SBE 38
Digital Thermometer

User Manual, Version 013

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SBE 38 DIGITAL THERMOMETER OPERATING MANUAL

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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
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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

SBE 38 Digital Oceanographic Thermometer

With RS-232 or optional RS-485 Interface

User's Manual

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Manual Version #013, 03-23-11
Firmware Version 1.4 and later

$C\epsilon$

Limited Liability Statement

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Table of Contents

Section 1: Introduction

This section includes a Quick Start procedure, and photos of a standard SBE 38 shipment.

About this Manual

This manual is to be used with the SBE 38 Digital Oceanographic Thermometer. It is organized to guide the user from installation through operation and data collection. We've included detailed specifications, command descriptions, maintenance and calibration information, and helpful notes throughout the manual.

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

Quick Start

Follow these steps to get a Quick Start using the SBE 38 with a **standard RS-232 interface**. The manual provides step-by-step details for performing each task:

1. Test Power and Communications (see *Section 3: Preparing SBE 38 for Deployment*).

2. Deploy the SBE 38 (see *Section 4: Deploying and Operating RS-232 SBE 38* for a complete description of setup, or see *Appendix IV: RS-232 Command Summary*):
   A. Establish setup parameters.
   B. Check status (**DS**) and calibration coefficients (**DC**) to verify setup.
   C. Use **one** of the following sequences to start sampling:
      - If **AutoRun=N**: Send **Go** to start sampling continuously now, or **TS** or **TH** to take a single sample.
      - If **AutoRun=Y**: Apply power to start sampling continuously now.
   D. Deploy SBE 38.

For an SBE 38 with **optional RS-485 interface**, see *Appendix III: RS-485 Interface* for details.

Unpacking SBE 38

Shown below is a typical SBE 38 shipment.

SBE 38

I/O Cable with 9V battery snap
connector and 9V battery

User Manual

Software, and Electronic Copies of
Software Manuals and User Manual

Section 2: Description of SBE 38

This section describes the functions and features of the SBE 38, including specifications and dimensions.

System Description

Sophisticated A/D acquisition electronics, ultra-stable thermistor, and state-of-the-art calibration provide the standards-level performance of an expensive AC bridge and platinum thermometer at a small fraction of the cost. The SBE 38 is unaffected by shock and vibration, has high accuracy and stability, and is easy to use. It has a rugged, corrosion-proof, 10,500 meter (34,400 foot) titanium pressure housing. Real-time temperature data is transmitted in ASCII characters (in °C or raw counts) via an RS-232 or optional RS-485 serial interface for display or logging by PC or data logger.

The SBE 38's measurement range is -5 to +35 °C. Absolute accuracy is better than 0.001 °C (1 mK) and resolution is approximately 0.00025 °C (0.25 mK). Each sensor includes certification that demonstrates drift of less than 0.001 °C (1 mK) during a six-month period.

Applications include calibration baths, oceanographic/aquatic research, and environmental monitoring.

The SBE 38 operates in one of three ways:
- RS-232 (full duplex) with one SBE 38 connected to the interface
- RS-485 (half duplex) with one SBE 38 connected to the interface
- RS-485 (half duplex) with several RS-485 sensors sharing one pair of wires

On power-up, the SBE 38 reads its EEPROM, which includes calibration coefficients and other setup information. As programmed, the SBE 38 samples and transmits temperature continuously, or waits for a command to begin sampling. Note that for RS-485 applications with several sensors sharing one pair of wires, the SBE 38 cannot sample continuously.

The SBE 38 is frequently integrated as a remote temperature sensor with one of our thermosalinograph instruments (SBE 21 Thermosalinograph or SBE 45 MicroTSG), to provide accurate sea surface temperature. See the manuals for those instruments for integration information.

The SBE 38 is supplied with a powerful Win 2000/XP software package, SEASOFT V2, which includes:
- SEATERM terminal program for easy communication.
- Seasave V7 real-time data acquisition and SBE Data Processing post-processing programs –Seasave V7 and SBE Data Processing can be used to view and process the entire data stream, including data from the SBE 38, when the SBE 38 is integrated with one of the following -
  - SBE 21 or 45 thermosalinograph;
  - SBE 16*plus*, 16*plus* V2, or 16*plus*-IM V2 SEACAT C-T Recorder; or SBE 19*plus* V2 SEACAT CTD Profiler.

Notes:
- Help files provide detailed information on the software.
- Separate software manuals on CD-ROM contain detailed information on Seasave V7 and SBE Data Processing.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our FTP site. See our website (www.seabird.com) for the latest software version number, a description of the software changes, and instructions for downloading the software from the FTP site.

Specifications

Measurement Range	-5 to +35 °C
Initial Accuracy [1]	± 0.001 °C (1 mK)
Typical Stability	0.001 °C (1 mK) in 6 months, certified
Resolution	0.00025 °C (0.25 mK)
Calibration	-1 to +32 °C
Response Time [2]	500 milliseconds
Self-Heating Error	less than 200 µK
RMS Noise (at temperature equivalent of 8.5 °C)	**NAvg** **Noise (°C)** 1 0.000673 2 0.000408 4 0.000191 8 0.000133 16 0.000081 32 0.000052 *Note:* **NAvg** = number of A/D cycles per sample. Interval between samples (seconds) = (0.133 * **NAvg**) + 0.339
External Power	*RS-232 (standard):* 8 – 15 VDC at 15 milliamps average *RS-485 half-duplex (optional):* 8 – 15 VDC at 10 milliamps average
Materials	Titanium pressure case rated at 10,500 meters (34,400 feet)
Weight	In water: 0.5 kg (1.2 lbs) In air: 0.9 kg (2.0 lbs)

Notes:
[1] NIST-traceable calibration applying over the entire range.
[2] Time to reach 63% of final value following a step change in temperature.

Note:
If the SBE 38 is sampling data and the voltage is less than 6.5 volts for 10 consecutive scans, the SBE 38 halts sampling and displays a low battery indication in the data.

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Dimensions and End Cap Connector

The SBE 38 is available with a 4-pin XSG-4-BCL-HP-SS or optional MCBH-4MP (WB), TI (3/8" length base, ½-20 thread) (wet-pluggable) external connector.
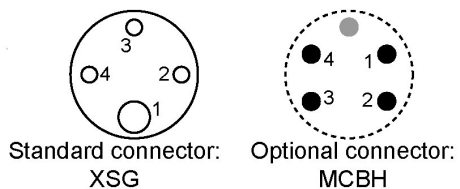
Standard connector:
XSG

Optional connector:
MCBH

Pin	Signal
1	Common
2	RS-232 Receive or RS-485 A
3	RS-232 Transmit or RS-485 B
4	Power

44.45 mm
(1.75 in.)

158.75 mm
(6.25 in.)

53.34 mm
(2.10 in.)

39.12 mm
(1.54 in.)
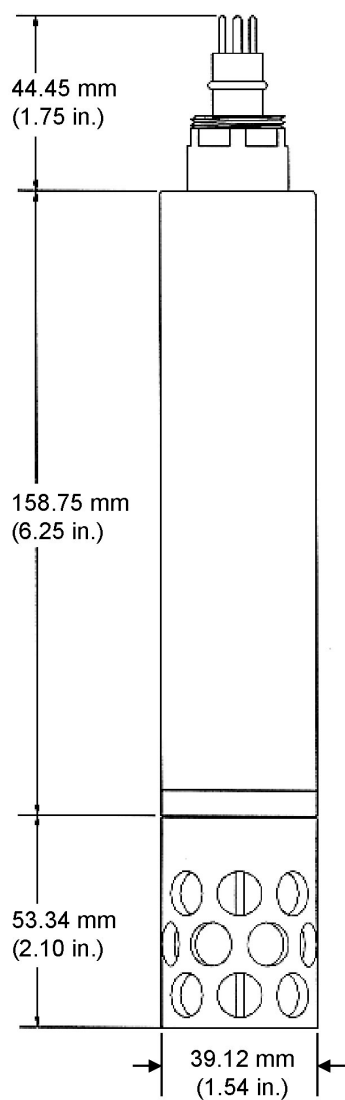
Section 3: Preparing SBE 38 for Deployment

This section describes the software installation and the pre-check procedure for preparing the SBE 38 for deployment.

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.
- It is possible to use the SBE 38 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 or Windows 7 (32-bit).

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, Seasave V7, and SBE Data Processing .

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

Power and Communications Test

Locking sleeve
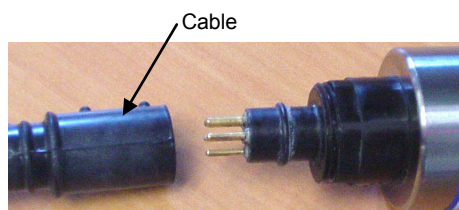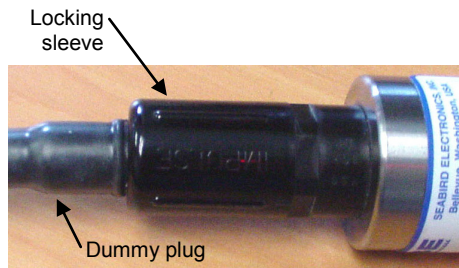
Dummy plug

Cable

Test Setup

1. If applicable, remove locking sleeve and dummy plug from bulkhead connector:
    A. By hand, unscrew the locking sleeve from the SBE 38's bulkhead connector. **If you must use a wrench or pliers, be careful not to loosen the bulkhead connector instead of the locking sleeve**.
    B. Remove the dummy plug from the SBE 38's bulkhead connector by pulling the plug firmly away from the connector.

2. Install the Sea-Bird I/O cable on the SBE 38:
    - **XSG Connector** (shown in photos) - Align the raised bump on the side of the connector with the large pin (pin 1 - ground) on the SBE 38.
    - **MCBH Connector** (optional) – Align the pins.

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

4. Connect the I/O cable battery terminal clip to a 9-volt battery. Note that the 9-volt battery supplied with the SBE 38 will provide approximately 50 hours of operation.

Test

> **Note:**
> See SEATERM's help files.

1. Double click on SeaTerm.exe. If this is the first time the program is used, the setup dialog box may appear:
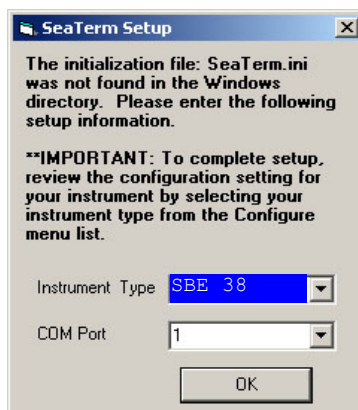
   Select the instrument type (SBE 38) and the computer COM port for communication with the SBE 38. Click OK.

2. The main screen looks like this:
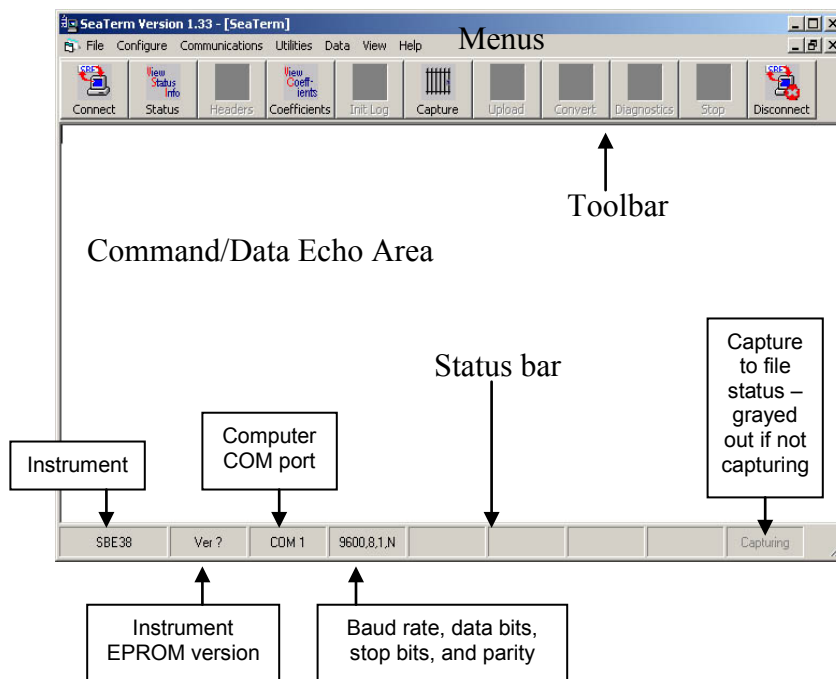
> **Note:**
> There is at least one way, and as many as three ways, to enter a command:
> - Manually type a command in Command/Data Echo Area
> - Use a menu to automatically generate a command
> - Use a Toolbar button to automatically generate a command

> **Note:**
> Once the system is configured and connected (Steps 3 through 5 below), to update the Status bar:
> - on the Toolbar, click Status; or
> - from the Utilities menu, select Instrument Status.
> SEATERM sends the status command, which displays in the Command/Data Echo Area, and updates the Status bar.

- Menus – Contains tasks and frequently executed instrument commands.
- Toolbar – Contains buttons for frequently executed tasks and instrument commands. All tasks and commands accessed through the Toolbar are also available in the Menus. To display or hide the Toolbar, select View Toolbar in the View menu. Grayed out Toolbar buttons are not applicable.
- Command/Data Echo Area – Echoes a command executed using a Menu or Toolbar button, as well as the instrument's response. Additionally, a command can be manually typed in this area, from the available commands for the instrument. Note that the instrument must be *awake* for it to respond to a command (use Connect on the Toolbar to wake up the instrument).
- Status bar – Provides status information. To display or hide the Status bar, select View Status bar in the View menu.

Following are the Toolbar buttons applicable to the SBE 38:

Toolbar Button	Description	Equivalent Command*
Connect	Re-establish communications with SBE 38. Computer responds with S> prompt.	(press Enter key)
Status	Display instrument setup and status (number of A/D cycles per sample, sampling status, etc.).	**DS**
Coefficients	Display calibration coefficients.	**DC**
Capture	Capture instrument responses on screen to file. File has .cap extension. Press Capture again to turn off capture. Capture status displays in Status bar.	—
Disconnect	Free computer COM port used to communicate with SBE 38. COM port can then be used by another program.	—

*See *Command Descriptions* in *Section 4: Deploying and Operating RS-232 SBE 38*.

3. In the Configure menu, select SBE 38. The dialog box looks like this:

Computer COM port, baud rate, data bits, and parity for communication between computer and SBE 38

Interface for communication between computer and SBE 38
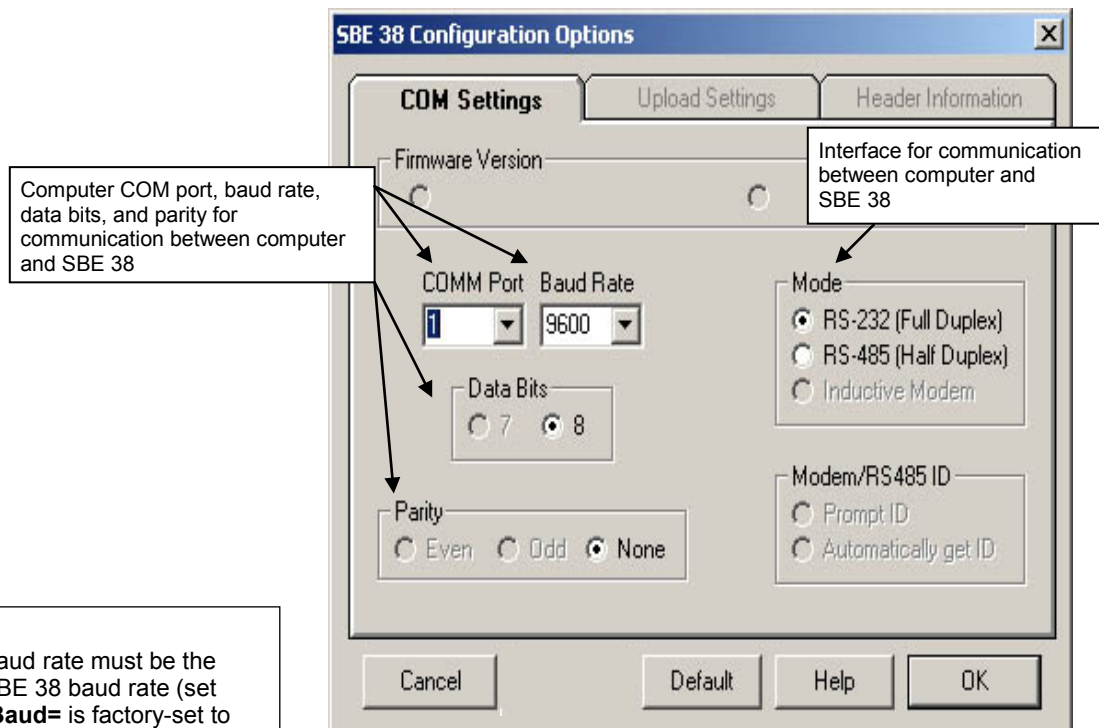
Notes:
- SEATERM's baud rate must be the same as the SBE 38 baud rate (set with **Baud=**). **Baud=** is factory-set to 9600, but can be changed by the user (see *Command Descriptions* in *Section 4: Deploying and Operating RS-232 SBE 38*).
- When you click OK, SEATERM saves the Configuration Options 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 38, 39, etc.) in the Configure menu, the Configuration Options dialog box shows the last saved settings for that instrument.

Make the selections in the Configuration Options dialog box:
- **COMM Port**: COM 1 through COM 10, as applicable
- **Baud Rate**: 9600 (documented on Configuration Sheet)
- **Data Bits**: 8
- **Parity**: None
- **Mode**: RS-232 (Full Duplex) or RS-485 (Half Duplex)
Click OK to save the settings.

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

5. Click Connect on the Toolbar. SEATERM tries to connect to the SBE 38 at the baud set in Step 3. If it cannot, it cycles through all other possible baud rates to try to connect. When it connects, the display looks like this:

    ```
    SBE 38  V 1.4   S/N 0090       (this line may not appear)
    S>
    ```

    This shows that correct communications between the computer and the SBE 38 has been established.
    If the system does not provide the S> prompt:
    - Click Connect again.
    - Verify the correct instrument was selected in the Configure menu and the settings were entered correctly in the Configuration Options dialog box. Note that the baud rate's factory setting is documented on the Configuration Sheet in this manual.
    - Check cabling between the computer and the SBE 38.

6. Display SBE 38 status information by clicking Status on the Toolbar. The display looks like this:

    ```
    SBE 38  V 1.4   S/N = 0090
    NAVG=1
    Not sampling data
    Automatically start sampling on power up
    Default interface is RS-232
    ```

7. Command the SBE 38 to take a sample by typing **TS** and pressing the Enter key. The display looks like this if the output format was set to converted data (**Format=C**) with 4 digits to the right of the decimal place (**Digits=4**):

    ```
    23.7658
    ```

    where   23.7658 = temperature in degrees Celsius
    This number should be reasonable; i.e., room temperature.

The SBE 38 is ready for programming and deployment.

Section 4:
Deploying and Operating RS-232 SBE 38

This section includes:

- system operation description, including example sets of operation commands
- baud rate, cable length, and power limitations
- detailed command descriptions
- data formats
- instructions for deploying and recovering the SBE 38

Sampling Modes

The SBE 38 has two sampling modes:

- Polled Sampling – take a single sample on command
- Continuous Sampling – sample continuously; start when power is applied or on command, depending on the setup

Descriptions and examples follow for an SBE 38 with **RS-232 Interface**. Note that the SBE 38's response to each command is not shown in the examples. Review the sampling modes and the commands described in *Command Descriptions* before setting up your system.

Polled Sampling

The SBE 38 takes one sample of data on command. Transmission of data to the computer is dependent on the particular command used.

Example: (user input in bold)
Apply power and establish communications. Set up to average 4 measurements per sample and output converted data with 3 digits after decimal place. Command SBE 38 to take a sample and send data to computer.

(Apply power and then click Connect on Toolbar.)
```
S>NAVG=4
S>FORMAT=C
S>DIGITS=3
S>DS          (to verify setup)
S>TS
```

Continuous Sampling

The SBE 38 continuously samples and transmits real-time data.

Sampling is started by:
- Sending **Go**, or
- Setting **AutoRun=Y**. If **AutoRun=Y**, sampling automatically starts when power is applied.

Sampling is stopped by:
- Sending **Stop**, or
- Removing power.

---

*Example: **Continuous Sampling** (user input in bold)*
Example 1 AutoRun=N: Apply power and establish communications. Set up to average 4 measurements per sample and output converted data with 3 digits after decimal place. Set up to wait for a command when power is applied. Remove power.
(Apply power and then click Connect on Toolbar.)
S>**NAVG=4**
S>**FORMAT=C**
S>**DIGITS=3**
S>**AUTORUN=N**
S>**DS**　　　　(to verify setup)
(Remove power.)

When ready to start sampling, apply power and establish communications. Send command to start sampling continuously, outputting real-time data. When desired, send command to stop sampling.
(Apply power and then click Connect on Toolbar.)
S>**GO**
S>**STOP**　　　　(You may need to send **Stop** several times to interrupt sampling.)

Example 2 AutoRun=Y: Apply power and establish communication. Set up to average 4 measurements per sample and output converted data with 3 digits after decimal place. Set up to automatically begin sampling when power is applied. Remove power.
(Apply power and then click Connect on Toolbar.)
S>**NAVG=4**
S>**FORMAT=C**
S>**DIGITS=3**
S>**AUTORUN=Y**
S>**DS**　　　　(to verify setup)
(Remove power.)

To start sampling, apply power. SBE 38 begins sampling continuously, outputting real-time data.
To stop sampling, remove power.

To change setup: apply power, and then stop sampling by command.
(Apply power)
(Press Enter key to get S> prompt)
S>**STOP**　　　　(You may need to send **Stop** several times to interrupt sampling.)
(Enter commands as desired to change setup.)

Baud Rate, Cable Length, and Power

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

Notes:
- Baud rate is set with **Baud=** (see *Command Descriptions* in this section).
- For RS-485, see *Appendix III: RS-485 Interface* for baud rate limitations.

Baud Rate and Cable Length

For **RS-232**, the length of cable that the SBE 38 can drive to transmit real-time data is dependent on the baud rate. The allowable combinations are:

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

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 SBE 38 and ground controller prevents the SBE 38 from transmitting real-time data.

V_{limit} = 1 volt = IR_{limit}
Where
I = current required by SBE 38 (15 mA for RS-232; 10 mA for RS-485).
Maximum cable length = R_{limit} / wire resistance per foot

Example 1 – For 18 gauge wire, what is maximum distance to transmit power to RS-232 SBE 38? Is this controlling factor for maximum cable length if wanting to transmit at 1200 baud?

R_{limit} = V_{limit} / I = 1 volt / 0.015 Amps = 67 ohms
For 18 gauge wire, resistance is 0.0064 ohms/foot.
Therefore, maximum cable length is 67 ohms / 0.0064 ohms/foot = 10417 feet = 3176 meters.
Note that 3176 meters > 800 meters (maximum distance SBE 38 can transmit data at 1200 baud), so IR loss is not controlling factor for this example.

Example 2 – Same as above, but there are 4 SBE 38s powered from the same power supply.

R_{limit} = V_{limit} / I = 1 volt / (0.015 Amps * 4 SBE 38s) = 17 ohms
For 18 gauge wire, resistance is 0.0064 ohms/foot.
Therefore, maximum cable length is 17 ohms / 0.0064 ohms/foot = 2604 feet = 794 meters (cable length to SBE 38 furthest from power source).

Supplying Enough Power to SBE 38

Another consideration in determining maximum cable length is supplying enough power at the power source so that sufficient voltage is available, after the IR loss in the cable, to power the SBE 38.

Example 1 – For 18 gauge wire, what is maximum distance to transmit power to RS-232 SBE 38 if using 8.5 volt power source to supply power? Is this controlling factor for maximum cable length if wanting to transmit at 1200 baud?

SBE 38's input power specification is 8 – 15 volts. Therefore, a 0.5 volt IR drop (8.5 volts – 8 volts) would still provide enough power to SBE 38.

$V = IR$ 0.5 volts = (0.015 Amps) * (0.0064 ohms/foot * cable length)   Cable length = 5208 ft = 1588 meters

Note that 1588 meters > 800 meters (maximum distance SBE 38 can transmit data at 1200 baud), so IR drop in power is not controlling factor for this example.

Example 2 – Same as above, but there are 4 SBE 38s powered from the same power supply.

$V = IR$ 0.5 volts = (0.015 Amps * 4 SBE 38s) * (0.0064 ohms/foot * cable length)

Cable length = 1302 ft = 397 meters (cable length to SBE 38 furthest from power source).

Note that 397 meters < 800 meters (maximum distance SBE 38 can transmit data at 1200 baud), so IR drop in power is controlling factor for this example. Using a higher voltage power supply or a different wire gauge (12 or 14 gauge) would provide sufficient power at SBE 38 to allow 800 meter cable length.

Command Descriptions

This section describes commands and provides sample outputs. See *Appendix IV: RS-232 Command Summary* for a summarized command list.

When entering commands:
- Input commands to the SBE 38 in upper or lower case letters and register commands by pressing the Enter key.
- The SBE 38 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.

Note:
If the voltage is below 6.5 volts, the following displays in response to **DS**:
`WARNING: LOW BATTERY VOLTAGE!!`

Status Command

DS	Display status and setup parameters. Equivalent to Status on Toolbar. Description in example includes, where applicable, command used to modify parameter.

```
Example: (user input in bold).
S>DS
SBE 38  V 1.4   S/N = 0090                              (firmware version, serial number)
NAVG=1                                 (number of A/D cycles to average for each sample [NAvg=])
Not sampling data                                                           (sampling status)
Automatically start sampling on power up                 (sampling start-up mode [AutoRun=])
Default interface is RS-232                      (RS-232 or RS-485 interface [Interface=])
```

Setup Commands

Interface=x	**x=232**: Set interface to RS-232. **x=485**: Set interface to RS-485. See *Appendix III: RS-485 Interface* for **all** details.

Note:
The SBE 38's baud (set with **Baud=**) must be the same as SEATERM's baud rate (set in Configure menu).

Baud=x	**x=** baud rate (1200, 2400, 4800, 9600). Default 9600.
Format=x	**x=C**: Output converted data (°C). **x=R**: Output raw data (counts).
Digits=x	**x=** number of digits (0 – 6) to right of decimal point for converted temperature (°C). Applicable only if **Format=C**.

Notes:
- The SBE 38 transmits data **after** it has completed the previous sample and before it starts the next sample.
- For continuous sampling with an RS-485 interface, set **NAvg** $\geq$ 30. See *Appendix III: RS-485 Interface*.

NAvg=x	**x=** number of A/D cycles to average per sample (1 – 127). Time between samples (seconds) $= (0.133 * \mathbf{NAvg}) + 0.339$ (Time between samples for continuous sampling; minimum time required for each polled sample.)

Note:
After you send **AutoRun=Y**, to start sampling immediately:
- Turn power off and then on again, or
- Send **Go**.

AutoRun=x	**x=N**: Wait for a command when power is applied. **x=Y**: Start continuous sampling automatically when power is applied.

Sampling Commands

These commands are used to request data from the SBE 38.

For all sampling commands:

- Output format is determined by **Format=** and **Digits=**.
- Number of A/D cycles per sample is defined by **NAvg**.

Go	Start sampling data continuously, and transmit data real-time.

Time between samples (seconds)

$$= (0.133 * \textbf{NAvg}) + 0.339$$

Stop	Stop continuous sampling. Press Enter key to get S> prompt before entering **Stop**.
TS	Take 1 sample and transmit data.
TH	Take 1 sample and hold data in SBE 38 buffer.
SH	Transmit data that was held in SBE 38 buffer.
SL	Transmit data from last sample from SBE 38 buffer.
SLT	Transmit data from last sample from SBE 38 buffer, and then take 1 new sample and hold data in buffer.

Notes:

- To capture real-time data to a file, do this *before* starting sampling:
  1. Click Toolbar's Capture button.
  2. Enter desired file name in dialog box. *Capture* status displays in status bar at bottom of screen.
- If the SBE 38 is sampling data and the voltage is less than 6.5 volts for ten consecutive scans, the SBE 38 halts sampling and sets the status to low battery.

Note:

You may need to send **Stop** several times to get the SBE 38 to respond.

Calibration Coefficients Commands

DC	Display calibration coefficients. Equivalent to Coefficients on Toolbar.

Example: Display coefficients for SBE 38 (user input in bold).

```
S>DC
SBE 38  V 1.4   S/N = 0090
Cal Date:    08-apr-96
A0 =-9.420702e-05
A1 = 2.937924e-04
A2 =-3.739471e-06
A3 = 1.909551e-07
Slope = 1.000000
Offset = 0.0000
```

Notes:

- Date shown is when calibration was performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificate shipped with SBE 38.
- See individual Coefficient Commands below for definitions of the data in the example.

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

TCalDate=S	**S**=Temperature calibration date
A0=F	**F**=Temperature A0
A1=F	**F**=Temperature A1
A2=F	**F**=Temperature A2
A3=F	**F**=Temperature A3
Slope=F	**F**=Temperature slope (default 1.0)
Offset=F	**F**=Temperature offset (°C) (default 0.0)

Note:

F = floating point number
S = string with no spaces

Data Formats

Notes:
- Each line of output is followed by a carriage return and line feed.
- For converted data, leading zeros for temperature output are suppressed, except for one zero to the left of the decimal point (for example, 0.1034).
- See *Appendix III: RS-485 Interface* for data output format for an SBE 38 with optional RS-485 interface.

Converted Data (Format=C)
    ttt.ttt
    where:
    t = temperature (degrees Celsius, ITS-90)
    Number of digits to right of decimal point is defined by **Digits**=.
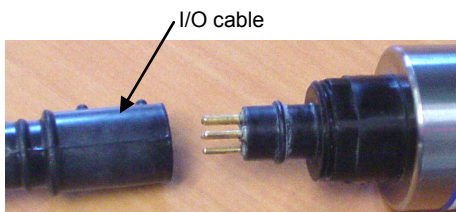
Raw Data (Format=R)
    nnnnnn.n
    where:
    n= counts

Deployment

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

I/O cable

Locking sleeve

1. Install the I/O cable:
   A. Lightly lubricate the inside of the cable connector with silicone grease (DC-4 or equivalent).
   B. **XSG Connector** (shown in photo) - Install the cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the SBE 38. Remove any trapped air by *burping* or gently squeezing the connector near the top and moving your fingers toward the end cap. **OR**
   MCBH Connector (optional) – Install the cable connector, aligning the pins.
   C. Place the locking sleeve over the connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

2. Mount the SBE 38.

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

4. Use **one** of the following sequences to start sampling:
   - If **AutoRun=N**: Send **Go** to start sampling continuously now, or **TS** or **TH** to take a single sample.
   - If **AutoRun=Y**: Apply power to start sampling continuously now.

5. Deploy the SBE 38.

Recovery

<table>
<tr><td>

WARNING!
If the SBE 38 stops working while underwater, is unresponsive to commands, or shows other signs of flooding or damage, carefully secure it away from people until you have determined that abnormal internal pressure does not exist or has been relieved. Pressure housings may flood under pressure due to dirty or damaged o-rings, or other failed seals. When a sealed pressure housing floods at great depths and is subsequently raised to the surface, water may be trapped at the pressure at which it entered the housing, presenting a danger if the housing is opened before relieving the internal pressure. Instances of such flooding are rare. However, a housing that floods at 5000 meters depth holds an internal pressure of more than 7000 psia, and has the potential to eject the end cap with lethal force. A housing that floods at 50 meters holds an internal pressure of more then 85 psia; this force could still cause injury.
If you suspect the SBE 38 is flooded, point it in a safe direction away from people, and loosen the bulkhead connector very slowly, at least 1 turn. This opens an o-ring seal under the connector. Look for signs of internal pressure (hissing or water leak). If internal pressure is detected, let it bleed off slowly past the connector o-ring. Then, you can safely remove the end cap.

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

1. Use **one** of the following sequences to stop sampling:

   - Press Enter key to get S> prompt, and then send **Stop** to stop sampling continuously.   **OR**

   - Remove power.

2. Rinse the SBE 38 with fresh water, and dry thoroughly.

Section 5: Routine Maintenance and Calibration

This section reviews corrosion precautions, connector mating and maintenance, and sensor calibration. The SBE 38's accuracy is sustained by the care and calibration of the sensor and by establishing proper handling practices.

Corrosion Precautions

All exposed materials are titanium or plastic. No corrosion precautions are required, but direct electrical connection of the SBE 38 housing to mooring or other dissimilar metal hardware should be avoided. Rinse the SBE 38 with fresh water after use and prior to storage.

Connector Mating and Maintenance

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

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

When remating:

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

1. Lightly lubricate the inside of the cable connector with silicone grease (DC-4 or equivalent).

2. **XSG Connector** - Install the cable connector, aligning the raised bump on the side of the plug/cable connector with the large pin (pin 1 - ground) on the SBE 38. Remove any trapped air by *burping* or gently squeezing the connector near the top and moving your fingers toward the end cap.   **OR**

   MCBH Connector (optional) - Install the cable connector, aligning the pins.

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

Verify that a cable is installed on the SBE 38 before deployment.

Sensor Calibration

Sea-Bird sensors are calibrated by subjecting them to known physical conditions and measuring the sensor responses. Coefficients are then computed, which may be used with appropriate algorithms to obtain engineering units. The temperature sensor on the SBE 38 is supplied fully calibrated, with coefficients printed on the Calibration Certificate (see back of manual). These coefficients have been stored in the SBE 38's EEPROM.

We recommend that the SBE 38 be returned to Sea-Bird for calibration.

The primary source of temperature sensor calibration drift is the aging of the thermistor element. Sensor drift is not substantially dependent upon the environmental conditions of use, and — unlike platinum or copper elements — the thermistor is insensitive to shock.

Sea-Bird's Calibration Methodology

The SBE 38 is calibrated in Sea-Bird's state-of-the-art calibration laboratory, which maintains primary temperature standards (water triple point [TPW] and gallium melting point [GaMP] cells), ITS-90 certified and standards-grade platinum resistance thermometers, and a low-gradient temperature bath.

Temperature is computed using the Steinhart-Hart polynomial for thermistors (Steinhart and Hart, 1968; Bennett, 1972), which is based on thermistor physics. The equation characterizes the non-linear temperature versus resistance response of the sensor. Note that thermistors require individualized coefficients to the Steinhart-Hart equation, because the thermistor material is an individualized mix of dopants:

$$t_{90} = \left[\frac{1.0}{a0 + a1 * [\ln(n)] + a2 * [\ln^2(n)] + a3 * [\ln^3(n)]} - 273.15 \right] * \text{Slope} + \text{Offset} \ [°C]$$

where
n = SBE 38 raw output (counts).

Glossary

PCB – Printed Circuit Board.

SBE 38 – High-accuracy digital oceanographic thermometer.

> **Note:**
> All Sea-Bird software listed was designed to work with a computer running Windows 2000/XP. Extensive testing has not shown any compatibility problems when using the software with a computer running Windows Vista or Windows 7 (32-bit).

SBE Data Processing – Sea-Bird's Win 2000/XP data processing software, which calculates and plots measured and derived variables. SBE Data Processing can be used to view and process the entire data stream, including data from the SBE 38, *when the SBE 38 is integrated with one of the following:*
- SBE 21 or 45 thermosalinograph,
- SBE 16*plus*, 16*plus* V2, or 16*plus* -IM V2 C-T Recorder
- SBE 19*plus* V2 CTD Profiler

Scan – One data sample.

Seasave V7 – Sea-Bird's Win 2000/XP software used to acquire, convert, and display real-time or archived raw data. Seasave V7 can be used to view and process the entire data stream, including data from the SBE 38, *when the SBE 38 is integrated with one of the following:*
- SBE 21 or 45 thermosalinograph,
- SBE 16*plus*, 16*plus* V2, or 16*plus* -IM V2 C-T Recorder
- SBE 19*plus* V2 CTD Profiler

SEASOFT V2 – Sea-Bird's complete Win 2000/XP software package, which includes software for communication, real-time data acquisition, and data analysis and display. SEASOFT V2 includes *SEATERM*, SeatermAF, SeatermV2, *Seasave V7*, *SBE Data Processing*, and Plot39.

SEATERM – Sea-Bird's Win 95/98/NT/2000/XP terminal program used to communicate with the SBE 38.

Appendix I: Functional Description

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. Maximum power dissipated in the thermistor is 0.5 microwatts, and contributes less than 200 μK of overheat error.

A raw count (ratio) is related to resistance measurements:

$$\textbf{raw counts} = 1048576 * (NT) / (NR)$$

where
NR = output from reference resistor
NT = thermistor output

The SBE 38's output is computed from the raw count and the calibration coefficients that are stored in EEPROM.

The number of acquisition cycles (raw counts) averaged per measurement is user-programmable (**NAvg=**; see *Section 4: Deploying and Operating RS-232 SBE 38*). Increasing the number of cycles per measurement increases the time to acquire the measurement and the interval between measurements, while reducing the RMS temperature noise from the sensor. The interval between measurements is:

$$\textbf{interval [seconds]} = (0.133 * \textbf{NAvg}) + 0.339$$

where
NAvg = number of acquisition cycles per measurement

The SBE 38 transmits data **after** it has completed the previous sample and before it starts the next sample.

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

where
number of characters is dependent on the output format. Include the decimal point when counting characters; add 2 to the number of characters output, to account for the carriage return and line feed at the end of each scan.

Settings

Calibration coefficients and setup parameters (**Baud=**, **NAvg=**, **Interface=**, etc.) are written to EEPROM and are non-volatile. These settings do not change if power is removed.
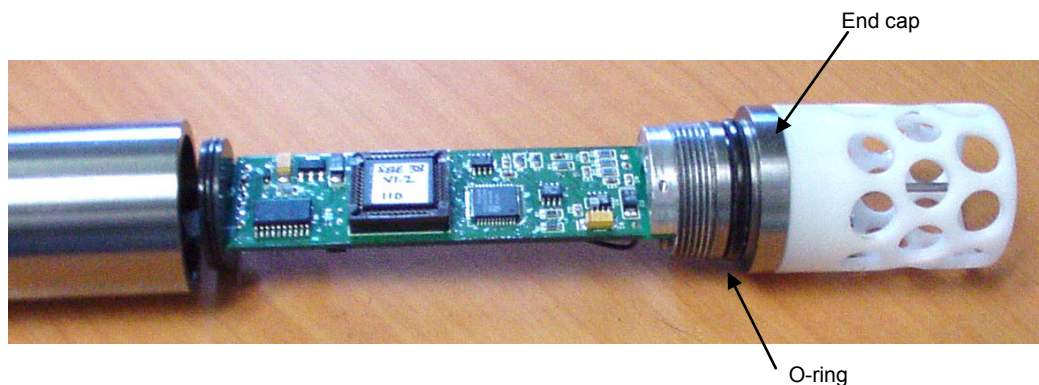
Appendix II: Electronics Disassembly/Reassembly

1. Remove the titanium end cap and electronics from the housing as follows:

   A. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.

   B. Unscrew the end cap.

   C. Pull the end cap and attached electronics out of the housing. Note that the PCB is electrically connected to the I/O connector.

   D. Remove any water from the end cap O-ring and mating surfaces inside the housing with a lint-free cloth or tissue.

   E. Be careful to protect the O-ring from damage or contamination.

2. Reinstall the end cap and electronics in the housing as follows:

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

   B. Carefully fit the electronics into the housing.

   C. Screw the end cap into the housing.

End cap

O-ring

Appendix III: RS-485 Interface

Operation Description

Commands can be directed to one SBE 38 or globally to all SBE 38s. If **IDReq=Y**, a command prefix (**#ii**) is used to direct commands to an SBE 38 with the same ID (ii = ID). Global commands do not use a prefix, regardless of the setting for **IDReq=**, and are recognized by all SBE 38s attached to the RS-485 interface.

An example follows for a system with two SBE 38s (IDs 01 and 02) online. Note that the SBE 38's response to each command is not shown in the example. Review the commands described in *Command Descriptions* and the example below before setting up your system.

Example: Wake up all SBE 38s. Set up all SBE 38s to average 40 measurements per sample and output converted data with 3 digits to the right of the decimal place. Command all SBE 38s to take a sample and hold data in buffer, and then command each SBE 38 to transmit data from buffer. Repeat sampling sequence a number of times. (user input in bold)

(Apply power and click Connect on Toolbar to wake up all SBE 38s.)
```
S>IDREQ=Y               (command to require ID prefix)
S>#01NAVG=40             (set number of measurements per sample to 40 for SBE 38 with ID=01)
S>#02NAVG=40             (set number of measurements per sample to 40 for SBE 38 with ID=02)
S>#01FORMAT=C           (set output format to converted data for SBE 38 with ID=01)
S>#02FORMAT=C           (set output format to converted data for SBE 38 with ID=02)
S>#01DIGITS=3           (set number of digits to right of decimal point to 3 for SBE 38 with ID=01)
S>#02DIGITS=3           (set number of digits to right of decimal point to 3 for SBE 38 with ID=02)
S>#01DS                 (verify setup with status command for SBE 38 with ID=01)
S>#02DS                 (verify setup with status command for SBE 38 with ID=02)
S>GDATA                 (global command to all SBE 38s to take sample and hold data in buffer)
S>DATA01                (get data from buffer of SBE 38 with ID=01)
S>DATA02                (get data from buffer of SBE 38 with ID=02)
```
(Repeat **GDATA** through **DATA02** as desired)

Command Descriptions

RS-485 Commands

> **Note:**
> For reliable operation, all commands *may* need to be preceded with two **@** characters to clear the buffers. *Example* (status command for SBE 38 with ID=01):
> S>@@**#01DS**

Global Commands

Global commands are recognized by **all** SBE 38s attached to the RS-485 interface.

TxDelay=x	**x=** delay after SBE 38 transmits a reply until SBE 38 transmitter is disabled (1 – 500 milliseconds). Default 25 milliseconds.
RxDelay=x	**x=** delay after SBE 38 receives a command until SBE 38 transmitter is enabled (1 – 500 milliseconds). Default 25 milliseconds.
GData	Command **all** SBE 38s to take 1 sample and hold data in SBE 38 buffer until receiving: - **DATAii**; - **SH**, **SL**, or **SLT** (if **#iiIDReq=N**); or - **#iiSH**, **#iiSL**, or **#iiSLT** (if **IDReq=Y**).

> **Note:**
> **GData** and **AData** perform the same function in the SBE 38. Both are included here to provide compatibility with RS-485 MicroCATs.

AData	Command **all** SBE 38s to take 1 sample and hold data in SBE 38 buffer until receiving: - **DATAii**; - **SH**, **SL**, or **SLT** (if **#iiIDReq=N**); or - **#iiSH**, **#iiSL**, or **#iiSLT** (if **IDReq=Y**).

Get Data Command

DATAii	Get data obtained with **GData** or **AData** from SBE 38 with ID = ii (ii = 0 -99).

ID Required Command

> **Note:**
> **IDReq=Y** does **not** require a **#ii** prefix.
> **IDReq=N does** require a **#ii** prefix (**#iiIDReq=N**).

IDReq=Y	Precede commands to individual SBE 38s with **#ii**, where ii= ID (ii = 0 -99). Use this setting for systems with multiple RS-485 instruments on 1 pair of wires. Note that the use of a prefix does not apply to Global, Get Data, or ID commands.
#iiIDReq=N	Do not precede commands to individual SBE 38s with **#ii**. Use this setting for systems with only 1 SBE 38.

> *Example 1:* Multiple RS-485 instruments on 1 pair of wires (user input in bold)
>
> | | |
> |---|---|
> | S>**IDREQ=Y** | (command to require ID prefix) |
> | S>**#01NAVG=40** | (set number of A/D cycles to average for SBE 38 with ID=01) |
> | S>**#02NAVG=40** | (set number of A/D cycles to average for SBE 38 with ID=02) |
> | S>**#01DS** | (verify setup with status command for SBE 38 with ID=01) |
> | S>**#02DS** | (verify setup with status command for SBE 38 with ID=02) |
>
> *Example 2:* Only 1 SBE 38 on 1 pair of wires, with ID=01 (user input in bold)
>
> | | |
> |---|---|
> | S>**#01IDREQ=N** | (command to **not** require ID prefix; note that #ii prefix is required) |
> | S>**NAVG=40** | (set number of A/D cycles to average for SBE 38, no ID required as part of command) |
> | S>**DS** | (verify setup with status command for SBE 38, no ID required as part of command) |

ID Commands

Only one SBE 38 can be online when sending these commands.

ID?	Display SBE 38 ID (ID = ii, where ii= 0-99) and whether ID is required as a prefix for commands to individual SBE 38s (see **IDReq=**).
***ID=ii**	Set SBE 38 ID to ii, where ii= 0-99. ***ID=** must be sent twice, because the SBE 38 requests verification. **If more than one RS-485 instrument is online when sending this command, all instruments online will be set to same ID**.

All Other Commands

All other commands (status, setup, sampling, and coefficients) are listed in *Section 4: Deploying and Operating RS-232 SBE 38* and in *Appendix IV: RS-232 Command Summary*.

Notes on use of these commands for an SBE 38 with RS-485 interface:

> **Note:**
> **IDReq=Y** does **not** require a **#ii** prefix.
> **IDReq=N does** require a **#ii** prefix (**#iiIDReq=N**).

- Effect of **IDReq=**:
  If **IDReq=Y**, precede these commands with **#ii** (ii = 0 – 99) to direct a command to a particular SBE 38.
  If **#iiIDReq=N**, do not precede these commands with **#ii**. This setting works only for a system with one SBE 38.

- The RS-485 interface cannot accommodate multiple instruments transmitting real-time data at the same time. Therefore, do not set **AutoRun=Y** (start sampling continuously when power is applied) for a system with more than one RS-485 instrument on a pair of wires. Similarly, do not attempt to send **Go** to multiple SBE 38s on a pair of wires, as the system cannot transmit a command to one instrument while another instrument is transmitting real-time data.

- **If planning to sample continuously:** If **AutoRun=Y** (sample continuously when power is applied) or using the **Go** command to start sampling continuously, **set NAvg= (A/D cycles to average per sample) to a value greater than or equal to 30.**

Data Formats

> **Notes:**
> - Each line of output is followed by a carriage return and line feed.
> - For converted data, leading zeros for temperature output are suppressed, except for one zero to the left of the decimal point (for example, 0.1034).

Converted Data (Format=C)
Output from continuous sampling: ttt.ttt
Output from DATAii, #iiTS, TS, #iiSH, SH, #iiSL, SL, #iiSLT, or SLT:
ii, sssss, ttt.ttt
where:
> ➤ t = temperature (°C, ITS-90)
>   (number of digits to right of decimal point is defined by **Digits=**)
> ➤ ii = ID (0 – 99)
> ➤ sssss = SBE 38 serial number

Raw Data (Format=R)
nnnnnn.n
*where:*
> ➤ n = counts

Wiring

Note:
See *Power and Cable Length* in *Section 4: Deploying and Operating RS-232 SBE 38* for cable limitations related to the supply of power.

When configured with the RS-485 interface, the SBE 38 can transmit data over up to 1200 meters of 26 AWG twisted pair wire cable.

The MAX1483 transceivers used in the SBE 38 are designed for bi-directional data communications on multi-point bus transmission lines. To minimize reflections, terminate the line at both ends in its characteristic impedance. Also, keep stub lengths off the main line as short as possible (although the slew-rate-limited MAX1483 is more tolerant of imperfect termination than standard RS-485 ICs).
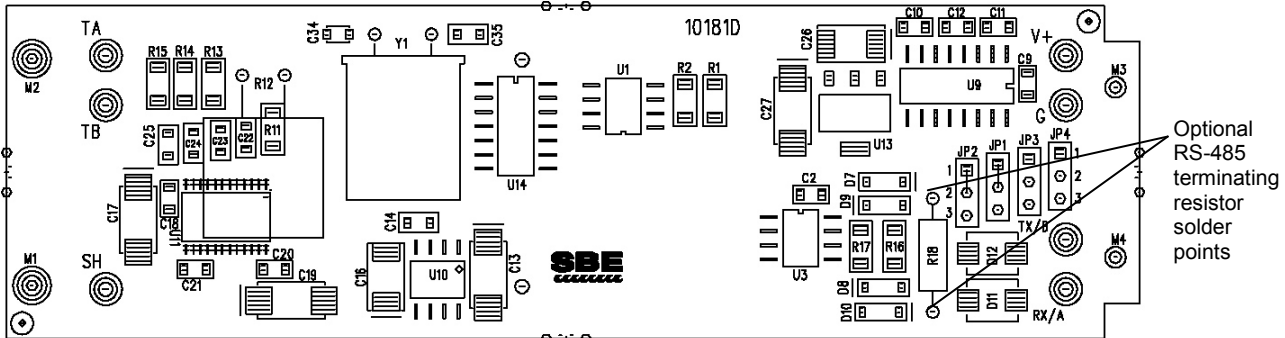
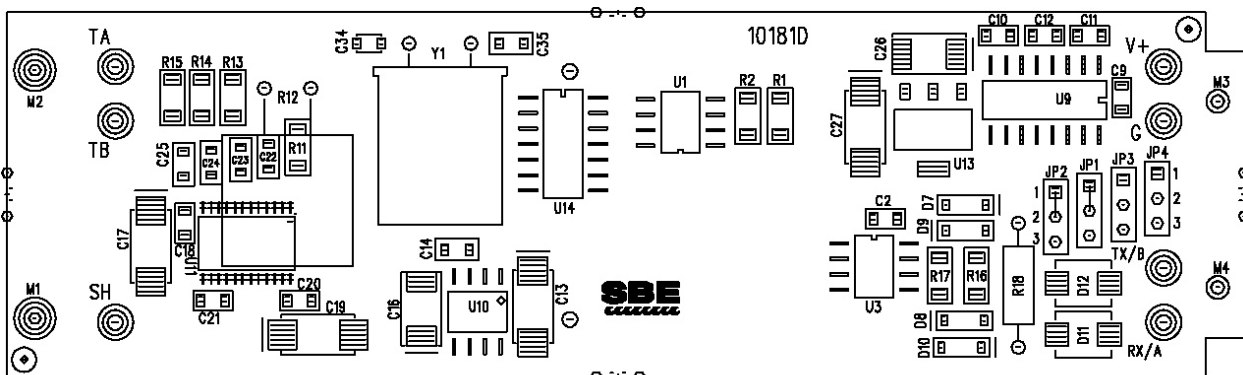## Conversion of RS-232 to RS-485 or RS-485 to RS-232

Notes:
- See *Appendix II: Electronics Disassembly / Reassembly* to access the PCB.
- Send **Interface=232** or **Interface=485** to program the SBE 38 to match the wired configuration.

Sea-Bird supplies the SBE 38 with the correct jumper settings on the Printed Circuit Board (PCB) for your ordered configuration (standard RS-232 or optional RS-485). If desired, you can modify the jumper settings to change the configuration:

Wiring: connect -
- Pin 2 (black) to RS-232 RX / RS-485 'A'
- Pin 3 (green) to RS-232 TX / RS-485 'B'

JP1/JP2 NOTE: PCB TRACE CONNECTION ACROSS PINS 1-2 MUST BE CUT BEFORE JUMPERING PINS 2-3

X = DON'T CARE

JUMPER CONFIGURATION: TRANSMIT/RECEIVE

	JP1	JP2	JP3	JP4
RS-232	1-2	1-2	1-2	1-2
RS-485	X	X	2-3	2-3

Appendix IV: RS-232 Command Summary

CATEGORY	COMMAND	DESCRIPTION
Status	**DS**	Display status and setup parameters.
Setup	**Interface=x**	**x=232**: RS-232 interface. **x=485**: RS-485 interface.
	Baud=x	**x=** baud rate (1200, 2400, 4800, 9600). Default 9600.
	Format=x	**x=C**: Output converted data (°C). **x=R**: Output raw data (counts).
	Digits=x	**x=** number of digits (0 – 6) to right of decimal point for converted temperature (°C). Applicable only if **Format=C**
	NAvg=x	**x=** A/D cycles to average per sample (1 – 127).
	AutoRun=x	**x=N**: Wait for a command when power applied. **x=Y**: Start continuous sampling automatically when power applied.
Sampling	**Go**	Start continuous sampling now.
	Stop	Stop continuous sampling. Press Enter key to get S> prompt before entering **Stop**.
	TS	Take 1 sample and transmit data.
	TH	Take 1 sample and hold data in buffer.
	SH	Transmit data that was held in buffer.
	SL	Transmit data from last sample from buffer.
	SLT	Transmit data from last sample from buffer, and then take 1 new sample and hold data in buffer.
Coefficients (F=floating point number; S=string with no spaces) Date shown is when calibration was performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificate shipped with SBE 38.	**DC**	Display calibration coefficients; all coefficients and dates listed below are included. Use individual commands below to modify a particular coefficient or date.
	CalDate=S	**S=**Temperature calibration date.
	A0=F	**F=**Temperature A0.
	A1=F	**F=**Temperature A1.
	A2=F	**F=**Temperature A2.
	A3=F	**F=**Temperature A3.
	Slope=F	**F=**Temperature slope (default 1.0).
	Offset=F	**F=**Temperature offset (default 0.0).

Appendix V: Replacement Parts

Part Number	Part	Application Description	Quantity in SBE 38
231361	Plastic temperature sensor guard	Screws to end cap to protect temperature sensor	1
30931	O-ring, Parker 2-214 N674-70	Placed in end cap groove for watertight seal	1
801376	4-pin RMG-4FS to 9-pin DB-9S I/O cable with battery snap, 2.4 m (8 ft) long	From SBE 38 **(XSG)** to computer	1
801263	4-pin MCIL-4FS to 9-pin DB-9S I/O cable with battery snap, 2.4 m (8 ft) long	From SBE 38 **(wet-pluggable)** to computer	1
171888	25-pin DB-25S to 9-pin DB-9P cable adapter	For use with computer with DB-25 connector	1
17046.1	4-pin RMG-4SD-LP dummy plug with locking sleeve	For SBE 38 **(XSG)** connector	1
171398.1	4-pin MCIL-4FS dummy plug with locking sleeve	For SBE 38 **(wet-pluggable)** connector	1

Appendix VI: Manual Revision History

Manual Version	Date	Description
006	03/03	Major rewrite: Remove DOS terminal program information and replace with SEATERM, add wet-pluggable connector option, correct calibration range to -1 to +32 (from -1 to +35 in old manual), correct calibration equation information.
007	03/04	• Correct available bauds in command summary (remove 19200 & 3840). • Add power vs cable length information. • Update cable list to 9-pin cable. • Update Seaterm screens.
008	01/05	• Firmware 1.3 added 3 commands: slope= (default 1.0), offset=(default 0). • Temperature calculation has slope & offset included in equation: $t = t * slope + offset$
009	05/06	• Remove high range temperature calibration option (removed from price list). • Update wet-pluggable connector information. • Add more information to Recovery Warning.
010	01/09	• PCB changed, connections and jumpers changed for conversion between RS-232 & RS-485. • Update for V2 Seacats –integration with 16plus V2, 16plus-IM V2, 19plus V2. • Add information about compatibility with Vista. • Remove information about DOS software. • Update connector maintenance information for consistency with application note 57.
011	04/09	• Change spec for current to 15 mA for RS-232 version. Also change current for RS-485 to 10 mA.
012	01/10	• Change Seasoft-Win32 to Seasoft V2, update file name to SeasoftV2_*date*.exe. • Add information required for CE certification, and add CE mark. • Update SBE address.
013	03/11	• Add more information on RS-485 operation: - Set **NAvg ≥ 30** for continuous sampling (using **Go** to start sampling, or if **AutoRun=Y**). - **IdReq=Y** does not require **#ii** prefix, but **IDReq=N** does require **#ii** prefix (**#iiIDReq=N**). - For customers using their own terminal program: terminate commands with CR (not CRLF) • Add information about compatibility with Windows 7

Index

SBE 38 Digital Oceanographic Thermometer Reference Sheet
(see SBE 38 User's Manual for complete details)

Interface

- **RS-232 (standard)** – one SBE 38 connected to the interface.

- **RS-485 (optional)** – one or more SBE 38s sharing one pair of wires.

Sampling Modes

- **Polled sampling** – SBE 38 takes one sample and transmits data.

- **Continuous sampling** – SBE 38 continuously samples and transmits data. As programmed, SBE 38 begins sampling on power-up or waits for a command to begin sampling. Note that for RS-485 applications with several sensors sharing one pair of wires, the SBE 38 cannot sample continuously.

For both polled and continuous sampling, the SBE 38 averages **NAvg** A/D cycles per sample. It outputs converted (°C) or raw (counts) data, depending on **Format=**. For converted data, number of digits after the decimal place is defined by **Digits=**.

Communication Setup Parameters

1. Double click on seaterm.exe.

2. Once main screen appears, in Configure menu select SBE 38. Input in dialog box:
   - Serial Port: COM1 through COM10 are available
   - Baud Rate: 9600 (or other if applicable)
   - Data Bits: 8
   - Parity: No Parity
   - Mode: RS-232 (Full Duplex) or RS-485 (Half Duplex)

Deployment

1. Install I/O cable and locking sleeve.

2. Program SBE 38 for intended deployment (see other side of this sheet for *Command Instructions and List*):

   A. Establish setup parameters.

   B. Use **one** of following sequences to start sampling:
      - If **AutoRun=N**: **Go** to start sampling continuously now, or **TS** or **TH** to take a single sample.
      - If **AutoRun=Y**: Apply power to start sampling continuously now.

3. Mount SBE 38.

Command Instructions and List

- Input commands to SBE 38 in upper or lower case letters and register commands by pressing the Enter key.
- SBE 38 sends `?CMD` if invalid command is entered.
- If system does not return `S>` prompt after executing a command, press Enter key to get `S>` prompt.

Shown below are the commands. See the Manual for detailed descriptions and examples.

RS-232 Commands

CATEGORY	COMMAND	DESCRIPTION
Status	DS	Display status.
Setup	Interface=x	**x=232**: RS-232 interface. **x=485**: RS-485 interface.
	Baud=x	**x=** baud rate (1200, 2400, 4800, 9600). Default 9600.
	Format=x	**x=C**: Output converted data (°C). **x=R**: Output raw data (counts).
	Digits=x	**x=** digits (0 – 6) to right of decimal point for converted temperature (°C).
	NAvg=x	**x=** A/D cycles to average per sample (1 – 127).
	AutoRun=x	**x=N**: Wait for a command when power applied. **x=Y**: Start continuous sampling automatically when power applied.
Sampling	Go	Start continuous sampling now.
	Stop	Stop continuous sampling. Press Enter key to get `S>` prompt before entering command.
	TS	Take 1 sample and transmit data.
	TH	Take 1 sample and hold data in buffer.
	SH	Transmit data that was held in buffer.
	SL	Transmit data from last sample from buffer.
	SLT	Transmit data from last sample from buffer, and then take 1 new sample and hold data in buffer.
Coefficients	DC	Display calibration coefficients.
	CalDate=S	**S**=Temperature calibration date.
	A0=F	**F**=Temperature A0.
	A1=F	**F**=Temperature A1.
	A2=F	**F**=Temperature A2.
	A3=F	**F**=Temperature A3.
	Slope=F	**F**=Temperature slope (default = 1.0).
	Offset=F	**F**=Temperature offset (°C) (default = 0.0).

RS-485 Commands

- See RS-232 Commands above for status, setup, sampling, and coefficients commands.
- If **IDReq=Y**, precede all above commands with **#ii** (ii = 0 – 99) to direct command to particular SBE 38.
  If **#iiIDReq=N**, do not precede above commands with **#ii** (applies only for a system with 1 SBE 38).
- For reliable operation, all commands *may* need to be preceded with two @ characters to clear buffers.
- RS-485 interface cannot accommodate multiple instruments transmitting real-time data at same time. Therefore, do not set **AutoRun=Y** (start sampling continuously when power is applied) for system with more than 1 RS-485 instrument on pair of wires. Similarly, do not attempt to send **Go** command to multiple SBE 38s on pair of wires, as system cannot transmit command to 1 instrument while another instrument is transmitting real-time data.
- If planning to sample continuously (**AutoRun=Y** or using **Go** to start sampling), set **NAvg≥30** (A/D cycles to average/sample).

CATEGORY	COMMAND	DESCRIPTION
Global	TxDelay=x	**x=** delay after SBE 38 transmits a reply until SBE 38 transmitter is disabled (1 – 500 milliseconds). Default 25 milliseconds.
	RxDelay=x	**x=** delay after SBE 38 receives a command until SBE 38 transmitter is enabled (1 – 500 milliseconds). Default 25 milliseconds.
	GData or AData	Command **all** SBE 38s to take 1 sample and hold data in SBE 38 buffer until receiving: **DATAii**; **SH**, **SL**, or **SLT** (if **IDReq=N**); or **#iiSH**, **#iiSL**, or **#iiSLT** (if **IDReq=Y**).
Get Data	DATAii	Get data obtained with **GDATA** or **ADATA** from SBE 38 with ID = ii (ii = 0 -99).
ID Required	IDReq=Y	Precede commands to individual SBE 38s with **#ii**, where ii= ID (ii = 0 -99).
	#iiIDReq=N	Do not precede commands to individual SBE 38s with **#ii**.
ID (only 1 SBE 38 can be online when sending these commands)	ID?	Display SBE 38 ID (ID = ii, where ii= 0-99) and whether ID is required as a prefix for commands (see **IDReq=**).
	*ID=ii	Set SBE 38 ID to ii, where ii= 0-99. This command must be sent twice, because the computer requests verification. **If more than one RS-485 instrument is online when sending this command, all instruments online will be set to same ID**.

CALIBRATION SHEETS

SBE38

Digital Oceanographic Thermometer

Instrument Configuration:

Serial Number   3865557-0639
Firmware Version   1.4
Interface Type   RS-232
Baud Rate   4800
Maximum Depth   10500 meters

CAUTION - The maximum deployment depth is limited by the pressure housing to 10500m.

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13431 NE 20th St. Bellevue, Washington 98005 USA
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SBE Pressure Test Certificate

Test Date: **3/22/2011**   Description **SBE-38 Digital Thermometer**

Job Number: **65557**   Customer Name **EMS/FRANCE**

SBE Sensor Information:

Model Number: **38**

Serial Number: **0639**

Pressure Sensor Information:

Sensor Type: **None**

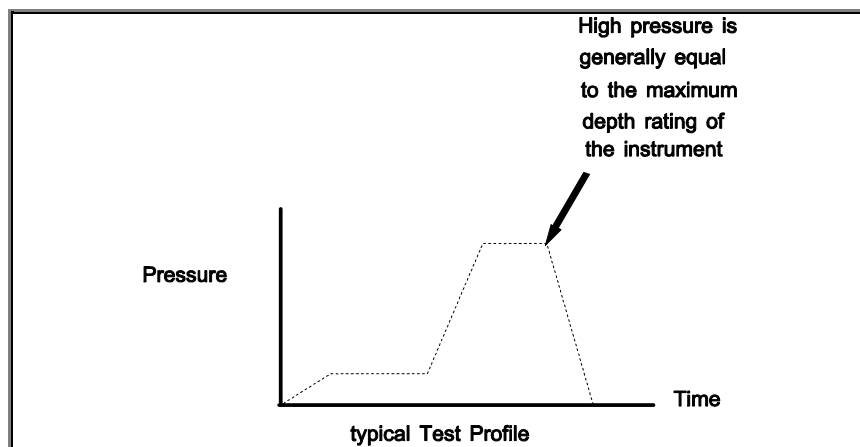Sensor Serial Number: **None**

Sensor Rating: **0**

Pressure Test Protocol:

Low Pressure Test: **40** PSI Held For: **15** Minutes

High Pressure Test: **10000** PSI Held For: **15** Minutes

Passed Test: ☑

Tested By: VG

High pressure is generally equal to the maximum depth rating of the instrument

Pressure

Time

typical Test Profile

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA

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

SENSOR SERIAL NUMBER: 0639
CALIBRATION DATE: 26-Aug-11

SBE 38 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = -4.502917e-006
a1 = 2.753940e-004
a2 = -2.452044e-006
a3 = 1.527765e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.50010	832868.9	-1.50009	0.00001
0.99990	742792.8	0.99990	0.00000
4.49990	634662.3	4.49988	-0.00002
7.99990	544072.3	7.99989	-0.00001
11.49990	467916.4	11.49991	0.00001
14.99990	403680.5	14.99992	0.00002
18.49990	349322.8	18.49990	0.00000
21.99990	303177.6	21.99993	0.00003
25.49990	263885.0	25.49986	-0.00004
28.99990	230325.5	28.99987	-0.00003
32.49990	201579.3	32.49993	0.00003

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

Residual = instrument temperature - bath temperature

Date, Delta T (mdeg C)

● 26-Aug-11   0.00
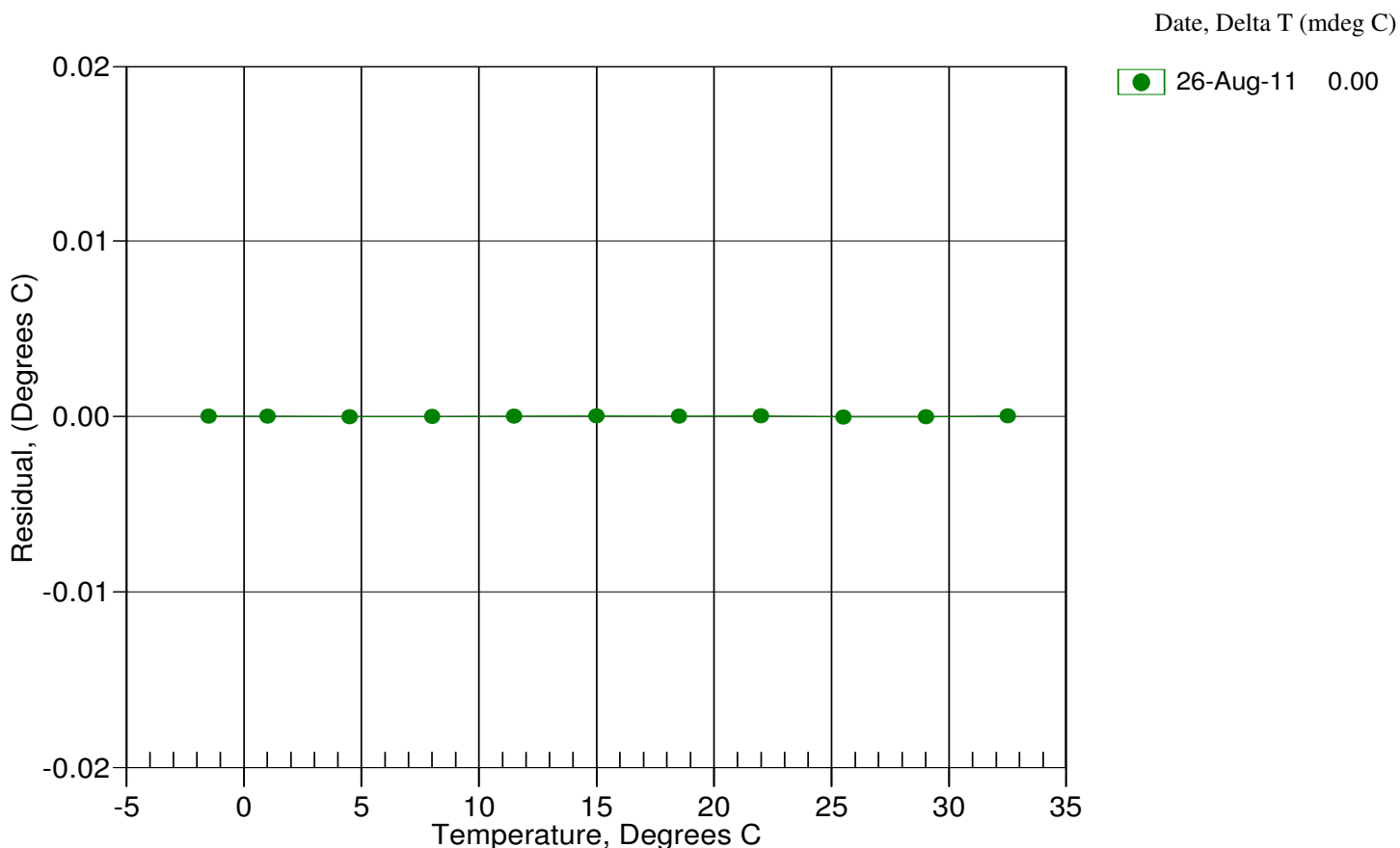
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Digital Oceanographic Thermometer   SBE 38

Sophisticated A/D acquisition electronics, ultra-stable thermistor, and state-of-the-art calibration provide the standards-level performance of an expensive AC bridge and platinum thermometer at a small fraction of the cost. The SBE 38 is unaffected by shock and vibration, has high accuracy and stability, and is easy to use. It has a rugged, corrosion-proof, 10,500 meter (34,400 foot) titanium pressure housing. Real-time temperature data is transmitted in ASCII characters (°C or raw counts) via an RS-232 or optional RS-485 serial interface for display or logging by PC or data logger.

The SBE 38's measurement range is -5 to +35 °C; absolute accuracy is better than 0.001 °C (1 mK) and resolution is approximately 0.00025 °C (0.25 mK). Each sensor includes certification that demonstrates drift of less than 0.001 °C (1 mK) during a six-month period.

Applications include calibration baths, oceanographic/aquatic research, and environmental monitoring. The SBE 38 is frequently integrated as a remote temperature sensor with an SBE 21 Thermosalinograph or SBE 45 MicroTSG, to provide accurate sea surface temperature. It can also be integrated as a secondary temperature sensor with an SBE 16*plus*, 16*plus*-IM, 16*plus* V2, 16*plus*-IM V2, or 19*plus* V2 SEACAT CTD.

OPERATION

The SBE 38 operates in one of three modes:
- RS-232 (full duplex) with one SBE 38 connected to the interface
- RS-485 (half duplex) with one SBE 38 connected to the interface
- RS-485 (half duplex) with several RS-485 sensors sharing one pair of wires

On power-up, the SBE 38 reads its EEPROM, which includes calibration coefficients and other setup information. As programmed, the SBE 38 samples and transmits temperature continuously, or waits for a command. For RS-485 applications with several sensors sharing one pair of wires, the SBE 38 cannot sample continuously.

MEASUREMENT METHOD

Temperature is determined by applying an AC excitation to reference resistances and an ultra-stable aged thermistor with a drift rate of less than 0.002 °C per year. Each of the resulting outputs is digitized by a 24-bit A/D converter. The reference resistor is a hermetically sealed VISHAY. AC excitation and ratiometric comparison using a common processing channel removes measurement errors due to parasitic thermocouples, offset voltages, leakage currents, and gain errors. The maximum power dissipated in the thermistor is 0.5 microwatts, and contributes less than 200 µK of overheat error.

A raw count (ratio) is related to resistance measurements:

raw counts = 1048576 * NT / NR
where NR is the output from the reference resistor and NT is the thermistor output.

The number of acquisition cycles (raw counts) averaged per sample is user-programmable. Increasing the number of cycles per sample increases the time to acquire the sample and the interval between samples, while reducing the RMS temperature noise from the sensor. The interval between samples is:

interval [seconds] = (0.133 * NAvg) + 0.339
where NAvg is the number of acquisition cycles per sample.

The SBE 38's converted output is computed from the raw count and the calibration coefficients that are stored in EEPROM.

Digital Oceanographic Thermometer

SBE 38

CALIBRATION

The SBE 38 is calibrated in Sea-Bird's state-of-the-art calibration laboratory, which maintains primary temperature standards (water triple point [TPW] and gallium melting point [GaMP] cells), ITS-90 certified and standards-grade platinum resistance thermometers, and a low-gradient temperature bath.

Temperature is computed using the Steinhart-Hart polynomial for thermistors (Steinhart and Hart, 1968; Bennett, 1972), which is based on thermistor physics. The equation characterizes the non-linear temperature versus resistance response of the sensor. Note that thermistors require individualized coefficients to the Steinhart-Hart equation, because the thermistor material is an individualized mix of dopants:

$$t_{90L} = \{[1.0 / (a0 + a1 * [\ln(n)] + a2 * [\ln^2(n)] + a3 * [\ln^3(n)])] - 273.15\} * Slope + Offset \ [°C]$$

where n is the SBE 38 output.

Pin	Signal
1	Common
2	RS-232 Receive or RS-485 A
3	RS-232 Transmit or RS-485 B
4	Power

Standard connector: XSG-4-BCL-HP-SS

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

44.45 mm (1.75 in.)

158.75 mm (6.25 in.)

53.34 mm (2.10 in.)

39.12 mm (1.54 in.)

SPECIFICATIONS

Interface and Power Requirements:

RS-232 (standard)	Power: 8-15 VDC at 15 milliamps average
RS-485 half duplex (optional)	Power: 8-15 VDC at 10 milliamps average
Housing:	Titanium, rated at 10,500 meters (34,400 feet)
Weight:	
In Air	0.9 kg (2.0 lbs)
In Water	0.5 kg (1.2 lbs)
Range:	-5 to +35 °C
Initial Accuracy[1]:	± 0.001 °C (1 mK)
Resolution:	0.00025 °C (0.25 mK)
Stability:	0.001 °C (1 mK) in six months, certified
Response Time[2]:	500 milliseconds
Self-heating Error:	less than 200 µK

1 *NIST-traceable calibration applying over the entire range.*
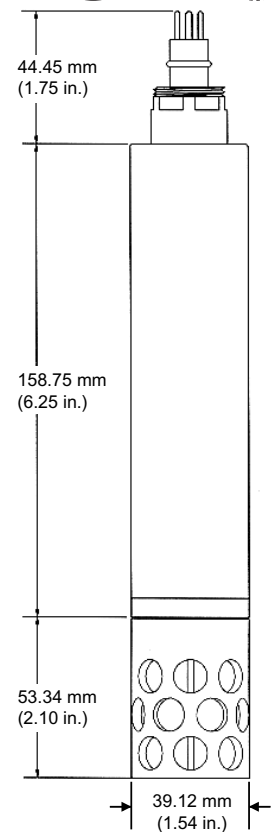2 *Time to reach 63% of final value following a step change in temperature.*

ACTUAL CALIBRATION DATA for Sensor Number 80

CALIBRATION DATE: 02 September 1997

a0 = -2.809379e-05   a2 = -2.619655e-06
a1 = 2.783483e-04   a3 = 1.598734e-07

Bath Temperature [°C]	Instrument Output [n]	Instrument Temperature [°C]	Residual (Instrument - Bath) [°C]
-1.52985	824162.7	-1.52983	0.00002
1.03108	733633.1	1.03106	-0.00002
4.60520	625547.1	4.60518	-0.00002
8.11169	536776.4	8.11169	-0.00000
11.61533	462132.6	11.61536	0.00003
15.17575	398167.3	15.17574	-0.00001
18.63931	345476.6	18.63934	0.00003
22.14032	300170.8	22.14031	-0.00001
25.66793	261276.6	25.66793	0.00000
29.13948	228549.1	29.13944	-0.00004
32.61481	200420.3	32.61484	0.00003
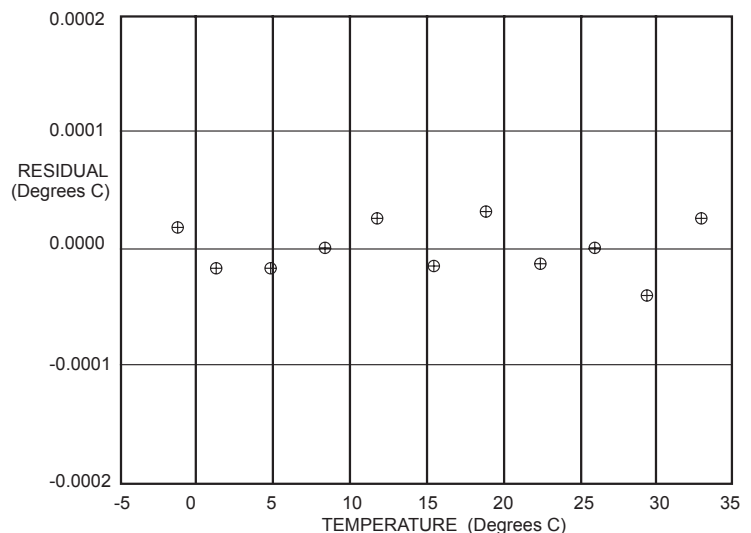
04/09

SBE

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APPLICATION NOTE NO. 42   Revised <u>February 2010</u>

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.

SBE
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<u>**Application Note 56**</u>   <u>**Revised February 2009**</u>

Interfacing to RS-485 Sensors

A few Sea-Bird instruments use the RS-485 protocol for transmitting setup commands to the instrument and receiving data from the instrument. However, most personal computers (PCs) do not come with an RS-485 port. This Application Note covers interfacing our RS-485 instruments with a PC by the following methods:

- Connecting the instrument to a **USB RS-485 Adapter** that plugs into an existing USB port on the PC, **OR**
- Connecting the instrument to an external **RS-485/RS-232 Interface Converter** that plugs into an existing RS-232 port on the PC, **OR**
- Installing an **RS-485 Interface Card** (and associated software) in the PC, and then connecting the instrument directly to the new RS-485 port in the PC.

The use of these adapters/converters/cards is described below.

Note: Sea-Bird is providing information on adapters / converters / cards that we have tested with our instruments. Other devices from these manufacturers, and devices from other manufacturers, **may** also be compatible with Sea-Bird instruments. **We recommend testing other devices with the instrument before deployment, to verify that there is no problem.**

USB RS-485 Adapter

A USB RS-485 adapter plugs into a USB port on the PC, and allows an RS-485 device to be connected through the adapter. Sea-Bird tested an adapter from one manufacturer with our instruments, and verified compatibility:

> **National Instruments (www.ni.com)** –
> **USB-485** with USB connector and RS-485 DB-9P connector

Follow this procedure to use the USB-485 Adapter:
1. Install the RS-485 driver software (provided with Adapter) on your PC before installing the Adapter.
2. Install the USB RS-485 Adapter.
3. Configure the USB port in your PC (directions are for a PC running Windows XP):
    A. Right click on My Computer and select Properties.
    B. In the System Properties dialog box, click on the Hardware tab. Click the Device Manager button.
    C. In the Device Manager window, double click on Ports. Double click on the desired USB port.
    D. In the Port Properties dialog box, click the Port Settings tab. Click the Advanced button.
    E. In the Advanced Settings dialog box, set Transceiver Mode to **2 wire Auto**. Verify that *Bias Resistors Enabled* is **not checked**. Click OK. Then click OK in the Port Properties dialog box.
4. Disconnect the USB RS-485 Adapter from the PC, then plug it back in again. The new settings from Step 3 should now be in effect.
5. Make a jumper cable (**do not use a standard adapter cable**) to connect the USB-485 Adapter to the instrument's I/O cable. Pin outs are shown for a Sea-Bird 9-pin (current production) or 25-pin (older production) I/O cable:

DB-9S (connect to USB-485 Adapter)	DB-9P (connect to Sea-Bird I/O cable PN 801385)	DB-25P (connect to Sea-Bird I/O cable PN 801046)
pin 1 common	pin 5 common	pin 7 common
pin 4 TX+	pin 3 'A'	pin 2 'A'
pin 8 RX+	pin 3 'A'	pin 2 'A'
pin 5 TX-	pin 2 'B'	pin 3 'B'
pin 9 RX-	pin 2 'B'	pin 3 'B'

6. Run the terminal program software (see instrument manual for correct software for your instrument):
    A. SEATERM: In SEATERM's Configure menu, select the desired instrument. In the Configuration Options dialog box, set Mode to RS-485 and set COMM Port to the appropriate USB port.
    B. SeatermV2: In SeatermV2's Instruments menu, select the desired instrument; Seaterm485 opens. In Seaterm485's Communications menu, select Configure. Set the Port to the appropriate USB port.

External RS-485/RS-232 Interface Converter

An RS-485/RS-232 Interface Converter plugs into an RS-232 port on the PC, and allows an RS-485 device to be connected through the Converter. Sea-Bird tested a Converter from one manufacturer with our instruments, and verified compatibility:

> **Black Box (www.blackbox.com)** –
> **IC520A-F** with RS-232 DB-25 female connector and RS-485 terminal block connector

Follow this procedure to use the IC520A-F Converter:
1. Connect the Converter to the PC:
    *   If the PC has a 25-pin male RS-232 connector, plug the Converter directly into the PC connector.
    *   If the PC has a 9-pin male RS-232 connector, plug the Converter into a 25-pin to 9-pin adapter (such as Black Box FA520A-R2 Adapter). Plug the 25-pin to 9-pin adapter into the PC.
2. On the Converter, measure the voltage between XMT+ and ground and between XMT- and ground. Connect whichever has the highest voltage to RS-485 'A' and the other to RS-485 'B'. The ground terminal can be left unconnected.

RS-485 Interface Card and Port in the PC

An RS-485 Interface Card installs in the PC, and allows an RS-485 device to be connected to the RS-485 port. When using with a Sea-Bird instrument:
*   **RS-485 Transmitter -** The Interface Card must be configured to automatically handle the RS-485 driver enable.
*   **Two-Wire Interface -**
    TX+ and RX+ on the Interface Card must be connector together and to 'A' on the instrument.
    TX- and RX- on the Interface Card must be connected together and to 'B' on the instrument.
    Note: Some Interface Cards have a jumper to make the connections internally, while for other Cards the connections must be made in a jumper cable.

Sea-Bird tested two Interface Cards from one manufacturer with our instruments, and verified compatibility:

> **National Instruments (www.ni.com)** -
> AT-485/2
> PCI-485/2

Follow this procedure to use the AT-485/2 or PCI-485/2 Interface Card:
1. Install the RS-485 driver software (provided with Interface Card) on your PC before installing the Interface Card.
2. Install the RS-485 Interface Card.
3. Configure the RS-485 Interface Card in your PC (directions are for a PC running Windows XP):
    A. Right click on My Computer and select Properties.
    B. In the System Properties dialog box, click on the Hardware tab. Click the Device Manager button.
    C. In the Device Manager window, double click on Ports. Double click on the desired RS-485 port.
    D. In the Communications Port Properties dialog box, click the Port Settings tab. Click the Advanced button.
    E. In the Advanced Settings dialog box, set Transceiver Mode to **2 wire TxRdy Auto**. Click OK. Then click OK in the Communications Port Properties dialog box.
4. Make a jumper cable (**do not use a standard adapter cable**) to connect the Interface Card to the instrument's I/O cable. Pin outs are shown for a Sea-Bird 9-pin (current production) or 25-pin (older production) I/O cable:

DB-9S (connect to PC)	DB-9P (connect to Sea-Bird I/O cable PN 801385)	DB-25P (connect to Sea-Bird I/O cable PN 801046)
pin 1 common	pin 5 common	pin 7 common
pin 4 TX+	pin 3 'A'	pin 2 'A'
pin 8 RX+	pin 3 'A'	pin 2 'A'
pin 5 TX-	pin 2 'B'	pin 3 'B'
pin 9 RX-	pin 2 'B'	pin 3 'B'

5. Run the terminal program software (see instrument manual for correct software for your instrument):
    A. SEATERM: In SEATERM's Configure menu, select the desired instrument. In the Configuration Options dialog box, set Mode to RS-485 and set COMM Port to the appropriate RS-485 port.
    B. SeatermV2: In SeatermV2's Instruments menu, select the desired instrument; Seaterm485 opens. In Seaterm485's Communications menu, select Configure. Set the Port to the appropriate RS-485 port.

SBE

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<u>APPLICATION NOTE NO. 57</u>   **Revised <u>February 2010</u>**

Connector Care and Cable Installation

This Application Note describes the proper care of connectors and installation of cables for Sea-Bird instruments. The Application Note is divided into three sections:
- Connector Cleaning and Inspection, and Cable / Dummy Plug Installation
- Locking Sleeve Installation
- Cold Weather Tips

Note: All photos in this Application Note show standard Impulse XSG/AG connectors. Except as noted, all procedures apply to standard XSG/AG connectors as well as to optional *wet-pluggable* MCBH connectors.
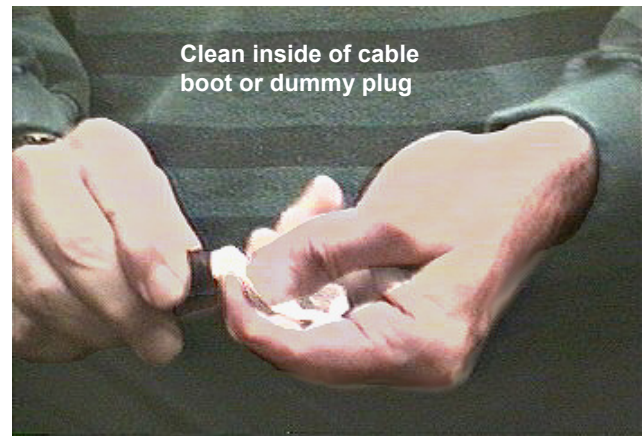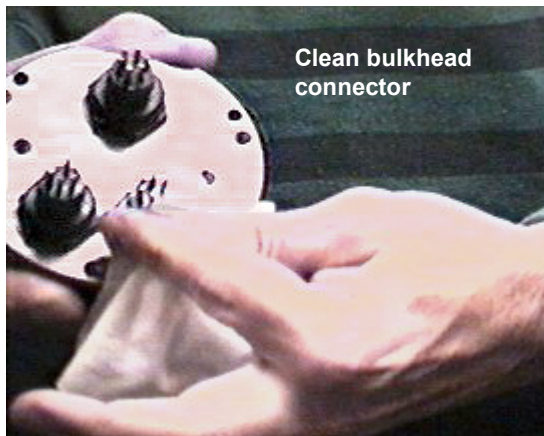
Connector Cleaning and Inspection, and Cable / Dummy Plug Installation

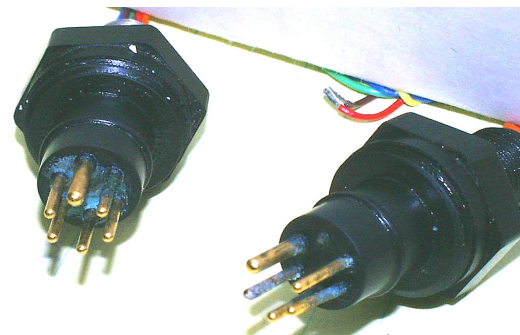Clean and inspect connectors, cables, and dummy plugs:
- Before every cruise.
- During the cruise – This is a good practice if you have a few days of down time between casts.
- After every cruise – This is the best way to find and remove any corrosion on connector pins before severe corrosion develops.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

Follow this procedure:

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

Clean bulkhead connector

Clean inside of cable boot or dummy plug

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

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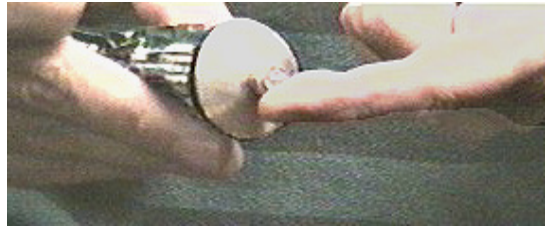

Corroded pins on bulkhead connectors - Connector on right has a missing pin

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

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

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

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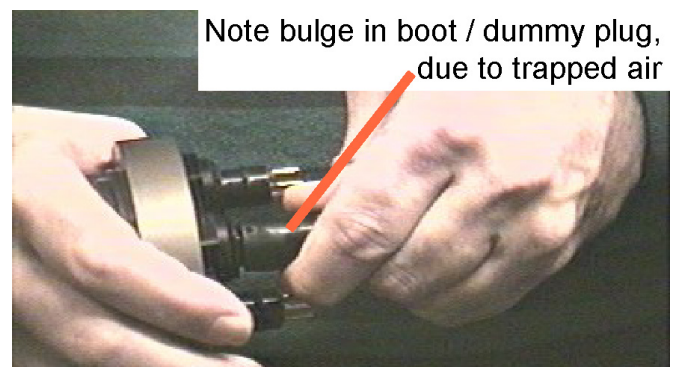

4. *Standard XSG/AG connectors only:* Align the *bump* on the cable boot or dummy plug with the large pin on the bulkhead connector, and align the sockets with the pins.

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

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

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

    Note bulge in boot / dummy plug, due to trapped air

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

    Slide hand to eject air

Locking Sleeve Installation

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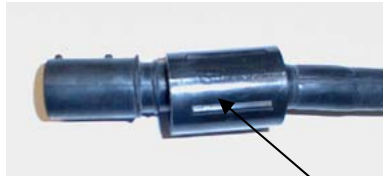
- Tighten the locking sleeve by hand. **Do not** use a wrench or pliers to tighten the locking sleeve. Over-tightening will gall the threads, which can bind the locking sleeve to the bulkhead connector. Attempting to remove a tightly bound locking sleeve may instead result in the bulkhead connector actually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

Locking sleeve

Cold Weather Tips

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

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

Installing a Standard XSG/AG Cable or Dummy Plug:
When possible, install cables and dummy plugs in warm environments. If not, warm the cable boot or dummy plug sufficiently so it is flexible. A flexible cable boot or dummy plug will install properly.

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

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APPLICATION NOTE NO. 68

Revised **June 2009**

Using USB Ports to Communicate with Sea-Bird Instruments

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

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

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

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

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

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

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

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

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

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APPLICATION NOTE NO. 71   Revised <u>March 2008</u>

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.
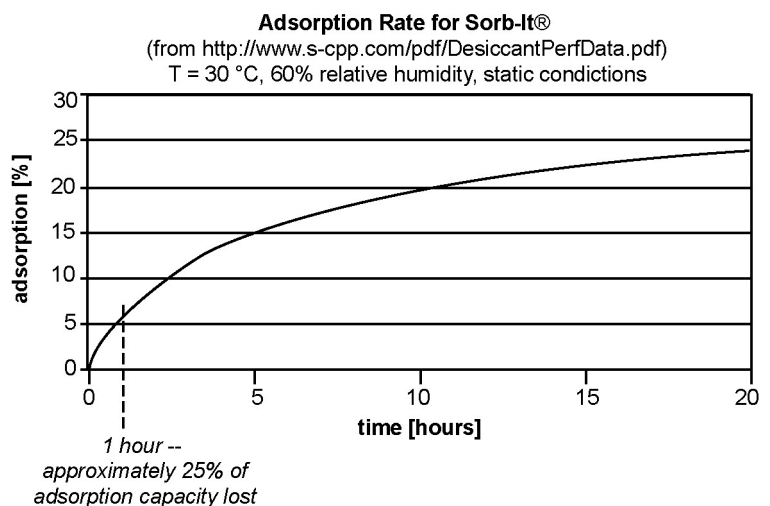
What do we mean by *expose the electronics*?
- For most battery-powered Sea-Bird instruments (such as SBE 16, 16*plus*, 16*plus* V2, 16*plus*-IM, 16*plus*-IM V2, 17*plus*, 19, 19*plus*, 19*plus* V2, 25, 26, 26*plus*, 37-SM, 37-SMP, 37-IM, 37-IMP, 44, 53, 54, 55, Auto Fire Module [AFM]), there is a bulkhead 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.**

Adsorption Rate for Sorb-It®
(from http://www.s-cpp.com/pdf/DesiccantPerfData.pdf)
T = 30 °C, 60% relative humidity, static condictions

*1 hour --
approximately 25% of
adsorption capacity lost*

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

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

SECTION I -- PRODUCT IDENTIFICATION

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

SECTION II -- HAZARDOUS INGREDIENTS

Components in the Solid Mixture

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

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

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

SECTION III -- PHYSICAL DATA

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

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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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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
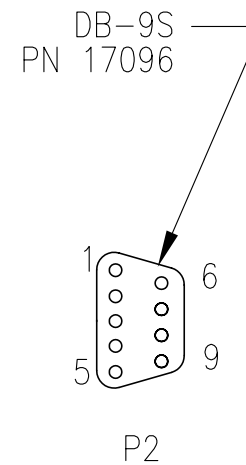**SORB-IT**®
Packaged Desiccant

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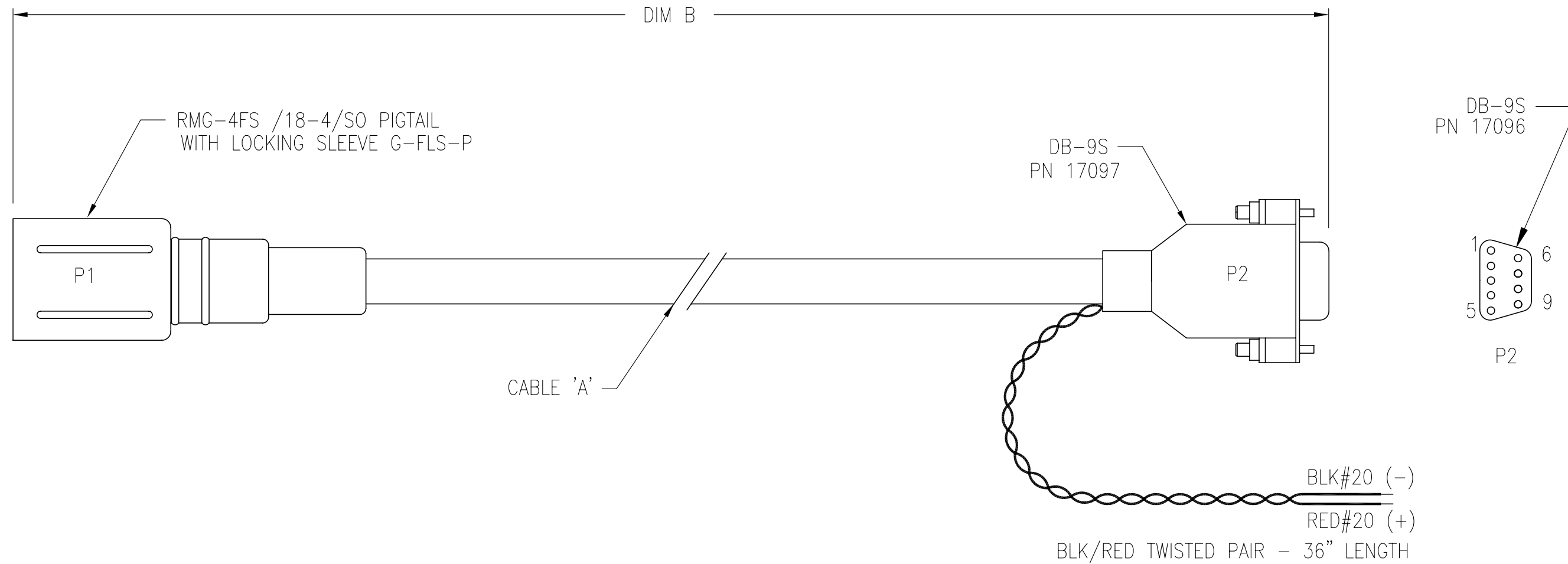## MATERIAL SAFETY DATA SHEET – August 13, 2002
SORB-IT®
Packaged Desiccant

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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.

DIM B

RMG-4FS /18-4/SO PIGTAIL
WITH LOCKING SLEEVE G-FLS-P

DB-9S
PN 17097

DB-9S
PN 17096

P1

P2

CABLE 'A'

1 6
5 9

P2

BLK#20 (−)
RED#20 (+)
BLK/RED TWISTED PAIR − 36" LENGTH

SBE PN	CABLE 'A' PN	DIM B
801133	17267	5 m
801302	171572	200 FT
801355	17114	20 m
801385	17031	8 FT
801461	17106	11 m
801560	17117	30 m

P1 RMG-4FS	P2 DB-9S	BLK/RED PAIR
PIN 1 WHITE	PIN 5	BLK
PIN 2 BLACK	PIN 3 ⚠A	
PIN 3 GRN	PIN 2 ⚠A	
PIN 4 RED		RED

SEA-BIRD ELECTRONICS, INC

TOLERANCES			
FRACTIONAL	P/N SEE TABLE	SCALE NTS	DRAWN BY RMB
DECIMAL			APPROVED BY
	TITLE CABLE: RMG-4FS TO DB-9S ASSEMBLY		
ANGULAR	DATE 3.26.99	DRAWING NUMBER 32277	REV A

"B" DIM

RMG-4FS /18-4/SO PIGTAIL
WITH LOCKING SLEEVE G-FLS-P
PIGTAIL FROM DRAWING 30581

DB-9S 17096

DB-9S
PN 17097

P2

1 6
5 9

P2

BLK#20 (−)
RED#20 (+)

BLK/RED TWISTED PAIR − 36" LENGTH

−

+

PN 30959, 9V BATTERY SNAP CONNECTOR CLIP

P1 RMG-4FS	P2 DB-9S ⚠	BLK/RED PAIR
PIN 1 WHITE	PIN 5	BLK
PIN 2 BLACK	PIN 3	
PIN 3 GRN	PIN 2	
PIN 4 RED	---	RED

ASSY PN	CABLE A PN	DIM B	
801311	171333	20 FEET	6 METER
801376	17031	8 FEET	2.4 METER
801629	171632	25 FEET	7.6 METER ⚠
801637	17106	35 FEET	10.6 METER ⚠
801945	172639	3.3 FEET	1 METER

SEA-BIRD ELECTRONICS, INC

P/N SEE TABLE	SCALE NTS	DRAWN BY PMC
		APPROVED BY CB

CABLE: RMG-4FS TO DB-9S W/BATT CONN
ASSEMBLY

DATE 10/10/01	DWG NO. 32604	SHEET 1 of 1	REV B

WARRANTY POLICY   2010

PRODUCT WARRANTY

5-YEAR LIMITED WARRANTY (NEW PRODUCTS)

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

LIMITED WARRANTY ON SERVICE & REPAIRS

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

MODIFICATIONS / EXCEPTIONS / EXCLUSIONS

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

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

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

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

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

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

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

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

WARRANTY ADMINISTRATION POLICY

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

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

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

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

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

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

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

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

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

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

SOFTWARE WARRANTY

SOFTWARE LICENSE AGREEMENT

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

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

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

SOFTWARE WARRANTY

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

Sea-Bird Service Request Form

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

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

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

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

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

CONTACT INFORMATION

Your Name:_____Institution/Company:_____

Shipping/Delivery address for packages:_____

_____

_____

Phone:_____Fax:_____E-mail:_____

SERVICE INFORMATION

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

Quantity:_____Serial Numbers:_____

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

_____

_____

_____

[   ] Calibration Services (includes basic diagnostic):

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

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

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

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

    [   ] System Upgrade or Conversion_____

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

    [   ] Download Data from instrument Memory_____

<u>PAYMENT/BILLING INFORMATION</u>

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

Name on Card:_____

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

[ ] Purchase Order (P.O.)

P.O. Number:_____

Billing Address (If different than shipping address):_____

_____

_____

_____

Instructions for Returning Goods to Sea-Bird
Note: Sea-Bird moved in January 2010; use the new address (shown below).

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

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

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

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

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

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

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

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