

SBE 56 Temperature Logger

With Internal USB 2.0 Interface



Note: NEW ADDRESS
as of January 2010

User's Manual

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Manual Version #004, 05/25/12
Firmware Version 20.8 and later
SeatermV2 Version 1.1g and later



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.

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Section 1: Introduction

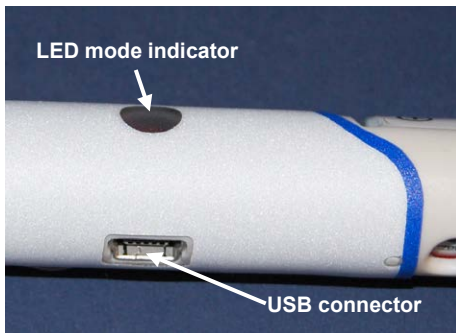
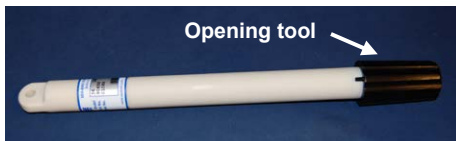
This section includes a Quick Start procedure, and photos of a standard SBE 56 shipment.

About this Manual

This manual is to be used with the SBE 56 Temperature Logger. It is organized to guide the user from installation through operation and data collection. We've 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 56. The manual provides step-by-step details for performing each task:

1. Using the opening tool, unscrew the SBE 56 end cap; pull the electronics out of the housing.
2. Connect the USB cable to the SBE 56's internal USB connector and to a USB port on your computer. The SBE 56 LED flashes quickly three times to indicate that the cable is plugged in (Command mode).
3. Double click on `SeatermV2.exe`. Select the SBE 56 Temperature Logger in the Instruments menu; this opens `SeatermUSB`.
4. Ensure all data has been uploaded.
5. In **Current Configuration**, review the **Memory remaining** and (calculated) **Battery life remaining** listings.

6. In **Configuration Options**, modify the SBE 56 setup as desired.
 - A. Change the **Sample Period**.
 - B. If desired, click the Time Options button to change the date and time tracked by the program. Options include computer time, user-input custom time, or selection of a time zone. If you enter a custom date/time, click the Synchronize button to set the custom date/time at that moment. After you click OK, the time shown in Configuration Options reflects your selection.
 - C. Click **Set time to . . .** to reset the real-time clock to match the time shown.
 - D. Click **Clear Memory** to make the entire memory available (when you clear the memory, the SBE 56 also clears its event counters).
 - E. Install a new battery if necessary, and click **New Battery Installed**.
 - F. To start sampling when you remove the cable, select **Start sampling on USB cable disconnect**. **OR**
To set a delayed date and time to start sampling, select **Start sampling at . . .**, and click the calendar icon. Select the desired start date and time in the calendar, and click OK.
 - G. Click the **Update Configuration** button to send the setup choices in Steps A through F to the SBE 56.
 - H. Unplug the USB cable from the SBE 56. The SBE 56 LED flashes slowly two times to indicate that it is in Acquisition mode (logging or waiting to start logging at the delayed start date and time).
 - I. Install a new desiccant capsule.
 - J. Close the housing.
7. Deploy the SBE 56, using customer-supplied mounting hardware.

Unpacking SBE 56

A typical SBE 56 shipment is shown below.



SBE 56



USB cable for
internal connector



Opening tool
(1 per shipment)



Spare parts kit



Software, and Electronic Copies of
Software Manuals and User Manual

Shipping Precautions

WARNING!

Do not ship spare batteries by passenger aircraft.

The SBE 56 was shipped from the factory with the AA lithium battery inside the instrument. When shipped in this manner, the lithium battery is **not** considered Dangerous/Hazardous Goods, and may be shipped via commercial aircraft (those governed by DOT or IATA, including passenger airlines, or cargo carriers such as FedEx, DHL, UPS, etc.) if no more than the one battery required to operate the instrument is included in the shipment (i.e., no spares are included). For international shipments, the airway bill must include the phrase, "Non Restricted Per Special Provision A45".

Note:

Remove the battery before returning the SBE 56 to Sea-Bird. Do not return the used battery to Sea-Bird when shipping the SBE 56 for repair or recalibration. All setup information is preserved in the SBE 56 when the battery is removed.

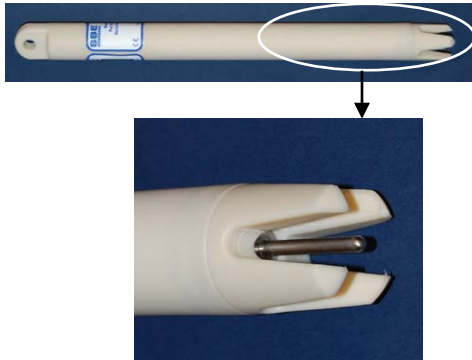
IMPORTANT NOTE:

Do not ship spare lithium batteries via passenger aircraft. Refer to *Lithium Battery Shipping Guidelines* for background information on the applicable regulations as well as Sea-Bird's interpretation of those regulations, how they apply to the batteries in our equipment, and how we package and label our equipment.

Section 2: Description

This section describes the functions and features of the SBE 56, including specifications, dimensions, battery endurance, and sample timing.

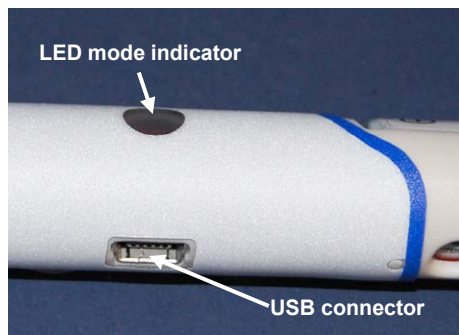
System Description



The SBE 56 is a high-accuracy temperature logger with internal battery and non-volatile memory, for deployment at depths up to 1500 meters (4900 feet). The SBE 56 is intended for moorings or other long-term, fixed-site applications, as well as shorter-term deployments on nets, towed vehicles, or ROVs. The SBE 56 samples and records at user-programmed 0.5-second to 9-hour intervals. Calibration coefficients are stored in FLASH, and included software automatically converts raw uploaded data to ASCII engineering units ($^{\circ}\text{C}$ and date/time).

The SBE 56's external thermistor is in a pressure-protected sheath (time constant approximately 0.5 seconds), for fast sampling. This is the same sensor used in the SBE 16*plus* V2 SeaCAT, SBE 37 MicroCAT, and SBE 39 Temperature Recorder, and has a long history of exceptional accuracy and stability; drift is typically less than $0.002\text{ }^{\circ}\text{C}$ per year.

The SBE 56 communicates with a computer via a standard USB 2.0 interface, at approximately 240,000 bits per second. To set up the instrument or upload data, simply open the housing and plug the data cable into the internal connector. Binary upload via the included software provides **fast upload** of large data sets; upload of the entire memory requires approximately 40 minutes.



The SBE 56 has two operating modes:

- **Acquisition mode** - Upon installing a battery and upon removing the USB cable, the internal LED flashes slowly two times to indicate that it is now sampling and logging data, or waiting to start sampling and logging data at the programmed delayed start date and time.
- **Command mode** - When a USB cable is plugged into the SBE 56's internal connector, the SBE 56 switches to Command mode, and the internal LED flashes quickly three times. The SBE 56 is now powered through the USB port. While in Command mode, you can upload data and change the SBE 56 setup. After the cable is removed from the connector, the LED flashes two times to indicate that it has automatically switched to Acquisition mode.

Note:

In January 2012, Sea-Bird modified the battery cradle orientation in the housing to provide the best battery endurance for the typical thermistor end down deployment. For older SBE 56s (serial number < 1088), the battery *button end* (+) down corresponded to the thermistor end down. Sea-Bird is retrofitting these older SBE 56s as they are returned for service or calibration, to flip the battery orientation. **Check the battery orientation in your SBE 56 to verify the best deployment orientation.**

With its 3.6 volt, AA non-hazardous, lithium battery and its low power consumption, the SBE 56 can acquire 5.3 million temperature samples when sampling at 0.5-second intervals (see *Specifications* and *Battery Endurance* for other sampling intervals). The SBE 56's non-volatile FLASH memory can store 15.9 million samples. Time is stored with every block of 123 samples of temperature data; on upload, the included software interpolates to determine and output the time of each sample.

The SBE 56's inherent accuracy, resolution, and stability, combined with a rigorous 11-point temperature calibration, yields a true research-quality tool. Primary temperature standards (water triple point and gallium melting point cells) and state-of-the-art equipment are maintained in our NIST-traceable calibration facility.

Future upgrades and enhancements to the SBE 56 firmware can be easily installed in the field through a computer USB port and the internal USB connector in the SBE 56, without the need to return the SBE 56 to Sea-Bird.

Notes:

- Help files provide detailed information on the software.
- A separate software manual on CD-ROM contains detailed information on SBE Data Processing.
- 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.

The SBE 56 is supplied with a powerful Win 2000/XP software package, Seasoft V2, which includes:

- **SeatermV2** - program for easy communication, setup, data retrieval, and data plotting. SeatermV2 is a *launcher*. Depending on the instrument selected, it launches **SeatermUSB** (USB instruments, such as this SBE 56), **Seaterm232** (RS-232 instruments), **Seaterm485** (RS-485 instruments), or **SeatermIM** (inductive modem instruments).
- **SBE Data Processing** - SBE Data Processing includes many post-processing modules; modules applicable to the SBE 56 are ASCII Out (export files for other programs) and Sea Plot (plot data).

Specifications

Measurement Range	-5 to +45 °C
Initial Accuracy	0.002 °C
Typical Stability	0.0002 °C per month
Resolution	0.0001 °C
Calibration	-5 to +35 °C
Memory and Data Storage	15.9 million samples in FLASH memory
Real-Time Clock	32,768 Hz TCXO accurate to ±1 minute/year
Power Requirements	<ul style="list-style-type: none"> • Quiescent current: 0.601 milliAmp hours/day • Self-discharge current: 0.067 milliAmp hours/day • Measurement: 0.371 microAmp hours/sample, for 0.44 seconds/sample
Power Supply and Endurance	<p>3.6 V, 2.6 A-hr AA Saft LS14500 non-hazardous Lithium Battery (see <i>Shipping Precautions</i> in <i>Section 1: Introduction</i> and see <i>Battery Endurance</i> in this section), derated to 2.0 Amp-hours for planning. This battery capacity is achieved if the SBE 56 is deployed in the recommended orientation: horizontal, or battery button (+) end up (see <i>Deployment Orientation</i> in <i>Section 3: Preparing for Deployment</i> for details and to verify battery orientation in housing).</p> <p>Note: Saft batteries can be purchased from Sea-Bird or other sources. See www.saftbatteries.com for suppliers.</p> <p>5.3 million samples at 0.5-second intervals (31 days) 5.3 million samples at 1-second intervals (61 days) 4.9 million samples at 5-second intervals (284 days) 4.1 million samples at 15-second intervals (717 days)</p>
Housing	Plastic housing rated at 1500 meters (4900 feet)
Weight	In air 0.2 kg (0.4 lbs), in water 0.05 kg (0.1 lbs)

Battery Endurance

Notes:

- See *Specifications* above for current draws, sample timing, and memory capacity.
- In January 2012, Sea-Bird modified the battery cradle orientation in the housing to provide the best battery endurance for the typical thermistor end down deployment. For older SBE 56s (serial number < 1088), the battery *button end* (+) down corresponded to the thermistor end down. If requested on the Service Request Form when the SBE 56 is returned for service/calibration, Sea-Bird is changing the cradle orientation, so that for the typical deployment the battery button end (+) is up. **Check the battery orientation in your SBE 56 to verify the best deployment orientation.** See *Deployment Orientation* in *Section 3: Preparing for Deployment* to verify the battery orientation in the housing.

The battery has a nominal capacity of 2.45 Amp-hours. For planning purposes, Sea-Bird recommends using a conservative value of 2.0 Amp-hours. The calculations in the examples below show how the *Battery life remaining* value in SeatermUSB Battery endurance is derived.

This battery capacity is achieved if the SBE 56 is deployed in the **recommended orientation: horizontal, or battery button end (+) up.** See *Deployment Orientation* in *Section 3: Preparing for Deployment* for details and to verify the battery orientation in the housing.

If deployed vertically with battery end (+) down, battery endurance may be reduced by up to 40%. However, for most typical customer applications, the SBE 56 battery endurance is sufficient, even with the potential 40% reduction. For example, the calculated endurance for a 15-second sample interval is 717 days (\approx 2 years). With a potential 40% reduction in battery capacity, the SBE 56 could be deployed for 430 days (\approx 1.2 years).

Examples:

0.5 second sample interval (172,800 samples/day)

Quiescent current = $[0.601 * (0.5 - 0.44 \text{ sec})/0.5 \text{ sec}] = 0.072 \text{ mA-hr/day}$

Self-discharge current = 0.067 mA-hr/day

Sampling current = $0.371 \mu\text{A-hr/sample} * 172800 \text{ samples/day} * 1 \text{ mA}/1000 \mu\text{A} = 64.109 \text{ mA-hr/day}$

Total current consumption = 64.248 mA-hr/day

Battery endurance = $2000 \text{ mA-hr} / 64.248 \text{ mA-hr/day} = 31 \text{ days}$; 31 days * 172800 samples/day = 5.3 million samples

1 second sample interval (86,400 samples/day)

Quiescent current = $[0.601 * (1 - 0.44 \text{ sec})/1 \text{ sec}] = 0.336 \text{ mA-hr/day}$

Self-discharge current = 0.067 mA-hr/day

Sampling current = $0.371 \mu\text{A-hr/sample} * 86400 \text{ samples/day} * 1 \text{ mA}/1000 \mu\text{A} = 32.054 \text{ mA-hr/day}$

Total current consumption = 32.457 mA-hr/day

Battery endurance = $2000 \text{ mA-hr} / 32.457 \text{ mA-hr/day} = 61 \text{ days}$; 61 days * 86400 samples/day = 5.3 million samples

15 second sample interval (5760 samples/day)

Quiescent current = $[0.601 * (15 - 0.44 \text{ sec})/15 \text{ sec}] = 0.583 \text{ mA-hr/day}$

Self-discharge current = 0.067 mA-hr/day

Sampling current = $0.371 \mu\text{A-hr/sample} * 5760 \text{ samples/day} * 1 \text{ mA}/1000 \mu\text{A} = 2.137 \text{ mA-hr/day}$

Total current consumption = 2.787 mA-hr/day

Battery endurance = $2000 \text{ mA-hr} / 2.787 \text{ mA-hr/day} = 717 \text{ days}$; 717 days * 5760 samples/day = 4.1 million samples

60 second sample interval (1440 samples/day)

Quiescent current = $[0.601 * (60 - 0.44 \text{ sec})/60 \text{ sec}] = 0.597 \text{ mA-hr/day}$

Self-discharge current = 0.067 mA-hr/day

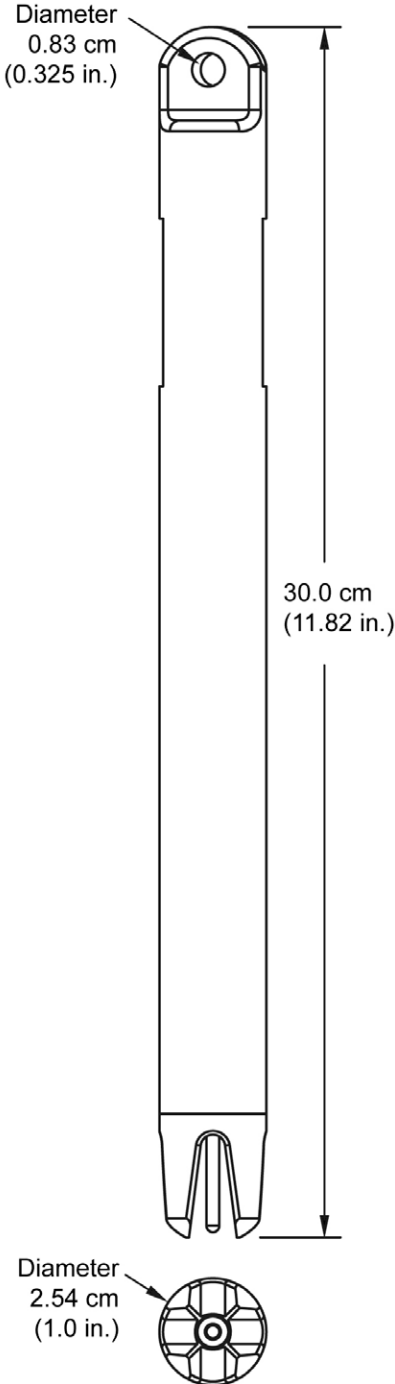
Sampling current = $0.371 \mu\text{A-hr/sample} * 1440 \text{ samples/day} * 1 \text{ mA}/1000 \mu\text{A} = 0.534 \text{ mA-hr/day}$

Total current consumption = 1.198 mA-hr/day

Battery endurance = $2000 \text{ mA-hr} / 1.198 \text{ mA-hr/day} = 1669 \text{ days}$; 1669 days * 1440 samples/day = 2.4 million samples

However, Sea-Bird recommends that batteries should not be expected to last longer than 2 years in the field.

Dimensions



Section 3: Preparing for Deployment

This section describes software installation, preparing the SBE 56 for deployment, and recommended deployment orientation.

Software Installation

Notes:

- Help files provide detailed information on the software.
- A separate software manual on the CD-ROM contains detailed information on SBE Data Processing.
- 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 or Windows 7 (32-bit).

Install Sea-Bird software on your computer using the supplied software CD:

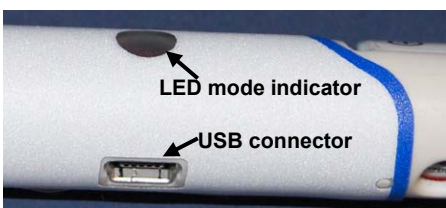
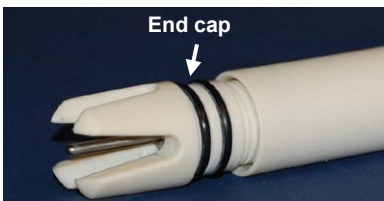
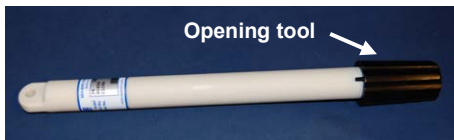
1. Insert the CD in your CD drive.
2. Install software: Double click on **SeasoftV2_date.exe** (*date* is the date that version of the software was created). Follow the dialog box directions to install the software. The installation program allows you to install the desired components. Install all the components, or just install **SeatermV2** (terminal program launcher for the SBE 56) 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.

Programming for Deployment

Note:

Sea-Bird ships the SBE 56 with an AA lithium battery installed. See *Shipping Precautions* in *Section 1: Introduction*.



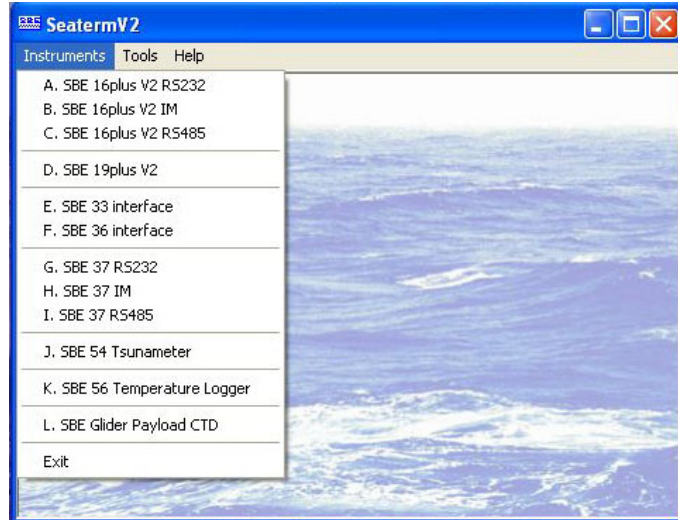
Connect to Internal USB Connector

1. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.
2. Using the opening tool, unscrew the end cap.
3. Pull the end cap and attached electronics out of the housing.
4. Remove any water from the end cap O-rings and mating surfaces inside the housing with a lint-free cloth or tissue.
5. Connect the USB cable to the internal connector on the electronics and to a USB port on your computer. The SBE 56 LED flashes quickly three times to indicate that the cable is plugged in (Command mode).

Programming

Note:
See SeatermV2's Help files.

1. Double click on **SeatermV2.exe**. The main screen looks like this:

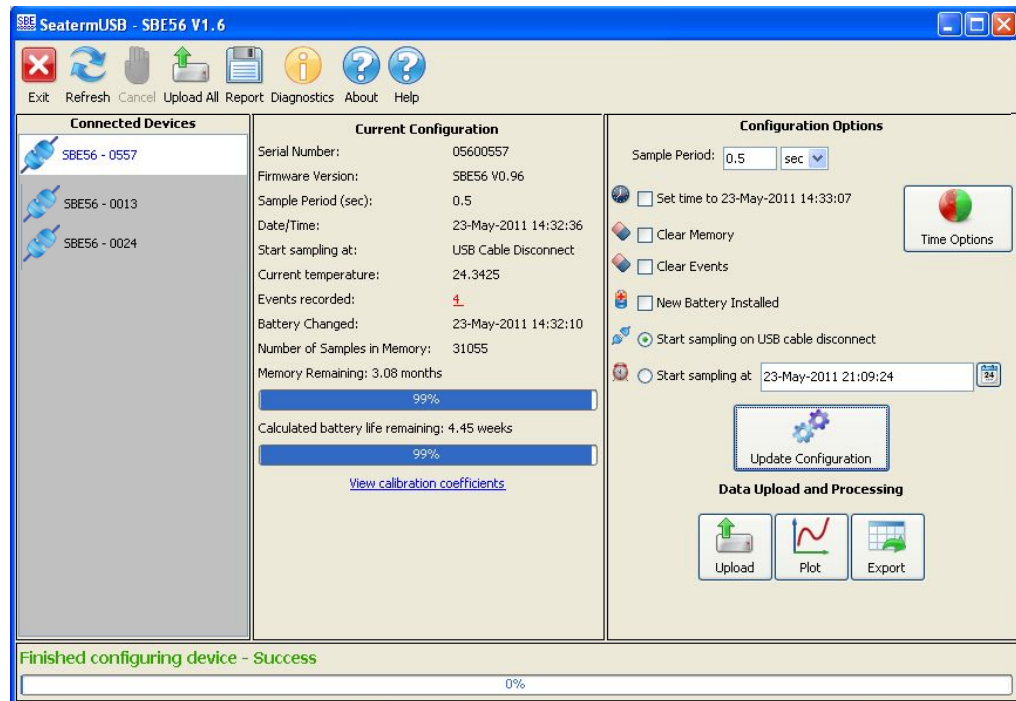


SeatermV2 is a *launcher*, and launches the appropriate terminal program for the selected instrument.

Notes:

- The first time you start SeatermUSB, you may get a message to close it, connect an SBE 56 to the computer, wait for drivers to install, and restart the computer.
- SeatermUSB runs tests to detect if the SBE 56 is plugged into a USB port. If it fails to find the SBE 56: unplug and plug in the device again, and click *Refresh*.
- See SeatermUSB's Help files.

2. In the Instruments menu, select **SBE 56 Temperature Logger**. **SeatermUSB** opens, and automatically tries to connect to the SBE 56. SeatermUSB looks like this with three SBE 56s plugged in:



- **Toolbar** – Buttons for frequently executed tasks.
 - Refresh - Refresh connection to SBE 56.
 - Cancel – Cancel current action, such as data upload.
 - Upload All – Upload all data from SBE 56 memory.
 - Report – Save current configuration to a .txt file to document setup.
 - Diagnostics – Enable diagnostic output for troubleshooting, select the diagnostic log location, display the log, and/or erase the log.
- **Connected Devices** – Multiple SBE 56s can be cabled to a single computer; each appears in this area. Selected instrument is highlighted.

- **Current Configuration** – Indicates the current SBE 56 setup.
 - Serial Number – SBE 56 serial number.
 - Firmware Version – SBE 56 firmware version.
 - Sample Period – Time between samples; 0.5 - 32,400 sec (9 hours).
 - Date/Time – SBE 56 real-time clock date and time. This is updated to time shown in Configuration Options each time user selects *Set time to . . .* or *New Battery Installed* and clicks Update Configuration button (see Configuration Options below), to eliminate any accumulated clock drift.
 - Start sampling at – on USB Cable Disconnect (start sampling when USB cable removed from SBE 56), or date and time to start.
 - Current temperature – Temperature measured by SBE 56 last time you connected to SBE 56 or clicked Refresh in toolbar; provides an indication of whether SBE 56 is functioning properly.
 - Events Recorded – SBE 56 event counter can help identify cause of a malfunction. It records number of occurrences of power-on resets (battery power removed and restored), timeouts, etc., and is cleared when you clear memory (see Configuration Options below).
 - Battery Changed – Last date that user selected *New Battery Installed* and clicked Update Configuration button.
 - Number of Samples in Memory – Number of samples (scans) available to upload.
 - Memory Remaining – Calculated value based on number of samples in memory, current sample period, and memory capacity.
 - Battery life remaining – Calculated value based on estimated sampling current draw, user input of when battery was last changed, de-rated estimate of total battery capacity when battery was fresh, and current sample period.
 - View Calibration Coefficients – Currently programmed coefficients; cannot be modified by user.

- **Configuration Options** – Allows you to reconfigure the SBE 56 setup:
 - Change sample period (interval).
 - Reset real-time clock to current computer time or to a user-set time (accessed by clicking Time Options button).
 - Clear memory.
 - Clear event counter.
 - Indicate if a new battery is installed (needed for *Battery life remaining* calculation in Current Configuration).
 - Set whether to start sampling as soon as USB cable is disconnected, or at a delayed start date and time after USB cable is disconnected.

After selections are entered, **you must click the Update Configuration button to send the setup commands to the SBE 56.**

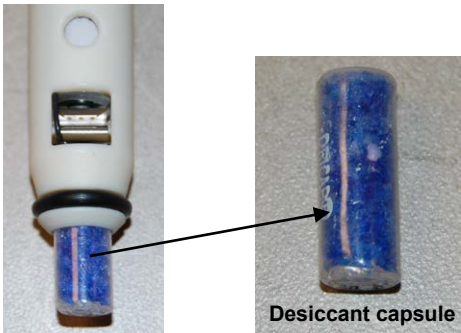
- **Data Upload and Processing** –
 - Upload – Upload data from SBE 56 memory. Upload file contains a header which includes calibration coefficients, followed by raw Hex data. File has a .xml extension.
 - Plot - View plotted uploaded data.
 - Export – Select file format for exporting uploaded data: .csv (comma-separated; compatible with MatLab and Excel), .cnv (compatible with SBE Data Processing), or .zip (compressed raw Hex data).

- Status bar – Located at the bottom of the main screen, this provides information such as whether the SBE 56 has successfully connected to the program, progress of any data upload, and data export status.

Note:

If any Events are recorded, the number is displayed in red and is underlined. Clicking on the number opens a dialog with a description of the events. The description can be copied into an email and sent to Sea-Bird for troubleshooting. See *Section 6: Troubleshooting* for common event codes.

3. Ensure all data has been uploaded.
4. In the **Current Configuration**, review the **Memory remaining** and (calculated) **Battery life remaining** listings.
5. In **Configuration Options**, modify the SBE 56 setup as desired.
 - A. Change the **Sample Period** (interval between samples). The SBE 56 can sample at intervals of 0.5 seconds to 9 hours.
 - B. If desired, click the **Time Options** button to change the date and time tracked by the program. Options include computer time, user-input custom time, or selection of a time zone. If you enter a custom date/time, click the Synchronize button to *set* the custom date/time at that moment. After you click OK, the time shown in Configuration Options reflects your selection.
 - C. Click **Set time to . . .** to reset the real-time clock to match the time shown.
 - D. Click **Clear Memory** to make the entire memory available for recording (when you clear the memory, the SBE 56 also clears its event counters).
 - E. Install a new battery if necessary, and click **New Battery Installed**.
 - F. To start sampling when you remove the cable, select **Start sampling on USB cable disconnect**. **OR**
To set a delayed date and time to start sampling, select **Start sampling at . . .**, and click the calendar icon. Select the desired start date and time in the calendar, and click OK.
 - G. Click the **Update Configuration** button to send the setup choices in Steps A through F to the SBE 56.
6. Unplug the USB cable from the SBE 56. The SBE 56 LED flashes slowly two times to indicate that it is in Acquisition mode (logging or waiting to start logging at the delayed start date and time).



7. Replace the desiccant capsule if you will be redeploying the SBE 56 (see *Replacing Desiccant* in *Section 5: Maintenance and Calibration*).
8. Reinstall the end cap and close the housing.
 - A. Remove any water from the O-rings and mating surfaces in the housing with a lint-free cloth or tissue. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-ring and mating surfaces.
 - B. Carefully fit the end cap into the housing, pushing in until the first O-ring is seated.
 - C. Using the opening tool, screw the end cap into the housing.

The SBE 56 is ready for deployment.

Deployment Orientation

Notes:

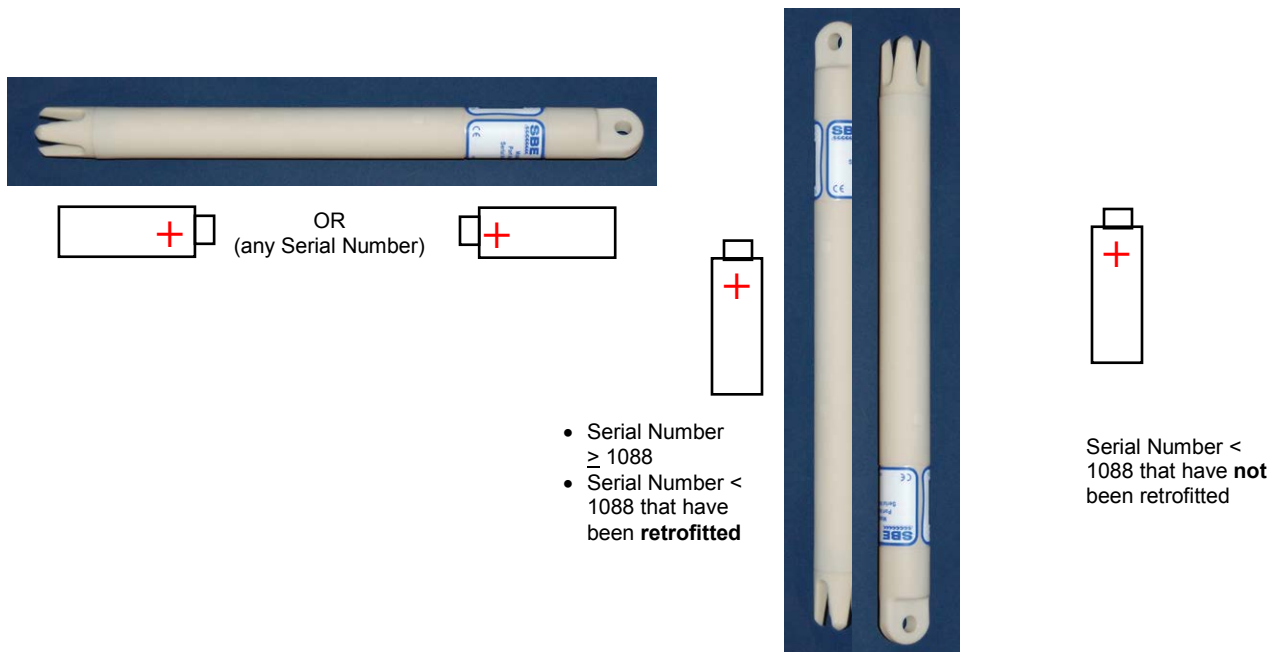
- See Field Service Bulletin 25 for a detailed discussion of deployment orientation.
- In January 2012, Sea-Bird modified the battery cradle orientation in the housing to provide the best battery endurance for the typical thermistor end down deployment. For older SBE 56s (serial number < 1088), the battery *button end (+)* down corresponded to the thermistor end down. If requested on the Service Request Form when the SBE 56 is returned for service/calibration, Sea-Bird is changing the cradle orientation, so that for the typical deployment the battery button end (+) is up. **Check the battery orientation in your SBE 56 to verify the best deployment orientation.**

The AA lithium battery that powers the SBE 56 is affected by deployment orientation. **SBE 56s deployed with the battery *button end (+)* down exhibit reduced battery capacity; battery endurance may be reduced by up to 40% from the capacity indicated by SeatermUSB. However, for most typical customer applications, the SBE 56 battery endurance is sufficient, even with the potential 40% reduction.**

If you require the full battery capacity calculated by SeatermUSB, Sea-Bird strongly recommends that you deploy the SBE 56 in one of the following orientations:

- **Horizontal**
- **Vertical**, with the battery *button end (+)* up
 - For serial numbers ≥ 1088 , this corresponds to the **thermistor end down**.
 - For serial numbers < 1088 that **have been retrofitted**, this corresponds to the **thermistor end down**.
 - For serial numbers < 1088 that have **not been retrofitted**, this corresponds to the **thermistor end up**.

Deployment Orientations for Best Battery Capacity



Section 4: Recovery and Uploading Data

This section provides discussions / instructions on:

- recovery
- uploading data
- data formats
- plotting data
- exporting data

Recovery

WARNINGS!

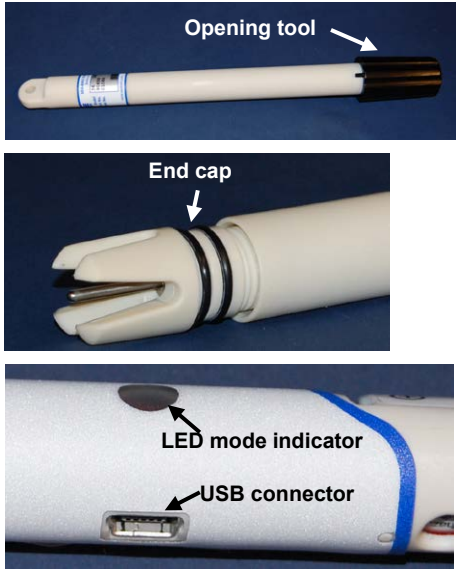
The housing can build up internal pressures that may be dangerous in either of the following scenarios:

- If seals fail and water enters the housing (indicated by a sloshing sound).
- If deployed in gas super-saturated lakes (for example, some volcanic lakes).

If you suspect the SBE 56 housing has been pressurized, point it in a safe direction away from people: If abnormal internal pressure exists, it should cause the thermistor probe to extrude from the housing, relieving the pressure.

Rinse the SBE 56 with fresh water, and dry thoroughly.

Uploading and Plotting Data



1. **Connect to the SBE 56 internal USB connector:**
 - A. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.
 - B. Using the opening tool, unscrew the end cap.
 - C. Pull the end cap and attached electronics out of the housing.
 - D. Remove any water from the end cap O-rings and mating surfaces inside the housing with a lint-free cloth or tissue.
 - E. Connect the USB cable to the internal connector on the electronics and to a USB port on your computer. The LED flashes quickly three times to indicate that the cable is plugged in (Command mode).

Notes:

- SeatermUSB runs tests to detect if the SBE 56 is plugged into a USB port. If it fails to find the SBE 56: unplug and plug in the device again, and click *Refresh*.
- See SeatermUSB's Help files.

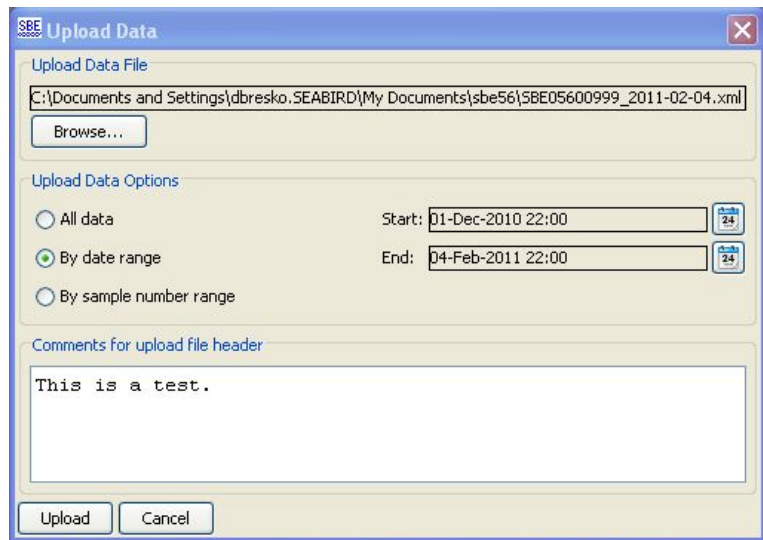
2. Double click on **SeatermV2.exe**. In the Instruments menu, select *SBE 56 Temperature Logger*. **SeatermUSB** opens, and automatically tries to connect to the SBE 56.

Note:
The uploaded .xml file contains raw Hex data; the header includes the calibration coefficients. To convert the raw Hex data to engineering units, and to export it as a .cnv, .csv, or .zip file for use in other software, see *Exporting Data* below.

3. Click the **Upload** button
 - A. The Save dialog box appears; navigate to the desired folder. SeatermUSB suggests a file name with a format *SBE056Serialnumber_Date.xml* (*Serialnumber* is the SBE 56's serial number, and *Date* is the upload date). You can enter a different file name if desired; the file name has an .xml extension. Click Save.
 - B. The Upload Data dialog box appears, showing the selected file name and location.

Select desired upload option.

Provide additional information to be included in upload file header.



- Make the desired selections/entries and click Upload.
 - C. The Status bar at the bottom of SeatermUSB displays the upload progress.

4. Click the **Plot** button to create a plot of the data and ensure all data has been uploaded from the SBE 56. The Plot Data dialog appears.

Input .xml data file:

- Pull down to select from list of most recent files downloaded from SBE 56, or
- Click Browse to select file.

Select plot variables:

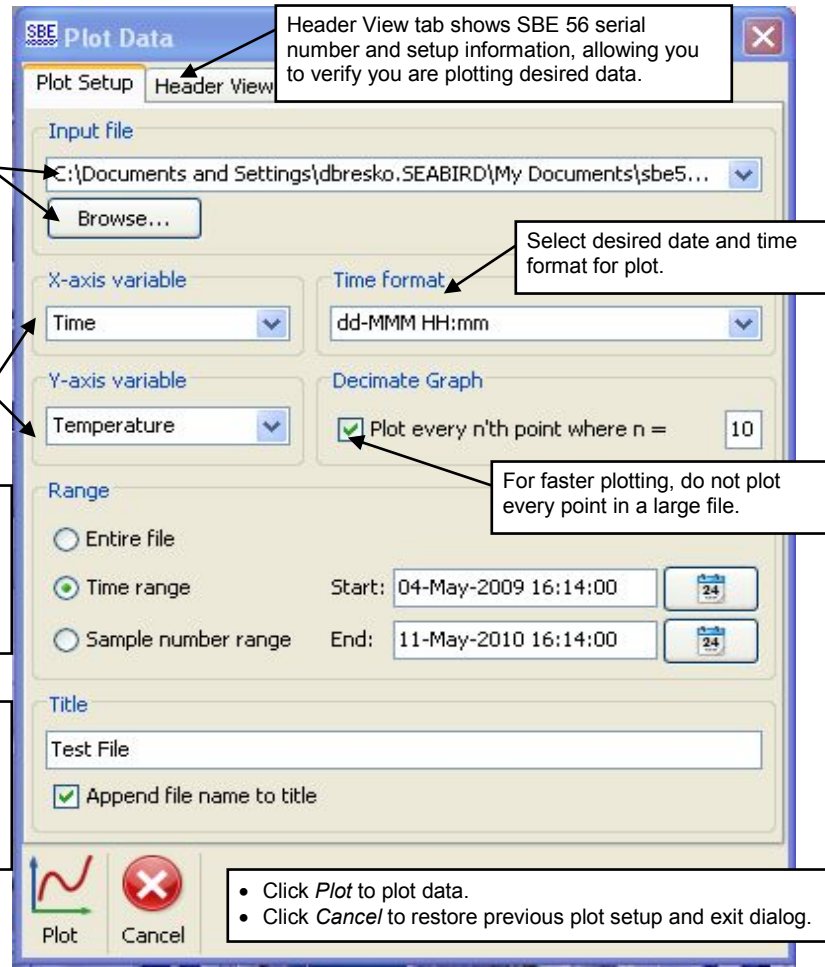
- X-axis - time or sample number.
- Y-axis - temperature or raw data.

Range to plot::

- Entire file
- Time range - enter desired start and end times.
- Sample number range - enter desired start and end sample numbers.

Enter desired plot Title.

- If you click *Append file name to title*, program adds input file name to end of title (Example: If input file name is SBE56.xml, and user enters Test File as Title, title on plot will be *Test File SBE56*).



Header View tab shows SBE 56 serial number and setup information, allowing you to verify you are plotting desired data.

Select desired date and time format for plot.

For faster plotting, do not plot every point in a large file.

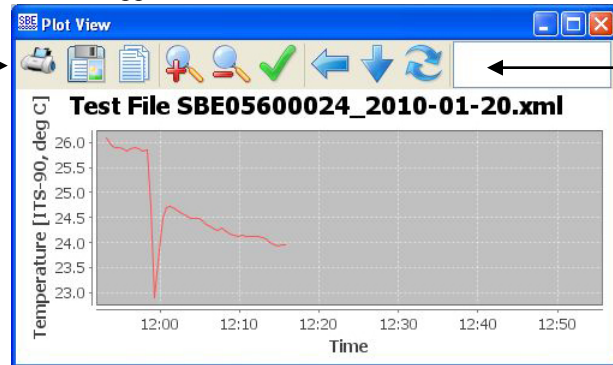
- Click *Plot* to plot data.
- Click *Cancel* to restore previous plot setup and exit dialog.

Make the desired selections and entries, and click the *Plot* button.

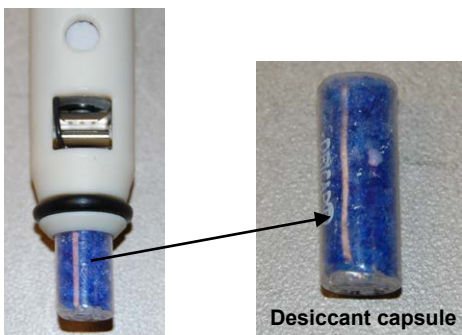
5. The Plot View appears:

Toolbar:

- Print plot
- Save plot - save as .jpeg, .gif, or .png
- Copy plot - allows you to paste plot into another program, such as Word
- Zoom in - click this, then click point of interest in plot
- Zoom out - click this, then click point of interest in plot
- Arrow cursor (check) - restore arrow cursor after using Zoom in or out
- Restore x-axis (horizontal arrow) to original range
- Restore y-axis (vertical arrow) to original range
- Restore both axes to original range



If you click on a point on plotted line, cursor x and y coordinates appear here



Desiccant capsule

6. After all data is uploaded, click **Clear Memory** and click the **Update Configuration** button. If you do not clear the memory, new data will be stored after the last sample, preventing use of the entire memory capacity.
 - The SBE 56 also clears its event counters when you clear the memory.
7. Unplug the USB cable from the SBE 56; the SBE 56 LED flashes slowly two times to indicate that it is in Acquisition mode (logging or waiting to start logging at the delayed start date and time).
8. Replace the desiccant capsule if you will be redeploying the SBE 56 (see *Replacing Desiccant* in *Section 5: Maintenance and Calibration*).

9. Reinstall the end cap and close the housing.
 - A. Remove any water from the O-rings and mating surfaces in the housing with a lint-free cloth or tissue. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-ring and mating surfaces.
 - B. Carefully fit the end cap into the housing, pushing in until the first O-ring is seated.
 - C. Using the opening tool, screw the end cap into the housing.

Data Formats

Uploaded .xml File

The uploaded .xml file has a header that includes calibration coefficient information, followed by the data in a raw Hex format. The .xml file can be plotted using SeatermUSB's **Plot** button, and it can also be exported as a .cnv, .csv, or .zip file for use in other software (see descriptions below).

Exported to .csv File (compatible with MatLab, Excel)

sample, date, hh:mm:ss, ttt.tttt

where:

sample = sample number (1, 2, 3, etc.), if *Output sample number* selected
date = yyyy-mm-dd (year, month, day), dd-mmm-yyyy (day, month [3-letter abbreviation; i.e., jan, feb, etc.], year), mm/dd/yyyy (month, day, year), or dd/mm/yyyy (day, month, year), depending on selection
hh:mm:ss = hour, minute, second
ttt.tttt = temperature (degrees Celsius, ITS-90)

Effect of other selections in Export Data dialog box:

- If *Output informational header* is selected, the data is preceded by a header that lists instrument type, serial number, and firmware version, conversion date, input (.xml) uploaded data file, and calibration date and coefficients.
- If *Split file into multiple parts for use by Excel* is selected, the maximum number of scans per .csv file is 64,000, for compatibility with Excel. Multiple files are created as necessary, to export all the data. The files are numbered 1, 2, etc. (for example, test_1.csv, test_2.csv, etc.).

Exported to .cnv File (compatible with SBE Data Processing's Sea Plot module)

sample time ttt.tttt flag

where:

sample = sample number (1, 2, 3, etc.), if *Output sample number* selected
time = seconds since 1-January-2000 or Julian days, depending on selection
ttt.tttt = temperature (degrees Celsius, ITS-90)
flag = error flag column, always set to 0

Exported to .zip File (compressed)

The .zip file contains the same information as the uploaded .xml file, with data in raw Hex. Sea-Bird may request this file if assisting with troubleshooting.

Notes:

- Each line of output is followed by a carriage return and line feed.
- Leading zeros for temperature output are suppressed, except for one zero to the left of the decimal point (for example, a temperature of 0.1034).

Notes:

- Each line of output is followed by a carriage return and line feed.
- Leading zeros for temperature output are suppressed, except for one zero to the left of the decimal point (for example, a temperature of 0.1034).

Plotting Data

Note:

The .xml data file can also be exported as a .csv, .cnv, or .zip file for use in other software; see *Exporting Data* below.

Click the Plot button to create a plot of the data. See *Uploading and Plotting Data* above for details.

Exporting Data

Note:

See *Data Formats* above.

The uploaded .xml file has a header that includes calibration coefficient information, followed by the data in a raw Hex format. The .xml file can be plotted using SeatermUSB's Plot button, and it can also be exported as a .csv (comma-separated; compatible with MatLab and Excel), .cnv (compatible with SBE Data Processing), or .zip (compressed raw Hex data) file for use in other software.

1. In SeatermUSB, click the **Export** button. The Export Data dialog appears.

Select desired file type:

- .csv Comma separated values,
- .cnv Compatible with SBE Data Processing, or
- .zip Compressed raw data

Click Browse button to select desired Upload Data File (.xml). In Open dialog box, select desired file and click Open.

Click Browse button to select desired location and name for Export file. In Select Export File dialog box, select desired file and click Open.

- If you selected a **.csv** output file: select options for date format, whether to output sample numbers (1, 2, etc.) with data, whether to include file header (SBE 56 serial number, firmware version, conversion date, input data file name, calibration date and coefficients), and splitting of file into multiple parts for use by Excel (maximum of 64,000 lines of data per file).
- If you selected a **.cnv** output file: select options for date format, whether to output sample numbers (1, 2, etc.) with the data, and whether to include file header (SBE 56 serial number, firmware version, conversion date, input data file name, calibration date and coefficients).

Make the desired selections.

2. Click the Export button. The Status bar at the bottom of SeatermUSB displays the export progress.

Section 5: Routine Maintenance and Calibration

This section reviews battery replacement, corrosion precautions, and sensor calibration. The SBE 56's accuracy is sustained by the care and calibration of the sensor and by establishing proper handling practices.

Replacing Battery

Note:

If power is removed:

- Clock resets to 1 January 2000, and
- Up to 123 samples of data in the 512 byte cache are lost (see *Memory in Appendix I: Functional Description*)

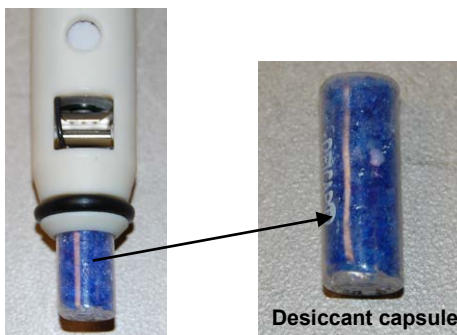
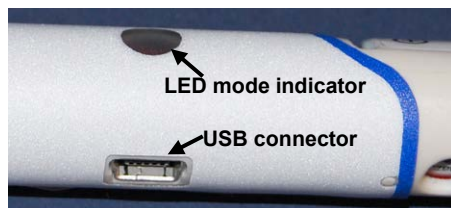
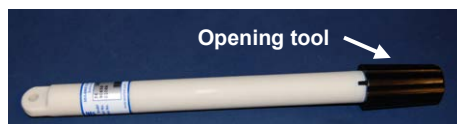
When plugged into the computer, you can remove and replace the battery without resetting the clock or losing data in the cache, because the SBE 56 is powered through the USB cable.

Sea-Bird ships the SBE 56 with a Saft 3.6-volt AA lithium battery installed. After uploading all data, remove the battery when storing the SBE 56.

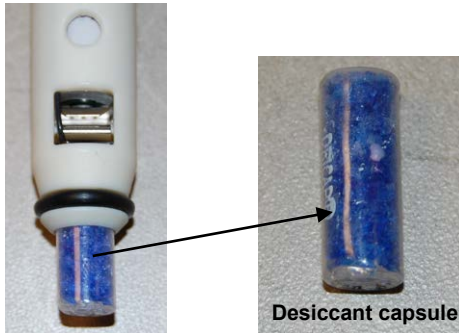
NOTE: Dispose of used batteries in accordance with federal, state, and local regulations.

Follow the instructions below to change the battery. See *Shipping Precautions in Section 1: Introduction* for details on shipping lithium batteries.

1. Remove the end cap and electronics from the housing as follows:
 - A. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.
 - B. Using the opening tool, unscrew the end cap.
 - C. Pull the end cap and attached electronics out of the housing.
 - D. Remove any water from the end cap O-rings and mating surfaces inside the housing with a lint-free cloth or tissue.
2. Replace the battery:
 - A. Supporting the electronics holder, use a pen or key to push on the back of the battery to pop it out.
 - B. Install a new Saft 3.6-volt AA lithium battery; the SBE 56 LED flashes slowly two times to indicate that it is now logging data or waiting to start logging at the programmed delayed start date and time.
 - C. If the SBE 56 was not plugged into a USB port when you removed the battery (thus removing all power), the real-time clock reset to January 1, 2000. If so, in SeatermUSB click **Set Time to . . .** and click the **Update Configuration** button to reset the SBE 56 real-time clock to match the displayed clock time.
3. Install a new desiccant capsule in the desiccant holder, to help prevent condensation. See *Replacing Desiccant* below.
4. Reinstall the end cap and close the housing:
 - A. Remove any water from the O-rings and mating surfaces in the housing with a lint-free cloth or tissue. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-ring and mating surfaces.
 - B. Carefully fit the end cap into the housing, pushing in until the first O-ring is seated.
 - C. Using the opening tool, screw the end cap into the housing.



Replacing Desiccant



If the SBE 56 housing has been opened to perform setup, upload data, or install a new battery, install a new desiccant capsule in the desiccant holder before redeployment, to help prevent condensation.

Note: In January 2012, Sea-Bird increased the length of the housing by approximately 1 cm (0.4 inches) to accommodate the pictured desiccant. The smaller desiccant *pill* previously shipped with the SBE 56 is no longer available from any manufacturer, due to safety concerns regarding the similarity of its size and shape to a pill that would be swallowed. The pictured desiccant will not fit in the older, shorter housing. When the SBE 56 is returned to Sea-Bird for service/calibration, we will replace the housing with the longer housing.

Corrosion Precautions

All exposed materials are plastic (housing) and titanium (thermistor). No corrosion precautions are required. Rinse the SBE 56 with fresh water after use and prior to storage.

Cleaning Housing

Do not use strong solvents, which could damage the plastic.

- To remove barnacles, soak the SBE 56 in white vinegar.
- To remove markings, use isopropyl alcohol.

After cleaning, rinse well with fresh water.

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 temperature sensor on the SBE 56 is supplied fully calibrated, with coefficients printed on the Calibration Certificate (in the manual). These coefficients have been stored in the SBE 56's memory.

We recommend that the SBE 56 be returned to Sea-Bird for calibration.

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.

Section 6: Troubleshooting

Note:

To clear the event counter, click *Clear Events* and then click the *Update Configuration* button. Note that the event counter is also cleared if you clear the memory.

This section reviews common *events* recorded in the SBE 56 event counter, and provides the most common causes.

Event counter data can help to identify the root cause of a malfunction, but also includes a number of common occurrences, such as power on resets, timeouts, etc. Listed below are the most common events recorded in the event counter:

- **POR_RESET:** This event is incremented each time the SBE 56 starts up from the beginning of its software. This occurs each time the battery is removed and replaced, and each time a PF_RESET or WDT_RESET event occurs.
- **PF_RESET:** This event is incremented if there is a low battery condition. The battery cutoff is not absolute and the detection circuitry is not noise free, so this may be triggered successively as a battery reaches exhaustion. POR_RESET is also incremented.
Solution: Upload all the data (see *Section 4: Recovery and Uploading Data*). Then install a new battery (see *Section 5: Routine Maintenance and Calibration*), and update the configuration to indicate that a new battery has been installed (see *Section 3: Preparing for Deployment*).
- **WDT_RESET:** This event is incremented if a firmware error occurs and the microcontroller is unresponsive for ~1.6 seconds. The watchdog timer automatically resets the SBE 56 and operation continues as planned. POR_RESET is also incremented.
- **MEMORY_FULL:** This event is incremented if the memory is full.
Solution: Upload all the data (see *Section 4: Recovery and Uploading Data*), and then clear the memory (see *Section 3: Preparing for Deployment*).
- **11:** This event is incremented if measurement of the bridge voltage indicates the thermistor has become open circuit or disconnected, suggesting a problem with the operation of the instrument.
Solution: Contact Sea-Bird.

There are a number of other event codes, which are seen only in the event of hardware failure. Contact Sea-Bird if you receive any other codes.

Glossary

Battery – Saft 3.6-volt AA lithium battery.

PCB – Printed Circuit Board.

SBE 56 – High-accuracy temperature logger with USB 2.0 interface.

SBE Data Processing – Sea-Bird’s Win 2000/XP data processing software, which calculates and plots temperature and derived variables. The only modules in SBE Data Processing that can be used with SBE 56 .cnv data are ASCII Out and Sea Plot.

Scan – One data sample containing temperature, and date and time.

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 *SeatermV2* and *SBE Data Processing*. Extensive testing has not shown any compatibility problems when using the software with a PC running Windows Vista or Windows 7.

SeatermUSB– Sea-Bird’s Win 2000/XP program used to communicate with the SBE 56, providing a status display, data acquisition setup, data retrieval, data export, and plotting functions. SeatermUSB is launched from SeatermV2.

SeatermV2– Win 2000/XP terminal program *launcher*. Depending on the instrument selected, it launches **SeatermUSB** (USB interface instrument for SBE 56), *Seaterm232* (RS-232 instruments), *Seaterm485* (RS-485 instruments), or *SeatermIM* (inductive modem instruments).

Appendix I: Functional Description

Sensor and Sensor Interface

The SBE 56 includes the same temperature sensor element (pressure-protected thermistor) previously employed in Sea-Bird's modular SBE 3 sensor, and in Sea-Bird's SeaCAT and MicroCAT families, and in the SBE 39 Temperature Recorder. It has a long history of exceptional accuracy and stability; drift is typically less than 0.002°C per year.

Temperature is acquired by applying a DC excitation to a hermetically sealed VISHAY reference resistor and an ultra-stable aged thermistor with a drift rate of less than 0.002°C per year. A 24-bit A/D converter digitizes the outputs of the reference resistor and thermistor. The ratiometric comparison between the reference and the thermistor avoids errors caused by offset voltages, leakage currents, and reference errors.

Real-Time Clock

To 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 at 0 °C to 40 °C (± 2 ppm).

Memory

The SBE 56 has a 64 MB FLASH memory for data storage. FLASH memory is non-volatile and data in the memory is not lost as a result of depletion or removal of the battery. Because FLASH is written a page (512 bytes) at a time, data is first accumulated in a 512 byte cache. When the cache is full, its contents are transferred to FLASH memory. The cache is volatile and therefore depends on battery power. If the SBE 56 battery becomes depleted or is removed, it will lose its most recent, to be stored data (up to a maximum of 512 bytes, corresponding to 123 samples).

If the battery has not been depleted, connect the SBE 56 to a computer prior to battery removal. The SBE 56 is powered through the USB cable when the cable is plugged into the computer. As the SBE 56 enters Command mode, it automatically saves the cached data to the FLASH memory.

Timekeeping

Time is stored in volatile memory; the clock resets to 1 January 2000 if power is removed. Upon restoration of power, the clock resumes normal operation.

The SBE 56 is powered through the USB cable when the cable is plugged into the computer. You can remove and replace the SBE 56's battery while plugged into the computer, without resetting the clock.

Other Settings

Calibration coefficients, sampling interval, and the error log are written to FLASH and are non-volatile; these do not change if power is removed.

Appendix II: Replacement Parts

Part Number	Part	Application Description	Quantity in SBE 56
22095	Battery, 3.6-volt, 2.6 A-hr AA lithium, Saft LS14500	Power SBE 56	1
172557	Cable, USB Type A to Mini-B, M5USB2-USB-A, 1.8 m (6 ft)	USB Cable from SBE 56 to computer	1
234372	Opening tool	Tool to simplify removal of SBE 56 end cap and electronics from housing	1 (per shipment)
60059	Spares kit for SBE 56	Includes: <ul style="list-style-type: none"> • 311004, O-Ring, Parker 3-909 N674-70 (in end cap grooves, for watertight seal) • 60058 Desiccant bottle for SBE 56 (5 desiccant capsules [silica gel] for replacing desiccant each time you open housing) 	1

Appendix III: Manual Revision History

Manual Version	Date	Description
001Beta	01/10	<ul style="list-style-type: none">• Initial release, Beta version.
002Beta	04/10	<ul style="list-style-type: none">• Second Beta version – product and software changes.
003	03/11	<ul style="list-style-type: none">• First production version release – product and software changes.
004	02/12	<ul style="list-style-type: none">• Add information on deployment orientation for best battery endurance.• Update photos and drawing for longer housing to accommodate new, longer desiccant.• Add information on opening tool.• SeatermV2 version 1.1g: Update SeatermUSB software toolbar description to add Upload All and Report buttons.

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