SBE48 Ship Hull

Temperature Sensor

User Manual, Version 004

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SBE 48 HULL MOUNT TEMPERATURE OPERATING MANUAL

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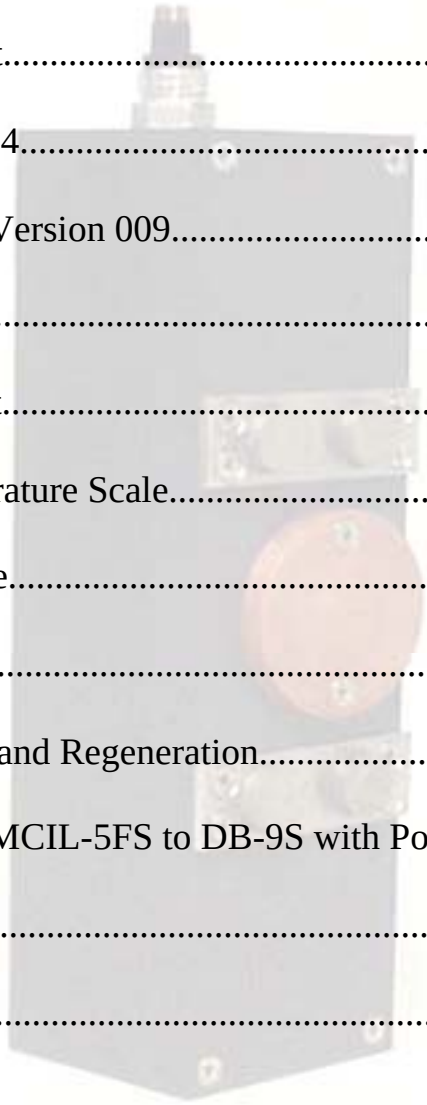

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Manual Generation Date: 27 June 2011

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 of servicing of this system.

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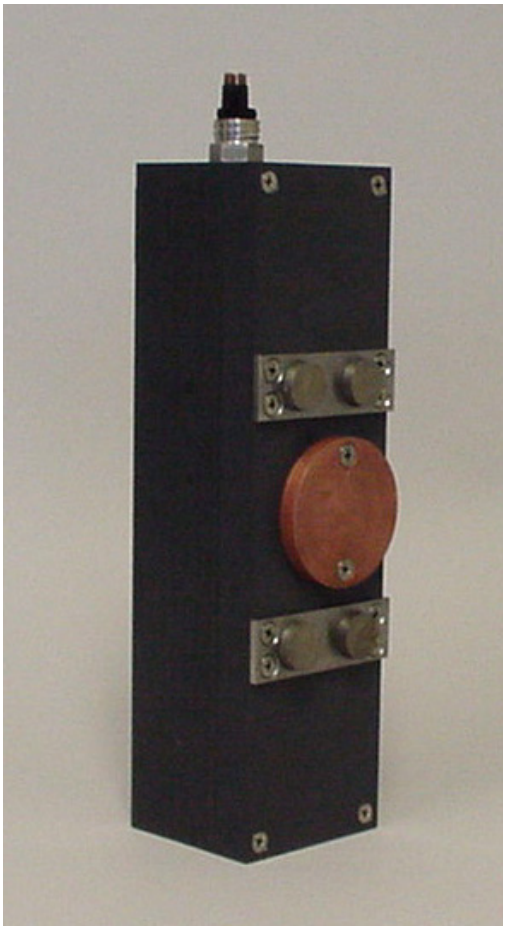
SBE 48
Hull Temperature Sensor

With RS-232 Serial Interface



Note: NEW ADDRESS
as of January 18, 2010

User's Manual

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Section 1: Introduction

This section includes contact information, Quick Start procedure, photos of a standard SBE 48 shipment, and shipping precautions.

About this Manual

This manual is to be used with the SBE 48 Hull Temperature Sensor.

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 e-mail any comments or suggestions to seabird@seabird.com.

How to Contact Sea-Bird

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Business hours:
Monday-Friday, 0800 to 1700 Pacific Standard Time
(1600 to 0200 Universal Time)
Except from April to October, when we are on *summer tim*e
(1500 to 0000 Universal Time)

Quick Start

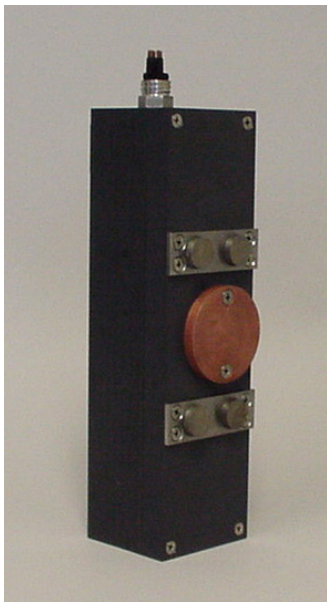
Follow these steps to get a Quick Start using the SBE 48. The manual provides step-by-step details for performing each task:

1. Test Power and Communications (*Section 3: Preparing SBE 48 for Deployment*).

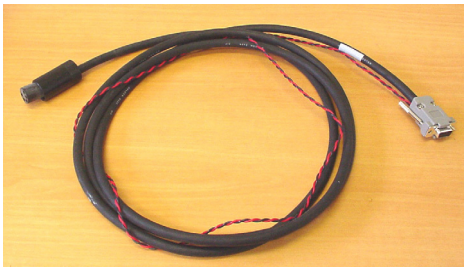
2. Deploy the SBE 48 (*Section 4: Deploying and Operating SBE 48*):
   A. Install a new battery if necessary (*Section 5: Routine Maintenance and Calibration*).
   B. Ensure all data has been uploaded, and then set **SampleNum=**0 to make entire memory available for recording if desired.
   C. Set date and then time.
   D. Establish logging parameters.
   E. Set SBE 48 to start logging now or in the future.
   F. Install dummy plug or I/O cable, and locking sleeve.
   G. Using magnets on housing, mount SBE 48 on inside of ship's hull below the waterline.

Unpacking SBE 48

Shown below is a typical SBE 48 shipment.



SBE 48



I/O Cable

25-pin to 9-pin adapter (for use with computer with DB-25 connector)

SBE 48 User Manual

Software, and Electronic Copies of Software Manuals and User Manual

Shipping Precautions

WARNING!
Do not ship spare batteries by passenger aircraft.

The SBE 48 was shipped from the factory with the 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 48 to Sea-Bird. Do not return the used battery to Sea-Bird when shipping the SBE 48 for repair or recalibration.
All setup information is preserved in EEPROM 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 of SBE 48

This section describes the functions and features of the SBE 48, including specifications, dimensions, sample timing, and battery endurance.

System Description

The SBE 48 is a high-accuracy temperature recorder with non-volatile memory, designed for shipboard determination of sea surface temperature. Installed with magnets just below the water line, the SBE 48's temperature sensor is in contact with the **inside** of the ship's hull. The SBE 48's internal battery runs the real-time clock and can be used to power the SBE 48 for very short deployments; external power is recommended for typical deployments.

The SBE 48 retains the temperature sensor used in the SBE 39 Temperature Recorder. The SBE 48's thermistor has a long history of exceptional accuracy and stability (typical drift is less than 0.002 °C per year).

The SBE 48 communicates directly with a computer via a standard RS-232 interface. Baud rates of 1200 to 38,400 are user-selectable. Setup and extraction of data from the SBE 48 is done via an I/O data cable plugged into an external connector. Calibration coefficients stored in EEPROM allow the SBE 48 to transmit data in engineering units.

Commands can be sent to the SBE 48 to provide status display, data acquisition setup, data retrieval, and diagnostic tests. User-selectable operating modes include:

- **Polled sampling** – The SBE 48 takes one sample and sends the data to the computer. Polled sampling is useful for testing.
- **Autonomous sampling** – There are two types of Autonomous sampling.
  - *Interval sampling*: At pre-programmed intervals, the SBE 48 wakes up, samples, stores data in memory, and powers off (enters quiescent state).
  - *Continuous sampling*: The SBE 48 continuously samples and stores data in memory, and does not power off between samples.

  The SBE 48 also calculates a running average of up to 120 temperature samples, which can be transmitted while logging data.
- **Serial Line Sync** - A pulse on the serial line causes the SBE 48 to wake up, sample, store data in memory, and power off. This mode provides easy integration with other instruments that can synchronize SBE 48 sampling with their own.

Future upgrades and enhancements to the SBE 48 firmware can be easily installed in the field through a computer serial port and the external connector on the SBE 48, without the need to return the SBE 48 to Sea-Bird.

Notes:
- Help files provide detailed information on the use of SEATERM, Plot39, and SBE Data Processing.
- A separate software manual on CD-ROM contains detailed information on the use of SBE Data Processing.

The SBE 48 is supplied with a powerful Win 2000/XP software package, SEASOFT-Win32, which includes:

- **SEATERM** - terminal program for easy communication and data retrieval.
- **Plot39** - program for plotting data from an SBE 48 or SBE 39.
- **SBE Data Processing** – program includes many post-processing modules; modules applicable to the SBE 48 are ASCII Out (export files for other programs) and Sea Plot (plot data).

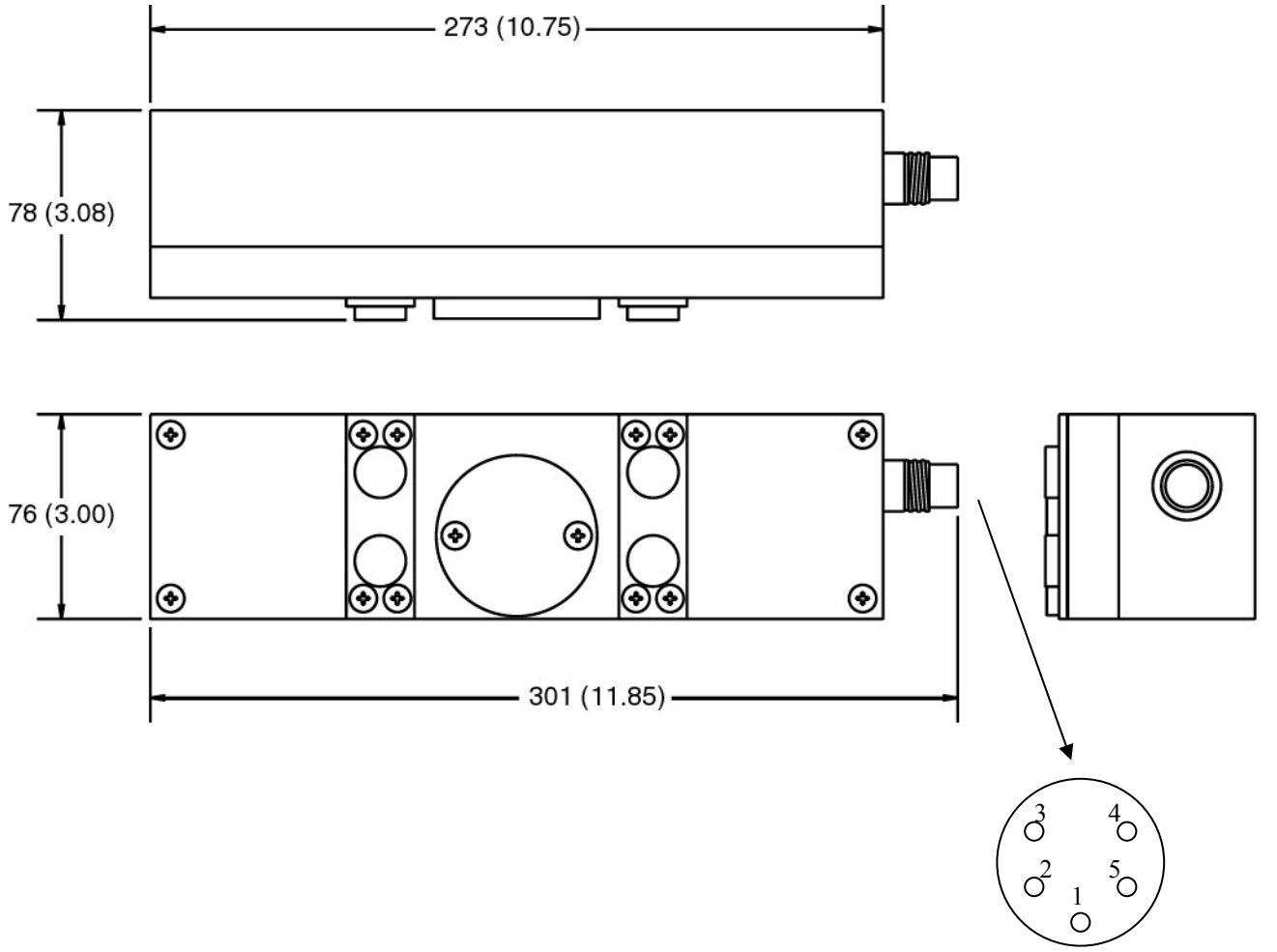
Specifications

Measurement Range	-5 to +35 °C
Initial Accuracy	0.002 °C
Typical Stability	0.0002 °C per month
Resolution	0.0001 °C
Sensor Calibration	+1 to +32 °C
Memory	64 Mbyte non-volatile FLASH memory (32,900,000 bytes usable)
Data Storage	Converted temperature: 3 bytes per sample. Time: 4 bytes per sample. Memory space (temperature and time): 4,700,000 samples.
Real-Time Clock	32,768 Hz TCXO accurate to ±1 minute/year
Internal Battery	9-volt lithium battery (unrestricted) - runs real-time clock; can also be used to power SBE 48, if external power is not supplied
External Power	8 - 16 VDC. The SBE 48 is typically deployed with external power. The internal lithium battery is diode-OR'd with the external source, so power will be drawn from whichever voltage source is higher.
Current	*Quiescent Current*: 10 microamps *Current Consumption (per sample)*: 0.018 Amp-second *Current Consumption (continuous sampling):* 15 milliAmps
Battery Endurance	Running clock only: 5 to 10 years Providing power for logging: 180,000 samples
Materials	PVC housing
Weight	2.3 kg (5 lbs)

Note:
If the SBE 48 is logging data and the voltage is less than 6.25 volts for 10 consecutive scans, the SBE 48 halts logging and displays a low battery indication in the data.

Dimensions and Connector

Dimensions in millimeters (inches)



Pin	Description
1	Ground
2	Transmit: RS-232C transmit data from SBE 48 to computer
3	Power: 8 - 16 VDC external power
4	Receive: RS-232C receive data transmitted from computer
5	Shield

Sample Timing

Note:
Sampling time shown does not include time to transmit real-time data, which is dependent on baud rate.

Time required to transmit data =
(# of characters * 10 bits/character) / baud

This corresponds to 0.28 seconds at 1200 baud to 0.01 seconds at 38400 baud.

Minimum timing between samples is dependent on whether real-time output is provided (**TxRealTime=**).

The table below provides the approximate interval between samples if the SBE 48 is set up for continuous sampling:

Real-Time Output?	Time (seconds)
No (**TxRealTime=N**)	0.80
Yes (**TxRealTime=Y**)	1.00

Battery Endurance

Notes:
- If the SBE 48 is logging data and the battery voltage is less than 6.25 volts for ten consecutive scans, the SBE 48 halts logging and displays a low battery indication in the data.
- **See *Specifications* above for data storage limitations.**

Battery capacity is as follows:
- **Standard lithium battery** - nominal capacity is 1.2 amp-hours. For planning purposes, use a conservative value of 1.1 amp-hours.
- **Duracell MN1604 alkaline battery** - nominal capacity is 0.4 amp-hours. For planning purposes, use a conservative value of 0.3 amp-hours.

Current consumption is as follows:
- Sampling (acquisition) current for *continuous, autonomous sampling* is 15 milliAmps.
- Sampling (acquisition) current for *polled sampling*; *interval, autonomous sampling*; or *serial line sync sampling* is 18 milliAmp-seconds/sample
- Quiescent current is 10 microAmps (0.09 AH per year).

So, battery endurance is dependent on the application. An example is shown below for two sampling schemes.

Example 1: SBE 48 is set up to sample autonomously every 5 minutes (12 samples/hour). How long can it be deployed with a lithium battery?

Sampling current consumption = 18 milliamp-seconds/sample = 0.018 amp-seconds/sample
In 1 hour, sampling current consumption = 12 * 0.018 amp-seconds/sample = 0.216 amp-seconds/hour
Quiescent current = 10 microamps = 0.01 mA = 0.00001 amps
In 1 hour, quiescent current consumption = 0.00001 mA * 3600 seconds/hour = 0.036 amp-seconds/hour
Current consumption / hour = 0.216 + 0.036 = 0.252 amp-seconds/hour
Capacity = (1.1 amp-hours * 3600 seconds/hr) / (0.252 amp-seconds/hour) = 15714 hours = 654 days = 1.7 years
Total number of samples = 15714 hours * 12 samples/hour = 188,000 samples

Example 2: SBE 48 is set up to sample continuously. How long can it be deployed with a lithium battery?

Sampling current consumption = 15 milliamps = 0.015 amps
Capacity = (1.1 amp-hours) / (0.015 amps) = 73 hours

Section 3: Preparing SBE 48 for Deployment

This section describes installing software and the pre-check procedure for preparing the SBE 48 for deployment.

Installing Software

Sea-Bird recommends the following minimum system requirements for SEASOFT-Win32: Pentium 90 CPU, 64 Mbyte RAM, Windows 98 or later.

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. Double click on **Seasoft-Win32.exe**.
3. Follow the dialog box directions to install the software.

The default location for the software is c:\Program Files\Sea-Bird. Within that folder is a sub-directory for each program. The installation program allows you to install the desired components. Install all the components, or just install SEATERM for now.

Note:
It is possible to use the SBE 48 without SEATERM by sending direct commands from a dumb terminal or terminal emulator, such as Windows HyperTerminal.

Power and Communications Test

The power and communications test will verify that the system works, prior to deployment.

Note:
Sea-Bird ships the SBE 48 with a 9-volt lithium battery installed. See *Section 5: Routine Maintenance and Calibration* for details on replacing the battery.

Test Setup

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

1. Install the I/O cable connector (see *Dimensions and Connector* in *Section 2: Description of SBE 48*):

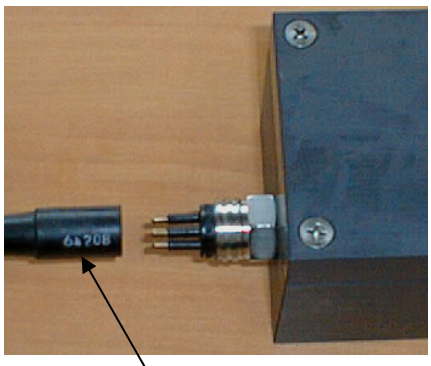
   A. Lightly lubricate the sides of the rubber prongs on the SBE 48 bulkhead connector with silicone grease (DC-4 or equivalent).

   B. Install the cable connector, aligning the holes with the five pins on the SBE 48's bulkhead connector.

   C. Place the locking sleeve over the connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

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

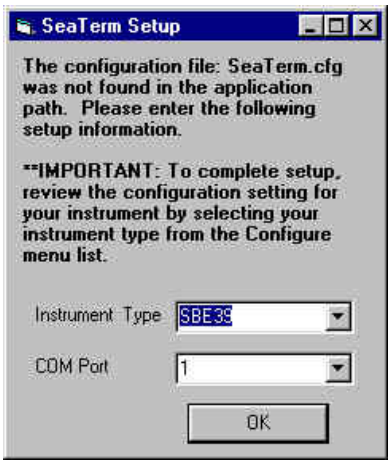
   E. Connect the I/O cable connector's red (+) and black (-) wires to a power supply (8 - 16 VDC).



Test

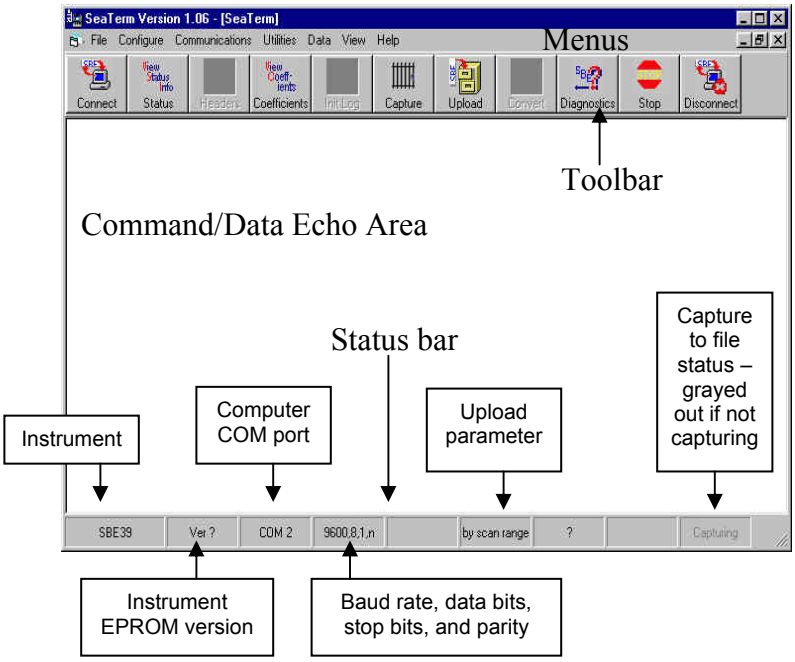
Notes:
- See SEATERM's Help files.
- The SBE 48 is not available in the list of instrument types. **Select the SBE 39 as the instrument type.**

1. Double click on SeaTerm.exe. If this is the first time the program is used, the setup dialog box appears:



Select the instrument type (**SBE 39**) and the computer COM port for communication with the instrument. 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
- Use a menu to automatically generate a command
- Use a Toolbar button to automatically generate a command

Note:
Once the system is configured and connected (Steps 3 and 4 below), to update the Status bar:
- on the Toolbar, click Status; or
- from the Utilities menu, select Instrument Status.

SEATERM sends the status command; the response displays in the Data Echo Area, and the Status bar is updated.

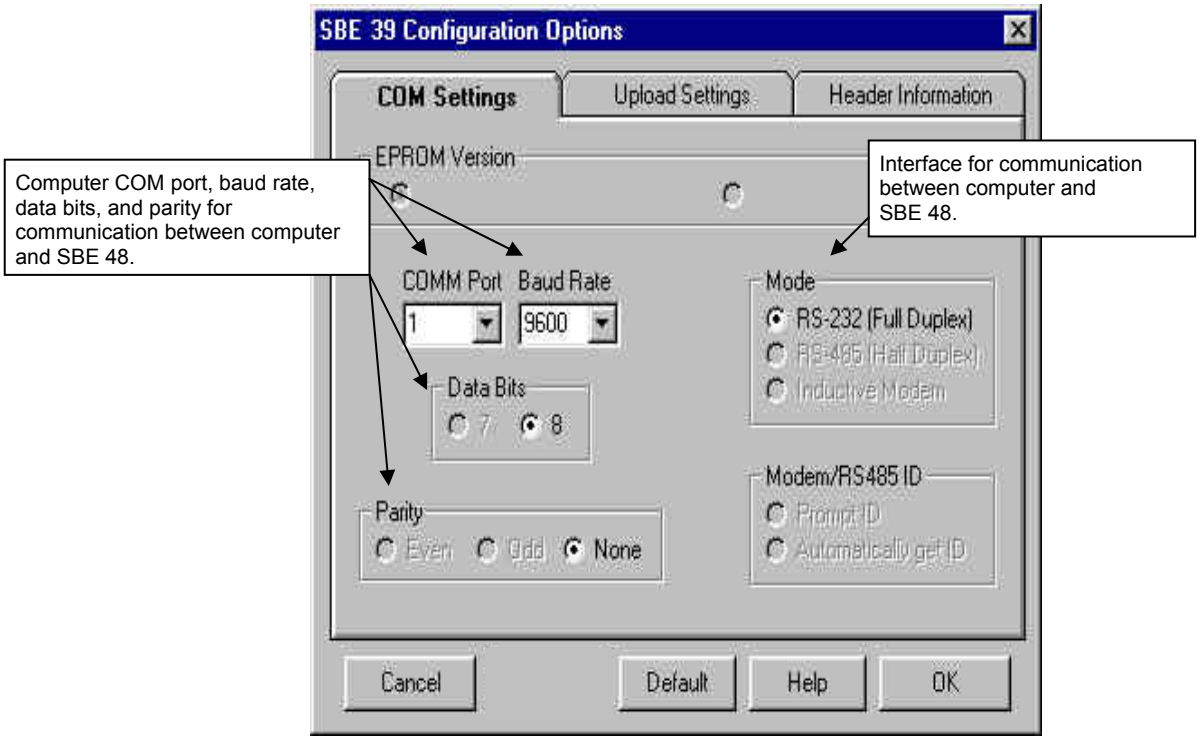
- Menus – Contains tasks and frequently executed instrument commands.
- Toolbar – Contains buttons for frequently executed tasks and instrument commands. All tasks and commands accessed through the Toolbar are also available in the Menus. To display or hide the Toolbar, select View Toolbar in the View 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 (use 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.

Following are the Toolbar buttons applicable to the SBE 48:

Toolbar Button	Description	Equivalent Command*
Connect	Re-establish communications with SBE 48. Computer responds with S> prompt. SBE 48 *goes to sleep* after 2 minutes without communication from computer have elapsed.	(press Enter key)
Status	Display instrument setup and status (logging, number of samples in memory, etc.).	**DS**
Coefficients	Display calibration coefficients.	**DC**
Capture	Capture instrument responses on screen to file; useful for diagnostics. File has .cap extension. Press Capture again to turn off capture. Capture status displays in Status bar.	—
Upload	Upload data stored in SBE 48's memory, in format to allow for post-processing by Plot39 or SBE Data Processing. Uploaded data has .asc extension. Before using Upload: • Configure upload and header parameters in Configure menu. • If Autonomous Sampling: Send **Stop** command to stop logging.	**DDb,e** (use Upload button if you will be post-processing data with Plot39 or SBE Data Processing)
Convert	Convert uploaded .asc data file to a .cnv data file, which can then be processed by SBE Data Processing.	—
Diagnostics	Perform one or more diagnostic tests on SBE 48. Diagnostic test(s) accessed in this manner are non-destructive –they do not write over any existing instrument settings.	**DS, DC, TS,** and **TSR**
Stop	Interrupt and end current activity, such as logging, uploading, or diagnostic test.	—
Disconnect	Free computer COM port used to communicate with SBE 48. COM port can then be used by another program.	—

*See *Command Descriptions* in *Section 4: Deploying and Operating SBE 48*.

3. In the Configure menu, select **SBE 39**. The dialog box looks like this:



Make the selections in the Configuration Options dialog box:
- **COMM Port**: COM 1 through COM 10, as applicable
- **Baud Rate**: 9600 (documented on front cover of this manual)
- **Data Bits**: 8
- **Parity**: None
- **Mode**: RS-232 (Full Duplex)

Click OK to save the settings.

Notes:
- SEATERM's baud rate must be the same as the SBE 48's baud rate (set with **Baud=**). **Baud=** is factory-set to 9600, but can be changed by the user (see *Command Descriptions* in *Section 4: Deploying and Operating SBE 48*).
- 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 37, 39, etc.) in the Configure menu, the Configuration Options dialog box shows the last saved settings for that instrument.

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

5. Click Connect on the Toolbar. SEATERM tries to connect to the SBE 48 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 48
S>
```

This shows that correct communications between the computer and the SBE 48 has been established.
If the system does not respond as shown above:
- 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's factory setting is documented on the front cover of this manual.
- Check cabling between the computer and the SBE 48.

6. Display SBE 48 status information by clicking Status on the Toolbar. The display looks like this:

```
SBE 48 V 2.0   SERIAL NO. 0916  08 Aug 2008 08:49:09
battery voltage = 7.5
logging not started
sample interval = 30 seconds
number of samples to average = 60
samplenumber = 89, free = 4699778
serial sync mode disabled
real-time output disabled
binary upload includes time
temperature =19.48 deg C
```

Note:
The SBE 48 has a 2 minute timeout algorithm designed to:
- restore control to the computer if an illegal command is sent
- conserve power if too much time elapses between commands

If the system does not appear to respond, click Connect on the Toolbar to reestablish communications.

7. Command the SBE 48 to take a sample by typing **TS** and pressing the Enter key. The display looks like this:

```
23.7658, 08 Aug 2008, 08:50:23
```

where 23.7658 = temperature in degrees Celsius
08 Aug 2008 = date
08:50:23 = time

These numbers should be reasonable; i.e., room temperature, current date and time (factory-programmed to Pacific Daylight or Standard Time; can be changed by user).

8. Command the SBE 48 to go to sleep (quiescent state) by typing **QS** and pressing the Enter key.

The SBE 48 is ready for programming and deployment.

Section 4: Deploying and Operating SBE 48

This section provides discussions and instructions on:
- System operation
- Example sets of operation commands for each operating mode
- Real-time data acquisition
- Detailed command descriptions
- Data output formats
- Deployment
- Uploading data
- Processing data

Sampling Modes

The SBE 48's user-selectable sampling modes for obtaining data include:

- Polled Sampling
- Autonomous Sampling - Interval and Continuous
- Serial Line Synchronization

Commands can be used in various combinations to provide a high degree of operating flexibility.

Descriptions and examples of the sampling modes follow. Note that the SBE 48's response to each command is not shown in the examples. Review the operation of the sampling modes and the commands described in *Command Descriptions* before setting up your system.

Polled Sampling (Operating commands)

The SBE 48 takes one sample of data and sends the data to the computer. Storing of data in the SBE 48's FLASH memory is dependent on the particular command used.

Example: (user input in bold)
Establish communication with SBE 48. Command SBE 48 to take a sample and send converted data to computer (do not store data in memory). Send power-off command to SBE 48.

(Click Connect on Toolbar to wake up)
S>**TS**
S>**QS**

Autonomous Sampling (Logging commands)

There are two types of Autonomous sampling:

- *Interval sampling*: At pre-programmed intervals, the SBE 48 wakes up, samples data and stores it in FLASH memory, and powers-off (enters quiescent state). The sampling interval is set with **Interval=**.
- *Continuous sampling*: The SBE 48 samples data continuously and stores it in FLASH memory, and does not power-off between samples. Continuous sampling is established by setting **Interval=0**. If not transmitting real-time output, the SBE 48 takes a sample at approximately 0.8-second intervals; if transmitting real-time data, the SBE 48 takes a sample at approximately 1.0-second intervals.

Note:
Use **Stop** to:
- stop logging
- stop waiting to start logging (after **StartLater** has been sent)

Logging is started with **StartNow** or **StartLater**, and is stopped with **Stop**. Transmission of real-time data to the computer is dependent on **TxRealTime=**.

Example: ***Autonomous Sampling - Interval Sampling*** (user input in bold)
Establish communication. Set sample number to 0 to overwrite previous data in memory. Set up to sample every 10 seconds, store data in memory, and not transmit real-time data to computer. Set up to automatically start on 10 January 2009 at 12:00:00. Verify setup. Send power-off command to SBE 48 after all parameters are entered - system will automatically wake up and power down for each sample.

(Click Connect on Toolbar to wake up)
S>**SAMPLENUM=0**
S>**INTERVAL=10**
S>**TXREALTIME=N**
S>**STARTMMDDYY=011009**
S>**STARTHHMMSS=120000**
S>**STARTLATER**
S>**DS** (verify setup)
S>**QS**

When ready to upload all data to computer, establish communication with SBE 48, stop sampling, and upload data. Send power-off command.

(Click Connect on Toolbar to wake up)
(Press Enter key to get S> prompt)
S>**STOP**
(Click Upload on Toolbar – program leads you through screens to define data to be uploaded and where to store it)
S>**QS**

Example: ***Autonomous Sampling - Continuous Sampling***
Same as above, but set **INTERVAL=0**.

Serial Line Sync

Serial Line Sync allows a simple pulse on the RS-232 line to initiate a sample. This mode provides easy integration with other instruments that can synchronize SBE 48 sampling with their own, without drawing on their battery or memory resources.

If this mode is enabled (**SyncMode=Y**) and the SBE 48 is powered down, setting the RS-232 RX line high (3 –10 VDC) for 1 to 1000 milliseconds wakes up the SBE 48 and executes the following sequence:

- Take sample
- Store sample in FLASH memory
- Output real-time data if **TxRealTime=Y**

The SBE 48 then checks the RS-232 line:

- **Mark State** (RS-232 RX line less than 0.5 volts)
  SBE 48 immediately powers down. Serial line sync mode remains enabled (**SyncMode=Y**).
- **Space State** (RS-232 RX line greater than 3 volts)
  SBE 48 monitors the RS-232 line for 100 milliseconds:
  - If line remains in space state - SBE 48 disables serial line sync mode (**SyncMode=N**) at end of time. Once serial line sync mode is disabled, you can communicate with the SBE 48 using the full range of commands (operating, logging, upload commands, etc.).
  - If line returns to mark state - SBE 48 immediately powers down. Serial line sync mode remains enabled (**SyncMode=Y**).

Note:
If running **SEATERM**, select *Send 5 second break* in the Communications menu to hold the RS-232 RX line in space state for 5 seconds. This will cause the SBE 48 to exit Serial Line Sync Mode.

In summary, to disable serial line sync after taking a sample, put the RS-232 line in space state (greater then 3 volts) for 100 milliseconds.

Example: ***Serial Line Sync Mode*** (user input in bold)
Establish communication. Set sample number to 0 to overwrite previous data in memory. Do not transmit real-time data to computer. Enable serial line sync mode. Verify setup. Send power-off command.

(Click Connect on Toolbar to wake up)
S>**SAMPLENUM=0**
S>**TXREALTIME=N**
S>**SYNCMODE=Y**
S>**DS** (to verify setup)
S>**QS**

Take samples using serial line sync mode:

(Set RS-232 RX line high [3-10 VDC] for 1-1000 milliseconds. SBE 48 takes sample and stores data in memory. Within 100 milliseconds, set RS-232 RX line to mark state [less than 0.5 volts]; SBE 48 powers down.)
(Repeat this process at periodic intervals as desired.)

When ready to upload all data to computer, disable serial line sync mode, and then upload data and power down:

(Set RS-232 RX line high [3-10 VDC] for 1-1000 milliseconds. SBE 48 takes sample and stores data in memory)
(Select *Send 5 second break* in Communications menu to disable serial line sync mode.)
(Press Enter key to get S> prompt.)
S>**DS** (to verify SBE 48 is communicating)
(Click Upload on Toolbar – program leads you through screens to define data to be uploaded and where to store it)
S>**QS**

Baud Rate and Cable Length

Notes:
- Set **TxRealTime=Y** to transmit real-time data for autonomous sampling or serial line sync mode.
- Set baud rate with **Baud=**.

See *Command Descriptions* in *Section 4: Deploying and Operating SBE 48* for command details.

The length of cable that the SBE 48 can drive for transmitting real-time data is dependent on the baud rate. The allowable combinations are:

Maximum Cable Length (meters)	Maximum Baud Rate
800	1200
400	2400
200	4800
100	9600
50	19200
25	38400

If acquiring real-time data, click Capture on SEATERM's Toolbar before you begin sampling. The data displayed in SEATERM will be saved to the designated file. Process the data as desired. Note that this real-time data file **cannot be processed by Plot39 or SBE Data Processing, as it does not have the required headers and format**. To process data with Plot39 or SBE Data Processing, upload the data from the SBE 48's memory.

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 48 in upper or lower case letters and register commands by pressing the Enter key.
- The SBE 48 sends `? CMD` 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 48 returns to the quiescent (sleep) state to prevent exhaustion of its battery.
- If in quiescent state, re-establish communications by clicking Connect on the Toolbar or pressing the Enter key to get an `S>` prompt.

Status Command

DS

Display 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 [**MMDDYY=** and **HHMMSS=**]
- input power voltage
- logging status (logging not started, logging data, not logging: waiting to start at … , not logging: received stop command, not logging: low battery, or unknown status)
- sample interval time [**Interval=**]
- number of samples to average (running average) [**NAvg=**]
- number of samples in memory, available sample space in memory
- serial line sync mode status [**SyncMode=**]
- real-time output status [**TxRealTime=**]
- binary upload includes time? [**BinaryTime=**]
- current temperature

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

```
S>DS
SBE48 V 2.0   SERIAL NO. 4355  24 Jul 2008  08:49:08          [MMDDYY= and HHMMSS=]
battery voltage = 7.5
logging not started
sample interval = 20 seconds                                   [Interval=]
number of samples to average = 60                              [NAvg=]
samplenumber = 89, free = 4699778
serial sync mode disabled                                      [SyncMode=]
real-time output disabled                                      [TxRealTime=]
binary upload includes time                                    [BinaryTime=]
temperature = 19.48 deg C
```

Setup Commands

Notes:
- **DDMMYY=** and **MMDDYY=** are equivalent. Either can be used to set the date.
- **Always set both date and then time.** If a new date is entered but not a new time, the new date will not be saved. If a new time is entered without first entering a new date, the date will reset to the last date it was set for with **MMDDYY=** or **DDMMYY=**.
- If the battery has been removed, date and time must be reset.
- If the SBE 48 is logging or waiting to start logging (**StartLater** command has been set), it will not allow the user to reset date or time.

MMDDYY=mmddyy — Set real-time clock month, day, year. Must be followed by **HHMMSS=** to set time.

DDMMYY=ddmmyy — Set real-time clock day, month, year. Must be followed by **HHMMSS=** to set time.

HHMMSS=hhmmss — Set real-time clock hour, minute, second.

Example: Set current date and time to 10 January 2009 12:00:00 (user input in bold).

```
S>MMDDYY=011009
S>HHMMSS=120000
```

or

```
S>DDMMYY=100109
S>HHMMSS=120000
```

Note:
The SBE 48's baud (set with **Baud=**) must be the same as SEATERM's baud (set in Configure menu).

Baud=x — **x=** baud rate (1200, 2400, 4800, 9600, 19200, 38400). Default 9600.

NAvg=x — **x=** number of scans in running average (1 - 120). Running average is reset to 0 when **StartNow** or **StartLater** is sent.

Notes:
- **TxRealTime=** applies to autonomous (continuous or interval sampling) and serial line sync mode.
- To capture real-time data to a file, do this *before* starting logging:
  A. Click Toolbar's Capture button.
  B. Enter desired file name in dialog box. *Capture* status displays in status bar at bottom of screen.

TxRealTime=x — **x=Y:** Output real-time data to computer. Data is transmitted immediately after it is sampled. **This does not affect storing data to FLASH memory, but slightly increases current consumption and increases amount of time needed to sample (and then transmit) data.**

x=N: Do not.

Note:
See *Sampling Modes* for details on serial line synchronization.

SyncMode=x — **x=Y:** Enable Serial Line Sync Mode. When RS-232 RX line is high (3-10 VDC) for 1 to 1000 milliseconds, SBE 48 takes a sample, stores data in FLASH memory, transmits real-time data (if **TxRealTime=Y**), and powers down.

x=N: Do not.

Note:
Do not send SampleNum=0 until all data has been uploaded. **SampleNum=0** does not delete data; it just resets the data pointer.
If you accidentally send this command before uploading, see *Memory* in *Appendix I: Functional Description* for a discussion of how to recover the data.

SampleNum=x — **x=** sample number for first sample when sampling begins. After all previous data has been uploaded from SBE 48, set sample number to 0 before starting to sample to make entire memory available for recording. If not set to 0, data will be stored after last recorded sample.

QS — Quit session and place SBE 48 in quiescent (sleep) state. Main power is turned off. Autonomous sampling and memory retention are unaffected, with one exception: If **Interval=0** (continuous sampling), do not send **QS** after sending **StartNow** (**QS** puts SBE 48 to sleep, preventing further logging).

Note:
If the SBE 48 is logging data and the voltage is less than 6.25 volts for ten consecutive scans, the SBE 48 halts logging and sets the logging status to low battery.

Autonomous Sampling (Logging) Commands

Autonomous sampling commands direct the SBE 48 to sample data at pre-programmed intervals and store the data in its FLASH memory.

Note:
Sampling time shown does not include time to transmit real-time data, which is dependent on baud rate.

Time required to transmit data =
(# of characters * 10 bits/character) / baud

This corresponds to 0.28 seconds at 1200 baud to 0.01 seconds at 38400 baud.

Interval=x

x= interval (seconds) between samples (0, or 3 to 32767). When commanded to start sampling with **StartNow** or **StartLater**, SBE 48 takes a sample, stores data in FLASH memory, transmits real-time data (if **TxRealTime=Y**), and powers down at **x** second intervals.

If **x=0**, SBE 48 samples continuously without powering down between samples. Approximate interval between samples:

Output	Time (seconds)
Not real-time (**TxRealTime=N**)	0.80
Real-time (**TxRealTime=Y**)	1.00

Note:
If **Interval=0** (continuous sampling), do not send **QS** after sending **StartNow**. **QS** puts the SBE 48 to sleep, preventing further logging.

StartNow

Start logging now. Running average is reset to 0. Data is stored in FLASH memory. Data is transmitted real-time if **TxRealTime=Y**.

StartMMDDYY=mmddyy

Set delayed logging start month, day, year. Must be followed by **StartHHMMSS=** to set delayed start time.

Note:
StartDDMMYY= and **StartMMDDYY=** are equivalent. Either can be used to set the delayed start date.

StartDDMMYY=ddmmyy

Set delayed logging start day, month, year. Must be followed by **StartHHMMSS=** to set delayed start time.

StartHHMMSS=hhmmss

Set delayed logging start hour, minute, second.

StartLater

Start logging at time set with delayed start date and time commands. Running average is reset to 0. Data is stored in FLASH memory. Data is transmitted real-time if **TxRealTime=Y**.

Notes:
- After receiving **StartLater**, the SBE 48 displays not logging: waiting to start in reply to **DS**. Once logging has started, the **DS** reply indicates logging data.
- If the delayed start time has already passed when **StartLater** is received, the SBE 48 executes **StartNow**.

Example: Program SBE 48 to start logging on 20 January 2009 12:00:00 (user input in bold).

```
S>STARTMMDDYY=012009
S>STARTHHMMSS=120000
S>STARTLATER
```

or

```
S>STARTDDMMYY=200109
S>STARTHHMMSS=120000
S>STARTLATER
```

Autonomous Sampling (Logging) Commands (*continued*)

SA	Transmit running average of temperature data.
SAQS	Transmit running average of temperature data, and **turn power off** (put SBE 48 in quiescent state).
Stop	Stop logging (started with **StartNow** or **StartLater**) or stop waiting to start logging (if **StartLater** was sent but logging has not begun yet). Press Enter key to get `S>` prompt before entering **Stop**. **Stop** must be sent before uploading data using Upload on the Toolbar, Upload Data in the Data menu, or **DDb,e** or **DBb,e**.

Note:
You may need to send **Stop** several times to get the SBE 48 to respond. This is most likely to occur if sampling continuously or with a small **Interval** and transmitting real-time data (**TxRealTime=Y**).

Polled Sampling Commands

These commands are used by an external controller to request a sample from the SBE 48.

TS	Take sample and transmit converted data. Data is **not** stored in FLASH memory. Do not send if SBE 48 is logging data.
TSR	Take sample and transmit raw data. Data is **not** stored in FLASH memory. Do not send if SBE 48 is logging data.
SLT	Transmit converted data from last sample from buffer, and then take new sample. Data is **not** stored in FLASH memory. Do not send if SBE 48 is logging data.
SLTR	Transmit raw data from last sample from buffer, and then take new sample. Data is **not** stored in FLASH memory. Do not send if SBE 48 is logging data.
TSS	Take sample, **store in FLASH memory**, transmit converted data, and **turn power off**. Do not send if SBE 48 is logging data.
TSSOn	Take sample, **store in FLASH memory**, and transmit converted data. Do not send if SBE 48 is logging data.
SL	Transmit converted data from last sample from buffer.

Note:
The SBE 48 has a buffer that stores the most recent data sample. Unlike data in the FLASH memory, data in the buffer is erased upon removal or failure of power.

Data Upload Commands

Notes:
- Manually entering **DDb,e** or **DBb,e** does not produce data with the required header information for processing by Plot39 or SBE Data Processing. **Use Upload on the Toolbar or Upload Data in the Data menu to upload data that will be processed by Plot39 or SBE Data Processing**. SEATERM checks the setting on the Upload Settings tab in the Configuration dialog box to determine whether to upload in ASCII or binary format.
- To save data to a file, click Capture on the Toolbar before entering **DDb,e** or **DBb,e**.
- See *Data Output Formats* after these *Command Descriptions*.

Send **Stop** before uploading data.

ASCII Upload:

DDb,e

Upload data **in ASCII** from scan **b** to scan **e**. First scan is number 1. If **DDb** is sent, only scan **b** is uploaded. If **DD** is sent, all scans in memory are uploaded.
As data uploads, the screen first displays `start time =, sample interval =, and start sample number =` . These are start time, sample interval, and starting sample number for the last set of logged data, which can be useful in determining what data to review.

Example: Upload data from memory (user input in bold).
(Click Capture on Toolbar and enter the desired filename in the dialog box before beginning upload.)

```
S>DD1,200      (Upload scans 1 through 200)
S>DD1          (Upload scan 1)
S>DD           (Upload all scans in memory)
```

Binary Upload:

Binary upload, useful for large data sets, is faster than ASCII upload. SEATERM uploads the data in binary and then converts to ASCII engineering units, **resulting in a .asc file with the same format as from an ASCII upload**. SEATERM uses the following relationships to convert the binary data back to ASCII engineering units:

t = (T / tscale) - toffset
time (binary) = seconds since 1980

where
- tscale and toffset are factory-programmed into the SBE 48
- T is a binary representation of temperature
- t is temperature in ASCII engineering units

DBb,e

Upload data **in binary** from scan **b** to scan **e**. First scan is number 1. If **DBb** is sent, only scan **b** is uploaded. If **DB** is sent, all scans in memory are uploaded.
As data uploads, screen first displays `start time =, sample interval =, and start sample number =` . These are start time, sample interval, and starting sample number for last set of logged data, which can be useful in determining what data to review.

Example: Upload data from memory (user input in bold).
(Click Capture on Toolbar and enter desired filename in dialog box before beginning upload.)

```
S>DB1,200      (Upload scans 1 through 200)
S>DB1          (Upload scan 1)
S>DB           (Upload all scans in memory)
```

Data Upload Commands (continued)

Note:
BinaryTime= has no effect on the standard ASCII upload.

BinaryTime=x

Applies to binary data upload only.

x=Y: Upload date and time for every scan from memory.

x=N: Upload date and time from memory only for scan at beginning of each block of data (350 scans/block), reducing time required for upload. SEATERM uses **Interval=** to calculate and insert date and time for each scan within block. If SBE 48 did not sample at correct interval, any discrepancy will be apparent by comparing *calculated* time for last scan in a data block to *uploaded* time for first scan in following data block.
Do not set BinaryTime=N if Interval=0 (continuous sampling); SEATERM will insert **same** date and time for every scan in block.

***DB**

Display binary upload parameters. Each parameter is separated by a comma and a space. List below includes, where applicable, command used to modify parameter.

- Sample interval time [**Interval=**]
- Type

Type	BinaryTime=
0	N
2	Y

- Tscale and toffset - factory-programmed parameters used to convert binary data from SBE 48 back to ASCII engineering units

Testing Commands

Data obtained with these commands is **not** stored in FLASH memory.

TT — Measure temperature for 100 samples or until Esc key is pressed, output converted data.

TTR — Measure temperature for 100 samples or until Esc key is pressed, output raw data.

Calibration Coefficients Commands

DC — Display calibration coefficients. Equivalent to Coefficients on Toolbar.

Example: Display coefficients for an SBE 48 (user input in bold).

```
S>DC
SBE48 V 2.0    0916
temperature:      28-jul-09
TA0 = -9.420702e-05
TA1 =  2.937924e-04
TA2 = -3.739471e-06
TA3 =  1.909551e-07
```

Notes:
- Date shown is when calibration was performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with SBE 48.
- See individual Coefficient Commands below for definitions of the data in the example.

The individual Coefficient Commands listed below are used to modify a particular coefficient or date:

Note:
F = floating point number
S = string with no spaces

TCalDate=S — **S=** Temperature calibration date.
TA0=F — **F=** Temperature A0.
TA1=F — **F=** Temperature A1.
TA2=F — **F=** Temperature A2.
TA3=F — **F=** Temperature A3.

Data Output Formats

The SBE 48 transmits data in engineering units (except in response to **TSR** and **SLTR**, which request raw data). The exact format of the output varies, as described below.

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).

- Output to SEATERM after Sending Polled Sampling Command (**TS, SL, SLT, TSS, TSSOn**) -
  ttt.tttt, dd mmm yyyy, hh:mm:ss
- Output to SEATERM if Transmitting Real-Time Data (**TxRealTime=Y**) -
  # ttt.tttt, dd mmm yyyy, hh:mm:ss
- Output to SEATERM after Manually Sending Data Upload Command **(DDB,e) -**
  ttt.tttt, dd mmm yyyy, hh:mm:ss
- Output to SEATERM after Manually Sending Binary Data Upload Command (**DBb,e**) - not usable
- Output to **.asc** file after Sending Data Upload Command with Upload on Toolbar or Upload Data in Data menu -
  ttt.tttt, dd mmm yyyy, hh:mm:ss
  Note: This applies to ASCII as well as binary upload

Where:
t = temperature (degrees Celsius, ITS-90)
hh:mm:ss = hour, minute, second
dd mmm yyyy = day, month, year
The month is a 3-character alphabetic abbreviation (jan, feb, mar, etc.)

Setup for Deployment

1. If not providing external power, install a new battery or ensure the existing battery has enough capacity to cover the intended deployment. See *Section 2: Description of SBE 48* for battery endurance specifications and *Section 5: Routine Maintenance and Calibration* for details on battery replacement.

2. Program the SBE 48 for the intended deployment (see *Section 3: Preparing SBE 48 for Deployment* for connection information; see information in this section on commands and sampling modes):

   A. Ensure all data has been uploaded, and then set **SampleNum=0** to make the entire memory available for recording. If **SampleNum-** is not reset to 0, data will be stored after the last recorded sample.

   B. Set the date and then time.

   C. Establish the setup and sampling parameters.

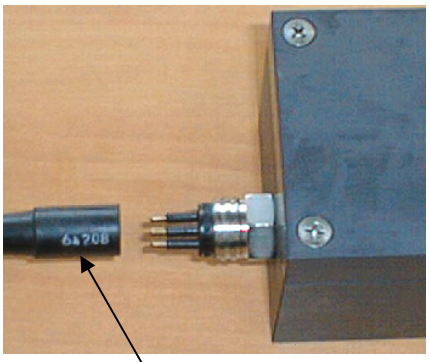
   D. Use **one** of the following sequences to initiate logging:
   - **StartNow** to start logging now, taking a sample every **Interval=** seconds.
   - **StartMMDDYY=, StartHHMMSS=,** and **StartLater** to start logging at the specified date and time, taking a sample every **Interval=** seconds.
   - **SyncMode=Y** to place the SBE 48 in serial line sync mode, so that a simple pulse on the RS-232 line will initiate a sample.

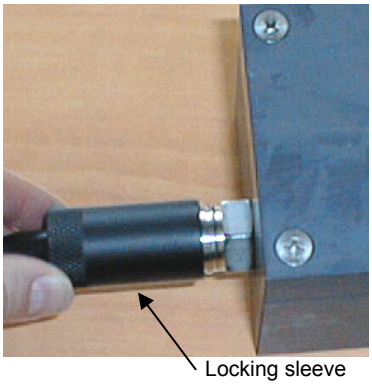
Notes:
- If the battery has been removed, date and then time must be reset.
- **It is always necessary to set both date and then time.**

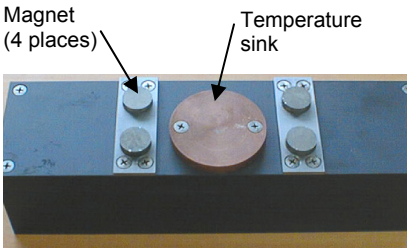
Note:
If **Interval=0**, the SBE 48 samples continuously, without powering down between samples.

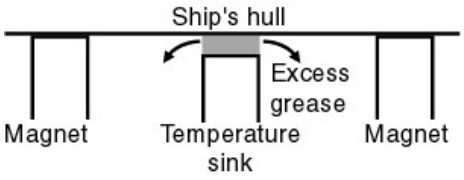
Deployment

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









1. Install the I/O cable connector:

   A. Lightly lubricate the sides of the rubber prongs on the SBE 48 bulkhead connector with silicone grease (DC-4 or equivalent).

   B. Install the cable connector, aligning the holes with the five pins on the SBE 48's bulkhead connector.

   C. Place the locking sleeve over the connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

   D. Connect the I/O cable connector to your computer's serial port. A 9-to-25 pin adapter is supplied for use if your computer has a 25-pin serial port.

   E. Connect the I/O cable connector's red (+) and black (-) wires to a power supply (8 - 16 VDC).

2. Generously coat the temperature sink with heat sink grease.

3. Mount the SBE 48 on the inside of the ship's hull, using the magnets. Excess heat sink grease should squeeze out the side of the temperature sink.
   - **If excess grease does not squeeze out the side, the temperature sink may not be in good contact with the hull.** Remove the SBE 48 from the hull, apply more heat sink grease, and remount.

Uploading Data

Note:
While uploading data, `Warning: Low Battery Voltage` may be displayed. Follow **one** of these procedures to continue uploading:

- Connect power to the I/O connector red and black wires, to provide external power. This prevents loss of clock information and data in the 256 byte cache buffer. Once external power is in place, you can replace the internal battery without loss of clock information or data.
- Remove the internal battery and install a new one. The momentary loss of power resets the clock, preventing analysis of any clock drift, and erases the 256 byte cache buffer data (most recently recorded data, corresponding to 36 data samples).

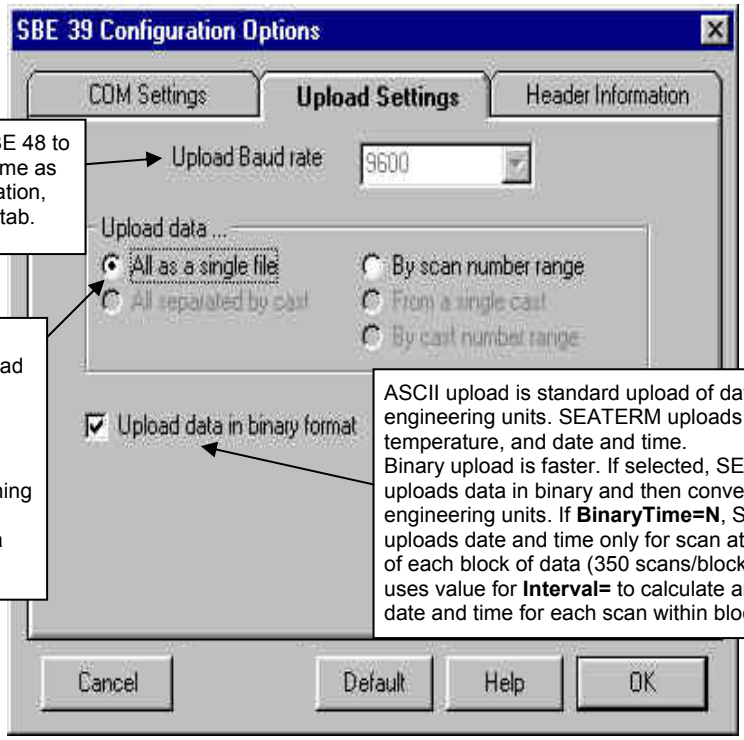
Note that all but the most recent data is stored in non-volatile FLASH memory, which is not affected by loss of power. See *Section 5: Routine Maintenance and Calibration* for replacement of the internal battery. See *Memory* in *Appendix I: Functional Description* for a discussion of the cache buffer.

1. If not already installed, install the I/O cable connector and connect it to an external power supply and to your computer's serial port. See *Power and Communications Test* in *Section 3: Preparing SBE 48 for Deployment*.

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

Note:
Set up **Upload Settings**, **Header Information**, and/or **Header Form** (Steps 3 through 5):
- The first time you upload data, and
- If you want to change upload or header parameters.

3. In the Configure menu, select **SBE 39**. Click on the Upload Settings tab. The dialog box looks like this:



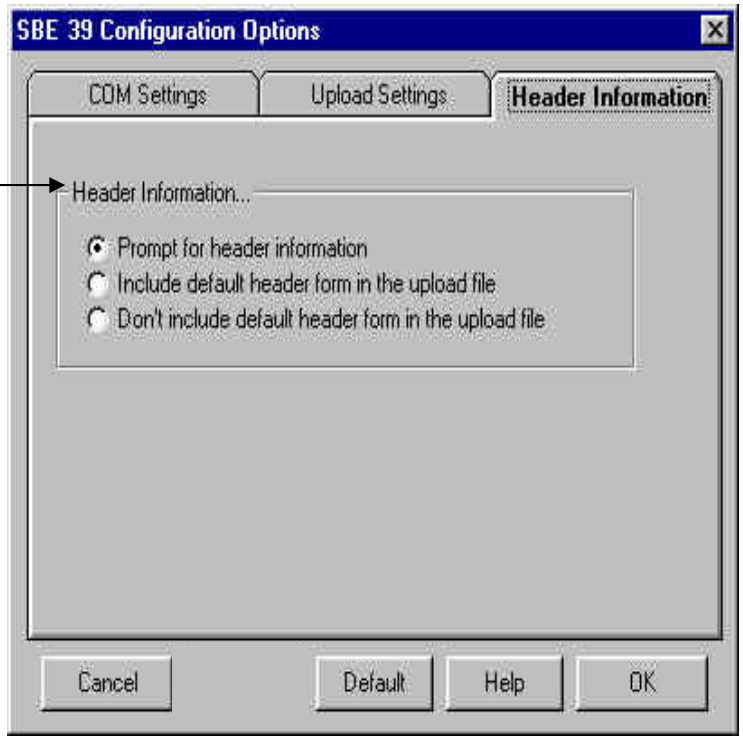
Baud for uploading data from SBE 48 to computer. For SBE 48, this is same as baud rate for general communication, which was set on COM Settings tab.

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.
- By scan number range – SEATERM prompts for beginning and ending scan (sample) numbers, and uploads all data within range into one file.

ASCII upload is standard upload of data in engineering units. SEATERM uploads temperature, and date and time.
Binary upload is faster. If selected, SEATERM uploads data in binary and then converts to ASCII engineering units. If **BinaryTime=N**, SEATERM uploads date and time only for scan at beginning of each block of data (350 scans/block), and then uses value for **Interval=** to calculate and insert date and time for each scan within block.

Make the selection for Upload Settings.

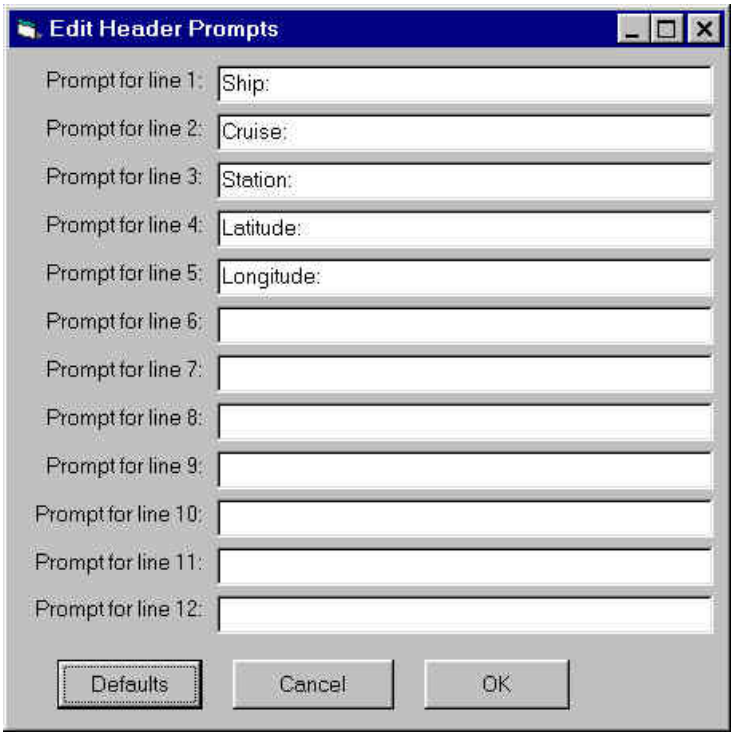
4. Click on the Header Information tab. The dialog box looks like this:



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 – Header information not included in upload file.

Select the desired header information option. Click OK to save the settings.

5. In the Configure menu, select Header Form to customize the 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:
- the 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 4)
- the header included with the uploaded data, if *Include default header form in upload file* was selected in the Configuration Options dialog box (Step 4)

Enter the desired header/header prompts. Click OK.

6. Click Connect on the Toolbar to begin communications with the SBE 48. The display looks like this:

```
SBE 48
S>
```

This shows that correct communications between the computer and the SBE 48 has been established.
If the system does not respond as shown above:
- Click Connect again.
- Check cabling between the computer and the SBE 48.
- Verify the correct instrument (**SBE 39**) was selected and the COM settings were entered correctly in the Configure menu.

7. If sampling autonomously, command the SBE 48 to stop logging by pressing the Enter key and sending **Stop**.

8. Display SBE 48 status information by clicking Status on the Toolbar. The display looks like this:

```
SBE 48 V 2.0   SERIAL NO. 0916  08 Aug 2008 08:49:09
battery voltage = 7.5
not logging: received stop command
sample interval = 30 seconds
number of samples to average = 60
samplenumber = 10000, free = 4689867
serial sync mode disabled
real-time output disabled
binary upload includes time
temperature =19.48 deg C
```

9. Click Upload on the Toolbar to upload stored data. SEATERM responds as follows:

   A. SEATERM sends the status (**DS**) command, displays the response, and writes the command and response to the upload file. **DS** provides you with information regarding the number of samples in memory as well as the instrument setup.

   B. **If you selected *By scan number range* in the Configuration Options dialog box (Configure menu)** – a dialog box requests the range. Enter the desired value(s), and click OK.

   C. SEATERM sends the calibration coefficients (**DC**) command, displays the response, and writes the command and response to the upload file. **DC** displays the SBE 48's calibration coefficients.

   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 .asc extension.

   F. SEATERM sends the data upload command (**DDb,e** or **DBb,e**, depending on your selection of ASCII or binary upload on the Upload Settings tab of the Configuration Options dialog box).

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

Note:
Binary upload is supported only for SBE 48 with firmware version 2.0 and later. SEATERM automatically checks the firmware version before it begins upload; if you selected binary upload but the SBE 48 firmware does not support it, SEATERM performs an ASCII upload instead.

10. Ensure all data has been uploaded from the SBE 48 by reviewing the data. Sea-Bird provides two options for reviewing/processing the data:

    A. Use **Plot39** to plot the ASCII (.asc) data (see *Appendix II: PLOT39 Data Plotting Program* for details), **OR**

    B. Use **SEATERM's Convert** utility to convert the .asc file to a .cnv file that can be used by SBE Data Processing.
    SBE Data Processing includes many post-processing modules; **the only modules applicable to the SBE 48 include ASCII OUT and Sea Plot**.

        1) In SEATERM, click Convert on the Toolbar. The Convert dialog box appears.

            - Enter the input (.asc) file name and the desired output (.cnv) file name; file names must include the path.
            - In processing the data, date and time is converted to Julian Day with five significant digits. As the default, Convert does not reset the Julian Day to 0 when rolling over from December 31 to January 1. If desired, click *Start new year at Julian time 0* to reset the Julian Day to 0 on January 1.
            - The *Convert pressure to depth* box is not applicable to the SBE 48 - an SBE 48 does not have a pressure sensor.

        2) After the data is converted, use SBE Data Processing to process the .cnv data. See the software manual on CD-ROM or Help files for details.

Notes:
To prepare the SBE 48 for re-deployment:
1. After all data has been uploaded, send **SampleNum=0**. If this command is not sent, new data will be stored after the last recorded sample, preventing use of the entire memory capacity.
2. Do *one* of the following:
   - Send **QS** to put the SBE 48 in quiescent (sleep) state until ready to redeploy. Leaving the SBE 48 with the battery in place and in quiescent state retains the date and time. The quiescent current is only 10 microamps, so the battery can be left in place without significant loss of capacity.
   - Use **StartNow** to begin logging immediately.
   - Set a time and date for logging to start using **StartMMDDYY=** or **StartDDMMYY=**, **StartHHMMSS=**, and **StartLater**.

Section 5: Routine Maintenance and Calibration

This section reviews corrosion precautions, sensor calibration, and replacement of the battery. The SBE 48's accuracy is sustained by the care and calibration of the sensor and by establishing proper handling practices.

Corrosion Precautions

When used as described in this manual, the SBE 48 is not exposed to seawater. No corrosion precautions are required.

Sensor Calibration

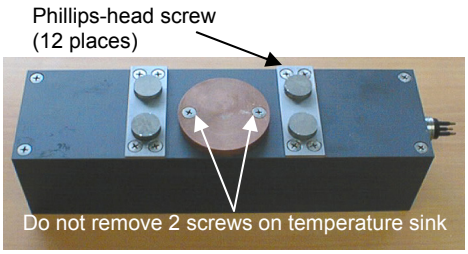
Sea-Bird sensors are calibrated by subjecting them to known physical conditions and measuring the sensor responses. Coefficients are then computed, which may be used with appropriate algorithms to obtain engineering units. The temperature sensor on the SBE 48 is supplied fully calibrated, with coefficients printed on the Calibration Certificate (see back of manual). These coefficients have been stored in the SBE 48's EEPROM.

We recommend that the SBE 48 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.

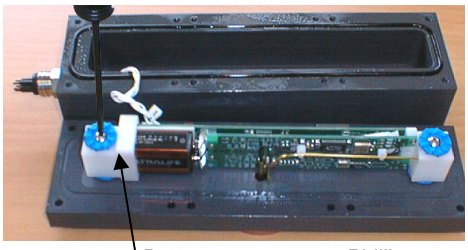
Replacing Battery

Sea-Bird ships the SBE 48 with a 9-volt lithium battery installed. Leave the battery in place when storing the SBE 48 (quiescent current is only 10 microamps). If the SBE 48 is supplied with external power, the battery only powers the real-time clock and should last for five to ten years. However, **replace the battery yearly to prevent battery leakage** (which could damage the SBE 48).

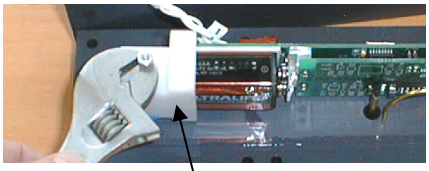


Follow the instructions below to change the battery. Use a 9-volt lithium or alkaline battery. See *Shipping Precautions* in *Section 1: Introduction* for details on shipping lithium batteries.

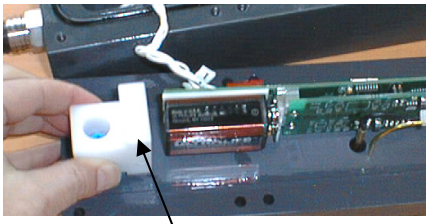
1. Remove the cover and electronics from the housing:
   A. Wipe the outside of the cover and housing dry, being careful to remove any water at the seam between them.
   B. Remove the twelve Phillips-head screws (around the perimeter of the cover) that secure the cover to the SBE 48. Carefully remove the cover and electronics - the connector is electrically connected to the electronics with a Molex connector.
   C. Remove any water from the cover O-ring and mating surfaces with a lint-free cloth or tissue.



2. Replace the battery:
   A. Remove the Phillips-head screw and grommet on the white battery cap.



   B. Remove the mounting post on the battery cap.



   C. Pull the battery cap off the battery.
   D. Unsnap the old battery and replace with the new one. (The circuit is reverse polarity protected. Accidental contact will not harm the SBE 48).
   E. Reinstall the battery cap with grommets (top and bottom), mounting post, and Phillips-head screw.

Note:
Before delivery, a desiccant package is placed in the housing, and the electronics chamber is filled with dry Argon gas. These measures help prevent condensation. To ensure proper functioning:
1. Install a new desiccant bag each time you open the housing. If a new bag is not available, see *Application Note 71: Desiccant Use and Regeneration (drying)*.
2. If possible, dry gas backfill each time you open the housing. If you cannot, wait at least 24 hours before redeploying, to allow the desiccant to remove any moisture from the housing.

3. Reinstall the electronics and cover:
   A. Remove the old desiccant bag and replace with a new one.
   B. 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 as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to O-ring and mating surfaces.
   C. Carefully fit the cover onto the housing.
   D. Install the twelve Phillips-head screws to secure the cover to the housing.

Glossary

Battery – 9-volt lithium or alkaline transistor battery

Convert – Toolbar button in SEATERM to convert ASCII (.asc) data uploaded from the SBE 48 with SEATERM to .cnv format. When converted to .cnv format, SBE Data Processing can be used to analyze and display data.

PCB – Printed Circuit Board.

Plot39 – Sea-Bird's Win 95/98/NT/2000/XP software for plotting SBE 48 (and SBE 39) data.

SBE 48 – High-accuracy temperature recorder.

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 48 .cnv data are ASCII Out and Sea Plot.

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

SEASOFT-Win32 – Sea-Bird's complete Win 2000/XP software package, which includes software for communication, real-time data acquisition, and data analysis and display. SEASOFT-Win32 includes **SEATERM**, SeatermAF, SEASAVE, **SBE Data Processing**, and **Plot39**.

SEATERM – Sea-Bird's Win 95/98/NT/2000/XP software used to communicate with the SBE 48. The SBE 48 is not available in SEATERM's Configure menu; **select the SBE 39 as the instrument type**.

Appendix I: Functional Description

Sensor

The SBE 48 includes the same temperature sensor element (pressure-protected thermistor) previously employed in Sea-Bird's modular SBE 3 sensor, SEACAT family, and SBE 39.

Sensor Interface

Temperature is acquired by applying an AC 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. AC excitation and ratiometric comparison using a common processing channel avoids errors caused by parasitic thermocouples, offset voltages, leakage currents, and reference errors.

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).

Memory

Data

The SBE 48 has a 64 MB FLASH memory for data storage (32,900,000 bytes usable). 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 to a *page* (256 bytes) at a time, data is first accumulated in a 256-byte cache buffer. When the cache is full, its contents are transferred to FLASH memory. The cache is volatile, and thus depends on battery power. That is why an SBE 48 with depleted battery will lose its most recently stored data unless an external power supply is used (see *Uploading Data* in *Section 4: Deploying and Operating SBE 48*).

The data upload process integrates the data from the FLASH memory and the cache. **SampleNum=** controls the memory pointers that manage this process. Setting **SampleNum=0** resets the pointer in the FLASH memory and in the cache memory, causing the SBE 48 to overwrite existing data. It is important not to change **SampleNum=** until all data has been uploaded.

If **SampleNum** is inadvertently set to 0 before data is uploaded, and you wish to upload data, the following conditions apply:

Was additional data logged after SampleNum= was changed?	User then returns SampleNum= to:	Description of Uploaded Data
No	Original value	All data (data in FLASH as well as data in cache) uploads correctly.
No	Estimated value larger than original value	All data in FLASH uploads correctly. Data in cache is corrupted (minimum of 0 and maximum of 36 scans).
Yes < 256 bytes of new data (36 scans)	Original value	Old data in FLASH uploads correctly. Old data in cache is corrupted. First scan of new data in cache is corrupted; remaining scans of new data in cache upload correctly.
Yes > 256 bytes of new data (36 scans)	Original value	Old data in FLASH is overwritten with new data. Old data in cache is corrupted. If new data set is smaller than old set, a portion of old set can be recovered; scan bridging old and new data is corrupted. First scan of new data in cache is corrupted; remaining scans of new data in cache upload correctly.

Timekeeping

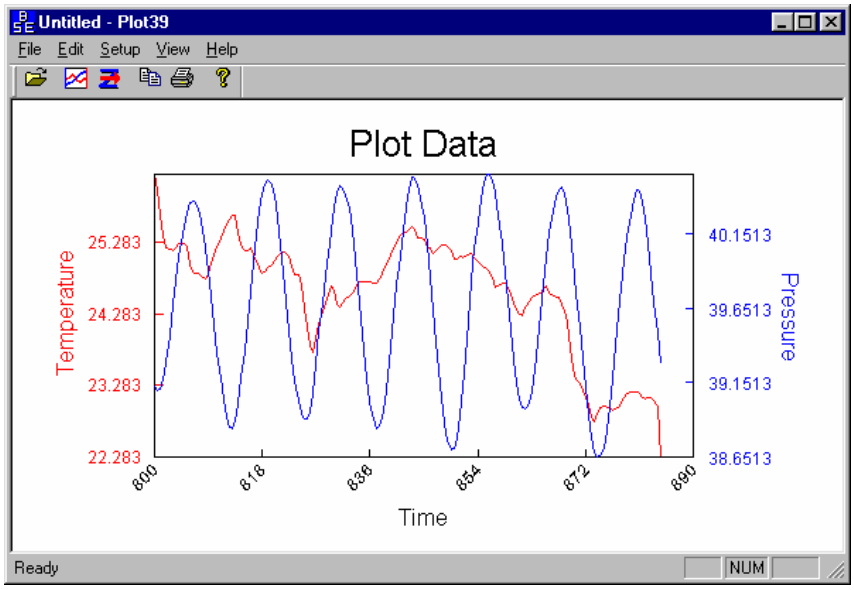
Time is stored in volatile memory. If power is removed, the clock resets to 1 January 1980. Upon restoration of power, the clock resumes normal operation.

Settings

Calibration coefficients and setup and operating parameters (**Baud=**, **SampleNum=**, **Interval=**, etc.) are written to EEPROM and are non-volatile. These settings do not change if power is removed.

Appendix II: Plot39 Data Plotting Program

Notes:
- **Pressure plot shown in the figure is not applicable to the SBE 48.**
- Help files provide detailed information on the use of Plot39.



Plot39 is used to plot ASCII data (.asc file) that has been uploaded from the SBE 48. Plot39:

- Plots the data in color. The plot can be saved as a graphic file for presentation.
- Improves display speed with data culling. Plot39 plots every Nth data value, where N is dependent on the number of data values to be displayed and the width of the display rectangle in pixels.
- Allows axis and font sizes to be easily changed.
- Allows a section of a plot to be magnified to reveal more detail.

If not already installed, install Plot39 and other Sea-Bird software programs on your computer using the supplied software CD:

1. Insert the CD in your CD drive.
2. Double click on **Seasoft-Win32.exe**.
3. Follow the dialog box directions to install the software.

The default location for the software is c:\Program Files\Sea-Bird. Within that folder is a sub-directory for each program. The installation program allows you to install the desired components. Install all the components, or just install Plot39 for now.

Appendix III: Command Summary

Note:
See *Command Descriptions* in *Section 4: Deploying and Operating SBE 48* for detailed information and examples.

CATEGORY	COMMAND	DESCRIPTION
Status	**DS**	Display status and setup parameters.
Setup	**MMDDYY= mmddyy**	Set real-time clock month, day, year. Must follow with **HHMMSS=**.
	DDMMYY= ddmmyy	Set real-time clock day, month, year. Must follow with **HHMMSS=**.
	HHMMSS= hhmmss	Set real-time clock hour, minute, second.
	Baud=x	**x=** baud rate (1200, 2400, 4800, 9600, 19200, 38400). Default 9600.
	NAvg=x	**x=** number of scans in running average (1 - 120).
	TxRealTime=x	**x=Y:** Output real-time data to computer. Does not affect storing data to memory, but slightly increases current consumption. **x=N:** Do not.
	SyncMode=x	**x=Y:** Enable Serial Line Sync Mode. When RS-232 RX line is high (3-10 VDC) for 1 - 1000 milliseconds, SBE 48 takes a sample, stores data in FLASH memory, transmits real-time data (if **TxRealTime=Y**), and powers down. **x=N:** Do not.
	SampleNum=x	**x=** sample number for first sample when sampling begins. After all previous data has been uploaded, set to 0 before starting to log to make entire memory available for recording. If not reset to 0, data is stored after last sample.
	QS	Enter quiescent (sleep) state. Data logging and memory retention unaffected.
Autonomous Sampling (Logging)	**Interval=x**	**x=** interval (seconds) between samples (0, or 3 - 32767). When commanded to start sampling with **StartNow** or **StartLater**, SBE 48 takes sample, stores data in FLASH memory, transmits real-time data (if **TxRealTime=Y**), and powers down at **x** second intervals. If **x=0**, SBE 48 samples continuously without powering down between samples.
	StartNow	Start logging now. Reset running average to 0.
	StartMMDDYY= mmddyy	Delayed logging start: month, day, year. Must follow with **StartHHMMSS=**.
	StartDDMMYY= ddmmyy	Delayed logging start: day, month, year. Must follow with **StartHHMMSS=**.
	StartHHMMSS= hhmmss	Delayed logging start: hour, minute, second.
	StartLater	Start logging at delayed logging start time. Reset running average to 0.
	SA	Transmit running average of data.
	SAQS	Transmit running average of data, and **turn power off**.
	Stop	Stop logging or stop waiting to start logging. Press Enter key to get `S>` prompt before entering **Stop**. Must send **Stop** before uploading data.

CATEGORY	COMMAND	DESCRIPTION
Polled Sampling *Do not send these commands if SBE 48 is logging data.	**TS ***	Take sample and transmit converted data. Data not stored in FLASH memory.
	TSR *	Take sample and transmit raw data. Data not stored in FLASH memory.
	SLT *	Transmit converted data from last sample from buffer, and then take new sample. Data not stored in FLASH memory.
	SLTR *	Transmit raw data from last sample from buffer, and then take new sample. Data not stored in FLASH memory.
	TSS *	Take sample, store data in FLASH memory, transmit converted data, and turn power off.
	TSSOn *	Take sample, store data in FLASH memory, and transmit converted data.
	SL	Transmit converted data from last sample from buffer.
Data Upload	**DDb,e**	Upload data in **ASCII** from scan **b** to scan **e**. Send **Stop** before sending **DDb,e**.
	DBb,e	Upload data in **binary** from scan b to e. Send **Stop** before sending **DBb,e**.
	BinaryTime=x	**Applies to binary data upload only.** **x=Y**: Upload date and time for every scan from memory. **x=N**: Upload date and time only for beginning scan in each data block; use **Interval=** to calculate and insert date and time for all other scans.
	***DB**	Display binary upload parameters.
Testing	**TT**	Measure temperature for 100 samples or until Esc key is pressed, output converted data.
	TTR	Measure temperature for 100 samples or until Esc key is pressed, output raw data
Coefficients (F=floating point number; S=string with no spaces) Date shown is when calibration was performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with SBE 48.	**DC**	Display calibration coefficients; all coefficients and date listed below are included. Use individual commands below to modify a particular coefficient or date.
	TCalDate=S	**S**=Temperature calibration date.
	TA0=F	**F**=Temperature A0.
	TA1=F	**F**=Temperature A1.
	TA2=F	**F**=Temperature A2.
	TA3=F	**F**=Temperature A3.

Note:
Use Upload on the Toolbar or Upload Data in the Data menu to upload data that will be processed by Plot39 or SBE Data Processing. Manually entering the data upload command does not produce data with the required header information for processing by our software. This command is included here for reference for users who are writing their own software.

Appendix IV: Replacement Parts

Part Number	Part	Application Description	Quantity in SBE 48
30845	Screw, 10-24 x 1 1/4" flat-head, Phillips-head, stainless steel	Secure cover to housing at corners and at magnet mounting bars	12
30144	Screw, 6-32 x 7/16" truss, Phillips-head, stainless steel	Secure Battery / PCB end caps	2
31109	Grommets	Isolate PCB from mounting posts	4
31111	Spacer, 6-32 x 1 3/8" hex, aluminum	Mounting post for Battery/PCB end caps	2
31121	O-ring, 2-263N674-70, Parker	Seal between cover and housing	1
22074	Battery, 9-volt lithium, UltraLife U9VL (standard)	Power SBE 48	1
22039	Battery, 9-volt alkaline, Duracell MN 1604 (optional)	Power SBE 48	1
801431	5-pin to 9-pin I/O cable with power leads, 2.4 m (8 ft) long	From SBE 48 to computer	1
171888	25-pin DB-25S to 9-pin DB-9P cable adapter	For use with computer with DB-25 connector	1

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SBE 37-SI (RS-485) MicroCAT Reference Sheet

(see SBE 37-SI [RS-485] MicroCAT User's Manual for complete details)

System Setup

1. Install I/O cable connector, aligning raised bump on connector side with large pin on MicroCAT. Connect to computer serial port and power supply.
2. Double click on SeatermV2.exe. SeatermV2 opens; in Instruments menu, select *SBE 37 RS485*. Seaterm485 opens.
3. In Seaterm485's Communications menu, select *Configure*. In dialog box, select Comm port and baud rate (factory set to 9600). Set ID to *Automatically get ID* for 1 MicroCAT on line; set ID to *Use fixed ID* for multiple MicroCATs on line. Click OK.
4. Seaterm485 should automatically connect to MicroCAT. As it connects, it sends **#iiGetHD** and displays response, and then fills Send Commands window with list of commands for your MicroCAT.
5. Set Date and Time — see Command Instructions and Command List.
6. Set up other parameters as desired — see Command Instructions and Command List. User-selectable sampling modes include:
   - **Autonomous** – At pre-programmed intervals, MicroCAT wakes up, samples, stores data in memory, and goes to sleep.
   - **Polled** – On command, MicroCAT takes 1 sample and sends data to computer. Useful for integrating with satellite, radio, or wire telemetry equipment.
   - **Serial Line Sync** - In response to simple pulse (or single character) on serial line, MicroCAT wakes up, samples, stores data in memory, transmits data (if **#iiTxSyncMode=Y**), and goes to sleep.

Deployment

1. Wiring– Install I/O cable connector, aligning raised bump on side of connector with large pin on MicroCAT. Install locking sleeve. Connect I/O cable connector to computer serial port and power supply.
2. Deploy MicroCAT, using optional Sea-Bird mounting brackets or customer-supplied hardware.

Data Uploading

1. Connect I/O cable from MicroCAT to computer.
2. Double click on SeatermV2.exe. SeatermV2 opens; in Instruments menu, select *SBE 37 RS485*. Seaterm485 opens.
3. In Seaterm485's Communications menu, select *Configure*. In dialog box, select Comm port and baud rate (factory set to 9600). Set ID to *Automatically get ID* for 1 MicroCAT on line; set ID to *Use fixed ID* for multiple MicroCATs on line. Click OK.
4. Seaterm485 should automatically connect to MicroCAT. As it connects, it sends **#iiGetHD** and displays response, and then fills Send Commands window with list of commands for your MicroCAT.
5. If sampling autonomously (logging), command MicroCAT to stop logging by sending **#iiStop**.
6. Click Upload menu to upload stored data.
7. Select *Convert .XML data file* in Tools menu to convert uploaded .xml file to .cnv file for use by data processing software (SBE Data Processing).
8. Process file and review data in Sea-Bird data processing software to ensure all data has been uploaded.

Command Instructions

- Input commands in upper or lower case letters, and register commands by pressing Enter key.
- MicroCAT sends an error message if invalid command is entered.
- If new command is not received within 2 minutes after completion of a command, MicroCAT returns to quiescent (sleep) state.
- If in quiescent (sleep) state, re-establish communications by selecting *Connect* in Seaterm485's Communications menu, sending two @ characters, or pressing any key.
- For reliable operation, all commands ***may*** need to be preceded with two **@** characters.
  Example (status command for MicroCAT 01): `@@#01DS`

Shown on page 2 are the commands used most commonly in the field. See the Manual for complete listing and detailed descriptions.

Command List

CATEGORY	COMMAND	DESCRIPTION
ID	**ID?**	Get MicroCAT ID.
	***ID=ii**	Set MicroCAT ID to **ii**, where ii= 0-99. Command must be sent twice.
Global	**DateTime= mmddyyyyhhmmss**	Set clock month, day, year, hour, minute, second.
	GData	Command **all** MicroCATs to take 1 sample. MicroCATs hold data in buffer until receiving **Dataii**. Data not stored in FLASH memory.
	PwrOff	Enter quiescent (sleep) state. Main power turned off, but data logging and memory retention unaffected.
Get Data	**Dataii**	Get data obtained with **GData**.
Status	**#iiGetCD**	Get and display configuration data.
	#iiGetSD	Get and display status data.
	#iiGetCC	Get and display calibration coefficients.
	#iiGetEC	Get and display event counter data.
	#iiResetEC	Reset event counter.
	#iiGetHD	Get and display hardware data.
	#iiDS or **!iiDS**	Get and display status.
	#iiDC	Get and display calibration coefficients.
General Setup	**#iiBaudRate=x**	**x=** baud rate (600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200).
	#iiRxDelay=x	**x=** delay after MicroCAT receives command until transmitter enabled (1 - 500 msec). Default 25 msec.
	#iiTxDelay=x	**x=** delay after MicroCAT transmits reply until transmitter disabled (1 - 500 msec). Default 25 msec.
	#iiDateTime= mmddyyyyhhmmss	Set clock month, day, year, hour, minute, second.
	#iiOutputExecutedTag=x	**x=Y**: output XML Executed and Executing tags. **x=N**: do not.
	#iiReferencePressure=x	**x=** reference pressure (gauge) in db (used when MicroCAT has no pressure sensor).
Memory Setup	**#iiInitLogging**	Initialize logging to make entire memory available for recording.
	#iiSampleNumber=x	**x=** sample number for last sample in memory. **#iiSampleNumber=0** equivalent to **#iiInitLogging**.
Output Format Setup	**#iiOutputFormat=x**	**x=0**: output raw decimal data. **x=2**: output converted decimal data in XML. **x=1**: output converted decimal data. **x=3**: output converted decimal data, alternate format.
	#iiOutputSal=x	**x=Y**: calculate and output salinity (psu). **x=N**: do not.
	#iiOutputSV=x	**x=Y**: calculate and output sound velocity (m/sec). **x=N**: do not.
	#iiOutputDensity=x	**x=Y**: calculate and output local density. **x=N**: do not.
	#iiOutputDepth=x	**x=Y**: calculate and output depth (m). **x=N**: do not.
	#iiLatitude=x	**x=** latitude (degrees) to use in depth calculation.
Autonomous Sampling (Logging)	**#iiSampleInterval=x**	**x** = interval between samples (6 – 21,600 seconds). When commanded to start sampling with **#iiStartNow** or **#iiStartLater**, at **x** second intervals MicroCAT takes sample, stores data in FLASH memory, and goes to sleep.
	#iiStartNow	Start logging now.
	#iiStartDateTime= mmddyyyyhhmmss	Delayed logging start: month, day, year, hour, minute, second.
	#iiStartLater	Start logging at delayed logging start time.
	#iiStop	Stop logging or waiting to start logging. Send **#iiStop** before uploading data.
Polled Sampling	**#iiTS**	Take sample, store data in buffer, output data.
	#iiTSR	Take sample, store data in buffer, output data in raw decimal form (regardless of **#iiOutputFormat=**).
	#iiTSH	Take sample, store data in buffer, do not output data.
	#iiTSS	Take sample, store data in buffer and in FLASH memory, output data.
	#iiTSn:x	Take **x** samples and output data.
	#iiSL	Output last sample stored in buffer.
	#iiSLT	Output last sample stored in buffer, then take new sample, and store data in buffer.
Serial Line Sync	**#iiSyncMode=x**	**x=Y**: Enable serial line sync mode. **x=N**: Disable serial line sync mode.
	#iiTxSyncMode=x	**x=Y**: Transmit real-time data in serial line sync mode. **x=N**: do not.
Data Upload	**#iiDDb,e**	Upload data from scan **b** to **e**, in alternate converted decimal form (**#iiOutputFormat=3**) (regardless of setting for **#iiOutputFormat**).
	#iiGetSamples:b,e	Upload data from scan **b** to **e**, in format defined by **#iiOutputFormat**.
Calibration Coefficients	*See manual*	
Hardware Configuration	*See manual.*	

CALIBRATION SHEETS

SBE 48 Temperature Calibration - S/N 0046..... 1

SBE 48 Temperature Calibration - S/N 0047..... 3

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SENSOR SERIAL NUMBER: 0046
CALIBRATION DATE: 03-Jun-11

SBE 48 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

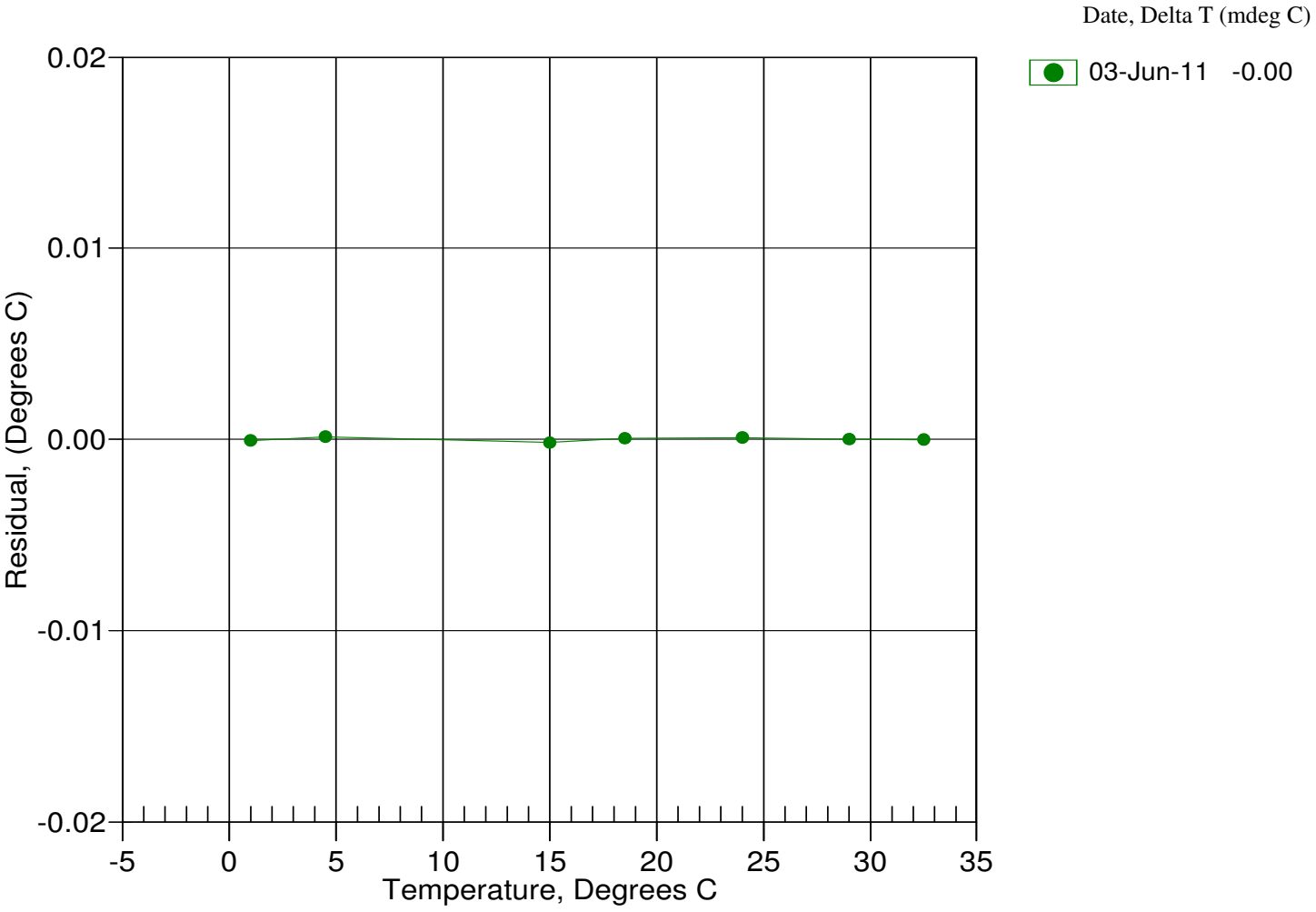
ITS-90 COEFFICIENTS

a0 = 6.757147e-005
a1 = 2.595297e-004
a2 = -1.309902e-006
a3 = 1.212740e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	772728.3	0.9999	-0.0001
4.4999	659537.0	4.5000	0.0001
15.0000	418250.3	14.9998	-0.0002
18.5000	361583.5	18.5001	0.0001
24.0001	289366.4	24.0002	0.0001
29.0000	237758.3	29.0000	-0.0000
32.5000	207901.9	32.5000	-0.0000

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



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SENSOR SERIAL NUMBER: 0047
CALIBRATION DATE: 19-Jun-11

SBE 48 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

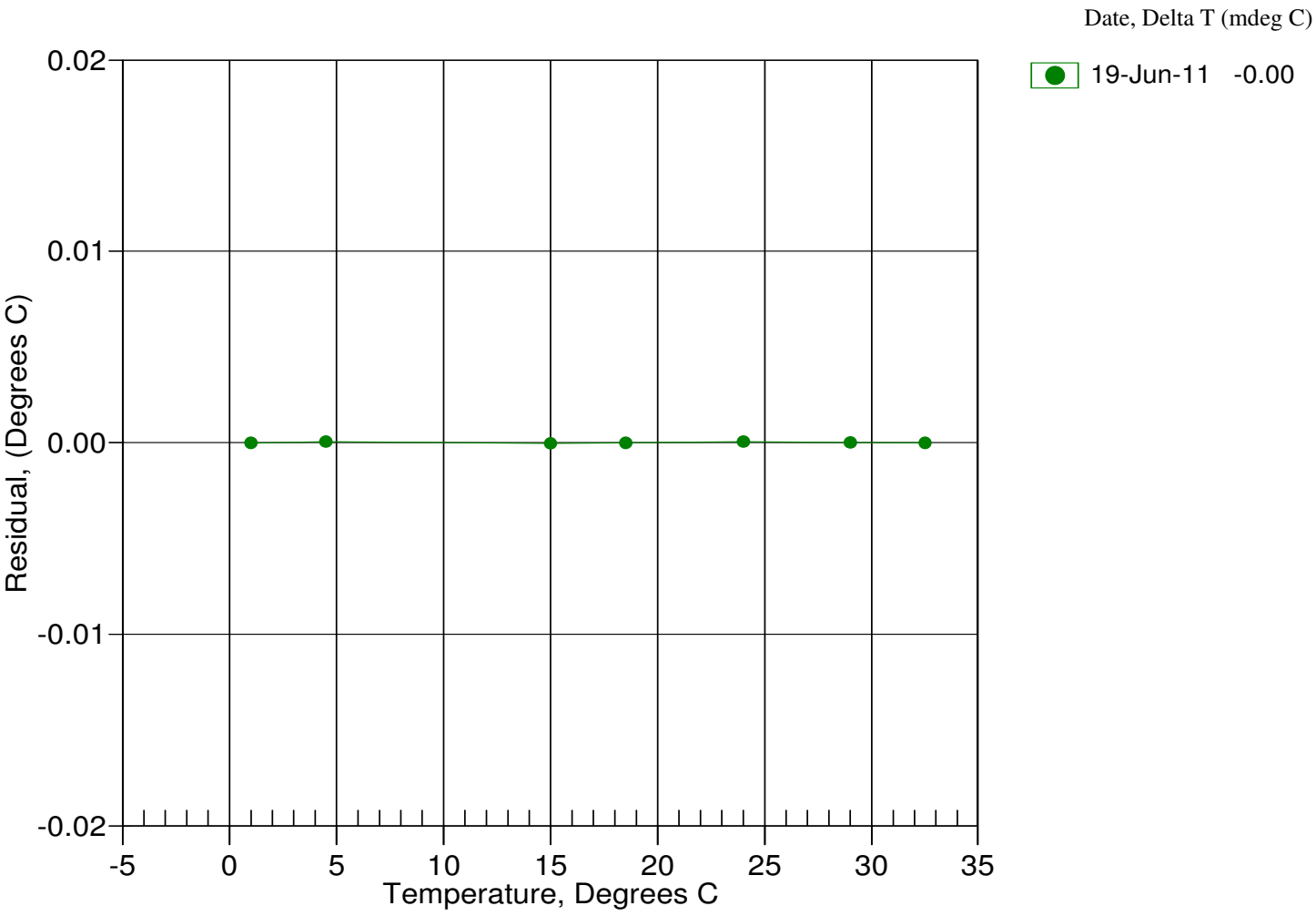
ITS-90 COEFFICIENTS

a0 = 1.872113e-006
a1 = 2.715217e-004
a2 = -2.284995e-006
a3 = 1.450152e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	837077.7	1.0000	-0.0000
4.5000	714156.4	4.5000	0.0000
15.0000	452318.5	15.0000	-0.0000
18.5000	390881.6	18.5000	-0.0000
24.0000	312622.4	24.0000	0.0000
29.0000	256728.6	29.0000	0.0000
32.5000	224409.7	32.5000	-0.0000

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



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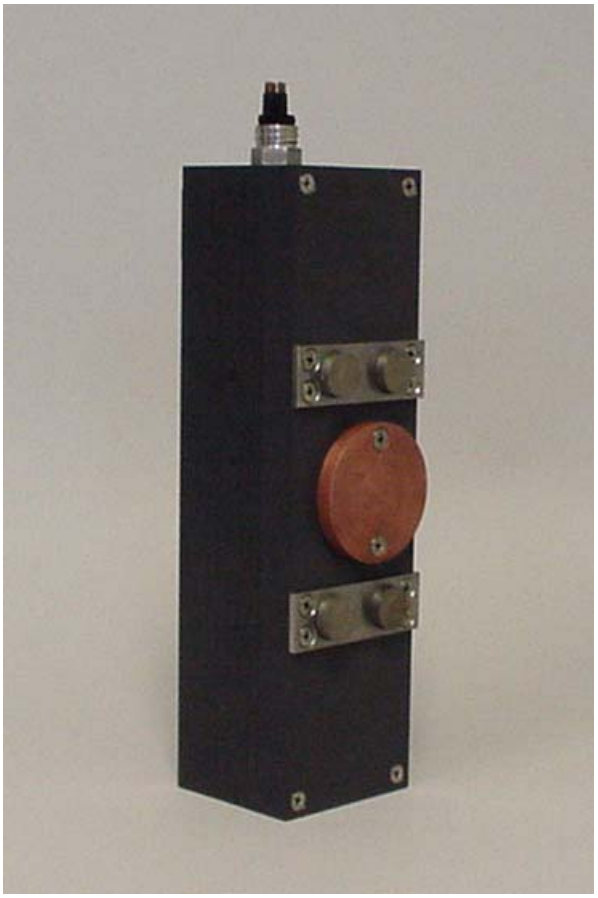
Hull Temperature Sensor

SBE 48



The SBE 48 is a high-accuracy temperature recorder with non-volatile memory, designed for shipboard determination of sea surface temperature. Mounted with magnets just below the water line, the SBE 48's temperature sensor is in contact with the **inside** of the ship's hull. The SBE 48's internal battery runs the real-time clock and can be used to power the instrument for very short deployments; external power is recommended for typical deployments.

The SBE 48's thermistor, the same sensor used in the SBE 37 MicroCAT and SBE 39 Temperature Recorder, has a long history of exceptional accuracy and stability. Demonstrated drift is typically less than 0.002 °C per year.

COMMUNICATIONS AND INTERFACING

The SBE 48 communicates directly with a computer via a standard RS-232 interface, at a user-selectable baud rate of 1200 to 38,400. Setup and extraction of data is done via an I/O data cable plugged into an external connector. Calibration coefficients are stored in EEPROM, allowing the SBE 48 to transmit data in ASCII engineering units (°C).

User-selectable operating modes include:

- **Polled Sampling** allows sampling and data transmission to be triggered by a command from a computer, or satellite, radio, or wire telemetry equipment.
- **Autonomous Sampling** allows sampling at pre-programmed intervals, and can be set up to start at a future date and time. There are two types of Autonomous Sampling —
  — *Interval*: At pre-programmed (3-second to 9-hour) intervals, SBE 48 wakes up, samples, and powers off.
  — *Continuous*: SBE 48 continuously samples at approximately 1-second intervals, and does not power off between samples.
  The SBE 48 also calculates a running average for up to 120 samples, which can be transmitted while logging data.
- **Serial Line Sync** allows sampling and data transmission to be triggered by a pulse on the serial line, which causes a sleeping SBE 48 to wake up, sample, and power-off automatically.

DATA STORAGE AND BATTERY ENDURANCE

The SBE 48 has 64 MBytes (32 MB usable) of non-volatile FLASH memory and can store 4,700,000 samples of temperature (3 bytes per sample) and time (4 bytes per sample).

The SBE 48's internal, 9-volt, lithium battery powers the real-time clock. Running the clock alone, the battery will last for five to ten years. If external power is not provided, the battery can provide power for logging up to 180,000 samples.

SENSOR INTERFACE ELECTRONICS

Temperature is acquired by applying an AC excitation to a hermetically sealed VISHAY reference resistor and an ultra-stable aged thermistor. A 24-bit A/D converter digitizes the outputs of the reference resistor and thermistor. AC excitation and ratiometric comparison using a common processing channel avoids errors caused by parasitic thermocouples, offset voltages, leakage currents, and reference errors.

SOFTWARE

The SBE 48 is supplied with a powerful Win 2000/XP software package, SEASOFT©-Win32, which includes:

- SEATERM© — terminal program for easy communication and data retrieval.
- PLOT39© — program for plotting data from an SBE 48

SBE

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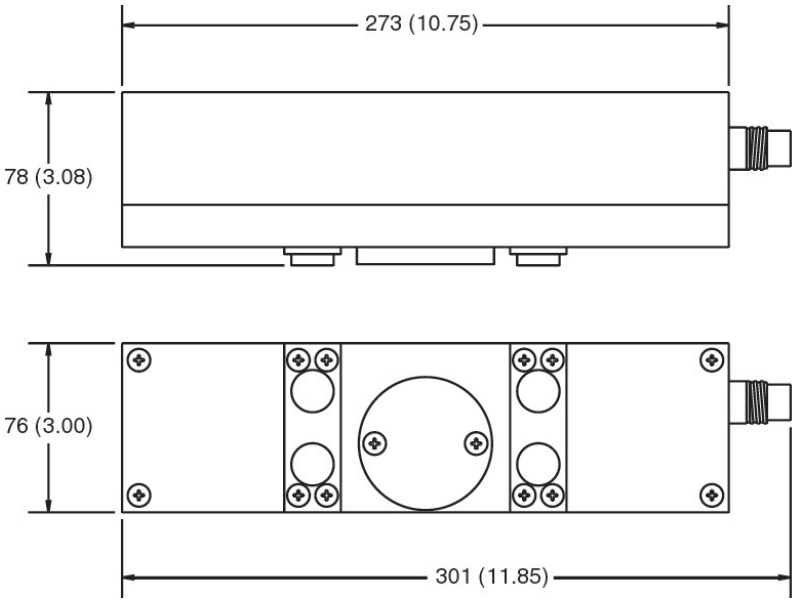
Hull Temperature Sensor

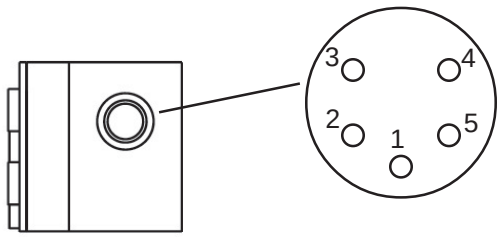
SBE 48

SPECIFICATIONS

Measurement Range	-5 to +35 °C
Initial Accuracy	± 0.002 °C
Typical Stability (per month)	0.0002 °C
Resolution	0.0001 °C
Clock Accuracy	1 minute/year
Internal Power	9V non-hazardous lithium battery: Runs real-time clock (5 to 10 year battery endurance). Can power SBE 48 (up to 180,000 samples) if external power not supplied.
External Power	8 - 16 VDC
Quiescent Current	10 microAmps
Operating Current	0.018 Amp-seconds per sample; 15 milliAmps for continuous sampling
Memory Capacity	4,700,000 samples (temperature and time) (temperature=3 bytes/sample; time=4 bytes/sample)
Materials	PVC housing
Weight	2.3 kg (5 lbs)



Pin	Description
1	Ground
2	Transmit: RS-232C transmit data from SBE 48 to computer
3	Power: 8 - 16 VDC external power
4	Receive: RS-232C receive data transmitted from computer
5	Shield



07/08

SBE
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APPLICATION NOTE NO. 42 **Revised February 2010**

ITS-90 TEMPERATURE SCALE

Beginning in January 1995, Sea-Bird's temperature metrology laboratory (based upon water triple-point and gallium melt cell, SPRT, and ASL F18 Temperature Bridge) converted to ITS-90 (T90). These T90 standards are employed in calibrating *all* Sea-Bird temperature sensors, and as the reference temperature used in conductivity calibrations.

The international oceanographic research community continues to use IPTS-68 (T68) for computation of salinity and other seawater properties. Therefore, following the recommendations of Saunders (1990) and as supported by the Joint Panel on Oceanographic Tables and Standards (1991), our software and our instrument firmware (for instruments that can calculate and output salinity and other seawater properties directly) converts between T68 and T90 according to the linear relationship:

$$T_{68} = 1.00024 * T_{90}$$

The use of T68 for salinity and other seawater calculations is automatic in our software and in those instruments that directly output salinity and other seawater parameters.

Note: In our SEASOFT V2 suite of software programs, edit the CTD configuration (.con or .xmlcon) file to enter calibration coefficients using the Configure Inputs menu in Seasave V7 (real-time data acquisition software) or the Configure menu in SBE Data Processing (data processing software).

SBE 9*plus* (using SBE 3*plus* temperature sensor), 16, 19, 21, and 25 (using SBE 3F temperature sensor)

Beginning in January 1995, Sea-Bird temperature calibration certificates began listing a set of coefficients labeled *g*, *h*, *i*, *j*, and *F0*, corresponding to ITS-90 (T90) temperatures. For user convenience and for historical comparison with older calibrations, the certificates also continue to list *a*, *b*, *c*, *d*, and *F0* coefficients corresponding to IPTS-68 (T68) temperatures. The T90 coefficients result directly from T90 standards; the T68 coefficients are computed using the Saunders linear approximation.

SEASOFT supports entry of either the T90 or the T68 coefficients for these instruments. When selecting temperature as a display/output variable, you must select which standard (T90 or T68) is to be used to compute temperature. SEASOFT recognizes whether you have entered T90 or T68 coefficients in the configuration (.con or .xmlcon) file, and performs the calculations accordingly, depending on which coefficients were used and which display variable type is selected.

- If *g, h, i, j, F0* coefficients (T90) are entered in the configuration file and you select temperature display/output variable type as T68, SEASOFT computes T90 temperature directly and multiplies it by 1.00024 to display or output T68.
- If *a, b, c, d,* and *F0* coefficients (T68) are entered in the configuration file and you select temperature display/output variable type as T90, SEASOFT computes T68 directly and divides by 1.00024 to display or output T90.

SBE 16*plus*, 16*plus*-IM, 16*plus* V2, 16*plus*-IM V2, 19*plus*, 19*plus* V2, 26*plus*, 35, 35RT, 37 (all), 38, 39 and 39-IM, 45, 49, 51, 52-MP, 53, *and all higher numbered instruments*

For these instruments, all first manufactured after the switch of our metrology lab to ITS-90, Sea-Bird provides only one set of temperature calibration coefficients, based on the T90 standards. These instruments all have user-programmable internal calibration coefficients, and can output data in engineering units (°C, S/m, dbar, etc. as applicable to the instrument). When outputting temperature in engineering units, these instruments always output T90 temperatures.

- Instruments that can internally compute and then output salinity and other seawater parameters (for example, SBE 37-SI) - Use of T68 for salinity and other seawater calculations is automatic; the instrument internally performs the conversion between T90 and T68 according to the Saunders equation.
- Instruments supported in SEASOFT (for example, SBE 19*plus* V2) - Use of T68 for salinity and other seawater calculations is automatic; the software performs the conversion between T90 and T68 according to the Saunders equation. When selecting temperature as a display/output variable, you must select which standard (T90 or T68) is to be used to compute temperature.

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APPLICATION NOTE NO. 57 **Revised February 2010**

Connector Care and Cable Installation

This Application Note describes the proper care of connectors and installation of cables for Sea-Bird instruments. The Application Note is divided into three sections:

- Connector Cleaning and Inspection, and Cable / Dummy Plug Installation
- Locking Sleeve Installation
- Cold Weather Tips

Note: All photos in this Application Note show standard Impulse XSG/AG connectors. Except as noted, all procedures apply to standard XSG/AG connectors as well as to optional *wet-pluggable* MCBH connectors.

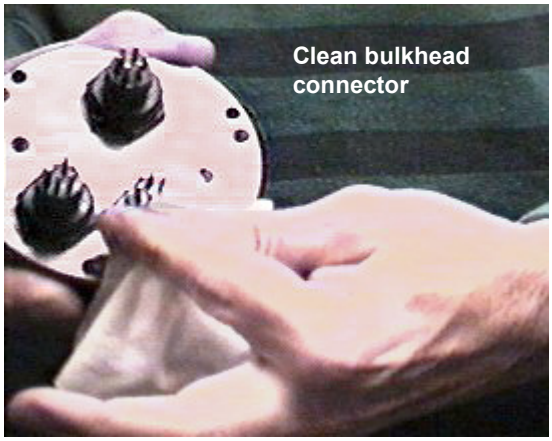
Connector Cleaning and Inspection, and Cable / Dummy Plug Installation

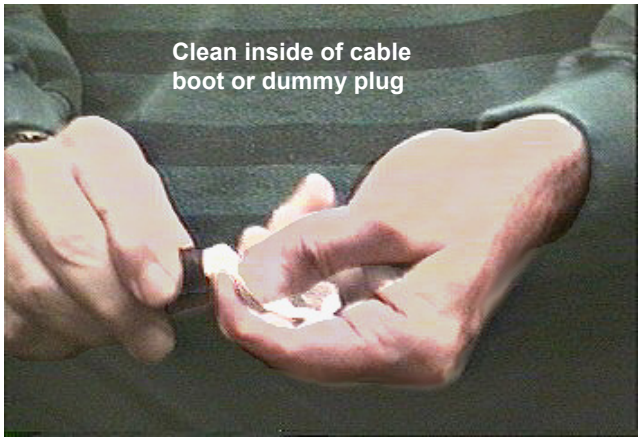
Clean and inspect connectors, cables, and dummy plugs:

- Before every cruise.
- During the cruise – This is a good practice if you have a few days of down time between casts.
- After every cruise – This is the best way to find and remove any corrosion on connector pins before severe corrosion develops.
- As part of your yearly equipment maintenance.

Follow this procedure:

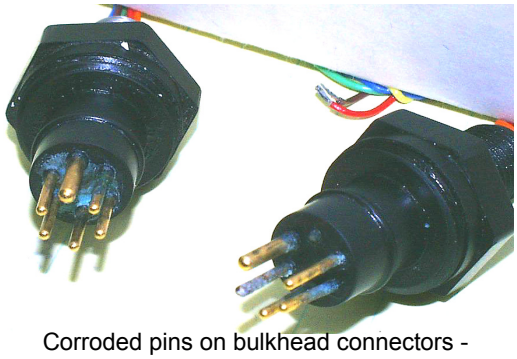
1. Carefully clean the bulkhead connector and the inside of the mating cable's boot or the dummy plug with a Kim wipe. Remove all grease, hair, dirt, and other contamination.





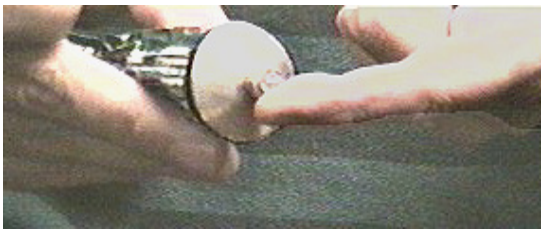
2. Inspect the connector and cable boot or dummy plug:
   A. Inspect the pins on the bulkhead connector for signs of corrosion. The pins should be bright and shiny, with no discoloration. If the pins are discolored or corroded, clean with alcohol and a Q-tip.
   B. Inspect the bulkhead connector for chips, cracks, or other flaws that may compromise the seal.
   C. Inspect the cable boot or dummy plug for cuts, nicks, breaks, or other problems that may compromise the seal.

   Replace severely corroded or otherwise damaged connectors, cables, and dummy plugs - contact Sea-Bird for instructions and a Return Material Authorization (RMA) number.

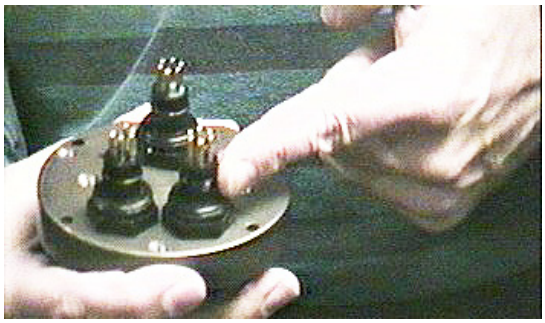


Corroded pins on bulkhead connectors - Connector on right has a missing pin

3. Using a tube of 100% silicone grease (Dow DC-4 or equivalent), grease the bulkhead connector and the cable boot or dummy plug.



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



A. Squeeze the silicone grease -- approximately half the size of a pea -- onto the end of your finger. Apply a light, even coating of grease to the molded ridge around the base of the bulkhead connector. The ridge looks like an O-ring molded into the bulkhead connector base and fits into the groove of the mating cable boot or dummy plug.

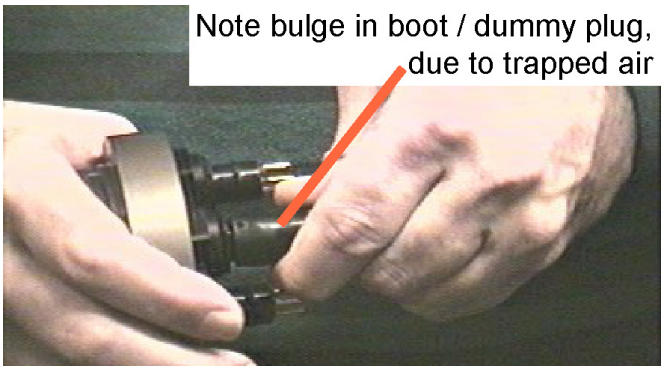
B. Squeeze approximately half the size of a pea of the silicone grease onto the end of your finger. Apply a light, even coating of grease to the inside of the cable boot or dummy plug.

4. *Standard XSG/AG connectors only:* Align the *bump* on the cable boot or dummy plug with the large pin on the bulkhead connector, and align the sockets with the pins.

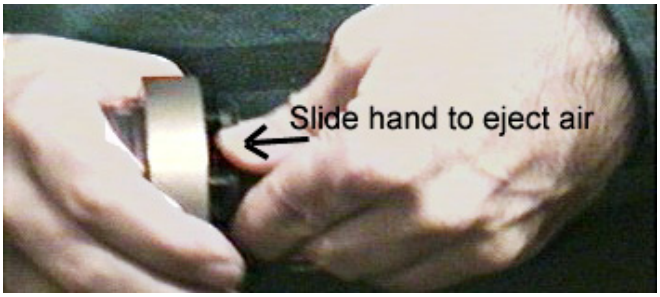
   Optional wet-pluggable MCBH connectors only: Align the non-conducting guide pin and the conducting pins with the mating sockets.

   - Do not twist the cable boot or dummy plug on the bulkhead connector; twisting can lead to bent pins, which will soon break.

5. Push the cable boot or dummy plug all the way onto the bulkhead connector.
   - *Standard XSG/AG connectors only:* You may note a bulge in the boot or dummy plug, which is due to trapped air. There may be an audible pop, which is good. With some newer cables or dummy plugs, or in cold weather, there may not be an initial audible pop.



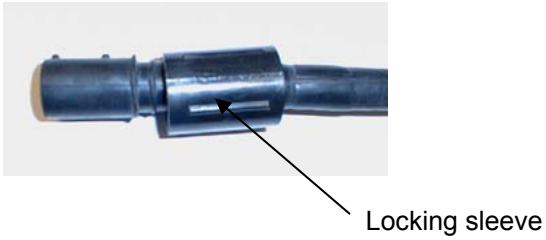
6. *Standard XSG/AG connectors only:* After the cable or dummy plug is mated, run your fingers along the cable boot or dummy plug toward the bulkhead connector, *milking* any trapped air out of the boot or plug. You should hear the air being ejected.
   CAUTION:
   Failure to eject the trapped air will result in the connector leaking.



Locking Sleeve Installation

After the cable boot or dummy plug is mated to the bulkhead connector, install the locking sleeve. The locking sleeve secures the cable or dummy plug to the bulkhead connector and prevents them it being inadvertently removed. Important points regarding locking sleeves:

- Tighten the locking sleeve by hand. **Do not** use a wrench or pliers to tighten the locking sleeve. Over-tightening will gall the threads, which can bind the locking sleeve to the bulkhead connector. Attempting to remove a tightly bound locking sleeve may instead result in the bulkhead connector actually unthreading from the end cap. A loose bulkhead connector will lead to a flooded instrument. **Pay particular attention when removing a locking sleeve to ensure the bulkhead connector is not loosened**.
- It is a common misconception that the locking sleeve provides watertight integrity. **It does not, and continued re-tightening of the locking sleeve will not *fix* a leaking connector**.
- As part of routine maintenance at the end of a day's casts, remove the locking sleeve, slide it up the cable, and rinse the connection (still mated) with fresh water. This will prevent premature cable failure.



Cold Weather Tips

In cold weather, the cable or dummy plug may be hard to install and remove.

Removing a *Frozen* Cable Boot or Dummy Plug:

1. Wrap the cable boot or dummy plug with a washrag or other cloth.
2. Pour hot water on the cloth and let it sit for a minute or two. The cable boot or dummy plug should thaw and become flexible enough to be removed.

Installing a Standard XSG/AG Cable or Dummy Plug:

When possible, install cables and dummy plugs in warm environments. If not, warm the cable boot or dummy plug sufficiently so it is flexible. A flexible cable boot or dummy plug will install properly.

Note about Wet-Pluggable (MCBH) Connectors:

As an option, Sea-Bird offers *wet-pluggable* (MCBH) connectors in place of the standard Impulse XSG/AG connectors. Wet-pluggable connectors have a non-conducting guide pin to assist pin alignment and require less force to mate, making them **easier to mate reliably under dark or cold conditions**, compared to our standard connectors. Wet-pluggable connectors may be mated in wet conditions; their pins do not need to be dried before mating. By design, water on the connector pins is forced out as the connector is mated. However, they must not be mated or un-mated while submerged. Like standard connectors, wet-pluggables need proper lubrication and require care during use to avoid trapping water in sockets.

If desired, Sea-Bird can retrofit your existing instruments with wet-pluggable connectors; contact Sea-Bird for pricing information.

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APPLICATION NOTE NO. 68 **Revised June 2009**

Using USB Ports to Communicate with Sea-Bird Instruments

Most Sea-Bird instruments use the RS-232 protocol for transmitting setup commands to the instrument and receiving data from the instrument. However, most newer PCs and laptop computers have USB port(s) instead of RS-232 serial port(s).

USB serial adapters are available commercially. These adapters plug into the USB port, and allow one or more serial devices to be connected through the adapter. Sea-Bird tested USB serial adapters from several manufacturers on computers at Sea-Bird, and verified compatibility with our instruments. These manufacturers and the tested adapters are:

- **FTDI** (www.ftdichip.com) -
  "ChiPi" USB-RS232 Converter (model # FTDI UC232R-10).
  Note: This adapter can also be purchased from Sea-Bird, as Sea-Bird part # 20200.
  Drivers for this adapter can be found at http://www.ftdichip.com/Drivers/VCP.htm.

- **IOGEAR** (www.iogear.com) –
  USB 1.1 to Serial Converter Cable (model # GUC232A).
  Note: We have had several reports from customers that they could not communicate with their instrument using a laptop computer and this adapter.

- **Keyspan** (www.keyspan.com) -
  USB 4-Port Serial Adapter (part # USA-49WLC, replacing part # USA-49W)
  Note: We have one report from a customer that he could not communicate with his instrument using a notebook computer and this adapter. He was able to successfully communicate with the instrument using an XH8290 DSE Serial USB Adapter (www.dse.co.nz).

- **Edgeport** (www.ionetworks.com) -
  Standard Serial Converter Edgeport/2 (part # 301-1000-02)

Other USB adapters from these manufacturers, and adapters from other manufacturers, **may** also be compatible with Sea-Bird instruments.

We recommend testing any adapters, *including those listed above*, with the instrument and the computer you will use it with before deployment, to verify that there is no problem.

See Application Note 56: Interfacing to RS-485 Sensors for information on using a USB port to communicate with a Sea-Bird instrument that communicates via RS-485 telemetry.

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APPLICATION NOTE NO. 71 — Revised March 2008

Desiccant Use and Regeneration (drying)

This application note applies to all Sea-Bird instruments intended for underwater use. The application note covers:
- When to replace desiccant
- Storage and handling of desiccant
- Regeneration (drying) of desiccant
- Material Safety Data Sheet (MSDS) for desiccant

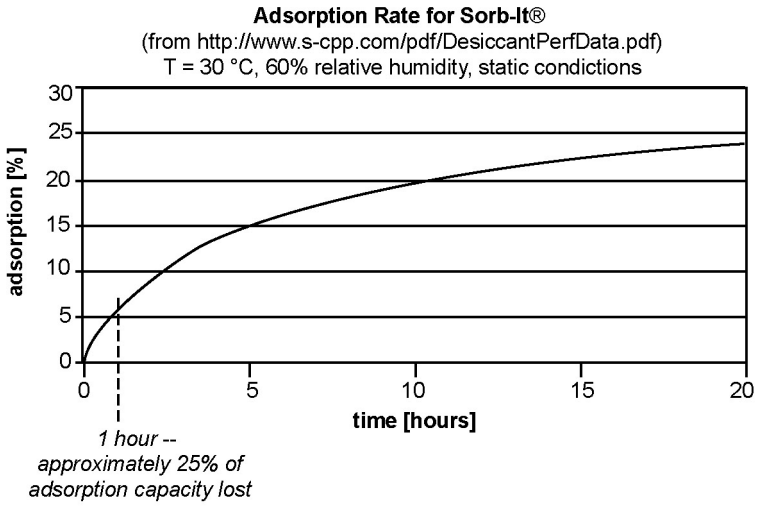
When to Replace Desiccant Bags

Before delivery of the instrument, a desiccant package is placed in the housing, and the electronics chamber is filled with dry Argon. These measures help prevent condensation. To ensure proper functioning:
1. Install a new desiccant bag each time you open the housing and expose the electronics.
2. If possible, dry gas backfill each time you open the housing and expose the electronics. If you cannot, wait at least 24 hours before redeploying, to allow the desiccant to remove any moisture from the chamber.

What do we mean by *expose the electronics*?
- For most battery-powered Sea-Bird instruments (such as SBE 16, 16*plus*, 16*plus* V2, 16*plus*-IM, 16*plus*-IM V2, 17*plus*, 19, 19*plus*, 19*plus* V2, 25, 26, 26*plus*, 37-SM, 37-SMP, 37-IM, 37-IMP, 44, 53, 54, 55, Auto Fire Module [AFM]), there is a bulkhead between the battery and electronics compartments. Battery replacement does not affect desiccation of the electronics, as the batteries are removed without removing the electronics and no significant gas exchange is possible through the bulkhead. Therefore, opening the battery compartment to replace the batteries does not expose the electronics; you do not need to install a new desiccant bag in the electronics compartment each time you open the battery compartment. For these instruments, install a new desiccant bag if you open the electronics compartment to access the printed circuit boards.
- For the SBE 39, 39-IM, and 48, the electronics must be removed or exposed to access the battery. Therefore, install a new desiccant bag each time you open the housing to replace a battery.

Storage and Handling

Testing by Süd-Chemie (desiccant's manufacturer) at 60% relative humidity and 30 °C shows that approximately 25% of the desiccant's adsorbing capacity is used up after only 1 hour of exposure to a constantly replenished supply of moisture in the air. In other words, if you take a bag out of a container and leave it out on a workbench for 1 hour, one-fourth of its capacity is gone before you ever install it in the instrument. Therefore:
- Keep desiccant bags in a tightly sealed, impermeable container until you are ready to use them. Open the container, remove a bag, and quickly close the container again.
- Once you remove the bag(s) from the sealed container, rapidly install the bag(s) in the instrument housing and close the housing. **Do not use the desiccant bag(s) if exposed to air for more than a total of 30 minutes.**



Regeneration (drying) of Desiccant

Replacement desiccant bags are available from Sea-Bird:

- PN 60039 is a metal can containing 25 1-gram desiccant bags and 1 humidity indicator card. The 1-gram bags are used in our smaller diameter housings, such as the SBE 3 (*plus*, F, and S), 4 (M and C), 5T and 5P, 37 (-SI, -SIP, -SM, -SMP, -IM, and –IMP), 38, 39, 39-IM, 43, 44, 45, 48, 49, and 50.
- PN 31180 is a 1/3-ounce desiccant bag, used in our SBE 16*plus*, 16*plus* V2, 16*plus*-IM, 16*plus*-IM V2, 19*plus*, 19*plus* V2, 21, and 52-MP.
- PN 30051 is a 1-ounce desiccant bag. The 1-ounce bags are used in our larger diameter housings, such as the SBE 9*plus*, 16, 17*plus*, 19, 25, 26, 26*plus*, 32, 53 BPR, 54, 55, AFM, and PDIM.

However, if you run out of bags, you can regenerate your existing bags using the following procedure provided by the manufacturer (Süd-Chemie Performance Packaging, a Division of United Catalysts, Inc.):

MIL-D-3464 Desiccant Regeneration Procedure

Regeneration of the United Desiccants' Tyvek Desi Pak® or Sorb-It® bags or United Desiccants' X-Crepe Desi Pak® or Sorb-It® bags can be accomplished by the following method:

1. Arrange the bags on a wire tray in a single layer to allow for adequate air flow around the bags during the drying process. The oven's inside temperature should be room or ambient temperature (25 – 29.4 °C [77 – 85 °F]). **A convection, circulating, forced-air type oven is recommended for this regeneration process. Seal failures may occur if any other type of heating unit or appliance is used.**

2. When placed in forced air, circulating air, or convection oven, allow a minimum of 3.8 to 5.1 cm (1.5 to 2.0 inches) of air space between the top of the bags and the next metal tray above the bags. If placed in a radiating exposed infrared-element type oven, shield the bags from direct exposure to the heating element, giving the closest bags a minimum of 40.6 cm (16 inches) clearance from the heat shield. Excessive surface film temperature due to infrared radiation will cause the Tyvek material to melt and/or the seals to fail. Seal failure may also occur if the temperature is allowed to increase rapidly. This is due to the fact that the water vapor is not given sufficient time to diffuse through the Tyvek material, thus creating internal pressure within the bag, resulting in a seal rupture. Temperature should not increase faster than 0.14 to 0.28 °C (0.25 to 0.50 °F) per minute.

3. Set the temperature of the oven to 118.3 °C (245 °F), and allow the bags of desiccant to reach equilibrium temperature. **WARNING**: Tyvek has a melt temperature of 121.1 – 126.7 °C (250 – 260 °F) (Non MIL-D-3464E activation or reactivation of both silica gel and Bentonite clay can be achieved at temperatures of 104.4 °C [220 °F]).

4. Desiccant bags should be allowed to remain in the oven at the assigned temperature for 24 hours. At the end of the time period, the bags should be immediately removed and placed in a desiccator jar or dry (0% relative humidity) airtight container for cooling. If this procedure is not followed precisely, any water vapor driven off during reactivation may be re-adsorbed during cooling and/or handling.

5. After the bags of desiccant have been allowed to cool in an airtight desiccator, they may be removed and placed in either an appropriate type polyliner tightly sealed to prevent moisture adsorption, or a container that prevents moisture from coming into contact with the regenerated desiccant.

NOTE: Use only a metal or glass container with a tight fitting metal or glass lid to store the regenerated desiccant. Keep the container lid **closed tightly** to preserve adsorption properties of the desiccant.

SÜD-CHEMIE
Creating Performance Technology
ISO 9002 CERTIFIED

Sud-Chemie Performance Packaging
101 Christine Dr.
Belen, New Mexico 87002
Phone: (505) 864-6691
Fax: (505) 864-9296

MATERIAL SAFETY DATA SHEET – August 13, 2002
SORB-IT®
Packaged Desiccant

SECTION I -- PRODUCT IDENTIFICATION

Trade Name and Synonyms:	Silica Gel, Synthetic Amorphous Silica, Silicon, Dioxide
Chemical Family:	Synthetic Amorphous Silica
Formula:	SiO_2.x H_2O

SECTION II -- HAZARDOUS INGREDIENTS

Components in the Solid Mixture

COMPONENT	CAS No	%	ACGIH/TLV (PPM)	OSHA-(PEL)
Amorphous Silica	63231-67-4	>99	PEL - 20 (RESPIRABLE), TLV – 5	LIMIT – NONE, HAZARD - IRRITANT

Synthetic amorphous silica is not to be confused with crystalline silica such as quartz, cristobalite or tridymite or with diatomaceous earth or other naturally occurring forms of amorphous silica that frequently contain crystalline forms.

This product is in granular form and packed in bags for use as a desiccant. Therefore, no exposure to the product is anticipated under normal use of this product. Avoid inhaling desiccant dust.

SECTION III -- PHYSICAL DATA

Appearance and Odor:	White granules; odorless.
Melting Point:	>1600 Deg C; >2900 Deg F
Solubility in Water:	Insoluble.
Bulk Density:	>40 lbs./cu. ft.
Percent Volatile by Weight @ 1750 Deg F:	<10%.

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SECTION IV -- FIRE EXPLOSION DATA

Fire and Explosion Hazard - Negligible fire and explosion hazard when exposed to heat or flame by reaction with incompatible substances.

Flash Point - Nonflammable.

Firefighting Media - Dry chemical, water spray, or foam. For larger fires, use water spray fog or foam.

Firefighting - Nonflammable solids, liquids, or gases: Cool containers that are exposed to flames with water from the side until well after fire is out. For massive fire in enclosed area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of the tank due to fire.

SECTION V -- HEALTH HAZARD DATA

Health hazards may arise from inhalation, ingestion, and/or contact with the skin and/or eyes. Ingestion may result in damage to throat and esophagus and/or gastrointestinal disorders. Inhalation may cause burning to the upper respiratory tract and/or temporary or permanent lung damage. Prolonged or repeated contact with the skin, in absence of proper hygiene, may cause dryness, irritation, and/or dermatitis. Contact with eye tissue may result in irritation, burns, or conjunctivitis.

First Aid (Inhalation) - Remove to fresh air immediately. If breathing has stopped, give artificial respiration. Keep affected person warm and at rest. Get medical attention immediately.

First Aid (Ingestion) - If large amounts have been ingested, give emetics to cause vomiting. Stomach siphon may be applied as well. Milk and fatty acids should be avoided. Get medical attention immediately.

First Aid (Eyes) - Wash eyes immediately and carefully for 30 minutes with running water, lifting upper and lower eyelids occasionally. Get prompt medical attention.

First Aid (Skin) - Wash with soap and water.

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NOTE TO PHYSICIAN: This product is a desiccant and generates heat as it adsorbs water. The used product can contain material of hazardous nature. Identify that material and treat accordingly.

SECTION VI -- REACTIVITY DATA

Reactivity - Silica gel is stable under normal temperatures and pressures in sealed containers. Moisture can cause a rise in temperature which may result in a burn.

SECTION VII --SPILL OR LEAK PROCEDURES

Notify safety personnel of spills or leaks. Clean-up personnel need protection against inhalation of dusts or fumes. Eye protection is required. Vacuuming and/or wet methods of cleanup are preferred. Place in appropriate containers for disposal, keeping airborne particulates at a minimum.

SECTION VIII -- SPECIAL PROTECTION INFORMATION

Respiratory Protection - Provide a NIOSH/MSHA jointly approved respirator in the absence of proper environmental control. Contact your safety equipment supplier for proper mask type.

Ventilation - Provide general and/or local exhaust ventilation to keep exposures below the TLV. Ventilation used must be designed to prevent spots of dust accumulation or recycling of dusts.

Protective Clothing - Wear protective clothing, including long sleeves and gloves, to prevent repeated or prolonged skin contact.

Eye Protection - Chemical splash goggles designed in compliance with OSHA regulations are recommended. Consult your safety equipment supplier.

SECTION IX -- SPECIAL PRECAUTIONS

Avoid breathing dust and prolonged contact with skin. Silica gel dust causes eye irritation and breathing dust may be harmful.

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SORB-IT®
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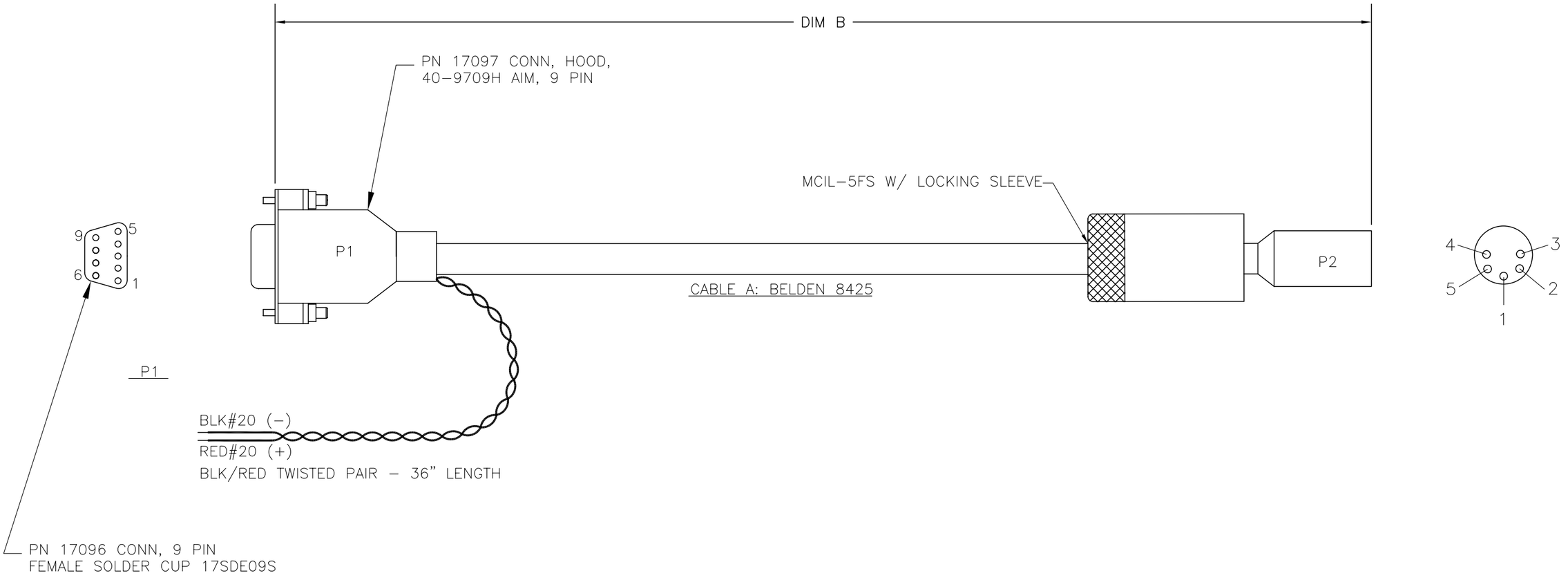
* No Information Available

HMIS (Hazardous Materials Identification System) for this product is as follows:

Health Hazard	0
Flammability	0
Reactivity	0
Personal Protection	HMIS assigns choice of personal protective equipment to the customer, as the raw material supplier is unfamiliar with the condition of use.

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
5.16.03	A	FIXED PIN CALLOUTS	CB	KLP	
2.5.07	B	ECN1062: ADD SHIELD	CB	CB	



P1 DB-9S	DATA CABLE	P2 SUBCONN MCIL-5FS	RED & BLACK
PIN 5	BLACK\SHIELD	PIN 1 COMMON	BLACK
PIN 2	WHITE	PIN 2 TX	--
--	RED	PIN 3 POWER+	RED
PIN 3	GREEN	PIN 4 RX	--
--	BLUE	PIN 5	--

B

SBE PN	CABLE A SBE PN	DIM B
801431	171442	8 FEET
801432	171659	10 METER
801433	171788	15 METER
801699	172274	50 METER

NOTE: PIGTAIL DRAWING 32663

TOLERANCES	SEA-BIRD ELECTRONICS, INC		
FRACTIONAL	P/N SEE TABLE	SCALE NTS	DRAWN BY KLP
			APPROVED BY
DECIMAL	TITLE SBE48 DATA I/O AND POWER CABLE, DB-9S		
ANGULAR	DATE 5.13.03	DRAWING NUMBER 32805	REV B

WARRANTY POLICY 2010

PRODUCT WARRANTY

5-YEAR LIMITED WARRANTY (NEW PRODUCTS)

For a period of five years after the date of original shipment from our factory, products manufactured by Sea-Bird are warranted to function properly and be free of defects in materials and workmanship. Should a Sea-Bird instrument fail during the warranty period, return it freight pre-paid to our factory. We will repair it (or at our option, replace it) at no charge, and pay the cost of shipping it back to you. Certain products and components have modified coverage under this warranty as described below.

LIMITED WARRANTY ON SERVICE & REPAIRS

Service work, repairs, replacement parts and modifications are warranted to be free of defects in materials or workmanship for the remainder of the original 5-year warranty or one year from the date of shipment from our factory after repair or service, which ever is longer. Certain products and components have modified coverage under this warranty as described below.

MODIFICATIONS / EXCEPTIONS / EXCLUSIONS

1. The SBE 43 DO sensor is warranted to function properly for 5 years. Under normal use however, the electrolyte in an SBE 43 DO sensor will require replenishment after about 3 years (or longer, depending on conditions of use). Anytime during the warranty period (typically after 3 years), the SBE 43 will be refurbished once without charge, Return the sensor freight pre-paid to our factory. We will refurbish it for free (electrolyte refill, membrane replacement, and recalibration) and pay the cost of shipping it back to you. Membrane damage or depletion of electrolyte caused by membrane damage is not covered by this warranty.

2. The pH sensor electrode used in the SBE 18 pH sensor and SBE 27 pH/ORP sensor has a limited design life caused by depletion of their chemical constituents during normal storage and use, and is covered under warranty for the first 90 days only. Other components of the sensor (housing, electronics, etc.) are covered for 5 years.

3. Instruments or sensors manufactured by other companies are warranted only to the limit of the warranties provided by their original manufacturers, typically 1 year. (example: fluorometers, transmissometers, PAR, optical backscatter sensors, altimeters, etc.)

4. Water sample bottles manufactured by other companies, and PVC plastic bottle parts used to make Sea-Bird Improved Sample Bottles are warranted only to the limit of the warranties provided by their original manufacturers, typically one year. The mounting bracket (except stainless steel band clamp) used in Sea-Bird Improved Sample Bottles is covered for 5 years.

5. Batteries, zinc anodes, anti-foulant devices, or other consumable/expendable items are not covered under this warranty.

6. Electrical cables, dummy plugs, and stainless steel band clamps are warranted to function properly and be free of defects in materials and workmanship for 1 year.

7. This warranty is void if in our opinion the instrument has been damaged by accident, mishandled, altered, improperly serviced, or repaired by the customer where such treatment has affected its performance or reliability. In the event of such misuse/abuse by the customer, costs for repairs plus two-way freight costs will be borne by the customer. Instruments found defective should be returned to the factory carefully packed, as the customer will be responsible for freight damage.

8. Incidental or consequential damages or costs incurred as a result of product malfunction are not the responsibility of SEA-BIRD ELECTRONICS, INC.

WARRANTY ADMINISTRATION POLICY

Sea-Bird Electronics, Inc. and its authorized representatives or resellers provide warranty support only to the original purchaser. Warranty claims, requests for information or other support, and orders for post-warranty repair and service, by end-users that did not purchase directly from Sea-Bird or an authorized representative or reseller, must be made through the original purchaser. The intent and explanation of our warranty policy follows:

1. Warranty repairs are only performed by Sea-Bird.

2. Repairs or attempts to repair Sea-Bird products performed by customers (owners) shall be called *owner repairs*.

3. Our products are designed to be maintained by competent owners. Owner repairs of Sea-Bird products will NOT void the warranty coverage (as stated above) simply as a consequence of their being performed.

4. Owners may make repairs of any part or assembly, or replace defective parts or assemblies with Sea-Bird manufactured spares or authorized substitutes without voiding warranty coverage of the entire product, or parts thereof. Defective parts or assemblies removed by the owner may be returned to Sea-Bird for repair or replacement within the terms of the warranty, without the necessity to return the entire instrument. If the owner makes a successful repair, the repaired part will continue to be covered under the original warranty, as if it had never failed. Sea-Bird is not responsible for any costs incurred as a result of owner repairs or equipment downtime.

5. We reserve the right to refuse warranty coverage *on a claim by claim basis* based on our judgment and discretion. We will not honor a warranty claim if in our opinion the instrument, assembly, or part has been damaged by accident, mishandled, altered, or repaired by the customer *where such treatment has affected its performance or reliability*.

6. For example, if the CTD pressure housing is opened, a PC board is replaced, the housing is resealed, and then it floods on deployment, we do not automatically assume that the owner is to blame. We will consider a claim for warranty repair of a flooded unit, subject to our inspection and analysis. If there is no evidence of a fault in materials (e.g., improper or damaged o-ring, or seal surfaces) or workmanship (e.g., pinched o-ring due to improper seating of end cap), we would cover the flood damage under warranty.

7. In a different example, a defective PC board is replaced with a spare and the defective PC board is sent to Sea-Bird. We will repair or replace the defective PC board under warranty. The repaired part as well as the instrument it came from will continue to be covered under the original warranty.

8. As another example, suppose an owner attempts a repair of a PC board, but solders a component in backwards, causing the board to fail and damage other PC boards in the system. In this case, the evidence of the backwards component will be cause for our refusal to repair the damage under warranty. However, this incident will NOT void future coverage under warranty.

9. If an owner's technician attempts a repair, we assume his/her qualifications have been deemed acceptable to the owner. The equipment owner is free to use his/her judgment about who is assigned to repair equipment, and is also responsible for the outcome. The decision about what repairs are attempted and by whom is entirely up to the owner.

SOFTWARE WARRANTY

SOFTWARE LICENSE AGREEMENT

By downloading or installing any of our software, you expressly agree to the following:

Sea-Bird's SEASOFT© software is provided free of charge to Sea-Bird users and is not subject to any license. SEASOFT is protected by copyright laws and international copyright treaties, as well as other intellectual property laws and treaties. All title and copyrights in and to SEASOFT and the accompanying printed materials, and any copies of SEASOFT, are owned by Sea-Bird Electronics. There are no restrictions on its use or distribution, provided such use does not infringe on our copyright.

Note: SEASOFT is a modular program that includes SEASOFT V2 (Seasave V7, Seasave-Win32, SBE Data Processing, SeatermV2, Seaterm, SeatermAF, SeatermV2, Plot39, and Deployment Endurance Calculator), SEASOFT for Waves - Win32, SEASOFT-DOS, and SEASOFT for Waves - DOS.

SOFTWARE WARRANTY

Sea-Bird Electronics expressly disclaims any warranty for software. Software and any related documentation is provided "as is" without warranty of any kind, either expressed or implied, including and without limitation, the implied warranties or merchantability, fitness for a particular purpose, or non infringement. The entire risk arising out of use or performance of SEASOFT remains with you.
In no event shall Sea-Bird Electronics or its representatives or suppliers be liable for any damages whatsoever (including, without limitation, damages for loss of business profits, business interruption, loss of business information, or any other pecuniary loss) arising out of the use of or inability to use this Sea-Bird Electronics product, even if Sea-Bird has been advised of the possibility of such damages.

Sea-Bird Service Request Form

To return instruments for calibration or other service, please provide the information below, so we can serve you better and prevent delays in the return of the instruments:

1. Get a Returned Material Authorization (RMA) number from Sea-Bird (seabird@seabird.com, phone [+1] 425-643-9866, fax [+1] 425-643-9954). Reference the RMA number on this form, on the outside shipping label for the instruments, and in all related correspondence.
2. Include this form when shipping the instruments to Sea-Bird for servicing.
3. E-mail or fax us a copy of this form on the day you ship. seabird@seabird.com or fax [+1] 425-643-9954

RMA Number:_____ **Date equipment needed:**_____

Do you need a written quote? [ ] No [ ] Yes

IMPORTANT! Was this equipment deployed in the Gulf of Mexico during/after the Spring 2010 oil spill?
[ ] No [ ] Yes (specify serial numbers if not applicable to all instruments in shipment)_____

CONTACT INFORMATION

Your Name:_____ Institution/Company:_____

Shipping/Delivery address for packages:_____

Phone:_____ Fax:_____ E-mail:_____

SERVICE INFORMATION

Date Shipped:_____ Sea-Bird Model Numbers (i.e., SBE 37-SM, etc.):_____

Quantity:_____ Serial Numbers:_____

Special Instructions – for example, if specific services are required for some instruments (i.e., if 10 instruments need calibration, and 1 also needs repairs, specify the serial number for the instrument needing repairs):

[ ] Calibration Services (includes basic diagnostic):

[ ] Temperature [ ] Conductivity [ ] Pressure [ ] Oxygen [ ] pH

[ ] Other (i.e., fluorometer, turbidity, par, etc.):_____

[ ] Additional Services (additional charges apply; specify serial numbers):

[ ] Internal Inspection & O-Ring Replacement (includes hydrostatic pressure test)_____

[ ] System Upgrade or Conversion_____

[ ] Diagnose & Repair Problems (provide as much information as possible - description(s), configuration [.con or .xmlcon] file and raw data [.hex or .dat] file showing problems, etc.)_____

[ ] Download Data from instrument Memory_____

PAYMENT/BILLING INFORMATION

[ ] Credit Card (Sea-Bird accepts payment by VISA, Master Card, or American Express)

Name on Card:_____

Please call Cheryl Reed (425-644-3244) with credit card information.

[ ] Purchase Order (P.O.)

P.O. Number:_____

Billing Address (If different than shipping address):_____

_____

_____

_____

Instructions for Returning Goods to Sea-Bird

Note: Sea-Bird moved in January 2010; use the new address (shown below).

1. **Domestic Shipments (USA) - Ship prepaid** (via UPS, FedEx, DHL, etc.) directly to:
   Sea-Bird Electronics, Inc.
   13431 NE 20th Street
   Bellevue, WA 98005, USA
   Telephone: 425-643-9866, Fax: 425-643-9954

2. **International Shipments** –
   Option A. Ship via **PREPAID AIRFREIGHT to SEA-TAC International Airport (IATA Code "SEA")**:
   Sea-Bird Electronics, Inc.
   13431 NE 20th Street
   Bellevue, WA 98005, USA
   Telephone: [+1] 425-643-9866, Fax: [+1] 425-643-9954, E-mail: seabird@seabird.com

   Notify: MTI Worldwide Logistics for Customs Clearance
   Seattle, WA, USA
   Telephone: [+1] 206-431-4366 Fax: [+1] 206-431-4374 E-mail: bill.keebler@mti-worldwide.com

   E-mail flight details and airway bill number to seabird@seabird.com and bill.keebler@mti-worldwide.com when your shipment is en-route. Include your RMA number in the e-mail.

   Option B. Ship via **EXPRESS COURIER directly to Sea-Bird Electronics (see address above)**:
   If you choose this option, **we recommend shipping via UPS, FedEx, or DHL**. Their service is door-to-door, including customs clearance. It is not necessary to notify our customs agent, MTI Worldwide, if you ship using a courier service.

   E-mail the airway bill / tracking number to seabird@seabird.com when your shipment is en-route. Include your RMA number in the e-mail.

   For All International Shipments:
   Include a **commercial invoice** showing the description of the instruments, and **Value for Customs purposes only**. Include the following statement: **"U.S. Goods Returned for Repair/Calibration. Country of Origin: USA. Customs Code: 9801001012."** ***Failure to include this statement in your invoice will result in US Customs assessing duties on the shipment, which we will in turn pass on to the customer/shipper.***

Note: Due to changes in regulations, if Sea-Bird receives an instrument from outside the U.S. in a crate containing non-approved (i.e., non-heat-treated) wood, we will return the instrument in a new crate that meets the requirements of ISPM 15 (see http://www.seabird.com/customer_support/retgoods.htm for details). We will charge $50 to $150 for the replacement crate, based on the crate type. These prices are valid only for crate replacement required in conjunction with return of a customer's instrument after servicing, and only when the instrument was shipped in a crate originally supplied by Sea-Bird.