Glossary for Sea-Bird Electronics Training for Data Collection in the Ocean

Note: Unless stated otherwise, all references in this document (*see . . .*) are to other listings in the document or to documents on the Sea-Bird website.

A

Absolute Salinity

Absolute Salinity (g/kg) is defined by a Thermodynamic Equation of State of Seawater (TEOS-10) released in 2010. See Salinity and *Application Note 90: Absolute Salinity and TEOS-10: Sea-Bird's Implementation*.

Accuracy

Comparison of reading from a sensor to a known standard.

Acoustic Doppler Current Profiler (ADCP)

Instrument that obtains water velocity profiles by transmitting sound of known frequency into the water and measuring the Doppler shift of reflections from plankton, suspended sediment, and bubbles, assumed to be moving with the water.

Many ADCPs are compatible with the SBE 44 Underwater Inductive Modem, making it possible to integrate the ADCP with other instruments that communicate via Sea-Bird's inductive modem telemetry system.

Anti-foulant device

Material used to reduce biological fouling. In a conductivity sensor, a very thin coating of biological fouling can change the conductivity cell geometry, having a large effect on the conductivity measurement.

Sea-Bird’s AF24173 Anti-Foulant Device is an expendable device that is installed on each end of the conductivity cell, so that any water that enters the cell is treated. The active ingredient in the anti-foulant device is TBTO. AF24173 is registered with the U.S Environmental Protection Agency (EPA), and approved for use with Sea-Bird conductivity sensors.

Anti-Foulant Devices are supplied with moored CTDs (SBE 16, 16*plus*, 16*plus*-IM, 16*plus* V2, 16*plus*-IM V2, 37 [SMP-ODO, SMP-IDO, SMP, SM, SIP-ODO, SIP-IDO, SIP, SI, IMP-ODO, IMP-IDO, IMP, IM], 52-MP), thermosalinographs (SBE 21 and 45), and drifters (SBE 41/41CP Argo float CTDs), and may be provided with other instruments (SBE 4M, 19*plus*, 19*plus* V2, 26*plus*, 49, 53). Useful life varies, depending on several factors. We recommend that customers consider more frequent anti-foulant replacement when high biological activity and strong current flow (greater dilution of the anti-foulant concentration) are present. Moored instruments in high growth and strong dilution environments have been known to obtain a few months of quality data, while drifters that operate in non-photic, less turbid deep ocean environments may achieve years of quality data. Experience may be the strongest determining factor in specific deployment environments. Sea-Bird recommends that you keep track of how long the devices have been deployed, to allow you to purchase and replace the devices when needed.

For handling information, refer to the instrument manual, and to the Material Safety Data Sheet on our MSDS page. AF24173 Anti-Foulant Device is not classified by the U.S. DOT or IATA as hazardous material.

Argo Program

Program to establish and maintain a working population of 3000 autonomous profiling floats dispersed throughout the world, transmitting near-real-time temperature and salinity from the upper 2000 meters of the ocean. Sea-Bird's SBE 41/41CP CTD, sold to several float manufacturers, supplies more than 90% of the annual Argo program requirement. Sea-Bird's Navis float was introduced in 2011. A Navis float with Biogeochemical sensors and a Navis Float with Integrated Biogeochemical sensors are also available.

Autonomous Underwater Vehicle (AUV)

Unmanned submersible with propulsion and pre-programmed navigation, used to collect oceanographic data. The SBE 49 is a common choice of CTD for AUVs.

Auto-fire

Auto-fire capability allows a water sampler to operate autonomously on non-conducting cables, using pre-programmed pressures (from a CTD integrated with the system) or elapsed times to determine when to close water bottles.

- The SBE 32 Carousel Water Sampler can operate autonomously when integrated with an SBE 17*plus* V2 Searam (and an SBE 9*plus* CTD) or an Auto Fire Module (and an SBE 19, 19*plus*, 19*plus* V2, 25, or 25*plus* CTD; or SBE 50 Pressure Sensor; or no CTD).
- The SBE 55 ECO Water Sampler has built-in auto-fire capability, and can operate autonomously when integrated with an SBE 19, 19*plus*, 19*plus* V2, 25, or 25*plus* CTD; or SBE 50 Pressure Sensor; or no CTD.

Sea-Bird's SeatermAF software interfaces with these systems.

B

Baud

Number of bytes per second for the transfer of data.

Bin averaging

Means of reducing data set to a more tractable size, by making a statistical estimate of data values at a user-prescribed interval, based on the surrounding data. Sea-Bird's SBE Data Processing software includes a Bin Average module.

Bit

The smallest unit of binary information; 0 or 1.

Byte

Unit of binary information; 8 bits = 1 byte.

C

.cfg file

A .cfg file is used by Seasave-Win32 (version < 7.0) to remember the way you had the program set up. The .cfg file is created by Seasave to store program settings, such as the instrument .con file name and path, serial ports, water sampler, serial data output, etc. as well as size, placement, and setup for each display window. You can save the .cfg file to a desired filename and location, and then use it when you run the software the next time, to ensure that the software will be set up the same way.

.con file

See Configuration file.

Calibration

A procedure for comparing the signal from an instrument with a known or standard value. Calibration coefficients are calculated by mathematically fitting calibration data to an equation, providing for converting sensor output to engineering units (°C, S/m, etc). Sea-Bird's conductivity and temperature calibration system is detailed in an issue of the Sea-Bird Journal; the oxygen calibration system is detailed in an article in International Ocean System.

CDOM

Colored Dissolved Organic Matter. Organic compounds that form from decomposing plant materials. CDOM absorbs light at the blue end of the spectrum, and can give water a yellowish color at high concentrations. CDOM is fluorescent, and can be measured by a fluorometer. Sea-Bird CTDs that accept 0-5 Volt auxiliary sensor inputs are compatible with several types of third party CDOM fluorometers.

Chlorophyll

Plant compound, found in phytoplankton, which converts radiant energy to chemical energy through photosynthesis. Chlorophyll is fluorescent, and can be measured with a fluorometer. Sea-Bird CTDs that accept 0-5 Volt auxiliary sensor inputs are compatible with several types of chlorophyll fluorometers.

Conductivity

Conductivity (reciprocal resistivity) is an intrinsic property of seawater from which salinity and density may be derived. Oceanographic sensors cannot measure conductivity directly; instead they measure conductance, i.e., the voltage produced in response to the flow of a known electrical current. Conductivity is calculated from the conductance measured by the sensor using a scale factor or cell constant that reflects the ratio of length and cross-sectional area of the sampled water volume in which the electrical current actually flows.

See *Conductivity Sensors for Moored and Autonomous Operation* for detailed information.

Configuration file

The configuration file defines the instrument - auxiliary sensors integrated with the instrument, and channels, serial numbers, and calibration dates and coefficients for all the integrated sensors (conductivity, temperature, and pressure as well as auxiliary sensors). Sea-Bird's real-time acquisition and data processing software uses the information in the configuration file to interpret and process the raw data (sensor frequencies and voltages). If the configuration file does not match the actual instrument configuration, the software will not be able to interpret and process the data correctly.

When Sea-Bird ships a new instrument, we include a configuration (.con or .xmlcon) file that reflects the current instrument configuration. The file is named with the instrument serial number, followed with the .con or .xmlcon extension. For example, for an instrument with serial number 2375, Sea-Bird names the file 2375.con or 2375.xmlcon. You may rename the file if desired; this will not affect the results.

Seasave and SBE Data Processing versions 7.20 introduced .xmlcon files (in XML format) in 2009. Versions 7.20 and later allow you to open a .con or .xmlcon file, and save it to a .con or .xmlcon file.

To view or modify the configuration file, use the Configure Inputs menu in Seasave V7 or the Configure menu in SBE Data Processing.

Copenhagen water

See Standard seawater.

CTD

Instrument for measuring **C**onductivity, **T**emperature, and **D**epth. Despite the name, all CTDs actually measure pressure, which is not quite the same thing as depth. The relationship between pressure and depth is a complex one involving water density and compressibility as well as the strength of the local gravity field. The CTD data can be used to calculate salinity, density, sound velocity, and other parameters of interest. The term *CTD* is often used today to describe a *package* that includes the actual CTD as well as auxiliary sensors to measure other parameters (such as dissolved oxygen, pH, turbidity, fluorometers, altimeters, etc.) and a water sampler to collect water samples for later analysis in the lab.

Sea-Bird manufactures a large number of CTDs, with varying sample rates, telemetry systems, operation modes (profiling vs moored), and abilities to acquire data from auxiliary sensors. Types of CTDs include profiling instruments (9*plus*, 19*plus* V2, 25*plus*, 49), moored instruments (SBE 16*plus* V2, 16*plus*-IM V2, 37 [SMP-ODO, SMP-IDO, SMP, SM, SIP-ODO, SIP-IDO, SIP, SI, IMP-ODO, IMP-IDO, IMP, IM], 52-MP), drifters (SBE 41/41CP Argo float CTDs), and gliders.

D

Decibar

Unit for measuring pressure (1 decibar = 1.4503774 psi). For oceanographic purposes, pressure at the water surface (rather than absolute or total pressure) is defined as the reference pressure (0 decibars); this is the value required by the UNESCO formulas for computation of salinity, density, and other derived variables. The relationship between pressure and depth is a complex one involving water density and compressibility as well as the strength of the local gravity field, but it is convenient to think of a decibar as essentially equivalent to a meter, an approximation which is correct within 3% for almost all combinations of salinity, temperature, depth, and gravitational constant.

Density

Mass per unit volume; the reciprocal of specific volume. By definition, the density of fresh water is 1.0000 kilograms/liter. Density is calculated from CTD data, based on the measured temperature and pressure, and the calculated salinity. Oceanographers often report density as a Sigma value, which is (density – 1) * 1000. The formula for this and other derived parameters is included in an Appendix of the SBE Data Processing manual. Also see Sigma and Specific volume.

Depth

Measure of the height of the water column above a pressure sensor. The relationship between pressure and depth is a complex one involving water density and compressibility as well as the strength of the local gravity field. When talking in general terms, oceanographers often use the depth in meters and the pressure in decibars interchangeably (i.e, 10 meters and 10 decibars are approximately equivalent).

Depth is a calculated parameter, based on the measured pressure and the value of gravity (a function of latitude). The formula for this and other derived parameters is included in an Appendix of the SBE Data Processing manual.

Desiccant

Material placed in an equipment housing to absorb moisture and prevent condensation. See *Application Note 71: Desiccant Use and Regeneration*.

E

EEPROM

Electronically Erasable Programmable Read-Only Memory; allows user-input settings of parameters, and maintains settings in memory when power is removed. An EEPROM stores user-input settings on most Sea-Bird instruments.

F

Firmware

Software stored in an instrument, providing the instrument’s operating instructions.

Fluorometer

Instrument that provides the concentration of a given material by measuring the amount of fluorescence attributed to the material. Fluorescence is an optical phenomenon that occurs when light absorbed by a material creates a molecular excitation that causes the material to re-emit light as a different wavelength. Sea-Bird CTDs that accept 0-5 Volt auxiliary sensor inputs are compatible with several types of fluorometer.

Fouling

See Anti-foulant device.

Frequency

Number of cycles per unit of time, usually measured in Hertz (cycles per second). Often used to described sampling rates (for example, the SBE 9*plus* operates at 24 Hertz – it takes 24 measurements per second) or wave frequency.

Profiling rate and sampling rate interact to determine the depth interval between measurements. See Sampling rate.

G

Gallium-Melt Point

Temperature at which extremely pure gallium melts; 29.764600 °C. The Gallium-melt point (GaMP) is measured in a Gallium-melt cell, which consists of a closed-end Teflon tube with a Teflon-tube reentrant well, aluminum shell, and Teflon jacket, filled with high-purity gallium metal. The frozen cell is heated above the gallium melt point (GaMP) temperature, establishing the gallium melt plateau, and allowed to melt over a period of 8 to 12 hours, achieving the assigned gallium melt temperature. A Gallium-melt cell is used as one physical standard in the calibration of Sea-Bird temperature sensors; because of a pressure effect, the temperature at the depth where we actually take the measurement is 29.76458 °C. Triple-Point-of-Water is another physical standard. Measurement Accuracy at Triple Point of Water and Gallium Melt Point Supports a Total Measurement Uncertainty of 0.0006 degrees C provides more details.

GaMP

See Gallium-Melt Point.

GPS

See NMEA 0183.

H

Hertz (Hz)

Frequency unit; number of cycles (or measurements) per second. Often used to described sampling rates (for example, the SBE 9*plus* operates at 24 Hertz – it takes 24 measurements per second) or wave frequency.

Profiling rate and sampling rate interact to determine the depth interval between measurements. See Sampling rate.

Hysteresis

The dependence of a system not just on its current environment, but also on its past. In oceanography, one symptom of hysteresis is a difference between downcast and upcast data through the same body of water.

Under extreme pressure, changes can occur in gas permeable Teflon membranes (such as in the SBE 43 Dissolved Oxygen sensor) that affect their permeability characteristics. Some of these changes (plasticization and amorphous/crystallinity ratios) have long time constants and depend on the sensor's time-pressure history. These slow processes result in hysteresis in long, deep casts. SBE Data Processing software uses a hysteresis correction algorithm that 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.

I

Inductive modem telemetry

An inductive modem uses electrical current loops to transmit information. Electrical current flowing in a wire loop induces current to flow in a loop that passes through it. These loops are like links in a chain. The first loop is in the surface buoy. The second loop is formed by the mooring cable and the seawater. The third loop is at the instrument, underwater. Because all coupling is done in loops, no cable breakouts are required.

The communications link is one way only, meaning that if the surface modem is transmitting to the remote instruments, then the remote instruments must all be listening. Conversely, if one of the remote instruments is transmitting, then the surface modem must be listening. To achieve this, all instruments have a unique two-digit address from 00 to 99.

The electrical current carries an AC signal that is phase-shift-keyed. Digital data is encoded by the transmitting modem into an AC signal that is impressed on the current loop, and it is received and decoded by the remote modem's receiver.

Application Note 92: Real-Time Oceanography with Inductive Moorings and the Inductive Modem Module provides more details.

A number of Sea-Bird instruments (SBE 16*plus*-IM V2, 37-IM, 37-IMP, 37-IMP-IDO, 37-IMP-ODO, 39-IM, 44) are available with an inductive modem interface.

IPTS-68

See ITS-90.

ITS-90

ITS-90 is the current (as of 1990) temperature scale; IPTS-68 was the previous standard. The differences are related to redefining certain triple points and other melt or freeze cells that are used as the fundamental standards for temperature. Over the oceanographic ranges of temperature, a linear approximation is used to convert: IPTS-68 = 1.00024 * ITS-90.
The difference is small, but at WOCE levels it is significant. See *Application Note 42: ITS-90 Temperature Scale*.

Note: Salinity, density, and sound velocity are still defined in terms of IPTS-68 temperature. Sea-Bird's software uses IPTS-68 temperature to calculate these derived parameters, regardless of which temperature scale you select for temperature output (i.e., it automatically converts ITS-90 to IPTS-68 temperature for input to the salinity, density, and sound velocity algorithms).

M

Mixed layer

Surface ocean that is fairly homogeneous in properties because of wind and storm mixing.

N

NMEA 0183

Standard format for transmission of navigational data (latitude and longitude) from GPS devices. Sea-Bird deck units (requires an optional interface in some deck units) can append NMEA 0183 data to the CTD or thermosalinograph data stream. Recent versions (2009 and later) of Seasave V7 real-time data acquisition software can also append NMEA 0183 data to the CTD or thermosalinograph data stream in the computer, allowing navigational data acquisition without a deck unit.

P

.psa file

A .psa (program setup) file is used by Seasave V7 and by each module in SBE Data Processing to remember the way the program was set up. You can save the .psa file to a desired filename and location, and then use it when you run the software the next time, to ensure the same setup:

- A .psa file is created by Seasave V7 to store program settings, such as instrument configuration (.con or .xmlcon) file name and path, serial ports, water sampler, TCP/IP ports, serial data output, etc. as well as size, placement, and setup for each display window.
- A .psa file is created by each module in SBE Data Processing to store program settings, such as input filename and path, output filename, and module-specific parameters (for example, for Data Conversion: variables to convert, ascii or binary output, etc.).

.psu file

A .psu (program setup) file was used by early versions (< 5.30b) of SBE Data Processing to remember the way the program was set up. Current versions can still use your existing .psu files. However, if you make any setup changes, SBE Data Processing will save the changes to a new **.psa** file. You can save the .psa file to a desired filename and location, and then use it when you run the software the next time, to ensure that the software will be set up the same way:

PAR

Photosynthetically Active Radiation; wavelengths of sunlight that can be absorbed by plants for photosynthesis. PAR sensors are available for both underwater and surface measurement. Sea-Bird CTDs that accept auxiliary sensor inputs (SBE 9*plus*, 16, 16*plus*, 16*plus*-IM, 16*plus* V2, 16*plus*-IM V2, 19, 19*plus*, 19*plus* V2, 25, or 25*plus*) are compatible with several types of underwater PAR sensors (requires optional interface in some CTDs); Sea-Bird deck units (SBE 11*plus*, 33, 36) can append Surface PAR data to the CTD data stream (requires optional interface in older deck units).

Underwater PAR sensors are available as Scalar (4 pi) sensors and Cosine (2 pi) sensors. The difference between the two sensor types is the geometry of the light collectors.

- **Scalar (4-pi) PAR sensors** are directionally neutral in responding to light. This means that the sensor will respond equally to light arriving on the surface of the collector, regardless of the direction it came from. People who use Scalar sensors tend to be more interested in how *much light there is,* rather than *what is the light doing.* Scalar sensors are good general-purpose sensors for biologists, because chloroplasts in phytoplankton cells (in general) behave more like scalar sensors than other collector geometries (e.g., the 2-pi collector) when it comes to capturing light. Visual predators (and their prey) in pelagic systems use the total light field, and many ichthyologists who model these responses want Scalar irradiance. Construction and materials used in scalar sensors usually limit their use to shallow depths (under 2000 m).
- **Cosine (2-pi) PAR sensors** measure vector irradiance (often called *downward* irradiance, but they can easily be used inverted to measure upward irradiance as well). The response is highly directional and closely follows the cosine law. Light incident at the apparent zenith has the maximum response (cosine 0 = 100%), and decreases as the cosine of the angle until it is undefined (vanishingly small) at 90 degrees. People who deploy Cosine sensors tend to be interested in the physics of light transmission through the water, rather than just *how much light* there is. This includes physical oceanographers and remote sensing modelers. Some models of Cosine sensors have depth ratings to full ocean depths (7000 m).

Sometimes the sensor type choice is dictated by the need for consistency with existing data sets. However, if you have no specific research goal but want to measure underwater PAR, we suggest the Cosine PAR sensor. It is not as fragile and does not need to be removed from the CTD cage for deep casts. Also, it can be positioned in the CTD cage so that the measurement will not be contaminated by shadows or reflections from other equipment attached to the cage.

Sea-Bird thanks John Morrow of Biospherical Instruments for much of this information on the use of Scalar and Cosine sensors.

Plot39

Plots ASCII data that has been uploaded from SBE 39, 39-IM, or 39*plus* Temperature Recorder or SBE 48 Hull Temperature Sensor.

Potential temperature

Temperature an element of seawater would have if raised adiabatically with no change in salinity to a reference pressure. Sea-Bird software uses a reference pressure of 0 decibars. The formula for this and other derived parameters is included in an Appendix of the SBE Data Processing manual.

Practical Salinity

See PSS and Salinity.

Profile

Set of data for one or more environmental measurements, such as temperature and conductivity, taken at a regular interval over the ocean depth.

Profiling rate

Speed at which the instrument package descends. Profiling rate and sampling rate interact to determine the depth interval between measurements. See Sampling rate.

psi

Unit for measuring pressure - pounds per square inch (1 psi = 0.6894757 decibars).

psia

Unit for measuring pressure - pounds per square inch, absolute; absolute means that the indicated pressure is referenced to a vacuum. Absolute pressure includes atmospheric pressure (approximately 14.7 psi when in air at sea level).

PSS

The modern oceanographic definition of salinity is the Practical Salinity Scale of 1978 (PSS-78). It yields a practical salinity from new equations, smooth expansions of conductivity ratio, which were carefully fit to the real salinity of diluted North Atlantic seawater. The numeric unit from PSS-78 is psu (practical salinity unit) and is distinct from the previous physical quantity ppt (kg salt per kg water in parts per thousand). The primary motivation for psu was consistency; it focused on a trace to a primary conductivity standard (K15) and recognition that ocean ion ratios were not identical. Salinometer work was plagued by an inconsistent standard and the ppt equations included ion ratios from different oceans. So, the trade was a consistent standard and equation that works for a single ion mix instead of exact salinity in other ocean basins. G. Siedler and H. Peters highlighted where PSS-78 and EOS-80 formulas deviate from real salinity and density (e.g., Baltic Sea is difficult, but the deep Pacific has EOS-80 deviations of up to 0.02 kg/m^3, implying salinity errors of order 0.02 psu).

The Practical Salinity Scale of 1978 is only valid when used with the temperature scale of 1968 (IPTS-68) over a temperature range of -2 °C to 35 °C, and it is only valid for seawater that has salinity between 2 and 42 psu.

See Salinity and *Application Note 14: 1978 Practical Salinity Scale*.

R

Real-time data

Viewing and storing data on the computer at almost the same time that the measurement is being made. The only delay involved is the time required to transmit the data to the computer. Sea-Bird's real-time data acquisition software, Seasave V7, acquires, converts, and displays real-time or archived data from most Sea-Bird CTDs.

Resolution

The smallest amount of change that can be detected in a measurement. For example, a 12-bit system resolves into 4096 discrete steps ($2^{12} = 4096$); if the system has a range of 5 V, it can resolve 1.2 mV steps (5 V / 4096 = 0.0012 V) in a signal.

Rhodamine

Fluorescent dye used to monitor water circulation by tracking its signal with a fluorometer. Sea-Bird CTDs that accept 0-5 Volt auxiliary sensor inputs are compatible with several types of Rhodamine fluorometer.

Remotely Operated Vehicle (ROV)

Remotely controlled unmanned submersible, connected to an operator by a communication and/or power tether, used to collect oceanographic data. The SBE 49 is a common choice of CTD for ROVs.

RS-232

Computer serial interface standard. An Electronics Industries Association standard asynchronous serial line that is used commonly for modems, computer terminals, and serial printers. RS-232 uses a 25-pin or 9-pin connector. The standard designates the purpose for each of the 25 or 9 lines, including lines for sending and receiving data, ground connections, and control lines. The base model of most Sea-Bird instruments includes an RS-232 interface.

RS-485

Computer serial interface standard. An Electronics Industries Association standard that uses a pair of wires to send a differential signal; typically provides for communications over longer distances than RS-232. Several Sea-Bird instruments are available with an optional RS-485 interface (SBE 26*plus*, 37-SMP-ODO, 37-SMP-IDO, 37-SMP, 37-SM, 37-SIP-ODO, 37-SIP-IDO, 37-SIP, 37-SI, 38). RS-485 can be configured for either half- or full-duplex; most Sea-Bird RS-485 applications are half-duplex.

S

Salinity

Defined in 1902 as the amount of salts in 1 kg of seawater; major salts are NaCl, $MgCl_2$, $MgSO_4$, and $CaSO_4$. The relative proportion of each salt in seawater remains almost constant all over the ocean (this does not hold true in areas of freshwater influence, such as river estuaries, or at high latitudes when the ice is melting). As an approximation, 35 grams of salts dissolved in 1 liter of water equals 35 PSU salinity. Salinity is calculated from CTD data, based on the measured temperature, conductivity, and pressure, and must be calculated from measurements made on the same water parcel. The formula for this and other derived parameters is included in an Appendix of the SBE Data Processing manual. Also see Conductivity, T-C duct, and PSS.

Practical Salinity (PSU) is defined by the 1978 Practical Salinity Scale (PSS 1978); see *Application Note 14: 1978 Practical Salinity Scale*.

Absolute Salinity (g/kg) is defined by a Thermodynamic Equation of State of Seawater (TEOS-10) that was released in 2010, which takes into account the fact that the mass of dissolved constituents are regionally variable and are not always accurately represented when using conductivity measurements of seawater, the key parameter in the calculation of Practical Salinity. See *Application Note 90: Absolute Salinity and TEOS-10: Sea-Bird's Implementation*.

In December 2009, Sea-Bird implemented the Absolute Salinity calculation as an option in SeaCalc II, a seawater calculator module in SBE Data Processing that computes a number of derived variables from one user-input data scan. This implementation was intended to enable scientists to become familiar with Absolute Salinity and the new equation of state, TEOS-10.

In 2013, Sea-Bird released SBE Data processing version 7.23.1: In this software version:
- SeaCalc II was replaced by SeaCalc III, to update the calculations to correspond to the most up-to-date algorithms for Absolute Salinity, and
- A new module, Derive TEOS-10, was introduced. Derive TEOS-10 allows you to calculate most relevant TEOS-10 variables when processing data sets.

Sampling rate

Number of measurements taken per unit of time. Profiling rate and sampling rate interact to determine the average depth interval between measurements. For example, if sampling at 24 Hz (24 measurements/second) and descending at 1 m/sec, the depth interval between measurements is:
(1 m/sec) / (24 /sec) = 0.042 m = 4.2 cm

Because the ship heaves, alternately slowing and lifting the instrument package or dropping and accelerating the instrument package, the actual depth interval between measurements varies.

SBE Data Processing©

Data processing program that converts, edits, processes, and plots data from most Sea-Bird CTDs.

Seasave©-Win32

Old real-time data acquisition program that acquires, converts, and displays real-time or archived data from most Sea-Bird CTDs. Seasave-Win32 was replaced by Seasave V7 in 2007; we recommend that you upgrade to the new software.

Seasave© V7

Real-time data acquisition program that acquires, converts, and displays real-time or archived data from most Sea-Bird CTDs. Released in 2007, Seasave V7 replaces Seasave-Win32. Sea-Bird highly recommends that users switch to Seasave V7.

Seasoft©

Suite of stand-alone programs for use with most Sea-Bird instruments, including terminal programs (SeatermV2, Seaterm, and SeatermAF), real-time data acquisition program (Seasave V7), and data processing/plotting programs (SBE Data Processing and Plot39).

Seasoft© for Waves

Program for use with the SBE 26 / 26*plus* Seagauge Wave & Tide Recorder and SBE 53 BPR Bottom Pressure Recorder. Includes modules for pre-deployment planning, setup, data retrieval, data processing, auto-spectrum and time series analysis, statistics reporting, and plotting.

Seaterm©

Terminal program that interfaces with most Sea-Bird instruments, providing setup, data retrieval, and diagnostic tests.

Seaterm232©

Terminal program used with RS-232 instruments developed or redesigned in 2006 and later; part of SeatermV2.

Seaterm485©

Terminal program used with RS-485 instruments developed or redesigned in 2006 and later; part of SeatermV2.

SeatermAF©

Terminal program that interfaces with instruments that provide auto-fire capability for operating an SBE 32 Carousel Water Sampler (with SBE 17*plus* V2 or Auto Fire Module) or SBE 55 ECO Water Sampler, providing setup, data retrieval, and diagnostic tests.

SeatermIM©

Terminal program used with Inductive Modem (IM) instruments developed or redesigned in 2006 and later; part of SeatermV2.

SeatermUSB©

Terminal program used with instruments that can communicate via an internal USB interface; part of SeatermV2.

SeatermV2©

Terminal program launcher that interfaces with instruments developed or redesigned in 2006 and later. The common feature of this generation of instruments is the ability to output data in XML. SeatermV2 can be used with SBE 16*plus* V2, 16*plus*-IM V2, 19*plus* V2, 37 (SM, SMP, IM, IMP, SI, SIP – all firmware 3.0 or later), 37 IDO (SMP-IDO, SIP-IDO, IMP-IDO), 37 ODO (SMP-ODO, SIP-ODO, IMP-ODO), 39*plus*, 54, PN 90588, and Glider Payload CTD. SeatermV2 launches Seaterm232 (for RS-232 instruments), Seaterm485 (for RS-485 instruments), or SeatermIM (for inductive modem instruments), as applicable.

Sensor

A device that allows a physical characteristic of the environment to be converted into an electrical signal. Oceanographic sensors convert pressure, temperature, conductivity, or other physical parameters into electrical signals that are related to the value of the physical parameter. The simplest sensors have a linear response to the parameter of interest. However, the relationship between the measured parameter and the electrical output for most oceanographic sensors is a polynomial, and often related to other parameters (for example, the pressure sensor's response is based on both the pressure and the temperature of the water).

Sigma

Sigma is defined as (density – 1) * 1000. For example, if the density of a sample of seawater is 1.0250 kilograms/liter, sigma is 25.000. Sigma is also referenced to pressure:

- Sigma-t is referenced to pressure at the surface.
- Sigma-theta is referenced to the *in-situ* pressure.
- Sigma-1 is referenced to 1000 dbar pressure, sigma-2 to 2000 dbar pressure, etc.

The formula for this and other derived parameters is included in an Appendix of the SBE Data Processing manual.

Slip ring

An electromechanical device that mounts to the part of the winch that rotates (the drum). When the instrument package is raised or lowered the drum turns, winding sea cable in or letting it out. The slip ring makes a connection between the sea cable rotating on the drum and the cable that connects to the deck unit / computer on the ship. One side of the slip ring connects to the sea cable's internal conductor and the armor of the sea cable; this side has rings of metal separated by insulators arranged in a cylinder. The other side, which connects to the deck unit / computer, has conducting fingers that rest on the metal rings, providing continuity between the sea cable and the cable connecting to the deck unit / computer.

Sound velocity

The distance that a sound pulse travels per unit time. Theoretically, sound velocity can be measured directly by measuring the time required for a sound pulse to travel over a fixed length; however, uncertainties in the measurement lead to substantial errors. Sound velocity in seawater can be calculated more accurately from measurements from a CTD, based on the measured conductivity, temperature, and pressure. See *Application Note 6: Determination of Sound Velocity from CTD Dat*a.

Specific conductance

Conductivity normalized to 25 °C, used to visualize conductivity without the temperature dependence.

Specific Conductance = (mmhos/cm) = (C * 10000) / (1 + A * [T -25])

where:
A = 0.019-0.020 = thermal coefficient of conductivity for natural salt ion solutions (Seasoft uses 0.020),
C = conductivity [S/m],
T = temperature [°C].

Specific volume

Volume per unit mass; the reciprocal of density. By definition, the specific volume of fresh water is 1.0000 liters/kilogram. The formula for this and other derived parameters is included in an Appendix of the SBE Data Processing manual. Also see Density.

Standard seawater

Primary standard for the conductivity of seawater. IAPSO commissions Ocean Scientific International Limited to provide this water for the oceanographic community. Ocean Scientific collects seawater in the North Atlantic, filters and adjusts it to 35.000 psu salinity, and seals it in vials or bottles for use in standardizing laboratory salinometers. Standard seawater was originally referred to as *Copenhagen* water.

Surface layer

See Mixed layer.

T

T-C duct

Plumbing between the temperature and conductivity sensor. To ensure that temperature and conductivity measurements are made on the same water sample (necessary for correct salinity calculation), the sensors are plumbed together with a T-C duct; a pump draws water past the temperature sensor and then through the duct and conductivity cell at a consistent, known speed. See *Application Note 38: Fundamentals of the TC Duct and Pump-Controlled Flow Used on Sea-Bird CTDs*.

Tau (τ)

See Time constant.

TBTO

Bis (tributyltin) oxide, the active ingredient in Sea-Bird’s AF24173 Anti-Foulant Device. See Anti-foulant device.

Thermocline

Region in the ocean where temperature changes rapidly.

Thermosalinograph

Instruments used to collect temperature and conductivity information about the sea surface, typically in flow-through systems operating continuously throughout a cruise. Thermosalinographs are usually installed inside and near to the hull of a ship in order to make measurements on uncontaminated seawater. Optionally, you can plumb other types of sensors into the system for a wider range of measurements. Sea-Bird manufactures two thermosalinographs -- SBE 21 and 45.

Time constant (τ)

Sensor response time, typically stated as the time to come to 63% of the final value after a step change in the environment.

- For a thermistor housed in a thin metal sheath, the delay in response to a sharp change in temperature from warm to cold is due to the time required for the heat in the thermistor to diffuse into the environment.
- For a conductivity cell, the delay in response is affected by the flushing time of the cell. Water is pumped through the conductivity cell in Sea-Bird profiling CTDs, resulting in a constant flushing time and a known time constant. For free flushing conductivity cells, the time constant varies with the speed of descent/ascent.
- For a membrane-type dissolved oxygen sensor, the delay in response is related to the time required for the concentration of O_2 near the electrode to equilibrate with the environment. See *Application Note 64: SBE 43 Dissolved Oxygen Sensor -- Background Information, Deployment Recommendations, and Cleaning and Storage*.

TPW

See Triple-Point-of-Water.

Triple-Point-of-Water

Temperature at which water exists as a liquid, a vapor, and a solid, 0.010000 °C. The triple-point-of-water is measured in a Triple-Point-of-Water (TPW) Cell, which consists of a cylinder of borosilicate glass with a reentrant tube serving as a thermometer well, filled with high-purity, gas-free water, and sealed. When an ice mantle is frozen around the well, and a thin layer of this ice mantle is melted next to the well, the triple-point-of-water temperature can be measured in the well. A TPW cell is used as one physical standard in the calibration of Sea-Bird temperature sensors; because of a pressure effect, the temperature at the depth where we actually take the measurement is 0.00997 °C. Gallium melt point is another physical standard. *Measurement Accuracy at Triple Point of Water and Gallium Melt Point Supports a Total Measurement Uncertainty of 0.0006 degrees C* provides more details.

Triton

Triton X-100 is Octyl Phenol Ethoxylate, a reagent grade non-ionic surfactant (detergent). Sea-Bird uses it to help keep our conductivity cells clean and the electrodes wetted and ready for immediate use in water (a dry cell requires a few minutes to become completely wetted after immersion). Triton can be ordered from Sea-Bird, but should also be available locally from chemical supply or lab products companies. It is manufactured by Avantor Performance Materials (http://avantormaterials.com/commerce/product.aspx?id=2147509608). See our *MSDS* page.

Turbidity Sensor

Scattering sensor used to determine suspended particle concentration in the water. Sea-Bird CTDs that accept 0-5 Volt auxiliary sensor inputs are compatible with several types of turbidity sensors.

U

Unmanned Underwater Vehicle (UUV)

Unmanned submersible; see Remotely Operated Vehicle (ROV) and Autonomous Underwater Vehicle (AUV). The SBE 49 is a common choice of CTD for UUVs.

W

Water Sampler

A water sampler is often used in conjunction with a CTD. The water sampler collects 1 or more actual samples of water for analysis in the lab after recovery of the package. The water samples can be used to verify the accuracy of data measured by the instruments on the package, and/or to provide additional information that cannot be measured with an instrument.

Sea-Bird manufactures two water samplers: the SBE 32 Carousel (up to 36 bottles, 1.7 - 30 liters, available in regular, compact, and sub-compact sizes) and SBE 55 ECO (3- or 6-bottles, depths to 600 meters). Both of these samplers can be controlled (i.e., bottles closed) from deck via a Sea-Bird deck unit and software, or can be pre-programmed to close bottles at desired depths.

Wet-Pluggable Connector

Wet-pluggable (also called wet-mateable or MCBH) connectors, an option on many of our instruments, may be mated in wet conditions. The pins do not need to be dried before mating. By design, water on the pins is forced out as the connector is mated. However, they must not be mated or un-mated while submerged. Wet-pluggable connectors have a non-conducting guide pin to assist alignment (exception: 6-pin connectors) and require less force to mate, making them easier to mate reliably under dark or cold conditions, compared to our standard (Impulse XSG/RMG) connectors (standard connectors may not seal well in extreme cold; we recommend connecting cables in warm ship's lab rather than on deck for these conditions). Like standard connectors, wet-pluggables need proper lubrication and require care during use to avoid trapping water in sockets.

When should you consider configuring your instrument with wet-pluggable connectors?

- **Internal recording with a profiling CTD** (for example, SBE 9*plus* with 17*plus* V2, 19*plus* V2, 25*plus*) -- Connecting/disconnecting frequently to the CTD is typical for these systems, for uploading of the internally recorded data. Wet-pluggable connectors are **recommended**.
- **Autonomous water sampling** (SBE 32 Carousel with AFM or 17*plus* V2, or SBE 55 ECO Water Sampler) and internal recording with a profiling CTD -- Connecting/disconnecting to the underwater electronics is required after every cast, to re-arm the electronics for autonomous water sampling. Connecting/disconnecting is often done on deck, where the connectors are exposed to splashing and rain; wet-pluggable connectors are **strongly recommended**.
- **Real-time data acquisition with a profiling CTD** (for example, SBE 9*plus* with 11*plus* Deck Unit, SBE 19*plus* V2 or 25*plus* with PDIM and SBE 33 or 36 Deck Unit) -- The underwater units in these systems are plugged into the sea cable, and typically are disconnected infrequently. Wet-pluggable connectors are **not as important** for this application.
- **Moored instruments** --
  - If data upload after recovery will occur on deck to allow for quick redeployment, wet-pluggable connectors are **recommended**.
  - If data upload after recovery will occur in a lab, wet-pluggable connectors are **not as important** for this application.

Winkler Titration

Winkler titration is used to determine the concentration of Dissolved Oxygen (D.O.) in water samples. An excess of manganese(II) salt, iodide (I-) and hydroxide (HO^-) ions is added to a water sample, causing a white precipitate of $Mn(OH)_2$ to form. This precipitate is then oxidized by the D.O. in the water sample into a brown manganese precipitate. A strong acid (hydrochloric or sulfuric acid) is added to acidify the solution. The brown precipitate then converts the iodide ion (I-) to iodine. The amount of D.O. is directly proportional to the titration of iodine with a thiosulfate solution. Today, the method is effectively used as its colorimetric modification, where the trivalent manganese produced on acidifying the brown suspension is directly reacted with EDTA to give a pink color. As Manganese is the only common metal giving a color reaction with EDTA, it has the added effect of masking other metals as colorless complexes.

X

.xmlcon file

See Configuration file.