SEA-BIRD SCIENTIFIC

User manual

SBE 38 Digital Oceanographic Thermometer

Document No.	SBE38
Release Date:	2024-06-26
Version:	C
Firmware:	2.0.0

425-643-9866
seabird.com

Table of Contents

Section 1 Safety information

Please read this entire manual before this equipment is unpacked, set up, or operated. Pay attention to all danger, warning, and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

⚠DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠WARNING

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

⚠CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, may cause damage to equipment. Information that requires special emphasis.

1.1 Hazard information

⚠WARNING

This product can expose the user to chemicals with silica, crystalline (airborne particles of respirable size), which is known to the State of California to cause cancer and birth defects or other reproductive harm. For more information, go to www.P65Warnings.ca.gov.

NOTICE

The manufacturer is not responsible for any damages due to misapplication of misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect process during a possible equipment malfunction.

1.2 Equipment labels

Read all labels and tags attached to the equipment. Personal injury or damage to the equipment could occur if not observed. A symbol on the equipment is referenced in the manual with a precautionary statement.

	Electrical equipment marked with this symbol may not be disposed of in European domestic or public disposal systems. Return old or end-of-life equipment to the manufacturer at no charge to the user.

	EFUP E: No hazardous material exists over the threshold of GB/T 26572-2011 standard, China's Requirements for Concentration Limits for Certain Hazardous Substances in Electrical and Electronic Products. This product should be recycled after its environmentally friendly use period.

Section 2 SBE 38 quick start guide

This quick start guide gives the steps necessary to make sure that the SBE 38 sensor operates correctly and collects data before it is deployed.

This quick start guide and user manual applies to both RS232 and RS485 models.

What's in the box:

- SBE 38
- CD—has software, calibration files, documentation
- I/O cable with 9V battery snap connector and battery.

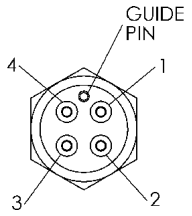
1. Install the manufacturer-supplied software on a PC (refer to Install software on page 9 for details.)
2. Connect the sensor to the PC and double-click on **SeaTerm.exe** to start the software.
3. Set up the sensor for deployment (refer to Set up sensor and verify operation on page 9 for details.)
   a. If necessary, make sure that all data stored in the sensor is transmitted to a PC.
   b. Set the date and time (DateTime)
   c. Configure the data collection settings.
   d. Send the DS and DC commands to verify the setup.
   e. For autonomous data collection, send StartNow to start operation immediately. Send StartDateTime= or StartLater to start at a user-selected time in the future.
4. Immediately after the sensor is recovered from a deployment:
   a. Use the software to turn off the sensor.
   b. Rinse the sensor with fresh water.
   c. Keep the sensor out of direct sunlight between deployments.
5. To store the sensor, flush the sensor thoroughly with clean water, then dry. Attach the dummy plug.

Section 3 Specifications

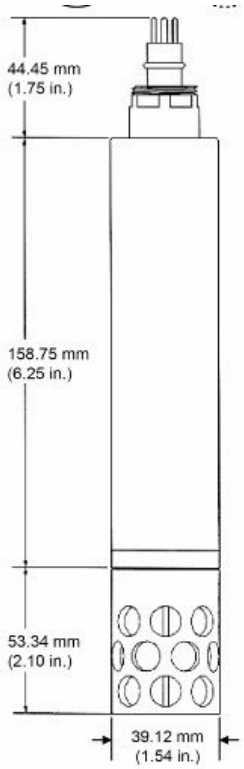
3.1 Mechanical

Material	Titanium
Depth rating	10,500 m
Weight in air, water	0.9, 0.5 kg

3.1.1 Bulkhead connector

Contact	Function	MCBH4MP
1	Ground	
2	RS232 or RS485A RX	
3	RS232 or RS485B TX	
4	Voltage in	

3.1.2 Dimensions



3.2 Analytical

Range	-5 to 35 °C
Accuracy	±0.001 °C (1 mK)
Stability	0.001 °C (1 mK) in 6 months, certified
Resolution	0.00025 °C (0.25 mK)
Calibration	-1 to 32 °C

3.3 Electrical

External power	RS232: 8–15 VDC @ 15 mA avg RS485 half duplex: 8–15 VDC @ 10 mA avg	
Current draw, data collection	RS232: 6.3 mA @ 12 V (navg=1) RS485: 3.5 mA @ 12 V (navg=30)	
Current draw, low power	RS232: 6.2 mA @ 12 V (navg=1) RS485: 3.5 mA @ 12 V (navg=30)	
Baud rates	1200, 2400, 4800, **9600 (default)**, 19200, 38400	
Response time	500 msec	
Self-heating error	less than 200 µK	
RMS noise, 8.5 °C NAvg = number of A/D cycles per sample. Interval between samples, seconds = (2/15 × NAvg) + 1/3	**NAvg** 1 2 4 8 16 32	**Noise °C** 0.000673 0.000408 0.000191 0.000133 0.000081 0.000052

Section 4 Set up sensor and verify operation

The SBE 38 Digital Oceanographic Thermometer is a high-accuracy temperature recorder that transmits real-time data in ASCII, in °C or in raw counts, through either an RS232 or RS485 serial interface. The user can use a PC to see the data in real-time, and it can be stored to a PC or data logger.

The SBE 38 operates in one of three ways:

- RS232 full duplex, with one SBE 38 connected to the interface
- RS485 half duplex, with one SBE 38 connected to the interface
- RS485 half duplex, with several RS485 sensors on one pair of wires.

When power is supplied, the SBE 38 reads its EEPROM, which includes calibration coefficients and other setup information. The SBE 38 samples and transmits temperature data continuously, or will wait for a command to start data collection.

The SBE 38 is frequently used as a remote temperature sensor with a SBE 21 thermosalinograph or a SBE 45 Micro thermosalinograph to get accurate sea surface temperatures. Seasave and SBE Data Processing software can be used to see and process the entire data stream when the SBE 38 is used with the SBE 21, SBE 45, or SBE 16 or 19plus V2. If the SBE 38 is used with the SBE 25plus, data cannot be seen in real-time.

Set up the hardware and install the software for the sensor to make sure that it operates correctly before a deployment.

4.1 Install software

Make sure that the sensor is connected to the PC through the serial connector on the supplied cable. A serial-to-USB adapter is necessary. Make sure that the USB driver software is installed on the PC so that there is communication between the sensor and the PC.

1. Install the SeasoftV2 software from the manufacturer-supplied CD.
2. Double-click on **Seaterm.exe** to start the launcher. If this is the first time the software is opened, a SeaTerm Setup window opens. The software automatically connects at the default baud rate of 9600 but will try others if necessary. The software automatically looks for the serial port number of the connected sensor.
3. At the **Instrument Type** dropdown, select SBE 38.
4. Push **OK** to close this window.
   The main window opens. The area on the top shows the menu of available commands. The large area below shows commands and the responses from the sensor to those commands.

4.2 Set up and test RS232 communication

Use the manufacturer-supplied cable to connect the sensor to the PC and a 9 V battery if it is not already connected.

1. Start Seaterm.
2. From the **Configure** menu, select *SBE 38 RS232*.
   Seaterm232 opens.

Table 1 Toolbar menu buttons

Connect enable communication with the sensor.
Disconnect the sensor so the COM port on the PC is available again.
Coefficients shows the calibration coefficients stored in the sensor.
Capture Capture sensor response on the screen to a file with a .cap extension. Push **Capture** again to turn off this function.

3. Change any settings in the **SBE 38 Configuration Options** window.
   a. Select the applicable COM port.
   b. Baud rate: 9600 is default.
   c. Data bits: 8.
   d. Parity: none.
   e. Mode: RS232 or RS485.
   f. Push **OK** to save the settings.
4. In the **Communications** menu, select *Options/cycle baud when connecting*.
5. Select **Connect**.
   The software tries to connect to the SBE 38 at the baud rate set in Step 3.b. If it cannot, it will try all other possible baud rates to try to connect. When it connects, the display will show `SBE 38 V 2.0.0 S/N xxxx` then `S>`. If the user does not see the `S>` prompt, select **Connect** again and make sure the correct sensor was selected in the **Configure** menu and the settings were entered correctly in the **Configuration Options** window. Make sure that the cable is connected correctly.
6. Select **Status** on the toolbar to see the SBE 38 status information:
   ```
   SBE 38 V 2.0.0 S/N = xxxx
   NAVG=1
   Not sampling data
   Automatically start sampling on power up
   Default interface is RS-232
   ```
7. Enter `TS` then push **Enter** to take a sample.
   If the output format was set to converted data (**Format=C**) with four digits to the right of the decimal (**Digits=4**): `23.7658` shows, *where*23.7658 = temperature in °C. This value should be approximately the ambient temperature. The SBE 38 is ready to configure and deploy.

4.3 Cable length and external power

Calculate IR loss for real-time data collection for use with external power.

1. The communications IR loss should be 1 V or less when real-time data is transmitted. The 38 will not transmit data if the IR loss is greater than 1V because of the difference in ground potential.
2. Supply enough power so that sufficient power is available to the sensor after IR loss is calculated.

Limit IR loss to 1 V to transmit real-time data

Maximum communications current draw × common wire resistance on the power wire = limit to the length of the cable.

$V_{limit} = 1\ V = IR_{limit}$

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

I = current required by SBE 38 = 15 mA for RS232, or 10 mA for RS485 (RS485).

Example 1:
What is the maximum cable length that can supply power to the SBE 38 with 18 gauge wire? Is the cable length the limiter at 1200 baud?

$R_{limit} = V_{limit} \div I = 1\ V \div 0.015\ A = 67$ ohms

Maximum cable length = 67 ohms ÷ 0.0064 ohms/ft = 10417 ft (3176 m)

3176 m > 800 m (maximum distance the SBE 38 can transmit data at 1200 baud) so IR loss is not the limiter for this example.

Example 2:
Same as above, but with four SBE 38 sensors powered from the same power supply.

$R_{limit} = V_{limit} \div I = 1\ V \div (0.015\ A \times 4$ SBE 38s) = 17 ohms

Maximum cable length = 67 ohms ÷ 0.0064 ohms/ft = 10468 ft (3190 m)

3190 m > 800 m (maximum distance the SBE 38 can transmit data at 1200 baud) so IR loss is not the limiter for this example.

Table 2 Common wire resistances

Gauge	Ohms/ft.
12	0.0016
14	0.0025
16	0.0040
18	0.0064
19	0.0081
20	0.0107
22	0.0162
24	0.0257
26	0.0410
28	0.0653

Table 3 Maximum cable length and baud rate

Length, m	Baud rate
1600	600
800	1200
400	2400
200	4800
100	9600
50	19200
25	38400
16	57600
8	115200

To use the Seaterm232 software to see data in real-time, Select the **Capture** menu, enter a file name, then push **Save**. This data file **cannot be processed by Plot39 or SBE Data Processing software** because it does not have the required headers and format. To process data with this software, transmit the data from SBE 39plus to a PC.

Supply sufficient power to 39plus

The power requirement depends on sufficient voltage at the power source after IR loss:

Example 1:
What is the maximum distance to supply power to the RS232 SBE 38 with 18 gauge wire and a 8.5 V power supply at 1200 baud?

The input power specification for the SBE 38 is 8–15 volts. A 0.5 IR drop would still supply enough power to the SBE 38.

V=IR

0.5 volts = 0.015 amps × (0.0064 ohms/foot × cable length) Cable length = 5208 ft (1588 m).

Note that 1588 m > 800 m, the maximum distance SBE 38 can transmit data at 1200 baud, so the IR loss does not limit the distance.

Example 2:

Same as above but with four SBE 38 sensors powered from the same power supply

0.5 volts = (0.015 amps × 4 SBE 38s) × (0.0064 ohms/foot × cable length) Cable length = 130 ft (39 m).

Note that 397 m < 800 m, the maximum distance SBE 38 can transmit data at 1200 baud, so the IR loss limits the distance. Use a higher voltage power supply or a 12 or 14 gauge wire to supply sufficient power.

Section 5 Deployment and recovery

Set up the sensor hardware for deployment. Make sure the SBE 38 is attached correctly to any frame, and that all cables are attached correctly and the lock collars are tight. The manufacturer recommends that the sensor is deployed with the thermistor end down to keep sediment out of the thermistor.

Refer to the section on Cable length and external power on page 10 for details on the correct length of cable to use.

Refer to the Command reference on page 17 section for details on specific commands to control the SBE 38.

Use one of the sequences below to start data collection.

- **AutoRun=Y**: supply power to start to continuously collect data.
- **AutoRun=N**: send **Go** to start to continuously collect data immediately, or **TS** or **TH** to take a single sample.

Deploy the SBE 38.

Recovery

⚠WARNING

If the user thinks that a sensor has water in the pressure housing: Disconnect the sensor from any power supply. Put on safety glasses and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, use the purge port (if the sensor is so equipped), or very SLOWLY loosen the bulkhead connector to let the pressure release.

To stop the SBE 38, push **Enter**, then send **Stop**, or remove power to the sensor. Make sure to flush the SBE 38 with fresh water, then dry, and attach the dummy plug and lock collar.

5.1 Data formats

Data from the SBE 38 is either converted or raw. Each line of data ends with a carriage return and line feed.

Converted data

ttt.ttt

where t = temperature, °C.

The number of digits to the right of the decimal point is user-selected with the **Digits=** command.

Raw data

nnnnnn.n

where n = counts

⚠WARNING

If the user thinks that a sensor has water in the pressure housing: Disconnect the sensor from any power supply. Put on safety glasses and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, use the purge port (if the sensor is so equipped), or very SLOWLY loosen the bulkhead connector to let the pressure release.

6.1 Clean bulkhead connectors

NOTICE

Do not use WD-40® or petroleum-based lubricant on bulkhead connectors. It will cause damage to the rubber.
Damaged connectors can cause a loss of data and additional costs for service.

Damaged connectors can cause damage to the sensor and make it unserviceable.

Use silicone-based lubricants only.

Examine, clean, and lubricate bulkhead connectors at regular intervals. Connectors that are not lubricated increase the damage to the rubber that seals the connector contacts. The incorrect lubricant will cause the failure of the bulkhead connector.

1. Apply isopropyl alcohol (IPA) as a spray or with a nylon brush or lint-free swab or wipes to clean the contacts.
2. Flush with additional IPA.
3. Shake the socket ends and wipe the pins of the connectors to remove the IPA.
4. Blow air into the sockets and on the pins to make sure they are dry.
5. Use a flashlight and a magnifying glass to look for:

Any corrosion.		
Cracks, scratches, or other damage on the rubber pins or in the sockets.		
Separation of the rubber from the pins.		
Swelled or bulging rubber pins.		

6. Use a silicone-based lubricant on each of the contacts of the bulkhead connector. The manufacturer recommends any of the products listed below.
   - 3M™ Spray Silicone Lubricant (3M ID# 62-4678-4930-3). Make sure to let it dry.
   - Dow Corning Molykote® III Compound (DC III)
   - Dow Corning High Vacuum Grease® (DC 976 V)

- Dow Corning 4 Electrical Insulating Compound® (DC 4)
- Dow Corning Molykote 44 High Temperature Grease® (DC 44)

Use a finger to put a small quantity (approximately 1 cm in diameter) of silicone grease on the socket end of the connector and push as much of the lubricant as possible into each socket. Do not use too much lubricant, as that will prevent a good seal.

7. Connect the connectors.
8. Use a lint-free wipe to clean any unwanted lubricant from the sides of the connectors.

6.2 Examine O-rings

NOTICE

Do not use petroleum-based lubricants on O-rings. It will cause damage to the O-rings. Damaged O-rings can cause the sensor to flood and make it unserviceable.

Examine the O-rings on the sensor every time they are exposed—on the connector end flange and other parts. O-rings must be pristine. If there is any question about whether an O-ring is clean and undamaged, replace it with a new one.

1. Dry the O-rings and O-ring grooves with a lint-free cloth or tissue.
2. Examine each O-ring to make sure there is no damage, dirt, lint or hair on it.
3. Replace an O-ring if necessary.
4. Apply a small quantity of silicone-based Parker Super O Lube® or Dow Corning® high vacuum grease to each O-ring.
   - The lubricant helps the O-ring move into its groove with no twist, which can compromise the seal.
   - Do NOT use petroleum-based lubricants on any O-ring.

6.3 Replacement parts

Part number	Description	Application	Quantity
231361	Plastic temperature sensor guard	Attaches to end flange to protect temperature sensor	1
30931	O-ring, Parker 2-214 N674-70	Install in end flange groove	1
801263	MCIL4FS to DB9S I/O cable with battery snap, 2.4 m	from SBE 38 to PC	1
171398.1	MCIL4FS dummy plug and lock collar	Bulkhead connector protection	1

Section 7 Command reference

7.1 RS232 commands

Enter commands to the SBE 38 in upper- or lower-case letters and push **Enter** to send commands. The SBE 38 sends `? CMD` if an invalid command is entered.

If the sensor does not respond with an `S>` prompt when a command is sent, push **Enter** to get the `S>` prompt.

Status	
DS	show status and setup parameters. Equivalent to **Status** on the software toolbar
Note:	if the voltage is below 6.5 volts, the display shows `WARNING: LOW BATTERY VOLTAGE!!`

Setup	
Interface=x	x=232: RS232 interface x=485: RS485 interface
Baud=x	x= baud rate, default 9600. Supported rates: 1200, 2400, 4800, 9600, 19200, 38400
Format=x	x=C: transmit converted data, °C x=R: transmit raw data, counts
Digits=x	x= the number of digits, 0–6, to the right of the decimal point for converted data. Applies only if **Format=C**
NAvg=x	x= A/D cycles to average per sample, 1–127
AutoRun=x	x=N or 1: wait for command when power is supplied x=Y or 0: start continuous data collection automatically when power is supplied
Notes:	• The baud rate sent to the SBE 38 must agree with the Seaterm software rate. • The SBE 38 transmits data *after* it completes the previous and before it starts the next sample. • To start data collection immediately after **AutoRun=Y** is sent, turn power off, then on again, or send **Go**.

Data collection	
Go	start continuous data collection now
Start **StartNow**	start data collection
Stop	stop continuous data collection push **Enter** to get the `S>` prompt, then enter **Stop**
TS	take one sample and transmit data
TSR	take one raw (counts) sample
TH	take one sample and hold data in the buffer
SH	transmit data from the buffer
SL	transmit data from last sample from the buffer
SLT	transmit data from last sample from the buffer, then take one new sample and hold data in buffer
Notes:	• To capture real-time data to a file, select **Capture** on the toolbar in the software and enter a file name. Do this **before** you start data collection. • If the voltage drops below 6.5 volts for ten consecutive scans during data collection, the SBE 38 stops and sets the status to `low battery`. • It may be necessary to send **Stop** several times to get a response from the SBE 38.

Coefficients	
DC	show calibration coefficients

CalDate=S	S=temperature calibration date
A0=F	F=temperature A0
A1=F	F=temperature A1
A2=F	F=temperature A2
A3=F	F=temperature A3
Slope=F	F=temperature slope, default 1.0
Offset=F	F=temperature offset, default 0.0
F= floating point number. S= string with no spaces. The date shown is the date the calibration date. Calibration coefficients are set by the manufacturer and should be the same as the values on the Calibration Certificate for the SBE 38.	

7.2 RS485 commands

It may be necessary to enter @@ before all commands to make sure the buffer is clear. For example, `S>@@#01DS`.

Global	
TxDelay=x	x= delay after the SBE 38 transmits a response until the transmitter is disabled, 1–500 milliseconds Default 25
RxDelay=x	x= delay after the SBE 38 receives a command until the transmitter is enabled, 1–500 milliseconds Default 25
GData	command all SBE 38s to take one sample and hold the data in the buffer until they receive **DATAii, SH, SL, SLT**, if **#iiIDReq=N**, or **#iiSH, #iiSL,#iiSLT**, if **IDReq=Y**
AData	see above. **GData** and **AData** are the same, included for compatibility with RS485 MicroCATS

Get Data	
Dataii	transmit data from SBE38 with ID = ii, 0–99, when a **GData** or **AData** command was sent

ID Required	
IDReq=Y	use **#ii**, 0–99, before commands to individual sensors. Use this setting for systems with multiple RS485 sensors on one pair of wires. **IDReq=Y** does not require **#ii** but subsequent commands to any sensor *do* require **#ii**
#iiIDReq=N	do not use **#ii** before a command to a single sensor. use this setting when there is only one SBE 38 **IDReq=N** does require **#ii** but subsequent commands to any sensor *do not* require **#ii**

ID (used when only on SBE 38 is online)	
ID?	show SBE38 ID, where ID = ii, and ii is 0–99, and whether ID is required before commands to a single sensor
***ID=ii**	set the SBE 38 ID to ii, 0–99. Send ***ID=** two times because the SBE 38 requests verification **if there is more than one RS485 sensor online when this command is sent, all sensors online will be set to the same ID**

Do not set **AutoRun=Y** on a system with more than one RS485 SBE 38 on a pair of wires. Only one sensor at a time can transmit data in real-time on the RS485 interface.

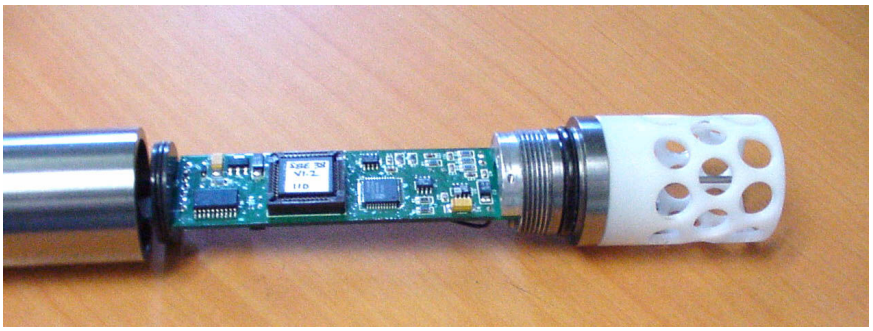
Do not send **Go** to more than one RS485 sensor. The system cannot transmit a command to one SBE 38 at the same time another sensor transmits real-time data.

To collect data continuously: if **AutoRun=Y** or **Go** is used, **set NAvg= to a value greater than or equal to 30.**

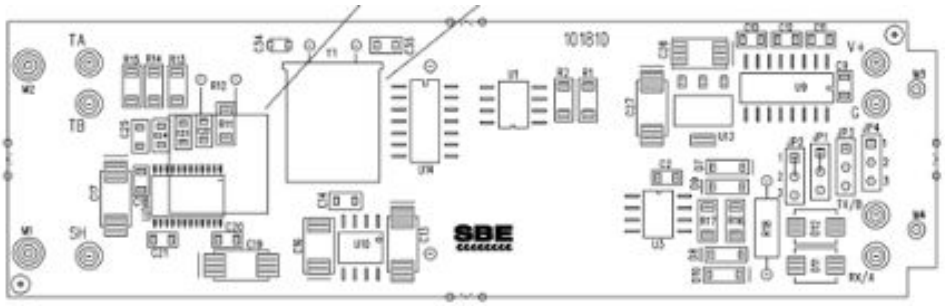
Section 8 Change interface

The SBE 38 ships from the manufacturer with a user-specified RS232 or RS485 interface. Do the steps below to change RS232 to RS485, or RS485 to RS232.

1. Make sure that the sensor is dry and remove any water that may be in the seam between the pressure housing and the end flange.
2. Unscrew the end flange.
3. Pull the end flange out of the pressure housing.



4. Remove any water from the O-ring and connection surfaces inside the housing with a lint-free cloth or tissue.
5. Examine the O-ring to make sure there is no damage or contamination.
6. Change the jumper settings:
   - Pin 2 (black) to RS232 RX and RS485A
   - Pin 3 (green) to RS232 TX and RS485B



	JP1	JP2	JP3	JP4
RS232	1-2	1-2	1-2	1-2
RS485	N/A	N/A	2-3	2-3

JP1-JP2: PCB trace connection across pins 1-2. Must be cut before pins 2-3 are jumpered. For RS485, the JP1 and JP2 setting does not have an effect on the output.

7. Replace the desiccant bag.
8. Make sure that O-ring and connection surface are dry and the O-ring is pristine. If there is any question, replace the Parker 2-214 O-ring.
9. Apply a light coat of lubricant to the O-ring.
   The manufacturer recommends silicone-based Parker Super O-lube™.
10. Carefully put the electronics into the pressure housing again.
11. Screw the end flange into the pressure housing.
12. If possible, use dry gas such as Argon to fill the electronics housing.
    This helps to prevent condensation.
13. If it is not possible to fill the SBE 38 with dry gas, wait at least 24 hours to deploy the SBE 38 so the desiccant removes any moisture inside the sensor.

Section 9 General information

Revised editions of this user manual are on the manufacturer's website.

9.1 Warranty

Refer to the manufacturer's website for warranty information (seabird.com/warranty).

9.2 Service and support

The manufacturer recommends that sensors be sent back to the manufacturer annually to be cleaned, calibrated, and for standard maintenance.
Refer to the website for FAQs and technical notes, or contact the manufacturer for support at support@seabird.com. Do the steps below to send a sensor back to the manufacturer.

1. Complete the online Return Merchandise Authorization (RMA) form or contact the manufacturer.
   Note: *The manufacturer is not responsible for damage to the sensor during return shipment.*
2. Remove all anti-fouling treatments and devices.
   Note: *The manufacturer will not accept sensors that have been treated with anti-fouling compounds for service or repair. This includes AF 24173 devices, tri-butyl tin, marine anti-fouling paint, ablative coatings, etc.*
3. Use the sensor's original ruggedized shipping case to send the sensor back to the manufacturer.
4. Write the RMA number on the outside of the shipping case and on the packing list.
5. Use 3rd-day air to ship the sensor back to the manufacturer. Do not use ground shipping.
6. The manufacturer will supply all replacement parts and labor and pay to send the sensor back to the user via 3rd-day air shipping.

Sea-Bird Electronics
13431 NE 20th Street
Bellevue WA 98005 U.S.A.
(425) 643-9866