Software Manual

Seasoft V2:

SBE Data Processing

CTD Data Processing & Plotting Software for Windows

Release Date	07/26/2017
Software	SBE Data Processing 7.26.7 & later

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Section 1: Introduction

This section includes a brief description of Seasoft V2 and its components, and a more detailed description of SBE Data Processing.

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

Summary

Seasoft V2 consists of modular, menu-driven routines for acquisition, display, processing, and archiving of oceanographic data acquired with Sea-Bird equipment. Seasoft V2 is designed to work with a PC running Windows 7/8/10 (32 bit or 64 bit).

Seasoft V2 is actually several stand-alone programs:

- SeatermV2 (a *launcher* for Seaterm232, Seaterm485, SeatermIM, and SeatermUSB), Seaterm, and SeatermAF terminal programs that send commands for status, setup, data retrieval, and diagnostics to a wide variety of Sea-Bird instruments.
  Note: SeatermV2 is used with our newest generation of instruments, which have the ability to output data in XML.
- Seasave V7 program that acquires and displays real-time and raw archived data for a variety of Sea-Bird instruments.
- **SBE Data Processing** program that converts, edits, processes, and plots data for a variety of Sea-Bird instruments.
- Plot39 program for plotting SBE 39, 39-IM, 39*plus*, 39*plus*-IM, and 48 data.

Note:
The following Seasoft-DOS calibration modules are not available in Seasoft V2:
- OXFIT – compute oxygen calibration coefficients
- OXFITW – compute oxygen calibration coefficients using Winkler titration values
- PHFIT – compute pH coefficients

See the Seasoft-DOS manual.

This manual covers only SBE Data Processing.

System Requirements

Seasoft V2 was designed to work with a PC running Windows 7/8/10 (32 bit or 64 bit).

Products Supported

Notes:
- SBE **37-SI** and **37-SIP** - SBE Data Processing can be used with data uploaded from firmware version 3.0 and later. Earlier versions of these MicroCATs did not have internal memory, and SBE Data Processing is not compatible with real-time MicroCAT data.
- SBE **39**, **39-IM**, **39*plus***, **39*plus*-IM**, and **48** data - SBE Data Processing support is limited; see *Processing SBE 39, 39-IM, and 48 Data* and *Processing SBE 39plus and 39plus-IM Data* in *Section 3: Typical Data Processing Sequences*.

SBE Data Processing supports the following Sea-Bird products:

- SBE 9*plus* CTD with SBE 11*plus* Deck unit (often referred to as 911*plus*) or with SBE 17 or 17*plus* Searam (often referred to as 917*plus*)
- SBE 16 SeaCAT C-T (optional pressure) Recorder
- SBE 16*plus* and 16*plus*-IM SeaCAT C-T (optional pressure) Recorder
- SBE 16*plus* **V2** and 16*plus*-IM **V2** SeaCAT C-T (optional pressure) Recorder
- SBE 19 SeaCAT Profiler
- SBE 19*plus* SeaCAT Profiler
- SBE 19*plus* **V2** SeaCATProfiler
- SBE 21 SeaCAT Thermosalinograph
- SBE 25 Sealogger CTD
- SBE 25*plus* Sealogger CTD
- SBE 37-SM, 37-SMP, 37-IM, 37-IMP, 37-SI, and 37-SIP MicroCAT Conductivity and Temperature (optional pressure) Recorder
- SBE 37-SMP-IDO, 37-IMP-IDO, and 37-SIP-IDO MicroCAT Conductivity, Temperature, and Dissolved Oxygen (optional pressure) Recorder
- SBE37-SMP-ODO, 37-IMP-ODO, and 37-SIP-ODO MicroCAT Conductivity, Temperature, Optical Dissolved Oxygen (optional pressure) Recorder
- SBE 39 and 39-IM Temperature (optional pressure) Recorder
- SBE 39*plus* and 39*plus*-IM Temperature (optional pressure) Recorder
- SBE 45 MicroTSG Thermosalinograph
- SBE 48 Hull Temperature Sensor
- SBE 49 FastCAT CTD Sensor
- SBE Glider Payload CTD (GPCTD)

Additionally, SBE Data Processing 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 SBE 55 ECO Water Sampler; and assorted equipment from third party manufacturers.

Software Modules

SBE Data Processing includes the following modules:

Type	Module Name	Module Description
Instrument configuration See *Section 4*.	**Configure**	Define instrument configuration and calibration coefficients.
Data conversion See *Section 5*.	**Data Conversion**	Convert raw .hex or .dat data to engineering units, and store converted data in .cnv file (all data) and/or .ros file (water bottle data).
	Bottle Summary	Summarize data from water sampler .ros file, storing results in .btl file.
	Mark Scan	Create .bsr bottle scan range file from .mrk data file.
Data processing Performed on converted data from a .cnv file. See *Section 6*.	**Align CTD**	Align data (typically conductivity, temperature, oxygen) relative to pressure.
	Bin Average	Average data, basing bins on pressure, depth, scan number, or time range.
	Buoyancy	Compute Brunt Väisälä buoyancy and stability frequency.
	Cell Thermal Mass	Perform conductivity thermal mass correction.
	Derive	Calculate salinity, density, sound velocity, oxygen, etc. **based on EOS-80 (Practical Salinity) equations**.
	Derive TEOS-10	Calculate salinity, density, sound velocity, etc. **based on TEOS-10 (Absolute Salinity) equations**.
	Filter	Low-pass filter columns of data.
	Loop Edit	Mark scan with *badflag* if scan fails pressure reversal or minimum velocity test.
	Wild Edit	Mark data value with *badflag* to eliminate wild points.
	Window Filter	Filter data with triangle, cosine, boxcar, Gaussian, or median window.
File manipulation See *Section 7*.	**ASCII In**	Add header information to .asc file containing ASCII data.
	ASCII Out	Output data and/or header from .cnv file to ASCII file (.asc for data, .hdr for header). Used to export converted data for processing by non-Sea-Bird software.
	Section	Extract data rows from .cnv file.
	Split	Split data in .cnv file into upcast and downcast files.
	Strip	Extract data columns from .cnv file.
	Translate	Convert data in .cnv file from ASCII to binary, or vice versa.
Data plotting Performed on converted data from a .cnv file. See *Section 8*.	**Sea Plot**	Plot data (C, T, P as well as derived variables, overlay plots, and TS contour plots). Plots can be printed, or saved to a file or clipboard. Can plot data at any point after Data Conversion has been run.
Miscellaneous Performed on data typed in by user. See *Section 9*.	**SeaCalc III**	Calculate derived variables from one user-input scan of temperature, pressure, etc.

Section 2: Installation and Use

Seasoft V2 was designed to work with a PC running Windows 7/8/10 (32 bit or 64 bit).

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 website.
- 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.

If not already installed, install SBE Data Processing and other Sea-Bird software programs on your computer using the supplied software CD:

1. Insert the CD in your CD drive.

2. Double click on **SeasoftV2_*date*.exe** (where *date* is the date the software release was created).

3. 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 SBE Data Processing.

Note that the following additional software is installed with SBE Data Processing, in the same directory as SBE Data Processing:
- **StripNullChars.exe** – This program removes null characters from an uploaded SBE 25*plus* data file; the file can then be processed in SBE Data Processing's Data Conversion module.
  - Run StripNullChars.exe from a DOS window, following instructions provided in the software.
  - Note that the null characters in the file also prevent uploading of the data from the SBE 25*plus* via RS-232. You must open the 25*plus* and upload via the internal USB connector.
- **NMEATest.exe** – This program simulates a NMEA navigation device; see the manual for your deck unit (SBE 11*plus*, 33, or 36 Deck Unit).
- **phFit.exe** – This program calculates a new offset and slope for a pH sensor; see Application Note 18-1 (www.seabird.com/document /an18-1-sbe-18-27-and-30-amt-ph-sensor-calibration-phfit-version-21). *Note:* phfit can be run from SBE Data Processing's Run menu.

Getting Started

> **Note:**
> SBE Data Processing modules can be run from the command line. Also, batch file processing can be used to process a batch file to automate data processing tasks. See *Appendix I: Command Line Options, Command Line Operation, and Batch File Processing*.

SBE Data Processing Window

To start SBE Data Processing:

- Double click on SBEDataProc.exe
  (default location c:\Program Files\Sea-Bird\SBEDataProcessing-Win32), **or**
- Left click on Start and follow the path
  Programs\Sea-Bird\SBEDataProcessing-Win32

The SBE Data Processing window looks like this:

The window's menus are described below.

- Run -
  - List of data processing modules, separated into categories: typical processing for profiling CTDs (1-8), other data processing (9-13), file manipulation (14-19), plotting (20), and seawater calculator (21). Select the desired module to set up the module parameters and process data. *Module Dialog Box* provides an overview of the module dialog box for all modules except Sea Plot and SeaCalc III; Sections 5 through 9 provide details for each module.
  - Command Line Options: Select Command Line Options to assist in automating processing. See *Appendix I: Command Line Options, Command Line Operation, and Batch File Processing*.
  - phfit: Calculate offset and slope for an SBE 18, 27, or 30 pH sensor.
  - Exit: Select to exit the program.
- Configure - List of instruments that require a configuration (.con or .xmlcon) file, which defines the number and type of sensors interfacing with the instrument, as well as the sensor calibration coefficients. Select the desired instrument to modify or create a .con or .xmlcon file. See *Section 4: Configuring Instrument (Configure)*.
- Help - General program help files as well as context-specific help.

Module Dialog Box

To open a module, select it in the Run menu of the SBE Data Processing window. Each module's dialog box has three menus:

- **File** –
  - *Start Process* - begin to process data as defined in dialog box
  - *Open* - select a different program setup (.psa) file
  - *Save* or *Save As* - save all current settings to a .psa file
  - *Restore* - reset all settings to match last saved .psa file
  - *Default File Setup* - reset all settings on File Setup tab to defaults
  - *Default Data Setup* - reset all settings on Data Setup tab to defaults
  - *Exit* or *Save & Exit* - exit module and return to SBE Data Processing window

- **Options** (where applicable) –
  - *Confirm Program Setup Change* -
    - If **selected**, program provides a prompt to save the program setup (.psa) file if you make changes and click the Exit button or select Exit in the File menu without clicking or selecting Save or Save As.
    - If **not selected**, program changes *Exit* to *Save & Exit*; to exit without saving changes, use the Cancel button.
  - *Confirm Instrument Configuration Change* -
    - If **selected**, program provides a prompt to save the configuration (.con or .xmlcon) file if you make changes and then click the Exit button in the Configuration dialog box without clicking Save or Save As.
    - If **not selected**, program changes *Exit* button to *Save & Exit*; to exit without saving changes, use the Cancel button.
  - *Overwrite Output File Warning* -
    - If **selected**, program provides a warning if output data will overwrite an existing file.
    - If **not selected**, program automatically overwrites an existing file with the same file name as the output file.
  - *Inconsistent Data Setup Warning* -
    - If **selected**, program provides a warning if the configuration (.con or .xmlcon) file and/or the input data file are inconsistent with the selected output variables. For example, if the user-selected output variables include conductivity difference, but you remove the second conductivity sensor from the configuration file, a warning will appear. The warning details what output variable cannot be calculated, and allows you to retain the change to the configuration file (and remove the inconsistent output variable) or restore the configuration file to the previous configuration.
    - If **not selected**, program automatically changes the user-selected output variables to be consistent with the selected configuration or data file.

- *Diagnostics log* – If selected, brings up a Diagnostics dialog box.
  - Select *Keep a diagnostics log* to enable diagnostics output.
  - Click *Select Path* to select the location and name for the diagnostics file. The default location is %USERPROFILE%\Application Data\ Sea-Bird; the default name is PostProcLog.txt (*Example* c:\Documents and Settings\dbresko\Application Data\ Sea-Bird\PostProcLog.txt).
  - Select the *Level* of diagnostics to include: Errors, Warnings (includes Errors), or Information (includes Errors and Warnings).
  - If desired, click *Display Log File* to display the contents of the indicated file, using Notepad.
  - If desired, click *Erase Log File* to erase the contents of the indicated file. If not erased, SBE Data Processing appends diagnostics data to the end of the file.
  - Click OK.

- **Help** - contains general program help files as well as context-specific help (where applicable)

Note:
The dialog box for Sea Plot and SeaCalc III differ from the other modules. See *Section 8: Data Plotting Module – Sea Plot* and *Section 9: Miscellaneous Module – SeaCalc III*.

Each module's dialog box typically has three tabs - File Setup, Data Setup, and Header View. The File Setup and Header View tabs are similar for most modules, and are discussed below. The Data Setup tab contains input parameters specific to the module. Additionally, Data Conversion and Derive have a fourth tab – Miscellaneous. See the module discussions in Sections 5 through 7 for details.

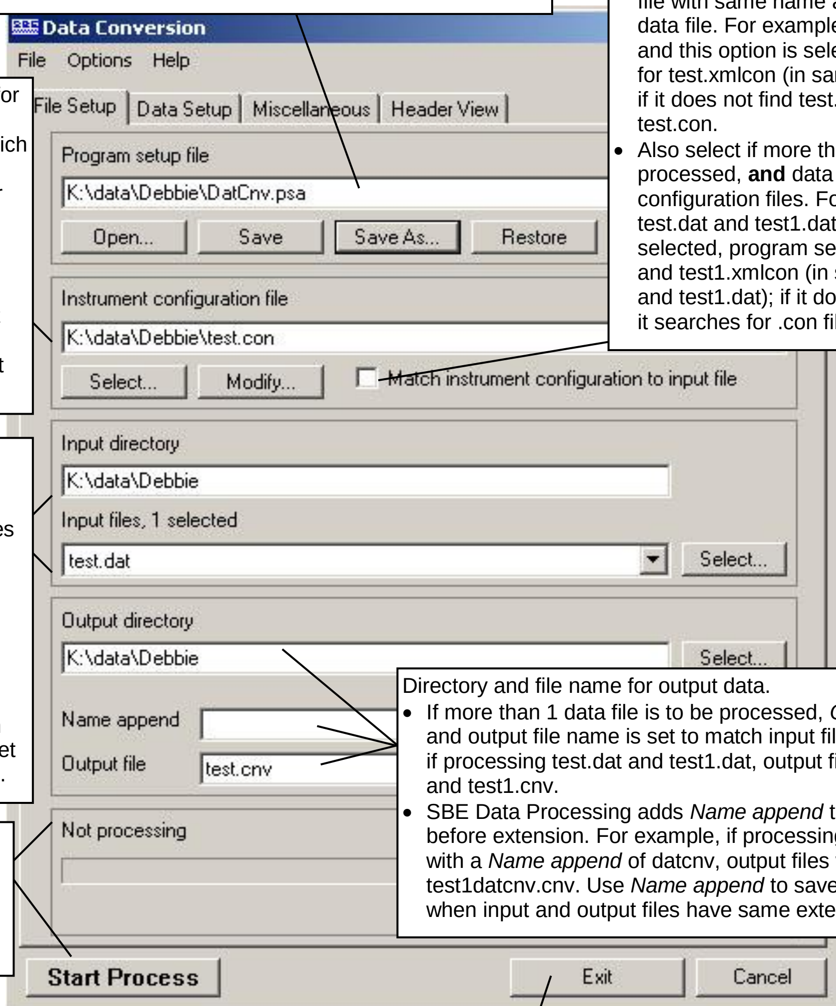
The following examples and discussion of the File Setup and Header View tabs is for Data Conversion. The other modules (except Sea Plot and SeaCalc III) are similar; however, not all fields are applicable to all modules.

File Setup Tab

Directory and file name for file to store **all** information input in File Setup and Data Setup tabs. **Open** to select a different .psa file, **Save** or **Save As** to save current settings, or **Restore** to reset all settings to match last saved version.
See note above.

- Select to have program find .con or .xmlcon file with same name and in same directory as data file. For example, if processing test.dat and this option is selected, program searches for test.xmlcon (in same directory as test.dat); if it does not find test.xmlcon, it searches for test.con.
- Also select if more than 1 data file is to be processed, **and** data files have different configuration files. For example, if processing test.dat and test1.dat, and this option is selected, program searches for test.xmlcon and test1.xmlcon (in same directory as test.dat and test1.dat); if it does not find .xmlcon files, it searches for .con files.

Directory and file name for instrument configuration (.con or .xmlcon) file, which defines instrument configuration and sensor calibration coefficients. This file is used in Data Conversion, Bottle Summary, and Derive. **Select** to pick a different file, or **Modify** to view and/or modify instrument configuration.



Directory and file names for input data. **Select** to pick a different file. To process multiple data files from same directory:

1. Click **Select**.
2. In Select dialog box, hold down Ctrl key while clicking on each desired file.

If multiple files are selected, header in each file must contain same set of sensors and variables.

Directory and file name for output data.

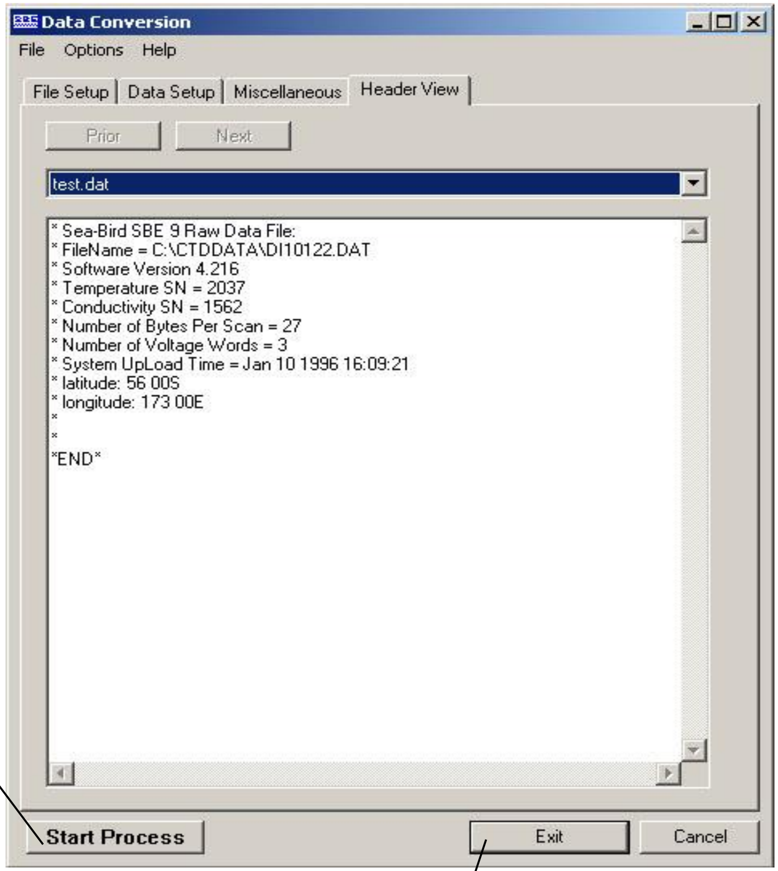
- If more than 1 data file is to be processed, *Output file* field disappears and output file name is set to match input file name. For example, if processing test.dat and test1.dat, output files will be test.cnv and test1.cnv.
- SBE Data Processing adds *Name append* to (each) output file name, before extension. For example, if processing test.dat and test1.dat with a *Name append* of datcnv, output files will be testdatcnv.cnv and test1datcnv.cnv. Use *Name append* to save intermediate data files when input and output files have same extension.

Click **Start Process** to begin processing data. Status field shows *Processing complete* when done.

Return to SBE Data Processing window.

- If *Confirm Program Setup Change* was selected in Options menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Program Setup Change* was not selected in Options menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Header View Tab



Begin processing data.
Status field on File Setup tab shows *Processing complete* when done.

Return to SBE Data Processing window.

- If *Confirm Program Setup Change* was selected in Options menu -
  If you made changes in the File Setup or Data Setup tab and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Program Setup Change* was not selected in Options menu -
  Button says **Save & Exit**. If you do not want to save changes made on the File Setup or Data Setup tab, use Cancel button to exit.

File Formats

File extensions are used by Seasoft to indicate the file type:

Extension	Description
.afm	Bottle sequence, date and time, firing confirmation, and 5 scans of CTD data, created by Auto Fire Module (AFM) or (when used for autonomous operation) SBE 55 ECO Water Sampler.
.asc	Data file: • Data portion of .cnv converted data file written in ASCII by ASCII Out • File written by Seaterm for data uploaded from SBE 37 (firmware < 3.0), 39, 39-IM, or 48. **Notes**: 1. Convert button on Seaterm's toolbar can convert .asc file to .cnv file that can be used by SBE Data Processing to process data. 2. Not applicable to SBE 37 IDO or ODO MicroCATs. • File written by SeatermV2 for data uploaded from SBE 39*plus* or 39*plus*-IM..
.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 1.5-second duration for each bottle. Seasave writes information to file each time bottle fire confirmation is received from SBE 32 Carousel Water Sampler or SBE 55 ECO Water Sampler or (only when used with SBE 911*plus*) G.O. 1016 Rosette. File can be used by Data Conversion.
.bmp	Sea Plot output bitmap graphics file.
.bsr	Bottle scan range file created by Mark Scan, and used by Data Conversion to create a .ros file.
.btl	Averaged and derived bottle data from .ros file, created by Bottle Summary.
.cnv	Converted (engineering units) data file, with ASCII header preceding data. Created by: • Data Conversion. • SeatermV2's *Convert XML data file* (in Tools menu of Seaterm232 or SeatermIM, or Convert XML Data button in SeatermUSB) for SBE 39*plus* or 39*plus*-IM. • Upload menu in Seaterm232 (SBE Glider Payload CTD only) • Seaterm's Convert button (SBE 37 [firmware < 3.0], 39, 39-IM, or 48 only). Note: Not applicable to SBE 37 IDO or ODO MicroCATs.
.con or **.xmlcon**	Instrument configuration - number and type of sensors, channel assigned to each sensor, and calibration coefficients. SBE Data Processing uses this information to interpret raw data from instrument. Latest version of configuration file for your instrument is supplied by Sea-Bird when instrument is purchased, upgraded, or calibrated. If you make changes to instrument (add or remove sensors, recalibrate, etc.), you must update configuration file. Can be viewed and/or modified in SBE Data Processing in Configure, Data Conversion, Derive, and Bottle Summary; and in Seasave. • .xmlcon files, written in XML format, were introduced with SBE Data Processing and Seasave 7.20a. Instruments introduced after that are compatible only with .xmlcon files.
.dat	Data file - binary raw data file created by older versions (Version < 6.0) of Seasave from real-time data stream from SBE 911*plus*. File includes header information.

Notes:

- Configuration files (.con or .xmlcon) can also be opened, viewed, and modified with DisplayConFile.exe, a utility that is installed in the same folder as SBE Data Processing. Right click on the desired configuration file, select *Open With*, and select *DisplayConFile*. This utility is often used at Sea-Bird to quickly open and view a configuration file for troubleshooting purposes, without needing to go through the additional steps of selecting the file in SBE Data Processing or Seasave.
- We recommend that you **do not** open **.xmlcon** files with a text editor (i.e., Notepad, Wordpad, etc.).

Note:
Seatermv2 version 1.1 and later creates a .hex file from data uploaded from an SBE 37. Earlier versions of SeatermV2, and all versions of Seaterm, created a .cnv file.

.hdr	Header recorded when acquiring real-time data (same as header information in data file), or header portion of .cnv converted data file written by ASCII Out. Header information includes software version, sensor serial numbers, instrument configuration, etc.
.hex	Data file: • Hexadecimal raw data file created by Seasave from real-time data stream from SBE 9*plus* (Seasave $\geq$ 7.0), 16, 16*plus*, 16*plus* V2, 19, 19*plus*, 19*plus* V2, 21, 25, 25*plus*, or 49. • Data uploaded from memory of SBE 16, 16*plus*, 16*plus*-IM, 16*plus* V2, 16*plus*-IM V2, 17*plus* (used with SBE 9*plus* CTD), 19, 19*plus*, 19*plus* V2, 21, 25, or 37. • Converted (engineering units) data file created by Seasave from real-time data stream from SBE 45. File includes header information.
.jpg	Sea Plot output JPEG graphics 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 Mark Scan.
.psa	File containing input file name and data path, output data path, and module-specific parameters used by SBE Data Processing. - - Primary .psa file default location, if available, is: %LOCALAPPDATA%\Sea-Bird\SBEDataProcessing-Win32\ (Example c:\Users\dbresko\AppData\Local\Sea-Bird\SBEDataProcessing-Win32\DatCnv.psa) - Secondary .psa file default location is: %APPDATA%\Sea-Bird\SBEDataProcessing-Win32\ (Example c:\Documents and Settings\dbresko.SEABIRD\Application Data\Sea-Bird\SBEDataProcessing-Win32\DatCnv.psa) **PostProcSuite.ini** contains a list of paths and file names for recently used .psa files. To view list, click File in module dialog box and select Recent Setup Files. - Primary PostProcSuite.ini file default location, if available, is: %LOCALAPPDATA%\Sea-Bird\IniFiles\ (Example c:\Users\dbresko\AppData\Local\Sea-Bird\IniFiles\ PostProcSuite.ini) - Secondary PostProcSuite.ini file default location is: %APPDATA%\Sea-Bird\IniFiles\ (Example c:\Documents and Settings\dbresko.SEABIRD\ Application Data\Sea-Bird\IniFiles\PostProcSuite.ini)
.ros	File containing data for each scan associated with a bottle closure, as well as data for a user-selected range of scans before and after each closure; created by Data Conversion.
.txt	• Easy-to-read file (for viewing only; cannot be modified) that shows all parameters in .con or .xmlcon file. Created by clicking Report in Configuration dialog box. SBE Data Processing creates this as a *temporary* file; to save it to document your settings, select *Save and exit* and enter desired file name and location. Alternatively, create file by running ConReport.exe. • File written by Seaterm232 for data uploaded from SBE 25*plus*, containing data from serial sensors.

.wmf	Sea Plot output Windows metafile graphics file.
.xml	• Sensor calibration coefficient file. This file can be exported and/or imported from the dialog box for a sensor. This allows you to move a sensor from one instrument to another and update the instrument's .con or .xmlcon file while eliminating need for typing or resulting possibility of typographical errors. • File written by Seaterm232, Seaterm485, or SeatermIM for data uploaded from all SBE 37 IDO and ODOs, and other SBE 37s with firmware version 3.0 and later (**Note**: Seaterm232, Seaterm485, and SeatermIM [all version 1.1 and later] automatically convert .xml file to .hex file that can be used by SBE Data Processing to process data). • File written by Seaterm232, SeatermIM, or SeatermUSB for data uploaded from SBE 39*plus* or 39*plus*-IM. • File written by Seaterm232 for data uploaded from SBE 25*plus*.
.xmlcon	See .con extension above.

Note:
Seatermv2 version 1.1 and later automatically creates a .hex file from the .xml data file uploaded from an SBE 37. Earlier versions of SeatermV2, and all versions of Seaterm, created a .cnv file.

Converted Data File (.cnv) Format

Converted files consist of a descriptive header followed by converted data in engineering units. The header contains:

1. Header information from the raw input data file (these lines begin with *****).

2. Header information describing the converted data file (these lines begin with **#**). The descriptions include:
   - number of rows and columns of data
   - variable for each column (for example, pressure, temperature, etc.)
   - interval between each row (scan rate or bin size)
   - historical record of processing steps used to create or modify file

3. ASCII string ***END** to flag the end of the header information.

Converted data is stored in rows and columns of ASCII numbers (11 characters per value) or as a binary data stream (4 byte binary floating point number for each value). The last column is a flag field used to mark scans as *bad* in Loop Edit.

Editing Raw Data Files

Note:
See *Section 5: Raw Data Conversion Modules* and *Section 7: File Manipulation Modules* for converting the data to a .cnv file and then editing the data.

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.**

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

.hex Files

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 and before *END***. 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). Something similar to 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, called Fixdat, which *may* repair a corrupted .dat file.

- Fixdat.exe is installed with, and located in the same directory as, SBE Data Processing.

Section 3: Typical Data Processing Sequences

Notes:
- The processing sequence may differ for your application.
- Sea Plot can display data at any point after a .cnv file has been created.
- Use ASCII Out to export converted data (without header) to other software.
- Oxygen computed by Seasave and Data Conversion differs from oxygen computed by Derive. 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 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.

This section includes *typical* data processing sequences for each instrument, broken into four categories:

- Profiling CTDs that have a configuration (.con or .xmlcon) file– SBE 9*plus*, 19, 19*plus*, 19*plus* V2, 25, 25*plus*, and 49.
- Other instruments (moored CTDs and thermosalinographs) that have a configuration (.con or .xmlcon) file – SBE 16, 16*plus*, 16*plus*-IM, 16*plus* V2, 16*plus*-IM V2, 21, and 45.
- MicroCATs with data uploaded using SeatermV2 version 1.1 or later, providing a .hex data file and a .xmlcon configuration file- SBE 37-SM, 37-SMP, 37-SMP-IDO, 37-SMP-ODO, 37-IM, 37-IMP, 37-IMP-IDO, 37-IMP-ODO, 37-SI, 37-SIP, 37-SIP-IDO, and 37-SIP-ODO.
- MicroCATs with data uploaded using Seaterm or SeatermV2 version 1.00i or earlier, providing a .xml or .asc data file (and no configuration [.con or .xmlcon] file) – SBE 37-SM, 37-SMP, 37-IM, 37-IMP, 37-SI, and 37-SIP.
- Instruments that do not have a configuration (.con or .xmlcon) file and have limited compatibility with SBE Data Processing –
  SBE 39, 39-IM, and 48.
  SBE 39*plus* and 39*plus*-IM.
- Glider Payload CTD

Processing Profiling CTD Data (SBE 9*plus*, 19, 19*plus*, 19*plus* V2, 25, 25*plus*, and 49)

Notes:

- The example assumes that a configuration (.con or .xmlcon) file is available. A configuration file is provided by Sea-Bird when the instrument is purchased, based on the user-specified configuration and the factory-calibration. An existing configuration file can be modified in Configure, Data Conversion, Derive, or Bottle Summary, or in Seasave. If you do not have a configuration file, use SBE Data Processing's Configure menu to create the file.
- The order for running Bin Average and Derive can be switched, **unless oxygen is being computed in Derive**.
- See the program modules for Sea-Bird recommendations for typical parameter values for filtering, aligning, etc. Use judgment in evaluating your data set to determine the best values.

The processing sequence is based on a *typical* situation with a boat at low latitude lowering an instrument at 1 meter/second.

Program / Module	Function
1. Seasave, Seaterm232, Seaterm, or SeatermAF	Acquire real-time raw data (Seasave) or upload data from memory (Upload menu in Seaterm232 for 19*plus* V2 or 25*plus*, or Upload button in Seaterm or SeatermAF, as applicable).
2. Data Conversion	Convert raw data to a .cnv file, selecting ASCII as data conversion format. Converted data includes: • pressure, temperature, and conductivity • (if applicable) dissolved oxygen current and dissolved oxygen temperature (SBE 13 or 23); dissolved oxygen signal (SBE 43); dissolved oxygen phase delay and thermistor voltage (SBE 63) • (if applicable) light transmission, pH, fluorescence, etc.
3. Filter	Low-pass filter pressure to increase pressure resolution for Loop Edit, and low-pass filter temperature and conductivity to smooth high frequency data.
4. Align CTD	Advance conductivity, temperature, and oxygen relative to pressure, to align parameters in time. This ensures that calculations of salinity, dissolved oxygen, and other parameters are made using measurements from same parcel of water.
5. Cell Thermal Mass	Perform conductivity cell thermal mass correction if salinity accuracy of better than 0.01 PSU is desired in regions with steep gradients. Note: Do not use Cell Thermal Mass for freshwater data.
6. Loop Edit	Mark scans where CTD is moving less than minimum velocity or traveling backwards due to ship roll.
7. Derive (EOS-80, Practical Salinity)	Compute: • Practical Salinity, density, and other parameters • oxygen from oxygen current and oxygen temperature (SBE 13 or 23); oxygen signal (SBE 43); or oxygen phase delay and thermistor voltage (SBE 63) Note that input file must include conductivity, temperature, and pressure.
8. Derive TEOS-10 (TEOS-10, Absolute Salinity)	(optional) Compute thermodynamic properties based on TEOS-10.
9. Bin Average	Average data into desired pressure or depth bins.
10.Sea Plot	Plot data.

Processing SBE 16, 16*plus*, 16*plus*-IM, 16*plus* V2, 16*plus*-IM V2, 21, and 45 Data

Notes:

- The example assumes that a configuration (.con or .xmlcon) file is available. A configuration file is provided by Sea-Bird when the instrument is purchased, based on the user-specified configuration and the factory-calibration. An existing configuration file can be modified in Configure, Data Conversion, Derive, or Bottle Summary, or in Seasave. If you do not have a configuration file, use SBE Data Processing's Configure menu to create the file.
- Even if your instrument does not have a pressure sensor (SBE 21 and 45; SBE 16, 16*plus*, 16*plus*-IM, 16*plus* V2, and 16*plus*-IM V2 without optional pressure sensor): Select pressure as an output variable in Data Conversion if you plan to calculate salinity, density, or other parameters that require pressure in Derive or Sea Plot. For the SBE 16 series instruments, Data Conversion inserts a column with the moored pressure (entered in the .con or .xmlcon file *Data* dialog) in the output .cnv file. For the SBE 21 and 45, Data Conversion inserts a column of 0's for pressure in the output .cnv file.
- The SBE 45 outputs data in engineering units. However, you must still run Data Conversion to put the data in a format that can be used by SBE Data Processing's other modules.
- For an SBE 21 or 45 with a remote temperature sensor, Seasave, Data Conversion, Derive, and Derive TEOS-10 all use the remote temperature data when calculating density and sound velocity.

Program / Module	Function
1. Seasave, Seaterm232, Seaterm485, SeatermIM, or Seaterm	Acquire real-time raw data (Seasave) or upload data from memory: • Upload menu in Seaterm232 or Seaterm485 for 16*plus* V2 or SeatermIM for 16*plus*-IM V2; • Upload button in Seaterm.
2. Data Conversion	Convert raw data to a .cnv file, selecting ASCII as data conversion format. Converted data includes: • pressure, temperature, and conductivity • (if applicable) dissolved oxygen current and dissolved oxygen temperature (SBE 13 or 23); dissolved oxygen signal (SBE 43); dissolved oxygen phase delay and thermistor voltage (SBE 63) • (if applicable) light transmission, pH, fluorescence, etc.
3. Derive (EOS-80, Practical Salinity)	Compute: • Practical Salinity, density, and other parameters. • oxygen from oxygen current and oxygen temperature (SBE 13 or 23); oxygen signal (SBE 43); or oxygen phase delay and thermistor voltage (SBE 63) Note that input file must include conductivity, temperature, and pressure.
4. Derive TEOS-10 (TEOS-10, Absolute Salinity)	(optional) Compute thermodynamic properties based on TEOS-10.
5. Sea Plot	Plot data.

Processing SBE 37-SM, SMP, SMP-IDO, SMP-ODO, IM, IMP, IMP-IDO, IMP-ODO, SI, SIP, SIP-IDO, and SIP-ODO Data with a .hex data file and .xmlcon configuration file

Note:
SBE 37-SI and 37-SIP with firmware version 3.0 and later have internal memory; follow the procedure described here to upload and process the data. Earlier versions of the 37-SI and 37-SIP did not have internal memory; SBE Data Processing cannot be used to process the real-time data obtained with these older instruments.

Program / Module	Function
1. **Seaterm232, Seaterm485, or SeatermIM (all version 1.1 or later)**	For SBE 37 (without oxygen) with firmware ≥ 3.0 and all IDO and ODO SBE 37- Use Upload menu to upload data (in engineering units). SeatermV2 uploads data as an XML (.xml) file. It automatically converts data to .hex format, and creates a configuration (.xmlcon) file; .hex and .xmlcon file.
2. **Data Conversion**	Convert raw data to a .cnv file, selecting ASCII as data conversion format. Converted data includes: • conductivity, temperature, and pressure • (for IDO and ODO MicroCATs) dissolved oxygen signal
3. **Derive** (EOS-80, Practical Salinity)	Compute: • Practical Salinity, density, and other parameters. • oxygen from oxygen signal
4. **Derive TEOS-10** (TEOS-10, Absolute Salinity)	(optional) Compute thermodynamic properties based on TEOS-10.
5. **Sea Plot**	Plot data.

Processing SBE 37-SM, SMP, IM, IMP, SI, and SIP Data without a configuration file

Note:
SBE 37-SI and 37-SIP with firmware version 3.0 and later have internal memory; follow the procedure described here to upload and process the data. Earlier versions of the 37-SI and 37-SIP did not have internal memory; SBE Data Processing cannot be used to process the real-time data obtained with these older instruments.

Program / Module	Function
1. **Seaterm232, Seaterm485, or SeatermIM (all version 1.00l or earlier), or Seaterm**	Seaterm232, Seaterm485, or SeatermIM for SBE 37 (non-IDO) with firmware version ≥ 3.0 - Use Upload menu to upload data (in engineering units) in XML (.xml) format. Use *Convert .XML data file* in Tools menu to convert .xml to .cnv file, which can be used by SBE Data Processing. **or** Seaterm for SBE 37 (non-IDO) with firmware version < 3.0 - Use Upload button to upload data (in engineering units) in ASCII (.asc) format. Use Convert button to convert .asc to .cnv file, which can be used by SBE Data Processing.
2. **Derive** (EOS-80, Practical Salinity)	Compute Practical Salinity, density, and other parameters. **Note**: An SBE 37 stores calibration coefficients internally, and does not have a .con or .xmlcon file. However, Derive **requires** you to select a .con or .xmlcon file before it will process data. You can use a .con or .xmlcon file from **any** other Sea-Bird instrument; the contents of the file will not affect the results. If you do not have a .con or .xmlcon file for another Sea-Bird instrument, create one: 1. Click SBE Data Processing's Configure menu and select **any** instrument. 2. In the Configuration dialog box, click Save As, and save the .con or .xmlcon file with the desired name and location.
3. **Derive TEOS-10** (TEOS-10, Absolute Salinity)	(optional) Compute thermodynamic properties based on TEOS-10.
4. **Sea Plot**	Plot data.

Processing SBE 39, 39-IM, and 48 Data

Note:
The .cnv file from an SBE 39, 39-IM, or 48 cannot be processed by any SBE Data Processing modules other than Sea Plot and ASCII Out.

Program / Module	Function
1. Seaterm	Use Upload button to upload data (in engineering units) in ASCII (.asc) format. Use Convert button to convert .asc to .cnv file, which can be used by SBE Data Processing.
2. Sea Plot	Plot data.

Processing SBE 39*plus* and 39*plus*-IM Data

Note:
The .cnv file from an SBE 39*plus* or 39plus-IM cannot be processed by any SBE Data Processing modules other than Sea Plot and ASCII Out.

Program / Module	Function
1. SeatermV2	Use Upload button in appropriate program to upload data (in engineering units) in XML and ASCII (.asc) format. Use *Convert XML data file* in Tools menu of Seaterm232 or SeatermIM (as applicable), or Convert XML Data button in SeatermUSB to convert to .cnv file, which can be used by SBE Data Processing.
2. Sea Plot	Plot data.

Processing Glider Payload CTD Data (GPCTD)

Notes:
- The example assumes that a configuration (.xmlcon) file is available. A configuration file is created by Seaterm232 when data is uploaded from memory, based on the factory configuration and the calibration data programmed into the instrument. An existing configuration file can be modified in Configure or Derive. If you do not have a configuration file, you can use SBE Data Processing's Configure menu to create the file.
- Use judgment in evaluating your data set to determine the best values for filtering, aligning, etc.

The processing sequence is based on a *typical* situation with the Glider Payload CTD acquiring data via Continuous Sampling.

Program / Module	Function
1. Seaterm232	Upload data from memory (Upload menu in Seaterm232).
2. Filter	Low-pass filter pressure to increase pressure resolution for low-pass filter temperature and conductivity to smooth high frequency data.
3. Align CTD	Advance conductivity, temperature, and oxygen relative to pressure, to align parameters in time. This ensures that calculations of salinity, dissolved oxygen, and other parameters are made using measurements from same parcel of water.
4. Cell Thermal Mass	Perform conductivity cell thermal mass correction if salinity accuracy of better than 0.01 PSU is desired in regions with steep gradients.
5. Derive (EOS-80, Practical Salinity)	Compute: • Practical Salinity, density, and other parameters • oxygen (optional) Note that input file must include conductivity, temperature, and pressure.
6. Derive TEOS-10 (TEOS-10, Absolute Salinity)	(optional) Compute thermodynamic properties based on TEOS-10.
7. Sea Plot	Plot data.

Section 4: Configuring Instrument (Configure)

Module Name	Module Description
Configure	Define instrument configuration and calibration coefficients.

Introduction

Configure creates or modifies a configuration (.con or .xmlcon) file to define the instrument configuration and sensor calibration coefficients. The .con or .xmlcon file is used in both SBE Data Processing and in Seasave. Configure is applicable to the following instruments:

- SBE 9*plus* with SBE 11*plus* Deck Unit **or** SBE 17*plus* Searam (SBE *9plus* is listed as the 911/917plus in the Configure menu)
- SBE 16
- SBE 16*plus* (including 16*plus*-IM)
- SBE 16*plus* V2 (including 16*plus*-IM V2)
- SBE 19
- SBE 19*plus*
- SBE 19*plus* V2
- SBE 21
- SBE 25
- SBE 25*plus*
- SBE 37
- SBE 45
- SBE 49
- SBE Glider Payload CTD

Notes:
- Sea-Bird supplies a .con or .xmlcon file with each instrument. **The file must match the existing instrument configuration and contain current sensor calibration information.** Exception: An .xmlcon file is generated by Seaterm232 when you upload data from an SBE Glider Payload CTD; Sea-Bird does not provide the file.
- An existing .con or .xmlcon file can be modified in Configure; in Data Conversion, Derive, or Bottle Summary; or in Seasave.
- Configuration files (.con or .xmlcon) can also be opened, viewed, and modified with DisplayConFile.exe, a utility that is installed in the same folder as SBE Data Processing. Right click on the desired configuration file, select *Open With*, and select *DisplayConFile*. This utility is often used at Sea-Bird to quickly open and view a configuration file for troubleshooting purposes, without needing to go through the additional steps of selecting the file in SBE Data Processing or Seasave.
- *Appendix II: Configure (.con or .xmlcon) File Format* contains a line-by-line description of the contents of a .con configuration file.
- An SBE 37, 39, 39-IM, 39*plus*, 39*plus*-IM, and 48 stores calibration coefficients internally, and does not have a .con or .xmlcon file.

The discussion of Configure is in five parts:

- *Instrument Configuration* covers the Configuration dialog box - number and type of sensors on the instrument, etc. - for each of the instruments listed above. Unless noted otherwise, SBE Data Processing 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 *Calibration Coefficients for Voltage Sensors* for those sensors that SBE Data Processing supports in a redundant configuration (two or more of the same sensor interfacing with the CTD).

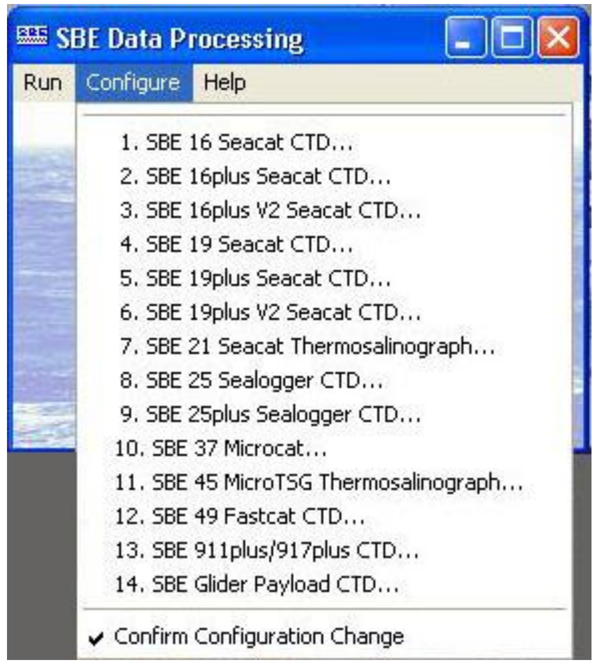
- *Calibration Coefficients for Frequency Sensors* covers calculation of coefficients for each type of frequency sensor (temperature, conductivity, Digiquartz pressure, IOW sound velocity, etc.).

- *Calibration Coefficients for A/D Count Sensors* covers calculation of coefficients for A/D count sensors (temperature and strain gauge pressure) used on the SBE 16*plus* (and -IM), 16*plus* (and -IM) V2, 19*plus*, 19*plus* V2, 37, and 49.

- *Calibration Coefficients for Voltage Sensors* covers calculation of coefficients for each type of voltage sensor (strain gauge pressure, oxygen, pH, etc.).

- *Calibration Coefficients for RS-232 Sensors* covers specification of an Aanderaa Optode, which can be integrated with an SBE 19*plus* V2.

Access Configure by selecting the desired instrument in the Configure menu in the SBE Data Processing window.



- Before selecting the instrument, review the status of *Confirm Configuration Change* in the Configure menu. If *Confirm Configuration Change* is selected, the program provides a prompt to save the configuration (.con or .xmlcon) file if you make changes and then click the Exit button in the Configuration dialog box without clicking Save or Save As. **If not selected, the program changes the *Exit* button to *Save & Exit*; to exit without saving changes, use the Cancel button**.

Instrument Configuration

SBE 9*plus* Configuration

Channel/Sensor table reflects this choice. Voltage channel 0 in .con or .xmlcon 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 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.

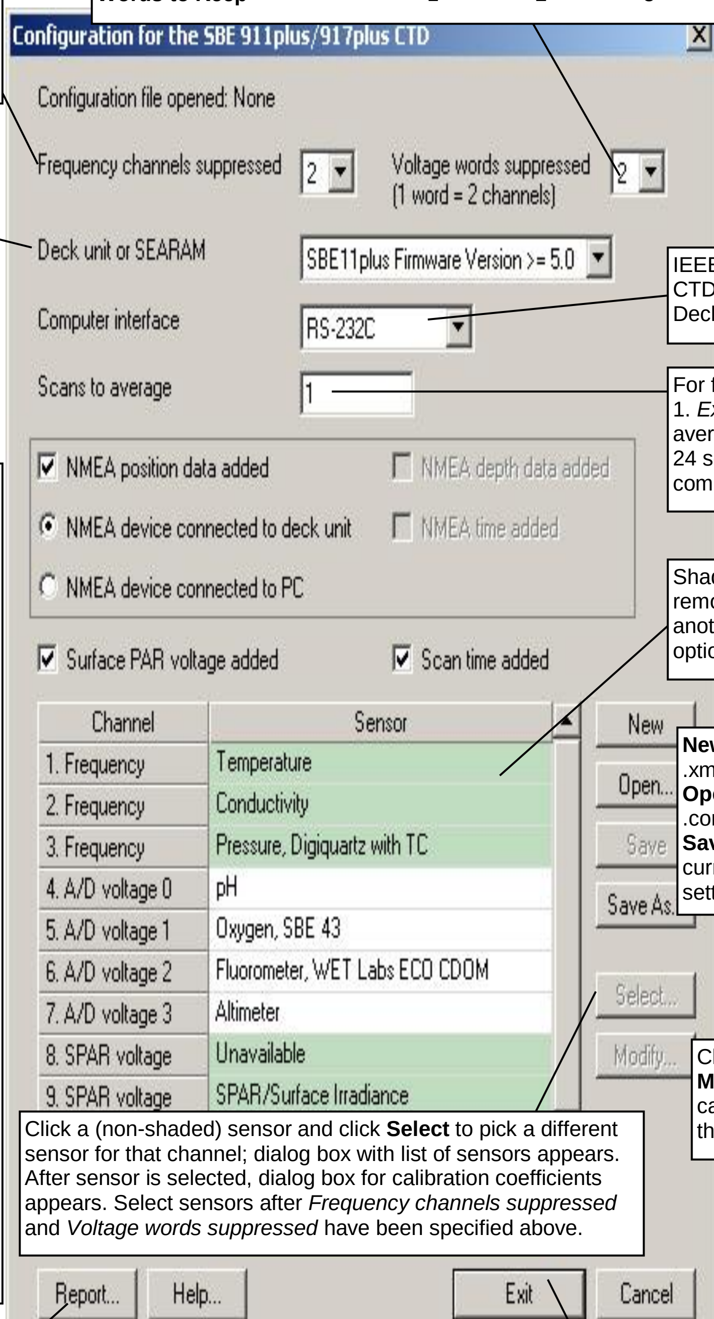
External Voltage (not spare)	0 or 1	2 or 3	4 or 5	6 or 7
Connector	AUX 1	AUX 2	AUX 3	AUX 4
Words to Keep	1	2	3	4

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

11plus ≥ 5.0: Seasave sends **AddSpar=** command to Deck Unit, consistent with configuration file selection for Surface PAR.
11plus < 5.0: Surface PAR acquisition is set in Deck Unit with dip switch.
17plus: Data uploaded from 17*plus* memory.
None: Not using 11*plus* or 17*plus*; see *Appendix I: Command Line Operation.*

- **NMEA** - Select if NMEA navigation device used, and if NMEA depth data and NMEA time data were also appended. Seasave adds current latitude, longitude, and universal time code to data header; appends NMEA data to every scan; and writes NMEA data to .nav file every time Ctrl F7 is pressed or Add to .nav File is clicked. Note: Whether NMEA device was connected to a deck unit or directly to computer during data acquisition in Seasave has no effect on data file used by SBE Data Processing, and therefore has no effect on data processing.
- **Surface PAR** - Select if Surface PAR sensor used; must agree with Deck Unit setup if 11*plus* firmware < 5.0. Seasave appends Surface PAR data to every scan. 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.
- **Scan time** – Select if Seasave appended time (seconds since January 1, 1970 GMT) to each data scan.



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

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

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

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

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

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.

Opens a .txt file (for viewing only; cannot be modified) that shows all parameters in .con or .xmlcon file. For command line generation of report, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

Return to SBE Data Processing window.

- If *Confirm Configuration Change* was selected in Configure menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Configuration Change* was not selected in Configure menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Shown below is an example status (**DS**) response ***in Seaterm*** that corresponds to the setup shown in the Configuration dialog box above, for an SBE 9*plus* used with an SBE 11*plus* Deck Unit. Shown below the appropriate lines are the commands used in Seaterm to modify the setup of parameters critical to use of the 9*plus* with Seasave and processing of data with SBE Data Processing, as well as any explanatory information.

```
SBE 11plus V 5.1f
```

```
Number of scans to average = 1
```

(11*plus* reads this from .con or .xmlcon file in Seasave when data acquisition is started.)

```
pressure baud rate = 9600
```

```
NMEA baud rate = 4800
```

```
surface PAR voltage added to scan
```

(11*plus* reads this from .con or .xmlcon file in Seasave when data acquisition is started.)

```
A/D offset = 0
```

```
GPIB address = 1
```

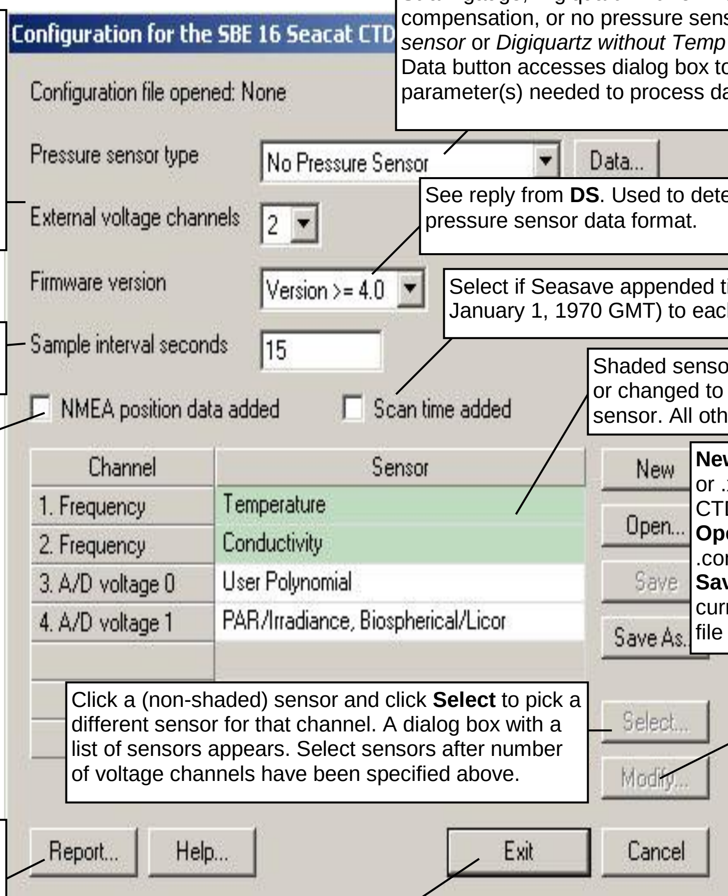
(GPIB address must be 1 [GPIB=1] to use Seasave, if *Computer interface* is IEEE-488 (GPIB) in .con or .xmlcon file.)

```
advance primary conductivity 0.073 seconds
```

```
advance secondary conductivity 0.073 seconds
```

```
autorun on power up is disabled
```

SBE 16 Seacat C-T Recorder Configuration



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 dialog box to input additional parameter(s) needed to process data.

Channel/Sensor table reflects this choice. Must agree with SBE 16 setup for **SVn** (n=0, 1, 2, 3, 4); see reply from **DS**. Voltage channel 0 in .con or .xmlcon file corresponds to sensor wired to channel 0 on end cap connector, voltage channel 1 corresponds to sensor wired to channel 1 on end cap connector, etc.

See reply from **DS**. Used to determine strain gauge pressure sensor data format.

Select if Seasave appended time (seconds since January 1, 1970 GMT) to each data scan.

Time between scans. Must agree with SBE 16 setup (**SI**); see reply from **DS**.

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

Select if using with deck unit connected to NMEA navigation device. Seasave adds current latitude, longitude, and universal time code to data header; appends NMEA data to every scan; and writes NMEA data to .nav file every time Ctrl F7 is pressed or Add to .nav File is clicked.

New to create new .con or .xmlcon file for this CTD.
Open to select different .con or .xmlcon file.
Save or **Save As** to save current .con or .xmlcon 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 only; cannot be modified) that shows all parameters in .con or .xmlcon file. For command line generation of report, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

Return to SBE Data Processing window.

- If *Confirm Configuration Change* was selected in Configure menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Configuration Change* was not selected in Configure menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Shown below is an example status (**DS**) response ***in Seaterm*** that corresponds to the setup shown in the Configuration dialog box above.
Shown below the appropriate lines are the commands used in Seaterm to modify the setup of parameters critical to use of the SBE 16 with Seasave and processing of data with SBE Data Processing, as well as any explanatory information.

```
SEACAT V4.0h SERIAL NO. 1814 07/14/95 09:52:52.082
```

(If pressure sensor installed, pressure sensor information appears here in status response; must match *Pressure sensor type* in .con or .xmlcon file.)

```
clk = 32767.789, iop = 103, vmain = 8.9, vlith = 5.9

sample interval = 15 sec
```

(Sample interval [SI] must match *Sample interval seconds* in .con or .xmlcon file.)

```
delay before measuring volts = 4 seconds

samples = 0, free = 173880, lwait = 0 msec

SW1 = C2H, battery cutoff = 5.6 volts

no. of volts sampled = 2
```

(Number of auxiliary voltage sensors enabled [SVn] must match *External voltage channels* in .con or .xmlcon file.)

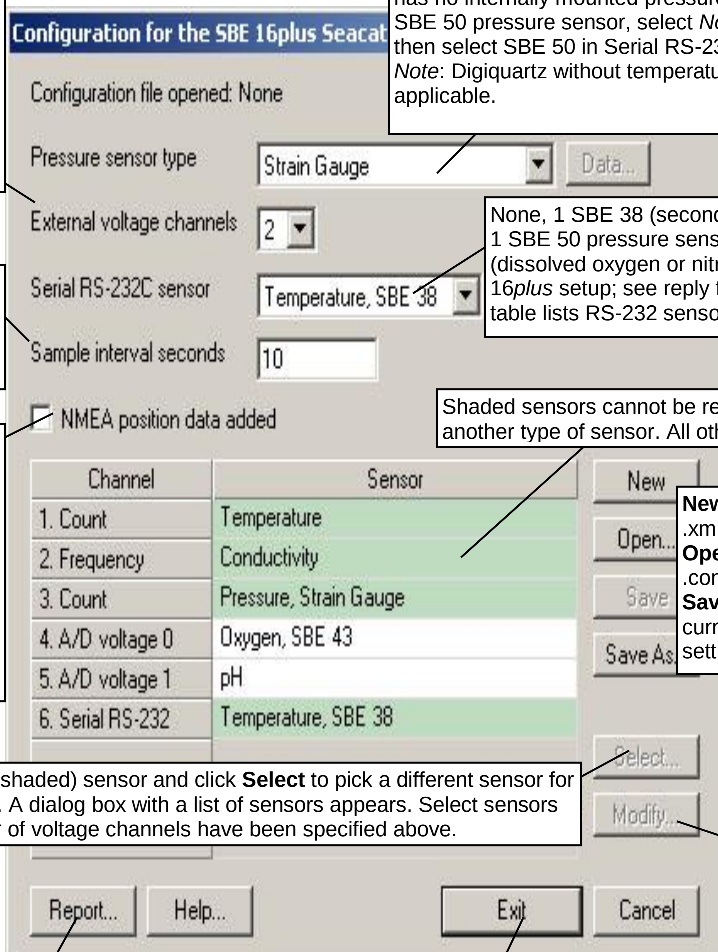
```
mode = normal

logdata = NO
```

SBE 16*plus* or 16*plus*-IM Seacat C-T Recorder Configuration

> **Note:**
> The SBE 16*plus* is available with an optional RS-485 interface. All commands to a particular 16*plus* with RS-485 are preceded by **#ii**, where ii = instrument ID (0-99). Therefore, commands mentioned in the dialog box description below have a slightly different form for the RS-485 version (**#iiDS**, **#iiPType=**, **#iiVoltn=**, and **#iiSampleInterval=**).

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.

The SBE 16*plus*-IM can interface with one SBE 38 secondary temperature sensor through the 16*plus*-IM optional RS-232 connector, but **cannot interface with an SBE 50 or GTD**. All commands to a particular 16*plus*-IM are preceded by **#ii**, where ii = instrument ID (0-99). Therefore, commands mentioned in the dialog box description below have a slightly different form for the 16*plus*-IM (**#iiDS**, **#iiPType=**, **#iiVoltN=**, and **#iiSampleInterval=**).



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

Channel/Sensor table reflects this choice (0, 1, 2, 3, or 4). Must agree with 16*plus* setup for **VoltN=** (N=0, 1, 2, and 3); see reply from **DS**. Voltage channel 0 in .con or .xmlcon file corresponds to first external voltage in data stream, voltage channel 1 to second external voltage in data stream, etc.

None, 1 SBE 38 (secondary temperature), 1 SBE 50 pressure sensor, or up to 2 GTDs (dissolved oxygen or nitrogen). Must agree with 16*plus* setup; see reply from **DS**. Channel/Sensor table lists RS-232 sensors below voltage channels.

Time between scans. Must agree with 16*plus* setup (**SampleInterval=**); see reply from **DS**.

Select if using with deck unit connected to a NMEA navigation device. Seasave adds current latitude, longitude, and universal time code to data header; appends NMEA data to every scan; and writes NMEA data to .nav file every time Ctrl F7 is pressed or Add to .nav File is clicked.

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

New to create new .con or .xmlcon file for this CTD. **Open** to select different .con or .xmlcon file. **Save** or **Save As** to save current .con or .xmlcon 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 only; cannot be modified) that shows all parameters in .con or .xmlcon file. For command line generation of report, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

Return to SBE Data Processing window.
- If *Confirm Configuration Change* was selected in Configure menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Configuration Change* was not selected in Configure menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Shown below is an example status (**DS**) response ***in Seaterm*** for a 16*plus* with standard RS-232 interface that corresponds to the setup shown in the Configuration dialog box above. Shown below the appropriate lines are the commands used in Seaterm to modify the setup of parameters critical to use of the SBE 16*plus* with Seasave and processing of data with SBE Data Processing, as well as any explanatory information.

```
SBE 16plus V 1.6e SERIAL NO. 4300 03 Mar 2005 14:11:48

vbatt = 10.3, vlith = 8.5, ioper = 62.5 ma,
ipump = 21.6 ma, iext01 = 76.2 ma, iserial = 48.2 ma

status = not logging

sample interval = 10 seconds, number of measurements
per sample = 2
```

(Sample interval [SampleInterval=] must match *Sample interval seconds* in .con or .xmlcon file.)

```
samples = 823, free = 465210

run pump during sample, delay before sampling =
2.0 seconds

transmit real-time = yes
```

(Real-time data transmission must be enabled [TxRealTime=Y] to acquire data in Seasave.)

```
battery cutoff = 7.5 volts

pressure sensor = strain gauge, range = 1000.0
```

(Internal pressure sensor [PType=] must match *Pressure sensor type* in .con or .xmlcon file.)

```
SBE 38 = yes, SBE 50 = no, Gas Tension Device = no
```

(Selection/enabling of RS-232 sensors [SBE38=, SBE50=, GTD=, DualGTD=] must match *Serial RS-232C sensor* in .con or .xmlcon file.)

```
Ext Volt 0 = yes, Ext Volt 1 = yes, Ext Volt 2 = no, Ext
Volt 3 = no
```

(Number of external voltage sensors enabled [Volt0= through Volt3=] must match *External voltage channels* in .con or .xmlcon file.)

```
echo commands = yes

output format = raw HEX
```

(Output format must be set to raw Hex [OutputFormat=0] to acquire data in Seasave.)

```
serial sync mode disabled
```

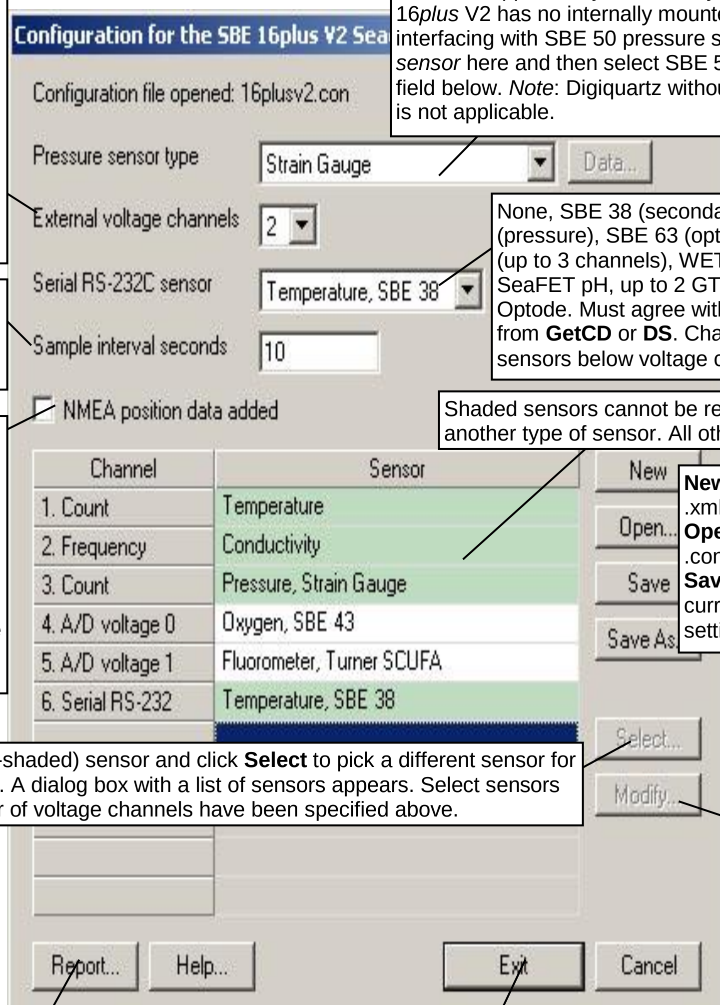
(Serial sync mode must be disabled [SyncMode=N] to acquire data in Seasave.)

SBE 16*plus* V2 or 16*plus*-IM V2 SeaCAT C-T Recorder Configuration

Note:
The Satlantic SeaFET pH sensor and WET Labs SeaOWL are not currently compatible with the SBE 16*plus*-IM V2. We expect to add compatibility in the future.

Through the CTD's RS-232 sensor connector, the SBE 16*plus* V2 and 16*plus*-IM V2 can interface with an SBE 38 secondary temperature sensor, SBE 50 pressure sensor, SBE 63 Optical Dissolved Oxygen Sensor, WET Labs sensor [single, dual, or triple channel ECO; WETStar; or C-Star], WET Labs SeaOWL UV-A, Satlantic SeaFET pH sensor, Optode, **or** up to two Pro-Oceanus Gas Tension Devices (GTDs). This data is appended to the data stream; SBE 38 and SBE 50 data does not replace the internal CTD data.

All commands to a particular 16*plus*-IM V2 are preceded by **#ii**, where ii = instrument ID (0-99). Therefore, commands mentioned in the dialog box description below have a slightly different form for the 16*plus*-IM V2 (**#iiGetCD**, **#iiDS**, **#iiPType=**, **#iiVoltN=**, and **#iiSampleInterval=**).



Internally mounted pressure sensor: strain gauge, Digiquartz with temperature compensation, or no pressure sensor. If *no pressure sensor* is selected, Data button accesses dialog box to input additional parameter needed to process data. Must agree with 16*plus* V2 setup (**PType=**); see reply from **GetCD** or **DS**. Selection applies only to internally mounted pressure sensor; if 16*plus* V2 has no internally mounted pressure sensor but is interfacing with SBE 50 pressure sensor, select *No pressure sensor* here and then select SBE 50 in Serial RS-232C sensor field below. *Note*: Digiquartz without temperature compensation is not applicable.

Channel/Sensor table reflects this choice (0, 1, 2, 3, 4, 5, or 6). Must agree with 16*plus* V2 setup for **VoltN=** (N=0, 1, 2, 3, 4, and 5); see reply from **GetCD** or **DS**. Voltage channel 0 in .con or .xmlcon file corresponds to first external voltage in data stream, voltage channel 1 to second external voltage in data stream, etc.

None, SBE 38 (secondary temperature), SBE 50 (pressure), SBE 63 (optical DO), WET Labs sensor (up to 3 channels), WET Labs SeaOWL UV-A , SeaFET pH, up to 2 GTDs (DO or nitrogen), or Optode. Must agree with 16*plus* V2 setup; see reply from **GetCD** or **DS**. Channel/Sensor table lists RS-232 sensors below voltage channels.

Time between scans. Must agree with 16*plus* V2 setup (**SampleInterval=**); see reply from **GetCD** or **DS**.

Select if using with deck unit connected to a NMEA navigation device. Seasave adds current latitude, longitude, and universal time code to data header; appends NMEA data to every scan; and writes NMEA data to .nav file every time Ctrl F7 is pressed or Add to .nav File is clicked.

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

New to create new .con or .xmlcon file for this CTD. **Open** to select different .con or .xmlcon file. **Save** or **Save As** to save current .con or .xmlcon 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 only; cannot be modified) that shows all parameters in .con or .xmlcon file. For command line generation of report, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

Return to SBE Data Processing window.
- If *Confirm Configuration Change* was selected in Configure menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Configuration Change* was not selected in Configure menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Shown below is an example status (**DS**) response ***in a terminal program*** for a 16*plus* V2 with RS-232 interface that corresponds to the setup shown in the Configuration dialog box above. Shown below the appropriate lines are the commands used in the terminal program to modify the setup of parameters critical to use of the SBE 16*plus* V2 with Seasave and processing of data with SBE Data Processing, as well as any explanatory information.

```
SBE 16plus V 3.1.8 SERIAL NO. 50175 13 Apr 2016 14:11:48

vbatt = 10.3, vlith = 8.5, ioper = 62.5 ma,
ipump = 21.6 ma, iext01 = 76.2 ma, iserial = 48.2 ma

status = not logging

samples = 0, free = 3463060

sample interval = 10 seconds, number of measurements
per sample = 1
```

(Sample interval [SampleInterval=] must match *Sample interval seconds* in .con or .xmlcon file.)

```
pump = run pump during sample, delay before sampling =
2.0 seconds, delay after sampling = 0.0 seconds

transmit real-time = yes
```

(Real-time data transmission must be enabled [TxRealTime=Y] to acquire data in Seasave.)

```
battery cutoff = 7.5 volts

pressure sensor = strain gauge, range = 1000.0
```

(Internal pressure sensor [PType=] must match *Pressure sensor type* in .con or .xmlcon file.)

```
SBE 38 = yes, SBE 50 = no, WETLABS = no, OPTODE = no,
SBE63 = no, SeaFET = no, Gas Tension Device = no
```

(Selection/enabling of RS-232 sensors [SBE38=, SBE50=, WetLabs=, Optode=, SBE63=, SeaFET=, GTD=, DualGTD=] must match *Serial RS-232C sensor* in .con or .xmlcon file.)

```
Ext Volt 0 = yes, Ext Volt 1 = yes,
Ext Volt 2 = no, Ext Volt 3 = no,
Ext Volt4 = no, Ext Volt 5 = no
```

(Number of external voltage sensors enabled [Volt0= through Volt5=] must match *External voltage channels* in .con or .xmlcon file.)

```
echo characters = yes

output format = raw HEX
```

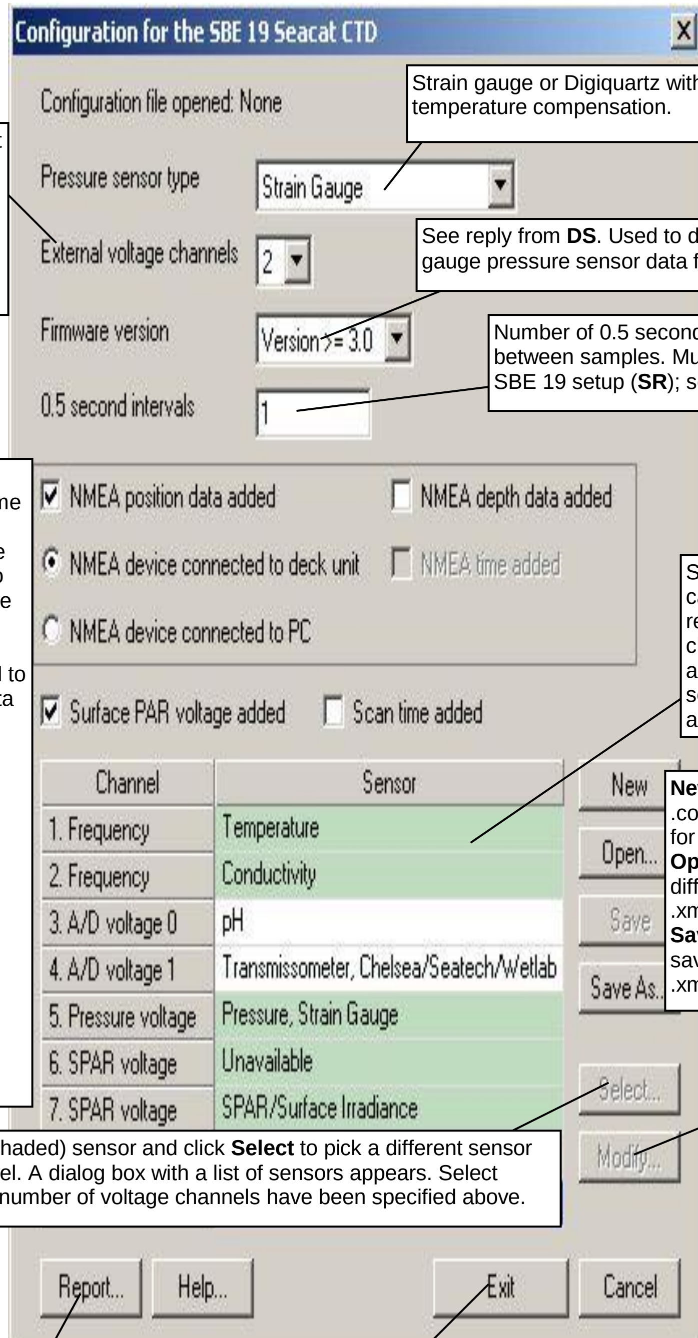
(Output format must be set to raw Hex [OutputFormat=0] to acquire data in Seasave.)

```
serial sync mode disabled
```

(Serial sync mode must be disabled [SyncMode=N] to acquire data in Seasave.)

SBE 19 Seacat Profiler Configuration

Seasave and SBE Data Processing always treat 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 or .xmlcon file, select the SBE 16).



Strain gauge or Digiquartz with temperature compensation.

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

See reply from **DS**. Used to determine strain gauge pressure sensor data format.

Number of 0.5 second intervals between samples. Must agree with SBE 19 setup (**SR**); see reply from **DS**.

- **NMEA** - Select if NMEA navigation device used, and if NMEA depth data and NMEA time data were also appended. Seasave adds current latitude, longitude, and universal time code to data header; appends NMEA data to every scan; and writes NMEA data to .nav file every time Ctrl F7 is pressed or Add to .nav File is clicked.
  Note: Whether NMEA device was connected to a deck unit or directly to computer during data acquisition in Seasave has no effect on data file used by SBE Data Processing, and therefore has no effect on data processing.
- **Surface PAR** - Select if using with deck unit connected to Surface PAR sensor. Seasave appends Surface PAR data to every scan. 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 sensors. See Application Note 47.
- **Scan time added** - Select if Seasave appended time (seconds since January 1, 1970 GMT) to each data scan.

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

New to create new .con or .xmlcon file for this CTD.
Open to select different .con or .xmlcon file.
Save or **Save As** to save current .con or .xmlcon 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 only; cannot be modified) that shows all parameters in .con or .xmlcon file. For command line generation of report, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

Return to SBE Data Processing window.
- If *Confirm Configuration Change* was selected in Configure menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Configuration Change* was not selected in Configure menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Shown below is an example status (**DS**) response ***in Seaterm*** that corresponds to the setup shown in the Configuration dialog box above.
Shown below the appropriate lines are the commands used in Seaterm to modify the setup of parameters critical to use of the SBE 19 with Seasave and processing of data with SBE Data Processing, as well as any explanatory information.

```
SEACAT PROFILER V3.1B SN 936 02/10/94 13:33:23.989

strain gauge pressure sensor: S/N = 12345,
range = 1000 psia, tc = 240
```

(Pressure sensor (strain gauge or Digiquartz) must match *Pressure sensor type* in .con or .xmlcon file.)

```
clk = 32767.766 iop = 172 vmain = 8.1 vlith = 5.8

mode = PROFILE ncasts = 0
```

(Mode must be profile [MP] if setting up .con or .xmlcon file for SBE 19; create .con or .xmlcon file for SBE 16 for SBE 19 in moored mode [MM].)

```
sample rate = 1 scan every 0.5 seconds
```

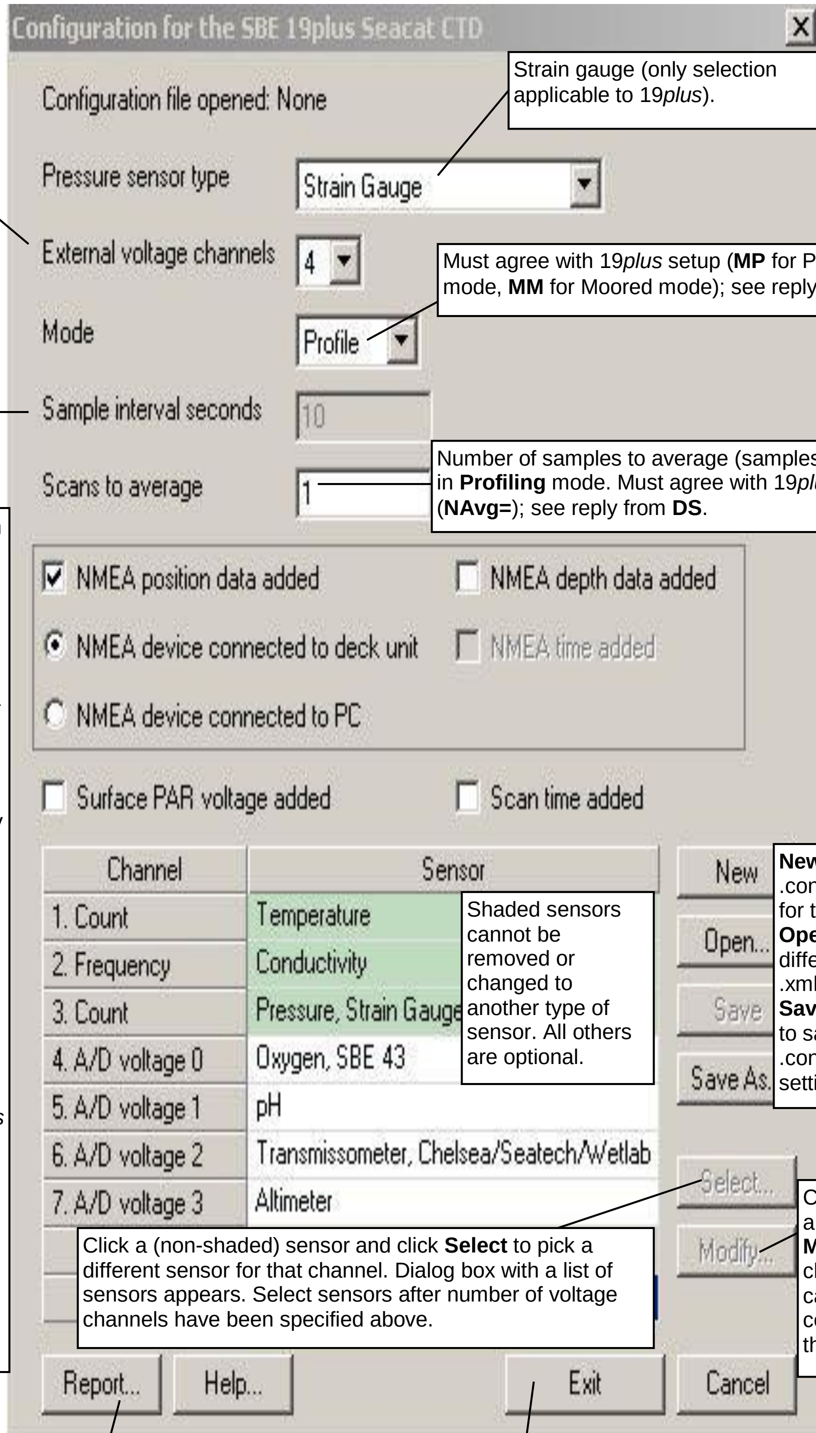
(Sample rate [SR] must match *0.5 second intervals* in .con or .xmlcon file.)

```
minimum raw conductivity frequency for pump turn on =
3206 hertz

pump delay = 40 seconds

samples = 0 free = 174126 lwait = 0 msec

battery cutoff = 7.2 volts

number of voltages sampled = 2
```

(Number of auxiliary voltage sensors enabled [SVn] must match *External voltage channels* in .con or .xmlcon file.)

```
logdata = NO
```

SBE 19*plus* Seacat Profiler Configuration



Channel/Sensor table reflects this choice (0, 1, 2, 3, or 4). Must agree with 19*plus* setup for **VoltN=** (N=0, 1, 2,and 3); see reply from **DS**. Voltage channel 0 in .con or .xmlcon file corresponds to first external voltage in data stream, voltage channel 1 to second external voltage in data stream, etc.

Strain gauge (only selection applicable to 19*plus*).

Must agree with 19*plus* setup (**MP** for Profiing mode, **MM** for Moored mode); see reply from **DS**.

Interval between scans in **Moored** mode. Must agree with 19*plus* setup (**SampleInterval=**); see reply from **DS**.

Number of samples to average (samples at 4 Hz) in **Profiling** mode. Must agree with 19*plus* setup (**NAvg=**); see reply from **DS**.

- **NMEA** - Select if NMEA navigation device used, and if NMEA depth data and NMEA time data were also appended. Seasave adds current latitude, longitude, and universal time code to data header; appends NMEA data to every scan; and writes NMEA data to .nav file every time Ctrl F7 is pressed or Add to .nav File is clicked.
  Note: Whether NMEA device was connected to a deck unit or directly to computer during data acquisition in Seasave has no effect on data file used by SBE Data Processing, and therefore has no effect on data processing.
- **Surface PAR** - Select if using with deck unit connected to Surface PAR sensor. Seasave appends Surface PAR data to every scan. 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 sensors. See Application Note 47.
- **Scan time added** - Select if Seasave appended time (seconds since January 1, 1970 GMT) to each data scan.

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

New to create new .con or .xmlcon file for this CTD.
Open to select different .con or .xmlcon file.
Save or **Save As** to save current .con or .xmlcon 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 only; cannot be modified) that shows all parameters in .con or .xmlcon file. For command line generation of report, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

Return to SBE Data Processing window.
- If *Confirm Configuration Change* was selected in Configure menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Configuration Change* was not selected in Configure menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Shown below is an example status (**DS**) response ***in Seaterm*** that corresponds to the setup shown in the Configuration dialog box above.
Shown below the appropriate lines are the commands used in Seaterm to modify the setup of parameters critical to use of the 19*plus* with Seasave and processing of data with SBE Data Processing, as well as any explanatory information.

```
SeacatPlus V 1.5 SERIAL NO. 4000 22 May 2005 14:02:13

vbatt = 9.6, vlith = 8.6, ioper = 61.2 ma,
ipump = 25.5 ma, iext01 = 76.2 ma, iext23 = 65.1 ma

status = not logging

number of scans to average = 1
```

(Scans to average [NAvg=] must match *Scans to Average* in .con or .xmlcon file.)

```
samples = 0, free = 381300, casts = 0

mode = profile, minimum cond freq = 3000,
pump delay = 60 sec
```

(Mode [MP for profile or MM for moored] must match *Mode* in .con or .xmlcon file.)

```
autorun = no, ignore magnetic switch = no

battery type = ALKALINE, battery cutoff = 7.3 volts

pressure sensor = strain gauge, range = 1000.0
```

(Pressure sensor [PType=] must match *Pressure sensor type* in .con or .xmlcon file.)

```
SBE 38 = no, Gas Tension Device = no
```

(RS-232 sensors (which are used for custom applications only) must be disabled to use Seasave.)

```
Ext Volt 0 = yes, Ext Volt 1 = yes, Ext Volt 2 = yes,
Ext Volt 3 = yes
```

(Number of external voltage sensors enabled [Volt0= through Volt3=] must match *External voltage channels* in .con or .xmlcon file.)

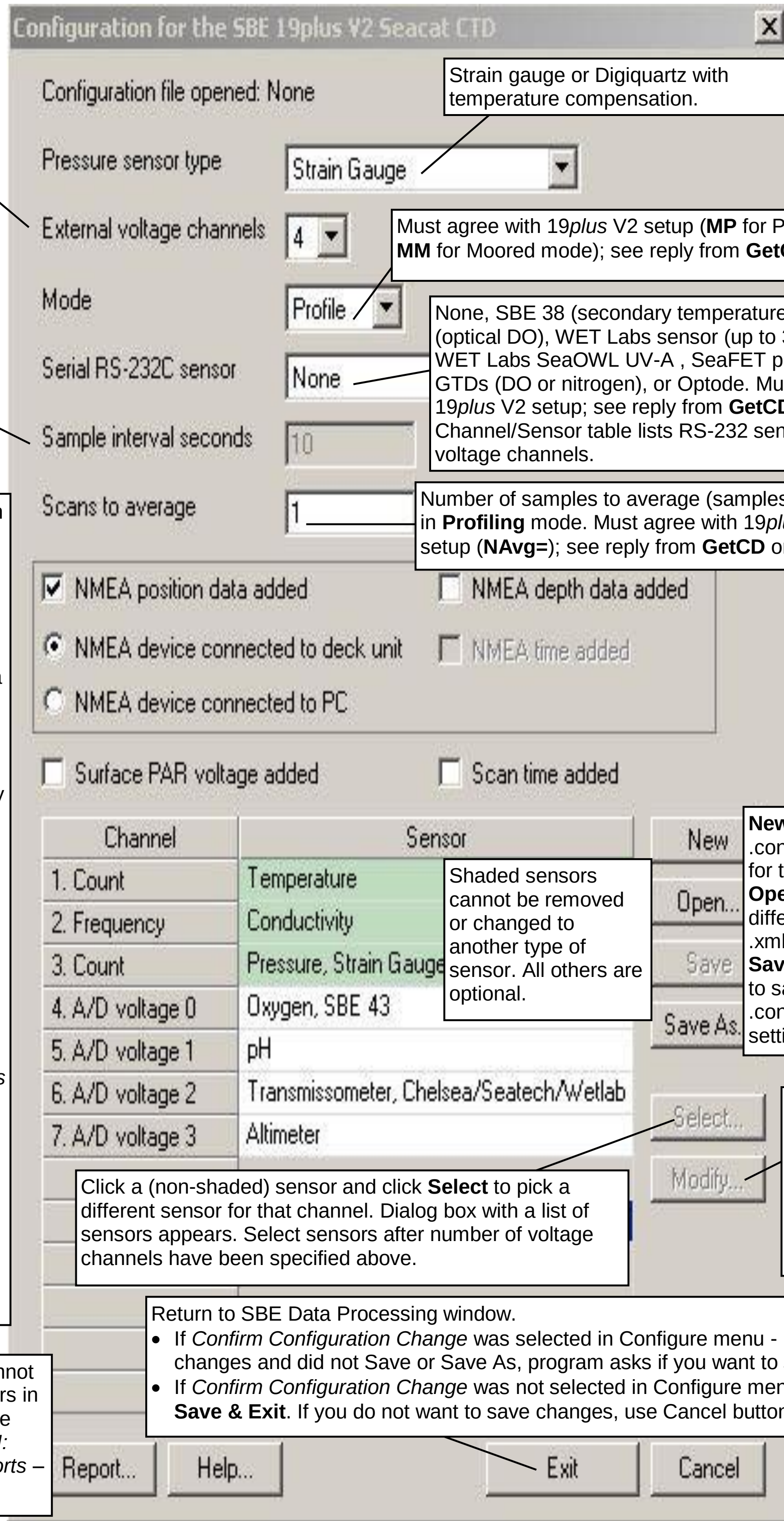
```
echo commands = yes

output format = raw Hex
```

(Output format must be set to raw Hex [OutputFormat=0] to acquire data in Seasave.)

Note:
Satlantic SeaFET pH sensor and Pro-Oceanus Gas Tension Devices can only be used when 19*plus* V2 is in Moored mode.

SBE 19*plus* V2 SeaCAT Profiler Configuration

Through the CTD's RS-232 sensor connector, the SBE 19*plus* V2 can interface with an SBE 38 secondary temperature sensor, SBE 63 Optical Dissolved oxygen sensor, WET Labs sensor [single, dual, or triple channel ECO; WETStar; or C-Star], WET Labs SeaOWL UV-A, Satlantic SeaFET pH sensor, Optode, **or** up to two Pro-Oceanus Gas Tension Devices (GTDs). This data is appended to the data stream; SBE 38 data does not replace the internal 19*plus* V2 temperature data.



Channel/Sensor table reflects this choice (0, 1, 2, 3, 4, 5, or 6). Must agree with 19*plus* V2 setup for **VoltN=** (N=0, 1, 2, 3, 4, and 5); see reply from **GetCD** or **DS**. Voltage channel 0 in .con or .xmlcon file corresponds to first external voltage in data stream, voltage channel 1 to second external voltage in data stream, etc.

Strain gauge or Digiquartz with temperature compensation.

Must agree with 19*plus* V2 setup (**MP** for Profiing mode, **MM** for Moored mode); see reply from **GetCD** or **DS**.

None, SBE 38 (secondary temperature), SBE 63 (optical DO), WET Labs sensor (up to 3 channels), WET Labs SeaOWL UV-A , SeaFET pH,up to 2 GTDs (DO or nitrogen), or Optode. Must agree with 19*plus* V2 setup; see reply from **GetCD** or **DS**. Channel/Sensor table lists RS-232 sensors below voltage channels.

Interval between scans in **Moored** mode. Must agree with 19*plus* V2 setup (**SampleInterval=**); see reply from **GetCD** or **DS**.

Number of samples to average (samples at 4 Hz) in **Profiling** mode. Must agree with 19*plus* V2 setup (**NAvg=**); see reply from **GetCD** or **DS**.

- **NMEA** - Select if NMEA navigation device used, and if NMEA depth data and NMEA time data were also appended. Seasave adds current latitude, longitude, and universal time code to data header; appends NMEA data to every scan; and writes NMEA data to .nav file every time Ctrl F7 is pressed or Add to .nav File is clicked.
  Note: Whether NMEA device was connected to a deck unit or directly to computer during data acquisition in Seasave has no effect on data file used by SBE Data Processing, and therefore has no effect on data processing.
- **Surface PAR** - Select if using with deck unit connected to Surface PAR sensor. Seasave appends Surface PAR data to every scan. 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* V2 from auxiliary sensors. See Application Note 47.
- **Scan time added** - Select if Seasave appended time (seconds since January 1, 1970 GMT) to each data scan.

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

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

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

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.

Return to SBE Data Processing window.
- If *Confirm Configuration Change* was selected in Configure menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Configuration Change* was not selected in Configure menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Opens a .txt file (for viewing only; cannot be modified) that shows all parameters in .con or .xmlcon file. For command line generation of report, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

Shown below is an example status (**DS**) response ***in a terminal program*** that corresponds to the setup shown in the Configuration dialog box above. Shown below the appropriate lines are the commands used in the terminal program to modify the setup of parameters critical to use of the 19*plus* V2 with Seasave and processing of data with SBE Data Processing, as well as any explanatory information.

```
SBE 19plus V 3.1.8 SERIAL NO. 4000 13 Apr 2016 14:02:13

vbatt = 9.6, vlith = 8.6, ioper = 61.2 ma,
ipump = 25.5 ma, iext01 = 76.2 ma, iext2345 = 65.1 ma

status = not logging

number of scans to average = 1
```

(Scans to average [NAvg=] must match *Scans to Average* in .con or .xmlcon file.)

```
samples = 0, free = 4386532, casts = 0

mode = profile, minimum cond freq = 3000,
pump delay = 60 sec
```

(Mode [MP for profile or MM for moored] must match *Mode* in .con or .xmlcon file.)

```
autorun = no, ignore magnetic switch = no

battery type = ALKALINE, battery cutoff = 7.5 volts

pressure sensor = strain gauge, range = 1000.0
```

(Pressure sensor [PType=] must match *Pressure sensor type* in .con or .xmlcon file.)

```
SBE 38 = no, WETLABS = no, OPTODE = no, SBE63 = no,
SeaFET = no, Gas Tension Device = no
```

(Selection/enabling of RS-232 sensors [SBE38=, WetLabs=, Optode=, SBE63=, SeaFET=, GTD=, DualGTD=] must match *Serial RS-232C sensor* in .con or .xmlcon file.)

```
Ext Volt 0 = yes, Ext Volt 1 = yes,
Ext Volt 2 = yes, Ext Volt 3 = yes,
Ext Volt 4 = no, Ext Volt 5 = no
```

(Number of external voltage sensors enabled [Volt0= through Volt3=] must match *External voltage channels* in .con or .xmlcon file.)

```
echo characters = yes

output format = raw Hex
```

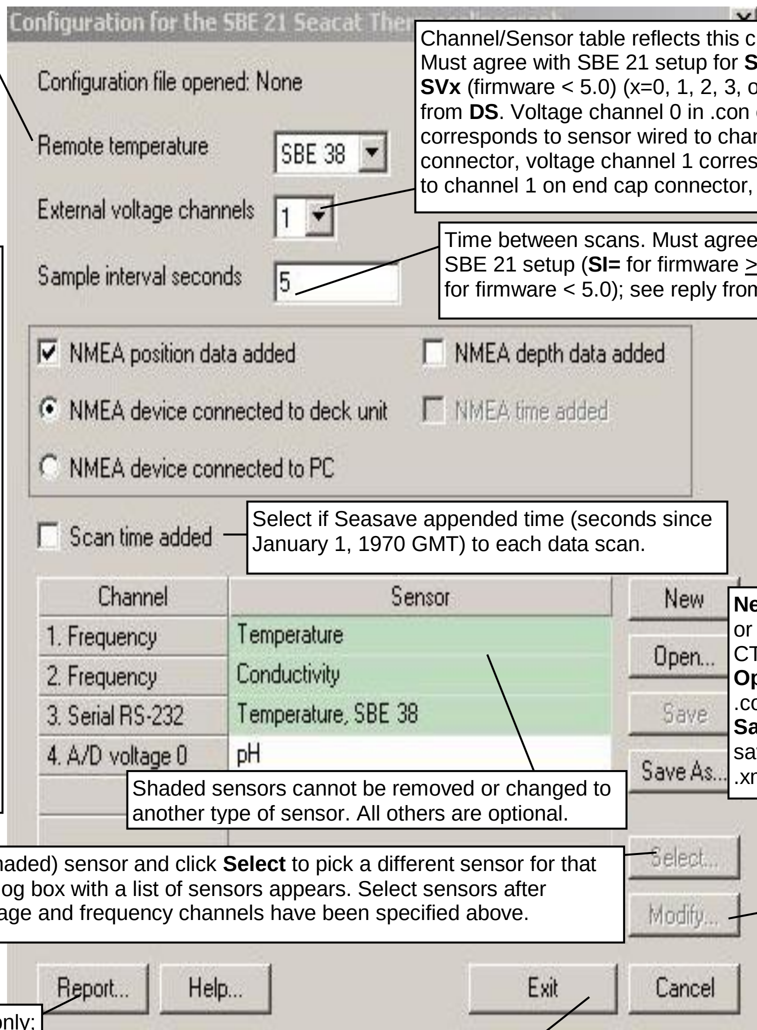
(Output format must be set to raw Hex [OutputFormat=0] to acquire data in Seasave.)

SBE 21 Thermosalinograph Configuration

In July 2009, Sea-Bird updated the SBE 21 electronics and firmware. As a result, there were some changes in capabilities and in commands.

- **Firmware version < 5.0** – Depending on serial number, these SBE 21s may be integrated with an SBE 38 remote temperature sensor (if SBE 21 equipped with 4-pin remote temperature connector) or an SBE 3 remote temperature sensor (if SBE 21 equipped with 3-pin remote temperature connector).
- **Firmware version $\geq$ 5.0** – These SBE 21s are compatible with an SBE 38 remote temperature sensor, and are **not** compatible with an SBE 3 remote temperature sensor.

Channel/Sensor table reflects this choice (shows RS-232 channel if SBE 38 selected, or additional frequency-based temperature channel if SBE 3 selected). Must agree with SBE 21 setup (**SBE38=** and **SBE3=**); see reply from **DS**. If remote temperature is selected, Seasave, Data Conversion, and Derive use remote temperature data when calculating density and sound velocity.



Channel/Sensor table reflects this choice. Must agree with SBE 21 setup for **SV=x** (firmware $\geq$ 5.0) or **SVx** (firmware < 5.0) (x=0, 1, 2, 3, or 4 channels); see reply from **DS**. Voltage channel 0 in .con or .xmlcon file corresponds to sensor wired to channel 0 on end cap connector, voltage channel 1 corresponds to sensor wired to channel 1 on end cap connector, etc.

Time between scans. Must agree with SBE 21 setup (**SI=** for firmware $\geq$ 5.0 or **SI** for firmware < 5.0); see reply from **DS**.

NMEA - Select if NMEA navigation device used, and if NMEA depth data and NMEA time data were also appended. Seasave adds current latitude, longitude, and universal time code to data header; appends NMEA data to every scan; and writes NMEA data to .nav file every time Ctrl F7 is pressed or Add to .nav File is clicked.
Note: NMEA time can only be appended if NMEA device connected to computer.
Note: Whether NMEA device was connected to a deck unit or directly to computer during data acquisition in Seasave has no effect on data file used by SBE Data Processing, and therefore has no effect on data processing.

Select if Seasave appended time (seconds since January 1, 1970 GMT) to each data scan.

New to create new .con or .xmlcon file for this CTD.
Open to select different .con or .xmlcon file.
Save or **Save As** to save current .con or .xmlcon 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 only; cannot be modified) that shows all parameters in .con or .xmlcon file. For command line generation of report, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

Return to SBE Data Processing window.
- If *Confirm Configuration Change* was selected in Configure menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Configuration Change* was not selected in Configure menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Shown below is an example status (**DS**) response ***in Seaterm*** that corresponds to the setup shown in the Configuration dialog box above.
Shown below the appropriate lines are the commands used in Seaterm to modify the setup of parameters critical to use of the SBE 21 with Seasave and processing of data with SBE Data Processing, as well as any explanatory information.

Note:
The status response shown is for an SBE 21 with firmware ≥ 5.0. The response, and the commands used to change the sample interval and the number of auxiliary voltage sensors, differs for older firmware.

```
SEACAT THERMOSALINOGRAPH V5.0 SERIAL NO. 4300 07/15/2009
14:23:14
```

```
ioper = 50.7 ma, vmain = 11.4, vlith = 8.8
```

```
samples = 0, free = 5981649
```

```
sample interval = 5 seconds, no. of volts sampled = 1
```

(Sample interval [SI=] must match *Sample interval seconds* in .con or .xmlcon file. Number of auxiliary voltage sensors enabled [SV=] must match *External voltage channels* in .con or .xmlcon file.)

```
sample external SBE 38 temperature sensor
```

(External temperature sensor [SBE38=] must match *Remote temperature* in .con or .xmlcon file, this line appears only if SBE 38 is enabled [**SBE38=Y**]**)**

```
output format = SBE21
```

(Output format must be set to SBE 21 [F1] to acquire data in Seasave.)

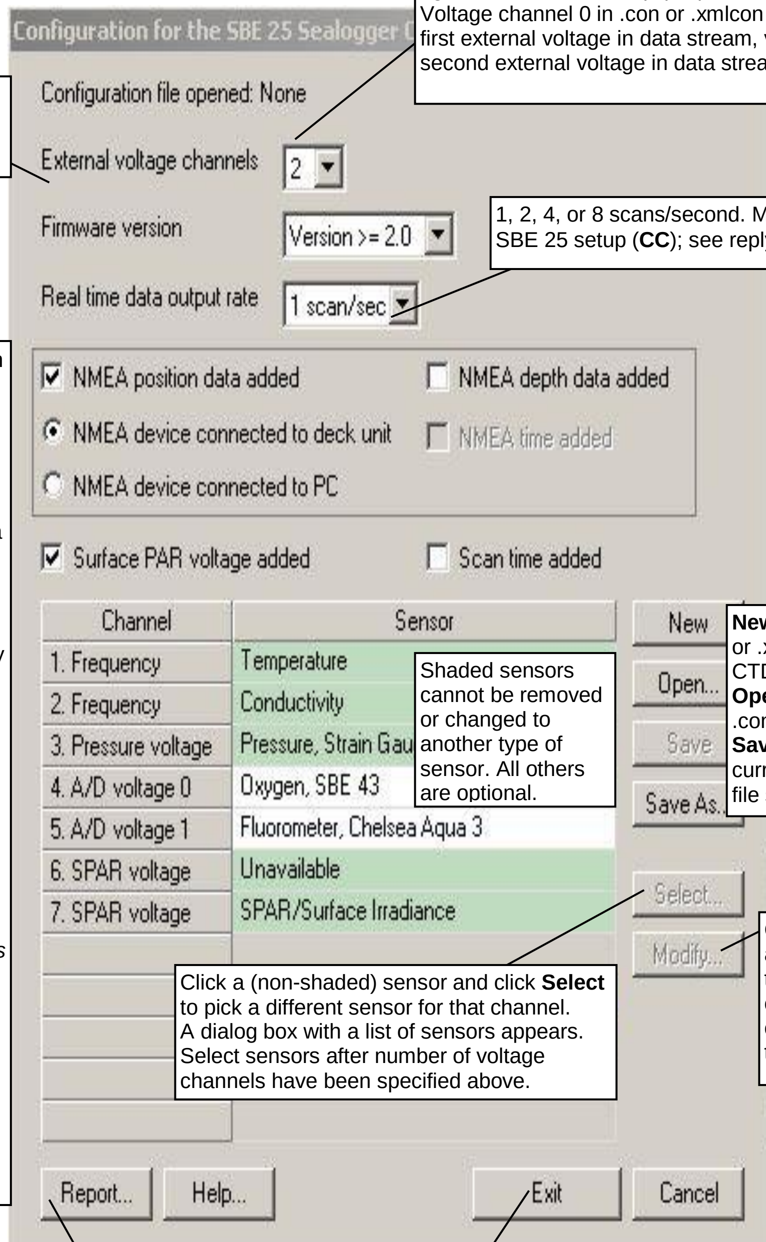
```
start sampling when power on = yes
```

```
average data during sample interval = yes
```

```
logging data = no
```

```
voltage cutoff = 7.5 volts
```

SBE 25 Sealogger Configuration



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

Used to determine strain gauge pressure sensor data format. See reply from **DS**.

1, 2, 4, or 8 scans/second. Must agree with SBE 25 setup (**CC**); see reply from **DS**.

- **NMEA** - Select if NMEA navigation device used, and if NMEA depth data and NMEA time data were also appended. Seasave adds current latitude, longitude, and universal time code to data header; appends NMEA data to every scan; and writes NMEA data to .nav file every time Ctrl F7 is pressed or Add to .nav File is clicked.
  Note: Whether NMEA device was connected to a deck unit or directly to computer during data acquisition in Seasave has no effect on data file used by SBE Data Processing, and therefore has no effect on data processing.
- **Surface PAR** - Select if using with deck unit connected to Surface PAR sensor. Seasave appends Surface PAR data to every scan. Adds 2 channels to Channel/Sensor table. Do not increase *External voltage channels* to reflect this; *External voltage channels* reflects only external voltages going directly to SBE 25 from auxiliary sensor See Application Note 47.
- **Scan time added** - Select if Seasave appended time (seconds since January 1, 1970 GMT) to each data scan.

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

New to create new .con or .xmlcon file for this CTD.
Open to select different .con or .xmlcon file.
Save or **Save As** to save current .con or .xmlcon 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 only; cannot be modified) that shows all parameters in .con or .xmlcon file.
For command line generation of report, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

Return to SBE Data Processing window.
- If *Confirm Configuration Change* was selected in Configure menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Configuration Change* was not selected in Configure menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Shown below is an example status (**DS**) response ***in Seaterm*** that corresponds to the setup shown in the Configuration dialog box above.
Shown below the appropriate lines are the commands used in Seaterm to modify the setup of parameters critical to use of the SBE 25 with Seasave and processing of data with SBE Data Processing, as well as any explanatory information.

```
SBE 25 CTD V 4.1a SN 323 04/26/02 14:02:13

external pressure sensor, range = 5076 psia, tcval = -55

xtal=9437363 clk=32767.107 vmain=10.1 iop=175 vlith=5.6

ncasts=0 samples=0 free = 54980 lwait = 0 msec

stop upcast when CTD ascends 30 % of full scale pressure
sensor range (2301 counts)

CTD configuration:

number of scans averaged=1, data stored at 8 scans
per second

real time data transmitted at 1 scans per second
```

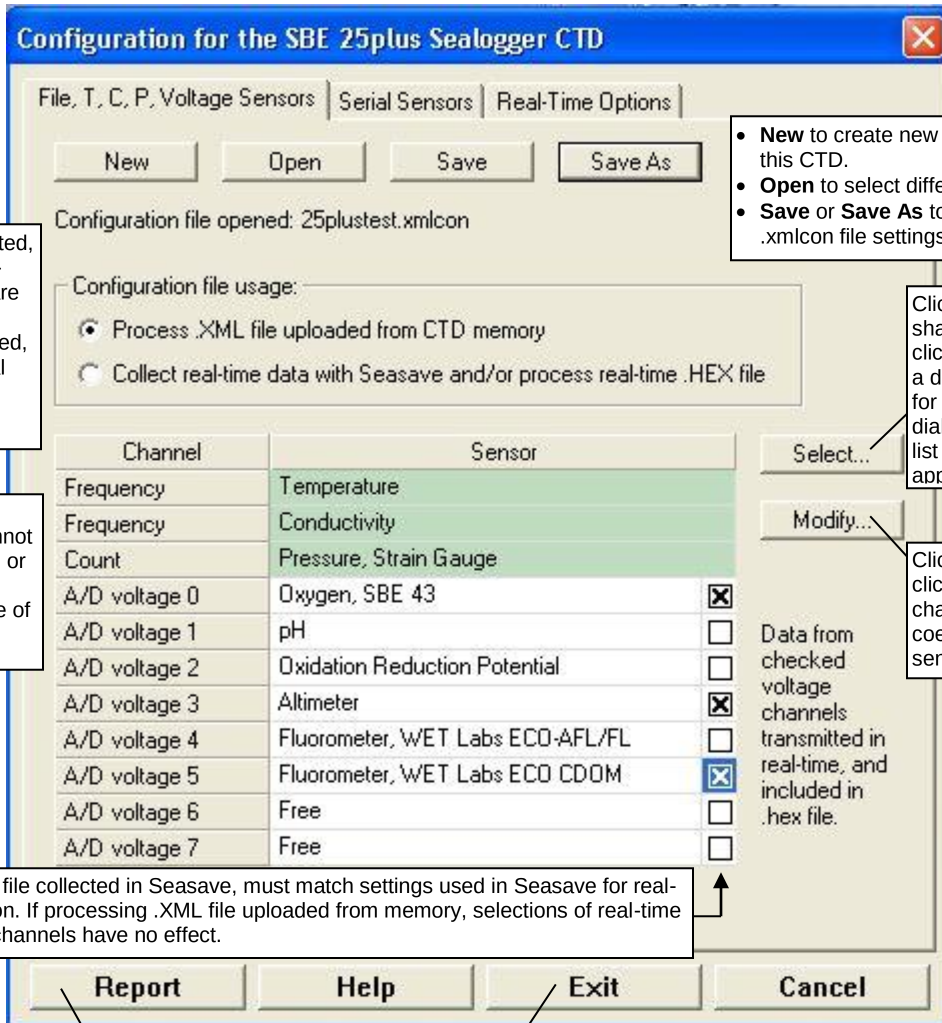
(real-time data transmission [CC] must match *Real time data output rate* in .con or .xmlcon file.)

```
minimum conductivity frequency for pump turn on = 2950

pump delay = 45 seconds

battery type = ALKALINE

2 external voltages sampled
```

(Number of auxiliary voltage sensors enabled [CC] must match *External voltage channels* in .con or .xmlcon file.)

```
stored voltage #0 = external voltage 0

stored voltage #1 = external voltage 1
```

SBE 25*plus* Sealogger Configuration



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

- **.XML file** – if selected, selections on Real-Time Options tab are grayed out.
- **.HEX file** - if selected, selections on Serial Sensors tab are grayed out.

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.

Shaded sensors cannot be removed or changed to another type of sensor.

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

If processing .HEX file collected in Seasave, must match settings used in Seasave for real-time data acquisition. If processing .XML file uploaded from memory, selections of real-time data from voltage channels have no effect.

Opens a .txt file (for viewing only; cannot be modified) that shows all parameters in .con or .xmlcon file.
For command line generation of report, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

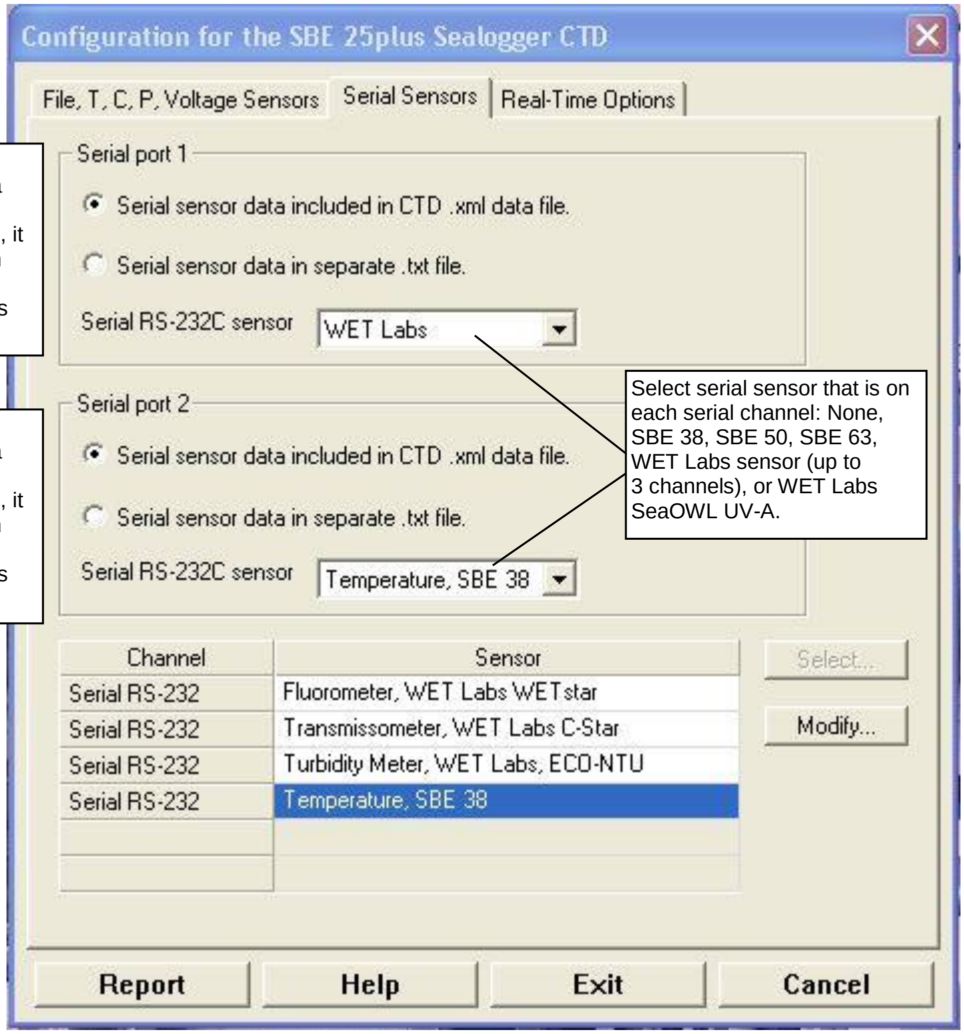
Return to SBE Data Processing window.
- If *Confirm Configuration Change* was selected in Configure menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Configuration Change* was not selected in Configure menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Note:
This tab is grayed out if you selected Collect real-time data with Seasave and/or process real-time .HEX file *on the first tab, because the 25*plus *does not transmit real-time serial sensor data.*

If you selected *Process .XML file uploaded from CTD memory*, click the Serial Sensors tab.

25*plus* collected serial sensor data if**SetEnableSer1=Y**. Serial sensor data was included in CTD .xml data file in memory if **SetInlineSer1=Y**. Otherwise, it was placed in a separate .txt file (which cannot be processed by SBE Data Processing); if in a .txt file, all selections are grayed out.

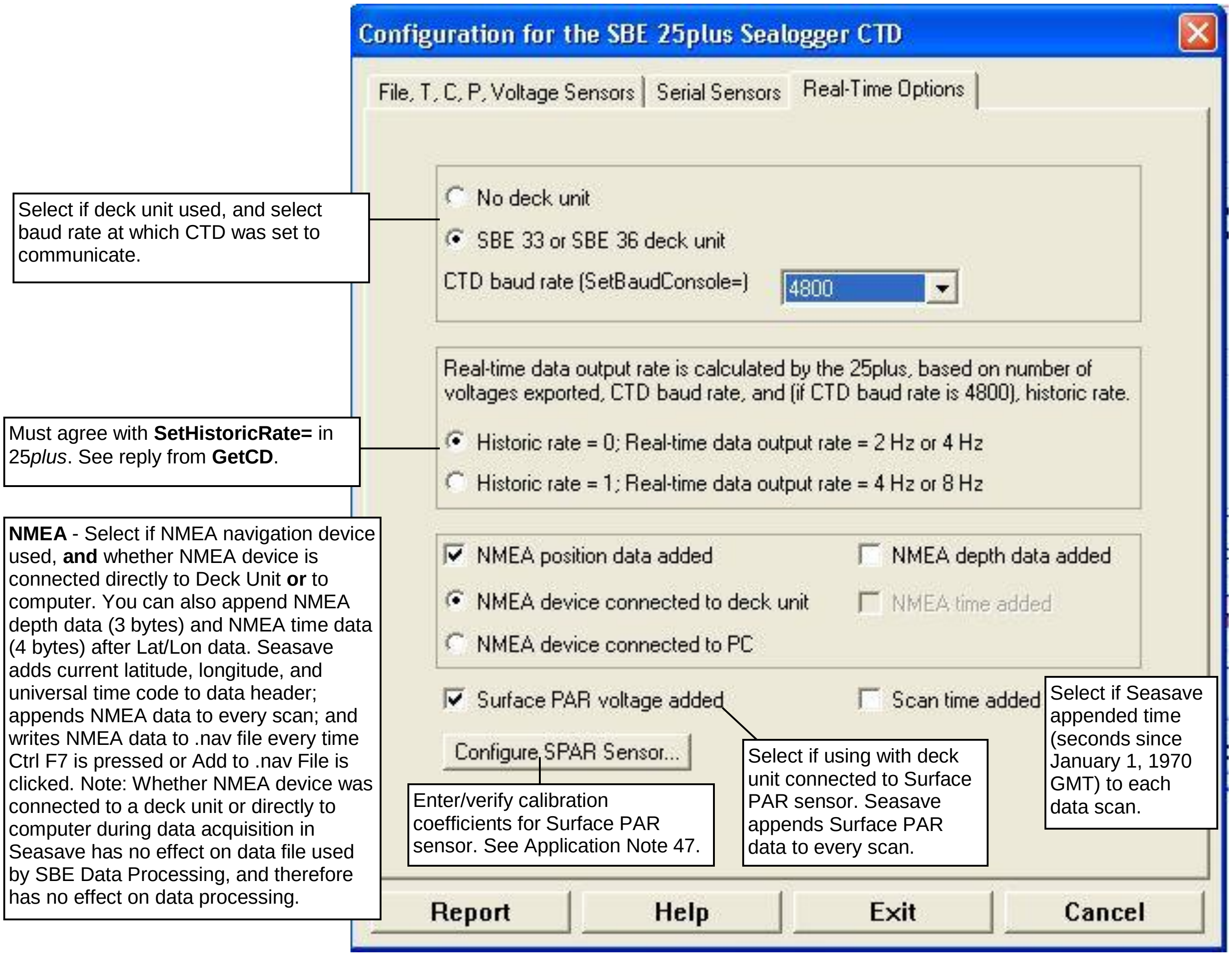
25*plus* collected serial sensor data if**SetEnableSer2=Y**. Serial sensor data was included in CTD .xml data file in memory if **SetInlineSer2=Y**. Otherwise, it was placed in a separate .txt file (which cannot be processed by SBE Data Processing); if in a .txt file, all selections are grayed out.



Select serial sensor that is on each serial channel: None, SBE 38, SBE 50, SBE 63, WET Labs sensor (up to 3 channels), or WET Labs SeaOWL UV-A.

Note:
This tab is grayed out if you selected Process .XML file uploaded from CTD memory *on the first tab, because data is memory is always saved at 16 Hz, and NMEA, Surface PAR, and scan time data is not available in an uploaded file.*

If you selected *Collect real-time data with Seasave and/or process real-time .HEX file*, click the Real-Time Options tab.



Shown below is an example status (**GetCD**) response ***in Seaterm232*** that corresponds to the setup shown in the Configuration dialog box above. Shown below the appropriate lines are the commands used in Seaterm 232 to modify the setup of parameters critical to use of the SBE 25*plus* with Seasave and processing of data with SBE Data Processing, as well as any explanatory information.

```
S>getcd
<ConfigurationData DeviceType='SBE25plus' SerialNumber='0250003'>
   <Serial>
      <SerialPort0>
         <baudconsole>4800</baudconsole>
         <echoconsole>1</echoconsole>
         </SerialPort0>
      <SerialPort1>
(serial sensor 1 setup data)
         </SerialPort1>
      <SerialPort2>
(serial sensor 2 setup data)
         </SerialPort2>
      </Serial>
   <Settings>
(assorted settings)
      </Settings>
   <RealTimeOutput>
      <outputformat>0</outputformat>
      <historicrate>1</historicrate>
      <vout0>1</vout0>
      <vout1>0</vout1>
      <vout2>0</vout2>
      <vout3>1</vout3>
      <vout4>0</vout4>
      <vout5>1</vout5>
      <vout6>0</vout6>
      <vout7>0</vout7>
      <outputrate>2</outputrate>
      </RealTimeOutput>
   </ConfigurationData>
<Executed/>
```

(Number of auxiliary voltage sensors enabled [SetVOut#=] must match real-time output selection in .xmlcon file.)

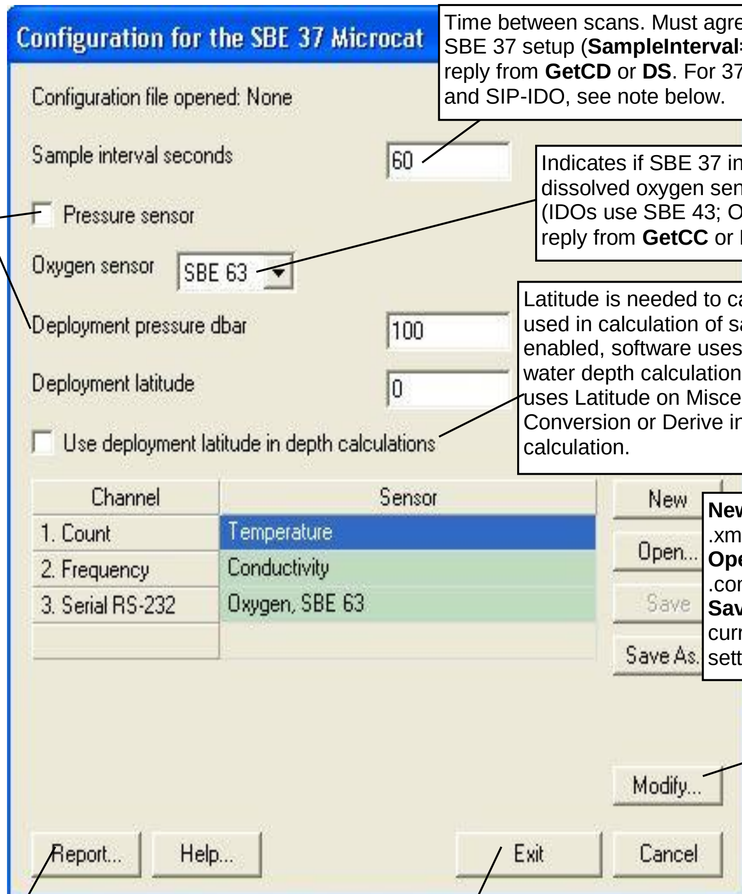
Notes:
- The SBE 37 is available with an RS-232, Inductive Modem (IM series), or RS-485 interface. All commands to a particular 37 with IM or RS-485 interface are preceded by **#ii**, where ii = instrument ID (0-99). Therefore, commands mentioned in the dialog box description below have a slightly different form for these versions (**#iiGetCD**, **#iiDS**, **#iiDC**, etc.).
- Commands shown here are for the current SBE 37 firmware versions. See the appropriate SBE 37 manual for commands for your instrument.

SBE 37 MicroCAT C-T Recorder Configuration

The .xmlcon file for the SBE 37 is created by SeatermV2 (version 1.1 and later) when you upload data from the SBE 37. Note that you cannot save the SBE 37 configuration as a .con file.

Indicates if SBE 37 includes optional pressure sensor. Must agree with factory setup; see reply from **DC** (display calibration coefficients); if pressure sensor is included, response includes pressure sensor coefficients. If no pressure sensor included, additional field for deployment pressure is used to calculate conductivity (and derived variables such as salinity and sound velocity). Value shown is based on **ReferencePressure=** that was programmed into SBE 37; **you can change this value in .xmlcon file, if you have updated deployment depth information**.

Time between scans. Must agree with SBE 37 setup (**SampleInterval=**); see reply from **GetCD** or **DS**. For 37-SI, SIP, and SIP-IDO, see note below.



Indicates if SBE 37 includes integrated dissolved oxygen sensor and type of sensor (IDOs use SBE 43; ODOs use SBE 63); see reply from **GetCC** or **DS**.

Latitude is needed to calculate local gravity, used in calculation of salt water depth. If enabled, software uses input latitude in salt water depth calculation. If disabled, software uses Latitude on Miscellaneous tab of Data Conversion or Derive in salt water depth calculation.

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

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

Opens a .txt file (for viewing only; cannot be modified) that shows all parameters in .con or .xmlcon file. For command line generation of report, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

Return to SBE Data Processing window.
- If *Confirm Configuration Change* was selected in Configure menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Configuration Change* was not selected in Configure menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Note:
For 37-SI, SIP: Sample interval seconds in the .xmlcon file is based on:
- If **SampleMode=2**: **SampleInterval=**
- If **SampleMode=3**:
  Firmware < 4.0 - 1 sec if SBE 37 has no pressure sensor, 1.5 sec if SBE 37 has pressure sensor
  Firmware ≥ 4.0 – 0.9 sec if SBE 37 has no pressure sensor, 1.3 sec if SBE 37 has pressure sensor

Shown below is an example status (**DS**) response ***in a terminal program*** for a SBE 37-SMP-IDO with standard RS-232 interface that corresponds to the setup shown in the Configuration dialog box above. Shown below the appropriate lines are the commands used in the terminal program to modify the setup of parameters critical processing of to SBE 37-SMP-IDO data with SBE Data Processing, as well as any explanatory information.

```
SBE37SMP-ODO-232 1.0  SERIAL NO. 12345  20 Sep 2012 00:48:50
```
('IDO' indicates MicroCAT includes integrated oxygen sensor; must match *oxygen sensor* enable/disable in .xmlcon file.)
```
vMain =  13.31, vLith =  3.19
samplenumber = 1728, free = 522560
not logging, stop command
sample interval = 60 seconds
```
(Sample interval [SampleInterval=] must match *Sample interval seconds* in .xmlcon file.)
```
data format = converted engineering
transmit real-time data = yes
sync mode = no
minimum conductivity frequency = 3000.0
adaptive pump control enabled
```

If no pressure sensor is installed, a line in the **DS** response provides user-input reference pressure information; if the pressure sensor is installed, that line is missing (as shown in the above example response). This must match the *pressure sensor* enable/disable in the .xmlcon file.

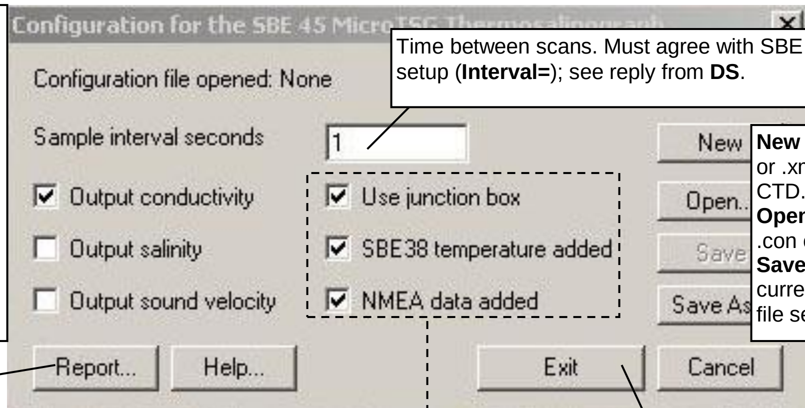
SBE 45 MicroTSG Configuration

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

Define data in SBE 45 data stream:

- **Output conductivity** - Must agree with SBE 45 setup (**OutputCond=**).
- **Output salinity** – Must agree with SBE 45 setup (**OutputSal=**).
- **Output sound velocity** – Must agree with SBE 45 setup (**OutputSV=**).

See reply from **DS** for setup programmed into SBE 45.



Time between scans. Must agree with SBE 45 setup (**Interval=**); see reply from **DS**.

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

Opens a .txt file (for viewing only; cannot be modified) that shows all parameters in .con or .xmlcon file. For command line generation of report, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

- **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. Seasave appends SBE 38 data to data stream. Seasave, Data Conversion, and Derive use remote temperature data when calculating density and sound velocity.
- **NMEA data added** - Select if 90402 – SBE 45 Interface Box is connected to NMEA navigation device. Seasave adds current latitude, longitude, and universal time code to data header; appends NMEA data to every scan; and writes NMEA data to .nav file every time Ctrl F7 is pressed or Add to .nav File is clicked.

Return to SBE Data Processing window.

- If *Confirm Configuration Change* was selected in Configure menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Configuration Change* was not selected in Configure menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Shown below is an example status (**DS**) response ***in Seaterm*** that corresponds to the setup shown in the Configuration dialog box above.
Shown below the appropriate lines are the commands used in Seaterm to modify the setup of parameters critical to use of the SBE 45 with Seasave and processing of data with SBE Data Processing, as well as any explanatory information.

```
SBE45 V 1.1 SERIAL NO. 1258
```

```
logging data
```

```
sample interval = 1 seconds
```

(Sample interval [Interval=] must match *Sample interval seconds* in .con or .xmlcon file.)

```
output conductivity with each sample
```

(Enabling of conductivity output [OutputCond=] must match *Output conductivity* in .con or .xmlcon file.)

```
do not output salinity with each sample
```

(Enabling of salinity output [OutputSal=] must match *Output salinity* in .con or .xmlcon file.)

```
do not output sound velocity with each sample
```

(Enabling of sound velocity output [OutputSV=] must match *Output sound velocity* in .con or .xmlcon file.)

```
start sampling when power on
```

```
do not power off after taking a single sample
```

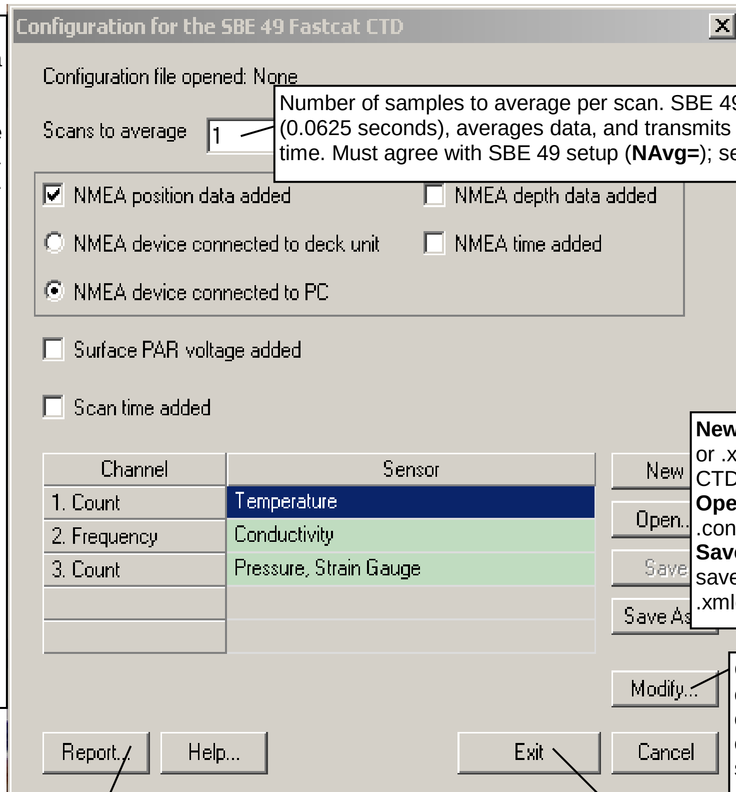
(Power off after taking a single sample must be disabled [SingleSample=N] to acquire data in Seasave.)

```
do not power off after two minutes of inactivity
```

```
A/D cycles to average = 2
```

SBE 49 FastCAT Configuration

- **NMEA** - Select if NMEA navigation device used, and if NMEA depth data and NMEA time data were also appended. Seasave adds current latitude, longitude, and universal time code to data header; appends NMEA data to every scan; and writes NMEA data to .nav file every time Ctrl F7 is pressed or Add to .nav File is clicked.
  Note: Whether NMEA device was connected to a deck unit or directly to computer during data acquisition in Seasave has no effect on data file used by SBE Data Processing, and therefore has no effect on data processing.
- **Surface PAR** - Select if used with deck unit connected to Surface PAR sensor. Seasave appends Surface PAR data to every scan. Adds 2 channels to Channel/Sensor table. See Application Note 47.
- **Scan time** - Select if Seasave appended time (seconds since January 1, 1970 GMT) to each data scan.



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 SBE 49 setup (**NAvg=**); see reply from **DS**.

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

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

Opens a .txt file (for viewing only; cannot be modified) that shows all parameters in .con or .xmlcon file. For command line generation of report, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

Return to SBE Data Processing window.
- If *Confirm Configuration Change* was selected in Configure menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Configuration Change* was not selected in Configure menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Shown below is an example status (**DS**) response ***in Seaterm*** that corresponds to the setup shown in the Configuration dialog box above.
Shown below the appropriate lines are the commands used in Seaterm to modify the setup of parameters critical to use of the SBE 49 with Seasave and processing of data with SBE Data Processing, as well as any explanatory information.

```
SBE 49 FastCAT V 1.2 SERIAL NO. 0055
```

```
number of scans to average = 1
```
(Scans to average [NAvg=] must match *Scans to average* in .con or .xmlcon file.)

```
pressure sensor = strain gauge, range = 1000.0
```

```
minimum cond freq = 3000, pump delay = 30 sec
```

```
start sampling on power up = yes
```

```
output format = raw HEX
```
(Output format must be set to raw Hex [OutputFormat=0] to acquire data in Seasave.)

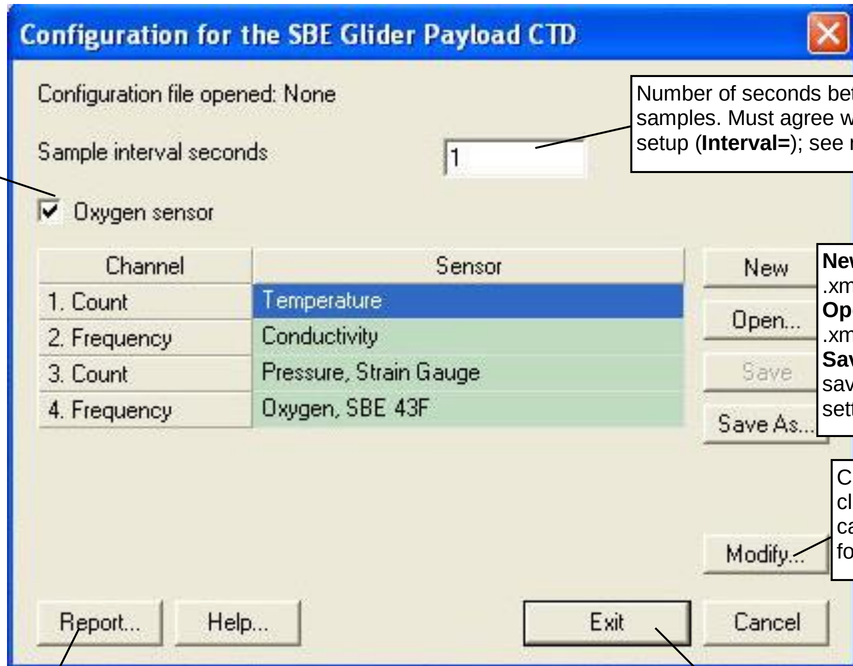
```
temperature advance = 0.0625 seconds
```

```
celltm alpha = 0.03
```

```
celltm tau = 7.0
```

```
real-time temperature and conductivity correction disabled
```

SBE Glider Payload CTD Configuration



Select if GPCTD is integrated with optional SBE 43F Dissolved Oxygen sensor. Must agree with GPCTD setup (**OxygenInstalled=**); see reply from **DS**.

Number of seconds between samples. Must agree with GPCTD setup (**Interval=**); see reply from **DS**.

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

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

Opens a .txt file (for viewing only; cannot be modified) that shows all parameters in .con or .xmlcon file. For command line generation of report, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

Return to SBE Data Processing window.

- If *Confirm Configuration Change* was selected in Configure menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Configuration Change* was not selected in Configure menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Shown below is an example status (**DS**) response ***in Seaterm232*** that corresponds to the setup shown in the Configuration dialog box above. Shown below the appropriate lines are the commands used in Seaterm232 to modify the setup of parameters critical to processing of Glider Payload CTD data with SBE Data Processing, as well as any explanatory information.

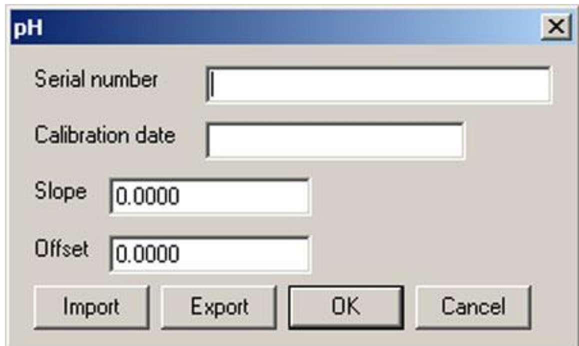
```
SBE Glider Payload CTD 1.0  SERIAL NO. 12345  27 Apr 2010 09:38:22
vMain =  9.37, vLith =  3.04
autorun = no
samplenumber = 57, free = 559183, profiles = 3
not logging
sample every 1 seconds
```
(must match *Sample interval seconds* in .xmlcon file.)

```
sample mode is continuous
data format = raw Decimal
do not force on RS232 transmitter
transmit real time data
acquire SBE 43 oxygen
```
(must match *Oxygen sensor installed* in .xmlcon file.)

```
minimum conductivity frequency = 3011.0
custom pump mode disabled
```

Accessing Calibration Coefficients Dialog Boxes

1. In the Configure menu, select the desired instrument.
2. In the Configuration dialog box, click Open. Browse to the desired .con or .xmlcon file and click Open.
3. In the Configuration dialog box, click a sensor and click **Modify** to change the calibration coefficients for that sensor (or right click on the sensor and select *Modify . . Calibration*, or double click on the sensor); the calibration coefficients dialog box for the sensor appears (example is shown for a pH sensor).



Importing and Exporting Calibration Coefficients

Calibration coefficient dialog boxes contain Import and Export buttons, which can be used to simplify entering calibration coefficients. These buttons are particularly useful when swapping sensors from one instrument to another, allowing you to enter calibration coefficients without the need for typing or the resulting possibility of typographical errors. An example dialog box is shown above for a pH sensor.

The **Export** button allows you to export coefficients for the selected sensor to an .XML file. If you move that sensor onto another instrument, you can then import the coefficients from the .XML file when setting up the .con or .xmlcon configuration file for that instrument.

The **Import** button allows you to import coefficients for the selected sensor from another .con or .xmlcon file or from an .XML file. When you click the Import button, a dialog box appears. Select the desired file type, and then browse to and select the file:

- **.con or .xmlcon configuration file** – opens a .con or .xmlcon file, retrieves the calibration coefficients from the file for the type of sensor you selected, and enters the coefficients in the calibration coefficients dialog box. If the .con or .xmlcon file contains more than one of that type of sensor (for example, SBE Data Processing can process data for an instrument interfacing with up to two SBE 43 oxygen sensors, so the .con or .xmlcon file could contain coefficients for two SBE 43 sensors), a dialog box allows you to select the desired sensor by serial number. If the .con or .xmlcon file does not contain any of that type of sensor, SBE Data Processing responds with an error message.
- **.XML file** – imports an .XML file that contains calibration coefficients for one sensor. If the .XML file you select is not compatible with the selected sensor type, SBE Data Processing responds with an error message.

Calibration Coefficients for Frequency Sensors

View and/or modify the sensor calibration coefficients by selecting the sensor and clicking the Modify button in the instrument Configuration dialog box. 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 in the SBE 16*plus* (and -IM), 16*plus* (and -IM) V2, 19*plus*, 19*plus* V2, 37, 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

Note:
See Application Note 94 for information on wide-range calibrations.

A wide-range conductivity sensor has been modified to provide conductivity readings over a wider range 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 documentation includes the equation as well as the cell constant and series resistance to be entered in the program.

If the conductivity sensor serial number on the conductivity calibration sheet includes a **w** (an indication that it is a wide-range sensor; for example, 4216**w**):

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 instrument's documentation) 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* (and -IM), 16*plus* (and -IM) V2, 19*plus*, 19*plus* V2, 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.

Oxygen (SBE 43I) Calibration Coefficients

The SBE 43I is the Integrated Dissolved Oxygen sensor used on the SBE 37 (37-SMP-IDO, 37-IMP-IDO, and 37-SIP-IDO). The calibration coefficients for this sensor are as described for the SBE 43 voltage sensor (see *Calculation Coefficients for Voltage Sensors* below).

Bottles Closed (HB - IOW) Calibration Coefficients

No calibration coefficients are entered for this parameter.
The number of bottles closed is calculated by Data Conversion 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

View and/or modify the sensor calibration coefficients by selecting the sensor and clicking the Modify button in the instrument Configuration dialog box. 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* (and -IM), 16*plus* (and-IM) V2, 19*plus*, 19*plus* V2, 37, 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 -IM), 16*plus* (and IM) V2, 19*plus*, and 19*plus* V2 configured with a strain gauge pressure sensor, and for all SBE 37s and 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

Note:
Unless noted otherwise, SBE Data Processing supports only one of each auxiliary sensor model on a CTD (for example, you cannot specify two Chelsea Minitracka fluorometers, but you can specify a Chelsea Minitracka and a Chelsea UV Aquatracka fluorometer. See the sensor descriptions below for those sensors that SBE Data Processing supports in a redundant configuration (two or more of the same model interfacing with the CTD).

View and/or modify the sensor calibration coefficients by selecting the sensor and clicking the Modify button in the instrument Configuration dialog box. 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* (and -IM), 16*plus* (and -IM) V2, 19*plus*, 19*plus* V2, 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:
In Seasave, enter the altimeter alarm set point, alarm hysteresis, and minimum pressure to enable alarm.

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 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: SBE Data Processing can process data for an instrument interfacing with up to two Chelsea Aqua 3 fluorometers.

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, from water sample = 0.450
Sample 2 Concentration–
from SBE Data Processing = 0.028, from water sample = 0.020
Linear regression to this data yields slope = 1.188 and offset = - 0.013

Note:
See Application Note 61 for 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

- **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: SBE Data Processing can process data for an instrument interfacing with up to two Chelsea UV Aquatracka fluorometers.

- **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 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: SBE Data Processing can process data for an instrument interfacing with up to two Seapoint fluorometers.

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

Note:
See Application Note 77 for calculation of Seapoint ultraviolet fluorometer calibration coefficients.

- **Seapoint Ultraviolet**
  Enter range and offset.
  Concentration = (V * range / 5) + offset
  Note: SBE Data Processing can process data for an instrument interfacing with up to two Seapoint ultraviolet fluorometers.

Notes:
- See Application Note 9 for 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.

- **Sea Tech and WET Labs Flash Lamp Fluorometer (FLF)**
  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 one for the range voltage. 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 74 for calculation of Turner Cyclops fluorometer calibration coefficients.

- **Turner Cyclops**
  Enter scale factor and offset, and select measured parameter (chlorophyll, rhodamine, fluorescein, .phycocyanin, phycoerythrin, CDOM, crude oil, optical brighteners, or turbidity)
  concentration = (scale factor * voltage) + offset
  where
  scale factor = range / 5 volts
  offset = - scale factor * blank voltage
  Range and blank voltage are from calibration sheet.
  Output units are dependent on selected measured parameter.
  Note: SBE Data Processing can process data for an instrument interfacing with up to seven Turner Cyclops fluorometers.

Notes:
- To *enable* entry of the mx, my, and b coefficients, you must first select the Turner SCUFA (OBS/Nephelometer/Turbidity).
- See Application Note 63 for calculation of Turner SCUFA calibration coefficients.

- **Turner SCUFA**
  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: SBE Data Processing can process data for an instrument interfacing with up to two Turner SCUFA sensors.

- **WET Labs AC3**
  This sensor requires two channels - one for fluorometer voltage (listed under fluorometers in the dialog box) and one for transmissometer voltage (listed under transmissometers). 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:
- Units are dependent on the substance measured by the fluorometer. For example, units are µg/l for chlorophyll, ppb for Rhodamine, ppt for Phycocyanin, etc.
- See Application Note 62 for calculation of ECO-AFL/ -FL calibration coefficients.
- For ECO-FL-NTU, a second channel is required for turbidity. Set up the second channel as a WET Labs ECO-NTU, as described below for OBS/Nephelometer/Turbidity sensors.

- **WET Labs ECO-AFL and ECO-FL**
  Enter Dark Output and scale factor.
  Concentration (units) = (V – Dark Output) * scale factor
  where
  V = in situ voltage output
  Dark Output = clean water voltage output with black tape on detector
  Scale factor = multiplier (units/Volt)
  The calibration sheet lists either:
  - Dark Output and scale factor, **OR**
  - Vblank (old terminology for Dark Output) and Scale Factor, **OR**
  - Vblank (old terminology for Dark Output) 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: SBE Data Processing can process data for an instrument interfacing with up to six ECO-AFL (or ECO-FL) sensors.

- **WET Labs ECO CDOM (Colored Dissolved Organic Matter)**
  Enter Dark Output and scale factor.
  Concentration (ppb) = (V – Dark Output) * Scale Factor
  where
  V = in situ voltage output
  Dark Output = clean water voltage output with black tape on detector
  Scale Factor = multiplier (ppb/Volt)
  Calibration sheet lists Dark Output and Vcdom (voltage output measured with known concentration of colored dissolved organic matter). Determine an initial scale factor value by using colored dissolved organic matter concentration corresponding to Vcdom:
  scale factor = cdom concentration / (Vcdom – Dark Output)
  Perform calibrations using seawater with CDOM types similar to what is expected in situ.
  Note: SBE Data Processing can process data for an instrument interfacing with up to six ECO CDOM sensors.

Notes:
- Units are dependent on the substance measured by the fluorometer. For example, units are µg/l for chlorophyll, ppb for Rhodamine, ppt for Phycocyanin, etc.
- See Application Note 41 for calculation of WETStar calibration coefficients.

- **WET Labs WETStar**
  Enter Blank Output and Scale Factor.
  Concentration (units) = (V – Blank Output) * Scale Factor
  where
  V = in situ voltage output
  Blank Output = clean water blank voltage output
  Scale Factor = multiplier (units/Volt)
  The calibration sheet lists either:
  - Blank Output and Scale Factor, **OR**
  - Vblank (old terminology for Blank Output) and Scale Factor, **OR**
  - Vblank (old terminology for Blank Output) 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: SBE Data Processing can process data for an instrument interfacing with up to six WET Labs WETStar sensors.

Methane Sensor Calibration Coefficients

The **Franatech**(formerly Capsum) **METS** sensor requires two channels – one for methane concentration and oner for temperature measured by the sensor. 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 = temperature voltage Vm = methane concentration voltage

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

OBS/Nephelometer/Turbidity 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 calculation of OBS-3 calibration coefficients.

Note:
- See Application Note 81 for 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
  Note: SBE Data Processing can process data for an instrument interfacing with up to two OBS-3 sensors.

- **Downing & Associates [D & A] OBS-3+**
  Enter A0, A1, and A2.
  output = A0 + (A1 * V) + (A2 * V^2)
  where
  V = voltage from sensor (**milli**Volts)
  A0, A1, and A2 = calibration coefficients from D & A calibration sheet
  Note: SBE Data Processing 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 direct voltage and one for measured voltage. Select both when configuring the CTD.
  For the direct voltage channel, enter vm0, vd0, d0, and k.
  diffusion = [k * (vm – vm0) / (vd – vd0)] – d0
  where
  k = scale factor
  vm0 = measured voltage offset
  vd0 = direct voltage offset
  vm = measured voltage
  vd = direct voltage
  d0 = diffusion offset

Note:
See Application Note 48 for 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: SBE Data Processing can process data for an instrument interfacing with up to two Seapoint Turbidity sensors.

- **Seatech LS6000 and WET Labs LBSS**
  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):
  High Gain: 2.25, 7.5, 75, 225, 33; Low Gain: 7.5, 25, 250, 750, 100
  Note: SBE Data Processing can process data for an instrument interfacing with up to two Seatech LS6000 or WET Labs LBSS sensors.

Notes:
- To *enable* entry of the mx, my, and b coefficients for the SCUFA fluorometer, you must first select the Turner SCUFA (OBS/Nephelometer/Turbidity).
- See Application Note 63 for calculation of Turner SCUFA calibration coefficients.

- **Turner SCUFA**
  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: SBE Data Processing can process data for an instrument interfacing with up to two Turner SCUFA sensors.

Note:
See Application Note 87 for calculation of WET Labs ECO-BB calibration coefficients.

- **WET Labs ECO-BB**
  Enter Scale Factor and Dark Output.
  $\beta(\Theta c)$ [m^{-1} sr^{-1}]= (V – Dark Output) * Scale Factor
  where
  V = voltage from sensor
  Scale Factor and Dark Output are from calibration sheet.
  Note: SBE Data Processing can process data for an instrument interfacing with up to five WET Labs ECO-BB sensors.

Note:
See Application Note 62 for calculation of WET Labs ECO-NTU calibration coefficients.

- **WET Labs ECO-NTU**
  Enter scale factor and Dark Output.
  NTU = (V – Dark Output) * Scale Factor
  where
  V = voltage from sensor
  Scale Factor and Dark Output are from calibration sheet.
  Note: SBE Data Processing can process data for an instrument interfacing with up to five WET Labs ECO-NTU sensors.

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

Oxidation Reduction Potential (ORP) Calibration Coefficients

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

Notes:

- See Application Notes 13-1 and 13-3 for calibration coefficients for Beckman- or YSI-type sensors.
- See Application Notes 64 and 64-2 for SBE 43 calibration coefficients.
- The Tau correction ([tau(T,P) * δV/δt] in the SBE 43 or [tau * doc/dt] in the SBE 13 or 23) improves response of the measured signal in regions of large oxygen gradients. However, this term also amplifies residual noise in the signal (especially in deep water), and in some situations this negative consequence overshadows the gains in signal responsiveness. To perform this correction, select *Apply Tau correction* on Data Conversion's or Derive's Miscellaneous tab.
- If the Tau correction is enabled, oxygen computed by Seasave and Data Conversion differ from values computed by Derive. Both algorithms compute the derivative of the oxygen signal with respect to time, and require a user-input window size:
  - 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 centered window (equal number of points before and after scan) to compute the derivative.

  In Data Conversion or Derive, the window size is input on the Miscellaneous tab.
- A hysteresis correction can be applied in Data Conversion for the SBE 43. To perform this correction, select *Apply hysteresis correction* on Data Conversion's Miscellaneous tab. H1, H2, and H3 coefficients for hysteresis correction (entered in the .con or .xmlcon file) are available on calibration sheets for SBE 43s calibrated after October 2008.
- See *Calibration Coefficients for RS-232 Sensors* below for the SBE 63 Optical Dissolved Oxygen Sensor and Aanderaa Optode Oxygen sensor.

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 one for oxygen temperature (enter k and c). Select both when configuring the instrument. Note: SBE Data Processing can process data for an instrument interfacing with up to two Beckman- or YSI-type oxygen sensors.
- **IOW sensor** - These sensors require two channels - one for oxygen current (enter b0 and b1) and one for oxygen temperature (enter a0, a1, a2, and a3). 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)** - This sensor requires only one channel.
  In Spring of 2008, Sea-Bird began using a new equation, the *Sea-Bird* equation, for calibrating the SBE 43. Calibration sheets for SBE 43s calibrated after this date will only include coefficients for the *Sea-Bird* equation, but our software (Seasave-Win32, Seasave V7, and SBE Data Processing) supports both equations. **We recommend that you use the *Sea-Bird* equation for best results.**

  Sea-Bird: Enter Soc, Voffset, A, B, C, E, Tau20, D1, D2, H1, H2, and H3.
  OX =
  $Soc * [V + Voffset + tau(T,P) * \delta V/\delta t] * OxSOL(T,S) *$
  $1.0 + A*T + B*T^2 + C*T^3) * e^{(E*P / K)}$
  where
  - OX = dissolved oxygen concentration (ml/l)
  - T, P = measured temperature (ºC) and pressure (decibars) from CTD
  - S = calculated salinity from CTD (PSU)
  - V = temperature-compensated oxygen signal (volts)
  - Soc = linear scaling calibration coefficient
  - Voffset = voltage at zero oxygen signal
  - tau(T,P) = sensor time constant at temperature and pressure
  - tau20 = sensor time constant tau(T,P) at 20 C, 1 atmosphere, 0 PSU; slope term in calculation of tau(T,P)
  - D1, D2 = calibration terms used in calculation of tau(T,P)
  - δV/δt = time derivative of oxygen signal (volts/sec)
  - H1, H2, H3 = calibration terms used for hysteresis correction
  - K = absolute temperature (Kelvin)
  - Oxsol(T,S) = oxygen saturation (ml/l); a parameterization from Garcia and Gordon (1992)

  OR

  Owens-Millard: Enter Soc, Boc, Voffset, tcor, pcor, and tau.
  OX =
  [Soc*{(V+Voffset)+(tau* dV/dt)}+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)
  dV/dt = derivative of oxygen signal (volts/sec)
  Oxsat(T,S) = oxygen saturation (ml/l)

  Note: SBE Data Processing can process data for an instrument interfacing with up to two SBE 43 oxygen sensors.

PAR/Irradiance Calibration Coefficients

Notes:
- See Application Note 11General to convert units from μEinsteins/m^2 sec or μmol photons/m^2 sec (which are equivalent). **Conversion unit selection for all PAR sensors appears in the data file header, but it does not modify the calculated values**.
- See Application Notes 11QSP-L (Biospherical sensor with built-in log amplifier), 11QSP-PD (Biospherical sensor without built-in log amplifier), 11Licor, and 11Chelsea for calculation of calibration coefficients for those underwater PAR sensors.
- Selection of *Par / Irradiance, Biospherical / Licor* as the voltage sensor is also applicable to the Chelsea PAR sensor.
- See Application Note 11S (SBE 11*plus* Deck Unit) or 47 (SBE 33 or 36 Deck Unit) for calculation of calibration coefficients for Biospherical surface PAR sensors.
- See Application Note 96 for calculation of calibration coefficients for Satlantic underwater and surface PAR sensors.
- Surface PAR ratio multiplier is used in Corrected Irradiance (CPAR) calculation; see *Appendix V: Derived Parameter Formulas (EOS-80; Practical Salinity)*.

Underwater PAR Sensor

- **PAR/Irradiance, Biospherical/Licor**
  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;
  multiplier = 1.0 for units of μEinsteins/m^2 sec
  - **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 *in water* calibration constant (in units of μamps/1000 μmoles/m^2·sec) from Licor or Sea-Bird calibration sheet.
    M and B are taken from Sea-Bird calibration sheet.
  - **Chelsea PAR sensor**
    Calibration constant
    = 10^9 / 0.01
    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)

  Note: SBE Data Processing can process data for an instrument interfacing with up to two PAR/irradiance Biospherical/Licor sensors.

- **Satlantic Logarithmic PAR sensor**
  Enter a0, a1, and lm from Satlantic calibration sheet.
  PAR = multiplier * Im * $10^{(V - a0) / a1}$
  where multiplier = 1.0 for units of μmol photons/ m^2 sec.

Surface PAR Sensor

Select a **surface** PAR sensor by clicking *Surface PAR voltage added* in the Configure dialog box.

- ***Biospherical Surface PAR Sensor***
  Enter conversion factor and ratio multiplier.
- ***Satlantic Linear Surface PAR Sensor***
  Enter a0, a1, and Im from Satlantic calibration sheet. Enter conversion factor and ratio multiplier.
  PAR = conversion factor ***** Im * a1 (V − a0)
- ***Satlantic Logarithmic Surface PAR Sensor***
  Enter a0, a1, and Im from Satlantic calibration sheet. Enter conversion factor and ratio multiplier.
  PAR = conversion factor * Im * $10^{(V - a0) / a1}$

Particle Size Calibration Coefficients

The **Sequoia LISST-200X** sensor requires two channels – one for total concentration output and one for Sauter Mean Diameter (SMD) output. Select both when configuring the instrument.
Total Volume Concentration = 0.01 * $10^{(2.0 * V_C)}$ [ppm]
Sauter Mean Diameter = 200 * (V_D – 0.5) [microns]
where:
V_C = voltage from total volume concentration channel
V_D = voltage from mean diameter channel

The mean diameter and total concentration calculated from the LISST-200X analog output are approximations, provided for convenient real-time display. For full accuracy and detail, you must upload and process the digital data from the LISST-200X's memory (disconnect LISST-200X from CTD and connect it to computer; use Sequoia software to upload and process).

Notes:
- See Application Notes 18-1 and 18-2 for 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.
- For the Satlantic SeaFET, see *Calibration Coefficients for RS-232 Sensors*.

pH Calibration Coefficients

For the SBE 18, SBE 27, SBE 30, and AMT pH sensors, 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: SBE Data Processing can process data for an instrument interfacing with up to eight pressure/fgp sensors.

Suspended Sediment Calibration Coefficients

- **Sequoia LISST-25**
  The LISST-25 sensor requires two channels – one for scattering output and one for transmission output. 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.

- **Sequoia LISST-ABS**
  Enter Calibration factor.
  Concentration (mg/L) = calibration factor * $10^{2 \text{(Volts -1)}}$
  where
  The calibration factor can be set to 1.0 for *uncalibrated* concentration. Perform calibrations as described in Sequoia's user manual.

Transmissometer Calibration Coefficients

Note:
See Application Note 7 for calculation of M and B.

- **Sea Tech and Chelsea (Alphatracka)**
  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
  beam attenuation coefficient (c) = **-** (1/z) * ln (light transmission [decimal])
  where
  M = (Tw / [W0 – Y0]) (A0 – Y0) / (A1 – Y1) B = - M * Y1
  A0 = factory voltage output in **air** (manufacturer factory calibration)
  A1 = current (most recent) voltage output in **air**
  Y0 = factory **dark or zero** (blocked path) voltage (manufacturer factory calibration)
  Y1 = current (most recent) **dark or zero** (blocked path) voltage
  W0 = factory voltage output in pure **water** (manufacturer factory calibration)
  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 V, Y0 = 0.002 V, 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: SBE Data Processing can process data for an instrument interfacing with up to two transmissometers in any combination of Sea Tech and Chelsea Alphatracka,

- **WET Labs AC3**
  This sensor requires two channels - one for fluorometer voltage (listed under fluorometers in the dialog box) and one for transmissometer voltage (listed under transmissometers). 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

- **WET Labs C-Star**
  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
  beam attenuation coefficient (c) = **-** (1/z) * ln (light transmission [decimal])
  where
  M = (Tw / [W0 – Y0]) (A0 – Y0) / (A1 – Y1)   B = - M * Y1
  A0 = Vair = factory voltage output in **air** (manufacturer factory calibration)
  A1 = current (most recent) voltage output in **air**
  Y0 = Vd = factory **dark or zero** (blocked path) voltage (manufacturer factory calibration)
  Y1 = current (most recent) **dark or zero** (blocked path) voltage
  W0 = Vref = factory voltage output in pure **water** (manufacturer factory calibration)
  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) Vair = 4.743 V, Vd = 0.002 V, Vref = 4.565 V
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: SBE Data Processing can process data for an instrument interfacing with up to six WET Labs C-Stars.

User Exponential (for user-defined sensor) Calibration Coefficients

The user exponential 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. This equation is useful for an **exponential/logarithmic** relationship between output voltage and converted units.
Enter scaling factor and exponent factor.
Val = scaling factor * $10^{(\text{exponent factor} * V)}$
where:
V = voltage from sensor
Scaling and exponent factors = user-defined sensor exponential coefficients
If desired, enter the sensor name and sensor units. These will appear in the data file header.
Note: SBE Data Processing can process data for an instrument interfacing with up to three sensors defined with user exponential.

> ***Example***
> A manufacturer defines the output voltage V of their sensor as:
> $V = 0.5 * \log_{10}(100C)$, where C is the value in engineering units.
> Converting this to an exponential equation:
> $C = 0.01 * 10^{2V}$
> Set this equal to user exponential equation and calculate scaling and exponent factor.
> $0.01 * 10^{2V}$ = scaling factor * $10^{(\text{exponent factor} * V)}$
> scaling factor = 0.01 exponent factor = 2

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. This equation is useful for a **polynomial relationship** between output voltage and converted units.
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: SBE Data Processing can process data for an instrument interfacing with up to three sensors defined with user polynomials.

> ***Example***
> A manufacturer defines the output of their sensor as:
> 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]

Calibration Coefficients for RS-232 Sensors

Unless otherwise noted, SBE Data Processing supports only one of each auxiliary sensor model (for example, you cannot specify two Aanderaa Optodes).

Note:
The SBE 63 is compatible only with the SBE 16*plus* V2, 19*plus* V2, 25*plus*, and ODO MicroCATs (37-SMP-ODO, SIP-ODO, IMP-ODO). See the CTD manual for required setup for the SBE 63.

SBE 63 Optical Dissolved Oxygen Sensor Calibration Coefficients

The SBE 63 must be set up to output data in a format compatible with Sea-Bird CTDs (**SetFormat=1**). The SBE 63 manual lists the equation for calculating dissolved oxygen and the calibration coefficients (see the manual on our website). Enter the serial number, calibration date, and calibration coefficients.

Notes:
- The SBE 38 is compatible only with the SBE 16*plus* V2, 16*plus*-IM V2, 19*plus* V2, and 25*plus*.
- The SBE 50 is compatible only with the SBE 16*plus* V2, 16*plus*-IM V2, and 25*plus*.

See the CTD manual for required setup for the SBE 38 and SBE 50.

SBE 38 Temperature Sensor and SBE 50 Pressure Sensor Calibration Coefficients

The SBE 38 must be set up to output converted data (°C) when integrated with a CTD. The SBE 50 must be set up to output converted data (psia) when integrated with a CTD. Therefore, calibration coefficients are not required in SBE Data Processing; just enter the serial number and calibration date.
Note: SBE Data Processing can process data for an SBE 25*plus* interfacing with up to two SBE 38s or two SBE 50s.

Notes:
- WET Labs RS-232 sensors are compatible only with the SBE 16*plus* V2, 16*plus*-IM V2, 19*plus* V2, and 25*plus*. See the CTD manual for required setup for the WET Labs RS-232 sensor.
- **See below for WET Labs SeaOWL sensor.**

WET Labs Sensor Calibration Coefficients

If you select the WET Labs RS-232 sensor, SBE Data Processing adds three lines to the Channel/Sensor table. If integrating an ECO Triplet, select sensors for all three channels. If integrating a dual ECO sensor (such as the FLNTU), select sensors for the first two channels, and leave the third channel *Free*. If integrating a single sensor, select the sensor for the first channel, and leave the second and third channels *Free*.

The following WET Labs sensors are available as RS-232 output sensors:
- Fluorometers – ECO CDOM, ECO-AFL/FL, and WETStar
- Transmissometers – C-Star
- Turbidity Meters – ECO-BB and ECO NTU

These sensors are also available as voltage sensors; calibration coefficient information for these sensors is detailed above in *Calibration Coefficients for Voltage Sensors*. Values for the calibration coefficients are listed on the WET Labs calibration sheets in terms of both analog output (voltage) and digital output (counts); use the digital output values when calculating / entering calibration coefficients for the RS-232 sensors. SBE Data Processing calculates the converted sensor output based on the counts output (instead of the voltage output) by the sensor. For all sensors, enter the serial number, calibration date, and calibration coefficients.

Note: SBE Data Processing can process data for an SBE 25*plus* interfacing with up to two RS-232 WET Labs sensors.

WET Labs SeaOWL UVA Sensor Calibration Coefficients

Notes:
- WET Labs SeaOWL UV-A™ is compatible only with the SBE 16*plus* V2, 19*plus* V2, and 25*plus*. See the CTD manual for required setup for the WET Labs SeaOWL.
- **See above for other WET Labs RS-232 sensors.**

If you select the WET Labs SeaOWL UVA sensor, SBE Data Processing adds three lines to the Channel/Sensor table. Enter the serial number, calibration date, and calibration coefficients Dark Output and scale factor for each channel (chlorophyll fluorometer, turbidity meter, and FDOM fluorometer).

Concentration (units) = (V – Dark Output) * scale factor
where
V = in situ voltage output
Dark Output = clean water voltage output with black tape on detector
Scale factor = multiplier (units/count)

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. Perform calibrations using seawater with typical water sample (i.e., particles, phytoplankton populations, etc. that are similar to what is expected in situ).

Note: SBE Data Processing can process data for an SBE 25*plus* interfacing with up to two WET Labs SeaOWL sensors.

Satlantic SeaFET pH Sensor Calibration Coefficients

Notes:
- The SeaFET is compatible only with the SBE 16*plus* V2 and 19*plus* V2 (19*plus* V2 must be in Moored mode). See the CTD manual for required setup for the SeaFET.
- See the SeaFET manual for a discussion of which pH value, internal or external, to use.
- For the SBE 18, SBE 27, SBE 30, and AMT pH sensors, see *Calibration Coefficients for Voltage Sensors*.

If you select pH, SeaFET, SBE Data Processing adds two lines to the Channel/Sensor table. Enter the serial number, calibration date, and calibration coefficients slope and offset for each channel (internal reference electrode and external reference electrode).

$$pH_{int} = (V_{int} - k_{0i} - k_{2i}\,T) / S_{nernst}$$

$$pH_{ext} = [(V_{ext} - k_{0e} - k_{2e}\,T) / S_{nernst}] + \log(Cl_T) + 2\log(\gamma_{HCl}) - \log(1 + [S_T / Ks])$$

where
- V_{int} = internal reference electrode voltage output
- k_{2i} = internal reference electrode slope
- k_{0i} = internal reference electrode offset
- V_{ext} = external reference electrode voltage output
- k_{2e} = external reference electrode slope
- k_{0e} = external reference electrode offset
- T = temperature (K)
- t = temperature (C)
- S = salinity (psu)
- R = universal gas constant (R = 8.314 472(15) J K^{-1} mol^{-1})
- F = Faraday constant (F = 96485.3415 C mol^{-1})
- $S_{nernst} = R\,T \ln(10) / F$
- $S_T = (0.1400 / 96.062)(S / 1.80655)$
- $Cl_T = (0.99889 / 35.453)(S / 1.80655)$
- $A_{DH} = 0.00000343\,t^2 + 0.00067524\,t + 0.49172143$
- $I = 19.924\,S / (1000 - 1.005\,S)$
- $\text{Log}(\gamma_{HCl}) = -[A_{DH}(I^{1/2}) / (1 + 1.394\,I^{1/2})] + (0.08885 - 0.000111\,t)\,I$
- $Ks = (1 - 0.01055\,S)\,e^{x}$
- $x = -4276.1/T + 141.328 - 23.093\ln(T) + (-13856/T + 324.57 - 47.986\cdot\ln(T))\,I^{½} + (35474/T - 771.54 + 114.723\ln(T))\,I - (2698/T)\cdot I^{1.5} + (1776/T)\,I^{2}$

Notes:
- The GTD is compatible only with the SBE 16*plus* V2, 16*plus*-IM V2, and 19*plus* V2. See the CTD manual for required setup for the GTD.
- SBE Data Processing supports single or dual GTDs.

GTD Calibration Coefficients

The GTD must be set up to output converted data (millibars) when integrated with a CTD. Therefore, calibration coefficients are not required in SBE Data Processing; just enter the serial number and calibration date.

Notes:
- The Optode is compatible only with the SBE 16*plus* V2, 16*plus*-IM V2, and 19*plus* V2. See the CTD manual for required setup for the Optode.
- See *Calibration Coefficients for Voltage Sensors* above for voltage-output Oxygen sensors, including the SBE 43.

Aanderaa Oxygen Optode Calibration Coefficients

Enter the serial number, calibration date, and information required for salinity and depth corrections. The *internal salinity* must match the value you programmed into the Optode (the value is ignored if you do not enable the *Salinity correction*). If you enable *Salinity correction*, SBE Data Processing corrects the oxygen output from the Optode based on the actual salinity (calculated from the CTD data). If you enable *Depth correction*, SBE Data Processing corrects the oxygen output from the Optode based on the depth (calculated from the CTD data).

Section 5: Raw Data Conversion Modules

Module Name	Module Description
Data Conversion	Convert raw data from CTD (.hex, .dat, or .xml file) to engineering units, storing the converted data in .cnv file (all data) and/or .ros file (water bottle data). Note: .xml file conversion only applicable to SBE 25*plus*.
Bottle Summary	Summarize data from water sampler bottle .ros file, storing the results in .btl file.
Mark Scan	Create .bsr bottle scan range file from .mrk data file.

Data Conversion

Notes:
Algorithms used for calculation of derived parameters in Data Conversion, Derive, Sea Plot, SeaCalc III [EOS-80 (Practical Salinity) tab], and Seasave are identical, except as noted in *Appendix V: Derived Parameter Formulas (EOS-80; Practical Salinity)*, and are based on EOS-80 equations.

Data Conversion:

1. Converts raw data to engineering units from:
   - .dat file from SBE 911*plus*, acquired with Seasave versions < 6.0, or
   - .hex file from SBE 911*plus*, acquired with Seasave versions ≥ 7.0, or
   - hex file from other CTDs, acquired with any version of Seasave or by uploading data from memory (if applicable), or
   - .xml file uploaded from SBE 25*plus*.

2. Stores the converted data in a .cnv file and (optional) .ros file.

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

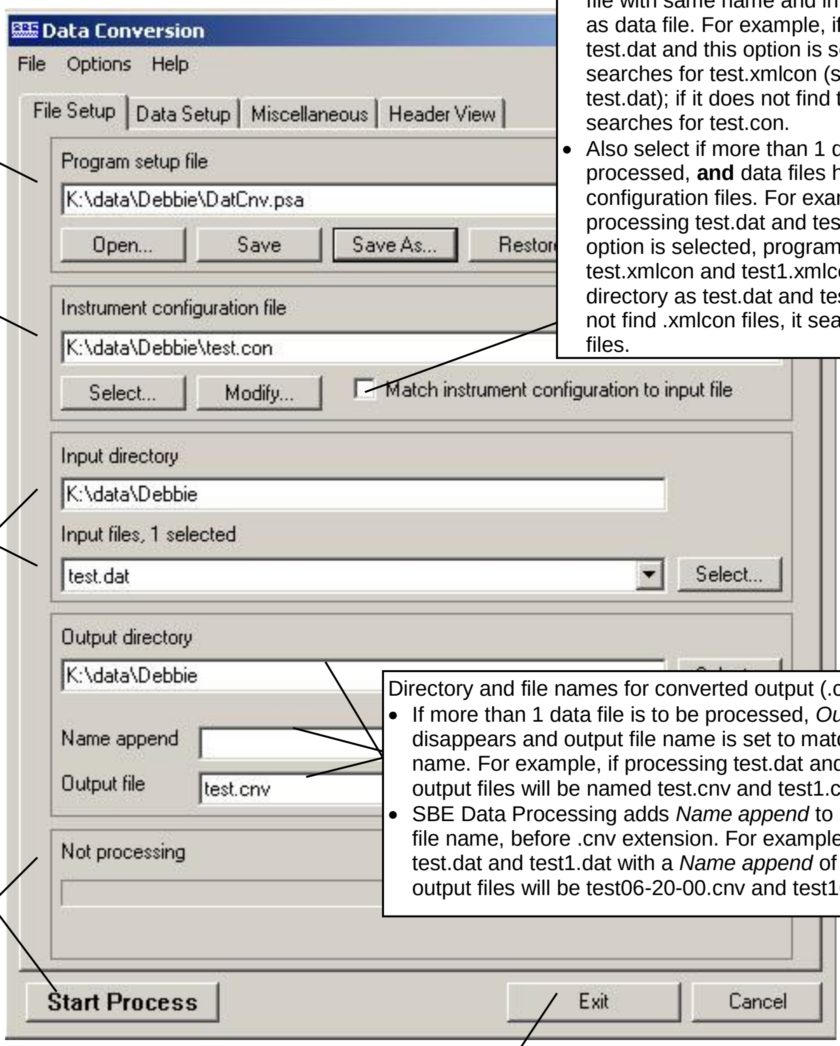
Location to store all information input in File Setup and Data Setup tabs. **Open** to select different .psa file, **Save** or **Save As** to save current settings, or **Restore** to reset all settings to match last saved version. **See note above.**

Instrument configuration file location. **Select** to pick a different .con or .xmlcon file, or **Modify** to view and/or modify instrument configuration. See *Section 4: Configuring Instrument (Configure)*.

Directory and file names for raw data (.hex, .dat, or .xml). **Select** to pick a different file. To process multiple raw data files from same directory:
1. Click **Select**.
2. In Select dialog box, hold down Ctrl key while clicking on each desired file.

Click **Start Process** to begin processing data. Status field shows *Processing complete* when done.

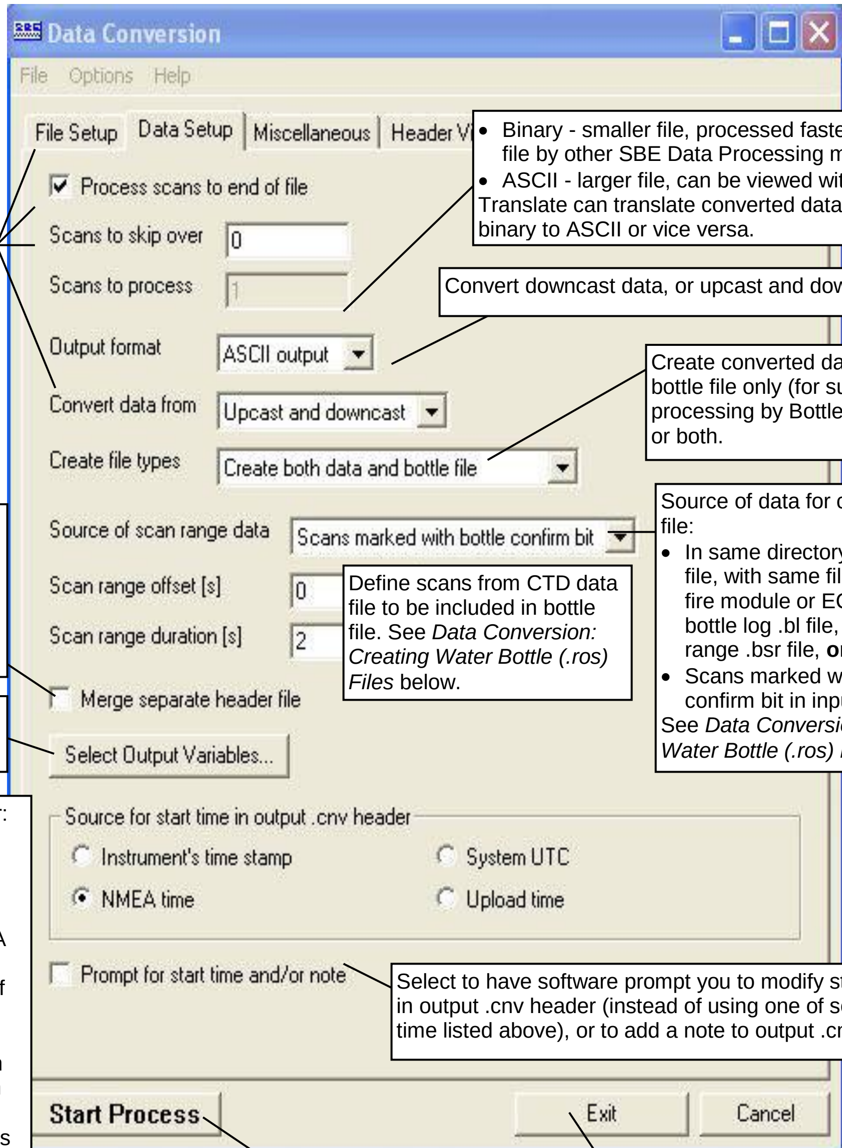
- Select to have program find .con or .xmlcon file with same name and in same directory as data file. For example, if processing test.dat and this option is selected, program searches for test.xmlcon (same directory as test.dat); if it does not find test.xmlcon, it searches for test.con.
- Also select if more than 1 data file is to be processed, **and** data files have different configuration files. For example, if processing test.dat and test1.dat, and this option is selected, program searches for test.xmlcon and test1.xmlcon (same directory as test.dat and test1.dat); if it does not find .xmlcon files, it searches for .con files.



Directory and file names for converted output (.cnv) data.
- If more than 1 data file is to be processed, *Output file* field disappears and output file name is set to match input file name. For example, if processing test.dat and test1.dat, output files will be named test.cnv and test1.cnv.
- SBE Data Processing adds *Name append* to (each) output file name, before .cnv extension. For example, if processing test.dat and test1.dat with a *Name append* of 06-20-00, output files will be test06-20-00.cnv and test106-20-00.cnv.

Return to SBE Data Processing window.
- If *Confirm Program Setup Change* was selected in Options menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Program Setup Change* was not selected in Options menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

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



Program skips first *scans to skip over* scans.

- If *Process scans to end of file* selected: process all remaining scans (upcast and downcast scans if *Upcast and downcast* selected; downcast scans only if *downcast* selected).
- If *Process scans to end of file* not selected: process next *scans to process*.

- Binary - smaller file, processed faster than ASCII file by other SBE Data Processing modules.
- ASCII - larger file, can be viewed with a text editor.

Translate can translate converted data file from binary to ASCII or vice versa.

Convert downcast data, or upcast and downcast data.

Create converted data file only, bottle file only (for subsequent processing by Bottle Summary), or both.

Source of data for creating bottle file:

- In same directory as input data file, with same file name - auto fire module or ECO .afm file, bottle log .bl file, or bottle scan range .bsr file, **or**
- Scans marked with bottle confirm bit in input data file

See *Data Conversion: Creating Water Bottle (.ros) Files* below.

Define scans from CTD data file to be included in bottle file. See *Data Conversion: Creating Water Bottle (.ros) Files* below.

Select to replace existing header in input file with header in .hdr file. Program looks for a file with a matching name (but .hdr extension) in same directory as input file.

Select which variables to convert and output (see dialog box below).

Select start time source for header:

- Instrument's time stamp – instrument's time stamp in first data scan (if available) or in header of input raw data file.
- NMEA time – time from a NMEA device that was integrated with system; time in first data scan (if available) or in header of input raw data file.
- System UTC – computer time in first data scan (if available) or in header of input raw data file.
- Upload time – time that data was uploaded from instrument's memory.

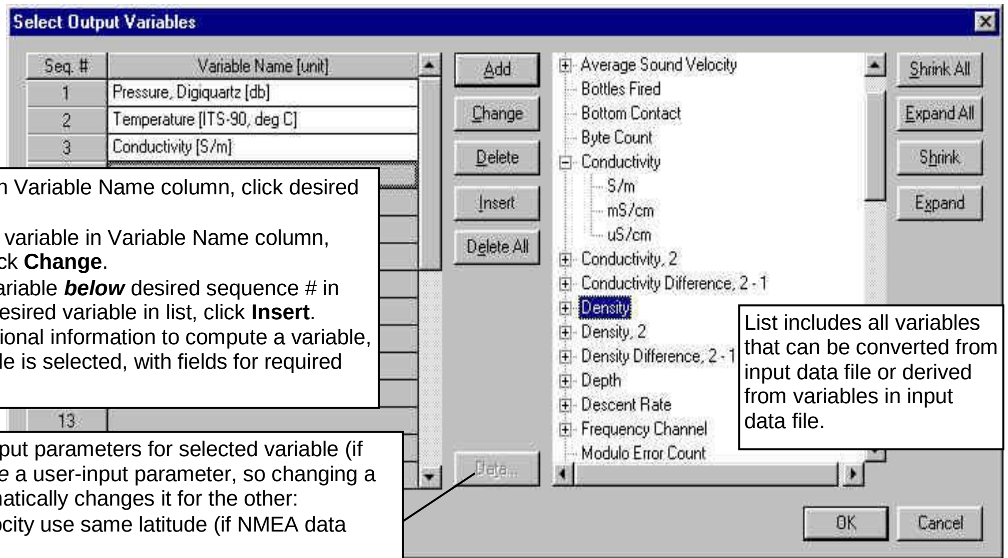
Select to have software prompt you to modify start time to put in output .cnv header (instead of using one of sources for start time listed above), or to add a note to output .cnv header.

Begin processing data. Status field on File Setup tab shows *Processing complete* when done.

Return to SBE Data Processing window.

- If *Confirm Program Setup Change* was selected in Options menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Program Setup Change* was not selected in Options menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

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



- Add variable: click blank field in Variable Name column, click desired variable in list, click **Add**.
- Change variable: click existing variable in Variable Name column, click desired variable in list, click **Change**.
- Insert variable: click existing variable ***below*** desired sequence # in Variable Name column, click desired variable in list, click **Insert**.

If Data Conversion requires additional information to compute a variable, a dialog box appears after variable is selected, with fields for required user-input parameters.

List includes all variables that can be converted from input data file or derived from variables in input data file.

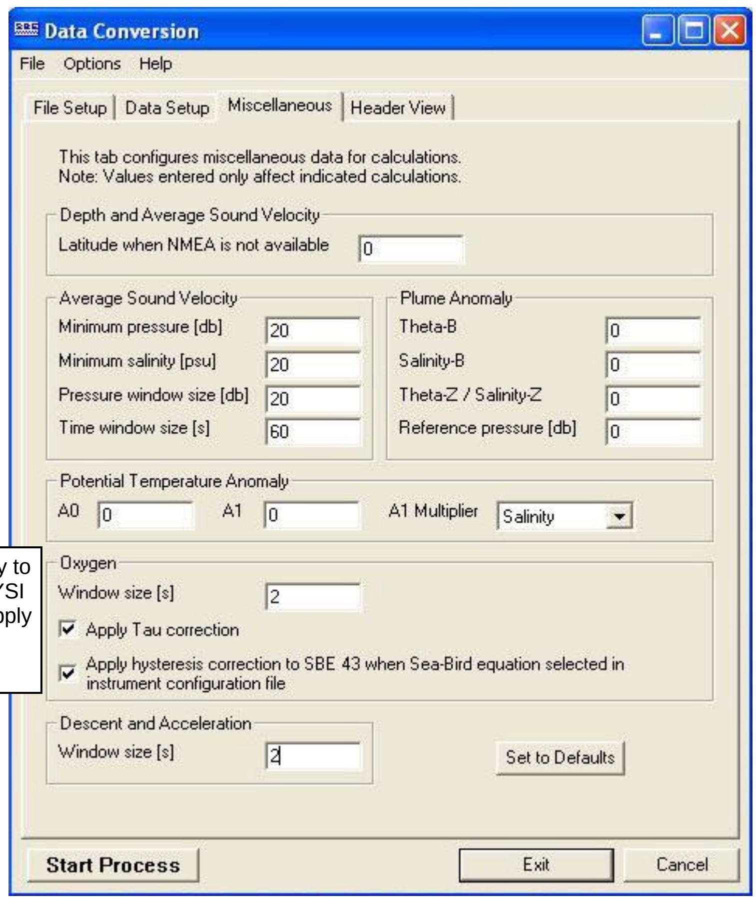
Click **Data** to view/modify user-input parameters for selected variable (if applicable). Some variables *share* a user-input parameter, so changing a parameter for one variable automatically changes it for the other:

- Depth and average sound velocity use same latitude (if NMEA data unavailable).
- Descent rate and acceleration use same time window size.
- All SBE 13, 23, and 43 oxygen sensors use same time window size, Tau correction, and (SBE 43 only) hysteresis correction.

Note: An alternate method of entering these parameters is on Miscellaneous tab in Data Conversion dialog box.

The Miscellaneous tab in the Data Conversion dialog box looks like this:

Note:
Values for these parameters can be changed on the Miscellaneous tab or by double clicking on the output variable in the Select Output Variables dialog box (above); changes made in one location are automatically made in the other location.



Oxygen selections apply to SBE 43 and Beckman/YSI sensors. They do not apply to SBE 63 or Aanderaa Oxygen Optode.

The Miscellaneous tab defines parameters required for output of specific variables (depth, average sound velocity, plume anomaly, potential temperature anomaly, oxygen, descent rate, and acceleration). Entries are used only if you are calculating and outputting the associated variable to the .cnv file. For example, if you do not select Oxygen in the Select Output Variables dialog box, Data Conversion ignores the Oxygen window size and the enabling of hysteresis and Tau corrections on the Miscellaneous tab.

Data Conversion: Creating Water Bottle (.ros) Files

A .ros water bottle file contains:

- data for each scan associated with a bottle firing, and
- data for user-selected range of scans before and after each bottle firing

Scan range data for creation of a water bottle file can come from:

- *Scans marked with bottle confirm bit in input data file* - if used
  - SBE 9*plus* with an SBE 11*plus* Deck Unit and G.O. 1015 Rosette, **or**
  - SBE 9*plus* with an SBE 17*plus* Searam and SBE 32 Carousel Water Sampler.

  For these systems, the bottle confirm bit in the input (.hex or .dat) data file is set for all scans within a 1.5-second duration after a bottle firing confirmation is received from the water sampler.
- *Bottle log (.bl) file* - if used Seasave to interface with
  - SBE 9*plus* with SBE 11*plus* Deck Unit and G.O. 1016 Rosette or SBE 32 Carousel Water Sampler, **or**
  - SBE 19, 19*plus*, 19*plus* V2, 25, or 49 with SBE 33 Deck Unit and SBE 32 Carousel Water Sampler, **or**
  - SBE 19, 19*plus*, 19*plus* V2, 25, or 49 with SBE 33 Deck Unit and SBE 55 ECO Water Sampler.

  For these systems, Seasave creates the .bl file. Each time a bottle fire confirmation is received, the bottle sequence number, position, date, time, and beginning and ending scan numbers (1.5-second duration for each bottle) are written to the .bl file.
- *Auto Fire Module or ECO (.afm) file* - if used
  - Carousel Auto Fire Module (AFM) with SBE 19, 19*plus*, 19*plus* V2, 25, or 50 and SBE 32 Carousel Water Sampler, **or**
  - SBE 19, 19*plus*, 19*plus* V2, 25, or 50 and SBE 55 ECO Water Sampler (autonomous operation).

  For these systems, the .afm file contains five scans of data recorded by the AFM or SBE 55 ECO Water Sampler for each bottle firing.
- *Bottle scan range (.bsr) file* - if used Mark Scan feature in Seasave during data acquisition to create a .mrk file; use Mark Scan to convert the .mrk file to a .bsr file before running Data Conversion. The format for the .bsr file is:
  beginning scan # for bottle #1, ending scan # for bottle #1
  …
  beginning scan # for last bottle, ending scan # for last bottle
  Example: test.bsr contains -
  ```
  1000, 1020
  2000, 2020
  4000, 4020
  ```
  The .ros file created using test.bsr would contain scans 1000 - 1020 for bottle #1, 2000 - 2020 for bottle #2, and 4000 - 4020 for bottle #3.

Notes:

- You may have more than one source of scan range data available. For example, if Seasave is used with an SBE 911*plus* and SBE 32 Carousel Water Sampler, a bottle log (.bl) file is created. Additionally, if you used the Mark Scan feature in Seasave, a .mrk file is created.
- If scan range data is defined by a .afm file, Data Conversion creates a .bl file (same name as input data file, with .bl extension). The .bl file is used when processing the water bottle data in Bottle Summary.
- You can create a .bsr file in a text editor if scan range data is not available in any of these forms.

The amount of data written to the .ros file is based on:

- *Scan range offset* - determines the first scan output to the .ros file for each bottle, relative to the first scan with a confirmation bit set or written to a .afm, .bsr, or .bl file.
- *Scan range duration* - determines the number of scans output to the .ros file for each bottle.

Example: A bottle confirmation for an SBE 911*plus* is received at scan 10,000 (scan 10,000 and subsequent scans for 1.5 seconds have confirmation bit set). In Data Conversion, *Scan range offset* is set to -2 seconds, and *Scan range duration* is set to 5 seconds. If the scan rate is 24 scans/second,
10,000 - 2 second offset (24 scans/second) = 9,952
9,952 + 5 second duration (24 scans/second) = 10,072
Therefore, scans 9,952 through 10,072 will be written to the .ros file.

Data Conversion: Notes and General Information

> **Note:**
> If you choose to compute derived parameters in Data Conversion, note that the algorithms are the same as used in Derive (with the exception of the oxygen, descent rate, and acceleration calculations); **see *Appendix V: Derived Parameter Formulas* for algorithms for derived variables**.

Data Conversion was written to accommodate most sensors that have been installed on Sea-Bird products. See the configuration page at the beginning of your instrument manual for the sensors that were installed on your system.

- If you plan to process the data with other modules, select only the primary variables to be converted, and then use Derive to compute derived parameters such as salinity, density, sound velocity, and oxygen.
- If desired, you can select the same variable multiple times for the output .cnv file. If you do, data processing operations on that variable in other modules will use the *last* occurrence of the variable in the file.
  Example: Select Primary Conductivity, Primary Temperature, Pressure, and Primary Conductivity (again) for output variables (columns 1, 2, 3, and 4 respectively). Then, if you run Cell Thermal Mass, it will correct the conductivity in column 4 only, leaving column 1 uncorrected; you could plot the corrected and uncorrected conductivity to see the changes. If you then run Derive to calculate salinity, it will use the corrected conductivity in column 4 in the salinity calculation.
- If you will use Derive to compute:
  - Salinity, density, or other parameters that depend on salinity - include pressure, temperature, and conductivity in the output file.
    For a moored instrument without optional pressure sensor (SBE 16, 16*plus*, 16*plus*-IM, 16*plus* V2, or 16*plus*-IM V2), if you select pressure as an output variable, Data Conversion inserts a column with the moored pressure (entered in the configuration file *Data* dialog) in the output .cnv file. For a thermosalinograph (SBE 21 or 45), if you select pressure as an output variable, Data Conversion inserts a column of 0's for the pressure in the output .cnv file. The pressure column is needed for Derive to calculate salinity, density, etc.
  - Oxygen - include in the output file (along with pressure, temperature, and conductivity)
    For SBE 13 or 23 - oxygen current and oxygen temperature
    For SBE 43 - oxygen value
- If you will use Bin Average:
  - With depth bins - include depth in the output file
  - With pressure bins - include pressure in the output file
- Pressure temperature is computed using a backward-looking, 30-second running average, to prevent bit transitions in pressure temperature from causing small jumps in computed pressure. Because the heavily insulated pressure sensor has a thermal time constant on the order of one hour, the 30-second average does not significantly alter the computed pressure temperature.
- Oxygen, descent rate, and acceleration computed by Seasave and Data Conversion are somewhat different from values computed by Derive, because the algorithms calculate the derivative of the signal (oxygen signal for oxygen, pressure signal for descent rate and acceleration) 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 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 oxygen, descent rate, and acceleration; use Derive to obtain the most accurate values.
- For an SBE 21 or 45 with a remote temperature sensor, Seasave, Data Conversion, Derive, and Derive TEOS-10 all use the remote temperature data when calculating density and sound velocity.

Data Conversion has the following /x parameters when run from the Command Line Options dialog box, from the command line, or with batch file processing:

/x Parameter	Description
/xdatcnv:skipN	N = number of scans to skip.
/xdatcnv:pump	For SBE 911*plus*, do not output scans if pump status = off.
/xdatcnv:nomatch	Disable matching of header information to .con or .xmlcon configuration file - program continues to run even if there is a discrepancy in header information.

See *Appendix I: Command Line Options, Command Line Operation, and Batch File Processing* for details on using parameters.

Data Conversion adds the following to the data file header for a **.cnv converted data file**:

Label	Description
Nquan	Number of columns (fields) of converted data. **Note**: Data Conversion automatically adds 1 field to number selected by user (i.e., if user selects 3 variables to convert, then nquan=4). This added field, initially set to 0, is used by Loop Edit to mark bad scans.
Nvalues	Number of scans converted.
Units	Specified (indicates units are specified separately for each variable).
Name n	Sensor (and units) associated with data in column n.
Span n	Span (highest - lowest value) of data in column n.
Interval	Scan rate (seconds).
Start_time	Data start time.
Bad_flag	For information only; value that Loop Edit and Wild Edit will use to mark bad scans and bad data values.
Sensors	Sensor description, serial number, and calibration date and coefficients, all in XML format.
Datcnv_date	Date and time that module was run. Also shows how many columns of data output (not including flag column).
Datcnv_in	Input .hex (or .dat) data file and .con or .xmlcon configuration file.
Datcnv_skipover	Number of scans to skip over in processing.
Datcnv_ox_ hysteresis_correction	Whether hysteresis correction was performed on oxygen data.
Datcnv_ox_tau_ correction	Whether tau correction was performed on oxygen data.
File type	Selected output file type - ASCII or binary.

Notes:
- Each SBE Data Processing module that modifies a .cnv file adds information to the header and updates nquan, nvalues, name n, span n, interval, and file_type, as applicable.
- Calibration coefficients were added to the file header for a .cnv file and for a .ros water bottle file in SBE Data Processing version 7.19.

Data Conversion adds the following to the data file header for a **.ros water bottle file**:

Label	Description
Nquan	Number of columns (fields) of converted data. **Note**: Data Conversion automatically adds 1 field to number selected by user (i.e., if user selects 3 variables to convert, then nquan=4). This added field, initially set to 0, is used by Loop Edit to mark bad scans.
Nvalues	Number of scans converted.
Units	Specified (indicates units are specified separately for each variable).
Name n	Sensor (and units) associated with data in column n.
Interval	Scan rate (seconds).
Start_time	Data start time.
Sensors	Sensor description, serial number, and calibration date and coefficients, all in XML format.
Datcnv_date	Date and time that module was run.
Datcnv_in	Input .hex (or .dat) data file and .con or .xmlcon configuration file.
Datcnv_bottle_ scan_range_source	Source of data for creating bottle file, and scan range offset and duration.
Datcnv_scans_ per_bottle	Number of data scans/bottle in .ros file; based on scan range offset and duration, and CTD sampling rate

Bottle Summary

Note:
Bottle Summary was previously called *Rosette Summary*.

Bottle Summary reads a .ros file created by Data Conversion and writes a bottle data summary to a .btl file. The .ros file must contain (as a minimum) temperature, pressure, and conductivity (or salinity).
The output .btl file includes:

- Bottle position, optional bottle serial number, and date/time
- User-selected derived variables - computed for each bottle from mean values of input variables (temperature, pressure, conductivity, etc.)
- User-selected averaged variables - computed for each bottle from input variables

The maximum number of scans processed per bottle is 1440.

In addition to the .ros input file:

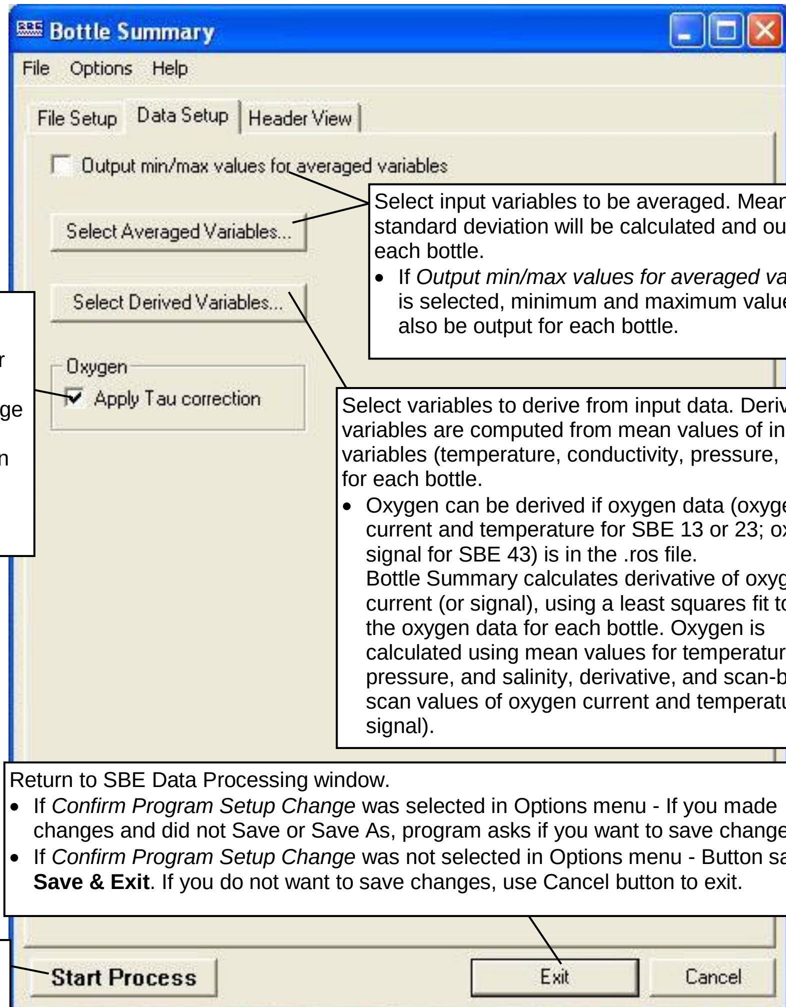
Note:
A .bl file is created by:
- Seasave, during real-time data acquisition, or
- Data Conversion, if the source of scan rage data was a .afm file.

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

- If a .bl file (same name as input data file, with .bl extension) is found in the input file directory, Bottle Summary uses bottle position data from the .bl file. The bottle position data defines the bottle firing sequence - the .bl file contains the bottle firing sequence number, bottle position, date and time, and beginning and ending scan number for each bottle.
- If a .sn file (same name as input data file, with .sn extension) is found in the input file directory, bottle serial numbers are inserted between the bottle position and date/time columns in the .btl file output. The format for the .sn file is:
  Bottle position, serial number (with a comma separating the two fields)

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

Note:
The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.



Select input variables to be averaged. Mean and standard deviation will be calculated and output for each bottle.

- If *Output min/max values for averaged variables* is selected, minimum and maximum values will also be output for each bottle.

Ignored if not computing oxygen in derived variables:
Tau correction ([tau(T,P) * δV/δt] in SBE 43 or [tau * doc/dt] in SBE 13 or 23) improves response of measured signal in regions of large oxygen gradients. However, this term also amplifies residual noise in signal (especially in deep water), and in some situations this negative consequence overshadows gains in signal responsiveness.

Select variables to derive from input data. Derived variables are computed from mean values of input variables (temperature, conductivity, pressure, etc.) for each bottle.

- Oxygen can be derived if oxygen data (oxygen current and temperature for SBE 13 or 23; oxygen signal for SBE 43) is in the .ros file.
  Bottle Summary calculates derivative of oxygen current (or signal), using a least squares fit to all the oxygen data for each bottle. Oxygen is calculated using mean values for temperature, pressure, and salinity, derivative, and scan-by-scan values of oxygen current and temperature (or signal).

Return to SBE Data Processing window.

- If *Confirm Program Setup Change* was selected in Options menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Program Setup Change* was not selected in Options menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Begin processing data. Status field on File Setup tab shows *Processing complete* when done.

Bottle Summary adds the following to the data file header:

Label*	Description
Bottlesum_date	Date and time that module was run.
Bottlesum_in	Input .ros bottle data file and .con or .xmlcon configuration file.
Bottlesum_ox_tau_correction	Tau correction applied to oxygen data? Only appears if oxygen is derived.

*Labels were previously rossum_date and rossum_in.

Mark Scan

Note:
Alternatively, an ASCII text editor can be used to create the .bsr file. The format for the output .bsr file is:

Beginning scan for bottle 1, ending scan for bottle 1
Beginning scan for bottle 2, ending scan for bottle 2
.
Beginning scan for last bottle, ending scan for last bottle

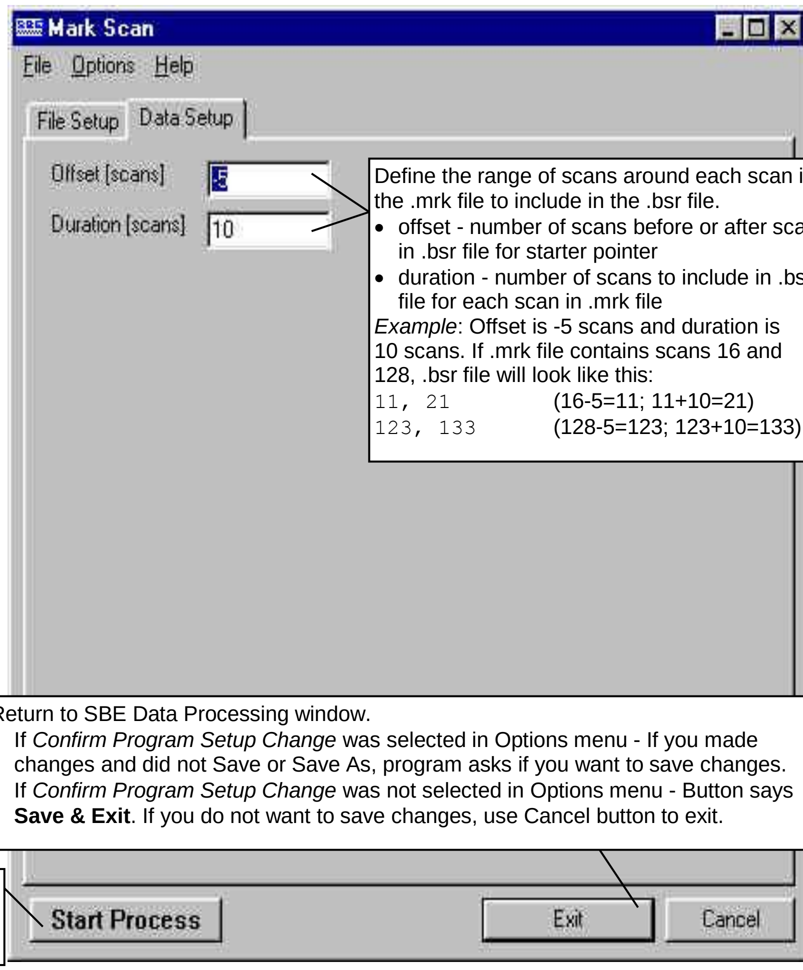
Note that a comma must separate the beginning and ending scan numbers.

Mark Scan creates a bottle scan range (.bsr) file from a .mrk data file created in Seasave. The data in the .bsr file can be used by Data Conversion to create a .ros file, and the .ros file can be used by Bottle Summary to create a bottle data summary .btl file.

The input .mrk file contains one scan with the mark number, system time, and scan number for each time Mark Scan was clicked while in Seasave's Mark Scan Control dialog box (accessed by selecting Mark Scan Control in Seasave's Real-Time Control menu). Mark Scan's output .bsr file *points to* a user-defined range of adjacent scans for each marked scan. Note that the output .bsr file only contains the pointers to the scans, and does not contain the data.

Note:
The File Setup tab is similar for all modules; see *Section 2: Installation and Use*.

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



Define the range of scans around each scan in the .mrk file to include in the .bsr file.
- offset - number of scans before or after scan in .bsr file for starter pointer
- duration - number of scans to include in .bsr file for each scan in .mrk file

Example: Offset is -5 scans and duration is 10 scans. If .mrk file contains scans 16 and 128, .bsr file will look like this:
`11, 21` (16-5=11; 11+10=21)
`123, 133` (128-5=123; 123+10=133)

Return to SBE Data Processing window.
- If *Confirm Program Setup Change* was selected in Options menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Program Setup Change* was not selected in Options menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Begin processing data. Status field on File Setup tab shows *Processing complete* when done.

Mark Scan's output .bsr file does not have a header.

Section 6: Data Processing Modules

All data processing is performed on converted data from a .cnv file.

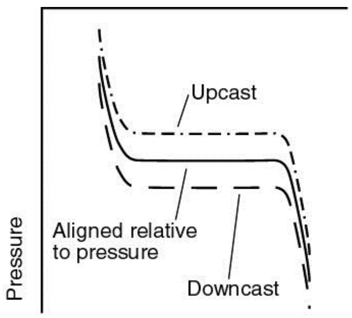
Module Name	Module Description
Align CTD	Align data relative to pressure (typically used for conductivity, temperature, and oxygen).
Bin Average	Average data, basing bins on pressure, depth, scan number, or time range.
Buoyancy	Compute Brunt Väisälä buoyancy and stability frequency.
Cell Thermal Mass	Perform conductivity thermal mass correction.
Derive	Calculate salinity, density, sound velocity, oxygen, potential temperature, dynamic height, etc. based on EOS-80 (Practical Salinity) equations.
Derive TEOS-10	Calculate thermodynamic properties based on TEOS-10 (Absolute Salinity).
Filter	Low-pass filter columns of data.
Loop Edit	Mark a scan with *badflag* if scan fails pressure reversal or minimum velocity tests.
Wild Edit	Mark a data value with *badflag* to eliminate wild points.
Window Filter	Filter data with triangle, cosine, boxcar, Gaussian, or median window.

Align CTD

Note:
Align CTD cannot be run on files that have been averaged into pressure or depth bins in Bin Average. If alignment is necessary, run Align CTD before running Bin Average.

Align CTD aligns parameter data in time, relative to pressure. This ensures that calculations of salinity, dissolved oxygen concentration, and other parameters are made using measurements from the same parcel of water. Typically, Align CTD is used to align temperature, conductivity, and oxygen measurements relative to pressure.

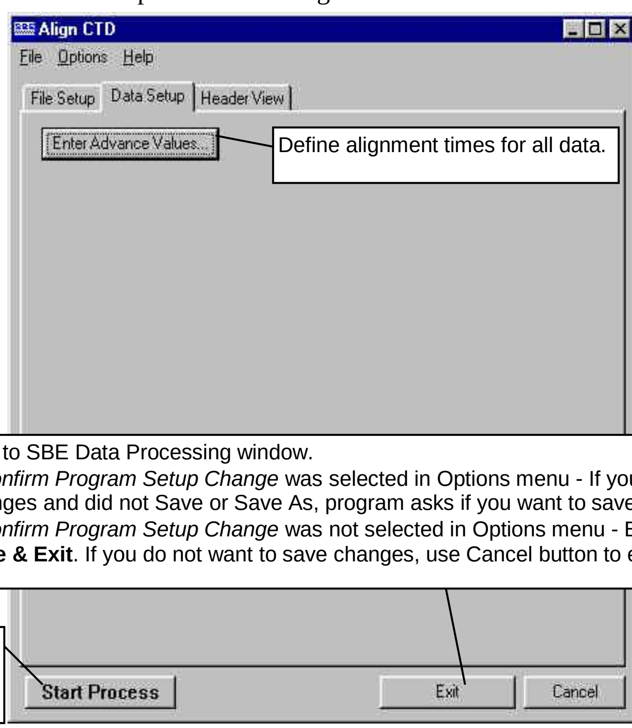
There are three principal causes of misalignment of CTD measurements:
- physical misalignment of the sensors in depth
- inherent time delay (time constants) of the sensor responses
- water transit time delay in the pumped plumbing line - the time it takes the parcel of water to go through the plumbing to each sensor (or, for free-flushing sensors, the corresponding flushing delay, which depends on profiling speed)



Upcast and Downcast mismatch with Respect to Pressure

When measurements are properly aligned, salinity spiking (and density) errors are minimized, and oxygen data corresponds to the proper pressure (e.g., temperature vs. oxygen plots agree between down and up profiles).

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



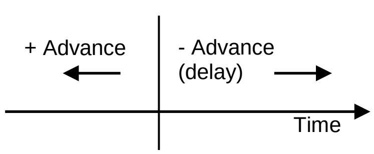
Note:
The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.

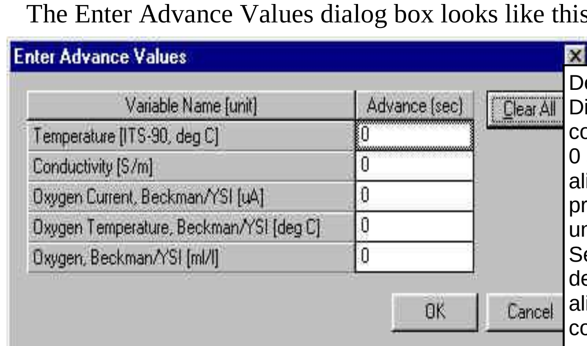
Define alignment times for all data.

Return to SBE Data Processing window.
- If *Confirm Program Setup Change* was selected in Options menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Program Setup Change* was not selected in Options menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Begin processing data. Status field on File Setup tab shows *Processing complete* when done.

The Enter Advance Values dialog box looks like this:





Define alignment times. Diagram shows sign convention for Advance. If 0 seconds is entered, alignment relative to pressure (and time) remains unchanged for that variable. See discussion below to determine appropriate alignment times for conductivity, temperature, and oxygen.

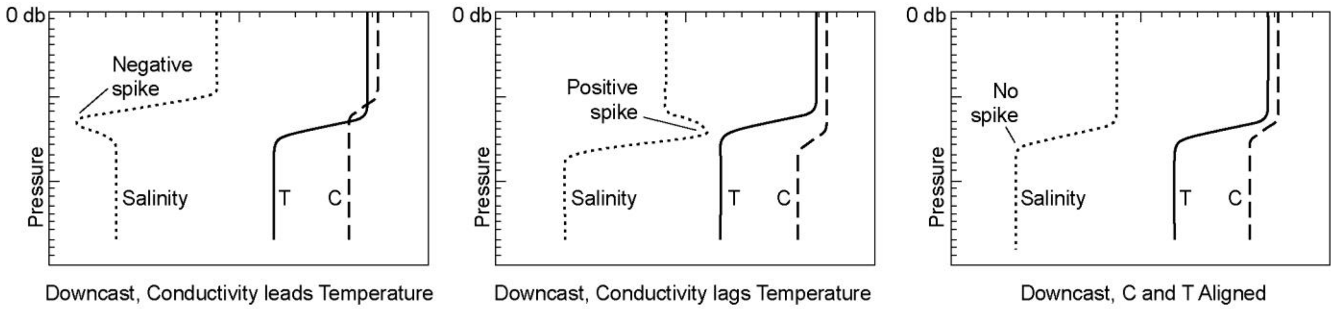
Align CTD: Conductivity and Temperature

Temperature and conductivity are often misaligned with respect to pressure. Shifting temperature and conductivity relative to pressure can compensate. As shown in the figures, indications of misalignment include:

- Depth mismatch between downcast and upcast data
- Spikes in the calculated salinity (which is dependent on temperature, conductivity, and pressure) - caused by misalignment of temperature and conductivity *with each other*

The best diagnostic of proper alignment is the elimination of salinity spikes that coincide with very sharp temperature steps. To determine the best alignment, plot 10 meters of temperature and salinity data at a depth that contains a very sharp temperature step. For the downcast, when temperature and salinity decrease with increasing pressure:

- A negative salinity spike at the conductivity step means that conductivity leads temperature (conductivity sensor *sees* step before temperature sensor does). Advance conductivity *relative to temperature* a **negative** number of seconds.
- Conversely, if the salinity spike is positive, advance conductivity *relative to temperature* a **positive** number of seconds.



The best alignment of conductivity with respect to temperature is obtained when the salinity spikes are minimized. Some experimentation with different advances is required to find the best alignment.

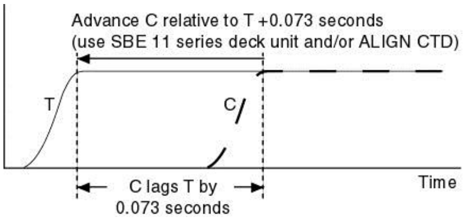
Typical Temperature Alignment

The SBE 19, 19*plus*, and 19*plus* V2 use a temperature sensor with a relatively slow time response, while the SBE 9*plus*, 25, 25*plus*, and 49 use a temperature sensor with a faster time response. Typical advances are:

Instrument	Advance of Temperature Relative to Pressure (seconds)
9*plus*	0
19, 19*plus*, or 19*plus* V2	+ 0.5
25 or 25*plus*	0
49 *	+ 0.0625

*The SBE 49 can be programmed to advance temperature relative to pressure in real-time, eliminating the need to run Align CTD. See the SBE 49 manual for details.

Note:
All SBE 11 series deck units can advance **primary** conductivity, which *may* eliminate the need to use Align CTD for conductivity. The SBE 11*plus* does not advance secondary conductivity. The SBE 11*plus* V2 can advance secondary conductivity and all voltage channels; the advance time is user-programmable.



Typical Conductivity Alignment

- SBE 9*plus* - For an SBE 9*plus* with TC-ducted temperature and conductivity sensors and a 3000-rpm pump, the typical lag of conductivity relative to temperature is 0.073 seconds. The Deck Unit can be programmed to advance conductivity relative to pressure, eliminating the need to run Align CTD.
  Following is an example of determining the value to enter in Align CTD:
  Example: The SBE 11*plus* is factory-set to advance the primary conductivity +1.75 scans (at 24 Hz, this is 1.75 / 24 = 0.073 seconds). Advance conductivity relative to temperature in Align CTD:
  0.073 - 1.75/24 = 0.0 seconds (enter 0 seconds for conductivity).

- SBE 19*plus* or 19*plus* V2 – For an SBE 19*plus* or 19*plus* V2 with a standard 2000-rpm pump, do not advance conductivity.

- SBE 19 (not *plus*) – For an unpumped SBE 19, the conductivity measurement may lead or lag that of temperature, because the flushing rate of the conductivity cell depends on drop speed. If the SBE 19 is lowered very slowly (< 20 cm/second, typically from a fixed platform or ice), conductivity lags temperature. If the SBE 19 is lowered fast, conductivity leads temperature. Typical advances of conductivity *relative to temperature* range from 0 seconds at a lowering rate of 0.75 meters/second to -0.6 seconds for 2 meters/second (if temperature was advanced +0.5 seconds, these correspond to conductivity advances of +0.5 seconds and -0.1 seconds respectively).

- SBE 25 or 25*plus* - For an SBE 25 or 25*plus* with a standard 2000-rpm pump, a typical advance of conductivity *relative to temperature* is +0.1 seconds.

- SBE 49 – For a typical SBE 49 with TC duct and 3000 rpm pump, do not advance conductivity.

If temperature is advanced relative to pressure and you do not want to change the relative timing of temperature and conductivity, you must add the same advance to conductivity.

Example (typical of an unpumped SBE 19):

Advance temperature relative to pressure +0.5 seconds to compensate for slow response time of sensor.
- If the CTD is lowered at 0.75 m/s, advance conductivity *relative to temperature* 0 seconds. Calculate advance of conductivity *relative to pressure* to enter in Align CTD: +0.5 + 0 = +0.5 seconds
- If the CTD is lowered at 2 m/s, advance conductivity *relative to temperature* -0.6 seconds. Calculate advance of conductivity *relative to pressure* to enter in Align CTD: +0.5 + (-0.6) = -0.1 seconds

Align CTD: Oxygen

Oxygen data is also systematically delayed with respect to pressure. The two primary causes are the long time constant of the oxygen sensor (for the SBE 43, ranging from 2 seconds at 25 ºC to approximately 5 seconds at 0 ºC) and an additional delay from the transit time of water in the pumped plumbing line. As with temperature and conductivity, you can compensate for this delay by shifting oxygen data relative to pressure. Typical advances for the SBE 43, 13, or 23 are:

Instrument	Advance of Oxygen Relative to Pressure (seconds)
9*plus*	+2 to +5
19*plus* or 19*plus* V2	+3 to +7
19 (not *plus*)	+3 to +7 (pumped), +1 to +5 (unpumped)
25 or 25*plus*	+3 to +7

Align CTD adds the following to the data file header:

Label	Description
Alignctd_date	Date and time that module was run.
Alignctd_in	Input .cnv converted data file.
Alignctd_adv	Variables aligned and their respective alignment times.

Bin Average

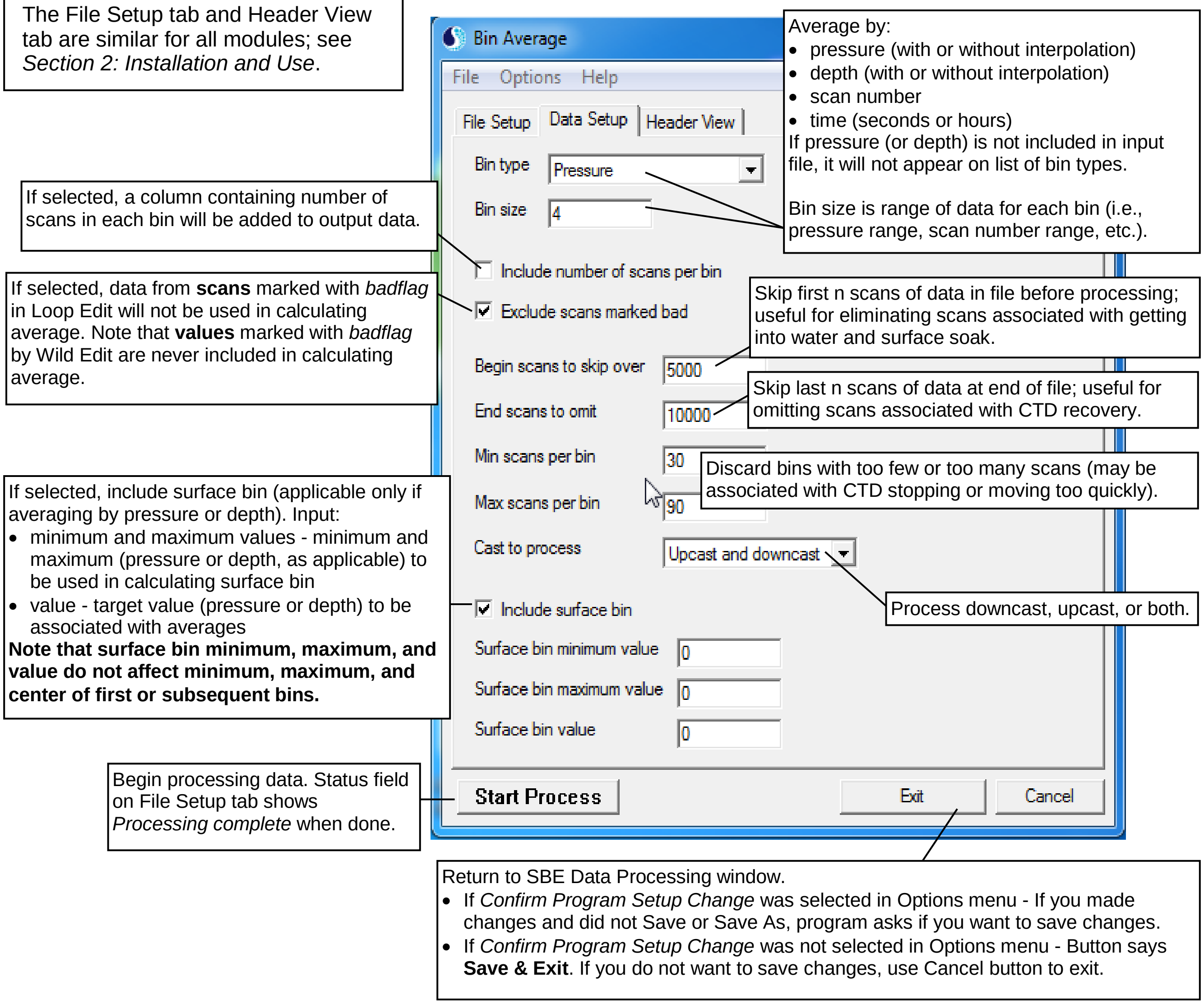
> **Note:**
> Align CTD, which aligns parameter data in time, relative to pressure, cannot be run on files that have been averaged into pressure or depth bins in Bin Average. If alignment is necessary, run Align CTD before running Bin Average.

Bin Average averages data, using averaging intervals based on:

- pressure range,
- depth range,
- scan number range, or
- time range

> **Note:**
> The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.

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

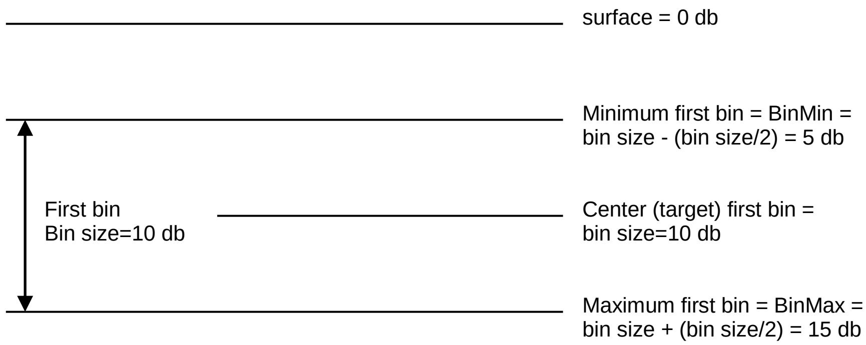


Bin Average: Formulas

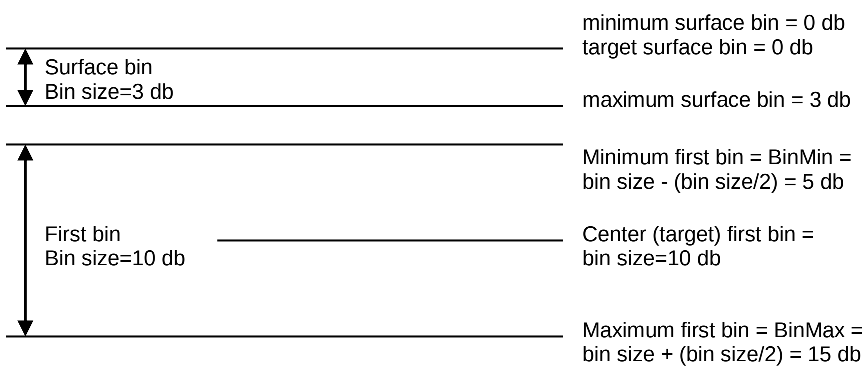
> **Note:**
> If *Exclude scans marked bad* is selected in the dialog box, data from **scans** marked with *badflag* in Loop Edit are not used in calculating average. **Values** marked with *badflag* by Wild Edit are never included in calculating the average. If the number of points included in the average is 0 (all data and/or scans in the bin are marked with *badflag*), the average value is set to *badflag.*

The center value of the first (not surface) bin is set equal to the bin size. The surface bin, if included, cannot overlap the first bin.

Example (pressure bin, surface bin not included):
Bin size is 10 db. The first bin is defined as follows:



Example (pressure bin, surface bin included):
Bin size is 10 db. Surface bin is included, and surface bin parameters are 0 db minimum, 3 db maximum, and 0 db value. The bins are defined as follows:



Note that for this example, the surface bin could have a maximum of up to 5 db (the minimum value for the first bin).

The algorithms used for each type of averaging follow.

Pressure Bins (no interpolation)
For each bin:
BinMin = center value - (bin size / 2)
BinMax = center value + (bin size / 2)

1. Add together valid data for scans with BinMin < pressure $\leq$ BinMax.
2. Divide sum by the number of valid data points to obtain average, and write average to output file.
3. Repeat Steps 1 through 2 for each variable.
4. For next bin, compute center value and repeat Steps 1 through 3.

Pressure Bins (with interpolation)

For each bin:
BinMin = center value - (bin size / 2)
BinMax = center value + (bin size / 2)

1. Add together valid data for scans with BinMin < pressure $\le$ BinMax.
2. Divide sum by number of valid data points to obtain average.
3. Interpolate as follows, and write interpolated value to output file:
   P_p =average pressure of previous bin
   X_p =average value of variable in previous bin
   P_c =average pressure of current bin
   X_c =average value of variable in current bin
   P_i = center value for pressure in current bin
   X_i =interpolated value of variable (value at center pressure P_i)
   $= ((X_c - X_p) * (P_i - P_p) / (P_c - P_p)) + X_p$
4. Repeat Steps 1 through 3 for each variable.
5. Compute center value and Repeat Steps 1 through 4 for next bin.

Values for first bin are interpolated *after* averages for second bin are calculated; values from *next* (second) bin instead of *previous* bin are used in equations.

Depth Bins (with or without interpolation)

Depth bin processing is similar to processing pressure bins, but bin size and center values are based on depth.

Scan Number Bins

Scan number bin processing is similar to processing pressure bins without interpolation. If *exclude scans marked bad* is selected, Bin Average averages *bin size* good scans (not marked with *badflag* in Loop Edit).

Example: Bin size is 100. First bin should include scans 50-149. However, scans 93, 94, and 126 are marked with *badflag* in Loop Edit, and user selected *exclude scans marked bad*. To include 100 valid scans in average, Bin Average includes scans 50 - 152 in first bin.

Time Bins

Time bin processing is similar to processing pressure bins without interpolation. Bin Average determines the number of scans to include based on the input bin size and the data sampling interval:
Number of scans = bin size [seconds] / interval ***or***
Number of scans = (bin size [hours] x 3600 seconds/hour) / interval

Bin Average has the following /x parameter when run from the Command Line Options dialog box, from the command line, or with batch file processing:

/x Parameter	Description
/xbinavg:cN	N = center value for first bin.

See *Appendix I: Command Line Options, Command Line Operation, and Batch File Processing* for details on using parameters.

Bin Average adds the following to the data file header:

Label	Description
Binavg_date	Date and time that module was run.
Binavg_in	Input .cnv converted data file.
Binavg_bintype	Bin type (pressure, depth, scan time in seconds or hours).
Binavg_binsize	Bin size.
Binavg_excl_ bad_scans	If yes, values from scans marked with *badflag* in Loop Edit are not included in average.
Binavg_skipover	Number of scans skipped at beginning of file.
Binavg_omit	Number of scans skipped at end of file.
Binavg_min_ scans_bin	Minimum number of scans/bin; bins with fewer scans are discarded.
Binavg_max_ scans_bin_	Maximum number of scans/bin; bins with more scans are discarded.
Binavg_surface_ bin	Surface bin included? Minimum and maximum values for surface bin.

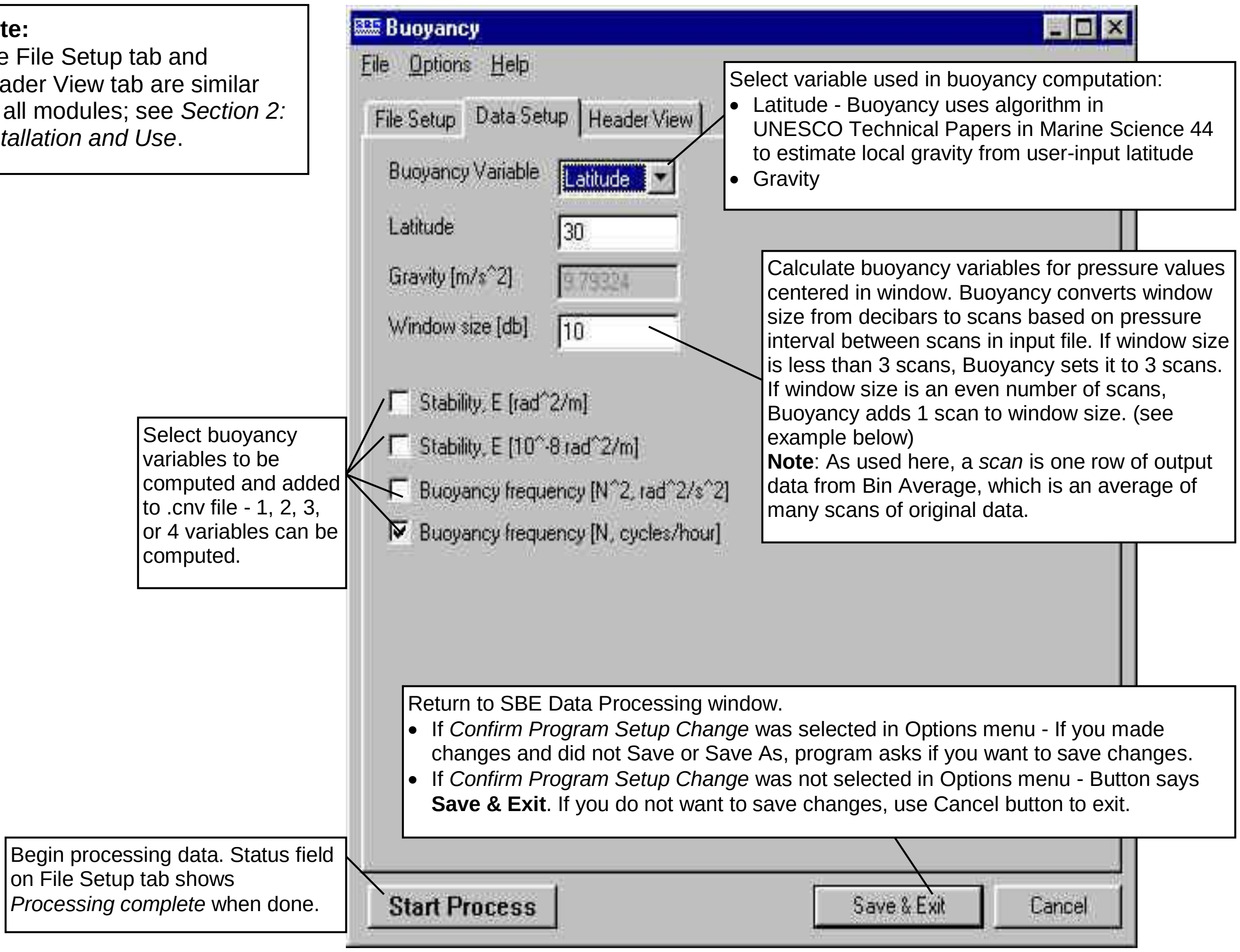
Buoyancy

> **Note:**
> The input .cnv file for Buoyancy must have been processed with Bin Average on pressure bins (with or without interpolation) and must contain pressure, temperature, and either salinity or conductivity.

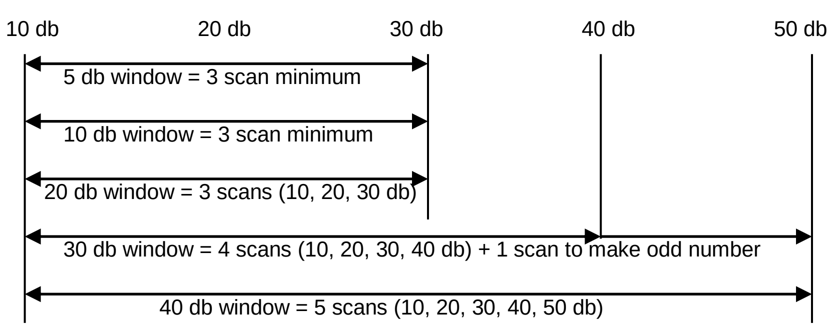
Buoyancy calculates buoyancy (Brunt-Väisälä) frequency (N) and stability (E) using the Fofonoff adiabatic leveling method (Bray N. A. and N. P. Fofonoff (1981) Available potential energy for MODE eddies. *Journal of Physical Oceanography*, 11, 30-46.).

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

> **Note:**
> The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.



Example: For an interval of 10 db between scans, buoyancy window sizes of 5, 10, or 20 db result in a window size of 3 scans. Window sizes of 30 or 40 db result in a window size of 5 scans.



Buoyancy: Formulas

The relationship between frequency N and stability E is:

$N^2 = gE \quad [rad^2/s^2]$

where g = gravity [m / s^2]

The algorithm used to compute N^2 for the pressure value centered in the buoyancy window is:

1. Compute averages:
   p_bar = average pressure in the buoyancy window [decibars]
   t_bar = average temperature in the buoyancy window [deg C]
   s_bar = average salinity in the buoyancy window [PSU]
   rho_bar = density (s_bar, t_bar, p_bar) [Kg / m^3]

2. Compute the vertical gradient:
   theta = potential temperature (s, t, p, p_bar)
   v = 1 / density(s, theta, p_bar)
   where s, t, and p are the averaged values for salinity, temperature, and pressure calculated in Bin Average

   Use a least squares fit to compute the linear gradient dv/dp in the buoyancy window.

3. Compute N^2, N, E, and 10^{-8}E:

$$N^2 = -1.0e^{-4}\, rho\_bar^2\, g^2 \frac{\delta v}{\delta p} \qquad [rad^2/s^2]$$

$$N = \frac{3600}{2\Pi}\sqrt{N^2} \qquad [cycles/hour]$$

$$E = \frac{N^2}{g} \qquad [rad^2/m]$$

$$E = 10^8 \frac{N^2}{g} \qquad [10^{-8}\, rad^2/m]$$

Buoyancy adds the following to the data file header:

Label	Description
Buoyancy_date	Date and time that module was run.
Buoyancy_in	Input .cnv converted data file.
Buoyancy_vars	Gravity value (input value or value based on input latitude) and buoyancy window size (adjusted to provide a minimum of three scans and an odd number of scans).

Cell Thermal Mass

> **Note:**
> Cell thermal mass corrections should **not be applied to freshwater data**. It can give bad results, due to the way the derivative dC/dT is calculated in regions where conductivity changes are very small.

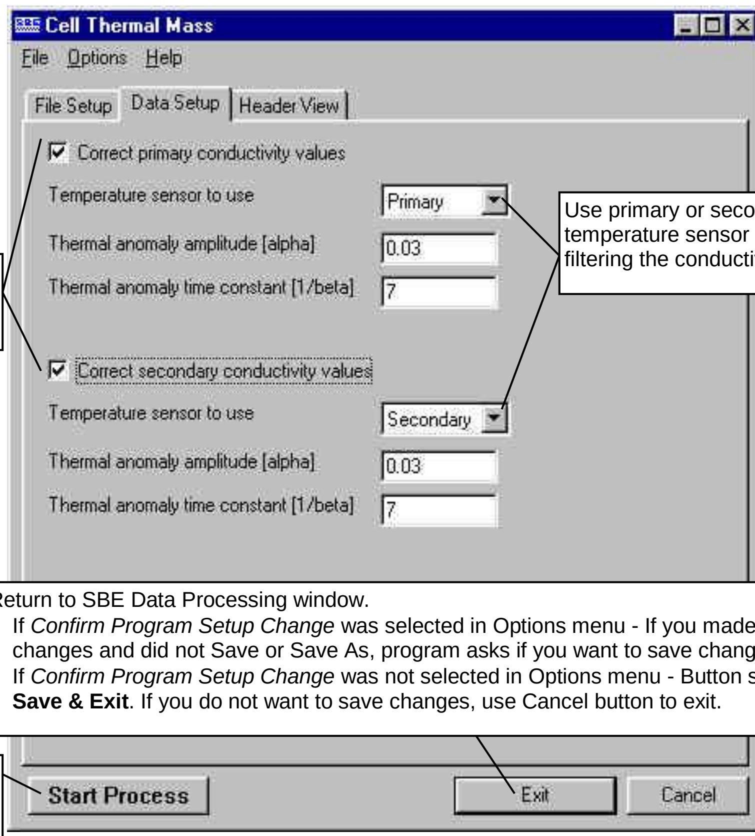
Cell Thermal Mass uses a recursive filter to remove conductivity cell thermal mass effects from the measured conductivity. Typical values for alpha and 1/beta are:

Instrument	alpha	1/beta
SBE 9*plus* with TC duct and 3000 rpm pump	0.03	7.0
SBE 19*plus* or 19*plus* V2 with TC duct and 2000 rpm pump	0.04	8.0
SBE 19 (not *plus*) with TC duct and 2000 rpm pump	0.04	8.0
SBE 19 (not *plus*) with no pump, moving at 1 m/sec	0.042	10.0
SBE 25 or 25*plus* with TC duct and 2000 rpm pump	0.04	8.0
SBE 49 with TC duct and 3000 rpm pump *	0.03	7.0

*The SBE 49 can be programmed to correct for conductivity cell thermal mass effects in real-time, eliminating the need to run Cell Thermal Mass. See the SBE 49 manual for details.

> **Note:**
> The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.

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



Cell Thermal Mass: Formulas

The algorithm used is:

a = 2 * alpha / (sample interval * beta + 2)
b = 1 - (2 * a / alpha)
dc/dT = 0.1 * (1 + 0.006 * [temperature - 20])
dT = temperature - previous temperature
ctm [S/m] = -1.0 * b * previous ctm + a * (dc/dT) * dT

where
sample interval is measured in seconds and temperature in °C
ctm is calculated in S/m

If the input file contains conductivity in units other than S/m, Cell Thermal Mass applies the following scale factors to the calculated ctm:
ctm [mS/cm] = ctm [S/m] * 10.0
ctm [µS/cm] = ctm [S/m] * 10000.0

corrected conductivity = c + ctm

To determine the values for alpha and beta, see:
Lueck, R.G., 1990: Thermal Inertia of Conductivity Cells: Theory., American Meteorological Society Oct 1990, 741-755.

Cell Thermal Mass adds the following to the data file header:

Label	Description
Celltm_date	Date and time that module was run.
Celltm_in	Input .cnv converted data file.
Celltm_alpha	Value used for alpha.
Celltm_tau	Value used for 1/beta.
Celltm_temp_sensor_use_for_cond	Temperature sensor for primary conductivity filter, temperature sensor for secondary conductivity filter.

Derive (EOS-80; Practical Salinity)

Notes:

- Derive's File Setup tab **requires** selection of an input data file and instrument configuration (.con or .xmlcon) file. **SBE 37** stores calibration coefficients internally, and does not have a .con or .xmlcon file provided by Sea-Bird.
  - If you used SeatermV2 version 1.1 or later to upload SBE 37 data, the software created a .xmlcon file when it created the .hex file.
  - If you used an earlier version of SeatermV2 or any version of Seaterm to upload SBE 37 data, use a .con or .xmlcon file from **any** other Sea-Bird instrument; the contents will not affect the results. If you do not have a .con or .xmlcon file for another instrument, create one in SBE Data Processing's Configure menu (select **any** instrument in the Configure menu, then click Save As in the Configuration dialog box).
- Algorithms used for calculation of derived parameters in Data Conversion, Derive, Sea Plot, SeaCalc III [EOS-80 (Practical Salinity) tab], and Seasave are identical, except as noted in *Appendix V: Derived Parameter Formulas (EOS-80; Practical Salinity)*, and are based on EOS-80 equations.
- Derive is not compatible with a .cnv file from an **SBE 39**, **39-IM**, **39*plus***, **39*plus*-IM, or 48**.
- For an SBE 21 or 45 with a remote temperature sensor, Seasave, Data Conversion, Derive, and Derive TEOS-10 all use the remote temperature data when calculating density and sound velocity.

Derive uses pressure, temperature, and conductivity from the input .cnv file to compute the following oceanographic parameters:

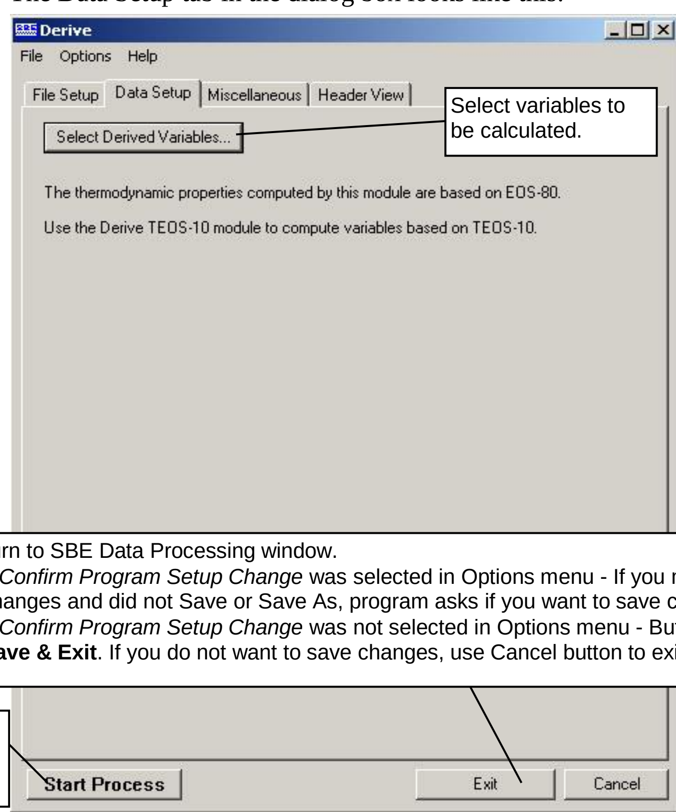
- density (density, sigma-theta, sigma-1, sigma-2, sigma-4, sigma-t)
- thermosteric anomaly
- specific volume
- specific volume anomaly
- geopotential anomaly
- dynamic meters
- depth (salt water, fresh water)
- salinity
- sound velocity (Chen-Millero, DelGrosso, Wilson)
- average sound velocity
- potential 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 (SBE 13 or 23) or oxygen signal (SBE 43)
- corrected irradiance (CPAR)

See *Appendix V: Derived Parameter Formulas* for the formulas used to calculate these parameters.

See **Derive TEOS-10** after this module to calculate TEOS-10 (Absolute Salinity) parameters.

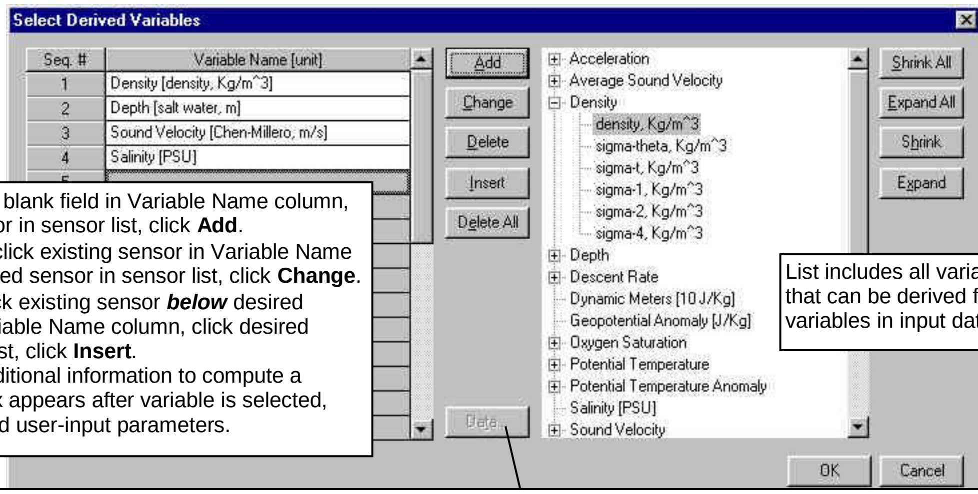
Note:
The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.

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



Begin processing data. Status field on File Setup tab shows *Processing complete* when done.

The Select Derived Variables dialog box looks like this:



- Add variable: click blank field in Variable Name column, click desired sensor in sensor list, click **Add**.
- Change variable: click existing sensor in Variable Name column, click desired sensor in sensor list, click **Change**.
- Insert variable: click existing sensor ***below*** desired sequence # in Variable Name column, click desired sensor in sensor list, click **Insert**.

If Derive requires additional information to compute a variable, a dialog box appears after variable is selected, with fields for required user-input parameters.

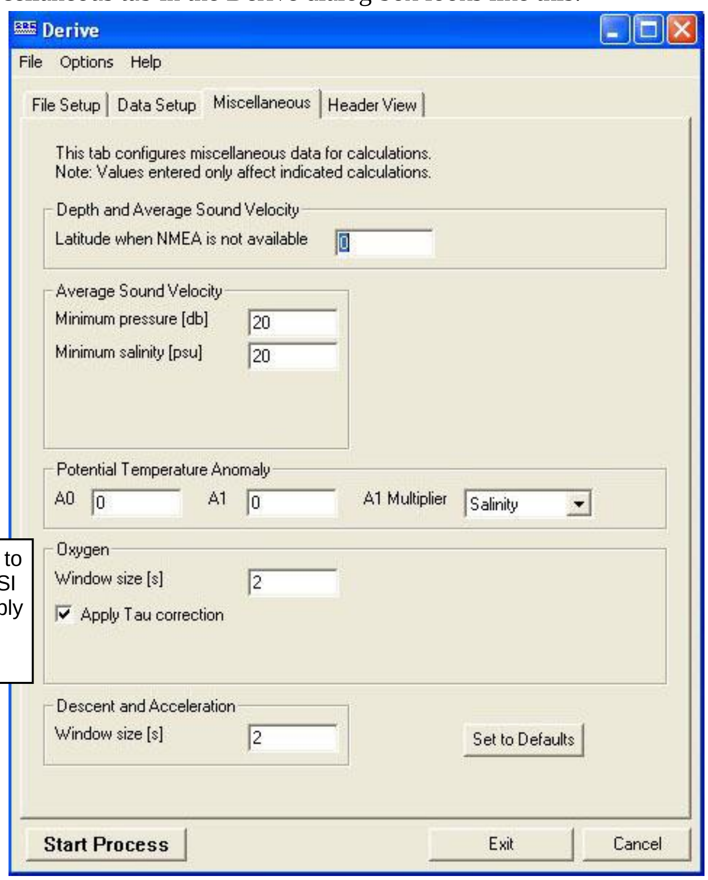
List includes all variables that can be derived from variables in input data file.

Click **Data** to view/modify user-input parameters for selected variable (if applicable). Some variables *share* a user-input parameter, so changing a parameter for one variable automatically changes it for the other:
- Depth and average sound velocity use same latitude (if NMEA data not available).
- Descent rate and acceleration use same time window size.
- All SBE 13, 23, and 43 oxygen sensors use same time window size, Tau correction, and (SBE 43 only) hysteresis correction.

Note: An alternate method of entering these parameters is on Miscellaneous tab in Derive dialog box.

The Miscellaneous tab in the Derive dialog box looks like this:

Note:
Values for these parameters can be changed on the Miscellaneous tab or by double clicking on the output variable in the Select Derived Variables dialog box (above); changes made in one location are automatically made in the other location.



Oxygen selections apply to SBE 43 and Beckman/YSI sensors. They do not apply to SBE 63 or Aanderaa Oxygen Optode.

The Miscellaneous tab defines parameters required for output of specific variables (depth, average sound velocity, potential temperature anomaly, oxygen, descent rate, and acceleration). Entries on this tab are used only if you are calculating and outputting the associated variable to the .cnv file. For example, if you do not select Oxygen in the Select Derived Variables dialog box, Derive ignores the value entered for Oxygen window size and the enabling of the Tau correction on the Miscellaneous tab.

In Derive, derivative variables (oxygen, descent rate, and acceleration) are computed by looking at data centered around the current data point with a time span equal to the user-input time window size and using a linear regression to determine the slope. This differs from how the calculation is done in Seasave and Data Conversion, which compute the derivative looking backward in time, since they share common code and Seasave cannot use future values while acquiring data in real-time.

Derive has the following /x parameter when run from the Command Line Options dialog box, from the command line, or with batch file processing:

/x Parameter	Description
/xderive:pump	For SBE 911*plus*, do not output scans if pump status = off.

See *Appendix I: Command Line Options, Command Line Operation, and Batch File Processing* for details on using parameters.

Derive adds the following to the data file header:

Label	Description
Derive_date	Date and time that module was run. Also shows how many columns of data (how many variables) were derived.
Derive_in	Input .cnv converted data file and .con or .xmlcon configuration file.
Derive_time_window_docdt	Window size for oxygen derivative calculation (seconds).
Derive_time_window_dzdt	Window size for descent rate and acceleration calculation (seconds).
Derive_ox_tau_ correction	Whether tau correction was performed on oxygen data.

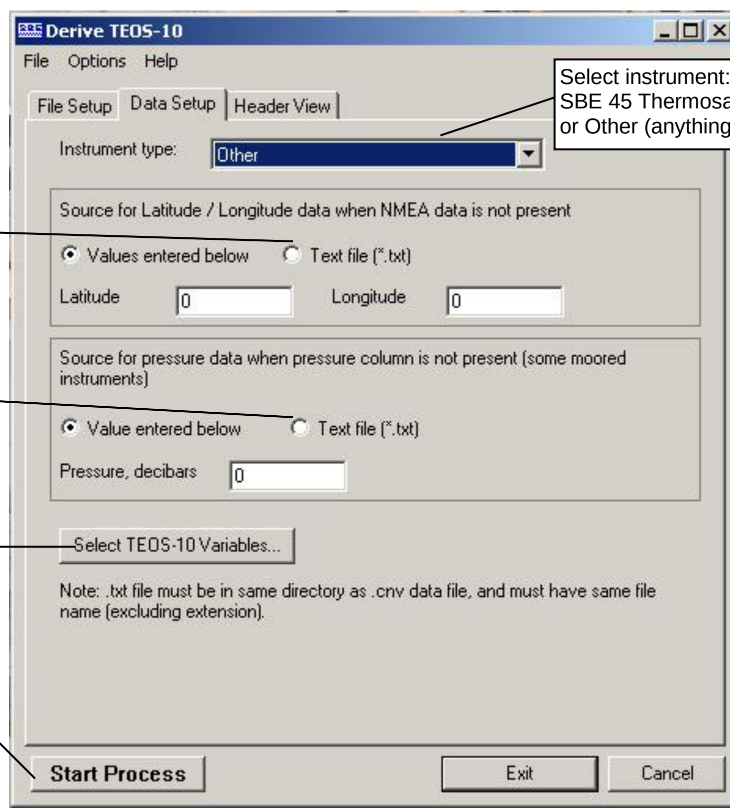
Derive TEOS-10

Notes:
- Algorithms used in Derive TEOS-10 are based on the TEOS-10 website: www.TEOS-10.org.
- Derive TEOS-10 is not compatible with a .cnv file from an **SBE 39, 39-IM, 39*plus*, 39*plus*-IM, or 48**.
- For an SBE 21 or 45 with a remote temperature sensor, Seasave, Data Conversion, Derive, and Derive TEOS-10 all use the remote temperature data when calculating density and sound velocity.

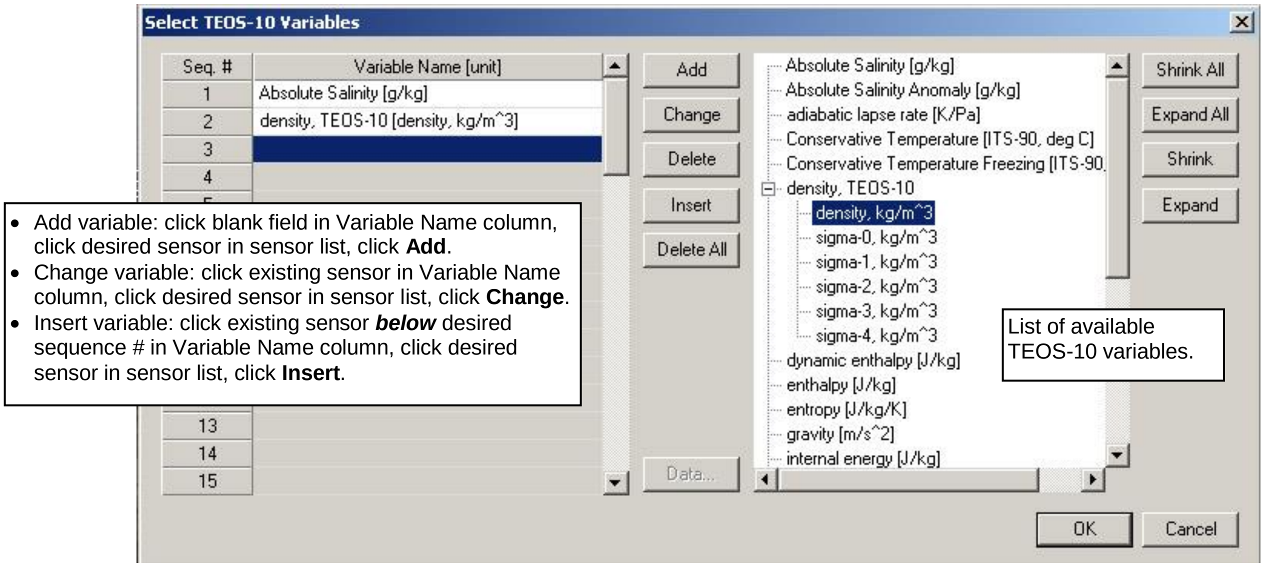
Derive TEOS-10 uses temperature, conductivity **or** salinity (Practical, EOS-80), pressure, latitude, and longitude to compute the following thermodynamic parameters using TEOS-10 equations:
- Absolute Salinity
- Absolute Salinity Anomaly
- adiabatic lapse rate
- Conservative Temperature
- Conservative Temperature freezing
- density
- dynamic enthalpy
- enthalpy
- entropy
- gravity
- internal energy
- isentropic compressibility
- latent head of evaporation
- latent heat of melting
- potential temperature
- Preformed Salinity
- Reference Salinity
- saline contraction coefficient
- sound speed
- specific volume
- specific volume anomaly
- temperature freezing
- thermal expansion coefficient

Notes:
- The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.
- (if used) Values for longitude, latitude, and pressure in .txt files are not limited to the number of digits shown in the examples.

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



The Select TEOS-10 Variables dialog box looks like this:



Derive TEOS-10 adds the following to the data file header:

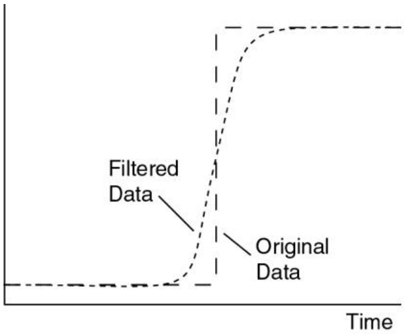
Label	Description
DeriveTEOS_10_date	Date and time that module was run. Also shows how many columns of data (how many variables) were derived.
DeriveTEOS_10_in	Input .cnv converted data file
DeriveTEOS_10_ latitude_source	Source of latitude data.
DeriveTEOS_10_ longitude_source	Source of longitude data.
Using the GSW Toolkit version xx.xx	Source and version of equations used in TEOS-10 calculations.

TEOS-10 Formulas

The following table references the C functions from www.TEOS-10.org that are implemented in Derive TEOS-10:

SBE Data Processing variable name (in Select TEOS-10 Variables dialog and in output .cnv file)	**C function from www.TEOS-10.org code**
Absolute Salinity	gsw_sa_from_sp
Absolute Salinity Anomaly	gsw_deltasa_from_sp
adiabatic lapse rate	gsw_adiabatic_lapse_rate_from_ct
Conservative Temperature	gsw_ct_from_t
Conservative Temperature freezing	gsw_ct_freezing
density, TEOS-10	gsw_rho (use gsw_rho with reference pressure for the sigmas)
dynamic enthalpy	gsw_dynamic_enthalpy
enthalpy	gsw_enthalpy
entropy	gsw_entropy_from_t
gravity	gsw_grav
internal energy	gsw_internal_energy
isentropic compressibility	gsw_kappa
latent heat of evaporation	gsw_latentheat_evap_ct
latent heat of melting	gsw_latentheat_melting
potential temperature	gsw_pt0_from_t
Preformed Salinity	gsw_sstar_from_sa
Reference Salinity	gsw_sr_from_sp
saline contraction coefficient	gsw_beta
sound speed	gsw_sound_speed
specific volume	gsw_specvol
specific volume anomaly	gsw_specvol_anom
temperature freezing	gsw_t_freezing
thermal expansion coefficient	gsw_alpha

Filter



Filter runs a low-pass filter on one or more columns of data. A low-pass filter smoothes high frequency (rapidly changing) data. To produce zero phase (no time shift), the filter is first run forward through the data and then run backward through the forward-filtered data. This removes any delays caused by the filter.

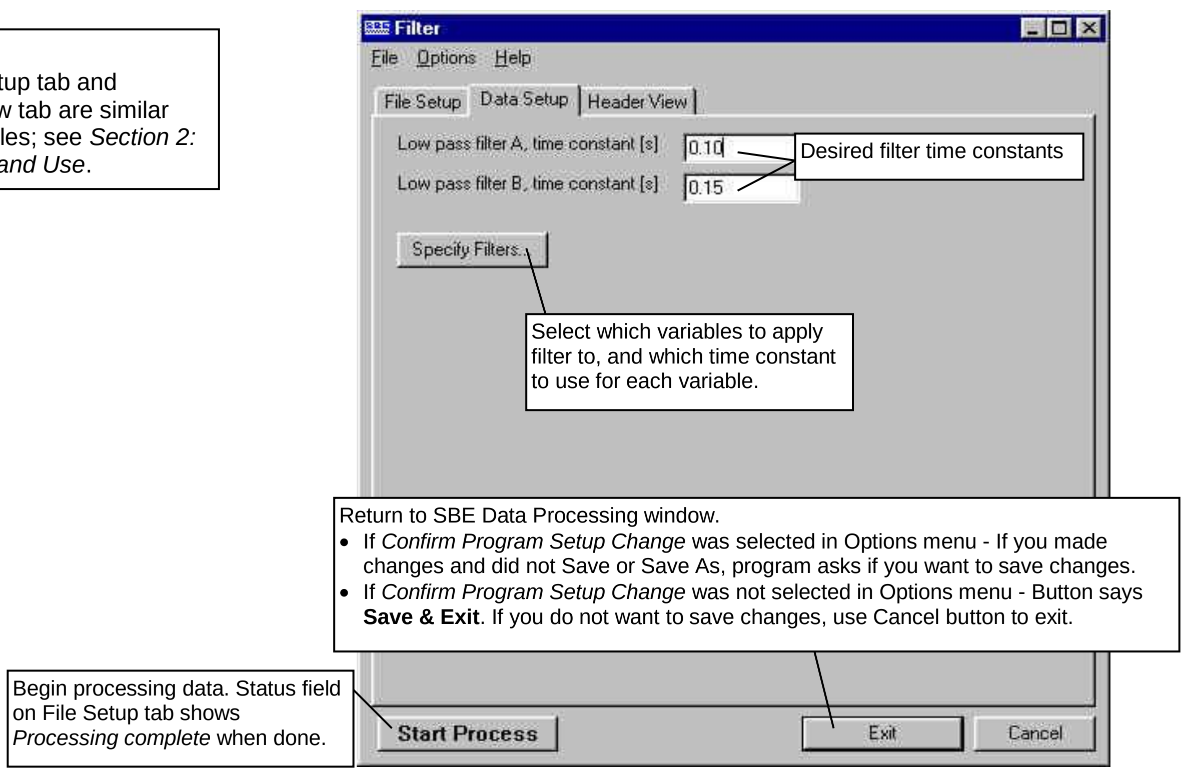
Pressure data is typically filtered with a time constant equal to four times the CTD scan rate. Conductivity and temperature are typically filtered for *some* CTDs. Two time constants can be specified, so different parameters can be filtered with different time constants in one run of Filter. Typical time constants are:

Instrument	Temperature (seconds)	Conductivity (seconds)	Pressure (seconds)
SBE 9*plus*	-	-	0.15
SBE 19*plus* or 19*plus* V2	0.5	0.5	1.0
SBE 19 (not *plus*) with or without TC duct and pump	0.5	0.5	2.0
SBE 25 or 25*plus*	0.1	0.1	0.5
SBE 49 with TC duct and 3000 rpm pump *	0.085	0.085	0.25

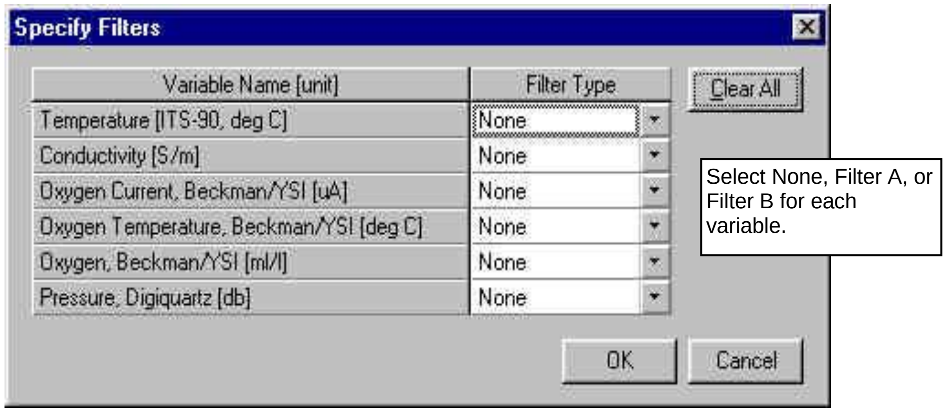
*The SBE 49 can be programmed to filter the data in real-time with a cosine window filter (see *WFilter*), eliminating the need to run Filter on temperature and conductivity data. See the SBE 49 manual for details.

Note:
The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.

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



The Specify Filters dialog box looks like this:



Filter: Formulas

For a low-pass filter with time constant Γ:

$\Gamma = 1/\omega \qquad \omega = 2\pi f$
T = sample interval (seconds)
$S_0 = 1/\Gamma$

Laplace transform of the transfer function of a low-pass filter (single pole) with a time constant of Γ seconds is:

$$H(s) = \frac{1}{1 + (S/S_0)}$$

Using the bilinear transform:

$$S - f(z) \overset{\Delta}{=} \frac{2\,(1 - z^{-1})}{T\,(1 + z^{-1})} = \frac{2\,(z-1)}{T\,(z+1)}$$

$$H(z) = \frac{1}{1 + \dfrac{2\,(z-1)}{T\,(z+1)\,S_0}} = \frac{z^{-1} + 1}{1 + \dfrac{2}{TS_0}\left\{1 + \left(\dfrac{1 - 2/TS_0}{1 + 2/TS_0}\right) z^{-1}\right\}}$$

If: $$A = \frac{1}{1 + \dfrac{2}{TS_0}} \qquad B = \frac{1 - \dfrac{2}{TS_0}}{1 + \dfrac{2}{TS_0}}$$

Then: $$H(z) = \frac{Y(z)}{X(z)} = \frac{A\,(z^{-1} + 1)}{(1 + Bz^{-1})}$$

Where z^{-1} is the unit delay (one scan behind).

y[N] = current output
y[N-1] = previous output
x[N] = input data (current scan)
x[N-1] = previous input data (from previous scan)

$Y(z)\,(1 + Bz^{-1}) = X(z)\,A\,(z^{-1} + 1)$
$y[N] + By[N-1] = Ax[N-1] + Ax[N]$
$y[N] = A(x[N] + x[N-1]) - By[N-1]$

Example: Time constant = 0.5 second, sample interval = 1/24 second

$$A = \frac{1}{(1 + 2 * 0.5 * 24)} = \frac{1}{(1 + 24)} = 0.04$$

$$B = (1 - 2 * 0.5 * 24)\ A = \frac{1 - 24}{1 + 24} = -0.92$$

Filter adds the following to the data file header:

Label	Description
Filter_date	Date and time that module was run.
Filter_in	Input .cnv converted data file.
Filter_low_pass_tc_A	Time constant for filter A.
Filter_low-Pass_tc_B	Time constant for filter B.
Filter_low_pass_A_vars	List of variables filtered with time constant A.
Filter_low_pass_B_vars	List of variables filtered with time constant B.

Loop Edit

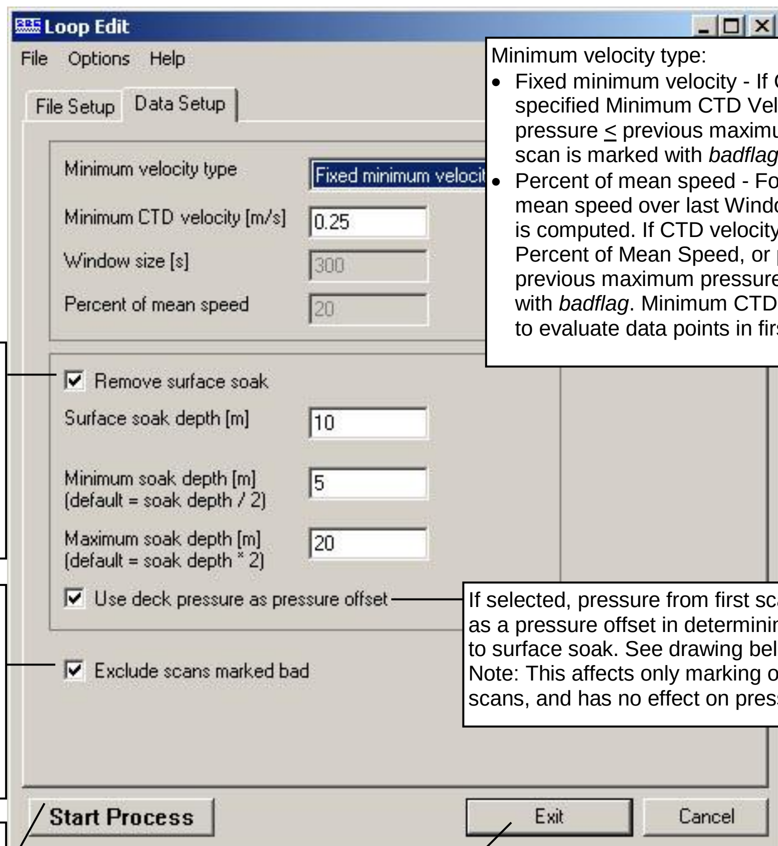
Loop Edit marks scans *bad* by setting the flag value associated with the scan to *badflag* in input .cnv files that have pressure slowdowns or reversals (typically caused by ship heave). Optionally, Loop Edit can also mark scans associated with an initial surface soak with *badflag*. The *badflag* value is documented in the input .cnv header.

Note:
Data Conversion calculates velocity with a 2-second window (e.g., 48 scans for an SBE 9*plus*), giving a much smoother measure of velocity.

Loop Edit operates on three successive scans to determine velocity. This is such a fine scale that noise in the pressure channel from counting jitter or other unknown sources can cause Loop Edit to mark scans with *badflag* in error. **Therefore, you must run Filter on the pressure data to reduce noise before you run Loop Edit**. See *Filter* for pressure filter recommendations for each instrument.

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

Note:
The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.



Minimum velocity type:
- Fixed minimum velocity - If CTD velocity < specified Minimum CTD Velocity, or pressure ≤ previous maximum pressure, scan is marked with *badflag*.
- Percent of mean speed - For each scan, mean speed over last Window Size seconds is computed. If CTD velocity < specified Percent of Mean Speed, or pressure ≤ previous maximum pressure, scan is marked with *badflag*. Minimum CTD Velocity is used to evaluate data points in first time window.

If selected, scans related to surface soak are marked with *badflag*, based on Minimum soak depth and Maximum soak depth (note that Surface soak depth is not actually used in calculation of surface soak scans). See drawing below for details.

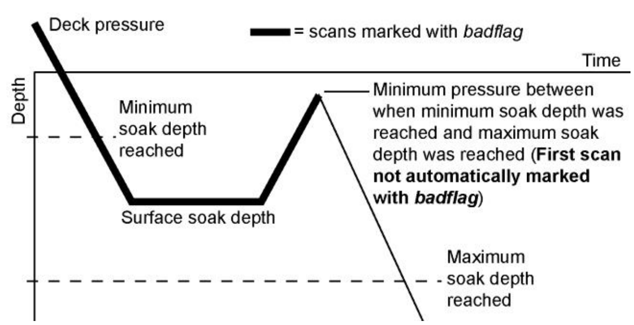
If selected, pressure from first scan in file is used as a pressure offset in determining scans related to surface soak. See drawing below for details. Note: This affects only marking of surface soak scans, and has no effect on pressure data in file.

- If selected, scans previously marked with *badflag* (for example, in a previous run of Loop Edit) will not be evaluated.
- If not selected, scans previously marked with *badflag* will be reevaluated, and scan's flag will be reset accordingly.

Begin processing data. Status field on File Setup tab shows *Processing complete* when done.

Return to SBE Data Processing window.
- If *Confirm Program Setup Change* was selected in Options menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Program Setup Change* was not selected in Options menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Algorithm for removal of surface soak data



Loop Edit adds the following to the data file header:

Label	Description
Loopedit_date	Date and time that module was run.
Loopedit_in	Input .cnv converted data file.
Loopedit_minVelocity	If *Fixed Minimum Velocity* was selected - minimum CTD velocity for good scans; scans with velocity less than this are marked with *badflag*.
Loopedit_percentMeanSpeed	If *Percent of Mean Speed* was selected - minimum CTD velocity for first time window, window size, and percent of mean speed for good scans; scans that do not meet this criteria are marked with *badflag*.
Loopedit_surfaceSoak	If *Remove surface soak* was selected – minimum soak depth, maximum soak depth, and whether to use deck pressure as a pressure offset (1 = yes, 0 = no).
Loopedit_excl_bad_scans	If yes, do not evaluate scans marked with *badflag* in a previous run of Loop Edit.

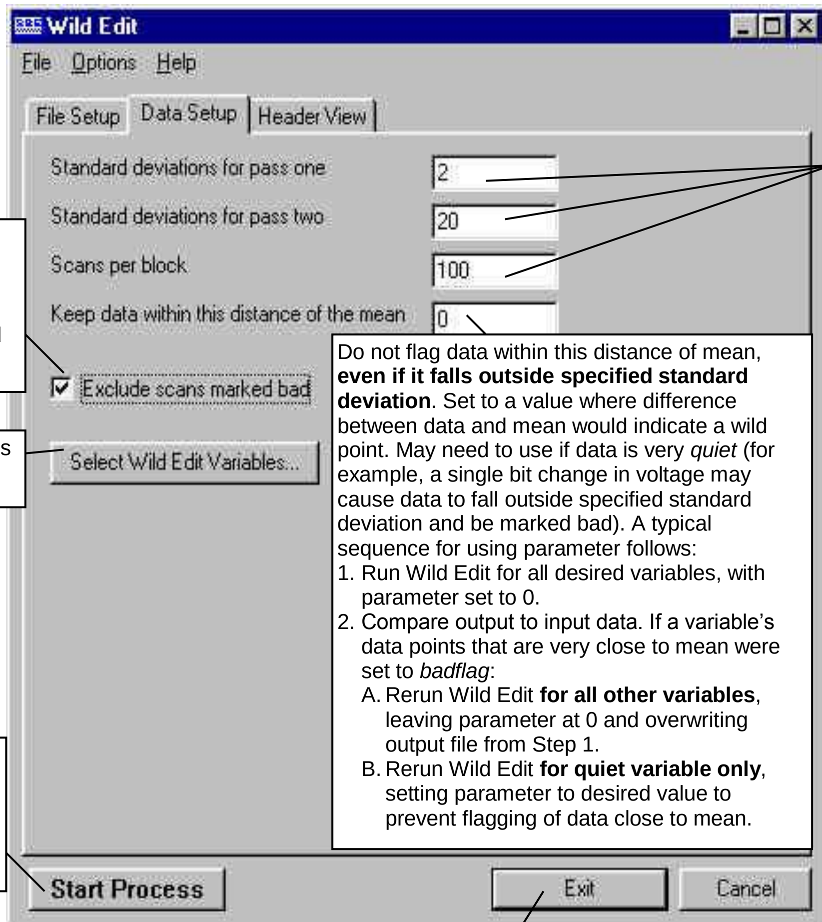
Wild Edit

> **Note:**
> Wild Edit marks **individual data** (for example, a conductivity value) with *badflag*, but does not mark the entire scan (which may include other data that is valid, such as temperature, pressure, etc.).

> **Note:**
> The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.

Wild Edit marks wild points in the data by replacing the data value with *badflag*. The *badflag* value is documented in the input .cnv header.
Wild Edit's algorithm requires two passes through the data: the first pass obtains an accurate estimate of the data's true standard deviation, while the second pass replaces the appropriate data with *badflag*.

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



Wild Edit operates as follows:
1. Compute mean and standard deviation of data in block (specified by Scans per Block) for each selected variable. **Temporarily** flag values that differ from mean by more than standard deviations specified for pass 1.
2. Recompute mean and standard deviation, excluding temporarily flagged values. Mark values that differ from mean by more than standard deviations specified for pass 2 by replacing data value with *badflag*.
3. Repeat Steps 1 and 2 for next block of scans.
   - If last block of data in input file has less than specified number of scans, use data from previous block to fill in block.

If selected, data from scans marked with *badflag* in Loop Edit will not be used in calculating mean and standard deviation.

Do not flag data within this distance of mean, **even if it falls outside specified standard deviation**. Set to a value where difference between data and mean would indicate a wild point. May need to use if data is very *quiet* (for example, a single bit change in voltage may cause data to fall outside specified standard deviation and be marked bad). A typical sequence for using parameter follows:
1. Run Wild Edit for all desired variables, with parameter set to 0.
2. Compare output to input data. If a variable's data points that are very close to mean were set to *badflag*:
   A. Rerun Wild Edit **for all other variables**, leaving parameter at 0 and overwriting output file from Step 1.
   B. Rerun Wild Edit **for quiet variable only**, setting parameter to desired value to prevent flagging of data close to mean.

Select which variables to run Wild Edit on.

Begin processing data. Status field on File Setup tab shows *Processing complete* when done.

Return to SBE Data Processing window.
- If *Confirm Program Setup Change* was selected in Options menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Program Setup Change* was not selected in Options menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

If the data file is particularly corrupted, you may need to run Wild Edit more than once, with different block sizes and number of standard deviations.

If the input file has some variables with large values and some with relatively smaller values, it may be necessary to run Wild Edit more than once, varying the value for *Keep data within this distance of mean* so that it is meaningful for each variable. Better results may also be obtained by increasing *Scans per block* from 100 to around 500.

Example
Sensor A's range is approximately 1000 and Sensor B's range is approximately 10. Run Wild Edit on Sensor A, using *Keep data within this distance of mean* = 10. Then run Wild Edit on Sensor B, using *Keep data within this distance of mean* = 0.1

Wild Edit adds the following to the data file header:

Label	Description
Wildedit_date	Date and time that module was run.
Wildedit_in	Input .cnv converted data file.
Wildedit_pass1_nstd	Number of standard deviations for pass 1 test.
Wildedit_pass2_nstd	Number of standard deviations for pass 2 test.
Wildedit_pass2_mindelta	Keep data within this distance of mean.
Wildedit_npoint	Number of points to include in each test.
Wildedit_vars	List of the variables tested for wild points.
Wildedit_excl_bad_scans	If yes, values in scans marked with *badflag* (in Loop Edit) will not be used to determine standard deviation.

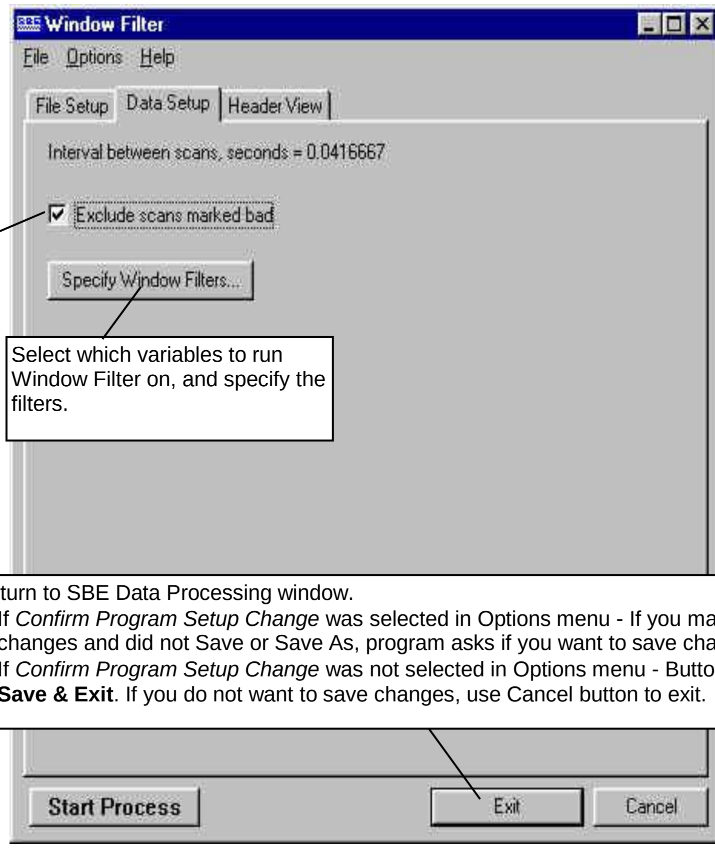
Window Filter

Window Filter provides four types of window filters and a median filter for data smoothing of .cnv files:

- Window filters calculate a weighted average of data values about a center point and replace the data value at the center point with this average.
- The median filter calculates a median for data values about a center point and replaces the data value at the center point with the median.

Note:
The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.

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

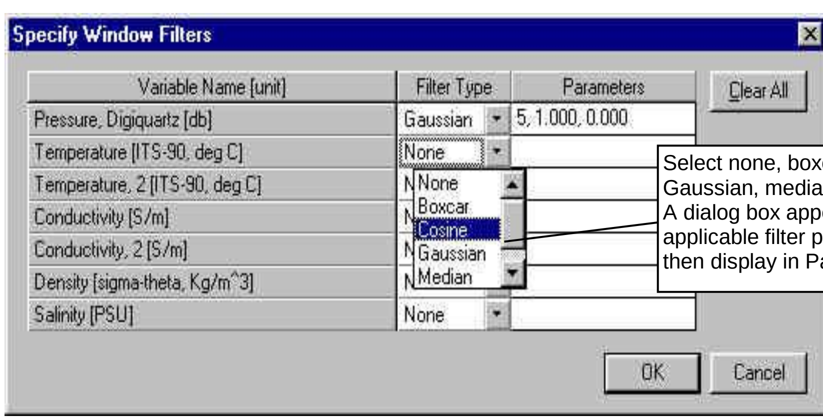


If selected, data from scans marked with *badflag* in Loop Edit will not be used.

Select which variables to run Window Filter on, and specify the filters.

Return to SBE Data Processing window.
- If *Confirm Program Setup Change* was selected in Options menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Program Setup Change* was not selected in Options menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

The Specify Window Filters dialog box looks like this:



Select none, boxcar, cosine, Gaussian, median, or triangle filter. A dialog box appears to enter applicable filter parameters, which then display in Parameters column.

Window Filters: Descriptions and Formulas

Shape and length define filter windows:

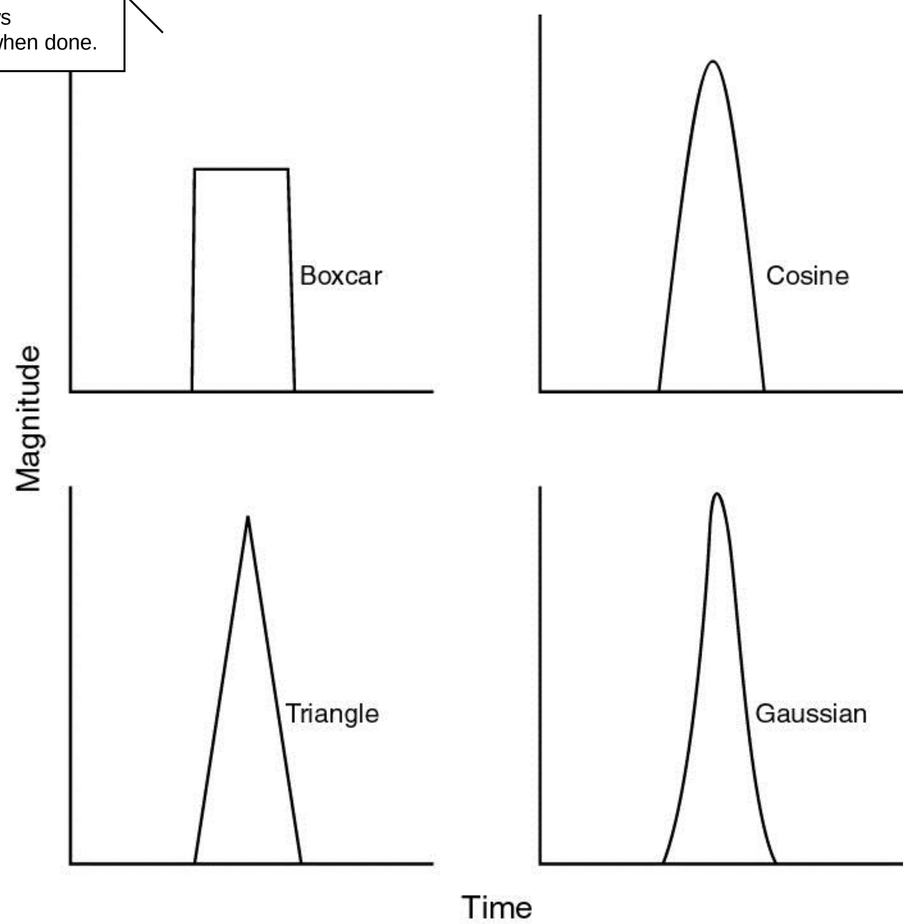
- Window Filter provides four window **shapes**: boxcar, cosine, triangle, and Gaussian.
- The minimum window **length** is 1 scan, and the maximum is 511 scans. Window length must be an odd number, so that the window has a center point. If a window length is specified as an even number, Window Filter automatically adds 1 to make the length odd.

The window filter calculates a weighted average of data values about a center point, using the following transfer function:

$$y(n) = \sum_{k=-L/2}^{L/2} w(k)\ x(n-k)$$

The figure below shows the impulse response of each of the four filter types for a filter of length 17 scans. The impulse response of a filter is obtained by filtering a data set that has zeros everywhere except one data value that is set to 1.

Begin processing data. Status field on File Setup tab shows *Processing complete* when done.



Note:
In the window filter equations:
- L = window length in scans, (always an odd number)
- n = window index, -L/2 to +L/2, with 0 the center point of the window
- w(n) = set of window weights

The window filtering process is similar for all filter types:
1. Filter weights are calculated (see the equations below).
2. Filter weights are normalized to sum to 1.
   - When a bad data point is encountered (scan marked with *badflag* if *exclude scans marked bad* was selected **or** data value marked with *badflag*), the weights are renormalized, excluding the filter element that would operate on the bad data point.

Boxcar Filter

$$w(n) = \frac{1}{L} \quad \textit{for } n = -\frac{L-1}{2} \,..\, \frac{L-1}{2}$$

Cosine Filter

$$w(n) = 1 \quad \textit{for } n = 0$$

$$w(n) = \cos \frac{n \times \pi}{L+1} \quad \textit{for } n = -\frac{L-1}{2} \,..\, -1,\ 1 \,..\, \frac{L-1}{2}$$

Triangle Filter

$$w(n) = 1 \quad \textit{for } n = 0$$

$$w(n) = \frac{|n|}{K} \quad \textit{for } n = -\frac{L-1}{2} \,..\, -1,\ 1 \,..\, \frac{L-1}{2}$$

$$\textit{where } K = \frac{L-1}{2} + 1$$

Gaussian Filter

$$\textit{phase} = \frac{\textit{offset}\ (\mathrm{sec})}{\textit{sample interval}\ (\textit{sec})}$$

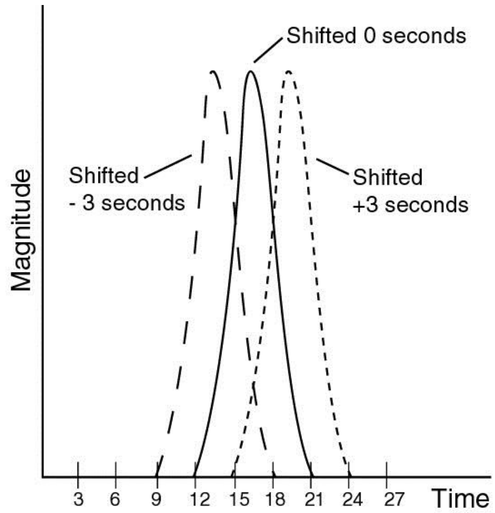
$$\textit{scale} = \log(2) \times \left(2 \times \frac{\textit{sample rate}}{\textit{half width}\ (\mathrm{scans})}\right)^2$$

$$w(n) = e^{-\textit{phase} \times \textit{phase} \times \textit{scale}} \quad \textit{for } n = 0$$

$$w(n) = e^{-(n - \textit{phase})^2 \times \textit{scale}} \quad \textit{for } n = -\frac{L-1}{2} \,..\, -1,\ 1 \,..\, \frac{L-1}{2}$$

The Gaussian window has parameters of halfwidth (in scans) and offset (in time), in addition to window length (in scans). These extra parameters allow data to be filtered and shifted in time in one operation. Halfwidth determines the width of the Gaussian curve. A window length of 9 and halfwidth of 4 produces a set of filter weights that fills the window. A window length of 17 and halfwidth of 4 produces a set of filter weights that fills only half the window. If the filter weights do not fill the window, the offset parameter may be used to shift the weights within the window without clipping the edge of the Gaussian curve.

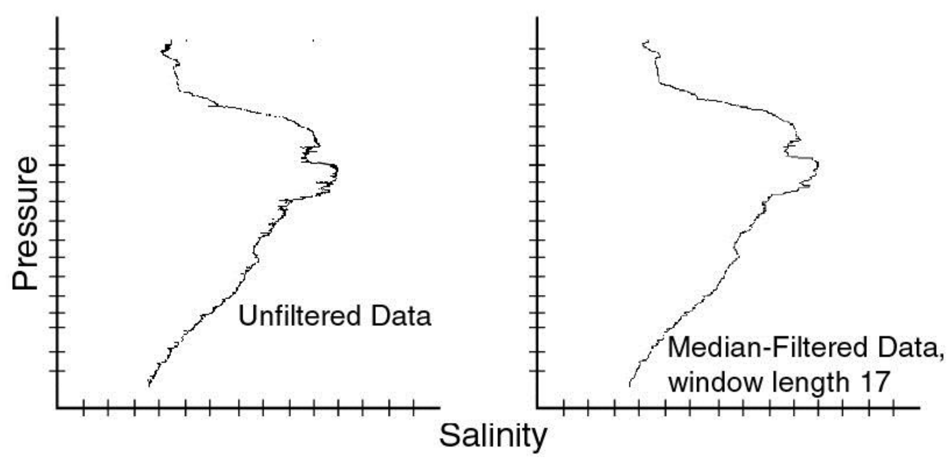
Example: Window length is 33 scans and halfwidth is 4 scans. Offset is -3 seconds in left curve, 0 in middle curve, and +3 seconds in right curve.



Note that the window length in the example is larger than the halfwidth. This allows the complete Gaussian curve to be expressed in the window when the offset parameter shifts the curve forward or backward in time. If the halfwidth was larger, the trailing edge of the -3 second offset curve would be truncated and the leading edge of the +3 second curve would be truncated. The offset parameter moves the Gaussian shape of the window weights forward or backward in time. Since the weighted average is calculated for a data value in the center of the window, this has the effect of shifting the data that the filter is operating on forward or backward in time relative to the other data in the file. This capability allows filtering and time shifting to be done in one step.

Median Filter: Description

The median filter is not a smoothing filter in the same sense as the window filters described above. Median filtering is most useful in spike removal.
A median value is determined for a specified window, and the data value at the window's center point is replaced by the median value.



Window Filter has the following /x parameter when run from the Command Line Options dialog box, from the command line, or with batch file processing:

/x Parameter	Description
/xwfilter:diff	Output difference between original and filtered value instead of outputting filtered value.

See *Appendix I: Command Line Options, Command Line Operation, and Batch File Processing* for details on using parameters.

Window Filter adds the following to the data file header:

Label	Description
Wfilter_date	Date and time that module was run.
Wfilter_in	Input .cnv converted data file.
Wfilter_excl_ bad_scans	If yes, values in scans marked with *badflag* in Loop Edit will not be used.
Wfilter_action	Data channel identifier, filter type, filter parameters.

Section 7: File Manipulation Modules

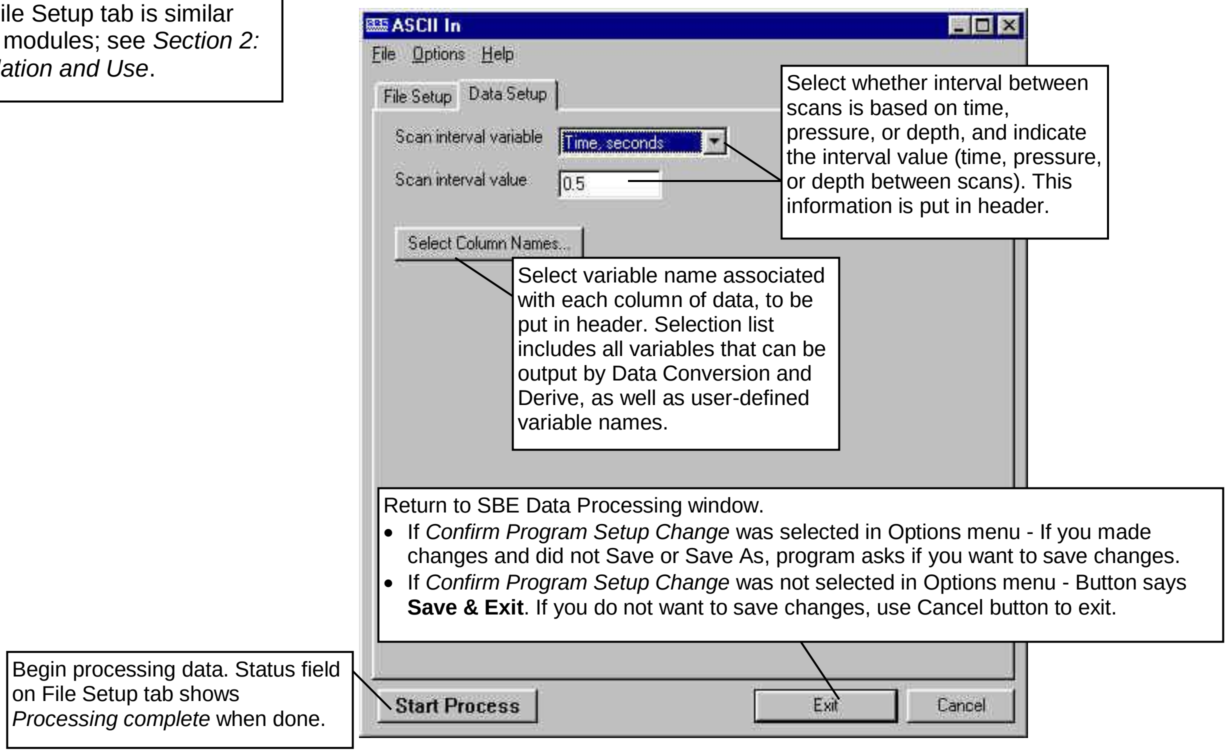
Module Name	Module Description
ASCII In	Add header information to a .asc file containing rows and columns of ASCII data.
ASCII Out	Output data portion and/or header portion from .cnv converted data file to an ASCII file (.asc for data, .hdr for header). Useful for exporting converted data for processing by other (non-Sea-Bird) software.
Section	Extract rows of data from .cnv converted data file.
Split	Split data in .cnv converted data file into upcast and downcast files.
Strip	Extract columns of data from .cnv converted data file.
Translate	Convert data format in .cnv converted data file from ASCII to binary, or vice versa.

ASCII In

ASCII In adds a header to a .asc file that contains rows of ASCII data. The data can be separated by spaces, commas, or tabs (or any combination of spaces, commas, and tabs). The output file, which contains both the header and the data, is a .cnv file. ASCII In can be used to add a header to data that was generated by a non-Seasoft program.

> **Note:**
> The File Setup tab is similar for all modules; see *Section 2: Installation and Use*.

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



ASCII In creates a data file header containing the following information:

Label	Description
Nquan	Number of columns (fields) of data. **NOTE**: ASCII In automatically adds 1 field to number of fields in input .asc file (i.e., if the .asc file contains 3 columns of data, then nquan=4). This field, initially set to 0, is used by Loop Edit to mark bad scans.
Nvalues	Number of scans converted.
Units	Specified (indicates units are specified separately for each variable).
Name n	Sensor (and units) associated with data in column n.
Span n	Span (highest - lowest value) of data in column n.
Interval	Scan rate (seconds).
Start_time	Start time for when ASCII In was run.
Bad_flag	Provided for information only; value that Loop Edit will use to mark bad scans and Wild Edit will use to mark bad data values.
Asciiin_in	Input .asc data file.
File type	Selected output file type - ASCII data.

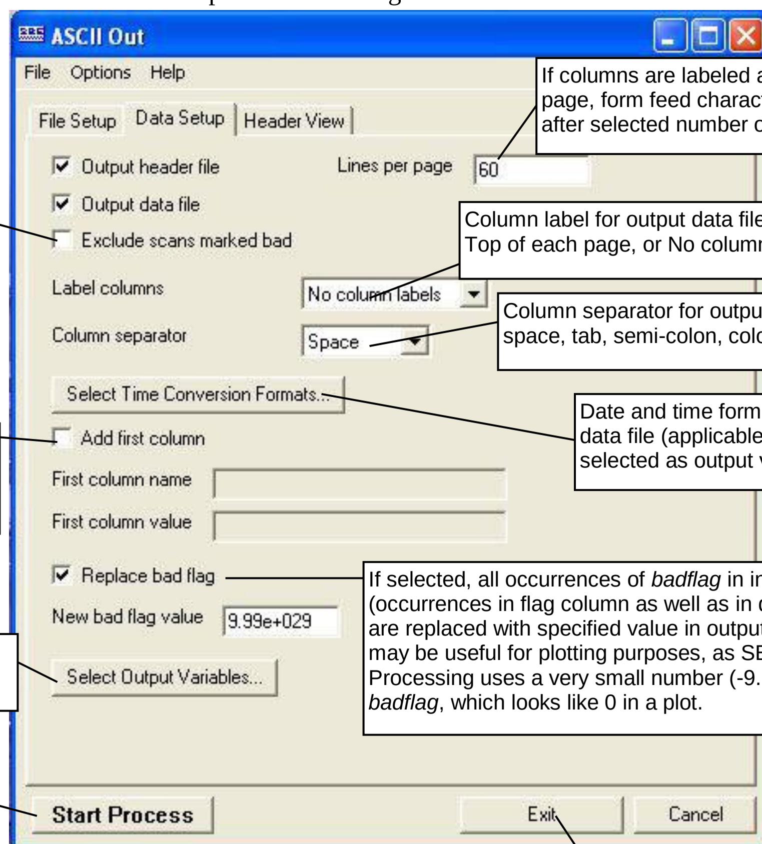
ASCII Out

> **Note:**
> The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.

ASCII Out outputs the header portion and/or the data portion of a converted data file (.cnv).

- The data portion is written in ASCII engineering units to a .asc file, and may be useful if you are planning to export converted data for processing by other (non-Sea-Bird) software.
- The header portion is written to a .hdr file.

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



ASCII Out has the following /x parameter when run from the Command Line Options dialog box, from the command line, or with batch file processing:

/x Parameter	Description
/xascii_out:first_ column_value=string	string = value (maximum of 11 characters) placed in each row of column inserted before first column of data.
/xascii_out:label_ format=mon/day/yr_ hh:mm	mon/day/yr is heading for date column; hh:mm is heading for time column.

See *Appendix I: Command Line Options, Command Line Operation, and Batch File Processing* for details on using parameters.

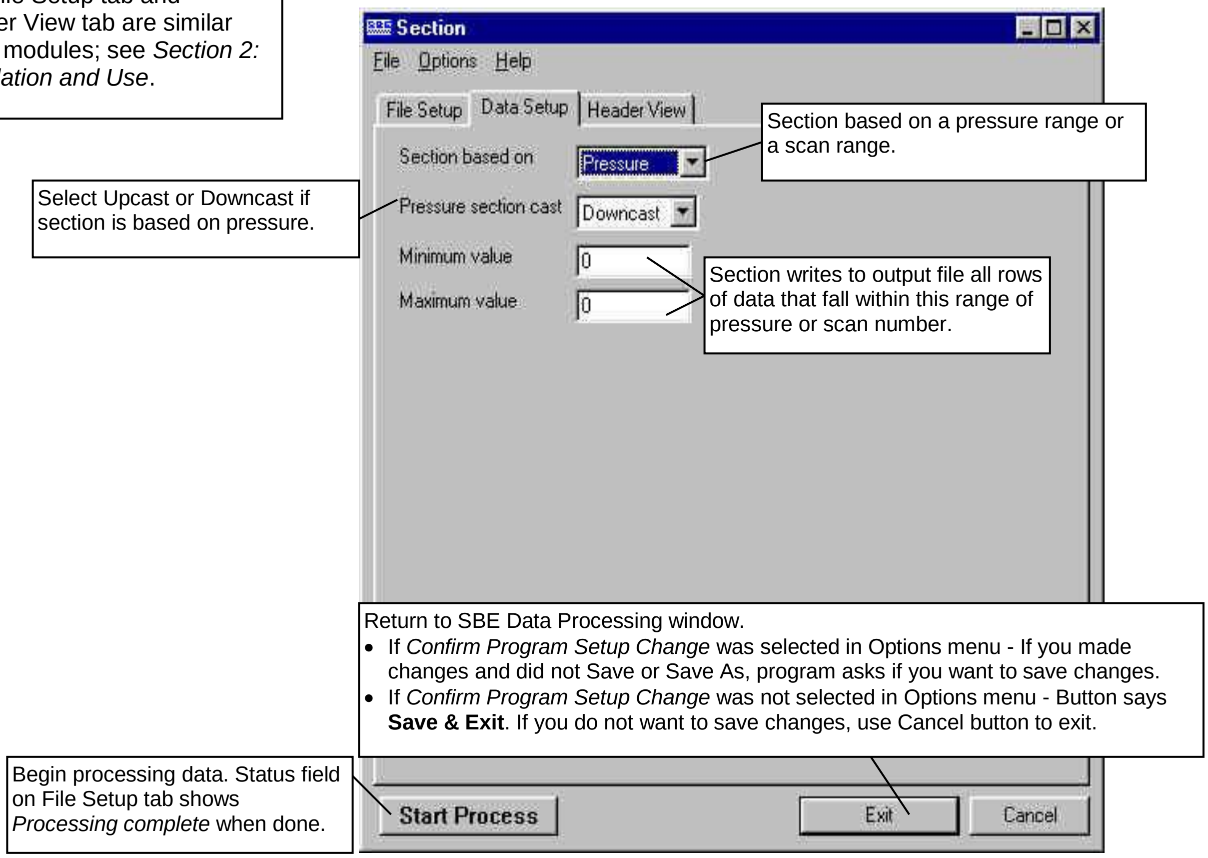
ASCII Out does not add anything to the data file header. The output header (.hdr) file contains the header from the input (.cnv) file.

Section

Section extracts **rows** of data from the input .cnv file, based on a pressure range or scan number range, and writes the rows to an output .cnv file.

> **Note:**
> The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.

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



Section adds the following to the data file header:

Label	Description
Section_date	Date and time that module was run.
Section_in	Input .cnv converted data file.
Section_type	Evaluate data based on pressure or scan range.
Section_range	Range of (pressure or scan count) data to keep.

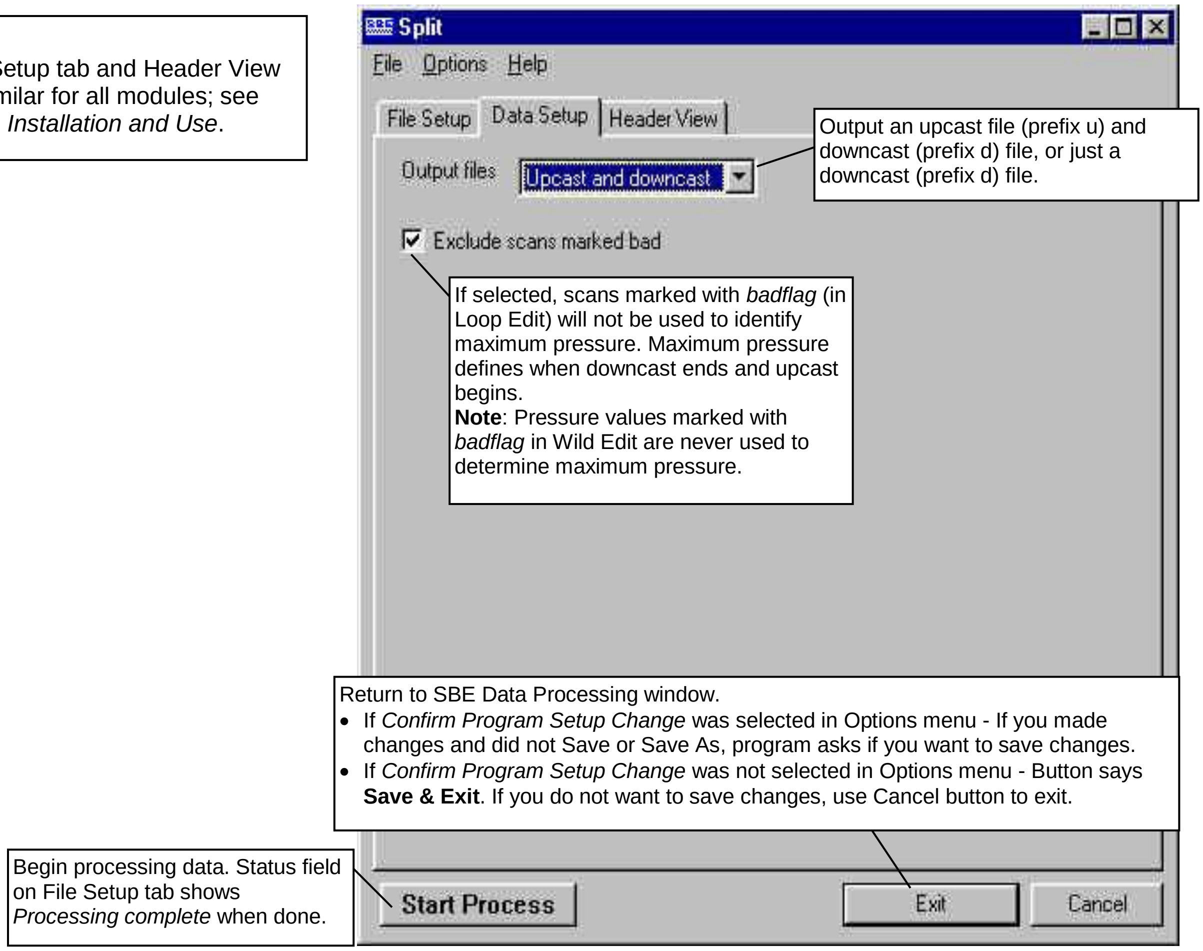
Split

Note:
Bin Average provides the option of processing upcast, downcast, or both, possibly removing the need to run Split.

Note:
The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.

Split separates the data from an input .cnv file into upcast (pressure decreasing) and downcast (pressure increasing) files. Split writes the data to an output .cnv file(s). The upcast output file name is the input file name prefixed by **u**. The downcast output file name is the input file name prefixed by **d**.

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



Split adds the following to the data file header:

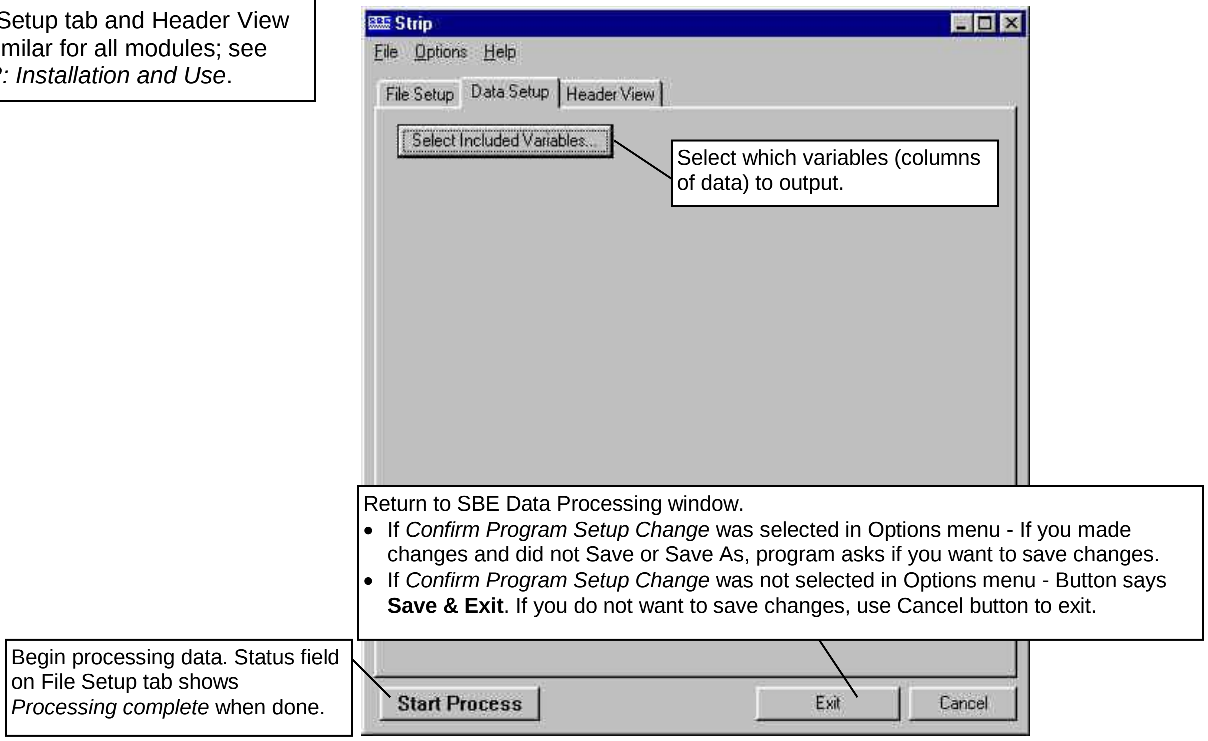
Label	Description
Split_date	Date and time that module was run.
Split_in	Input .cnv converted data file.
Split_excl_bad_scans	If *Yes*, pressure from scans marked with *badflag* (in Loop Edit) were not used to determine maximum pressure (for determining when downcast ends and upcast begins).

Strip

Strip outputs selected columns of data from the input .cnv file. Strip writes the data to an output .cnv file.

Note:
The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.

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



Strip adds the following to the data file header:

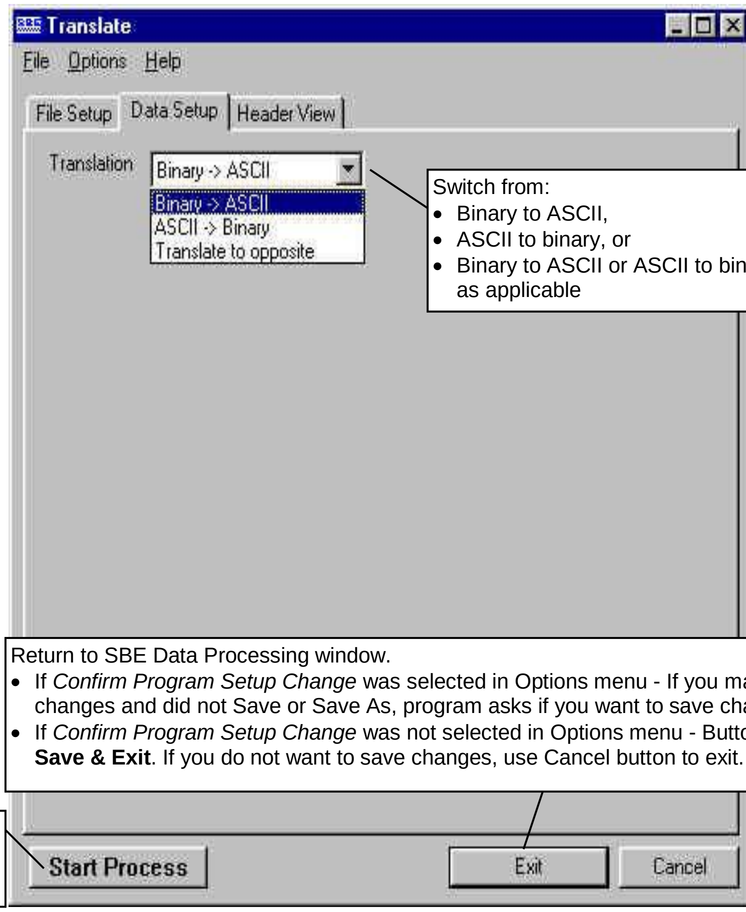
Label	Description
Strip_date	Date and time that module was run.
Strip_in	Input .cnv converted data file.

Translate

Translate changes the converted data file format from binary to ASCII or vice versa, and writes the data to an output .cnv file.

Note:
The File Setup tab and Header View tab are similar for all modules; see *Section 2: Installation and Use*.

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



Switch from:
- Binary to ASCII,
- ASCII to binary, or
- Binary to ASCII or ASCII to binary, as applicable

Return to SBE Data Processing window.
- If *Confirm Program Setup Change* was selected in Options menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Program Setup Change* was not selected in Options menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Begin processing data. Status field on File Setup tab shows *Processing complete* when done.

Translate changes the following in the data file header:

Label	Description
File_type	File type - changes to ASCII or binary, as applicable.

Section 8: Data Plotting Module – Sea Plot

Notes:
- Converted data (.cnv) files are typically created in Data Conversion and manipulated in other SBE Data Processing modules. Sea Plot can plot data at any point after Data Conversion has been run.
  - For SBE 37 (firmware < 3.0), 39, 39-IM, and 48, a converted (.cnv) data file is created from an uploaded .asc file using the Convert button in Seaterm's Toolbar.
  - For SBE 39*plus* and 39*plus*-IM, a converted (.cnv) data file is created from an uploaded .xml file using *Convert .XML data file* in SeatermV2's Tools menu or *Convert XML Data* button in SeatermUSB.
- Algorithms for calculation of derived parameters in Data Conversion, Derive, Sea Plot, SeaCalc III [EOS-80 (Practical Salinity) tab], and Seasave are identical, except as noted in *Appendix V: Derived Parameter Formulas (EOS-80; Practical Salinity)*, and are based on EOS-80 equations.
- Calculation of Absolute Salinity and associated parameters **(TEOS-10) is available in Derive TEOS-10 and SeaCalc III [TEOS-10 (Absolute Salinity) tab]. Once they are calculated in Derive TEOS-10, they can be plotted in Sea Plot. See *Section 6: Data Processing Modules* and *Section 9: Miscellaneous Module – SeaCalc III*.**

Note:
When plotting date and time, the following restrictions apply:
- On the Plot Setup tab, select *Single X – Multiple Y* or *Single X – Multiple Y, Overlay* for plot type
- On the X Axis tab, select *Julian days* or *Elapsed time* for the variable, and select *Show as Date/Time.*
- On the X Axis tab, **do not** select *Reverse scale direction*.

Sea Plot can be used to plot C, T, and P, as well as derived variables and data from auxiliary sensors, from any converted .cnv data file. Sea Plot can:

- Plot up to 5 variables on one plot, with a single X axis and up to four Y axes or a single Y axis and up to four X axes.
- Plot any variable on a linear or logarithmic scale (logarithmic scale not applicable to TS plots).
- Derive and plot *derived salinity* and/or *derived density*, if conductivity, temperature, and pressure data are in the input file. This allows you to skip running Derive if salinity and density are the only derived parameters you are interested in. Alternatively, you can calculate and plot *derived salinity* and/or *derived density* even if salinity and density are already in the input file; the values may differ because of processing steps performed on C, T, or P after Derive was run. **Note that the calculations for *derived salinity* and *derived density* are based on EOS-80 equations (Practical Salinity)**. For TEOS-10 (Absolute Salinity), you must calculate the parameters in Derive TEOS-10 before plotting with Sea Plot.
- Plot time series data; the time scale selections include Julian Days, elapsed time in hours, minutes, or seconds, or date and time.
- Create contour plots, generating density (sigma-t or sigma-theta) or thermosteric anomaly contours on temperature-salinity (TS) plots.
- Process and plot multiple input files that contain the same variables and with the same setup parameters, each on their own plot, allowing the user to quickly switch the view from one file to the next.
- Process and plot multiple input files that contain the same variables on an overlay plot, allowing the user to view multiple sets of data at the same time. If desired, the user can offset each file on the plot to create a *waterfall* plot.
- Zoom in on plot features.
- Send plots to a printer, save plots to the clipboard for insertion in another program (such as Microsoft Word), or save plots as graphic files in bitmap, metafile, or JPEG format.
- Run in batch processing mode. See *Appendix I: Command Line Options, Command Line Operation, and Batch File Processing*.

The Sea Plot dialog box differs somewhat from the other SBE Data Processing modules. Each tab of the Sea Plot dialog box is described below, as well as options for viewing, printing, and saving a plot.

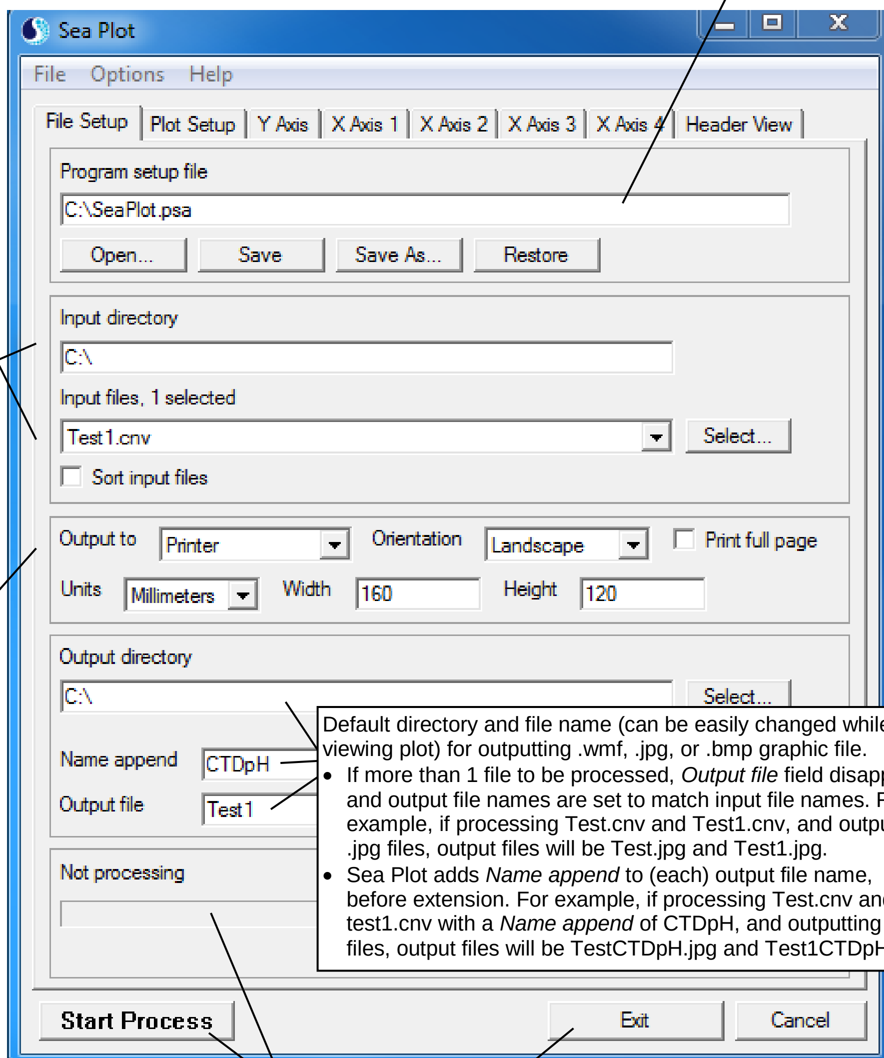
Sea Plot File Setup Tab

The File Setup tab defines the Program Setup file; input data file(s); and output type, orientation, and (if applicable) file name. The File Setup tab looks like this:

File to store **all** information input in File, Plot, and Axis Setup tabs. **Open** to select a different .psa file, **Save** or **Save As** to save current settings, or **Restore** to reset all settings to match last saved version.

Input data directory and file names. **Select** to pick a different file.
To process multiple files from same directory:
1. Click **Select**.
2. In Select dialog box, hold down Ctrl key while clicking on each desired file.

If multiple files selected, header in each file must contain same set of sensors and variables.
For overlay plots:
- If *Sort input files* selected: Sea Plot sorts input files in alphabetical order.
- If *Sort input files* **not** selected: Sea Plot maintains order of files as you selected them using Ctrl key. Use this feature if there is a particular data set you want to use as *base* on a waterfall overlay plot. Note that using Shift key to select files will not maintain selected order.



Output Information is default, and is only used automatically for batch processing or when running with *Auto start* command line option. For all other cases, Sea Plot does not automatically print or output plot to file when you click Start Process. You can choose to print or output plot to file while viewing a plot; output destination and parameters can be easily changed at that time.
- **Output to**: Printer, Metafile (.wmf), JPEG (.jpg), or Bitmap (.bmp). When viewing plot, you can also output to clipboard; from clipboard, you can paste plot into another application (such as Microsoft Word).
- **Orientation**: if outputting to printer. Driver default, Landscape, or Portrait. If Driver default selected, orientation determined by default for printer you select.
- **Print full page**: Applicable for outputting to printer. If selected, Sea Plot sizes plot to fit $8^1/_2$ x 11 inch paper. If not selected, input desired plot size (**Units**, **Width**, and **Height**).
- **Units**, **Width**, and **Height**: Plot size. Applicable when outputting to printer (if *Print full page* was not selected), or graphics file.

Default directory and file name (can be easily changed while viewing plot) for outputting .wmf, .jpg, or .bmp graphic file.
- If more than 1 file to be processed, *Output file* field disappears and output file names are set to match input file names. For example, if processing Test.cnv and Test1.cnv, and outputting .jpg files, output files will be Test.jpg and Test1.jpg.
- Sea Plot adds *Name append* to (each) output file name, before extension. For example, if processing Test.cnv and test1.cnv with a *Name append* of CTDpH, and outputting .jpg files, output files will be TestCTDpH.jpg and Test1CTDpH.jpg.

Click **Start Process** to begin processing data. Status field shows *Processing complete* when done.

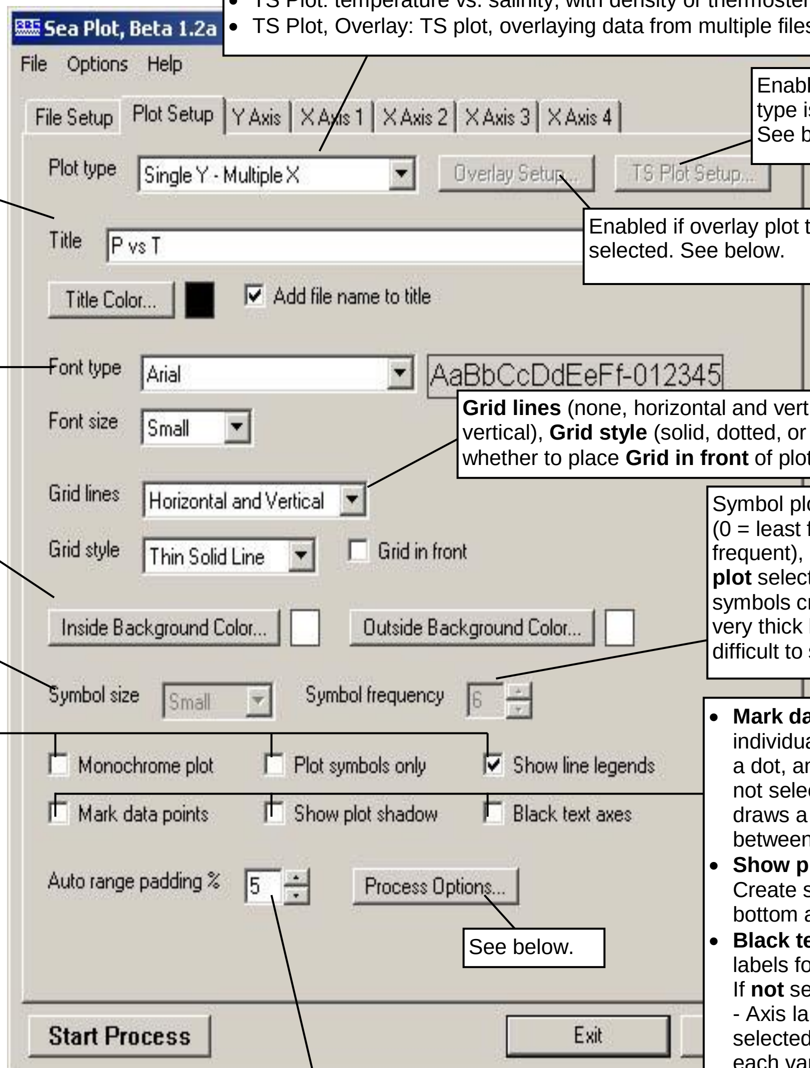
Return to SBE Data Processing window.
- If *Confirm Program Setup Change* selected in Options menu - If you made changes and did not Save or Save As, program asks if you want to save changes.
- If *Confirm Program Setup Change* not selected in Options menu - Button says **Save & Exit**. If you do not want to save changes, use Cancel button to exit.

Sea Plot Plot Setup Tab

The Plot Setup tab defines the plot type, scans to be included, and plot layout (title, color, font grid lines, etc.). The Plot Setup tab looks like this:

- Single X - Multiple Y: 1 X axis and up to 4 Y axes
- Single X - Multiple Y, Overlay: 1 X axis and up to 4 Y axes, overlaying data from multiple files on 1 plot
- Single Y - Multiple X: 1 Y axis and up to 4 X axes
- Single Y - Multiple X, Overlay: 1 Y axis and up to 4 X axes, overlaying data from multiple files on 1 plot
- TS Plot: temperature vs. salinity, with density or thermosteric anomaly contours
- TS Plot, Overlay: TS plot, overlaying data from multiple files on 1 plot

Plot **Title** and **Title color**. Select **Add file name to title** to add input data (.cnv) file name to title (for overlay plots, it adds *first* file name to title). For example, if you enter title as P vs T, select *Add file name to title*, and data file name is October1.cnv, title will be *P vs T, October 1.cnv*.



Enabled if TS plot type is selected. See below.

Enabled if overlay plot type is selected. See below.

Plot **Font type** and **Font size** (small, medium, or large). Sea Plot displays example of font type to right of selection. List of fonts depends on what fonts are installed on your computer.

Grid lines (none, horizontal and vertical, horizontal, or vertical), **Grid style** (solid, dotted, or dashed line), and whether to place **Grid in front** of plotted data.

Inside Background Color defines color within axes. **Outside Background Color** defines color outside axes.

Symbol plotting frequency (0 = least frequent, 9 = most frequent), if **Monochrome plot** selected. If too frequent, symbols create illusion of very thick line, making details difficult to see.

Size (small, medium, or large) of symbol for each variable, if **Monochrome plot** or **Plot symbols only** selected.

- **Monochrome plot**: Substitute black lines with symbols for colors (Colors and symbols are defined on Axis setup tabs for non-overlay plots. For overlay plots, click Overlay Setup button to define). Enables you to set up axes with colors for viewing on screen, and then switch to black lines with symbols for black and white printing.
- **Plot symbols only**: Mark each individual data point with a symbol, and do not connect symbols with a line (Symbols are defined on Axis setup tabs for non-overlay plots. For overlay plots, click Overlay Setup button to define).
- **Show line legends**: Show line legends below plot title. Legend indicates line color and type (for color plots) or line symbol and type (for monochrome plots). For overlay plots, legend indicates line color or symbol only for first file.

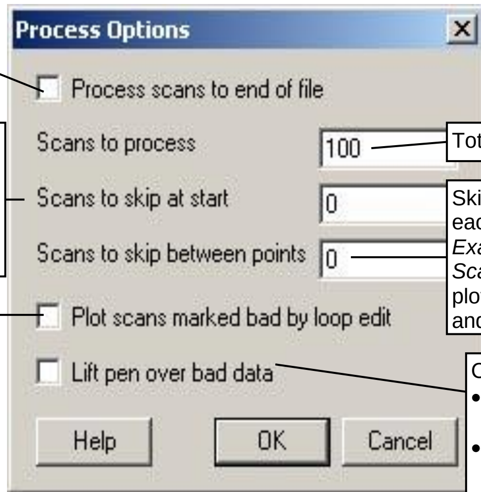
- **Mark data points**: Mark individual data points with a dot, and connect dots. If not selected, Sea Plot just draws a continuous line between data points.
- **Show plot shadow**: Create shadow effect to bottom and right of axes.
- **Black text axes** – Create labels for all axes in black. If **not** selected:
  - Axis label color matches selected plot color for each variable.
  - For overlay files, colors match colors for variables in *first* file.

See below.

Define space between axes and maximum and minimum plotted values, if *Auto range* selected on Axis setup tabs. For 0%, maximum and minimum values plot on axes.

Process Options

If the **Process Options** button is clicked on the Plot Setup tab, the following dialog box appears:



Plot all scans in file. If not selected, plot **Scans to process**.

Skip these scans at beginning of cast, and then plot remaining scans or number of scans designated by *Scans to process*. *Example*: If *Scans to process* is 100 and *Scans to skip at start* is 10, Sea Plot processes scans 10 through 109.

Plot scans that were marked with *bad flag* in Loop Edit. If not selected, Sea Plot omits those data points from plot. See illustration below.

Total number of scans to process.

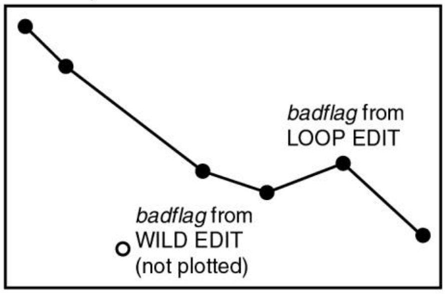
Skip this number of scans between each scan to plot. *Example*: If *Scans to process* is 10 and *Scans to skip at start* is 2, Sea Plot plots every other scan (scans 0, 2, 4, 6, and 8).

Create a discontinuous line:

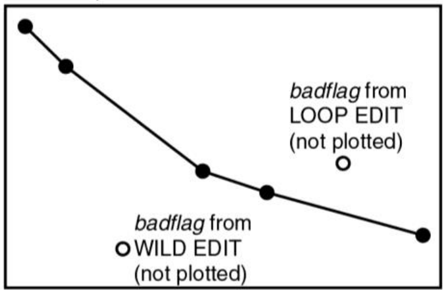
- Lift pen over data marked with *bad flag* in Wild Edit, **and**
- Lift pen over scans marked with *bad flag* in Loop Edit (if *Plot scans marked bad by loop edit* was not selected).

See illustration below.

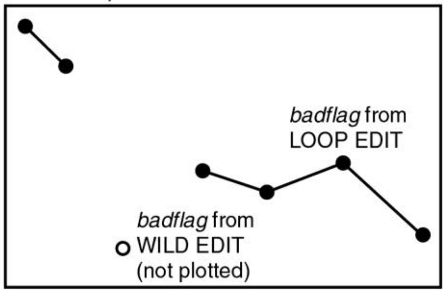
Plot scans marked bad by loop edit selected.
Lift pen over bad data not selected.



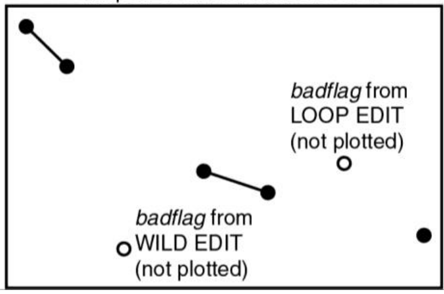
Plot scans marked bad by loop edit not selected.
Lift pen over bad data not selected.



Plot scans marked bad by loop edit selected.
Lift pen over bad data selected.



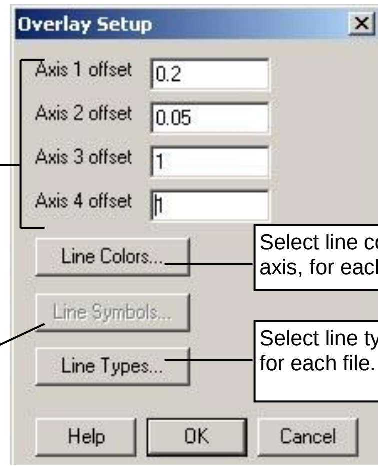
Plot scans marked bad by loop edit not selected.
Lift pen over bad data selected.



Overlay Setup

If an overlay plot type is selected on the Plot Setup tab, the **Overlay Setup** button is enabled. If clicked, the following dialog box appears:

Axis offsets define distance to separate plot from each file, for each axis. Offset units match axis units. For example, if Axis 1 is temperature in °C, a 0.2 offset means that file 1 plots at actual data points, file 2 plots at 0.2 °C more than actual data points, file 3 plots at 0.4 °C more than actual data points, etc. This creates a *waterfall* effect and allows user to see changes in shape that would be difficult to see if plots were not offset from each other. ***Note:*** Axis offsets are not applicable for TS plots.



Select line colors for each axis, for each file. See below.

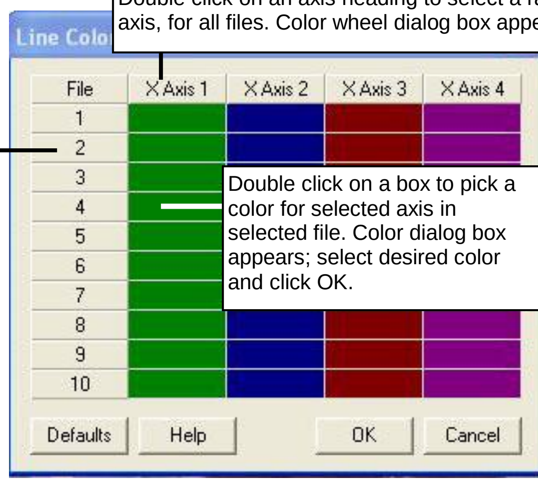
Select line symbols for each axis, for each file. Applicable if *Monochrome Plot* or *Plot symbols only* selected on Plot Setup tab. See below.

Select line types for each axis, for each file. See below.

Line Colors

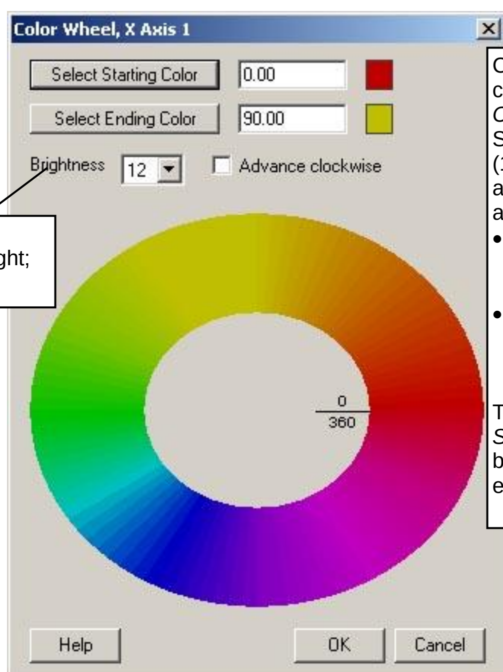
Double click on an axis heading to select a range of colors for that axis, for all files. Color wheel dialog box appears (see below).

Double click on a file heading to select a range of colors for that file, for all axes. Color wheel dialog box appears (see below).



Double click on a box to pick a color for selected axis in selected file. Color dialog box appears; select desired color and click OK.

Note:
If more than 10 files were selected on the File Setup tab, Sea Plot repeats the colors defined for files 1-10. For example, if 20 files were selected, files 1 and 11 have the same color, 2 and 12 have the same color, etc.



Select desired color brightness (1 = least bright; 15 = brightest).

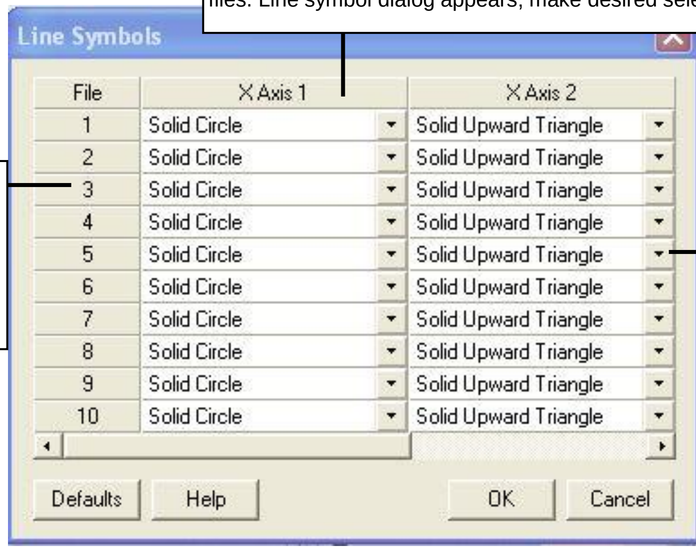
Click *Select Starting Color* and click desired color in color wheel; then click *Select Ending Color* and click desired color in color wheel. Sea Plot calculates evenly spaced colors (10 evenly spaced colors if you selected an axis or 4 evenly spaced colors if you selected a file).

- *Advance clockwise* **not selected**: Sea Plot calculates colors moving counterclockwise around circle from starting to ending color.
- *Advance clockwise* **selected**: Sea Plot calculates colors moving clockwise around circle from starting to ending color.

To set 1 color for all selected lines, click *Select Starting Color* and enter desired color value in box; then tab to *Select Ending Color* box and enter same value again.

Line Symbols

Double click on axis heading to select same line symbol for that axis, for all files. Line symbol dialog appears; make desired selection and click OK.



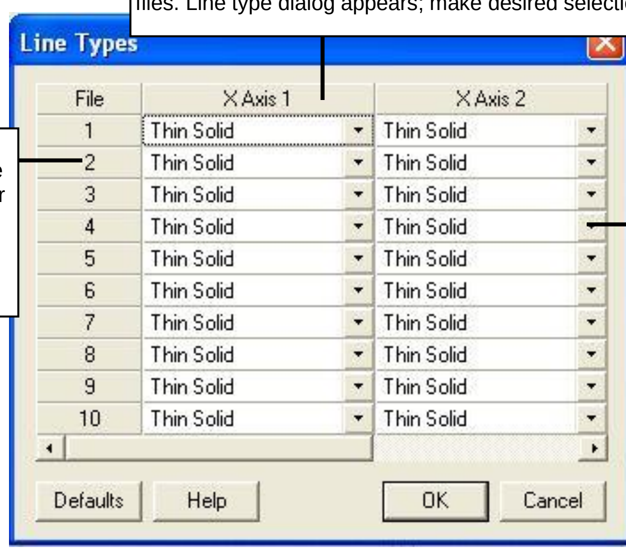
Double click on file heading to select same line symbol for that file, for all axes. Line symbol dialog appears; make desired selection and click OK.

Pull down on box to pick line symbol for selected axis in selected file.

Note:
If more than 10 files were selected on the File Setup tab, Sea Plot repeats the line symbols and types defined for files 1-10. For example, if 20 files were selected, files 1 and 11 have the same line symbol and type, 2 and 12 have the same line symbol and type, etc.

Line Types

Double click on axis heading to select same line type for that axis, for all files. Line type dialog appears; make desired selection and click OK.



Double click on file heading to select same line type for that file, for all axes. Line type dialog appears; make desired selection and click OK.

Pull down on box to pick line type for selected axis in selected file.

TS Plot Setup

If a TS plot type is selected on the Plot Setup tab, the **TS Plot Setup** button is enabled. The TS Plot Setup defines the contour lines for the plot; the user selects from the following contour types:

- Density contours – Sea Plot calculates and plots sigma-t contours if temperature is plotted, or sigma-theta contours if potential temperature is plotted (see *Axis Setup Tabs* below for selection of temperature parameter).
- Thermosteric anomaly contours

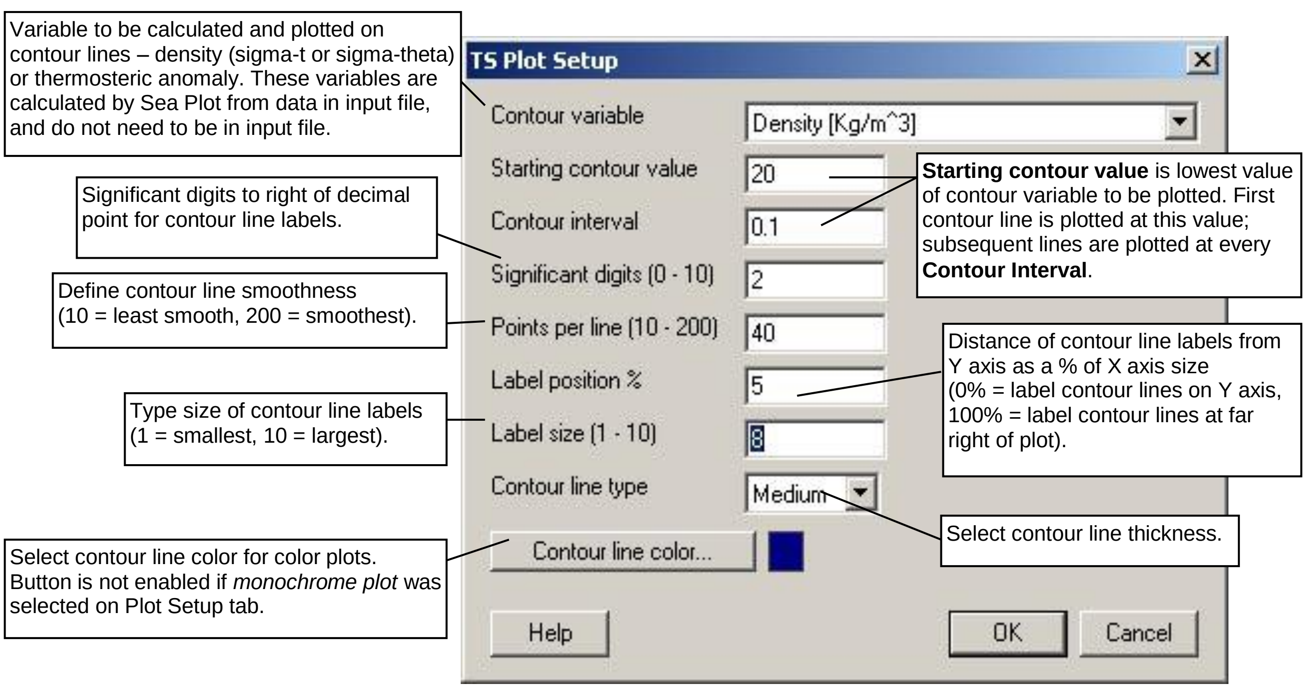
The units for the parameters in the input data file do not affect the contour calculations. For example, temperature could be in °C or °F, ITS-90 or IPTS-68; Sea Plot performs the required conversions to calculate the contours.

The following table defines the required input parameters for various combinations of temperature, salinity, and contours:

To plot:	Input .cnv file must include:
temperature, salinity, density sigma-t **or** temperature, salinity, thermosteric anomaly	temperature, salinity
temperature, derived salinity, density sigma-t **or** temperature, derived salinity, thermosteric anomaly	temperature, conductivity, pressure
potential temperature, salinity, density sigma-theta **or** potential temperature, salinity, thermosteric anomaly	potential temperature, salinity
potential temperature, derived salinity, density sigma-t **or** potential temperature, derived salinity, thermosteric anomaly	potential temperature, temperature *, conductivity, pressure

*Derived salinity requires actual temperature in the input file. Potential temperature cannot be used in calculation of derived salinity.

If the TS Plot Setup button is clicked, the following dialog box appears:



Sea Plot Axis Setup Tabs

Each Axis Setup tab defines a plot variable, scale, and line type.

- Axis tabs are labeled X Axis and Y Axis if an X-Y plot was selected on the Plot Setup tab.
- Axis tabs are labeled Temperature and Salinity if a TS plot was selected on the Plot Setup tab.

X-Y Axis Setup Tabs

An Axis Setup tab looks like this for **X-Y** plots (X Axis 2 tab shown; other axis tabs are similar):

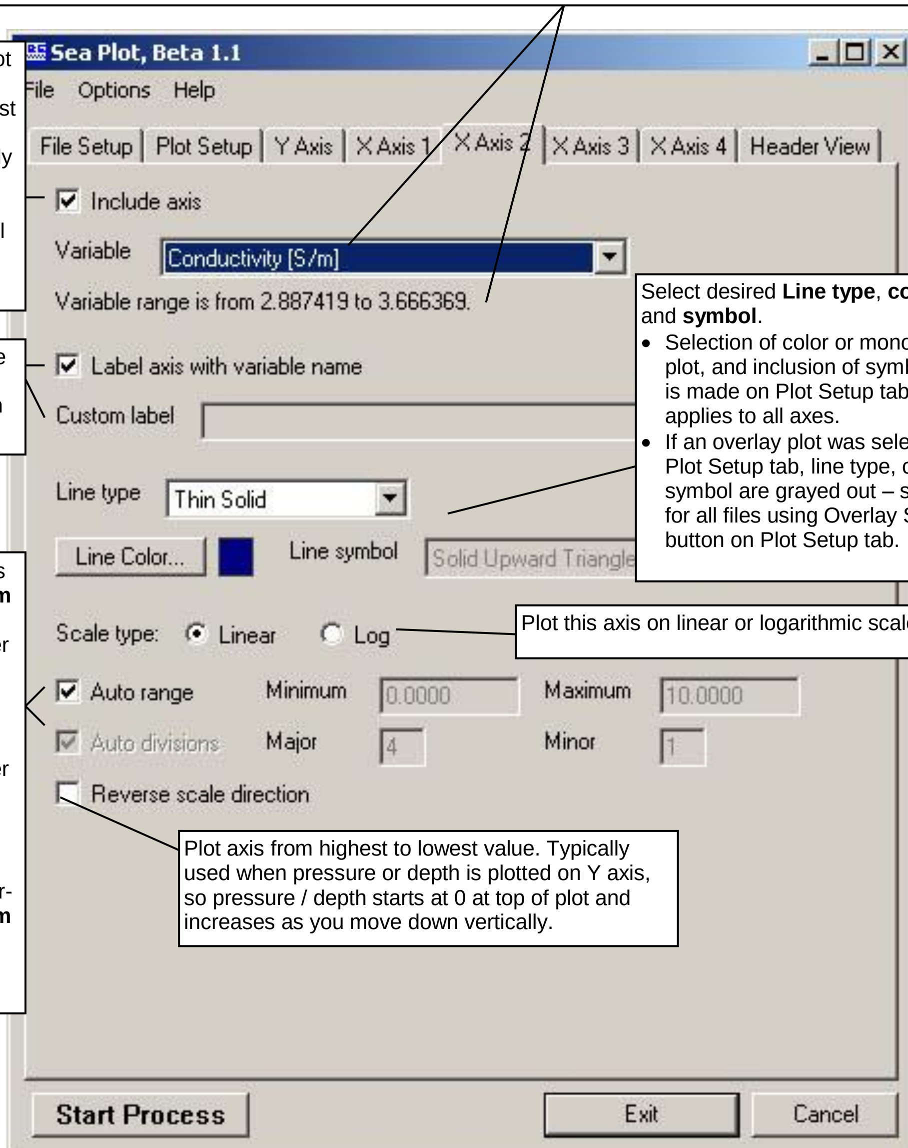
Drop down list includes all variables in data (.cnv) file. Sea Plot indicates range of data for selected variable, to assist setup of plot scale. **Range is full range of data in file(s)**, and does not reflect your selection of *Scans to process*, *Scans to skip at start*, *Scans to skip between points*, etc. in Process Options dialog box. If file contains data collected while instrument was in air, range reflects these values. If multiple files were selected on File Setup tab, range is lowest value in all files to highest value in all files. If selected variable is *derived salinity* or *derived density*, variable range shown is 0 to 0, because Sea Plot does not know derived salinity or density values until you click Start Process and it begins to calculate derived values.
Order in drop down list reflects order of variables in file. If file contains multiple occurrences of a variable (for example, you calculated salinity in Data Conversion and then again in Derive, after aligning and filtering data), list adds a suffix (1^{st}, 2^{nd}, 3^{rd}, etc.) to variable name; do not confuse this with labeling for data from duplicate sensors (for example, *Salinity, 2 [PSU] 1^{st}* is first occurrence in file of salinity calculated from secondary temperature and conductivity sensor data). Select desired variable for plotting.

Include this axis in plot. Sea Plot can plot up to 5 variables (1 Y and 4 X, or 1 X and 4 Y). At least 1 X and 1Y variable is required, so this selection is available only on Axis Setup tab for third, fourth, and fifth axis.
Note: If you deselect an axis, all axes numbered above that axis are automatically deselected.

Select to label axis with variable name as listed in drop down Variable list, or enter a **Custom label** for axis.

- **Auto range**: Sea Plot selects axis **Minimum** and **Maximum** values, number of **Major** divisions on axis, and number of **Minor** divisions between major divisions.
- **Auto divisions**: Sea Plot selects number of major divisions on axis, and number of minor divisions between major divisions. User selects axis **Minimum** and **Maximum** values.

Any values that fall outside user-selected **Minimum** to **Maximum** range will plot at minimum or maximum, as applicable.



Select desired **Line type**, **color**, and **symbol**.

- Selection of color or monochrome plot, and inclusion of symbols in plot, is made on Plot Setup tab, and applies to all axes.
- If an overlay plot was selected on Plot Setup tab, line type, color, and symbol are grayed out – select these for all files using Overlay Setup button on Plot Setup tab.

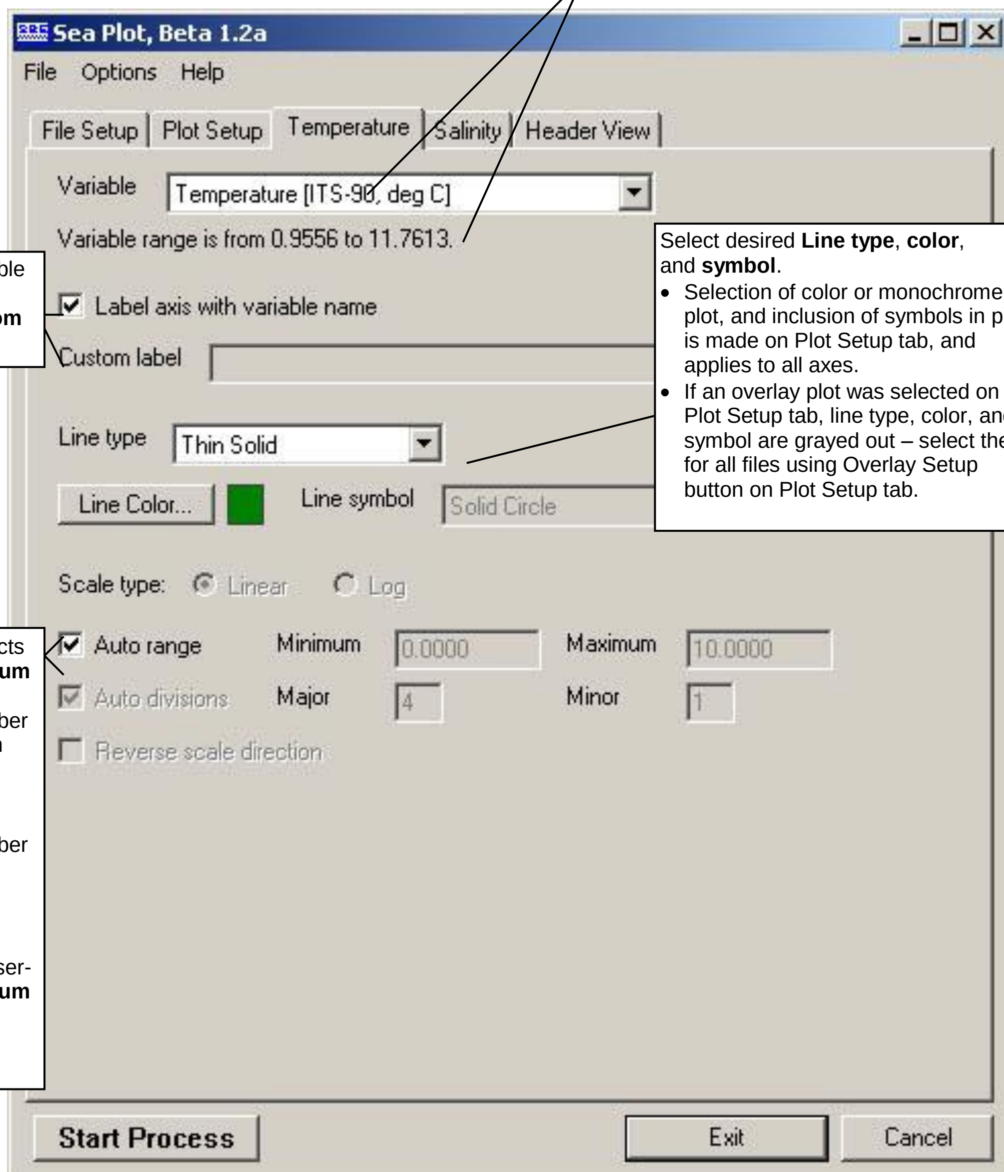
Plot this axis on linear or logarithmic scale.

Plot axis from highest to lowest value. Typically used when pressure or depth is plotted on Y axis, so pressure / depth starts at 0 at top of plot and increases as you move down vertically.

TS Plot Axis Setup Tabs

An Axis Setup tab looks like this for **TS plots** (Temperature axis tab shown; Salinity axis tab is similar):

Drop down list includes all applicable variables in data (.cnv) file - temperature and potential temperature (for Temperature tab) and salinity (for Salinity tab), as well as derived salinity (for Salinity tab). Sea Plot indicates range of data for selected variable, to assist you in setup of plot scale. **Range is full range of data in .cnv file(s)**, and does not reflect your selection of *Scans to process*, *Scans to skip at start*, *Scans to skip between points*, etc. in Process Options dialog box. If file contains data collected while instrument was in air, range reflects these values. If multiple files were selected on File Setup tab, range is lowest value in all files to highest value in all files. If selected variable (on Salinity tab) is *derived salinity*, variable range shown is 0 to 0, because Sea Plot does not know derived salinity values until you click Start Process and it begins to calculate derived values.
Order in drop down list reflects order of variables in file. If file contains multiple occurrences of a variable (for example, you calculated salinity in Data Conversion and then again in Derive, after aligning and filtering data), list adds a suffix (1st, 2nd, 3rd, etc.) to variable name; do not confuse this with labeling for data from duplicate sensors (for example, *Salinity, 2 [PSU] 1st* is first occurrence in file of salinity calculated from secondary temperature and conductivity sensor data). Select desired variable for plotting.



Select to label axis with variable name as listed in drop down Variable list, or enter a **Custom label** for axis.

Select desired **Line type**, **color**, and **symbol**.

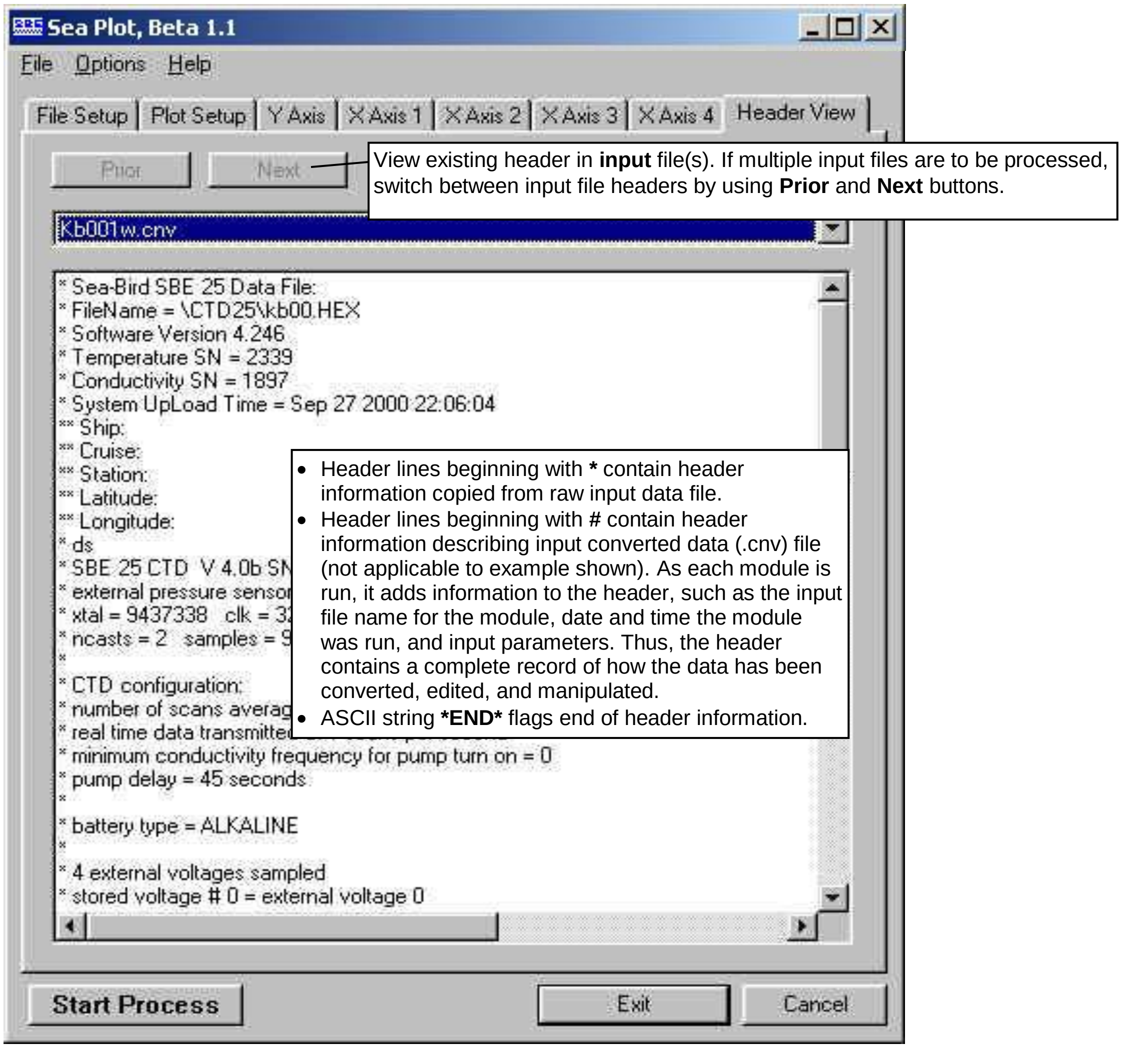
- Selection of color or monochrome plot, and inclusion of symbols in plot, is made on Plot Setup tab, and applies to all axes.
- If an overlay plot was selected on Plot Setup tab, line type, color, and symbol are grayed out – select these for all files using Overlay Setup button on Plot Setup tab.

- **Auto range**: Sea Plot selects axis **Minimum** and **Maximum** values, number of **Major** divisions on axis, and number of **Minor** divisions between major divisions.
- **Auto divisions**: Sea Plot selects number of major divisions on axis, and number of minor divisions between major divisions. User selects axis **Minimum** and **Maximum** values.

Any values that fall outside user-selected **Minimum** to **Maximum** range will plot at minimum or maximum, as applicable.

Sea Plot Header View Tab

The Header View tab allows you to view the existing header in the input file(s). The Header View tab looks like this:



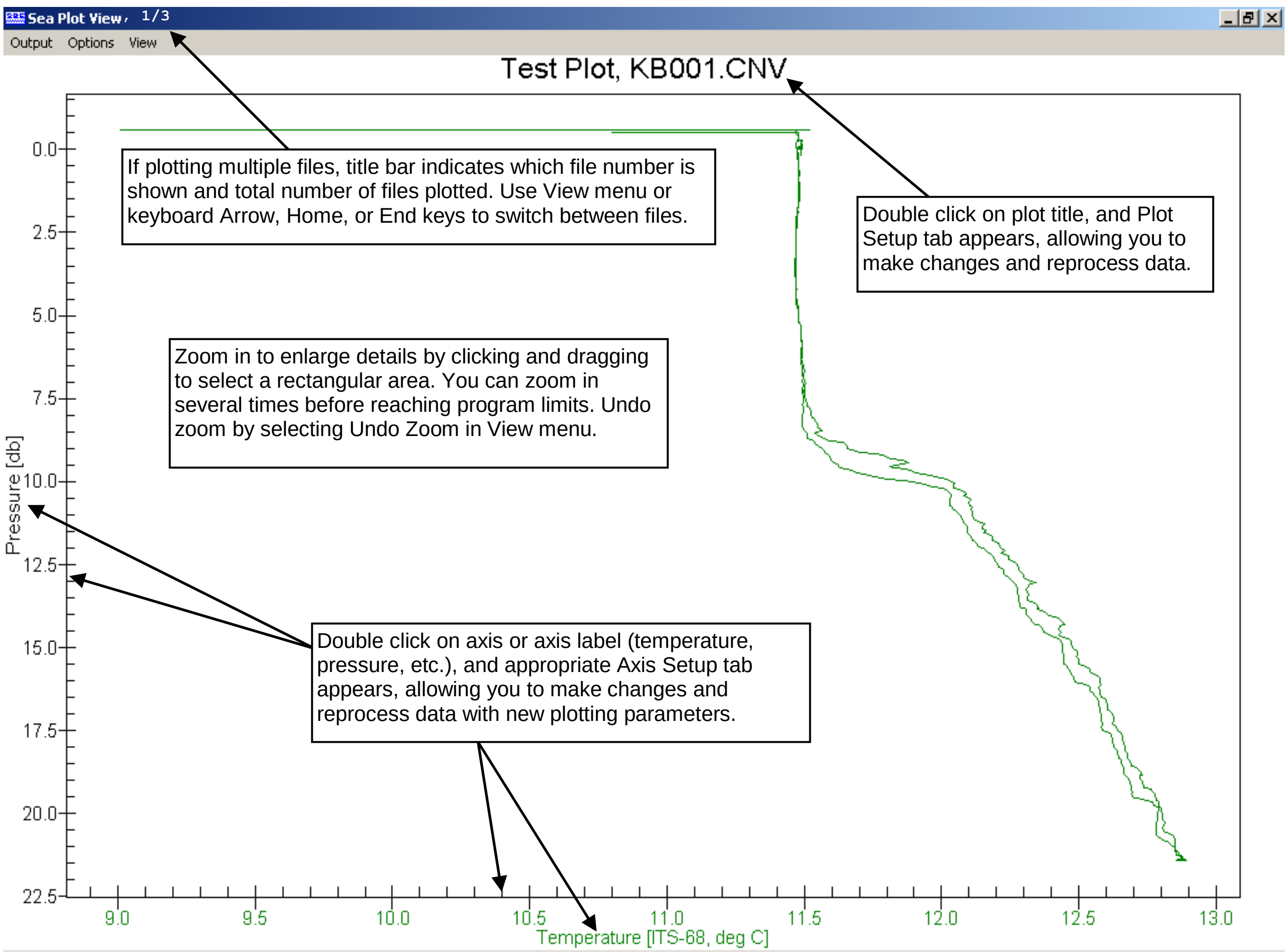
Viewing Sea Plot Plots

Shown below are three examples:

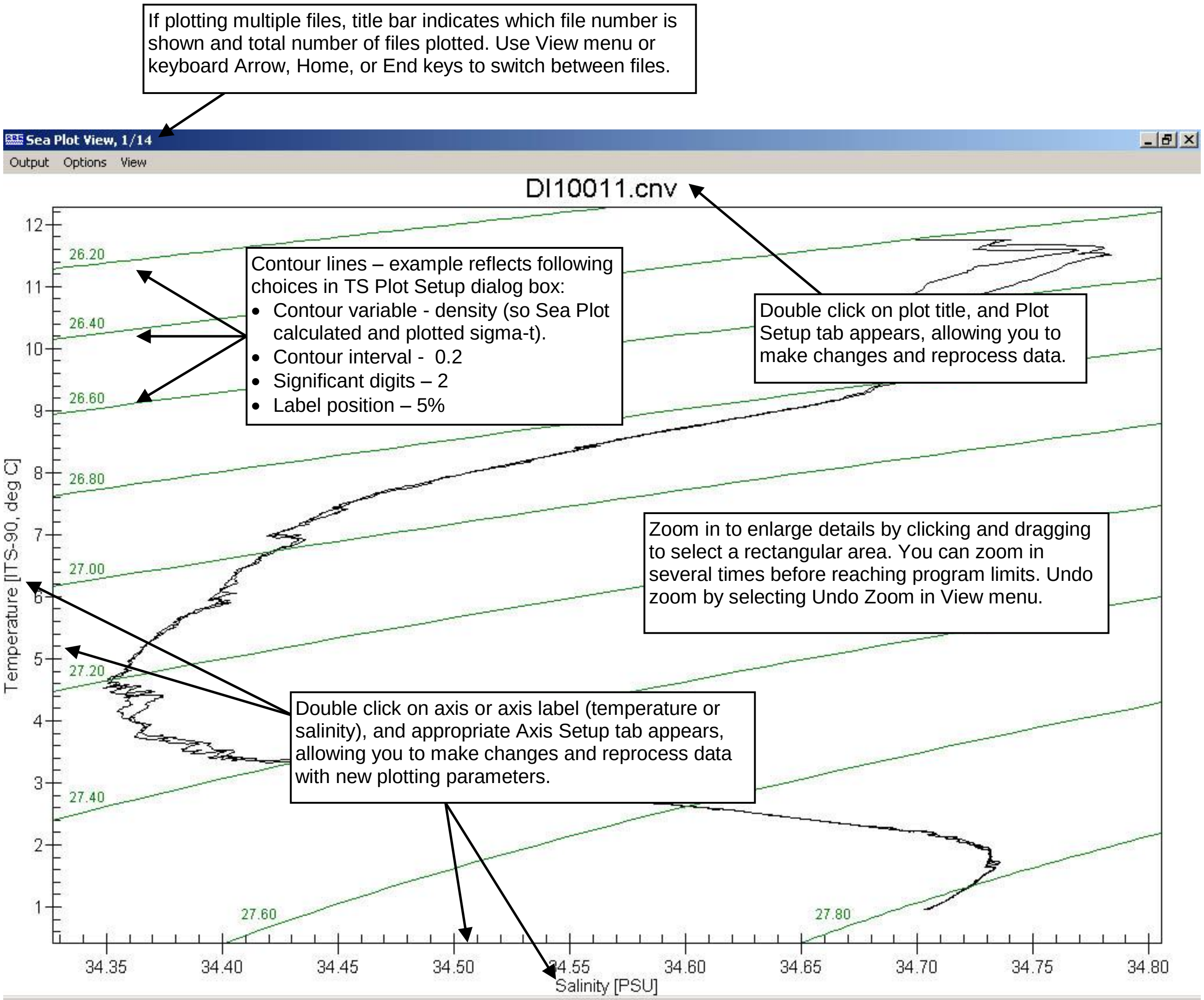
- Multiple X-Y plots, no overlay
- Multiple TS plots, no overlay
- X-Y overlay plot

Following the examples is a detailed description of the plot's menus.

Multiple X-Y Plots, No Overlay



Multiple TS Plots, No Overlay

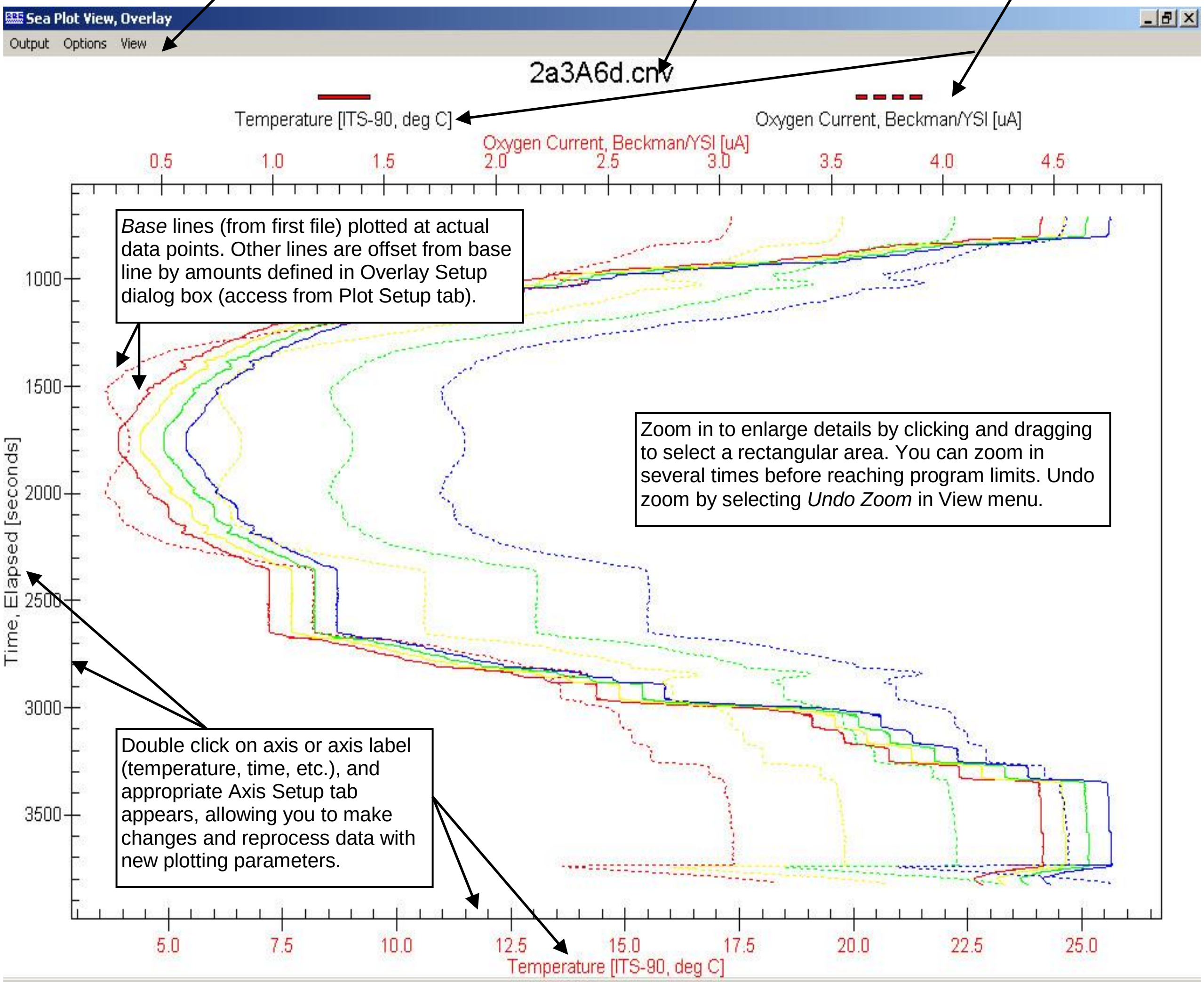


X-Y Overlay Plot

In View menu, select *Show Plot Legends* to view complete list of file names and plot colors or plot symbols (if *monochrome plot* was selected on Plot Setup tab). You can highlight 1 line, all lines in 1 file, or 1 line in all files with color or line symbol. See below.

Double click on plot title, and Plot Setup tab appears, allowing you to make changes and reprocess data.

Legend shows line color and type for each axis in **first** file if *Show line legends* selected on Plot Setup tab.



Note:
If *Monochrome plot* or *Plot symbols only* were selected on the Plot Setup tab, the Plot Legend dialog box shows each line symbol instead of each line color, and provides for user selection of a highlight symbol instead of a highlight color.

If you select *Show Plot Legend* in the View menu, the Plot Legend dialog box shows the color for each line in each file, and allows you to apply a highlight color to a selected line or lines. The dialog box looks like this:

Click to select desired highlight color. Color dialog box appears; make selection and click OK.

Double click on file name, and **all** lines (all axes) for selected file change to highlight color.

Double click on axis heading, and **all** files for selected axis change to highlight color.

Double click on color, and selected axis in selected file changes to highlight color.

Note that if you print, save, or copy plot to clipboard, it **does not include legend**. To save legend information, click Copy. Legend can then be pasted into another application, such as Microsoft Word, and saved.

With the highlight color applied, you can view the plot on screen and output to the printer, file, or clipboard. When you click Cancel in the Plot Legend dialog box, the colors return to what they were before you applied the highlight.

Plot Menus

Note:
If you print, save, or copy the plot to the clipboard, it does not include the legend. To save legend information, click Copy in the Plot Legend dialog box. The legend can then be pasted into another application, such as Microsoft Word, and saved.

The Sea Plot View window's menus are described below:

Output - Directs Sea Plot to **output plot now** to printer, clipboard, or a file. If multiple files are plotted (but not as an overlay), you can output plot shown on screen or plots for all files. How plot is output (size, file type, etc.) is controlled by Options menu.

Options - Sets up how plot is output to printer, clipboard, or a file.

- *Print* -
  - Orientation – landscape, portrait, or print driver default
  - Print full page - scale plot to fit 8 1/2 x 11 inch page. If not selected, Size determined by -
    Sea Plot View Dimensions - dimensions of plot as shown on screen
    File Setup tab entries - entries on File Setup tab for Width and Height
    Values Entered Below - dimensions entered in dialog box (in mm)
- *File* -
  - Data format - Metafile (.wmf), Jpeg (.jpg), or Bitmap (.bmp)
  - Size determined by
    Sea Plot View Dimensions - dimensions of plot as shown on screen
    File Setup tab entries - entries on File Setup tab for Width and Height
    Values Entered Below - dimensions entered in dialog box (in mm)
- *Clipboard* -
  - Data format - Metafile (.wmf), Jpeg (.jpg), or Bitmap (.bmp)
  - Size determined by -
    Sea Plot View Dimensions - dimensions of plot as shown on screen
    File Setup tab entries - entries on File Setup tab for Width and Height
    Values Entered Below - dimensions entered in dialog box (in mm)

View – Sets up viewing options.

- *Show cursor position* – Directs Sea Plot to show the coordinates of the cursor as you move the cursor around when viewing a plot.
- *Next Plot*, *Prior Plot* – Directs Sea Plot to switch between plots, if you selected multiple files on File Setup tab but are not doing an overlay plot.
- *File name* – Lists, and allows you to select from, all input files, if you selected multiple files on File Setup tab but are not doing an overlay plot.
- *Show plot legends* – For overlay plots only, allows you to view a complete list of file names and plot colors or plot symbols (if monochrome plot was selected on Plot Setup tab).
- *Undo Zoom* – Directs Sea Plot to return plot to original ranges specified on Axis Setup tabs. *Undo Zoom* is grayed out unless you have zoomed in (by clicking and dragging to select a rectangular area) to enlarge details.
- *Set Zoomed Ranges* – Directs Sea Plot to substitute current zoomed ranges of plot for Minimum and Maximum plot ranges on Axis Setup tabs. This provides ability to save ranges of zoomed view, so you can go to exactly same view next time you run Sea Plot. *Set Zoomed Ranges* is grayed out unless you have zoomed in (by clicking and dragging to select a rectangular area) to enlarge details.

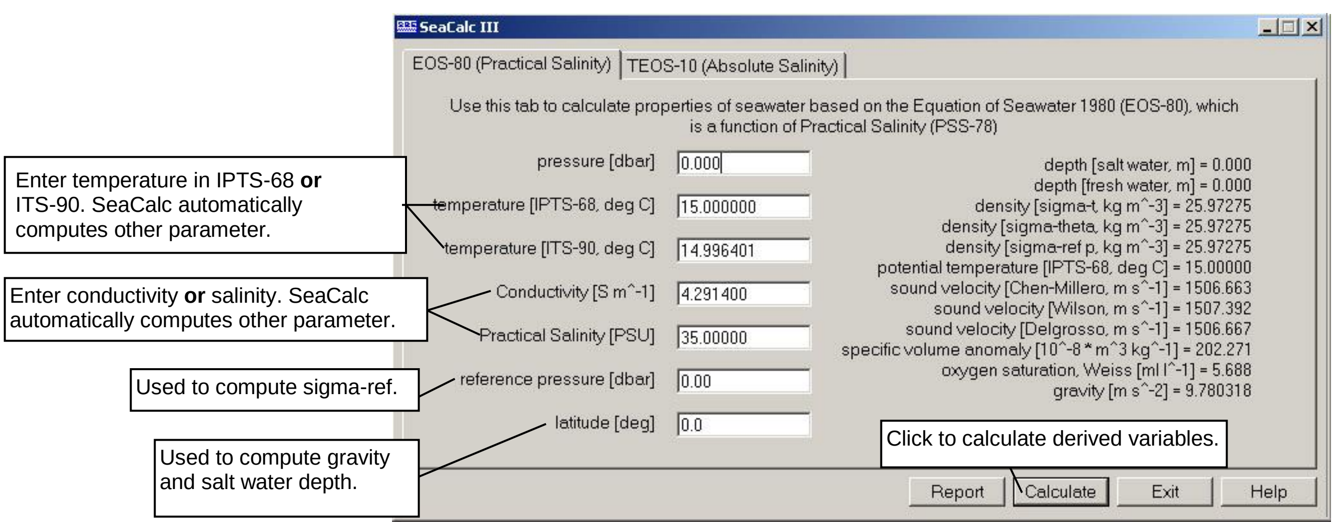
Section 9: Miscellaneous Module – SeaCalc III

Notes:

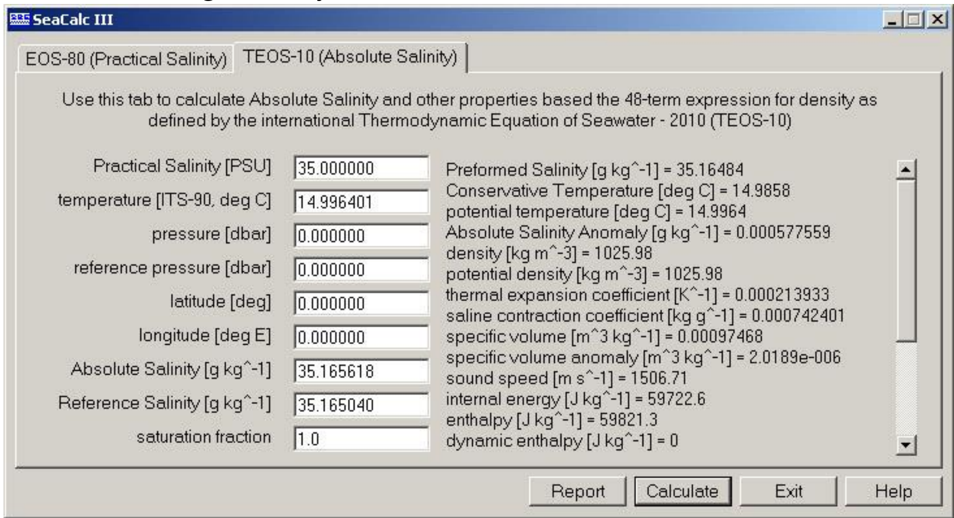
- Algorithms used for calculation of derived parameters in Data Conversion, Derive, Sea Plot, SeaCalc III [EOS-80 (Practical Salinity) tab], and Seasave are identical, except as noted in *Appendix V: Derived Parameter Formulas (EOS-80; Practical Salinity*), and are based on EOS-80 equations.
- Algorithms used for calculation of TEOS-10 parameters in Derive TEOS-10 and SeaCalc III [TEOS-10 (Absolute Salinity) tab] are described in *Derive TEOS-10* in *Section 6*: *Data Processing Modules*.

SeaCalc is a seawater calculator that computes a number of derived variables from one user-input scan of temperature, pressure, etc. SeaCalc has two tabs:

- The first tab calculates **Practical Salinity** and associated parameters using **EOS-80** equations. SeaCalc *remembers* whether you last changed conductivity or salinity, and calculates other parameters based on this. For example, if you change conductivity, salinity is recalculated; if you then change temperature, salinity is recalculated again (based on input C, P, and t). Conversely, if you change salinity, conductivity is recalculated; if you then change temperature, conductivity is recalculated again (based on input S, P, and t).



- The second tab calculates **Absolute Salinity** and associated parameters, using **TEOS-10** equations. SeaCalc automatically populates this tab with Practical Salinity, temperature [ITS-90, deg C], pressure, reference pressure, and latitude from the Practical Salinity tab, and requires a Longitude entry.



If you go back to the Practical Salinity tab, SeaCalc automatically populates it with values from the Absolute Salinity tab.

Appendix I: Command Line Options, Command Line Operation, and Batch File Processing

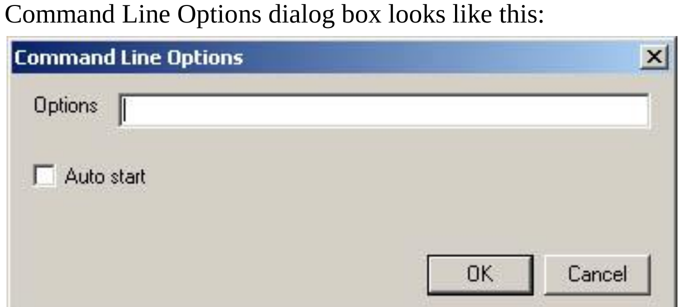
Command Line Options

Note:
The default program setup (.psa) file is the last saved .psa file for the module. PostProcSuite.ini contains the location and file name of the last saved .psa file for each module.
- Primary PostProcSuite.ini file default location, if available, is:
%LOCALAPPDATA%\Sea-Bird\IniFiles\
(Example c:\Users\dbresko\AppData\Local\Sea-Bird\IniFiles\PostProcSuite.ini)
- Secondary PostProcSuite.ini file default location is:
%APPDATA%\Sea-Bird\IniFiles\
(Example c:\Documents and Settings\dbresko.SEABIRD\Application Data\Sea-Bird\IniFiles\PostProcSuite.ini)

Command line options can be used to assist in automating processing, by overriding information in an existing program setup (.psa) file or designating a different .psa file.

Access the Command Line Options dialog box by selecting Command Line Options in the SBE Data Processing window's Run menu:

The Command Line Options dialog box looks like this:



The option parameters are:

Parameter	Description
/cString	Use String as instrument **configuration (.con or .xmlcon)** file. String must include full path **and** file name. **Note**: If using this parameter, you must also specify input file name (using /iString).
/iString	Use String as **input data** file name. String must include full path **and** file name. The /iString option supports standard wildcard expansion: • ? matches any single character in specified position within file name or extension. • * matches any set of characters starting at specified position within file name or extension and continuing until end of file name or extension or another specified character.
/oString	Use String as **output directory** (not including file name).
/fString	Use String as **output file** name (not including directory).
/aString	**Append** String to **output file** name (before extension).
/pString	Use String as **Program Setup (.psa)** file. String must include full path **and** file name.
/xModule: String	Use String to define an **additional parameter** to pass to Module. Not all modules have x parameters; see module descriptions. If specifying multiple x parameters, enclose in double quotes and separate with a space; do not specify x parameter more than once. *Example*: Run Data Conversion, telling it to skip first 1000 scans, and also run Window Filter, telling it to output difference between original and filtered value: /x“datcnv:skip1000 wfilter:diff” *Correct* /xdatcnv:skip1000 /xwfilter:diff *Incorrect*

If specifying multiple parameters, insert one or more spaces or tabs between each parameter in the list.

Example: You set up and saved .psa files for Filter, Loop Edit, Bin Average, and Derive within each module’s dialog box, and ran each module successively. The input and output file names in all the .psa files were the same - c:\1st\test.cnv (this has the effect of overwriting the module input with the module output).
You now want to run each process again, using a different input and output file - c:\2nd\test1.cnv. You enter the following in SBE Data Processing’s Command Line Options dialog box:

```
/ic:\2nd\test1.cnv  /ftest1.cnv  /oc:\2nd
```

When you pull down on the Run menu and select Filter, you see in the Filter dialog box that the program substituted c:\2nd\test1.cnv for c:\1st\test.cnv as the input data and output data path and file. Similarly, test1.cnv is shown as the input and output data file in all the modules. You can run each process rapidly in succession, without needing to enter the new path and file name individually in each module.

Note:
If you do not select Auto Start, when you select a module the module dialog box appears, allowing you to review the selected input files and data setup before beginning processing.

***Auto Start** (for running a module)*

Select this and then select the desired module to have SBE Data Processing *automatically* run the module with the last saved setup parameters (defined by the .psa file) and any entered Command Line Options.

- If you select Auto Start, a *Run Minimized* selection box appears. If selected, SBE Data Processing minimizes its window while processing the data, allowing you to do other work on the computer. When processing is complete, the SBE Data Processing window reappears.

Command Line Operation

The following modules can be run from the command line (default location for files is c:\Program Files\Sea-Bird\SBEDataProcessing-Win32):

Module	Executable File Name
Align CTD	AlignCTDW.exe
ASCII In	ASCII_InW.exe
ASCII Out	ASCII_OutW.exe
Bin Average	BinAvgW.exe
Bottle Summary	BottleSumW.exe *
Buoyancy	BuoyancyW.exe
Cell Thermal Mass	CellTMW.exe
Data Conversion	DatCnvW.exe
Derive	DeriveW.exe
Derive TEOS-10	DeriveTEOS_10W.exe
Filter	FilterW.exe
Loop Edit	LoopEditW.exe
Mark Scan	MarkScanW.exe
SeaCalc III	SeaCalcII.exe
Sea Plot	SeaPlotW.exe
Section	SectionW.exe
Split	SplitW.exe
Strip	StripW.exe
Translate	TransW.exe
Wild Edit	WildEditW.exe
Window Filter	W_FilterW.exe

* Bottle Summary's executable file name was previously RosSumW.exe. BottleSumW.exe will run if BottleSumW.exe **or** RosSumW.exe is typed on command line.

Note:
The default program setup (.psa) file is the last saved .psa file for the module. PostProcSuite.ini contains the location and file name of the last saved .psa file for each module.
- Primary PostProcSuite.ini file default location, if available, is: %LOCALAPPDATA%\Sea-Bird\IniFiles\ (Example c:\Users\dbresko\AppData\Local\Sea-Bird\IniFiles\PostProcSuite.ini)
- Secondary PostProcSuite.ini file default location is: %APPDATA%\Sea-Bird\IniFiles\ (Example c:\Documents and Settings\dbresko.SEABIRD\Application Data\Sea-Bird\IniFiles\PostProcSuite.ini)

Command line parameters can be used to override existing information in the .psa file. The command line parameters are:

Parameter	Description
/cString	Use String as instrument **configuration (.con or .xmlcon)** file. String must include full path **and** file name. **Note**: If using /cString, must also specify input file name (using /iString).
/iString	Use String as **input data** file name. String must include full path **and** file name. This parameter supports standard wildcard expansion: • ? matches any single character in specified position within file name or extension • * matches any set of characters starting at specified position within file name or extension and continuing until end of file name or extension or another specified character
/oString	Use String as **output directory** (not including file name).
/fString	Use String as **output file** name (not including directory).
/aString	**Append** String to **output file** name (before file name extension).
/pString	Use String as **Program Setup (.psa)** file. String must include full path **and** file name.
/xModule: String	Use String to define an **additional parameter** to pass to Module. Not all modules have x parameters; see module descriptions. If specifying multiple x parameters, enclose in double quotes and separate with a space. *Example*: Run Data Conversion from command line, telling it to skip first 1000 scans: datcnvw.exe /xdatcnv:skip1000
/s	**Start** processing now.

If specifying multiple parameters, insert one or more spaces or tabs between each parameter in the list.

Example: The specified input file directory contains test.dat, test1.dat, and test2.dat. Select Run in the Windows Start menu. The Run dialog box appears.

Note:
If you have not modified your autoexec.bat file to put the .exe files in the path statement, specify the full path of the .exe file in the Run dialog box.

For the command line shown (datcnvw.exe /itest*.dat /s), SBE Data Processing will process test.dat, test1.dat, and test2.dat using Data Conversion. If the ? wildcard symbol is used (datcnvw /itest?.dat) instead of the *, Data Conversion will process only test1.dat and test2.dat.

Batch File Processing

Note:
A duplicate copy of SBEBatch.exe is placed in the Windows folder when SBE Data Processing is installed. This allows the user to run SBEBatch.exe from anywhere, without having to specify its path.

Traditional DOS batch file processing cannot be used with the 32-bit processing modules because the Windows operating system will start the second process before the first process is finished. The program SBEBatch.exe (default location c:\Program Files\Sea-Bird\SBEDataProcessing-Win32) or the Windows Scripting Host can be used to process a batch file to automate data processing tasks. The format for SBEBatch is:

sbebatch filename parameters

The parameters are referenced in the batch file in the same way as the DOS batch file, using the percent sign (%) followed by numbers 1 through 9. %1 in the batch file is replaced by the first command line parameter, %2 in the batch file is replaced by the second command line parameter, and so on until %9.

Note:
SBEBatch can also launch system commands, such as copying or renaming a file, deleting a file from an intermediate step, etc. Additionally, it can launch non-Sea-Bird programs, such as Word Pad. If you call a program that does not run and then shut down automatically, such as Word Pad, you must manually close the program before batch processing will continue to the next step.

Each line in the batch file contains the process name followed by command line arguments. The process names are:

Module	Process Name
Align CTD	Alignctd
ASCII In	Asciiin
ASCII Out	Asciiout
Bin Average	Binavg
Bottle Summary	Bottlesum *
Buoyancy	Buoyancy
Cell Thermal Mass	Celltm
Data Conversion	Datcnv
Derive	Derive
Derive TEOS-10	DeriveTEOS10
Filter	Filter
Loop Edit	Loopedit
Mark Scan	Markscan
Sea Plot	Seaplot
Section	Section
Split	Split
Strip	Strip
Translate	Trans
Wild Edit	Wildedit
Window Filter	Wfilter

* Bottle Summary's process name was previously Rossum. Bottlesum will run if Bottlesum **or** Rossum is used in the batch file.

Note:
The default program setup (.psa) file is the last saved .psa file for the module. PostProcSuite.ini contains the location and file name of the last saved .psa file for each module.
- Primary PostProcSuite.ini file default location, if available, is: %LOCALAPPDATA%\Sea-Bird\IniFiles\ (Example c:\Users\dbresko\AppData\Local\Sea-Bird\IniFiles\PostProcSuite.ini)
- Secondary PostProcSuite.ini file default location is: %APPDATA%\Sea-Bird\IniFiles\ (Example c:\Documents and Settings\dbresko.SEABIRD\Application Data\Sea-Bird\IniFiles\PostProcSuite.ini)

The batch file can also contain comment lines to document the file purpose. Any line beginning with **@** is a comment line, and does not affect the results.

Parameters specified **in the batch file** can be used to override existing information in the .psa file. These parameters are:

Parameter	Description
/cString	Use String as instrument **configuration (.con or .xmlcon)** file. String must include full path **and** file name. **Note**: If using /cString, must also specify input file name (using /iString).
/iString	Use String as **input file** name. String must include full path **and** file name. This parameter supports standard wildcard expansion: • ? matches any single character in specified position within file name or extension • * matches any set of characters starting at specified position within file name or extension and continuing until the end of file name or extension or another specified character
/oString	Use String as **output directory** (not including file name).
/fString	Use String as **output file** name (not including directory).
/aString	**Append** String to **output file** name (before extension).
/pString	Use String as **Program Setup (.psa)** file. String must include full path **and** file name.
/xModule: String	Use String to define an **additional parameter** to pass to Module. Not all modules have x parameters; see module descriptions. If specifying multiple x parameters, enclose in double quotes and separate with a space. *Example*: Run Data Conversion, telling it to skip first 1000 scans: /xdatcnv:skip1000
/w	**Wait** for user input at start of Module, allowing user to review setup before processing data for a particular Module. After reviewing setup, user clicks *Start Process* in Module dialog box to continue.
/d	**Pause** processing data at end of Module, allowing user to review output from a particular Module before continuing with rest of processing.

If specifying multiple parameters, insert one or more spaces or tabs between each parameter in the list.

Parameters specified **on the Run line** can also be used to control the process:

#m	**Minimize** SBE Data Processing window while processing data, allowing you to do other work on computer.
#w	**Wait** for user input at start of **each** Module, allowing user to review setup before processing data for each Module. After reviewing setup, user clicks *Start Process* in Module dialog box to continue.
#d	**Pause** processing data at end of **each** Module, allowing user to review output from each Module before continuing with rest of processing.

To process data using a batch file:

Note:
For Sea Plot, enter the desired choices in the File Setup, Plot Setup, and Axis Setup tabs.

1. Run each software module, entering the desired choices in the File Setup and Data Setup dialog boxes. Upon completing setup, press Save or Save As on the File Setup tab. The configuration is stored in the Program Setup File (.psa).

2. Create a batch file to process the data.

Following are two examples of typical batch files.

Example 1 – Process Single File, and Save All Intermediate Files

The data file is c:\leg1\cast5.dat, and the .con file is c:\leg1\cast5.con.

1. Set up each software module, entering desired choices in Setup dialog boxes. In the File Setup dialog boxes, delete the output file name (this allows program to base output file name on input file name and any appended text), and set the output file path as c:\leg1.

2. Create a batch file named prcast.txt in c:\leg1, which contains:
```
@ Lines starting with @ are comment lines
@ Comment lines have no effect on the result
datcnv  /ic:\leg1\%1.dat  /cc:\leg1\%1.con  /a%2
wildedit  /ic:\leg1\%1%2.cnv  /as1
filter  /ic:\leg1\%1%2s1.cnv  /as2
loopedit  /ic:\leg1\%1%2s1s2.cnv  /as3
derive  /ic:\leg1\%1%2s1s2s3.cnv  /cc:\leg1\%1.con  /as4
seaplot  /ic:\leg1\%1%2s1s2s3s4.cnv
```
Module names and options are separated by one or more spaces or tabs.

3. Select Run in the Windows Start menu. The Run dialog box appears.

4. Type in the program name and parameters as shown:
sbebatch c:\leg1\prcast.txt cast5 test1
(batch filename is c:\leg1\prcast1.txt; parameter %1 is cast5; parameter %2 is test1)

5. The data is processed as follows (all input and output files are in c:\leg1):

Module	Input File(s)	Output File
Data Conversion (datcnv)	cast5.dat cast5.con	cast5test1.cnv
Wild Edit (wildedit)	cast5test1.cnv	cast5test1s1.cnv
Filter (filter)	cast5test1s1.cnv	cast5test1s1s2.cnv
Loop Edit (loopedit)	cast5test1s1s2.cnv	cast5test1s1s2s3.cnv
Derive (derive)	cast5test1s1s2s3.cnv cast5.con	cast5test1s1s2s3s4.cnv
Sea Plot (seaplot)	cast5test1s1s2s3s4.cnv	cast5test1s1s2s3s4.jpg (if File Setup tab was set to output to jpeg)

Example 2 – Process Several Files, and Overwrite All Intermediate Files

Process all data files in c:\leg1. The data files are c:\leg1\cast1.dat and c:\leg1\cast2.dat, and the .con file is c:\leg1\cast.con.

1. Set up each software module, entering desired choices in Setup dialog boxes. In the File Setup dialog boxes, delete the output file name (this allows program to base output file name on input file name and any appended text). Set the output file path as c:\leg1.

2. Create a batch file named prallcasts.txt in c:\leg1, which contains:
   ```
   @ Lines starting with @ are comment lines
   @ Comment lines have no effect on the result
   datcnv  /i%1\*.dat  /c%1\cast.con  /o%1
   wildedit  /i%1\*.cnv  /o1%
   filter  /i%1\*.cnv  /o1%
   loopedit  /i%1\*.cnv  /o1%
   binavg  /i%1\*.cnv  /aavg  /o%1
   derive  /i%1\*avg.cnv  /c%1\cast.con  /o%1
   seaplot  /i%1\*.cnv
   ```
   Module names and options are separated by one or more spaces or tabs.

3. Select Run in the Windows Start menu. The Run dialog box appears.

4. Type in the program name and parameters as shown:
   sbebatch c:\leg1\prallcasts.txt c:\leg1
   (batch filename is c:\leg1\prallcasts.txt; parameter %1 is c:\leg1)

5. The data is processed as follows (all input and output files are in c:\leg1):

Module	Input File(s)	Output File
Data Conversion (datcnv)	cast1.dat cast2.dat cast.con	cast1.cnv cast2.cnv
Wild Edit (wildedit)	cast1.cnv cast2.cnv	cast1.cnv cast2.cnv
Filter (filter)	cast1.cnv cast2.cnv	cast1.cnv cast2.cnv
Loop Edit (loopedit)	cast1.cnv cast2.cnv	cast1.cnv cast2.cnv
Bin Average (binavg)	cast1.cnv cast2.cnv	cast1avg.cnv cast2avg.cnv
Derive (derive)	cast1avg.cnv cast2avg.cnv cast.con	cast1.cnv cast2.cnv
Sea Plot (seaplot)	cast1.cnv cast2.cnv	cast1.jpg cast2.jpg (if File Setup tab was set to output to jpeg)

Appendix II: Configure (.con or .xmlcon) File Format

Note:
For an easy-to-read report of .con or .xmlcon file contents, see *Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe*.

Modify a .con or .xmlcon configuration file by selecting the instrument in the Configure menu.

Configuration files (.con or .xmlcon) can also be opened, viewed, and modified with DisplayConFile.exe, a utility that is installed in the same folder as SBE Data Processing. Right click on the desired configuration file, select *Open With*, and select *DisplayConFile*. This utility is often used at Sea-Bird to quickly open and view a configuration file for troubleshooting purposes, without needing to go through the additional steps of selecting the file in SBE Data Processing or Seasave.

.xmlcon Configuration File Format

Note:
We recommend that you **do not** open .xmlcon files with a text editor (i.e., Notepad, Wordpad, etc.).

.xmlcon configuration files, written in XML format, were introduced with SBE Data Processing and Seasave 7.20a. A .xmlcon file uses XML tags to describe each line in the file. Versions 7.20a and later allow you to open a .con or a .xmlcon file, and to save the configuration to a .con or a .xmlcon file. Instruments introduced after 7.20a are compatible only with .xmlcon files.

.con Configuration File Format

Shown below is a line-by-line description of a .con configuration file contents, which can be viewed in a text editor (i.e., Notepad, Wordpad, etc.).

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, deck unit or searam?
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	Primary OBS/Nephelometer seapoint turbidity meter sensor serial number
149	Primary 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	Franatech (formerly Capsum) METS serial number
206	Franatech (formerly Capsum) METS calibration date
207	Franatech (formerly 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
251	OBS D&A 3+ serial number
252	OBS D&A 3+ calibration date
253	OBS D&A 3+ a0, a1, a2
254	Secondary OBS D&A 3+ serial number
255	Secondary OBS D&A 3+ calibration date
256	Secondary OBS D&A 3+ a0, a1, a2
257	SBE 16, 19, 19plus, 21, 25, or 49 scan time added? NMEA time added? NMEA device connected to PC?
258	SBE 43 Oxygen sensor: use Sea-Bird equation, Soc2007, A, B, C, E, Voffset, Tau20, D0, D1, D2, H1, H2, H3
259	Secondary SBE 43 Oxygen sensor: use Sea-Bird equation, Soc2007, A, B, C, E, Voffset, Tau20, D0, D1, D2, H1, H2, H3
260	File version of SB_ConfigCTD.dll which saved the .con file
261	IFREMER OBS/nephelometer sensor serial number
262	Primary Beckman Oxygen Temperature sensor – calibration date
263	Primary Beckman Oxygen Temperature sensor – serial number
264	Secondary Beckman Oxygen Temperature sensor – calibration date
265	Secondary Beckman Oxygen Temperature sensor – serial number
266	IOW Oxygen Temperature sensor – calibration date
267	IOW Oxygen Temperature sensor – serial number
268	Methane Gas Tension, Franatech (formerly Capsum) METS sensor – calibration date
269	Methane Gas Tension, Franatech (formerly Capsum) METS sensor –serial number
270	Secondary WET Labs ECO-AFL fluorometer serial number
271	Secondary WET Labs ECO-AFL fluorometer calibration date
272	Secondary WET Labs ECO-AFL fluorometer vblank, scale factor
273	Secondary OBS/Nephelometer D&A Backscatterance sensor serial number
274	Secondary OBS/Nephelometer D&A Backscatterance gain, offset
275	Secondary OBS/Nephelometer D&A Backscatterance sensor calibration date
276	Aanderaa Oxygen Optode serial number
277	Aanderaa Oxygen Optode calibration date
278	Aanderaa Oxygen Optode: do salinity correction? do depth correction? internal salinity value
279	Satlantic PAR/Logarithmic serial number
280	Satlantic PAR/Logarithmic calibration date
281	Satlantic PAR/Logarithmic a0, a1, lm

Appendix III: Generating .con or .xmlcon File Reports – ConReport.exe

The configuration file report is an ASCII .txt file that shows all parameters in the .con or .xmlcon file in an easy-to-read form. The .txt report is for viewing only, and cannot be used to modify parameters in the configuration file for processing data. The .txt file is generated by:

- Clicking Report in a Configuration dialog box (see *Instrument Configuration* in *Section 4: Configuring Instrument (Configure)*), **or**
- Using ConReport.exe.

ConReport.exe is run from the command line or from a DOS prompt, and accepts wildcards for the file names, so multiple reports can be produced at one time, and reports can be placed into a specified directory. ConReport is automatically installed when you install SBE Data Processing (default location c:\Program Files\Sea-Bird\SBEDataProcessing-Win32). The format for running ConReport is:

Conreport InputFilename OutputDirectory /S

Parameter	Description
InputFilename	InputFilename is .con or .xmlcon file for which you want to generate a report. Must include full path **and** file name. This parameter supports standard wildcard expansion with *: • * matches any set of characters starting at specified position within file name or extension and continuing until the end of file name or extension or another specified character.
OutputDirectory	(optional) Full path to location to store output .txt file(s). If not specified, defaults to location of input .con or .xmlcon file(s).
/S	(optional) Do not echo messages to screen.

If specifying multiple parameters, insert one or more spaces or tabs between each parameter in the list.

Example – Generate Reports for All .con Files in Directory, and Save to Different Directory

The .con files test1.con, test2.con, and test3.con are in c:\leg1, and you want to generate the .txt reports and save them to c:\CruiseSummary.

At the DOS prompt, starting in the directory where ConReport is located (default c:\Program Files\Sea-Bird\SBEDataProcessing-Win32), type in the program name and parameters as shown:

conreport c:\leg1*.con c:\CruiseSummary

The program responds:

c:\CruiseSummary\test1.txt
c:\CruiseSummary\test2.txt
c:\CruiseSummary\test3.txt
3 reports written to c:\CruiseSummary

Note:
You can also run ConReport from a Run dialog (select Run in the Windows Start menu). If you have not modified your autoexec.bat file to put the ConReport.exe file in the path statement, specify the full path of the .exe file in the Run dialog box.

Appendix IV: 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 (software@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 processing, you may be asked to send a sample of the data to Sea-Bird for evaluation.

Appendix V: Derived Parameter Formulas (EOS-80; Practical Salinity)

Notes:

- Algorithms used for calculation of derived parameters in Data Conversion, Derive, Sea Plot, SeaCalc III [EOS-80 (Practical Salinity) tab], and Seasave are identical, except as noted in this section, and are based on EOS-80 equations (*Practical Salinity*).
- **Calculation of Absolute Salinity and associated parameters** (TEOS-10) is available in Derive TEOS-10 and SeaCalc III [TEOS-10 (Absolute Salinity) tab]. Once they are calculated in Derive TEOS-10, they can be plotted in Sea Plot. See *Section 6: Data Processing Modules* and *Section 9: Miscellaneous Module – SeaCalc III*.

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, except as noted. Following the recommendation of JPOTS, T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C).
- Salinity is PSS-78 (Practical Salinity) (see *Application Note 14: 1978 Practical Salinity Scale*). By definition, PSS-78 is valid only in the range of 2 to 42 psu. Sea-Bird uses the PSS-78 algorithm in our software, without regard to those limitations on the valid range.
  Unesco technical papers in marine science 62 "Salinity and density of seawater: Tables for high salinities (42 to 50)" provides a method for calculating salinity in the higher range (http://unesdoc.unesco.org/images/0009/000964/096451mb.pdf).

Equations / descriptions are provided for the following 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)
- seafloor depth (salt water, fresh water)
- Practical Salinity (psu)
- sound velocity (Chen-Millero, DelGrosso, Wilson)
- average sound velocity
- potential temperature (reference pressure = 0.0 decibars)
- potential temperature anomaly
- plume anomaly
- specific conductivity
- 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 signal (for SBE 43), oxygen current and oxygen temperature (for SBE 13 or 23), or oxygen phase and thermistor voltage (SBE 63)
- oxygen saturation
- oxygen percent saturation
- nitrogen saturation
- derivative variables (descent rate and acceleration) - if input file has not been averaged into pressure or depth bins
- 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*]

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

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

Note:
You can also enter the latitude on the Miscellaneous tab in Data Conversion or Derive, as applicable.

depth = [*m*]
(When you select *salt* water depth as a derived variable, SBE Data Processing prompts you to input the latitude, which is needed to calculate local gravity. It uses the user-input value, unless latitude is written in the input data file header [from a NMEA navigation device]. If latitude is in the input file header, SBE Data Processing uses the header value, and ignores the user-input latitude.).

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);
}
```

seafloor depth = depth + altimeter reading [*m*]

Note:
Absolute Salinity (TEOS-10) is available in our seawater calculator, Sea Calc III. See *Section 9: Miscellaneous Module – SeaCalc III*. **All other SBE Data Processing modules output only Practical Salinity, and all parameters derived from salinity in those modules (density, sound velocity, etc) are based on Practical Salinity**.

Practical Salinity = [*PSU*]
(Salinity is PSS-78, valid from 2 to 42 psu.)

Practical 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;
}
```

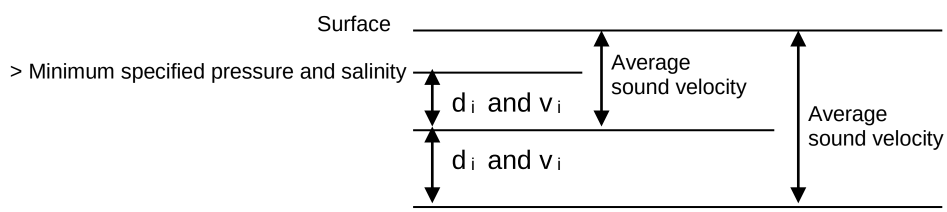
$$\textbf{average sound velocity} = \frac{\sum_{\Delta p,p=min}^{p=p} \mathbf{d_i}}{\sum_{\Delta p,p=min}^{p=p} \mathbf{d_i / v_i}} \quad [m/s]$$

Average sound velocity is the harmonic mean (average) **from the surface** to the current CTD depth, and 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 (regardless of whether latitude data from a NMEA navigation device is in the data file).

- In Derive, 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]
- In Seasave and Data Conversion, 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 [m]
  $\mathbf{v_i}$ =
  (sound velocity at start of window + sound velocity at end of window) / 2 [m/sec]

When you select average sound velocity as a derived variable, SBE Data Processing prompts you to enter the minimum pressure, minimum salinity, and if applicable, pressure window size and time window size.

Note:
You can also enter the user-input parameters on the Miscellaneous tab in Data Conversion or Derive, as applicable.



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*]

Note:
You can also enter the user-input parameters on the Miscellaneous tab in Data Conversion or Derive, as applicable.

potential temperature anomaly =
potential temperature - a0 - a1 x salinity
or
potential temperature - a0 - a1 x Sigma-theta
(When you select potential temperature anomaly as a derived variable, SBE Data Processing prompts you to enter a0, a1, and the selection of salinity or sigma-theta.)

Notes:
- You can also enter the user-input parameters on the Miscellaneous tab in Data Conversion; plume anomaly is not available as a derived variable in Derive.
- Reference: Baker, E.T., Feely, R.A., Mottl, M.J., Sansone, F. T., Wheat, C.G., Resing, J.A., Lupton, J.E., "Hydrothermal plumes along the East Pacific Rise, 8° 40′ to 11° 50′ N: Plume distribution and relationship to the apparent magmatic budget", Earth and Planetary Science Letters 128 (1994) 1-17.

plume anomaly =
potential temperature (s, t, p, Reference Pressure) – Theta-B
– Theta-Z / Salinity-Z * (salinity – Salinity-B)
(When you select plume anomaly as a derived variable, SBE Data Processing prompts you to enter Theta-B, Salinity-B, Theta-Z / Salinity-Z, and Reference Pressure.)

The plume anomaly equation is based on work in hydrothermal vent plumes. The algorithm used for identifying hydrothermal vent plumes uses potential temperature, gradient conditions in the region, vent salinity, and ambient seawater conditions adjacent to the vent. This function is specific to hydrothermal vent plumes, and more specifically, temperature and potential density anomalies. It is not a generic function for plume tracking (for example, not for wastewater plumes). One anomaly for one region and application does not necessarily apply to another type of anomaly in another region for a different application. The terms are specific to corrections for hydrothermal vent salinity and local hydrographic features near vents. They are likely not relevant to other applications in this exact form.

If looking at wastewater plumes, you need to derive your own anomaly function that is specific to what it is you are looking for and that is defined to differentiate between surrounding waters and the wastewater plume waters.

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.)

Note:
Oxygen [ml/l] for the SBE 63 Optical Dissolved Oxygen Sensor is calculated as described in its manual. Tau and hysteresis corrections are not applicable to the SBE 63.

Note:
You can also enter the oxygen window size, and enable / disable the Tau and hysteresis corrections, on the Miscellaneous tab in Data Conversion or Derive, as applicable.

Note:
The hysteresis correction can be performed to calculate and output oxygen voltage and/or calculated oxygen (ml/l, etc.) in Data Conversion. Hysteresis-corrected voltage from Data Conversion can be further processed in other modules (such as Align CTD) before calculating oxygen values (ml/l, etc.) in Derive.

Oxygen [*ml/l*] is calculated as described in *Application Note 64: SBE 43 Dissolved Oxygen Sensor* **or** *Application Note 13-1: SBE 13, 23, 30 Dissolved Oxygen Sensor Calibration & Deployment*.

When you select oxygen as a derived variable, **Data Conversion** prompts you to enter the window size (seconds), and asks if you want to apply the Tau correction and the hysteresis correction:

- ***Tau correction*** – The Tau correction ([tau(T,P)*δV/δt] in SBE 43 or [tau*doc/dt] in SBE 13 or 23) improves response of the measured signal in regions of large oxygen gradients. However, this term also amplifies residual noise in the signal (especially in deep water); in some situations this negative consequence overshadows gains in signal responsiveness.
  If the Tau correction is enabled, oxygen computed by Seasave and Data Conversion is somewhat different from values computed by Derive. Both algorithms compute the derivative of the oxygen signal with respect to time (with a user-input window size for calculating the derivative), 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) 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.
- ***Hysteresis correction*** (SBE 43 only, when using *Sea-Bird* equation) - Under extreme pressure, changes can occur in gas permeable Teflon membranes that affect their permeability characteristics. Some of these changes (plasticization and amorphous/crystalinity ratios) have long time constants and depend on the sensor's time-pressure history. These slow processes result in *hysteresis* in long, deep casts. The hysteresis correction algorithm (using H1, H2, and H3 coefficients entered for the SBE 43 in the .con or .xmlcon file) operates through the entire data profile and corrects the oxygen voltage values for changes in membrane permeability as pressure varies. At each measurement, the correction to the membrane permeability is calculated based on the current pressure and how long the sensor spent at previous pressures.
  Hysteresis responses of membranes on individual SBE 43 sensors are very similar, and in most cases the default hysteresis parameters provide the accuracy specification of 2% of true value. For users requiring higher accuracy (±1 µmol/kg), the parameters can be fine-tuned, if a complete profile (descent and ascent) made preferably to greater than 3000 meters is available. H1, the effect's amplitude, has a default of -0.033, but can range from -0.02 to -0.05 between sensors. H2, the effect's non-linear component, has a default of 5000, and is a second-order parameter that does not require tuning between sensors. H3, the effect's time constant, has a default of 1450 seconds, but can range from 1200 to 2000.
  Hysteresis can be eliminated by alternately adjusting H1 and H3 in the .con or .xmlcon file during analysis of the complete profile. Once established, these parameters should be stable, and can be used without adjustment on other casts with the same SBE 43.

When you select oxygen as a derived variable, **Derive** prompts you to enter the window size (seconds), and asks if you want to apply the Tau correction (described above for Data Conversion). **You cannot apply the hysteresis correction in Derive**, to prevent users from applying the correction to oxygen voltage in Data Conversion and then applying it again in Derive, providing erroneous results.

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

Notes:

- The oxygen saturation equation based on work from Garcia and Gordon (1992) reduces error in the Weiss (1970) parameterization at cold temperatures.
- As implemented in Sea-Bird software, the Garcia and Gordon equation is valid for -5 < T < 50 and 0 < S < 60. Outside of those ranges, the software returns a value of -99 for Oxsol.
- As implemented in Sea-Bird software, the Weiss equation is valid for -2 < T < 40 and 0 < S < 42. Outside of those ranges, the software returns a value of -99 for Oxsat.

Oxygen saturation is the theoretical saturation limit of the water at the local temperature and salinity value, but with local pressure reset to zero (1 atmosphere). This calculation represents what the local parcel of water could have absorbed from the atmosphere when it was last at the surface (p=0) but at the same (T,S) value. Oxygen saturation can be calculated as Garcia and Gordon, or Weiss –

Garcia and Gordon:

Oxsol(T,S) = exp {A0 + A1(Ts) + A2(Ts) ^{2} + A3(Ts) ^{3} + A4(Ts) ^{4} + A5(Ts) ^{5} + S * [B0 + B1(Ts) + B2(Ts) ^{2} + B3(Ts) ^{3}] + C0(S) ^{2}}

where

- Oxsol(T,S) = oxygen saturation value (ml/l)
- S = salinity (psu)
- T = water temperature (ITS-90, ºC)
- Ts = ln [(298.15 – T) / (273.15 + T)]
- A0 = 2.00907 A1 = 3.22014 A2 = 4.0501
  A3 = 4.94457 A4 = - 0.256847 A5 = 3.88767
- B0 = -0.00624523 B1 = -0.00737614
  B2 = -0.010341 B3 = -0.00817083
- C0 = -0.000000488682

Weiss:

Oxsat(T,S) = exp {[A1 + A2 * (100/T_a) + A3 * ln(T_a/100) + A4 * (T_a/100)] + S * [B1 + B2 * (T_a/100) + B3 * (T_a/100)^2]}

where

- Oxsat(T,S) = oxygen saturation value (ml/l)
- S = salinity (psu)
- T = water temperature (IPTS-68, ºC)
- T_a = absolute water temperature (T + 273.15)
- A1 = -173.4292 A2 = 249.6339 A3 = 143.3483 A4 = -21.8492
- B1 = -0.033096 B2 = 0.014259 B3 = -0.00170

Oxygen, percent saturation is the ratio of calculated oxygen to oxygen saturation, in percent:

(Oxygen / Oxygen saturation) * 100%.

The Oxygen Saturation value used in this calculation is the value that was used in the Oxygen calculation –

- SBE 43 -if you selected the *Sea-Bird* equation in the .con or .xmlcon file, the software uses the Garcia and Gordon Oxsol in this ratio; if you selected the *Owens-Millard* equation in the .con or .xmlcon file, the software uses the Weiss Oxsat in this ratio.
- SBE 13, 23, or 30 – the software uses the Weiss Oxsat for this ratio.

Note:
The nitrogen saturation equation is based on work from Weiss (1970).

Nitrogen saturation is the theoretical saturation limit of the water at the local temperature and salinity value, but with local pressure reset to zero (1 atmosphere). This calculation represents what the local parcel of water could have absorbed from the atmosphere when it was last at the surface (p=0) but at the same (T,S) value.

N2sat(T,S) = exp {[A1 + A2 * (100/T_a) + A3 * ln(T_a/100) + A4 * (T_a/100)] + S * [B1 + B2 * (T_a/100) + B3 * (T_a/100) ^{2}]}

where

- N2Sat(T,S) = nitrogen saturation value (ml/l)
- S = salinity (psu)
- T = water temperature (ºC)
- T_a = absolute water temperature (ºC + 273.15)
- A1 = -172.4965 A2 = 248.4262 A3 = 143.0738 A4 = -21.7120
- B1 = -0.049781 B2 = 0.025018 B3 = -0.0034861

Descent rate and **acceleration** are computed by calculating the derivative of the pressure signal with respect to time (with a user-input window size for calculating the derivative), using a linear regression to determine the slope. Values computed by Seasave and Data Conversion are somewhat different from values computed by Derive. Seasave and Data Conversion compute the derivative looking backward in time (with a user-input window size), 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; user-input window size) 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.
(When you select descent rate or acceleration as a derived variable, SBE Data Processing prompts you to enter the window size (seconds).)

Note:
You can also enter the descent rate and acceleration window size on the Miscellaneous tab in Data Conversion or Derive, as applicable.

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 or .xmlcon file entry for surface PAR sensor;
Underwater PAR = underwater PAR data;
Surface PAR = surface PAR data)

Note:
See Application Note 11S (SBE 11*plus* Deck Unit with Biospherical surface PAR sensor), 47 (SBE 33 or 36 Deck Unit with Biospherical surface PAR sensor), or 96 (SBE 11*plus*, 33, or 36 Deck Unit with Satlantic surface PAR sensor for description of ratio multiplier.

Appendix VI: Output Variable Names

This appendix provides a list of output variable names. The names vary, depending on whether you are viewing header information in a data file or viewing real-time data in Seasave.

- Headers generated by modules in **SBE Data Processing** show 'Short name: Full name' in header.
  Example:
  # name 0 = prdM: Pressure, Strain Gauge [db]
  (*# name 0* indicates that this is the header for the first data column;
  prdM is the Short name used in the software coding;
  Pressure, Strain Gauge [db] is the more descriptive Full name)
- **Seasave's scrolled display** shows a 'Friendly name' in heading.
  Example:
  pr M
  (this is the Friendly name for *Pressure, Strain Gauge [db]*;
  pr indicates pressure and *M* indicates metric units)
- **Seasave's fixed display and plot display** show 'Full name'.
  Example:
  Pressure, Strain Gauge [db]
  (this is the Full name)

Note:
The Notes/Comments column in the table below indicates *1st sensor*, *2nd sensor*, etc. For parameters calculated from multiple sensors (for example, salinity is a function of temperature, conductivity, and pressure), 1st refers to the 1st sensor T-C pair, 2nd refers to the secondary T-C pair.

For CTDs that support redundant sensors: Unless noted otherwise, derived variables are calculated only from primary sensor(s).
Example:
Sound Velocity [Chen-Millero, m/s] can be calculated from both primary and secondary temperature and conductivity sensors on an SBE 9*plus* (which supports secondary temperature and conductivity sensors), as indicated by the presence of both *Sound Velocity [Chen-Millero, m/s]* and *Sound Velocity,**2** [Chen-Millero, m/s]* in the table.
However, *Average Sound Velocity [Chen-Millero, m/s]* can only be calculated from the primary temperature and conductivity sensors (there is no entry for this variable with a *2*).

For some parameters, there are multiple entries in the table with the same meaning for the user (but different meanings for the software).
Example:
Short names of *c_S/m*, *cond0S/m*, and *c0S/m* all have long names of *Conductivity [S/m]*; these parameters all provide conductivity in S/m. However, the short names are different because of differences in the conductivity equation used by the software in the calculation (equation varies, depending on the CTD).

All variable selections can be made in Seasave and in SBE Data Processing's Derive module, except as noted.

The list is in two parts:

- **Practical Salinity** and related thermodynamic parameters (**EOS-80**), and auxiliary sensor data
- **Absolute Salinity** and related thermodynamic parameters (calculated in and output by **SBE Data Processing's Derive TEOS-10 module**)

Practical Salinity and related Thermodynamic Parameters (EOS-80), and Auxiliary Sensor Data

Short Name	Full Name	Friendly Name	Units	Notes/Comments
accM	Acceleration [m/s^2]	acc M	m/s^2	
accF	Acceleration [ft/s^2]	acc F	ft/s^2	
altM	Altimeter [m]	alt M	m	
altF	Altimeter [ft]	alt F	ft	
avgsvCM	Average Sound Velocity [Chen-Millero, m/s]	avgsv-C M	Chen-Millero, m/s	
avgsvCF	Average Sound Velocity [Chen-Millero, ft/s]	avgsv-C F	Chen-Millero, ft/s	
avgsvDM	Average Sound Velocity [Delgrosso, m/s]	avgsv-D M	Delgrosso, m/s	
avgsvDF	Average Sound Velocity [Delgrosso, ft/s]	avgsv-D F	Delgrosso, ft/s	
avgsvWM	Average Sound Velocity [Wilson, m/s]	avgsv-W M	Wilson, m/s	
avgsvWF	Average Sound Velocity [Wilson, ft/s]	avgsv-W F	Wilson, ft/s	
bat	Beam Attenuation, Chelsea/Seatech [1/m]	bat	1/m	1st sensor
bat1	Beam Attenuation, Chelsea/Seatech, 2 [1/m]	bat2	1/m	2nd sensor
batdiff	Beam Attenuation, Chelsea/Seatech/WET Labs CStar, Diff, 2 - 1 [1/m]	batdiff	1/m	2nd sensor - 1st sensor
wetBAttn	Beam Attenuation, WET Labs AC3 [1/m]	wetBAttn	1/m	
CStarAt0	Beam Attenuation, WET Labs C-Star [1/m]	CStarAt	1/m	1st sensor
CStarAt1	Beam Attenuation, WET Labs C-Star, 2 [1/m]	CStarAt2	1/m	2nd sensor
CStarAt2	Beam Attenuation, WET Labs C-Star, 3 [1/m]	CStarAt3	1/m	3rd sensor
CStarAt3	Beam Attenuation, WET Labs C-Star, 4 [1/m]	CStarAt4	1/m	4th sensor
CStarAt4	Beam Attenuation, WET Labs C-Star, 5 [1/m]	CStarAt5	1/m	5th sensor
CStarAt5	Beam Attenuation, WET Labs C-Star, 6 [1/m]	CStarAt6	1/m	6th sensor
CStarAtDiff	Beam Attenuation, WET Labs C-Star, Diff, 2 - 1 [1/m]	CStarAtDiff	1/m	2nd sensor - 1st sensor
xmiss	Beam Transmission, Chelsea/Seatech [%]	xmiss	%	1st sensor
xmiss1	Beam Transmission, Chelsea/Seatech, 2 [%]	xmiss2	%	2nd sensor
xmissdiff	Beam Transmission, Chelsea/Seatech/WET Labs CStar, Diff, 2 - 1 [%]	xmissdiff	%	2nd sensor - 1st sensor
wetBTrans	Beam Transmission, WET Labs AC3 [%]	wetBTrans	%	
CStarTr0	Beam Transmission, WET Labs C-Star [%]	CStarTr	%	1st sensor
CStarTr1	Beam Transmission, WET Labs C-Star, 2 [%]	CStarTr2	%	2nd sensor
CStarTr2	Beam Transmission, WET Labs C-Star, 3 [%]	CStarTr3	%	3rd sensor
CStarTr3	Beam Transmission, WET Labs C-Star, 4 [%]	CStarTr4	%	4th sensor
CStarTr4	Beam Transmission, WET Labs C-Star, 5 [%]	CStarTr5	%	5th sensor
CStarTr5	Beam Transmission, WET Labs C-Star, 6 [%]	CStarTr6	%	6th sensor
CStarTrdiff	Beam Transmission, WET Labs C-Star, Diff, 2 - 1 [%]	CStarTrdiff	%	2nd sensor - 1st sensor
bpos	Bottle Position in Carousel	bpos		
HBBotCls	Bottles Closed, HB	HBBotCls		
nbf	Bottles Fired	nbf		
bct	Bottom Contact	bct		
N	Buoyancy [cycles/hour]	N	cycles/hour	Calculated in SBE Data Processing's Buoyancy module
N^2	Buoyancy [rad^2/s^2]	N^2	rad^2/s^2	Calculated in SBE Data Processing's Buoyancy module
nbytes	Byte Count	nbytes		

Short Name	Full Name	Friendly Name	Units	Notes/Comments
cdomflTC0	CDOM, Turner Cyclops [ppb QS]	cdomflTC	ppb QS	1st sensor
cdomflTC1	CDOM, Turner Cyclops, 2 [ppb QS]	cdomflTC2	ppb QS	2nd sensor
cdomflTCdiff	CDOM, Turner Cyclops, Diff, 2 - 1 [ppb QS]	cdomflTCdiff	ppb QS	2nd sensor - 1st sensor
chloroflTC0	Chlorophyll, Turner Cyclops [ug/l]	chloroflTC	ug/l	1st sensor
chloroflTC1	Chlorophyll, Turner Cyclops, 2 [ug/l]	chloroflTC2	ug/l	2nd sensor
chloroflTCdiff	Chlorophyll, Turner Cyclops, Diff, 2 - 1 [ug/l]	chloroflTCdiff	ug/l	2nd sensor - 1st sensor
c_S/m, cond0S/m, or cond0S/m	Conductivity [S/m]	c S/m	S/m	1st sensor
c_mS/cm, cond0mS/cm, or c0mS/cm	Conductivity [mS/cm]	c mS/cm	mS/cm	1st sensor
c_uS/cm, cond0uS/cm, or cond0uS/cm	Conductivity [uS/cm]	c uS/cm	uS/cm	1st sensor
c1S/m	Conductivity, 2 [S/m]	c2 S/m	S/m	2nd sensor
c1mS/cm	Conductivity, 2 [mS/cm]	c2 mS/cm	mS/cm	2nd sensor
c1uS/cm	Conductivity, 2 [uS/cm]	c2 uS/cm	uS/cm	2nd sensor
C2-C1S/m	Conductivity Difference, 2 - 1 [S/m]	c2-c1 S/m	S/m	2nd sensor - 1st sensor
C2-C1mS/cm	Conductivity Difference, 2 - 1 [mS/cm]	c2-c1 mS/cm	mS/cm	2nd sensor - 1st sensor
C2-C1uS/cm	Conductivity Difference, 2 - 1 [uS/cm]	c2-c1 uS/cm	uS/cm	2nd sensor - 1st sensor
cpar	CPAR/Corrected Irradiance [%]	cpar	%	
croilflTC0	Crude Oil, Turner Cyclops [ppb QS]	croilflTC	ppb QS	1st sensor
croilflTC1	Crude Oil, Turner Cyclops, 2 [ppb QS]	croilflTC2	ppb QS	2nd sensor
croilflTCdiff	Crude Oil, Turner Cyclops, Diff, 2 - 1 [ppb QS]	croilflTCdiff	ppb QS	2nd sensor - 1st sensor
density00	Density [density, kg/m^3]	density	density, kg/m^3	1st sensor
sigma-é00	Density [sigma-theta, kg/m^3]	sigmath	sigma-theta, kg/m^3	1st sensor
sigma-t00	Density [sigma-t, kg/m^3]	sigmat	sigma-t, kg/m^3	1st sensor
sigma-100	Density [sigma-1, kg/m^3]	sigma1	sigma-1, kg/m^3	1st sensor
sigma-200	Density [sigma-2, kg/m^3]	sigma2	sigma-2, kg/m^3	1st sensor
sigma-400	Density [sigma-4, kg/m^3]	sigma4	sigma-4, kg/m^3	1st sensor
density11	Density, 2 [density, kg/m^3]	density 2	density, kg/m^3	2nd sensor
sigma-é11	Density, 2 [sigma-theta, kg/m^3]	sigmath 2	sigma-theta, kg/m^3	2nd sensor
sigma-t11	Density, 2 [sigma-t, kg/m^3]	sigmat 2	sigma-t, kg/m^3	2nd sensor
sigma-111	Density, 2 [sigma-1, kg/m^3]	sigma1 2	sigma-1, kg/m^3	2nd sensor
sigma-211	Density, 2 [sigma-2, kg/m^3]	sigma2 2	sigma-2, kg/m^3	2nd sensor
sigma-411	Density, 2 [sigma-4, kg/m^3]	sigma4 2	sigma-4, kg/m^3	2nd sensor
D2-D1,d	Density Difference, 2 - 1 [density, kg/m^3]	D2-D1,d	density, kg/m^3	2nd sensor - 1st sensor
D2-D1	Density Difference, 2 - 1 [sigma-theta, kg/m^3]	D2-D1,th	sigma-theta, kg/m^3	2nd sensor - 1st sensor
D2-D1,t	Density Difference, 2 - 1 [sigma-t, kg/m^3]	D2-D1,t	sigma-t, kg/m^3	2nd sensor - 1st sensor
D2-D1,1	Density Difference, 2 - 1 [sigma-1, kg/m^3]	D2-D1,1	sigma-1, kg/m^3	2nd sensor - 1st sensor
D2-D1,2	Density Difference, 2 - 1 [sigma-2, kg/m^3]	D2-D1,2	sigma-2, kg/m^3	2nd sensor - 1st sensor
D2-D1,4	Density Difference, 2 - 1 [sigma-4, kg/m^3]	D2-D1,4	sigma-4, kg/m^3	2nd sensor - 1st sensor
depSM	Depth [salt water, m]	depS M	salt water, m	
depSF	Depth [salt water, ft]	depS F	salt water, ft	
depFM	Depth [fresh water, m]	depF M	fresh water, m	
depFF	Depth [fresh water, ft]	depF F	fresh water, ft	
dNMEA	Depth, NMEA [salt water, m]	dNMEA	salt water, m	

Short Name	Full Name	Friendly Name	Units	Notes/Comments
dz/dtM	Descent Rate [m/s]	dz/dt M	m/s	
dz/dtF	Descent Rate [ft/s]	dz/dt F	ft/s	
dm	Dynamic Meters [10 J/kg]	dm	10 J/kg	Calculated in SBE Data Processing's Derive module
flag	Flag	flag		
chConctr	Fluorescence, Biospherical Chl Con	chConctr		Concentration
naFluor	Fluorescence, Biospherical Natural	naFluor		Natural fluorescence
product	Fluorescence, Biospherical Production	product		Production
flC	Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]	flC	ug/l	1st sensor
flC1	Fluorescence, Chelsea Aqua 3 Chl Con, 2 [ug/l]	flC2	ug/l	2nd sensor
flCdiff	Fluorescence, Chelsea Aqua 3 Chl Con, Diff, 2 - 1 [ug/l]	flCdiff	ug/l	2nd sensor - 1st sensor
flCM	Fluorescence, Chelsea Mini Chl Con [ug/l]	flCM	ug/l	
flCUVA	Fluorescence, Chelsea UV Aquatracka [ug/l]	flCUVA	ug/l	1st sensor
flCUVA1	Fluorescence, Chelsea UV Aquatracka, 2 [ug/l]	flCUVA2	ug/l	2nd sensor
flCUVAdiff	Fluorescence, Chelsea UV Aquatracka, Diff, 2 - 1 [ug/l]	flCUVAdiff	ug/l	2nd sensor - 1st sensor
haardtC	Fluorescence, Dr. Haardt Chlorophyll a	haardtC		
haardtP	Fluorescence, Dr. Haardt Phycoerythrin	haardtP		
haardtY	Fluorescence, Dr. Haardt Yellow Sub	haardtY		
flSP	Fluorescence, Seapoint	flSP		1st sensor
flSP1	Fluorescence, Seapoint, 2	flSP2		2nd sensor
flSPdiff	Fluorescence, Seapoint Diff, 2 - 1	flSPdiff		2nd sensor - 1st sensor
flSPR	Fluorescence, Seapoint Rhodamine	flSPR		
flSPuv0	Fluorescence, Seapoint Ultraviolet	flSPuv		1st sensor
flSPuv1	Fluorescence, Seapoint Ultraviolet, 2	flSPuv2		2nd sensor
flSPuvdiff	Fluorescence, Seapoint Ultraviolet, Diff, 2 - 1	flSPuvdiff		2nd sensor - 1st sensor
flS	Fluorescence, Seatech	flS		Sea Tech fluorometer or WET Labs Flash Lamp fluorometer
flT	Fluorescence, Turner 10-005	flT		
flTAu	Fluorescence, Turner 10-Au-005	flTAu		
flSCC	Fluorescence, Turner Cor Chl [RFU]	flSCC	RFU	SCUFA corrected chlorophyll; 1st sensor
flSCC1	Fluorescence, Turner Cor Chl, 2 [RFU]	flSCC2	RFU	SCUFA corrected chlorophyll; 2nd sensor
flSCCdiff	Fluorescence, Turner Cor Chl, Diff, 2 - 1	flSCCdiff	RFU	SCUFA corrected chlorophyll; 2nd sensor - 1st sensor
flScufa	Fluorescence, Turner SCUFA [RFU]	flScufa		SCUFA chlorophyll; 1st sensor
flScufa1	Fluorescence, Turner SCUFA, 2 [RFU]	flScufa2		SCUFA chlorophyll; 2nd sensor
flScufadiff	Fluorescence, Turner SCUFA Diff, 2 - 1	flScufadiff		SCUFA chlorophyll; 2nd sensor - 1st sensor
wetChAbs	Fluorescence, WET Labs AC3 Absorption [1/m]	wetChAbs	1/m	
wetCDOM	Fluorescence, WET Labs CDOM [mg/m^3]	wetCDOM	mg/m^3	1st sensor
wetCDOM1	Fluorescence, WET Labs CDOM, 2 [mg/m^3]	wetCDOM2	mg/m^3	2nd sensor
wetCDOM2	Fluorescence, WET Labs CDOM, 3 [mg/m^3]	wetCDOM3	mg/m^3	3rd sensor
wetCDOM3	Fluorescence, WET Labs CDOM, 4 [mg/m^3]	wetCDOM4	mg/m^3	4th sensor
wetCDOM4	Fluorescence, WET Labs CDOM, 5 [mg/m^3]	wetCDOM5	mg/m^3	5th sensor
wetCDOM5	Fluorescence, WET Labs CDOM, 6 [mg/m^3]	wetCDOM6	mg/m^3	6th sensor
wetCDOMdiff	Fluorescence, WET Labs CDOM, Diff, 2 - 1 [mg/m^3]	wetCDOMdiff	mg/m^3	2nd sensor - 1st sensor
wetChConc	Fluorescence, WET Labs Chl Con [mg/m^3]	wetChConc	mg/m^3	WET Labs AC3 chlorophyll

Short Name	Full Name	Friendly Name	Units	Notes/Comments
flECO-AFL	Fluorescence, WET Labs ECO-AFL/FL [mg/m^3]	eco-afl	mg/m^3	1st sensor
flECO-AFL1	Fluorescence, WET Labs ECO-AFL/FL, 2 [mg/m^3]	eco-afl2	mg/m^3	2nd sensor
flECO-AFL2	Fluorescence, WET Labs ECO-AFL/FL, 3 [mg/m^3]	eco-afl3	mg/m^3	3rd sensor
flECO-AFL3	Fluorescence, WET Labs ECO-AFL/FL, 4 [mg/m^3]	eco-afl4	mg/m^3	4th sensor
flECO-AFL4	Fluorescence, WET Labs ECO-AFL/FL, 5 [mg/m^3]	eco-afl5	mg/m^3	5th sensor
flECO-AFL5	Fluorescence, WET Labs ECO-AFL/FL, 6 [mg/m^3]	eco-afl6	mg/m^3	6th sensor
flECO-AFLdiff	Fluorescence, WET Labs ECO-AFL/FL, Diff, 2 - 1 [mg/m^3]	eco-afldiff	mg/m^3	2nd sensor - 1st sensor
flWETSeaOWLchl0	Fluorescence, WET Labs SeaOWL CHL	flWETSeaOWLchl0	µg/l	1st chlorophyll sensor
flWETSeaOWLchl1	Fluorescence, WET Labs SeaOWL CHL, 2	flWETSeaOWLchl1	µg/l	2nd chlorophyll sensor
flWETSeaOWLchldiff	Fluorescence, WET Labs SeaOWL CHL, Diff, 2 - 1	flWETSeaOWLchldiff	µg/l	2nd – 1st chlorophyll sensor
flWETSeaOWLfdom0	Fluorescence, WET Labs SeaOWL FDOM	flWETSeaOWLfdom0	µg/l	1st FDOM sensor
flWETSeaOWLfdom1	Fluorescence, WET Labs SeaOWL FDOM	flWETSeaOWLfdom1	µg/l	2nd FDOM sensor
flWETSeaOWLfdomdiff	Fluorescence, WET Labs SeaOWL FDOM, Diff, 2 - 1	flWETSeaOWLfdomdiff	µg/l	2nd – 1st FDOM sensor
wetStar	Fluorescence, WET Labs WETstar [mg/m^3]	WETstar	mg/m^3	1st sensor
wetStar1	Fluorescence, WET Labs WETstar, 2 [mg/m^3]	WETstar2	mg/m^3	2nd sensor
wetStar2	Fluorescence, WET Labs WETstar, 3 [mg/m^3]	WETstar3	mg/m^3	3rd sensor
wetStar3	Fluorescence, WET Labs WETstar, 4 [mg/m^3]	WETstar4	mg/m^3	4th sensor
wetStar4	Fluorescence, WET Labs WETstar, 5 [mg/m^3]	WETstar5	mg/m^3	5th sensor
wetStar5	Fluorescence, WET Labs WETstar, 6 [mg/m^3]	WETstar6	mg/m^3	6th sensor
wetStardiff	Fluorescence, WET Labs WETstar, Diff, 2 - 1 [mg/m^3]	wetStardiff	mg/m^3	2nd sensor - 1st sensor
flflTC0	Fluorescein, Turner Cyclops [ppb]	flflTC	ppb	1st sensor
flflTC1	Fluorescein, Turner Cyclops, 2 [ppb]	flflTC2	ppb	2nd sensor
flflTCdiff	Fluorescein, Turner Cyclops, Diff, 2 - 1 [ppb]	flflTCdiff	ppb	2nd sensor - 1st sensor
f0	Frequency 0	f0	Hz	1st sensor
f1	Frequency 1	f1	Hz	2nd sensor
f2	Frequency 2	f2	Hz	3rd sensor
f3	Frequency 3	f3	Hz	4th sensor
f4	Frequency 4	f4	Hz	5th sensor
f5	Frequency 5	f5	Hz	6th sensor
f6	Frequency 6	f6	Hz	7th sensor
f7	Frequency 7	f7	Hz	8th sensor
f8	Frequency 8	f8	Hz	9th sensor
f9	Frequency 9	f9	Hz	10th sensor
f10	Frequency 10	f10	Hz	11th sensor
f11	Frequency 11	f11	Hz	12th sensor
f12	Frequency 12	f12	Hz	13th sensor
f13	Frequency 13	f13	Hz	14th sensor
f14	Frequency 14	f14	Hz	15th sensor
f15	Frequency 15	f15	Hz	16th sensor
f16	Frequency 16	f16	Hz	17th sensor
f17	Frequency 17	f17	Hz	18th sensor
f18	Frequency 18	f18	Hz	19th sensor
f19	Frequency 19	f19	Hz	20th sensor
f20	Frequency 20	f20	Hz	21st sensor

Short Name	Full Name	Friendly Name	Units	Notes/Comments
f21	Frequency 21	f21	Hz	22nd sensor
f22	Frequency 22	f22	Hz	23rd sensor
f23	Frequency 23	f23	Hz	24th sensor
f24	Frequency 24	f24	Hz	25th sensor
f25	Frequency 25	f25	Hz	26th sensor
f26	Frequency 26	f26	Hz	27th sensor
f27	Frequency 27	f27	Hz	28th sensor
f28	Frequency 28	f28	Hz	29th sensor
f29	Frequency 29	f29	Hz	30th sensor
f30	Frequency 30	f30	Hz	31st sensor
f31	Frequency 31	f31	Hz	32nd sensor
f32	Frequency 32	f32	Hz	33rd sensor
f33	Frequency 33	f33	Hz	34th sensor
f34	Frequency 34	f34	Hz	35th sensor
f35	Frequency 35	f35	Hz	36th sensor
f36	Frequency 36	f36	Hz	37th sensor
gpa	Geopotential Anomaly [J/kg]	gpa	J/kg	Calculated in SBE Data Processing's Derive module
GTDDOP0	GTD-DO Pressure [mb]	GTDDOP	mb	1st sensor
GTDDOP1	GTD-DO Pressure, 2 [mb]	GTDDOP2	mb	2nd sensor
GTDDOPdiff	GTD-DO Pressure, Diff, 2 - 1 [mb]	GTDDOPdiff	mb	2nd sensor - 1st sensor
GTDDOT0	GTD-DO Temperature [deg C]	GTDDOT	deg C	1st sensor
GTDDOT1	GTD-DO Temperature, 2 [deg C]	GTDDOT2	deg C	2nd sensor
GTDDOTdiff	GTD-DO Temperature, Diff, 2 - 1 [deg C]	GTDDOTdiff	deg C	2nd sensor - 1st sensor
GTDN2P0	GTD-N2 Pressure [mb]	GTDN2P	mb	1st sensor
GTDN2P1	GTD-N2 Pressure, 2 [mb]	GTDN2P2	mb	2nd sensor
GTDN2Pdiff	GTD-N2 Pressure, Diff, 2 - 1 [mb]	GTDN2Pdiff	mb	2nd sensor - 1st sensor
GTDN2T0	GTD-N2 Temperature [deg C]	GTDN2T	deg C	1st sensor
GTDN2T1	GTD-N2 Temperature, 2 [deg C]	GTDN2T2	deg C	2nd sensor
GTDN2Tdiff	GTD-N2 Temperature, Diff, 2 - 1 [deg C]	GTDN2Tdiff	deg C	2nd sensor - 1st sensor
latitude	Latitude [deg]	latitude	deg	From NMEA device
lisstBC	LISST-25A, Beam C [1/m]	lisstBC	1/m	
lisstOT	LISST-25A, Optical Transmission [%]	lisstOT	%	
lisstMD	LISST-25A, Sauter Mean Diameter [u]	lisstMD	u	
lisstTVC	LISST-25A, Total Volume Conc. [ul/l]	lisstTVC	ul/l	
lisst200X-MD	LISST-200X, Sauter Mean Diameter	Lisst200X-MD	u	Microns
lisst200X-TVC	LISST-200X, Total Volume Conc	Lisst200X-TVC	ppm	
lisstABS-PC	LISST-ABS, Particle Concentration	lisstABS-PC	Cu or mg/l	Calibration factor = 1.0 Cu else mg/l
longitude	Longitude [deg]	longitude	deg	From NMEA device
meth	Methane Conc., Franatech METS [umol/l]	meth	umol/l	
methT	Methane Gas Temp., Franatech METS [deg C]	methT	deg C	
modError	Modulo Error Count	modError		
mod	Modulo Word	mod		
newpos	New Position	newpos		
n2satML/L	Nitrogen Saturation [ml/l]	N2sat ml/l	ml/l	
n2satMg/L	Nitrogen Saturation [mg/l]	N2sat mg/l	mg/l	
n2satumol/kg	Nitrogen Saturation [umol/kg]	N2sat umol/kg	umol/kg	
obs	OBS, Backscatterance (D & A) [NTU]	obs	NTU	1st sensor
obs1	OBS, Backscatterance (D & A), 2 [NTU]	obs2	NTU	2nd sensor
obsdiff	OBS, Backscatterance (D & A), Diff, 2 - 1 [NTU]	obsdiff	NTU	2nd sensor - 1st sensor
nephc	OBS, Chelsea Nephelometer [FTU]	nephc	FTU	
obs3+	OBS, D & A 3plus [NTU]	obs3+	NTU	D&A OBS 3+; 1st sensor
obs3+1	OBS, D & A 3plus, 2 [NTU]	obs3+2	NTU	D&A OBS 3+; 2nd sensor
obs3+diff	OBS, D & A 3plus, Diff, 2 - 1 [NTU]	obs3+diff	NTU	D&A OBS 3+; 2nd sensor - 1st sensor
haardtT	OBS, Dr. Haardt Turbidity	haardtT		
diff	OBS, IFREMER	diff		

Short Name	Full Name	Friendly Name	Units	Notes/Comments
stLs6000	OBS, Seatech LS6000	stLs6000		Sea Tech LS6000 or WET Labs LBSS; 1st sensor
stLs60001	OBS, Seatech LS6000, 2	stLs60002		Sea Tech LS6000 or WET Labs LBSS; 2nd sensor
stLs6000diff	OBS, Seatech LS6000, Diff, 2 - 1	stLs6000diff		Sea Tech LS6000 or WET Labs LBSS; 2nd sensor - 1st sensor
obsscufa	OBS, Turner SCUFA [NTU]	obsscufa	NTU	1st sensor
obsscufa1	OBS, Turner SCUFA, 2 [NTU]	obsscufa2	NTU	2nd sensor
obsscufadiff	OBS, Turner SCUFA, Diff, 2 - 1 [NTU]	obsscufadiff	NTU	2nd sensor - 1st sensor
obrflTC0	Optical Brighteners, Turner Cyclops [ppb QS]	obrflTC	ppb QS	1st sensor
obrflTC1	Optical Brighteners, Turner Cyclops, 2 [ppb QS]	obrflTC2	ppb QS	2nd sensor
obrflTCdiff	Optical Brighteners, Turner Cyclops, Diff, 2 - 1 [ppb QS]	obrflTCdiff	ppb QS	2nd sensor - 1st sensor
orp	Oxidation Reduction Potential [mV]	orp	mV	
sbeox0V	Oxygen raw, SBE 43 [V]	sbeoxV	V	1st sensor
sbeox0F	Oxygen raw, SBE 43 [Hz]	sbeoxF	Hz	1st sensor
sbeox1V	Oxygen raw, SBE 43, 2 [V]	sbeoxV2	V	2nd sensor
sbeox1F	Oxygen raw, SBE 43, 2 [Hz]	sbeoxF2	Hz	2nd sensor
sbeox0ML/L	Oxygen, SBE 43 [ml/l]	sbeox ml/l	ml/l	1st sensor
sbeox0Mg/L	Oxygen, SBE 43 [mg/l]	sbeox mg/l	mg/l	1st sensor
sbeox0PS	Oxygen, SBE 43 [% saturation]	sbeox %S	% saturation	1st sensor
sbeox0Mm/Kg	Oxygen, SBE 43 [umol/kg]	sbeox mm/kg	umol/kg	1st sensor
sbeox0Mm/L	Oxygen, SBE 43 [umol/l]	sbeoxMm/L	umol/l	1st sensor
sbeox0dOV/dT	Oxygen, SBE 43 [dov/dt]	sbeox dov/dt	dov/dt	1st sensor
sbeox1ML/L	Oxygen, SBE 43, 2 [ml/l]	sbeox2 ml/l	ml/l	2nd sensor
sbeox1Mg/L	Oxygen, SBE 43, 2 [mg/l]	sbeox2 mg/l	mg/l	2nd sensor
sbeox1PS	Oxygen, SBE 43, 2 [% saturation]	sbeox2 %S	% saturation	2nd sensor
sbeox1Mm/Kg	Oxygen, SBE 43, 2 [umol/kg]	sbeox2 mm/kg	umol/kg	2nd sensor
sbeox1Mm/L	Oxygen, SBE 43, 2 [umol/l]	sbeoxMm/L2	umol/l	2nd sensor
sbeox1dOV/dT	Oxygen, SBE 43, 2 [dov/dt]	sbeox2 dov/dt	dov/dt	2nd sensor
sbeox0ML/Ldiff	Oxygen, SBE 43, Diff, 2 - 1 [ml/l]	sbeox ml/l diff	ml/l	2nd sensor - 1st sensor
sbeox0Mg/Ldiff	Oxygen, SBE 43, Diff, 2 - 1 [mg/l]	sbeox mg/l diff	mg/l	2nd sensor - 1st sensor
sbeox0PSdiff	Oxygen, SBE 43, Diff, 2 - 1 [% saturation]	sbeox %S diff	% saturation	2nd sensor - 1st sensor
sbeox0Mm/ Kgdiff	Oxygen, SBE 43, Diff, 2 - 1 [umol/kg]	sbeox mm/kg diff	umol/kg	2nd sensor - 1st sensor
sbeox0Mm/Ldiff	Oxygen, SBE 43, Diff, 2 - 1 [umol/l]	sbeox mm/l diff	umol/l	2nd sensor - 1st sensor
sbeoxpd	Oxygen raw, SBE 63 phase delay [usec]	sbeoxpd	usec	1st sensor
sbeoxpdv	Oxygen raw, SBE 63 phase delay [V]	sbeoxpdv	V	1st sensor
sbeoxpd1	Oxygen raw, SBE 63 phase delay, 2 [usec]	sbeoxpd2	usec	2nd sensor
sbeoxpdv1	Oxygen raw, SBE 63 phase delay, 2 [V]	sbeoxpdv2	V	2nd sensor
sbeoxtv	Oxygen raw, SBE 63 thermistor voltage [V]	sbeoxtv	V	1st sensor
sbeoxtv1	Oxygen raw, SBE 63 thermistor voltage, 2 [V]	sbeoxtv2	V	2nd sensor
sbeoxTC	Oxygen Temperature, SBE 63 [ITS-90, deg C]	sbeoxTC	ITS-90, deg C	1st sensor
sbeoxTF	Oxygen Temperature, SBE 63 [ITS-90, deg F]	sbeoxTF	ITS-90, deg F	1st sensor
sbeoxTC1	Oxygen Temperature, SBE 63, 2 [ITS-90, deg C]	sbeoxTC1	ITS-90, deg C	2nd sensor
sbeoxTF1	Oxygen Temperature, SBE 63, 2 [ITS-90, deg F]	sbeoxTF1	ITS-90, deg F	2nd sensor
sbeopoxML/L	Oxygen, SBE 63 [ml/l]	sbeopox ml/l	ml/l	1st sensor
sbeopoxMg/L	Oxygen, SBE 63 [mg/l]	sbeopox mg/l	mg/l	1st sensor
sbeopoxPS	Oxygen, SBE 63 [% saturation]	sbeopox %S	% saturation	1st sensor
sbeopoxMm/Kg	Oxygen, SBE 63 [umol/kg]	sbeopox Mm/Kg	umol/kg	1st sensor
sbeopoxMm/L	Oxygen, SBE 63 [umol/l]	sbeopox Mm/L	umol/l	1st sensor
sbeopoxML/L1	Oxygen, SBE 63, 2 [ml/l]	sbeopox ml/l2	ml/l	2nd sensor
sbeopoxMg/L1	Oxygen, SBE 63, 2 [mg/l]	sbeopox mg/l2	mg/l	2nd sensor
sbeopoxPS1	Oxygen, SBE 63, 2 [% saturation]	sbeopox %S2	% saturation	2nd sensor
Sbeopox Mm/Kg1	Oxygen, SBE 63, 2 [umol/kg]	sbeopox Mm/Kg2	umol/kg	2nd sensor
sbeopoxMm/L1	Oxygen, SBE 63, 2 [umol/l]	sbeopox Mm/L2	umol/l	2nd sensor

Short Name	Full Name	Friendly Name	Units	Notes/Comments
opoxML/L	Oxygen Optode, Aanderaa [ml/l]	opox ml/l	ml/l	
opoxMg/L	Oxygen Optode, Aanderaa [mg/l]	opox mg/l	mg/l	
opoxPS	Oxygen Optode, Aanderaa [% saturation]	opox %S	% saturation	
opoxMm/L	Oxygen Optode, Aanderaa [umol/l]	opox Mm/l	umol/l	
oxC	Oxygen Current, Beckman/YSI [uA]	oxc	uA	1st sensor
oxsC	Oxygen Current, Beckman/YSI, 2 [uA]	oxc2	uA	2nd sensor
oxTC	Oxygen Temperature, Beckman/YSI [deg C]	oxT C	deg C	1st sensor
oxTF	Oxygen Temperature, Beckman/YSI [deg F]	oxT F	deg F	1st sensor
oxsTC	Oxygen Temperature, Beckman/YSI, 2 [deg C]	oxT2 C	deg C	2nd sensor
oxsTF	Oxygen Temperature, Beckman/YSI, 2 [deg F]	oxT2 F	deg F	2nd sensor
oxML/L	Oxygen, Beckman/YSI [ml/l]	ox ml/l	ml/l	1st sensor
oxMg/L	Oxygen, Beckman/YSI [mg/l]	ox mg/l	mg/l	1st sensor
oxPS	Oxygen, Beckman/YSI [% saturation]	ox %S	% saturation	1st sensor
oxMm/Kg	Oxygen, Beckman/YSI [umol/kg]	ox mm/Kg	umol/kg	1st sensor
oxdOC/dT	Oxygen, Beckman/YSI [doc/dt]	ox doc/dt	doc/dt	1st sensor
oxsML/L	Oxygen, Beckman/YSI, 2 [ml/l]	ox2 ml/l	ml/l	2nd sensor
oxsMg/L	Oxygen, Beckman/YSI, 2 [mg/l]	ox2 mg/l	mg/l	2nd sensor
oxsPS	Oxygen, Beckman/YSI, 2 [% saturation]	oxs %S	% saturation	2nd sensor
oxsMm/Kg	Oxygen, Beckman/YSI, 2 [umol/kg]	oxs mm/Kg	umol/kg	2nd sensor
oxsdOC/dT	Oxygen, Beckman/YSI, 2 [doc/dt]	oxs doc/dt	doc/dt	2nd sensor
iowOxML/L	Oxygen, IOW [ml/l]	iowox ml/l	ml/l	
oxsolML/L	Oxygen Saturation, Garcia & Gordon [ml/l]	oxsol ml/l	ml/l	
oxsolMg/L	Oxygen Saturation, Garcia & Gordon [mg/l]	oxsol mg/l	mg/l	
oxsolMm/Kg	Oxygen Saturation, Garcia & Gordon [umol/kg]	oxsol Mm/kg	umol/kg	
oxsatML/L	Oxygen Saturation, Weiss [ml/l]	oxsat ml/l	ml/l	
oxsatMg/L	Oxygen Saturation, Weiss [mg/l]	oxsat mg/l	mg/l	
oxsatMm/Kg	Oxygen Saturation, Weiss [umol/kg]	oxsat Mm/kg	umol/kg	
par	PAR/Irradiance, Biospherical/Licor	par		Biospherical, Licor, or Chelsea sensor; 1st sensor
par1	PAR/Irradiance, Biospherical/Licor, 2	par2		Biospherical, Licor, or Chelsea sensor; 2nd sensor
par/log	PAR/Logarithmic, Satlantic	par/log		
ph	pH	ph		
phInt	pH Internal, SeaFET	Internal pH		Satlantic SeaFET pH
phExt	pH External, SeaFET	External pH		Satlantic SeaFET pH
phycyflTC0	Phycocyanin, Turner Cyclops [RFU]	phycyflTC	RFU	1st sensor
phycyflTC1	Phycocyanin, Turner Cyclops, 2 [RFU]	phycyflTC2	RFU	2nd sensor
phycyflTCdiff	Phycocyanin, Turner Cyclops, Diff, 2 - 1 [RFU]	phycyflTCdiff	RFU	2nd sensor - 1st sensor
phyeryflTC0	Phycoerythrin, Turner Cyclops [RFU]	phyeryflTC	RFU	1st sensor
phyeryflTC1	Phycoerythrin, Turner Cyclops, 2 [RFU]	phyeryflTC2	RFU	2nd sensor
phyeryflTCdiff	Phycoerythrin, Turner Cyclops, Diff, 2 - 1 [RFU]	phyeryflTCdiff	RFU	2nd sensor - 1st sensor
pla	Plume Anomaly	pla		
potemp090C	Potential Temperature [ITS-90, deg C]	potemp 90 C	ITS-90, deg C	1st sensor
potemp090F	Potential Temperature [ITS-90, deg F]	potemp 90 F	ITS-90, deg F	1st sensor
potemp068C	Potential Temperature [IPTS-68, deg C]	potemp 68 C	IPTS-68, deg C	1st sensor
potemp068F	Potential Temperature [IPTS-68, deg F]	potemp 68 F	IPTS-68, deg F	1st sensor
potemp190C	Potential Temperature, 2 [ITS-90, deg C]	potemp2 90 C	ITS-90, deg C	2nd sensor
potemp190F	Potential Temperature, 2 [ITS-90, deg F]	potemp2 90 F	ITS-90, deg F	2nd sensor
potemp168C	Potential Temperature, 2 [IPTS-68, deg C]	potemp2 68 C	IPTS-68, deg C	2nd sensor
potemp168F	Potential Temperature, 2 [IPTS-68, deg F]	potemp2 68 F	IPTS-68, deg F	2nd sensor
potemp90Cdiff	Potential Temperature, Diff, 2 - 1 [ITS-90, deg C]	potemp diff 90 C	ITS-90, deg C	2nd sensor - 1st sensor
potemp90Fdiff	Potential Temperature, Diff, 2 - 1 [ITS-90, deg F]	potemp diff 90 F	ITS-90, deg F	2nd sensor - 1st sensor
potemp68Cdiff	Potential Temperature, Diff, 2 - 1 [IPTS-68, deg C]	potemp diff 68 C	IPTS-68, deg C	2nd sensor - 1st sensor
potemp68Fdiff	Potential Temperature, Diff, 2 - 1 [IPTS-68, deg F]	potemp diff 68 F	IPTS-68, deg F	2nd sensor - 1st sensor

Short Name	Full Name	Friendly Name	Units	Notes/Comments
pta090C	Potential Temperature Anomaly [ITS-90, deg C]	pta 90 C	ITS-90, deg C	1st sensor
pta090F	Potential Temperature Anomaly [ITS-90, deg F]	pta 90 F	ITS-90, deg F	1st sensor
pta068C	Potential Temperature Anomaly [IPTS-68, deg C]	pta 68 C	IPTS-68, deg C	1st sensor
pta068F	Potential Temperature Anomaly [IPTS-68, deg F]	pta 68 F	IPTS-68, deg F	1st sensor
pta190C	Potential Temperature Anomaly, 2 [ITS-90, deg C]	pta1 90 C	ITS-90, deg C	2nd sensor
pta190F	Potential Temperature Anomaly, 2 [ITS-90, deg F]	pta1 90 F	ITS-90, deg F	2nd sensor
pta168C	Potential Temperature Anomaly, 2 [IPTS-68, deg C]	pta1 68 C	IPTS-68, deg C	2nd sensor
pta168F	Potential Temperature Anomaly, 2 [IPTS-68, deg F]	pta1 68 F	IPTS-68, deg F	2nd sensor
prM	Pressure [db]	pr M	db	User-entry for moored pressure (instrument with no pressure sensor)
prE	Pressure [psi]	pr E	psi	User-entry for moored pressure (instrument with no pressure sensor)
ptempC	Pressure Temperature [deg C]	ptemp C	deg C	Temperature measured by pressure sensor
ptempF	Pressure Temperature [deg F]	ptemp F	deg F	Temperature measured by pressure sensor
prDM	Pressure, Digiquartz [db]	pr M	db	Digiquartz pressure sensor
prDE	Pressure, Digiquartz [psi]	pr E	psi	Digiquartz pressure sensor
fgp0	Pressure, FGP [KPa]	fgp	KPa	1st FGP pressure sensor
fgp1	Pressure, FGP, 2 [KPa]	fgp2	KPa	2nd FGP pressure sensor
fgp2	Pressure, FGP, 3 [KPa]	fgp3	KPa	3rd FGP pressure sensor
fgp3	Pressure, FGP, 4 [KPa]	fgp4	KPa	4th FGP pressure sensor
fgp4	Pressure, FGP, 5 [KPa]	fgp5	KPa	5th FGP pressure sensor
fgp5	Pressure, FGP, 6 [KPa]	fgp6	KPa	6th FGP pressure sensor
fgp6	Pressure, FGP, 7 [KPa]	fgp7	KPa	7th FGP pressure sensor
fgp7	Pressure, FGP, 8 [KPa]	fgp8	KPa	8th FGP pressure sensor
pr50M	Pressure, SBE 50 [db]	pr50 M	db	1st SBE 50 pressure sensor
pr50E	Pressure, SBE 50 [psi]	pr50 E	psi	1st SBE 50 pressure sensor
pr50M1	Pressure, SBE 50, 2 [db]	pr50 M2	db	2nd SBE 50 pressure sensor
pr50E1	Pressure, SBE 50, 2 [psi]	pr50 E2	psi	2nd SBE 50 pressure sensor
prSM or prdM	Pressure, Strain Gauge [db]	pr M	db	strain-gauge pressure sensor
prSE or prdE	Pressure, Strain Gauge [psi]	pr E	psi	strain-gauge pressure sensor
pumps	Pump Status	pumps		
rfuels0	Refined Fuels, Turner Cyclops [ppb NS]	rfuels	ppb NS	1st sensor
rfuels1	Refined Fuels, Turner Cyclops, 2 [ppb NS]	fuels2	ppb NS	2nd sensor
rfuelsdiff	Refined Fuels, Turner Cyclops, Diff, 2 - 1 [ppb NS]	rfuelsdiff	ppb NS	2nd sensor - 1st sensor
rhodflTC0	Rhodamine, Turner Cyclops [ppb]	rhodflTC	ppb	1st sensor
rhodflTC1	Rhodamine, Turner Cyclops, 2 [ppb]	rhodflTC2	ppb	2nd sensor
rhodflTCdiff	Rhodamine, Turner Cyclops, Diff, 2 - 1 [ppb]	rhodflTCdiff	ppb	2nd sensor - 1st sensor
wl0	RS-232 WET Labs raw counts 0	wl	Counts	1st sensor
wl1	RS-232 WET Labs raw counts 1	wl2	Counts	2nd sensor
wl2	RS-232 WET Labs raw counts 2	wl3	Counts	3rd sensor
wl3	RS-232 WET Labs raw counts 3	wl4	Counts	4th sensor
wl4	RS-232 WET Labs raw counts 4	wl5	Counts	5th sensor
wl5	RS-232 WET Labs raw counts 5	wl6	Counts	6th sensor
sal00 or sal_	Salinity, Practical [PSU]	sal	PSU	1st sensor
sal11	Salinity, Practical, 2 [PSU]	sal2	PSU	2nd sensor
secS-priS	Salinity, Practical, Difference, 2 - 1 [PSU]	sal2-sal1	PSU	2nd sensor - 1st sensor
scan	Scan Count	scan		
nbin	Scans Per Bin	nbin		Calculated in SBE Data Processing's Bin Average module

Short Name	Full Name	Friendly Name	Units	Notes/Comments
sfdSM	Seafloor depth [salt water, m]	sfdS M	salt water, m	
sfdSF	Seafloor depth [salt water, ft]	sfdS F	salt water, ft	
sfdFM	Seafloor depth [fresh water, m]	sfdF M	fresh water, m	
sfdFF	Seafloor depth [fresh water, ft]	sfdF F	fresh water, ft	
svCM	Sound Velocity [Chen-Millero, m/s]	svC M	Chen-Millero, m/s	1st sensor
svCF	Sound Velocity [Chen-Millero, ft/s]	svC F	Chen-Millero, ft/s	1st sensor
svDM	Sound Velocity [Delgrosso, m/s]	svD M	Delgrosso, m/s	1st sensor
svDF	Sound Velocity [Delgrosso, ft/s]	svD F	Delgrosso, ft/s	1st sensor
svWM	Sound Velocity [Wilson, m/s]	svW M	Wilson, m/s	1st sensor
svWF	Sound Velocity [Wilson, ft/s]	svW F	Wilson, ft/s	1st sensor
svCM1	Sound Velocity, 2 [Chen-Millero, m/s]	svC2 M	Chen-Millero, m/s	2nd sensor
svCF1	Sound Velocity, 2 [Chen-Millero, ft/s]	svC2 F	Chen-Millero, ft/s	2nd sensor
svDM1	Sound Velocity, 2 [Delgrosso, m/s]	svD2 M	Delgrosso, m/s	2nd sensor
svDF1	Sound Velocity, 2 [Delgrosso, ft/s]	svD2 F	Delgrosso, ft/s	2nd sensor
svWM1	Sound Velocity, 2 [Wilson, m/s]	svW2 M	Wilson, m/s	2nd sensor
svWF1	Sound Velocity, 2 [Wilson, ft/s]	svW2 F	Wilson, ft/s	2nd sensor
iowSv	Sound Velocity, IOW [m/s]	iowSv	m/s	IOW sound velocity sensor
sbeSv-iowSv	Sound Velocity Diff, SBE - IOW [m/s]	svSbeC-svIOW	m/s	SBE CTD - IOW SV sensor
spar	SPAR/Surface Irradiance	spar		Biospherical or Licor sensor
spar/sat/lin	SPAR/Linear, Satlantic	spar/sat/lin		
spar/sat/log	SPAR/Logarithmic/Satlantic	spar/sat/log		
specc	Specific Conductance [uS/cm]	specc	uS/cm	
speccumhoscm	Specific Conductance [umhos/cm]	speccumhoscm	umhos/cm	
speccmsm	Specific Conductance [mS/cm]	speccmsm	mS/cm	
speccmmhoscm	Specific Conductance [mmhos/cm]	speccmmhoscm	mmhos/cm	
sva	Specific Volume Anomaly [10^-8 * m^3/kg]	sva	10^-8 * m^3/kg	
E	Stability [rad^2/m]	E	rad^2/m	Calculated in SBE Data Processing's Buoyancy module
E10^-8	Stability [10^-8 * rad^2/m]	E10^-8	10^-8 * rad^2/m	Calculated in SBE Data Processing's Buoyancy module
t090Cm, t4990C, tnc90C, or tv290C	Temperature [ITS-90, deg C]	t 90 C	ITS-90, deg C	1st sensor
t090F, t4990F, tnc90F, or tv290F	Temperature [ITS-90, deg F]	t 90 F	ITS-90, deg F	1st sensor
t068C, t4968C, tnc68C, or tv268C	Temperature [IPTS-68, deg C]	t 68 C	IPTS-68, deg C	1st sensor
t068F, t4968F, tnc68F, or tv268F	Temperature [IPTS-68, deg F]	t 68 F	IPTS-68, deg F	1st sensor
t190C or tnc290C	Temperature, 2 [ITS-90, deg C]	t2 90 C	ITS-90, deg C	2nd sensor
t190F or tnc290F	Temperature, 2 [ITS-90, deg F]	t2 90 F	ITS-90, deg F	2nd sensor
t168C or tnc268C	Temperature, 2 [IPTS-68, deg C]	t2 68 C	IPTS-68, deg C	2nd sensor
t168F or tnc268F	Temperature, 2 [IPTS-68, deg F]	t2 68 F	IPTS-68, deg F	2nd sensor
T2-T190C	Temperature Difference, 2 - 1 [ITS-90, deg C]	T2-T1 90 C	ITS-90, deg C	2nd sensor - 1st sensor
T2-T190F	Temperature Difference, 2 - 1 [ITS-90, deg F]	T2-T1 90 F	ITS-90, deg F	2nd sensor - 1st sensor
T2-T168C	Temperature Difference, 2 - 1 [IPTS-68, deg C]	T2-T1 68 C	IPTS-68, deg C	2nd sensor - 1st sensor
T2-T168F	Temperature Difference, 2 - 1 [IPTS-68, deg F]	T2-T1 68 F	IPTS-68, deg F	2nd sensor - 1st sensor

Short Name	Full Name	Friendly Name	Units	Notes/Comments
t3890C or t38_90C	Temperature, SBE 38 [ITS-90, deg C]	t38 90 C	ITS-90, deg C	1st sensor
t3890F or t38_90F	Temperature, SBE 38 [ITS-90, deg F]	t38 90 F	ITS-90, deg F	1st sensor
t3868C or t38_68C	Temperature, SBE 38 [IPTS-68, deg C]	t38 68 C	IPTS-68, deg C	1st sensor
t3868F or t38_68F	Temperature, SBE 38 [IPTS-68, deg F]	t38 68 F	IPTS-68, deg F	1st sensor
t3890C1	Temperature, SBE 38, 2 [ITS-90, deg C]	t38 90 C2	ITS-90, deg C	2nd sensor
t3890F1	Temperature, SBE 38, 2 [ITS-90, deg F]	t38 90 F2	ITS-90, deg F	2nd sensor
t3868C1	Temperature, SBE 38, 2 [IPTS-68, deg C]	t38 68 C2	IPTS-68, deg C	2nd sensor
t3868F1	Temperature, SBE 38, 2 [IPTS-68, deg F]	t38 68 F2	IPTS-68, deg F	2nd sensor
tsa	Thermosteric Anomaly [10^-8 * m^3/kg]	tsa	10^-8 * m^3/kg	
timeS	Time, Elapsed [seconds]	time S	seconds	Elapsed time (seconds) based on first scan in data file and sample rate (profiling) or sample interval (moorings); sample rate is defined by configuration (.con or .xmlcon) file.
timeM	Time, Elapsed [minutes]	time M	minutes	Elapsed time (minutes) based on first scan in data file and sample rate (profiling) or sample interval (moorings); sample rate or interval is as defined by configuration (.con or .xmlcon) file.
timeH	Time, Elapsed [hours]	time H	hours	Elapsed time (hours) based on first scan in data file and sample rate (profiling) or sample interval (moorings); sample rate or interval is as defined by configuration (.con or .xmlcon) file.
timeJ	Julian Days	time J	julian days	Elapsed time (Julian days) based on first scan in data file and sample rate (profiling) or sample interval (moorings); sample rate or interval is as defined by configuration (.con or .xmlcon) file.
timeN	Time, NMEA [seconds]	timeN	seconds	From NMEA device: Seconds since January 1, 1970; only for SBE 45
timeQ	Time, NMEA [seconds]	timeQ	seconds	From NMEA device: Seconds since January 1, 2000; everything but SBE 45
timeK	Time, Instrument [seconds]	timeK	seconds	Seconds since January 1, 2000, based on time stamp in 16plus V2 or 19plus V2 (in moored mode).
timeJV2	Time, Instrument [julian days]	timeJV2	julian days	Julian days, based on time stamp in 16plus V2 or 19plus V2 (in moored mode).
timeSCP	Time, Seacat plus [julian days]	timeSCP	julian days	Julian days, based on time stamp in 16plus or 19plus (in moored mode). Not applicable to V2 versions.
timeY	Time, System [seconds]	timeY	seconds	Computer time (seconds) since January 1, 1970, appended by Seasave V7 if 'Scan time added' selected in configuration (.con or .xmlcon) file.

Short Name	Full Name	Friendly Name	Units	Notes/Comments
seaTurbMtr	Turbidity, Seapoint [FTU]	seaTurbMtr	FTU	1st sensor
seaTurbMtr1	Turbidity, Seapoint, 2 [FTU]	seaTurbMtr2	FTU	2nd sensor
seaTurbMtrdiff	Turbidity, Seapoint, Diff, 2 - 1 [FTU]	seaTurbMtrdiff	FTU	2nd sensor - 1st sensor
turbflTC0	Turbidity, Turner Cyclops [NTU]	turbflTC	NTU	1st sensor
turbflTC1	Turbidity, Turner Cyclops, 2 [NTU]	turbflTC2	NTU	2nd sensor
turbflTCdiff	Turbidity, Turner Cyclops, Diff, 2 - 1 [NTU]	turbflTCdiff	NTU	2nd sensor - 1st sensor
turbWETbb0	Turbidity, WET Labs ECO BB [m^-1/sr]	turbWETbb	m^-1/sr	1st sensor
turbWETbb1	Turbidity, WET Labs ECO BB, 2 [m^-1/sr]	turbWETbb2	m^-1/sr	2nd sensor
turbWETbb2	Turbidity, WET Labs ECO BB, 3 [m^-1/sr]	turbWETbb3	m^-1/sr	3rd sensor
turbWETbb3	Turbidity, WET Labs ECO BB, 4 [m^-1/sr]	turbWETbb4	m^-1/sr	4th sensor
turbWETbb4	Turbidity, WET Labs ECO BB, 5 [m^-1/sr]	turbWETbb5	m^-1/sr	5th sensor
turbWETbbdiff	Turbidity, WET Labs ECO BB, Diff, 2 - 1 [m^-1/sr]	turbWETbbdiff	m^-1/sr	2nd sensor - 1st sensor
turbWETntu0	Turbidity, WET Labs ECO [NTU]	turbWETntu	NTU	1st sensor
turbWETntu1	Turbidity, WET Labs ECO, 2 [NTU]	turbWETntu2	NTU	2nd sensor
turbWETntu2	Turbidity, WET Labs ECO, 3 [NTU]	turbWETntu3	NTU	3rd sensor
turbWETntu3	Turbidity, WET Labs ECO, 4 [NTU]	turbWETntu4	NTU	4th sensor
turbWETntu4	Turbidity, WET Labs ECO, 5 [NTU]	turbWETntu5	NTU	5th sensor
turbWETntu5	Turbidity, WET Labs ECO, 6 [NTU]	turbWETntu6	NTU	6th sensor
turbWETntudiff	Turbidity, WET Labs ECO, Diff, 2 - 1 [NTU]	turbWETntudiff	NTU	2nd sensor - 1st sensor
turbWET SeaOWLbb0	Turbidity, WET Labs SeaOWL BB	turbWETSeaOWLbb	$m^{-1}sr^{-1}$	1st turbidity sensor
turbWET SeaOWLbb1	Turbidity, WET Labs SeaOWL BB, 2	turbWETSeaOWL bb2	$m^{-1}sr^{-1}$	2nd turbidity sensor
turbWET SeaOWLbbdiff	Turbidity, WET Labs SeaOWL BB, Diff, 2 - 1	turbWETSeaOWL bbdiff	$m^{-1}sr^{-1}$	2nd – 1st turbidity sensor
user1	User Defined Variable	user		1st sensor; user selects variable name for file imported to ASCII In
user2	User Defined Variable, 2	user2		2nd sensor; user selects variable name for file imported to ASCII In
user3	User Defined Variable, 3	user3		3rd sensor; user selects variable name for file imported to ASCII In
user4	User Defined Variable, 4	user4		4th sensor; user selects variable name for file imported to ASCII In
user5	User Defined Variable, 5	user5		5th sensor; user selects variable name for file imported to ASCII In
uexpo0	User Exponential	uexpo		1st user exponential sensor
uexpo1	User Exponential, 2	uexpo1		2nd user exponential sensor
uexpo2	User Exponential, 3	uexpo2		3rd user exponential sensor
upoly0	User Polynomial	upoly		1st user polynomial sensor
upoly1	User Polynomial, 2	upoly2		2nd user polynomial sensor
upoly2	User Polynomial, 3	upoly3		3rd user polynomial sensor

Short Name	Full Name	Friendly Name	Units	Notes/Comments
v0	Voltage 0	v0	V	1st voltage sensor
v1	Voltage 1	v1	V	2nd voltage sensor
v2	Voltage 2	v2	V	3rd voltage sensor
v3	Voltage 3	v3	V	4th voltage sensor
v4	Voltage 4	v4	V	5th voltage sensor
v5	Voltage 5	v5	V	6th voltage sensor
v6	Voltage 6	v6	V	7th voltage sensor
v7	Voltage 7	v7	V	8th voltage sensor
v8	Voltage 8	v8	V	9th voltage sensor
v9	Voltage 9	v9	V	10th voltage sensor
v10	Voltage 10	v10	V	11th voltage sensor
v11	Voltage 11	v11	V	12th voltage sensor
v12	Voltage 12	v12	V	13th voltage sensor
v13	Voltage 13	v13	V	14th voltage sensor
v14	Voltage 14	v14	V	15th voltage sensor
v15	Voltage 15	v15	V	16th voltage sensor
zaps	Zaps [nmol]	zaps	nmol	

Absolute Salinity and related Thermodynamic Parameters (TEOS-10)

Short Name	Full Name	Friendly Name	Units	Notes/Comments
gsw_saA0	Absolute Salinity [g/kg]	gsw_sa	g/kg	1st sensor
gsw_saA1	Absolute Salinity, 2 [g/kg]	gsw_sa2	g/kg	2nd sensor
gsw_deltasaA0	Absolute Salinity Anomaly [g/kg]	gsw_deltasaA0	g/kg	1st sensor
gsw_deltasaA1	Absolute Salinity Anomaly, 2 [g/kg]	gsw_deltasaA1	g/kg	2nd sensor
gsw_adlr0A	adiabatic lapse rate [K/Pa]	gsw_adlr0A	K/Pa	1st sensor
gsw_adlr1A	adiabatic lapse rate, 2 [K/Pa]	gsw_adlr1A	K/Pa	2nd sensor
gsw_ctA0	Conservative Temperature [ITS-90, deg C]	gsw_ct	ITS-90, deg C	1st sensor
gsw_ctA1	Conservative Temperature, 2 [ITS-90, deg C]	gsw_ct2	ITS-90, deg C	2nd sensor
gsw_ctfA0	Conservative Temperature Freezing [ITS-90, deg C]	gsw_ctfA0	ITS-90, deg C	1st sensor
gsw_ctfA1	Conservative Temperature Freezing, 2 [ITS-90, deg C]	gsw_ctfA1	ITS-90, deg C	2nd sensor
gsw_densityA0	density, TEOS-10 [density, kg/m^3]	gsw_densityA0	density, kg/m^3	1st sensor
gsw_sigma0A0	density, TEOS-10 [sigma-0, kg/m^3]	gsw_sigma0A0	sigma-0, kg/m^3	1st sensor
gsw_sigma1A0	density, TEOS-10 [sigma-1, kg/m^3]	gsw_sigma1A0	sigma-1, kg/m^3	1st sensor
gsw_sigma2A0	density, TEOS-10 [sigma-2, kg/m^3]	gsw_sigma2A0	sigma-2, kg/m^3	1st sensor
gsw_sigma3A0	density, TEOS-10 [sigma-3, kg/m^3]	gsw_sigma3A0	sigma-3, kg/m^3	1st sensor
gsw_sigma4A0	density, TEOS-10 [sigma-4, kg/m^3]	gsw_sigma4A0	sigma-4, kg/m^3	1st sensor
gsw_densityA1	density, TEOS-10, 2 [density, kg/m^3]	gsw_densityA1	density, kg/m^3	2nd sensor
gsw_sigma0A1	density, TEOS-10, 2 [sigma-0, kg/m^3]	gsw_sigma0A1	sigma-0, kg/m^3	2nd sensor
gsw_sigma1A1	density, TEOS-10, 2 [sigma-1, kg/m^3]	gsw_sigma1A1	sigma-1, kg/m^3	2nd sensor
gsw_sigma2A1	density, TEOS-10, 2 [sigma-2, kg/m^3]	gsw_sigma2A1	sigma-2, kg/m^3	2nd sensor
gsw_sigma3A1	density, TEOS-10, 2 [sigma-3, kg/m^3]	gsw_sigma3A1	sigma-3, kg/m^3	2nd sensor
gsw_sigma4A1	density, TEOS-10, 2 [sigma-4, kg/m^3]	gsw_sigma4A1	sigma-4, kg/m^3	2nd sensor
gsw_dynenthA0	dynamic enthalpy [J/kg]	gsw_dynenthA0	J/kg	1st sensor
gsw_dynenthA1	dynamic enthalpy, 2 [J/kg]	gsw_dynenthA1	J/kg	2nd sensor
gsw_enthalpyA0	enthalpy [J/kg]	gsw_enthalpyA0	J/kg	1st sensor
gsw_enthalpyA1	enthalpy, 2 [J/kg]	gsw_enthalpyA1	J/kg	2nd sensor
gsw_entropyA0	entropy [J/kg/K]	gsw_entropyA0	J/kg/K	1st sensor
gsw_entropyA1	entropy, 2 [J/kg/K]	gsw_entropyA1	J/kg/K	2nd sensor
gsw_gravA	gravity [m/s^2]	gsw_gravA	m/s^2	
gsw_ieA0	internal energy [J/kg]	gsw_ieA0	J/kg	1st sensor
gsw_ieA1	internal energy, 2 [J/kg]	gsw_ieA1	J/kg	2nd sensor
gsw_icA0	isentropic compressibility [1/Pa]	gsw_icA0	1/Pa	1st sensor
gsw_icA1	isentropic compressibility, 2 [1/Pa]	gsw_icA1	1/Pa	2nd sensor
gsw_lheA0	latent heat of evaporation [J/kg]	gsw_lheA0	J/kg	1st sensor
gsw_lheA1	latent heat of evaporation, 2 [J/kg]	gsw_lheA1	J/kg	2nd sensor
gsw_lhmA0	latent heat of melting [J/kg]	gsw_lhmA0	J/kg	1st sensor
gsw_lhmA1	latent heat of melting, 2 [J/kg]	gsw_lhmA1	J/kg	2nd sensor
gsw_ptA0	potential temperature [ITS-90, deg C]	gsw_ptA0	ITS-90, deg C	1st sensor
gsw_ptA1	potential temperature, 2 [ITS-90, deg C]	gsw_ptA1	ITS-90, deg C	2nd sensor
gsw_sstarA0	Preformed Salinity [g/kg]	gsw_sstarA0	g/kg	1st sensor
gsw_sstarA1	Preformed Salinity, 2 [g/kg]	gsw_sstarA1	g/kg	2nd sensor
gsw_srA0	Reference Salinity [g/kg]	gsw_srA0	g/kg	1st sensor
gsw_srA1	Reference Salinity, 2 [g/kg]	gsw_srA1	g/kg	2nd sensor
gsw_betaA0	saline contraction coefficient [kg/g]	gsw_betaA0	kg/g	1st sensor
gsw_betaA1	saline contraction coefficient, 2 [kg/g]	gsw_betaA1	kg/g	2nd sensor
gsw_ssA0	sound speed, TEOS-10 [m/s]	gsw_ssA0	m/s	1st sensor
gsw_ssA1	sound speed, TEOS-10, 2 [m/s]	gsw_ssA1	m/s	2nd sensor
gsw_specvolA0	specific volume, TEOS-10 [m^3/kg]	gsw_specvolA0	m^3/kg	1st sensor
gsw_specvolA1	specific volume, TEOS-10, 2 [m^3/kg]	gsw_specvolA1	m^3/kg	2nd sensor
gsw_svolanomA0	specific volume anomaly, TEOS-10 [m^3/kg]	gsw_svolanomA0	m^3/kg	1st sensor
gsw_svolanomA1	specific volume anomaly, TEOS-10, 2 [m^3/kg]	gsw_svolanomA1	m^3/kg	2nd sensor
gsw_tfA0	temperature freezing [ITS-90, deg C]	gsw_tfA0	ITS-90, deg C	1st sensor
gsw_tfA1	temperature freezing, 2 [ITS-90, deg C]	gsw_tfA1	ITS-90, deg C	2nd sensor
gsw_alphaA0	thermal expansion coefficient [1/K]	gsw_alphaA0	1/K	1st sensor
gsw_alphaA1	thermal expansion coefficient, 2 [1/K]	gsw_alphaA1	1/K	2nd sensor

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