SBE 35-RT

Reversing Thermometer

Serial Number: 35RT54996-0072

User Manual, Version 010

Sea-Bird Electronics, Inc.
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SBE 35RT DIGITAL REVERSING THERMOMETER OPERATING MANUAL

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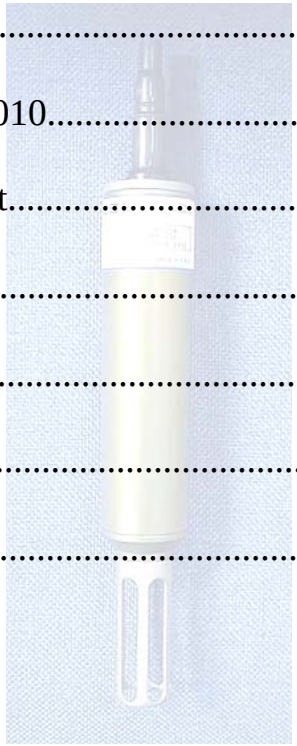

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Manual Generation Date: 03 August 2009

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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CALIBRATION SHEETS

SBE 35 RT

Reversing Thermometer

Instrument Configuration:

Serial Number	35RT54996-0072
Baud Rate	300
Pressure Sensor	None
Interface Type	RS-232
Firmware Version	2.0a
Maximum Depth	**6800 meters**

Sea-Bird Electronics, Inc.
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SBE Pressure Test Certificate

Test Date: **10/26/2006** Description **SBE-35 Deep Ocean Standards Thermometer**

Job Number: **54996** Customer Name **NOAA/PMEL**

SBE Sensor Information:

Model Number: **35**
Serial Number: **0072**

Pressure Sensor Information:

Sensor Type: **None**
Sensor Serial Number: **None**
Sensor Rating: **0**

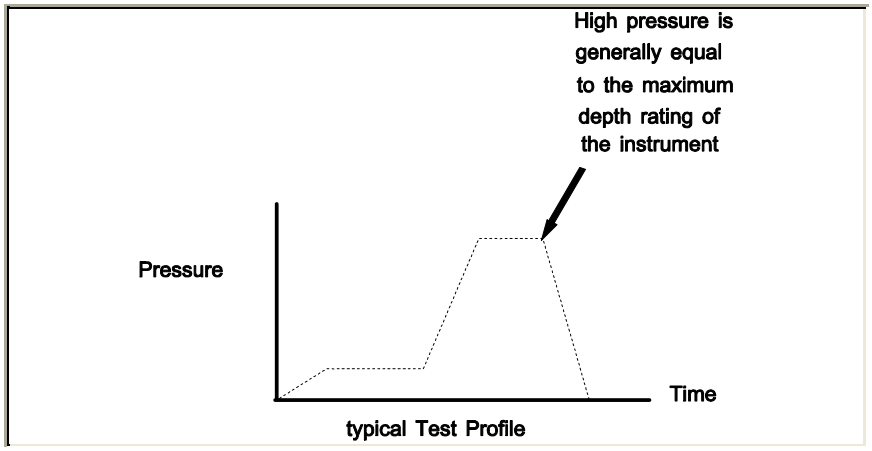
Pressure Test Protocol:

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

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

Passed Test: ☑

Tested By: PC



typical Test Profile

SEA-BIRD ELECTRONICS, INC.

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SENSOR SERIAL NUMBER: 0072
CALIBRATION DATE: 20-Jun-09p

SBE 35 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

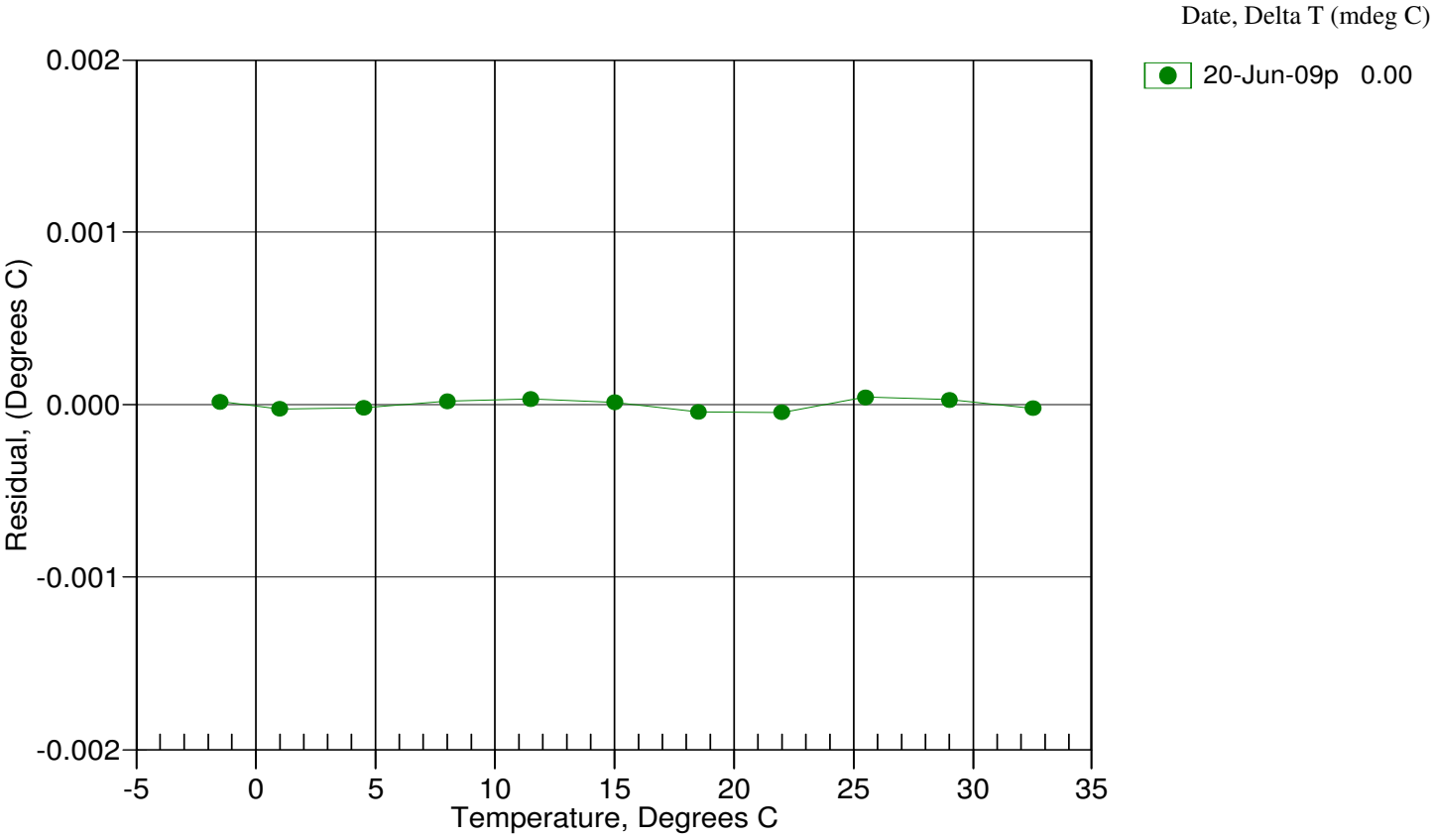
ITS-90 COEFFICIENTS

a0 = 4.76300784e-003
a1 = -1.30407952e-003
a2 = 1.94496085e-004
a3 = -1.07929807e-005
a4 = 2.29690061e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT (n)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.499970	734117.94	-1.499952	0.000018
0.999960	657830.92	0.999934	-0.000026
4.499960	565446.89	4.499941	-0.000019
7.999960	487340.51	7.999980	0.000020
11.500010	421150.61	11.500043	0.000033
15.000040	364925.16	15.000053	0.000013
18.500020	317046.92	18.499977	-0.000043
22.000030	276172.90	21.999984	-0.000046
25.499960	241191.28	25.500003	0.000043
28.999950	211177.20	28.999978	0.000028
32.499930	185359.91	32.499908	-0.000022

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)] + a4[ln^4(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



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SBE 35RT Digital Reversing Thermometer

User's Manual

Sea-Bird Electronics, Inc.
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Website: www.seabird.com

Manual Version #010, 02-02-09
Firmware Version 2.0a and later
SEASAVE V7 Version 7.18c and later

Limited Liability Statement

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Table of Contents

Section 1: Introduction

This section includes contact information and photos of a standard SBE 35RT shipment.

About this Manual

This manual is to be used with the SBE 35RT Digital Reversing 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 e-mail any comments or suggestions to seabird@seabird.com.

How to Contact Sea-Bird

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Bellevue, Washington 98005 USA

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E-mail: seabird@seabird.com Website: http://www.seabird.com

Business hours:
Monday-Friday, 0800 to 1700 Pacific Standard Time
(1600 to 0100 Universal Time)
Except from April to October, when we are on *summer time*
(1500 to 0000 Universal Time)

Unpacking SBE 35RT

Shown below is a typical SBE 35RT shipment.

SBE 35RT

Optional Interface Box

Optional SBE 35RT to Interface Box cable

Optional Interface Box to computer cable

Optional 25-pin to 9-pin adapter (for use with computer with DB-25 connector, when connecting through optional Interface Box)

Optional AC power cord for Interface Box

User Manual

Software, and Electronic Copies of Software Manuals on CD-ROM

Section 2: Description of SBE 35RT

This section describes the functions and features of the SBE 35RT, including specifications, dimensions, and connectors.

System Description

Note:
Each sample consists of **NCycles=** measurements (1 – 127), with the average of the measurements stored and/or transmitted as applicable.

Real-Time Operation:

11*plus* — 9*plus* CTD — Carousel
35RT

33–Carousel–19, 19*plus*, 19*plus* V2, or 25 CTD
35RT

Autonomous Operation:

9*plus* CTD — 17*plus* — Carousel
35RT

19,19*plus*,19*plus* V2, or 25 CTD–AFM — Carousel
35RT

Notes:
- Help files provide detailed information on the software.
- Separate software manuals on CD-ROM contain detailed information on the setup and use of SEASAVE V7 and SBE Data Processing.
- Sea-Bird also has an older version of SEASAVE, SEASAVE-Win32. However, **all SEASAVE instructions in this manual are written for SEASAVE V7**. See SEASAVE-Win32's manual and/or Help files if you prefer to use the older software; note that SEASAVE-Win32 is not compatible with the SBE 19*plus* V2.

The SBE 35RT is an accurate, ocean-range temperature sensor that is capable of measuring temperature in the ocean to depths of 6800 meters (22,300 ft). The SBE 35RT communicates via a standard RS-232 interface at 300 baud, 8 data bits, no parity.

The SBE 35RT is used with the SBE 32 Carousel Water Sampler and one of the following CTD systems:
- **Real-Time Operation**
  SBE 9*plus* CTD with SBE 11*plus* Deck Unit, **or**
  SBE 19, 19*plus*, 19*plus* V2, or 25 CTD with SBE 33 Deck Unit
- **Autonomous Operation** (details not documented in this manual)
  SBE 9*plus* CTD with SBE 17*plus* V2 SEARAM, **or**
  SBE 19, 19*plus*, 19*plus* V2, or 25 CTD with Auto Fire Module (AFM)

The SBE 35RT makes a temperature measurement each time a bottle fire confirmation is received, and stores the value in EEPROM. Each stored value contains the time and bottle position in addition to the temperature data, allowing comparison of the SBE 35RT record with CTD and water bottle data. Using one SBE 35RT eliminates the need for reversing thermometers, and provides higher accuracy temperature readings at lower cost.

Calibration coefficients stored in EEPROM allow the SBE 35RT to transmit data in engineering units. When configured in a real-time system, the SBE 35RT can use the system modem channel for two-way communications; it is not necessary to change cable connections to communicate with and retrieve data from the SBE 35RT.

Commands can be sent to the SBE 35RT to provide status display, data acquisition setup, data retrieval, and diagnostic tests.

The SBE 35RT can be supplied with an optional Interface Box for setup and lab use. The Interface Box provides isolated power to the SBE 35RT and buffers the serial communication lines to minimize noise input to the SBE 35RT from external sources. When used with the Interface Box, user-selectable operating modes are:
- Sample continuously and output the real-time data (data is not stored in EEPROM), or
- Take a single sample, store the data in EEPROM, and output the real-time data.

The SBE 35RT is supplied with a powerful Windows 2000/XP software package, **SEASOFT-Win32**, which includes: :
- **SEATERM** and **SeatermV2** – terminal programs for easy communication and data retrieval.
- **SEASAVE V7** – real-time data acquisition and display.
- **SBE Data Processing** – program for calculation and plotting of CTD parameters and derived variables.

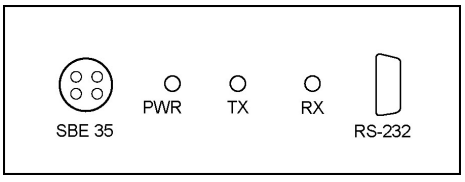
SBE 35RT Specifications

Measurement Range	-5 to +35 °C
Initial Accuracy	0.001 °C
Typical Stability (per year)	0.001 °C
Resolution	0.000025 °C
Sensor Calibration	-1.5 to + 32.5 °C
Data Storage	Up to 179 samples (each an average of **NCycles=** measurements [1 - 127])
Real-Time Clock	Watch-crystal type
External Power	9-16 VDC
Current	*On power application (approximately 1 minute)*: 140 – 160 mA *Operating:* 60 – 70 mA
Materials	Aluminum pressure case rated at 6,800 meters (22,300 feet)
Weight	In water: 0.3 kg (0.7 lbs) In air: 0.7 kg (1.5 lbs)

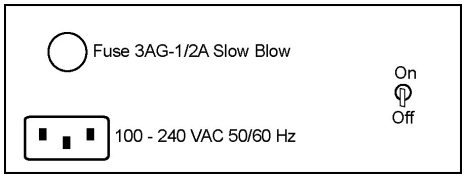
Optional Interface Box Specifications

Power Requirements	100-240 VAC 50-60 Hz
Dimensions	178 x 127 x 57 mm (7 x 5 x 2.25 inch)
Weight	1.1 kg (2.5 lbs)

Optional Interface Box Connectors, Switches, and LEDs

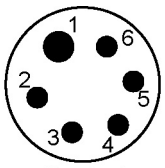


Optional Interface Box (front and back)

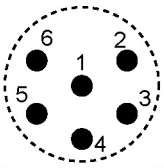


- *Connections*:
  - *RS-232* - connects to the computer
  - *SBE 35* - connects to the SBE 35RT
  - *AC Input* - connects to 100-240 VAC power supply
- *Power* switch and LED - switch turns power to the Interface Box on/off. Red *PWR* LED turns on to indicate power is on.
- *LEDs* - indicate if the Interface Box is communicating with other parts of the system:
  - Yellow *TX* LED - flashes when a message is received from the SBE 35RT
  - Green *RX* LED - flashes when a message is transmitted to the SBE 35RT

Dimensions and End Cap Connector

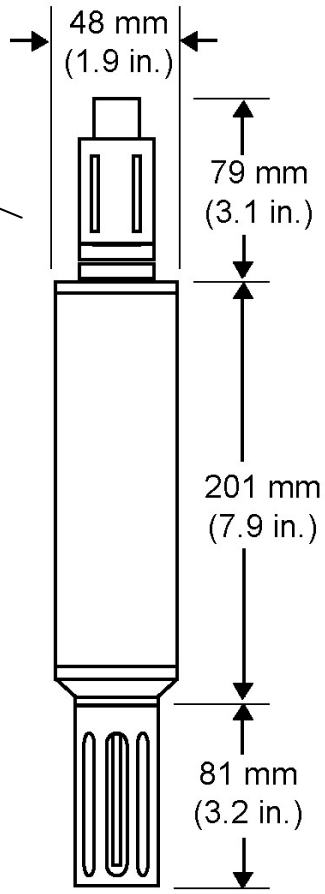


Standard
Connector
AG-306-HP-SS



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

Pin	Signal
1	Ground
2	Receive from SBE 9*plus*, SBE 33, or Interface Box
3	Transmit
4	N/C
5	Bottle fire confirmation from Carousel
6	Power +9 to +16V



Section 3: Preparing for Deployment

This section describes software installation, testing and setting up the SBE 35RT, commands, and data formats.

Software Installation

Sea-Bird recommends the following minimum system requirements for SEASOFT-Win32: Windows 2000 or later, 500 MHz processor, 256 MB RAM, and 90 MB free disk space for installation. Although SEASOFT-Win32 was designed to work with a PC running Win 2000/XP; extensive testing has not shown any compatibility problems when using the software with a PC running Windows Vista.

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

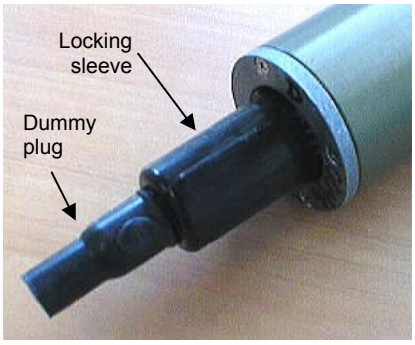
1. Insert the CD in your CD drive.

2. Install software: Double click on **Seasoft-Win32_*date*.exe** (*date* is the date that version of the software was created). Follow the dialog box directions to install the software. The installation program allows you to install the desired components. Install all the components, or just install SEATERM (terminal program), SeatermV2 (terminal program for use when directly communicating with an SBE 19*plus* V2), SEASAVE V7 (real-time data acquisition), and SBE Data Processing (data processing).

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

Notes:
- It is possible to use the SBE 35RT without SEATERM by sending direct commands from a dumb terminal or terminal emulator, such as Windows HyperTerminal.
- Help files provide detailed information on the software.
- Separate software manuals on CD-ROM contain detailed information on the setup and use of the software.
- Sea-Bird also supplies an older version of SEASAVE, SEASAVE-Win32. However, all SEASAVE instructions in this manual are written for SEASAVE V7. See SEASAVE-Win32's manual and/or Help files if you prefer to use the older software; note that SEASAVE-Win32 is not compatible with the SBE 19*plus* V2.
- 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.

Power and Communications Test



Test Setup

You can communicate with and program the SBE 35RT:
- Through an optional Interface Box (for easy setup in the lab)
- Through an SBE 11*plus* Deck Unit (connected to the SBE 9*plus* CTD and SBE 32 Carousel Water Sampler)
- Through an SBE 33 Deck Unit (connected to an SBE 32 Carousel Water Sampler)

Setup for each of these options is described below.

1. By hand, unscrew the locking sleeve from the SBE 35RT's bulkhead connector. **If you must use a wrench or pliers, be careful not to loosen the bulkhead connector instead of the locking sleeve**.

2. Remove the dummy plug from the SBE 35RT's bulkhead connector by pulling the plug firmly away from the connector.

Note:
For Steps 3, 4, and 5:
For the standard AG-306 bulkhead connector on the SBE 35RT, align the raised bump on the side of the cable connector with the large pin (pin 1 - ground) on the SBE 35RT.

3. For use with the optional Interface Box:
   A. Connect the SBE 35RT to *SBE 35* on the Interface Box using the Sea-Bird cable supplied with the Interface Box (cable 80555 – drawing 31116 – for standard connector on the SBE 35RT).
   B. Connect *RS-232* on the Interface Box to your computer's serial port using the DB 9P / DB 9S cable.
   C. Connect the Interface Box to a standard, 3-prong, grounded AC outlet, using the UL/IEC-approved power cord (AC voltage between 85-270 VAC). Turn on power to the Interface Box.

Note:
For details on wiring, setup, and operation of the entire system, see the SBE 11*plus* or SBE 33 manual as applicable. Only details relating to the use of the SBE 35RT are covered here.

4. For use with the SBE 11*plus* Deck Unit:
   A. Connect the SBE 35RT to the SBE 9*plus* JT7 and SBE 32 Carousel Water Sampler JB2 using the Sea-Bird Y-cable (cable 171220 - drawing 32208 - for standard connectors on all three instruments). The three arms of the cable are labeled *SBE 9*, *SBE 32*, and *SBE 35*. Connect each arm to the proper instrument.
   B. Connect the SBE 9*plus* to the SBE 11*plus* Deck Unit, and the SBE 11*plus* to the computer. Turn on power to the SBE 11*plus*.

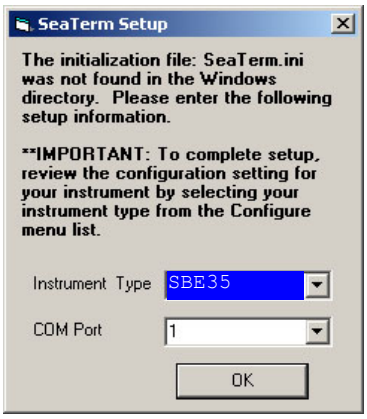
5. For use with the SBE 33 Deck Unit:
   A. Connect the SBE 35RT to the SBE 32 Carousel Water Sampler JB2 using the Sea-Bird cable (cable 171221 - drawing 32209 – for standard connectors on both instruments). Connect the end labeled *SBE 35* to the SBE 35RT and the end labeled *SBE 32* to the Carousel.
   B. Connect the SBE 32 to the SBE 33 Deck Unit, and the SBE 33 to the computer. Turn on power to the SBE 33.

Test

Note:
See SEATERM's help files.

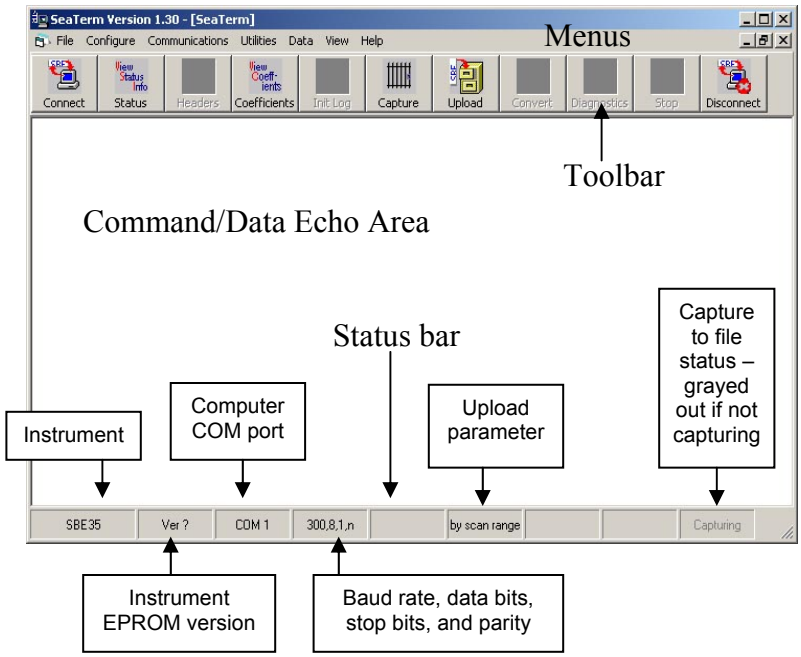
Proceed as follows:

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 35*) and the computer COM port for communication with the SBE 35RT. Click OK.

2. The main screen looks like this:



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

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

Note:
Once the system is configured and connected (Steps 3 through 5 below), to update the Status bar:
- on the Toolbar, click Status; or
- from the Utilities menu, select Instrument Status.

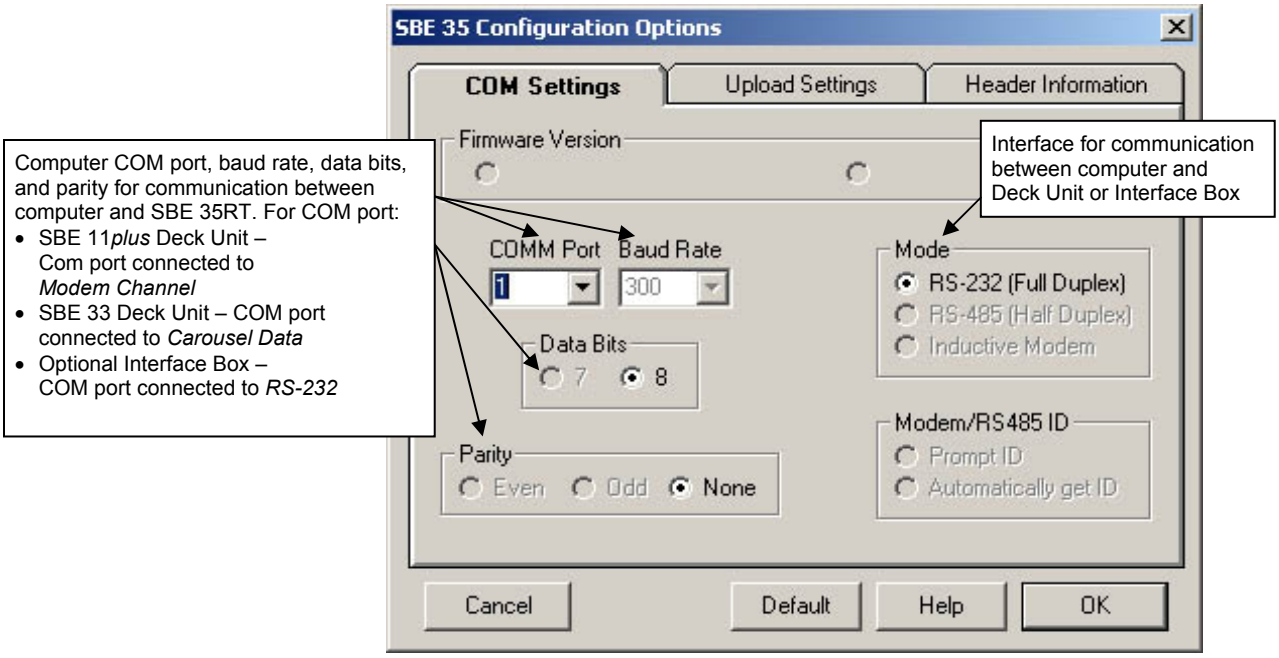
SEATERM sends the status command, which displays in the Command/Data Echo Area, and updates the Status bar.

Following are the Toolbar buttons applicable to the SBE 35RT:

Toolbar Button	Description	Equivalent Command*
Connect	Re-establish communications with SBE 35RT. Computer responds with `S>` prompt.	(press Enter key)
Status	Display instrument setup and status (number of measurements to take and average per sample, number of samples in memory, etc.).	**DS**
Coefficients	Display calibration coefficients.	**DC**
Capture	Capture instrument responses on screen to file. File has .cap extension. Press Capture again to turn off capture. Capture status displays in Status bar.	—
Upload	Upload data stored in SBE 35RT's memory, along with status, calibration coefficient, and user-input header information. Uploaded file has .asc extension. Before using Upload: • Configure upload and header parameters in Configure menu. • Remove power to stop sampling.	**DDb,e** (use Upload to include status, calibration coefficient and user-input header information in file)
Disconnect	Free computer COM port used to communicate with SBE 35RT. COM port can then be used by another program.	—

*See *Command Descriptions* in this section.

3. In the Configure menu, select *SBE 35*. The dialog box looks like this:



Make the selections in the Configuration Options dialog box:
- **COMM Port**: COM 1 through COM 10, as applicable
- **Baud Rate**: 300
- **Data Bits**: 8
- **Parity**: None
- **Mode**: RS-232 (Full Duplex)

Click OK to save the settings.

Note:
When you click OK, SEATERM saves the Configuration Options settings to the SeaTerm.ini file in your Windows directory. SeaTerm.ini contains the last saved settings for each instrument (SBE 35, 37, etc.). When you open SEATERM and select the desired instrument in the Configure menu, the Configuration Options dialog box shows the last saved settings for that instrument.

4. (If using the optional Interface Box) Click Connect on the Toolbar.

5. The display looks like this:

```
S>
```

This shows that correct communications between the computer and the SBE 35RT has been established.
If the system does not respond as shown above:
- (If using the optional Interface Box) Click Connect again.
- Verify the correct instrument was selected in the Configure menu and the COM setting was entered correctly in the Configuration Options dialog box. Note that the baud rate's factory setting is documented on the front cover of this manual.
- Check the cabling between all components of the system.

6. Display SBE 35RT status information by clicking Status on the Toolbar. The display looks like this:

```
SBE 35 V 2.0a SERIAL NO. 0013  07 Nov 2008 08:49:08
number of measurement cycles to average = 8
number of data points stored in memory = 2
bottle confirm interface = SBE 911plus
```

7. Command the SBE 35RT to take a sample by typing **TS** and pressing the Enter key. The display looks like this:

```
197.20  1047481  289795.4  15  35  29  289955.4  22.654745
```

where

- `197.20` = average of raw **reference** *zero* readings taken during a measurement
- `1047481` = average of raw **reference** resistor *full scale* readings taken during a measurement
- `289795.4` = average of raw thermistor readings taken during a measurement
- `15` = (maximum – minimum) raw **reference** *zero* reading during a measurement (provides a measure of the amount of variation during the measurement)
- `35` = (maximum – minimum) raw **reference** resistor *full scale* reading during a measurement (provides a measure of the amount of variation during the measurement)
- `29` = (maximum – minimum) raw thermistor reading during a measurement (provides a measure of the amount of variation during the measurement)
- `289955.4` = average raw thermistor reading, corrected for *zero* and *full scale* reference readings
- `22.654745` = average corrected raw thermistor reading, converted to engineering units (°C [ITS-90])

These numbers should be reasonable; i.e., the thermistor should be reading room temperature.

Note:
See *Data Formats* for detailed descriptions of each output parameter.

The SBE 35RT is ready for programming and deployment.

Command Descriptions

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

When entering commands:

- Input commands to the SBE 35RT in upper or lower case letters and register commands by pressing the Enter key.
- The SBE 35RT 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.
- Establish communications by clicking Connect on the Toolbar or pressing the Enter key to get an `S>` prompt.

Status Command

DS

Display setup parameters.
Equivalent to Status on Toolbar.

List below includes, where applicable, command used to modify parameter.

- firmware version, serial number, date and time [**MMDDYY=** and **HHMMSS=**]
- number of measurements to take and average per sample [**NCycles=**]
- number of samples in memory [**SampleNum=**]
- interface for use with SBE 32 Carousel Water Sampler [**Interface=**] – *SBE 911plus* (for use with SBE 9*plus* CTD, SBE 11*plus* Deck Unit, and SBE 32 Carousel Water Sampler)
  or
  SBE 32 with serial interface (for use with SBE 19, 19*plus*, 19*plus* V2, or 25 CTD; SBE 33 Deck Unit; and SBE 32 Carousel Water Sampler)

Example: Display status for SBE 35RT (user input in bold).

```
S>DS
SBE 35 V 2.0a SERIAL NO. 0013  07 Nov 2008 08:49:08        [MMDDYY= and HHMMSS=]
number of measurement cycles to average = 8                          [NCycles=]
number of data points stored in memory = 2                           [SampleNum=]
bottle confirm interface = SBE 911plus                               [Interface=]
```

Setup Commands

Notes:
- **DDMMYY=** and **MMDDYY=** are equivalent. Either can be used to set the date.
- **Always set date and then time.** If a new date is entered but not a new time, the new date will not be saved. If a new time is entered without first entering a new date, the date will reset to the last date it was set for with **MMDDYY=** or **DDMMYY=**.

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

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

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

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

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

or

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

Note:
See *Data Formats* for more details on how **NCycles** affects the measurement.

NCycles=x **x=** number of measurements to take and average per sample (1 – 127).
Time required for each measurement is 1.1 seconds; therefore, total time for each sample is (1.1 seconds * **NCycles**).
Averaged data is stored in EEPROM and/or transmitted real-time, depending on sampling mode.

In a thermally quiet environment, temperature noise standard deviation is:
0.000029 * sqrt (8 / **NCycles**) (°C)

Interface=x **x=911plus**: SBE 35RT used with SBE 9*plus* CTD, SBE 11*plus* Deck Unit, and SBE 32 Carousel Water Sampler.

x=32serial: SBE 35RT used with SBE 19, 19*plus*, 19*plus* V2, or 25 CTD; SBE 33 Carousel Deck Unit; and SBE 32 Carousel Water Sampler.

Note:
SampleNum=0 does not delete data; it just resets the data pointer.
If you accidentally send this command before uploading, recover data as follows:
1. Set **SampleNum=a**, where **a** is your estimate of number of samples in memory.
2. Upload data. If **a** is more than actual number of samples, data for non-existent samples will be bad, random data. Review uploaded data file carefully and delete any bad data.
3. If desired, increase **a** and upload data again, to see if there is additional valid data in memory.

SampleNum=x **x=** sample number for first sample when sampling begins. After all previous data has been uploaded from SBE 35RT, set sample number to 0 before starting to sample again to make entire memory available for recording. If **SampleNum** is not reset to 0, data will be stored after last recorded sample.
SBE 35RT can store up to 179 samples.

Sampling Commands

The SBE 35RT samples when commanded by the user (**Cal**, **Run**, or **TS**), or *automatically* upon receipt of a valid bottle fire confirmation sequence (when used with an SBE 32 Carousel Water Sampler).

- When the SBE 35RT receives a valid bottle fire confirmation sequence (a character with decimal value 6 followed by a character with decimal value greater than 48 and less than 84), it takes a measurement **NCycles** in duration and stores the data in EEPROM.

Notes:
- Data format varies, depending on the sampling command. See *Data Formats* after these *Command Descriptions*.
- To capture real-time data from **Cal**, **Run**, or **TS** to a file, do this *before* starting sampling:
  A. Click Capture on Toolbar.
  B. Enter desired file name in dialog box. *Capture* status displays in status bar at bottom of screen.

Cal

Start data sampling continuously now, outputting real-time raw data. Data is not stored in EEPROM. To stop sampling, press Esc key or type Ctrl C, and then press Enter key.

Time from start of one sample to start of next is:
[(1.1 * **NCycles**) + 2.7] seconds
The 2.7 seconds is required for transmitting real-time data.

Run

Start data sampling continuously now, outputting real-time raw data as well as computed temperature (°C). Data is not stored in EEPROM. To stop sampling, press Esc key or type Ctrl C, and then press Enter key.

Time from start of one sample to start of next is:
[(1.1 * **NCycles**) + 2.7] seconds
The 2.7 seconds is required for converting measured values to computed temperature and transmitting real-time data.

TS

Take one sample (consisting of **NCycles** measurements), store average in EEPROM, and transmit average real-time.

Data Upload Command

Notes:
- To save data to a file, click Capture on the Toolbar before entering **DDb,e**.
- See *Data Formats* after these *Command Descriptions*.
- **Use Upload on the Toolbar or Upload Data in the Data menu to write SBE 35RT setup, calibration coefficients, and a user-input header along with uploaded data to a .asc file.**

DDb,e

Upload data from memory, from sample **b** to sample **e**. First sample is number 1. If **DD** is sent, all samples are uploaded.

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

S>**DD1,16**	(Upload scans 1 through 16)
S>**DD1,1**	(Upload scan 1)
S>**DD**	(Upload all scans in memory)

Testing Commands

***RTCTest** — Test battery-backed static RAM in real-time clock module. **Test resets date and time to default (01 Jan 1980 00:00:00)**, but does not reset other setup parameters or destroy sampling data in memory. SBE 35RT requires you to enter command twice, to provide verification before it proceeds.

***EETest** — Test EEPROM memory. Allow 30 seconds for test. **Test destroys all sampling data and setup parameters** (calibration coefficients, **NCycles**, etc.) stored in EEPROM. SBE 35RT requires you to enter command twice, to provide verification before it proceeds.

Calibration Coefficients Commands

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

Notes:
- Date shown is when calibration was performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificate shipped with SBE 35RT.
- See individual Coefficient Commands below for definitions of the data in the example.

Example: Display coefficients for SBE 35RT (user input in bold).

```
S>DC
SBE35   V 2.0a   SERIAL NO. 0011
08-apr-08
A0 =   5.156252707e-03
A1 =   -1.430180396e-03
A2 =   2.092145355e-04
A3 =   -1.156278215e-05
A4 =   2.446454055e-07
SLOPE = 1.000000
OFFSET = 0.000000
```

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

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

CalDate=S	**S**=Temperature calibration date.
TA0=F	**F**=Temperature A0.
TA1=F	**F**=Temperature A1.
TA2=F	**F**=Temperature A2.
TA3=F	**F**=Temperature A3.
TA4=F	**F**=Temperature A4.
Slope=F	**F**=Temperature calibration slope.
Offset=F	**F**=Temperature calibration offset.

Data Formats

Each sample consists of the following measurement scheme repeated **NCycles** times:

- Raw **reference** *zero*.- Raw A/D reading of 16 samples with circuit ground switched in place of the thermistor.
- Raw **reference** *full scale* - Raw A/D reading of 16 samples with a hermetically sealed precision resistor switched in place of the thermistor.
- Raw **thermistor** - Raw A/D reading of 16 samples with the thermistor in the circuit.

For example, if **NCycles** is 8, the total number of readings is 128 (= 8 * 16) reference zero readings, 128 reference full scale readings, and 128 thermistor readings. The reported values are the simple average of the 128 readings. The (maximum – minimum) values are the maximum value read during the 128 readings minus the minimum value read during the 128 readings.

The average raw thermistor value, corrected for *zero* and *full scale* reference readings, is:

$$\frac{1048576 * (\text{raw thermistor average} - \text{raw reference resistor } \textit{zero} \text{ average})}{(\text{raw reference resistor } \textit{full scale} \text{ average} - \text{raw reference resistor } \textit{zero} \text{ average})}$$

Plugging this value into the calibration equation yields the computed temperature in engineering units (°C [ITS-90]).

Data Uploaded from EEPROM

Note:
For all data formats, each line of output is followed by a carriage return and line feed.

Data is placed in the SBE 35RT's EEPROM:

- Each time the SBE 35RT receives a valid bottle fire confirmation sequence when used with the SBE 32 Carousel Water Sampler
- When the user sends **TS** (typically for lab use)

Data is uploaded (using SEATERM's Upload button or **DDb,e**) in the following format:

Column	Description
1	sample number
2	date (DD MMM YYYY – day, month, year). The month is a 3-character alphabetic abbreviation; e.g., jan, feb, mar, etc.)
3	time (HH:MM:SS – hour, minute, second)
4	bn = bottle position number (bottle position number is 0 if sample was taken in response to **TS**)
5	diff = (maximum – minimum) raw thermistor reading during a measurement (provides a measure of the amount of variation during the measurement)
6	val = average raw thermistor reading, corrected for *zero* and *full scale* reference readings
7	t90 = average corrected raw thermistor reading, converted to engineering units (°C [ITS-90])

Example: SBE 35RT at room temperature (user input in bold)

```
S>DD1,2
1 30 Sep 1998 16:15:13 bn=8 diff=19 val=284583.3 t90=23.133510
2 30 Sep 1998 16:15:41 bn=6 diff=21 val=284568.0 t90=23.134886
```

Real-Time Data from Cal Command

When the user sends **Cal**, real-time data is output in the following format:

Column	Description
1	average of raw **reference** *zero* readings taken during a measurement
2	average of raw **reference** resistor *full scale* readings taken during a measurement
3	average of raw thermistor readings taken during a measurement
4	(maximum – minimum) raw **reference** *zero* reading during a measurement (provides a measure of the amount of variation during the measurement)
5	(maximum – minimum) raw **reference** resistor *full scale* reading during a measurement (provides a measure of the amount of variation during the measurement)
6	(maximum – minimum) raw thermistor reading during a measurement (provides a measure of the amount of variation during the measurement)
7	average raw thermistor reading, corrected for *zero* and *full scale* reference readings

Example: SBE 35RT at room temperature (user input in bold)

```
S>CAL
197.64 1047488 269139.8 13 37 52 269275.4
191.77 1047493 268895.0 12 35 57 269030.4
197.12 1047501 268859.8 14 27 48 268988.9
```

Real-Time Data from Run or TS Command

When the user sends **Run** or **TS**, real-time data is output in the same format as for **Cal**, with the addition of an eighth column for average corrected raw thermistor reading, converted to engineering units (°C [ITS-90]).

Example: SBE 35RT at room temperature (user input in bold)

```
S>RUN
197.64 1047488 269139.8 13 37 52 269275.4 24.556287
191.77 1047493 268895.0 12 35 57 269030.4 24.579808
197.12 1047501 268859.8 14 27 48 268988.9 24.583787
```

Section 4: Deploying and Operating SBE 35RT

Note:
Operation of an autonomous water sampler system (i.e., without conducting cable) with the SBE 35RT is not detailed in this manual.

This section provides instructions for operating the SBE 35RT with a CTD, Deck Unit, and SBE 32 Carousel Water Sampler, and discusses:

- Deployment
- Recovery
- Uploading data from the SBE 35RT
- Comparing SBE 35RT data to CTD data

The SBE 35RT can act as a stand-alone substitute for a reversing thermometer, recording temperature with each bottle closing. The SBE 35RT is mounted in a secure area on the water sampler frame, where the water flushes freely and there is minimal contamination from the passive thermal mass of the metal frame or active thermal dissipation from electronic instruments.

Note:
For details on creation of a .ros file, see *Comparing SBE 35RT Data to CTD Data* below.

The SBE 35RT has a time constant of 0.5 seconds, so it lags the SBE 3 (temperature sensor on SBE 9*plus* and SBE 25 CTDs) if temperature is changing during the measurement interval. For a first order correction, determine the temporal gradient during the measurement interval from the SBE 3 temperature data in the .ros file:

gradient-corrected SBE 35RT temperature = measured SBE 35RT temperature + 0.5g

where
g = temperature gradient [°C/second]

Deployment with SBE 9*plus* CTD, SBE 11*plus* Deck Unit, and SBE 32 Carousel Water Sampler

1. Mount the SBE 35RT in a secure area on the water sampler frame, where the water flushes freely and there is minimal contamination from the passive thermal mass of the metal frame or active thermal dissipation from electronic instruments.

Note:
For details on wiring, setup, and operation of the entire system, see the SBE 11*plus* manual. Only details relating to the use of the SBE 35RT are covered here.

2. Connect the SBE 35RT to the SBE 9*plus* JT7 and SBE 32 Carousel Water Sampler JB2 using the Sea-Bird Y-cable (cable 171220 - drawing 32208 - for standard connector on the SBE 35RT). The three arms of the cable are labeled *SBE 9*, *SBE 32*, and *SBE 35*. Connect each arm to the proper device. See *Connector Mating and Maintenance* in *Section 5: Routine Maintenance and Calibration* for information on lubricating and burping the connectors.

3. Turn on power to the SBE 11*plus* Deck Unit.

4. Double click on Seaterm.exe to verify communications and setup:
   A. In the Configure menu, select *SBE 35*. Select the Com port that is connected to *Modem Channel* on the back of the SBE 11*plus* Deck Unit (the SBE 35RT uses the modem channel for communications). Click OK.
   B. Click Status on the Toolbar (**DS** command) to verify communication with the SBE 35RT and check setup parameters. Change any parameters if desired (see *Command Descriptions* in *Section 3: Preparing for Deployment*), and resend the status command to verify the changes.
   C. Ensure all data has been uploaded, and then type **SampleNum=0** and press the Enter key to make the entire memory available for recording. If **SampleNum** is not reset to zero, data will be stored after the last recorded sample.
   D. Click Disconnect on the Toolbar to free the computer Com port.
   E. Close SEATERM.

5. Double click on Seasave.exe to acquire the CTD cast:
   A. Set up the system and display windows.
   B. In the Real-Time Data menu, select *Start*. Make the desired selections in the Start Real-Time Data Acquisition dialog box, and then click the *Start* button.
   C. Fire bottles as desired. Each time it receives a bottle confirmation, the SBE 35RT takes a sample and stores the data in EEPROM. If the next bottle is fired before the SBE 35RT finishes sampling (time required / sample = 1.1 * **NCycles** + 2.7 seconds), the SBE 35RT ignores the next bottle confirmation.
   D. When the cast is complete, in the Real-Time Data menu select *Stop*. Turn off power to the SBE 11*plus* Deck Unit.

Deployment with SBE 19, 19*plus*, 19*plus* V2, or 25 CTD; SBE 33 Deck Unit; and SBE 32 Carousel Water Sampler

Note:
For details on wiring, setup, and operation of the entire system, see the SBE 33 and the CTD manuals. Only details relating to the use of the SBE 35RT are covered here.

1. Mount the SBE 35RT in a secure area on the water sampler frame, where the water flushes freely and there is minimal contamination from the passive thermal mass of the metal frame or active thermal dissipation from electronic instruments.

2. Connect the SBE 35RT to the SBE 32 Carousel Water Sampler JB2 using the Sea-Bird cable (cable 171221 - drawing 32209 – for standard connector on the SBE 35RT). Connect the end labeled *SBE 35* to the SBE 35RT and the end labeled *SBE 32* to the Carousel. See *Connector Mating and Maintenance* in *Section 5: Routine Maintenance and Calibration* for information on lubricating and burping the connectors.

3. Turn on power to the SBE 33 Deck Unit.

4. Double click on Seaterm.exe to verify communications and setup:
   A. In the Configure menu, select *SBE 35*. Select the Com port that is connected to *Carousel Data* on the back of the SBE 33 Deck Unit (the SBE 35RT uses the Carousel data channel for communications). Click OK.
   B. Click Status on the Toolbar (**DS** command) to verify communication with the SBE 35RT and check setup parameters. Change any parameters if desired (see *Command Descriptions* in *Section 3: Preparing for Deployment*), and resend the status command to verify the changes.
   C. Ensure all data has been uploaded, and then type **SampleNum=0** and press the Enter key to make the entire memory available for recording. If **SampleNum** is not reset to zero, data will be stored after the last recorded sample.
   D. Click Disconnect on the Toolbar to free the computer Com port.
   E. Close SEATERM.

5. Double click on Seasave.exe to acquire the CTD cast:
   A. Set up the system and display windows.
   B. In the Real-Time Data menu, select *Start*. Make the desired selections in the Start Real-Time Data Acquisition dialog box, and then click the *Start* button.
   C. Fire bottles as desired. Each time it receives a bottle confirmation, the SBE 35RT takes a sample and stores the data in EEPROM. If the next bottle is fired before the SBE 35RT finishes sampling (time required / sample = 1.1 * **NCycles** + 2.7 seconds), the SBE 35RT ignores the next bottle confirmation.
   D. When the cast is complete, in the Real-Time Data menu select *Stop*. Turn off power to the SBE 33 Deck Unit.

Recovery

WARNING!
If the SBE 35RT 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 35RT is flooded, point the SBE 35RT in a safe direction away from people, and loosen the bulkhead connector very slowly, at least 1 turn. This opens an o-ring seal under the connector. Look for signs of internal pressure (hissing or water leak). If internal pressure is detected, let it bleed off slowly past the connector o-ring. Then, you can safely remove the end cap.

Rinse the SBE 35RT and the other underwater instruments with fresh water, and dry thoroughly.

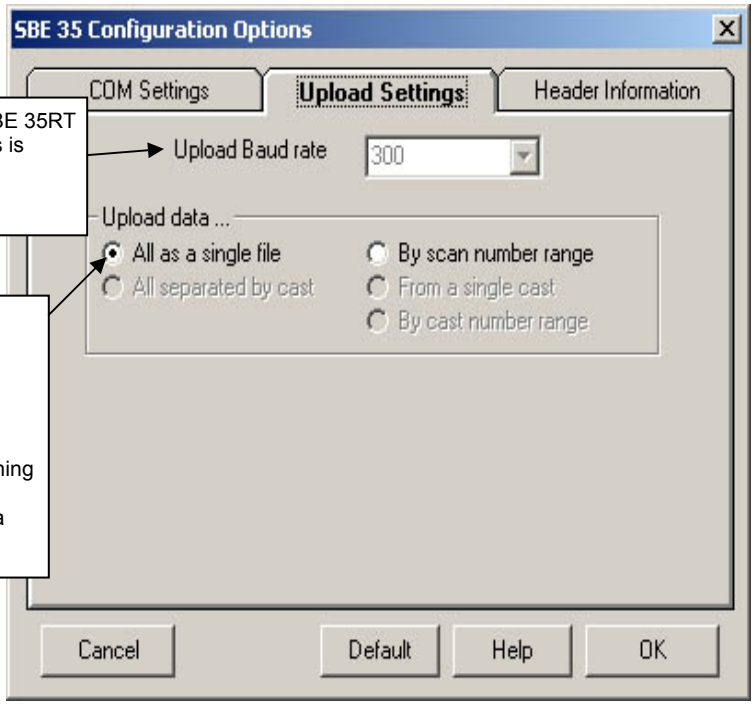
Uploading Data from SBE 35RT

Note:
Set up **Upload Settings**, **Header Information**, and/or **Header Form** (Steps 4 through 6):
- The first time you upload data, and
- If you want to change upload or header parameters.

1. With the SBE 35RT still connected to the system, turn on power to the Deck Unit.
2. Double click on SeaTerm.exe. The display shows the main screen.
3. In the Configure menu, select *SBE 35*. On the COM Settings tab, select the COM port that is connected to *Modem Channel* (SBE 11*plus* Deck Unit) or *Carousel Data* (SBE 33 Deck Unit), as applicable.
4. Click on the Upload Settings tab. The dialog box looks like this:

Baud for uploading data from SBE 35RT to computer. For SBE 35RT, this is same as baud rate for general communication, 300 baud.

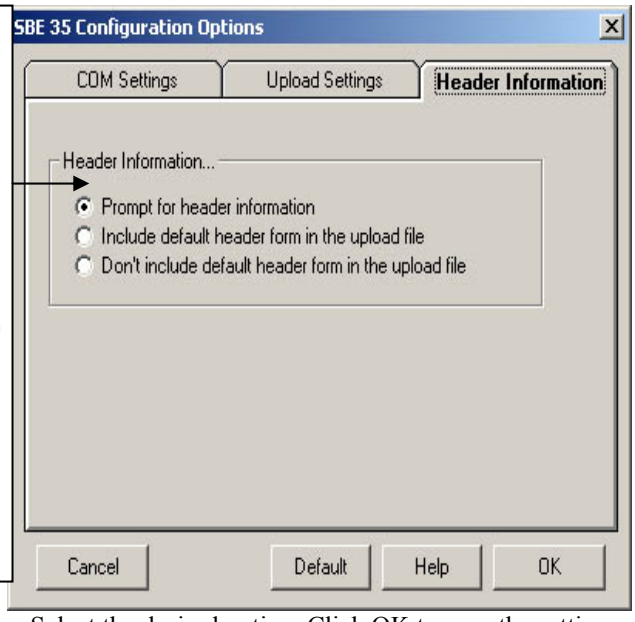
Defines data upload type when using Upload on Toolbar or Upload Data in Data menu:
- All as single file – All data uploaded into one file.
- By scan number range – SEATERM prompts for beginning and ending scan (sample) numbers, and uploads all data within range into one file.



Make the selection for Upload Settings.

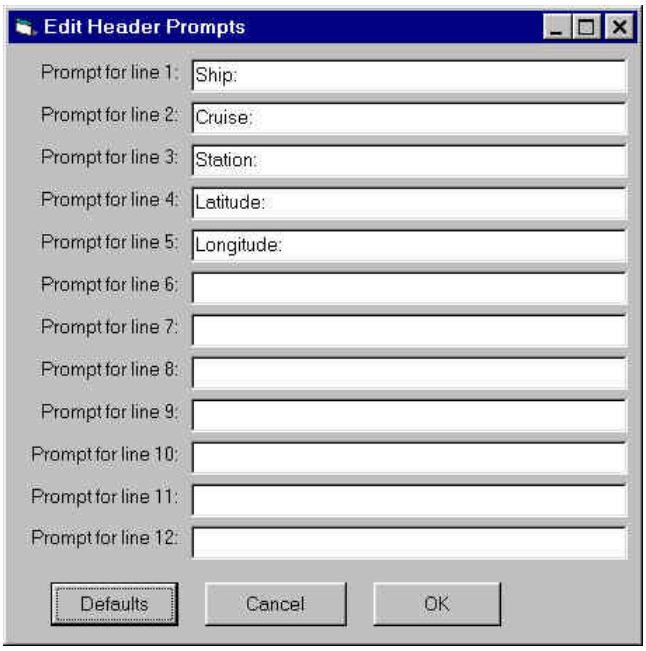
5. Click on the Header Information tab. The dialog box looks like this:

Defines header information included with uploaded data:
- Prompt for header information – Each time data is uploaded, user is prompted to fill out user-defined header form.
- Include default header form in upload file – User-defined default header form included in upload file. User is not prompted to add any information when data is uploaded.
- Don't include default header form in upload file – Header information not included in upload file.



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

6. In the Configure menu, select Header Form to customize the header. The dialog box looks like this (default prompts are shown):



The entries are free form, 0 to 12 lines long. This dialog box establishes:
- the header prompts that appear for the user to fill in when uploading data, if *Prompt for header information* was selected in the Configuration Options dialog box (Step 5)
- the header included with the uploaded data, if *Include default header form in upload file* was selected in the Configuration Options dialog box (Step 5)

Enter the desired header/header prompts. Click OK.

7. Click Upload on the Toolbar to upload stored data from the SBE 35RT. SEATERM responds as follows:
   A. SEATERM sends the status (**DS**) command, displays the response, and writes the command and response to the upload file. This provides you with information regarding setup and the number of samples in memory.
   B. **If you selected *By scan number range* in the Configuration Options dialog box (Configure menu)** – a dialog box requests the range. Enter the desired value(s), and click OK.
   C. SEATERM sends the calibration coefficients (**DC**) command, displays the response, and writes the command and response to the upload file. This provides the calibration coefficients.
   D. **If you selected *Prompt for header information* in the Configuration Options dialog box (Configure menu)** – a dialog box with the header form appears. Enter the desired header information, and click OK.
   E. In the Open dialog box, enter the desired upload file name and click OK. The upload file has a .asc extension.
   F. SEATERM sends the data upload command (**DDb,e**).
   G. When the data has been uploaded, SEATERM shows the `S>` prompt.

8. Ensure all data has been uploaded by reviewing the data.

Note:
To prepare for re-deployment: After all data has been uploaded, send **SampleNum=0**. If this command is not sent, new data will be stored after the last recorded sample, preventing use of the entire memory capacity.

Comparing SBE 35RT Data to CTD Data

Note:
For complete details on use of SBE Data Processing, see the SBE Data Processing manual or Help files. Only details relating to the use of the SBE 35RT are covered here.

To compare the uploaded SBE 35RT .asc data file to the CTD data file (.hex or .dat), process **the CTD data** in SBE Data Processing:

1. Double click on SBEDataProc.exe.

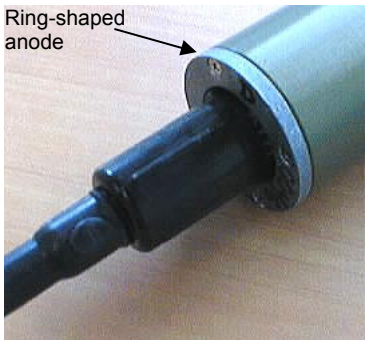
2. Create a .ros bottle file, which contains CTD data for a user-selected range of scans before and after each bottle firing:
   A. In SBE Data Processing's Run menu, select Data Conversion.
   B. On the File Setup tab, select the configuration (.con) file and data (.dat or .hex) file for your CTD.
   C. On the Data Setup tab, set the following:
      Create file types = create both data and bottle file **or** bottle file only
      Source of scan range data = scans marked with bottle confirm bit
      Scan range offset = 0
      Scan range duration = 1.1 *** NCycles**
   D. See the SBE Data Processing manual or Help files for selection of other parameters on the File Setup and Data Setup tabs.
   E. Click Start Process. SBE Data Processing creates a .cnv file with all the CTD data (if *create both data and bottle file* was selected in Step 2C), and a .ros file with CTD data for the scans associated with each bottle.

3. Create a .btl bottle summary file, which contains averaged values as well as optional minimum, maximum, and standard deviation, for each bottle:
   A. In SBE Data Processing's Run menu, select Bottle Summary.
   B. On the File Setup tab, select the .con and .ros files for your CTD.
   C. On the Data Setup tab, set the following:
      Output min/max values for averaged variables – select to obtain minimum, maximum, and standard deviation for each parameter
      Select Averaged Variables – click to select parameters to process
      Select Derived Variables – click to select parameters to calculate from input parameters
   D. Click Start Process. SBE Data Processing creates a .btl file with summary CTD data for the scans associated with each bottle firing.

Section 5: Routine Maintenance and Calibration

This section reviews corrosion precautions, connector mating and maintenance, and sensor calibration. The SBE 35RT's accuracy is sustained by the care and calibration of the sensors and by establishing proper handling practices.

Corrosion Precautions



Rinse the SBE 35RT with fresh water after use and prior to storage.

All stainless steel screws that are exposed to salt water have been generously lubricated with Blue Moly™. After each cruise, remove these screws and re-lubricate. **This compound is electrically conductive; use care to ensure it does not get on PCBs.**

A ring-shaped zinc anode is attached to the connector end of the SBE 35RT housing. Check the anode periodically to verify that it is securely fastened and has not been eaten away.

Avoid direct attachment of metal objects to the housing.

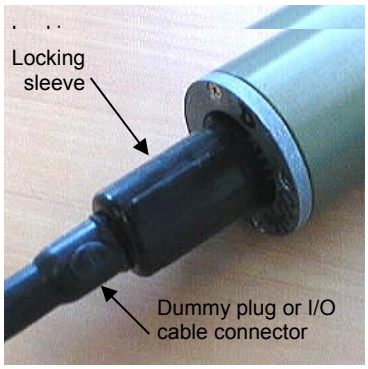
Connector Mating and Maintenance

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

Clean and inspect connectors, cables, and dummy plugs 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 connectors.



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

2. **Standard Connector** - Install the plug/cable connector, aligning the raised bump on the side of the plug/cable connector with the large pin (pin 1 - ground) on the SBE 35RT. Remove any trapped air by *burping* or gently squeezing the plug/connector near the top and moving your fingers toward the end cap. **OR**
   MCBH Connector – Install the plug/cable connector, aligning the pins.

3. Place the locking sleeve over the plug/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 or dummy plug is installed for each connector on the system before deployment.

Calibration

SBE 35RTs are calibrated to ITS-90 temperature using Sea-Bird's computer-controlled calibration baths. Extremely well insulated, the baths provide a uniform toroidal circulation yielding an overall transfer accuracy against an SPRT within 0.00025 °C. Repeatability at each of eleven individually mapped sensor positions is better than 0.0001 °C. Sea-Bird's metrology laboratory underpins the temperature calibration baths. Following consultation with the U.S. National Institute of Standards and Technology, the metrology lab was configured to achieve temperature precision of 50 µK and accuracy of 0.0005 °C. To obtain this performance, premium primary references including four Jarrett water triple-point cells (with maintenance bath) and an Isotech gallium melt cell are operated in conjunction with two YSI 8163 standards-grade platinum resistance thermometers and an ASL F18 Automatic Temperature Bridge.

Glossary

PCB – Printed Circuit Board.

SBE 35RT – High-accuracy digital reversing thermometer.

SBE Data Processing – Sea-Bird's Windows 2000/XP data processing software, which calculates and plots conductivity, temperature, pressure, data from auxiliary sensors, and derived variables.

Scan – One data sample.

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

SEASOFT-Win32 – Sea-Bird's complete Windows 2000/XP software package, which includes software for communication, real-time data acquisition, and data analysis and display. SEASOFT-Win32 includes **SEATERM**, **SeatermV2**, **SEASAVE V7**, **SBE Data Processing**.

SEATERM – Sea-Bird's Windows 95/98/NT/2000/XP terminal program used to communicate with the SBE 35RT.

SeatermV2 – Win 2000/XP terminal program *launcher*. Depending on the instrument selected, it launches Seaterm232 (RS-232 instruments), Seaterm485 (RS-485 instruments), or SeatermIM (inductive modem instruments).

Seaterm232 – Win 2000/XP terminal program used with Sea-Bird instruments that communicate via an RS-232 interface, and that were developed or redesigned in 2006 and later. The common feature of these instruments is the ability to output status information in XML. The current list of instruments supported by Seaterm232 includes: SBE 16*plus* V2 (RS-232 interface, version 2 or later firmware); SBE 19*plus* V2 (version 2 or later firmware); SBE 37-SM / -SMP / -SI / -SIP (all version 3 or later firmware), and SBE 54.

Appendix I: Functional Description

Measurement Cycle

The SBE 35RT determines temperature by applying a 1.2 kHz AC excitation to a reference resistor, zero ohms, and an ultrastable thermistor and digitizing the output from each with a 20-bit delta-sigma A/D converter. The reference resistor is a hermetically sealed VISHAY VHP202K inside a temperature-controlled oven. The switches are *All-Position* mercury wetted reed relays with a stable contact resistance. AC excitation and ratiometric comparison using a common processing channel removes measurement errors due to parasitic thermocouples, offset voltages, leakage currents, and gain errors. Maximum power dissipated in the thermistor is 5×10^{-7} watts.

Sensor output = 1048576 * (NT - NZ) / (NR - NZ)

where
NR = output from the reference resistor
NZ = output from zero ohms
NT = output from the thermistor

The process for each acquisition cycle is:
1. Select zero ohms, wait 0.1 seconds for the output to stabilize.
2. Average for 0.267 seconds; this is NZ.
3. Select reference resistor, wait 0.1 seconds for the output to stabilize.
4. Average for 0.267 seconds; this is NR.
5. Select thermistor, wait 0.1 seconds for the output to stabilize.
6. Average for 0.267 seconds; this is NT.

The total time per cycle is 1.1 seconds.

The number of acquisition cycles per sample is user-programmable (**NCycles**). Increasing the number of cycles per sample increases the time to acquire the sample, while reducing the RMS temperature noise from the sensor. The following RMS noise values are typical for an SBE 35 in a Triple Point of Water cell:

Note:
The SBE 35 and 35RT have the same circuitry, so the SBE 35 RMS noise values are also valid for the SBE 35RT.

NCycles	Acquisition Time	Standard Deviation (°C)
8	8.8 seconds	0.000029
32	35.2 seconds	0.000014

Temperature is computed using the Steinhart-Hart polynomial for thermistors (Steinhart and Hart, 1968; Bennett, 1972) as follows (n = output from SBE 35):

$$t_{90L} = \frac{1.0}{a0 + a1\ln(n) + a2\ln^2(n) + a3\ln^3(n) + a4\ln^4(n)} - 273.15$$

$$t_{90} = slope * t_{90L} + offset \qquad [°C, ITS\text{-}90]$$

Carrying the polynomial to the fourth order captures the non-linearity of the SBE 35RT thermistor output to better than ± 0.0001 °C.

Real-Time Clock

A low power *watch* crystal is used as the real-time-clock frequency source.

Memory

Data

The SBE 35RT stores up to 179 samples in EEPROM. EEPROM memory is non-volatile, and data in the memory is not lost as a result of removal of external power.

Timekeeping

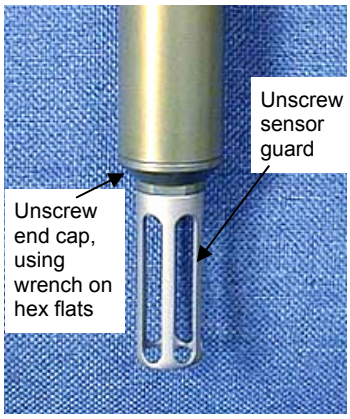
Time is stored in the real-time clock with a back-up lithium battery. Time is kept when external power is removed.

Settings

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

Appendix II: Electronics Disassembly/Reassembly

Disassembly



1. **As a precaution, before beginning:**
   Upload any data in memory, and
   Record the setup parameters from the **DS** command response.

2. Remove the sensor end cap and electronics:
   A. Wipe the outside of the sensor end cap and housing dry, being careful to remove any water at the seam between them.
   B. To access the hex flats for unscrewing the end cap, first unthread the sensor guard by rotating counter-clockwise. Carefully, remove the sensor guard.
   C. Unthread the end cap by rotating counter-clockwise, using a wrench on the hex flats if necessary.
   D. Slide the end cap and attached electronics out of the housing. Note that the electronics are electrically connected to the bulkhead connector.
   E. Remove any water from the O-ring and mating surface inside the housing with a lint-free cloth or tissue.
   F. Be careful to protect the sensor and O-ring from damage or contamination.

Reassembly

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

1. Reinstall the sensor end cap and electronics:
   A. Remove any water from the O-ring and mating surface in the housing with a lint-free cloth or tissue. Inspect the O-ring and mating surface for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to the O-ring and mating surface.
   B. Carefully fit the end cap and electronics into the housing and rethread the end cap into place. Use a wrench on the hex flats to ensure the end cap is tightly secured.
   C. Carefully fit the sensor guard over the sensor. Tighten the sensor guard. **Do not overtighten the sensor guard and do not use a wrench or pliers**.

2. Check the instrument setup using **DS** (see *Section 3: Preparing for Deployment*), and if necessary re-enter the desired parameters.

Appendix III: Command Summary

Note:
See *Command Descriptions* in *Section 3: Preparing for Deployment* for detailed information and examples.

Note:
Use Upload on the Toolbar or Upload Data in the Data menu to write SBE 35RT setup, calibration coefficients, and a user-input header along with uploaded data to a .asc file.

CATEGORY	COMMAND	DESCRIPTION
Status	**DS**	Display setup parameters.
Setup	**MMDDYY= mmddyy**	Set real-time clock month, day, year. Must follow with **HHMMSS=**.
	DDMMYY= ddmmyy	Set real-time clock day, month, year. Must follow with **HHMMSS=**.
	HHMMSS= hhmmss	Set real-time clock hour, minute, second.
	NCycles=x	**x=** number of measurements to take and average per sample (1 – 127).
	Interface=x	**x=911plus:** SBE 35RT used with SBE 9*plus* CTD, SBE 11*plus* Deck Unit, and SBE 32 Carousel Water Sampler. **x=32serial:** SBE 35RT used with SBE 19, 19*plus*, 19*plus* V2, or 25 CTD; SBE 33 Carousel Deck Unit; and SBE 32 Carousel Water Sampler.
	SampleNum=x	**x=** sample number for first sample when sampling begins. After all data has been uploaded, set to 0 before starting to sample to make entire memory available for recording. If not reset to 0, data stored after last sample.
Sampling	**Cal**	Start sampling continuously now, outputting real-time raw data. Data not stored in EEPROM.
	Run	Start sampling continuously now, outputting real-time raw data as well as computed temperature (°C). Data not stored in EEPROM.
	TS	Take one sample; store in EEPROM and output real-time.
Data Upload	**DDb,e**	Upload data from sample **b** to **e**.
Testing	***RTCTest**	Test battery-backed static RAM in real-time clock module. Test resets date and time to default.
	***EETest**	Test EEPROM memory. Allow 30 seconds for test. Test destroys all sampling data and setup parameters (calibration coefficients, etc.) stored in EEPROM.
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 35RT.	**DC**	Display calibration coefficients; all coefficients and date listed below are included. Use individual commands below to modify a particular coefficient or date.
	CalDate=S	**S=**Temperature calibration date.
	TA0=F	**F=**Temperature A0.
	TA1=F	**F=**Temperature A1.
	TA2=F	**F=**Temperature A2.
	TA3=F	**F=**Temperature A3.
	TA4=F	**F=**Temperature A4.
	Offset=F	**F=**Temperature offset.
	Slope=F	**F=**Temperature slope.

Appendix IV: References

Steinhart, J.S. and Hart, S.R. (1968) "Calibration Curves for Thermistors", Deep-Sea Research, 15, p.497.

Bennett, A.S. (1972) "The Calibration of Thermistors over the Temperature range 0-30 °C", Deep-Sea Research, 19, p.157.

Appendix V: Replacement Parts

Part Number	Part	Application Description	Quantity in SBE 35RT
23013C	Aluminum temperature sensor guard	Screws to end cap to protect temperature sensor	1
90248	Interface Box	For lab use with SBE 35RT	1
171887	DB-9P to DB-9S I/O cable, 3.0 m (10 ft) long	Connect Interface Box to computer	1
171888	25-pin DB-25S to 9-pin DB-9P cable adapter	For use with computer with DB-25 connector	-
17015	AC power cable	For Interface Box	1
80555	6-pin AG-206 to 4-pin MS3106A-14S-2P cable, 2.4 m (8 ft) long *	Connect SBE 35RT to Interface Box	1
17047.1	6-pin AG-206 dummy plug with locking sleeve *	For SBE 35RT connector	1
17043	Plastic locking sleeve *	For cable/dummy plug	1
171220	6-pin AG-206 to 6-pin AG-206 to 6-pin AG-206 Y-cable *	From SBE 35RT to SBE 32 Carousel Water Sampler and: • SBE 9*plus* CTD, • AFM, **or** • SBE 17*plus* V2 SEARAM	-
171221	6-pin AG-206 to 6-pin AG-206 cable, 2.4 m (8 ft) long *	From SBE 35RT to SBE 32 Carousel Water Sampler (for use with SBE 19, 19*plus*, 19*plus* V2, or 25 CTD and SBE 33 Carousel Deck Unit)	-
801534	6-pin MCIL-6FS **wet-pluggable** connector to 4-pin MS3106A-14S-2P cable, 2.4 m (8 ft) long	Connect SBE 35RT to Interface Box	1
171498.1	6-pin MCDC-6-F **wet-pluggable** dummy plug with locking sleeve	For SBE 35RT connector	1
171192	Plastic locking sleeve for **wet-pluggable** connector	For cable/dummy plug	1
171995	6-pin MCIL-6FS to 6-pin MCIL-6FS to 6-pin MCIL-6FS (**wet-pluggable**) Y-cable	From SBE 35RT to SBE 32 Carousel Water Sampler and: • SBE 9*plus* CTD, • AFM, **or** • SBE 17*plus* V2 SEARAM	-
171996	6-pin MCIL-6FS to 6-pin MCIL-6FS (**wet-pluggable**) cable, 2.4 m (8 ft) long	From SBE 35RT to SBE 32 Carousel Water Sampler (for use with SBE 19, 19*plus*, 19*plus* V2, or 25 CTD and SBE 33 Carousel Deck Unit)	-
23041	Anode ring	For corrosion resistance; connector end of housing	1
30126	4-40 x 3/8 flat head, stainless steel screws	Secure anode ring to housing	4
30806	LS021 L-seal	O-ring placed in end cap groove	1
50309	Mount kit	For mounting SBE 35RT on SBE 32C (Compact) or 32SC (Sub-Compact) Carousel Water Sampler	-

** For standard connectors*

Index

Digital Reversing Thermometer

SBE 35RT

The SBE 35RT is an accurate, ocean-range temperature sensor that is capable of measuring temperature in the ocean to depths of 6800 meters (22,300 ft). The SBE 35RT communicates via a standard RS-232 interface at 300 baud, 8 data bits, no parity.

Real-Time Operation:

11*plus* — 9*plus* CTD — Carousel
35RT

33–Carousel–19, 19*plus*, 19*plus* V2, or 25 CTD
35RT

Autonomous Operation:

9*plus* CTD — 17*plus* — Carousel
35RT

19,19*plus*,19*plus* V2, or 25 CTD–AFM — Carousel
35RT

The SBE 35RT is used with the SBE 32 Carousel Water Sampler and one of the following CTD systems:

- **Real-time** (bottles closed by command from ship)
  SBE 9*plus* CTD with SBE 11*plus* Deck Unit, ***or***
  SBE 19, 19*plus*, 19*plus* V2, or 25 CTD with SBE 33 Deck Unit
- **Autonomous** (bottles closed based on programmed pressures or times)
  SBE 9*plus* CTD with SBE 17*plus* V2 SEARAM, ***or***
  SBE 19, 19*plus*, 19*plus* V2 or 25 CTD with Auto Fire Module (AFM)

The SBE 35RT makes a temperature measurement each time a bottle fire confirmation is received, and stores the value in EEPROM. Each stored value contains the time and bottle position in addition to the temperature data, allowing comparison of the SBE 35RT record with CTD and water bottle data. Using one SBE 35RT eliminates the need for reversing thermometers, and provides higher accuracy temperature readings at lower cost.

Calibration coefficients stored in EEPROM allow the SBE 35RT to transmit data in engineering units. SEATERM, the terminal program in our SEASOFT©-Win32 software suite, provides easy SBE 35RT setup and data uploading. When configured in a real-time system, the SBE 35RT can use the system modem channel for two-way communications; it is not necessary to change cable connections to communicate with and retrieve data from the SBE 35RT.

The SBE 35RT can be supplied with an optional, small, desktop Interface Box that is connected to the SBE 35RT and a computer for setup and lab use. The Interface Box is 110/220 VAC powered, provides 15 VDC to the SBE 35RT, and buffers the communication lines to minimize interference from external noise. When used with the Interface Box, user-selectable operating modes are:

- Sample continuously and output real-time data (data is not stored in EEPROM), or
- Take a single sample, store the data in EEPROM, and output real-time data.

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Fax: (425) 643-9954

Digital Reversing Thermometer SBE 35RT

MEASUREMENT METHOD

Temperature is determined by applying an AC excitation to reference resistances and an ultrastable aged thermistor with a drift rate of less than 0.001°C per year. Each of the resulting outputs is digitized by a 20-bit A/D converter. The reference resistor is a hermetically sealed, temperature-controlled VISHAY. The switches are mercury wetted reed relays with a stable contact resistance. AC excitation and ratiometric comparison using a common processing channel removes measurement errors due to parasitic thermocouples, offset voltages, leakage currents, and gain errors. Maximum power dissipated in the thermistor is 0.5 microwatts, and contributes less than 200 μK of overheat error. The output from the sensor is a raw count related to resistance measurements:

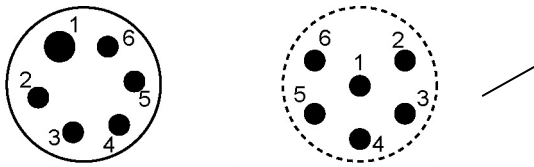
Sensor Output (raw counts) = 1048576 * (NT - NZ) / (NR - NZ)

where NR is reference resistor output, NZ is zero ohms output, and NT is thermistor output.

Each measurement acquisition cycle takes 1.1 seconds. The number of cycles per measurement is programmable. Increasing the cycles increases acquisition time while reducing RMS temperature noise from the sensor. In a thermally quiet environment, the temperature noise standard deviation is: 82 * sqrt (1/n cycles) [μK].

SPECIFICATIONS

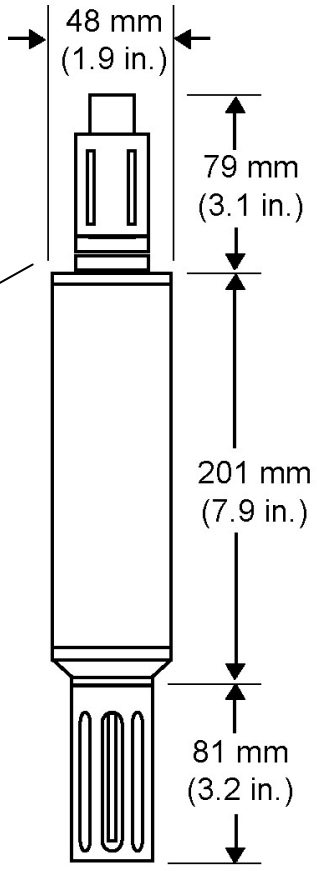
Measurement range	-5 to +35 °C
Initial accuracy	0.001 °C
Typical stability (per year)	0.001 °C
Resolution	0.000025 °C
Sensor calibration	-1.5 to + 32.5 °C
Data storage	Up to 179 samples
Real-time clock	Watch-crystal type
External power	9 - 16 VDC
Current	
On power application (≈ 1 minute)	140 – 160 mA
Operating	60 – 70 mA
Housing materials	Aluminum, rated at 6,800 meters (22,300 feet)
Weight	
In water	0.3 kg (0.7 lbs)
In air	0.7 kg (1.5 lbs)



Standard Connector AG-306-HP-SS

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

Pin	Signal
1	Ground
2	Receive from SBE 9*plus*, SBE 33, or Interface Box
3	Transmit
4	N/C
5	Bottle fire confirmation from Carousel
6	Power +9 to +16V



02/09

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DRAWINGS

DATE	SYM	REVISION RECORD	AUTH	DR	CK
	A	CHANGE F1 TO SLOW BLOW			
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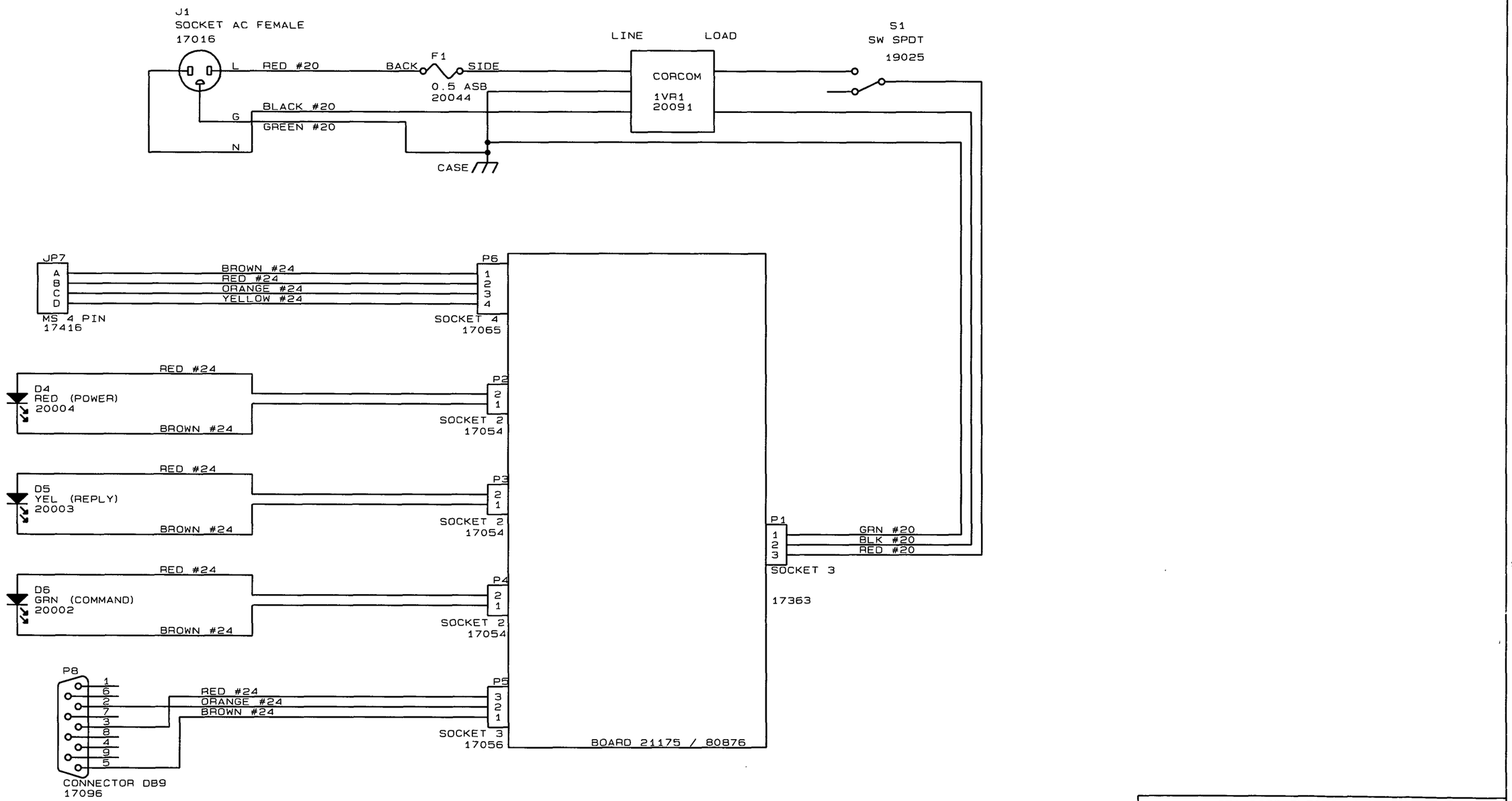
07/30/97	C	ECN467: LABEL F1 SIDE/BACK	JB	DG	



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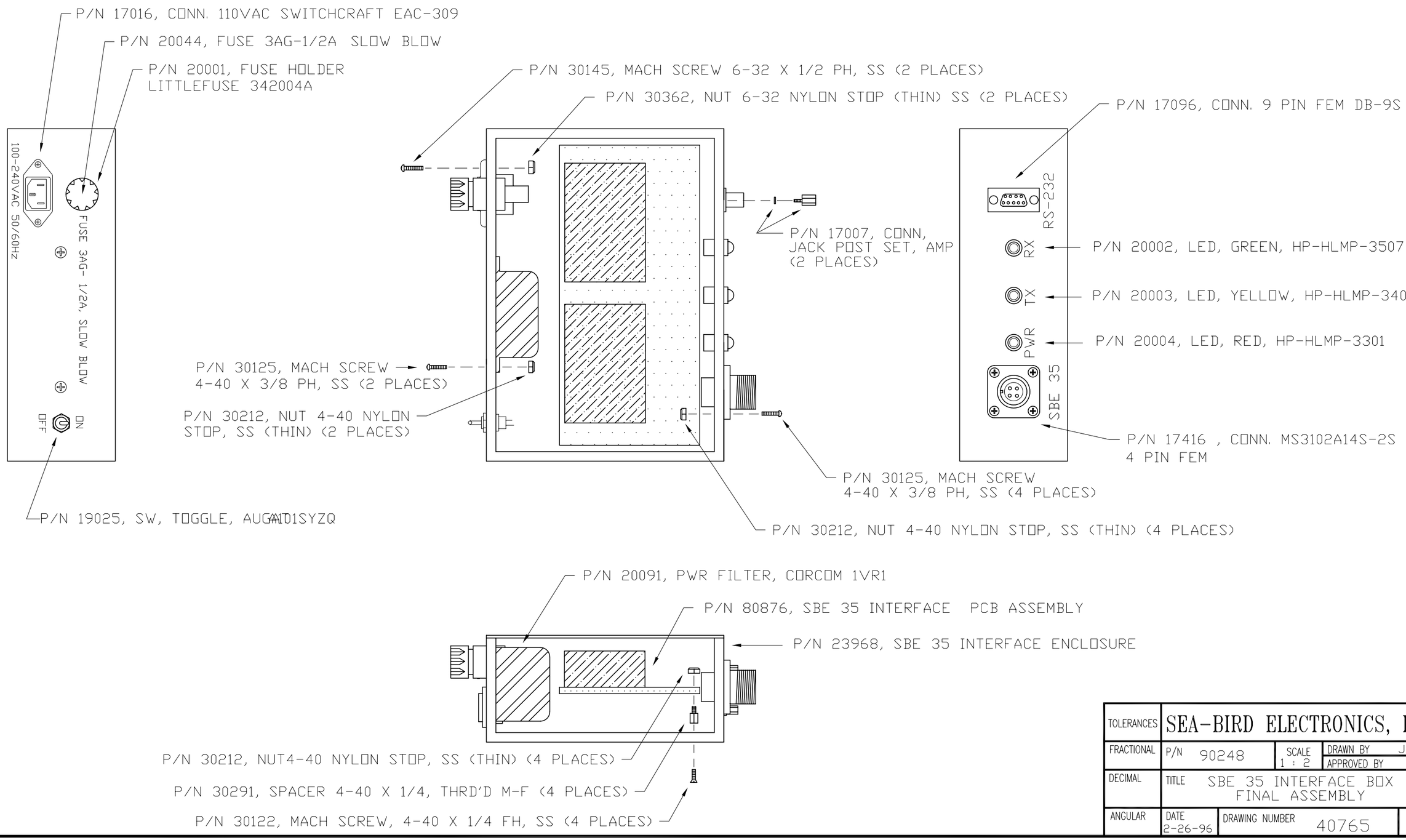
Date: August 12, 1997	Sheet 1 of 1	

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
3.96	A	ADDED BOX LABELS		JEB	
3.6.98	B	ADDED HARDWARE PARTS		CEG	
2.27.06	C	Change Screw 30129 (ECN901)		MJ	



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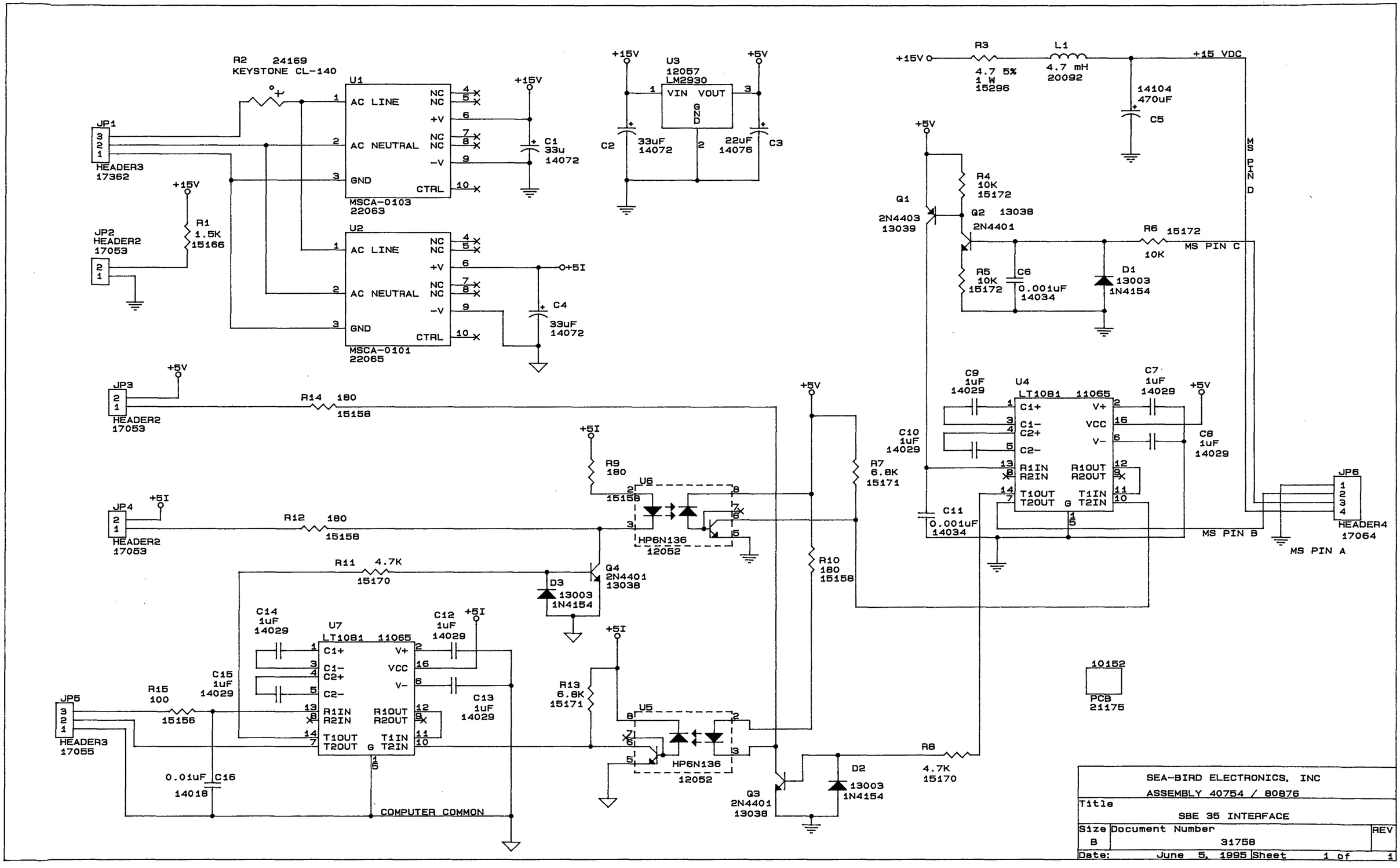
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JP2
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R3
4.7 5%
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15170
10152
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ASSEMBLY 40754 / 80876
Title
SBE 35 INTERFACE
Size
B
Document Number
31758
REV
Date: June 5, 1995
Sheet 1 of 1

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
8/1/95	A	CORRECTED U1 & U2 PINS		BMS	

PART NUMBER.	DESCRIPTION.....	QPA.....	ITM REF DESIG..... NBR
80876	SBE 35 INTERFACE PCB ASSY, /DWG 40754		
11065	IC, LT1081CN, LINEAR TECH, RS232	2.0000	U4 U7
12052	IC, HP6N136, OPTO COUPLER	2.0000	U5 U6
12057	IC, LM2930T-5.0, 5V REG.	1.0000	U3
13003	DIODE, 1N4154, UNITRODE	3.0000	D1 D2 D3
13038	XISTOR, 2N4401	3.0000	Q2 Q3 Q4
13039	XISTOR, 2N4403	1.0000	Q1
14018	CAP, .01 uf, 100V CER, SR211C103KAA, X7R	1.0000	C16
14029	CAP, 1 uf, 50V CER, SR305E105MAA, Z5U	8.0000	C7 C8 C9 C10 C12 C13 C14 C15
14034	CAP, .001 uf, 200V CER, C322C102J2G5CA, NPO	2.0000	C6 C11
14072	CAP, 33 uf, 25V DIPPED TANT, TAP336K025HSB	3.0000	C1 C2 C4
14076	CAP, 22 uF, 35V DIPPED TANT, TAP226K035HSB	1.0000	C3
14104	CAP, 470uf 25v, UVZ1E471MPH NICHICON	1.0000	C5
15156	RES, 100 OHM, 5%, 1/4 W	1.0000	R15
15158	RES, 180 OHM, 5%, 1/4 W	4.0000	R9 R10 R12 R14
15166	RES, 1.5K OHM, 5%, 1/4 W	1.0000	R1
15170	RES, 4.7K OHM, 5%, 1/4 W	2.0000	R8 R11
15171	RES, 6.8K OHM, 5%, 1/4 W	2.0000	R7 R13
15172	RES, 10K OHM, 5%, 1/4 W	3.0000	R4 R5 R6
15296	RES, 4.7 OHM, 1W 5%, METAL OXIDE	1.0000	R3
17053	HEADER, 2 PIN, MOLEX 6373-22-11-2022	3.0000	JP2 JP3 JP4
17055	HEADER, 3 PIN, MOLEX 6373-22-11-2032	1.0000	JP5
17064	HEADER, 4 PIN, MOLEX 6373-22-11-2042	1.0000	JP6
17362	HEADER, 3 PIN, MOLEX 41671-26-48-2035	1.0000	JP1
20092	CHOKE, IHD-3, DALE	1.0000	L1
21175	PCB, SBE 35 INTERFACE, /DWG 10152	1.0000	PCB
22063	PWR SUPPLY, ASTRODYNE MSCA-0103, 85 - 265 VAC	1.0000	U1
22065	PWR SUPPLY, ASTRODYNE MSCA-0101	1.0000	U2
24169	THERMISTOR, KEYSTONE CL-140	1.0000	R2

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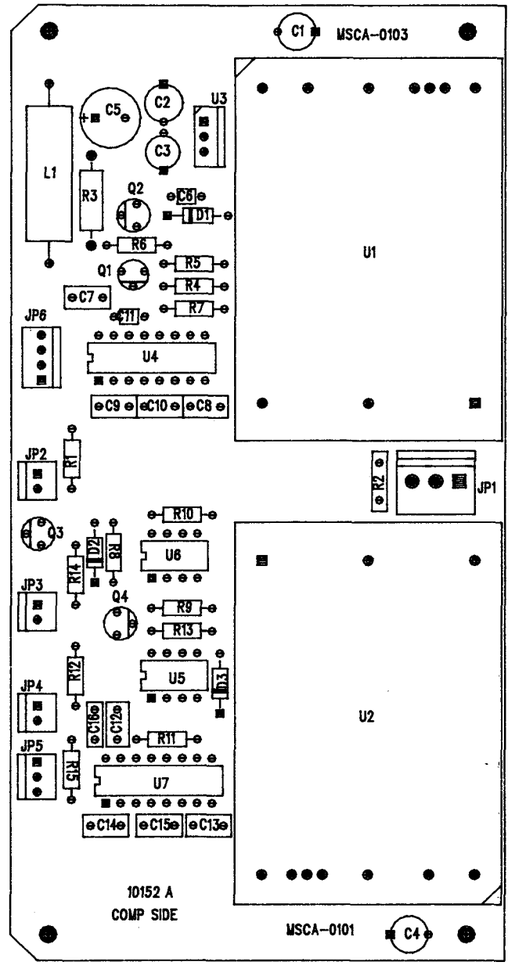

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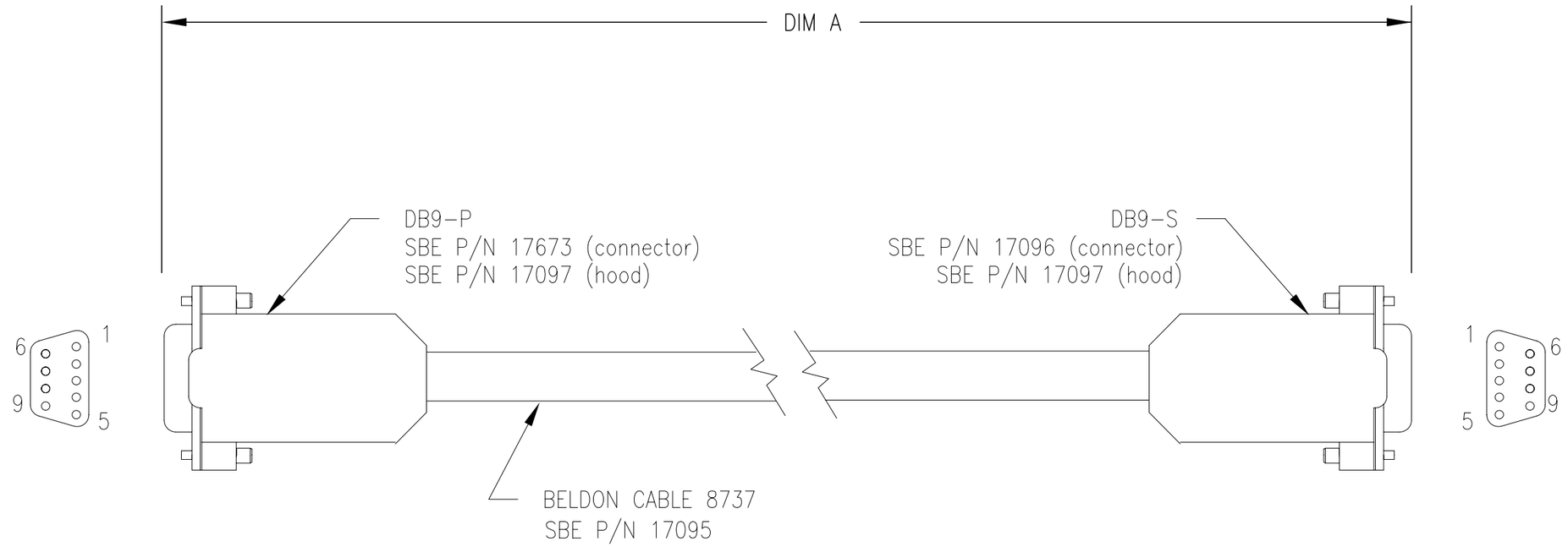
ANGULAR ±	DATE 8-1-95	DRAWING NUMBER 40754	REV A

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.

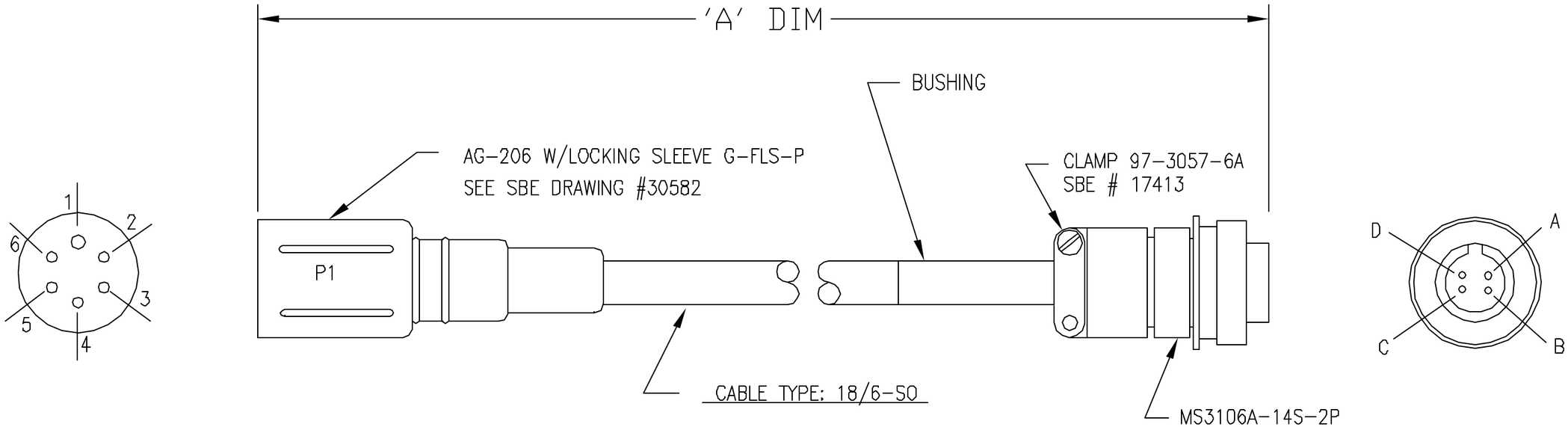


P1 DB9-P	COLOR	P2 DB-9S
PIN 1		PIN 1
PIN 2	RED	PIN 2
PIN 3	BLACK	PIN 3
PIN 4		PIN 4
PIN 5	SHIELD	PIN 5
PIN 6		PIN 6
PIN 7		PIN 7
PIN 8		PIN 8
PIN 9		PIN 9

SBE PN	DIM A
801235	6 FT
801373	8 FT
801592	10 M

TOLERANCES	SEA-BIRD ELECTRONICS, INC		
FRACTIONAL	P/N SEE TABLE	SCALE NTS	DRAWN BY MJ APPROVED BY
DECIMAL	TITLE CABLE ASSY, SBE-21 OPTO I/O		
ANGULAR	DATE 07.00	DRAWING NUMBER 32431	REV

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
3.30.95	A	ADDED TABLE AND PART #'S			



P1

P2

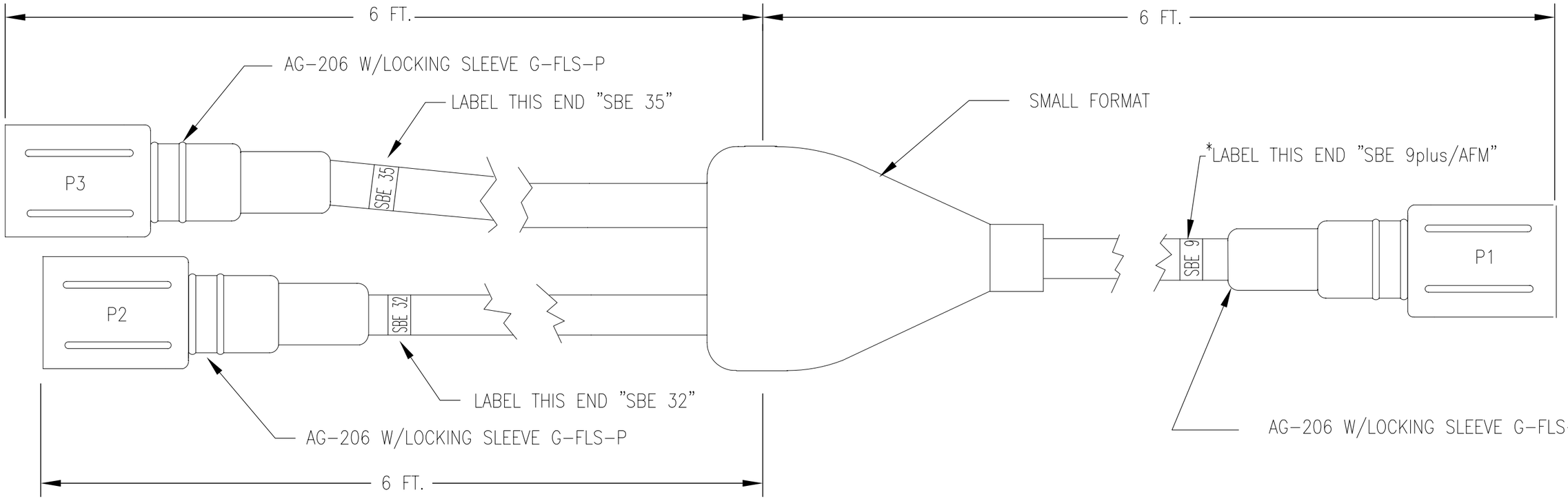
P1 AG-206	P2 MS3106A	COLOR
PIN 1	A	WHITE
PIN 2	B	BLACK
PIN 3	C	BLUE
PIN 4	–	–
PIN 5	–	–
PIN 6	D	RED

SBE PN	CABLE 'A'	DIM A
80555	17032	8 FT (2.46m)
80860	17757	65 FT (20m)
801453	17955	17 FT

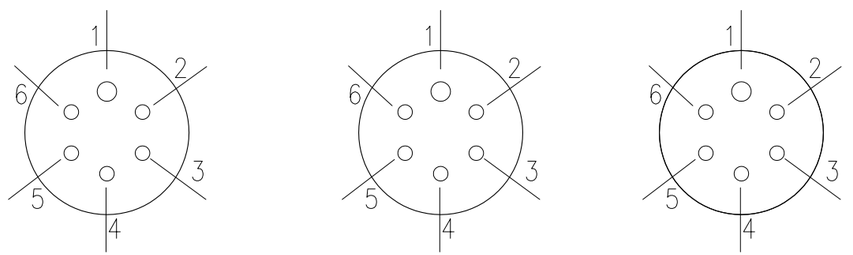
REDRAWN ON ACAD 8/11/92

TOLERANCES	SEA-BIRD ELECTRONICS, INC		
FRACTIONAL	P/N SEE TABLE	SCALE 1:1	DRAWN BY BMC APPROVED BY
DECIMAL	TITLE UNI OPTO BOX DATA CABLE ASSY 6 PIN TO 4 PIN		
ANGULAR	DATE 4/21/92	DRAWING NUMBER 31116	REV A

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
10/04	A	ADD NOTE	CB	KH	



*SBE 9plus/AFM	SBE 32	SBE 35
P1 AG-206	P2 AG-206	P3 AG-206
PIN 1	PIN 1	PIN 1
PIN 2	PIN 2	PIN 2
PIN 3	NC	PIN 3
PIN 4	NC	NC
PIN 5	NC	NC
PIN 6	PIN 6	PIN 6
NC	PIN 3	PIN 5

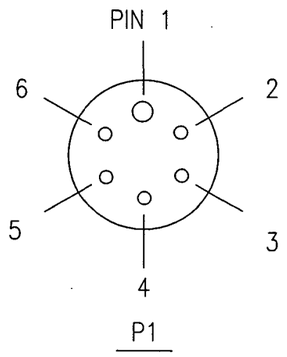


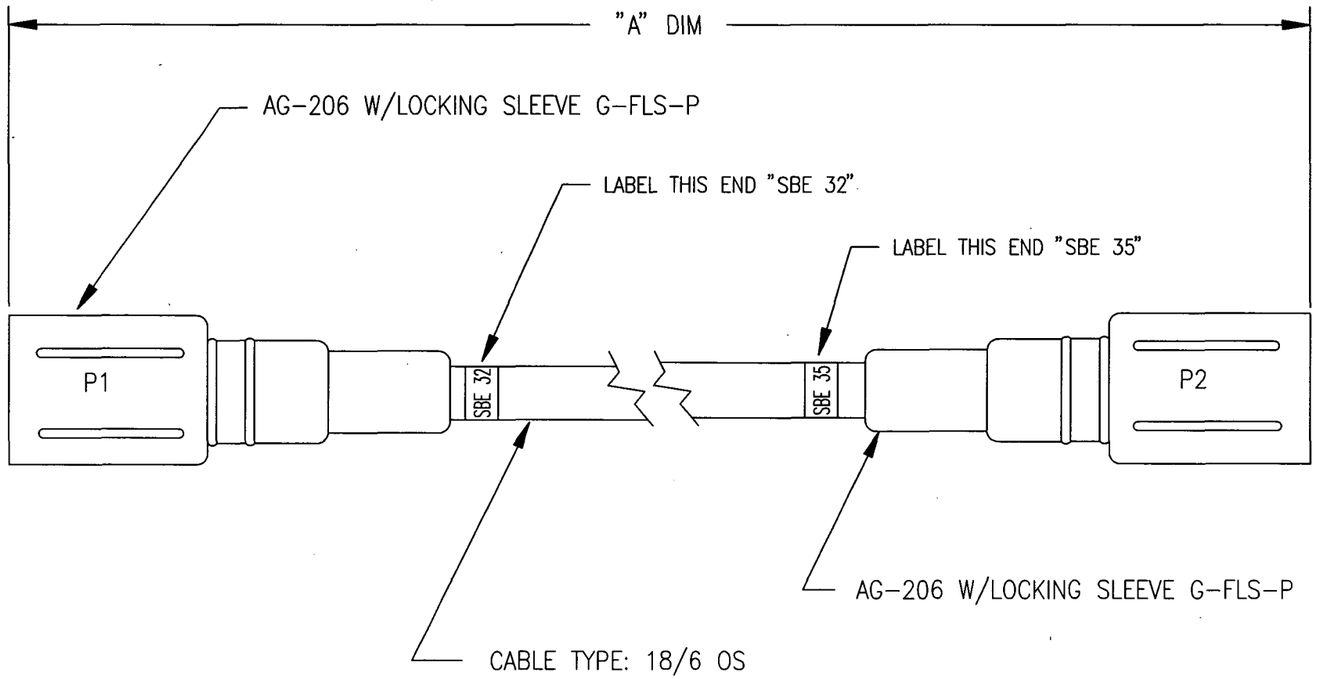
P1 P2 P3

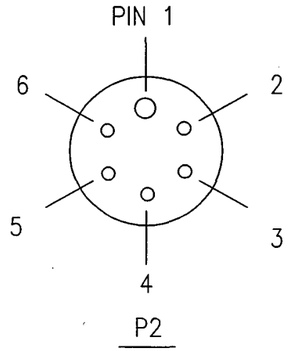
*When used as 32/35/AFM or 32/35/17plusV2 combination, connect P1 to AFM (JB2) or 17plusV2 (J3)

TOLERANCES	SEA-BIRD ELECTRONICS, INC			
FRACTIONAL	P/N 171220	SCALE 1:1	DRAWN BY CEG	
			APPR BY RB	
DECIMAL	TITLE SBE35 v2 TO SBE 9/32 Y-CABLE			
ANGULAR	DATE 9.16.98	DRAWING NUMBER 32208		REV A

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.







SBE PART NO	A DIM
171221	96 IN.

P1 SBE32	P2 SBE35
PIN 1	PIN 1
PIN 2	NC
PIN 3	PIN 5
PIN 4	PIN 3
PIN 5	PIN 2
PIN 6	PIN 6

TOLERANCES	SEA-BIRD ELECTRONICS, INC		
FRACTIONAL	P/N SEE TABLE	SCALE 1:1	DRAWN BY CEG APPROVED BY RB
DECIMAL	TITLE CABLE, SBE35 v2 TO SBE32 AG-206 W/ LOCKING SLEEVE		
ANGULAR	DATE 9.16.98	DRAWING NUMBER 32209	REV

APPLICATION NOTES

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APPLICATION NOTE NO. 42 **Revised March 2008**

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-Win32 suite of software programs, edit the CTD configuration (.con) 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) 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 .con 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 .con file and you select temperature display/output variable type as T90, SEASOFT computes T68 directly and divides by 1.00024 to display or output T90.

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

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

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

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APPLICATION NOTE NO. 57 **Revised May 2003**

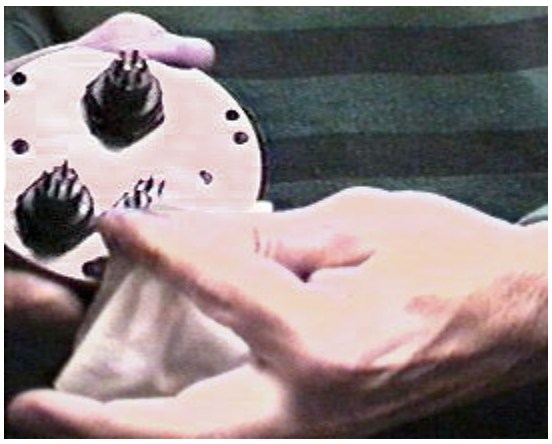
I/O Connector Care and Installation

This Application Note describes the proper care and installation of standard I/O connectors for Sea-Bird CTD instruments. Once properly installed, the connections require minimal care. Unless access to the bulkhead is required, the connections can be left in place indefinitely.

The Application Note is divided into three sections:
- Connector Cleaning and Installation
- Locking Sleeve Installation
- Cold Weather Tips

Connector Cleaning and Installation

1. Carefully clean the bulkhead connector and the inside of the mating inline (cable end) connector with a Kimwipe. Remove all grease, hair, dirt, and other contamination.

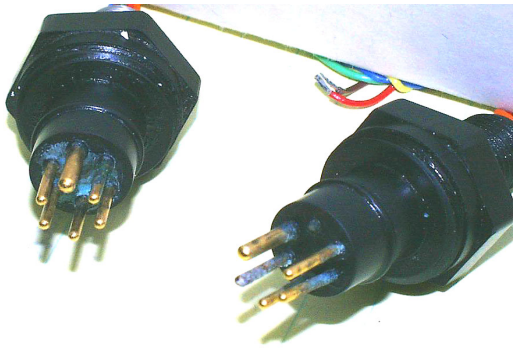


Clean bulkhead connector

Clean inside of connector

2. Inspect the connectors:
   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 inline connector for cuts, nicks, breaks, or other problems that may compromise the seal.

   Replace severely corroded or otherwise damaged connectors - contact SBE for instructions or a Return Authorization Number (RMA number).

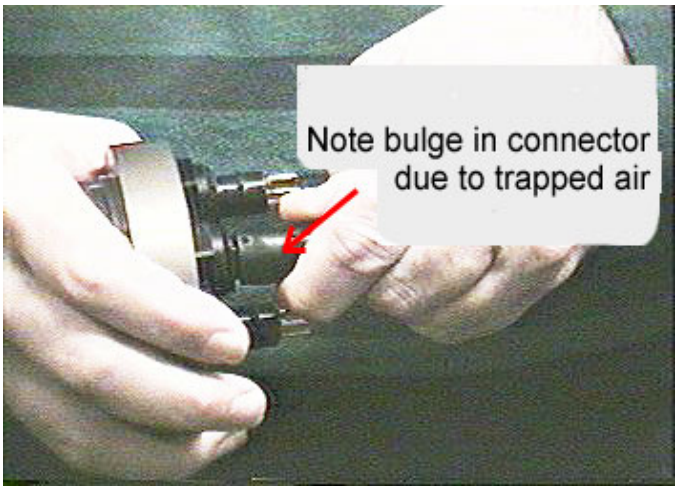


Corroded pins on bulkhead connectors - Connector on right has a missing pin

3. Using a tube of 100% silicone grease (Dow DC-4 or equivalent), squeeze approximately half the size of a pea onto the end of your finger.

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

4. 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 inline connector.

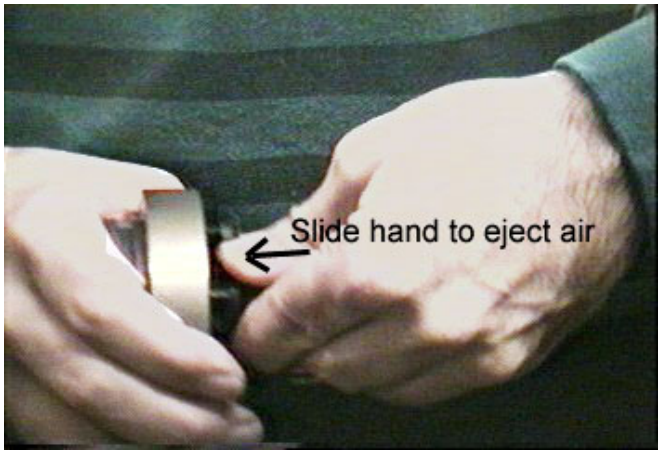


5. Mate the inline connector to the bulkhead, being careful to align the pins with the sockets. Do not twist the inline connector on the bulkhead connector. Twisting can lead to bent pins, which will soon break.

6. Push the connector all the way onto the bulkhead. There may be an audible pop, which is good. With some newer cables, or in cold weather, there may not be an initial audible pop.

7. After the cable is mated, run your fingers along the inline connector toward the bulkhead, *milking* any trapped air out of the connector. You should hear the air being ejected.

   CAUTION:
   Failure to eject the trapped air will result in the connector leaking.



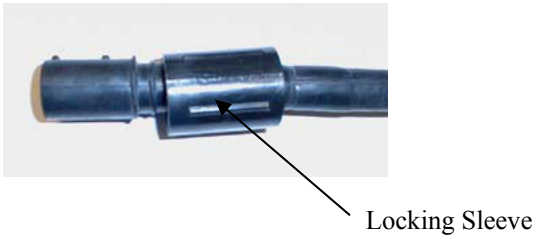
Locking Sleeve Installation

After the connectors are mated, install the locking sleeve. The locking sleeve secures the inline connector to the bulkhead connector and prevents the cable from 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. Overtightening 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 every cruise, remove the locking sleeve, slide it up the cable, and rinse the connection (still mated) with fresh water. This will prevent premature cable failure.



Cold Weather Tips

In cold weather, the connector may be hard to install and remove.

Removing a *frozen* inline connector:

1. Wrap the connector with a washrag or other cloth.

2. Pour hot water on the cloth and let the connector sit for a minute or two. The connector should thaw and become flexible enough to be removed.

Installing an inline connector:
When possible, mate connectors in warm environments before the cruise and leave them connected.
If not, warm the connector sufficiently so it is flexible. A flexible connector will install properly.

By following these procedures, you will have many years of reliable service from your cables!

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

Using USB Ports to Communicate with Sea-Bird Instruments

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

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

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

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

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

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

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

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

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

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APPLICATION NOTE NO. 71 Revised March 2008

Desiccant Use and Regeneration (drying)

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

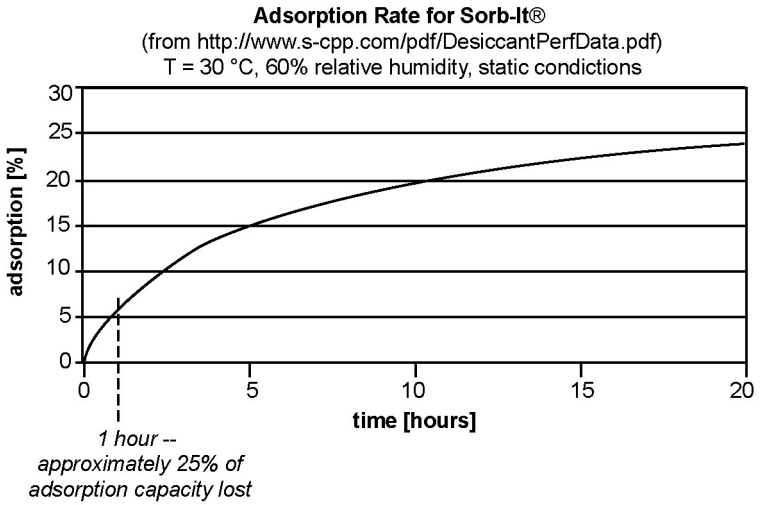
When to Replace Desiccant Bags

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

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

Storage and Handling

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



Regeneration (drying) of Desiccant

Replacement desiccant bags are available from Sea-Bird:

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

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

MIL-D-3464 Desiccant Regeneration Procedure

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

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

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

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

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

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

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

SÜD-CHEMIE
Creating Performance Technology
ISO 9002 CERTIFIED

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

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

SECTION I -- PRODUCT IDENTIFICATION

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

SECTION II -- HAZARDOUS INGREDIENTS

Components in the Solid Mixture

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

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

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

SECTION III -- PHYSICAL DATA

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

SÜD-CHEMIE
Creating Performance Technology
ISO 9002 CERTIFIED

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

SECTION IV -- FIRE EXPLOSION DATA

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

Flash Point - Nonflammable.

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

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

SECTION V -- HEALTH HAZARD DATA

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

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

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

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

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

SÜD-CHEMIE
Creating Performance Technology
ISO 9002 CERTIFIED

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

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

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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* 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.

WARRANTY POLICY 2006

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. Purchase of an SBE 43 includes one free electrolyte replenishment (as necessitated by chemical depletion of electrolyte) anytime during the warranty period. To obtain the replenishment, 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. Because pH and other dissolved oxygen (DO) electrodes have a limited life caused by the depletion of their chemical constituents during normal storage and use, our warranty applies differently to such electrodes. Electrodes in SBE 13Y and 23Y DO sensors, SBE 18 pH sensors, and SBE 27 pH/ORP sensors are covered under warranty for the first 90 days only. Other components of the sensor are covered for 5 years.

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

4. Batteries, zinc anodes or other consumable/expendable items are not covered under this warranty.

5. Electrical cables and dummy plugs are warranted to function properly and be free of defects in materials and workmanship for 1 year.

6. 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.

7. 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.

Service Request Form

To return your instrument for calibration or other service, please take a few moments to provide us with the information we need, so we can serve you better.

PLEASE:

1. **Get a Returned Material Authorization (RMA) number from Sea-Bird (*phone 425-643-9866, fax 425-643-9954, or email seabird@seabird.com*). Reference the RMA number on this form, on the outside shipping label for the equipment, and in all correspondence related to this service request.**
2. **Fill out 1 form for each type (model) of instrument.**
3. **Include this form when shipping the instrument to Sea-Bird for servicing.**
4. **Fax us a copy of this form on the day you ship.** ***FAX: (425) 643-9954***

RETURNED MATERIAL AUTHORIZATION (RMA) NUMBER: _____

DATE EQUIPMENT REQUIRED BY: _____

DO YOU REQUIRE A WRITTEN QUOTE? _____

CONTACT INFORMATION

Your name: _____

Institution/Organization/Company: _____

Shipping/Delivery address for packages: _____

_____

_____

Telephone: _____ Fax: _____

e-mail: _____

SERVICE INFORMATION

Date Shipped: _____

Sea-Bird Model Number (for example, SBE 37-SM): _____

Quantity: _____

Serial Numbers: _____

_____

_____

(**Note**: **Specify instrument serial numbers below** if specific services are required for some instruments. For example, if 10 instruments are being returned for calibration, and 1 of the 10 also requires repairs, specify the serial number for the instrument requiring repairs in the appropriate section of the form.)

SEASOFT Version you have been using with this instrument(s): _____

[ ] Calibration Services:

___Calibration (includes basic diagnostic):

___Temperature ___Conductivity ___Pressure ___DO ___pH

(Please allow a minimum of 3 weeks after we receive the instrument(s) to complete calibration.)

___Other (specify): _____

_____

[ ] Internal Inspection and O-Ring Replacement (includes hydrostatic pressure test):

Additional charges may apply.

_____

_____

[ ] System Upgrade or Conversion:

Specify (include instrument serial number if multiple instruments are part of shipment): _____

_____

_____

[ ] Diagnose and Repair Operational Faults:

Please send a disk containing the raw data (.hex or .dat files) that shows the problems you describe. Also send the .con files you used to acquire or display the data.

Problem Description (continue on additional pages if needed; include instrument serial number if multiple instruments are part of shipment): _____

_____

_____

_____

PAYMENT/BILLING INFORMATION
Credit Card: Sea-Bird accepts payment by VISA, MasterCard, or American Express.
[ ] MasterCard [ ] Visa [ ] American Express
Account Number: _____ Expiration Date: _____
Credit Card Holder Name (printed or typed): _____
Credit Card Holder Signature: _____
Credit Card Billing Address (if different than shipping address):

_____
_____
_____

Invoice/Purchase Order: If you prefer us to invoice you, please complete the following or enclose a copy of your Purchase Order:
Purchase Order Number: _____
Billing Address (if different than shipping address):

_____
_____
_____

Instructions for Returning Goods to Sea-Bird

1. **Domestic Shipments (USA) - Ship prepaid** (via UPS, FedEx, DHL, etc.) directly to:
   Sea-Bird Electronics, Inc.
   1808 136th Place NE
   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.
   1808 136th Place NE
   Bellevue, WA 98005, USA
   Telephone: (425) 643-9866 Fax: (425) 643-9954 E-mail: seabird@seabird.com

   Notify: MTI Worldwide Logistics for Customs Clearance
   Seattle, WA, USA
   Telephone: (206) 431-4366 Fax: (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**:
   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 for the replacement crate based on the dimensions of the crate we receive, determined as follows:
1. Multiply the crate length x width x height in centimeters (overall volume in cm^3, not internal volume).
2. Determine the price based on your calculated overall volume and the following chart:

Overall Volume (cm^3)	< 52,000	52,000 to < 65,000	65,000 to < 240,000	> 240,000
Example Instrument	37-SM MicroCAT	SEACAT, no cage	CTD in cage	--
Price (USD)	$45	$70	$125	consult factory

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.