



SEA-BIRD
SCIENTIFIC

User Manual

Release Date: 02/18/2015

SBE Sea-Bird
Electronics

SBE 50 Digital Oceanographic Pressure Sensor

With RS-232 Interface and optional Voltage Output



Manual version
Firmware version

- 011
- 1.0d & later



Sea-Bird Electronics
13431 NE 20th Street
Bellevue, Washington
98005 USA

Tel: +1 425-643-9866
seabird@seabird.com
www.seabird.com

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.

Declaration of Conformity

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005 USA

DECLARATION OF CONFORMITY

Manufacturer's Name: Sea-Bird Electronics
Manufacturer's Address: 13431 NE 20th Street
Bellevue, WA 98005, USA

The Authorized Representative located within the Community is:
OTT MESSTECHNIK GmbH & Co.KG
P.O.Box: 2140 / 87411 Kempten / Germany
Ludwigstrasse 16 / 87437 Kempten
Internet: <http://www.ott.com>
Phone: +49 831 5617 – 100
Fax: +49 831 5617 - 209

Device Description: Various Data Acquisition Devices and Sensors

Model Numbers:

| | | | | | | | | |
|-----------|--------------------|--------|---------------------------------------|-----------|--------------|--------|-----------|--------|
| 3S | 3F | 3plus | 4C | 4M | 5T | 5P | 5M | 7 |
| 8 | 9plus | 11plus | 14 | 16plus V2 | 16plus-IM V2 | | 17plus V2 | 18 |
| 19plus V2 | 21 | 25plus | 26plus | 27 | 29 | 32 | 32C | 32SC |
| 33 | 35 | 35RT | 36 | 37-IMP | 37-IM | 37-SMP | 37-SM | 37-SIP |
| 37-SI | 38 | 39 | 39-IM | 39plus | 41 | 41CP | 43 | 43F |
| 44 | 45 | 49 | 50 | 52-MP | 53BPR | 54 | 55 | 56 |
| 63 | SIM | ICC | IMM | PDIM | AFM | 90488 | 90204 | 90402 |
| 90504 | Glider Payload CTD | | NiMH Battery Charger and Battery Pack | | | | | |

Applicable EU Directives: Machinery Directive 98 / 37 /EC
EMC Directive 2004 / 108 /EC
Low Voltage Directive (73 / 23 /EEC) as amended by (93 / 68 /EEC)

Applicable Harmonized Standards:
EN 61326-1:2006 Class A Electrical Equipment for Measurement, Control, and Laboratory Use, EMC Requirement – Part 1: General Requirements
(EN 55011:2007 Group 1, Class A)

EN 61010-1:2001, Safety Requirements for Electrical Equipments for Measurement, Control, and Laboratory Use – Part 1: General Requirements

Declaration based upon compliance to the Essential Requirements and Letter of Opinion from CKC Certification Services, LLC., Notified Body 0976

I, the undersigned, hereby declare that the equipment specified above conforms to the above European Union Directives and Standards.

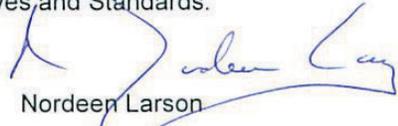
Authorized Signature: 
Name: Nordeen Larson
Title of Signatory: President
Date: 3 September 2013
Place: Bellevue, WA

Table of Contents

| | |
|--|-----------|
| Limited Liability Statement | 2 |
| Declaration of Conformity | 3 |
| Table of Contents | 4 |
| Section 1: Introduction | 5 |
| About this Manual | 5 |
| Quick Start | 5 |
| Unpacking SBE 50..... | 6 |
| Section 2: Description of SBE 50 | 7 |
| System Description | 7 |
| Specifications..... | 9 |
| Dimensions and End Cap Connector | 10 |
| Cables and Wiring | 11 |
| Section 3: Preparing SBE 50 for Deployment | 12 |
| Software Installation..... | 12 |
| Power and Communications Test | 12 |
| Test Setup | 12 |
| Test | 13 |
| Section 4: Deploying and Operating SBE 50 | 16 |
| Sampling Modes | 16 |
| Polled Sampling..... | 16 |
| Autonomous Sampling | 17 |
| Baud Rate, Cable Length, Power, and Data Transmission Rate | 18 |
| Voltage Output Interface..... | 20 |
| Command Descriptions..... | 20 |
| Data Output Formats..... | 25 |
| Deployment..... | 26 |
| Recovery..... | 27 |
| Section 5: Routine Maintenance and Calibration | 28 |
| Corrosion Precautions..... | 28 |
| Connector Mating and Maintenance | 28 |
| Pressure Sensor Maintenance..... | 29 |
| O-Ring Maintenance..... | 29 |
| Sensor Calibration..... | 30 |
| Section 6: Troubleshooting | 31 |
| Problem 1: Unable to Communicate with SBE 50..... | 31 |
| Problem 2: Unreasonable Data | 31 |
| Glossary | 32 |
| Appendix I: Functional Description | 33 |
| Sensor | 33 |
| Sensor Interface | 33 |
| Appendix II: Electronics Disassembly/Reassembly | 34 |
| Appendix III: Command Summary | 35 |
| Appendix IV: Replacement Parts | 36 |
| Appendix V: Manual Revision History | 37 |
| Index | 38 |

Section 1: Introduction

This section includes a Quick Start procedure, and photos of a typical SBE 50 shipment.

About this Manual

This manual is to be used with the SBE 50 Digital Oceanographic Pressure 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 contact us with any comments or suggestions (seabird@seabird.com or 425-643-9866). Our business hours are Monday through Friday, 0800 to 1700 Pacific Standard Time (1600 to 0100 Universal Time) in winter and 0800 to 1700 Pacific Daylight Time (1500 to 0000 Universal Time) the rest of the year.

Quick Start

Follow these steps to get a Quick Start using the SBE 50. The manual provides step-by-step details for performing each task:

1. Perform pre-check procedures (see *Section 3: Preparing SBE 50 for Deployment*):
 - A. Test power and communications.
2. Deploy the SBE 50 (see *Section 4: Deploying and Operating SBE 50*):
 - A. Establish setup and operating parameters.
 - B. Check status (**DS**) and calibration coefficients (**DCal**) to verify setup.
 - C. Install I/O cable connector and locking sleeve.
 - D. Deploy SBE 50, using customer-supplied hardware.

Unpacking SBE 50

Shown below is a typical SBE 50 shipment.



SBE 50



I/O Cable
(for 4-pin connector)



Software, and Electronic Copies of
Software Manuals and User Manual

Section 2: Description of SBE 50

This section describes the functions and features of the SBE 50, including specifications and dimensions.

System Description

The SBE 50 is a high-accuracy, high-resolution, high sample rate (16 Hz sampling) pressure monitor, designed to be incorporated into oceanographic sensing systems at depths up to 7000 meters (23,000 feet).

The SBE 50's strain-gauge pressure sensor is offered in eight full-scale ranges from 20 to 7000 decibars. Compensation of the temperature influence on pressure offset and scale is performed by the SBE 50's CPU.

The SBE 50 is an easy-to-use, light, compact instrument ruggedly made of titanium and other low-maintenance (plastic) materials; it is well suited to even the smallest vehicle. Commands sent to the SBE 50 provide status display, data acquisition setup, and diagnostic tests. Its data is telemetered by its internal, 3-wire, RS-232C interface. The SBE 50 has no memory or internal batteries.

The SBE 50 samples in two modes:

- **Autonomous sampling** –The SBE 50 runs continuously and samples at 16 Hz (16 scans per second). It can be set to average up to 255 samples, and transmits the averaged data. The SBE 50 can be programmed to begin autonomous sampling when power is applied or on command.
- **Polled sampling** – On command, the SBE 50 takes one sample and transmits the data.

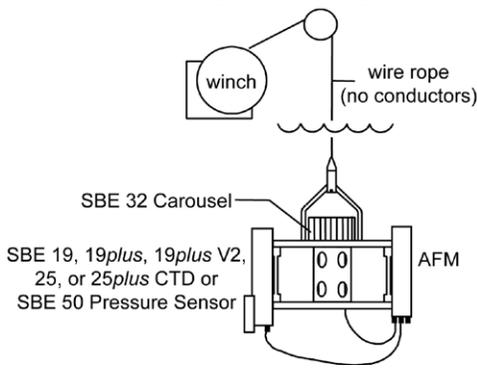
The SBE 50 outputs data in one of the following formats:

- Raw pressure and pressure temperature values.
- Data in ASCII engineering units (pressure in decibars or psia, or depth in meters or feet) - pressure is calculated using calibration coefficients stored in EEPROM; depth is calculated from pressure, based on user-selection of fresh or salt water and user-input latitude (for salt water only).
- Pressure and scan number in hexadecimal – this format is used when the SBE 50 interfaces with the Auto Fire Module (AFM) for controlling an SBE 32 Carousel Water Sampler.

Configuration selections include:

- **Pressure sensor range** – 20, 100, 350, 600, 1000, 2000, 3500, or 7000 m
- **Interface** – RS-232 digital output, or RS-232 digital output plus Voltage Output (0-5 volt output proportional to the pressure or depth).
- **Connector** - XSG/AG glass-reinforced epoxy connector or MCBH Micro (wet-pluggable) connector.

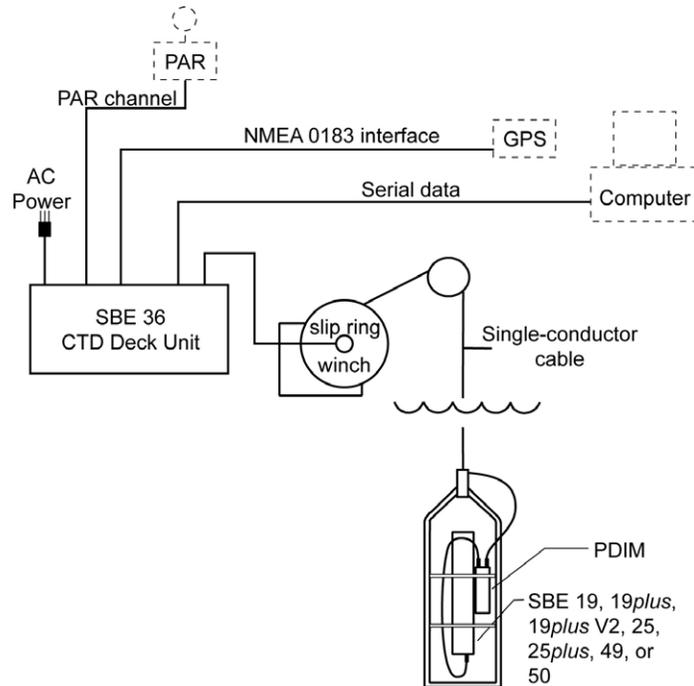
The SBE 50 can be used with the following Sea-Bird equipment:



- SBE 32 Carousel Water Sampler and Auto Fire Module (AFM) -**
 The SBE 32 is a 12-, 24, or 36-bottle water sampler, available with bottle sizes up to 30 liters. The AFM, mounted in a bottle position on the SBE 32, allows the SBE 32 to operate autonomously on non-conducting cables. The AFM supplies the power, logic, and control commands to operate the SBE 32, and supplies power for the SBE 50. The AFM monitors the pressure data transmitted by the SBE 50 in real-time, closing bottles at predefined pressures (depths) or whenever the system is stationary for a specified period of time. Bottle number, firing confirmation, and five scans of SBE 50 data are recorded in the AFM memory for each bottle fired. See the AFM manual for details.

Note:
 Seasave (our real-time data acquisition software) does not support the SBE 50 used with the SBE 36/PDIM. Real-time data can be viewed in Seaterm (terminal program). Surface PAR data (if applicable) is output as raw data.

- SBE 36 CTD Deck Unit and Power Data Interface Module (PDIM) –**
 These items provide power and real-time data handling capability over single-conductor sea cables. The PDIM is a small pressure housing that is mounted with the SBE 50. It provides +15 VDC power to the SBE 50 and interfaces two-way RS-232 communications from the SBE 50 to the telemetry used on the sea cable. See the SBE 36/PDIM manual for operating details.



Notes:

- Help files provide detailed information on the software.
- See the AFM manual for details on the use of SeatermAF with an SBE 50 and AFM.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our website. See our website for the latest software version number, a description of the software changes, and instructions for downloading the software.

The SBE 50 is supplied with a powerful Windows software package, Seasoft V2, which includes:

- **Seaterm** - terminal program for communication and data acquisition. Seaterm can send commands to the SBE 50 to provide status display, data acquisition setup, data display and capture, and diagnostic tests.
- **SeatermAF** – terminal program for communication with the SBE 50 when used with an SBE 32 Carousel Water Sampler and AFM.

Note that Seaterm and SeatermAF **do not process the data**.

Specifications

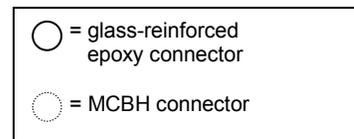
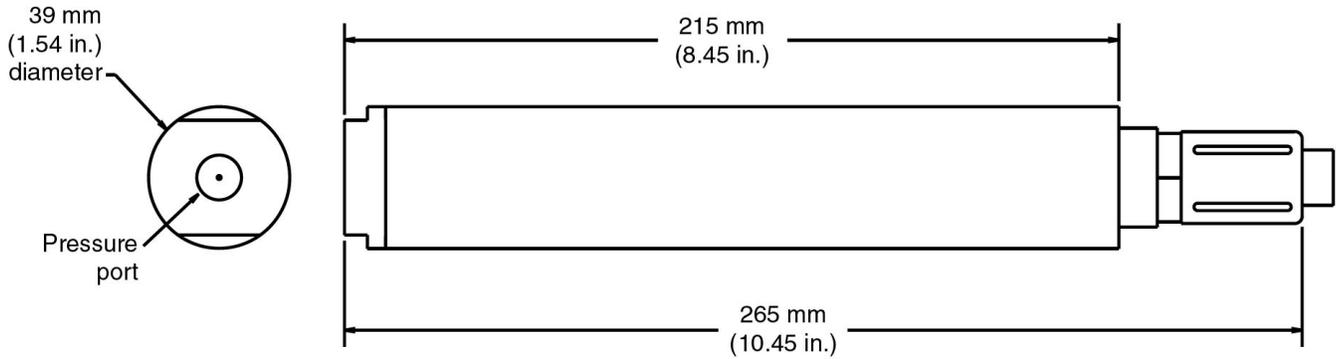
Note:

Pressure ranges are expressed in meters of deployment depth capability.

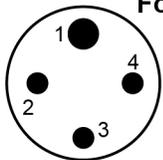
| | | |
|--|--|----------------------------|
| Measurement Range | 0 to full scale range: 20 / 100 / 350 / 600 / 1000 / 2000/ 3500 / 7000 meters | |
| Initial Accuracy | ± 0.1% of full scale range | |
| Typical Stability (per year) | 0.05% of full scale range | |
| Resolution | 0.002% of full scale range (D/A resolution for 0-5 volt output: 16 bit) | |
| Sensor Calibration | Ambient pressure to full scale range in 5 steps | |
| Sampling Speed | 16 Hz (16 samples/sec) | |
| External Input Power | 8-30 VDC | |
| Power Requirements (with voltage output installed) | <u>Input (Volts)</u> | <u>Current (milliamps)</u> |
| | 8 | 51 |
| | 10 | 43 |
| | 15 | 29 |
| | 20 | 22 |
| | 25 | 19 |
| | 30 | 21 |
| Housing | Titanium pressure case rated at 7000 meters (23,000 feet) | |
| Weight | In air: 0.7 kg (1.5 lbs) In water: 0.4 kg (0.9 lbs) | |

Dimensions and End Cap Connector

Dimensions in millimeters (inches)

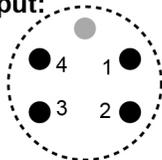


For RS-232 Output:



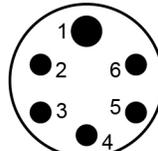
4-pin Connector
XSG-4-BCL-HP

| Pin | Signal |
|-----|--------------------------------|
| 1 | Ground |
| 2 | RS-232 receive (from computer) |
| 3 | RS-232 transmit (to computer) |
| 4 | 8-30 VDC power in |



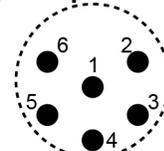
4-pin Wet-Pluggable Connector
MCBH-4MP (WB), TI
(3/8" length base, 1/2-20 thread)

For RS-232 and Voltage Output:



6-pin Connector
AG-306-HP

| Pin | Signal |
|-----|--------------------------------|
| 1 | Ground |
| 2 | RS-232 receive (from computer) |
| 3 | RS-232 transmit (to computer) |
| 4 | Pressure output voltage + |
| 5 | Pressure output voltage - |
| 6 | 8-30 VDC power in |

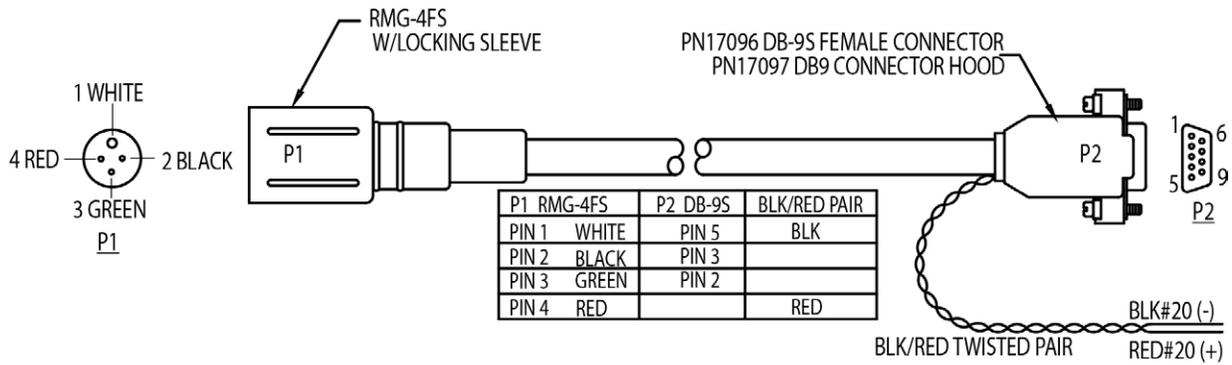


6-pin Wet-Pluggable Connector
MCBH-6MP (WB), TI
(3/8" length base, 1/2-20 thread)

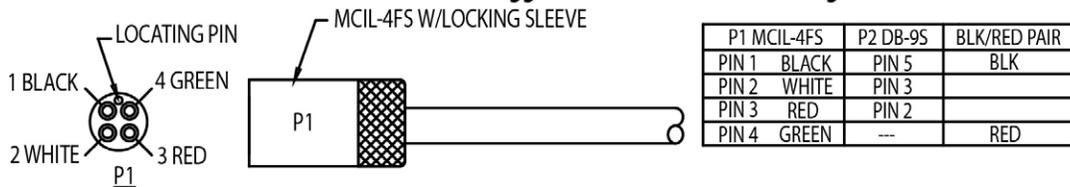
Cables and Wiring

4-Pin Connector (RS-232 Output)

RMG Connector Cable Wiring -- DN 32277

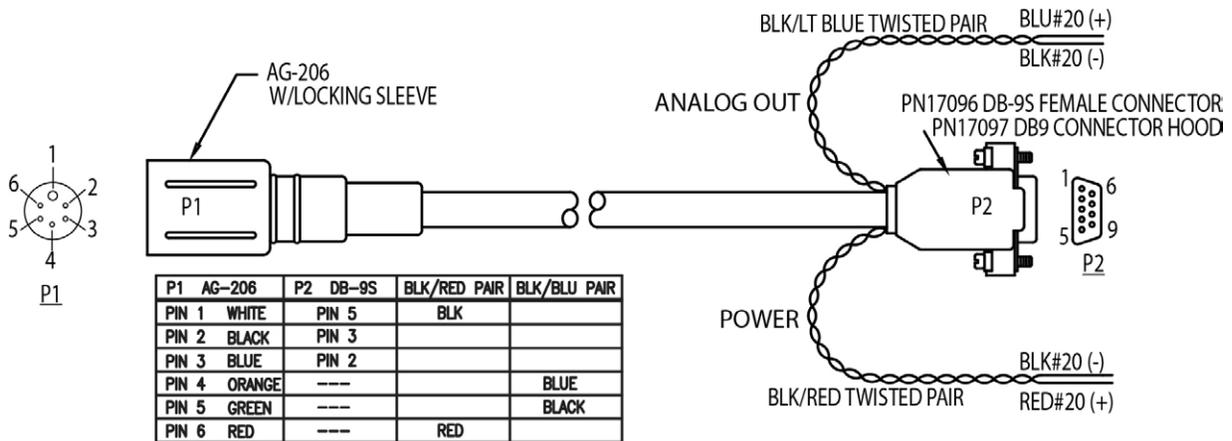


MCIL Wet-Pluggable Connector Cable Wiring -- DN 32366

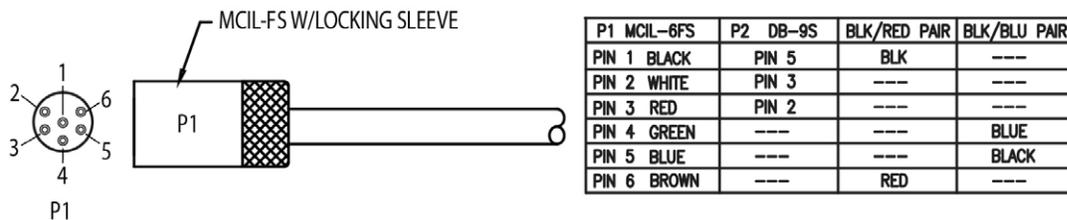


6-Pin Connector (with Voltage Output)

AG-206 Connector Cable Wiring -- DN 32737



MCIL Wet-Pluggable Connector Cable Wiring -- DN 32738



Section 3:

Preparing SBE 50 for Deployment

This section describes installing software and testing power and communications.

Software Installation

Notes:

- Help files provide detailed information on the software.
- It is possible to use the SBE 50 without the Seaterm terminal program by sending direct commands from a dumb terminal or terminal emulator, such as Windows HyperTerminal.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our website. See our website for the latest software version number, a description of the software changes, and instructions for downloading the software.

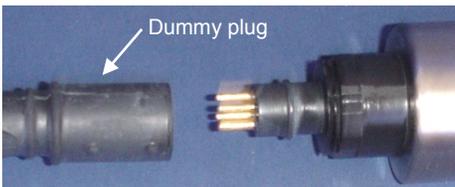
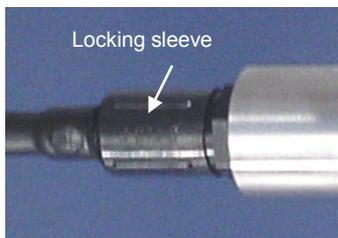
Seasoft V2 was designed to work with a PC running Windows XP service pack 2 or later, Windows Vista, or Windows 7 (32-bit or 64-bit).

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

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

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

Power and Communications Test



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

Test Setup

1. By hand, unscrew the locking sleeve from the SBE 50's bulkhead connector. **If you must use a wrench or pliers, be careful not to loosen the bulkhead connector instead of the locking sleeve.**
2. Remove the dummy plug from the SBE 50's I/O bulkhead connector by pulling the plug firmly away from the connector.
3. **XSG/AG Connector** - Install the I/O cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - common) on the SBE 50. **OR**
MCBH Connector – Install the I/O cable connector, aligning the pins.
4. Connect the I/O cable connector to your computer's serial port.
5. Connect the I/O cable connector's red (+) and black (-) wires to a power supply (8-30 VDC).

Test

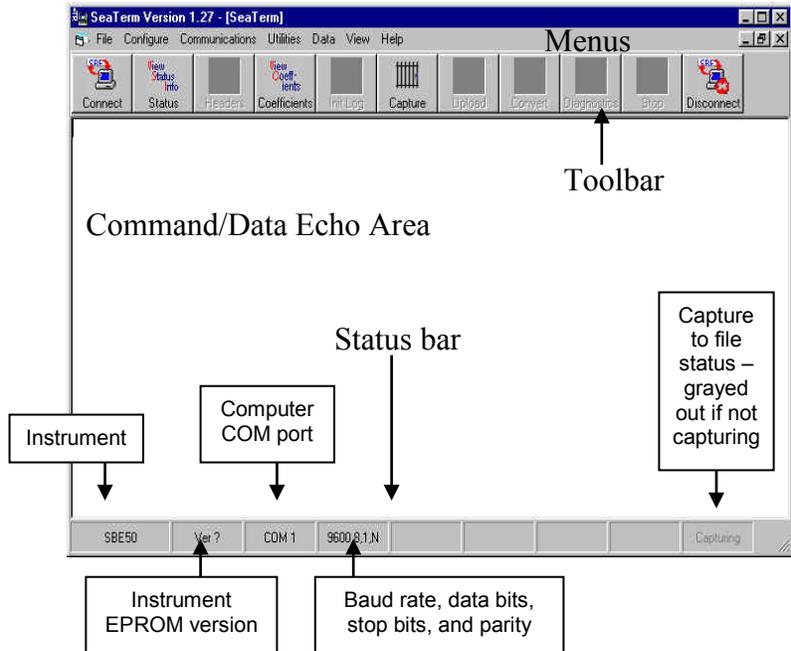
Note:
See Seaterm's help files for detailed information.

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



Select the instrument type (*SBE 50*) and the computer COM port for communication with the SBE 50. Click OK.

2. The main screen looks like this:



Note:
There is at least one way, and as many as three ways, to enter a command:

- Manually type a command in Command/Data Echo Area
- Use a menu to automatically generate a command
- Use a Toolbar button to automatically generate a command

Note:
Once the system is configured and connected (Steps 3 through 5 below), to update the Status bar:

- on the Toolbar, click Status; or
- from the Utilities menu, select Instrument Status.

Seaterm sends the status command, which displays in the Command/Data Echo Area, and updates the Status bar.

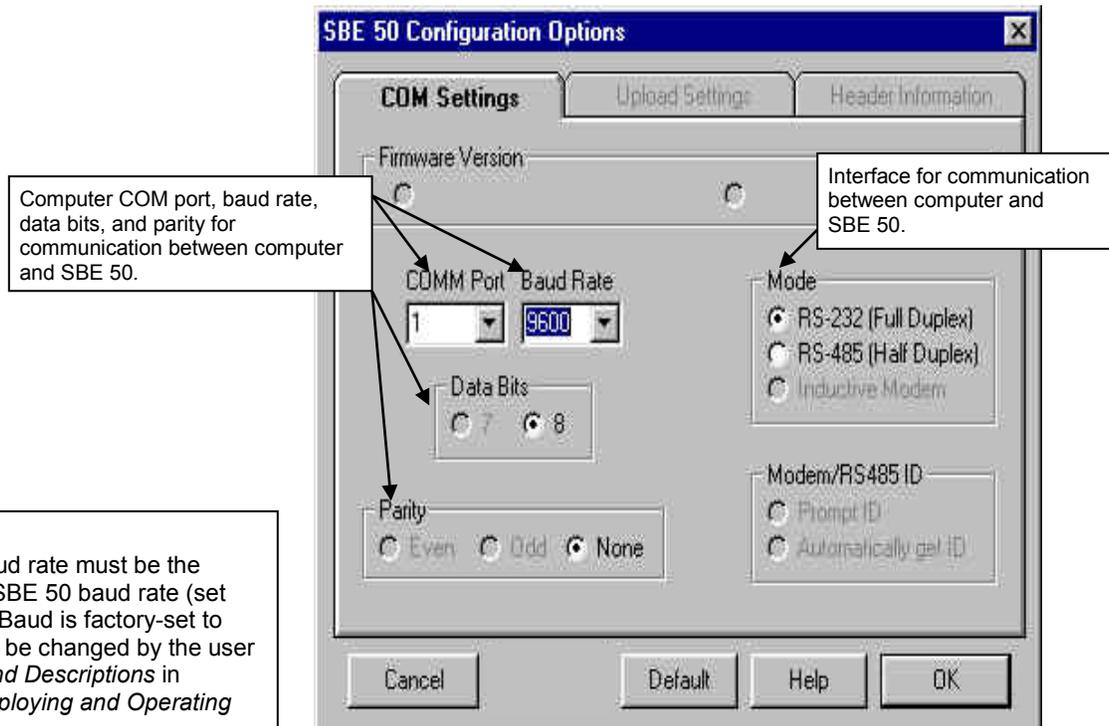
- Menus – Contains tasks and frequently executed instrument commands.
- Toolbar – Contains buttons for frequently executed tasks and instrument commands. All tasks and commands accessed through the Toolbar are also available in the Menus. To display or hide the Toolbar, select View Toolbar in the View 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 *connected* for it to respond to a command (click Connect on the Toolbar to connect 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 50:

| Toolbar Button | Description | Equivalent Command* |
|----------------|--|---------------------|
| Connect | Re-establish communications with SBE 50. Computer responds with S> prompt. | (press Enter key) |
| Status | Display instrument setup. | DS |
| Coefficients | Display calibration coefficients. | DCal |
| Capture | Capture instrument responses on screen to file. File has .cap extension. As SBE 50 has no internal memory, you must capture before sampling begins to save data for future review and processing. Press Capture again to turn off capture. Capture status displays in Status bar. | — |
| Disconnect | Free computer COM port used to communicate with SBE 50. COM port can then be used by another program. Note that SBE 50 must be connected to COM port for data to be obtained, since it has no internal memory. | — |

*See *Command Descriptions* in *Section 4: Deploying and Operating SBE 50*.

- In the Configure menu, select *SBE 50*. The dialog box looks like this:



Note:

- Seaterm's baud rate must be the same as the SBE 50 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 50*).
- 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, 50, etc.) in the Configure menu, the Configuration Options dialog box shows the last saved settings for that instrument.

Make the selections in the Configuration Options dialog box:

- COMM Port:** COM 1 through COM 10, as applicable
- Baud Rate:** 9600 (documented on Configuration Sheet)
- Data Bits:** 8
- Parity:** None
- Mode:** RS-232 (Full Duplex)

Click OK to save the settings.

4. In the Communications menu, select *Options / Cycle baud when connecting*.
5. Click Connect on the Toolbar. Seaterm tries to connect to the SBE 50 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:
S>
This shows that correct communications between the computer and the SBE 50 has been established.
If the system does not respond with the S> prompt:
 - Click Connect again or press the Enter key twice.
 - Verify the correct instrument was selected in the Configure menu and the settings were entered correctly in the Configuration Options dialog box. Note that the baud rate is documented on the Configuration Sheet.
 - Check cabling between the computer and SBE 50.
6. Display SBE 50 status information by clicking Status on the Toolbar. The display looks like this:
SBE50 V 1.0b SERIAL NO. 0011
Number of scans to average = 1
Start sampling on power up = no
Output format = depth, salt, meters, 2 decimals
Voltage output enabled
7. Command the SBE 50 to take a sample by typing **TS** and pressing the Enter key. The display looks like this (with output formatted for depth for salt water in meters, 2 digits after the decimal point):
0.06
where 0.06 = depth in meters
This number should be reasonable; i.e., corresponding to approximately atmospheric pressure (0 decibars, 14.7 psia, or 0 depth).
8. Send commands to set up the instrument as desired, after reviewing the information in *Section 4: Deploying and Operating SBE 50* on sampling modes and commands.

The SBE 50 is ready for deployment.

Section 4: Deploying and Operating SBE 50

Note:

See Seaterm's help files for detailed information.

This section provides instructions for deploying the SBE 50. It includes:

- system operation
- example sets of operation commands
- cable length limitations
- setup of voltage output interface
- detailed command descriptions
- data output formats
- deployment
- recovery

Sampling Modes

The SBE 50 has two basic sampling modes for obtaining data: Polled Sampling and Autonomous Sampling.

Shown below are descriptions and examples of the two basic sampling modes. Note that the SBE 50's response to each command is not shown in the examples. Review the operation of the basic sampling modes and the commands described in *Command Descriptions* before setting up your system.

Polled Sampling

On command (**TS**), the SBE 50 takes one sample of data and transmits the data real-time.

Note:

Sea-Bird ships the SBE 50 with **AutoRun=N** (it will not automatically start sampling when power is applied). If you previously sent **AutoRun=Y**, send **Stop** to stop sampling. You will then be able to send commands to change the SBE 50 setup.

Example: Polled Sampling (user input in bold).

Set up to output pressure in decibars, with two digits after the decimal point. Set up to wait for a command upon power up. Verify setup with status (**DS**) command. Remove power.

(Apply power, then click Connect on Toolbar.)

S>**OUTPUTFORMAT=2**

S>**DECIMALS=2**

S>**AUTORUN=N**

S>**DS** (to verify setup)

(Remove power.)

When ready to take a sample:

(Apply power, then click Connect on Toolbar.)

S>**TS**

Autonomous Sampling

The SBE 50 samples data at 16 Hz. The output rate is determined by **NAvg**:

$$\text{Output rate} = 16 \text{ samples per second} / \text{NAvg}$$

AutoRun defines how sampling starts:

Note:

Sea-Bird ships the SBE 50 with **AutoRun=N** (it will not automatically start sampling when power is applied). If you send **AutoRun=Y**, turn power off and then on again to start sampling, or send **Start**.

| AutoRun= | To Start Autonomous Sampling | To Stop Autonomous Sampling |
|-----------------|-------------------------------------|--|
| Y | Turn on power. | <ul style="list-style-type: none"> • Turn off power, or • Send Stop or type Ctrl Z. (Stopping this way allows you to then send commands to check/modify the setup.) |
| N | Send Start . | |

Note:

When using the SBE 50 with an AFM and an SBE 32 Carousel Water Sampler, the following setup is required:

- **AutoRun=Y**
- **OutputFormat=7**
- **NAvg=16**

SeatermAF automatically sets these parameters in the SBE 50 to the appropriate values when you arm the AFM, and then sends **Start** to begin sampling.

*Example 1: Autonomous Sampling Setup for **AutoRun=N** (user input in bold).*

Set up to output a sample every 0.5 seconds (averaging 8 samples per output sample) and output pressure in decibars, with 2 digits after the decimal point. Verify setup with status (**DS**) command. Remove power.

(Apply power, then click Connect on Toolbar.)

```
S>NAVG=8
S>OUTPUTFORMAT=2
S>DECIMALS=2
S>AUTORUN=N
```

S>**DS** (to verify setup)
(Remove power.)

When ready to begin sampling:

(Apply power, then click Connect on Toolbar.)
S>**START**

When ready to stop sampling:

(Press Enter key to get S> prompt.)
S>**STOP**

*Example 2: Autonomous Sampling Setup for **AutoRun=Y** (user input in bold).*

Set up to output a sample every 0.5 seconds (averaging 8 samples per output sample) and output pressure in decibars, with 2 digits after the decimal point. Verify setup with status (**DS**) command. Remove power.

(Apply power, then click Connect on Toolbar.)

```
S>NAVG=8
S>OUTPUTFORMAT=2
S>DECIMALS=2
S>AUTORUN=Y
```

S>**DS** (to verify setup)
(Remove power.)

When ready to begin sampling:

(Apply power – SBE 50 automatically begins sampling.)

When ready to stop sampling:

(Press Enter key to get S> prompt.)
S>**STOP**

Baud Rate, Cable Length, Power, and Data Transmission Rate

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

Baud Rate, Cable Length, and Data Transmission Rate

Notes:

- Baud rate is set with **Baud=**.
- Real-time output rate is set with **NAvg=**.
- Output format is set with **OutputFormat=**.

See *Command Descriptions* in this section for command details.

The rate that real-time data can be transmitted from the SBE 50 is dependent on the amount of data to be transmitted per scan and the serial data baud rate:

$$\text{Time required to transmit data} = \frac{(\text{number of characters} * 10 \text{ bits/character})}{\text{baud rate}}$$

where

Number of characters is dependent on the included data and output format (see *Data Output Formats* in this section). Add 2 to the number of characters shown in the output format, to account for the carriage return and line feed at the end of each scan. For decimal output (**OutputFormat=1** through **6**), include decimal points, commas, and spaces when counting the number of characters.

Time required to transmit data must be less than the real-time output rate.

The length of cable that the SBE 50 can drive to transmit real-time data is also dependent on the baud rate. The allowable combinations are:

| Maximum Cable Length (meters) | Maximum Baud Rate |
|-------------------------------|-------------------|
| 1600 | 600 |
| 800 | 1200 |
| 400 | 2400 |
| 200 | 4800 |
| 100 | 9600 |
| 50 | 19200 |
| 25 | 38400 |

Example - What is the fastest rate you can transmit real-time data over 800 m with **OutputFormat=0** (raw A/D pressure counts and pressure temperature voltage)?

With 800 meters of cable, the SBE 50 requires a baud rate of 1200 or less.

Number of characters for **OutputFormat=0** (from *Data Output Formats*) =

$$6 (P) + 2 (\text{comma \& space}) + 6 (P \text{ temperature voltage}) + 2 (\text{carriage return \& line feed}) = 16$$

Time required to transmit data = $(16 \text{ characters} * 10 \text{ bits/character}) / 1200 =$

$$0.133 \text{ seconds} > 0.0625 \text{ seconds (16 Hz, maximum sampling rate).}$$

Therefore, set **NAvg=3**, averaging 3 measurements/sample and transmitting 1 sample every 0.1875 seconds.

Power and Cable Length

Note:

Common wire resistances:

| Gauge | Resistance (ohms/foot) |
|-------|------------------------|
| 12 | 0.0016 |
| 14 | 0.0025 |
| 16 | 0.0040 |
| 18 | 0.0064 |
| 19 | 0.0081 |
| 20 | 0.0107 |
| 22 | 0.0162 |
| 24 | 0.0257 |
| 26 | 0.0410 |
| 28 | 0.0653 |

There are two issues to consider:

- Limiting the communication IR loss to 1 volt **if transmitting real-time data via RS-232**; higher IR loss will cause the instrument to transmit data that does not meet the RS-232 communication standard.
- Supplying enough power at the power source so that sufficient power is available at the instrument after considering IR loss.

Looking at each issue separately:

Limiting IR Loss to 1 Volt

The limit to cable length is typically reached when the maximum communication current times the power common wire resistance is more than 1 volt.

$$V_{\text{limit}} = 1 \text{ volt} = IR_{\text{limit}}$$

Where I is the current required by the SBE 50.

$$\text{Maximum cable length} = R_{\text{limit}} / \text{wire resistance per foot}$$

Example 1 – For 8 volt power and 18 gauge wire, what is maximum distance to transmit power to SBE 50? Is this controlling factor for maximum cable length if wanting to transmit at 1200 baud?

With 8 volt power, the SBE 50 draws 51 milliamps (from *Specifications* in *Section 2: Description of SBE 50*).

$$R_{\text{limit}} = V_{\text{limit}} / I = 1 \text{ volt} / 0.051 \text{ amps} = 19.6 \text{ ohms}$$

For 18 gauge wire, resistance is 0.0064 ohms/foot.

Therefore, maximum cable length is 19.6 ohms / 0.0064 ohms/foot = 3063 feet = 934 meters.

Note that 934 meters > 800 meters (maximum distance SBE 50 can transmit data at 1200 baud), so IR loss is not controlling factor for this example.

Example 2 – Same as above, but there are 4 SBE 50s powered from the same power supply.

With 8 volt power, the SBE 50 draws 51 milliamps (from *Specifications* in *Section 2: Description of SBE 50*).

$$R_{\text{limit}} = V_{\text{limit}} / I = 1 \text{ volt} / (0.051 \text{ amps} * 4 \text{ SBE 50s}) = 4.9 \text{ ohms}$$

For 18 gauge wire, resistance is 0.0064 ohms/foot.

Therefore, maximum cable length is 4.9 ohms / 0.0064 ohms/foot = 764 feet = 233 meters (this is cable length to SBE 50 furthest from power source).

Supplying Enough Power to SBE 50

Another consideration in determining maximum cable length is supplying enough power at the power source so that sufficient voltage is available, after the IR loss in the cable, to power the SBE 50.

Example 1 – For 18 gauge wire, what is maximum distance to transmit power to SBE 50 if using 8.5 volt power source to supply power? Is this controlling factor for maximum cable length if wanting to transmit at 1200 baud?

SBE 50's input power specification is 8 – 30 volts. Therefore, a 0.5 volt IR drop (8.5 volts – 8 volts) would still provide enough power to SBE 50.

$$V = IR \quad 0.5 \text{ volts} = (.051 \text{ amps}) * (0.0064 \text{ ohms/foot} * \text{cable length}) \quad \text{Cable length} = 1530 \text{ ft} = 466 \text{ meters}$$

Note that 466 meters < 800 meters (maximum distance SBE 50 can transmit data at 1200 baud), so IR drop in power is controlling factor for this example. Using a higher voltage power supply or a different wire gauge (12 or 14 gauge) would provide sufficient power at SBE 50 to allow 800 meter cable length.

Example 2 – Same as above, but there are 4 SBE 50s powered from the same power supply.

$$V = IR \quad 0.5 \text{ volts} = (.051 \text{ amps} * 4 \text{ SBE 50s}) * (0.0064 \text{ ohms/foot} * \text{cable length})$$

Cable length = 382 ft = 116 meters (this is cable length to SBE 50 furthest from power source).

Voltage Output Interface

The voltage output interface provides voltage output proportional to pressure or depth, *in addition to* the RS-232C output. If the voltage output feature is installed (6-pin connector in place of 4-pin connector), the SBE 50 can output 0.05 - 4.95 volts.

- See *Dimensions and End Cap Connector* in *Section 2: Description of SBE 50* for voltage pinouts.
- See *0-5 VDC Voltage Output Commands* in *Command Descriptions* to enable / disable voltage output (**OutputVolt=**), and to set up the voltage scale factor (**VRange=**) to meet your deployment needs.

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 50 in upper or lower case letters and register commands by pressing the Enter key.
- The SBE 50 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 the SBE 50 is transmitting data and you want to stop it, send **Stop** or type Ctrl Z. Press the Enter key to get the S> prompt. Alternatively, remove power.
- The SBE 50 responds only to **Stop** while sampling autonomously.

Entries made with the commands are permanently stored in the SBE 50 and remain in effect until you change them.

Status Command

DS

Display operating status and setup parameters. Equivalent to Status on Toolbar. List below includes, where applicable, command used to modify parameter.

- firmware version and serial number
- number of scans to average [**NAvg=**]
- start autonomous sampling automatically when power applied [**AutoRun=**]?
- Output format [**OutputFormat=**], digits after decimal point [**Decimals=**]
- 0-5 VDC voltage output [**OutputVolt=**]?

Note: This line only appears if enabled.

Example: (user input in bold)

```
S>DS
SBE50 V 1.0b SERIAL NO. 0011
number of scans to average = 1
start sampling on power up = no
output format = depth, salt, meters, 2 decimals
voltage output enabled
```

[**NAvg=**]
[**AutoRun=**]
[**OutputFormat=**, **Decimals=**]
[**OutputVolt=**]

Setup Commands

Note:

The SBE 50's baud rate (set with **Baud=**) must be the same as Seaterm's baud rate (set in the Configure menu).

Notes:

- See *Data Output Formats* for details.
- If you change the data output format:
 - Re-enter **POffset=** with a value that corresponds to the selected units. See *Calibration Coefficients Commands* below.
 - If the voltage output is enabled, re-enter **VRange=** with a value that corresponds to the selected units. See *0-5 VDC Voltage Output Commands* below.
- When using the SBE 50 with an AFM for control of an SBE 32 Carousel Water Sampler, SeatermAF automatically sets **OutputFormat=7**, **NAvg=16**, and **AutoRun=Y** in the SBE 50 when you arm the AFM. SeatermAF then automatically sends **Start** to begin sampling.

Baud=x

x= baud rate (600, 1200, 2400, 4800, 9600, 19200, or 38400). Default 9600.

OutputFormat=x

Data output format (applies to both autonomous and polled sampling):

x=0: Raw pressure A/D counts and pressure temperature voltage.

x=1: Pressure in psia. This is required format for SBE 50 interfacing with SBE 16*plus*, 16*plus* V2, or 16*plus*-IM V2, and using Sea-Bird software for real-time data acquisition and/or processing.

x=2 (default): Pressure in decibars.

x=3: Depth in meters for salt water.

x=4: Depth in feet for salt water.

x=5: Depth in meters for fresh water.

x=6: Depth in feet for fresh water.

x=7: Pressure (decibars) and scan number in hexadecimal form. **OutputFormat=7** required for interfacing SBE 50 with AFM and SBE 32 Carousel Water Sampler.

Decimals=x

x= number of digits to output to right of decimal point. Applicable for **OutputFormat=1** through 6.

Examples: Output formats and digits

- **OutputFormat=0**
553438, 1.5971
- **OutputFormat=1** and **Decimals=2**
291.62
- **OutputFormat=3** and **Decimals=1**
189.3

Note:

The input value for **Latitude=** is listed with the calibration coefficients in response to **DCal**.

Latitude=x

x= latitude (degrees) to use in salt water depth calculation. Applicable for **OutputFormat=3** and 4.

0-5 VDC Voltage Output Commands

If the voltage output feature is installed (6-pin connector in place of 4-pin connector), the SBE 50 can output 0.05 - 4.95 volts in addition to the RS-232 data. Use **OutputVolt=** to enable / disable output voltage.

OutputVolt=x**x=Y**: Voltage output enabled.**x=N**: Voltage output not enabled.**VRange=x****x=** Voltage output scale factor.**Note:**

If you change the data output format (**OutputFormat=**), re-enter **VRange=** with a value that corresponds to the selected units.

Output voltage = $0.1 + (4.8 * P / \mathbf{VRange})$
where

P = computed pressure or depth in units set with **OutputFormat=**.

If the computed voltage is less than 0.05, it is set to 0.05. If it is greater than 4.95, it is set to 4.95.

Examples: SBE 50 with 100 meter pressure sensor.

Start by rearranging equation to solve for VRange: $\mathbf{VRange} = (4.8 * P) / (\text{Output Voltage} - 0.1)$

Example 1: **OutputFormat=2** (decibars), and you want to set up SBE 50 so that output is at its maximum (4.95 volts) when pressure is 100 decibars.

Substituting P = 100 db and Output voltage = 4.95 volts into equation,
 $\mathbf{VRange} = (4.8 * 100) / (4.95 - 0.1) = \mathbf{98.97}$. Enter this value into SBE 50.

Example 2: **OutputFormat=4** (feet, in salt water), and you want to set up SBE 50 so that output is at its maximum (4.95 volts) when depth is 328 feet.

Substituting P = 328 feet and Output voltage = 4.95 volts into equation,
 $\mathbf{VRange} = (4.8 * 328) / (4.95 - 0.1) = \mathbf{324.62}$. Enter this value into SBE 50.

Notes:

- The scale factor calculated using **VCal** is independent of the scale factor entered with **VRange=**.
- The values for **VRange=**, **VOffset=**, and **VScale=** are listed with the calibration coefficients in response to **DCal**.

VCal

Test used to internally calculate SBE 50's D/A converter offset and scale factor (**VOffset=** and **VScale=** respectively). This test requires use of a voltmeter. When **VCal** is sent:

1. SBE 50 outputs 0.2 volts, and then prompts for voltmeter reading. Enter voltmeter reading (in volts) and press Enter.
2. SBE 50 outputs 4.8 volts, and then prompts for voltmeter reading. Enter voltmeter reading (in volts) and press Enter.

Based on the entered voltmeter readings, the SBE 50 calculates the D/A offset and scale factor, and stores them in EEPROM.

Volt=x

Set output voltage to **x** (volts). Use this command, and a voltmeter, to verify that the D/A converter offset and scale factor calculated with **VCal** are correct. If **VCal** was performed properly, the voltmeter reading should equal **x**.

Sampling Commands

Sampling commands configure the SBE 50's response upon waking up, and direct the SBE 50 to sample data once or continuously.

Note:

After you send **AutoRun=Y**, to start autonomous sampling immediately:

- turn power off and then on again, or
- send **Start**

Note:

When using the SBE 50 with an AFM for control of an SBE 32 Carousel Water Sampler, SeatermAF automatically sets **AutoRun=Y**, **NAvg=16**, and **OutputFormat=7** in the SBE 50 when you arm the AFM. SeatermAF then automatically sends **Start** to begin sampling.

AutoRun=x

x=N: Wait for a command when power is applied. Default.

x=Y: Start autonomous sampling at 16 Hz automatically when power is applied. SBE 50 will continue sampling until power is removed or **Stop** is sent. **AutoRun=Y** required for interfacing SBE 50 with AFM and SBE 32 Carousel Water Sampler.

NAvg=x

x= number of samples to average for autonomous sampling (range 1 to 255; default 1). SBE 50 samples at 16 Hz (every 0.0625 seconds), averages **NAvg** samples, and transmits the averaged data. **NAvg=16** required for interfacing SBE 50 with AFM and SBE 32 Carousel Water Sampler.

Start

Start autonomous sampling at 16 Hz. Applicable if:

- **AutoRun=N**, or
- **AutoRun=Y** and you previously sent **Stop** to stop sampling.

Notes:

- You may need to send **Stop** several times to get the SBE 50 to respond.
- You can also stop autonomous sampling by typing Ctrl Z or removing power.

Stop

Stop autonomous sampling. Press Enter key to get an **S>** prompt before entering this command. Once sampling is stopped and Seaterm shows **S>** prompt, you can send desired commands (setup, status, etc.) to SBE 50.

TS

Take **one** sample and transmit data.

Calibration Coefficients Commands

Notes:

- Date shown is when calibration was performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificate shipped with SBE 50.
- See individual Coefficient Commands below for definitions of the data in the example.

DCal

Display calibration coefficients.
Equivalent to Coefficients on Toolbar.

Example: (user input in bold).

```
S>DCAL
SBE 50 V 1.0b SERIAL NO. 0011
pressure S/N 2357, range = 3000 psia: 14-jul-01
PA0 = -9.800510e+00
PA1 = 8.881598e-03
PA2 = -1.574956e-10
PTCA0 = 5.204502e+05
PTCA1 = -7.501161e+01
PTCA2 = 1.016521e+00
PTCB0 = 2.483463e+01
PTCB1 = -7.500000e-05
PTCB2 = 0.000000e+00
PTEMPA0 = -6.530763e+01
PTEMPA1 = 5.171258e+01
PTEMPA2 = -2.201600e-01
POFFSET = 0.000000e+00
VOFFSET = -8.717179e-06
VSCALE = 1.001546e+00
VRANGE = 2.000000e+03
Latitude = 45.0
```

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

PSN=S

S=Pressure sensor serial number

PRange=F

F=Full scale pressure range in psia

PCalDate=S

S=Pressure calibration date

PA0=F

F=Pressure A0

PA1=F

F=Pressure A1

PA2=F

F=Pressure A2

PTCA0=F

F=Pressure ptca0

PTCA1=F

F=Pressure ptca1

PTCA2=F

F=Pressure ptca2

PTCB0=F

F=Pressure ptcb0

PTCB1=F

F=Pressure ptcb1

PTCB2=F

F=Pressure ptcb2

PTempA0=F

F=Pressure ptempa0

PTempA1=F

F=Pressure ptempa1

PTempA2=F

F=Pressure ptempa2

POffset=F

F=Pressure offset; added to computed pressure in units determined with

OutputFormat=**VOffset=, VScale=, VRange=**

See 0-5 VDC Voltage Output Commands above.

Latitude=

See Setup Commands above.

Note:

If you change the data output format (**OutputFormat=**), re-enter **POffset=** with a value that corresponds to the selected units.

Data Output Formats

Notes:

- Each scan of data ends with a carriage return and line feed.
- **OutputFormat=0** through **6**: data is in decimal form.
- **OutputFormat=1** through **6**: Leading zeros are suppressed, except for one zero to the left of the decimal point. **Decimals=** defines the number of digits to the right of the decimal point.
- **OutputFormat=1** (psia) is required format for an SBE 50 interfacing with an SBE 16*plus*, 16*plus* V2, or 16*plus*-IM V2 and using Sea-Bird software for real-time data acquisition and/or processing.

- **OutputFormat=0** - Raw A/D pressure counts and pressure temperature voltage:
pppppp, v.vvvv
where pppppp = pressure counts v.vvvv = pressure temperature voltage
The pressure sensor is an absolute sensor, so its raw output includes the effect of atmospheric pressure (14.7 psi). See the SBE 50's Calibration Sheet for the equation to convert the pressure counts and pressure temperature voltage to pressure.

- **OutputFormat=1** (psia) and **2** (decibars) - Pressure:

When **OutputFormat=1**, the SBE 50 outputs pressure in psia, which includes the effect of atmospheric pressure (i.e., output pressure at the surface is 14.7 psia).

When **OutputFormat=2**, the SBE 50 outputs pressure in decibars, relative to the ocean surface (i.e., output pressure at the surface is 0 decibars).

As shown on the Calibration Sheet, Sea-Bird's calibration (and resulting calibration coefficients) is in terms of psia. The SBE 50 uses the following equation to convert psia to decibars:

$$\text{pressure (db)} = [\text{pressure (psia)} - 14.7] * 0.689476;$$

Pressure in decibars is the value required by the UNESCO formulas for computation of salinity, density, and other derived variables.

- **OutputFormat=3** (meters) and **4** (feet) - Depth for salt water:
For oceanic applications, it is assumed that salinity is 35 PSU and temperature is 0 °C, and the water compressibility (with accompanying density variation) is taken into account in the depth calculation. This is the method recommended in UNESCO Technical Paper No. 44 and is a logical approach, because most of the deep-ocean water column approximates these salinity and temperature values. Since pressure is also proportional to gravity and the major variability in gravity depends on latitude, the input latitude (**Latitude=**) is used to estimate the magnitude of the local gravity.
- **OutputFormat=5** (meters) and **6** (feet) - Depth for fresh water:
For fresh water applications, compressibility is not significant in the shallow depths encountered and is ignored, as is the latitude-dependent gravity variation. Fresh water density is assumed to be 1 gm/cm for the calculation of depth.

- **OutputFormat=7** – Pressure and scan number in hexadecimal:

ppppsssss

where pressure [decibars] = pppp – 100 ssssss = scan number

OutputFormat=7 required for communicating with the **Auto Fire Module (AFM) and SBE 32 Carousel Water Sampler**. This allows the AFM to use the SBE 50's pressure data to determine when to close water bottles.

Note:

When using the SBE 50 with an AFM for control of an SBE 32 Carousel Water Sampler, SeatermAF automatically sets **OutputFormat=7**, **NAvg=16**, and **AutoRun=Y** in the SBE 50 when you arm the AFM. SeatermAF then automatically sends **Start** to begin sampling.

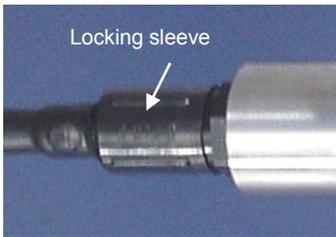
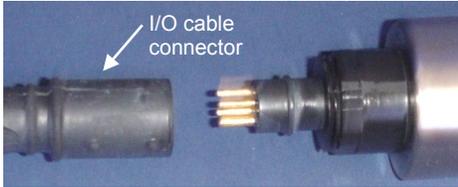
Example: SBE 50 used with AFM and Carousel,
example scan = ppppssssss = 00C80001F0

- Pressure = pppp = 00C8 (200 decimal);
pressure (decibars) = 200 - 100 = 100 decibars
- Scan number = ssssss = 0001F0 (496 decimal);
scan number = 496

Deployment

CAUTIONS:

- Do not use WD-40 or other petroleum-based lubricants, as they will damage the connector.
- For wet-pluggable MCBH connectors: **Silicone lubricants in a spray can** may contain ketones, esters, ethers, alcohols, or glycols in their propellant. **Do not use these sprays, as they will damage the connector.**



1. Install the I/O cable on the SBE 50 end cap:
 - A. Lightly lubricate the inside of the cable connector with silicone grease (DC-4 or equivalent).
 - B. **XSG/AG Connector** - Install the cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the SBE 50. Remove any trapped air by *burping* or gently squeezing the connector near the top and moving your fingers toward the end cap. **OR**
MCBH Connector – Install the cable connector, aligning the pins.
 - 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.**
2. Connect the I/O cable to the computer/controller.
3. Connect the I/O cable's red (+) and black (-) wires to a power supply (8-30 VDC).
4. Verify that the hardware and external fittings are secure.
5. Immediately prior to deployment, apply power.
 - If **AutoRun=Y**, the SBE 50 will begin sampling.
 - If **AutoRun=N**, send **Start** to begin autonomous (continuous) sampling or send **TS** to take a single sample.
6. If the SBE 50 is connected directly to the computer and you will be using Seterm to view real-time data, press Capture on the Toolbar to save the data to a .cap file.

The SBE 50 is ready to go into the water.

Recovery

WARNING!

If the SBE 50 stops working while underwater, is unresponsive to commands, or shows other signs of flooding or damage, carefully secure it away from people until you have determined that abnormal internal pressure does not exist or has been relieved. Pressure housings

may flood under pressure due to dirty or damaged o-rings, or other failed seals. When a sealed pressure housing floods at great depths and is subsequently raised to the surface, water may be trapped at the pressure at which it entered the housing, presenting a danger if the housing is opened before relieving the internal pressure. Instances of such flooding are rare. However, a housing that floods at 5000 meters depth holds an internal pressure of more than 7000 psia, and has the potential to eject the end cap with lethal force. A housing that floods at 50 meters holds an internal pressure of more than 85 psia; this force could still cause injury.

If you suspect the SBE 50 is flooded, point it in a safe direction away from people, and loosen the bulkhead connector very slowly, at least 1 turn. This opens an o-ring seal under the connector. Look for signs of internal pressure (hissing or water leak). If internal pressure is detected, let it bleed off slowly past the connector o-ring. Then, you can safely remove the end cap.

Rinse the outside of the SBE 50 with fresh water.

Section 5: Routine Maintenance and Calibration

This section reviews corrosion precautions, connector mating and maintenance, pressure sensor maintenance, O-ring maintenance, and sensor calibration. The accuracy of the SBE 50 is sustained by establishing proper handling practices.

Corrosion Precautions

Rinse the SBE 50 with fresh water after use and prior to storage.

All exposed metal is titanium; other materials are plastic. No corrosion precautions are required, but direct electrical connection of titanium to dissimilar metal hardware should be avoided.

Connector Mating and Maintenance

Note:

See *Application Note 57: Connector Care and Cable Installation*.

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

When remating:

CAUTIONS:

- **Do not use WD-40** or other petroleum-based lubricants, as they will damage the connector.
- For wet-pluggable MCBH connectors: **Silicone lubricants in a spray can** may contain ketones, esters, ethers, alcohols, or glycols in their propellant. **Do not use these sprays, as they will damage the connector.**

1. Lightly lubricate the inside of the cable connector with silicone grease (DC-4 or equivalent).
2. **XSG/AG Connector** - Install the cable connector, aligning the raised bump on the side of the cable connector with the large pin (pin 1 - ground) on the SBE 50. Remove any trapped air by *burping* or gently squeezing the connector near the top and moving your fingers toward the end cap. **OR**
MCBH Connector – Install the cable connector, aligning the pins.
3. Place the locking sleeve over the cable connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

Verify that a cable is installed before deployment.

Pressure Sensor Maintenance



The pressure port plug has a small vent hole to allow hydrostatic pressure to be transmitted to the pressure sensor inside the instrument, while providing protection for the pressure sensor, keeping most particles and debris out of the pressure port.

Periodically (approximately once a year) inspect the pressure port to remove any particles, debris, etc.:

1. Unscrew the pressure port plug from the pressure port.
2. Rinse the pressure port with warm, de-ionized water to remove any particles, debris, etc.
3. Replace the pressure port plug.

CAUTION:

Do not put a brush or any object in the pressure port. Doing so may damage or break the pressure sensor.

O-Ring Maintenance

Note:

For details on recommended practices for cleaning, handling, lubricating, and installing O-rings, see the *Basic Maintenance of Sea-Bird Equipment* module in the Sea-Bird training materials on our website.

O-rings on the SBE 50 are typically only disturbed if it is necessary to open the housing for diagnosis and/or repair of an electronics malfunction. Sea-Bird recommends that the O-rings be inspected and replaced approximately every 3 to 5 years.

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

CAUTION:

Do not use Parker O-Lube, which is petroleum based; use only Super O-Lube.

Sensor Calibration



Note:

The SBE 50's pressure sensor is an absolute sensor, so its **raw** output includes the effect of atmospheric pressure (14.7 psi). As shown on the Calibration Sheet, Sea-Bird's calibration (and resulting calibration coefficients) is in terms of psia. However, when outputting pressure in **engineering units**, the SBE 50 outputs pressure relative to the ocean surface (i.e., at the surface the output pressure is 0 decibars). The SBE 50 uses the following equation to convert psia to decibars:

$$\text{Pressure (db)} = [\text{pressure (psia)} - 14.7] * 0.689476$$

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 SBE 50's pressure sensor is supplied fully calibrated, with coefficients printed on the Calibration Certificate. These coefficients have been stored in the SBE 50's EEPROM.

The strain-gauge pressure sensor is a mechanical diaphragm type, with an initial static error band of 0.05%. Consequently, the sensor is capable of meeting SBE 50's 0.10% error specification with some allowance for aging and ambient-temperature induced drift.

Pressure sensors show most of their error as a linear offset from zero. A technique is provided below for making small corrections to the pressure sensor calibration using the *offset* (**POffset=**) calibration coefficient term by comparing SBE 50 pressure output to readings from a barometer.

Allow the SBE 50 to equilibrate (with power on) in a reasonably constant temperature environment for at least 5 hours before starting. Pressure sensors exhibit a transient change in their output in response to changes in their environmental temperature. Sea-Bird instruments are constructed to minimize this by thermally decoupling the sensor from the body of the instrument. However, there is still some residual effect; allowing the SBE 50 to equilibrate before starting will provide the most accurate calibration correction.

1. Place the SBE 50 in the orientation it will have when deployed.
2. In Seaterm:
 - A. Set the pressure offset to 0.0 (**POffset=0**).
 - B. Send **TS** a number of times to measure and transmit SBE 50 pressure.
3. Compare the SBE 50 output to the reading from a good barometer at the same elevation as the SBE 50's pressure sensor. Convert the barometer reading to units consistent with **OutputFormat=**. Calculate *offset* = barometer reading – SBE 50 reading
4. Enter the offset (positive or negative) in the SBE 50's EEPROM, using **POffset=** in Seaterm. **The offset must be entered in units consistent with OutputFormat=** (for example, if the output format is decibars, enter an offset in decibars).

Offset Correction Example

Absolute pressure measured by a barometer is 1010.50 mbar. Pressure displayed from SBE 50 with output in decibars (**OutputFormat=2**) is -2.5 dbars.

Convert barometer reading to dbars using the relationship: mbar * 0.01 = dbar

Barometer reading = 1010.50 mbar * 0.01 = 10.1050 dbar

The SBE 50's internal calculations and our processing software output gage pressure, using an assumed value of 14.7 psi for atmospheric pressure. Convert SBE 50 reading from gage to absolute by adding 14.7 psia to the SBE 50's output:

-2.5 dbars + (14.7 psi * 0.689476 dbar/psia) = -2.5 + 10.13 = 7.635 dbars

Offset = 10.1050 – 7.635 = + 2.47 dbars

Enter offset in SBE 50 with **POffset=**.

For demanding applications, or where the sensor's air ambient pressure response has changed significantly, calibration using a dead-weight generator is recommended. The pressure sensor port uses a ⁷/₁₆-20 straight thread for mechanical connection to the pressure source. Use a fitting that has an O-ring tapered seal, such as Swagelok-200-1-4ST, which conforms to MS16142 boss.

Section 6: Troubleshooting

This section reviews common problems in operating the SBE 50, and provides the most likely causes and solutions.

Problem 1: Unable to Communicate with SBE 50

The `S>` prompt indicates that communications between the SBE 50 and computer have been established. Before proceeding with troubleshooting, attempt to establish communications again by clicking Connect on Seaterm's toolbar or hitting the Enter key several times.

Cause/Solution 1: The I/O cable connection may be loose. Check the cabling between the SBE 50 and computer for a loose connection.

Cause/Solution 2: The instrument type and/or its communication settings may not have been entered correctly in Seaterm. Select *SBE 50* in the Configure menu and verify the settings in the Configuration Options dialog box. The settings should match those on the instrument Configuration Sheet.

Cause/Solution 3: The I/O cable may not be the correct one. The I/O cable supplied with the SBE 50 permits connection to DB-9P input connectors, i.e., RS-232 interfaces.

- SBE 50 Pin 1 goes to DB-9 pin 5 (ground)
- SBE 50 pin 2 goes to DB-9 pin 3
- SBE 50 pin 3 goes to DB-9 pin 2

See *Section 2: Description of SBE 50* for the connector details.

Problem 2: Unreasonable Data

The symptom of this problem is data that contains unreasonable values (for example, values that are outside the expected range of the data).

Cause/Solution 1: Data with unreasonable values may be caused by incorrect calibration coefficients in the SBE 50's EEPROM (if looking at data output in converted format, **OutputFormat = 1** through 7). Verify the calibration coefficients in EEPROM, using **DCal**.

Glossary

SBE 50 – High-accuracy Digital Oceanographic Pressure Sensor.

PCB – Printed Circuit Board.

Scan – One data sample.

Note:

All Sea-Bird software listed was designed to work with a computer running Windows XP service pack 2 or later, Windows Vista, or Windows 7 (32-bit or 64-bit).

Seasoft V2– Sea-Bird’s complete Windows software package, which includes software for communication, real-time data acquisition, and data analysis and display. Seasoft V2 includes **Seaterm**, **SeatermAF**, Seasave, SBE Data Processing, and Plot39. Only Seaterm and SeatermAF are applicable to the SBE 50.

Seaterm – Sea-Bird’s Windows terminal program software used to communicate with the SBE 50.

SeatermAF – Sea-Bird’s Windows terminal program software used to communicate with the SBE 50 when it is used with an SBE 32 Carousel Water Sampler and Auto Fire Module (AFM). See the AFM manual for details.

CAUTION:

Do not use Parker O-Lube, which is petroleum based; use only Super O-Lube.

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

Appendix I: Functional Description

Sensor

Note:

Pressure ranges are expressed in meters of deployment depth capability.

The SBE 50's strain-gauge pressure sensor is available in the following pressure ranges: 20, 100, 350, 600, 1000, 2000, 3500, and 7000 meters. Compensation of the temperature influence on pressure offset and scale is performed by the SBE 50's CPU. The pressure sensor

Sensor Interface

Strain-gauge pressure is acquired by applying an AC excitation to the pressure bridge. A 24-bit A/D converter digitizes the output of the bridge. AC excitation and ratiometric comparison avoids errors caused by parasitic thermocouples, offset voltages, leakage currents, and reference errors. A silicon diode embedded in the pressure bridge is used to measure the temperature of the pressure bridge. This temperature is used to perform offset and span corrections on the measured pressure signal.

Appendix II: Electronics Disassembly/Reassembly

Disassembly



Unscrew end cap

1. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.
2. Using a wrench, unscrew the end cap.
3. Carefully pull the end cap and attached electronics out of the housing. Note that the electronics are electrically connected to the I/O connector.
4. Remove any water from the O-ring and mating surfaces inside the housing with a lint-free cloth or tissue.
5. Be careful to protect the O-ring from damage or contamination.



Reassembly

Note:

Before delivery, a desiccant package is placed in the housing, and the housing 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.

1. Remove any water from the end cap's O-ring and mating surfaces in the housing 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 the O-rings and mating surfaces.
2. Carefully fit the electronics into the housing until you feel resistance.
3. Using a wrench, screw the end cap onto the housing.

CAUTION:

Do not use Parker O-Lube, which is petroleum based; use only Super O-Lube.

Appendix IV: Replacement Parts

| Part Number | Part | Application Description | Quantity in SBE 50 |
|-------------|---|---|--------------------|
| 30931 | Parker 2-214N674-70 O-ring | End cap O-ring | 1 |
| 801385 | 4-pin RMG-4FS to 9-pin DB-9S I/O cable, 2.4 m (8 ft long) | SBE 50 (RS-232 connector) to computer and power supply | 1 |
| 801386 | 6-pin AG-206 to 9-pin DB-9S I/O cable, 2.4 m (8 ft long) | SBE 50 (RS-232 and Voltage Output connector) to computer and power supply | 1 |
| 801206 | 4-pin MCIL-4FS to 9-pin DB-9S I/O cable, 2.4 m (8 ft long) | SBE 50 (RS-232, wet-pluggable connector) to computer and power supply | 1 |
| 801387 | 6-pin MCIL-6FS to 9-pin DB-9S I/O cable, 2.4 m (8 ft long) | SBE 50 (RS-232 and Voltage Output, wet-pluggable connector) to computer and power supply | 1 |
| 171888 | 25-pin DB-25S to 9-pin DB-9P cable adapter | For use with computer with DB-25 connector | 1 |
| 171730 | Double Y-cable (AFM 6-pin AG-206 and 3-pin RMG-3FS to SBE 32 6-pin AG-206 and SBE 50 4-pin RMG-4FS) | SBE 50 used with SBE 32 Carousel Water Sampler and Auto Fire Module (XSG/AG connectors on SBE 50, SBE 32, and AFM) | - |
| 171991 | Double Y-cable (AFM 6-pin MCIL-6FS and 3-pin MCIL-3FS to SBE 32 6-pin MCIL-6FS and SBE 50 4-pin MCIL-4FS) | SBE 50 used with SBE 32 Carousel Water Sampler and Auto Fire Module (wet-pluggable connectors on SBE 50, SBE 32, and AFM) | - |
| 17043 | Locking sleeve | Locks cable or dummy plug in place (SBE 50 with XSG/AG connector) | 1 |
| 171192 | Locking sleeve | Locks cable or dummy plug in place (SBE 50 with wet-pluggable connector) | 1 |
| 17046.1 | 4-pin RMG-4FSD dummy plug with locking sleeve | Connector protection (SBE 50 with RS-232 output, XSG connector) | 1 |
| 17047.1 | 6-pin AG-206 dummy plug with locking sleeve | Connector protection (SBE 50 with RS-232 and Voltage Output, AG connector) | 1 |
| 171398.1 | 4-pin MCDC-4-F dummy plug with locking sleeve | Connector protection (SBE 50 with RS-232 output, wet-pluggable connector) when I/O cable not connected | 1 |
| 171498.1 | 6-pin MCDC-6-F dummy plug with locking sleeve | Connector protection when I/O cable not connected (SBE 50 with RS-232 and Voltage Output, wet-pluggable connector) | 1 |

Appendix V: Manual Revision History

| Manual Version | Date | Description |
|----------------|-------|--|
| 001 | 05/02 | <ul style="list-style-type: none"> Initial release of production units. |
| 002 | 11/02 | <ul style="list-style-type: none"> Add information on baud rate and sampling time and cable length. Add information that SBE 50 can be used with AFM to trigger bottle closures. Add more cable information in replacement parts list. Remove oil sensor refill kit from shipment photos and spare parts list. Correct pressure sensor calibration fitting. Add pressure sensor maintenance information. |
| 003 | 02/03 | <ul style="list-style-type: none"> Firmware version 1.0b: Add new output format for compatibility with AFM. |
| 004 | 03/04 | <ul style="list-style-type: none"> Add information on D/A resolution to specifications. Update power and cable length section. Remove spare parts kit from shipment photos (not included). Remove warnings to user to set NAvg=16, AutoRun=y, & OutputFormat=7 in SBE 50 when you use SBE 50 with AFM, because code was added to SeatermAF to automatically set those. Update Seaterm screens. |
| 005 | 09/04 | <ul style="list-style-type: none"> Remove “90208” from name of AFM (90208 only for AFM with XSG connectors; AFM with MCBH connectors is 90491). Add PN for double y-cable with wet-pluggable connector (use with AFM and SBE 32 Carousel). |
| 006 | 05/06 | <ul style="list-style-type: none"> Update recovery warning, adding more detail. Add 600 m pressure sensor. Update wet-pluggable connector. |
| 007 | 11/06 | <ul style="list-style-type: none"> Add examples of how to use VRange= to set up 0 -5 VDC output. Correct example of <i>display calibration</i> command (showed dc, corrected to dcal). Pressure port maintenance – SBE no longer putting silicon oil in pressure sensor port |
| 008 | 05/08 | <ul style="list-style-type: none"> Provide information on use with SBE 55 ECO Water Sampler for autonomous bottle firing. Change stability specification for pressure to /year instead of /month. Document that OutputFormat=1 required if using with 16plus, 16plus V2, or 16plus-IM V2 and using Seasave and/or SBE Data Processing. Update maintenance information on connector to be consistent with application note 57. |
| 009 | 01/10 | <ul style="list-style-type: none"> Add information that can use SBE 50 with SBE 36 and PDIM if you set SBE 50 to AutoRun=Y and Baud=4800. Can acquire NMEA and PAR, but PAR is raw data. Can view data in Seaterm; cannot use Seasave or SBE Data Processing. Update software name. Add CE mark and information required for certification. Update SBE address. |
| 010 | 01/13 | <ul style="list-style-type: none"> Update diagrams showing use with SBE 33 or 36 Deck Units, to include SBE 25<i>plus</i> in list of CTDs, and to Surface PAR as standard in the deck units. Remove references to Druck pressure sensors (can be supplied by other manufacturers). Remove references to SBE 50 use with SBE 55 ECO Water Sampler. Add Declaration of Conformity. Add cable and wiring diagrams. Update software compatibility information. |
| 011 | 02/15 | <ul style="list-style-type: none"> Specifications: clarify that accuracy specifications are \pm; add sampling rate. Update Declaration of Conformity. Add caution regarding using spray can lubricants on MCBH connectors. Add caution regarding using Parker Super O Lube, not Parker O Lube (which is petroleum based). Add information on O-ring maintenance. Remove <i>standard</i> and <i>optional</i> language related to SBE 50 features. Update language on where to find updated software on website. Switch to Sea-Bird Scientific cover. |

Index

O

0 – 5 Volt output · 20, 22

A

AFM · 8, 17, 25
Auto Fire Module · 8, 17, 25

B

Baud rate · 18

C

Cable length · 18, 19
Cables · 11
Calibration · 30
Carousel Water Sampler · 8, 17, 25
CE certification · 3
Command summary · 35
Commands
 calibration coefficients · 24
 descriptions · 20
 operating · 23
 output format · 21
 sampling · 23
 setup · 21
 status · 20
 voltage output · 22
Communication defaults · 14
Connector · 10, 28
Corrosion precautions · 28

D

Data output format · 21, 25
Data transmission rate · 18
Declaration of Conformity · 3
Deployment · 26
 preparing for · 12
Description · 7
Dimensions · 10

E

Electronics disassembly/reassembly · 34
End cap · 28

F

Functional description · 33

G

Glossary · 32

L

Limited liability statement · 2

M

Maintenance · 28
Manual revision history · 37
Modes · *See* Sampling modes

O

O-ring
 maintenance · 29
Output format · 25

P

Parts
 replacement · 36
PDIM · 8
Power · 9, 19
Pressure sensor
 maintenance · 29

Q

Quick start · 5

R

Recovery · 27
Replacement parts · 36
Revision history · 37

S

Sampling modes · 16
 autonomous · 17
 polled · 16
SBE 32 Carousel Water Sampler · 8, 17, 25
SBE 36 Deck Unit · 8
Seasoft · 8, 12
Seaterm · 8, 12, 13
 main screen · 13
 toolbar buttons · 14
SeatermAF · 8
Sensor · 9
Software · 8
Software installation · 12
Specifications · 9
System description · 7

T

Terminal program · 12
Testing · 12
Troubleshooting · 31

U

Unpacking SBE 50 · 6

V

Versions · 37
Voltage output interface · 20, 22

W

Water sampler · 17, 25
Wiring · 11, 12