SBE 45 MicroTSG THERMOSALINOGRAPH

Conductivity and Temperature Monitor with RS-232 Interface

Serial Number: 4566782-0402

User Manual, Version 015

Sea-Bird Electronics, Inc.
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SBE 45 MICRO-TSG OPERATING AND REPAIR MANUAL

TABLE OF CONTENTS

Manual Generation Date..... 1

Limited Liability Statement..... 2

Declaration of Conformity..... 4

SBE 45 Configuration - S/N 0402..... 5

SBE 45 Manual - Version 015..... 6

SBE 45 Reference Sheet - Version 007..... 59

SBE 45 Specification Sheet..... 61

PN 90402 Manual - Version 008..... 63

SBE 45 Calibrations..... 95

Appnotes..... 98

Drawings..... 125

Warranty..... 136

Service Request Form..... 139

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Manual Generation Date: 13 February 2012

LIMITED LIABILITY STATEMENT

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

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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	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	41	41CP	43	43F	44	45
49	50	52-MP	53BPR		54	55	SIM	ICC	IMM	PDIM	AFM
90488	90204	90402	90504		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: John Backes

Title of Signatory: Vice President

Date: 27 January 2010

Place: Bellevue, WA

SBE45 MicroTSG (Thermosalinograph)

Conductivity & Temperature Monitor with RS-232 Serial Interface

Instrument Configuration:

Serial Number	4566782-0402
Firmware Version	V 1.1b
Interface Type	RS-232
Conductivity Range	0-7 S/m
Baud Rate	4800
Power Up Jumper	Autopower Pins 1 & 2
Maximum Depth	**0**

CAUTION - This instrument is not intended for underwater use.

SBE 45 MicroTSG (Thermosalinograph)

Conductivity and Temperature Monitor with RS-232 Interface

Note: NEW ADDRESS
as of January 2010

User's Manual

Sea-Bird Electronics, Inc.
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Manual Version #015, 01/26/10
Firmware Version 1.1b and later
Seasave V7 Version 7.20a and later
SBE Data Processing Version 7.20a and later

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Table of Contents

Section 1: Introduction 5
About this Manual 5
Quick Start 5
Unpacking MicroTSG 6

Section 2: Description of MicroTSG 7
System Description 7
Specifications 9
Dimensions and Connector 10
Sample Timing 11
Baud Rate, Cable Length, Power, and Data Transmission Rate 12
Remote Temperature Sensor (optional) 14

Section 3: Installing System 15
Installing Software 15
System Schematic and Installation Guidelines 16
Power-Up Jumper Check 18
Installing MicroTSG 19

Section 4: Setting Up MicroTSG 20
Communications Test and Setup 20
Sampling Modes 24
Polled Sampling 24
Autonomous Sampling 25
Serial Line Synchronization (Serial Line Sync) 26
Timeout Description 26
Command Descriptions 27
Data Output Format 32
Setting Up Configuration (.xmlcon or .con) File 33

Section 5: Operating System 34
Acquiring Real-Time Data with Seasave 34
Processing Data 36

Section 6: Routine Maintenance and Calibration 37
Corrosion Precautions 37
Cleaning and Storage 37
Replacing Anti-Foulant Device (SBE 45) 39
Sensor Calibration 40

Section 7: Troubleshooting 41
Problem 1: Unable to Communicate with MicroTSG 41
Problem 2: Nonsense or Unreasonable Data 41
Problem 3: Salinity Lower than Expected 41

Glossary 42

Appendix I: Functional Description 43
Sensors 43
Sensor Interface 43
Appendix II: Electronics Disassembly/Reassembly 44
Appendix III: Command Summary 45
Appendix IV: AF24173 Anti-Foulant Device 47
Appendix V: Replacement Parts 51
Index 52

Section 1: Introduction

This section includes a Quick Start procedure, and photos of a standard SBE 45 MicroTSG shipment.

About this Manual

This manual is to be used with the SBE 45 MicroTSG Conductivity and Temperature Monitor. 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 MicroTSG.
The manual provides step-by-step details for performing each task:

1. Perform pre-check procedures (see *Sections 3* and *4*):
   A. On the Configuration Sheet (in the manual), check the factory-set power-up mode jumper setting. For a description of how the jumper setting affects operation, see *Power-Up Jumper Check* in *Section 3: Installing System*.
   B. Test power and communications.
   C. Establish setup and operating parameters.
   D. Check status (**DS**) and calibration coefficients (**DC**) to verify setup.

2. Deploy the MicroTSG (see *Sections 3*, *4*, and *5)*:
   A. Verify the AF24173 Anti-Foulant Device is installed.
   B. Install the MicroTSG.
   C. Send commands to run the system.

Unpacking MicroTSG

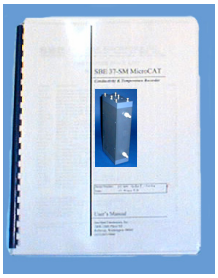
Shown below is a typical MicroTSG shipment.

MicroTSG

I/O cable

Spare parts kit

Conductivity cell cleaning solution (Triton X-100)



MicroTSG User Manual

Software, and Electronic Copies of Software Manuals and User Manual

Section 2: Description of MicroTSG

This section describes the functions and features of the MicroTSG, including:
- System description
- Specifications
- Dimensions and connector
- Sample timing
- Baud rate, cable length, and power requirements
- Optional remote temperature sensor

System Description

The SBE 45 MicroTSG is an externally powered, high-accuracy, conductivity and temperature monitor, designed for shipboard determination of sea surface (pumped-water) conductivity and temperature.

Communication with the MicroTSG is over an internal, 3-wire, RS-232C link, providing real-time data transmission. Commands can be sent to the MicroTSG to provide status display, data acquisition setup, data acquisition and display, and diagnostic tests. User-selectable operating modes include:

- **Polled sampling** – On command, the MicroTSG takes one sample and sends the data to the computer.

- **Autonomous sampling** – At pre-programmed intervals, the MicroTSG samples and sends the data to the computer. The MicroTSG does not enter quiescent (sleep) state between samples.

- **Serial Line Sync** - A pulse on the serial line causes the MicroTSG to wake up, sample, and enter quiescent (sleep) state automatically.

Calibration coefficients stored in EEPROM allow the MicroTSG to transmit data in engineering units. The MicroTSG retains the temperature and conductivity sensors used in the SBE 21 Thermosalinograph, but has improved acquisition electronics that increase accuracy and resolution, and lower power consumption. The MicroTSG's aged and pressure-protected thermistor has a long history of exceptional accuracy and stability (typical drift is less than 0.002 °C per year). Electrical isolation of the conductivity electronics eliminates any possibility of ground-loop noise.

The MicroTSG's internal-field conductivity cell is unaffected by external fouling. A plastic cup with O-ring retainer at one end of the cell retains the expendable AF24173 Anti-Foulant Device.

Note:
See the Interface Box manual for operation of the MicroTSG with the Interface Box. The Interface Box can be added to the system at any time, and does not need to be part of the original MicroTSG order.

An **optional AC- or DC-powered 90402 - SBE 45 Power, Navigation, and Remote Temperature Interface Box** provides:

- Power and an opto-isolated RS-232C interface for the MicroTSG
- An opto-isolated NMEA receiver for an optional NMEA navigation device which supports NMEA 0183 protocol, outputting data in GGA, GLL, RMA, RMC, or TRF format (NMEA navigation device not supplied by Sea-Bird)
- Power and an RS-232C interface for an optional **SBE 38** remote temperature sensor
- An RS-232C computer interface

Decoded Latitude, Longitude, date, and time and SBE 38 temperature data are appended to the MicroTSG data stream in the Interface Box. The data is transmitted to the computer for storage and/or display.

The MicroTSG is supplied with a powerful 2000/XP software package, Seasoft© V2, which includes:

- **SEATERM** – terminal program for easy communication and data retrieval, can send commands to the MicroTSG to provide status display, data acquisition setup, data display and capture, and diagnostic tests.
- **Seasave V7** – program for acquiring, saving, and displaying real-time or archived data.
- **SBE Data Processing** – program for calculation and plotting of conductivity, temperature, data from auxiliary sensors, and derived variables such as salinity and sound velocity.

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

Specifications

	Temperature (°C) [1]	Conductivity (S/m)	Salinity (PSU), typical
Measurement Range	-5 to +35	0 to 7 (0 to 70 mS/cm)	-
Initial Accuracy	0.002	0.0003 (0.003 mS/cm)	0.005
Typical Stability (per month)	0.0002	0.0003 (0.003 mS/cm)	0.003
Resolution [2]	0.0001	0.00001 (0.0001 mS/cm)	0.0002
Sensor Calibration Range	+1 to +32	0 to 6; physical calibration over the range 2.6 to 6 S/m, plus zero conductivity (air)	-
Counter Time-Base	Quartz TCXO, ±2 ppm per year aging; ±5 ppm vs. temperature (-5 to +30 °C)		
Input Power	8 - 30 VDC Quiescent (sleep) Current: 10 microamps Operating Current: 34 milliamps at 8 VDC 30 milliamps at 12-30 VDC		
Materials	PVC housing		
Recommended Flow Rate	10 to 30 milliliters/second (0.16 to 0.48 gallons/minute)		
Maximum Safe Operating Pressure	34.5 decibars (50 psi)		
Weight	4.6 kg (10.2 lbs)		

Notes:

[1] Temperature specifications above are for MicroTSG's temperature sensor. For optional remote temperature sensor (SBE 38), which can be integrated with optional 90402 Interface Box -

Measurement range: -5 to +35 °C — Initial accuracy: 0.001 °C
Resolution: 0.0003 °C — Calibration: -1 to +32 °C
Typical stability: 0.001 °C in 6 months, certified

[2] Resolution

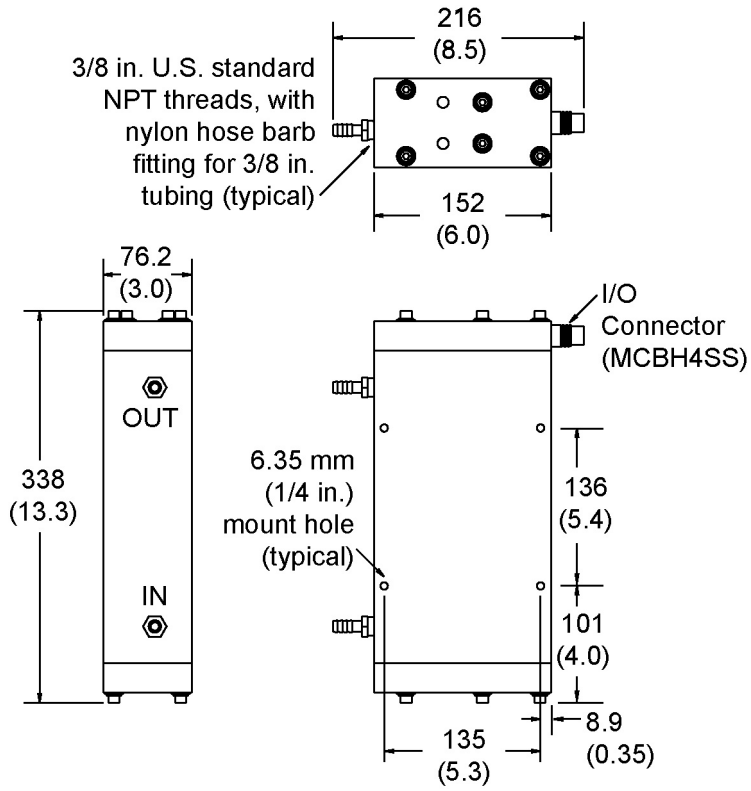
Typical RMS noise with fixed resistors on temperature and conductivity inputs:

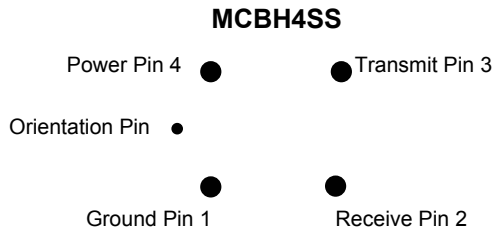
NCycles *	Temperature (°C)	Conductivity (S/m)	Salinity (psu)	Sound Velocity (m/sec)
1	0.000190	0.000014	0.00027	0.00066
2	0.000170	0.000010	0.00016	0.00057
4	0.000150	0.000005	0.00015	0.00055
8	0.000087	0.000005	0.00009	0.00033
16	0.000078	0.000004	0.00007	0.00025

* **NCycles** = number of measurements to average per sample.

Dimensions and Connector

Dimensions in millimeters (inches)





Ground pin = Computer data common (pin 1)
Receive pin = RS-232C receive data transmitted from computer (pin 2)
Transmit pin = RS-232C transmit from MicroTSG to computer (pin 3)
Power pin = 8-30 VDC (pin 4)

Sample Timing

The time to acquire the temperature and conductivity varies, depending on the mode of operation.

Note:
See *Command Descriptions* in *Section 4: Setting Up MicroTSG* for descriptions of **AutoRun=**, **Go**, **SingleSample=**, **NCycles=**, and **Interval=**.

Polled Sampling Mode

Polled Sampling Mode is in effect when:
- PCB J1 jumper is set to Normal or Autopower, **AutoRun=N**, and sampling is started with **Go** (if **SingleSample=Y**) or with a polled sampling command

Time from end of take sample command to beginning of reply (seconds)
= (**NCycles** * 0.1336) + 0.459

Autonomous Sampling Mode

Autonomous Sampling Mode is in effect when:
- PCB J1 jumper is set to Normal or Autopower, **AutoRun=Y**, and **SingleSample=N**, ***or***
- PCB J1 jumper is set to Normal (pins 2 and 3), **AutoRun=N**, **SingleSample=N**, and sampling is started with **Go**

Time to acquire temperature and conductivity (seconds)
= (**NCycles** * 0.1336) + 0.287

Serial Line Sync Mode

Serial Line Sync Mode is in effect when:
- PCB J1 jumper set to Normal (pins 2 and 3), **AutoRun=Y**, and **SingleSample=Y**

Time from wake-up to beginning of reply (seconds)
= (**NCycles** * 0.1336) + 1.643

Total Sampling Time

Once temperature and conductivity are acquired, the time to calculate the desired parameters is not a function of the mode of operation:
- Time to compute temperature = 8.8 msec
- Time to compute conductivity = 15.4 msec
- Time to compute salinity = 83 msec
- Time to compute sound velocity = 35 msec

Total time required for sample =
time to acquire temperature and conductivity
+ time to compute selected parameters
+ time to transmit computed parameters

Notes:
- The time to transmit computed parameters is dependent on baud rate. See *Baud Rate, Cable Length, Power, and Data Transmission Rate*.
- For autonomous sampling, if the total time required for the sample is greater than the user-input sample interval (**Interval=**), the MicroTSG begins the next sample as soon as it finishes transmitting the current sample.

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

Baud Rate, Cable Length, and Data Transmission Rate

Notes:
- Baud rate is set with **Baud=**.
- Real-time output rate is set with **Interval=**.
- Output format is set with **OutputCond=**, **OutputSal=**, and **OutputSV=**.

See *Command Descriptions* in *Section 4: Setting Up MicroTSG* for command details.

The rate that data can be transmitted from the MicroTSG is dependent on the amount of data to be transmitted per scan and the serial data baud rate:

Time to transmit data =
(number of characters * 10 bits/character) / baud rate

where

Number of characters is dependent on the included data and output format (see *Data Output Format* in *Section 4: Setting Up MicroTSG*). 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. Include decimal points, commas, and spaces when counting the number of characters.

Note that the MicroTSG transmits data **after** it has completed the previous sample and **before** it starts the next sample. See *Sample Timing* above for information on sampling time.

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

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

Example –

What is the minimum transmission time over 100 m of cable with **OutputCond=Y**, **OutputSal=Y**, **OutputSV=Y**, and **OutputFormat=0**?

With 100 meters of cable, the MicroTSG requires a baud rate of 9600 or less.
Number of characters (from *Data Output Format* in *Section 4: Setting Up MicroTSG*) =
8 (T) + 2 (comma & space) + 8 (C) + 2 (comma & space) + 8 (salinity) + 2 (comma & space) + 8 (sound velocity) + 2 (carriage return & line feed) = 40
Time required to transmit data = (40 characters * 10 bits/character) / 9600 = 0.042 seconds = 42 msec

What is the minimum **total** time required per sample (**Interval=**), if averaging 4 measurements/sample (**NCycles=4**) and operating in Autonomous Sampling Mode?

In Autonomous mode, time to acquire T and C (from *Sample Timing* above)
= (**NCycles** * 0.1336) + 0.287 = (4 * 0.1336) + 0.287 = 0.82 seconds
Total sampling time
= time to acquire T and C + time to compute parameters (from *Sample Timing* above) + time to transmit data
= 0.82 + (.0088 + .0154 + .083 + .035) + .042 = 1.00 second
Therefore, set **Interval=1**, transmitting 1 sample every second.

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 IR loss to 1 volt; higher IR loss will prevent the instrument from transmitting real-time data because of the difference in ground potential.
- 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 current times the power common wire resistance is more than 1 volt, because the difference in ground potential of the MicroTSG and ground controller prevents the MicroTSG from transmitting real-time data.

V_{limit} = 1 volt = IR_{limit}
Where I is the current required by the MicroTSG (34 milliamps at 8 VDC; see *Specifications* above).

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

Example – For 18 gauge wire, what is the maximum distance to transmit power to the MicroTSG? If this the controlling factor for maximum cable length if wanting to transmit at 1200 baud?

For 34 milliamp current, $R_{limit} = V_{limit} / I$ = 1 volt / 0.034 amps = 29 ohms
For 18 gauge wire, resistance is 0.0064 ohms/foot.
Therefore, maximum cable length is 29 ohms / 0.0064 ohms/foot = 4531 feet = 1381 meters.
Note that 1381 meters > 800 meters (maximum distance MicroTSG 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 MicroTSGs powered from the same power supply.

$R_{limit} = V_{limit} / I$ = 1 volt / (0.034 amps * 4 MicroTSGs) = 7.35 ohms
Therefore, maximum cable length is 7.35 ohms / 0.0064 ohms/foot = 1148 feet = 350 meters (this is cable length to MicroTSG furthest from power source).

Supplying Enough Power to MicroTSG

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 MicroTSG.

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

MicroTSG'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 MicroTSG.
V = IR 0.5 volts = (.034 amps) * (0.0064 ohms/foot * cable length) Cable length = 2297 ft = 700 meters
Note that 700 meters < 800 meters (maximum distance MicroTSG 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, 14, or 16 gauge) would provide sufficient power at MicroTSG to allow an 800 meter cable length.

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

V = IR 0.5 volts = (.034 amps * 4 MicroTSGs) *(0.0064 ohms/foot * cable length)
Cable length = 574 ft = 175 meters (this is cable length to MicroTSG furthest from power source).

Remote Temperature Sensor (optional)

Notes:
- See the Interface Box manual for operation of the MicroTSG with the Interface Box. The Interface Box can be added to the system at any time, and does not need to be part of the original MicroTSG order.
- Sea-Bird software (Seasave real-time data acquisition and SBE Data Processing's Data Conversion and Derive modules) uses the data from the MicroTSG's temperature and conductivity sensors to calculate salinity, and then uses that salinity with the temperature from the remote temperature sensor to calculate density and sound velocity.

The optional 90402 – SBE 45 Power, Navigation, and Remote Temperature Interface Box can append the output of an optional SBE 38 temperature sensor to the output from the MicroTSG. Often, the MicroTSG is mounted in the interior of the vessel. In this configuration the recorded conductivity is correct, but the water temperature has changed as it has passed through the plumbing system. The remote temperature sensor can be placed in a location that provides more accurate measurement of the sea surface water temperature. **The ideal location for the remote sensor is at the seawater intake (before the pump) near the bow of the ship.** This minimizes contamination of the surface temperature measurement by the ship's own thermal mass.

To compute salinity, always use the data from the temperature sensor on the MicroTSG, not from the remote temperature sensor. Conductivity has a strong thermal coefficient; therefore, it is critical to know the temperature of the water when the conductivity sensor samples it in order to compute salinity correctly. On a typical installation, there may be 20 to 30 meters of plumbing between the remote temperature sensor and the MicroTSG. As the water flows through the pipes it changes temperature dramatically, making the data from the remote temperature sensor an inaccurate representation of the temperature when the water reaches the conductivity sensor. **Use the remote temperature sensor only to report surface temperature, and to calculate density and sound velocity (density and sound velocity are a function of salinity and temperature)**.

Section 3: Installing System

This section provides information on:
- Software installation
- System schematic and installation guidelines
- Power-up mode jumper setting check
- MicroTSG installation

Installing Software

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

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

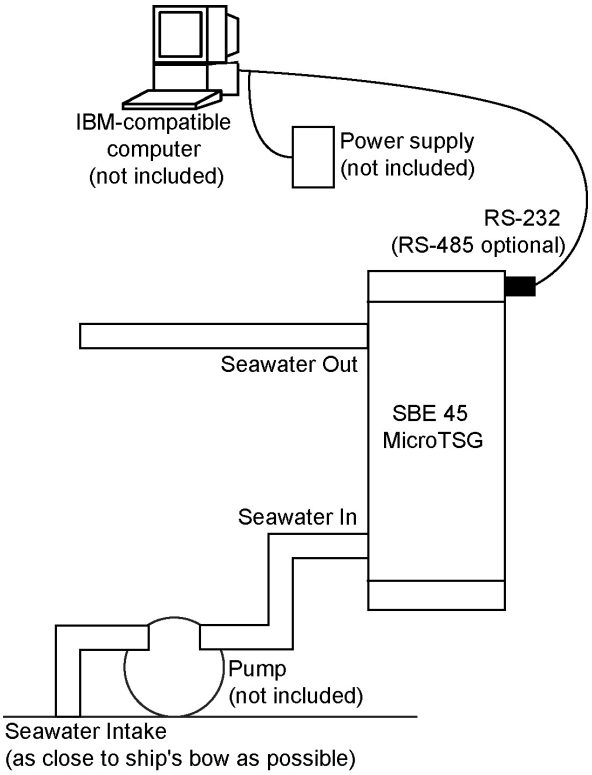
If not already installed, install Sea-Bird software programs on your computer using the supplied software CD.

1. Insert the CD in your CD drive.

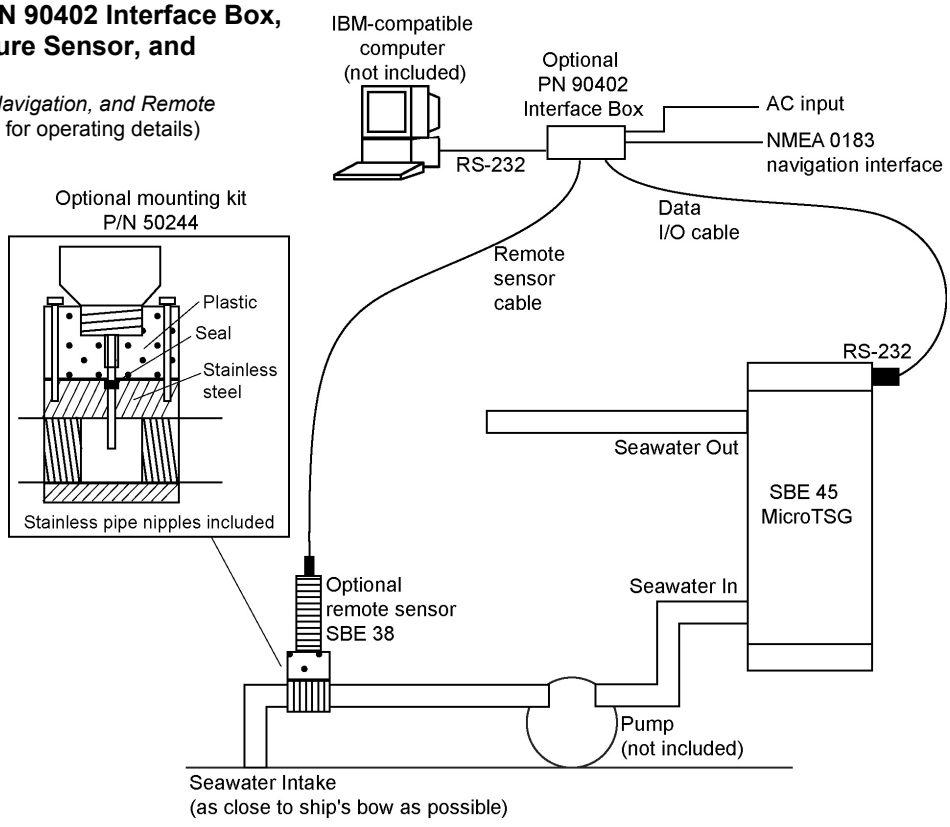
2. Install software: Double click on **SeasoftV2_*date*.exe** (*date* is the date that version of the software was created). Follow the dialog box directions to install the software. The installation program allows you to install the desired components. Install all the components, or just install SEATERM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

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

System Schematic and Installation Guidelines



MicroTSG with Optional PN 90402 Interface Box, SBE 38 Remote Temperature Sensor, and NMEA Navigation Device
(see *PN 90402 – SBE 45 Power, Navigation, and Remote Temperature Interface Box* manual for operating details)



Sea-Bird does not provide detailed installation instructions for the MicroTSG, given the unique nature of every ship and type of installation. The installation of the MicroTSG should be done by qualified shipfitters, with the oversight of a competent ship designer or naval architect. Consider the following:

Note:
The optional Interface Box appends data from the optional SBE 38 remote temperature sensor to the MicroTSG data stream.

- The MicroTSG can be mounted anywhere it will *fit* that is accessible for maintenance and cleaning. **For safety, mount the MicroTSG above the water line.**
  - If the remote temperature sensor is not used, mount the MicroTSG as close to the seawater intake as possible to avoid thermal contamination from long plumbing runs. Thermal contamination will not affect salinity accuracy, but the MicroTSG will report the temperature of the water when it reaches the instrument.
  - If the remote temperature sensor is used, the MicroTSG can be mounted in the ship's lab or other convenient location.
- Sea-Bird does not recommend or supply a pump.
  - The pump must provide 10 to 30 milliliter/second (0.16 to 0.48 gallons/minute) flow.
  - Pressure at the MicroTSG is limited to 34.5 decibars (50 psi).
  - Research vessels often maintain seawater delivery systems for a variety of scientific purposes, including feed to a thermosalinograph. Many vessels use engine raw cooling water. However, because the MicroTSG is designed for a flow rate of 10 to 30 milliliters/second, ensure that most of the coolant flow bypasses the MicroTSG.
  - Pleasure-boat pumps designed for salt water and for below-fluid level (non-priming) may be satisfactory, although their flow rates are much too high (more than 15 gallons/minute). Some method – flow restricting orifice, bypass, etc. – is needed to reduce the flow rate to the required level. Additionally, pleasure-boat pumps are not usually certified for below-waterline use.
- Bubbles in the plumbing of a flow-through system are a common problem and will cause noisy salinity data. To minimize bubbles:
  - Place the pump below the water line to *push* rather than *lift* the water.
  - Locate the MicroTSG's hull intake as deep as possible, as far as possible from bubble sources (bow wake, propeller, etc.).
- Depending on the chosen design of a permanent seawater supply (including pump, intake fitting, pipes, etc.), a de-bubbling device may be needed to separate bubbles from the water before it enters the MicroTSG. Note that a de-bubbler may cause additional temperature errors for the MicroTSG's primary temperature sensor; salinity accuracy (and accuracy of an optional remote temperature sensor) is not affected. Not all ships require de-bubblers, but many do for best quality salinity data. Large single point salinity spikes can be removed with the Wild Edit module in SBE Data Processing.
- Route cabling as cleanly as possible, avoiding sources of noise. Electric motors are a particular problem. Avoid routing the cable next to generators and air conditioners. 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.
- If practical, mount the optional SBE 38 remote temperature sensor outside the hull. However, the SBE 38 is usually mounted in the remote sensor mount kit, which has 1-inch pipe threads on each end; plumb the mount kit into your seawater system. Install the SBE 38 as close to the seawater intake as possible (before the pump), near the bow of the ship. Since the installation is below the water line, consult your ship's engineer / naval architect / shipyard regarding the actual installation. We cannot offer advice in this matter as each ship is different and plumbing regulations vary.

Power-Up Jumper Check

The MicroTSG's Printed Circuit Board (PCB) has a jumper that controls how the MicroTSG wakes up:

- Autopower (default) – The MicroTSG wakes up when power is applied. System capability is dependent on the *external* wiring configuration:
  - Three wires – **This configuration is useful in simple systems where a controller applies power, waits for data, and then removes power**. Only three of the four wires (Power, Ground, and Transmit) are needed for operation, since it is not necessary to command the MicroTSG to take samples. Note that the MicroTSG **does not respond to any commands in this configuration**, so initial setup of the system must be performed with all four wires in place (see *Command Descriptions* in *Section 4: Setting Up MicroTSG*).
  - Four wires – With all four wires (Power, Ground, Receive, and Transmit), the MicroTSG *can* receive and respond to most commands. Note that the MicroTSG does not respond to **QS** in this configuration.

Note:
For a three-wire external wiring configuration, or to use the MicroTSG with the Interface Box, set:
- J1 jumper to Autopower
- **AutoRun=Y**, and
- **SingleSample=N**

See *Section 4: Setting Up MicroTSG*.

- Normal – The MicroTSG wakes up when there is a pulse on the serial interface lines. In this configuration, the MicroTSG can be controlled using the documented commands and can be commanded into a quiescent (sleep) state with **QS**.

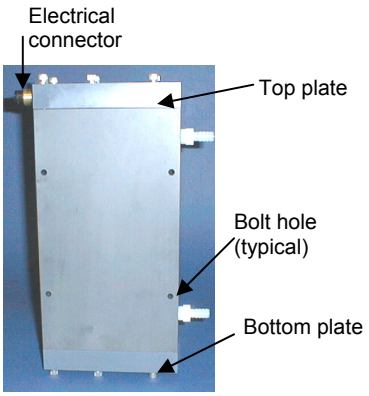
Verify the jumper setting in one of the following ways:

- Check the Configuration Sheet (in the manual) for the factory setting, or

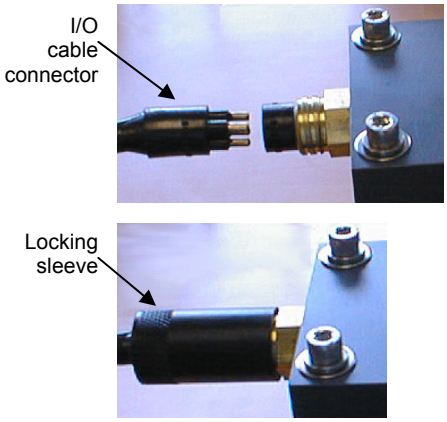
Note:
See *Appendix II: Electronics Disassembly/Reassembly* for details on accessing the PCB to change the jumper setting.

- Connect the MicroTSG to the computer as described in *Communications Test and Setup* in *Section 4: Setting Up MicroTSG*. Set the appropriate communications settings, wake up the MicroTSG with the Connect button on SEATERM's Toolbar, and then enter **QS** after the `S>` prompt. The response indicates whether the jumper is in the Normal or Autopower configuration:
  - Autopower – system returns `S>` prompt, indicating that the MicroTSG is **not** in quiescent (sleep) state.
  - Normal – system does not return `S>` prompt, indicating that the MicroTSG is in quiescent (sleep) state.

Installing MicroTSG



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



1. New MicroTSGs are shipped with an AF24173 Anti-Foulant Device pre-installed. Verify that the Anti-Foulant Device is in the anti-foulant device cup (see *Section 6: Routine Maintenance and Calibration* for access to and replacement of the Anti-Foulant Device).

2. Mount the MicroTSG, with the electrical connector at the top, using the four 1/4-inch bolt holes on the sides. Provide clearance as follows:
   - Bottom — 152 mm (6 inches) clearance for removal of the bottom plate, to allow access for replacing the AF24173 Anti-Foulant Device and cleaning.
   - Top — 305 mm (12 inches) clearance for removal of the top plate, to allow access for removing sensors and electronics.
   - Sides — small clearance by using washers with the mounting hardware, to prevent binding when removing the top or bottom plate.

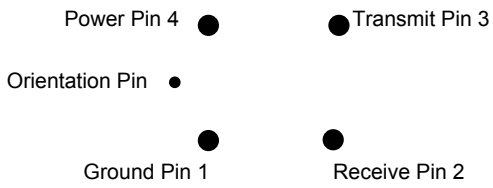
3. Install the I/O cable:
   A. Lightly lubricate the sides of the rubber prongs on the cable connector with silicone grease (DC-4 or equivalent).
   B. Install the cable connector, aligning the long pin with the small hole on the MicroTSG's bulkhead connector.
   C. Place the locking sleeve over the connector. Tighten the sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

4. Install the piping connections to the MicroTSG. The housing is tapped with 3/8-inch U.S. standard NPT threads. Nylon hose barb fittings for 3/8-inch tubing are provided.

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

6. For use **without** optional Interface Box: Connect the MicroTSG to the computer and power supply.

   - Connect the I/O cable connector to your computer's serial port.
   - Connect the I/O cable connector's red (+) and black (-) wires to a power supply (8-30 VDC).



   Ground pin: Computer data common (pin 1)
   Receive pin: RS-232C receive data transmitted from computer (pin 2)
   Transmit pin: RS-232C transmit from MicroTSG to computer (pin 3)
   Power pin: 8-30 VDC (pin 4)

7. For use **with** optional Interface Box: See schematic in *System Schematic and Installation Guidelines* above, and see *PN 90402 – SBE 45 Power, Navigation, and Remote Temperature Interface Box* manual.

Section 4: Setting Up MicroTSG

This section provides information on:

- MicroTSG setup
- Sampling modes and example sets of operation commands
- Timeout description
- Command descriptions
- Data output format
- Setting up configuration (.xmlcon or .con) file for real-time data acquisition and data processing

Communications Test and Setup

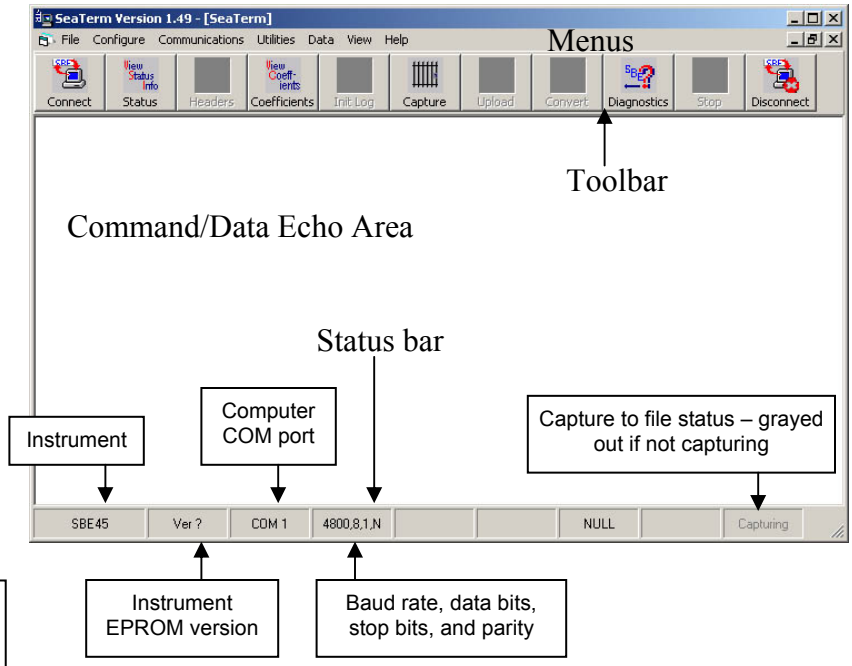
The power and communications test will verify that the system works, prior to deployment.

Note:
See SEATERM's Help files.

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

Select the instrument type (SBE 45) and the computer COM port for communication with the MicroTSG. 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), 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 'awake' for it to respond to a command (use Connect on the Toolbar to wake up the instrument).
- Status bar – Provides status information. To display or hide the Status bar, select View Status bar in the View menu.

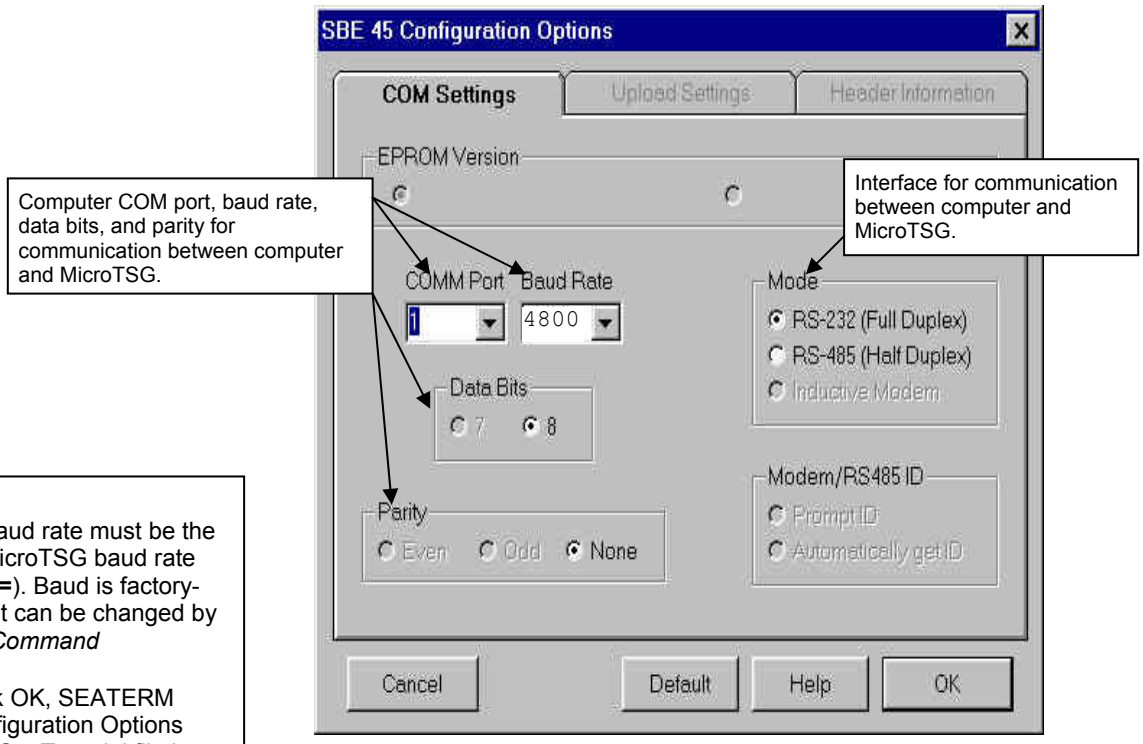
Following are the Toolbar buttons applicable to the MicroTSG:

Toolbar Buttons	Description	Equivalent Command*
Connect	Re-establish communications with MicroTSG. Computer responds with S> prompt.	(press Enter key)
Status	Display instrument status.	**DS**
Coefficients	Display calibration coefficients.	**DC**
Capture	Capture instrument responses on screen to file. File has .cap extension. Click Capture again to turn off capture. Capture status displays in Status bar. As MicroTSG has no internal memory, you must capture before sampling begins to save data for future review and processing.	—
Diagnostics	Perform one or more diagnostic tests on MicroTSG. Diagnostic test(s) accessed in this manner are non-destructive – they do not write over any existing instrument settings.	**DS, DC, TS,** and **TSR**
Disconnect	Free computer COM port used to communicate with MicroTSG. COM port can then be used by another program. Note that MicroTSG must be connected to COM port for data to be obtained.	—

*See *Command Descriptions*.

Note:
.cap file created by SEATERM is not compatible with our post-processing software (SBE Data Processing). Instead of using SEATERM's capture utility, use Seasave (our real-time data acquisition software) to create a .hex file that is compatible with SBE Data Processing (see *Section 5: Operating System*).

3. In the Configure menu, select SBE 45 TSG. The dialog box looks like this:



Note:
- SEATERM's baud rate must be the same as the MicroTSG baud rate (set with **Baud=**). Baud is factory-set to 4800, but can be changed by the user (see *Command Descriptions*).
- 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, 45, 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**: 4800 (documented on Configuration Sheet in manual)
- **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 MicroTSG 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>SBE45 V 1.1b
   S>
   ```

   This shows that correct communications between the computer and MicroTSG has been established. If the system does not respond as shown:
   - Click Connect again.
   - Verify the correct instrument was selected in the Configure menu and the settings were entered correctly in the Configuration Options dialog box.
   - Check cabling between the computer and MicroTSG.

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

   ```
   SBE45 V 1.1b  SERIAL NO. 1258
   not logging data
   sample interval = 30 seconds
   output conductivity with each sample
   do not output salinity with each sample
   do not output sound velocity with each sample
   do not start sampling when power on
   do not power off after taking a single sample
   do not power off after two minutes of inactivity
   A/D cycles to average = 4
   ```

7. Command the MicroTSG to take a sample by typing **TS** and pressing the Enter key. The display looks like this (if *output conductivity with each sample*, *do not output salinity with each sample*, and *do not output sound velocity with each sample* displayed in response to the status command in Step 6) :

   ```
   23.7658, 0.00019
   ```

   where 23.7658 = temperature in degrees Celsius
   0.00019 = conductivity in S/m
   These numbers should be reasonable; i.e., room temperature and zero conductivity.

8. Establish the sampling scheme, after reviewing the information in this section on sampling modes and commands.

9. Command the MicroTSG to go to sleep (quiescent state) by typing **QS** and pressing the Enter key. The response indicates whether the PCB's J1 jumper is in the Normal or Autopower configuration:
   - Autopower – system returns `S>` prompt.
   - Normal – system does not return `S>` prompt.

   If necessary, remove the PCB and move the jumper to the desired pins.

The MicroTSG is ready for deployment.

Notes:
- See *Power-Up Jumper Check* in *Section 3: Installing System* for a description of Autopower and Normal.
- See *Appendix II: Electronics Disassembly/Reassembly* to access the PCB and move the jumper.

Sampling Modes

The MicroTSG has three basic sampling modes for obtaining data: Polled Sampling, Autonomous Sampling, and Serial Line Synchronization Sampling. However, commands and the J1 jumper setting on the MicroTSG's PCB can be used in various combinations to provide a high degree of operating flexibility.

Shown below are descriptions and examples of the three basic sampling modes. Note that the MicroTSG'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.

Note:
After waking the MicroTSG, you may need to press the Enter key several times and send **Stop** to interrupt sampling, depending on how the instrument was set up the last time it was used.

Polled Sampling

On command, the MicroTSG takes one sample of data and sends the data to the computer.

Examples: ***Polled Sampling Mode*** (user input in bold)

Example 1*:* J1 jumper in Normal position (pins 2 and 3).
Wake up MicroTSG. Set up to wait for command each time MicroTSG wakes up, and send salinity with data. Send status command to verify setup. Send power-off command after all parameters are entered. Assuming that power is always applied:

(Click Connect on Toolbar to wake up.)
S>**AUTORUN=N**
S>**OUTPUTSAL=Y**
S>**DS** (to verify setup)
S>**QS**

When ready to take a sample (repeat as desired): wake up MicroTSG, command it to take a sample and output converted data to computer, and send power-off command.

(Before first sample, click Capture on Toolbar to capture data to a file – program requests file name for data to be stored.)
(Click Connect on Toolbar to wake up.)
S>**TS**
S>**QS**

Example 2*:* J1 jumper in Autopower position (pins 1 and 2).
Wake up MicroTSG. Set up to wait for command each time MicroTSG wakes up, and send salinity with data. Send status command to verify setup. Remove power after all parameters are entered.

(Apply power to wake up.)
S>**AUTORUN=N**
S>**OUTPUTSAL=Y**
S>**DS** (to verify setup)
(Remove power.)

When ready to take a sample (repeat as desired): wake up MicroTSG, command it to take a sample and output converted data to computer, and remove power.

(Before first sample, click Capture on Toolbar to capture data to a file – program requests file name for data to be stored.)
(Apply power to wake up.)
S>**TS**
(Remove power.)

Notes:
- After waking the MicroTSG, you may need to press the Enter key several times and send **Stop** to interrupt sampling, depending on how the instrument was set up the last time it was used.
- If using the MicroTSG with the Interface Box, set up the MicroTSG to operate in autonomous sampling mode:
  - J1 jumper in Autopower position (pins 1 and 2)
  - **AutoRun=Y**
  - **SingleSample=N**

Autonomous Sampling

The MicroTSG samples data at pre-programmed intervals, defined by **Interval=**, and sends the data to the computer. The MicroTSG does not enter quiescent (sleep) state between samples.

Examples: ***Autonomous Sampling Mode*** (user input in bold)

Example 1*:* J1 jumper in Normal position (pins 2 and 3)**, AutoRun=Y.**
Set up to take a sample every 20 seconds. Send status command to verify setup. Send power-off command after all parameters are entered. Assuming that power is always applied:

(Click Connect on Toolbar to wake up.)
S>**SINGLESAMPLE=N**
S>**INTERVAL=20**
S>**AUTORUN=Y**
S>**DS** (to verify setup)
S>**QS**

When ready to begin sampling:

(Click Capture on Toolbar to capture data to a file – program requests file name for data to be stored.)
(Click Connect on Toolbar to wake up – sampling begins automatically.)

When ready to stop sampling and go to sleep:

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

Example 2*:* J1 jumper in Normal position (pins 2 and 3)**, AutoRun=N.**
Set up to take a sample every 20 seconds. Send status command to verify setup. Send power-off command after all parameters are entered. Assuming that power is always applied:

(Click Connect on Toolbar to wake up.)
S>**SINGLESAMPLE=N**
S>**INTERVAL=20**
S>**AUTORUN=N**
S>**DS** (to verify setup)
S>**QS**

When ready to begin sampling:

(Click Capture on Toolbar to capture data to a file – program requests file name for data to be stored.)
(Click Connect on Toolbar to wake up.)
S>**GO**

When ready to stop sampling and go to sleep:

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

Example 3*:* J1 jumper in Autopower position (pins 1 and 2).
Set up to take a sample every 20 seconds. Send status command to verify setup. Remove power after all parameters are entered.

(Apply power to wake up.)
S>**SINGLESAMPLE=N**
S>**INTERVAL=20**
S>**AUTORUN=Y**
S>**DS** (to verify setup)
(Remove power.)

When ready to begin sampling:

(Click Capture on Toolbar to capture data to a file – program requests file name for data to be stored)
(Apply power to wake up; sampling begins automatically.)

When ready to stop sampling:

(Remove power.)

To change the setup:

(Apply power to wake up; sampling begins automatically. Press Enter key several times to get S> prompt.)
S>**STOP**
S> (send desired commands)
(Remove power.)

Serial Line Synchronization (Serial Line Sync)

Note:
After waking the MicroTSG, you may need to press the Enter key several times and send **Stop** to interrupt sampling, depending on how the instrument was set up the last time it was used.

In Serial Line Sync Mode, a simple pulse (a single character) on the RS-232 line causes the MicroTSG to wake up, take and output a single sample, and automatically go to sleep (enter quiescent state). This mode is enabled if **AutoRun=Y**, **SingleSample=Y**, and the PCB's J1 jumper is in the Normal position (pins 2 and 3).

Example: ***Serial Line Sync Mode*** (user input in bold)
(J1 jumper in Normal position – pins 2 and 3)

Set up to take a sample upon receipt of any character and then automatically go to sleep. Send status command to verify setup. Send power-off command to MicroTSG after all parameters are entered – system automatically wakes up and goes to sleep for each sample upon receipt of a character. Assuming that power is always applied:

(Click Connect on Toolbar to wake up.)
S>**SINGLESAMPLE=Y**
S>**AUTORUN=Y**
S>**DS** (to verify setup)
S>**QS**

When ready to take a sample (repeat as desired):

(Before first sample, click Capture on Toolbar to capture data to a file – program requests file name for data to be stored)
(Press Enter key to wake up, sample, and go to sleep.)

When ready to stop sampling or change setup:

(Press Enter key several times to get S> prompt)
S>**STOP**
S> (Enter desired commands)
S>**QS**

Timeout Description

The MicroTSG has a timeout algorithm when jumpered in the Normal configuration (PCB J1 pins 2 and 3). If the MicroTSG does not receive a command or sample data for two minutes and **AutoOff=Y**, it powers down its communication circuits. This places the MicroTSG in quiescent state, drawing minimal current. **To re-establish control (wake up), click Connect on the Toolbar or press the Enter key.** The system responds with the S> prompt.

Command Descriptions

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

When entering commands:
- Input commands to the MicroTSG in upper or lower case letters and register commands by pressing the Enter key.
- The MicroTSG 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 in quiescent state, re-establish communications by clicking Connect on the Toolbar or pressing the Enter key to get an `S>` prompt.

Status Command

DS

Display 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
- Logging status - `logging data, not logging data,` or `unknown status`
- Sample interval time [**Interval=**]
- Output conductivity with each sample [**OutputCond=**]?
- Output salinity with each sample [**OutputSal=**]?
- Output sound velocity with each sample [**OutputSV=**]? If yes, sound velocity algorithm [**SVAlgorithm=**].
- Start sampling automatically when power on [**AutoRun=**]?
- Go to sleep after taking single sample [**SingleSample=**]?
- Go to sleep after 2 minutes of inactivity [**AutoOff=**]?
- A/D cycles to average per sample [**NCycles=**]
- Output format (does not appear if **OutputFormat=0**. Shows *conductivity leading space is suppressed* if **OutputFormat=1**; shows *conductivity and salinity order reversed* if **OutputFormat=2**)

Example: (user input in bold)

```
S>DS
SBE45 V 1.1b  SERIAL NO. 1258
not logging data
sample interval = 10 seconds                                    [Interval=]
output conductivity with each sample                            [OutputCond=]
do not output salinity with each sample                         [OutputSal=]
do not output sound velocity with each sample                   [OutputSV= and SVAlgorithm=]
do not start sampling when power on                             [AutoRun=]
do not power off after taking a single sample                   [SingleSample=]
do not power off after two minutes of inactivity                [AutoOff=]
A/D cycles to average = 4                                       [NCycles=]
```

Setup Commands

Notes:
- The MicroTSG's baud rate (set with **Baud=**) must be the same as SEATERM's baud rate (set in the Configure menu).
- The maximum baud rate is dependent on cable length. See *Baud Rate, Cable Length, Power, and Data Transmission Rate* in *Section 2: Description of MicroTSG*.

Baud=x

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

Notes:
- See *Data Output Format*.
- Seasave, SBE Data Processing, and the optional Interface Box are all compatible with any combination of output parameters, if **OutputFormat=0** or **1**.

OutputFormat=x

x=0 (default): Output order is temperature, conductivity, salinity, sound velocity.

x=1: Suppress space before conductivity output.

x=2: Reverse conductivity and salinity order. This is not compatible with Seasave, SBE Data Processing, or optional Interface Box.

OutputCond=x

x=Y (default): calculate and output conductivity (S/m).

x=N: do not.

OutputSal=x

x=Y: calculate and output salinity (psu).

x=N (default): do not.

OutputSV=x

x=Y: calculate and output sound velocity (m/sec). Can be calculated as Chen and Millero or as Wilson; select desired algorithm with **SVAlgorithm=**.

x=N (default): do not.

SVAlgorithm=x

x=C: If **OutputSV=Y**, calculate sound velocity using Chen and Millero formula (UNESCO Technical Papers in Marine Science #44). Default.

x=W: If **OutputSV=Y**, calculate sound velocity using Wilson formula (UNESCO Technical Papers in Marine Science #44).

NCycles=x

x= number of measurements to average per sample (default = 4). Increasing **NCycles=** increases measurement resolution and time required for measurement. See *Sample Timing* in *Section 2: Description of MicroTSG*.

QS

Quit session and place MicroTSG in quiescent (sleep) state. Sampling stops. Applicable only if PCB J1 jumper is in Normal position.

Operating Commands

Operating commands configure the MicroTSG's response upon waking up, and direct the MicroTSG to sample data once or at pre-programmed intervals.

Note:
If the total time required for the sample is greater than **Interval=**, the MicroTSG begins the next sample as soon as it finishes transmitting the current sample.

Interval=x

x= interval (seconds) between samples (maximum 32767 seconds). MicroTSG samples at this interval, and does not enter quiescent (sleep) state between samples. Minimum time between samples determined by **NCycles=**, desired calculated parameters (salinity, etc.), and baud rate; see *Sample Timing* and *Baud Rate, Cable Length, Power, and Data Transmission Rate* in *Section 2: Description of MicroTSG*.

AutoOff=x

(Functional only if J1 jumper on PCB is in Normal position)
x=Y: Go to sleep (enter quiescent state) if 2 minutes have elapsed without receiving a command or without sampling data.

x= N: Do not automatically go to sleep.

AutoRun=x

x=Y or **N**: Interacts with **SingleSample=** and J1 jumper setting, as described in table below.

SingleSample=x

x=Y or **N**: Interacts with **AutoRun=** and J1 jumper setting, as described in table below.

Note:
If the MicroTSG is sampling data and the external voltage is less than 6.15 volts for ten consecutive scans, the MicroTSG halts logging.

Go

Start sampling, as defined by **SingleSample=** and **Interval=**.
Only applicable if:
- **AutoRun=N**, or
- **AutoRun=Y** and you previously sent **Stop** to stop sampling.

Note:
You may need to send **Stop** several times to get the MicroTSG to respond. This is most likely to occur if sampling with a small **Interval=**.

Stop

Stop sampling. Press Enter key to get `S>` prompt before entering **Stop**.

J1 Jumper	AutoRun	SingleSample	Effect
Normal (pins 2 and 3)	**N**	**Y** or **N**	Wake up (when Connect on Toolbar clicked or Enter key pressed while asleep) state and wait for command.
	Y	**N**	Wake up (when Connect on Toolbar clicked or Enter key pressed while asleep) and sample at rate specified by **Interval=**. To stop sampling and get `S>` prompt, type **Stop** and press Enter key.
	Y	**Y**	Wake up (when Connect on Toolbar clicked or Enter key pressed while asleep), take and output single sample, and automatically go to sleep. To wake up and get `S>` prompt, type **Stop** and press Enter key. Referred to as **Serial Line Sync Mode**.
Autopower (pins 1 and 2)	**N**	**Y** or **N**	Wake up when power applied and wait for command.
	Y	**N**	Wake up when power applied and sample at rate specified by **Interval=** until power removed. **Required settings for MicroTSG in 3-wire (power, ground, and transmit) configuration or when using MicroTSG with Interface Box.**
	Y	**Y**	Wake up when power applied and take and output a single sample. Wait for another command until power removed.

Polled Sampling Commands

These commands are used by an external controller to request a sample from the MicroTSG. The MicroTSG stores data for the most recent sample in its RAM. The MicroTSG does not automatically go to sleep after executing these commands. Do not send these commands if the MicroTSG is sampling data at pre-programmed intervals (defined by **Interval=** and **SingleSample=**).

TS	Take sample, hold converted data in RAM, output converted data.
TSR	Take sample, hold raw data (temperature and conductivity only) in RAM, output raw data.
SLT	Send last sample from RAM, output converted data, then take new sample and hold converted data in RAM.
TH	Take sample, hold converted data in RAM.
SH	Send held converted data from RAM.

Testing Commands

TT	Measure temperature 100 times or until Esc key is pressed, output converted data.
TC	Measure conductivity 100 times or until Esc key is pressed, output converted data.
TTR	Measure temperature 100 times or until Esc key is pressed, output raw data.
TCR	Measure conductivity 100 times or until Esc key is pressed, output raw data.

Calibration Coefficients Command

DC Display calibration coefficients.
Equivalent to Coefficients on Toolbar.

Notes:
- See individual Coefficient Commands below for definitions of the data in the example.
- Dates shown are when calibrations were performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with MicroTSGs.

Example: (user input in bold)

```
S>DC
SBE45   V 1.1b   0011
temperature: 08-apr-96
TA0 =  -9.420702e-05
TA1 =   2.937924e-04
TA2 =  -3.739471e-06
TA3 =   1.909551e-07
conductivity: 09-apr-96
G =           -1.036689e+00
H =            1.444342e-01
I =           -3.112137e-04
J =            3.005941e-05
CPCOR =       -9.570001e-08
CTCOR =        3.250000e-06
WBOTC =        1.968100e-05
```

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

Temperature

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

Conductivity

CCalDate=S **S**=Conductivity calibration date.
CG=F **F**=Conductivity G.
CH=F **F**=Conductivity H.
CI=F **F**=Conductivity I.
CJ=F **F**=Conductivity J.
WBOTC=F **F**=Conductivity wbotc.
CTCor=F **F**=Conductivity ctcor.
CPCor=F **F**=Conductivity cpcor.

Data Output Format

Each scan ends with a carriage return <CR> and line feed <LF>. Leading zeros are suppressed, except for one zero to the left of the decimal point. All data is separated with a comma and a space, except as noted.

Notes:
- For **OutputFormat=1**, the space before the conductivity output is eliminated. The remainder of the data format is unchanged from **OutputFormat=0**.
- Seasave, SBE Data Processing, and the optional Interface Box are all compatible with any combination of output parameters, if **OutputFormat=0** or **1**.

The converted output data format is:
- If **OutputFormat=0** (default):
  `ttt.tttt, cc.ccccc, sss.ssss, vvvv.vvv`
- If **OutputFormat=1**:
  `ttt.tttt,cc.ccccc, sss.ssss, vvvv.vvv`
- If **OutputFormat=2**:
  `ttt.tttt, sss.ssss, cc.ccccc, vvvv.vvv`
  Note: **OutputFormat=2** is **not compatible** with Seasave, SBE Data Processing, or the optional Interface Box.

where
t = temperature (degrees Celsius, ITS-90)
c = conductivity (S/m); data sent only if **OutputCond=Y**
s = salinity (psu); data sent only if **OutputSal=Y**
v = sound velocity (meters/second), calculated by Chen-Millero (if **SVAlgorithm=C**) or Wilson (if **SVAlgorithm=W**) equation; data sent only if **OutputSV=Y**

Example 1: Sample data output when **OutputFormat=0**, **OutputCond=Y**, **OutputSal=N**, and **OutputSV=N**:
`23.7658, 0.00019`
(temperature, conductivity)

Example 2: Sample data output when **OutputFormat=1**, **OutputCond=Y**, **OutputSal=N**, and **OutputSV=N**:
`23.7658,0.00019`
(temperature,conductivity)

Setting Up Configuration (.xmlcon or .con) File

Notes:
- Seasave and SBE Data Processing versions 7.20a introduced .xmlcon files (in XML format). Versions 7.20a and later allow you to open a .con or .xmlcon file, and to save t to a .con or .xmlcon file. Seasave and SBE Data Processing use the same file.
- A new or recalibrated instrument ships with a configuration file that reflects the current configuration *as we know it*. The file is named with the instrument serial number, followed by a .con extension. For example, for an instrument with serial number 2375, Sea-Bird names the file *2375.con*. You may rename the file (but not the extension) if desired; this will not affect the results.

Seasave and SBE Data Processing, our real-time data acquisition and data processing software (respectively), require a configuration file. The configuration file defines the MicroTSG – which parameters are output by the MicroTSG, and the data output rate - and indicates whether NMEA and SBE 38 data is to be appended to the data stream. The software uses the configuration file to interpret and process the data. **If the configuration file does not match the actual instrument configuration, the software will not be able to interpret and process the data correctly.**

To verify the contents of the .xmlcon or .con file:

1. Double click on Seasave.exe.

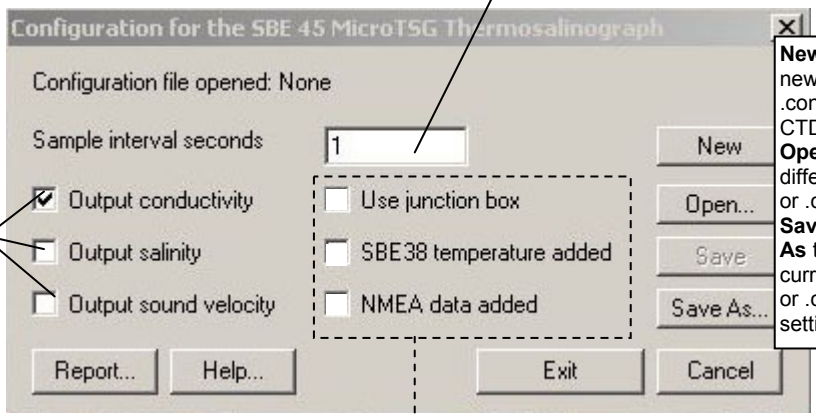
2. Click Configure Inputs. On the Instrument Configuration tab, click *Open*. In the dialog box, select the .xmlcon or .con file and click Open.

3. The configuration information appears on the Instrument Configuration tab. Verify the output matches the output programmed into the SBE 45, and the use of the optional Interface Box, SBE 38, and NMEA matches your system. Click Modify to bring up a dialog box (shown below) to change the configuration.

Time between scans. Must agree with MicroTSG setup (**Interval=**); see reply from **DS**.

Define data in MicroTSG data stream:
- *Output conductivity* with each scan - Must agree with MicroTSG setup (**OutputCond=**).
- *Output salinity* with each scan – Must agree with MicroTSG setup (**OutputSal=**).
- *Output sound velocity* with each scan – Must agree with MicroTSG setup (**OutputSV=**).

See reply from **DS** for setup programmed into MicroTSG.



New to create new .xmlcon or .con file for this CTD.
Open to select different .xmlcon or .con file.
Save or **Save As** to save current .xmlcon or .con file settings.

- *Use junction box* – Select if MicroTSG data transmitted to computer through Interface Box.
- *SBE 38 temperature added* – only applicable if *Use junction box* is selected. Select if Interface Box connected to SBE 38 remote temperature sensor. If selected, Seasave and SBE Data Processing (Data Conversion and Derive modules) use remote temperature data when calculating density and sound velocity.
- *NMEA data added* – only applicable if *Use junction box* is selected. Select if Interface Box connected to a NMEA navigation device. Seasave automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in Seasave's Configure menu to control how Lat/Lon data is incorporated.

See *PN 90402 – SBE 45 Power, Navigation, and Remote Temperatue Interface Box* manual.

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

Section 5: Operating System

Note:
For acquiring data in Seasave, the MicroTSG must be set up for autonomous sampling (**SingleSample=N**).

This section covers acquiring real-time data with Seasave, and processing data with SBE Data Processing.

- Seasave saves the data in the format – data format and header information – that is required by SBE Data Processing. If you use other software to acquire data, the data will not be in the format required by SBE Data Processing.

If using the MicroTSG with PN 90402 - SBE 45 Power, Navigation, and Remote Temperature Interface Box, see the Interface Box manual for operating the system.

Acquiring Real-Time Data with Seasave

Note:
See Seasave's manual and/or help files.

1. Turn on power to the MicroTSG.
   - If the MicroTSG is set to **AutoRun=Y** and the J1 jumper is in the Autopower position (start sampling automatically when power is turned on): MicroTSG will start sampling and transmitting data to the computer. Note that the data will not appear in Seasave until you tell Seasave to start real-time data acquisition in Step 7.
   - If the MicroTSG is set to **AutoRun=N** or the J1 jumper is in the Normal position: Run SEATERM, click SEATERM's Connect button, command the MicroTSG to start sampling (**Go**), click SEATERM's Disconnect button, and then close SEATERM.

   See *Section 4: Setting Up MicroTSG*.

2. Double click on Seasave.exe.

Note:
The baud rate between the MicroTSG and computer (defined in Configure Inputs, on the Serial Ports tab) must agree with the baud rate programmed into the MicroTSG with **Baud=**.

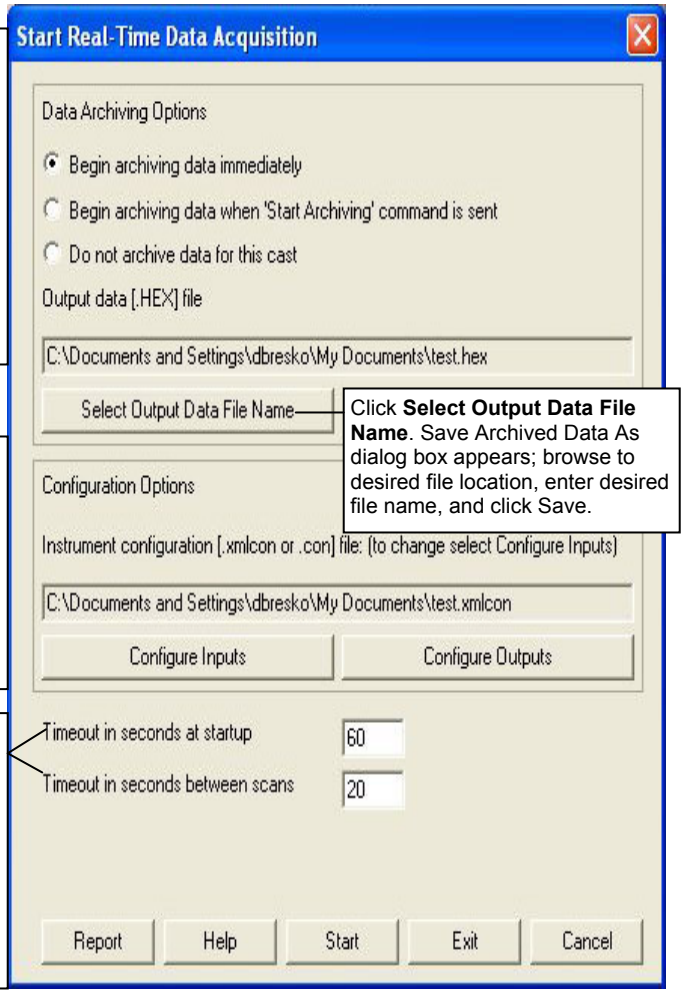
3. Perform any desired setup in the Configure Inputs, Configure Outputs, and Display menus.

4. In the RealTime Data menu, select *Start Acquisition*. The dialog box looks like this:

Data Archiving Options:
- **Begin archiving data immediately** to store raw (frequencies, A/D counts, and/or voltages) real-time data as soon as Start button is clicked and communication is established.
- **Begin archiving data when 'Start Archiving' command is sent** to control when data begins to be written to file. If you make this selection, when you click Start button and communication is established, a dialog box with Start Archiving button appears. Click this button when ready to begin saving scans to file, or select Start Archiving in Real-Time Data menu.
- **Do not archive data for this cast** to not save data to a file. Real-time data will still appear in displays.

Configuration Options: Currently selected instrument configuration (.xmlcon or .con) file is shown, containing information on output from MicroTSG, use of Interface Box, and inclusion of NMEA and SBE 38 data with output from MicroTSG. To modify input configuration (xmlcon or .con file, serial ports, TCP/IP ports, and/or miscellaneous), click Configure Inputs. To modify outputs (serial data output, serial ports shared file output, mark variables, TCP/IP output, TCP/IP ports, SBE 14 remote display, header form, and/or diagnostics), click Configure Outputs.

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



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

5. In the Start Real-Time Data Acquisition dialog box, click *Start*.
   A. If you selected *Begin archiving data immediately* or *Begin archiving data when 'Start Archiving' command is sent* above, and selected *Prompt for Header Information* in the Header Form setup (Configure Outputs), the Header Information dialog box appears. Fill in the desired header and click OK.
   B. If you selected *Check Scan Length* in the Options menu, Seasave checks the configuration (.xmlcon or .con) file to verify that the scan length defined by the configuration file matches the MicroTSG (i.e., number of sensors and inclusion of NMEA is as defined in the file). If a *Scan length error* appears, verify that:
      - You are using the correct .xmlcon or .con configuration file.
      - The configuration file has been updated as necessary if you added or deleted outputs, added or deleted Interface Box, etc.
   C. Seasave sends a message: *Waiting for data . . .* Seasave will *time out* if data is not received within *Timeout in seconds at startup*.
   D. Real-time data then starts appearing in the screen display(s).

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

7. Stop the MicroTSG sampling by turning off power.

Processing Data

Process the data in SBE Data Processing.

Note:
See the SBE Data Processing manual and/or Help files.

1. Convert the .hex data file created by Seasave to a .cnv file in SBE Data Processing's Data Conversion module.

2. Once the data is converted, it can be further processed and plotted in SBE Data Processing's other modules.

Editing .hex Data File

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

Note:
Although we provide this technique for editing a .hex file, **Sea-Bird's strong recommendation, as described above, is to always convert the .hex data file and then edit the converted (.cnv) file.**

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

1. **Make a back-up copy of your .hex data file before you begin.**
2. Run **WordPad**.
3. In the File menu, select Open. In the Open dialog box: for *Files of type*, select *All Documents (*.*)*. Browse to the desired .hex file and click Open.
4. Edit the file as desired, **inserting any new header lines after the System Upload Time line**. Note that all header lines must begin with an asterisk (*), and *END* indicates the end of the header. An example is shown below (for an SBE 21 data file), with the added lines in bold:

```
* Sea-Bird SBE 21 Data File:
* FileName = C:\Odis\SAT2-ODIS\oct14-19\oc15_99.hex
* Software Version Seasave Win32 v1.10
* Temperature SN = 2366
* Conductivity SN = 2366
* System UpLoad Time = Oct 15 1999  10:57:19
* Testing adding header lines
* Must start with an asterisk
* Place anywhere between System Upload Time & END of header
* NMEA Latitude = 30 59.70 N
* NMEA Longitude = 081 37.93 W
* NMEA UTC (Time) = Oct 15 1999  10:57:19
* Store Lat/Lon Data = Append to Every Scan and Append to .NAV
File When <Ctrl F7> is Pressed
** Ship:       Sea-Bird
** Cruise:     Sea-Bird Header Test
** Station:
** Latitude:
** Longitude:
*END*
```

5. In the File menu, select Save (**not** Save As). If you are running Windows 2000, the following message displays:

   ```
   You are about to save the document in a Text-Only format,
   which will remove all formatting. Are you sure you want to
   do this?
   ```

   Ignore the message and click *Yes*.
6. In the File menu, select Exit.

Section 6: Routine Maintenance and Calibration

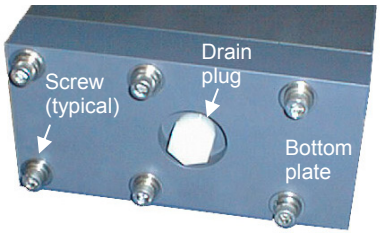
This section reviews corrosion precautions, conductivity cell cleaning and storage, replacement of the Anti-Foulant Device, and sensor calibration. The accuracy of the MicroTSG is sustained by the care and calibration of the sensors and by establishing proper handling practices.

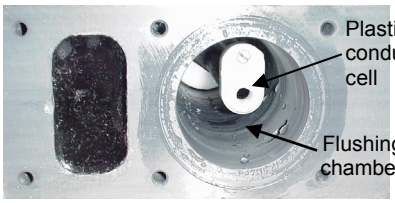
Corrosion Precautions

All hardware exposed to seawater is titanium; the housing is plastic. No corrosion precautions are required. The MicroTSG should be cleaned after use and prior to storage, as described in *Cleaning and Storage*.

Cleaning and Storage

CAUTION:
The MicroTSG's conductivity cell is shipped dry to prevent freezing in shipping. **Do not store the MicroTSG with water in the conductivity cell.** Freezing temperatures (for example, in Arctic environments or during air shipment) can break the cell if it is full of water.





CAUTION:
- **Do not put a brush or any object inside the cell.**
- **Do not spray any solutions directly into the open end of the cell.**

If fouling remains in the conductivity cell after these procedures, return the MicroTSG to Sea-Bird for internal cleaning and recalibration.

Clean the MicroTSG and conductivity cell:
- Monthly (during sustained use)
- Before periods of non-use – If the cell is not rinsed between usage, salt crystals may form on the platinized electrode surfaces. When the instrument is used next, sensor accuracy may be temporarily affected until these crystals dissolve.
- If the data looks incorrect –
  - Unusually *noisy* data may be caused by debris going through the cell.
  - Unusually *smooth* data may be caused by a blockage in the flow path or in the cell.
  - Shifted data may be caused by fouling inside the cell.

Follow this cleaning procedure:

Step 1: Clean Out Drain

A. Keeping the MicroTSG in an upright position, remove the drain plug from the housing's bottom plate.
B. Allow any water to drain out and remove any sediment or debris from the drain.

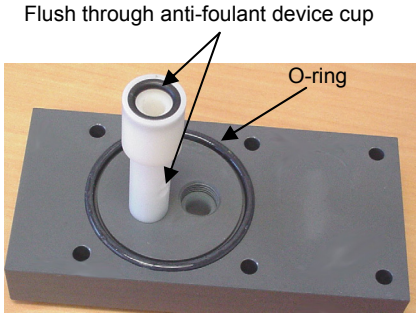
Step 2: Inspect and Clean Flushing Chamber

A. Remove the bottom plate:
   i. Remove the six 1/4-inch socket head screws, lock washers, and flat washers securing the plate to the housing body. Hold the bottom plate as you remove the hardware, to prevent the plate from falling.
   ii. Pull the bottom plate straight down from the housing body, being careful not to damage the conductivity cell, which sits in the housing.
B. Use a flashlight to inspect the flushing chamber and conductivity cell for debris or fine deposits. If this is a routine monthly maintenance, and there is no evidence of debris or fine deposits, proceed to *Step 4: Clean Bottom Plate Assembly*.
C. Gently spray fresh water up into the chamber to remove any fine deposits inside the housing. Be careful not to hit the conductivity cell with the spray hose.

Step 3: Flush Inside of Conductivity Cell

A. Remove the external plumbing connecting the seawater intake and drain lines to the MicroTSG.
B. Clean the inside of the conductivity cell with a series of slow back flushes into the **OUT** port (reverse of the normal operation flow). Collect the drainage in a bucket held below the open housing:
   - **Refer to *Application Note 2D: Instructions for Care and Cleaning of Conductivity Cells* for conductivity cell cleaning materials and concentrations.**
   - The Active Use (after each cast) section of the application note is not applicable to the MicroTSG.
C. If the MicroTSG is being stored, gently blow-dry the conductivity cell and flushing chamber. **Do not use compressed air**, which typically contains oil vapor.
D. Reinstall the external plumbing connecting the seawater intake and drain lines to the MicroTSG.

Step 4: Clean Bottom Plate Assembly



A. Remove the O-ring on the bottom plate. Put the O-ring aside, being careful to protect it from damage or contamination.
B. Flush the anti-foulant device cup on the bottom plate with fresh water, to remove any debris or fine deposits. See *Replacing Anti-Foulant Device* for details on touching or handling the AF24173 Anti-Foulant Device.
C. Rinse the bottom plate with fresh water.
D. Remove water from the O-ring and the bottom plate with a lint-free cloth or tissue.
E. 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-ring and mating surfaces.
F. Replace the O-ring on the bottom plate.

Note:
Early versions of the SBE 45 had a rectangular o-ring in addition to the round o-ring on the bottom plate; see the photo in *Replacing Anti-Foulant Device (SBE 45)*.

Step 5: Reinstall Bottom Plate

A. Align the bottom plate with the housing body, ensuring the end of the anti-foulant device cup is aligned with the conductivity cell. Slowly position the bottom plate on the housing.
B. Re-secure the bottom plate to the housing body with the six 1/4-inch socket head screws, lock washers, and flat washers.
C. Reinstall the drain plug in the bottom plate.

CAUTION:
- If you remove sensors and electronics from the housing to troubleshoot, **avoid getting anything on the PCB**, which can be damaged by water or other materials. See *Appendix II: Electronics Disassembly/ Reassembly*.
- **Do not put any object inside the conductivity cell to clean it.** Return the MicroTSG to Sea-Bird for internal cleaning and recalibration.

If the data still looks incorrect after cleaning, it may be caused by:
- a problem with the electrical connections
- a problem with the PCB
- internal fouling in the conductivity cell that was not removed by flushing
- sensors that need to be recalibrated

Replacing Anti-Foulant Device (SBE 45)

AF24173
Anti-Foulant
Device

The MicroTSG has an anti-foulant device cup inside the housing. New MicroTSGs are shipped with an Anti-Foulant Device pre-installed in the cup.

Anti-Foulant Devices are sold packaged in pairs. The second device should be retained as a spare; reseal in its original plastic bag and store in a cool location.

WARNING!

AF24173 Anti-Foulant Devices contain bis(tributyltin) oxide. Handle the devices only with rubber or latex gloves. Wear eye protection. Wash with soap and water after handling.

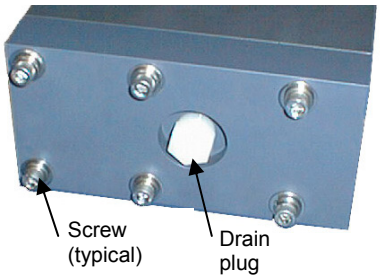
Read precautionary information on product label (see Appendix IV) before proceeding.

It is a violation of US Federal Law to use this product in a manner inconsistent with its labeling.

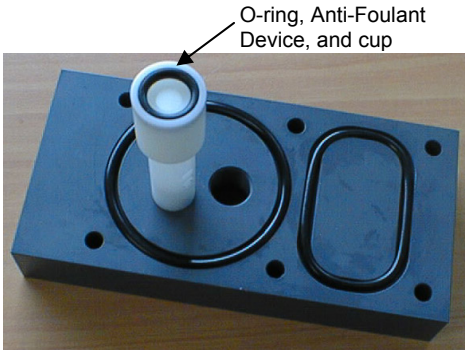
Wearing rubber or latex gloves, follow this procedure:

1. Keeping the MicroTSG in an upright position, remove the drain plug from the housing's bottom plate. Allow any water to drain out and remove any sediment or debris from the drain before proceeding.

2. Remove the bottom plate:
   A. Remove the six 1/4-inch socket head screws, lock washers, and flat washers securing the bottom plate to the housing body. Hold the bottom plate as you remove the hardware, to prevent it from falling.
   B. Pull the bottom plate straight down from the housing body, being careful not to damage the conductivity cell, which sits in the housing at the end of the anti-foulant device cup.



3. Remove the Anti-Foulant Device:
   A. Place the bottom plate on a horizontal surface. Remove the small O-ring securing the Anti-Foulant Device in the anti-foulant device cup.
   B. Remove the old Anti-Foulant Device. If it is difficult to remove, use needle-nose pliers and carefully break up the material.



4. Clean the bottom plate assembly:
   A. Remove the two O-rings on the bottom plate. Put the O-rings aside, being careful to protect them from damage or contamination.
   B. Rinse the bottom plate and flush the inside of the anti-foulant device cup and post with fresh water to remove sediment or debris.
   C. Remove water from the O-rings and the bottom plate with a lint-free cloth or tissue.
   D. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to the O-rings and mating surfaces.
   E. Replace the O-rings on the bottom plate.

5. Place the new Anti-Foulant Device in the cup, and replace the O-ring.

6. Reinstall the bottom plate:
   A. Align the bottom plate with the housing body, ensuring the end of the Anti-Foulant Device cup is aligned with the conductivity cell. Slowly position the bottom plate on the housing.
   B. Re-secure the bottom plate to the housing body with the six 1/4-inch socket head screws, lock washers, and flat washers.
   C. Reinstall the drain plug in the bottom plate.

Sensor Calibration

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

We recommend that MicroTSGs be returned to Sea-Bird for calibration.

Note:
Do not disassemble the MicroTSG to send the sensors to Sea-Bird for recalibration. Package the entire MicroTSG for shipment, after removing the AF24173 Anti-Foulant Device (see *Replacing Anti-Foulant Device*). Store the AF24173 Anti-Foulant Device for future use.

Conductivity Sensor Calibration

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

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

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

Temperature Sensor Calibration

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

Section 7: Troubleshooting

Note:
See the *PN 90402 – SBE 45 Power, Navigation, and Remote Temperature Interface Box* manual for additional troubleshooting steps when interfacing with the Box.

This section reviews common problems in operating the MicroTSG, and provides the most common causes and solutions.

Problem 1: Unable to Communicate with MicroTSG

The S> prompt indicates that communications between the MicroTSG 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 MicroTSG and computer (or optional Interface Box) for a loose connection.

Cause/Solution 2: The instrument type and/or its communication settings may not have been entered correctly in SEATERM. Select the SBE 45 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. Verify the cable is the correct one.

Problem 2: Nonsense or Unreasonable Data

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

Cause/Solution 1: A data file with nonsense values may be caused by incorrect instrument configuration in the .xmlcon or .con file. Verify the settings in the configuration file match your system.

Cause/Solution 2: Unreasonable values may be caused by incorrect calibration coefficients programmed into the MicroTSG. Verify the coefficients match the instrument Calibration Certificates, using **DC**.

Problem 3: Salinity Lower than Expected

Cause/Solution 1: A fouled conductivity cell will report lower than correct salinity. Large errors in salinity indicate that the cell is extremely dirty, has something large lodged in it, or is broken. Proceed as follows:

1. Clean the conductivity cell as described in *Cleaning and Storage* in *Section 6: Routine Maintenance and Calibration*.
2. Remove larger droplets of water by blowing through the conductivity cell. **Do not use compressed air**, which typically contains oil vapor.
3. Running the MicroTSG in air, use **TSR** to look at the raw conductivity frequency. It should be within 1 Hz of the zero conductivity value printed on the conductivity cell Calibration Sheet. If it is significantly different, the cell is probably damaged.

Glossary

Fouling – Biological growth in the conductivity cell during deployment.

PN 90402 - SBE 45 Power, Navigation, and Remote Temperature Interface Box – Optional Box provides:
- Power and an opto-isolated RS-232C interface for the MicroTSG
- An opto-isolated NMEA receiver for a NMEA navigation device (NMEA navigation device not supplied by Sea-Bird)
- Power and an RS-232C interface for an SBE 38 remote temperature sensor
- An RS-232 computer interface

PCB – Printed Circuit Board.

Scan – One data sample containing temperature and conductivity, as well as derived variables (salinity and sound velocity).

SBE 45 MicroTSG – High-accuracy conductivity and temperature monitor.

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

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

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

SEATERM – Sea-Bird's Win 95/98/NT/2000/XP terminal program used to communicate with the MicroTSG. SEATERM can send commands to the MicroTSG to provide status display, data acquisition setup, data display and capture, and diagnostic tests.

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

TCXO – Temperature Compensated Crystal Oscillator.

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

Appendix I: Functional Description

Sensors

The MicroTSG embodies the same sensor elements (3-electrode, 2-terminal, borosilicate glass cell, and pressure-protected thermistor) previously employed in Sea-Bird's modular SBE 3 and SBE 4 sensors, in the SEACAT and SEACAT *plus* family, and in the SBE 37 MicroCAT family.

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.

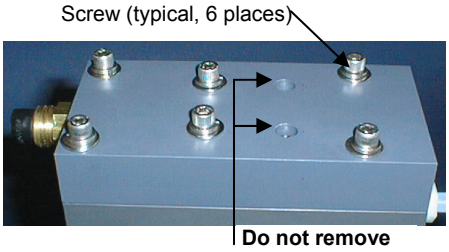
Conductivity is acquired using an ultra-precision Wein Bridge oscillator to generate a frequency output in response to changes in conductivity. A high stability TCXO reference crystal with a drift rate of less than 2 ppm/year is used to count the frequency from the Wein Bridge oscillator.

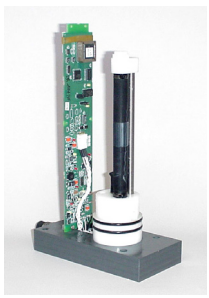
Appendix II: Electronics Disassembly/Reassembly

Note:
Do not disassemble the MicroTSG to send the sensors or PCB to Sea-Bird for recalibration or repair. Package the entire MicroTSG for shipment, after removing the AF24173 Anti-Foulant Device (see *Section 6: Routine Maintenance and Calibration*).

Do not disassemble the MicroTSG electronics unless:
- moving the J1 jumper on the PCB to change operation from Autopower (default) to Normal, or vice versa, or
- troubleshooting a problem, requiring access to the PCB or sensors

Disassembly





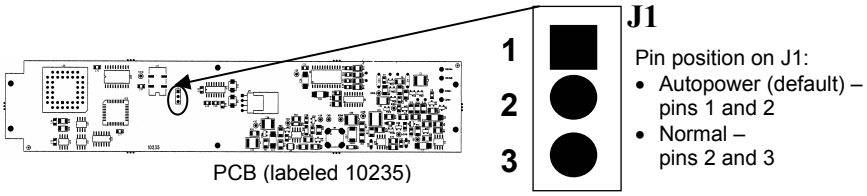
CAUTION:
Avoid getting anything on the PCB, which can be damaged by water or other materials.

1. Remove the six 1/4-inch socket head screws, lock washers, and flat washers securing the top plate to the housing body. **Do not remove the two screws that are recessed in the top plate – these secure the electronics to the top plate**.

2. Remove the top plate by pulling up on it firmly and steadily. It may be necessary to **slightly** twist the top plate back and forth to loosen the o-ring seals. Lift the top plate vertically off the housing body, **being careful not to hit the conductivity cell on the housing body.**

3. Remove any water from the O-ring mating surfaces on the top plate assembly and on the housing with a lint-free cloth or tissue.

4. If applicable, verify/change J1 jumper setting.



Pin position on J1:
- Autopower (default) – pins 1 and 2
- Normal – pins 2 and 3

Reassembly

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

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

2. Align the top plate with the housing body, with the conductivity cell's round end cap aligned with the round opening in the housing body. Slowly lower the top plate, checking that it remains aligned with the housing body. You will feel resistance as the O-rings on the sensor end cap enter the housing.

3. Re-secure the top plate to the housing body with the six 1/4-inch socket head screws, lock washers, and flat washers.

Appendix III: Command Summary

CATEGORY	COMMAND	DESCRIPTION
Status	**DS**	Display status.
Setup	**Baud=x**	**x=** baud rate (1200, 2400, 4800, 9600, 19200, or 38400). Default 4800.
	OutputFormat=x	**x=0** (default): Output order is temperature, conductivity, salinity, sound velocity. **x=1**: Suppress space before conductivity output. **x=2**: Reverse conductivity and salinity order (not for use with Seasave, SBE Data Processing, or optional Interface Box).
	OutputCond=x	**x=Y** (default): Output conductivity (S/m) with data. **x=N**: Do not.
	OutputSal=x	**x=Y**: Output salinity (psu) with data. **x=N** (default): Do not.
	OutputSV=x	**x=Y**: Output sound velocity (m/sec) with data, calculated as defined by **SVAlgorithm=**. **x=N** (default): Do not.
	SVAlgorithm=x	**x=C** (default): Calculate sound velocity as Chen and Millero. **x=W**: Calculate sound velocity as Wilson.
	NCycles=x	**x** = A/D cycles to average per sample (default=4).
	QS	Quit session and place MicroTSG in quiescent (sleep) state. Sampling stops. Applicable only if PCB J1 jumper in Normal position.
Operating PCB's J1 jumper interacts with these commands: • Autopower – pins 1 and 2 • Normal – pins 2 and 3	**Interval=x**	**x=** interval (seconds) between samples (maximum 32767). Minimum time between samples determined by **NCycles=**, desired parameters (salinity, etc.), and baud rate.
	AutoOff=x	**(Functional only if J1 jumper in Normal position)** **x=Y**: Go to sleep (enter quiescent state) if 2 minutes have elapsed without receiving a command or without sampling data. **x=N**: Do not automatically go to sleep.
	J1 jumper - Normal **AutoRun=N** **SingleSample=** **Y** or **N**	Wake up when Connect on Toolbar clicked or Enter key pressed while in quiescent (sleep) state, wait for a command.
	J1 jumper - Normal **AutoRun=Y** **SingleSample=N**	Wake up when Connect on Toolbar clicked or Enter key pressed while in quiescent (sleep) state, sample at rate specified by **Interval=**. To stop sampling and get `S>` prompt, type **Stop** and press Enter key.
	J1 jumper - Normal **AutoRun=Y** **SingleSample=Y**	Wake up when Connect on Toolbar clicked or Enter key pressed while in quiescent (sleep) state, take and output a single sample, automatically go to sleep. To wake up and get `S>` prompt, type **Stop** and press Enter key.
	J1 jumper - Autopower **AutoRun=N** **SingleSample=Y** or **N**	Wake up when power applied, wait for a command.
	J1 jumper - Autopower **AutoRun=Y** **SingleSample=N**	Wake up when power applied, sample at rate specified by **Interval=** until power removed. **Required settings for running MicroTSG in 3-wire (power, ground, transmit) configuration or with Interface Box**.
	J1 jumper - Autopower **AutoRun=Y** **SingleSample=Y**	Wake up when power applied, take and output a single sample. Wait for another command until power removed.
	Go	Start sampling, as defined by **SingleSample=** and **Interval=**. Applicable if **AutoRun=N**, or **AutoRun=Y** and you previously sent **Stop** to stop sampling.
	Stop	Stop sampling.

CATEGORY	COMMAND	DESCRIPTION
Polled Sampling Do not send these commands if MicroTSG is sampling data at pre-programmed intervals.	**TS**	Take sample, hold converted data in RAM, output converted data
	TSR	Take sample, hold raw data in RAM, output raw data.
	SLT	Send converted data from last sample in RAM, then take new sample and hold converted data in RAM.
	TH	Take sample, hold converted data in RAM.
	SH	Send held converted data from RAM.
Testing	**TT**	Measure temperature 100 times or until Esc key is pressed, output converted data.
	TC	Measure conductivity 100 times or until Esc key is pressed, output converted data.
	TTR	Measure temperature 100 times or until Esc key is pressed, output raw data
	TCR	Measure conductivity 100 times 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 MicroTSGs.	**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	**S**=Temperature calibration date.
	TA0=F	**F**=Temperature A0.
	TA1=F	**F**=Temperature A1.
	TA2=F	**F**=Temperature A2.
	TA3=F	**F**=Temperature A3.
	CCalDate=S	**S**=Conductivity calibration date.
	CG=F	**F**=Conductivity G.
	CH=F	**F**=Conductivity H.
	CI=F	**F**=Conductivity I.
	CJ=F	**F**=Conductivity J.
	WBOTC=F	**F**=Conductivity wbotc.
	CTCor=F	**F**=Conductivity ctcor.
	CPCor=F	**F**=Conductivity cpcor.

Appendix IV: AF24173 Anti-Foulant Device

AF24173 Anti-Foulant Devices supplied for user replacement are supplied in polyethylene bags displaying the following label:

AF24173 ANTI-FOULANT DEVICE

FOR USE ONLY IN SEA-BIRD ELECTRONICS' CONDUCTIVITY SENSORS TO CONTROL THE GROWTH OF AQUATIC ORGANISMS WITHIN ELECTRONIC CONDUCTIVITY SENSORS.

ACTIVE INGREDIENT:

Bis(tributyltin) oxide……..……....	53.0%
OTHER INGREDIENTS: …….....	47.0%
Total…….....	100.0%

DANGER

See the complete label within the Conductivity Instrument Manual for Additional Precautionary Statements and Information on the Handling, Storage, and Disposal of this Product.

Net Contents: Two anti-foulant devices

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

EPA Registration No. 74489-1
EPA Establishment No. 74489-WA-1

AF24173 Anti-Foulant Device

FOR USE ONLY IN SEA-BIRD ELECTRONICS' CONDUCTIVITY SENSORS TO CONTROL THE GROWTH OF AQUATIC ORGANISMS WITHIN ELECTRONIC CONDUCTIVITY SENSORS.

ACTIVE INGREDIENT:
Bis(tributyltin) oxide……..……..... 53.0%
OTHER INGREDIENTS: ……..... 47.0%
Total……..... 100.0%

DANGER
See Precautionary Statements for additional information.

FIRST AID	
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for15-20 minutes. • Call a poison control center or doctor for treatment advice.
If swallowed	• Call poison control center or doctor immediately for treatment advice. • Have person drink several glasses of water. • Do not induce vomiting. • Do not give anything by mouth to an unconscious person.
If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
HOT LINE NUMBER	
Note to Physician	Probable mucosal damage may contraindicate the use of gastric lavage.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For further information call National Pesticide Telecommunications Network (NPTN) at 1-800-858-7378.	

Net Contents: Two anti-foulant devices

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

EPA Registration No. 74489-1
EPA Establishment No. 74489-WA-1

PRECAUTIONARY STATEMENTS

HAZARD TO HUMANS AND DOMESTIC ANIMALS

DANGER

Corrosive - Causes irreversible eye damage and skin burns. Harmful if swallowed. Harmful if absorbed through the skin or inhaled. Prolonged or frequently repeated contact may cause allergic reactions in some individuals. Wash thoroughly with soap and water after handling.

PERSONAL PROTECTIVE EQUIPMENT

USER SAFETY RECOMMENDATIONS

Users should:

- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Wear protective gloves (rubber or latex), goggles or other eye protection, and clothing to minimize contact.
- Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.
- Wash hands with soap and water before eating, drinking, chewing gum, using tobacco or using the toilet.

ENVIRONMENTAL HAZARDS

Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of EPA. This material is toxic to fish. Do not contaminate water when cleaning equipment or disposing of equipment washwaters.

PHYSICAL OR CHEMICAL HAZARDS

Do not use or store near heat or open flame. Avoid contact with acids and oxidizers.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling. For use only in Sea-Bird Electronics' conductivity sensors. Read installation instructions in the applicable Conductivity Instrument Manual.

STORAGE AND DISPOSAL

PESTICIDE STORAGE: Store in original container in a cool, dry place. Prevent exposure to heat or flame. Do not store near acids or oxidizers. Keep container tightly closed.

PESTICIDE SPILL PROCEDURE: In case of a spill, absorb spills with absorbent material. Put saturated absorbent material to a labeled container for treatment or disposal.

PESTICIDE DISPOSAL: Pesticide that cannot be used according to label instructions must be disposed of according to Federal or approved State procedures under Subtitle C of the Resource Conservation and Recovery Act.

CONTAINER HANDLING: Nonrefillable container. Do not reuse this container for any other purpose. Offer for recycling, if available.

Sea-Bird Electronics/label revised 01-28-10

Appendix V: Replacement Parts

Part Number	Part	Application Description	Quantity in MicroTSG
30541	3/8" NPT to Hose Barb Fitting for 3/8" Tygon tubing, Parker, N6MCB6	Intake and exhaust nozzles on water jacket	2
801542.1	AF24173 Anti-Foulant Device	Bis(tributyltin) oxide device inserted into anti-foulant device cup	1
30411	Triton X-100	Octyl Phenol Ethoxylate – Reagent grade non-ionic cleaning solution for conductivity cell (supplied in 100% strength; dilute as directed)	1
801392	4-pin MCIL-4MP to 9-pin DB-9S I/O cable with power leads, 2.4 m (8 ft) long	From MicroTSG to computer	1
171888	25-pin DB-25S to 9-pin DB-9P cable adapter	For use with computer with DB-25 connector	1
60036	Spare hardware/ O-ring kit	Assorted hardware and O-rings, including: • 31132 Cap screw, 1/4-20 x 1 3/4", 316 stainless steel (secures top and bottom plates to housing body) • 30254 Washer, 1/4" split ring lock, stainless steel (for screw 31132) • 30570 Washer, 1/4" flat, stainless steel (for screw 31132) • 31057 O-ring, Parker 2-229N674-70 (round seal between bottom plate and housing) • 31062 Plug N6HPL, 3/8 NPT Nylon (drain plug for bottom plate)	-
30507	O-ring, Parker 2-206N674-70	Seal for conductivity cell end, secures AF24173 Anti-Foulant Device in anti-foulant device cup	1
31058	O-ring, Parker 2-239N674-70	Large seal for top plate to housing body	1
30818	O-ring, Parker 2-203N674-70	Seal for top plate to housing body center screws	2

Index

.

.con file · 33
.xmlcon file · 33

A

Anti-Foulant Device · 47
  removal before shipping to Sea-Bird · 40
  replacing · 39

B

Baud rate · 12
Bubbles · 16

C

Cable length · 12, 13
Calibration · 40
Cleaning · 37
Command summary · 45
Commands
  autonomous sampling · 29
  averaging · 28
  baud · 28
  calibration coefficients · 31
  descriptions · 27
  format · 28
  operating · 29
  polled sampling · 30
  sampling · 29
  setup · 28
  sleep · 28
  status · 27
  testing · 30
Communication defaults · 22
Configuration file · 33
Connector · 10
Corrosion precautions · 37

D

Data acquisition · 34
Data output format · 32
Data processing · 36
Data transmission rate · 12
Description · 7
Dimensions · 10

E

Electronics disassembly/reassembly · 44

F

Format
  data output · 32
Functional description · 43

G

Glossary · 42

I

Installation
  remote temperature sensor · 14
  system · 19
Installation guidelines · 16
Interface Box · 16

J

Jumper
  power-up · 18, 23, 44

M

Maintenance · 37
Modes · *See* Sampling modes
Mounting · 16

O

Operating system · 34

P

Parker Super O-Lube · 42
Parts
  replacement · 51
Power · 13
Processing data · 36
Pump · 16

Q

Quick start · 5

R

Real-time acquisition · 34
Remote temperature sensor · 14, 16
Replacement parts · 51

S

Sample timing · 11
Sampling modes · 24
SBE 38 remote temperature sensor · 14, 16
SBE Data Processing · 8, 15, 33, 36
Schematic · 16
Seasave · 8, 15, 33, 34
SEASOFT · 8, 15
SEATERM · 8, 15, 20
Setup · 20
Software · 8, 15
Specifications · 9
Storage · 37
Super O-Lube · 42
System
  operation · 34
  schematic · 16
System description · 7

T

Terminal program · 8
Testing · 20
Timeout description · 26
Triton · 42
Troubleshooting · 37, 41

U

Unpacking MicroTSG · 6

SBE 45 MicroTSG (RS-232) Reference Sheet

(see SBE 45 MicroTSG User's Manual for complete details)

Deployment

1. Verify setting of Power-Up Jumper J1 (see product configuration sheet on manual front cover for factory-setting):
   - Autopower (default) – pins 1 and 2. The MicroTSG wakes up when power is applied.
   - Normal – pins 2 and 3. The MicroTSG power up (wakes up) when there is a pulse on the serial lines. In this configuration, the MicroTSG can be commanded into a quiescent (sleep) state with the **QS** command.

   If the factory-setting listed on the product configuration sheet does not match your desired operation, see the manual for procedures for accessing the PCB.

2. Mount MicroTSG on ship, with electrical connector at top, using four 1/4-inch bolt holes on sides. Provide clearance as follows:
   - Bottom — 152 mm (6 inches) clearance for removal of the bottom plate, to allow access for replacing the anti-foul cylinder and cleaning.
   - Top — 305 mm (12 inches) clearance for removal of the top plate, to allow access for removing sensors and electronics.
   - Sides — small clearance by using washers with the mounting hardware, to prevent binding when removing the top or bottom plate.

3. Install piping connections to MicroTSG's 3/8-inch U.S. Standard NPT threads.

4. Wiring to MicroTSG:
   A. Install I/O cable connector, aligning long pin with small hole on MicroTSG I/O connector.
   B. Tighten locking sleeve on I/O cable connector.
   C. Connect I/O cable connector to computer serial port.
   D. Connect I/O cable connector's red and black wires to power supply (8-30 VDC).

Communication Setup Parameters

1. Double click on the SEATERM icon.

2. Once the main screen appears, in the Configure menu select the SBE 45 TSG. Input:
   - Serial Port: COM1 through COM10 are available
   - Baud Rate: 4800 (or other if applicable)
   - Data Bits: 8
   - Parity: No Parity
   - Mode: RS-232 (full duplex)

Sampling Modes

User-selectable modes include:

- **Polled sampling** – The MicroTSG takes one sample and sends the data to the computer. Polled sampling is useful for testing.
- **Autonomous sampling** – The MicroTSG samples data at pre-programmed intervals, defined by the **Interval=** command, and sends the data to the computer. The MicroTSG does not enter quiescent (sleep) state between samples.
- **Serial Line Sync** - A pulse on the serial line causes the MicroTSG to wake up, take and output a single sample, and enter quiescent (sleep) state automatically.

Command Instructions and List

- Input commands in upper or lower case letters and register commands by pressing the Enter key.
- If in quiescent (sleep) state, re-establish communications by pressing Connect on the Toolbar or the Enter key to get `S>` prompt.
- If system does not return `S>` prompt after executing a command, press Enter key to get `S>` prompt.
- MicroTSG sends `?CMD` if invalid command is entered.

Shown below are the commands used most commonly in the field. See the Manual for a complete list and detailed descriptions.

CATEGORY	COMMAND	DESCRIPTION
Status	**DS**	Display status.
Setup	**Baud=x**	**x=** baud rate (1200, 2400, 4800, 9600, 19200, 38400). Default 4800.
	OutputFormat=x	**x=0** (default): Output order is temperature, conductivity, salinity, sound velocity. **x=1**: Suppress space before conductivity output. **x=2**: Reverse conductivity and salinity order (not for use with SEASAVE, SBE Data Processing, or optional Interface Box).
	OutputCond=x	**x=Y** (default): Output conductivity (S/m) with data. **x=N**: Do not output conductivity with data.
	OutputSal=x	**x=Y**: Output salinity (psu) with data. **x=N** (default): Do not output salinity with data.
	OutputSV=x	**x=Y**: Output sound velocity (m/sec) with data, calculated as defined by **SVAlgorithm=**. **x=N** (default): Do not output sound velocity with data.
	SVAlgorithm=x	**x=C** (default): Calculate sound velocity as Chen and Millero. **x=W**: Calculate sound velocity as Wilson.
	NCycles=x	**x** = number of A/D cycles to average (default=4).
	QS	Quit session and place MicroTSG in quiescent (sleep) state. Sampling stops. Applicable only if Interface PCB J1 jumper in Normal position.
Operating Mode Interface PCB's J1 jumper interacts with these commands: • Autopower (default) – pins 1 and 2 • Normal – pins 2 and 3	**Interval=x**	**x** = interval between samples (maximum 32767 seconds). Minimum time between samples determined by **NCycles**, desired parameters (salinity, etc.), and baud rate.
	AutoOff=x	**(Functional only if J1 jumper in Normal position)** **x=Y**: Power-off (enter quiescent state) if 2 minutes have elapsed without receiving command or sampling data. **x=N**: Do not automatically power-off.
	J1 jumper - Normal **AutoRun=N** **SingleSample=Y** or **N**	Wake up when Enter key pressed while in quiescent (sleep) state, wait for command.
	J1 jumper - Normal **AutoRun=Y** **SingleSample=N**	Wake up when Enter key pressed while in quiescent (sleep) state, sample at rate specified by **Interval=**. To stop sampling and get `S>` prompt, type **Stop** and press Enter key.
	J1 jumper - Normal **AutoRun=Y** **SingleSample=Y**	Wake up when Enter key pressed while in quiescent (sleep) state, take and output single sample and automatically power-off. To wake up and get `S>` prompt, type **Stop** and press Enter key.
	J1 jumper - Autopower **AutoRun=N** **SingleSample=Y** or **N**	Wake up when power applied, wait for a command.
	J1 jumper - Autopower **AutoRun=Y** **SingleSample=N**	Wake up when power applied, sample at rate specified by **Interval=** until power removed. **These are the required settings for running MicroTSG in 3-wire (power, ground, and transmit) configuration or with a 90402 Interface Box**.
	J1 jumper - Autopower **AutoRun=Y** **SingleSample=Y**	Wake up when power applied, take and output a single sample. Wait for another command until power removed.
	Go	Start sampling, as defined by **SingleSample=** and **Interval=**. Applicable if **AutoRun=N**, or **AutoRun=Y** and you previously sent **Stop** to stop sampling.
	Stop	Stop sampling data.
Sampling Do not send if MicroTSG is sampling data at pre-programmed intervals.	**TS**	Take sample, hold converted data in MicroTSG's RAM, output converted data
	TSR	Take sample, hold raw data in MicroTSG's RAM, output raw data.
	SLT	Send converted data from last sample in MicroTSG's RAM, then take new sample and hold converted data in MicroTSG's RAM.
	TH	Take sample, hold converted data in MicroTSG's RAM.
	SH	Send held converted data from MicroTSG's RAM.
Testing	**TT**	Measure temperature for 100 samples or until Esc key is pressed, output converted data.
	TC	Measure conductivity 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.
	TCR	Measure conductivity for 100 samples or until Esc key is pressed, output raw data.
Coefficients	**DC**	Display calibration coefficients.

MicroTSG (Thermosalinograph)

SBE 45

The SBE 45 MicroTSG Thermosalinograph is an externally powered, high-accuracy instrument, designed for shipboard determination of sea surface (pumped-water) conductivity and temperature. Salinity and sound velocity can also be computed. The MicroTSG is constructed of plastic and titanium to ensure long life with minimum maintenance.

OPERATION OVERVIEW

Communication with the MicroTSG is over an internal, 3-wire, RS-232C link, providing real-time data transmission. Commands can be sent to the MicroTSG to provide status display, data acquisition setup, data display and capture, and diagnostic tests. User-selectable operating modes include:

- **Polled sampling** – On command, the MicroTSG takes one sample and sends the data to the computer.
- **Autonomous sampling** – At pre-programmed intervals, the MicroTSG samples and sends the data to the computer. The MicroTSG does not enter quiescent (sleep) state between samples.
- **Serial Line Sync** – A pulse on the serial line causes the MicroTSG to wake up, sample, and enter quiescent state automatically.

Calibration coefficients stored in EEPROM allow the MicroTSG to transmit data in engineering units.

SENSORS

The MicroTSG retains the temperature and conductivity sensors used in the SBE 21 Thermosalinograph, but has improved acquisition electronics that increase accuracy and resolution, and lower power consumption. The MicroTSG's aged and pressure-protected thermistor has a long history of exceptional accuracy and stability (typical drift is less than 0.002 °C per year). Electrical isolation of the conductivity electronics eliminates any possibility of ground-loop noise.

The MicroTSG's internal-field conductivity cell is unaffected by external fouling, and uses expendable anti-foulant devices.

OPTIONAL PN90402 - SBE 45 POWER, NAVIGATION, and REMOTE TEMPERATURE INTERFACE BOX

An optional AC- or DC-powered Interface Box:

- Provides isolated DC power and an optically isolated RS-232 data interface.
- Contains a NMEA 0183 port for appending navigation information from a NMEA navigation device to the data stream.
- Contains an RS-232 port for appending the output of an optional remote temperature sensor (SBE 38), allowing for measurement of sea surface temperature with minimal thermal contamination from the ship's hull.
- Outputs the data stream (MicroTSG, NMEA navigation device, and SBE 38 data) to the computer over an RS-232 interface.

SOFTWARE

The MicroTSG is supplied with a powerful Win 2000/XP software package, SEASOFT© V2. SEASOFT's modular programs include:

- SEATERM — terminal program for instrument setup and data display.
- Seasave — real-time data acquisition and display
- SBE Data Processing — filtering, aligning, averaging, and plotting of data and derived variables.

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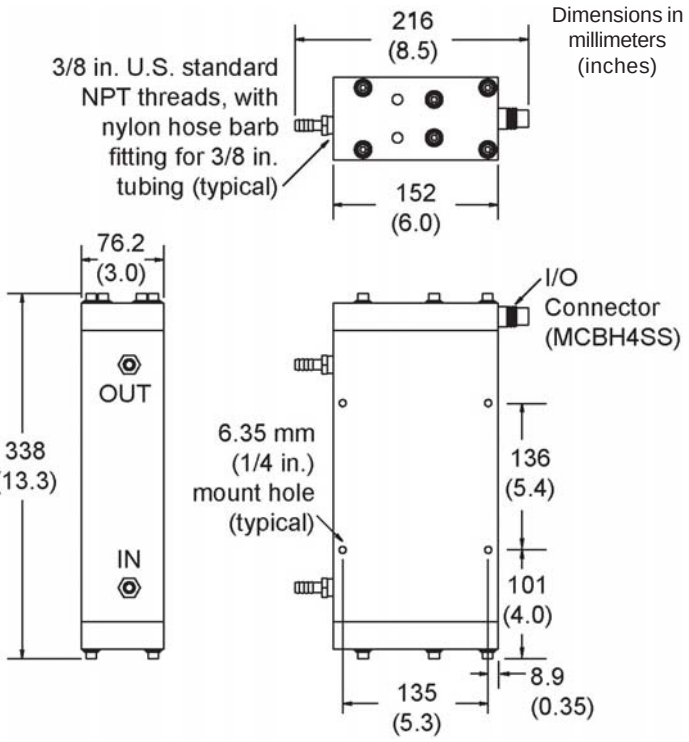
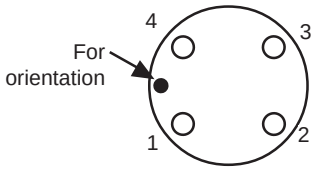
MicroTSG (Thermosalinograph) SBE 45

SPECIFICATIONS

Measurement Range	
Conductivity:	0-7 S/m (0-70 mS/cm)
*Temperature *:*	-5 to 35 °C
Initial Accuracy	
Conductivity:	0.0003 S/m (0.003 mS/cm)
*Temperature *:*	0.002 °C
Salinity:	0.005 PSU, typical
Typical Stability *(per month)*	
Conductivity:	0.0003 S/m (0.003 mS/cm)
*Temperature *:*	0.0002 °C
Salinity:	0.003 PSU, typical
Resolution	
Conductivity:	0.00001 S/m (0.0001 mS/cm)
*Temperature *:*	0.0001 °C
Salinity:	0.0002 PSU, typical
Calibration Range	
Conductivity:	0-6 S/m (60 mS/cm); physical calibration 2.6-6 S/m (26-60 mS/cm), plus zero conductivity (air)
*Temperature *:*	+1 to +32 °C
Time Resolution	1 second
Clock Stability	13 seconds/month
Input Power	8-30 VDC
Acquisition Current	34 mA at 8 VDC; 30 mA at 12-30 VDC
Quiescent Current	10 microamps
Acquisition Rate	1 Hz maximum
Operating Pressure	34.5 decibars (50 psi) maximum
Flow Rate	10 to 30 ml/sec (0.16 to 0.48 gal/min)
Materials	PVC housing
Weight	4.6 kg (10.2 lbs)

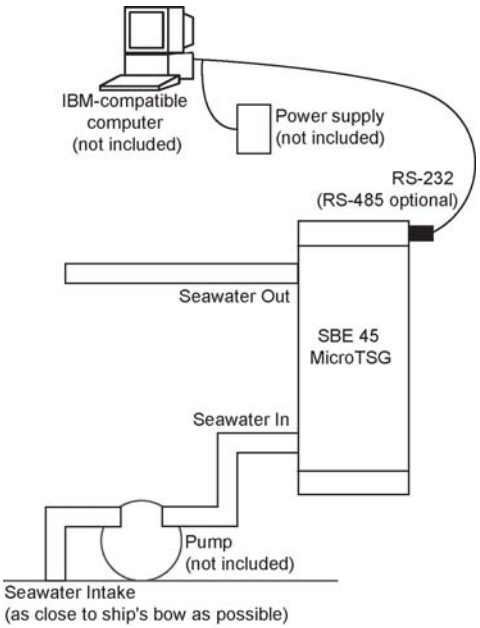
* For specifications for optional SBE 38 remote temperature sensor, see SBE 38 datasheet.



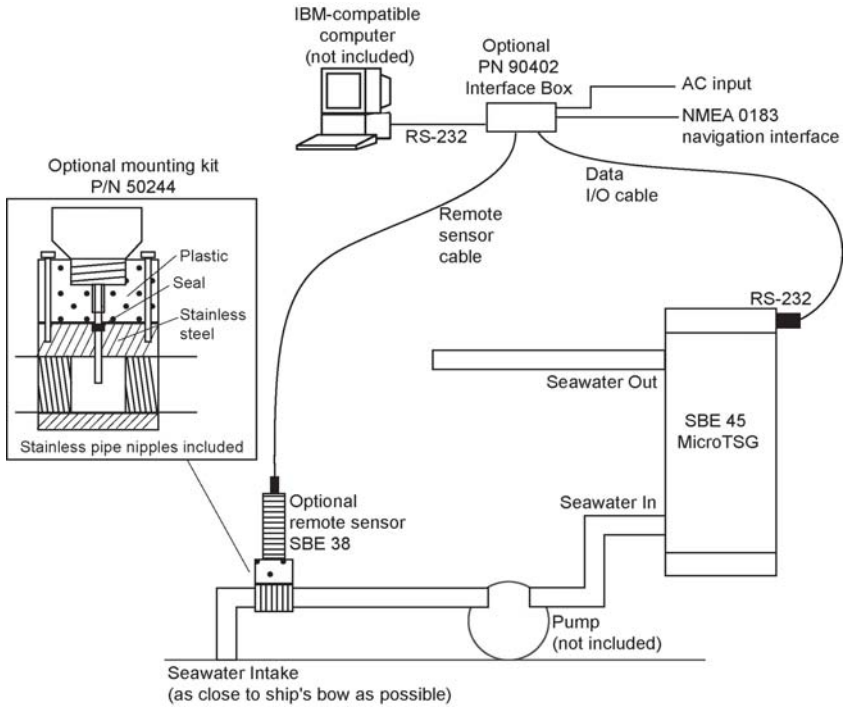


Pin	Signal
1	Common
2	RS-232 RX from computer
3	RS-232 TX to computer
4	External power in (8 - 30 VDC)

System Schematic: SBE 45



System Schematic: SBE 45 with Optional PN 90402 Interface Box and Remote Temperature Sensor



12/09

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PN 90402 - SBE 45 Power, Navigation, and Remote Temperature Interface Box

For use with SBE 45 MicroTSG

Note: NEW ADDRESS
as of January 18, 2010

User's Manual

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Manual Version #008, 02/02/10
Firmware Version 2.0 and later
Seasave V7 Version 7.20a and later
SBE Data Processing Version 7.20a and later

Limited Liability Statement

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

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 4
About this Manual 4
Unpacking Interface Box 5

Section 2: Interface Box Description 6
System Description 6
Specifications 7
System Communications 7
Connections, Switches, and LEDs 8
Data Output Format 9

Section 3: Setting Up System 10
Installing Software 10
Communications Test and Setup 11
Commands 14
Setting Up Instruments 17
SBE 45 17
SBE 38 17
NMEA Navigation Device 18
Setting Up SBE 45 Configuration (.xmlcon or .con) File in Seasave 19

Section 4: Operating System 20
Acquiring Real-Time Data with Seasave 20
Processing Data with SBE Data Processing 21

Section 5: Routine Maintenance 22

Section 6: Troubleshooting 23
Problem 1: Unable to Communicate with Interface Box 23
Problem 2: Unable to Communicate with SBE 45 through Interface Box 23
Problem 3: Unable to Communicate with SBE 38 through Interface Box 24
Problem 4: Unable to Communicate with NMEA Navigation Device through Interface Box 24
Problem 5: Nonsense or Unreasonable Data 24
Problem 6: Changing SBE 45 and/or SBE 38 Baud Rate without Cables for Direct Connection 25

Glossary 26
Safety and Electrical Symbols 26

Appendix I: NMEA Data 27
NMEA Raw Message Formats 27
Troubleshooting NMEA 28
Problem 1: Yellow *NMEA* LED Not Flashing 28
Problem 2: Yellow *NMEA* LED Flashing, but Lat/Lon Data Not Displaying 28
NMEA Simulation Program 29

Appendix II: Replacement Parts 31

Index 32

Section 1: Introduction

This section includes photos of a standard PN 90402 – SBE 45 Power, Navigation, and Remote Temperature Interface Box shipment.

About this Manual

This manual is to be used with the PN 90402 – SBE 45 Power, Navigation, and Remote Temperature Interface Box for the SBE 45 MicroTSG. It is organized to guide the user from installation through operation. We have included specifications, setup and operation descriptions, and helpful notes throughout the manual.

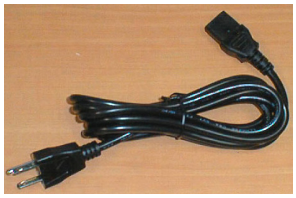
Sea-Bird welcomes suggestions for new features and enhancements of our products and/or documentation. Please contact us with any comments or suggestions (seabird@seabird.com or 425-643-9866). Our business hours are Monday through Friday, 0800 to 1700 Pacific Standard Time (1600 to 0100 Universal Time)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

Unpacking Interface Box

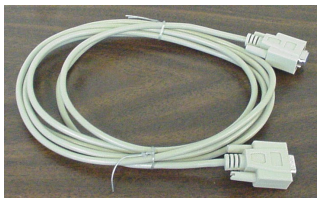
Shown below is a typical PN 90402 – SBE 45 Power, Navigation, and Remote Temperature Interface Box shipment.

Interface Box

Cable -
SBE 45 to Interface Box


AC power cable

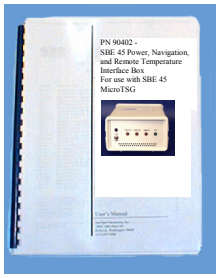
DC power
connector


I/O cable (Interface Box
to computer)

Connectors for *SBE 45*,
SBE 38, and *NMEA*
(3 connectors/Interface Box)

Navigation Interface test cable
(Interface Box to NMEA navigation
device simulation computer)

(optional) Cable -
SBE 38 to Interface Box



Interface Box
Manual

Software, and Electronic Copies of
Software Manuals and User Manual

Section 2: Interface Box Description

This section describes the functions and features of the Interface Box, system communications, and output data format.

System Description

The PN 90402 – SBE 45 Power, Navigation, and Remote Temperature Interface Box provides continuous power and an opto-isolated RS-232C interface for the SBE 45 MicroTSG Thermosalinograph. Additionally, the Interface Box provides:

- An opto-isolated NMEA receiver for an optional NMEA navigation device (not supplied by Sea-Bird)
- Power and an RS-232C interface for an optional SBE 38 remote temperature sensor

Baud rates between the Interface Box and SBE 45, SBE 38, NMEA navigation device, and computer are user-programmable.

The Interface Box merges position data and SBE 38 remote temperature data with SBE 45 data. The NMEA Interface decodes messages that are output from navigation devices supporting NMEA 0183 protocol, outputting data in GGA, GLL, RMA, RMC, or TRF format. Decoded Latitude, Longitude, date, and time and SBE 38 temperature data are appended to the SBE 45 data stream in the Interface Box. The data, in ASCII engineering units, is passed to the computer for storage and/or display.

The Interface Box can be AC- or DC-powered:

- **AC power** - universal 85-265 VAC input with frequency of 47-63 Hz
- **DC power** - 10-28 VDC input.

The Interface Box is supplied with a powerful Win 2000/XP software package, SEASOFT V2, which includes:

- **SEATERM** – terminal program for easy setup.
- **Seasave V7** – program for acquiring, converting, and displaying real-time or archived raw data.
- **SBE Data Processing** – program for calculation and plotting of conductivity, temperature, pressure, auxiliary sensor data, and derived variables such as salinity and sound velocity.

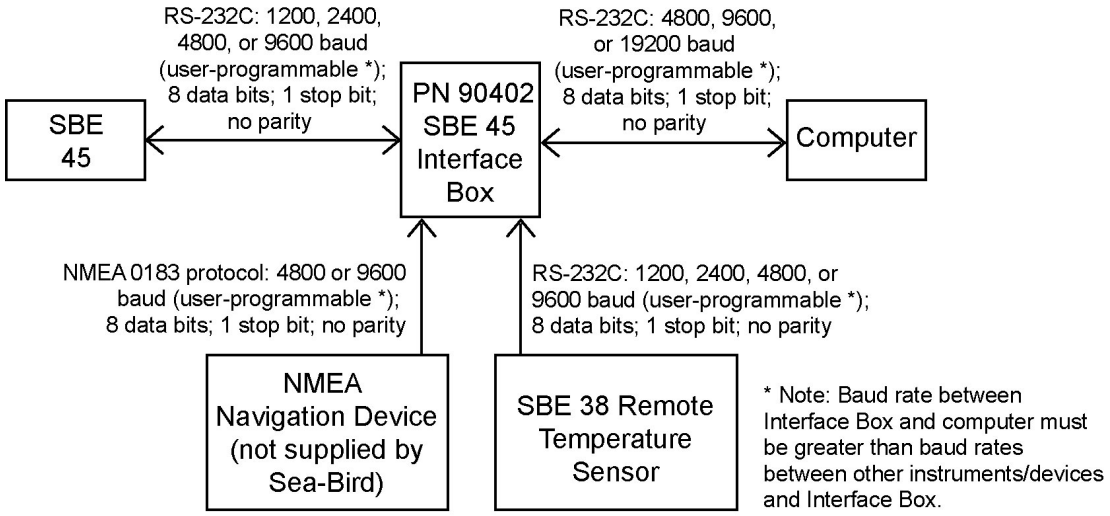
Notes:

- Help files provide detailed information on software use.
- NMEATest, a NMEA navigation device simulation program, is part of the SBE Data Processing installation.
- Separate software manuals on CD-ROM contain detailed information on the setup and use of Seasave V7 and SBE Data Processing.
- Sea-Bird also supplies an older version of Seasave, Seasave-Win32. However, all Seasave instructions in this manual are written for Seasave V7. See Seasave-Win32's manual and/or Help files if you prefer to use the older software.

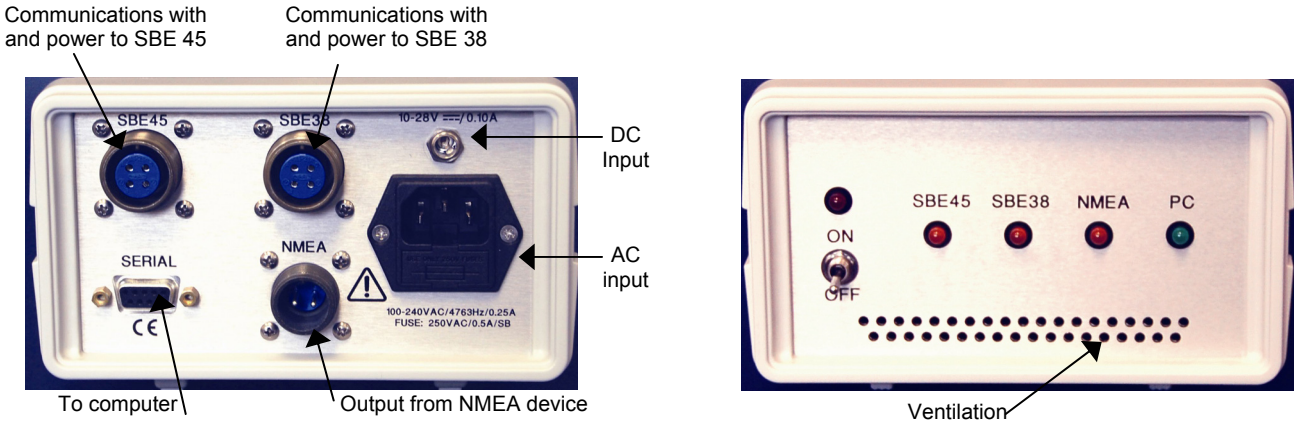
Specifications

Power Requirements	*AC:* 100-240 VAC / 47-63Hz / 0.25A, The Interface Box should always be used with a three-terminal outlet that includes a protective earth. **or** *DC:* 10-28 VDC / 0.10A
Fuse	5x20mm, 250VAC Slow-Blow, 0.5 Amp
Operating Current	Interface Box alone: 27 mA Interface Box with SBE 45: 65 mA Interface Box with SBE 45 and 38: 80 mA
Dimensions	200 x 121 x 76 mm (7.875 x 4.75 x 3 inch)
Weight	1.1 kg (2.5 lbs)
Installation Environment	Interface Box operates properly under the following conditions: • Indoor use • Altitude up to 2000 meters • Temperature from 5 °C to 40 °C • Maximum relative humidity 80%, non-condensing • Mains supply voltage ±10%

System Communications



Connections, Switches, and LEDs



Connections:
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.

- ***SBE 45*** - to SBE 45 MicroTSG; use supplied 4-pin MS-3106A-14S-2P connector or supplied cable:

Interface Box	Function
Pin A	Common
Pin B	RS-232 data transmit to SBE 45
Pin C	RS-232 data receive from SBE 45
Pin D	Power to SBE 45

- ***NMEA*** - to NMEA navigation device; use supplied 2-pin MS-3106A12S-3S connector or supplied test cable:

Interface Box	Function
Pin A	NMEA *A* (signal)
Pin B	NMEA *B* (signal return)

- ***SBE 38*** - to SBE 38 remote temperature sensor; use supplied 4-pin MS-3106A-14S-2P connector or optional cable:

Interface Box	Function
Pin A	Common
Pin B	RS-232 data transmit to SBE 38
Pin C	RS-232 data receive from SBE 38
Pin D	Power to SBE 38

- ***Serial*** - to computer with supplied DB-9P/DB-9S cable.

Interface Box	Function
Pin 2	RS-232 data transmit to computer
Pin 3	RS-232 data receive from computer
Pin 5	Ground

- ***AC Input*** - to standard, 3-prong, grounded, VAC power supply, using the supplied UL/IED-approved power cord, **or**
  DC Input - to VDC power supply.

Power Switch and Red LED:
Switch turns power to Interface Box on/off. Red LED turns on to indicate power is on.

LEDs:
Indicate if Interface Box is communicating with other parts of system:

LED:	Flashes when carriage return (decimal 13) received from:
Yellow *SBE 45*	SBE 45
Yellow *SBE 38*	SBE 38
Yellow *NMEA*	NMEA navigation device
Green *PC*	Computer

Data Output Format

The time between each output scan is governed by the SBE 45's setup. The Interface Box outputs the most recent data from the SBE 38 and/or NMEA navigation device with each scan of SBE 45 data. The Interface Box outputs data in the following format and order:

Format=0 (standard format)

```
t1=ttt.tttt, c1=cc.ccccc, s = sss.ssss, sv=vvvv.vvv,
t2 = ttt.tttt, lat = DD MM.MMMM W, lon = DDD MM.MMMM W,
hms = HHMMSS, dmy = DDMMYY
```

where

- t1 = temperature from SBE 45 (°C, ITS-90).
- c1 = conductivity from SBE 45 (S/m);
  output if **OutputCond=Y** in SBE 45.
- s = salinity (psu) calculated from t1 and c1 by SBE 45;
  output if **OutputSal=Y** in SBE 45.
- sv = sound velocity (m/sec); output if **OutputSV=Y** in SBE 45.
  - If the Interface Box is acquiring data from an **SBE 38** remote temperature sensor and if the SBE 45 is set to **OutputCond=Y** or **OutputSal=Y**: the Interface Box ***recalculates*** sound velocity based on s (or t1 and c1) from the SBE 45 and temperature t2 from the SBE 38. This provides the most accurate sound velocity results, because sound velocity is a function of salinity and temperature, and the SBE 38 typically provides more accurate sea surface temperature than the thermosalinograph, since it is closer to the seawater intake.
  - Otherwise: the Interface Box outputs sound velocity calculated from t1 and c1 by the SBE 45.
- t2 = temperature from SBE 38 (°C, ITS-90 if **Format=C** in SBE 38; number of digits after decimal point is set with **Digits=** in SBE 38).
- lat = latitude from NMEA navigation device.
  DD = degrees.
  MM.MMMM = minutes and fractions of minutes; number of digits after decimal point is number of digits in received NMEA string.
  W = N (north) or S (south).
- lon = longitude from NMEA navigation device.
  DDD = degrees.
  MM.MMMM = minutes and fractions of minutes; number of digits after decimal point is number of digits in received NMEA string.
  W = E (east) or W (west).
- hms = time from NMEA navigation device (hour, minute, second).
- dmy = date from NMEA navigation device (day, month, year).

All data is separated with a comma and a space. Each scan ends with a carriage return <CR> and line feed <LF>. Leading zeros are suppressed, except for one zero to the left of the decimal point.

Notes:
- Inclusion of all parameters except for t1 (temperature from SBE 45) is dependent on configuration – if the system does not include the specified instrument or the parameter is not enabled, the corresponding data is not included in the output data stream, shortening the data string.
- Not all NMEA navigation devices transmit time and / or date.
- The SBE 45 must be set up to output data with **OutputFormat=0** or **1** (SBE 45 **OutputFormat=2** is not compatible with the Interface Box).

Format=1 (custom format for interfacing with a Kongsberg EM 300 Multibeam Echo Sounder)

```
tt.ttt vvvv.v
```

where

- `tt.ttt` = temperature from SBE 38 remote temperature sensor (°C, ITS-90).
- `vvvv.v` = sound velocity (m/sec) calculated in Interface Box from:
  - salinity based on conductivity and temperature measured by SBE 45, and
  - temperature measured by SBE 38 remote temperature sensor

Temperature and sound velocity data is separated with a space. Each scan ends with a carriage return <CR> and line feed <LF>. Leading zeros are suppressed, except for one zero to the left of the decimal point.

Note:
When using **Format=1**:
- Set up the SBE 45 with:
  - **OutputFormat=0** or **1**,
  - **OutputSV=Y**, and
  - **OutputCond=Y** and/or **OutputSal=Y**

  and connect an SBE 38 to the Interface Box.
- The Interface Box will not output any parameters other than what is shown at right, regardless of settings in the SBE 45 or connection of the Interface Box to a NMEA navigation device.
- **Format=1** is not compatible with Seasave real-time data acquisition software or SBE Data Processing post-processing software.

Section 3: Setting Up System

This section covers:

- Installing Sea-Bird software
- Communications testing and setup
- System commands
- Setting up the SBE 45 configuration (.xmlcon or .con) file

Installing Software

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

If not already installed, install Sea-Bird software on your computer using the supplied software CD.

1. Insert the CD in your CD drive.

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

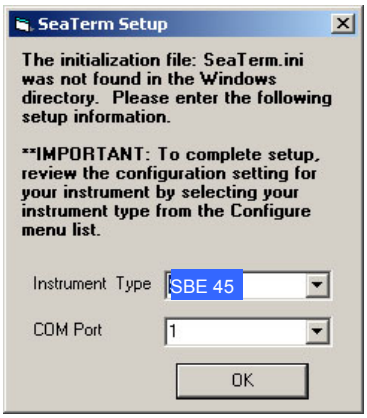
The default location for the software is c:\Program Files\Sea-Bird. Within that folder is a sub-directory for each program.

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

Communications Test and Setup

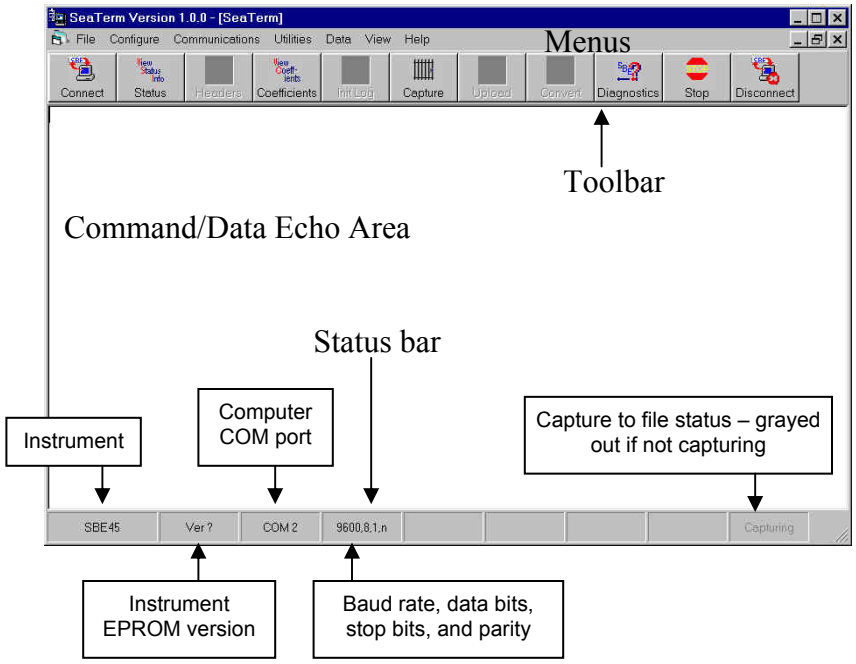
Notes:
- See SEATERM's Help files.
- The Interface Box is not available in the list of instrument types. **Select *SBE 45* as the instrument type.**

1. With power to the Interface Box **off**, double click on SeaTerm.exe. If this is the first time SEATERM is used, the setup dialog box may appear:



Select the instrument type (SBE 45 TSG) and the computer COM port for communication with the Interface Box. Click OK.

2. The main screen looks like this:



- 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.
- Status bar – Provides status information. To display or hide the Status bar, select View Status bar in the View menu.

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.

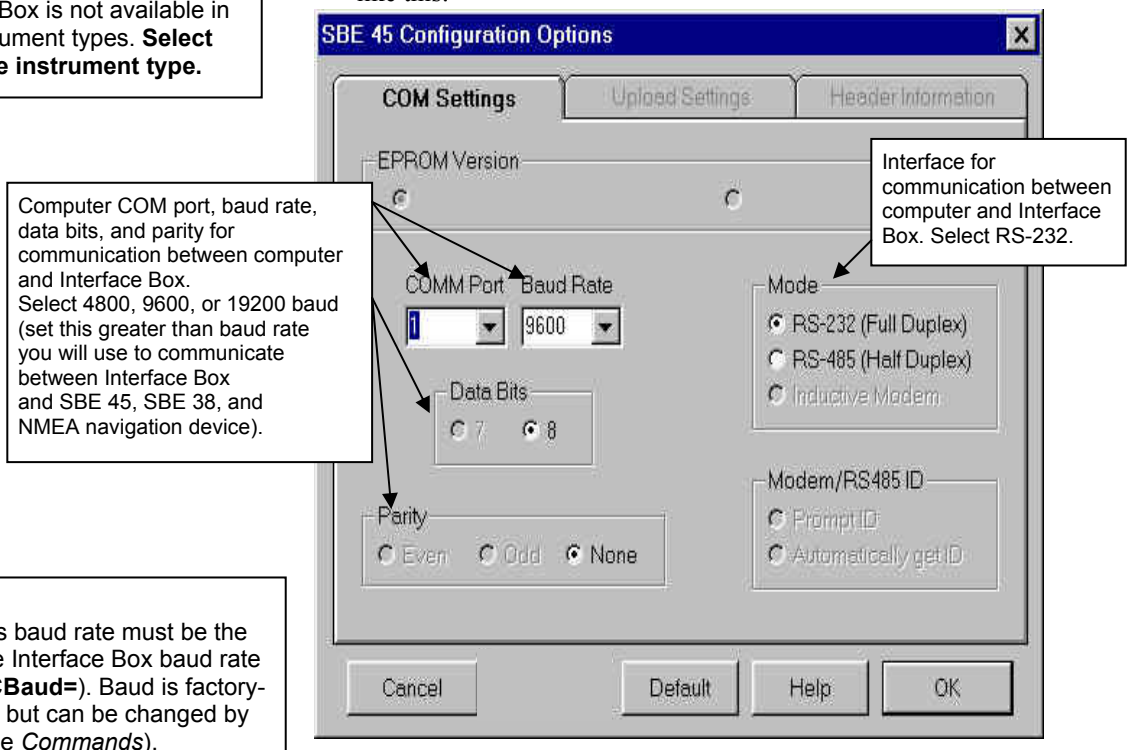
Following are the Toolbar keys applicable to the Interface Box:

Toolbar Keys	Description	Equivalent Command*
Connect	Re-establish communications with Interface Box. Computer responds with `S>` prompt.	(press Enter key)
Status	Display instrument status.	**DS**
Capture	Capture instrument responses on screen to file. Interface Box has no internal memory; **you must capture before sampling begins to save data for future review and processing, or use Seasave for data acquisition**. File has .cap extension. Press Capture again to turn off capture. Capture status displays in Status bar.	—
Disconnect	Free computer COM port used to communicate with Interface Box. COM port can then be used by another program.	—

*See *Command Descriptions*.

Note:
The Interface Box is not available in the list of instrument types. **Select *SBE 45* as the instrument type.**

3. In the Configure menu, select SBE 45 TSG. The dialog box looks like this:



Make the selections in the Configuration Options dialog box. Click OK to save the settings.

Notes:
- SEATERM's baud rate must be the same as the Interface Box baud rate (set with **PCBaud=**). Baud is factory-set to 9600, but can be changed by the user (see *Commands*).
- 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 (SBE 37, 45, etc.). When you open SEATERM and select the desired instrument in the Configure menu, the Configuration Options dialog box shows the last saved settings for that instrument.

4. Turn on power to the Interface Box. The display looks like this (if the Interface Box is set up to power-up in Normal mode with the **IMode=NORMAL** command; see *Commands* for details):

```
SBE45 Junction Box V 1.4
mode is normal
```

If the system does not respond as described:
- Click Connect on the Toolbar to attempt to establish communications.
- Verify the SBE 45 was selected in the Configure menu and settings were entered correctly in the Configuration Options dialog box.
- Check cabling between the computer and the Interface Box.
- If the response shows `mode is connect45`, the Interface Box is set up to power-up in SBE 45 mode (**IMode=CONNECT45**). Type @ to return to Normal mode for communication with the Interface Box.

5. If the SBE 45 was set to **AutoRun=Y** and its J1 jumper was set to pins 1 and 2 (begin sampling automatically on power up), data from the Interface Box begins scrolling on the screen. Each time data is received from an instrument (SBE 45, SBE 38, and NMEA navigation device), the corresponding LED on the Interface Box flashes. If data is not received, is incorrect, or is not updating properly for some or all instruments:
   - Verify that the instrument is connected to the Interface Box and that the proper cable is used.
   - Check the baud rate of each instrument (SBE 45, SBE 38, and NMEA navigation device). These baud rates must be less than the baud rate for communication between the Interface Box and the computer. If necessary, connect each instrument directly to the computer and use SEATERM to reset its baud rate. See the appropriate instrument manual for details.
   - Check that the setup of each instrument is compatible with operation with the Interface Box. See *Setting Up Instruments*.
   - If data is not received from a NMEA navigation device, see *Appendix I: NMEA Data* for troubleshooting information.

Note:
The Interface Box outputs data at the SBE 45's data output rate. If the SBE 45 is not outputting any data, data from the SBE 38 and/or NMEA navigation device will not appear at all.

6. If desired, type **Stop** and press the Enter key to stop the scrolling data. Note that you can send commands to the Interface Box and/or attached instruments while it is transmitting data, but it easier to see what the commands and responses are without the scrolling data.

7. Display Interface Box status information by clicking Status on the Toolbar. The display looks like this:
   ```
   SBE45 Junction Box V 1.4
   SBE 45 baud rate = 4800
   SBE 38 baud rate = 4800
   NMEA baud rate = 4800
   standard output format
   ```
   Note that the baud rates shown must be less than the baud rate for communication between the Interface Box and the computer.

8. Verify SBE 45 setup by putting the Interface Box in SBE 45 mode:
   A. Type **Connect45** and press the Enter key. If the SBE 45 is set for **AutoPower=Y** and **SingleSample=N**, SBE 45 data will scroll across the screen. Type **Stop** and press the Enter key to stop the scrolling data.
   B. Send desired setup commands to the SBE 45 (see *Setting Up Instruments* for required setup parameters).
   C. Type **GO** and press the Enter key to restart SBE 45 sampling. SBE 45 data should begin scrolling on the screen.
   D. Type @ to return to Normal mode for communication with the Interface Box.

Note:
You must restart SBE 45 and SBE 38 sampling using **Go** before returning to Normal mode, or these instruments will not transmit their data to the Interface Box.

9. Verify SBE 38 setup by putting the Interface Box in SBE 38 mode:
   A. Type **Connect38** and press the Enter key. If the SBE 38 is set for **AutoPower=Y**, SBE 38 data will scroll across the screen. Type **Stop** and press the Enter key to stop the scrolling data.
   B. Send desired setup commands to the SBE 38 (see *Setting Up Instruments* for required setup parameters).
   C. Type **Go** and press the Enter key to restart SBE 38 sampling. SBE 38 data should begin scrolling on the screen.
   D. Type @ to return to Normal mode for communication with the Interface Box.

10. Type **Start** and press the Enter key to restart data transmission through the Interface Box.

The system is ready for deployment.

Commands

This section describes commands and provides sample outputs.
When entering commands:

- Input commands to the Interface Box in upper or lower case letters and register commands by pressing the Enter key.
- The Interface Box sends `?` if an invalid command is entered.
- If the system does not return an `S>` prompt after executing a command, press the Enter key to get the `S>` prompt.
- The Interface Box can accept commands while transmitting data. Type in any command and press the Enter key; the `S>` is not required.

Status Command

DS

Display firmware version and baud rate settings. Equivalent to Status button on Toolbar.
List includes, where applicable, command used to modify parameter.

- firmware version
- SBE 45 baud rate [**45Baud=**]
- SBE 38 baud rate [**38Baud=**]
- NMEA baud rate [**NMEABaud=**]
- output format [**Format=**] – `standard output format` or `output format 1`

Example: (user input shown in bold)

```
S>DS
SBE45 Junction Box V 1.4
SBE 45 baud rate = 4800                    [45Baud=]
SBE 38 baud rate = 4800                    [38Baud=]
NMEA baud rate = 4800                   [NMEABaud=]
standard output format                     [Format=]
```

Baud Rate Commands

Note:
Baud rate for communication between Interface Box and computer must be greater than baud between Interface Box and SBE 45, SBE 38, and NMEA navigation device.

PCBaud=x

x= baud rate for communication between Interface Box and computer (4800, 9600, or 19200). Default 9600.

45Baud=x

x= baud rate for communication between Interface Box and SBE 45 (1200, 2400, 4800, or 9600). Default 4800. Must match baud set in SBE 45 with **Baud=**.

38Baud=x

x= baud rate for communication between Interface Box and optional SBE 38 (1200, 2400, 4800, or 9600). Default 4800. Must match baud set in SBE 38 with **Baud=**.

NMEABaud=x

x= baud rate for communication between Interface Box and optional NMEA navigation device (4800 or 9600). Default 4800. Must match baud of NMEA navigation device.

Mode Commands

Notes:
- **IMode=Connect45** is not compatible with Seasave real-time data acquisition software.
- Type @ or press the Esc key to exit SBE 45, SBE 38, or NMEA mode and return to Normal mode for communicating with the Interface Box.

IMode=x

x=Normal: On power-up, Interface Box is in Normal mode for communicating with Interface Box.

x=Connect45: On power-up, Interface Box is in SBE 45 mode, for communicating with SBE 45 through Interface Box. Equivalent to powering up in Normal mode, and then immediately sending **Connect45**. *When you send **IMode=Connect45**, Interface Box is also immediately placed in SBE 45 mode.*

Example: (user input shown in bold)

With the Interface Box in Normal mode, turn power on. Interface Box responds as follows:

```
S>SBE 45 Junction Box V 1.4
mode is normal
S>IMODE=CONNECT45        (send command to change start-up mode; also switches to SBE 45 mode now)
Connected to SBE 45, press @ or Esc to return to normal mode
S>DS        (transmitted to SBE 45, so status response is from SBE 45)
SBE45 V 1.1 SERIAL NO. 0059
. . . .     (see SBE 45 manual for remainder of SBE 45 status response)
S>          (send other commands to SBE 45 as desired)
@           (put Interface Box back in normal mode)
mode switched back to normal
S>DS        (transmitted to Interface Box, so status response is from Box)
SBE45 Junction Box V 1.4
. . . .     (see above for remainder of Interface Box status response)
```

Turn power off and then on again. Interface Box starts up in SBE 45 mode:

```
S>SBE 45 Junction Box V 1.4
Mode is connect 45
SBE45 V 1.1
S>          (send commands to SBE 45 as desired)
```

Connect45

Put Interface Box in SBE 45 mode, allowing you to send commands to SBE 45 through Interface Box.

Example: (user input shown in bold)

```
S>CONNECT45
Connected to SBE 45, press @ or Esc to return to normal mode
S>DS        (transmitted to SBE 45, so status response is from SBE 45)
SBE45 V 1.1 SERIAL NO. 0059
. . . .     (see SBE 45 manual for remainder of SBE 45 status response)
S>OUTPUTSV=N        (do not output sound velocity from SBE 45)
@
mode switched back to normal
S>DS        (transmitted to Interface Box, so status response is from Interface Box)
SBE45 Junction Box V 1.4
. . . .     (see above for remainder of Interface Box status response)
```

Connect38

Put Interface Box in SBE 38 mode, allowing you to send commands to SBE 38 through Interface Box.

ConnectNMEA

Put Interface Box in NMEA mode, allowing you to look at data *as transmitted* by NMEA navigation device.

Note:
See *Data Output Format* in *Section 2: Interface Box Description* for details.
- **Format=1** is not compatible with Seasave real-time data acquisition software or SBE Data Processing post-processing software.

Output Format Command

Format=x

x=0: Output standard format (default)
```
t1=ttt.tttt, c1=cc.ccccc, s =
sss.ssss, sv=vvvv.vvv, t2 =
ttt.tttt, lat = DD MM.MMMM W,
lon = DDD MM.MMMM W, hms =
HHMMSS, dmy = DDMMYY
```

x=1: Output custom format for Kongsberg EM 300 Multibeam Echo Sounder
```
tt.ttt vvvv.v
```

Note:
Interface Box starts transmitting data automatically when power is turned on and stops when power is removed. Use **Stop** to stop transmitting data temporarily while setting up the instruments, and then restart transmitting data by sending **Start**.

Sampling Commands

Start Start transmitting data.

Stop Stop transmitting data.

Diagnostic Command

***EETest** Test EEPROM; reset baud rates to defaults (new bauds take effect on next power up).

Example: (user input shown in bold)
```
S>*eetest
wr: 128
. .
wr: 1920
rd: 256
. .
rd: 1792
passed EEprom test
S>
```

Setting Up Instruments

Notes:
- In SEATERM, use the @ character or press the Esc key to exit SBE 45 mode, SBE 38 mode, or NMEA mode and return to Normal mode for communicating with the Interface Box.
- If you reset the baud rate, you may need to turn power off and then on again to resume communications at the new baud rate.
- SBE 45 **OutputFormat=2** is not compatible with the Interface Box.

SBE 45

Set the SBE 45 J1 jumper to Autopower (pins 1 and 2) for use with the Interface Box (this is the default setting when the SBE 45 is shipped).

With the SBE 45 directly connected to the computer, set the SBE 45 baud rate with **Baud=** to match the baud rate set in the Interface Box with **45Baud=**.

The remaining setup can be performed with the SBE 45 directly connected to the computer, or through the Interface Box. With the Interface Box connected to the computer and SBE 45, send **Connect45** to the Interface Box to put the Interface Box in SBE 45 mode and send commands to the SBE 45 through the Interface Box.

- Set up the SBE 45 to begin sampling when power is applied by sending **AutoRun=Y** and **SingleSample=N**.

- Set up the SBE 45 to output data in the following order: temperature, conductivity, salinity, and sound velocity by sending **OutputFormat=0** or **OutputFormat=1**.
  Note: The SBE 45 always outputs temperature. Conductivity is output if **OutputCond=Y**, salinity is output if **OutputSal=Y**, and sound velocity is output if **OutputSal=Y**.

- Set the other sampling and output parameters for the SBE 45 as desired (see the SBE 45 manual).

SBE 38

With the SBE 38 directly connected to the computer:

- Set the SBE 38 baud rate with **Baud=** to match the baud rate set in the Interface Box with **38Baud=**.

- Set up the SBE 38 to communicate using RS-232 with **Interface=232**.

The remaining setup can be performed with the SBE 38 directly connected to the computer, or through the Interface Box. With the Interface Box connected to the computer, SBE 45, and SBE 38, send **Connect38** to the Interface Box to put the Interface Box in SBE 38 mode and send commands to the SBE 38 through the Interface Box.

- Set up the SBE 38 to begin sampling when power is applied by sending **AutoRun=Y**.

- Set the output format and number of digits with **Format=** and **Digits=**. **You must set the format to converted data (Format=C) if you will process the data with SBE Data Processing.**

- Set the other sampling parameters for the SBE 38 as desired (see the SBE 38 manual).

NMEA Navigation Device

The Interface Box is designed to decode messages that are output from navigation devices supporting NMEA 0183 protocol, outputting messages in GGA, GLL, RMA, RMC, or TRF format. Verify that the navigation device baud rate matches the baud rate set in the Interface Box with **NMEABaud=** (4800 or 9600).

Note:
Not all NMEA navigation devices transmit time and / or date.

The most recent decoded Latitude, Longitude, time, and date data is appended to the end of the SBE 45 data stream in the Interface Box and passed to the computer for storage and/or display with the SBE 45 data. Position data format is detailed in *Appendix I: NMEA Data*. The Yellow *NMEA* LED on the Interface Box flashes each time a NMEA message is received (should be the same rate at which your navigation device is transmitting).

Example 1: SBE 45 is set up to output data once every 10 seconds. A navigation device outputs its NMEA message once every 5 seconds. The Yellow *NMEA* LED flashes every 5 seconds. However, only the most recent NMEA message is appended to each scan of SBE 45 data.

Example 2: SBE 45 is set up to output data once every 1 second. A navigation device outputs its NMEA message once every 5 seconds, and the Yellow *NMEA* LED flashes every 5 seconds. The same message is appended to each scan of SBE 45 data within that 5 seconds.

While communicating with the Interface Box, send the **ConnectNMEA** command to view the raw NMEA data.

Setting Up SBE 45 Configuration (.xmlcon or .con) File in Seasave

Notes:
- Seasave and SBE Data Processing versions 7.20a introduced .xmlcon files (in XML format). Versions 7.20a and later allow you to open a .con or .xmlcon file, and to save it to a .con or .xmlcon file. Seasave and SBE Data Processing use the same file.
- A new or recalibrated CTD ships with a configuration file that reflects the current configuration *as we know it*. The file is named with the instrument serial number, followed by a .con extension. For example, for a CTD with serial number 2375, Sea-Bird names the file *2375.con*. You may rename the file (but not the extension) if desired; this will not affect the results.

The Interface Box integrates optional NMEA navigation device data and optional SBE 38 data into the SBE 45 data stream. Seasave, Sea-Bird's real-time data acquisition and display program, stores and displays this data along with the SBE 45 data. Seasave requires a configuration file, which defines the SBE 45 – which parameters are output by the SBE 45, and the data output rate - and indicates whether NMEA and SBE 38 data is to be appended to the data stream. Seasave (as well as our data processing software) uses the information in the configuration file to interpret and process the data. **If the configuration file does not match the actual instrument configuration, the software will not be able to interpret and process the data correctly.**

To verify the contents of the .xmlcon or .con configuration file:

1. Double click on Seasave.exe.

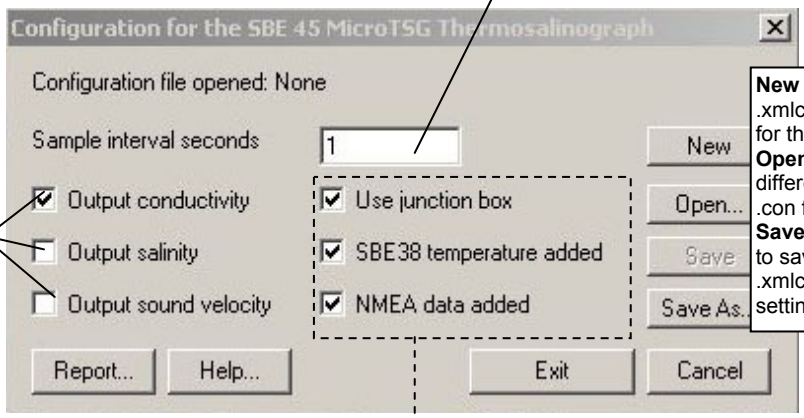
2. Click Configure Inputs. On the Instrument Configuration tab, click *Open*. In the dialog box, select the .xmlcon or .con file and click Open.

3. The configuration information appears on the Instrument Configuration tab. Verify that the outputs match those programmed into your SBE 45, and that the use of the Interface Box, and addition of remote temperature and NMEA, are correct. Click Modify to bring up a dialog box (shown below) to change the configuration.

Time between scans. Must agree with SBE 45 setup (**Interval=**); see reply from **DS**.

Define data in SBE 45 data stream:
- *Output conductivity* with each scan - Must agree with SBE 45 setup (**OutputCond=**).
- *Output salinity* with each scan – Must agree with SBE 45 setup (**OutputSal=**).
- *Output sound velocity* with each scan – Must agree with SBE 45 setup (**OutputSV=**).

See reply from **DS** for setup programmed into SBE 45.



New to create new .xmlcon or .con file for this CTD.
Open to select different .xmlcon or .con file.
Save or **Save As** to save current .xmlcon or .con file settings.

- *Use junction box* - Select if SBE 45 data transmitted to computer through Interface Box.
- *SBE 38 temperature added* – Select if Interface Box connected to SBE 38 remote temperature sensor. If selected, Seasave and SBE Data Processing (Data Conversion and Derive modules) use remote temperature data when calculating density and sound velocity.
- *NMEA data added* - Select if Interface Box connected to a NMEA navigation device. Seasave automatically adds current latitude, longitude, and universal time code to data header. Select NMEA (Lat/Lon) Interface in Seasave's Configure menu to control how Lat/Lon data is incorporated.

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

Section 4: Operating System

Note:
For acquiring data in Seasave:
- SBE 45 must be set up for autonomous sampling (**SingleSample=N**, **AutoRun=Y**, and J1 jumper in Autopower position – pins 1 and 2), and with **OutputFormat=0** or **1**. See *Section 3: Setting Up System*.
- Interface Box must be set up with **Format=0** (standard format) and **IMode=NORMAL** (Normal mode).

This section covers acquiring real-time data with Seasave and processing data with SBE Data Processing.

- Seasave saves the data in the format (data format and header) required by SBE Data Processing. If you use other software to acquire data, the data will not be in the format required by SBE Data Processing.

See *Connections, Switches, and LEDs* in *Section 2: Interface Box Description* for wiring details.

Acquiring Real-Time Data with Seasave

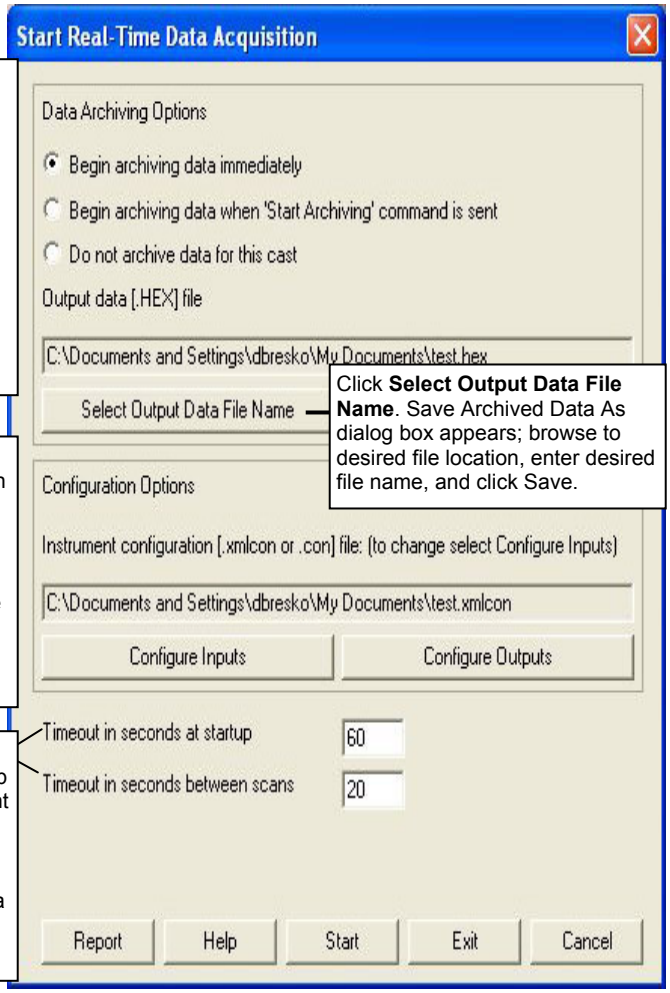
Notes:
- If the system includes an SBE 38 remote temperature sensor, Seasave uses the remote temperature data when calculating density and sound velocity.
- The baud between the Interface Box and computer (defined in Configure Inputs, on the serial Ports tab) must agree with the baud programmed into the Box with **PCBaud=**.

1. Turn on power to the Interface Box. The SBE 45 will start sampling and transmitting data to the Interface Box. Data will not appear in Seasave until you tell Seasave to start real-time data acquisition below.
2. Double click on Seasave.exe.
3. Perform any desired setup in the Configure Inputs, Configure Outputs, and Display menus.
4. In the Real-Time Data menu, select *Start*. The dialog box looks like this:

Data Archiving Options:
- **Begin archiving data immediately** to store raw (frequencies, A/D counts, and/or voltages) real-time data as soon as Start button is clicked and communication is established.
- **Begin archiving data when 'Start Archiving' command is sent** to control when data begins to be written to file. If you make this selection, when you click Start button and communication is established, a dialog box with Start Archiving button appears. Click this button when ready to begin saving scans to file, or select Start Archiving in Real-Time Data menu.
- **Do not archive data for this cast** to not save data to a file. Real-time data will still appear in displays.

Configuration Options: Currently selected instrument configuration (.xmlcon or .con) file is shown, containing information on which parameters are output by SBE 45, SBE 45 data output rate, and whether NMEA and SBE 38 data are appended to data stream. To modify input configuration (.xmlcon or .con file, serial port, water sampler, TCP/IP ports, and/or miscellaneous), click Configure Inputs. To modify outputs (serial data output, shared file output, mark variables, TCP/IP output, TCP/IP ports, SBE 14 remote display, PC alarms, header form and/or diagnostics), click Configure Outputs.

- **Timeout in seconds at startup**: Time allowed before first data scan is received from instrument. Seasave will *time out* and stop attempting to acquire data if data is not received from instrument within this time period.
- **Timeout in seconds between scans**: Maximum **gap** allowed between scans after first data scan is received from instrument. Seasave will *time out* and stop attempting to acquire data if data is not received from instrument within this time period, Seasave stops attempting to acquire data after this gap).



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

5. In the Start Real-Time Data Acquisition dialog box, click *Start*.
   A. If you selected *Begin archiving data immediately* or *Begin archiving data when 'Start Archiving' command is sent* above, and selected *Prompt for Header Information* in the Header Form setup (Configure Outputs), the Header Information dialog box appears. Fill in the desired header and click OK.

   B. If you selected *Check Scan Length* in the Options menu, Seasave checks the configuration (.xmlcon or .con) file to verify that the scan length defined by the configuration file matches the SBE 45 (i.e., number of outputs and inclusion of NMEA is as defined in the configuration file). If a *Scan length error* appears, verify that:
      - You are using the correct .xmlcon or .con file.
      - The .xmlcon or .con file has been updated as necessary if you added or deleted the SBE 38, added or deleted NMEA, etc.

   C. Seasave sends a message: *Waiting for data . . .*. Seasave will *time out* if data is not received within *Timeout in seconds at startup*.

   D. Real-time data then starts appearing in the screen display(s).

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

7. Stop the SBE 45 sampling by turning off power to the Interface Box.

Processing Data with SBE Data Processing

Note:
See the SBE Data Processing manual and/or Help files.

1. Convert the .hex data file created by Seasave to a .cnv file in SBE Data Processing's Data Conversion module.

2. Once the data is converted, it can be further processed and plotted in SBE Data Processing's other modules. Note that if the data stream includes SBE 38 remote temperature data, SBE Data Processing's Data Conversion and Derive modules use the remote temperature data when calculating density and sound velocity.

Section 5: Routine Maintenance

To clean the Interface Box:

1. Disconnect the power and any other cables from the Interface Box.

2. Using a soft cotton cloth dampened with warm water, clean the exterior of the Interface Box with gentle pressure. Use special care cleaning around any connectors, to avoid getting water into them.

3. Wait until the Interface Box is completely dry before reconnecting power cables and other electrical connections.

Section 6: Troubleshooting

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

Problem 1: Unable to Communicate with Interface Box

The Interface Box message prompt indicates that communications between the Interface Box and computer have been established. Before proceeding with troubleshooting, attempt to establish communications again by clicking the Connect button 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 Interface Box 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 45* 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 Interface Box permits connection to the DB-9P input connectors used on standard RS-232 interfaces.

Problem 2: Unable to Communicate with SBE 45 through Interface Box

In SEATERM, while communicating with the Interface Box, send **Connect45**. The following message should appear:

```
connected to SBE 45 . . .
```

This indicates that communications between the Interface Box and SBE 45 have been established. If this messages does not appear:

Cause/Solution 1: The cable connection may be loose. Check the cabling between the SBE 45 and Interface Box for a loose connection.

Cause/Solution 2: The cable between the SBE 45 and Interface Box may not be the correct one. Verify that the cable is the correct one.

Cause/Solution 3: The instrument type and/or its communication settings may not have been entered correctly in SEATERM. Select *SBE 45* 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 4: The baud rate for communication between the SBE 45 and Interface Box may not match. The SBE 45's baud rate (set with **Baud=** when directly communicating with the SBE 45) must be the same as the baud rate set in the Interface Box with **45Baud=**.

Note:
If applicable, see *Problem 6: Changing SBE 45 and/or SBE 38 Baud Rate without Cables for Direct Connection* below.

Cause/Solution 5: The SBE 45 baud rate may be too high. The baud rate for communication between the Interface Box and computer must be greater than the baud rate between the Interface Box and SBE 45.

- Increase the Interface Box baud rate using **PCBaud=**. **Or**
- Connect the SBE 45 directly to the computer and decrease its baud rate using **Baud=**. Then, with the Interface Box connected to the computer, use **45Baud=** to match the baud set in the SBE 45.

Problem 3: Unable to Communicate with SBE 38 through Interface Box

In SEATERM, while communicating with the Interface Box, send **Connect38**. The following message should appear:

```
connected to SBE 38 . . .
```

This indicates that communications between the Interface Box and SBE 38 have been established. If this messages does not appear:

Cause/Solution 1: The cable connection may be loose. Check the cabling between the SBE 38 and Interface Box for a loose connection.

Cause/Solution 2: The cable between the SBE 38 and Interface Box may not be the correct one. Verify that the cable is the correct one.

Cause/Solution 3: The baud rate for communication between the SBE 38 and Interface Box may not match. The SBE 38's baud rate (set with **Baud=** when directly communicating with the SBE 38) must be the same as the baud rate set in the Interface Box with **38Baud=**.

Note:
If applicable, see *Problem 6: Changing SBE 45 and/or SBE 38 Baud Rate without Cables for Direct Connection* below.

Cause/Solution 4: The SBE 38 baud rate may be too high. The baud rate for communication between the Interface Box and computer must be greater than the baud rate between the Interface Box and SBE 38.

- Increase the Interface Box baud rate using **PCBaud=**. **Or**
- Connect the SBE 38 directly to the computer and decrease its baud rate using **Baud=**. Then, with the Interface Box connected to the computer, use **38Baud=** to match the baud set in the SBE 38.

Problem 4: Unable to Communicate with NMEA Navigation Device through Interface Box

See *Appendix I: NMEA Data* for NMEA troubleshooting.

Problem 5: Nonsense or Unreasonable Data

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

Cause/Solution 1: A data file with nonsense values may be caused by incorrect instrument configuration in the .xmlcon or .con file. Verify the settings in the configuration file match your system.

Cause/Solution 2: Unreasonable values may be caused by incorrect calibration coefficients programmed into the instrument. Verify the calibration coefficients in the SBE 45 and (optional) SBE 38 match the Calibration Certificates. To verify calibration coefficients, use **DC** while communicating with each instrument (either directly connected to the computer or through the Interface Box) in SEATERM.

Cause/Solution 3: Unreasonable values may be caused by setting the SBE 45's output format to **OutputFormat=2**, which is incompatible with the Interface Box. Verify that the SBE 45 is set to **OutputFormat=0** or **OutputFormat=1** by sending **DS** while communicating with the SBE 45 (if the SBE 45 is set to **OutputFormat=2**, the last line of the **DS** response shows *conductivity and salinity order reversed*).

Problem 6: Changing SBE 45 and/or SBE 38 Baud Rate without Cables for Direct Connection

Note:
If you have a cable for direct connection of the SBE 45 to the computer and the SBE 38 to the computer, see *Setting Up Instruments* in *Section 3: Setting Up System* to change the baud rates.

The baud rate for communication between the Interface Box and computer must be greater than the baud rate between the Interface Box and SBE 45 and baud rate between the Interface Box and the SBE 38. If you need to change the baud rate in the SBE 45 and/or SBE 38 for compatibility with the Interface Box, this procedure allows you to change the baud rate while the instrument is communicating through the Interface Box. The procedure is written assuming that the SBE 45 and SBE 38 are set to 9600 baud, but that you want the computer to communicate with the Interface Box at 9600 baud.

In SEATERM:

1. Establish communications with the Interface Box, as described in Steps 1 through 4 in *Communications Test and Setup* in *Section 3: Setting Up System*.

2. With the Interface Box in Normal mode, send **PCBaud=19200** to change the baud rate between the Interface Box and the computer to 19200.

3. In the Configure menu, select the SBE 45 and set the baud rate to 19200. Turn power to the Interface Box off, and then on again. The Interface Box is now communicating at 19200 baud.

4. To modify the SBE 45 baud rate:
   A. Send **45Baud=9600** to set the baud rate in the Interface Box for communication with the SBE 45 to 9600.
   B. Send **Connect45** to communicate with the SBE 45.
   C. If the SBE 45 is sampling data, stop sampling by sending **Stop** (you may need to send the command several times).
   D. Send **Baud=4800** to set the SBE 45 baud rate to 4800.
   E. Type @ to return to Normal mode for communication with the Interface Box.
   F. Send **45Baud=4800** to set the baud rate in the Interface Box for communication with the SBE 45 to 4800.

5. To modify the SBE 38 baud rate:
   A. Send **38Baud=9600** to set the baud rate in the Interface Box for communication with the SBE 38 to 9600.
   B. Send **Connect38** to communicate with the SBE 38.
   C. If the SBE 38 is sampling data, stop sampling by sending **Stop** (you may need to send the command several times).
   D. Send **Baud=4800** to set the SBE 38 baud rate to 4800.
   E. Type @ to return to Normal mode for communication with the Interface Box.
   F. Send **38Baud=4800** to set the baud rate in the Interface Box for communication with the SBE 45 to 4800.

6. Send **PCBaud=9600** to change the baud rate between the Interface Box and the computer to 9600.

7. In the Configure menu, select the SBE 45 and set the baud rate to 9600. Turn power to the Interface Box off, and then on again. The Interface Box is now communicating with the computer at 9600 baud. If the SBE 45 and SBE 38 are set up to begin sampling when power is applied, data will appear.

Glossary

NMEATest – Sea-Bird's NMEA message simulation program, which simulates NMEA messages for testing purposes. NMEATest is installed as part of the SBE Data Processing installation.

PCB – Printed Circuit Board.

SBE 45 MicroTSG – High-accuracy conductivity and temperature monitor.

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

Scan – One data sample containing temperature and conductivity, as well as data from auxiliary sensors.

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

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

SEATERM – Sea-Bird's Win 95/98/NT/2000/XP terminal program used to communicate with the Interface Box and/or the SBE 45. SEATERM can send commands to provide status display, data acquisition setup, data display and capture, and diagnostic tests.

Safety and Electrical Symbols

Some or all of the following symbols may be used on the Interface Box:

Symbol	Description
	Potentially hazardous voltage.
	Hazardous! Voltage > 30 VDC may be present.
	Attention! There is a potential hazard; consult the manual before continuing.
	DC (Direct Current).
	Double insulated. The metal enclosure of the Interface Box is isolated such that protection from electrical shock is provided through reinforced electrical insulation.
	Static awareness. Static discharge can damage part(s).
	Protective earthing terminal.

Appendix I: NMEA Data

NMEA Raw Message Formats

The Interface Box can interpret NMEA data from a NMEA navigation device if the data is in one of the following formats:

Notes:
- -- represents two device-specific characters.
- See the table below for definitions of message parameters.
- <CR> is carriage return.
- <LF> is line feed.

GGA - Global Positioning System Fix Data
Time, position, and fix-related data for a GPS receiver.
$--GGA,hhmmss.ss,llll.ll,a,yyyyy.yy,b,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh<CR><LF>

GLL - Geographic Position - Latitude/Longitude
Latitude and Longitude of present position, time of position fix, and status.
$--GLL,llll.ll,a,yyyyy.yy,b,hhmmss.ss,A*hh<CR><LF>

RMA - Recommended Minimum Specific Loran-C Data
Position, course, and speed data provided by a LORAN-C receiver.
$--RMA,A,llll.ll,a,yyyyy.yy,b,x.x,x.x,x.x,x.x,x.x,a*hh<CR><LF>

RMC - Recommended Minimum Specific GPS/TRANSIT Data
Time, date, position, course, and speed data provided by a GPS or TRANSIT navigation receiver.
$--RMC,hhmmss.ss,A,llll.ll,a,yyyyy.yy,b,x.x,x.x,ddmmyy,x.x,a*hh<CR><LF>

TRF - TRANSIT Fix Data
Time, date, position, and information related to a TRANSIT fix.
$--TRF,hhmmss.ss,ddmmyy,llll.ll,a,yyyyy.yy,b,x.x,x.x,x.x,x.x,xxx,A*hh<CR><LF>

where

Field Type	Symbol	Definition
Status	A	Single character field: A = Yes, data valid, warning flag clear V = No, data invalid, warning flag set
Latitude	llll.ll	Fixed/Variable length field: degrees|minutes.decimal - 2 fixed digits of degrees, 2 fixed digits of minutes, and variable number of digits for decimal-fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. Decimal point and associated decimal-fraction are optional if full resolution not required.
	a	N or S
Longitude	yyyyy.yy	Fixed/Variable length field: degrees|minutes.decimal - 3 fixed digits of degrees, 2 fixed digits of minutes, and variable number of digits for decimal-fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. Decimal point and associated decimal - fraction optional if full resolution not required.
	b	E or W
Time	hhmmss.ss	Fixed/variable length field: hours|minutes|seconds.decimal - 2 fixed digits of hours, 2 fixed digits of seconds, and variable number of digits for decimal-fraction of seconds. Leading zeros always included for hours, minutes, and seconds to maintain fixed length. Decimal point and associated decimal-fraction optional if full resolution not required.
Checksum	*	Optional Checksum Delimiter.
	hh	Optional Checksum Field: Absolute value calculated by exclusive OR'ing 8 data bits (no start or stop bits) of each character in message, between, but excluding *$* and *.

Troubleshooting NMEA

Problem 1: Yellow *NMEA* LED Not Flashing

Cause/Solution 1: Wiring may be incorrect. Check cables and connections between the Interface Box, NMEA navigation device, and computer.

Cause/Solution 2: NMEA navigation device may be set to the wrong communication parameters (Interface Box requires 4800 or 9600 baud, 8 data bits, 1 stop bit, and no parity). Reset device's communication parameters. Verify that the baud rate in the Interface Box for communication with the NMEA navigation device is set to match (**NMEABaud=**), and that the baud rate is less than the baud rate for communication between the Interface Box and the computer.

Cause/Solution 3: NMEA navigation device may not be transmitting data. See the device manual for setup details. To verify that it is sending data, connect an oscilloscope with ground on NMEA B (T17) and the probe on NMEA A (T16). The signal should be less than 0.5 volts between messages and have pulses greater than 4 volts for at least 0.2 milliseconds during the message.

Cause/Solution 4: Interface Box may not be operating properly. To verify, use the simulation program supplied with SEASOFT V2. This program simulates a NMEA navigation device transmitting a NMEA message. See *NMEA Message Simulation Program* for details.

Problem 2: Yellow *NMEA* LED Flashing, but Lat/Lon Data Not Displaying

Cause/Solution 1: NMEA navigation device may be transmitting NMEA messages in a format that cannot be interpreted by the Interface Box. To verify, view the raw NMEA messages:

1. With the Interface Box running in Normal mode, type **ConnectNMEA** and press the Enter key to switch to NMEA mode. The display looks like this:

```
Decode NMEA messages, press @ or Esc to return to normal mode
```

2. The ***raw*** NMEA data should begin scrolling on the screen, followed by the ***decoded*** data. A typical RMC NMEA message is:

```
NMEA: $LGRMC,123113.21,A,3625.12,N,12121.34,W,1.2,4.5,231294,1.2,a*45<CR><LF>
Decoded: , lat=36 25.12 N, lon=121 21.34 W, hms=123113, dmy=231294
```

See *NMEA Raw Message Formats* for a description of all the NMEA messages the Interface Box can decode.

- **If a different NMEA message is received than the Interface Box is set up to decode**, reconfigure your NMEA navigation device to transmit GGA, GLL, RMA, RMC, or TRF.

- **If no NMEA messages are received in NMEA mode**, the problem could be in the Interface Box, cable, or NMEA navigation device. Verify that the Interface Box is operating properly using the simulation program supplied with SEASOFT V2. This program simulates a NMEA navigation device transmitting a NMEA message. See *NMEA Message Simulation Program* for details.

3. Type @ to return to Normal mode.

NMEA Simulation Program

Sea-Bird provides a NMEA message simulation program, NMEATest, as a troubleshooting aid. NMEATest, part of the SEASOFT V2 package, simulates a NMEA navigation device transmitting NMEA messages. If the system does not work with the NMEA navigation device, but works with NMEATest, the problem is with the interface cable from the NMEA navigation device to the Interface Box or in the NMEA navigation device itself.

NMEATest is just a simulation, and does not provide an actual data stream from an actual NMEA navigation device. The data transmission baud rate (4800 or 9600) and time between messages are user-programmable. The NMEA message format (RMA, RMC, GLL, or GGA) generated by the program is also user-programmable. Alternatively, the user can specify an existing raw NMEA data file to use for the simulation; see *NMEA Raw Message Formats* for the required raw data format.

Note:
You can also run the simulation using only one computer, if the computer has a spare COM port.

To execute the simulation program, a **second computer** (computer 2) is needed to emulate the NMEA navigation device. A laptop computer is adequate for this purpose. Install NMEATest on computer 2 (NMEATest is part of the SBE Data Processing installation).

Note:
The Interface Box must be connected to the SBE 45 to test the Box, because the Box only transmits a scan of data when data is received from the SBE 45.

Use the NMEA Interface test cable (PN 801422 - supplied with the Interface Box) to connect the Interface Box to the simulation computer. The simulation test cable connections are:

MS-3106A12S-3S	DB-9S	Function
Pin A	Pin 3	NMEA *A* (signal)
Pin B	Pin 5	NMEA *B* (signal return)

Proceed as follows (instructions are written assuming you are using a second computer to emulate the NMEA navigation device):

1. On computer 1, double click on **Seaterm.exe**.

2. Turn on power to the Interface Box. SEATERM displays:
   ```
   SBE 45 Junction Box V 1.4
   ```
   Data from the SBE 45 should begin scrolling on the screen.

3. On computer 2, double click on **nmeatest.exe** (in same directory as SBE Data Processing). The NMEATest screen appears.

4. On the NMEATest screen, click on the Configure menu. The Configure dialog box appears. Select:
   - NMEA message to be simulated (RMA, RMC, GLL, or GGA) **or** select an existing NMEA data file on your computer by clicking *Send File* and browsing to the desired file
   - Baud rate (4800 or 9600) for transmission of simulated NMEA data to Interface Box – **must be less than baud rate between Interface Box and computer 1**
   - COMM port on computer 2 for transmission of NMEA data to Interface Box
   - Message interval (time between simulated messages to be transmitted to Interface Box)

   Click OK.

5. On the NMEATest screen, click Start. NMEA data should begin to display on the NMEATest screen. Additionally, NMEA data should begin to display appended to the SBE 45 data in SEATERM on computer 1. The yellow *NMEA* LED should flash on the Interface Box each time the simulation program transmits a new position. The appended data should correspond to the most recent simulation program data. For example, if NMEATest is set to output RMC data:

NMEATest output -
```
RMC: 2212.345,N, 04459.876,E, 15 May 2002 00:00:22
```

SEATERM output (appended after SBE 45 data and optional SBE 38 data) -
```
lat=22 12.345 N, lon=044 59.877 E, hms=000022, dmy=150502
```

See *NMEA Raw Message Formats* for the NMEA message formats.

If properly decoded data appears in SEATERM, the Interface Box is working properly. If the system works with the simulation program but does not work when connected to the actual NMEA navigation device, the problem is with the cable from the NMEA navigation device to the Interface Box, or in the NMEA navigation device itself.

- Verify that the cable pinouts are correct, especially at the NMEA navigation device. See *Connections, Switches, and LEDs* in *Section 2: Interface Box Description* and also refer to the NMEA navigation device documentation.
- If the cable is correct, verify that the NMEA navigation device is on and is configured to send data. Many NMEA navigation devices have programmable NMEA outputs and may need to be configured before they will transmit NMEA messages. Refer to the NMEA navigation device documentation, or contact the device's manufacturer for customer support.

Appendix II: Replacement Parts

Part Number	Part	Application Description	Quantity
171887	DB-9P to DB-9S cable, 3 m (10 ft)	From Interface Box to computer	1
171888	25-pin DB-25S to 9-pin DB-9P cable adapter	For use with computer with DB-25 connector	-
801216	4-pin MCIL-4MP to 4-pin MS3106A-14S-2P cable, 2.5 m (8 ft) long	From SBE 45 to Interface Box	1
80437 or 80438	4-pin RMG-4FS to 4-pin MS-3106A-14S-2P: 80437 – 2.5 m (8 ft) 80438 – 10 m (33 ft)	From SBE 38 to Interface Box	1
801422	2-pin MS-3106A-12S-3S to 9-pin DB-9S NMEA Interface test cable, 1.8 m (6 ft)	From *NMEA* on Interface Box to computer running NMEA simulation program for test purposes	1
17015	Interface Box **AC** power cable	Connect Interface Box to **AC** power source	1
17315	MS-3106A12S-3S connector	2-pin *NMEA* connector to Interface Box	1
17316	MS3057-4A clamp	Assembled to 17315	1
17317	MS-3420-4 boot	Assembled to 17315	1
17412	MS-3106A-14S-2P	4-pin *SBE 45* and *SBE 38* connector to Interface Box	2
17413	Clamp	Assembled to 17412	2
17414	Boot	Assembled to 17412	2
17671	MS-3106A-12S-3S	2-pin *NMEA* connector	1
17413	Clamp	Assembled to 17671	1
17414	Boot	Assembled to 17671	1

Index

.

.con file · 19
.xmlcon file · 19

B

Baud rate · 7

C

Cleaning · 22
Commands
  baud rate · 14
  diagnostic · 16
  mode · 15
  output format · 16
  sampling · 16
  status · 14
Communications · 7, 12
Configuration file · 19
Connections · 8

D

Data acquisition · 20
Data format · 9
Data processing · 21
Description · 6

E

Electrical symbols · 26

F

Format · 9

G

Glossary · 26

I

Installing software · 10
Instrument setup · 17

L

LEDs · 8

M

Maintenance · 22

N

NMEA · 18
  baud rate · 14, 18
  mode · 15, 18
  raw message formats · 27
  simulation program · 29
  troubleshooting · 28
NMEATest · 6, 10, 29

O

Operating system · 20

P

Parts
  replacement · 31
Power-up
  mode · 15
Processing data · 21

R

Real-time acquisition · 20
Replacement parts · 31
Routine maintenance · 22

S

Safety symbols · 26
SBE 38 · 17
  baud rate · 14, 17
  mode · 15, 17
  setup · 17
SBE 45 · 17
  baud rate · 14, 17
  mode · 15, 17
  setup · 17
SBE Data Processing · 6, 10, 19, 21
Seasave · 6, 10, 19, 20
SEASOFT · 6, 10
SEATERM · 6, 10
Setting up instruments · 17
Setup · 11
Simulation program · 29
Software · 6, 10
Specifications · 7
System
  communications · 7
  description · 6
  operation · 20
  wiring · 8

T

Testing · 11
Troubleshooting · 28

U

Unpacking · 5

W

Wiring · 8

CALIBRATION SHEETS

SBE 45 Temperature Calibration - S/N 0402..... 1

SBE 45 Conductivity Calibration - S/N 0402..... 2

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SENSOR SERIAL NUMBER: 0402
CALIBRATION DATE: 31-Jan-12

SBE 45 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

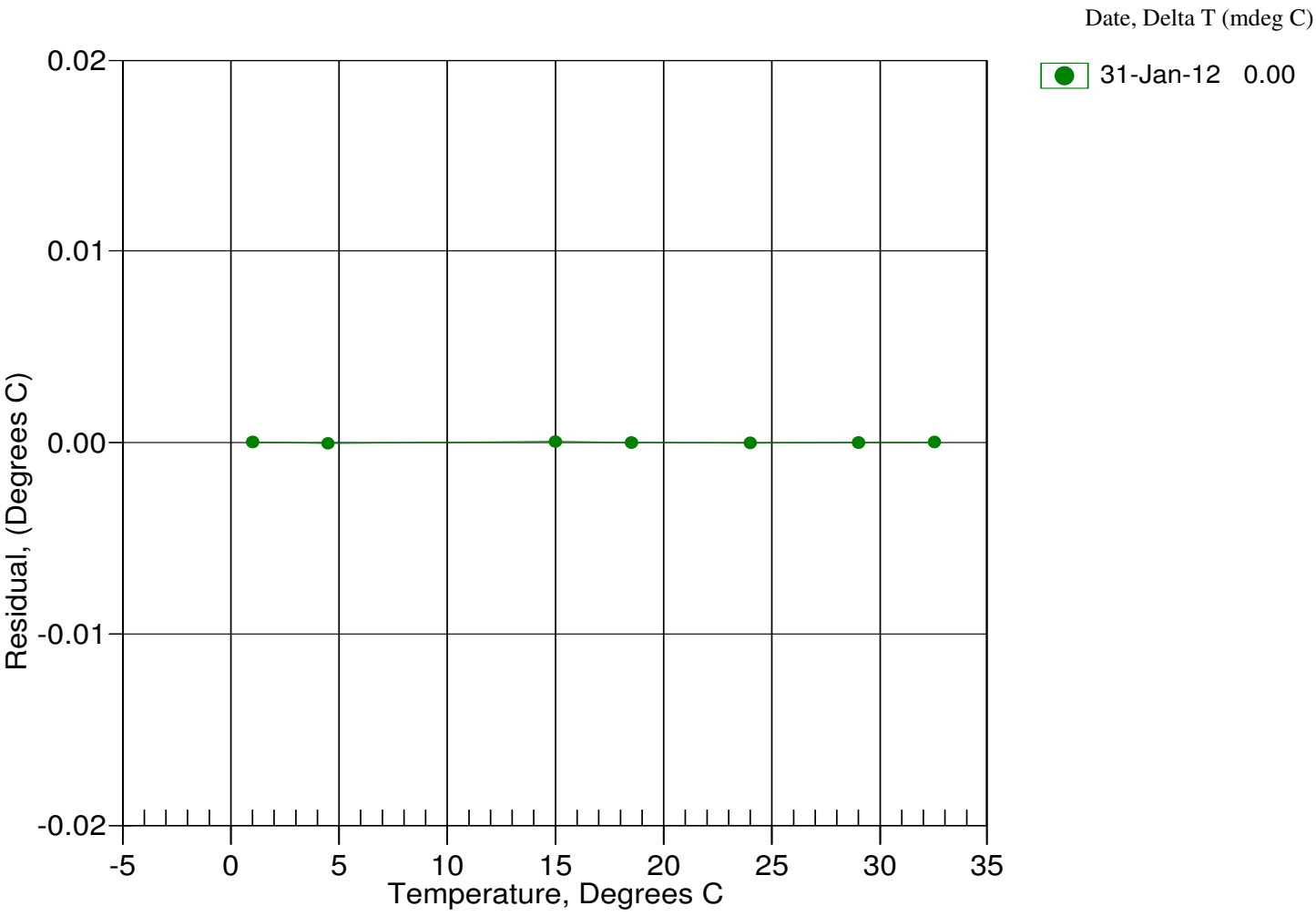
ITS-90 COEFFICIENTS

a0 = 5.724520e-005
a1 = 2.658577e-004
a2 = -1.827700e-006
a3 = 1.335867e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	744013.0	1.0000	0.0000
4.5000	634618.6	4.5000	-0.0000
15.0000	401693.2	15.0000	0.0000
18.5000	347069.1	18.5000	-0.0000
24.0000	277505.6	24.0000	-0.0000
29.0001	227834.0	29.0001	-0.0000
32.5001	199120.0	32.5001	0.0000

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

Residual = instrument temperature - bath temperature



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SENSOR SERIAL NUMBER: 0402
CALIBRATION DATE: 31-Jan-12

SBE 45 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g = -9.795662e-001
h =  1.448786e-001
i = -4.310804e-004
j =  5.434011e-005

CPcor = -9.5700e-008
CTcor =  3.2500e-006
WBOTC =  1.5981e-007
```

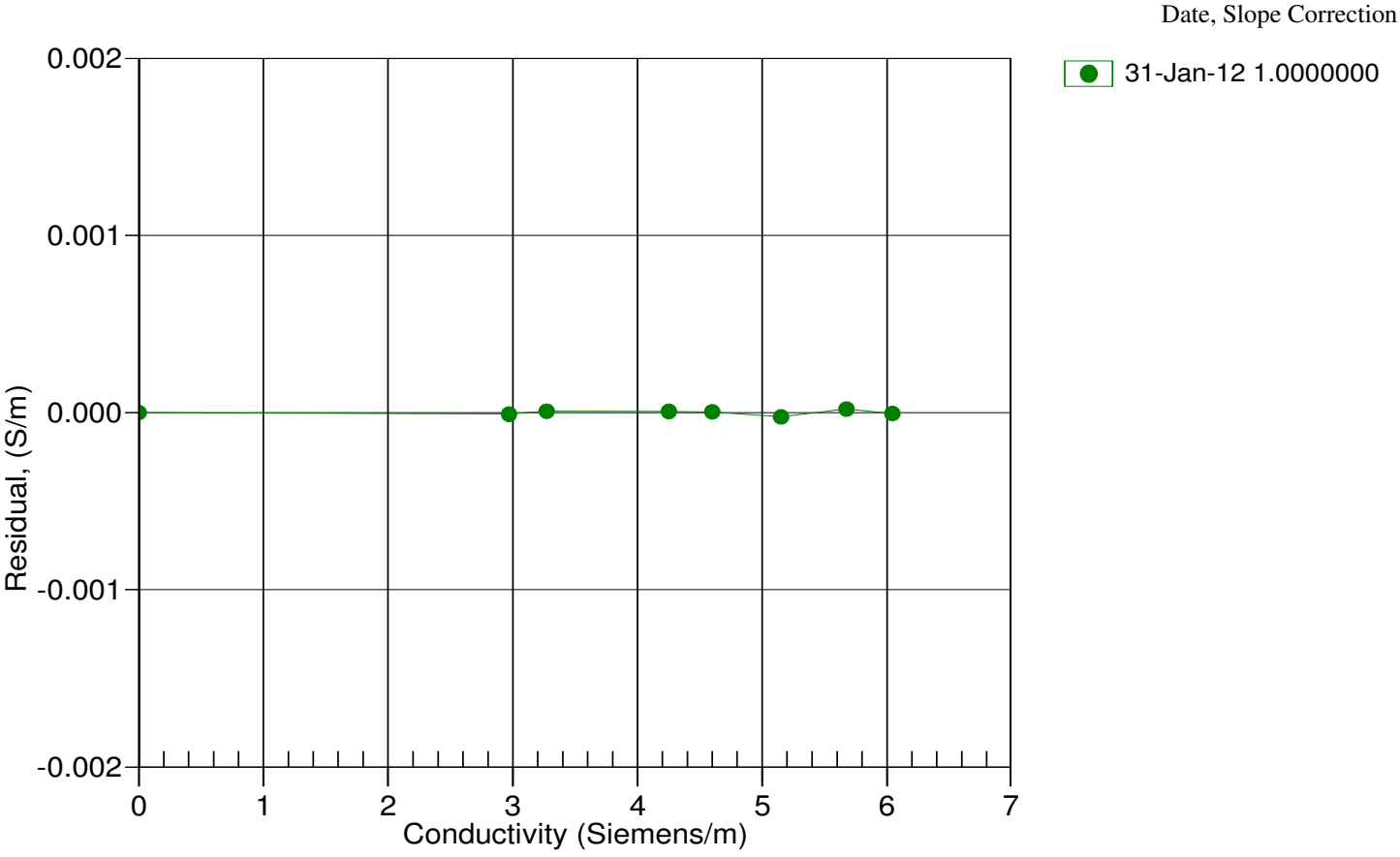
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2607.04	0.00000	0.00000
1.0000	34.7095	2.96770	5233.60	2.96770	-0.00001
4.5000	34.6893	3.27392	5432.28	3.27393	0.00001
15.0000	34.6465	4.25298	6022.85	4.25299	0.00001
18.5000	34.6376	4.59721	6216.85	4.59722	0.00000
24.0000	34.6279	5.15369	6517.91	5.15367	-0.00002
29.0001	34.6228	5.67419	6787.08	5.67421	0.00002
32.5001	34.6205	6.04571	6972.59	6.04570	-0.00001

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity



APPLICATION NOTES

Appnote 2D Conductivity..... 1

Appnote 6 Sound Velocity..... 6

Appnote 10 Conductivity..... 8

Appnote 14 1978 Practical Salinity Scale..... 10

Appnote 31 Coefficient Corrections..... 12

Appnote 42 ITS-90 Temperature Scale..... 19

Appnote 68 USB Ports..... 20

Appnote 71 Desiccant Use and Regeneration..... 21

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APPLICATION NOTE NO. 2D **Revised October 2010**

Instructions for Care and Cleaning of Conductivity Cells

This application note presents new recommendations (as of October 2006), based on our recent research, for cleaning and storing conductivity sensors. In the past, Sea-Bird had recommended cleaning and storing conductivity sensors with a Triton X-100 solution, and cleaning conductivity sensors with an acid solution. **Our latest research leads us to recommend adding the use of a dilute bleach solution to eliminate growth of bio-organisms, and eliminating the use of acid in most cases**.

The application note is divided into three sections:
- General discussion
- Rinsing, cleaning, and storage procedures
- Cleaning materials

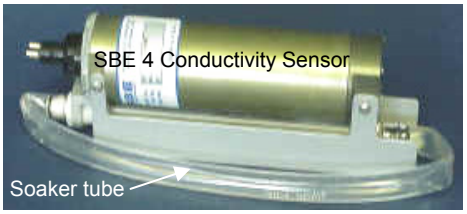
General Discussion

Since any conductivity sensor's output reading is proportional to its cell dimensions, it is important to keep the cell clean of internal coatings. Also, cell electrodes contaminated with oil, biological growths, or other foreign material will cause low conductivity readings. A desire to provide better control of growth of bio-organisms in the conductivity cell led us to develop revised rinsing and cleaning recommendations.
- A dilute bleach solution is extremely effective in controlling the growth of bio-organisms in the conductivity cell. Lab testing at Sea-Bird indicates no damaging effect from use of a dilute bleach solution in cleaning the conductivity cell. Sea-Bird now recommends cleaning the conductivity sensor in a bleach solution.
- Triton X-100 is a mild, non-ionic surfactant (detergent), valuable for removal of surface and airborne oil ingested into the CTD plumbing as the CTD is removed from the water and brought on deck. Sea-Bird had previously recommended, and continues to recommend, rinsing and cleaning the conductivity sensor in a Triton solution.
- Sea-Bird had previously recommended acid cleaning for eliminating bio-organisms or mineral deposits on the inside of the cell. However, bleach cleaning has proven to be effective in eliminating growth of bio-organisms; bleach is much easier to use and to dispose of than acid. Furthermore, data from many years of use shows that mineral deposits are an unusual occurrence. Therefore, Sea-Bird now recommends that, in most cases, acid should not be used to clean the conductivity sensor. ***In rare instances***, acid cleaning may still be required for mineral contamination of the conductivity cell. ***Sea-Bird recommends that you return the equipment to the factory for this cleaning if it is necessary***.

Sea-Bird had previously recommended storing the conductivity cell filled with water to keep the cell wetted, unless the cell was in an environment where freezing is a possibility (the cell could break if the water freezes). However, no adverse affects have been observed as a result of dry storage, if the cell is rinsed with fresh, clean water before storage to remove any salt crystals. This leads to the following revised conductivity cell storage recommendations:
- Short term storage (less than 1 day, typically between casts): If there is no danger of freezing, store the conductivity cell with a dilute bleach solution in Tygon tubing looped around the cell. If there is danger of freezing, store the conductivity cell dry, with Tygon tubing looped around the cell.
- Long term storage (longer than 1 day): Since conditions of transport and long term storage are not always under the control of the user, we now recommend storing the conductivity cell dry, with Tygon tubing looped around the cell ends. Dry storage eliminates the possibility of damage due to unforeseen freezing, as well as the possibility of bio-organism growth inside the cell. Filling the cell with a Triton X-100 solution for 1 hour before deployment will *rewet* the cell adequately.

Note that the Tygon tubing looped around the ends of the conductivity cell, whether dry or filled with a bleach or Triton solution, has the added benefit of keeping air-borne contaminants (abundant on most ships) from entering the cell.

Rinsing, Cleaning, and Storage Procedures



Note: See *Cleaning Materials* below for discussion of appropriate sources / concentrations of water, Triton X-100, bleach, and tubing.

CAUTIONS:

- The conductivity cell is primarily glass, and can break if mishandled. Use the correct size Tygon tubing; using tubing with a smaller ID will make it difficult to remove the tubing, and the cell end may break if excessive force is used. **The correct size tubing for use in cleaning / storing all conductivity cells produced since 1980 is 7/16" ID, 9/16" OD**. Instruments shipped prior to 1980 had smaller retaining ridges at the ends of the cell, and 3/8" ID tubing is required for these older instruments.
- **Do not put a brush or object (e.g., Q-Tip) inside the conductivity cell to clean it or dry it.** Touching and bending the electrodes can change the calibration; large bends and movement of the electrodes can damage the cell.
- **If an SBE 43 dissolved oxygen (DO) sensor is plumbed to the CTD** - Before soaking the conductivity cell for more than 1 minute in Triton X-100 solution, **disconnect the tubing between the conductivity cell and DO sensor** to prevent extended Triton contact with the DO sensor membrane (extended Triton contact can damage the membrane). See *Application Note 64* for rinsing, cleaning, and storage recommendations for the SBE 43.
- **IDO MicroCATs** (37-SMP-IDO, 37-SIP-IDO, 37-IMP-IDO) have an integrated dissolved oxygen sensor. **Do not follow the rinsing, cleaning, and storage recommendations in this application note for IDO MicroCATs;** extended Triton contact with the DO sensor membrane can damage it, and the recommended solution temperature can cause a temporary increase in sensitivity. See *Application Note 64* for rinsing, cleaning, and storage recommendations for IDO MicroCATs.

Active Use (after each cast)

1. Rinse: Remove the plumbing (Tygon tubing) from the exhaust end of the conductivity cell. **Flush** the cell with a **0.1% Triton X-100** solution. **Rinse** thoroughly with **fresh, clean water** and drain.
   - If not rinsed between uses, salt crystals may form on the conductivity cell platinized electrode surfaces. When the instrument is used next, sensor accuracy may be temporarily affected until these crystals dissolve.
2. Store: The intent of these storage recommendations is to keep contamination from aerosols and spray/wash on the ship deck from harming the sensor's calibration.
   - ***No danger of freezing***: **Fill** the cell with a **500 – 1000 ppm bleach** solution, using a loop of Tygon tubing attached to each end of the conductivity sensor to close the cell ends.
   - ***Danger of freezing***: Remove larger droplets of water by blowing through the cell. **Do not use compressed air**, which typically contains oil vapor. Attach a loop of Tygon tubing to each end of the conductivity cell to close the cell ends.

Routine Cleaning (no visible deposits or marine growths on sensor)

1. **Agitate** a **500 – 1000 ppm Bleach** solution warmed to 40 °C through the cell in a washing action (this can be accomplished with Tygon tubing and a syringe kit – see *Application Note 34*) for **2 minutes**. **Drain and flush** with warm (not hot) fresh, clean water for **5 minutes**.
2. **Agitate** a **1%-2% Triton X-100** solution warmed to 40 °C through the cell many times in a washing action (this can be accomplished with Tygon tubing and a syringe kit). Fill the cell with the solution and let it **soak** for **1 hour**. **Drain and flush** with warm (not hot) fresh, clean water for **5 minutes**.

Cleaning Severely Fouled Sensors (visible deposits or marine growths on sensor)

Repeat the *Routine Cleaning* procedure up to 5 times.

Long-Term Storage (after field use)

1. Rinse: Remove the plumbing (Tygon tubing) from the exhaust end of the conductivity cell. **Flush** the cell with a **0.1% Triton X-100** solution. **Rinse** thoroughly with **fresh, clean water** and drain. Remove larger droplets of water by blowing through the cell. **Do not use compressed air**, which typically contains oil vapor.
2. Store: Attach a loop of Tygon tubing to each end of the conductivity cell to close the cell ends and prevent contaminants from entering the cell.
   - Storing the cell dry prevents the growth of any bio-organisms, thus preserving the calibration.
3. When ready to deploy again: **Fill** the cell with a **0.1% Triton X-100** solution for **1 hour** before deployment. Drain the Triton X-100 solution; there is no need to rinse the cell.

Cleaning Materials

Water

De-ionized (DI) water, commercially distilled water, or fresh, clean, tap water is recommended for rinsing, cleaning, and storing sensors.

- On ships, **fresh water is typically made in large quantities by a distillation process, and stored in large tanks. This water may be contaminated with small amounts of oil, and should not be used for rinsing, cleaning, or storing sensors**.

Where fresh water is in extremely limited supply (for example, a remote location in the Arctic), you can substitute **clean seawater** for rinsing and cleaning sensors. If not immediately redeploying the instrument, follow up with a **brief fresh water rinse** to eliminate the possibility of salt crystal formation (salt crystal formation could cause small shifts in calibration).

- **The seawater must be extremely clean, free of oils that can coat the conductivity cell. To eliminate any bio-organisms in the water, Sea-Bird recommends boiling the water or filtering it with a 0.5 micron filter.**

Triton X-100

Triton X-100 is Octyl Phenol Ethoxylate, a mild, non-ionic surfactant (detergent). Triton X-100 is included with every CTD shipment and can be ordered from Sea-Bird, but may be available locally from a chemical supply or lab products company. It is manufactured by Mallinckrodt Baker (see http://www.mallbaker.com/changecountry.asp?back=/Default.asp for local distributors). Other liquid detergents can probably be used, but scientific grades (with no colors, perfumes, glycerins, lotions, etc.) are required because of their known composition. It is better to use a non-ionic detergent, since conductivity readings taken immediately after use are less likely to be affected by any residual detergent left in the cell.

100% Triton X-100 is supplied by Sea-Bird; dilute the Triton as directed in *Rinsing, Cleaning, and Storage Procedures*.

Bleach

Bleach is a common household product used to whiten and disinfect laundry. Commercially available bleach is typically 4 % - 7% (40,000 – 70,000 ppm) sodium hypochlorite (Na-O-Cl) solution that includes stabilizers. Some common commercial product names are Clorox (U.S.) and eau de Javel (French).

Dilute to 500 – 1000 ppm. For example, if starting with 5% (50,000 ppm) sodium hypochlorite, diluting 50 to 1 (50 parts water to 1 part bleach) yields a 1000 ppm (50,000 pm / 50 = 1000 ppm) solution.

Tygon Tubing

Sea-Bird recommends use of Tygon tubing, because it remains flexible over a wide temperature range and with age. Tygon is manufactured by Saint-Gobain (see *www.tygon.com*). It is supplied by Sea-Bird, but may be available locally from a chemical supply or lab products company.

Keep the Tygon in a clean place (so that it does not pick up contaminants) while the instrument is in use.

Acid

In rare instances, acid cleaning is required for mineral contamination of the conductivity cell. ***Sea-Bird recommends that you return the equipment to the factory for this cleaning***. Information below is provided if you cannot return the equipment to Sea-Bird.

CAUTIONS:

- **SBE 37-IMP, 37-SMP, 37-SIP, 37-IMP-IDO, 37-SMP-IDO, or 37-SIP-IDO MicroCAT; SBE 49 FastCAT; SBE 52-MP Moored Profiler CTD; or other instruments with an integral, internal pump - Do not perform acid cleaning.** Acid cleaning may damage the internal, integral pump. Return these instruments to Sea-Bird for servicing if acid cleaning is required.
- **SBE 9*plus* or SBE 25 CTD** – Remove the SBE 4 conductivity cell from the CTD and remove the TC Duct before performing the acid cleaning procedure.
- **All instruments which include AF24173 Anti-Foulant Devices** – Remove the AF24173 Anti-Foulant Devices before performing the acid cleaning procedure. See the instrument manual for details and handling precautions when removing AF24173 Anti-Foulant Devices.

WARNING! Observe all precautions for working with strong acid. Avoid breathing acid fumes. Work in a well-ventilated area.

The acid cleaning procedure for the conductivity cell uses approximately 50 - 100 cc of acid. Sea-Bird recommends using a 20% concentration of HCl. However, acid in the range of 10% to full strength (38%) is acceptable.

If starting with a strong concentration of HCl that you want to dilute:
For each 100 cc of concentrated acid, to get a 20% solution, mix with this amount of water -
Water = [(conc% / 20%) – 1] * [100 + 10 (conc% / 20%)] cc
Always add acid to water; never add water to acid.

Example -- concentrated solution 31.5% that you want to dilute to 20%:
[(31.5% / 20%) – 1] * [100 + 10 (31.5% / 20%)] = 66.6 cc of water.
So, adding 100 cc of 31.5% HCl to 66.6 cc of water provides 166.6 cc of the desired concentration.
For 100 cc of solution:
100 cc * (100 / 166.6) = 60 cc of 31.5% HCl
66.6 cc * (100 / 166.6) = 40 cc of water

For acid disposal, dilute the acid heavily or neutralize with bicarbonate of soda (baking soda).

1. Prepare for cleaning:
   A. Place a 0.6 m (2 ft) length of Tygon tubing over the end of the cell.
   B. Clamp the instrument so that the cell is vertical, with the Tygon tubing at the bottom end.
   C. Loop the Tygon tubing into a U shape, and tape the open end of the tubing in place at the same height as the top of the glass cell.
2. Clean the cell:
   A. Pour **10% to 38% HCl** solution into the open end of the tubing until the cell is nearly filled. **Let it soak for 1 minute only.**
   B. Drain the acid from the cell and flush for 5 minutes with warm (not hot), clean, de-ionized water.
   C. Rinse the exterior of the instrument to remove any spilled acid from the surface.
   D. Fill the cell with a **1% Triton X-100** solution and let it stand for 5 minutes.
   E. Drain and flush with warm, clean, de-ionized water for 1 minute.
   F. Carefully remove the 0.6 m (2 ft) length of Tygon tubing.
3. Prepare for deployment, **or** follow recommendations above for storage.

Application Note Revision History

Date	Description
January 1998	Initial release.
October 2002	Remove reference to part number for the small anti-foul cylinders (which have been eliminated) in Tygon tubing.
January 2005	Change in recommendations. Clean with bleach solution as well as Triton. Acid cleaning is not recommended in general, but some information on acid is still provided for the few cases where it is necessary. A section on Materials added, defining water, Triton, etc. in more detail.
July 2005	Include information on common names of commercially available bleach
October 2006	Update manufacturer name and website link for Triton
September 2008	Add SBE 52-MP to list of instruments with integral, internal pump that should not have acid cleaning.
October 2010	- Add reference to IDO MicroCATs, with caution to following cleaning and storage procedures in Application Note 64 instead of in this application note. - Update address.

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APPLICATION NOTE NO. 6 **Revised August 2004**

DETERMINATION OF SOUND VELOCITY FROM CTD DATA

Use of CTD measurement for determination of sound velocity is appealing because these instruments are simpler and more rugged, and because their resolution, accuracy, and stability lead to far better **precision** than can be obtained with direct SV measuring devices. For example, specifications of 0.01 mS/cm conductivity, 0.01 degrees C temperature, and 1 meter in depth are readily achieved with good quality CTD equipment. Assuming that the relationship between C, T, and D *and* SV is exactly known (see below), the resulting uncertainty in SV would be as follows:

Error Type	Sound Velocity Error
temperature error of 0.01 deg C	0.021 meters/second
conductivity error of 0.01 mS/cm	0.011 meters/second
salinity error of 0.01 psu	0.012 meters/second
depth error of 1 meter	0.017 meters/second

The equivalent SV errors (considered at 15 degrees C, 42.9 mS/cm, 35 psu, and 0 pressure, i.e., typical open-ocean surface conditions) are much smaller than those usually claimed for direct-measurement instruments.

The question about the **absolute** accuracy of the inference of SV from CTD data is more difficult to answer. The main reason for this is apparently the result of differences in the instrumentation used by various researchers and is compounded by the difficulty of performing direct measurements of sound velocity under controlled conditions of temperature, salinity, and (especially) pressure. For example, three widely used equations (Wilson, 1959; Del Grosso, 1972; Millero and Chen, 1977) show differences in absolute sound speed on the order of 0.5 meters/second for various combinations of water temperature, salinity, and pressure, despite being based on careful measurements made under laboratory conditions.

The work of Millero and Chen is, however, the most modern, and it builds upon and attempts to incorporate the work of earlier investigators. Accordingly, the SV/CTD relationship described by these researchers in their paper of 1977 was used as a major component in the derivation of the Equation of State (Unesco technical papers in marine science no. 44). Millero and Chen's 1977 equation is also the one endorsed by the Unesco/SCOR/ICES/IASPO Joint Panel on Oceanographic Tables and Standards, which comprises the internationally recognized authority for measurements of ocean parameters (in Sea-Bird's SEASOFT software, users may select any of the 3 equations mentioned above).

Pike and Beiboer, 1993, made a careful comparison of algorithms used to calculate sound velocity. They concluded that use of the Wilson equation should be discontinued, and that the Chen and Millero algorithm should be used on the continental shelf while the Del Grosso formula is more appropriate for deep ocean waters and long path lengths. Their paper includes tables showing valid temperature and salinity ranges for each of the algorithms.

We draw the following conclusions from the research papers listed above:

1) Investigators using specialized equipment under scrupulously controlled laboratory conditions report measurements of SV vs. changes in temperature, salinity, and pressure which differ by 0.5 meters/second and more. *It is unrealistic to expect that commercial direct-measurement instruments will be more accurate under field conditions than the laboratory equipment used by successions of careful researchers.*

2) The claimed *accuracy* of commercial direct-measurement SV probes probably more legitimately represents their *precision* (compare with CTD/SV uncertainties tabulated above) rather than their absolute accuracy. The relationship between what these instruments read and true sound velocity is probably just as dependent on the same vagaries that are also the only significant sources of error when employing the CTD approach.

3) Because of the uncertainties in the time-delays associated with the acoustic transducers and electronics (and because of the difficulty of measuring with sufficient accuracy the length of the acoustic path), direct-measurement probes must be calibrated in water. As suggested by the research under controlled laboratory conditions, this is not an easy task, especially over a range of temperature, pressure, and salinity. On the other hand, a CTD probe can easily be calibrated using accepted methods.

4) A CTD can predict **absolute** SV to something better than 0.5 meters/second (a judgment seconded by Professor Millero in a private conversation), while its **relative accuracy** (precision) is probably better than 0.05 meters/second under the most demanding conditions of field use.

5) The very high precision associated with CTD measurements and the existence of an internationally accepted relationship (even if imperfect) between CTD and SV permits very consistent intercomparison and a high degree of uniformity among CTD-derived SV data sets, no matter when and where taken.

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APPLICATION NOTE NO. 10 **Revised March 2008**

COMPRESSIBILITY COMPENSATION OF SEA-BIRD CONDUCTIVITY SENSORS

Sea-Bird conductivity sensors provide precise characterization of deep ocean water masses. To achieve the accuracy of which the sensors are capable, an accounting for the effect of hydrostatic loading (pressure) on the conductivity cell is necessary. Conductivity calibration certificates show an equation containing the appropriate pressure-dependent correction term, which has been derived from mechanical principles and confirmed by field observations. The form of the equation varies somewhat, as shown below:

SBE 4, 9, 9*plus*, 16, 19, 21, 25, 26, 26*plus*, and 53 BPR

$$\text{Conductivity (Siemens/meter)} = \text{slope}\ \frac{(g + h f^2 + i f^3 + j f^4)/10}{1 + [\text{CTcor}]\, t + [\text{CPcor}]\, p} + \text{offset} \qquad \textbf{(recommended)}$$

or

$$\text{Conductivity (Siemens/meter)} = \text{slope}\ \frac{(a f^m + b f^2 + c + dt)/10}{1 + [\text{CPcor}]\, p} + \text{offset}$$

SBE 16*plus*, 16*plus*-IM, 16*plus* V2, 16*plus*-IM V2, 19*plus*, 19*plus* V2, 37, 45, 49, and 52-MP

$$\text{Conductivity (Siemens/meter)} = \text{slope}\ \frac{g + h f^2 + i f^3 + j f^4}{1 + [\text{CTcor}]\, t + [\text{CPcor}]\, p} + \text{offset}$$

where

- a, b, c, d, m, and CPcor are the calibration coefficients used for older sensors (prior to January 1995). Sea-Bird continues to calculate and print these coefficients on the calibration sheets for use with old software, but recommends use of the g, h, i, j, CTcor, CPcor form of the equation for most accurate results.
- g, h, i, j, CTcor, and CPcor are the calibration coefficients used for newer sensors.
  Note: The SBE 26, 26*plus*, and 53 BPR use the SBE 4 conductivity sensor, so both sets of calibration coefficients are reported on the calibration sheet. *SEASOFT for Waves* **for DOS**, which can be used with the SBE 26 only, only supports use of the a, b, c, d, CTcor, and CPcor coefficients. The current processing software for these instruments, *SEASOFT for Waves* **for Windows**, only supports use of the g, h, i, j, CTcor, CPcor coefficients.
- **CPcor is the correction term for pressure effects on conductivity (see below for discussion)**
- slope and offset are correction coefficients used to make corrections for sensor drift between calibrations; set to 1.0 and 0 respectively on initial calibration by Sea-Bird (see Application Note 31 for details on calculating slope and offset)
- f is the instrument frequency (kHz) for all instruments except the SBE 52-MP.
  For the SBE 52-MP, f = instrument frequency (kHz) * $(1.0 + \text{WBOTC} * t)^{0.5} / 1000.00$
- t is the water temperature (°C).
- p is the water pressure (decibars).

Sea-Bird CTD data acquisition, display, and post-processing software *SEASOFT for Waves* (for SBE 26, 26*plus*, and 53 only) and *SEASOFT* (for all other instruments) automatically implement these equations.

DISCUSSION OF PRESSURE CORRECTION

Conductivity cells do not measure the specific conductance (the desired property), but rather the conductance of a *specific geometry* of water. The ratio of the cell's length to its cross-sectional area (*cell constant*) is used to relate the measured conductance to specific conductance. Under pressure, the conductivity cell's length and diameter are reduced, leading to a lower indicated conductivity. The magnitude of the effect is not insignificant, reaching 0.0028 S/m at 6800 dbars.

The compressibility of the borosilicate glass used in the conductivity cell (and all other homogeneous, noncrystalline materials) can be characterized by E (Young's modulus) and ν (Poisson's ratio). For the Sea-Bird conductivity cell, $E = 9.1 \times 10^6$ psi, ν = 0.2, and the ratio of indicated conductivity divided by true conductivity is:

$1 + s$
where s = (CPcor) (p)
Typical value for CPcor is -9.57×10^{-8} for pressure in decibars **or** -6.60×10^{-8} for pressure in psi

Note: This equation and the mathematical derivations below deal only with the pressure correction term, and do not address the temperature correction term.

MATHEMATICAL DERIVATION OF PRESSURE CORRECTION

For a cube under hydrostatic load:

$\Delta L / L = s = -p (1 - 2 \nu) / E$
where

- p is the hydrostatic pressure
- E is Young's modulus
- ν is Poisson's ratio
- $\Delta L / L$ and s are strain (change in length per unit length)

Since this relationship is linear in the forces and displacements, the relationship for strain also applies for the length, radius, and wall thickness of a cylinder.

To compute the effect on conductivity, note that $R_0 = \rho L / A$, where R_0 is resistance of the material at 0 pressure, ρ is volume resistivity, L is length, and A is cross-sectional area. For the conductivity cell $A = \pi r^2$, where r is the cell radius. Under pressure, the new length is $L (1 + s)$ and the new radius is $r (1 + s)$. If R_p is the cell resistance under pressure:

$$R_p = \rho L (1 + s) / (\pi r^2 [1 + s]^2) = \rho L / \pi r^2 (1 + s) = R_0 / (1 + s)$$

Since conductivity is 1/R:

$C_p = C_0 (1 + s)$ and $C_0 = C_p / (1 + s) = C_p / (1 + [\text{Cpcor}] [p])$
where

- C_0 is conductivity at 0 pressure
- C_p is conductivity measured at pressure

A less rigorous determination may be made using the material's bulk modulus. For small displacements in a cube:

$\Delta V / V = 3\Delta L / L = -3p (1 - 2 \nu) / E$ or $\Delta V/V = -p / K$
where

- $\Delta V / V$ is the change in volume per volume or volume strain
- K is the bulk modulus. K is related to E and ν by $K = E / 3 (1 - 2 \nu)$.

In this case, $\Delta L / L = -p / 3K$.

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APPLICATION NOTE NO. 14 **January 1989**

1978 PRACTICAL SALINITY SCALE

Should you not be already familiar with it, we would like to call your attention to the January 1980 issue of the IEEE Journal of Oceanic Engineering, which is dedicated to presenting the results of a multi-national effort to obtain a uniform repeatable Practical Salinity Scale, based upon electrical conductivity measurements. This work has been almost universally accepted by researchers, and all instruments delivered by Sea-Bird since February 1982 have been supplied with calibration data based upon the new standard.

The value for conductivity at 35 ppt, 15 degrees C, and 0 pressure [C(35,15,0)] was not agreed upon in the IEEE reports -- Culkin & Smith used 42.914 mmho/cm (p 23), while Poisson used 42.933 mmho/cm (p 47). It really does not matter which value is used, provided that the same value is used during data reduction that was used to compute instrument calibration coefficients. Our instrument coefficients are computed using C(35,15,0) = 42.914 mmho/cm.

The PSS 1978 equations and constants for computing salinity from *in-situ* measurements of conductivity, temperature, and pressure are given in the 'Conclusions' section of the IEEE journal (p 14) and are reproduced back of this note. In the first equation, 'R' is obtained by dividing the conductivity value measured by your instrument by C(35,15,0), or 42.914 mmho/cm. Note that the PSS equations are based upon conductivity in units of mmho/cm, which are equal in magnitude to units of mS/cm. **If you are working in conductivity units of Siemens/meter (S/m), multiply your conductivity values by 10 before using the PSS 1978 equations**.

Also note that the equations assume pressure relative to the sea-surface. Absolute pressure gauges (as used in all Sea-Bird CTD instruments) have a vacuum on the reference side of their sensing diaphragms and indicate atmospheric pressure (nominally 10.1325 dBar) at the sea-surface. This reading must be subtracted to obtain pressure as required by the PSS equations. The pressure reading displayed when using Sea-Bird's SEASOFT CTD acquisition, display, and post-processing software is the corrected sea-surface pressure and is used by SEASOFT to compute salinity, density, etc in accordance with the PSS equations.

1978 PRACTICAL SALINITY SCALE EQUATIONS, from IEEE Journal of Oceanic Engineering, Vol. OE-5, No. 1, January 1980, page 14.

CONCLUSIONS

Using Newly generated data, a fit has been made giving the following algorithm for the calculation of salinity from data of the form:

$$R = \frac{C(S,T,P)}{C(35,15,0)}$$

T in °C (IPTS '68), P in decibars.

$$R_T = \frac{R}{R_P r_T}; R_P = 1 + \frac{P \times (A_1 + A_2 P + A_3 P^2)}{1 + B_1 T + B_2 T^2 + B_3 R + B_4 R T}$$

$$r_T = c_0 + c_1 T + c_2 T^2 + c_3 T^3 + c_4 T^4$$

$A_1 = 2.070 \times 10^{-5}$ $B_1 = 3.426 \times 10^{-2}$

$A_2 = -6.370 \times 10^{-10}$ $B_2 = 4.464 \times 10^{-4}$

$A_3 = 3.989 \times 10^{-15}$ $B_3 = 4.215 \times 10^{-1}$

$B_4 = -3.107 \times 10^{-3}$

$c_0 = 6.766097 \times 10^{-1}$

$c_1 = 2.00564 \times 10^{-2}$

$c_2 = 1.104259 \times 10^{-4}$

$c_3 = -6.9698 \times 10^{-7}$

$c_4 = 1.0031 \times 10^{-9}$

$$S = \sum_{j=0}^{5} a_j R_T^{j/2} + \frac{(T-15)}{1 + k(T-15)} \sum_{j=0}^{5} b_j R_T^{j/2}$$

$a_0 = 0.0080$ $b_0 = 0.0005$ $k = 0.0162.$

$a_1 = -0.1692$ $b_1 = -0.0056$

$a_2 = 25.3851$ $b_2 = -0.0066$

$a_3 = 14.0941$ $b_3 = -0.0375$

$a_4 = -7.0261$ $b_4 = 0.0636$

$a_5 = 2.7081$ $b_5 = -0.0144$

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APPLICATION NOTE NO. 31 **Revised February 2010**

Computing Temperature and Conductivity *Slope* and *Offset* Correction Coefficients from Laboratory Calibrations and Salinity Bottle Samples

Conductivity Sensors

The conductivity sensor *slope* and *offset* entries in the configuration (.con or .xmlcon) file in SEASOFT permit the user to make corrections for sensor drift between calibrations. The correction formula is:

(corrected conductivity) = slope * (computed conductivity) + offset

where :
slope = (true conductivity span) / (instrument reading conductivity span)
offset = (true conductivity - instrument reading conductivity) * slope *measured at 0 S/m*

For newly calibrated sensors, use slope = 1.0, offset = 0.0.

Sea-Bird conductivity sensors usually drift by changing span (the slope of the calibration curve), and changes are typically toward lower conductivity readings with time. Any offset error in conductivity (error at 0 S/m) is usually due to electronics drift, typically less than ±0.0001 S/m per year. Offsets greater than ±0.0002 S/m per year are symptomatic of sensor malfunction. **Therefore, Sea-Bird recommends that conductivity drift corrections be made by assuming no offset error, unless there is strong evidence to the contrary or a special need.**

Example
true conductivity =3.5 S/m
instrument reading conductivity = 3.49965 S/m
slope = 3.5 / 3.49965 = 1.000100

Correcting for Conductivity Drift Based on Pre- and Post-Cruise Laboratory Calibrations

Suppose a conductivity sensor is calibrated (pre-cruise), then immediately used at sea, and then returned for post-cruise calibration. The pre- and post-cruise calibration data can be used to generate a slope correction for data obtained between the pre- and post-cruise calibrations.

If **α** is the conductivity computed from the **pre-cruise bath data** (temperature and frequency) using **post-cruise calibration coefficients** and **β** is the true conductivity in the **pre-cruise bath**, then:

$$\textbf{postslope} = \frac{\sum_{i=1}^{n} (\alpha_i)(\beta_i)}{\sum_{i=1}^{n} (\alpha_i)(\alpha_i)}$$

(postslope is typically < 1.0)

Sea-Bird calculates and prints the value for postslope on the conductivity calibration sheet for all calibrations since February 1995 (see *Appendix I: Example Conductivity Calibration Sheet*)
.

To correct conductivity data taken between pre- and post-cruise calibrations:

islope = 1.0 + (b / n) [(1 / postslope) - 1.0]

where

islope = interpolated slope; this is the value to enter in the configuration (.con or .xmlcon) file
b = number of days between pre-cruise calibration and the cast to be corrected
n = number of days between pre- and post-cruise calibrations
postslope = slope from calibration sheet as calculated above (see *Appendix I: Example Conductivity Calibration Sheet*)

In the configuration (.con or .xmlcon) file, use the **pre-cruise calibration coefficients** and use **islope** for the value of slope.*

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

For typical conductivity drift rates (equivalent to -0.003 PSU/month), islope does not need to be recalculated more frequently than at weekly intervals.

* You can also calculate preslope. If **α** is the conductivity computed from **post-cruise bath data** (temperature and frequency) using **pre-cruise calibration coefficients** and **β** is the true conductivity in the **post-cruise bath**, then:

$$\textbf{preslope} = \frac{\sum_{i=1}^{n} (\alpha_i)(\beta_i)}{\sum_{i=1}^{n} (\alpha_i)(\alpha_i)}$$ (preslope is typically > 1.0)

In this case, pre-cruise calibration coefficients would be used and:
islope = 1.0 + (b / n) (preslope - 1.0)

Correcting for Conductivity Drift Based on Salinity Bottles Taken At Sea

For this situation, the **pre-cruise** calibration coefficients are used to compute conductivity and CTD salinity. Salinity samples are obtained using water sampler bottles during CTD profiles, and the difference between CTD salinity and bottle salinity is used to determine the drift in conductivity.

In using this method to correct conductivity, it is important to realize that differences between CTD salinity and hydrographic bottle salinity are due to errors in conductivity, temperature, and pressure measurements, as well as errors in obtaining and analyzing bottle salinity values. For typical Sea-Bird sensors that are calibrated regularly, 70 - 90% of the CTD salinity error is due to conductivity calibration drift, 10 - 30% is due to temperature calibration drift, and 0 - 10% is due to pressure calibration drift. All CTD temperature and pressure errors and bottle errors must first be corrected before attributing the remaining salinity difference as due to CTD conductivity error and proceeding with conductivity corrections.

Example

Three salinity bottles are taken during a CTD profile; assume for this discussion that shipboard analysis of the bottle salinities is perfect. The **uncorrected** CTD data (from Seasave V7) and bottle salinities are:

Approximate Depth (m)	CTD Raw Pressure (dbar)	CTD Raw Temperature (°C) *	CTD Raw Conductivity (S/m)	CTD Raw Salinity	Bottle Salinity
200	202.7	18.3880	4.63421	34.9705	34.9770
1000	1008.8	3.9831	3.25349	34.4634	34.4710
4000	4064.1	1.4524	3.16777	34.6778	34.6850

****** Temperatures shown are **ITS-90**. However, the salinity equation is in terms of IPTS-68; you must convert ITS-90 to IPTS-68 (IPTS-68 = 1.00024 * ITS-90) before calculating salinity. SEASOFT does this automatically.*

The uncorrected salinity differences (CTD raw salinity - bottle salinity) are approximately -0.007 psu. To determine conductivity drift, first correct the CTD temperature and pressure data. Suppose that the error in temperature is +0.0015 °C uniformly at all temperatures, and the error in pressure is +0.5 dbar uniformly at all pressures (drift offsets are obtained by projecting the drift history of both sensors from pre-cruise calibrations). Enter these offsets in the configuration (.con or .xmlcon) file to calculate the corrected CTD temperature and pressure, and calculate the CTD salinity using the corrected CTD temperature and pressure. This correction method assumes that the pressure coefficient for the conductivity cell is correct. The CTD data with **corrected** temperature (ITS-90) and pressure are:

Corrected CTD Pressure (dbar)	Corrected CTD Temperature (°C)	CTD Raw Conductivity (S/m)	CTD Salinity [T,P Corrected]	Bottle Salinity
202.2	18.3865	4.63421	34.9719	34.9770
1008.3	3.9816	3.25349	34.4653	34.4710
4063.6	1.4509	3.16777	34.6795	34.6850

The salinity difference (CTD salinity – bottle salinity) of approximately -0.005 psu is now properly categorized as conductivity error, equivalent to about -0.0005 S/m at 4.0 S/m.

Compute bottle conductivity (conductivity calculated from bottle salinity and CTD temperature and pressure) using SeacalcW (in SBE Data Processing); enter bottle salinity for *salinity*, corrected CTD temperature for *ITS-90 temperature*, and corrected CTD pressure for *pressure*:

CTD Raw Conductivity (S/m)	Bottle Conductivity (S/m)	[CTD - Bottle] Conductivity (S/m)
4.63421	4.63481	-0.00060
3.25349	3.25398	-0.00049
3.16777	3.16822	-0.00045

By plotting conductivity error versus conductivity, it is evident that the drift is primarily a slope change. If **α** is the CTD conductivity computed with **pre-cruise** coefficients and **β** is the true bottle conductivity, then:

$$\textbf{slope} = \frac{\sum_{i=1}^{n} (\alpha_i)(\beta_i)}{\sum_{i=1}^{n} (\alpha_i)(\alpha_i)} \qquad \text{(slope is typically > 1.0)}$$

Using the above data, the slope correction coefficient for conductivity at this station is:

Slope = [(4.63421 * 4.63481) + (3.25349 * 3.25398) + (3.16777 * 3.16822)] /
[(4.63421 * 4.63421) + (3.25349 * 3.25349) + (3.16777 * 3.16777)] = **+1.000138**

Following Sea-Bird's recommendation of assuming no offset error in conductivity, **set offset to 0.0**.

Temperature Sensors

The temperature sensor *slope* and *offset* entries in the configuration (.con or .xmlcon) file in SEASOFT permit the user to make corrections for sensor drift between calibrations. The correction formula is:

corrected temperature = slope * (computed temperature) + offset

where :

slope = (true temperature span) / (instrument reading temperature span)

offset = (true temperature - instrument reading temperature) * slope *measured at 0.0 °C*

For newly calibrated sensors, use slope = 1.0, offset = 0.0.

Sea-Bird temperature sensors usually drift by changing offset (an error of equal magnitude at all temperatures). In general, the drift can be toward higher or lower temperature with time; however, for a specific sensor the drift remains the same sign (direction) for many consecutive years. Many years of experience with thousands of sensors indicates that the drift is smooth and uniform with time, allowing users to make very accurate drift corrections to field data based only on pre- and post-cruise laboratory calibrations.

Span errors cause slope errors, as described in the equation for slope above. Sea-Bird temperature sensors rarely exhibit span errors larger than 0.005 °C over the range -5 to 35 °C, even after years of drift. Temperature calibrations performed at Sea-Bird since January 1995 have slope errors less than 0.0002 °C in 30 °C. Prior to January 1995, some calibrations were delivered that include slope errors up to 0.004 °C in 30 °C because of undetected systematic errors in calibration. A slope error that increases by more than ±0.0002 [°C per °C per year] indicates an unusual aging of electronic components and is symptomatic of sensor malfunction. **Therefore, Sea-Bird recommends that drift corrections**
to temperature sensors be made assuming no slope error, unless there is strong evidence to the contrary or a special need.

Calibration checks at-sea are advisable for consistency checks of the sensor drift rate and for early detection of sensor malfunction. However, data from reversing thermometers is rarely accurate enough to make calibration corrections that are better than those possible by shore-based laboratory calibrations. **For the SBE 9*plus***, a proven alternate consistency check is to use dual SBE 3 temperature sensors on the CTD and to track the difference in drift rates between the two sensors. In the deep ocean, where temperatures are uniform, the difference in temperature measured by two sensors can be resolved to better than 0.0002 °C and will change smoothly with time as predicted by the difference in drift rates of the two sensors.

Correcting for Temperature Drift Based on Pre- and Post-Cruise Laboratory Calibrations

Suppose a temperature sensor is calibrated (pre-cruise), then immediately used at-sea, and then returned for post-cruise calibration. The pre-and post-cruise calibration data can be used to generate an offset correction for data obtained between the pre- and post-cruise calibrations.

Calibration coefficients are calculated with the post-cruise calibration. Using the pre-cruise bath data and the post-cruise calibration coefficients, a mean residual over the calibration temperature range is calculated.

residual = instrument temperature – bath temperature

Sea-Bird calculates and prints the value for the residual on the temperature calibration sheet (see *Appendix II: Example Temperature Calibration Sheet*).

To correct temperature data taken between pre- and post-cruise calibrations:

Offset = b * (residual / n)

where

b = number of days between pre-cruise calibration and the cast to be corrected
n = number of days between pre- and post-cruise calibrations
residual = residual from calibration sheet as described above (see *Appendix II: Example Temperature Calibration Sheet*)

In the configuration (.con or .xmlcon) file, use the **pre-cruise calibration coefficients** and use the calculated **offset** for the value of offset.

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

Example
Instrument was calibrated (pre-cruise), used at sea for 4 months, and returned for post-cruise calibration. Using **pre-cruise bath data** and **post-cruise coefficients**, the calibration sheet shows a mean residual of -0.2 millidegrees C (-0.0002 °C).

For preliminary work at sea, use the **pre-cruise calibration coefficients** and **slope = 1.0, offset = 0.0**.
After the cruise, correct temperature data obtained during the cruise for drift using properly scaled values of correction coefficients:

For data from the end of the first month (30 days) at sea:
Offset = b * (residual / n) = 30 * (-0.0002 / 120) = - 0.00005;
Convert data using **pre-cruise coefficients** and **-0.00005** as the offset in the configuration file.

For data from the end of the second month (60 days) at sea:
Offset = b * (residual / n) = 60 * (-0.0002 / 120) = - 0.0001;
Convert data using **pre-cruise coefficients** and **-0.0001** as the offset in the configuration file.

For data from the end of the third month (90 days) at sea:
Offset = b * (residual / n) = 90 * (-0.0002 / 120) = - 0.00015;
Convert data using **pre-cruise coefficients** and **-0.00015** as the offset in the configuration file.

For data from the end of the 4-month cruise:
Offset = - 0.0002;
Convert data using **pre-cruise coefficients** and **-0.0002** as the offset in the configuration file, or using **post-cruise** coefficients and **0** as the offset in the configuration file.

Appendix I: Example Conductivity Calibration Sheet

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2218
CALIBRATION DATE: 30-Dec-99

SBE4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS

```
g = -1.02414422e+001
h =  1.49331006e+000
i = -1.50844862e-003
j =  1.99364517e-004
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

Coefficients from *30-Dec-99* calibration.

ABCDM COEFFICIENTS

```
a =  3.56563909e-006
b =  1.48964234e+000
c = -1.02346588e+001
d = -8.62052534e-005
m =  5.4
CPcor = -9.5700e-008 (nominal)
```

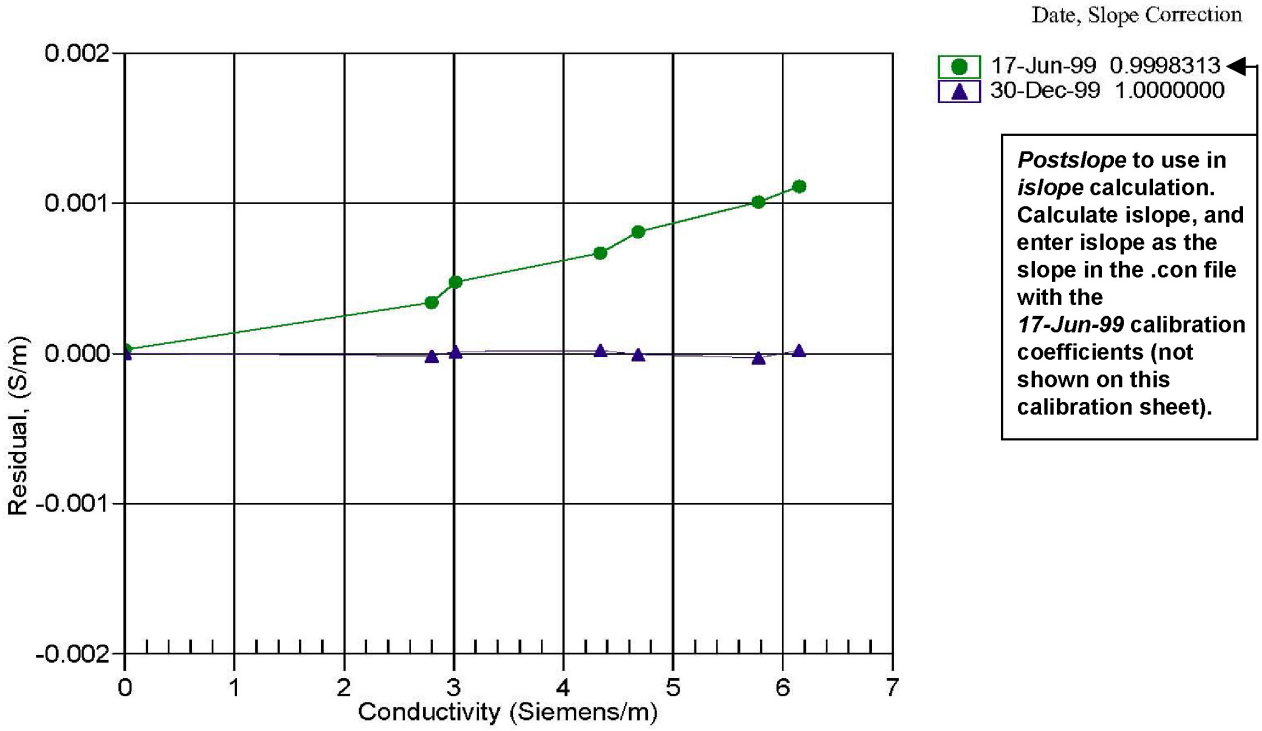
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.62109	0.00000	0.00000
-1.3895	35.1839	2.79817	5.06354	2.79815	-0.00002
1.1492	35.1843	3.01746	5.20666	3.01747	0.00001
15.2688	35.1829	4.33837	5.99642	4.33839	0.00002
18.7065	35.1798	4.68224	6.18534	4.68224	-0.00001
29.2500	35.1699	5.78041	6.75306	5.78038	-0.00003
32.6897	35.1622	6.15002	6.93359	6.15004	0.00002

Conductivity = $(g + hf^2 + if^3 + jf^4) / 10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt) / [10 (1 + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



***Poststope* to use in *islope* calculation. Calculate islope, and enter islope as the slope in the .con file with the *17-Jun-99* calibration coefficients (not shown on this calibration sheet).**

Appendix II: Example Temperature Calibration Sheet

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2700
CALIBRATION DATE: 28-Dec-99

SBE3 TEMPERATURE CALIBRATION DATA
IPTS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.36260004e-003
h = 6.49083037e-004
i = 2.42497805e-005
j = 2.36365545e-006
f0 = 1000.0

Coefficients from *28-Dec-99* calibration.

ITS-68 COEFFICIENTS

a = 3.67991178e-003
b = 6.04738390e-004
c = 1.65374250e-005
d = 2.36525963e-006
f0 = 2978.914

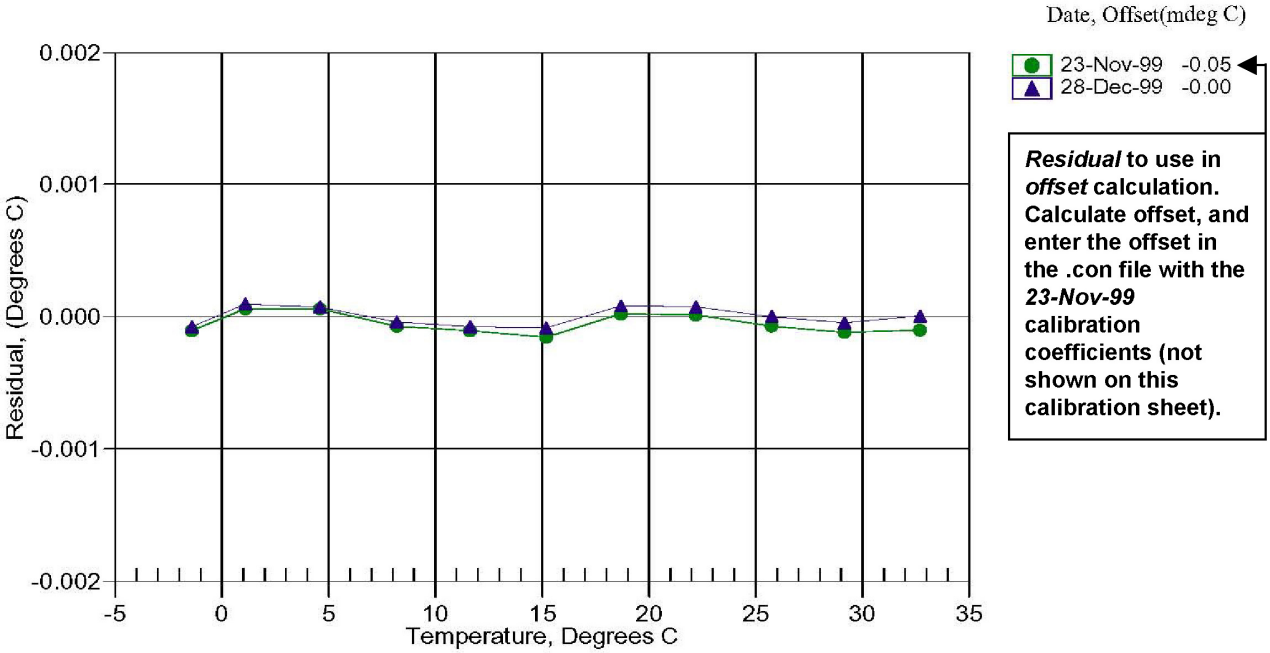
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.4039	2978.914	-1.4040	-0.00008
1.1062	3149.847	1.1063	0.00009
4.5979	3399.248	4.5980	0.00007
8.1955	3670.718	8.1954	-0.00004
11.6295	3943.970	11.6295	-0.00007
15.1862	4241.874	15.1861	-0.00009
18.6903	4550.560	18.6904	0.00008
22.1892	4874.139	22.1893	0.00007
25.7491	5219.423	25.7491	-0.00000
29.1638	5566.173	29.1637	-0.00005
32.6970	5941.274	32.6970	0.00001

Temperature ITS-90 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 = $1/\{a + b[ln(f_0/f)] + c[ln^2(f_0/f)] + d[ln^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C)

Residual = instrument temperature - bath temperature



***Residual* to use in *offset* calculation. Calculate offset, and enter the offset in the .con file with the *23-Nov-99* calibration coefficients (not shown on this calibration sheet).**

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

ITS-90 TEMPERATURE SCALE

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

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

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

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

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

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

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

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

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

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

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

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

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

Using USB Ports to Communicate with Sea-Bird Instruments

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

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

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

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

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

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

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

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

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

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APPLICATION NOTE NO. 71 Revised March 2008

Desiccant Use and Regeneration (drying)

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

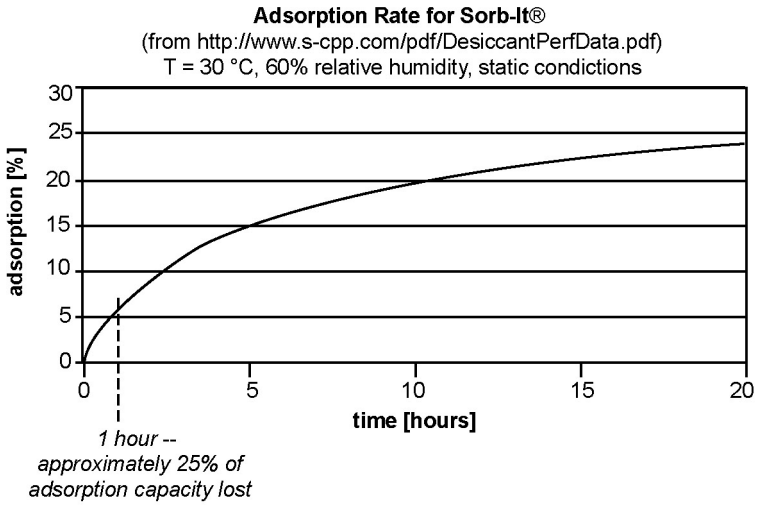
When to Replace Desiccant Bags

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

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

Storage and Handling

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



Regeneration (drying) of Desiccant

Replacement desiccant bags are available from Sea-Bird:

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

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

MIL-D-3464 Desiccant Regeneration Procedure

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

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

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

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

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

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

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

SÜD-CHEMIE
Creating Performance Technology
ISO 9002 CERTIFIED

Sud-Chemie Performance Packaging
101 Christine Dr.
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Phone: (505) 864-6691
Fax: (505) 864-9296

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

SECTION I -- PRODUCT IDENTIFICATION

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

SECTION II -- HAZARDOUS INGREDIENTS

Components in the Solid Mixture

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

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

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

SECTION III -- PHYSICAL DATA

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

SÜD-CHEMIE
Creating Performance Technology
ISO 9002 CERTIFIED

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

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

SECTION IV -- FIRE EXPLOSION DATA

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

Flash Point - Nonflammable.

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

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

SECTION V -- HEALTH HAZARD DATA

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

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

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

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

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

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Packaged Desiccant

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

SECTION VI -- REACTIVITY DATA

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

SECTION VII --SPILL OR LEAK PROCEDURES

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

SECTION VIII -- SPECIAL PROTECTION INFORMATION

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

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

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

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

SECTION IX -- SPECIAL PRECAUTIONS

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

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MATERIAL SAFETY DATA SHEET – August 13, 2002
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* No Information Available

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

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

The information contained herein is based upon data considered true and accurate. However, United Desiccants makes no warranties expressed or implied, as to the accuracy or adequacy of the information contained herein or the results to be obtained from the use thereof. This information is offered solely for the user's consideration, investigation and verification. Since the use and conditions of use of this information and the material described herein are not within the control of United Desiccants, United Desiccants assumes no responsibility for injury to the user or third persons. The material described herein is sold only pursuant to United Desiccants' Terms and Conditions of Sale, including those limiting warranties and remedies contained therein. It is the responsibility of the user to determine whether any use of the data and information is in accordance with applicable federal, state or local laws and regulations.

DRAWINGS

Dwg 50179 SBE 45 External I/O Wiring, RS-232..... 1

Dwg 41053 SBE 45 Internal I/O Molex Wiring..... 2

Dwg 32756 Cable Assy, Data I/O with Power Leads, DB-9S, PN 801392..... 3

Dwg 31063C Cable Assy, SBE 38 to Jct Box, RMG-4FS to MS, PN 80437..... 4

Dwg 32397A Cable Assy, SBE 45 to Jct Box, RMG-4FS to MS, PN 801216..... 5

Dwg 32398 Cable Assy, SBE 45 DC Power Cable, PN 801217..... 6

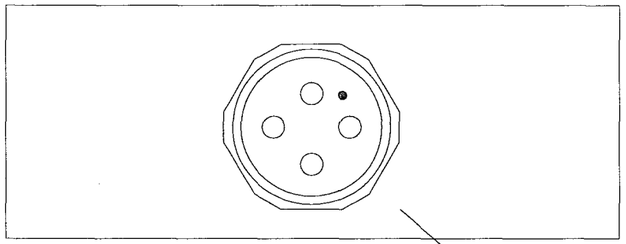
Dwg 32786C Cable Assy, NMEA Test Cable, PN 801422..... 7

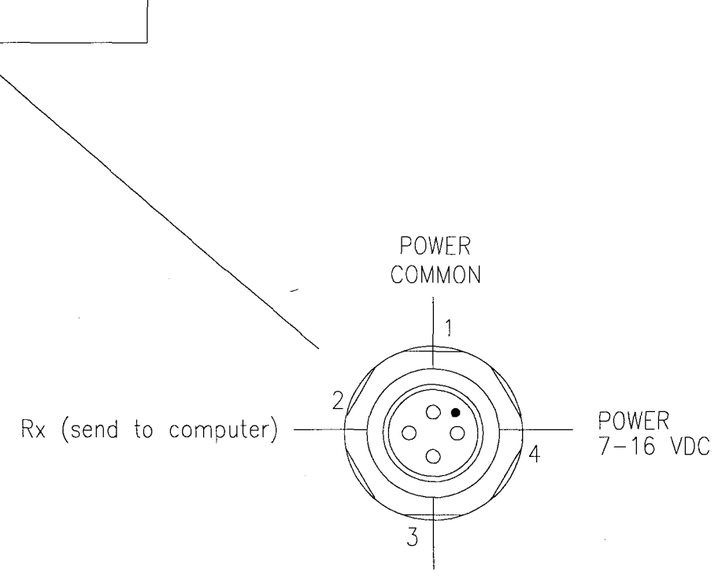
Dwg 32431 Cable Assy, DB-9P to DB-9S, PN 801373..... 8

Dwg 32365A Cable, MCIL-4MP Pigtail..... 9

Dwg 30581A Cable, RMG-4FS Pigtail..... 10

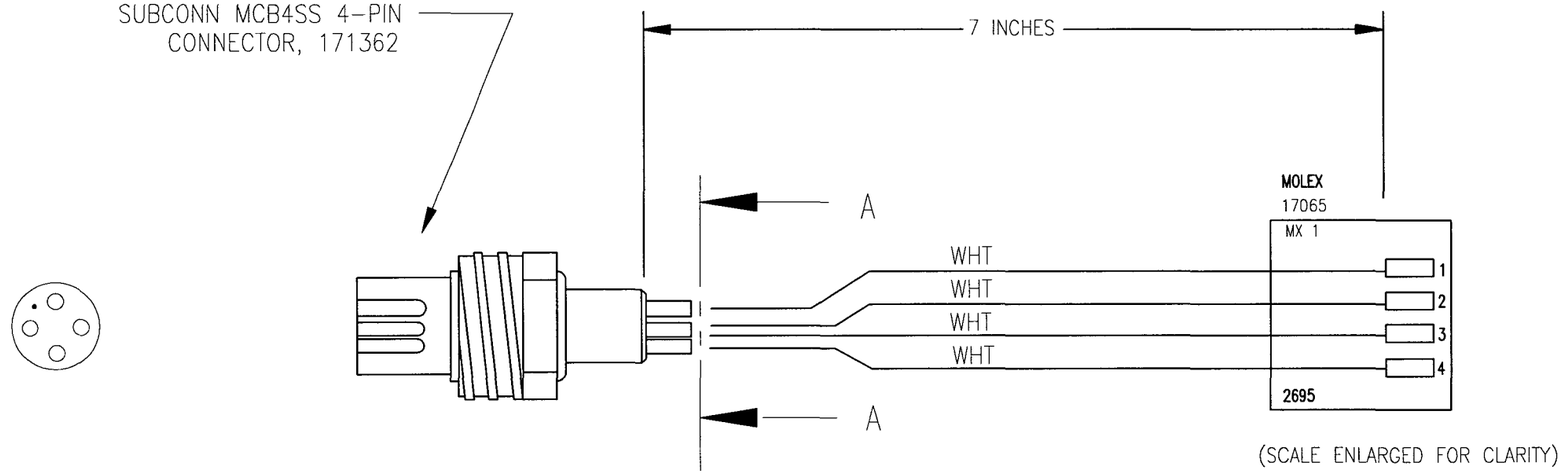
DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.

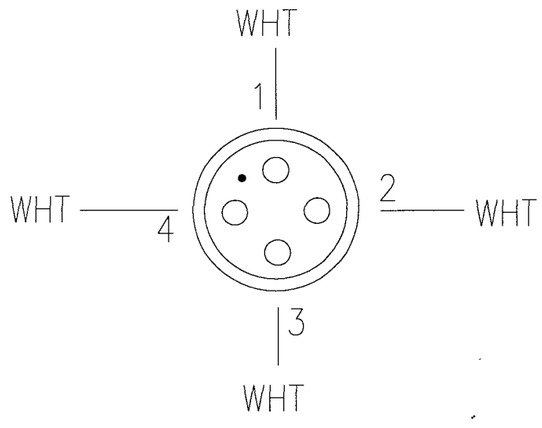




TOLERANCES	SEA-BIRD ELECTRONICS, INC			
FRACTIONAL	P/N N/A	SCALE NTS	DRAWN BY MJ	
			APPROVED BY	
DECIMAL	TITLE SBE 45 MicroTSG, RS-232 EXTERNAL POWER, EXTERNAL I/O WIRING			
ANGULAR	DATE 02.07.00	DWG NO. 50179		REV

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.

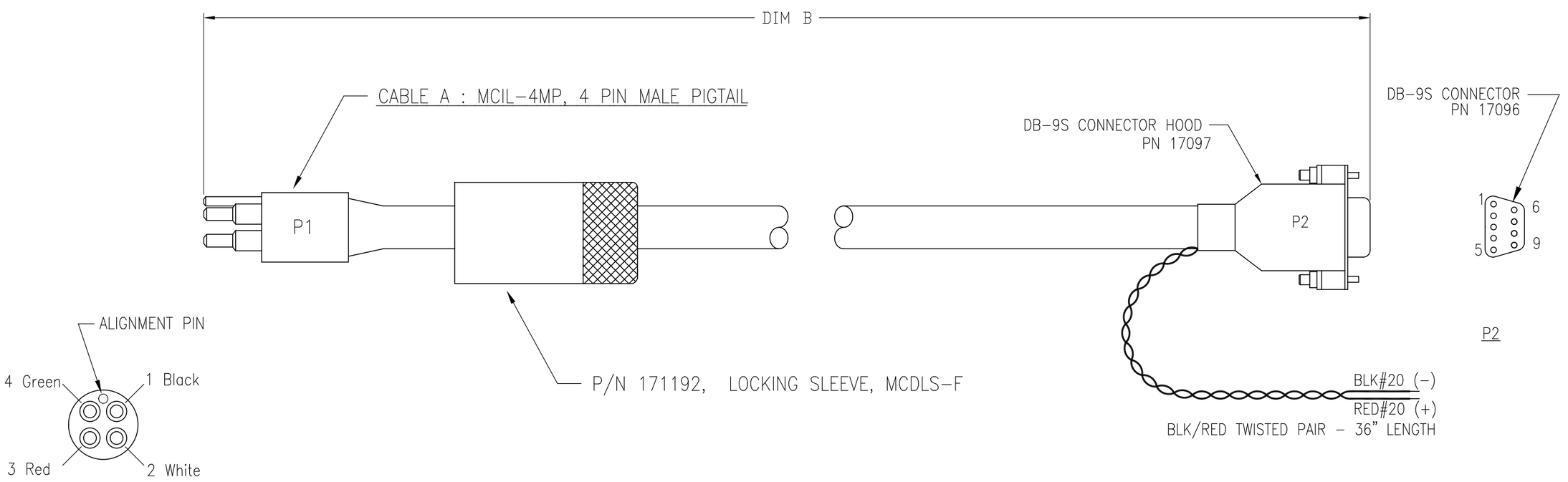




VIEW A-A

TOLERANCES	SEA-BIRD ELECTRONICS, INC			
FRACTIONAL	P/N N/A	SCALE NTS	DRAWN BY MJ	
			APPROVED BY	
DECIMAL	TITLE SBE45 Micro TSG 4 PIN DATA I/O STANDARD WIRING			
ANGULAR	DATE 02.07.00	DRAWING NUMBER 41053		REV

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.

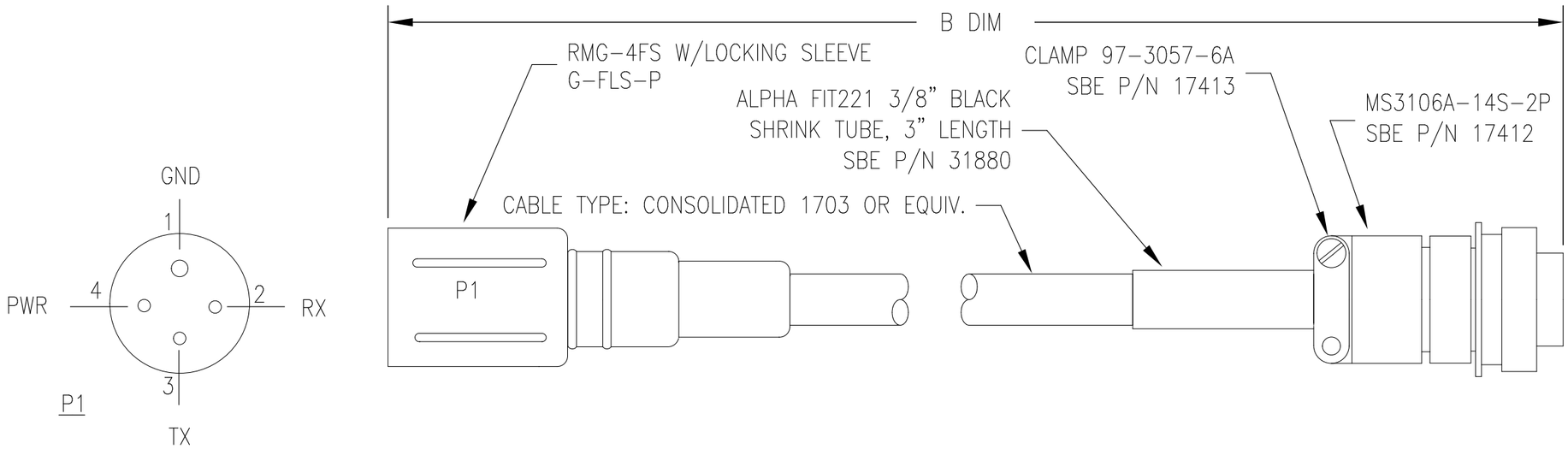


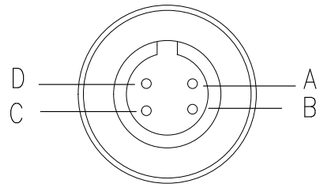
COLOR	P1 MCIL-4MP	P2 DB-9S	BLK/RED PAIR
BLACK	PIN 1	PIN 5	BLK
WHITE	PIN 2	PIN 3	
RED	PIN 3	PIN 2	
GREEN	PIN 4	N/C	RED

SBE PN	CABLE A PN	DIM B
801392	171364	8 FT
802042	171680	10 M

TOLERANCES	SEA-BIRD ELECTRONICS, INC		
FRACTIONAL	P/N SEE TABLE	SCALE NTS	DRAWN BY KLP APPROVED BY
DECIMAL	TITLE MCIL4M TO DB-9s RS-232 DATA/POWER I/O CABLE		
ANGULAR	DATE 12/18/02	DWG NO. 32756	REV

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
4/91	A	REDRAWN SEE HISTORY	KL	BMc	
3/93	B	ADDED COLOR 1	KL	BMc	
3/29/11	C	Changed boot to heatshrink	FS	PC	





SBE 28 I/O, RMG-4FS TO MS CABLE ASSEMBLY					
SHIELDED ASSY P/N	PIGTAIL P/N	LENGTH 'B' (FT)	LENGTH 'B' (m)	KEVLAR ASSY P/N	KEVLAR LENGTH
80437 *	17031**	8	2.5		
80438	17204	33	10		
80455	17221	66	20		
80456	17232	100	30	80464	20 m
80457	17350	132	40	80465	30 m
80458	17351	165	50	80466	40 m
80459	17187	200	60	80467	50 m
80460	17148	330	100	80468	90 m
80461	17369	492	150	80469	140 m
80462	17244	660	200	80470	190 m
80463	17216	1500	455	80471	445 m
80693	17696	984	300		
80720	17723	500	152		
80755	17744	820	250		
	17640	363	110	80757	100 m
801050	17608	250	76	80801	61 m
80823	17614	462	140	80824	130 m
	17890	433	131	80843	121 M / #16 AWG
80941	17183	83	25		
	17783	281	85	801037	75 m
801041	17340	120	36		
801089	171194	174	53		
801111	17230	50	15		
	171244	853	260	801113	250 m
801124	17477	17	5		
801625	172157	10	3		

SBE 28 I/O, RMG-4FS TO MS CABLE ASSEMBLY					
SHIELDED ASSY P/N	PIGTAIL P/N	LENGTH 'B' (FT)	LENGTH 'B' (m)	KEVLAR ASSY P/N	KEVLAR LENGTH
801668	172200	13	4		
801701	172278	220	67		
801706	172283	40	12		
801950	172657	15	4.5		

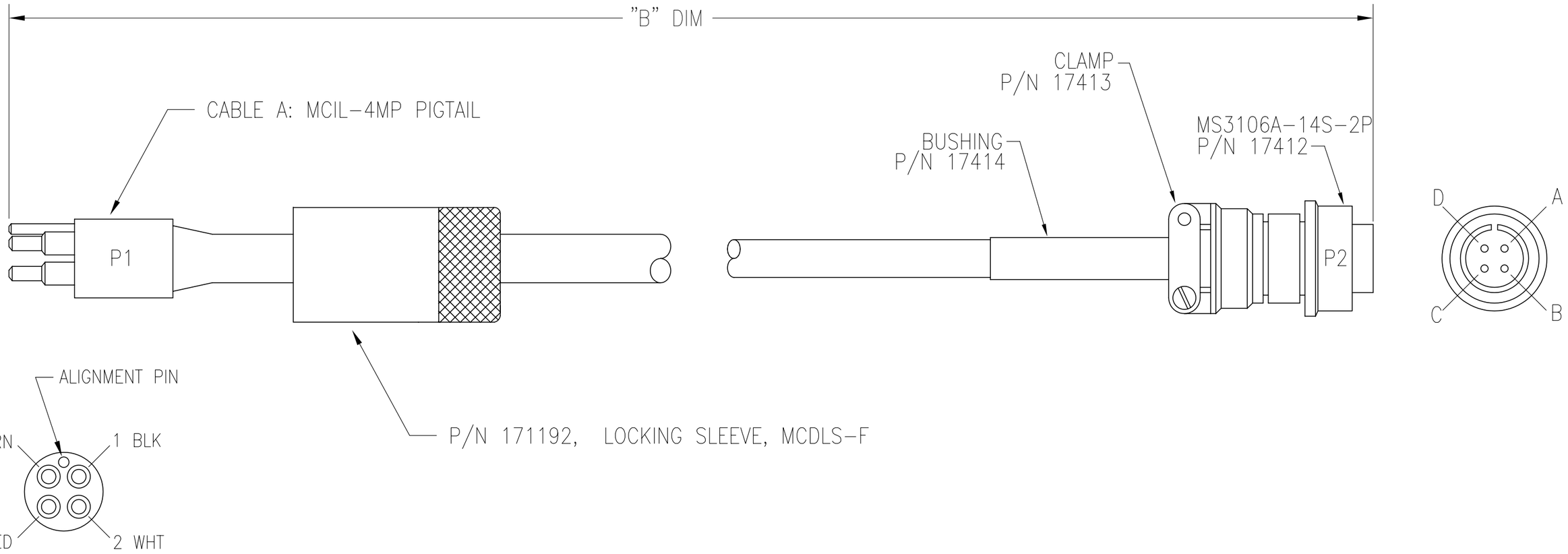
WIRING CONNECTIONS			
P1	*COLOR 1	COLOR 2	P2
PIN 1	WHITE	SHIELD	A
PIN 2	BLACK	BLACK	B
PIN 3	GREEN	WHITE	C
PIN 4	RED	RED	D

* COLOR 1: 80437 ONLY
COLOR 2: ALL OTHER

PIGTAILS ARE PURCHASED PER DWG 30585
KEVLAR COATING PER DWG 20252
** P/N 17031 IS NOT SHIELDED AND DOES NOT REQUIRE THE HEATSHRINK (31880)

TOLERANCES	SEA-BIRD ELECTRONICS, INC		
FRACTIONAL	P/N SEE TABLE	SCALE 1:1	DRAWN BY BMC APPROVED BY KDL
DECIMAL	TITLE UNIOPTOBOX DATA CABLE ASSY		
ANGULAR	DATE 4/3/91	DRAWING NUMBER 31063	REV C

DATE	REV	REVISION RECORD	AUTH.	DR.	CK.
1.17.03	A	SWITCHED PINS	CB	KLP	

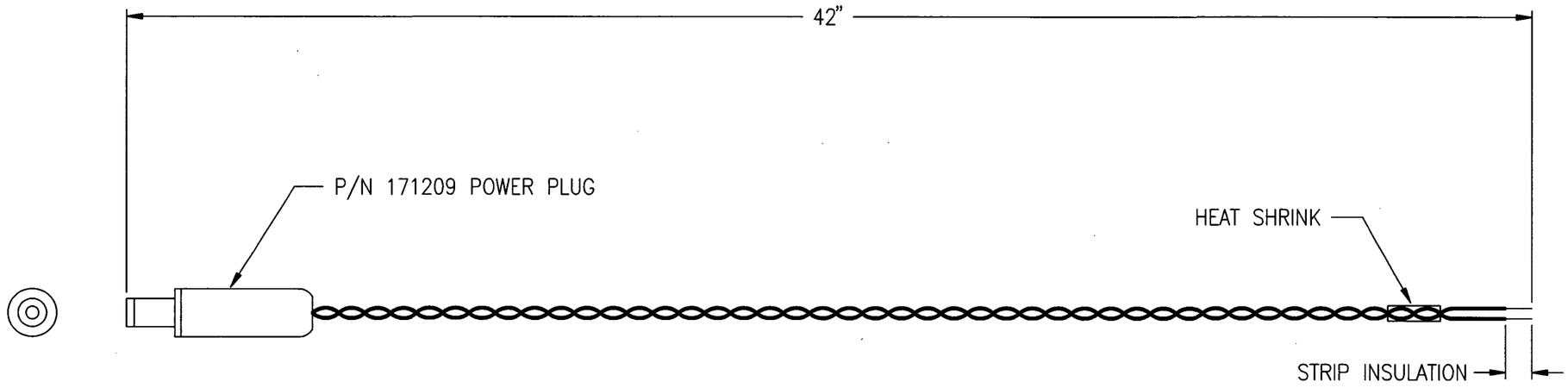


P1 MCIL-4MP	WIRE COLOR	P2 MS3106A
PIN 1	1 BLK	PIN A
PIN 2	2 WHT	PIN B (A)
PIN 3	3 RED	PIN C (A)
PIN 4	4 GRN	PIN D

ASSY P/N	"A" CABLE P/N	"B" DIM
801216	171364	8 FT
801416	171680	10 m
801417	171534	30 m
801418	171779	50 m
801702	172279	58 m

TOLERANCES	SEA-BIRD ELECTRONICS, INC		
FRACTIONAL	P/N SEE TABLE	SCALE –	DRAWN BY DG APPROVED BY
DECIMAL	TITLE CABLE ASSY: SBE 46 TO SBE 45 TSG		
ANGULAR	DATE 5/24/00	DWG NO. 32397	REV A

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.

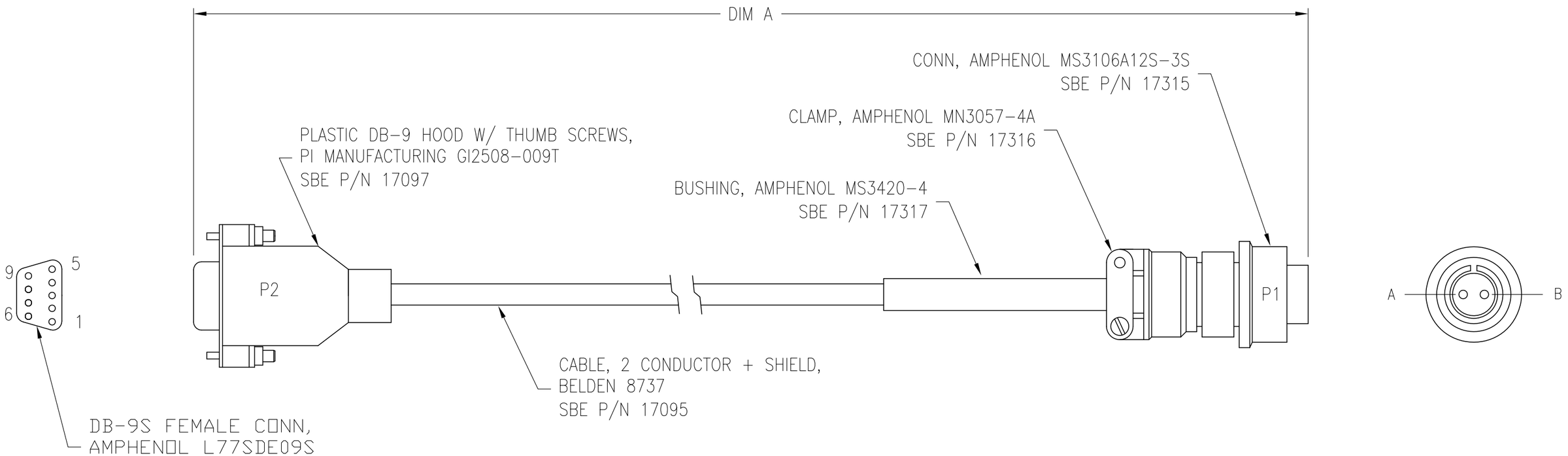


INNER CONDUCTOR	RED#20	+Vdc
OUTER CONDUCTOR	BLK#20	GROUND

TOLERANCES	SEA-BIRD ELECTRONICS, INC		
FRACTIONAL	P/N 801217	SCALE —	DRAWN BY DG APPROVED BY
DECIMAL	TITLE SBE 46 : DC POWER CABLE		
ANGULAR	DATE 5/24/00	DWG NO. 32398	REV

0216.

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
5.16.03	A	FIXED PIN CALLOUTS	CB	KLP	
02.09.07	B	ADDED PN TABLE	CB	PL	
01.13.11	C	CLARIFIED PART SPECS	CB	PC	

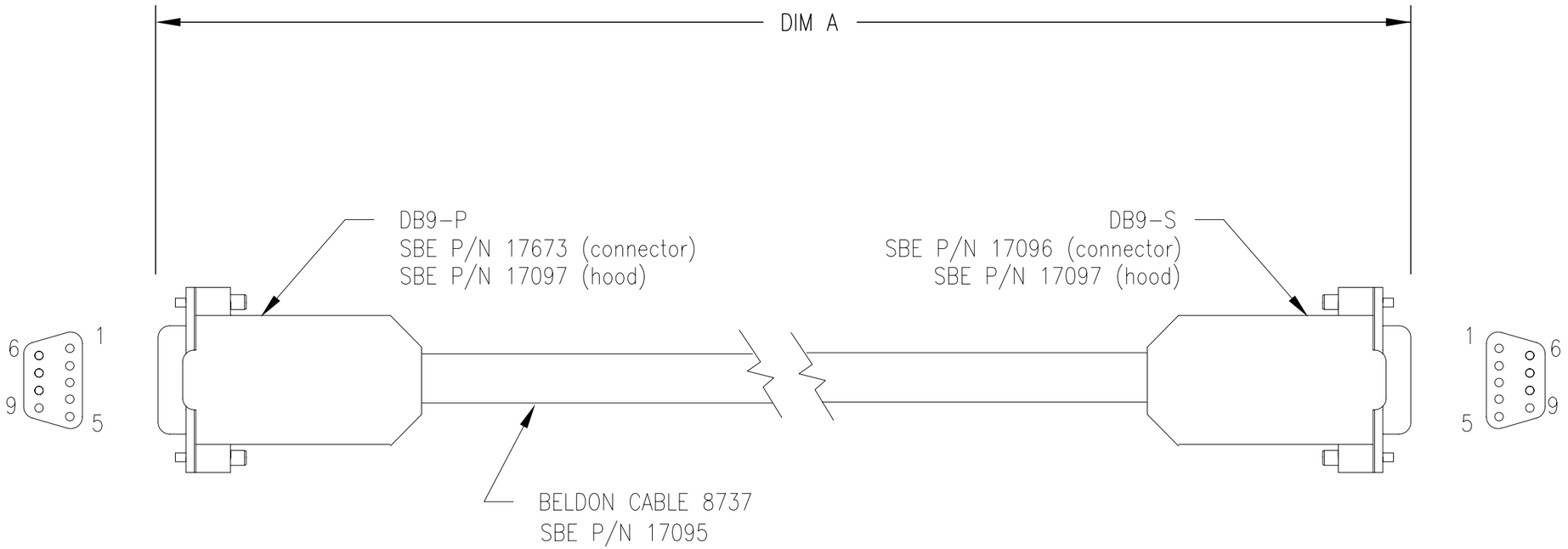


CABLE PN	DIM A	
801422	6 FT	1.8 m
801703	75.5 FT	23 m
801904	33 FT	10 m

P1 MS3106A12S-3S	P2 DB-9S	COLOR
PIN A	PIN 3	RED
PIN B	PIN 5	BLK

TOLERANCES	SEA-BIRD ELECTRONICS, INC		
FRACTIONAL	P/N SEE TABLE	SCALE NTS	DRAWN BY KLP APPROVED BY
DECIMAL	TITLE NMEA TEST CABLE, 11PLUS/33/36		
ANGULAR	DATE 4/09/03	DWG NO. 32786	REV C

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.

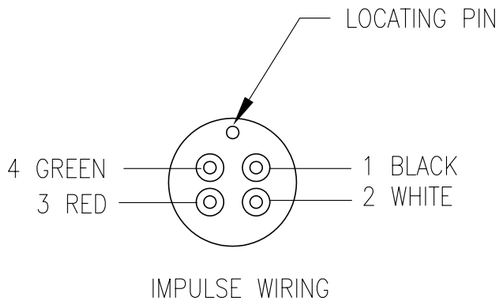


P1 DB9-P	COLOR	P2 DB-9S
PIN 1		PIN 1
PIN 2	RED	PIN 2
PIN 3	BLACK	PIN 3
PIN 4		PIN 4
PIN 5	SHIELD	PIN 5
PIN 6		PIN 6
PIN 7		PIN 7
PIN 8		PIN 8
PIN 9		PIN 9

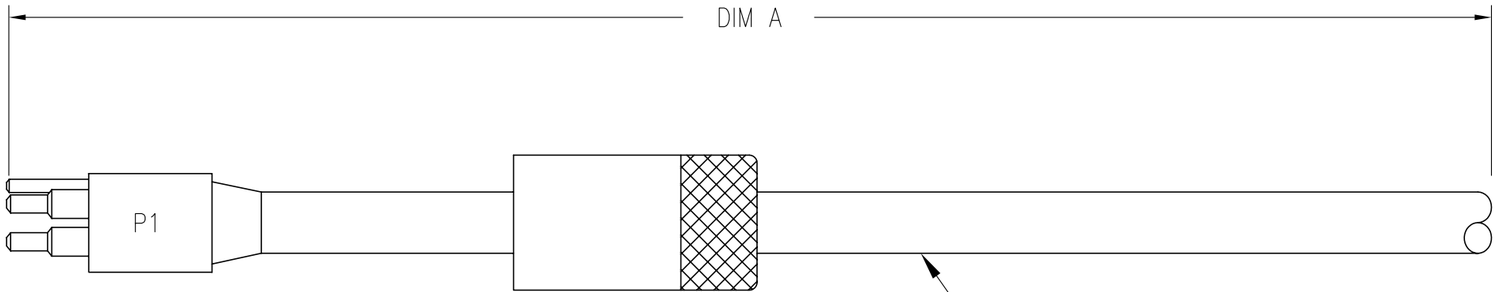
SBE PN	DIM A
801235	6 FT
801373	8 FT
801592	10 M
801952	5 M

TOLERANCES	SEA-BIRD ELECTRONICS, INC		
FRACTIONAL	P/N SEE TABLE	SCALE NTS	DRAWN BY MJ APPROVED BY
DECIMAL	TITLE CABLE ASSY, SBE-21 OPTO I/O		
ANGULAR	DATE 07.00	DRAWING NUMBER 32431	REV

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
8/23/01	A	CHANGED CABLE TYPE		LRG	



IMPULSE WIRING



MCIL-4MP W/MCDLS-F LOCKING SLEEVE (SBE PN 171192)

CABLE TYPE: BELDEN 8424

SBE PN	DIM A
171363	2 feet
171364	8 feet
171534	30 m
171680	10 m
171779	50 m
171884	3 m
172071	15 m
172279	58 m

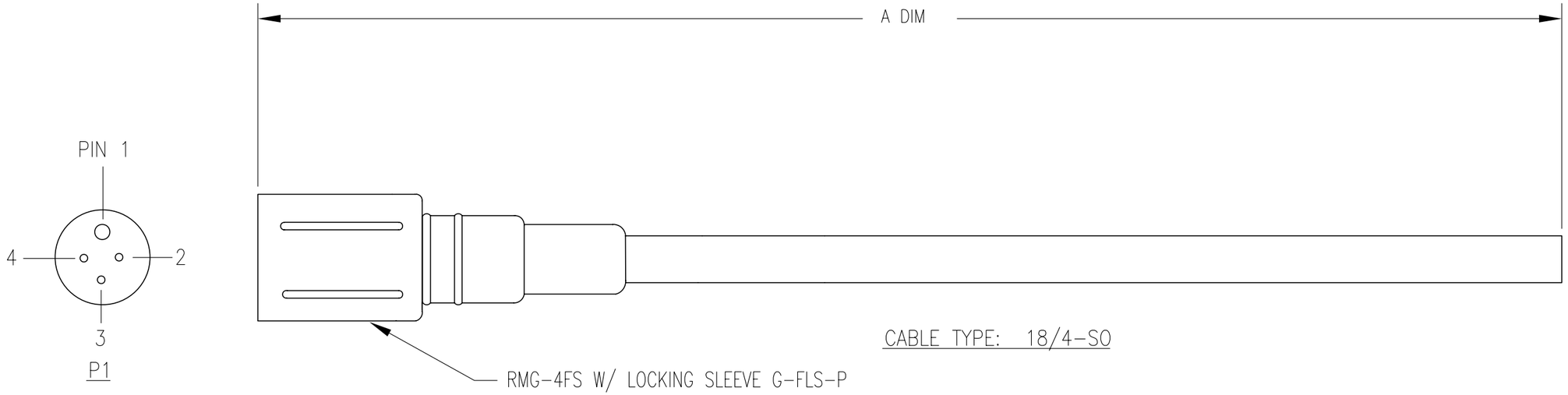
SEA-BIRD ELECTRONICS, INC

P/N	SCALE	DRAWN BY	MJ
SEE TABLE	NTS	APPROVED BY	

CABLE: MCIL-4M PIGTAIL
WITH MCDLS-F LOCK SLEEVE

DATE	DWG NO.	SHEET	REV
2/03/01	32365	1 of 1	A

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
4.3.07	A	CORRECT LENGTH	CB	CB	



SBE PN	DIM A	
17031	8 FT	2.4 m
17102	360 FT	109 m
17106	35 FT	10.6 m
17114	66 FT	20 m
17117	100 FT	30 m
17142	83 FT	25 m
17195	158 IN	4 m
17267	17 FT	5 m
17308	165 FT	50 m
17776	231 FT	70 m
171214	10 FT	3 m
171333	20 FT	6 m
171555	1000 FT	305 m
171572	200 FT	60 m
171592	50 FT	15 m
171632	25 FT	7.6 m
172349	131 FT	40 m
172639	3.3 FT	1 m

B

P1 RMG-4FS	WIRE COLOR
PIN 1	WHITE
PIN 2	BLACK
PIN 3	GREEN
PIN 4	RED

TOLERANCES	SEA-BIRD ELECTRONICS, INC		
FRACTIONAL	P/N SEE TABLE	SCALE NTS	DRAWN BY BMC APPROVED BY
DECIMAL	TITLE CABLE, 4 PIN PIGTAIL RMG-4FS + LS		
ANGULAR	DATE 3/1/89	DRAWING NUMBER 30581	REV A

WARRANTY POLICY 2010

PRODUCT WARRANTY

5-YEAR LIMITED WARRANTY (NEW PRODUCTS)

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

LIMITED WARRANTY ON SERVICE & REPAIRS

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

MODIFICATIONS / EXCEPTIONS / EXCLUSIONS

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

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

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

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

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

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

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

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

WARRANTY ADMINISTRATION POLICY

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

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

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

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

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

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

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

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

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

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

SOFTWARE WARRANTY

SOFTWARE LICENSE AGREEMENT

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

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

SOFTWARE WARRANTY

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Sea-Bird Service Request Form

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

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

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

[ ] I need a written quote. **[ ] Send only electronic copies of service documents.**

CONTACT INFORMATION

Your Name:_____ Institution/Company:_____

Shipping/Delivery address for packages:_____

Phone:_____ Fax:_____ E-mail:_____

SERVICE INFORMATION

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

Quantity:_____ Serial Numbers:_____

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

[ ] Calibration Services (includes basic diagnostic):

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

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

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

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

[ ] Install new anti-foulant device(s) (moored instruments)_____

[ ] System Upgrade or Conversion_____

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

[ ] Download Data from instrument Memory_____

PAYMENT/BILLING INFORMATION

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

Name on Card:_____

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

[ ] Purchase Order (P.O.)

P.O. Number:_____

Billing Address (If different than shipping address):_____

_____

_____

_____

Instructions for Returning Goods to Sea-Bird

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

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

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

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

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

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

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

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

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