\Seasave-Win32).
.dsf	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.
.dso	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.
.dss	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.

Output files from real-time data acquisition:

Extension	Description
.bl	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.
.dat	Data file - binary raw data file created by SEASAVE from real-time data stream from SBE 911, 911e, or 911*plus*. File includes header information. File can be used by SBE Data Processing's Data Conversion module.
.hex	Data file: • Hexadecimal raw data file created by SEASAVE from real-time data stream from SBE 16, 16*plus*, 19, 19*plus*, 21, 25, and 49. Data uploaded from instrument's memory (not applicable to SBE 49) also has this extension. • Data uploaded from SBE 17*plus* (used with SBE 9*plus*). • 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

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.

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*.

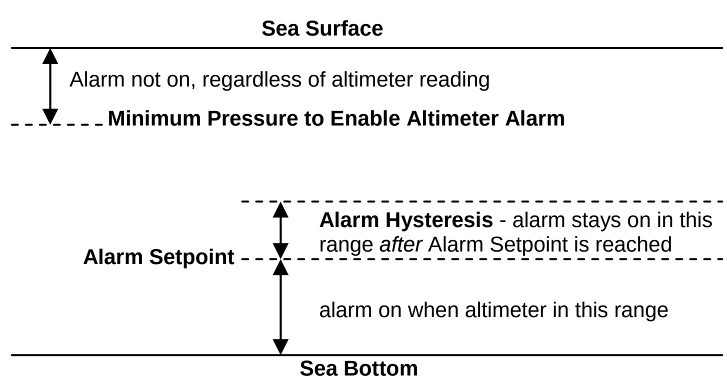
Alarms

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.



Remote Display Alarm

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 11*plus* Deck Unit, Remote Display alarm setup is done by sending commands to the SBE 11*plus* using SEATERM.

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.

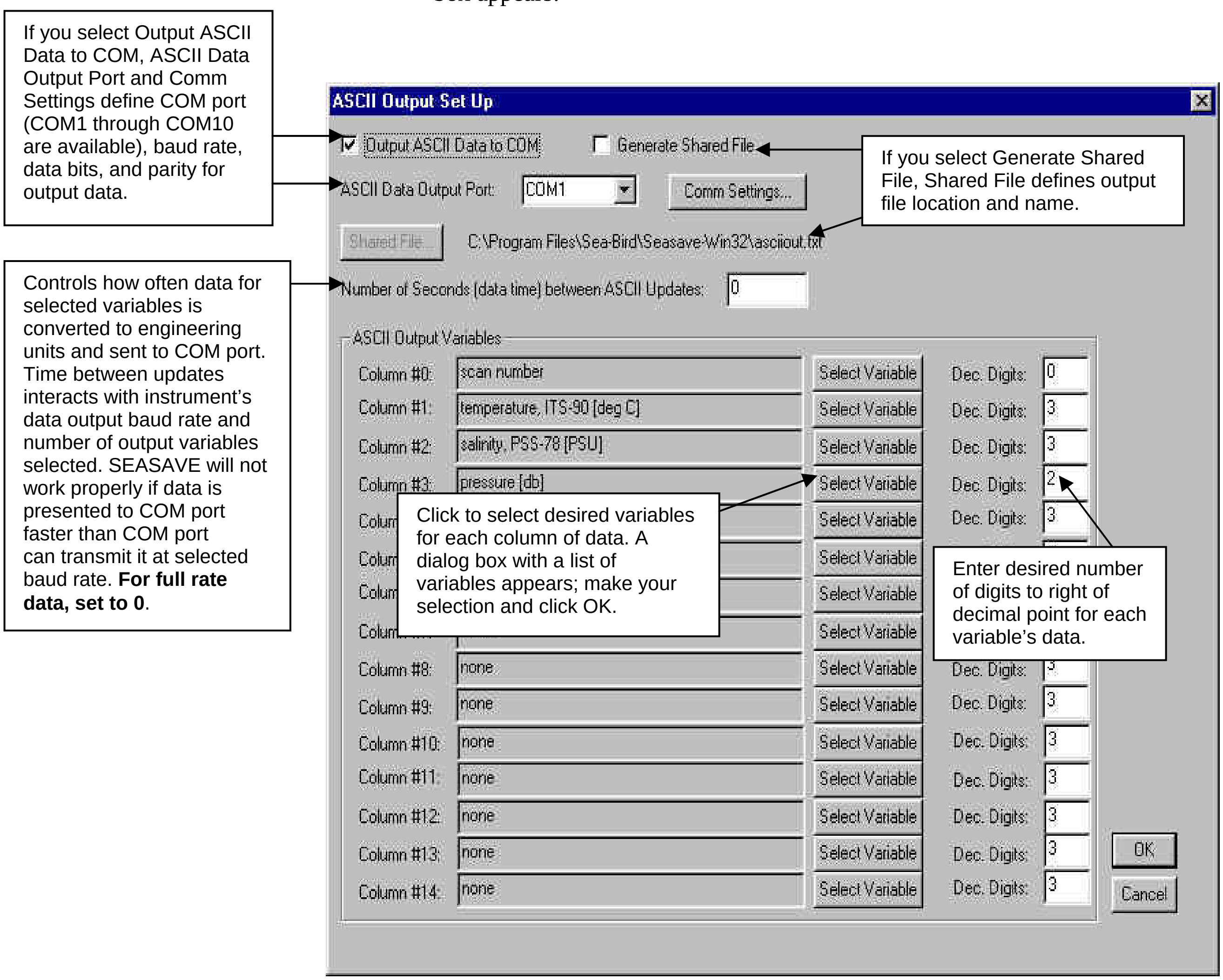
ASCII Output

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.

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.

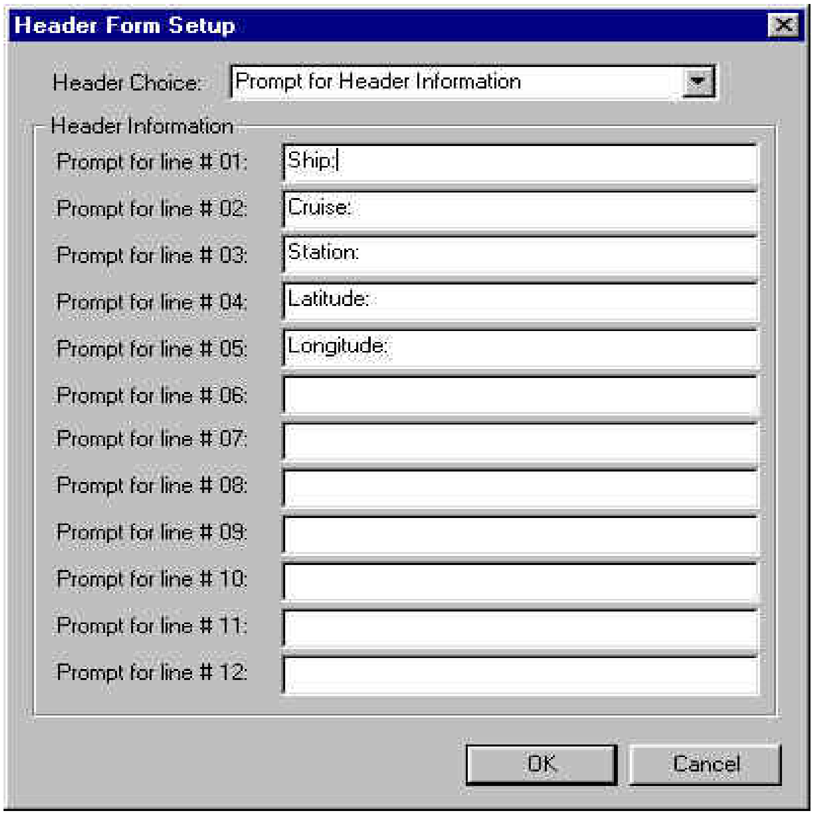
- **Don't Include Header Information in File** – User-input header information will not be added to the data file or placed in the .hdr file.

To set up the header:

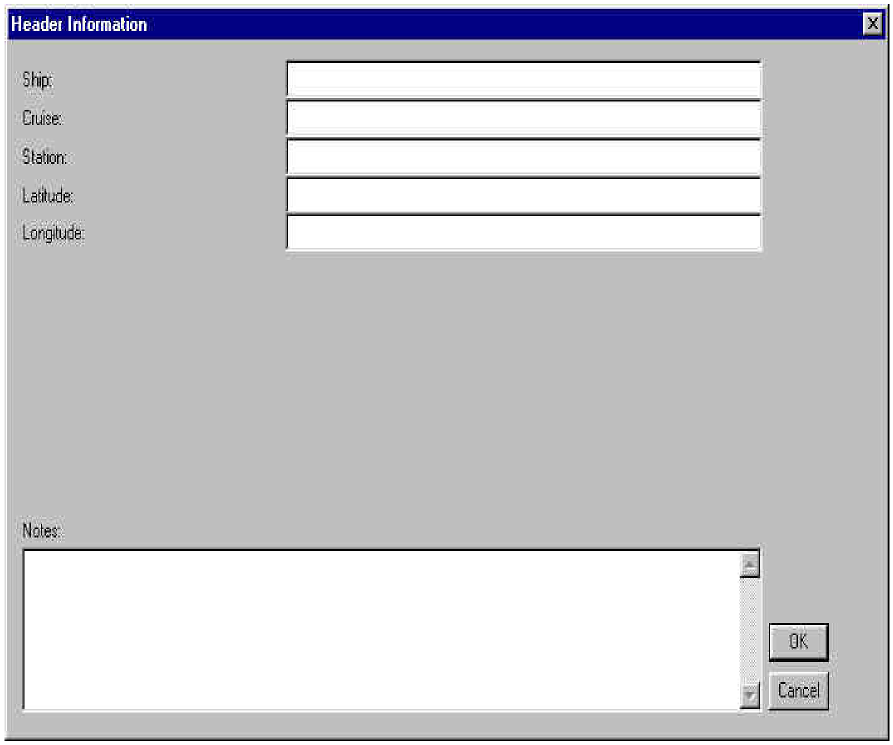
1. In the Configure menu, select Header Form. The Header Form Setup dialog box appears.

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.



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

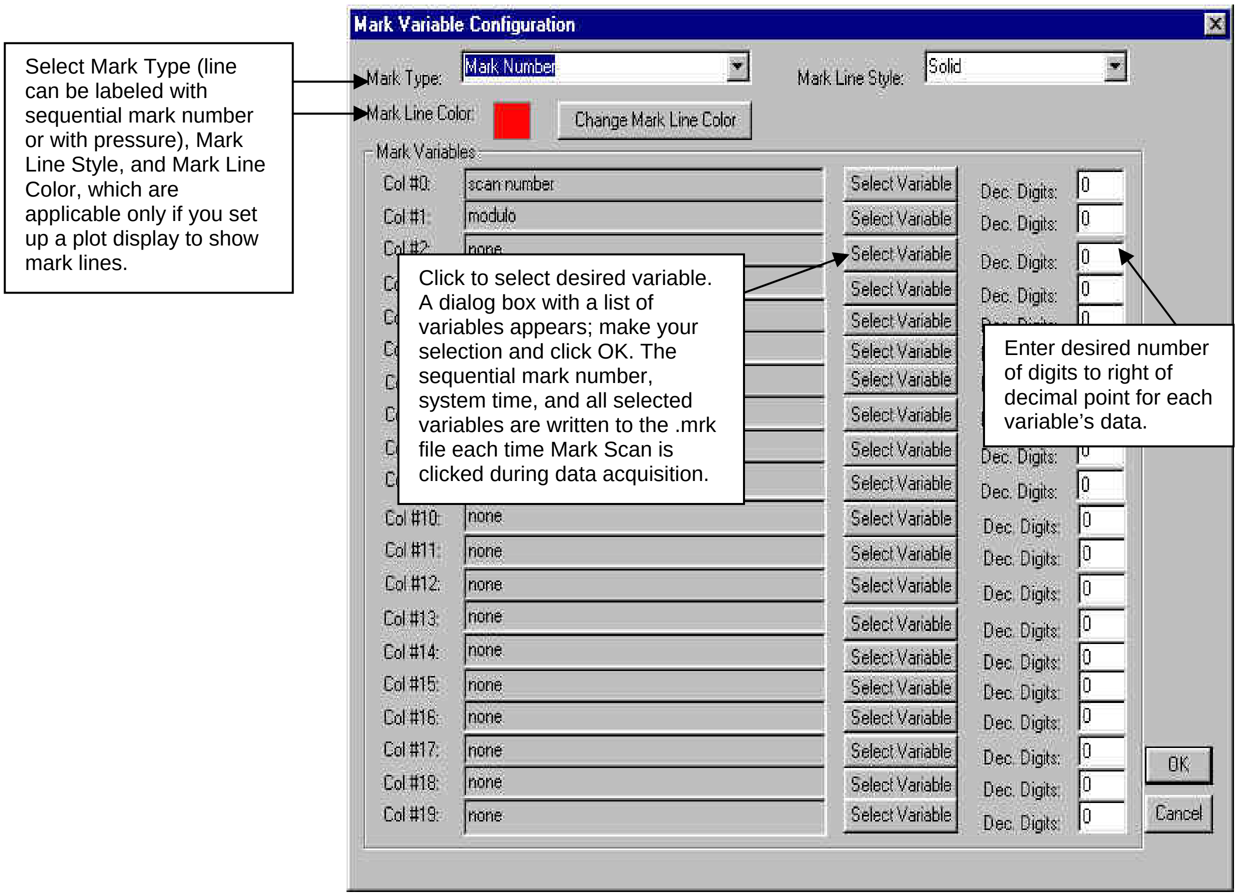
Note:
The .mrk file has the same file name as the data file. For example, if the data file is test1.hex, the .mrk file is test1.mrk.

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:



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.

Note:
When running Data Conversion in SBE Data Processing, if a .nav file is found in the same directory as the data file (and with the same name), the contents of the .nav file are added to the converted data file header.

Remote Display

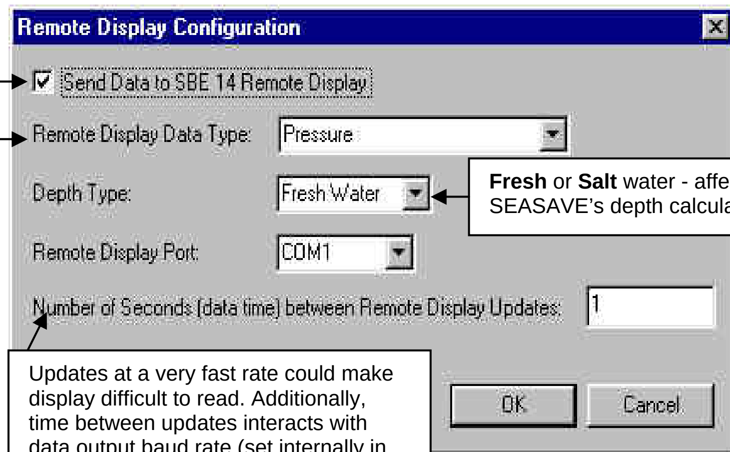
The SBE 14 Remote Display can display depth, pressure, and/or altimeter height for a CTD system.

To enable and set up the Remote Display:

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

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

- **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



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 11*plus* Deck Unit, Remote Display setup is done by sending commands to the SBE 11*plus* 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 911*plus* 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.

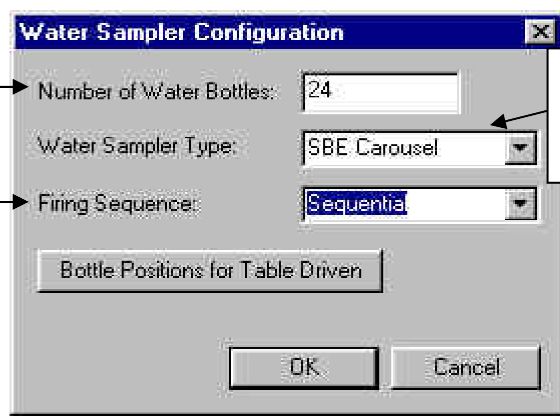
SBE Data Processing can use the bottle firing information, in any of these forms, to assist you in processing the water bottle data.

To enable and set up the water sampler:

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

Can be configured with up to 36 bottles, depending on water sampler capacity.

- **Sequential** - When commanded to fire, bottles are fired in order of position (bottle in position #1 fired first, bottle in position #2 fired second, etc.).
- **User input** - When commanded to fire, SEASAVE prompts you to select which bottle to fire.
- **Table driven** - When commanded to fire, bottles are fired in order pre-defined by user-input table. Click Bottle Positions for Table Driven to input bottle positions.



SBE Carousel (SBE 32), G.O.1015 or 1016, Hydro-Bios, IOW, or None.

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 16*plus* or 19*plus* 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 9*plus* with 11*plus* or 17*plus*, abbreviated in SEASAVE as 911/917*plus*). 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**.

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.

- 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.

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 911/917*plus*, 16, 16*plus*, 19, 19*plus*, 21, 25, 45, and 49).

- *Instrument Configuration* - *Old Style* (in this section):
  Configuration dialog box for each instrument available in the old style (SBE 911*plus*, 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

Note:
Unless noted otherwise, SEASAVE supports only one of each brand and type of auxiliary sensor (for example, you cannot specify two Chelsea Minitracka fluorometers, but you can specify a Chelsea Minitracka and a Chelsea UV Aquatracka fluorometer. See the individual sensor descriptions in *Section 5: Configure Menu, Part III – Calibration Coefficients* for those sensors that SEASAVE supports in a redundant configuration (two or more of the same sensor interfacing with the CTD) when using the New Style configuration.

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

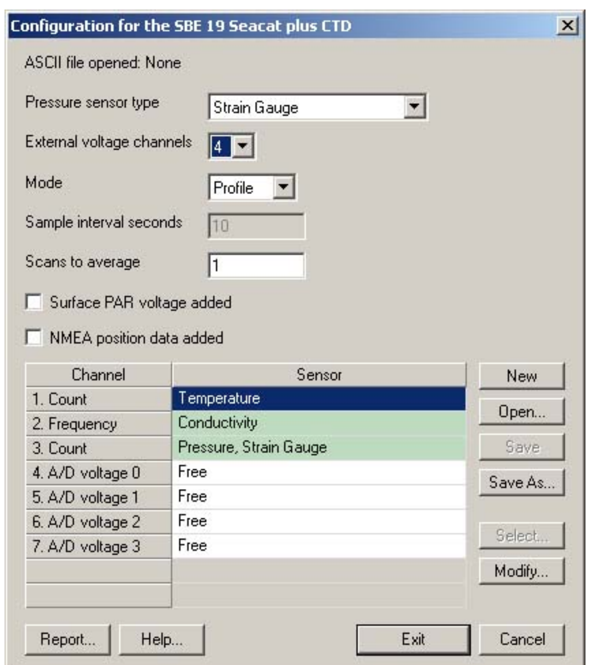
- General description of how to view, modify, or create a .con file
- Detailed description of the Configuration dialog box for each instrument

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 19*plus*.

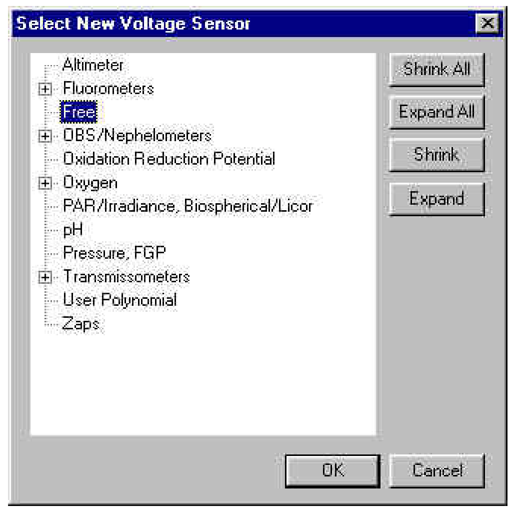


All Instrument Configuration dialog boxes include:

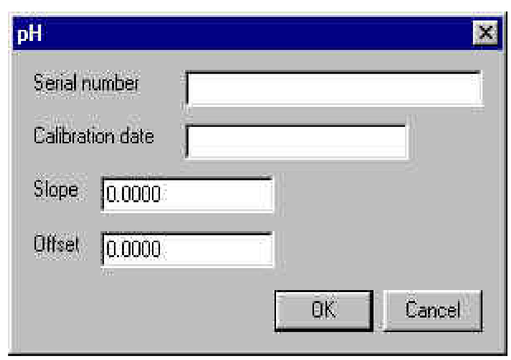
- List of instrument configuration options at the top (instrument-specific), such as number of auxiliary channels, pressure sensor type, addition of Surface PAR and NMEA to the CTD data string.

- 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.

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

    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 9*plus* Configuration

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

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

Channel/Sensor table reflects this choice. Typically:
- **0** = SBE 3 or 4 plugged into JB5 on 9*plus* (dual redundant sensor configuration)
- **1** = SBE 3 or 4 plugged into JB4 on 9*plus* and not using JB5 connector (single redundant sensor configuration)
- **2** = no redundant T or C sensors

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.

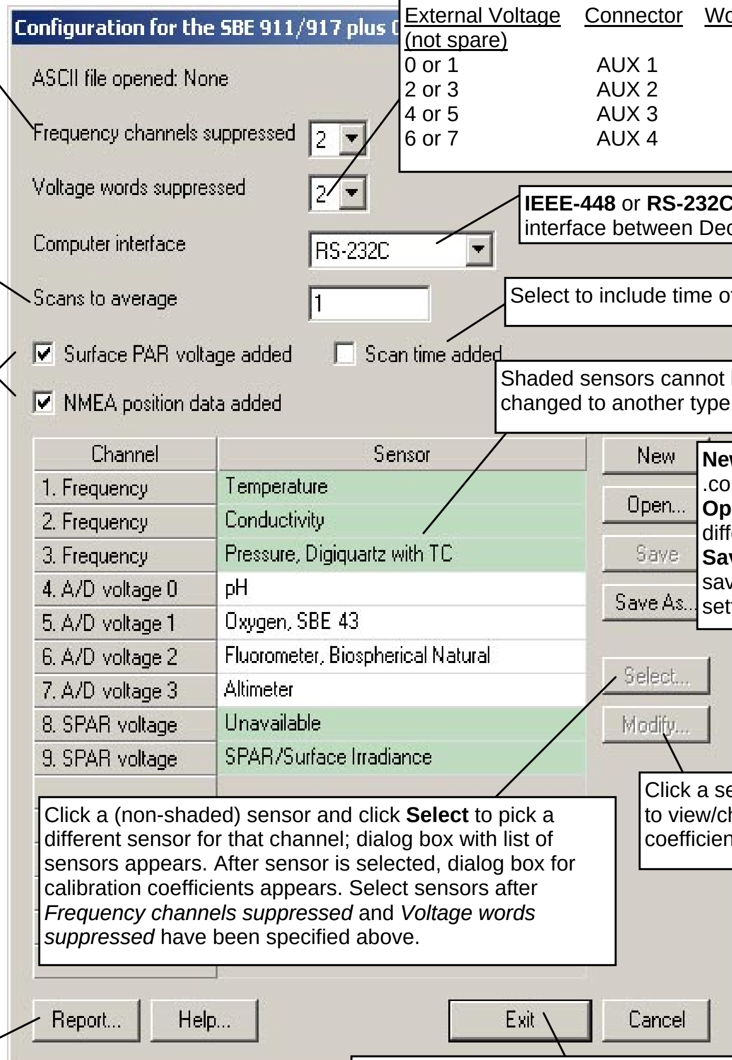
- Surface PAR - Select if Surface PAR sensor used; must agree with **ADDSPAR=** command programmed into Deck Unit. Adds 2 channels to Channel/Sensor table. Do not decrease *Voltage words suppressed* to reflect this; *Voltage words suppressed* reflects only external voltages going directly to 9*plus*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

IEEE-448 or **RS-232C** for CTD data interface between Deck Unit and computer.

Select to include time of each scan with data.

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

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

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

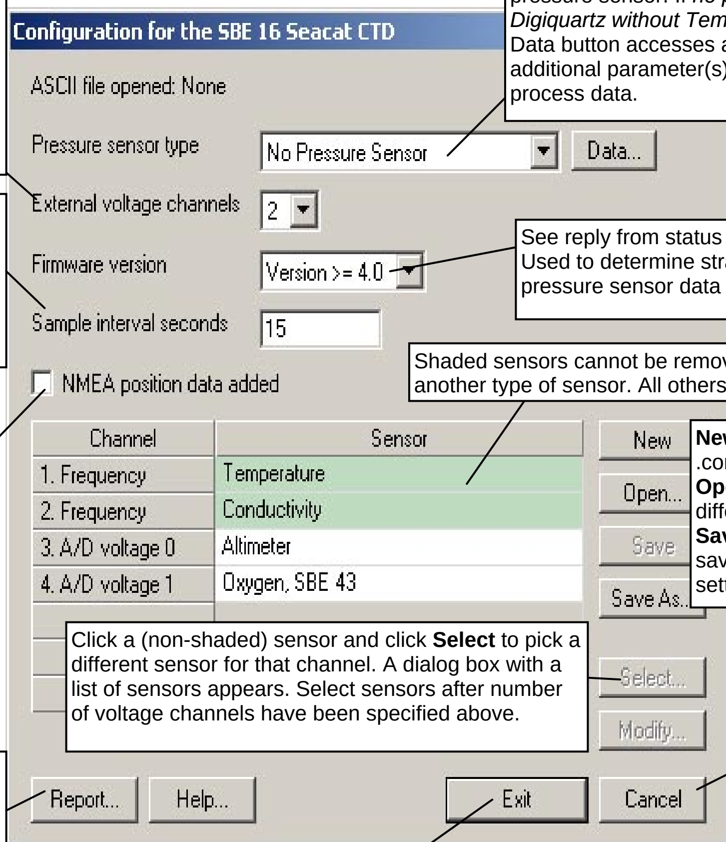
Opens a .txt file (for viewing and printing only; cannot be modified) that shows all parameters in .con file.

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

Channel/Sensor table 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**). 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 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.



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**).

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.

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 (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.

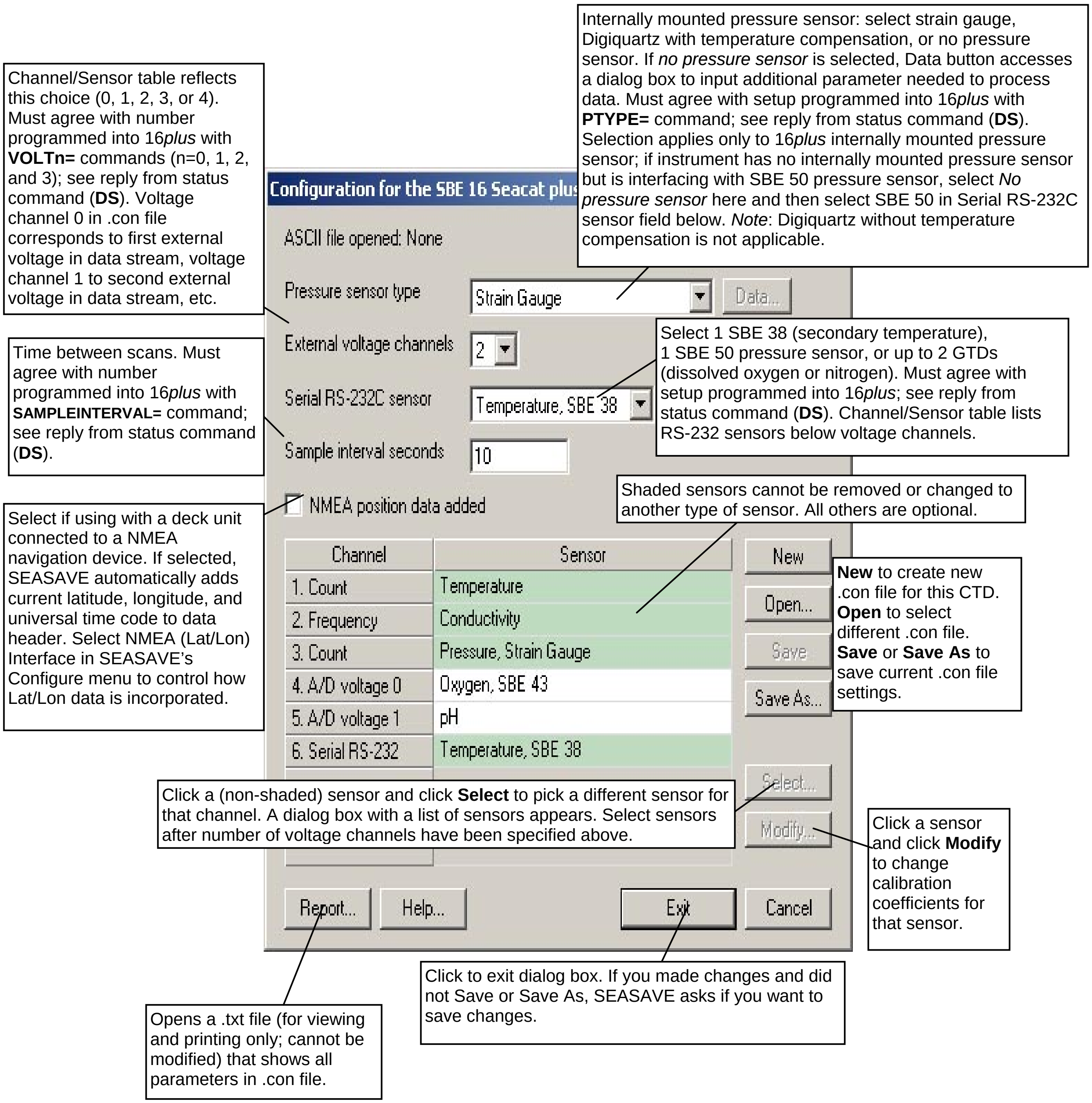
Opens a .txt file (for viewing and printing only; cannot be modified) that shows all parameters in .con file.

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*plus* SEACAT C-T Recorder Configuration

The SBE 16*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*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.



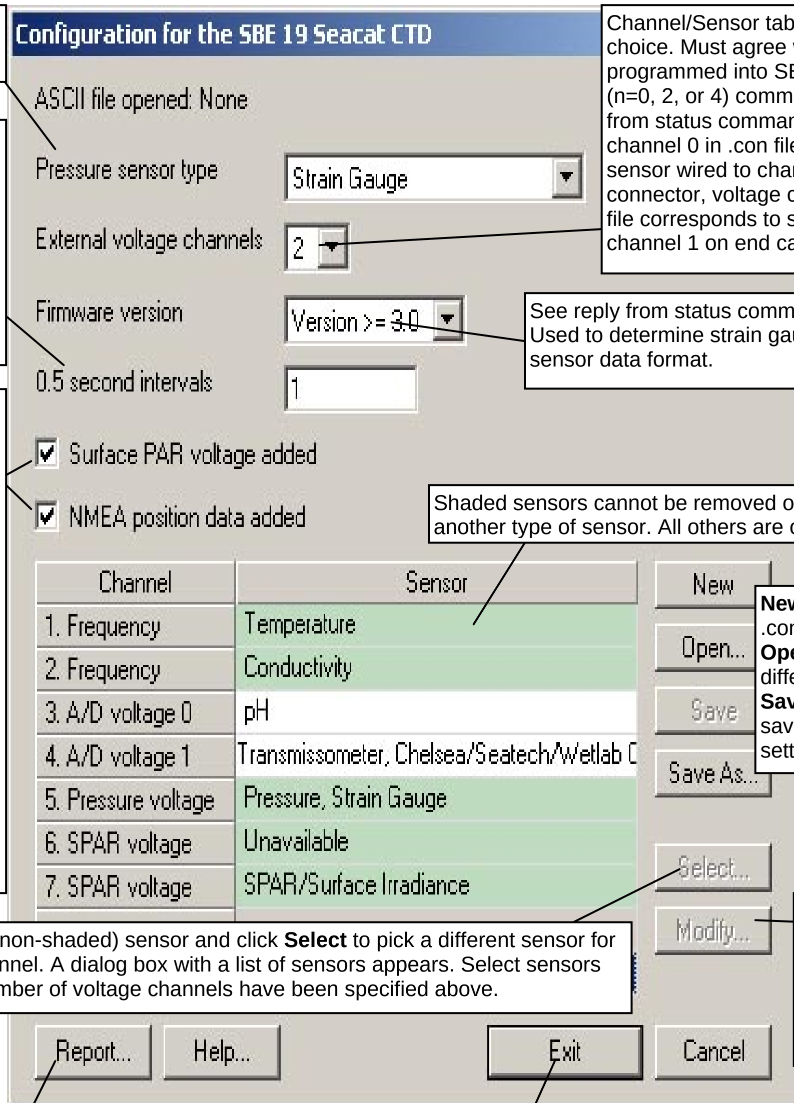
New Style SBE 19 SEACAT Profiler Configuration

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.



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.

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.

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.

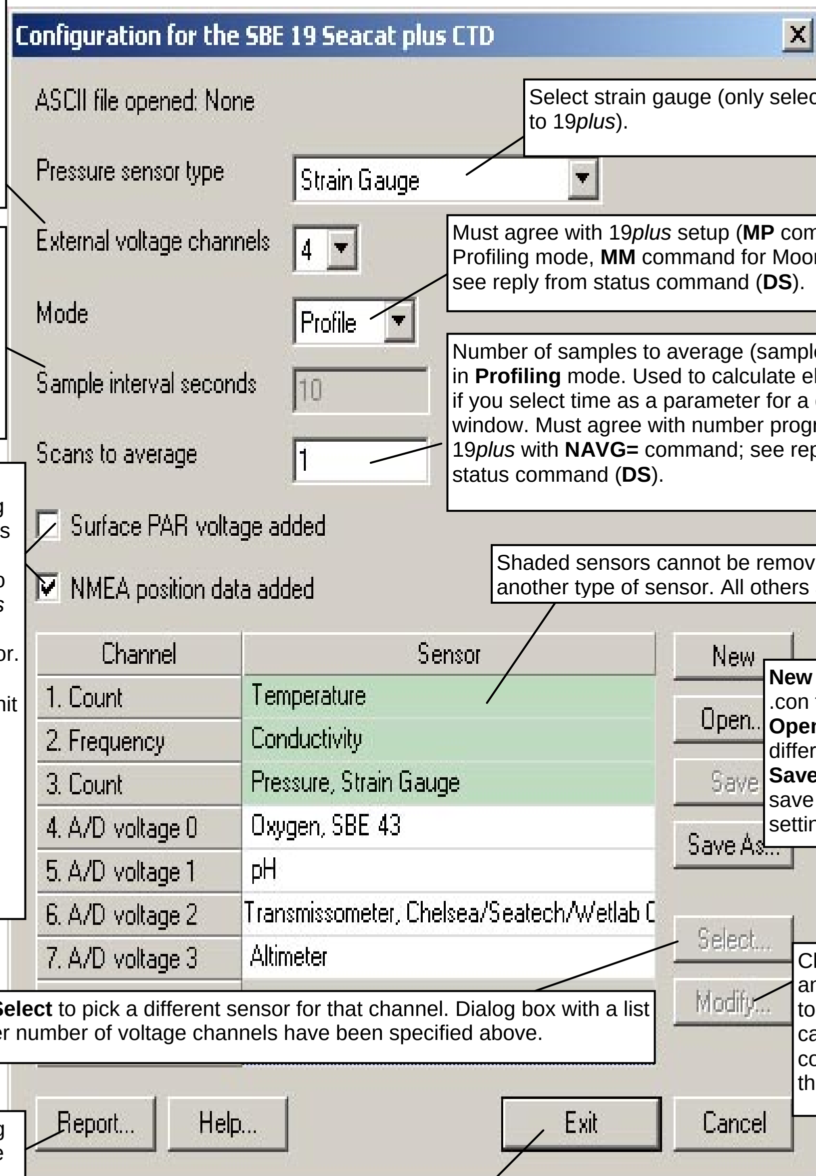
Click a (non-shaded) sensor and click **Select** to pick a different sensor for that channel. A dialog box with a list of sensors appears. Select sensors after number of voltage channels have been specified above.

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

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 19*plus* SEACAT Profiler Configuration



Channel/Sensor table reflects this choice (0, 1, 2, 3, or 4). Must agree with number programmed into 19*plus* with **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.

Select strain gauge (only selection applicable to 19*plus*).

Must agree with 19*plus* setup (**MP** command for Profiling mode, **MM** command for Moored mode); 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 19*plus* with **SAMPLEINTERVAL=** command; see reply from status command (**DS**).

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 19*plus* with **NAVG=** 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 19*plus* 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.

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

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 (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.

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

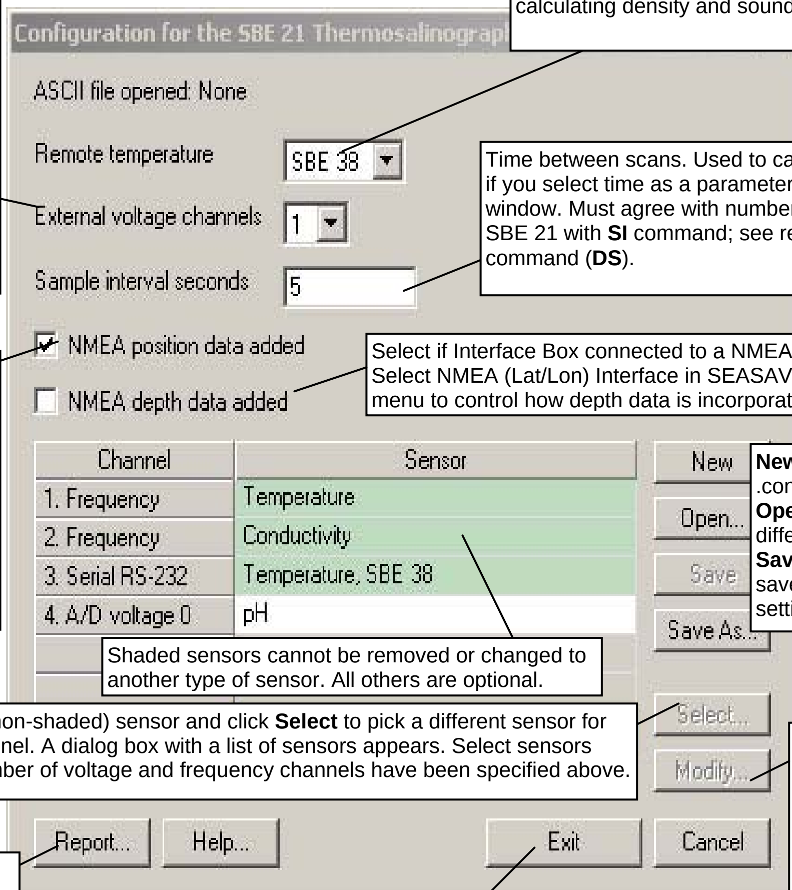
Opens a .txt file (for viewing and printing only; cannot be modified) that shows all parameters in .con file.

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 21 Thermosalinograph Configuration

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**).
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. Must agree with number programmed into SBE 21 with **SVx** (x=0, 1, 2, 3, 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.



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**).

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.

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.

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.

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

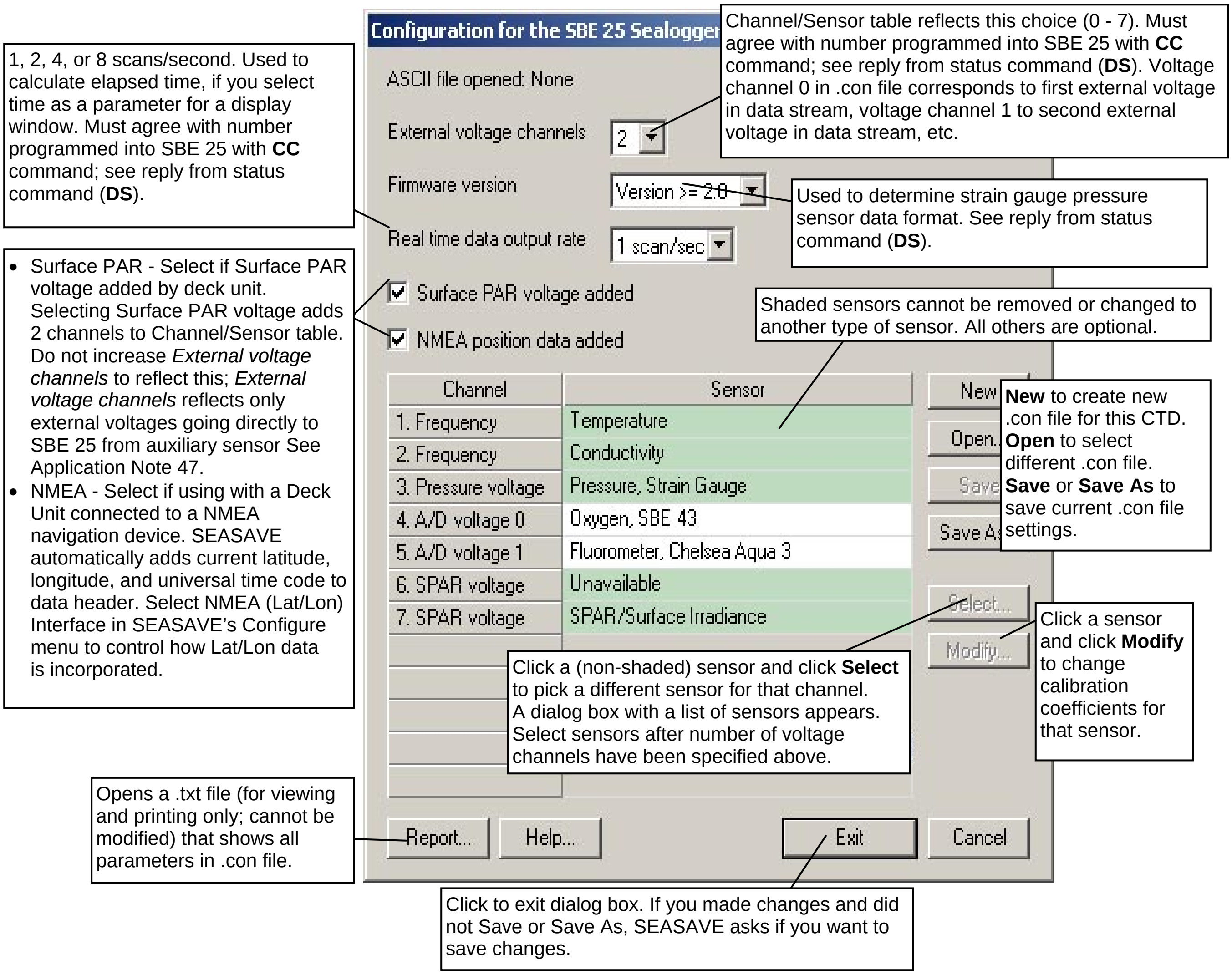
Click a (non-shaded) sensor and click **Select** to pick a different sensor for that channel. A dialog box with a list of sensors appears. Select sensors after number of voltage and frequency channels have been specified above.

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

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 25 SEALOGGER Configuration



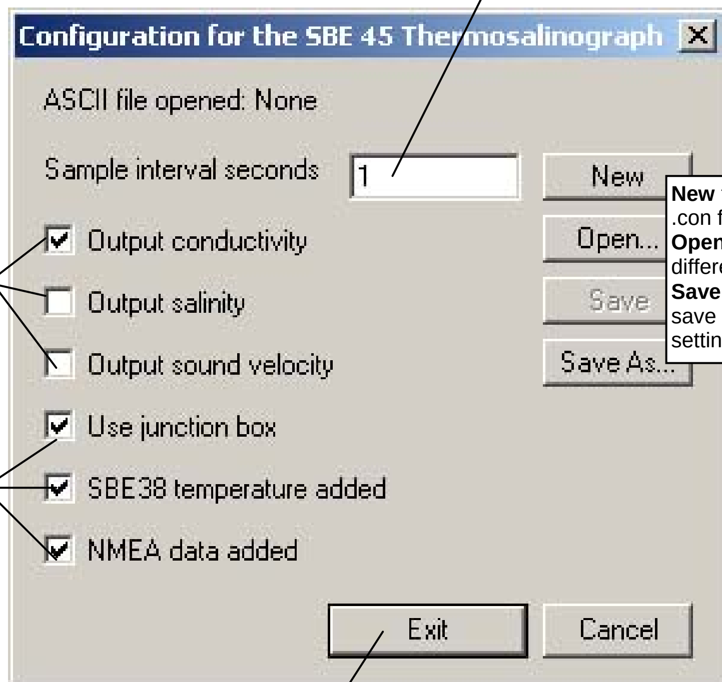
New Style SBE 45 MicroTSG Configuration

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.

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

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.

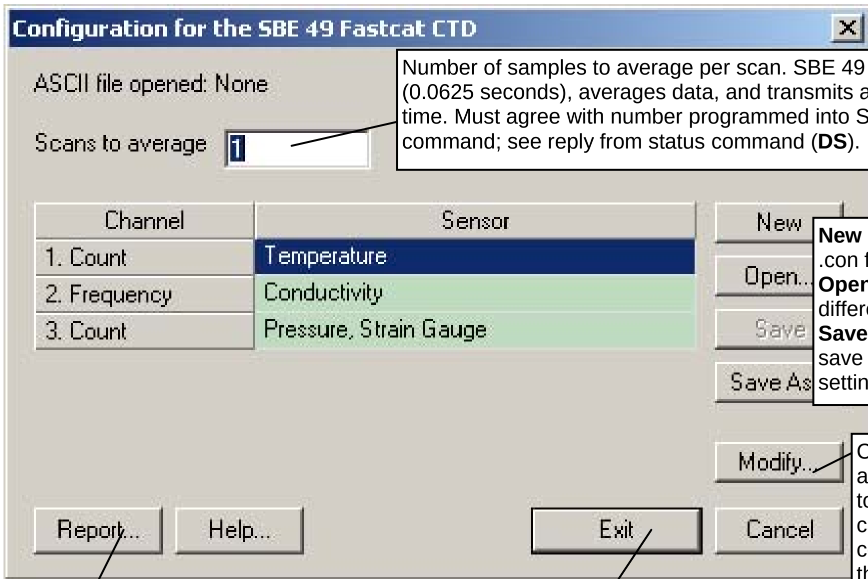


New to create new .con file for this CTD. **Open** to select different .con file. **Save** or **Save As** to save current .con file settings.

- 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.

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 **NAVG=** 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 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.

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

Instrument Configuration - Old Style

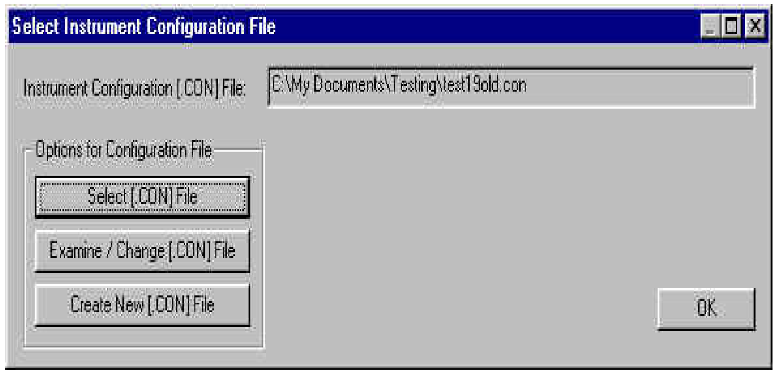
The discussion of old style instrument configuration is in two parts:

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

Viewing, Modifying, or Creating .con File

> **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.

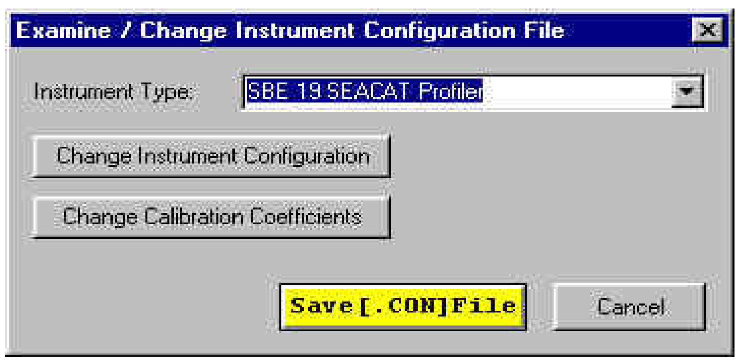
1. In the Configure menu, select Old Style Instrument Configuration. The Select Instrument Configuration File dialog box appears:



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.

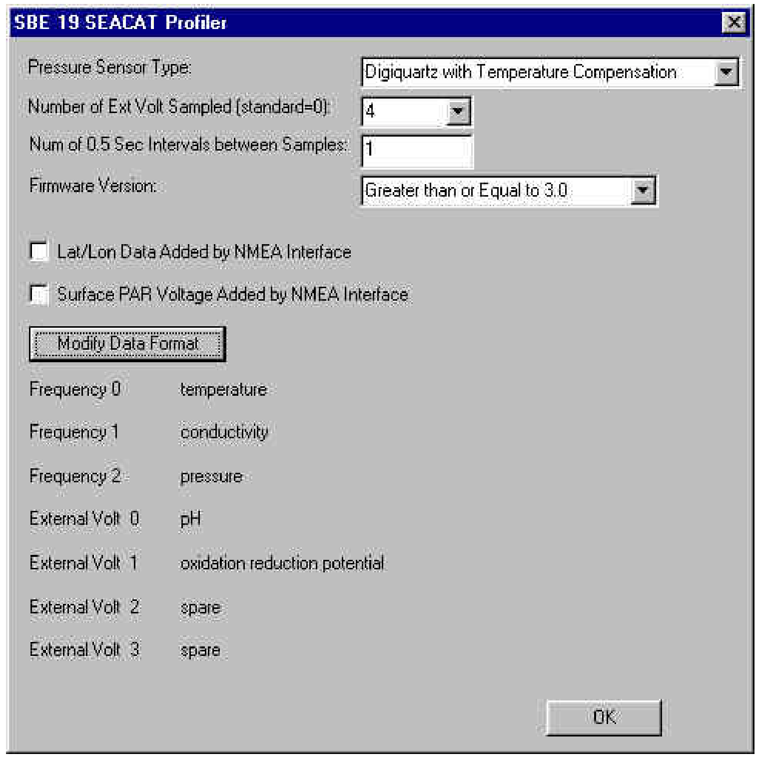
3. **To select and view or modify an existing .con file:** Click Select [.con] File. In the dialog box, browse to the desired file and click OK.

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.

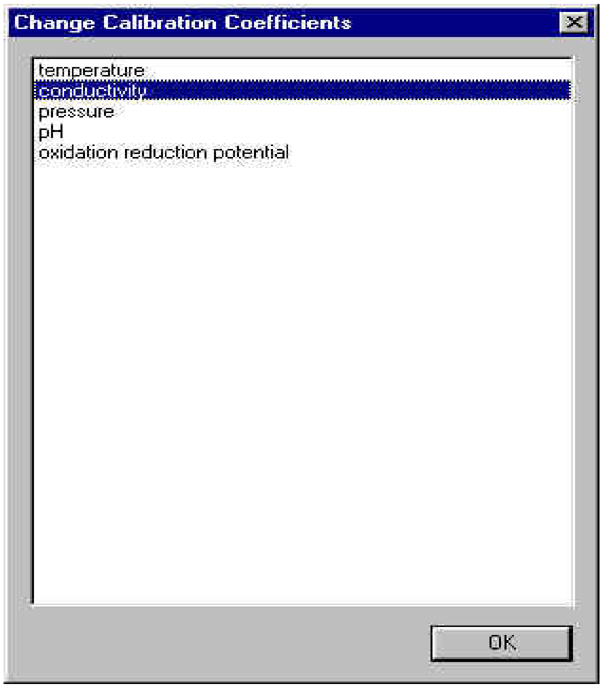


All Instrument Configuration dialog boxes include:

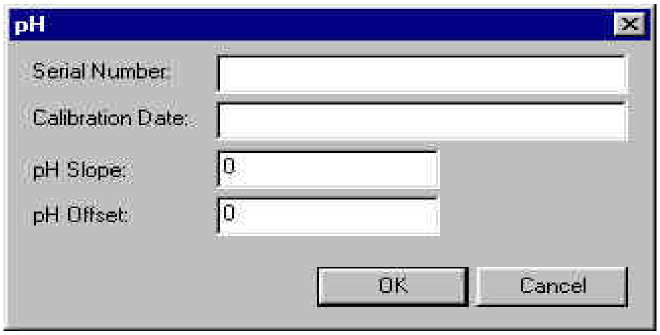
- **List of instrument configuration options at the top** (instrument-specific), such as number of auxiliary channels, pressure sensor type, addition of Surface PAR and NMEA to the CTD data string, etc.
- **Modify Data Format Button** and **List of Channels and Assigned Sensors**: This list reflects 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:



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



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**.

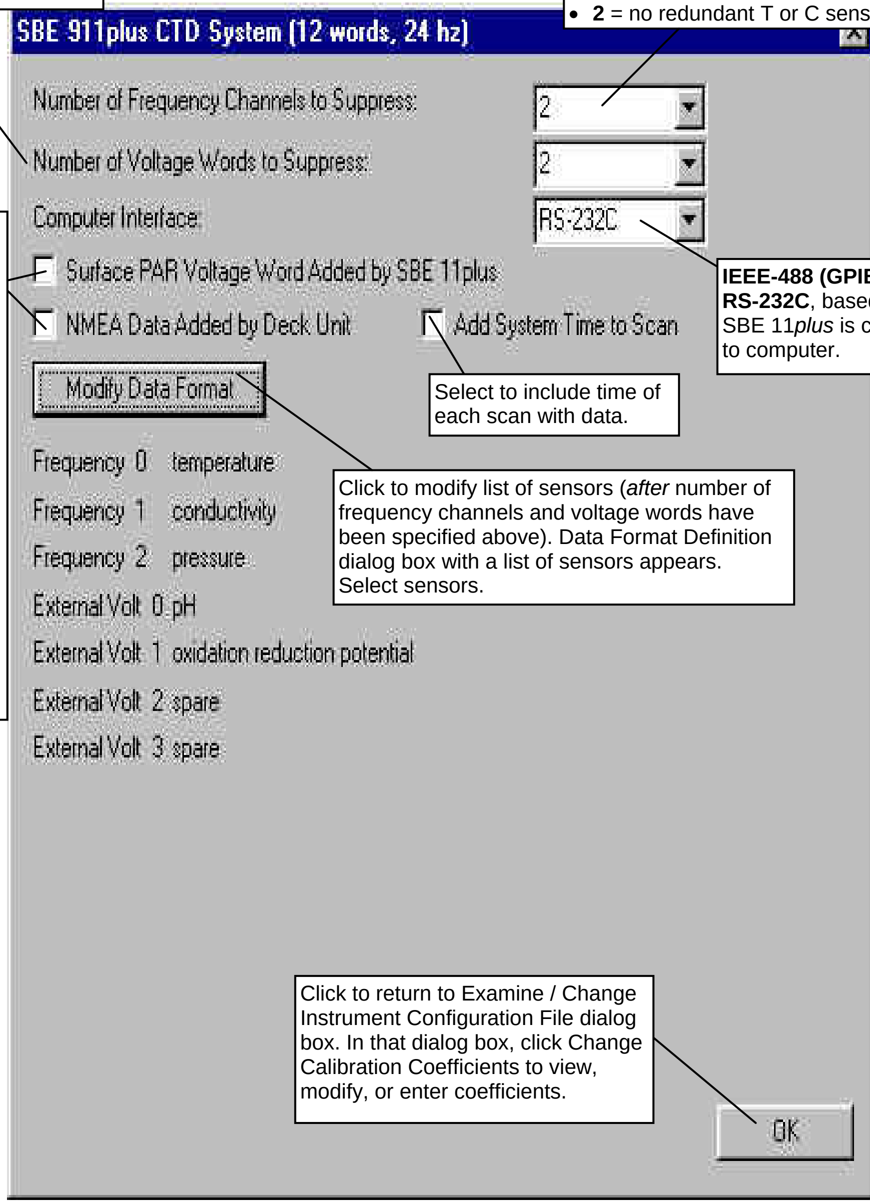
Old Style SBE 9*plus* Configuration

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 11*plus* suppresses words starting with highest numbered word. Number of words to keep is determined by highest numbered external voltage input that is not a spare:
Words to suppress = 4 - Words to Keep

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

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

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



- 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 9*plus* 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 11*plus* is connected to computer.

Select to include time of each scan with data.

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 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*.

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

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

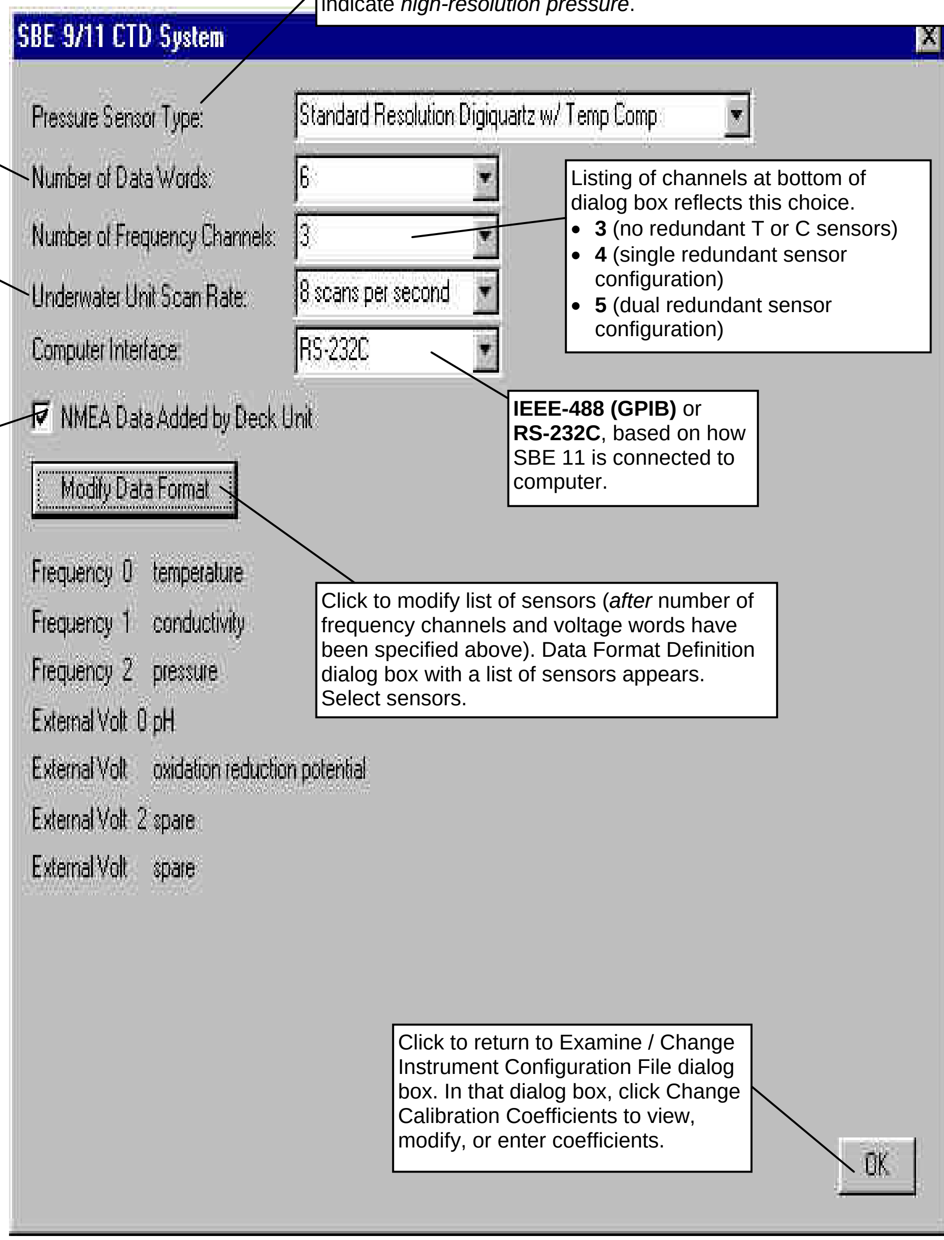
NMEA - Select if NMEA interface option installed in SBE 11 and connected to NMEA navigation device. If selected, SEASAVE automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in SEASAVE's Configure menu to control how Lat/Lon data is incorporated.

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

- **3** (no redundant T or C sensors)
- **4** (single redundant sensor configuration)
- **5** (dual redundant sensor configuration)

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.

Old Style SBE 911e 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*.

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 available with 3, 4, or 5 frequency channels.

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

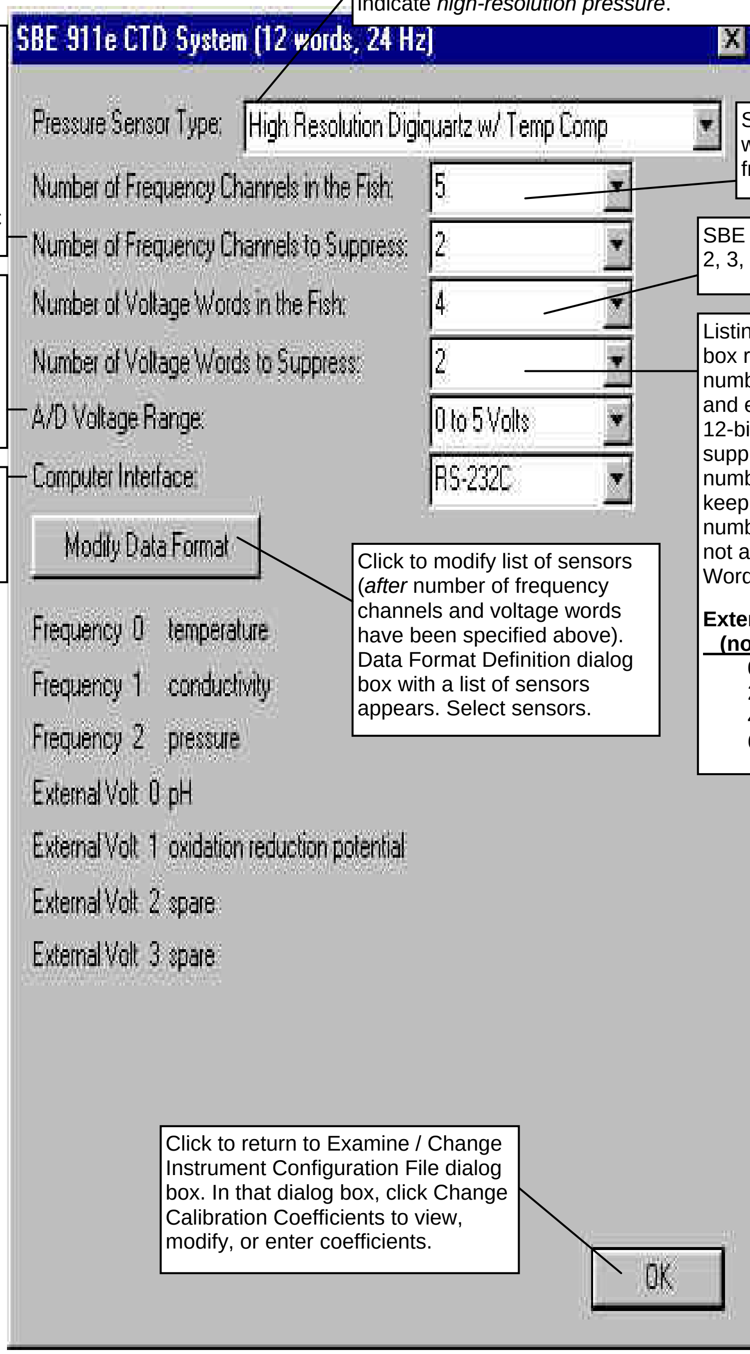
SBE 9 was configured to accept 0 to 5 volt (manufactured after February 1992) or -10 to 10 volt (before February 1992) inputs.

Listing of channels at bottom of dialog box reflects this choice. Maximum number of voltage words available is 4, and each word contains data from two 12-bit A/D channels. SBE 11 suppresses words starting with highest numbered word. Number of words to keep is determined by highest numbered external voltage input that is not a spare: Words to suppress = 4 - Words to Keep

External Voltage (not spare)	Words to Keep
0 or 1	1
2 or 3	2
4 or 5	3
6 or 7	4

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.

Old Style SBE 16 SEACAT C-T Recorder Configuration

Listing of channels at bottom of dialog box reflects this choice (0, 1, or 2); typically 0. Must agree with setup of SBE 16; external frequency channels were a custom application for the SBE 16 - see configuration sheet.

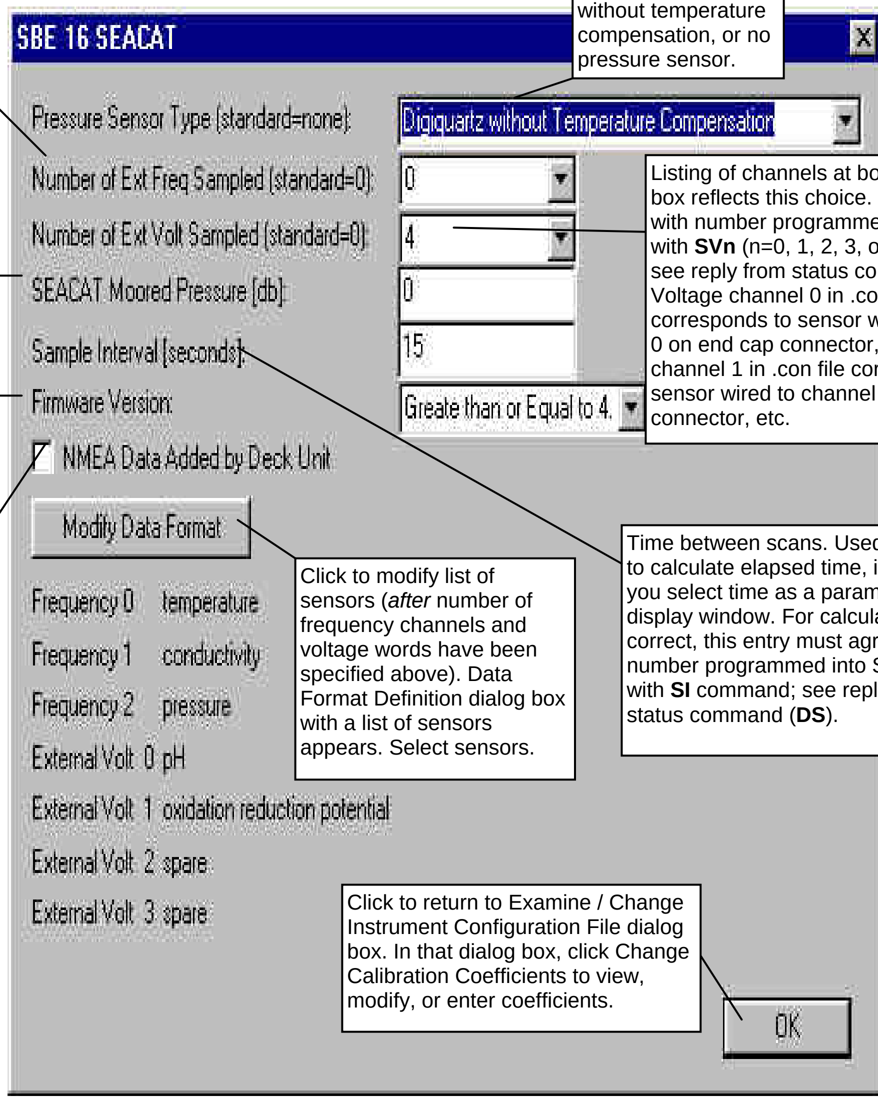
If *None* was selected for pressure sensor type, SEASAVE uses this pressure in calculations that are a function of pressure (conductivity, salinity, density, sound velocity, etc.).

See SBE 16 reply from status command (**DS**). Used to determine strain gauge pressure sensor data format.

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, Digiquartz with or without temperature compensation, or no pressure sensor.

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**). 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.



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.

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 16 with **SI** command; see reply from status command (**DS**).

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

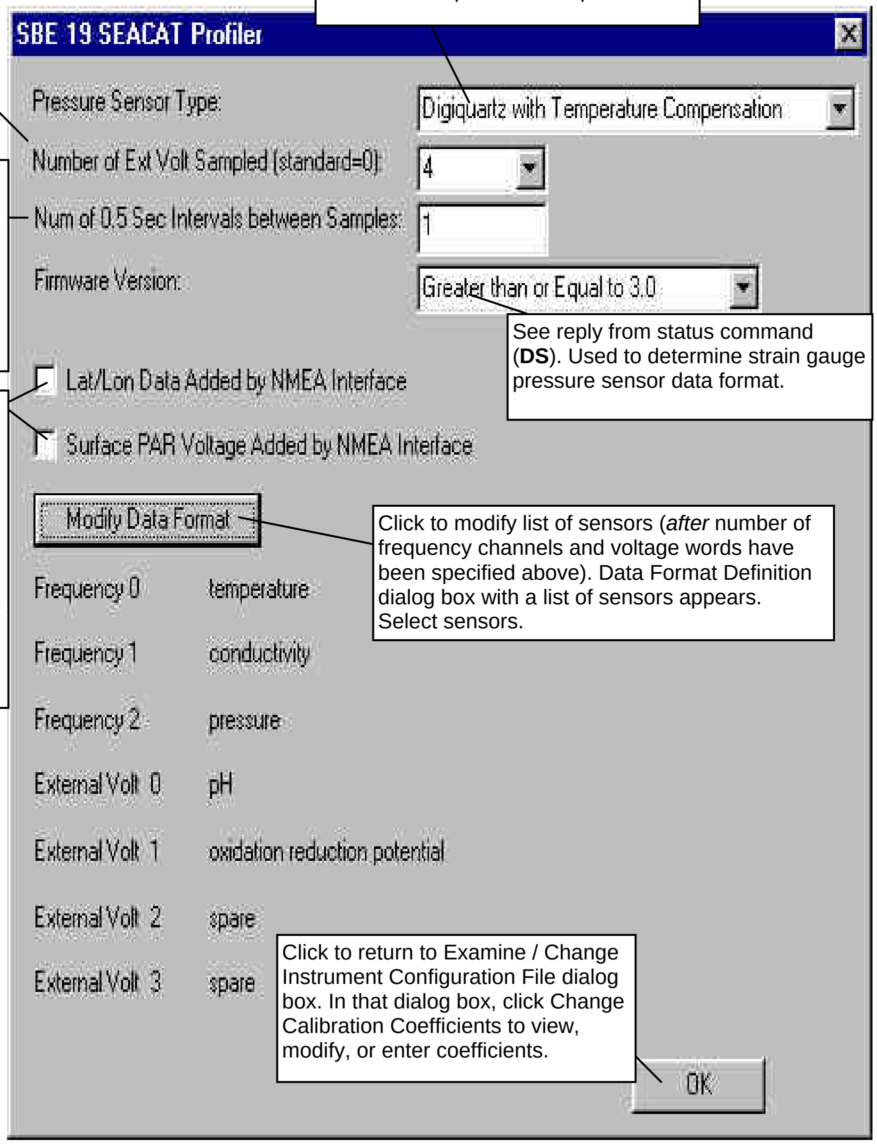
SEASAVE always treats the SBE 19 as if it is a Profiling instrument (i.e., it is in Profiling mode). If your SBE 19 is in Moored Mode, you must treat it like an SBE 16 (when setting up the .con file, select the SBE 16).

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.

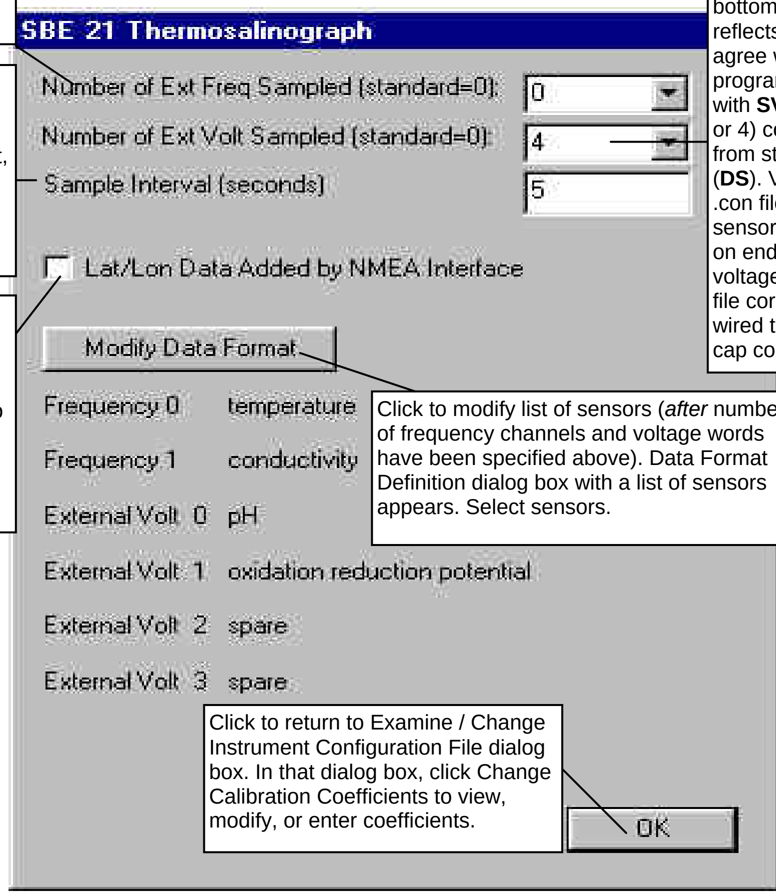
Click to return to Examine / Change Instrument Configuration File dialog box. In that dialog box, click Change Calibration Coefficients to view, modify, or enter coefficients.

Old Style SBE 21 Thermosalinograph Configuration

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.

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. Must agree with number programmed into SBE 21 with **SVn** (n= 0, 1, 2, 3, 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.

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.

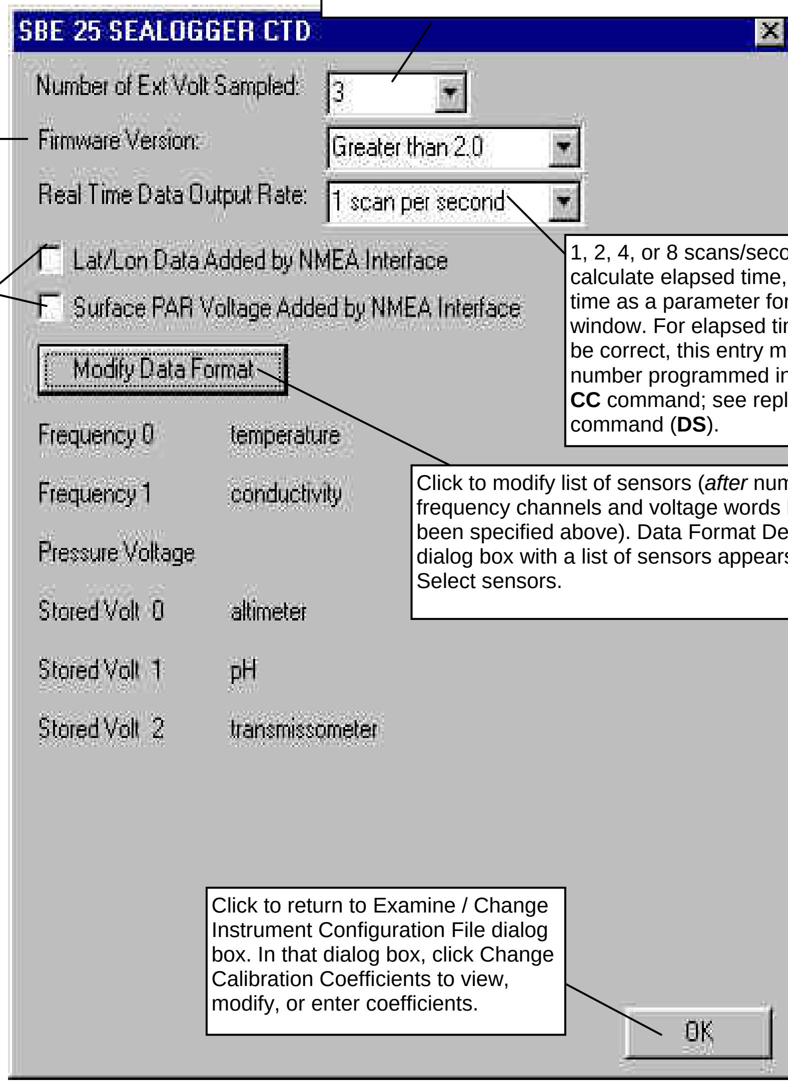
Click to return to Examine / Change Instrument Configuration File dialog box. In that dialog box, click Change Calibration Coefficients to view, modify, or enter coefficients.

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.

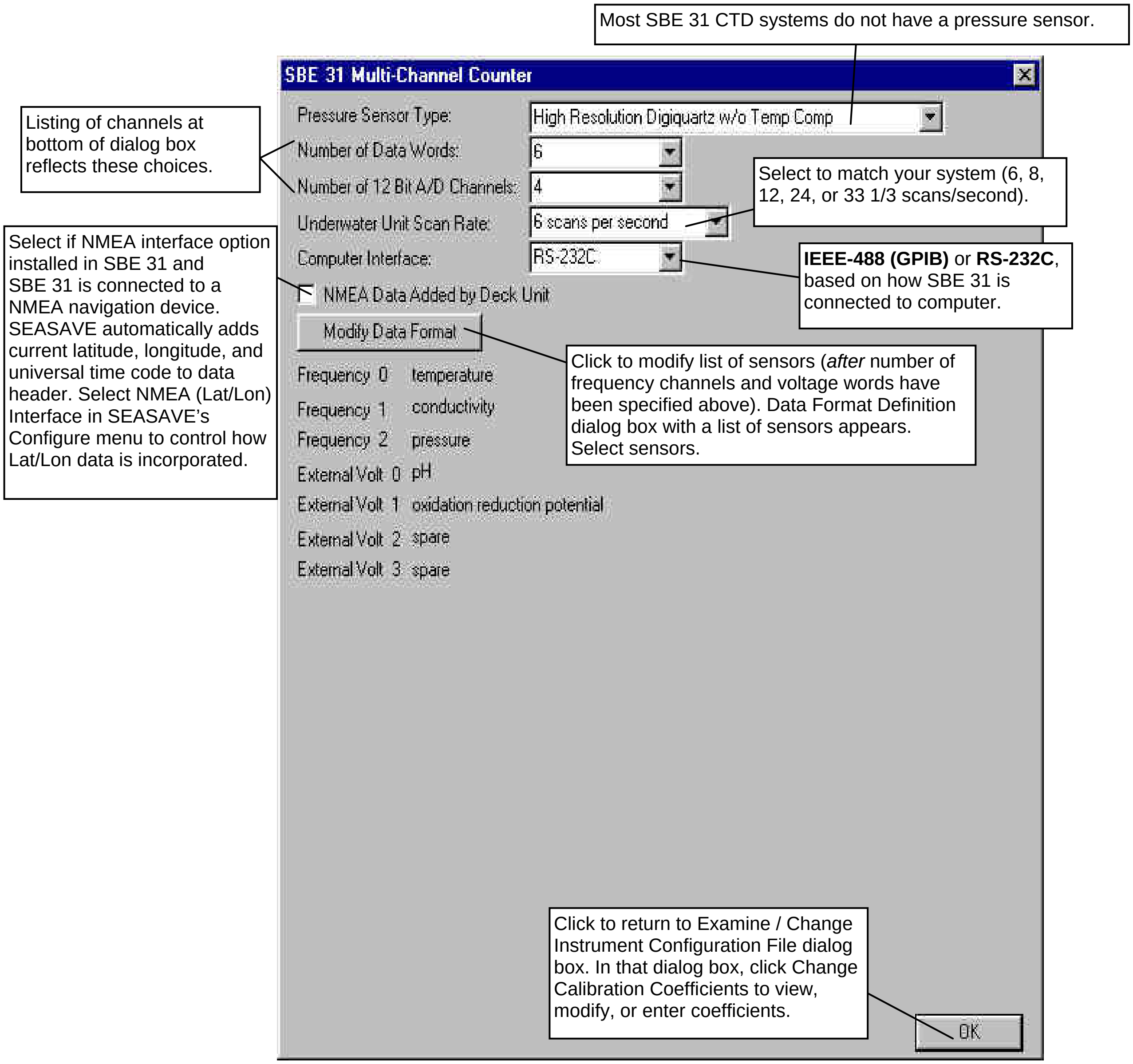


1, 2, 4, or 8 scans/second. Used to calculate elapsed time, if you select time as a parameter for a display window. For elapsed time calculation to be correct, this entry must agree with number programmed into SBE 25 with **CC** command; see reply from status command (**DS**).

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 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

Notes:
- Coefficients g, h, i, j, and f0 provide ITS-90 (T_{90}) temperature; a, b, c, d, and f0 provide IPTS-68 (T_{68}) temperature. The relationship between them is: $T_{68} = 1.00024\ T_{90}$
- See Application Note 31 for computation of slope and offset correction coefficients from pre- and post-cruise calibrations supplied by Sea-Bird.
- See *Calibration Coefficients for A/D Count Sensors* below for information on temperature sensors used on the SBE 16*plus*, 19*plus*, and 49.

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:

Corrected temperature = (slope * computed temperature) + 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

Note:
Use coefficients g, h, i, j, Ctcor, and Cpcor (if available on calibration sheet) for most accurate results; conductivity for older sensors was calculated based on a, b, c, d, m, and Cpcor.

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 dbars pressure (approximately 0.001 PSU per 1000 dbars).
  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

Note:
See Application Note 31 for computation of slope and offset correction coefficients from pre- and post-cruise calibrations supplied by Sea-Bird or from salinity bottle samples taken at sea during profiling.

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.

Note:
See *Calibration Coefficients for A/D Count Sensors* below for information on strain gauge pressure sensors used on the SBE 16*plus*, 19*plus*, and 49.
See *Calibration Coefficients for Voltage Sensors* below for information on strain gauge pressure sensors used on other instruments.

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 9*plus*, 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

Notes:
- These coefficients provide ITS-90 (T_{90}) temperature.
- See Application Note 31 for computation of slope and offset correction coefficients from pre- and post-cruise calibrations supplied by Sea-Bird.

For SBE 16*plus*, 19*plus*, and 49:
Enter a0, a1, a2, and a3 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:

Corrected temperature = (slope * computed temperature) + 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 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 ± 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.

Pressure (Strain Gauge) Calibration Coefficients

Note:
See *Calibration Coefficients for Voltage Sensors* below for information on strain gauge pressure sensors used on other instruments. See *Calibration Coefficients for Frequency Sensors* above for information on Paroscientific Digiquartz pressure sensors.

For SBE 16*plus* and 19*plus* configured with a strain gauge pressure sensor, and for all SBE 49s: Enter pA0, pA1, pA2, ptempA0, ptempA1, ptempA2, 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 *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. Strain gauge pressure sensors are covered first, followed by the remaining voltage sensor types in alphabetical order.

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

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.

Note:
To enter the altimeter alarm set point, alarm hysteresis, and minimum pressure to enable alarm, select Alarms in SEASAVE's Configure menu.

Altimeter Calibration Coefficients

Enter the scale factor and offset.
altimeter height = [300 * voltage / scale factor] + 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 * 10^V
  production = A1 * Fn / (A2 + PAR)
  chlorophyll concentration Chl = Fn / (B * PAR)
  where
  V is voltage from natural fluorescence sensor

Note:
See Application Note 39 for complete description of calculation of Chelsea Aqua 3 calibration coefficients.

- **Chelsea Aqua 3**
  Enter VB, V1, Vacetone, slope, offset, and SF.
  Concentration (µg/l) = slope*[($10.0^{(V/SF)} - 10.0^{VB}$)/($10.0^{V1} - 10.0^{Vacetone}$)] + 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 Aqua 3 Example* **-** *Calculation of Slope and Offset*
> Current slope = 1.0 and offset = 0.0
> Two in-situ samples:
> *Sample 1 –*
> Concentration (from SBE Data Processing) = 0.390
> Concentration (from water sample) = 0.450
> *Sample 2 –*
> Concentration (from SBE Data Processing) = 0.028
> Concentration (from water sample) = 0.020
> Linear regression to this data yields slope = 1.188 and offset = - 0.013

- **Chelsea UV Aquatracka**
  Enter A and B.
  Concentration (µg/l) = A * 10.0^{V} - B
  where
  A and B are from calibration sheet
  V is output voltage measured by CTD

Note:
See Application Note 61 for complete description of calculation of Chelsea Minitracka calibration coefficients.

- **Chelsea Minitracka**
  Enter Vacetone, Vacetone100, and offset.
  Concentration = (100 *[V - Vacetone]/[Vacetone100 - 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 * V)
    High gain: value = B0 + (B1 * V)
  - *Modulo Bit* if the instrument has control lines custom-wired to bits in the SBE 9*plus* modulo word
    Bit not set: value = A0 + (A1 * V)
    Bit set: value = B0 + (B1 * V)
  - *None* if the instrument does not change gain
    value = A0 + (A1 * V)

  where
  V = voltage from sensor

> *Dr Haardt Voltage Level Switching Examples*
> *Example: Chlorophyll a*
> Low range scale = 10 mg/l and Gain = 10/2.5 = 4 mg/l/volt
> A0 = 0.0 A1 = 4.0
> High range scale = 100 mg/l and Gain = 100/2.5 = 40 mg/l/volt
> B0 = -100 B1 = 40.0

> **Note:**
> See Application Note 54 for complete description of calculation of Seapoint fluorometer calibration coefficients.

- **Seapoint**
  Enter gain and offset.
  Concentration = (V * 30/gain) + 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 * 30/gain) + offset
  where
  Gain is dependent on cable used (see cable drawing, pins 5 and 6)

> **Notes:**
> - See Application Note 9 for complete description of calculation of WET Labs FLF and Sea Tech fluorometer calibration coefficients.
> - Offset and scale factor may be adjusted to fit a linear regression of fluorometer responses to known chlorophyll *a* concentrations.

- **WET Labs Flash Lamp Fluorometer (FLF) and Sea Tech**
  Enter scale factor and offset.
  Concentration = (voltage * scale factor / 5) + offset
  where
  Scale factor is dependent on fluorometer range

Fluorometer	Switch-Selectable Range (milligrams/m^3 or micrograms/liter)	Scale Factor
Sea Tech	0 – 3	3
	0 – 10 (default)	10
	0 - 30	30
	0-100	100
	0-300	300
	0-1000	1000
WET Labs FLF	0 – 100	100
	0 – 300 (default)	300
	0 - 1000	1000

  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: offset = - (scale factor * voltage) / 5

- **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 = [fluorescence voltage * scale factor / (range * 5)] + offset
  where
  range is defined in the following table

Range Voltage	Range
< 0.2 volts	1.0
≥ 0.2 volts and < 0.55 volts	3.16
≥ 0.55 volts and < 0.85 volts	10.0
≥ 0.85 volts	31.0

- **Turner 10-AU-005**
  Enter full scale voltage, zero point concentration, and full scale concentration from the calibration sheet.
  concentration = [(1.195 * voltage * (FSC – ZPC)) / FSV] + ZPC
  where
  voltage = measured output voltage from fluorometer
  FSV = full scale voltage; typically 5.0 volts
  FSC = full scale concentration
  ZPC = zero point concentration

> **Note:**
> See Application Note 63 for complete description of calculation of Turner SCUFA calibration coefficients.

- **Turner SCUFA** (New Style configuration only)
  Enter scale factor, offset, units, mx, my, and b from the calibration sheet.
  chlorophyll = (scale factor * voltage) + offset
  corrected chlorophyll = (mx * chlorophyll) + (my * NTU) + b
  where
  NTU = 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 kv, Vh2o, and A^X.
  concentration (mg/m^3) = kv * (Vout - Vh20) / A^X
  where
  Vout = measured output voltage
  kv = absorption voltage scaling constant (inverse meters/volt)
  Vh20 = measured voltage using pure water
  A^X = chlorophyll specific absorption coefficient

> **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:
>   a0 = - Vblank * scale factor
>   a1 = scale factor (NTU/volts)
>   a2 = a3 = 0
>   *where* scale factor and Vblank are for the turbidity measurement.

- **WET Labs WetStar, ECO-AFL, and ECO-FL** (ECO-AFL and -FL in New Style configuration only)
  Enter Vblank and scale factor.
  Concentration (µg/l) = (Vsample - V blank) * scale factor
  where
  Vsample = in situ voltage output
  Vblank = clean water blank voltage output
  Scale factor = multiplier (µg/l/Volt)
  The calibration sheet lists either:
  - Vblank and scale factor, **OR**
  - Vblank and Vcopro (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 Vcopro:
    scale factor = chlorophyll concentration / (Vcopro - Vblank)

  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 Vblank and scale factor.
  Concentration (µg/l) = (Vsample - V blank) * scale factor
  where
  Vsample = in situ voltage output
  Vblank = clean water blank voltage output
  Scale factor = multiplier (µg/l/Volt)
  The calibration sheet lists Vblank and Vcdom (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 Vcdom:
  scale factor = cdom concentration / (Vcdom - Vblank)
  Perform calibrations using seawater with cdom types that are similar to what is expected in situ.

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

$$= \exp \{D \ln [(B0 + B1 \exp \frac{-Vt}{B2}) * (\frac{1}{Vm} - \frac{1}{A0 - A1 * Vt})]\} \quad [\mu mol / l]$$

Where
Vt = Capsum METS temperature voltage
Vm = Capsum METS methane concentration voltage

For the temperature channel, enter T1 and T2.
Gas temperature = (Vt * T1) + T2 [°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.

Note:
See Application Note 16 for complete description of calculation of OBS-3 calibration coefficients.

Note:
- See Application Note 81 for complete description of calculation of OBS-3+ calibration coefficients.
- You can interface to two OBS-3+ sensors, or to both the 1X and 4X ranges on one OBS-3+ sensor, providing two channels of OBS-3+ data.

- **Downing & Associates [D&A] OBS-3 Backscatterance**
  Enter gain and offset.
  output = (volts * gain) + 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.
  output = A1 + (A1 * V) + (A2 * V^2)
  where
  V = voltage from sensor (**milli**Volts)
  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.
  turbidity [F.T.U.] = (10.0^V – C) / 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 * V)
    High gain: value = B0 + (B1 * V)
  - *Modulo Bit* if the instrument has control lines custom-wired to bits in the SBE 9*plus* modulo word
    Bit not set: value = A0 + (A1 * V)
    Bit set: value = B0 + (B1 * V)
  - *None* if the instrument does not change gain
    value = A0 + (A1 * 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 vm0, vd0, d0, and k.
  diffusion = [k * (vm – vm0) / (vd – vd0)] – d0
  where
  k = scale factor — vm = measured voltage
  vm0 = measured voltage offset — vd = direct voltage
  vd0 = direct voltage offset — d0 = 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.
  output = (volts * 500 * scale factor)/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.
  Output = [volts * (range / 5) * slope] + 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):

Range for High Gain	Range for Low Gain
2.25	7.5
7.5	25
75	250
225	750
33	100

  Note: SEASAVE can process data for an instrument interfacing with up to two Seatech LS6000 sensors when using the New Style configuration.

Note:
See Application Note 63 for complete description of calculation of Turner SCUFA calibration coefficients.

- **Turner SCUFA** (New Style configuration only)
  Enter scale factor and offset.
  NTU = (scale factor * voltage) + offset
  corrected chlorophyll = (mx * chlorophyll) + (my * NTU) + b
  where
  mx, my, 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

Note:
See Application Note 19 for complete description of calculation of ORP calibration coefficients.

Enter M, B, and offset (mV).
Oxidation reduction potential = [(M * voltage) + B] + offset
Enter M and B from calibration sheet.

Notes:
- Enter soc and boc values from the most recent field calibration for Beckman-type, YSI-type, or Sea-Bird (SBE 43) oxygen sensor.
- See Application Notes 13-1 and 13-3 for complete description of calculation of calibration coefficients for Beckman- or YSI-type sensors.
- See Application Notes 64 and 64-2 for complete description of calculation of SBE 43 calibration coefficients.
- Oxygen values computed by SEASAVE and SBE Data Processing's Data Conversion module differ from values computed by SBE Data Processing's Derive module. Both algorithms use the derivative of the oxygen signal with respect to time:
  - Quick estimate - SEASAVE and Data Conversion compute the derivative looking back in time, because they share common code and SEASAVE cannot use future values while acquiring real-time data.
  - Most accurate results - Derive uses a user-input centered window (equal number of points before and after scan) to compute the derivative.

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, pcor, 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*δV/δt)}+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)
  δV/δt = 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.

Note:
See Application Notes 11 LICOR (LI-COR sensor), 11 QSP-L (Biospherical sensor with built-in log amplifier), and 11-QSP-PD (Biospherical sensor without built-in log amplifier) for complete description of calculation of calibration coefficients.

PAR/Irradiance Calibration Coefficients

Underwater PAR Sensor
Enter M, B, calibration constant, multiplier, and offset.
PAR = [multiplier * ($10^9 * 10^{(V-B)/M}$) / calibration constant] + 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_S 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.

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).

- **Chelsea PAR sensor**
  Calibration constant
  = 10^9 / 0.01 (for units of microEinsteins/sec–m^2) **or**
  = 10^9 / 0.04234 (for units of quanta/sec–m^2)
  M = 1.0 / (log e * A1 * 1000) = 1.0 / (0.43429448 * A1 * 1000)
  B = - M * log e * A0 = - M * 0.43429448 * A0
  where A0 and A1 are constants from Chelsea calibration sheet with an equation of form: PAR = A0 + (A1 * 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.

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:
  pH = pH old + (7 – 2087/°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.

pH Calibration Coefficients

Enter the slope and offset from the calibration sheet:
pH = 7 + (Vout – offset) / (°K * 1.98416e-4 * slope)
where
°K = temperature in degrees Kelvin

Pressure/FGP (voltage output) Calibration Coefficients

Enter scale factor and offset.
output [Kpa] = (volts * scale factor) + 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 (α), Clean H_2O scattering output (V_{S0}), and Clean H_2O 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 = $\tau = V_T / V_{T0}$
Beam C = - ln (τ) / 0.025 [1 / meters]
Total Volume Concentration = TV = Cal * [(V_S / τ) - V_{S0}] [µliters / liter]
Sauter Mean Diameter = SMD = α * [TV / (- ln (τ)] [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.

Transmissometer Calibration Coefficients

Note:
See Application Note 7 for complete description of computation of M and B.

- **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
  where
  M = (Tw / [W0 – Y0]) (A0 – Y0) / (A1 – Y1)
  B = - M * Y1
  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.

	Tw = % Transmission in Pure Water (relative to AIR)	
Wavelength	**10 cm Path Length**	**25 cm Path Length**
488 nm (blue)	99.8%	99.6%
532 nm (green)	99.5%	98.8%
660 nm (red)	96.0 - 96.4%	90.2 - 91.3%

  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 = {[log (Vh2o - VDark) - log (V - VDark)] /X} + Ch2o
  Beam transmission (%) = exp (-beam attenuation * X) * 100

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 a0, a1, a2, and a3.
Val = a0 + (a1 * V) + (a2 * V^2) + (a3 * V^3)
where:
V = voltage from sensor
a0, a1, a2, and a3 = 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, NTU = (Vsample – Vblank) * scale factor
Set this equal to user polynomial equation and calculate a0, a1, a2, and a3.
(Vsample – Vblank) * scale factor = a0 + (a1 * V) + (a2 * V^2) + (a3 * V^3)
Expanding left side of equation and using consistent notation (Vsample = V):
scale factor * V – scale factor * Vblank = a0 + (a1 * V) + (a2 * V^2) + (a3 * V^3)
Left side of equation has no V^2 or V^3 terms, so a2 and a3 are 0; rearranging:
(– scale factor * Vblank) + (scale factor * V) = a0 + (a1 * V)
a0 = – scale factor * Vblank   a1 = scale factor   a2 = a3 = 0

Zaps Calibration Coefficients

Enter M and B from calibration sheet.
z = (M * volts) + B [nmoles]

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.

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).

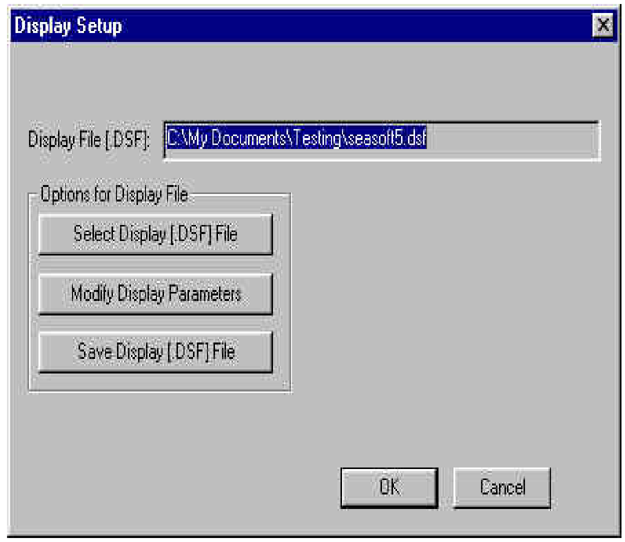
3. Right click in the desired window and select Update Rate. The Change Display Rate dialog box appears. The update rate is the time between each calculation of parameters for update of the display; each display window can have a different update rate. Enter the number of seconds between updates and 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.

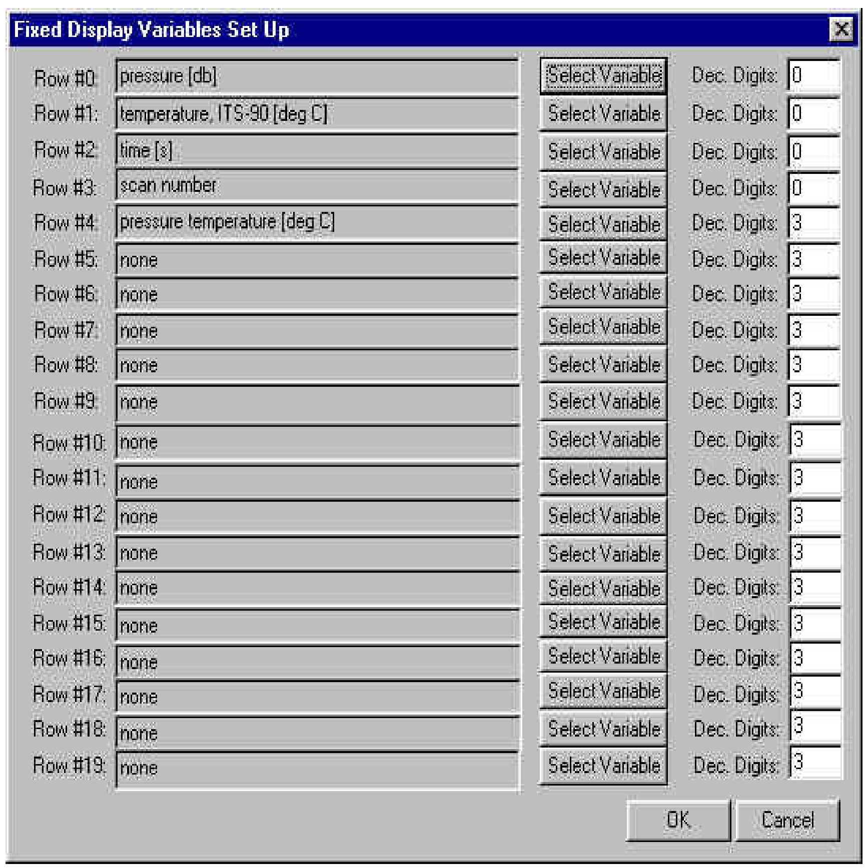
Fixed Display or Scrolled Display

Setup for the Fixed and Scrolled Displays are similar.

The Fixed Display Setup dialog box looks like this:



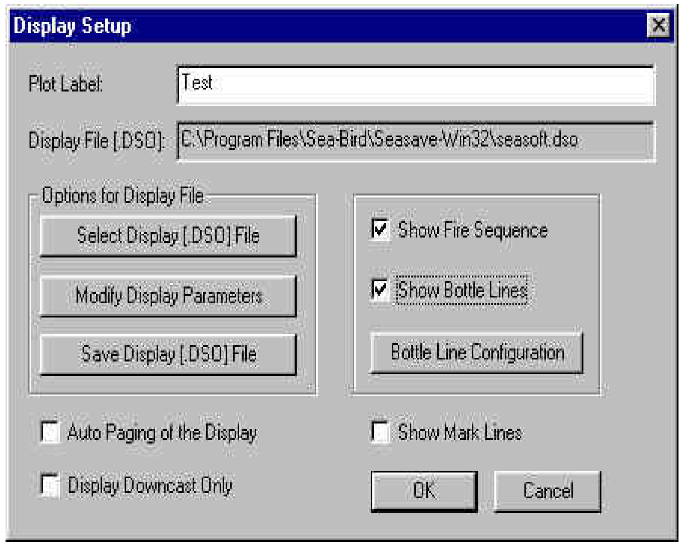
Click on Modify Display Parameters to get the Fixed Display Variables Setup dialog box:



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

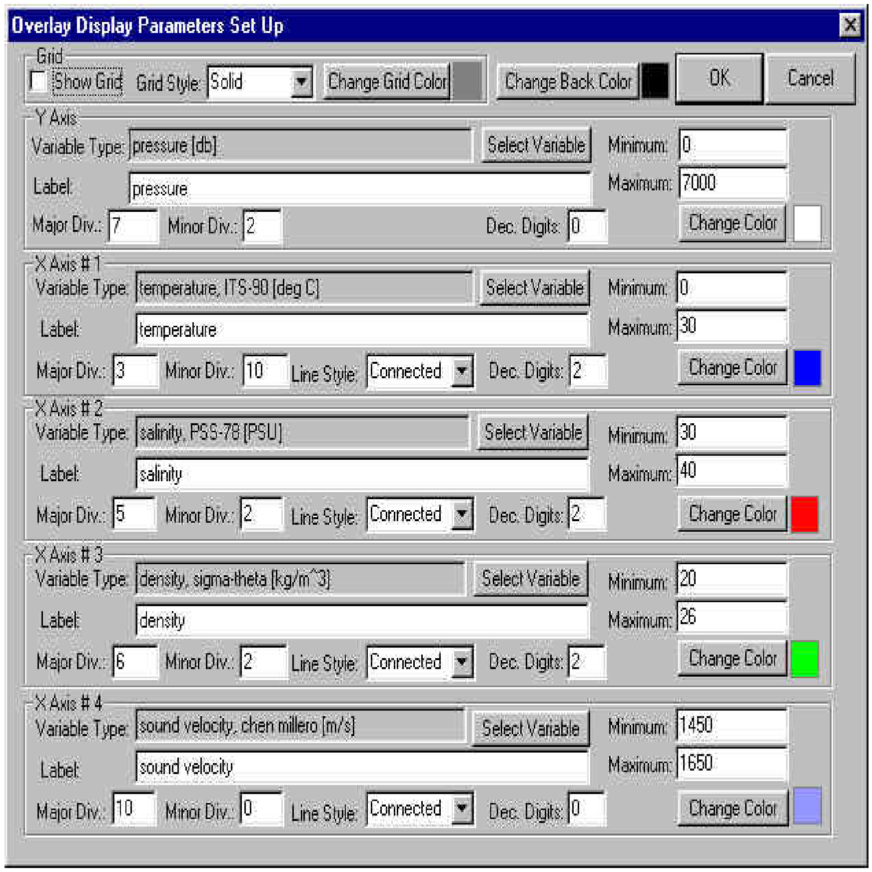
The Display Setup dialog box looks like this:



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 dbars, and the actual cast exceeds 1000 dbars, the y-axis minimum/maximum will adjust to 1000 to 2000 dbars 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*.

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

> **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.

This section covers:

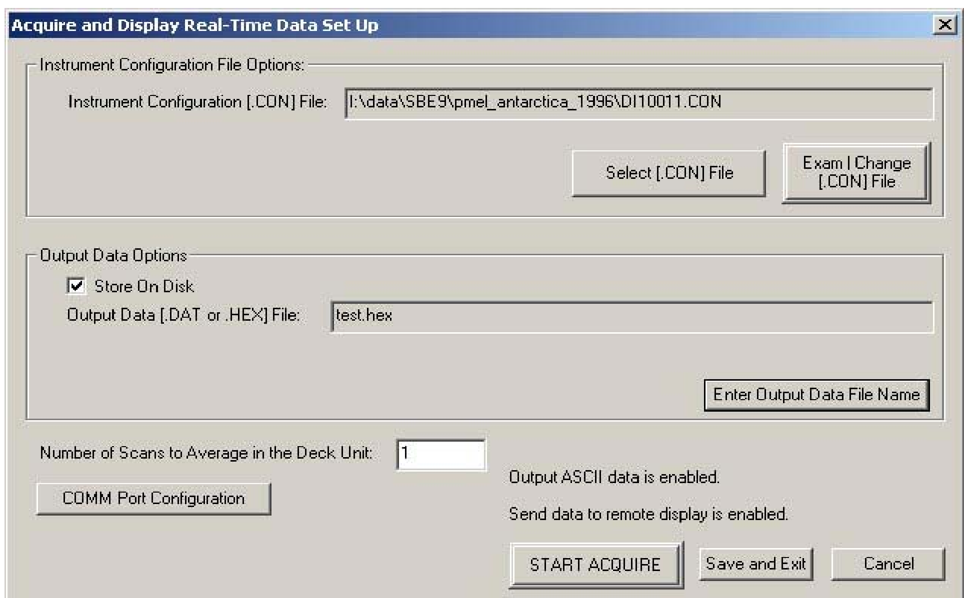
- Starting and stopping real-time data acquisition
- Firing bottles
- Marking scans
- Adding NMEA navigation data to a .nav file
- Manually turning an SBE 9*plus* pump on and off

Starting and Stopping Real-Time Data Acquisition

> **Note:**
> For SBE 16*plus*, 19*plus*, 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.

1. In the RealtimeData menu, select Start Acquisition.

2. The Acquire and Display Real-Time Data Setup dialog box appears:

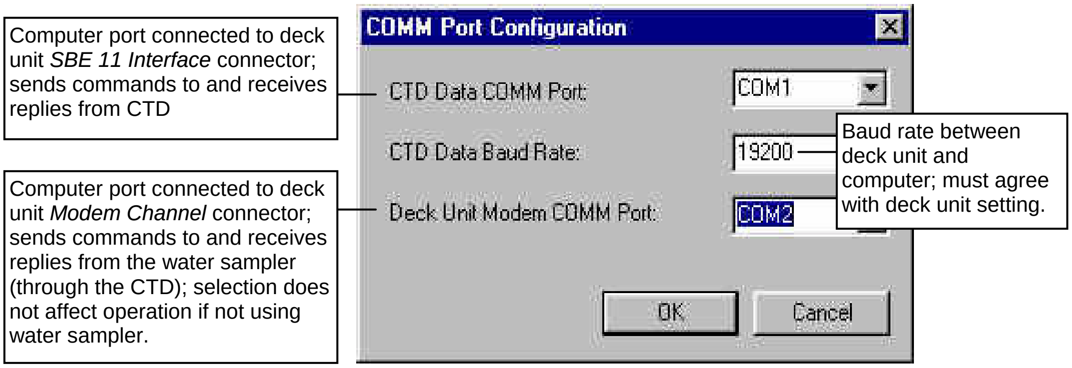


> **Note:**
> Note that just above the Start Acquire button, the dialog box indicates if Output ASCII data (to a COM port, not to a shared file) and/or sending data to a Remote Display (through a COM port) was enabled in the Configure menu. See *ASCII Output* and *Remote Display* in *Section 3: Configure Menu, Part I - General System Setup*.

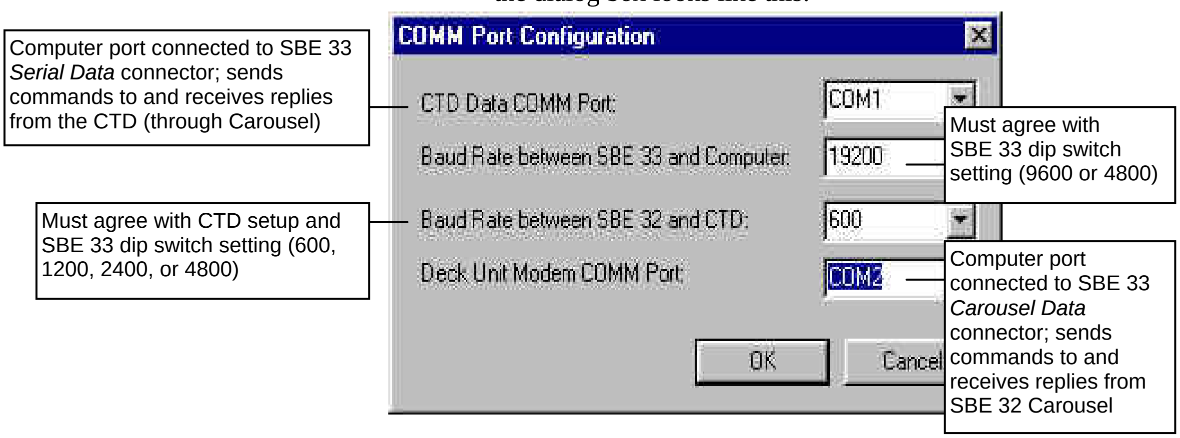
The dialog box selections include:

- **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, 911*plus*, and 31 only. For full rate data, set to 1. NOTE: The SBE 911*plus* 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.

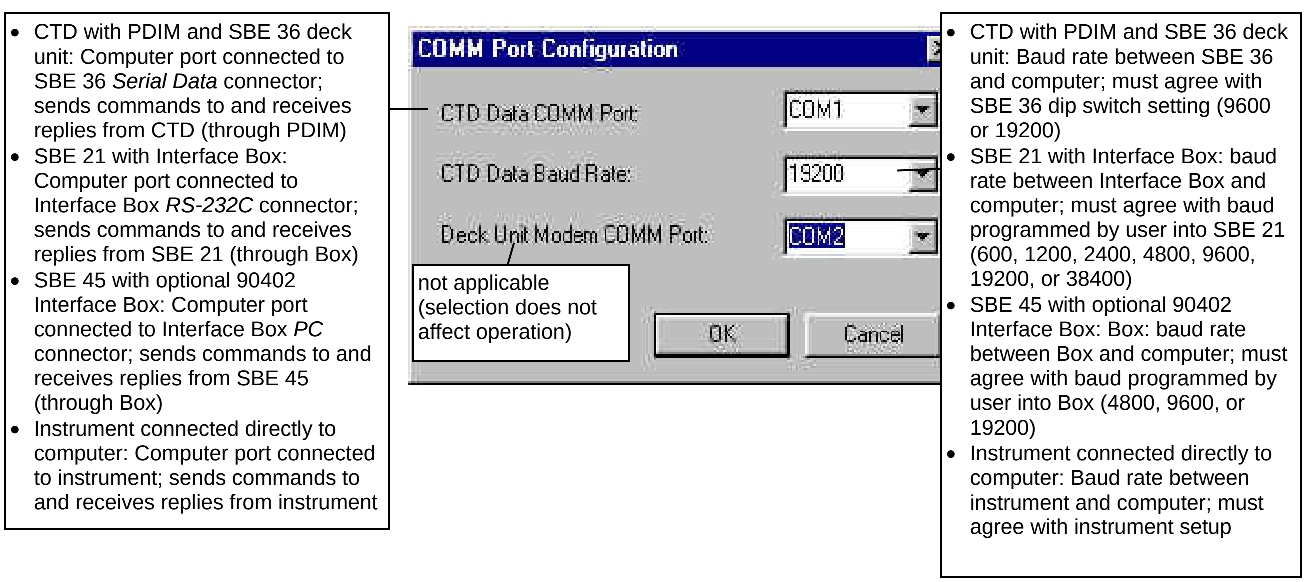
- **COMM Port Configuration**: Click to configure the transfer of data. The COMM Port Configuration dialog box varies, depending on your system setup.
  - ➢ SBE 911, 911e, or 911*plus*, with or without water sampler, the dialog box looks like this:



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



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



- **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, 19*plus*, or 25) -

  SEASAVE allows 60 seconds after you click Start Acquire for you to turn on the CTD magnetic switch. SEASAVE 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, 16*plus*, 21, 45, 49, or 911*plus*) -

  SEASAVE 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

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.

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 911*plus* 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.

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.

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.

Marking Scans

Note:
The .mrk 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 .mrk file is test1.mrk.

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.

Note:
If desired, you can mark scans without using the Mark Scan Control dialog box. Each time you want to mark a scan, select Mark Scan in the RealTimeData menu, or press Ctrl F5.

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

Note:
The .nav 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 .nav file is test1.nav.

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.

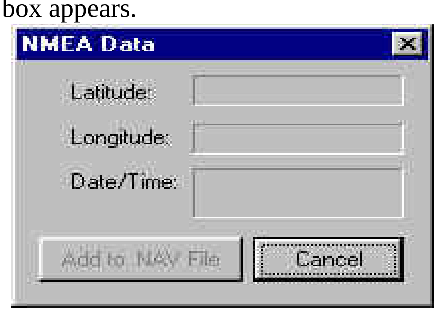
To add data to a .nav file:

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*).

Note:
If desired, you can add data to the .nav file without using the NMEA Data dialog box. Each time you want to add data, select Add to .nav File in the RealTimeData menu, or press Ctrl F7.

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 **911*plus*'** 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 911*plus* pump on / 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.

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.

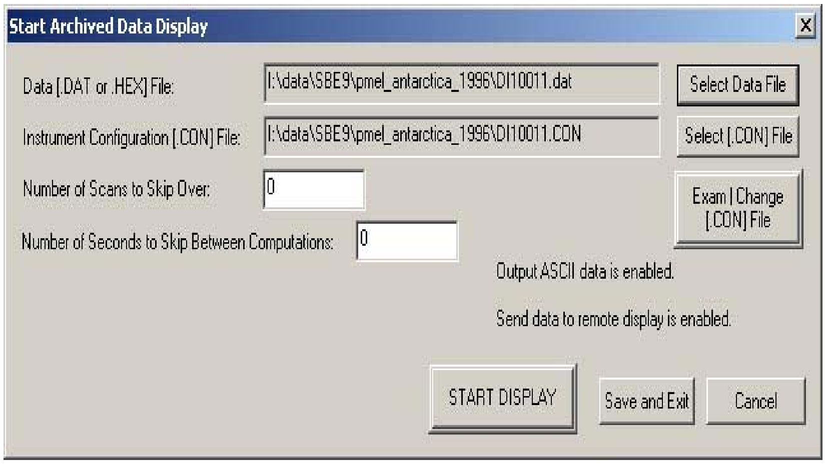
4. When desired:
   In the RealTime Data menu, select Turn Pump On or Turn Pump Off, **OR**
   Press Ctrl F2 (pump on) or Ctrl F4 (pump off).

Section 8: Displaying Archived Data

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.

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:
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.

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

.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:

Parameter	Function
-autostart= *filename*	Automatically start SEASAVE and data acquisition, saving data to *filename*. *Filename* must include path and extension (.dat for SBE 9*plus*; .hex for SBE 16, 16*plus*, 19, 19*plus*, 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.
-diffd2	Add [(secondary sensor sigma-2) - (primary sensor sigma-2)] to list of variables for display.
-pc	Enable pump control for SBE 911*plus* from within SEASAVE. Turn Pump On and Turn Pump Off selections in RealtimeData menu remain grayed out if this parameter is not used.
-wsN	Change time to wait for movement of magnetic switch from off to on (for SBE 19, 19*plus*, and 25) from default 90 seconds to N seconds. After you start real-time data acquisition, SEASAVE waits up to N seconds for you to turn the instrument's magnetic switch on before timing out.
-ss	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.
-nmeatime	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 dta acquisition. See description below.

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

For the **-nmeatime** command line parameter:

If NMEA Message Includes	-nmeatime Included in Command Line?	Information in NMEA UTC Time in Header	Information in NMEA Data dialog box on screen
Date & time	(no effect)	NMEA time & date	NMEA time & date
Time only	No	(none)	NMEA time only
Time only	Yes	NMEA time	NMEA time & computer date
No date or time	(no effect)	(none)	(none)

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.

Notes:
- If the path includes any spaces, enclose the path in quotes (“*path*“). See the examples.
- An alternative method of running SEASAVE with a Command Line Parameter is from a command prompt.

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.

Line	Contents
1	Conductivity sensor serial number
2	Conductivity M, A, B, C, D, CPCOR
3	Conductivity cell_const, series_r, slope, offset, use GHIJ coefficients?
4	Temperature sensor serial number
5	Temperature F0, A, B, C, D, slope, offset, use GHIJ coefficients?
6	Secondary conductivity sensor serial number
7	Secondary conductivity M, A, B, C, D, PCOR
8	Secondary conductivity cell_const, series_r, slope, offset, use GHIJ coefficients?
9	Secondary temperature sensor serial number
10	Secondary temperature F0, A, B, C, D, slope, offset, use GHIJ coefficients?
11	Pressure sensor serial number
12	Pressure T1, T2, T3, T4, T5
13	Pressure C1 (A1), C2 (A0), C3, C4 (A2) - parameters in parentheses for strain gauge sensor
14	Pressure D1, D2, slope, offset, pressure sensor type, AD590_M, AD590_B
15	Oxygen (Beckman/YSI type) sensor serial number
16	Oxygen (Beckman/YSI type) M, B, K, C, SOC, TCOR
17	Oxygen (Beckman/YSI type) WT, PCOR, TAU, BOC
18	pH sensor serial number
19	pH slope, offset, VREF
20	PAR light sensor serial number
21	PAR cal const, multiplier, M, B, surface_cc, surface_r, offset
22	Transmissometer (SeaTech, Chelsea AlphaTracka, WET Labs Cstar) sensor serial number
23	Transmissometer (SeaTech, Chelsea AlphaTracka, WET Labs Cstar) M, B, path length
24	Fluorometer SeaTech sensor serial number
25	Fluorometer SeaTech scale factor, offset
26	Tilt sensor serial number
27	Tilt XM, XB, YM, YB
28	ORP sensor serial number
29	ORP M, B, offset
30	OBS/Nephelometer D&A Backscatterance sensor serial number
31	OBS/Nephelometer D&A Backscatterance gain, offset
32	Altimeter scale factor, offset, hyst, min pressure, hysteresis
33	Microstructure temperature sensor serial number
34	Microstructure temperature pre_m, pre_b
35	Microstructure temperature num, denom, A0, A1, A3
36	Microstructure conductivity sensor serial number
37	Microstructure conductivity A0, A1, A2
38	Microstructure conductivity M, B, R
39	Number of external frequencies, number of bytes, number of voltages, instrument type, computer interface, scan rate, interval, store system time?
40	Data format channels 0 - 9
41	Data format channels 10 - 19
42	Data format channels 20 - 39
43	SBE 16: use water temperature?, fixed pressure, fixed pressure temperature
44	Firmware version
45	Miscellaneous: number of frequencies from SBE 9, number of frequencies from SBE 9 to be suppressed, number of voltages from SBE 9 to be suppressed, voltage range, add surface PAR voltage?, add NMEA position data?, include IOW sensors? Add NMEA depth data?
46	OBS/Nephelometer IFREMER sensor serial number
47	OBS/Nephelometer IFREMER VM0, VD0, D0, K
48	OBS/Nephelometer Chelsea sensor serial number
49	OBS/Nephelometer Chelsea clear water voltage, scale factor
50	ZAPS sensor serial number
51	ZAPS m, b
52	Conductivity sensor calibration date
53	Temperature sensor calibration date
54	Secondary conductivity sensor calibration date
55	Secondary temperature sensor calibration date
56	Pressure sensor calibration date
57	Oxygen (Beckman/YSI type) sensor calibration date
58	pH sensor calibration date
59	PAR light sensor calibration date
60	Transmissometer (SeaTech, Chelsea AlphaTracka, WET Labs Cstar) sensor calibration date
61	Fluorometer (SeaTech) sensor calibration date
62	Tilt sensor calibration date

63	ORP sensor calibration date
64	OBS/Nephelometer D&A Backscatterance sensor calibration date
65	Microstructure temperature sensor calibration date
66	Microstructure conductivity sensor calibration date
67	IFREMER OBS/nephelometer sensor calibration date
68	Chelsea OBS/nephelometer sensor calibration date
69	ZAPS sensor calibration date
70	Secondary oxygen (Beckman/YSI type) sensor serial number
71	Secondary oxygen (Beckman/YSI type) sensor calibration date
72	Secondary oxygen(Beckman/YSI type) M, B, K, C, SOC, TCOR
73	Secondary oxygen(Beckman/YSI type) WT, PCOR, TAU, BOC
74	User polynomial 1 sensor serial number
75	User polynomial 1 sensor calibration date
76	User poly1 A0, A1, A2, A3
77	User polynomial 2 sensor serial number
78	User polynomial 2 sensor calibration date
79	User polynomial 2 A0, A1, A2, A3
80	User polynomial 3 sensor serial number
81	User polynomial 3 sensor calibration date
82	User polynomial 3 A0, A1, A2, A3
83	Dr. Haardt Chlorophyll fluorometer sensor serial number
84	Dr. Haardt Chlorophyll fluorometer sensor calibration date
85	Dr. Haardt Chlorophyll fluorometer A0, A1, B0, B1, which modulo bit, gain range switching
86	Dr. Haardt Phycoerythrin fluorometer sensor serial number
87	Dr. Haardt Phycoerythrin fluorometer sensor calibration date
88	Dr. Haardt Phycoerythrin fluorometer A0, A1, B0, B1, which modulo bit, gain range switching
89	Dr. Haardt Turbidity OBS/nephelometer sensor serial number
90	Dr. Haardt Turbidity OBS/nephelometer sensor calibration date
91	Dr. Haardt Turbidity OBS/nephelometer A0, A1, B0, B1, which modulo bit, gain range switching
92	IOW oxygen sensor serial number
93	IOW oxygen sensor calibration date
94	IOW oxygen A0, A1, A2, A3, B0, B1
95	IOW sound velocity sensor serial number
96	IOW sound velocity sensor calibration date
97	IOW sound velocity A0, A1, A2
98	Biospherical natural fluorometer sensor serial number
99	Biospherical natural fluorometer sensor calibration date
100	Biospherical natural fluorometer Cfn, A1, A2, B
101	Sea tech ls6000 OBS/nephelometer sensor serial number
102	Sea tech ls6000 OBS/nephelometer sensor calibration date
103	Sea tech ls6000 OBS/nephelometer gain, slope, offset
104	Fluorometer chelsea Aqua 3 sensor serial number
105	Fluorometer chelsea Aqua 3 sensor calibration date
106	Fluorometer chelsea Aqua 3 scale factor, slope, offset, Vacetone, VB (static), V1ug/l
107	Fluorometer turner sensor serial number
108	Fluorometer turner sensor calibration date
109	Fluorometer turner scale factor, offset; or turner-10au-005 full scale concentration, full scale voltage, zero point concentration
110	Conductivity G, H, I, J, ctcor, cpcor
111	Temperature F0, G, H, I, J
112	Secondary conductivity G, H, I, J, ctcor, cpcor
113	Secondary temperature F0, G, H, I, J
114	WET Labs AC3 beam transmission transmissometer sensor serial number
115	WET Labs AC3 beam transmission transmissometer sensor calibration date
116	WET Labs AC3 beam transmission transmissometer Ch2o, Vh2o, Vdark, x, chlorophyll absorption Kv, Vh2o, a^x
117	WET Labs WETStar fluorometer sensor serial number
118	WET Labs WETStar fluorometer sensor calibration date
119	WET Labs WETStar Vblank, scale factor
120	Primary conductivity sensor using g, h, i, j coefficients calibration date
121	Primary temperature sensor using g, h, i, j coefficients calibration date
122	Secondary conductivity sensor using g, h, i, j coefficients calibration date
123	Secondary temperature sensor using g, h, i, j coefficients calibration date
124	FGP pressure sensor #0 serial number
125	FGP pressure sensor #0 calibration date
126	FGP pressure sensor #0 scale factor, offset
127	FGP pressure sensor #1 serial number
128	FGP pressure sensor #1 calibration date
129	FGP pressure sensor #1 scale factor, offset
130	FGP pressure sensor #2 serial number
131	FGP pressure sensor #2 calibration date
132	FGP pressure sensor #2 scale factor, offset
133	FGP pressure sensor #3 serial number
134	FGP pressure sensor #3 calibration date
135	FGP pressure sensor #3 scale factor, offset

136	FGP pressure sensor #4 serial number
137	FGP pressure sensor #4 calibration date
138	FGP pressure sensor #4 scale factor, offset
139	FGP pressure sensor #5 serial number
140	FGP pressure sensor #5 calibration date
141	FGP pressure sensor #5 scale factor, offset
142	FGP pressure sensor #6 serial number
143	FGP pressure sensor #6 calibration date
144	FGP pressure sensor #6 scale factor, offset
145	FGP pressure sensor #7 serial number
146	FGP pressure sensor #7 calibration date
147	FGP pressure sensor #7 scale factor, offset
148	OBS/Nephelometer seapoint turbidity meter sensor serial number
149	OBS/Nephelometer seapoint turbidity meter sensor calibration date
150	Primary OBS/Nephelometer seapoint turbidity meter gain, scale
151	Secondary OBS/Nephelometer seapoint turbidity meter sensor serial number
152	Secondary OBS/Nephelometer seapoint turbidity meter sensor calibration date
153	Secondary OBS/Nephelometer seapoint turbidity meter gain, scale
154	Fluorometer Dr. Haardt Yellow Substance sensor serial number
155	Fluorometer Dr. Haardt Yellow Substance sensor calibration date
156	Fluorometer Dr. Haardt Yellow Substance A0, A1, B0, B1, which modulo bit, gain range switching
157	Fluorometer Chelsea Minitraka serial number
158	Fluorometer Chelsea Minitraka calibration date
159	Fluorometer Chelsea Minitraka vacetone, vacetone100, offset
160	Seapoint fluorometer serial number
161	Seapoint fluorometer calibration date
162	Seapoint fluorometer gain, offset
163	Primary Oxygen (SBE 43) serial number
164	Primary Oxygen (SBE 43) calibration date
165	Primary Oxygen (SBE 43) Soc, Tcor, offset
166	Primary Oxygen (SBE 43) Pcor, Tau, Boc
167	Secondary Oxygen (SBE 43) serial number
168	Secondary Oxygen (SBE 43) calibration date
169	Secondary Oxygen (SBE 43) Soc, Tcor, offset
170	Secondary Oxygen (SBE 43) Pcor, Tau, Boc
171	Secondary sea tech ls6000 OBS/nephelometer sensor serial number
172	Secondary sea tech ls6000 OBS/nephelometer sensor calibration date
173	Secondary sea tech ls6000 OBS/nephelometer gain, slope, offset
174	Secondary Chelsea Transmissometer sensor serial number
175	Secondary Chelsea Transmissometer calibration date
176	Secondary Chelsea Transmissometer M, B, path length
177	Altimeter serial number
178	Altimeter calibration date
179	WET Labs AC3 serial number
180	WET Labs AC3 calibration date
181	Surface PAR serial number
182	Surface PAR calibration date
183	SEACAT*plus* temperature sensor serial number
184	SEACAT*plus* temperature sensor calibration date
185	SEACAT*plus* temperature sensor A0, A1, A2, A3, slope, offset
186	SEACAT*plus* serial sensor, scans to average, mode
187	Pressure (strain gauge with span TC) serial number
188	Pressure (strain gauge with span TC) calibration date
189	Pressure (strain gauge with span TC) ptempA0, ptempA1, ptempA2, pTCA0, pTCA1, PTCA2
190	Pressure (strain gauge with span TC) pTCB0, pTCB1, pTCB2, pA0, pA1, pA2, offset
191	SBE 38 temperature sensor serial number
192	SBE 38 temperature sensor calibration date
193	Turner SCUFA fluorometer serial number
194	Turner SCUFA fluorometer calibration date
195	Turner SCUFA fluorometer scale factor, offset, units, mx, my, b
196	Turner SCUFA OBS serial number
197	Turner SCUFA OBS calibration date
198	Turner SCUFA OBS scale factor, offset
199	WET Labs ECO-AFL fluorometer serial number
200	WET Labs ECO-AFL fluorometer calibration date
201	WET Labs ECO-AFL fluorometer vblank, scale factor
202	Userpoly 0 name
203	Userpoly 1 name
204	Userpoly 2 name
205	CAPSUM METS serial number
206	CAPSUM METS calibration date
207	CAPSUM METS D, A0, A1, B0, B1, B2, T1, T2
208	Secondary PAR sensor serial number
209	Secondary PAR sensor calibration date
210	Secondary PAR sensor cal const, multiplier, M, B, offset

211	Secondary WET Labs WETStar Fluorometer sensor serial number
212	Secondary WET Labs WETStar Fluorometer sensor calibration date
213	Secondary WET Labs WETStar Fluorometer Vblank, scale factor
214	Secondary Seapoint Fluorometer sensor serial number
215	Secondary Seapoint Fluorometer sensor calibration date
216	Secondary Seapoint Fluorometer gain, offset
217	Secondary Turner SCUFA Fluorometer sensor serial number
218	Secondary Turner SCUFA Fluorometer sensor calibration date
219	Secondary Turner SCUFA Fluorometer scale factor, offset, units, mx, my, b
220	WET Labs WETStar CDOM sensor serial number
221	WET Labs WETStar CDOM sensor calibration date
222	WET Labs WETStar CDOM Vblank, scale factor
223	Seapoint Rhodamine Fluorometer sensor serial number
224	Seapoint Rhodamine Fluorometer sensor calibration date
225	Seapoint Rhodamine Fluorometer gain, offset
226	Primary Gas Tension Device sensor serial number
227	Primary Gas Tension Device sensor calibration date
228	Primary Gas Tension Device type
229	Secondary Gas Tension Device sensor serial number
230	Secondary Gas Tension Device sensor calibration date
231	Secondary Gas Tension Device type
232	Sequoia LISST-25A sensor serial number
233	Sequoia LISST-25A sensor calibration date
234	Sequoia LISST-25A Total Volume Conc Const, Sauter Mean Diameter Cal, Clean Water Scattering, Clean Water Trans
235	SBE 45 output conductivity? Output salinity? Output sound velocity? Use 90402 junction box? SBE 38 remote temperature?
236	SBE 21 remote temperature type
237	SBE 50 serial number
238	SBE 50 calibration date
239	Secondary Chelsea Aqua 3 fluorometer serial number
240	Secondary Chelsea Aqua 3 fluorometer calibration date
241	Secondary Chelsea Aqua 3 fluorometer scale factor, slope, offset, vacetone, vb, v1
242	Chelsea UV Aquatracka serial number
243	Chelsea UV Aquatracka calibration date
244	Chelsea UV Aquatracka a, b
245	SBE 49 temperature sensor serial number
246	SBE 49 temperature sensor calibration date.
247	SBE 49 temperature sensor A0, A1, A2, A3, slope, and offset.
248	Secondary Turner SCUFA OBS serial number
249	Secondary Turner SCUFA OBS calibration date
250	Secondary Turner SCUFA OBS scale factor, offset

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

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.

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)

density = $\rho = \rho$ (s, t, p) **[*kg/m³*]**
(density of seawater with salinity s, temperature t, and pressure p, based on the equation of state for seawater (EOS80))

Density calculation:

Using the following constants -

```
B0 = 8.24493e-1, B1 = -4.0899e-3, B2 = 7.6438e-5, B3 = -8.2467e-7, B4 = 5.3875e-9,
C0 = -5.72466e-3, C1 = 1.0227e-4, C2 = -1.6546e-6, D0 = 4.8314e-4, A0 = 999.842594,
A1 = 6.793952e-2, A2 = -9.095290e-3, A3 = 1.001685e-4, A4 = -1.120083e-6, A5 = 6.536332e-9,
FQ0 = 54.6746, FQ1 = -0.603459, FQ2 = 1.09987e-2, FQ3 = -6.1670e-5, G0 = 7.944e-2, G1 = 1.6483e-2,
G2 = -5.3009e-4, i0 = 2.2838e-3, i1 = -1.0981e-5, i2 = -1.6078e-6, J0 =1.91075e-4, M0 = -9.9348e-7,
M1 = 2.0816e-8, M2 = 9.1697e-10, E0 = 19652.21, E1 = 148.4206, E2 = -2.327105, E3 = 1.360477e-2,
E4 = -5.155288e-5, H0 = 3.239908, H1 = 1.43713e-3, H2 = 1.16092e-4, H3 = -5.77905e-7,
K0 = 8.50935e-5, K1 =-6.12293e-6, K2 = 5.2787e-8
```

C Computer Code -

```
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))*p + (bw + (M0 + M1*t + M2*t2)*s)*p*p;
       val = 1 - p / k;
       if (val)  sigma = sigma / val - 1000.0;
       return sigma;
}
```

Sigma-theta = $\sigma_\theta = \rho$ (s, θ(s, t, p, 0), 0) - 1000 **[*kg/m³*]**

Sigma-1 = $\sigma_1 = \rho$ (s, θ(s, t, p, 1000), 1000) - 1000 **[*kg/m³*]**

Sigma-2 = $\sigma_2 = \rho$ (s, θ(s, t, p, 2000), 2000) - 1000 **[*kg/m³*]**

Sigma-4 = $\sigma_4 = \rho$ (s, θ(s, t, p, 4000), 4000) - 1000 **[*kg/m³*]**

Sigma-t = $\sigma_t = \rho$ (s, t, 0) - 1000 **[*kg/m³*]**

thermosteric anomaly = 10^5 ((1000/(1000 + σ_t)) - 0.97266) [*10^{-8} m³/kg*]

specific volume = V(s, t, p) = 1/ρ **[*m³/kg*]**

specific volume anomaly = $\delta = 10^8$ (V(s, t, p) - V(35, 0, p)) **[*10^{-8} m³/kg*]**

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

dynamic meters = geopotential anomaly / 10.0
(1 dynamic meter = 10 J/kg;
(Sverdup, Johnson, Flemming (1946), UNESCO (1991)))

depth = [*m*]

Depth calculation:

C Computer Code –

```
// 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 = [*PSU*]

(Salinity is PSS-78.)

Salinity calculation:

Using the following constants -

```
A1 = 2.070e-5, A2 = -6.370e-10, A3 = 3.989e-15, B1 = 3.426e-2, B2 = 4.464e-4, B3 = 4.215e-1,
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 Computer Code –

```
static double a[6] = { /* constants for salinity calculation */
	0.0080, -0.1692, 25.3851, 14.0941, -7.0261, 2.7081
};
static double b[6]={   /* constants for salinity calculation */
	0.0005, -0.0056, -0.0066, -0.0375, 0.0636, -0.0144
};
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 {
		C *= 10.0;     /* convert Siemens/meter to mmhos/cm */
		R = C / 42.914;
		val = 1 + B1 * T + B2 * T * T + B3 * R + B4 * R * T;
		if (val)  RP = 1 + (P * (A1 + P * (A2 + P * A3))) / val;
		val = RP * (C0 + (T * (C1 + T * (C2 + T * (C3 + T * C4)))));
		if (val)  RT = R / val;
		if (RT <= 0.0)  RT = 0.000001;
		sum1 = sum2 = 0.0;
		for (i = 0;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;
}
```

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

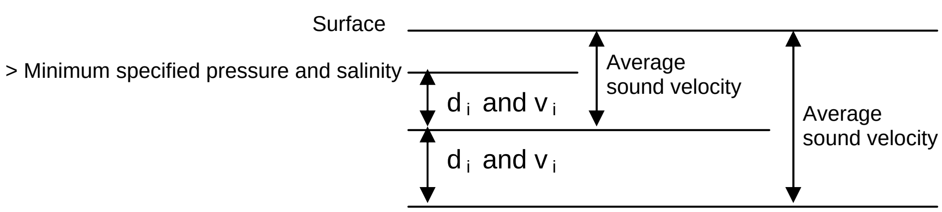
Sound velocity calculation:
C Computer Code –

```
// 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 = 7.3637e-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 = (((-2.0122e-10 * t + 1.0507e-8) * t - 6.4885e-8) * t - 1.2580e-5) * t + 9.4742e-5;
        a0 = (((-3.21e-8 * t + 2.006e-6) * t + 7.164e-5) * t -1.262e-2) * t + 1.389;
        a = ((a3 * p + a2) * p + a1) * p + a0;
        c3 = (-2.3643e-12 * t + 3.8504e-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 = (0.132952290781e1 + 0.128955756844e-3 * s) * s;
        dcp = (0.156059257041e0 + (0.244998688441e-4 - 0.83392332513e-8 * p) * p) * p;
        dcstp = -0.127562783426e-1 * t * s + 0.635191613389e-2 * t * p + 0.265484716608e-7 * t * t *
p * p - 0.159349479045e-5 * t * p * p + 0.522116437235e-9 * t * p * p * p - 0.438031096213e-6 * t *
t * t * p - 0.161674495909e-8 * s * s * p * p + 0.968403156410e-4 * t * t * s + 0.485639620015e-5 *
t * s * s * p - 0.340597039004e-3 * t * 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 - 4.4532e-2) * t + 4.5721) * t + 1449.14;
        sv = (7.7711e-7 * t - 1.1244e-2) * t + 1.39799;
        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;
}
```

$$\textbf{average sound velocity} = \frac{\displaystyle\sum_{\Delta p, p=min}^{p=p} \mathbf{d_i}}{\displaystyle\sum_{\Delta p, p=min}^{p=p} \mathbf{d_i / v_i}} \quad [m/s]$$

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:
  $\mathbf{d_i}$ = depth at end of window – depth at start of window [meters]
  $\mathbf{v_i}$ = (sound velocity at start of window + 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:
  $\mathbf{d_i}$ = depth of current scan – depth of previous scan [meters]
  $\mathbf{v_i}$ = sound velocity of this scan (bin) [m/sec]



potential temperature [IPTS-68] = θ (s, t, p, p_r)   [*°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:
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 */
// s = salinity, t = temperature deg C ITPS-68, p = pressure in decibars
{
       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 - 6.836e-8) * t + 8.5258e-6) * 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 */
// s = salinity, t0 = local temperature deg C ITPS-68, p0 = local pressure in decibars, pr =
reference pressure in decibars
{
       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] = θ (s, t, p, p_r) / 1.00024   [*°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 * 10,000) / (1 + A * [T – 25])   [*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.)

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.)

$$\textbf{oxygen } [\mu moles/kg] = \frac{\textbf{44660}}{\textit{Sigma-theta} + \textbf{1000}} \; \textbf{oxygen } [ml/l]$$

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

Corrected Irradiance [CPAR] =
100 * ratio multiplier * underwater PAR / surface PAR [%]
(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)

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