SBE 48
Hull Temperature Sensor

With RS-232 Serial Interface

User's Manual

Limited Liability Statement

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

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

Table of Contents

Section 1: Introduction

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

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

Sea-Bird Electronics, Inc.
1808 136th Place Northeast
Bellevue, Washington 98005 USA

Telephone:	425-643-9866
Fax:	425-643-9954
E-mail:	seabird@seabird.com
Website:	http://www.seabird.com

Business hours:
Monday-Friday, 0800 to 1800 Pacific Standard Time
        (1600 to 0200 Universal Time)
Except from April to October, when we are on 'summer time'
        (1500 to 0100 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 (see *Section 3: Preparing the SBE 48 for Deployment*).

2. Deploy the SBE 48 (see *Section 4: Deploying and Operating the SBE 48*):
    A. Install a new battery if necessary (see *Section 5: Routine Maintenance and Calibration*).
    B. Set time and date.
    C. Establish logging parameters.
    D. Ensure all data has been uploaded, and then set **SAMPLENUM**=0 to make entire memory available for recording if desired.
    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 the SBE 48

Shown below is a typical SBE 48 shipment.

SBE 48

I/O Cable

9-pin adapter

User and SEASOFT Manuals

Software

Section 2: Description of the SBE 48

This section describes the functions and features of the SBE 48, including specifications and dimensions.

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 mode).
  - ➢ *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.

The SBE 48 is supplied with a powerful software package that includes:

- **SEATERM** - Win 95/98/NT terminal program for easy communication and data retrieval.

- **PLOT39** - Win 95/98/NT program for plotting data from an SBE 48 or SBE 39.

- **SEASOFT** - DOS programs for calculation, display, and plotting of temperature. SEASOFT is designed to run on IBM compatible computers (XT/AT/386/486/Pentium). These programs usually perform correctly when run under Windows.

Notes:
- Help files provide detailed information on the use of SEATERM and PLOT39.
- A separate software manual contains detailed information on the setup and use of SEASOFT.
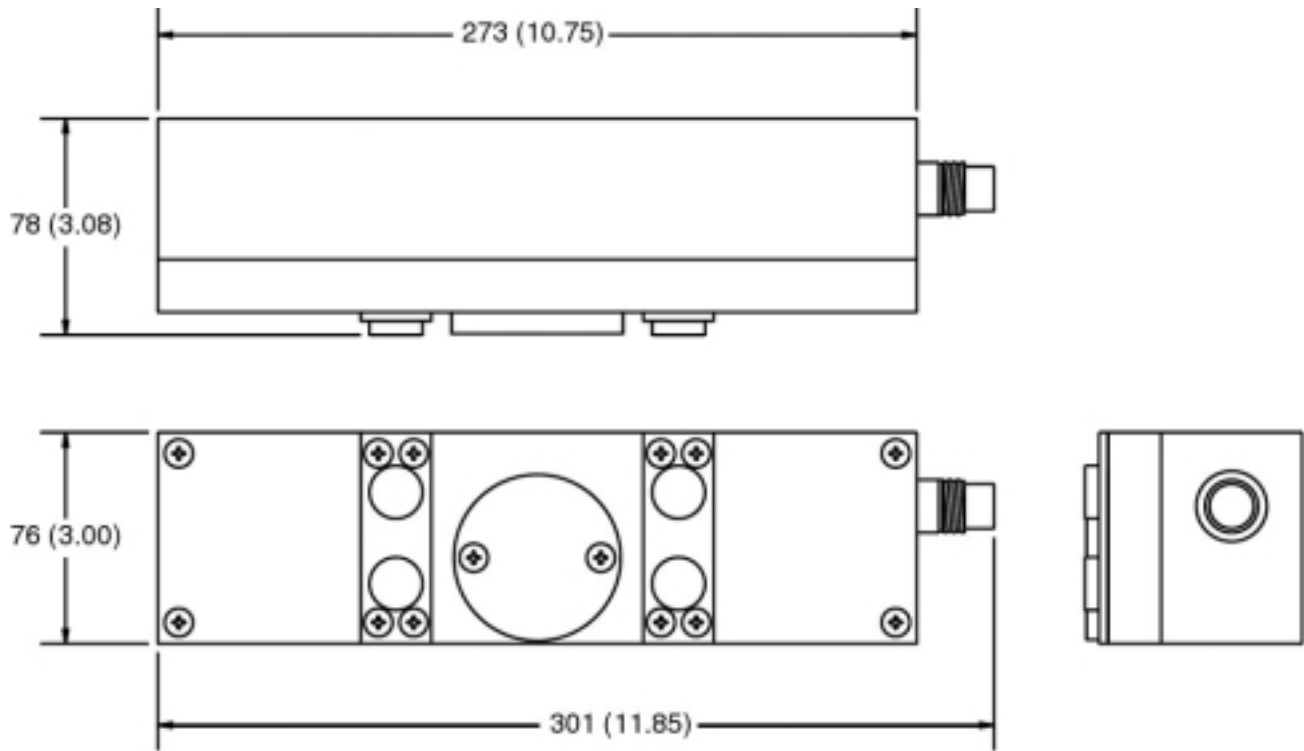
7

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
Sensor Calibration	-1 to +32 °C
Memory	2M byte non-volatile FLASH memory
Data Storage	Converted temperature: 3 bytes per sample. Time: 4 bytes per sample. Memory space: 276,000 samples.
Real-Time Clock	Watch-crystal type 32,768 Hz; Accuracy 15 seconds/month
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*: 0.015 amp-second
Battery Endurance	Running clock only: 5 to 10 years Providing power for logging: 150,000 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.

SBE 48 Dimensions in millimeters (inches)

Section 3: Preparing the SBE 48 for Deployment

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

Power and Communications Test

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.

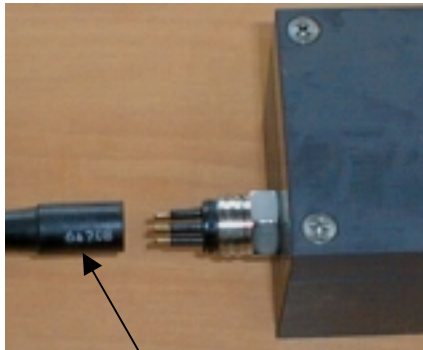The power and communications test will verify that the system works, prior to deployment.

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.
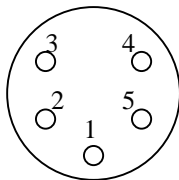
Test Set-Up

1. If not already installed, install SEATERM and other Sea-Bird software programs on your computer using the supplied software CD:
   A. Insert the CD in your CD drive.
   B. Double click on **Setup.exe**.
   C. 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.

I/O cable connector

2. 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 25-to-9 pin adapter is supplied for use if your computer has a 9-pin serial port.

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

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

Test

Proceed as follows:

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

SeaTerm Setup

The configuration file: SeaTerm.cfg was not found in the application path. Please enter the following setup information.

**IMPORTANT: To complete setup, review the configuration setting for your instrument by selecting your instrument type from the Configure menu list.

Instrument Type SBE39

COM Port 1

OK

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:

Menus

Toolbar

Command/Data Echo Area

Status bar

Capture to file status – grayed out if not capturing

Instrument

Computer COM port

Upload parameter

Instrument EPROM version

Baud rate, data bits, stop bits, and parity

- 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 the Connect button 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.

Notes:
- See SEATERM's help files for detailed information on the use of the program.
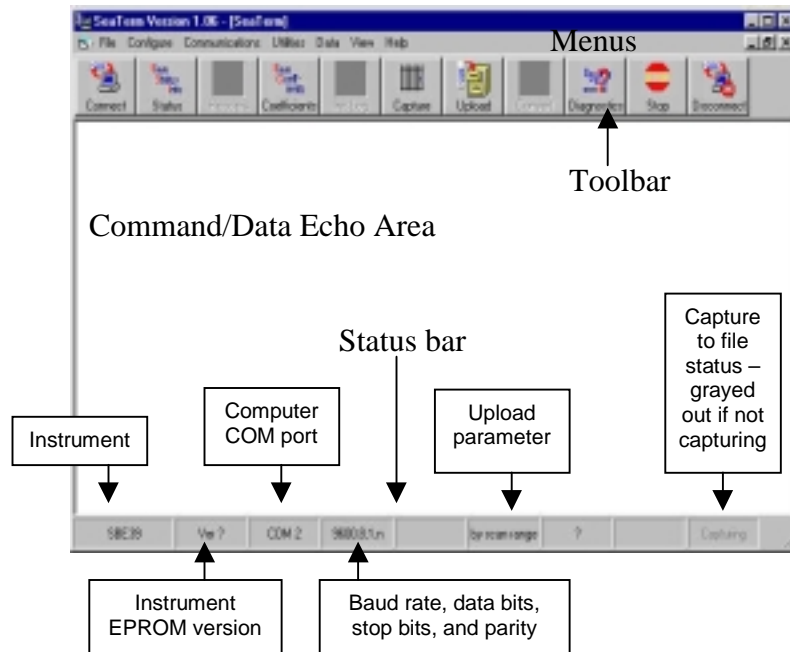- The SBE 48 is not available in the list of instrument types. **Select the SBE 39 as the instrument type.**

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

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, which displays in the Command/Data Echo Area, and updates the Status bar.
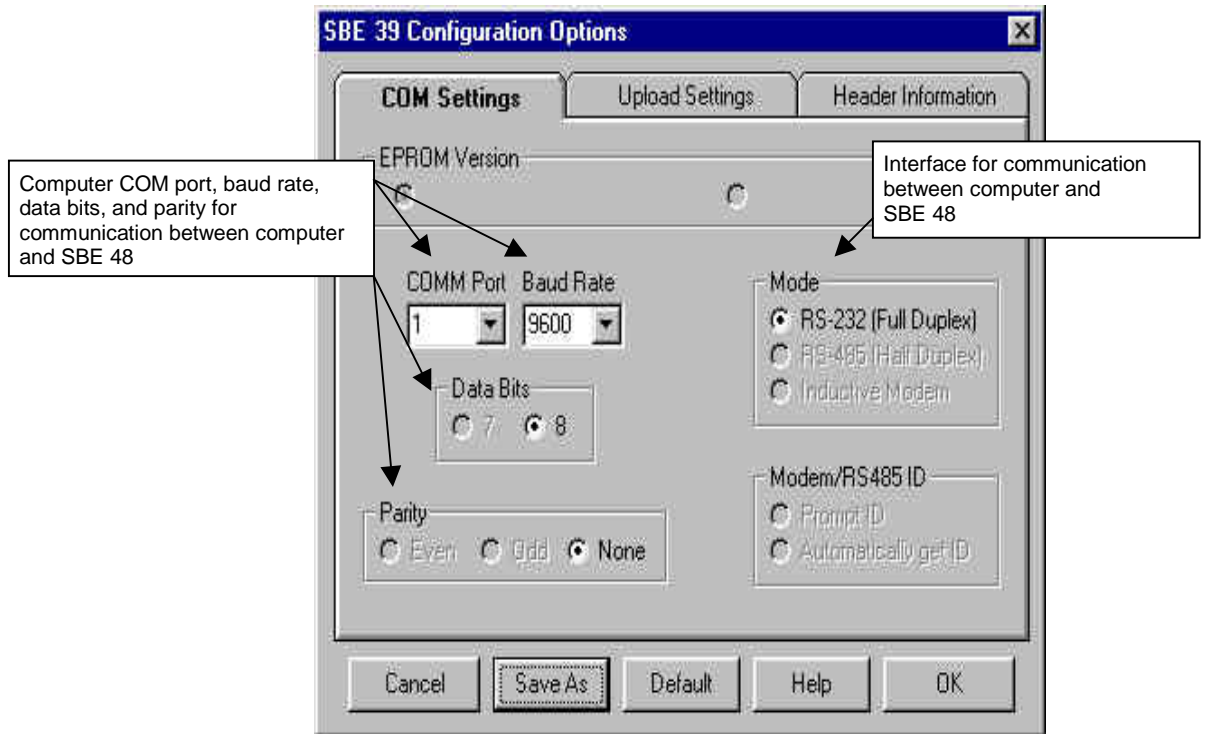
Following are the Toolbar buttons applicable to the SBE 48:

Toolbar Buttons	Description	Equivalent Command*
Connect	Re-establish communications with SBE 48. Computer responds with **S>** prompt. SBE 48 *goes to sleep* after two 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. 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 SEASOFT's Convert module (CNV39) can use to allow for post-processing in SEASOFT. Uploaded data has .ASC extension. Before using Upload: • Configure upload and header parameters in Configure menu • Send **STOP** command to stop logging.	**DDb,e** (use Upload key if you will be post-processing data with SEASOFT)
Convert	(not functional as of 11/1/00) Convert uploaded ASCII data to .CNV data, which can then be processed by SEASOFT. This performs the functions of CNV39 in SEASOFT.	—
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 the SBE 48*.

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

SBE 39 Configuration Options

Computer COM port, baud rate, data bits, and parity for communication between computer and SBE 48

Interface for communication between computer and SBE 48

COM Settings   Upload Settings   Header Information

EPROM Version

COMM Port   Baud Rate
1   9600

Data Bits
○ 7   ● 8

Parity
○ Even   ○ Odd   ● None

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

Modem/RS485 ID
○ Prompt ID
○ Automatically get ID

Cancel   Save As   Default   Help   OK

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 overwrite an existing configuration file, or click Save As to save the configuration as a new filename.

4. Click the Connect button on the Toolbar. 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 the Connect button again.
- Verify the correct instrument was selected in the Configure menu and the settings were entered correctly in the Configuration Options dialog box. Note that the baud rate is documented on the front cover of this manual.
- Check cabling between the computer and the SBE 48.

13

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

   SBE 48 V 1.0 SERIAL NO. 0916 08 Aug 2000 08:49:09
   logging not started
   sample interval = 30 seconds
   number of samples to average = 60
   samplenumber = 2, free = 299591
   serial sync mode disabled
   real-time output disabled
   temperature =19.48 deg C

6. 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 2000, 08:50:23

   where   23.7658 = temperature in degrees Celsius
                       08 Aug 2000 = date
                       08:50:23 = time

   These numbers should be reasonable; i.e., room temperature, current date and time (Pacific Daylight or Standard Time).

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

The SBE 48 is ready for deployment.

Section 4: Deploying and Operating the SBE 48

Note:
A separate software manual contains detailed information on installation, setup, and use of SEASOFT.

This section provides instructions for deploying the SBE 48.
It also includes a discussion of system operation, example sets of operation commands, and detailed command descriptions.

Set-Up 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 the SBE 48* for battery endurance specifications and *Section 5: Routine Maintenance and Calibration* for details on battery replacement.
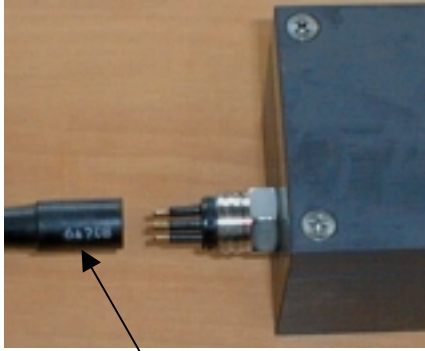
Notes:
- If the battery has been removed, the date and time must be reset.
- It is always necessary to set both date and time. **If a new date is entered but not a new time, the new date will not be saved.**
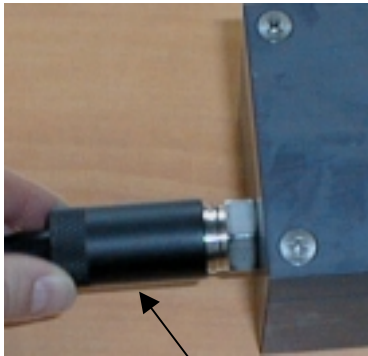
2. Program the SBE 48 for the intended deployment (see *Section 3: Preparing the SBE 48 for Deployment* for connection information; see information in this section on commands and sampling modes):

   A. Set the time and date.

   B. Establish the logging parameters.

   C. 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 zero, data will be stored after the last recorded sample.

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

   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.
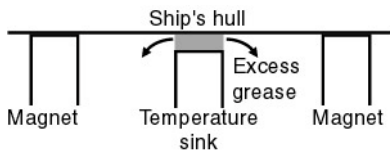
15

Deployment

I/O cable
connector

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.

Locking sleeve

    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 25-to-9 pin adapter is supplied for use if your computer has a 9-pin serial port.
    E. Connect the I/O cable connector's red (+) and black (-) wires to a power supply (8 - 16 VDC).

Magnet
(4 places)

Temperature
sink

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

Ship's hull

Excess
grease

Magnet

Temperature
sink

Magnet

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.

16

Sampling Modes

The SBE 48's user-selectable sampling modes for obtaining data include:
- Polled Sampling
- Autonomous Sampling - Interval Sampling and Continuous Sampling
- 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: **Polled Sampling***
> 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)
> **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 mode). The sampling interval is set with the **INTERVAL** command.
- *Continuous sampling*: The SBE 48 continuously samples data and stores it in FLASH memory, and does not power-off between samples. Continuous sampling is established by setting **INTERVAL=0**.

Logging is started with **STARTNOW** or **STARTLATER**, and is stopped with **STOP**. Transmission of real-time data to the computer is dependent on **TXREALTIME**.

Note:

Use the **STOP** command to:
- stop logging
- stop waiting to start logging (after **STARTLATER** command has been sent)

---

*Example: **Autonomous Sampling - Interval Sampling***
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 start on 10 January 2000 at 12:00:00. Do not transmit real-time data to computer. Send power-off command to SBE 48.

(Click Connect on Toolbar)
S>SAMPLENUM=0
S>INTERVAL=10
S>STARTMMDDYY=011000
S>STARTHHMMSS=120000
S>STARTLATER
S>TXREALTIME=N
S>QS

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

(Click Connect on Toolbar)
(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**.

18

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 a Take Sample command:

- 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:
  - ➢ 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.).
  - ➢ Line returns to mark state - SBE 48 immediately powers down. Serial line sync mode remains enabled (**SYNCMODE=Y**).

In summary, to disable serial line sync after executing the Take Sample command, put the RS-232 line in space state (greater then 3 volts) for 100 milliseconds.

> **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.

---

*Example: **Serial Line Sync Mode***
Establish communication with SBE 48. Reset sample number to zero to overwrite previous data in memory. Do not transmit real-time data to computer. Enable serial line sync mode.

(Click Connect on Toolbar to wake up)
S>SAMPLENUM=0
S>TXREALTIME=N
S>SYNCMODE=Y
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)
S>(Click Upload on Toolbar – program leads you through screens to define data to be uploaded and where to store it)
S>QS

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 two minutes after the completion of a command, the SBE 48 returns to the quiescent (sleep) mode to prevent exhaustion of its battery.

- If in quiescent mode, re-establish communications by clicking the Connect button on the Toolbar or pressing the Enter key to get an **S>** prompt.

Status Command

Note:
If the voltage is below 6.25 volts, the following displays in response to the status command:
WARNING: LOW BATTERY VOLTAGE!! Ensure the external power supply is adequate before continuing.

DS

Display operating status:
- firmware version, serial number, date and time
- logging status
- sample interval time
- number of samples to average (running average)
- number of samples in memory, available sample space in memory
- serial line sync mode status
- real-time output status
- current temperature

Logging status can be:
- logging not started
- logging data
- not logging: waiting to start at…
- not logging:received stop command
- not logging: low battery
- unknown status

Equivalent to Status button on Toolbar.

Example: Display status for SBE 48.

S>DS
SBE 48 V 1.0 SERIAL NO. 0916 08 Aug 2000 08:49:09
logging not started
sample interval = 30 seconds
number of samples to average = 60
samplenumber = 2, free = 299591
serial sync mode disabled
real-time output disabled
temperature =19.48 deg C

Setup Commands

Notes:
- **DDMMYY=** and **MMDDYY=** commands are equivalent. Either can be used to set the date.
- Always set both date and time. **If a new date is entered but not a new time, the new date will not be saved.**
- If the SBE 48 battery has been removed, date and time must be reset.
- If the SBE 48 is logging or is waiting to start logging **(STARTLATER** command has been set), it will not allow the user to reset the date or time.

MMDDYY=mmddyy	Set real-time clock month, day, and year. This command must be followed by **HHMMSS=** command to set time.
DDMMYY=ddmmyy	Set real-time clock day, month, and year. This command must be followed by **HHMMSS=** command to set time.
HHMMSS=hhmmss	Set real-time clock hour, minute, and second.

> *Example:* Set current date and time to 10 January 2000 12:00:00.
> **S>MMDDYY=011000**
> **S>HHMMSS=120000**
>
> or
>
> **S>DDMMYY=100100**
> **S>HHMMSS=120000**

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

BAUD=x	**x**= baud rate (1200, 2400, 4800, 9600, 19200, 38400). Default 9600.
NAVG=n	Set number of scans in the running average to **n** (1 - 120). Running average is reset to 0 when **STARTNOW** or **STARTLATER** command is sent.

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

TXREALTIME=x	**x=Y:** Output real-time data to the 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 output real-time data.

Note:
See *Sampling Modes* for complete details on the operation of 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 enable Serial Line Sync Mode.
QS	Quit session and place SBE 48 in quiescent (sleep) mode. Main power is turned off. Data logging and memory retention are not affected.

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.

Note:
SAMPLENUM=0 does not delete the 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.

Logging Commands

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

SAMPLENUM=n Set sample number for first sample when logging begins to **n**. After all previous data has been uploaded from SBE 48, set sample number to zero before starting to log to make entire memory available for recording. If **SAMPLENUM** is not reset to zero, data will be stored after last recorded sample.

INTERVAL=n Set interval between samples to **n** seconds (0, or 3 to 32767). This sets up the SBE 48 in Autonomous sampling mode. 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 **n** second intervals.

If **n=0**, SBE 48 samples continuously without powering down between samples. The table below provides the approximate interval between samples:

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

STARTNOW Start data logging now, as defined by **INTERVAL**. Data is stored in FLASH memory. Data is transmitted real-time if **TXREALTIME=Y**. Reset running average to 0.

Note:
STARTDDMMYY and **STARTMMDDYY** are equivalent. Either can be used to set the delayed start date.

STARTMMDDYY=mmddyy Set delayed start month, day, and year for data logging, as defined by **INTERVAL**. This command must be followed by **STARTHHMMSS=** command to set delayed start time.

STARTDDMMYY=ddmmyy Set delayed start day, month, and year for data logging, as defined by **INTERVAL**. This command must be followed by **STARTHHMMSS=** command to set delayed start time.

STARTHHMMSS=hhmmss Set delayed start hour, minute, and second for data logging, as defined by **INTERVAL**.

STARTLATER		Start data logging at time set with delayed start date and time commands, as defined by **INTERVAL**. Data is stored in FLASH memory. Data is transmitted real-time if **TXREALTIME=Y**. Reset running average to 0.

<table>
<tr><td>

Notes:
- After receiving **STARTLATER**, the SBE 48 displays **not logging: waiting to start** in reply to the Display Status (**DS**) command. 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**.

</td><td>

Example: Program SBE 48 to start logging on 20 January 2000 12:00:00.

S>**STARTMMDDYY=012000**
S>**STARTHHMMSS=120000**
S>**STARTLATER**

  or

S>**STARTDDMMYY=200100**
S>**STARTHHMMSS=120000**
S>**STARTLATER**

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

SA		Transmit running average of temperature data.
SAQS		Transmit running average of temperature data, and **turn power off** (put SBE 48 in quiescent mode).
STOP		Stop data logging (that was 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 an **S>** prompt before entering this command. This command must be sent before uploading data using the Upload button on the Toolbar, Upload Data in the Data menu, or the **DDb,e** command.

Note:
You may need to send the **STOP** command 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**).

23

Operating 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 this command if SBE 48 is logging data.

TSR
Take sample and transmit raw data. Data is **not** stored in FLASH memory. Do not send this command 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 this command 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 this command if SBE 48 is logging data.

TSS
Take sample, **store in FLASH memory**, transmit converted data, and **turn power off**. Do not send this command if SBE 48 is logging data.

TSSON
Take sample, **store in FLASH memory**, transmit converted data. Do not send this command if SBE 48 is logging data.

SL
Transmit converted data from last sample from buffer.

Data Upload Command

Send the **STOP** command before uploading data.

DDb,e — Upload data beginning with sample b, ending with sample e. First sample is number one.

As the data is uploaded, the screen first displays **start time =, sample interval =, and start sample number =** . These are the start time, sample interval, and starting sample number for the last set of logged data. This information can be useful in determining what data to review.

> *Example:* Upload samples 1 through 200:
> (Click Capture on Toolbar and enter the desired filename in the dialog box.)
> **S>DD1,200**

Testing Commands

Data obtained with these commands is **not** stored in the SBE 48's 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.

Coefficients Command

Notes:
- Dates shown are when calibrations were 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.

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

Example: Display coefficients for an SBE 48.
S>DC
SBE48 V 1.0 0916
temperature: 28-jul-00
TA0 = -9.420702e-05
TA1 =   2.937924e-04
TA2 = -3.739471e-06
TA3 =   1.909551e-07
rtc: 28-jul-00
RTCA0 =   9.999782e-01
RTCA1 =   1.749351e-06
RTCA2 =   -3.497835e-08

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	Temperature calibration date
TA0=F	Temperature A0
TA1=F	Temperature A1
TA2=F	Temperature A2
TA3=F	Temperature A3
RCALDATE=S	Real-time clock calibration date
RTCA0=F	Real-time clock A0
RTCA1=F	Real-time clock A1
RTCA2=F	Real-time clock A2

Data Output Formats

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

Note:
t = temperature
    (degrees Celsius, ITS-90)
hh:mm:ss = hour, minute, second
dd mmm yyyy = day, month, year

- **Output to Terminal Program after Sending Operating Command (TS, SL, SLT, TSS, TSSON)**
  ttt.tttt, dd mmm yyyy, hh:mm:ss

- **Output to Terminal Program if Transmitting Real-Time Data (TXREALTIME=Y)**
  # ttt.tttt, dd mmm yyyy, hh:mm:ss

- **Output to Terminal Program after Sending Data Upload Command (DDB,e)**
  ttt.tttt, dd mmm yyyy, hh:mm:ss

- **Output to .ASC file after Sending Data Upload Command (Upload button on Toolbar or Upload Data in Data menu)**
  ttt.tttt, dd mmm yyyy, hh:mm:ss

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 the SBE 48 for Deployment* for details.

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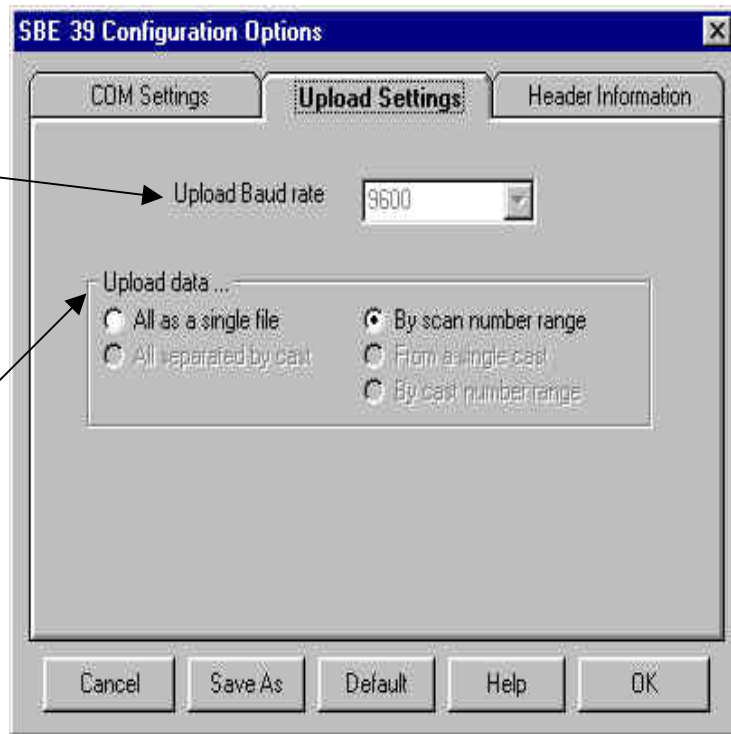Set up **Upload Settings**, **Header Information**, and/or **Header Form** (Steps 3 through 5):
- The first time you upload data, and
- If you want to change upload or header parameters.

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

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

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

Defines data upload type when using Upload button on Toolbar or Upload Data in Data menu:
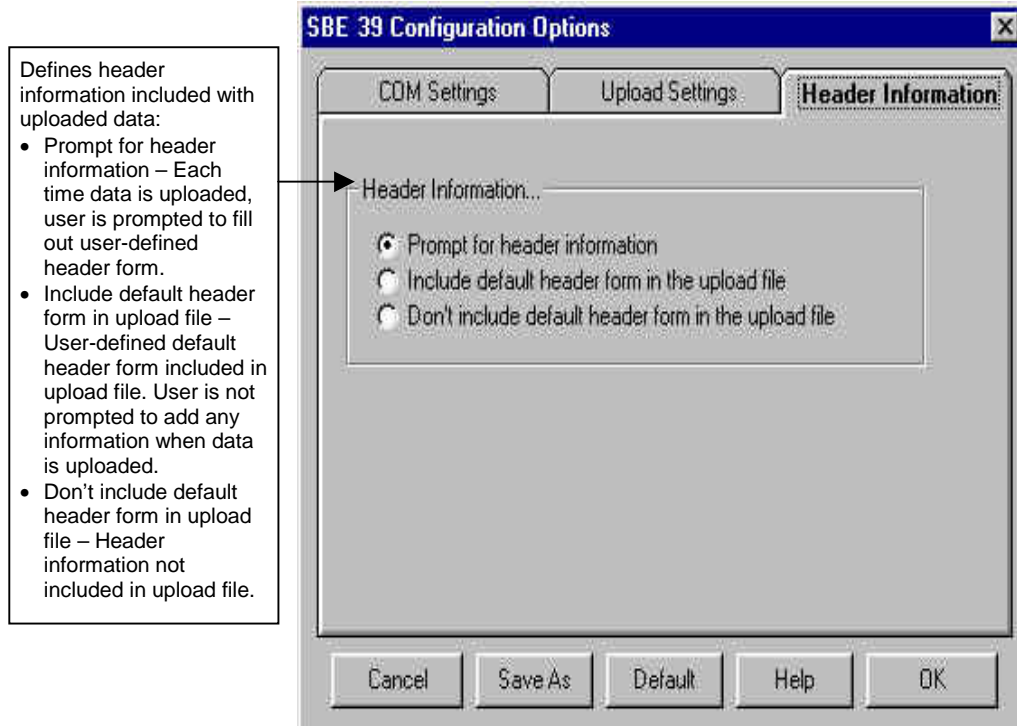- All as single file – All data uploaded into one file.
- By scan number range – SEATERM prompts for beginning and ending scan (sample) numbers, and uploads all data within range into one file.

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 overwrite an existing configuration file, or click Save As to save the configuration as a new filename.

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. Command the SBE 48 to stop data logging by pressing the Enter key and
    sending the **STOP** command.

Note:
Sea-Bird software does not correct for clock drift.

Notes:
To prepare the SBE 48 for re-deployment:
1. After all data has been uploaded, send the **SAMPLENUM=0** command. 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 the **QS** command to put the SBE 48 in quiescent (sleep) mode until ready to redeploy. Leaving the SBE 48 with the battery in place and in quiescent mode 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 **STARTDATE**, **STARTTIME**, and **STARTLATER**.

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

   SBE 48 V 1.0 SERIAL NO. 0916 08 Aug 2000 08:49:09
   not logging: received stop command
   sample interval = 30 seconds
   number of samples to average = 60
   samplenumber = 202, free = 299391
   serial sync mode disabled
   real-time output disabled
   temperature =19.48 deg C

   Compare the SBE 48's real-time clock data to actual time. This information can be useful later, if you need to correct for clock drift.

9. Click the Upload button on the Toolbar to upload stored data. SEATERM responds as follows before uploading the data:
   A. SEATERM sends the status (**DS**) command, displays the response, and writes the command and response to the upload file. This command provides you with information regarding the number of samples in memory.
   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. This command 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**).
   G. When the data has been uploaded, SEATERM shows the **S>** prompt.

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:
    - Use **PLOT39** to plot the ASCII (.ASC) data. See *Appendix II: PLOT39 Data Plotting Program* for details.
    - Use **SEASOFT**'s Convert module (CNV39) to convert the .ASC file to a .CNV file, and then use SEASOFT to process the (.CNV) file. SEASOFT includes many post-processing modules; modules applicable to the SBE 48 include ASCII OUT and SEAPLOT.
      ➢ CNV39 converts date and time (if present in the uploaded file) to Julian Days, with five significant digits. As the default, CNV39 does not reset Julian Day to 0 when rolling over from December 31 to January 1. To reset the Julian Day to 0 on January 1, run CNV39 with the command line option -r.

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. The SBE 48 should be rinsed with fresh water after use and prior to storage.

Sensor Calibration

Sea-Bird sensors are calibrated by subjecting them to known physical conditions and measuring the sensor responses. Coefficents 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 coefficents 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.
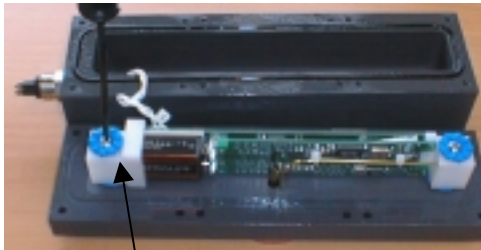
31
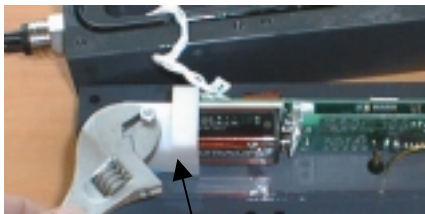
Replacing Battery

Phillips-head screw
(12 places)
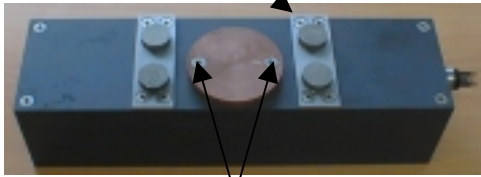
Do not remove 2 screws on temperature sink

Battery cap -
remove Phillips-head screw

Battery cap -
remove mounting post

Remove battery cap

Note:
Before delivery, 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 change the battery.
2. Dry gas backfill each time the electronics are exposed to the atmosphere, unless more than 24 hours will pass prior to deployment.

Sea-Bird ships the SBE 48 with a 9-volt lithium battery installed. 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.

Follow the instructions below to change the battery. This battery is non-hazardous (as defined by IATA or US DOT) and can be shipped either separately or installed in the SBE 48.

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.

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 battery

CNV39 – SEASOFT module to convert ASCII (.ASC) data uploaded with SEATERM to SEASOFT format (.CNV). When converted to .CNV format, the SEASOFT post-processing modules can be used to further analyze and display data.

PCB – Printed Circuit Board.

PLOT39 – Sea-Bird's WIN 95/98/NT software for plotting SBE 48 (and SBE 39) data.

SBE 48 – High-accuracy temperature recorder.

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

SEASOFT – Sea-Bird's Data Analysis Software, which calculates and displays temperature.

SEATERM – Sea-Bird's WIN 95/98/NT software used to communicate with the SBE 48.

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 battery current drain, a low power *watch* crystal is used as the real-time-clock frequency source. The sensitivity of the clock to ambient temperature is accurately measured during calibration. The results are stored in EEPROM and automatically applied during deployment.

Memory

Data

The SBE 48 has a 2 MB FLASH memory for data storage. FLASH memory is non-volatile, and data in the memory is not lost as a result of depletion or removal of the battery. Because FLASH is written 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 the SBE 48*).

The data upload process integrates the data from the FLASH memory with the data from the cache. The **SAMPLENUM** command controls the memory pointers that manage this process. Setting **SAMPLENUM** to zero resets the pointer in the FLASH memory as well as the pointer in the cache memory, causing the SBE 48 to overwrite existing data. It is important not to change **SAMPLENUM** until all the data has been uploaded.

If **SAMPLENUM** is inadvertently set to zero 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 - less than 256 bytes of new data (corresponding to 36 scans of temperature)	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 - more than 256 bytes of new data (corresponding to 36 scans of temperature)	Original value	Old data in FLASH is overwritten with new data. Old data in cache is corrupted. If the new data set is smaller than the old set, a portion of the old set can be recovered; the 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.
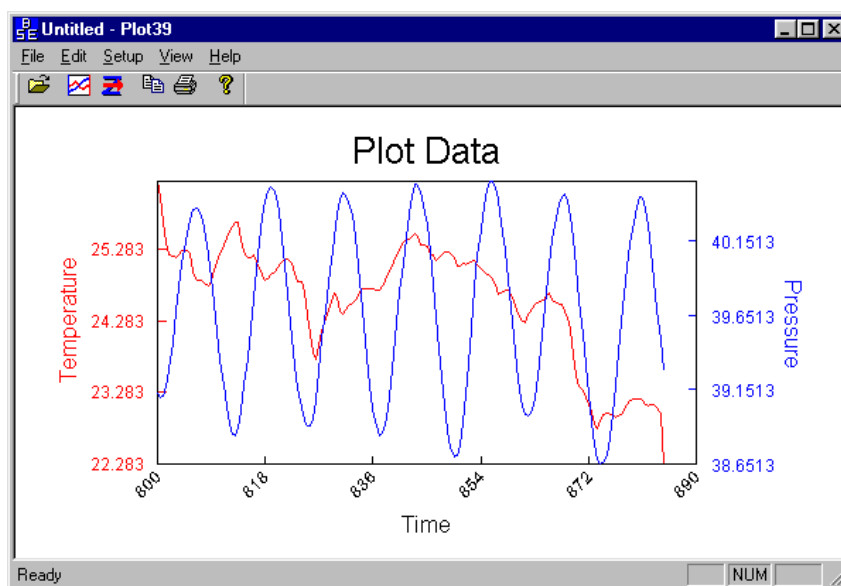
PLOT39 is used to plot ASCII data (.ASC file) that has been uploaded from the SBE 48. PLOT39:

- 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 PLOT 39 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 **Setup.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.

Appendix III: Command Summary

CATEGORY	COMMAND	DESCRIPTION
Status	**DS**	Display status.
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=n	**n**= 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 output real-time data.
	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 enable Serial Line Sync Mode.
	QS	Enter quiescent (sleep) mode. Data logging and memory retention unaffected.
Logging	**SAMPLENUM=n**	Set sample number for first sample when logging begins to **n**. After all previous data has been uploaded, set to zero before starting to log to make entire memory available for recording. If not reset to zero, data stored after last sample.
	INTERVAL=n	Set interval between samples to **n** seconds (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 **n** second intervals. If **n=0**, SBE 48 samples continuously without powering down between samples.
	STARTNOW	Start logging now, as defined by **INTERVAL**. 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, as defined by **INTERVAL**. 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 this command. Must send this command before uploading data.

Note:
Use the Upload button on the Toolbar or Upload Data in the Data menu to upload data that will be post-processed by SEASOFT. Manually entering the data upload command does not produce data in the correct format for post-processing by SEASOFT.

CATEGORY	COMMAND	DESCRIPTION
Operating *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 beginning with scan b, ending with scan e. Send **STOP** before sending this command.
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) Dates shown are when calibrations were performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with SBE 48.	**DC**	Display calibration coefficients; all coefficients and dates listed below are included in display. Use individual commands below to modify a particular coefficient or date.
	TCALDATE=S	Temperature calibration date.
	TA0=F	Temperature A0.
	TA1=F	Temperature A1.
	TA2=F	Temperature A2.
	TA3=F	Temperature A3.
	RCALDATE=S	Real-time clock calibration date.
	RTCA0=F	Real-time clock A0.
	RTCA1=F	Real-time clock A1.
	RTCA2=F	Real-time clock A2.

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	Power SBE 48	1
32442	5-pin I/O cable	From SBE 48 to computer	1
17130	25-pin to 9-pin adapter	Connects I/O cable to 9-pin COM port on computer	1

Index