SBE 25
SEALOGGER CTD

Conductivity, Temperature, and Pressure Recorder
with RS-232 Interface

Shown with optional auxiliary sensors

User's Manual

Limited Liability Statement

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

SEA-BIRD ELECTRONICS, INC. disclaims all product liability risks arising from the use or servicing of this system. SEA-BIRD ELECTRONICS, INC. has no way of controlling the use of this equipment or of choosing the personnel to operate it, and therefore cannot take steps to comply with laws pertaining to product liability, including laws which impose a duty to warn the user of any dangers involved in operating this equipment. Therefore, acceptance of this system by the customer shall be conclusively deemed to include a covenant by the customer to defend, indemnify, and hold SEA-BIRD ELECTRONICS, INC. harmless from all product liability claims arising from the use or servicing of this system.

Table of Contents

Section 1: Introduction

This section includes contact information, Quick Start procedure, and photos of a standard SBE 25 shipment.

About this Manual

This manual is to be used with the SBE 25 SEALOGGER Conductivity, Temperature, and Pressure Recorder.

It is organized to guide the user from installation through operation and data collection. We have included detailed specifications, command descriptions, maintenance and calibration information, and helpful notes throughout the manual.

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

Quick Start

Follow these steps to get a Quick Start using the SBE 25.
The manual provides step-by-step details for performing each task:

1. Install batteries and test power and communications (see *Section 3: Power and Communications Test*).
2. Deploy the SBE 25 (see *Section 4: Deploying and Operating SBE 25*):
   A. Install new batteries if necessary.
   B. Ensure all data has been uploaded, and then send **IL** to make entire memory available for recording if desired.
   C. Set date and time and establish setup and logging parameters.
      Send **QS** to put SBE 25 in quiescent state.
   D. Install dummy plugs and/or cable connectors, and locking sleeves.
   E. Remove Tygon tubing that was looped end-to-end around conductivity cell for storage. Reconnect cell to SBE 25 plumbing.
   F. Put magnetic switch in On position.
   G. Deploy SBE 25.

Unpacking SBE 25

Shown below is a typical SBE 25 shipment.

SBE 25 SEALOGGER in cage
(shown with optional auxiliary sensors)

Data I/O cable
(connects computer to Y-cable
from J1 connector on main housing
end cap)

Conductivity cell
cleaning solution
(Triton-X)

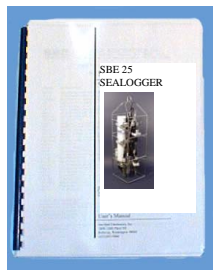Conductivity cell filling
and storage kit

Pressure sensor
oil refill kit

Jackscrew Kit

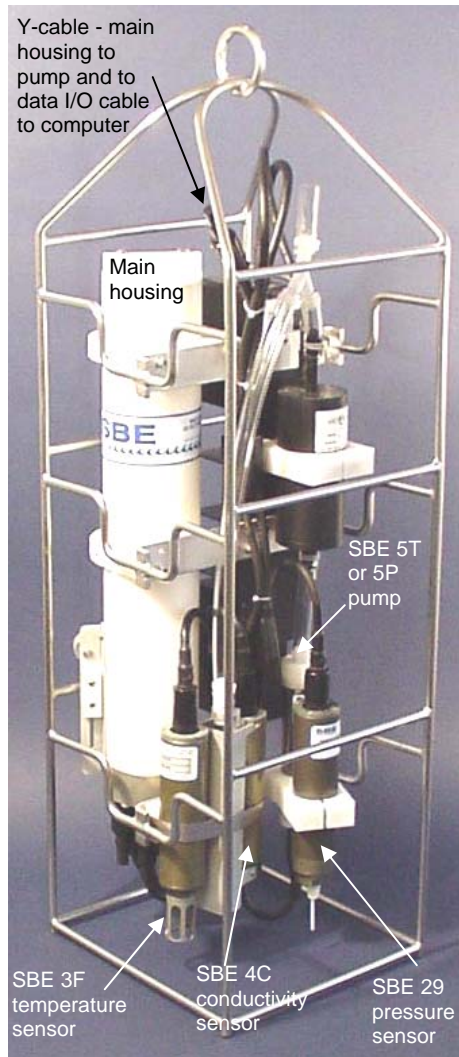Spare battery end cap
hardware and o-ring kit

SBE 25 Manual

Software, and Electronic Copies of
Software Manuals and User Manual

Section 2: Description of SBE 25

This section describes the functions and features of the SBE 25, including specifications, dimensions, end cap connectors, magnetic reed switch, data I/O, memory endurance, batteries and battery endurance, and plumbing.

System Description

Y-cable - main housing to pump and to data I/O cable to computer

Main housing

SBE 5T or 5P pump

SBE 3F temperature sensor

SBE 4C conductivity sensor

SBE 29 pressure sensor

Shown with optional auxiliary sensors

The SBE 25 SEALOGGER measures conductivity, temperature, and pressure in marine or fresh-water environments at depths up to 6800 meters (22,300 feet). Additionally, the SBE 25 powers and interfaces with up to seven auxiliary sensors. Designed for applications where vertical profiles of the measured parameters are required, the SBE 25 runs continuously and samples at eight scans per second (8 Hz). The SBE 25 can be set to average up to eight samples, storing and transmitting only the averaged data.

The SBE 25's main (battery/recorder) housing contains the acquisition electronics, microprocessor controller, memory, and batteries; bulkhead connectors for the modular sensors are mounted on the housing's bottom end cap. The SBE 25 uses Sea-Bird's modular SBE 3F Temperature Sensor and SBE 4C Conductivity Sensor. The SBE 25 also includes the SBE 5T (titanium) or 5P (plastic) Submersible Pump and TC Duct. The pump-controlled, TC-ducted flow configuration significantly reduces salinity spiking caused by ship heave, and in calm waters allows slower descent rates for improved resolution of water column features. Pressure is measured by the modular SBE 29 Temperature Compensated Strain-Gauge Pressure Sensor, available in eight depth ranges to suit the operating depth requirement.

Nine D-size alkaline batteries provide 24 hours operation for a system without auxiliary sensors, or 4 hours operation for a fully loaded system. The standard 8 Mbyte memory records 35 hours of conductivity, temperature, and strain-gauge pressure data while sampling at 8 scans per second (other configurations/setups vary). Simultaneous, real-time monitoring is possible using the SBE 25's opto-isolated RS-232C interface. Setup, diagnostics, and data extraction are performed without opening the housing.

A standard SBE 25 is supplied with:

- Plastic main housing for depths to 600 meters (1950 feet)
- Modular temperature (SBE 3F), conductivity (SBE 4C), and strain-gauge pressure (SBE 29) sensors
- T-C Duct, which ensures that Temperature and Conductivity measurements are made on the same parcel of water
- SBE 5P plastic submersible pump (for depths to 600 meters) for pumped conductivity; by fixing the flow to a constant rate, the pump ensures a constant conductivity time response. *The T-C duct and pump combination results in dramatically lower salinity spiking*.
- Seven 12-bit A/D input channels for optional auxiliary sensors: four single-ended, two differential, and one log amplified (for PAR sensor)
- 8 Mbyte memory
- 9 D-size alkaline batteries (Duracell MN1300, LR20)
- Glass-reinforced epoxy bulkhead connectors
- Protective cage with lifting eye ring

SBE 25 options include:

- Aluminum housing for use to 6800 meters (22,300 feet)
- SBE 5T titanium pump in place of SBE 5P plastic pump
- Wet-pluggable (MCBH) connectors in place of standard connectors
- Optional auxiliary sensors for dissolved oxygen, pH, fluorescence, light (PAR), light transmission, and turbidity
- Nickel Metal Hydride (NiMH) batteries and charger
- Nickel Cadmium (Ni-Cad) batteries and charger

Notes:
- The SBE 32 Carousel is a 12-, 24-, or 36-bottle water sampler.
  The SBE 55 ECO is a 3- or 6-bottle water sampler.
- Seasave 7.18 or later also supports acquisition of data from a NMEA device connected directly to the computer (instead of the deck unit).

The SBE 25 can be used with the following Sea-Bird equipment:

- **SBE 32 Carousel Water Sampler and SBE 33 Carousel Deck Unit OR SBE 55 ECO Water Sampler and SBE 33 Carousel Deck Unit** -
  The SBE 32 or SBE 55 provides +15 VDC power to the SBE 25 and has ample power available for auxiliary sensors not normally supported by battery-powered CTDs. CTD data from the SBE 25 is converted into single-wire telemetry for transmission over long (up to 10,000 meter [32,800 feet]) sea cables. Bottles may be closed at any depth without interrupting CTD data via software control using the Seasave program or from the front panel of the SBE 33 Deck Unit. See the SBE 33 manual for operating details.

SBE 55 Real-Time Operation

SBE 32 Real-Time Operation
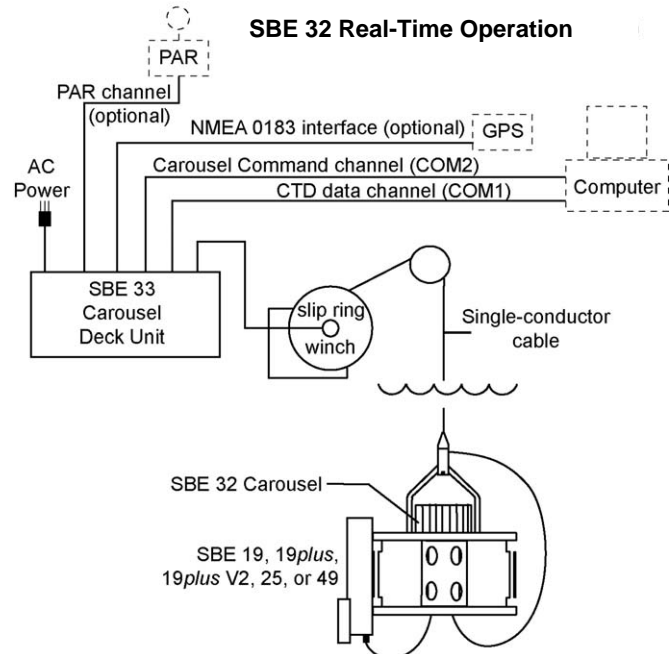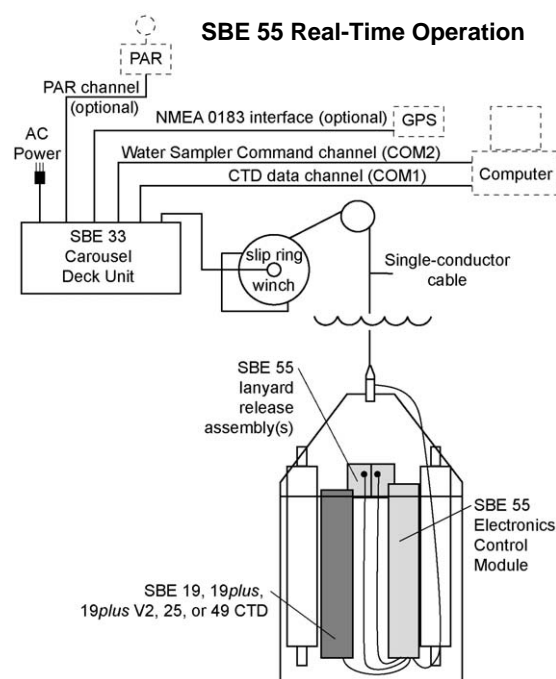
- **SBE 36 CTD Deck Unit and Power Data Interface Module (PDIM)** - These items provide power and real-time data handling capabilities over single-conductor sea cables using the same method as employed in the SBE 32/SBE 33. The PDIM is a small pressure housing that is mounted on or near the SBE 25. It provides +15 VDC power to the SBE 25 and interfaces two-way RS-232 communications from the SBE 25 to the telemetry used on the sea cable. See the SBE 36/PDIM manual for operating details.

Note:
Seasave 7.18 or later also supports acquisition of data from a NMEA device connected directly to the computer (instead of the deck unit).
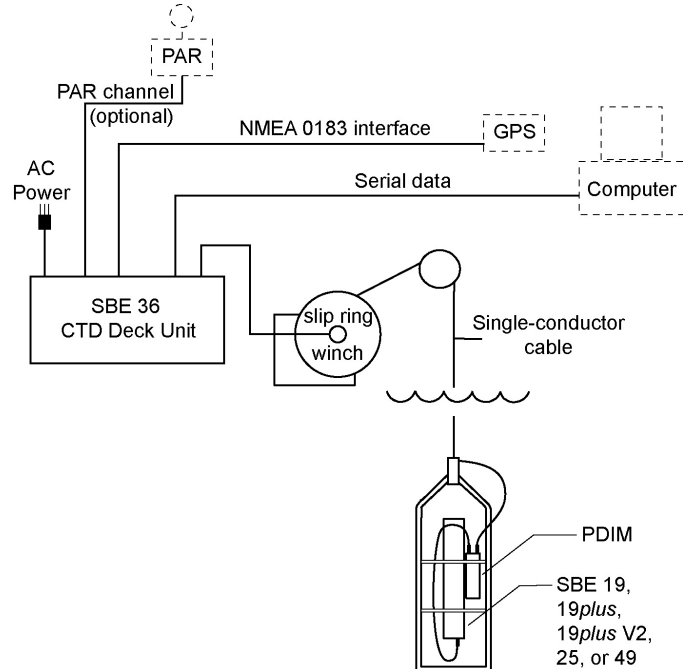
- **SBE 32 Carousel Water Sampler and Auto Fire Module (AFM)** - The AFM, mounted on or near the SBE 25, allows the SBE 32 to operate autonomously on non-conducting cables. The AFM supplies the operating voltage, logic, and control commands necessary to operate the SBE 32. The AFM monitors the pressure data recorded by the SBE 25 in real-time, closing water sampler bottles at predefined pressures (depths) or whenever the system is stationary for a specified period of time. Bottle number, firing confirmation, and five scans of CTD data are recorded in the AFM memory for each bottle fired. See the AFM manual for operating details.

SBE 32 Autonomous Operation
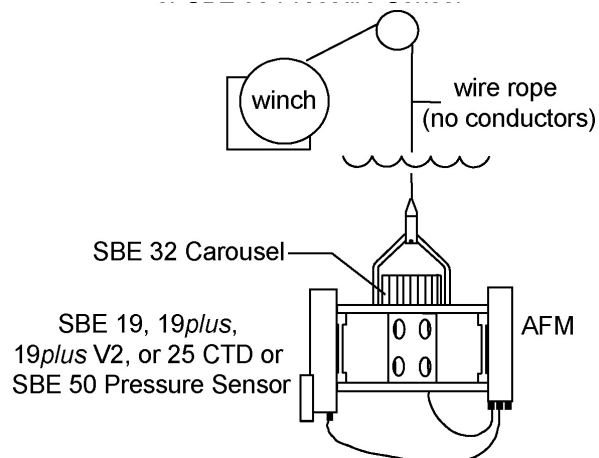
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- **SBE 55 ECO Water Sampler** - The SBE 55 has built-in capabilities similar to that of an SBE 32 Carousel Water Sampler integrated with an Auto Fire Module, allowing the SBE 55 to operate autonomously on non-conducting cables. The SBE 55 monitors the pressure data recorded by the SBE 25 in real-time, closing water sampler bottles at predefined pressures (depths) or whenever the system is stationary for a specified period of time. Bottle number, firing confirmation, and five scans of CTD data are recorded in the SBE 55 memory for each bottle fired. See the SBE 55 manual for operating details.

SBE 55 Autonomous Operation

The SBE 25 is supplied with a powerful Windows 2000/XP software package, SEASOFT© V2, which includes:

- **SEATERM** – terminal program for easy communication and data retrieval.

- **SeatermAF** – terminal program for easy communication and data retrieval when the SBE 25 is used with a water sampler operated autonomously (SBE 32 Carousel Water Sampler with Auto Fire Module **or** SBE 55 ECO Water Sampler).

- **Seasave V7** – program for acquiring, converting, and displaying real-time or archived raw data.

- **SBE Data Processing** - program for calculation and plotting of conductivity, temperature, pressure, data from auxiliary sensors, and derived variables such as salinity and sound velocity.

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

Specifications

	Temperature (°C)	Conductivity (S/m)	Pressure
Measurement Range	-5 to +35	0 to 7	0 to full scale range (expressed in meters of deployment depth capability): 20 / 100 / 350 / 600 / 1000 / 2000 / 3500 / 7000 meters
Initial Accuracy	0.002	0.0003	0.1% of full scale range
Resolution	0.0003	0.00004	0.015% of full scale range
Sensor Calibration (measurement outside these ranges may be at slightly reduced accuracy due to extrapolation errors)	-1.4 to +32.5	2.6 to 6 S/m, plus zero conductivity (air)	Ambient pressure to full scale range in 5 steps
Memory	8 MByte		
Data Storage	**Recorded Parameter** **Bytes/sample** temperature + conductivity + pressure 8.0 each external voltage 1.5		
Real-Time Clock	32,768 Hz TCXO accurate to ±1 minute/year		
Internal Batteries (nominal capacity)	Standard 9 alkaline D-cells (Duracell MN1300, LR20) - 24 hours operation. Optional NiMH battery pack - 17 hours operation per charge. Optional Ni-Cad battery pack - 8 hours operation per charge.		
External Power Supply (power required if not relying on internal batteries)	14-16 VDC		
Power Requirements	Sampling (no auxiliary sensors or pump) 190 mA Pump (SBE 5P or 5T) 150 mA Quiescent 150 μA		
Auxiliary Voltage Sensors	Auxiliary power out: up to 250 mA at 11.5 VDC A/D resolution: 12 bits Input range: 0 - 5 VDC		
Main Housing Material, Weight (including all standard sensors and cage)	600 meter (1950 ft) - acetal copolymer (plastic), 16.6 kg (37 lbs) in air; 7.4 kg (16.4 lbs) in water 6800 meter (22,300 ft) - 7075 aluminum, 19.4 kg (43 lbs) in air, 10.2 kg (23 lbs) in water		

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

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Dimensions

Cage depth (not shown) is 30.5 cm (12 in.).

Lifting Ring

Battery/Recorder Housing
(also called Main Housing)

Optional
PAR Sensor

Guard Cage
316 Stainless

Optional
DO/pH/ORP
Sensor

Optional
Fluorometer

Optional
Transmissometer

Pump

Pressure
Sensor

SBE 4
Conductivity
Sensor

SBE 3
Temperature
Sensor

95 cm
(38 in.)

28 cm
(11 in.)
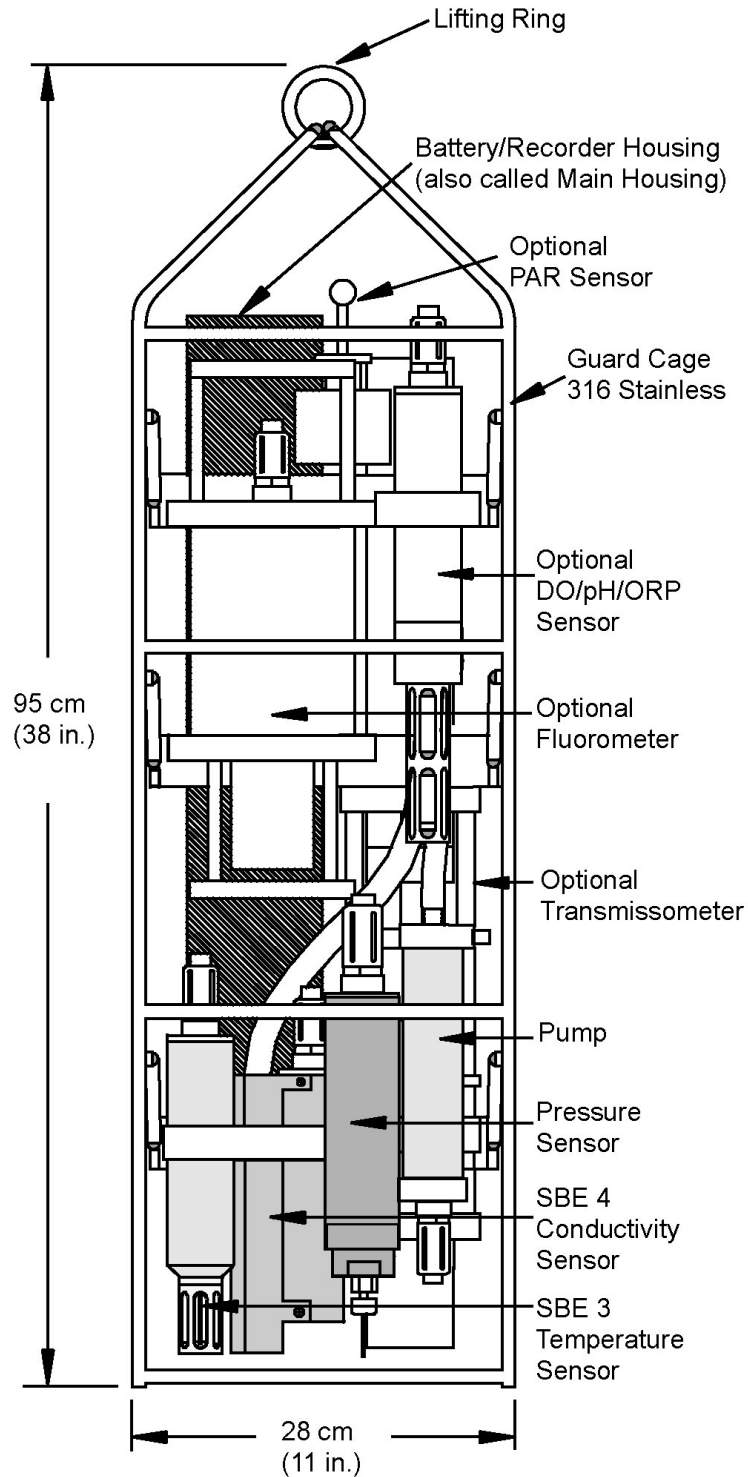
Main Housing End Cap Connectors

○ = **standard connectors**:
2-pin XSG-2-BCL-HP-SS,
3-pin XSG-3-BCL-HP-SS, and
6-pin AG-306-HP-SS as applicable.

○ = **optional MCBH (wet-pluggable) connectors
(all with 3/8" length base, ½-20 thread)**
2-pin MCBH-2MP (WB), AL
3-pin MCBH-3MP (WB), AL and
6-pin MCBH-6MP (WB), AL as applicable.

Note:
A y-cable from J1 connects to the pump and to a data I/O cable (for connection to the computer for setup and uploading of data).

Pressure

Pin	Signal
1	Power Common
2	Auxiliary Power Out -
3	Pressure Signal Common
4	Pressure Signal
5	Pressure Temperature Signal
6	Auxiliary Power Out +

Data I/O, Pump, and External Power

Pin	Signal
1	Common
2	RS-232C Receive from computer
3	RS-232C Transmit to computer
4	Pump Power Common
5	Pump Power
6	External Power In 14-16 VDC

Temperature

Pin	Signal
1	Common
2	Temperature frequency
3	Auxiliary Power Out

PAR (Voltage 6)

Pin	Signal
1	Common
2	PAR Signal (Voltage 6 Signal)

Conductivity

Pin	Signal
1	Common
2	Conductivity frequency
3	Auxiliary Power Out

Differential Input (Voltage 4,5)

Pin	Signal
1	Common
2	Voltage 4 Signal
3	Voltage 4 Common
4	Voltage 5 Signal
5	Voltage 5 Common
6	Auxiliary Power Out

Single-Ended Input (Voltage 0-3)

Pin	Signal
1	Common
2	Voltage 0 Signal
3	Voltage 3 Signal
4	Voltage 1 Signal
5	Voltage 2 Signal
6	Auxiliary Power Out

Magnetic Reed Switch

Magnetic switch

Connector end cap

A magnetic switch, mounted on the main housing, is used to start and stop logging. With the SBE 25 in quiescent (sleep) state, sliding the switch to the On position wakes up the SBE 25 and starts logging. Sliding the switch to the Off position stops logging. The switch should be Off (away from the connector end cap) when the SBE 25 is not logging data; i.e., during setup, diagnostics, and data extraction.

Data I/O

The SBE 25 receives set-up instructions and outputs diagnostic information or previously recorded data via a three-wire RS-232C link, and is factory-configured for 600 baud, 7 data bits, 1 stop bit, and even parity. SBE 25 RS-232 levels are directly compatible with standard serial interface cards (IBM Asynchronous Communications Adapter or equal). The communications baud rate can be changed using **SRx** (see *Section 4: Deploying and Operating SBE 25*).

Data Storage

The SBE 25 has an 8 MB memory. Shown below are calculations of available data storage for several configurations.

Example 1: 8 MB memory, no auxiliary sensors
T, C, and P = 8 bytes/sample
Storage space ≈ 8,000,000 / 8 ≈ 1,000,000 samples

Example 2: 8 MB memory, 4 auxiliary sensors
T, C, and P = 8 bytes/sample
External voltages = 1.5 bytes/sample x 4 sensors = 6 bytes/sample
Storage space ≈ 8,000,000 / (8 + 6) ≈ 570,000 samples

Batteries

For the main battery, the SBE 25 uses nine D-cell alkaline batteries (Duracell MN 1300, LR20), or rechargeable Nickel Metal Hydride (NiMH) or Nickel-Cadmium (Ni-Cad) batteries. If necessary, carbon-zinc or mercury cells can be used.

On-board lithium batteries (non-hazardous units that are unrestricted for shipping purposes) are provided to back-up the buffer and the real-time clock in the event of main battery failure or exhaustion. The main batteries may be replaced without affecting either the real-time clock or memory.

Battery Endurance

Notes:
- See *Specifications* for power requirements.
- See *Data Storage* and *Specifications* for data storage limitations.
- If the SBE 25 is logging data and the battery voltage is less than the battery cut-off, it halts logging and displays a low battery indication in the data. See the **CC** command in *Command Descriptions* in *Section 4: Deploying and Operating SBE 25* for cut-off values.

The standard 9-cell alkaline battery pack has a nominal capacity of 14 Amp-hours; for planning purposes, Sea-Bird recommends using a conservative value of 10.5 Amp-hours. The optional NiMH battery pack has a nominal capacity of 8 Amp-hours. The optional Ni-Cad battery pack has a nominal capacity of 4.4 Amp-hours. Current consumption varies, depending on inclusion of auxiliary sensors. Examples are shown below for two sampling schemes.

Example 1: standard alkaline batteries, no auxiliary sensors
Sampling current (T, C, and P) = 190 mA = 0.19 A
Pump current = 150 mA = 0.15 A
Maximum sampling time $\approx$ 10.5 Amp-hours / (0.19 A + 0.15 A) $\approx$ 30 hours

Example 2: standard alkaline batteries, auxiliary sensors drawing 100 mA
Sampling current (T, C, and P) = 190 mA = 0.19 A
Pump current = 150 mA = 0.15 A
Auxiliary sensor current = 100 mA = 0.10 A
Maximum sampling time $\approx$ 10.5 Amp-hours / (0.19 A + 0.15 A + 0.10 A) $\approx$ 23 hours

Plumbing

An SBE 25 is typically deployed in a vertical position. However, when used with an SBE 32 Carousel Water Sampler, the SBE 25 may be deployed in a horizontal position. Pump placement and plumbing for a horizontal mount is different than that for a vertical mount.

Sea-Bird provides the system with pump placement and plumbing for the desired orientation at the time of purchase. However, you may reorient the system later as needed. **Failure to place the pump and plumbing properly can trap air, preventing the pump from working properly.**

Shown below are schematics of the system configuration for vertical and horizontal deployment.

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Vertical Mount

- The main plumbing is 13 mm ID x 19 mm OD (1/2 inch x 3/4 inch) Tygon tubing.
- Place the exhaust as far from the intake as possible, preferably in diagonally opposing corners, so that exhaust water is not pulled into the intake. Failure to place the exhaust away from the intake can lead to errors in temperature data, because the pump transfers heat to the exhaust water.
- Place a 13 mm (0.5 inch) piece of 9.5 mm ID Tygon tubing at the dissolved oxygen (DO) sensor intake and exhaust. Slide the larger diameter Tygon tubing (13 mm ID) over the smaller diameter tubing to provide tight seals.
- If the system does not include a DO sensor, connect the tubing from the conductivity cell directly to the Y-fitting.

SBE 43

Exhaust

SBE 43 plenum

Intake

Place DO sensor with plenum intake closer than exhaust to SBE 43 housing, as shown. Note: SBE 43 housing orientation (connector end up or down) does not affect operation. Plenum can be reversed on housing by removing and replacing 2 screws.

Secure each tubing connection with 2 cable ties (not shown)

Approximately 100 mm (4 inch) length of Tygon tubing

Y-fitting and air release valve

Air release valve detail

0.5 mm (0.02 in.)

UP

Note: Periodically clean air release valve to ensure proper functioning.

SBE 43 DO sensor

Tygon tubing (typical)

DO sensor intake

Quick release coupling

Pump intake

Exhaust

Temperature sensor

Conductivity sensor

SBE 5T or 5P pump

DO sensor intake and exhaust detail

9.5 mm inner diameter Tygon tubing (13 mm long)

DO plenum hose

13 mm inner diameter Tygon tubing

TC Duct

Intake

Place intake and exhaust far enough away from each other to avoid recirculation of water

Horizontal Mount

- The main plumbing is 13 mm ID x 19 mm OD (1/2 inch x 3/4 inch) Tygon tubing.
- Place the DO sensor intake above the conductivity sensor exhaust.
- Place the pump intake above the DO sensor exhaust.
- Orient the pump with the exhaust outlet *corner* up.
- Place a 13 mm (0.5 inch) piece of the 9.5 mm ID Tygon tubing at the DO sensor intake and exhaust. Slide the larger diameter tubing (13 mm ID) over the smaller diameter tubing to provide tight seals.
- If the system does not include a DO sensor, connect the tubing from the conductivity cell directly to the pump intake.

Place pump exhaust above intake and
DO sensor, with exhaust outlet 'corner' up

Exhaust

Secure each tubing connection with
2 cable ties (not shown)

Tygon tubing

Pump intake

SBE 5T or 5P
pump

Conductivity
sensor

TC Duct

SBE 43
DO sensor

Temperature
sensor

Intake

SBE 43
plenum

Quick release
coupling

Exhaust

Intake

SBE 43
DO sensor

1. Place DO sensor with exhaust above intake, oriented as shown (± 45°).
2. Place DO sensor with plenum intake closer than exhaust to SBE 43 housing, as shown.
Note: SBE 43 housing orientation (connector end to left or to right) does not affect
operation. Plenum can be reversed on housing by removing and replacing 2 screws.

DO sensor intake
and exhaust detail

DO
plenum
hose

9.5 mm inner
diameter
Tygon tubing
(13 mm long)

13 mm inner diameter Tygon tubing

Section 3:
Power and Communications Test

This section describes software installation and the pre-check procedure for preparing the SBE 25 for deployment. The power and communications test will verify that the system works, prior to deployment.

Software Installation

Notes:
- Help files provide detailed information on the software. Separate software manuals on the CD-ROM contain detailed information on Seasave V7 and SBE Data Processing.
- Sea-Bird also supplies an older version of Seasave, Seasave-Win32. However, all Seasave instructions in this manual are for Seasave V7. See Seasave-Win32's manual and/or Help files if you prefer to use the older software.
- It is possible to use the SBE 25 without SEATERM by sending direct commands from a dumb terminal or terminal emulator, such as Windows HyperTerminal.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our FTP site. See our website (www.seabird.com) for the latest software version number, a description of the software changes, and instructions for downloading the software from the FTP site.

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

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

1. Insert the CD in your CD drive.

2. Install software: Double click on **SeasoftV2_*date*.exe** (*date* is the date that version of the software was created). Follow the dialog box directions to install the software. The installation program allows you to install the desired components. Install all the components, or just install SEATERM and SeatermAF (terminal programs), Seasave V7 (real-time data acquisition), and SBE Data Processing (data processing).

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

Test Setup

1. Remove the dummy plug from the Y-cable and install the I/O cable:
    A. Pulling the plug firmly away from the connector, remove the dummy plug from the SBE 25's Y-cable connector strapped to the Main housing near the top of the cage. Note that the Y-cable is connected to the J1 connector, and provides power to the pump as well as communications with the computer.
    B. **Standard Connector** - Install the I/O cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the Y-cable.   **OR**
        MCBH Connector – Install the I/O cable connector, aligning the pins.

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

Test

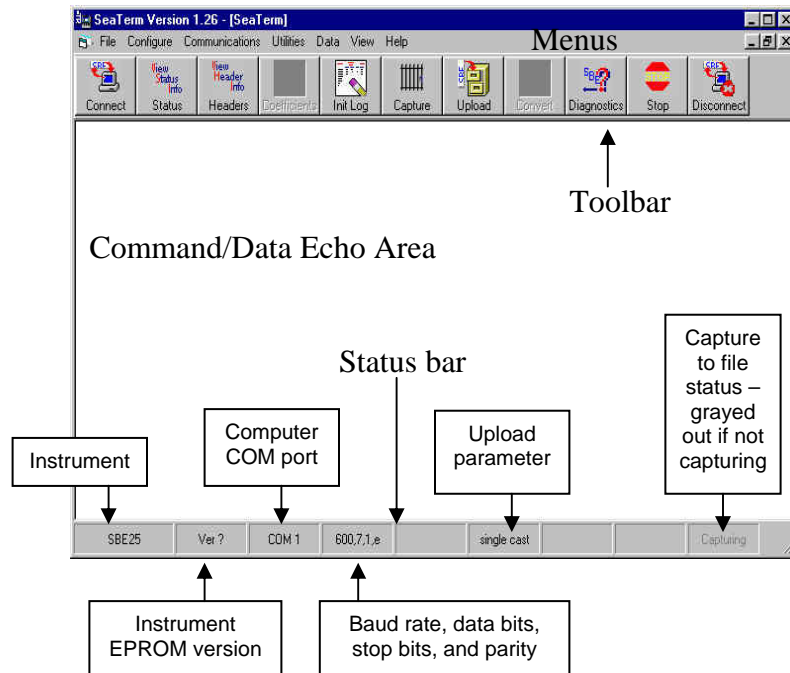1. Double click on SeaTerm.exe. If this is the first time the program is used, the setup dialog box may appear:
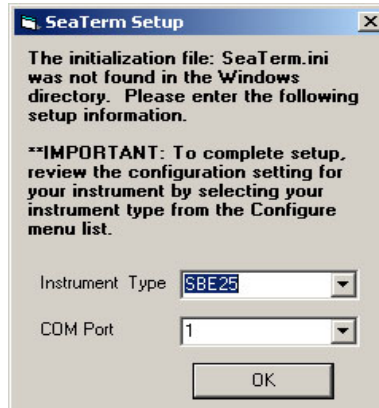
Select the instrument type (*SBE 25*) and the computer COM port for communication with the SBE 25. Click OK.

2. The main screen looks like this:

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

- Menus – Contains tasks and frequently executed instrument commands.
- Toolbar – Contains buttons for frequently executed tasks and instrument commands. All tasks and commands accessed through the Toolbar are also available in the Menus. To display or hide the Toolbar, select View Toolbar in the View menu. Grayed out Toolbar buttons are not applicable.
- Command/Data Echo Area – Echoes a command executed using a Menu or Toolbar button, as well as the instrument's response. Additionally, a command can be manually typed in this area, from the available commands for the instrument. Note that the instrument must be *awake* for it to respond to a command (click Connect on the Toolbar to wake up the instrument).
- Status bar – Provides status information. To display or hide the Status bar, select View Status bar in the View menu.

Note:
Once the system is configured and connected (Steps 3 through 5 below), to update the Status bar:
- on the Toolbar, click Status; or
- from the Utilities menu, select Instrument Status.
SEATERM sends the status command, which displays in the Command/Data Echo Area, and updates the Status bar.
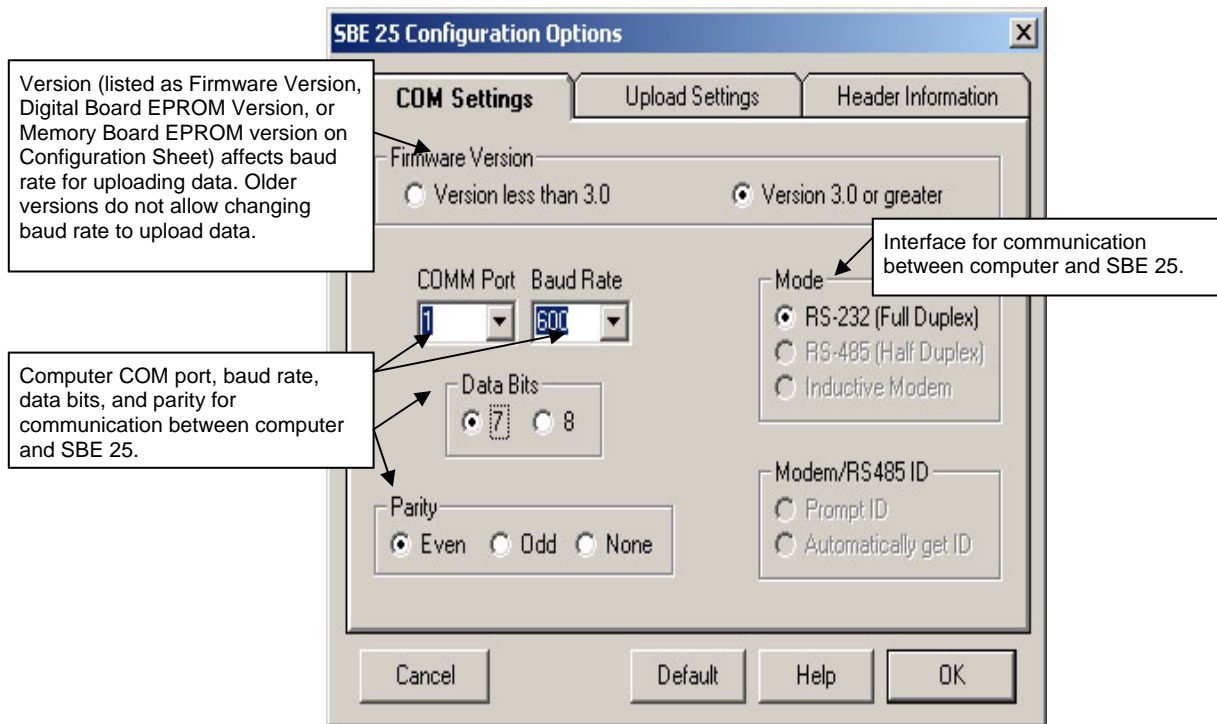
Following are the Toolbar buttons applicable to the SBE 25:

Toolbar Button	Description	Equivalent Command*
Connect	Re-establish communications with SBE 25. Computer responds with S> prompt. SBE 25 *goes to sleep* after 2 minutes without communication from computer have elapsed.	(press Enter key)
Status	Display instrument status and setup (samples in memory, sampling setup, etc.).	**DS**
Headers	View data headers (cast number, date and time, first and last sample in cast, number of external voltages sampled, number of measurements to average, and reason logging halted). A new header is generated for each cast.	**DH**
Init Log	Reset data pointers and cast numbers. This should be performed **after existing data has been uploaded from SBE 25** and prior to recording new data.	**IL**
Capture	Capture instrument responses on screen to file; may be useful for diagnostics. File has .cap extension. Click Capture again to turn off capture. Capture status displays in Status bar.	—
Upload	Upload data stored in memory, in format Sea-Bird's data processing software can use (raw Hex). Uploaded data has .hex extension. Before using Upload: • Configure upload and header parameters in Configure menu • **Stop logging** (put switch in Off position, send Ctrl Z, or click **STOP** on Toolbar)	**DCx**, **DAx**, **DBx**, **DEx**, or **DDb,e** (use Upload button if you will be processing data with SBE Data Processing)
Diagnostics	Perform one or more diagnostic tests on SBE 25. Diagnostic test(s) accessed in this manner are non-destructive – they do not write over any existing instrument settings.	**DS**, **J**, **FR**, **VR**
Stop	Interrupt and end current activity, such as logging, uploading, or diagnostic test.	(type Ctrl Z)
Disconnect	Free computer COM port used to communicate with SBE 25. COM port can then be used by another program.	—

*See *Command Descriptions* in *Section 4: Deploying and Operating SBE 25*.

3. In the Configure menu, select *SBE 25*. The dialog box looks
like this:

Version (listed as Firmware Version,
Digital Board EPROM Version, or
Memory Board EPROM version on
Configuration Sheet) affects baud
rate for uploading data. Older
versions do not allow changing
baud rate to upload data.

Interface for communication
between computer and SBE 25.

Computer COM port, baud rate,
data bits, and parity for
communication between computer
and SBE 25.

SBE 25 Configuration Options

COM Settings | Upload Settings | Header Information

Firmware Version
○ Version less than 3.0   ● Version 3.0 or greater

COMM Port   Baud Rate
[1 ▼]   [600 ▼]

Data Bits
● 7   ○ 8

Parity
● Even   ○ Odd   ○ None

Mode
● RS-232 (Full Duplex)
○ RS-485 (Half Duplex)
○ Inductive Modem

Modem/RS485 ID
○ Prompt ID
○ Automatically get ID

Cancel   Default   Help   OK

Notes:
- SEATERM's baud rate must be the
  same as the SBE 25's baud rate
  (set with **SRx**). Baud is factory-set to
  600, but can be changed by the user
  (see *Command Descriptions* in
  *Section 4: Deploying and Operating
  SBE 25*).
- When you click OK, SEATERM
  saves the Configuration Options
  settings to the SeaTerm.ini file in
  your Windows directory. SeaTerm.ini
  contains the last saved settings for
  each instrument. When you open
  SEATERM and select the desired
  instrument (SBE 19, 25, etc.) in the
  Configure menu, the Configuration
  Options dialog box shows the last
  saved settings for that instrument.

Make the selections in the Configuration Options dialog box:
- **COMM Port**: COM 1 through COM 10, as applicable
- **Baud Rate**: 600 (documented on Configuration Sheet)
- **Data Bits**: 7
- **Parity**: Even
- **Mode**: RS-232 (Full Duplex)
Click OK to save the settings.

If you did not enter the temperature and conductivity sensor serial
numbers on the Upload Settings tab, SEATERM responds:
*Temperature or conductivity serial number not
entered!* Ignore this message for now - the serial numbers are
required only when you upload data from the SBE 25's memory, and do
not affect the operation of the instrument (see *Uploading Data* in
Section 4: Deploying and Operating SBE 25).

4. In the Communications menu, select *Options / Cycle baud
when connecting*.

5. Click Connect on the Toolbar. SEATERM tries to connect to the SBE 25
at the baud set in Step 3. If it cannot, it cycles through all other possible
baud rates to try to connect. When it connects, the display looks like this:
    SBE 25 SEALOGGER CTD power on
    S>
This shows that correct communications between the computer and the
SBE 25 has been established.
If the system does not respond with the S> prompt:
- Click Connect again.
- Verify the correct instrument was selected in the Configure menu and
  the settings were entered correctly in the Configuration Options
  dialog box. Note that the baud rate is documented on the
  Configuration Sheet.
- Check cabling between the computer and SBE 25.

6. Display SBE 25 status information by clicking Status on the Toolbar.
    The display looks like this:

    ```
    SBE 25 CTD V 4.1b  SN 323    04/06/06  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 = 442800  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
    minimum conductivity frequency for pump turn on = 2950
    pump delay = 45 seconds

    battery type = ALKALINE

    7 external voltages sampled
    stored voltage #0 = external voltage 0
    stored voltage #1 = external voltage 1
    stored voltage #2 = external voltage 2
    stored voltage #3 = external voltage 3
    stored voltage #4 = external voltage 4
    stored voltage #5 = external voltage 5
    stored voltage #6 = external voltage 6
    ```

7. Command the SBE 25 to go to sleep (quiescent state) by typing **QS** and
    pressing the Enter key.

The SBE 25 is ready for programming and deployment.

Section 4: Deploying and Operating SBE 25

This section includes discussions of:

- Logging modes (Normal and Standby)

- Pump operation

- Real-time setup

- Timeout description

- Command descriptions

- Data format

- Optimizing data quality

- Setup for deployment

- Deployment

- Acquiring real-time data with Seasave

- Multiple deployments

- Recovery - physical handling and uploading data

- Processing data

Logging

When logging, the SBE 25 samples data at 8 Hz (8 samples/second), stores the data in its memory at a user-defined rate (**CC**), and transmits the data real-time at a user-defined rate (**CC**). Each time the SBE 25 begins logging, it writes a header to memory, containing the cast number, and date and time that logging was started. The maximum number of casts in memory is 100, even if the amount of data in memory is below the memory capacity. When the memory is full (or more than 100 casts have been taken), the SBE 25 will continue to operate and transmit real-time data. However, the data will not be recorded in memory and will not overwrite previously recorded data.

There are two logging modes - Normal and Standby. The mode affects how logging is started and stopped, and when power is applied to and removed from the sensors. Descriptions follow. Review the operation of the modes and the commands described in *Command Descriptions* before setting up your system.

Normal Mode

Logging is started by:

- Putting the SBE 25 in quiescent (sleep) state (**QS**), waiting at least 3 seconds, and then putting the magnetic switch in the On position. Data is stored in memory after the last recorded data.

    OR

- Putting the magnetic switch in the On position when not in quiescent state, and then sending **GL** (start logging, overwriting any data in memory) or **RL** (resume logging, adding data to memory after the last recorded data).

Power is applied as follows:

- Temperature, conductivity, and pressure sensors, and sensors connected to the single-ended input connector (J4) and PAR connector (J6) - Power is applied when the switch is put in the On position.

- Pump - Power is applied *pump delay* seconds after the *minimum conductivity frequency* is reached (see *Pump Operation*). Both the pump delay and the minimum conductivity frequency are user-programmable with **CC**.

- Sensors connected to the differential input connector (J5) - Power is applied 5 seconds after power is applied to the pump, to reduce the surge current required from the batteries at pump turn-on.

As soon as logging is started, the first data point is stored in memory and the cast header date and time is written. Therefore, the memory will include *bad* data at the beginning of the cast, because:
- sensors depending on the pump (conductivity, optional dissolved oxygen, etc.) will not provide *good* data until the pump turns on, and
- sensors connected to the differential input connector will not provide *any* data until differential input power is applied.

When processing data after the cast, you can eliminate these initial scans in memory by setting up the post-processing software to *skip* the scans (see SBE Data Processing's manual / Help files).

Logging is stopped by:

- Putting the magnetic switch in the Off position - stops logging and puts SBE 25 into quiescent (sleep) state, removing power from all equipment.

    OR

- Clicking Stop on SEATERM's Toolbar or typing Ctrl Z - stops logging, removes power from the pump and the sensors connected to the differential input connector, but does not put remove power from the other sensors. Note that the SBE 25 automatically enters quiescent (sleep) state, removing power from the remaining sensors, after 2 minutes without receiving a command.

Standby Mode

Standby Mode is designed for work where there are repetitive, short casts. In Normal Mode, power to the sensors is turned off at the end of each cast. This may not be desired when casts are made in rapid succession, if your system includes sensors that require a long *warm up* before providing accurate data (for example, a Beckman- or YSI-type oxygen sensor, or a Sea Tech fluorometer). Standby Mode provides a way to leave power on to all the sensors and the pump when you stop logging.

Logging is started by:

- Sending **SB**, waiting at least 3 seconds, and then putting the magnetic switch in the On position.

Note:
The SBE 25 will not respond to any commands after receiving **SB**, which places it in Standby Mode. You must remove it from Standby Mode by typing Ctrl Z or clicking Stop on SEATERM's Toolbar before it will respond to commands.

Power is applied as follows:

- Temperature, conductivity, and pressure sensors, and sensors connected to the single-ended input connector (J4) and PAR connector (J6) - Power is applied when the switch is put in the On position.

- Pump - Power is applied *pump delay* seconds after the *minimum conductivity frequency* is reached (see *Pump Operation*). Both the pump delay and the minimum conductivity frequency are user-programmable with **CC**.

- Sensors connected to the differential input connector (J5) - Power is applied 5 seconds after power is applied to the pump, to reduce the surge current required from the batteries at pump turn-on.

After power is applied to the differential input connector, the first data point is stored in memory and the cast header date and time is written.

Logging is stopped by:

- Putting the magnetic switch in the Off position - stops logging, but does not remove power from any sensors or the pump.

  OR

- Clicking Stop on SEATERM's Toolbar or typing Ctrl Z - stops logging, removes power from the pump and the sensors connected to the differential input connector, but does not put remove power from the other sensors. **This also causes the SBE 25 to exit Standby Mode**.

To start logging again if the SBE 25 is still in Standby Mode, wait at least 3 seconds after you put the switch in the Off position, then put the magnetic switch in the On position.

Note that while in Standby Mode, the SBE 25 continues to draw power from the batteries. To exit Standby Mode, type Ctrl Z or click Stop on SEATERM's Toolbar; this removes power from the pump and the sensors connected to the differential input connector, but does not remove power from the other sensors. **Failure to exit Standby Mode will run down the main battery supply.** Once the SBE 25 is out of Standby Mode, it will automatically enter quiescent (sleep) state, removing power from the remaining sensors, after 2 minutes without receiving a command.

Pump Operation

After the conductivity cell enters the water, there is a user-programmable delay before pump turn-on so that all the air in the pump tubing can escape. If the pump motor turns on when there is air in the impeller housing, priming is uncertain and a proper flow rate cannot be ensured. When the SBE 25 is deployed in a vertical orientation, the tubing extending above the air-bleed hole will contain a small reserve of water. This maintains the pump prime (for up to 1 minute, depending on the length of tubing above the air-bleed), even if the SBE 25 is lifted up so that the cell inlet and pump outlet are **just below** the water surface. This allows beginning the actual profile very near the top of the water. **The cell inlet and pump outlet must not come above the water surface or the prime will be lost.**

Note:
The SBE 25 automatically enters quiescent state after 2 minutes without receiving a command.

- If prime is lost, put the magnetic switch in the Off position. Wait at least 3 seconds, then put the switch in the On position, submerge the SBE 25 completely, and wait for the pump delay time before beginning the profile.

Pump turn-on occurs when two user-programmable conditions have been met:

- **Raw conductivity frequency exceeds the minimum conductivity frequency** (**CC**)
  Set the minimum conductivity frequency for pump turn-on above the instrument's *zero conductivity raw frequency* (shown on the SBE 25 Configuration Sheet), to prevent the pump from turning on when the SBE 25 is in air.
  - ➤ For salt water and estuarine applications -
    typical value = *zero conductivity raw frequency* + 500 Hz
  - ➤ For fresh/nearly fresh water -
    typical value = *zero conductivity raw frequency* + 5 Hz

  If the minimum conductivity frequency is too close to the *zero conductivity raw frequency*, the pump may turn on when the SBE 25 is in air as result of small drifts in the electronics. Some experimentation may be required, and in some cases it may be necessary to rely only on the pump turn-on delay time to control the pump. If so, set a minimum conductivity frequency lower than the *zero conductivity raw frequency*.

- **Pump turn-on delay time has elapsed** (**CC**)
  Set the pump turn-on delay time to allow time for the Tygon tubing and pump to fill with water after the SBE 25 is submerged. Determine the turn-on delay by immersing the SBE 25 (switch off, not running) just below the air-bleed hole at the top of the Tygon tubing (vertical orientation) or just below the pump exhaust (horizontal orientation). Measure the time needed to completely fill the tubing (by watching for when air bubbles stop coming of the air bleed valve or pump exhaust); 30 seconds is typical. Set the delay to approximately 1.5 times longer. When actually using the SBE 25, be sure to *soak* the instrument just under the surface for at least the time required for pump turn-on

Real-Time Setup

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

Baud Rate and Cable Length

Without a Sea-Bird Deck Unit

When used without a Sea-Bird deck unit, the rate that real-time data can be transmitted from the SBE 25 is dependent on the rate that data is stored in memory and the serial data baud rate. The length of cable that the SBE 25 can drive is also dependent on the baud rate. The allowable combinations are:

Notes:
- Set the baud rate with **SRx**.
- Set the internal data storage rate and real-time output rate with **CC**.
- Real-time output in the table at right is based on the assumption that all voltages are enabled, requiring that 40 characters (38 characters plus carriage return and line feed) are transmitted for each scan (see *Data Format*). If you have not enabled all voltages, you may be able to provide real-time output at a faster rate. Calculate maximum real-time output rate (seconds) = (# of characters * 10 bits/character) / baud.

Maximum Cable Length (meters)	Baud Rate	Data Storage in Memory (scans/second)	Real-Time Output (scans/second)
1600	600	8, 4, 2, or 1	1
800	1200	8, 4, or 2	1 or 2
		1	1
200	4800	8	1, 2, 4, or 8
		4	1, 2, or 4
		2	1 or 2
		1	1
100	9600	8	1, 2, 4, or 8
		4	1, 2, or 4
		2	1 or 2
		1	1

With a Sea-Bird Deck Unit

Note:
If using the SBE 25 with more than 4 auxiliary voltage sensors, using the SBE 33 or SBE 36 Deck Unit, **and** appending NMEA and Surface PAR data: Set the SBE 25 to output real-time data at 4 scans/second or less (***Real time data output rate*** in **CC** command prompt). The Deck Unit cannot keep up with data if outputting at 8 scans/second.

Set the SBE 25's baud rate to 4800 if using the SBE 25 with either of the following real-time data acquisition systems:
- SBE 36 CTD Deck Unit and Power and Data Interface Module (PDIM)
- SBE 33 Carousel Deck Unit and SBE 32 Carousel Water Sampler **OR** SBE 33 Carousel Deck Unit and SBE 55 ECO Water Sampler

The data telemetry link can drive 10,000 meters of cable while accepting 4800 baud serial data. The relationship between real-time output and data storage in memory is as shown in the table above for the 4800 baud rate.

Real-Time Data Acquisition

Real-time data can be acquired in either of the following ways:
- With Seasave (**typical method**) – Data can be viewed in Seasave in tabular form or as plots, as raw data or as converted (engineering units) data. Data acquired with Seasave can be processed with SBE Data Processing. See Seasave's manual / Help files for setting up the program displays, baud rates, etc., and beginning data acquisition.
- With SEATERM – Click Capture on SEATERM's Toolbar. Begin logging. The hex data displayed in SEATERM will be saved to the designated file. Process the data as desired. Note that this file **cannot be processed by Seasave or SBE Data Processing, as it does not have the required headers and format for Sea-Bird's processing software**.

Timeout Description

The SBE 25 has a timeout algorithm. If the SBE 25 does not receive a command or sample data for 2 minutes, it powers down its main digital circuits. This places the SBE 25 in quiescent (sleep) state, drawing minimal current. **To re-establish control (wake up), click Connect on SEATERM's Toolbar or press the Enter key.** The system responds with the S> prompt.

Command Descriptions

This section describes commands and provides sample outputs.
See *Appendix III: Command Summary* for a summarized command list.

When entering commands:

- Input commands to the SBE 25 in upper or lower case letters and register commands by pressing the Enter key.
- The SBE 25 sends **#** if an invalid command is entered.
- If the system does not return an S> prompt after executing a command, press the Enter key to get the S> prompt.
- If a new command is not received within 2 minutes after the completion of a command, the SBE 25 returns to the quiescent (sleep) state and the display indicates *time out*.
- If in quiescent state, re-establish communications by clicking Connect on SEATERM's Toolbar or pressing the Enter key to get an S> prompt.
- Commands followed by * alter SBE 25 memory and prompt the user twice before executing (* is not part of the command). To execute the command, type *y* and press the Enter key in response to *message* **Y/N**. Then hold down the Ctrl key and type *y*, and press the Enter key in response to **are you sure ^Y/N**. Any other responses abort the command.
- The SBE 25 does not respond to any commands while logging.
- If the SBE 25 is uploading data and you want to stop it, press the Esc key or click Stop on SEATERM's Toolbar. Press the Enter key to get the S> prompt.

Entries made with the commands are permanently stored in the SBE 25 and remain in effect until you change them.

- The only exception occurs if the electronics are removed from the housing and disconnected from the battery Molex connector (see *Appendix II: Electronics Disassembly/Reassembly*), or the SBE 25's reset switch is used (see *Section 6: Troubleshooting*). Upon reassembly or resetting, initialize RAM (**IR**), reset the date and time (**ST**), and re-enter all setup parameters.

Status Command

<table>
<tr><td>

Note:
If the battery voltage is below the battery cut-off voltage, the following displays in response to **DS**:
WARNING: LOW BATTERY VOLTAGE!! Replace the batteries before continuing.

</td>
<td>**DS**</td>
<td>

Display operating status and setup parameters.

Equivalent to Status on Toolbar.

List below includes, where applicable, command used to modify parameter.

- firmware version, serial number, date and time [**ST**]
- pressure sensor range and temperature compensation value [**CC**]
- sampling crystal frequency, real-time clock frequency, main battery voltage, operating current (not including pump or differential A/D channels), and back-up lithium battery voltage
- number of casts and samples in memory, available sample space in memory, and wait interval after each line of data [**LWx**]
- stop logging on upcast when CTD ascents a percentage of full scale pressure sensor range [**CC**]? (line appears in status response only if set to *Yes*)
- number of scans averaged for each scan in memory and scan storage rate in memory [**CC**]
- real-time data transmission rate [**CC**]
- minimum conductivity frequency for pump turn-on [**CC**]
- pump turn-on delay [**CC**]
- battery type [**CC**]
- number of external voltages sampled and assignment of voltages to channels [**CC**]

</td></tr>
</table>

Example (user input in bold, command used to modify parameter in parentheses):

```
S>DS
SBE 25 CTD V 4.1b  SN 323    04/06/06  14:02:13                          [ST]
external pressure sensor, range = 5076 psia, tcval = -55                 [CC]
xtal=9437363  clk=32767.107  vmain=10.1  iop=175  vlith=5.6
ncasts=0  samples=0  free = 442800  lwait = 0 msec                       [LWx]
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            [CC]
real time data transmitted at 1 scans per second                         [CC]
minimum conductivity frequency for pump turn on = 2950                    [CC]
pump delay = 45 seconds                                                   [CC]

battery type = ALKALINE                                                   [CC]

7 external voltages sampled                                               [CC]
stored voltage #0 = external voltage 0                                    [CC]
stored voltage #1 = external voltage 1                                    [CC]
stored voltage #2 = external voltage 2                                    [CC]
stored voltage #3 = external voltage 3                                    [CC]
stored voltage #4 = external voltage 4                                    [CC]
stored voltage #5 = external voltage 5                                    [CC]
stored voltage #6 = external voltage 6                                    [CC]
```

Setup Commands

ST   Set real-time clock date and time.

> *Example* (user input in bold):
> Set date and time to 05 October 2002 12:00:00.
> ```
> S>ST
> date (MMDDYY)=100502
> time (HHMMSS)=120000
> ```

> **Note:**
> The SBE 25's baud rate (set with **SRx**) must be the same as SEATERM's baud rate (set in the Configure menu).

SRx   **x=** baud rate indicator for communication with SBE 25 (1=600, 2=1200, 3=9600, 4=4800). If you change SBE 25's baud rate, SEATERM stops communicating. Change SEATERM's baud rate to match (In Configure menu: select SBE 25, select new baud on COM Settings tab of Configuration Options dialog box, and click OK. Then click Connect on Toolbar to reconnect at new baud rate.)

Baud resets to 600 if power is removed from PCBs (by disassembly of electronics or using Reset button on battery bulkhead).

Baud set with **SRx** is used by data upload command **DDb,e**. Baud set with **SRx** does not affect baud rate controlled by data upload commands **DCx**, **DAx**, **DBx**, or **DEx**.

> *Example* (user input in bold): Set baud rate to 4800.
> ```
> S>SR4
> ```

CC   *   Configure a number of parameters. SBE 25 prompts you by displaying present value and asking for new value for each parameter. Type in desired value and press Enter key. To accept present value without change, press Enter key.
In order, SBE 25 prompts you as follows:

configure CTD Y/N?

                                                    Y to continue, or *N* to exit **CC** without making any changes.

Are you sure ^Y/N?

                                                    Program requests verification before continuing; ^ character indicates Ctrl key. Press Ctrl and *y*, and press Enter key to continue; press Ctrl and *n* and press Enter key to exit **CC** without making any changes.

30

Setup Commands (*continued*)

<table>
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Notes:
- In place of **Z**, each SBE 25 prompt shows the last programmed value for that parameter.
- If calculating elapsed time in Seasave (real-time data acquisition program), Seasave uses the real time data output rate in the SBE 25 configuration (.xmlcon or .con) file. The configuration file must match the selection in **CC** of real-time data output rate. View and edit the configuration file in Seasave or SBE Data Processing.
- If calculating elapsed time in SBE Data Processing (post-processing software), SBE Data Processing uses the information in the .hex file header to determine the sample rate:
  - ➢ File saved by Seasave during real-time data acquisition - SBE Data Processing uses the real time data output rate in the header to calculate elapsed time.
  - ➢ File uploaded from SBE 25 memory - SBE Data Processing uses the internal data storage rate in the header to calculate elapsed time.

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internal data storage rate (scans/sec) [1, 2, 4, or 8] = Z, new value =
SBE 25 can store data at full sampling rate (8 scans/sec), or can average data for storage. Number of scans averaged in memory = 8 / internal data storage rate.

real time data output rate (scans/sec) [1, 2, 4, or 8] = Z, new value =
SBE 25 can transmit real-time data at full sampling rate (8 scans/sec), or can average data for real-time transmission. Number of scans averaged and output real-time = 8 / real time data output rate. **Real-time data output rate cannot be faster than internal storage rate** (see previous prompt)**, and is also dependent on baud rate and cable length** (see *Real-Time Setup*).
Note: If using SBE 25 with more than 4 auxiliary voltage sensors, using SBE 33 or SBE 36 Deck Unit, **and** appending NMEA and Surface PAR data – Set to output real-time data at 4 scans/sec or less. Deck Unit cannot keep up with data if outputting at 8 scans/sec.

pressure sensor range (psia) = Z, new value =
Range of SBE 29 pressure sensor from Calibration Sheet. SBE 25 uses this to determine when to stop logging if you set *stop CTD on upcast* to *Yes* (see below for prompt in **CC**).

pressure temperature compensation value = Z, new value =
Temperature Compensation (TC) value from SBE 29 pressure sensor Calibration Sheet. SBE 25 uses this to correct pressure data; corrected pressure data is stored in memory and transmitted real-time.

</td></tr>
<tr><td valign="top">

Note:
See *Pump Operation.*

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minimum conductivity frequency for pump turn on=Z, new value=
Minimum conductivity frequency (Hz) to enable pump turn-on, to prevent pump from turning on before SBE 25 is in water. Pump will not turn on until *pump delay* seconds (see next prompt) *after* minimum conductivity frequency is reached, allowing time for Tygon tubing and pump to fill with water after SBE 25 is submerged. Pump stops when conductivity frequency drops below minimum conductivity frequency. SBE 25 Configuration Sheet lists uncorrected (raw) frequency output at 0 conductivity. Typical value (and factory-set default) for **salt water** and **estuarine** application is:
(0 conductivity frequency + 500 Hz).
Typical value for **fresh water** applications is: (0 conductivity frequency + 5 Hz).

pump delay = Z, new value =
Time to wait after minimum conductivity frequency is reached before turning pump on. Typical value 30-45 seconds.

</td></tr>
</table>

Setup Commands (*continued*)
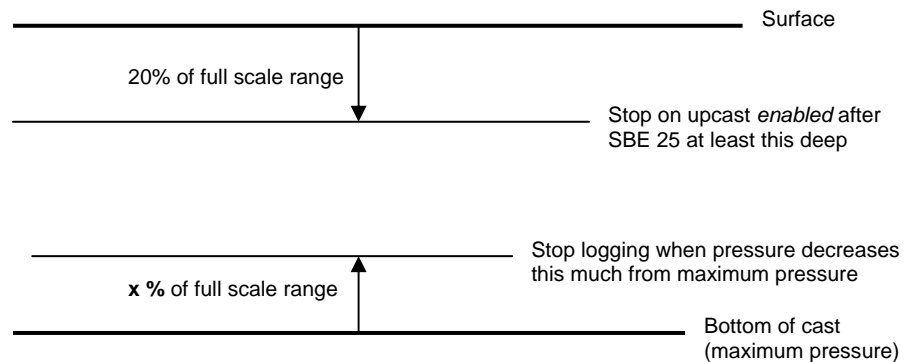
stop CTD on upcast (y/n)? = Z, new value =

If *N*, SBE 25 logs until stopped by putting magnetic switch in Off position, or by typing Ctrl Z or clicking Stop on SEATERM's Toolbar.

If *Y*, SBE 25 stops logging on upcast, turns off power to all sensors, and enters quiescent (sleep) state to maximize battery endurance and memory capacity.

If you enter *Y*, program prompts:

Stop upcast when CTD ascends x % of FSR, x=Z, new x =

Upcast is considered to have begun when pressure sensor reading is x% of full scale range (FSR) *less than* maximum value of pressure reached during downcast. Set this value greater than expected peak-to-peak ship heave to avoid stopping logging before upcast actually begins. Stopping on upcast is enabled only after cast has reached a pressure of at least 20% of FSR, to prevent SBE 25 from stopping while you are positioning it in water to begin cast.

Surface

20% of full scale range

Stop on upcast *enabled* after SBE 25 at least this deep

x % of full scale range

Stop logging when pressure decreases this much from maximum pressure

Bottom of cast (maximum pressure)

Notes:
- If the battery voltage is below the battery cut-off voltage, the following displays in response to **DS**: WARNING: LOW BATTERY VOLTAGE!! Replace the batteries before continuing.
- If using the SBE 25 with **Nickel Metal Hydride (NiMH)** batteries, set it up as though it is using NiCad batteries.

battery type, NICAD or ALKALINE (enter A or N) = Z, new value =

A for Alkaline, *N* for Ni-Cad (or NiMH).
- If Alkaline, logging halts when battery drops below 7.5 volts for five consecutive scans. This reduces battery load to quiescent current (150 microAmps).
- If Ni-Cad, logging halts when battery drops below 7.5 volts for five consecutive scans or when battery voltage is less than 10.2 volts and voltage drop is greater than 1 volt/minute as determined by two 30-second moving averages. This reduces battery load to quiescent current (150 microAmps) once first cell in battery pack is exhausted.

Setup Commands (*continued*)

number of external voltages to sample (0 - 7) = Z, new value =
Number of external voltages to sample. Factory configuration is in configuration section at beginning of manual. If number of external voltages is greater than 0, program prompts:
sample external volt # 0 (y/n) = Z, new value =
answer *Y* for voltages you wish to sample.

External voltage corresponds to wiring of sensor to an input channel on SBE 25's end cap. See *End Cap Connectors* in *Section 2: Description of SBE 25*. **Stored voltage** corresponds to voltage number specified in SBE 25 configuration (.xmlcon or .con) file.

Example (user input in bold):

You have connected sensors to two SBE 25 A/D channels - transmissometer connected to Voltage 4 on J5, and PAR connected to Voltage 6 on J6. In the .xmlcon or .con file (set up in the Configure Inputs menu in Seasave or Configure menu in SBE Data Processing), you set up voltage 0 for the transmissometer and voltage 1 for the PAR.
In SEATERM, send **CC**.

```
S>cc
.          (omitting details on all prompts except for external voltages)
.
number of external voltages to sample (0-7) = 0, new value = 2
Sample external volt #0 (y/n) = NO, new value = n
Sample external volt #1 (y/n) = NO, new value = n
Sample external volt #2 (y/n) = NO, new value = n
Sample external volt #3 (y/n) = NO, new value = n
Sample external volt #4 (y/n) = NO, new value = y    (transmissometer)
Sample external volt #5 (y/n) = NO, new value = n
Sample external volt #6 (y/n) = NO, new value = y    (PAR)
```

When finished, a summary of CTD configuration displays. For the example above:

```
.          (omitting details except for external voltages)
.
2 external voltages sampled
stored voltage #0 = external voltage 4
stored voltage #1 = external voltage 6
```

When finished entering all parameters in response to prompts for **CC**, a summary of CTD configuration displays, as shown below. This information is also included in response to **DS**.

Example: CTD configuration summary after data entered with **CC**

```
CTD configuration:
number of scans averaged=1, data stored at 8 scans per second
real time data transmitted at 1 scans per second
minimum conductivity frequency for pump turn on = 3450

battery type = ALKALINE

2 external voltages sampled
stored voltage #0 = external voltage 4
stored voltage #1 = external voltage 6
```

Setup Commands (*continued*)

LWx	**x**= wait interval (milliseconds) after each line of data. Normally set to 0; increase for very old (slow) computers. Range 0 - 65535.
IR *	Initialize memory, **which destroys all logged data in SBE 25's memory**. SBE 25 requires you to enter **IR** twice, to provide verification before it proceeds. All data bits are set to 0. Sample number, header number, and data pointers are set to 0. Send **IR** after uploading all data. Use of **IR** is optional, as SBE 25 writes over previously recorded information when **IL** is used before beginning logging. However, knowledge of initial memory contents (i.e., all zeros) can be a useful cross-check when data is retrieved.

Example (user input in bold): Initialize RAM memory.
```
S>IR
Initialize ram Y/N ? y
Are you sure ^Y/N ? ^y  (^ symbol indicates Ctrl key. Hold down Ctrl key while typing y or n.)
writing ram 0
. .
writing ram 31
```

QS	Quit session and place SBE 25 in quiescent (sleep) state (150 microAmps). Main power is turned off. Memory retention is not affected.

Put SBE 25 in quiescent state for at least 3 seconds *before* putting magnetic switch in On position to start logging. If not in quiescent state, SBE 25 will not respond to movement of magnetic switch and will not begin logging. |

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Logging Commands

Logging commands direct the SBE 25 to sample data. When commanded to start logging, the SBE 25 takes samples, stores the data in its memory, and transmits real-time data. Operation is dependent on the mode and setup. See the detailed mode descriptions in *Normal Mode* and *Standby Mode*.

Normal Mode and using the magnetic switch to start and stop logging:
The SBE 25 must be in quiescent (sleep) state before putting the magnetic switch in the On position. The first time logging is started after logging was initialized (**IL**), data recording starts at the beginning of memory and any previously recorded data is written over. When the switch is put in the Off position, recording stops. Each time the switch is put in the On position again, recording continues, with new data stored after the previously recorded data and a new header written to indicate the incremented cast number, date, time, and sample numbers contained in the cast.

Example (user input in bold)*:*

```
S>QS
S>time out    (SBE 25 automatically times out if 2 minutes elapse without a command, even if you do not send QS)
```

(wait at least 3 seconds after time out appears, then put switch in On position)
(hex data displays on SEATERM screen after a few seconds)

Normal Mode and using commands to start logging:
See **GL** and **RL** below.

IL   *   Initialize logging - after all previous data has been uploaded from SBE 25, initialize logging before starting to log again to make entire memory available for recording. **IL** sets sample number and header and cast number to 0 internally. If these are not set to 0, data will be stored after last recorded sample if you use magnetic switch to start logging. **Do not send IL until all existing data has been uploaded.** SBE 25 requires verification before it proceeds.

Example (user input in bold)*:*

```
S>IL
Initialize logging Y/N ?  y
Are you sure ^Y/N ?  ^y    (^ symbol indicates Ctrl key. Hold down Ctrl key while typing y or n.)
```

Logging Commands (*continued*)

GL   *

Start logging now, **overwriting all logged data in SBE 25 memory**. Magnetic switch must be On when sending **GL**. First sample number and header number is set to 0, so any previously recorded data is written over, regardless of whether memory has been initialized (**IL**). SBE 25 requires verification before it proceeds.

Example (user input in bold)*:*

```
S>          (while communicating with SBE 25, put switch in On position)
S>GL
Start logging Y/N ?  y
Are you sure ^Y/N ?   ^y   (^ symbol indicates Ctrl key. Hold down Ctrl key while typing y or n.)
(hex data displays on SEATERM screen after a few seconds)
```

RL   *

Resume logging, writing data to memory without resetting sample or header number (do not overwrite previously recorded data). Magnetic switch must be On when sending **RL**. SBE 25 requires verification before it proceeds.

Example (user input in bold)*:*

```
S>          (while communicating with SBE 25, put switch in On position)
S>RL
Start logging Y/N ?  y
Are you sure ^Y/N ?   ^y   (^ symbol indicates Ctrl key. Hold down Ctrl key while typing y or n.)
(hex data displays on SEATERM screen after a few seconds)
```

SB   *

Put SBE 25 in Standby Mode. SBE 25 requires verification before it proceeds. After **SB** is verified, wait at least 3 seconds and then put magnetic switch in On position to start logging. Put magnetic switch in Off position to stop logging; **logging stops but power is not removed from sensors or pump**. Send Ctrl Z or click Stop on SEATERM's Toolbar to take SBE 25 out of Standby Mode. **Failure to exit Standby mode results in exhaustion of main battery supply.**

Example (user input in bold):

```
S>SB
Start standby mode Y/N ?  y
Are you sure ^Y/N ?   ^y   (^ symbol indicates Ctrl key. Hold down Ctrl key while typing y or n.)
S>          (wait 3 seconds, then put switch in On position to start logging)
(hex data displays on SEATERM screen after a few seconds)
```

Data Upload Commands

Stop logging before uploading data.

DCx Upload data from cast **x** at 600 baud. If **x** is omitted, data from cast 0 is uploaded.

> *Example* (user input in bold): Upload all data in second cast (cast 1):
> (Click Capture on Toolbar and enter desired filename in dialog box.)
> S>**DC1**

DAx Same as **DCx**, but baud rate is 38400.

DBx Same as **DCx**, but baud rate is 9600.

DEx Same as **DCx**, but baud rate is 19200.

DDb,e Upload data from scan **b** to scan **e**. If **b** and **e** are omitted, all data is uploaded. First sample is 0. SBE 25 uploads data using baud rate for general communication (which was set with **SRx**).

> *Example* (user input in bold): Upload samples 0 through 199:
> (Click Capture on Toolbar and enter desired filename in dialog box.)
> S>**DD0,199**

DHb,e Upload headers from header **b** to header **e**. If **b** and **e** are omitted, all headers are uploaded. If only **b** is entered, header **b** is uploaded. First header is 0. A new header is written each time logging is started or resumed. Header includes:
- cast number
- month, day, hour, minute, and second when cast was started
- first and last sample in cast
- number of external voltages sampled
- number of scans averaged
- reason logging was halted (batfail = battery voltage too low; switch off = switch turned off; recv cmd = received null or Ctrl Z character; timeout = error condition; unknown = error condition; ?????? = error condition)

> *Example* (user input in bold)
> Upload header for cast 0 to a file:
> (Click Capture on Toolbar and enter desired filename in dialog box.)
> S>**DH0**
> cast 0 11/05 12:30:33 samples 0 to 87 nv=3 avg = 4, stop = switch off

Diagnostic Commands

TM	*	Perform memory test, **which destroys all logged data in SBE 25 memory**. SBE 25 requires verification before proceeding. A pattern is written into all locations of each RAM. Data in RAM is then compared to pattern.
TE	*	Perform extended memory test, **which destroys all logged data in SBE 25 memory**. SBE 25 requires verification before proceeding. Same as **TM** test, but 10 passes are performed, with pattern incremented by 1 for each pass.

```
Example (user input in bold):
S>te
Extended memory test Y/N ? y
Are you sure ^Y/N ? ^y   (^ symbol indicates Ctrl key. Hold down Ctrl key while typing y or n.)
Pass 1
Ram 0, OK
. .
Ram 31, OK

(repeats entire sequence for passes 2 through 10)

At conclusion of test or when Esc is received, SBE 25 displays:
Ram test passed with no errors
```

FR	Measure and display temperature (t) and conductivity (c) frequencies (Hz). **SBE 25 runs continuously during test, drawing current.** Press Esc key or click Stop on SEATERM's Toolbar to stop test.

```
Example (user input in bold):
S>fr
t = 4719.009    c = 2752.085
t = 4719.776    c = 2752.093
```

VR	Measure and display voltages read by A/D converter.

Column	Output
1	Main battery voltage / 5.0161
2	Back-up lithium battery voltage / 3.873
3	Pressure voltage
4	Pressure temperature voltage
5 and up	External voltages (if enabled)

SBE 25 runs continuously during test, drawing current. Press Esc key or click Stop on SEATERM's Toolbar to stop test.

Data Format

The SBE 25 outputs data in raw, hexadecimal form as described below. Eight to nineteen bytes are stored per CTD scan, depending on the number of external voltages (for auxiliary sensors) enabled. If the specified voltage is not enabled (see *Command Descriptions*), the corresponding data is not included in the output data stream, shortening the data string. The format is:

External Voltages Enabled	Data Format
0	ttttttccccccsppp
1	ttttttccccccsppp0uuu
2	ttttttccccccspppuuuvvv
3	ttttttccccccspppuuuvvv0www
4	ttttttccccccspppuuuvvvwwwxxx
5	ttttttccccccspppuuuvvvwwwxxx0yyy
6	ttttttccccccspppuuuvvvwwwxxxyyyzzz
7	ttttttccccccspppuuuvvvwwwxxxyyyzzz0aaa

where
    tttttt = temperature frequency, 3 bytes
    cccccc = conductivity frequency, 3 bytes
    s = sign character for pressure (sign character 0 = +; sign character 4 = -)
    ppp = pressure, 12 bits
    uuu = stored voltage output 0, 12 bits
    vvv = stored voltage output 1, 12 bits
    www = stored voltage output 2, 12 bits
    xxx = stored voltage output 3, 12 bits
    yyy = stored voltage output 4, 12 bits
    zzz = stored voltage output 5, 12 bits
    aaa = stored voltage output 6, 12 bits
    0 = zero, used to provide an even number of characters, 4 bits

Calculation of each parameter from the data is described below (use the decimal equivalent of the hex data in the equations).

- Frequency (temperature or conductivity)
  = (byte0 * 256) + byte1 + (byte2 / 256)
- pressure (corrected A/D counts) = ppp
- voltage = uuu / 819 (similar form for all voltage auxiliary sensors)

> **Note:**
> Sea-Bird's data processing software uses the equations shown, as well as the equations on the sensor calibration sheets, to convert raw data to engineering units. Alternatively, you can use the equations to develop your own processing software.

Example: SBE 25 with 2 external voltages sampled,
example scan = ttttttccccccspppuuuvvv
          = 1FE780281D1904293F2D1E

- Temperature = tttttt = 1FE780
  (1F = 31 decimal, E7 = 231 decimal, 80 = 128 decimal);
  temperature frequency = (31 * 256) + 231 + (128 / 256) = 8167.500 Hz
- Conductivity = cccccc = 281D19
  (28 = 40 decimal, 1D = 29 decimal, 19 = 25 decimal);
  conductivity frequency = (40 *256) + 29 + (25 / 256) = 10269.098 Hz
- Strain-gauge pressure= sppp = 0429
  Pressure sign character s= 0 (+)
  corrected A/D counts ppp = 429 (1065 decimal);
  corrected pressure A/D counts = + 1065
- First external voltage = uuu = 3F2 (1010 decimal);
  voltage = 1010 / 819 = 1.233 volts
- Second external voltage = vvv = D1E (3358 decimal);
  voltage = 3358 / 819 = 4.100 volts

After these equations are applied to the raw data, apply the calibration coefficients (see the calibration sheet for each sensor), resulting in converted data in engineering units.

Optimizing Data Quality

Our deployment recommendations are only general guidelines, and are focused primarily on maximizing data quality. Actual sea state conditions, and winch and deck gear configurations, may require some adaptation in order to achieve best data quality and avoid mechanical problems.

The SBE 25 is optimized for profiling rates of 0.5 to 2 meters/second, with 1 meter/second generally providing the best compromise between data quality and profile resolution. The SBE 25 pump maintains a constant and optimum flow rate, which ensures that the sensor response times are not dependent on the descent rate. Adjust the descent rate of the SBE 25 based on the amount of ship motion (i.e., sea state) imparted to the cable, and the size, weight, and drag of the underwater package at the end of the cable. Generally, use a faster lowering rate in rougher seas, allowing the SBE 25 to stay clear of turbulent wakes that are shed downward when the ship heaves up; *shed wakes* are an error source from which all CTDs suffer. When the sea is very calm, the SBE 25 can be lowered more slowly (for example, 10 to 20 cm/second) to give greater vertical resolution.

Like for other CTDs, the common configurations of the SBE 25 are intended for obtaining downcast data, because the sensors are oriented so that the T-C Duct inlet passes through relatively undisturbed water as the CTD is lowered. As the CTD is raised (upcast), the sensors sample the turbulent wake of the package, resulting in lower quality data. If planning to sample on the upcast, consider the following:

- Vertical orientation - In the typical, sensors-down configuration, the sensors are in the wake of the housing on the upcast, providing poor data quality. If you must have good quality upcast data, invert the SBE 25 so that the T-C Duct is at the top (ignore the downcast data for this configuration).
- Horizontal orientation (for example, under SBE 32 Carousel Water Sampler) - Upcast data is improved somewhat because the sensors are mounted as close as possible to the outside edge of the package. Position other instruments, sample bottles, etc. so that they are not directly above the T & C sensors and do not thermally contaminate the water that flows to the sensors at the T-C Duct inlet.

When an SBE 25 is installed on a water sampler, good conductivity and optional dissolved oxygen data can be collected, even when stopped to collect a water sample, because water continues to flow through the sensors at a fixed and optimal rate.

Whether sampling on the upcast and/or downcast, position the T-C Duct inlet so that other instruments, sample bottles, etc. do not thermally contaminate the water that flows past the sensors.

Where the water temperature is very different from the temperature at which the SBE 25 has been stored, better results are obtained if the SBE 25 is allowed to equilibrate to the water temperature at the surface (soak) for several (3 -5) minutes before beginning the profile. The reason is not that the electronics are temperature sensitive - they are not - but that the thermal influence of the instrument housing on the water entering the cell will be reduced. If the difference between water and storage temperature is extreme, allow more *soak time*.

When very heavy seas cause severe ship motion, the SBE 25 descent can actually stop or reverse direction if the ship heaves upward faster than the package can descend. These occurrences can often be seen as loops in the real-time temperature trace. If the winch payout rate is too high, a loop of wire can form under water when the package descent is slowed or reversed by ship heave and the winch is still paying out wire. Inevitably, the loop formation gets out of phase with the heave and the loop closes on itself when the ship heaves, causing a kink. If the package includes a Carousel Water Sampler as well as the CTD, the package creates much more drag than with only the CTD, further increasing the possibility that a loop will form in the cable. After 1000 to 2000 meters of cable are paid out, it can be difficult or impossible to detect a loop in the cable. Adding 100 to 200 kg (maybe more by experimentation) of lead weights to the Carousel frame will help overcome the effect of drag, and allow the package to descend faster and stay more in line directly below the overboarding sheave.

Spiking is sometimes seen in the derived values for salinity, density, or sound velocity. Spiking results largely from a response time mismatch of the conductivity and temperature sensors, especially when the profiling descent rate is non-uniform. Much of the spiking can be removed from the data set by aligning the data in time. This alignment can be performed when post-processing the data in SBE Data Processing.

> **Note:**
> See SBE Data Processing's Help files for information on data processing modules that can correct data for the influences of ship motion and minimize salinity spiking.

The amount of spiking depends on the temperature gradient, and is much worse when coupled surface motion causes the instrument to stop - or even reverse - its descent. In the event of heavy ship motion, it may be worth letting the instrument *free-fall*. When very heavy seas cause severe ship motion and result in periodic reversals of the instrument descent, the data set can be greatly improved by removing scans taken when the pressure is not increasing, using SBE Data Processing.

Setup for Deployment

1. Install new batteries (see *Section 5: Routine Maintenance and Calibration*) or ensure the existing batteries have enough capacity to cover the intended deployment.

2. Program the SBE 25 for the intended deployment using SEATERM (see *Section 3: Power and Communications Test* for connection information; see information in this section on commands and logging modes):

   A. Set the date and time (**ST**).

   B. Ensure all data has been uploaded, and then send **IL** to make the entire memory available for recording. If **IL** is not sent, data will be stored after the last recorded sample if logging is started with the magnetic switch.

   C. Establish the setup and logging parameters.

   D. Send **DS** to verify the setup.

3. If you will be using Seasave to acquire and view real-time data, verify that the configuration (.xmlcon or .con) file matches the instrument configuration. Sea-Bird supplies a configuration file to match the factory configuration and calibrations. If the instrument is recalibrated or the configuration is changed (such as by adding external sensors), the configuration file must be updated to reflect the current condition. See *Verifying Contents of Configuration (.xmlcon or .con) File*.

4. If you will be using SEATERM to view real-time data, click Capture on SEATERM's Toolbar to save the data to a file.

Deployment

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

1. Install a cable or dummy plug for each connector on the Main Housing end cap:
    A. Lightly lubricate the inside of the dummy plug/cable connector with silicone grease (DC-4 or equivalent).
    B. **Standard Connector** - Install the plug/cable connector, aligning the raised bump on the side of the plug/cable connector with the large pin (pin 1 - ground) on the SBE 25. Remove any trapped air by *burping* or gently squeezing the plug/connector near the top and moving your fingers toward the end cap.   **OR**
        MCBH Connector – Install the plug/cable connector, aligning the pins.
    C. Place the locking sleeve over the plug/cable connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**
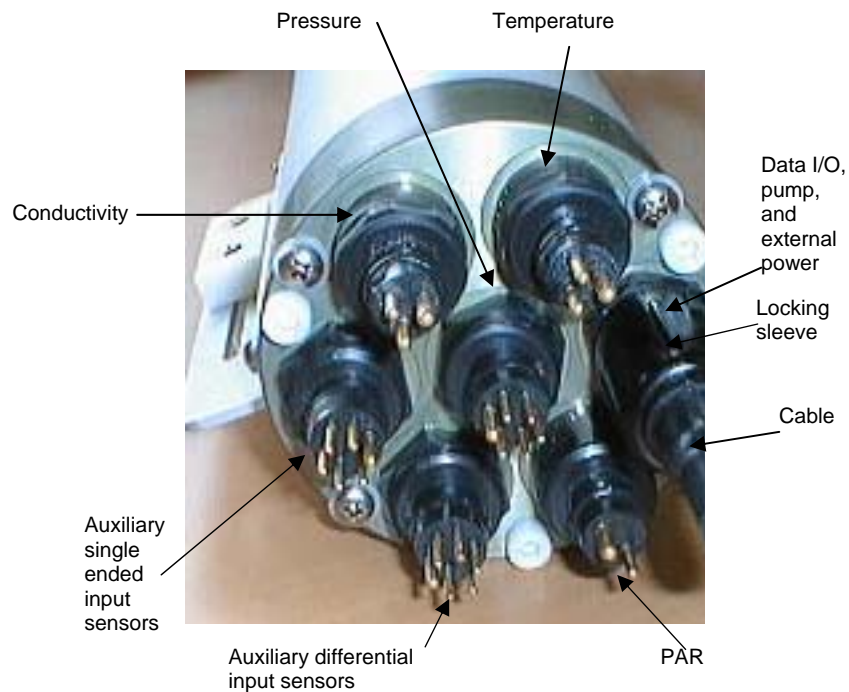
2. Connect the other end of the cables installed in Step 1 to the appropriate sensors.

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

4. If applicable, remove the Tygon tubing that was looped end-to-end around the conductivity cell for storage. Reconnect the system plumbing (see *Plumbing* in *Section 2: Description of SBE 25*).

5. Immediately prior to deployment:
    Normal Mode –
    *   With the SBE 25 in quiescent state for at least 3 seconds, put the magnetic switch in the On position, **or**
    *   With the SBE 25 awake, put the magnetic switch in the On position and then send **GL** or **RL**.
    Standby Mode -
    *   With the SBE 25 awake, send **SB**. Wait at least 3 seconds, and then put the magnetic switch in the On position.

The SBE 25 is ready to go into the water.

Acquiring Real-Time Data with Seasave

Notes:

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

- A new or recalibrated CTD ships with a configuration file that reflects the current configuration *as we know it*. The file is named with the instrument serial number, followed by a .con extension. For example, for a CTD with serial number 2375, Sea-Bird names the file *2375.con*. You may rename the file (but not the extension) if desired; this will not affect the results.

- In the SBE 25 setup command (**CC**), external voltage numbers 0 – 6 correspond to wiring of sensors to a voltage channel on the end cap (see *Main Housing End Cap Connectors* in *Section 2: Description of SBE 25*). However, in the .xmlcon or .con file, voltage 0 is the first external voltage in the data stream, voltage 1 is the second, etc.

Verifying Contents of Configuration (.xmlcon or .con) File

Seasave, our real-time data acquisition and display program, requires a configuration file, which defines the CTD – integrated auxiliary sensors, and channels, serial numbers, and calibration dates and coefficients for all sensors (conductivity, temperature, and pressure as well as auxiliary sensors). Seasave (as well as our data processing software) uses the information in the configuration file to interpret and process the raw data. **If the configuration file does not match the actual instrument configuration, the software will not be able to interpret and process the data correctly.**

1. Double click on Seasave.exe.

2. Click Configure Inputs. On the Instrument Configuration tab, click *Open*. In the dialog box, select the .xmlcon or .con file and click Open.

3. The configuration information appears on the Instrument Configuration tab. Verify that the sensors match those on your SBE 25, and that auxiliary sensors are assigned to the correct channels. Click Modify to bring up a dialog box (shown below) to change the configuration and/or to view / modify calibration coefficients.

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

1, 2, 4, or 8 scans/second. Used to calculate elapsed time, if you select time as an output parameter. Must agree with SBE 25 setup (**CC**); see reply from **DS**.

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

- **NMEA** - Select if NMEA navigation device used, **and** select whether NMEA device is connected directly to Deck Unit **or** to computer. You can also append NMEA depth data (3 bytes) and NMEA time data (4 bytes) after Lat/Lon data. 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.
  Notes:
  1. NMEA time can only be appended if NMEA device connected to computer.
  2. NMEA depth can only be appended if NMEA device connected to computer *or* if using SBE 25 with PN 90488 or 90545 Interface Box.
- **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.

Select to have Seasave append 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 .xmlcon or .con file for this CTD.
Open to select different .xmlcon or .con file.
Save or **Save As** to save current .xmlcon or .con file settings.

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. A dialog box with a list of sensors appears. Select sensors after number of voltage channels have been specified above.

Configuration for the SBE 25 Sealogge	
Configuration file opened: None	
External voltage channels	2
Firmware version	Version >= 2.0
Real time data output rate	1 scan/sec

☑ NMEA position data added　　☐ NMEA depth data added
◉ NMEA device connected to deck unit　　☐ NMEA time added
○ NMEA device connected to PC

☑ Surface PAR voltage added　　☐ Scan time added

Channel	Sensor
1. Frequency	Temperature
2. Frequency	Conductivity
3. Pressure voltage	Pressure, Strain Gauge
4. A/D voltage 0	Oxygen, SBE 43
5. A/D voltage 1	Fluorometer, Chelsea Aq
6. SPAR voltage	Unavailable
7. SPAR voltage	SPAR/Surface Irradiance

New　Open...　Save　Save As.　Select...　Modify...

Report...　Help...　Exit　Cancel

4. Click *Save* or *Save As* to save any changes to the .xmlcon or .con file. Click Exit when done reviewing / modifying the configuration.

Acquiring Real-Time Data

Instructions below are for an SBE 25 with a conventional single-core armored cable, used without a Sea-Bird Deck Unit. **If using the SBE 25 with the SBE 33 or 36 Deck Unit or the SEACAT/SEALOGGER RS-232 and Navigation Interface Box, see the Deck Unit or Interface Box manual.**

1. Wiring - Terminate the single-core armored cable with an RMG-4FS connector (for SBE 25 with standard connectors) or MCIL-4FS (for SBE 25 with optional wet-pluggable connectors). Wire the cable armor to pin 1 (large pin for SBE 25 with standard connectors) and the inner conductor to pin 3 (opposite large pin) on the SBE 25's data I/O-power connector (4-pin leg on Y-cable connected to J1). On deck, wire:

Slip-ring lead	25-pin serial port	9-pin serial port
from armor	Pin 7	Pin 5
from inner conductor	Pin 3	Pin 2

Note:
The baud rate between the SBE 25 and computer (defined in Configure Inputs, on the Serial Ports tab) must match the baud rate set in the SBE 25 with **SRx**.

2. Double click on **Seasave.exe**.

3. Perform any desired setup in the Configure Inputs, Configure Outputs, and Display menus..

4. In the Real-Time Data menu, select *Start*. The dialog box looks like this:

Data Archiving Options:
- **Begin archiving data immediately** to store raw (frequencies, A/D counts, and/or voltages) real-time data as soon as Start button is clicked and communication is established.
- **Begin archiving data when 'Start Archiving' command is sent** to control when data begins to be written to file. This allows you to eliminate scans associated with deploying CTD from ship deck and soaking instrument near surface (alternatively, remove these scans later in SBE Data Processing). If you make this selection, when you click Start button and communication is established, a dialog box with Start Archiving button appears. Click this button when ready to begin saving scans to file, or select Start Archiving in Real-Time Data menu.
- **Do not archive data for this cast** to not save data to a file. Real-time data will still appear in displays.

Configuration Options: Currently selected instrument configuration (.xmlcon or .con) file is shown, containing information on number and type of sensors interfacing with SBE 25, calibration coefficients, and inclusion of NMEA and/or Surface PAR data with output from CTD. To modify input configuration (.xmlcon or .con file, serial ports, water sampler, TCP/IP ports, and/or miscellaneous), click Configure Inputs. To modify outputs (serial data output, serial ports, shared file output, mark variables, TCP/IP output, TCP/IP ports, SBE 14 remote display, PC alarms, header form, and/or diagnostics), click Configure Outputs.

- **Timeout in seconds at startup**: Time allowed before first data scan is received from SBE 25. Seasave will *time out* and stop attempting to acquire data if data is not received from SBE 25 within this time period.
- **Timeout in seconds between scans**: Maximum **gap** allowed between scans after first data scan is received from SBE 25. Seasave will *time out* and stop attempting to acquire data if data is not received from SBE 25 within this time period (for example, if a shark bites cable and interrupts data acquisition, Seasave stops attempting to acquire data after this gap).

Click **Select Output Data File Name**. Save Archived Data As dialog box appears; browse to desired file location, enter desired file name, and click Save.

Note:
To prevent problems in the use of the COM port, click Disconnect on the Toolbar in SEATERM, and close SEATERM before starting real-time acquisition in Seasave.

5. In the Start Real-Time Data Acquisition dialog box, click *Start*.
    A. If you selected *Begin archiving data immediately* or *Begin archiving data when 'Start Archiving' command is sent* above, and selected *Prompt for Header Information* in the Header Form setup (Configure Outputs), the Header Information dialog box appears. Fill in the desired header and click OK.
    B. If you selected *NMEA position data added* in the .xmlcon or .con file, Seasave initializes NMEA communications.
    C. If you selected *Check Scan Length* in the Options menu, Seasave checks the .xmlcon or .con file to verify that the scan length defined by the configuration file matches the SBE 25 (i.e., number of sensors and inclusion of NMEA is as defined in the file). If a *Scan length error* appears, verify that:
        • You are using the correct .xmlcon or .con configuration file.
        • The configuration file has been updated as necessary if you added or deleted sensors, added or deleted NMEA or Surface PAR, etc.
    D. Seasave sends a message: *Please turn on the SBE 25 using the magnetic switch*. If you have already started logging data, ignore the message; otherwise, slide the switch to the On position. Seasave *times out* if data is not received within *Timeout in seconds at startup*.
    E. Real-time data then starts appearing in the screen displays.

6. To stop real-time data acquisition: In the Real-Time Data menu, select *Stop*.

7. Stop logging: Put the SBE 25 switch in the Off position.

Multiple Deployments

If there is enough memory available, it is not necessary to upload data before beginning subsequent casts. Proceed as follows:

• Normal Mode –
  Recover the CTD and slide the magnetic switch to the Off position. **Wait at least 3 seconds,** and then slide the magnetic switch to the On position. The SBE 25 will record new data in memory after the last recorded data. **Or**
  Recover the CTD and send a Ctrl Z or click Stop on SEATERM's Toolbar (leave the magnetic switch in the On position). When ready to redeploy, send **RL**. The SBE 25 will record new data in memory after the last recorded data.

• Standby Mode –
  Recover the CTD and slide the magnetic switch to the Off position. **Wait at least 3 seconds**, and then slide the magnetic switch to the On position. The SBE 25 will record new data in memory after the last recorded data.

Recovery

Physical Handling

<table>
<tr><td>

WARNING!
If the SBE 25 stops working while underwater, is unresponsive to commands, or shows other signs of flooding or damage, carefully secure it away from people until you have determined that abnormal internal pressure does not exist or has been relieved. Pressure housings may flood under pressure due to dirty or damaged o-rings, or other failed seals. When a sealed pressure housing floods at great depths and is subsequently raised to the surface, water may be trapped at the pressure at which it entered the housing, presenting a danger if the housing is opened before relieving the internal pressure. Instances of such flooding are rare. However, a housing that floods at 5000 meters depth holds an internal pressure of more than 7000 psia, and has the potential to eject the end cap with lethal force. A housing that floods at 50 meters holds an internal pressure of more then 85 psia; this force could still cause injury.
If you suspect the SBE 25 is flooded, point it in a safe direction away from people. Remove the 2 screws connecting the on/off bracket to the housing (leave in place the screws connecting the bracket to the end cap), and then loosen the 4 screws attaching the connector end cap to the housing about ½ turn. If there is internal pressure, the end cap will *follow* the screws out, and the screws will not become easier to turn. In this event, loosen 1 bulkhead connector very slowly, at least 1 turn. This opens an o-ring seal under the connector. Look for signs of internal pressure (hissing or water leak). If internal pressure is detected, let it bleed off slowly past the connector o-ring. Then, you can safely remove the end cap.

</td></tr>
</table>

1. Rinse the conductivity cell with fresh water. (See *Section 5: Routine Maintenance and Calibration* for cell cleaning and storage.)

2. If the batteries are exhausted, new batteries must be installed before the data can be extracted. Stored data will not be lost as a result of exhaustion or removal of batteries. (See *Section 5: Routine Maintenance and Calibration* for replacement of batteries.)

3. If immediate redeployment is not required, it is best to leave the SBE 25 with batteries in place and in a quiescent state (**QS**). Because the quiescent current required is only 150 microAmps, the batteries can be left in place without significant loss of capacity. If the SBE 25 is to be stored for long periods, **replace alkaline batteries yearly to prevent battery leakage** (which could damage the SBE 25).
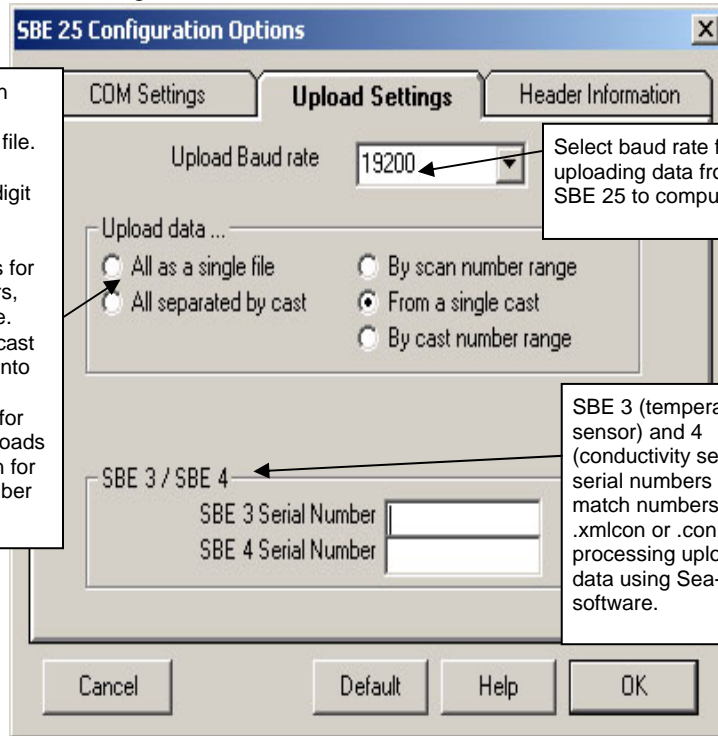
Uploading Data

1. Double click on SeaTerm.exe. The display shows the main screen.

2. In the Configure menu, select *SBE 25*. Click on the Upload Settings tab. The dialog box looks like this:

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

Select baud rate for uploading data from SBE 25 to computer.

SBE 3 (temperature sensor) and 4 (conductivity sensor) serial numbers must match numbers in CTD .xmlcon or .con file for processing uploaded data using Sea-Bird software.

Make the selection for Upload Settings.

Note:
Set up **Upload Settings**, **Header Information**, and/or **Header Form** (Steps 2 through 4):
- The first time you upload data, and
- If you want to change upload or header parameters.

3. Click on the Header Information tab. The dialog box looks like this:

Defines header information included with uploaded data:
- Prompt for header information – Each time data is uploaded, user is prompted to fill out user-defined header form.
- Include default header form in upload file – User-defined default header form included in upload file. User is not prompted to add any information when data is uploaded.
- Don't include default header form in upload file – User input header information not included in upload file.
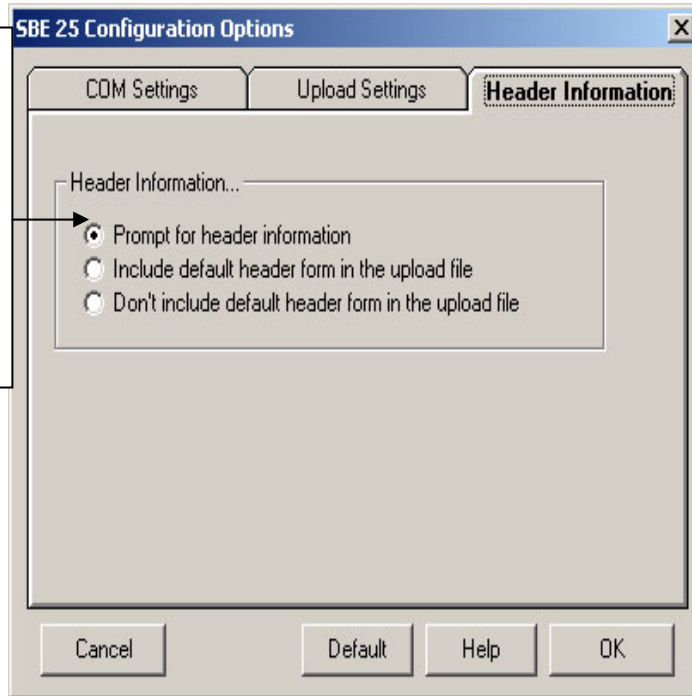
Note:
When you click OK, SEATERM saves the Configuration Options settings to the SeaTerm.ini file in your Windows directory. SeaTerm.ini contains the last saved settings for **each** instrument. When you open SEATERM and select the desired instrument (SBE 19, 25, etc.) in the Configure menu, the Configuration Options dialog box shows the last saved settings for that instrument.

Select the desired header information option. Click OK to save all the settings in the Configuration Options dialog box.

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

The entries are free form, 0 to 12 lines long. This dialog box establishes:

- header prompts that appear for the user to fill in when uploading data, if *Prompt for header information* was selected in the Configuration Options dialog box (Step 3)
- user-input header included with the uploaded data, if *Include default header form in upload file* was selected in the Configuration Options dialog box (Step 3)

Enter the desired header/header prompts. Click OK.

5. Click Connect on the Toolbar to begin communications with the SBE 25. The display looks like this:

```
SBE 25 SEALOGGER CTD power on

S>
```

This shows that correct communications between the computer and the SBE 25 has been established.
If the system does not respond as shown above:

- Click Connect again.
- Check cabling between the computer and the SBE 25.
- Verify the correct instrument was selected and the COM settings were entered correctly in the Configure menu.

6. Command the SBE 25 to stop data logging by:

- Moving the magnetic switch to the Off position, **or**
- Typing Ctrl Z or clicking Stop on the Toolbar.

7. Display SBE 25 status information by clicking Status on the Toolbar. The display looks like this:

```
SBE 25 CTD V 4.1b  SN 323     04/06/06  15:02:13
external pressure sensor, range = 5076 psia, tcval = -55
xtal=9437363  clk=32767.107  vmain=10.1  iop=175  vlith=5.6
ncasts=1  samples=100000  free = 342800  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
minimum conductivity frequency for pump turn on = 2950
pump delay = 45 seconds

battery type = ALKALINE

7 external voltages sampled
stored voltage #0 = external voltage 0
stored voltage #1 = external voltage 1
stored voltage #2 = external voltage 2
stored voltage #3 = external voltage 3
stored voltage #4 = external voltage 4
stored voltage #5 = external voltage 5
stored voltage #6 = external voltage 6
```

8. Click Upload on the Toolbar to upload stored data in a form that Sea-Bird's data processing software can use. SEATERM responds as follows before uploading the data:

   A. SEATERM sends the status (**DS**) command, displays the response, and writes the command and response to the upload file. This command provides information regarding the number of samples in memory, setup parameters, etc.

   B. SEATERM sends the header (**DH**) command, displays the response, and writes the command and response to the upload file. This command provides information regarding the number of casts in memory, samples per cast, date and time casts started, etc.

   C. **If you selected *By scan number range, From a single cast,* or *By cast number range* in the Configuration Options dialog box (Configure menu)** – a dialog box requests the range or cast number, as applicable. Enter the desired value(s), and click OK.

   D. **If you selected *Prompt for header information* in the Configuration Options dialog box (Configure menu)** – a dialog box with the header form appears. Enter the desired header information, and click OK.

   E. In the Open dialog box, enter the desired upload file name and click OK. The upload file has a .hex extension.
   If you selected *All separated by cast* or *By cast number range*, SEATERM automatically appends the 3-digit cast identification number to the upload file name (for example, if you specify the upload file name as *test* and upload casts 0 and 1, SEATERM creates test000.hex and test001.hex).

   F. SEATERM sends the data upload command (**DCx**, **DAx**, **DBx**, **DEx**, or **DDb,e**, as applicable).

   G. When the data has been uploaded, SEATERM shows the S> prompt.

9. Ensure all data has been uploaded from the SBE 25 by reviewing and processing the data:

   A. Use **Seasave** to display the *raw* (unprocessed) data from the SBE 25 in engineering units (see Seasave manual / Help files).

   B. Use **SBE Data Processing** to process the data and plot the processed data (see SBE Data Processing manual / Help files).

Note:

To prepare the SBE 25 for re-deployment:

1. After all data has been uploaded, send **IL**. If **IL** is not sent and the magnetic switch is used to start logging, new data will be stored after the last recorded sample, preventing use of the entire memory capacity.

2. Send **QS** to put the SBE 25 in quiescent (sleep) state until ready to redeploy. Quiescent current is only 150 microAmps, so the batteries can be left in place without significant loss of capacity.

Processing Data

Notes:
- Seasave and SBE Data Processing versions 7.20a introduced .xmlcon files (in XML format). Versions 7.20a and later allow you to open a .con or .xmlcon file, and to save it to a .con or .xmlcon file. Seasave and SBE Data Processing use the same file.
- A new or recalibrated CTD ships with a configuration file that reflects the current configuration *as we know it*. The file is named with the instrument serial number, followed by a .con extension. For example, for a CTD with serial number 2375, Sea-Bird names the file *2375.con*. You may rename the file (but not the extension) if desired; this will not affect the results.
- In the SBE 25 setup command (**CC**), external voltage numbers 0 – 6 correspond to wiring of sensors to a voltage channel on the end cap (see *Main Housing End Cap Connectors* in *Section 2: Description of SBE 25*). However, in the .xmlcon or .con file, voltage 0 is the first external voltage in the data stream, voltage 1 is the second, etc.

1. Convert the .hex (raw data) file (real-time file from Seasave **or** uploaded from SBE 25 memory) to a .cnv (engineering units) file in SBE Data Processing's Data Conversion module.
2. Once the data is converted: perform further processing (align, filter, remove bad data, etc.), calculate derived variables, and plot data using SBE Data Processing's other modules.

Verifying Contents of Configuration (.xmlcon or .con) File

To convert the .hex (raw data) file, you need a .xmlcon or .con configuration file, which defines the instrument – integrated sensors, and channels, serial numbers, and calibration dates and coefficients for all sensors (conductivity, temperature, and pressure as well as auxiliary sensors). SBE Data Processing (as well as our real-time data acquisition software) uses the configuration file information to interpret and process the raw data. **If the configuration file does not match the actual instrument configuration, the software will be unable to interpret and process the data correctly.**

To view or modify the .xmlcon or .con file:

1. Double click on SBEDataProc.exe.

2. In the Configure menu, select *SBE 25 Sealogger CTD*. The configuration dialog box appears; click Open.

3. In the Open dialog box, select the .xmlcon or .con file and click Open. Verify that the sensors match those on your SBE 25, and that auxiliary sensors are assigned to the correct voltage channels. Verify that calibration coefficients for all sensors are up-to-date.

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

1, 2, 4, or 8 scans/second. Used to calculate elapsed time, if you select time as an output parameter. Must agree with SBE 25 setup (**CC**); see reply from **DS**.

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

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

- **NMEA** - Select if NMEA navigation device used, **and** select whether NMEA device is connected directly to Deck Unit **or** to computer. You can also append NMEA depth data (3 bytes) and NMEA time data (4 bytes) after Lat/Lon data. 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.

New to create new .xmlcon or .con file for this CTD.
Open to select different .xmlcon or .con file.
Save or **Save As** to save current .xmlcon or .con 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. A dialog box with a list of sensors appears. Select sensors after number of voltage channels have been specified above.

4. Click *Save* or *Save As* to save any changes to the .xmlcon or .con file. Click Exit when done reviewing/modifying the configuration.

Editing Raw Data File

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

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

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

2. Run **WordPad**.

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

4. Edit the file as desired, **inserting any new header lines after the System Upload Time line**. Note that all header lines must begin with an asterisk (*), and *END* indicates the end of the header. An example is shown below (for an SBE 21), with the added lines in bold:
   ```
   * Sea-Bird SBE 21 Data File:
   * FileName = C:\Odis\SAT2-ODIS\oct14-19\oc15_99.hex
   * Software Version Seasave Win32 v1.10
   * Temperature SN = 2366
   * Conductivity SN = 2366
   * System UpLoad Time = Oct 15 1999  10:57:19
   * Testing adding header lines
   * Must start with an asterisk
   * Place anywhere between System Upload Time & END of header
   * NMEA Latitude = 30 59.70 N
   * NMEA Longitude = 081 37.93 W
   * NMEA UTC (Time) = Oct 15 1999  10:57:19
   * Store Lat/Lon Data = Append to Every Scan and Append to .NAV
   File When <Ctrl F7> is Pressed
   ** Ship:        Sea-Bird
   ** Cruise:      Sea-Bird Header Test
   ** Station:
   ** Latitude:
   ** Longitude:
   *END*
   ```

5. In the File menu, select Save (**not** Save As). If you are running Windows 2000, the following message displays:
   ```
   You are about to save the document in a Text-Only
   format, which will remove all formatting. Are you
   sure you want to
   do this?
   ```
   Ignore the message and click *Yes*.

6. In the File menu, select Exit.

> **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.**

Section 5: Routine Maintenance and Calibration

This section reviews corrosion precautions, connector mating and maintenance, plumbing air valve maintenance, battery replacement and recharging, conductivity cell storage and cleaning, pressure sensor maintenance, pump maintenance, and sensor calibration. The SBE 25's accuracy is sustained by the care and calibration of the sensors and by establishment of proper handling practices.

Corrosion Precautions

Rinse the SBE 25 with fresh water after use and prior to storage.

Plastic Main Housing

Stainless steel screws connecting the magnetic switch mount to the connector end cap have been generously lubricated with Blue Moly[TM]. All other stainless steel screws that are exposed to salt water have been generously lubricated with DC-4. After each cruise, remove all these screws and re-lubricate. **These compounds are electrically conductive; use care to ensure they do not get on PCBs.**

The SBE 25 has a large zinc anode screwed into the magnetic switch mount. Check the anode periodically to verify that it is securely fastened and has not been eaten away.

Avoid direct attachment of metal objects to the aluminum end cap.

Aluminum Main Housing

All stainless steel screws that are exposed to salt water have been generously lubricated with Blue Moly[TM]. After each cruise, remove these screws and re-lubricate. **This compound is electrically conductive; use care to ensure it does not get on PCBs.**

The SBE 25 has a large zinc anode screwed into the battery end cap and the magnetic switch mount. Check the anodes periodically to verify that they are securely fastened and have not been eaten away.

The housing is insulated from the stainless steel guard cage and sea cable power circuits, preventing heavy corrosion of the housing. Avoid direct attachment of metal objects to the housing.

Modular Sensors and Auxiliary Equipment

The modular temperature, conductivity, and pressure sensors have ring-shaped zinc anodes. Check the anodes periodically to verify that they are securely fastened and have not been eaten away.

Auxiliary equipment powered from the SBE 25 should ideally have a *floating* housing relative to their power circuits. In many cases, it is permissible to have the CTD power and/or signal common lines connected to the auxiliary equipment housing. However, do not connect the auxiliary equipment housing to the SBE 25's 10.5 volt power source, as this can damage the platinized surfaces of the conductivity cell electrodes.

Connector Mating and Maintenance

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

When remating:

1. Lightly lubricate the inside of the dummy plug/cable connector with silicone grease (DC-4 or equivalent).
2. **Standard Connector** - Install the plug/cable connector, aligning the raised bump on the side of the plug/cable connector with the large pin (pin 1 - ground) on the SBE 25. Remove any trapped air by *burping* or gently squeezing the plug/connector near the top and moving your fingers toward the end cap.   **OR**
    MCBH Connector – Install the plug/cable connector, aligning the pins.
3. Place the locking sleeve over the plug/cable connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

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

Plumbing Maintenance

Y-fitting with air release valve

For an SBE 25 deployed in a vertical orientation -
A clogged air release valve can trap air, preventing the pump from functioning properly; this will affect the data quality. Periodically clean the air release valve:

1. Use a 0.4 mm (0.016 inches) diameter wire (you can use #26 AWG wire) to clean the valve. The easiest way to do this is to remove the Tygon tubing above the air release valve, and use needle-nosed pliers to force the wire through the hole.
2. Blow through the air release valve to ensure it is open.
3. (if applicable) Replace the Tygon tubing above the air release valve.

Air release valve detail

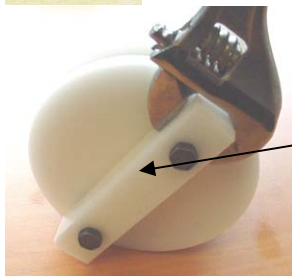0.5 mm (0.02 in.)   UP
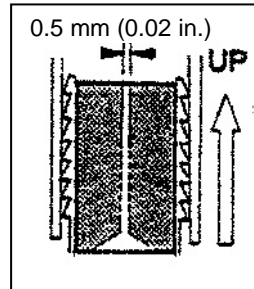
Battery Replacement / Recharging

Note:
If changing from alkaline to Ni-Cad or NiMH batteries, or vice versa, send **CC** to indicate the new battery type. If using NiMH batteries, set it up as though using Ni-Cad batteries.
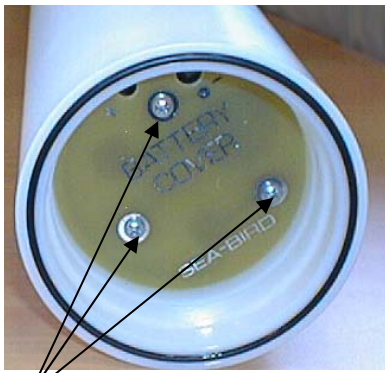
Alkaline D-cell
(MN1300, LR20)

Unthread cap
by rotating
counter-
clockwise

Remove Phillips-head
screws and washers

Leave the batteries in place when storing the SBE 25 to prevent depletion of the back-up lithium batteries by the real-time clock. Even *exhausted* main batteries will power the clock (150 microAmps) almost indefinitely. If the SBE 25 is to be stored for long periods, **replace alkaline batteries yearly to prevent battery leakage** (which could damage the SBE 25).

Replacing Alkaline Batteries

The SBE 25 uses alkaline D-cells (Duracell MN1300, LR20), dropped into the battery compartment.

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

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

3. Turn the SBE 25 over and remove the batteries.

4. Install the new batteries, with the + terminals against the flat battery contacts and the - terminals against the spring contacts.

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

6. Check the battery voltage at BAT + and BAT - on the battery cover plate. It should be approximately 13.5 volts.

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

Verify that the magnetic switch is Off, so the SBE 25 will be in quiescent (sleep) state.

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# Recharging Optional Nickel Metal Hydride Batteries

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

Unthread cap by rotating counter-clockwise

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

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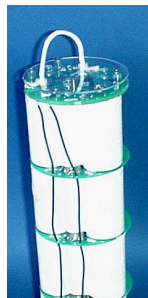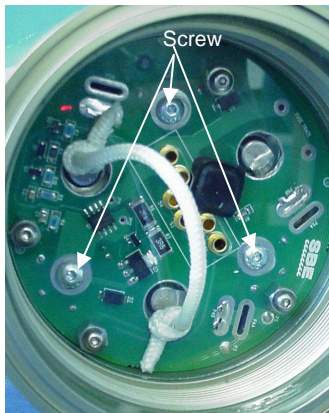
Screw

9-cell Battery pack

2. Remove the battery pack from the housing:
   A. The protective plastic plate over the battery cover plate prevents you from completely removing the cap screws that connect the battery pack to the SBE 25 battery posts in one step. Each of the screws is 12 mm (1/2 inch) long, but the clearance between the cover plate and plastic plate is only 6 mm (1/4 inch). Unscrew each of the three cap screws **just until they hit the bottom of the protective plastic plate**. The battery pack will *walk* out of the housing approximately 6 mm (1/4 inch) because of the spring contacts at the bottom of the battery compartment. Unscrew the cap screws again. The battery pack will *walk* out of the housing again, and should now be disconnected from the battery posts.
   B. Pull on the cord to remove the battery pack from the housing.

Power switch

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

3. Recharge the batteries:
   A. Plug the battery charger into a suitable power source and turn on power to the charger.
   B. Connect the charger cable to the battery pack and charger. The LED should show READY, and display the battery type and measured voltage.
   C. Press the **Discharge** button. The LED should show DISCHARGE. This starts the discharge cycle, which discharges any remaining battery capacity. Repeatedly charging without discharging may damage the battery pack. The Discharge cycle takes approximately 110 minutes. When discharging is complete, the LED should show EMPTY.
   D. Press the **Charge** button. The LED should show Fast Charge (it may also show WARM-UP CHARGE, REFILL CHARGE, and/or TOP OFF during the charge cycle). The Charge cycle takes approximately 2 hours. When charging is complete, the LED should show BATTERY FULL.
   E. Turn off power to the charger.
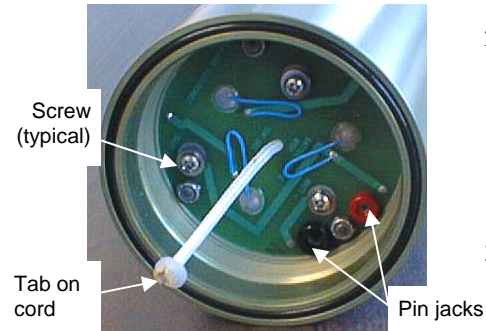   F. Disconnect the battery pack from the charger and the charger from the power source.

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

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

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

Verify that the magnetic switch is Off, so the SBE 25 will be in quiescent (sleep) state.

Recharging Optional Nickel-Cadmium Batteries

Unthread cap by rotating counter-clockwise

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

Screw (typical)

Tab on cord

Pin jacks

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

3. Recharge the batteries:
   A. Connect the battery charger leads to the battery cover pin jacks, matching black-to-black and red-to-red (the pin jacks are different sizes to prevent cross-wiring).
   B. Plug the battery charger into a suitable AC mains power source.
   C. The red **Charge** LED on the charger comes on. Recharging takes approximately 15 hours. When recharging is complete, the yellow **Trickle** LED comes on, indicating the charger is providing a maintenance level charge.
   D. Disconnect the battery pack from the charger and the charger from the power source.
   E. Check the voltage at BAT + and BAT – on the battery cover. It should be approximately 10.8 volts.

CAUTION:
Do not recharge the battery pack while it is in the housing. If you do so, you may damage the SBE 25 electronics.

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

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

Verify that the magnetic switch is Off, so the SBE 25 will be in quiescent (sleep) state.

Conductivity Cell Maintenance

CAUTIONS:
- **Do not put a brush or any object inside the conductivity cell to dry it or clean it.** Touching and bending the electrodes can change the calibration. Large bends and movement of the electrodes can damage the cell.
- **Do not store the SBE 4 with water in the conductivity cell.** Freezing temperatures (for example, in Arctic environments or during air shipment) can break the cell if it is full of water.

The SBE 4 conductivity cell is shipped dry to prevent freezing in shipping. Refer to *Application Note 2D: Instructions for Care and Cleaning of Conductivity Cells* for conductivity cell cleaning and storage procedures and materials.

Sea-Bird supplies a conductivity cell filling and storage kit to use in rinsing and cleaning the cell. Disconnect the plumbing from the conductivity cell to use the filling and storage kit.

Conductivity sensor
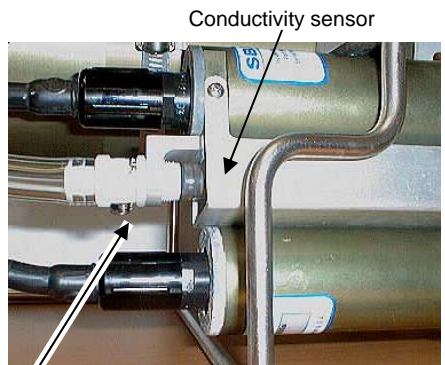
Conductivity *quick disconnect* – press metal lever and disconnect plumbing from cell to loop Tygon tubing to each end of cell
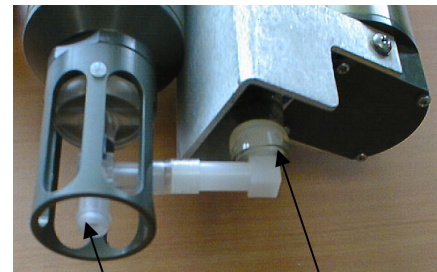
Do not remove TC Duct for rinsing, cleaning, or storage – attach Tygon tubing to end of TC Duct to loop Tygon tubing to each end of cell

Conductivity sensor

Pressure Sensor Maintenance

The SBE 29's nylon pressure capillary fitting – which includes a pressure port fitting and an external capillary tube – is filled with silicone oil. The oil transmits hydrostatic pressure via internal, stainless steel, capillary tubing to the pressure sensor inside the instrument, and prevents corrosion that might occur if the sensor diaphragm was exposed to water. The internal tubing and nylon capillary fitting are vacuum back-filled at the factory.

Because of the viscosity of the silicone oil and capillary action, the silicone oil does not run out of the external capillary tube. However, due to temperature and pressure cycling over long periods, it is normal for some oil to slowly leak out of the external capillary tube. **When the oil is not visible or is receding inside the translucent tube, or if the fitting has been damaged, refill the oil** using the supplied pressure sensor oil refill kit. See *Application Note 12-1: Pressure Port Oil Refill Procedure & Nylon Capillary Fitting Replacement*.

SBE 29 pressure port

Pump Maintenance

See *Application Note 75: Maintenance of SBE 5T, 5P, and 5M Pumps*.

Sensor Calibration

Sea-Bird sensors are calibrated by subjecting them to known physical conditions and measuring the sensor responses. Coefficients are then computed, which may be used with appropriate algorithms to obtain engineering units. The conductivity, temperature, and pressure sensors on the SBE 25 are supplied fully calibrated, with coefficients printed on their respective Calibration Certificates (see back of manual) and stored in the instrument configuration (.xmlcon or .con) file.

We recommend that the SBE 25 be returned to Sea-Bird for calibration.

> **Note:**
> After recalibration, Sea-Bird ships the sensors back to the user with an updated configuration (.con) file and Calibration Certificates showing the new coefficients.

Conductivity Sensor

The SBE 4 conductivity sensor incorporates a fixed precision resistor in parallel with the cell. When the cell is dry and in air, the sensor's electrical circuitry outputs a frequency representative of the fixed resistor. This frequency is recorded on the Calibration Certificate and should remain stable (within 1 Hz) over time.

The primary mechanism for calibration drift in conductivity sensors is the fouling of the cell by chemical or biological deposits. Fouling changes the cell geometry, resulting in a shift in cell constant.

Accordingly, the most important determinant of long-term sensor accuracy is the cleanliness of the cell. We recommend that the conductivity sensors be calibrated before and after deployment, but particularly when the cell has been exposed to contamination by oil slicks or biological material.

Temperature Sensor

The primary source of temperature sensor calibration drift is the aging of the thermistor element. Sensor drift will usually be a few thousandths of a degree during the first year, and less in subsequent intervals. Sensor drift is not substantially dependent upon the environmental conditions of use, and — unlike platinum or copper elements — the thermistor is insensitive to shock.

Pressure Sensor

The SBE 29 strain-gauge pressure sensor is capable of meeting the SBE 25's error specification with some allowance for aging and ambient-temperature induced drift.

Pressure sensors show most of their error as a linear offset from zero. A technique is provided below for making small corrections to the pressure sensor calibration using the *offset* calibration coefficient term by comparing SBE 25 pressure output to readings from a barometer.

Allow the SBE 25 to equilibrate (with power on) in a reasonably constant temperature environment for at least 5 hours before starting. Pressure sensors exhibit a transient change in their output in response to changes in their environmental temperature. Sea-Bird instruments are constructed to minimize this by thermally decoupling the sensor from the body of the instrument. However, there is still some residual effect; allowing the SBE 25 to equilibrate before starting will provide the most accurate calibration correction.

SBE 29
pressure
port

Note:
The SBE 29 pressure sensor is an absolute sensor, so its **raw** output includes the effect of atmospheric pressure (14.7 psi). As shown on the Calibration Sheet, Sea-Bird's calibration (and resulting calibration coefficients) is in terms of psia. However, when outputting pressure in **engineering units**, Seasave outputs pressure relative to the ocean surface (i.e., at the surface the output pressure is 0 decibars). Seasave uses the following equation to convert psia to decibars:
Pressure (db) =
[pressure (psia) - 14.7] * 0.689476

1. Place the SBE 25 in the orientation it will have when deployed.

2. In Seasave, in the .xmlcon or .con file, set the pressure offset to 0.0.

3. Acquire data, and display the SBE 25 pressure sensor output in decibars.

4. Compare the SBE 25 output to the reading from a good barometer at the same elevation as the SBE 25's pressure sensor.
    Calculate *offset* = barometer reading – SBE 25 reading

5. Enter calculated offset (positive or negative) in the .xmlcon or .con file.

Absolute pressure measured by a barometer is 1010.50 mbar. Pressure displayed from SBE 25 is -2.5 dbars.
Convert barometer reading to dbars using the relationship: mbar * 0.01 = dbar
Barometer reading = 1010.50 mbar * 0.01 = 10.1050 dbar
Seasave outputs gage pressure, using an assumed value of 14.7 psi for atmospheric pressure. Convert SBE 25 reading from gage to absolute by adding 14.7 psia to the SBE 25 output:
-2.5 dbars + (14.7 psi * 0.689476 dbar/psia) = -2.5 + 10.13 = 7.635 dbars
Offset = 10.1050 – 7.635 = + 2.47 dbars
Enter offset in .xmlcon or .con file.

For demanding applications, or where the sensor's air ambient pressure response has changed significantly, calibration using a dead-weight generator is recommended. The SBE 29 end cap's $^7/_{16}$-20 straight thread permits mechanical connection to the pressure source. Use a fitting that has an o-ring face seal, such as Swagelok-200-1-OR.

Section 6: Troubleshooting

This section reviews common problems in operating the SBE 25, and provides the most likely causes and solutions.

Each SBE 25 is shipped with a configuration (.xmlcon or .con) file that matches the configuration of the instrument (number and type of auxiliary sensors, etc.) and includes the instrument calibration coefficients.

Problem 1: Unable to Communicate with SBE 25

The S> prompt indicates that communications between the SBE 25 and computer have been established. Before proceeding with troubleshooting, attempt to establish communications again by clicking Connect on SEATERM's Toolbar or hitting the Enter key several times.

Cause/Solution 1: The I/O cable connection may be loose. Check the cabling between the SBE 25 and computer for a loose connection.

Cause/Solution 2: The instrument type and/or its communication settings may not have been entered correctly in SEATERM. Select the SBE 25 in the Configure menu and verify the settings in the Configuration Options dialog box. The settings should match those on the instrument Configuration Sheet.

Cause/Solution 3: The I/O cable may not be the correct one. The I/O cable supplied with the SBE 25 permits connection to standard RS-232 interfaces.
- SBE 25 Pin 1 (large pin) goes to DB-9 pin 5 (ground)
- SBE 25 pin 2 (counter-clockwise from large pin) goes to DB-9 pin 3
- SBE 25 pin 3 (opposite the large pin) goes to DB-9 pin 2

> **Note:**
> Using the reset switch erases the SBE 25 memory – all logged data in memory is erased and all user-programmable parameters (date and time, sampling scheme, etc.) are reset to default values.

Cause/Solution 4: In rare cases, the program that controls the SBE 25's microprocessor can be corrupted by a severe static shock or other problem. This program can be initialized by using the reset switch. Proceed as follows to initialize:
1. Open the main housing battery end cap and remove the batteries (see *Battery Replacement/Recharging* in *Section 5: Routine Maintenance and Calibration*).
2. There is a reset switch on the battery compartment bulkhead, which is visible after the batteries are removed. The switch is used to disconnect the back-up lithium batteries from the electronics. Set the switch to the reset position for at least 5 minutes.
3. Reinstall or replace the batteries, and close the battery end cap.
4. Establish communications with the SBE 25 (see *Section 3: Power and Communications Test*). Initialize RAM (**IR**), reset the date and time (**ST**), and re-enter all the setup parameters.

Problem 2: No Data Recorded

Cause/Solution 1: The SBE 25 may not have been in quiescent (sleep) state when you slid the magnetic switch to the On position. If using the magnetic switch to start logging, the SBE 25 must be in quiescent state for at least 3 seconds *before* sliding the magnetic switch to the On position, or logging will not start. Place the SBE 25 in quiescent state by sending **QS** or waiting **at least 2 minutes** after sending the last command and receiving a response.

Cause/Solution 2: The SBE 25's memory may be full, or you may have reached the maximum number of casts (100); once this occurs, no further data is recorded. Verify using **DS** (*free = 0* if memory is full; *ncasts=100* if maximum number of casts have been recorded). Sea-Bird recommends that you upload all previous data before beginning another deployment. Once the data is uploaded, use **IL** to reset the memory. After the memory is reset, **DS** will show *ncasts=0* and *samples = 0*.

Problem 3: Nonsense or Unreasonable Data

The symptom of this problem is an uploaded file that contains nonsense values (for example, 9999.999) or unreasonable values (for example, values that are outside the expected range of the data).

Cause/Solution 1: An uploaded data file with nonsense values may be caused by an incorrect firmware version or data upload baud rate in SEATERM's Configuration Options dialog box. Verify the correct firmware version with **DS** (firmware version is on the first line of the SBE 25 response).

Cause/Solution 2: An uploaded data file with nonsense values may be caused by incorrect instrument configuration in the .xmlcon or .con file or incorrect assignment of voltage channels with **CC**. Verify that the settings in the instrument configuration file match the instrument Configuration Sheet, and that the assignment of external voltages to stored voltages (check using **DS**) also matches the instrument Configuration Sheet.

Cause/Solution 3: An uploaded data file with unreasonable (i.e., out of the expected range) values for a sensor may be caused by incorrect calibration coefficients in the instrument .xmlcon or .con file. Verify that the calibration coefficients in the configuration file match the instrument Calibration Certificates.

Glossary

Batteries – Nine alkaline D-cells (Duracell MN1300, LR20) standard. Available with optional rechargeable NiMH or Ni-Cad battery pack.

Fouling – Biological growth in the conductivity cell during deployment.

PCB – Printed Circuit Board.

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

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

Seasave V7 – Sea-Bird's Win 2000/XP software used to acquire, convert, and display real-time or archived raw (unprocessed) data.

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

SEATERM – Sea-Bird's Win 95/98/NT/2000/XP terminal program used to communicate with the SBE 25.

SeatermAF – Sea-Bird's Win 95/98/NT/2000/XP terminal program used to communicate with the SBE 25 when it is used with a water sampler operated autonomously (SBE 32 Carousel Water Sampler with Auto Fire Module (AFM) **or** SBE 55 ECO Water Sampler). See the AFM manual or SBE 55 manual.

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

TCXO – Temperature Compensated Crystal Oscillator.

Triton X-100 – Reagent grade non-ionic surfactant (detergent), used for cleaning the conductivity cell. Triton can be ordered from Sea-Bird, but should also be available locally from chemical supply or laboratory products companies. Triton is manufactured by Mallinckrodt Baker (see www.mallbaker.com/changecountry.asp?back=/Default.asp for local distributors)

Appendix I: Functional Description and Circuitry

Sensors and Sensor Interface

The SBE 4 conductivity sensor contains a 3-electrode, 2-terminal, borosilicate glass cell. The SBE 3 temperature sensor has a pressure-protected thermistor. The conductivity and temperature sensors produce variable frequency outputs. To obtain the high encoding speed and resolution required by profiling applications, a *hybrid* period counting technique is used. Two 12-bit counters are used - one counter accumulates the integral number of sensor counts during the sample interval (1/36) second, and the other counter measures the time from the beginning of the measurement period until the first positive-going zero crossing of the sensor frequency, i.e., determines the *fractional* count.

The SBE 29 pressure sensor contains a Druck strain-gauge sensor and is powered with a 5-volt reference. The resulting output voltage is amplified and then digitized with a 12-bit A/D converter using the same 5-volt reference.

Sensor Frequency Ranges

Each counter can handle 4096 counts. The maximum time that the N_r counter is gated *on* is $1/F_s$. Since the N_r counter runs at 9,437,184 Hz, the minimum allowable F_s is given by (9,437,184 / 4096), or 2304 Hz. The maximum allowable sensor frequency is determined by the size of the N_s counter - no more than 4096 counts may be accumulated during the measurement interval. Thus, maximum F_s = 4096 / (1/36) = 147,456 Hz.

Resolution (CT Channels)

Resolution (Hz/bit) = 36 * F_s / F_r

where
F_s = sensor frequency
F_r = CTD reference frequency (9,437,184 Hz)

At 2 kHz the resolution is 0.0076 Hz / bit, and at 50 kHz the resolution is 0.191 Hz / bit. To get resolution in engineering units, divide by *sensitivity*, for example, Hz / (°C). To compute nominal values of resolution in engineering units, we use the approximate values for sensitivity (Sen) from the sensor specification sheets. The values given here are for illustration only - your computer must use the more exact equations and specific calibration constants for each sensor to convert to engineering units.

Temperature:
At -1 °C, F_s = 6 kHz and Sensitivity = 146 Hz / (°C).
At 31 °C, F_s = 12 kHz and Sensitivity = 233 Hz / (°C).

Resolution = 0.00016 °C / bit at -1 °C
           = 0.00020 °C / bit at 31 °C

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Conductivity:
At 1.4 Siemens / meter (S/m), $F_s = 5$ kHz and Sensitivity = 1900 Hz / (S/m).
At 5.8 S/m, $F_s = 11$ kHz and Sensitivity = 960 Hz / (S/m).

Resolution = 0.00001 S/m per bit at 1.4 S/m
            = 0.00004 S/m per bit at 5.8 S/m

Accuracy (CT Channels)

The accuracy of the system is determined by the accuracy of the sensors used and by the accuracy of the crystal oscillator used to generate the reference frequency F_r. F_r is stable to within 5 ppm over the range of 0 to 50 °C. Any error in F_r causes a corresponding error in computed sensor frequency F_s. A 5 ppm error in F_r would cause a 0.06 Hz error if $F_s = 12,000$ Hz. This in turn would result in a 0.0004 °C maximum error in temperature, or a 0.00007 S/m maximum error in conductivity. At lower sensor frequencies, the errors would be smaller. These errors are well below those typical of the sensors (0.002 °C and 0.0003 S/m). The sensor accuracies are detailed in their spec sheets, which are included in the calibration section of the manual.

Auxiliary Sensor Voltage Ranges

Up to 7 auxiliary voltages with the range 0 to 5 volts DC may by acquired by the SBE 25. The 2 channels at J5 are differentially processed, as required when using the Sea Tech Fluorometer and other high-current demand instruments.

Accuracy and Resolution (Pressure and Voltage Channels)

Overall accuracy of the Druck pressure sensor is 0.1% full scale range. Pressure resolution is 0.015% full scale range. The 5-volt reference used by the A/D converter is a Precision Monolithics REF-02EZ with a maximum output voltage temperature coefficient of 8.5 ppm/°C. The 12-bit A/D converter is a National Semiconductor ADC1205CCJ-1 with a linearity error of ±1 LSB. The 12-bit A/D converter resolution is (5 / 4096) or 0.0012 volts per bit.

Real-Time Clock

To minimize power and improve clock accuracy, a temperature-compensated crystal oscillator (TCXO) is used as the real-time-clock frequency source. The TCXO is accurate to ± 1 minute per year (0 °C to 40 °C).

Battery Wiring

SBE 25's main battery is a series connection of D-cells that drop into the battery compartment as a cluster of end-to-end stacks, three batteries each (standard 9-cell battery pack has three stacks). The positive battery connections are contact areas on double-thick printed circuit disks that form the internal bulkhead and battery retainer plates. Battery negative contacts are heavy beryllium-copper springs. The three cell stacks are aligned by plastic insulated aluminum spacers which also serve as electrical interconnects. The battery-to-circuit card connection is made by means of a Molex-type 3-pin pc board connector (JP3 on the power PCB).

The Power PCB contains two series-connected Panasonic BR-2/3A lithium cells (non-hazardous) which are diode OR'd with the main battery (and external power source, if used). The lithium supply is capable of supporting all SBE 25 functions and serves to permit orderly shutdown in the event of failed or exhausted main batteries. The main batteries can be changed without disturbing memory or the real-time clock. If the back-up lithium battery voltage (*vlith* in the **DS** response) falls below 4.5 volts, replace the back-up batteries.

Appendix II: Electronics Disassembly/Reassembly

> **Note:**
> **Disassembling the electronics erases the SBE 25 memory –** all logged data in memory is lost and all user-programmable parameters (date and time, sampling scheme, etc.) are reset to default values.

Disassembly

Jackscrew kit

Sea-Bird provides a jackscrew kit with the SBE 25, to assist in removal of the main housing connector end cap. The kit contains:
- 2 Allen wrenches
- 3 jackscrews
- 2 spare plastic socket hex-head screws

> **CAUTION:**
> Disconnect sensors from the connector end cap before disassembly, to avoid breaking sensors.

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

1. Establish communications with the SBE 25 (see *Section 4: Deploying and Operating SBE 25*). **Upload any data in memory before beginning.**

Leave in place screw connecting bracket to end cap (typical, 2 places)

Remove screw connecting bracket to housing (typical, 2 places)

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

3. Remove the 2 stainless steel Phillips-head screws securing the magnetic switch bracket to the side of the housing. **Do not remove the 2 screws securing the bracket to the end cap**; you will be sliding the bracket off with the end cap.

4. Remove the end cap (with attached magnetic switch bracket) and electronics:

   A. Remove the 4 stainless steel Phillips-head screws and washers securing the connector end cap to the housing.
   B. Remove the 3 plastic hex-head screws from the end cap using the larger Allen wrench. Insert the three jackscrews in these three holes in the end cap. When you begin to feel resistance, use the smaller Allen wrench to continue turning the screws. Turn each screw 1/2 turn at a time. As you turn the jackscrews, the end cap will push away from the housing. When the end cap is loosened, pull it and the PCB assembly out of the housing.
   C. Remove any water from the O-ring mating surfaces inside the housing with a lint-free cloth or tissue. Be careful to protect the O-rings from damage or contamination.
   D. Disconnect the Molex connector connecting the PCB assembly to the battery compartment bulkhead.
   E. Remove the jackscrews from the end cap.

Remove Phillips-head screw and washer (typical, 4 places)

Remove plastic hex-head screw (typical, 3 places)

Reassembly

Note:
Before delivery, a desiccant package is inserted in the electronics chamber, and the chamber is filled with dry Argon gas. These measures help prevent condensation. **If the electronics are exposed to the atmosphere, dry gas backfill with Argon, and replace the desiccant package.** See *Application Note 71: Desiccant Use and Regeneration (drying)* for desiccant information. Battery replacement does not affect desiccation of the electronics, as no significant gas exchange is possible unless the electronics PCBs are actually removed from the housing.

1. Remove any water from the O-ring and mating surfaces with a lint-free cloth or tissue. Inspect the O-ring and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-ring and mating surfaces

2. Reconnect the Molex connector to the PCB assembly. Verify the connector holds and pins are properly aligned

3. Carefully fit the PCB assembly into the housing, aligning the holes in the end cap and housing.

4. Reinstall the 4 Phillips-head screws and washers to secure the end cap to the housing.

5. Reinstall the 3 plastic hex head screws in the end cap.

6. Reinstall the 2 Phillips-head screws to secure the magnetic switch bracket to the side of the housing.

7. Establish communications with the SBE 25 (see *Section 4: Deploying and Operating SBE 25*). Initialize RAM (**IR**), reset the date and time (**ST**), and re-enter all the setup parameters.

Appendix III: Command Summary

CATEGORY	COMMAND	DESCRIPTION
Status	**DS**	Display status and setup parameters.
Setup	**ST**	Set real-time clock date and time.
	SRx	**x=** baud rate indicator (1=600, 2=1200, 3=9600, 4=4800). Default 600.
	CC *	Configure a number of parameters: • Internal data storage rate • Real-time data output rate • Pressure sensor range • Pressure temperature compensation value • Minimum conductivity frequency for pump turn on • Pump turn-on delay • Stop CTD on upcast? • Battery type • Number of external voltages to sample
	LWx	**x=** wait interval (milliseconds) after each line of data. Normally set to 0; increase for very slow computers. Range 0 – 65535.
	IR *	Initialize memory, which destroys all logged data in memory.
	QS	Enter quiescent (sleep) state. Main power turned off, but memory retention unaffected.
Logging	**IL ***	After all previous data has been uploaded, send **IL** before starting to log to make entire memory available for recording. If not sent, data stored after last sample if logging is started with magnetic switch.
	GL *	Start logging now, overwriting any data in memory. Magnetic switch must be On before sending **GL**.
	RL *	Resume logging now, storing data to memory *after* existing data. Magnetic switch must be On before sending **RL**.
	SB *	Put SBE 25 in Standby Mode.
Data Upload Stop logging before uploading.	**DCx**	Upload data from cast **x**, at 600 baud. If **x** omitted, data from cast 0 is uploaded.
	DAx	Same as **DCx**, but baud is 38400.
	DBx	Same as **DCx**, but baud is 9600.
	DEx	Same as **DCx**, but baud is 19200.
	DDb,e	Display data from scan **b** to scan **e**, using same baud rate as used for general communication (**SRx**). If **b** and **e** omitted, data from all casts are uploaded.
	DHb,e	Upload headers from header **b** to header **e**, using same baud rate as used for general communication (**SRx**). If **b** and **e** omitted, headers from all casts are uploaded.
Diagnostic	**TM ***	Perform memory test, which destroys all logged data in memory.
	TE *	Perform extended memory test, which destroys all logged data in memory.
	FR	Measure and display temperature and conductivity frequency. SBE 25 runs continuously during test, drawing current. Press Esc key or click Stop on SEATERM's Toolbar to stop test.
	VR	Measure and display (main battery voltage/5.0161), (back-up lithium battery voltage/3.873), pressure voltage, pressure temperature voltage, and external voltages. SBE 25 runs continuously during test, drawing current. Press Esc key or click Stop on SEATERM's Toolbar to stop test.

Appendix IV: Replacement Parts

Part Number	Part	Application Description	Quantity in 25
22018	Alkaline D-cell batteries, Duracell MN 1300 (LR20)	Power SBE 25	9
41124B	Battery cover plate	Retains alkaline batteries	1
801511	NiMH battery pack	Rechargeable 9-battery pack	-
90504	NiMH battery pack charger	For NiMH batteries	-
801641	Ni-Cad battery pack	Rechargeable 9-battery pack	-
90226	Ni-Cad battery charger	For Ni-Cad batteries	-
22009	Panasonic BR-2/3A lithium batteries	Back-up lithium cells on Analog Interface PCB	2
50092	SBE 16/19 Jackscrew Kit	For removing connector end cap	1
30411	Triton X-100	Octyl Phenol Ethoxylate – Reagent grade non-ionic cleaning solution for conductivity cell (supplied in 100% strength; dilute as directed)	1
30388	Tygon tube, ½ inch ID x ¾ inch OD	Main plumbing tubing	-
30579	Tygon tube, 3/8 inch ID x ½ inch OD	13 mm (0.5 inch) long pieces used on SBE 43 intake and exhaust to fit to main plumbing	-
171888	25-pin DB-25S to 9-pin DB-9P cable adapter	For use with computer with DB-25 connector	1
60021	Spare battery end cap hardware and o-ring kit	O-rings and hardware, including: • 30145 Screw, 6-32 x ^{1}/2 Phillips-head, stainless steel (secures alkaline battery cover plate to battery posts; secures Ni-Cad battery pack to battery posts) • 30242 Washer, #6 flat, stainless steel (for 30145) • 30816 Parker 2-234E603-70 (battery end cap to housing piston seal) • 30090 Parker 2-153N674-70 (battery end cap to housing face seal)	-

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Part Number	Part	Application Description	Quantity in 25
50069	Spare hardware and o-ring kit	O-rings and hardware, including: • 50087 TC Duct cell filling & storage kit • 30145 Screw, 6-32 x ½ Phillips-head, stainless steel (secures alkaline battery cover plate to battery posts; secures Ni-Cad battery pack to battery posts) • 30242 Washer, #6 flat, stainless steel (for 30145) • 30424 Screw, 10-24 x 2 PH SS, (connector end cap hardware, for plastic housing) • 30237 Washer, #10 Nylon (for 30424) • 30425 Screw, 8-32 x 2 PH SS, (connector end cap hardware, for aluminum housing) • 30267 Screw insulator, #8 x ½ (for 30425) • 30377 Bolt, ¼-20 x 1-1/4 socket SS (secures mount blocks to cage) • 30254 Washer, ¼" split ring lock (for 30377) • 30816 Parker 2-234E603-70 (battery end cap to housing piston seal) • 30090 Parker 2-153N674-70 (battery end cap to housing face seal) • 30815 Parker 2-233N674-70 (connector end cap to housing piston seal) • 30072 Parker 2-017N674-70, Bulkhead Connector O-Ring • 30804 SBE 4 L-Seal LS001 • 231002 Backup ring (for 30804) • 30806 L-Seal, LS021 (main end cap L-Seal, all sensors except SBE 4) • 231004 Backup ring (for 30806) • 30813 Morrison seal, .026 hole, .41 OD (temperature probe Morrison seal)	

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Part Number	Part	Application Description	Quantity in 25
50332	SEALOGGER CTD Support Kit, SBE 25 with standard connectors	Includes cables, connectors, dummy plugs, maintenance supplies, and other mechanical spares: • 17043 Locking sleeve (secure cables & dummy plugs) • 17044 2-pin RMG-2FS dummy plug • 17045 3-pin RMG-3FS dummy plug • 17046 4-pin RMG-4FS dummy plug • 17047 6-pin AG-206 dummy plug • 17420 Dust cover (protect connectors during storage) • 17628 6-pin AG-306-HP-SS bulkhead connector • 17652 2-pin XSG-2-BCL-HP-SS bulkhead connector • 17653 3-pin XSG-3-BCL-HP-SS bulkhead connector • 17654 4-pin XSG-4-BCL-HP-SS bulkhead connector • 30044 Seacat anode, 1" • 30384 Tygon tubing, 7/16 x 9/16 (conductivity soaker hose) • 30388 Tygon tubing, ¾' x ½" (main CTD plumbing) • 30409 Teflon tape, adhesive 1 side (insulation for metal parts to hose clamps) • 30411 Triton X-100 (conductivity cell cleaning solution) • 30457 Parker Super 'O' Lube (silicone-based o-ring lubricant) • 41124B Seacat battery cover plate (battery retainer plate) • 50025 Pressure sensor oil refill kit • 50026 Magnetic switch assembly • 50029 Pressure sensor capillary assembly • 50069 SBE 25 small hardware & o-ring kit (see above) • 17086 3-pin RMG-3FS to 3-pin RMG-3FS cable, 0.6 m (2.1 ft) long (temperature & conductivity sensor cables) • 17168 6-pin AG-206 to 6-pin AG-206 cable, 1.1 m (3.7 ft) long (pressure sensor cable) • 801225 4-pin RMG-4FS to 9-pin DB-9S, 2.4 m (8 ft) data I/O cable (for bench use, from SBE 25 J1 Y-cable 17709 to computer) • 801380 4-pin RMG-4FS to 9-pin DB-9S shielded I/O cable, 20 m (66 ft) long (for real-time logging, from SBE 25 J1 Y-cable 17709 to computer) • 17709 6-pin AG-206 to 2-pin RMG-2FS and 4-pin RMG-4MP Pump / Data I/O Y-cable (from SBE 25 J1 to pump (2-pin) and data I/O (4-pin))	-

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Part Number	Part	Application Description	Quantity in 25
50331	SEALOGGER CTD Support Kit, SBE 25 with wet-pluggable connectors	Includes cables, connectors, dummy plugs, maintenance supplies, and other mechanical spares: • 171192 Locking sleeve (secure cables & dummy plugs) • 171497 2-pin MCDC-2-F dummy plug • 171500 3-pin MCDC-3-F dummy plug • 171398 4-pin MCDC-4-F dummy plugs • 171498 6-pin MCDC-6-F dummy plug • 172023 2-pin MCBH-2MP(WB) bulkhead connector • 172024 3-pin MCBH-3MP(WB) bulkhead connector • 172025 4-pin MCBH-4MP(WB) bulkhead connector • 172026 6-pin MCBH-6MP(WB) bulkhead connector • 171888 DB-25F to DB-9M adapter • 30044 Seacat anode, 1" • 30384 Tygon tubing, 7/16 x 9/16 (conductivity soaker hose) • 30388 Tygon tubing, ¾' x ½" (main CTD plumbing) • 30409 Teflon tape, adhesive 1 side (insulation, metal parts to hose clamps) • 30411 Triton X-100 (conductivity cell cleaning solution) • 30457 Parker Super 'O' Lube (silicone-based o-ring lubricant) • 41124B Seacat battery cover plate (battery retainer plate) • 50025 Pressure sensor oil refill kit • 50026 Magnetic switch assembly • 50029 Pressure sensor capillary assembly • 50069 SBE 25 small hardware & o-ring kit (see above) • 171669 3-pin MCIL-3FS to 3-pin MCIL-3FS cable, 0.7 m (2.5 ft) (temperature & conductivity sensor cables) • 171798 6-pin MCIL-6FS to 6-pin MCIL-6FS cable, 1.0 m (3.3 ft) (pressure sensor cable) • 801374 4-pin MCIL-4FS to 9-pin DB-9S, 2.4 m (8 ft) data I/O cable (for bench use, from SBE 25 J1 Y-cable 171883 to computer) • 801421 4-pin MCIL-4FS to 9-pin DB-9S, I/O cable, 20 m (66 ft) (for real-time logging, from SBE 25 J1 Y-cable 171883 to computer) • 171883 6-pin MCIL-6FS to 2-pin MCIL-2FS and 4-pin MCIL-4MP Pump / Data I/O Y-cable (from SBE 25 J1 to pump (2-pin) and data I/O (4-pin)	-

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