



SEA-BIRD
SCIENTIFIC

User manual

SBE 21 SeaCAT Thermosalinograph

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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 or 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: Hazardous material exists over the threshold of GB/T 26572.2011. The number in the center of the symbol is the Environmentally Friendly Use Period as specified by SJ/T 11364-2014, China's marking for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products. This product should be recycled after its environmentally friendly use period.

Section 2 SBE 21 SeaCAT TSG quick start guide

This quick start guide gives the steps necessary to make sure that the SBE 21 SeaCAT Thermosalinograph sensor operates correctly and collects data before it is deployed.

What's in the box:

- SBE 21
 - Navigation and Interface Box and power cord
 - Conductivity cell cleaning kit
 - Spare parts kit
 - DB9-to-RS232 cable
 - I/O cable
 - CD or USB drive—has software, calibration files, documentation.
1. Install the SBE 21 in the hull of the ship.
Refer to [Install SeaCAT system](#) on page 11 for details.
 2. Set up the sensor for deployment.
Refer to [Set up system and verify functionality](#) on page 15 for details.
 3. Maintain the SBE 21 after each use and before it is put into storage.
Refer to [Maintenance](#) on page 27 for details.

Section 3 Specifications

3.1 Electrical

| | |
|-------------------|--|
| Input | 9–14 VDC |
| Real-time clock | 32,678 Hz TCXO accurate to ± 1 minute per year |
| Auxiliary sensors | Auxiliary power out: up to 500 mA @ 10.5–11 VDC; Input range: 0–5 VDC A/D resolution: 12 bits |

3.2 Communications

| | |
|-----------------------------|--|
| Communication interface | RS232 |
| Data collection rate | 4 Hz; 3–600 seconds, user-programmable |
| Memory | 64 MB non-volatile flash |
| Firmware versions | 5.0 and newer; Interface Box 3.1b; optional SBE 38 1.4 and newer |
| Data size per sample, bytes | |
| Temperature | 3 |
| Conductivity | 3 |
| Each external voltage | 2 |
| SBE 38 | 3 |

3.3 Analytical

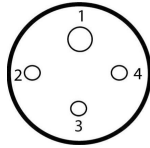
| Parameter | Range | Accuracy | Resolution | Calibration range |
|------------------------|----------|-------------|------------|-------------------|
| Conductivity, S/m | 0–7 | ± 0.001 | 0.0001 | 0–7 |
| Temperature, °C | -5 to 35 | ± 0.01 | 0.001 | 1–32 |
| SBE 38 temperature, °C | — | ± 0.001 | 0.0003 | -1 to 32 |

3.4 Mechanical

| | |
|----------------------------------|------------------------|
| Maximum safe pressure to operate | 34.5 decibars (50 psi) |
| Weight | 4.1 kg |
| Recommended flow rate | 1 liter/second |
| Pressure housing | PVC |

3.4.1 Bulkhead connector

Table 1 SBE 38

| Contact | Function | XSG4BCL-HP-SS |
|---------|------------|---|
| 1 | Ground |  |
| 2 | RS232 TX | |
| 3 | RS232 RX | |
| 4 | Voltage in | |

The I/O connector is counter-clockwise from the SBE 38 connector. Do not connect the I/O cable to the SBE 38 connector.

Specifications

Table 2 I/O connector, power and communications

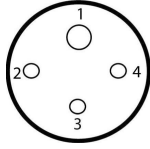
| Contact | Function | XSG4BCL-HP-SS |
|---------|------------|---|
| 1 | Ground |  |
| 2 | RS232 RX | |
| 3 | RS232 TX | |
| 4 | Voltage in | |

Table 3 Single-ended A/D inputs

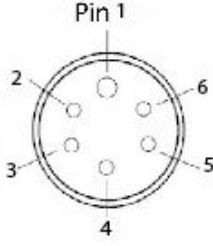
| Contact | Function | AG306-HP-SS |
|---------|--------------------|---|
| 1 | Ground |  |
| 2 | External voltage 0 | |
| 3 | External voltage 3 | |
| 4 | External voltage 1 | |
| 5 | External voltage 2 | |
| 6 | Voltage out | |

Table 4 Differential A/D inputs

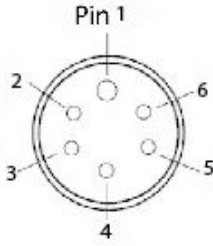
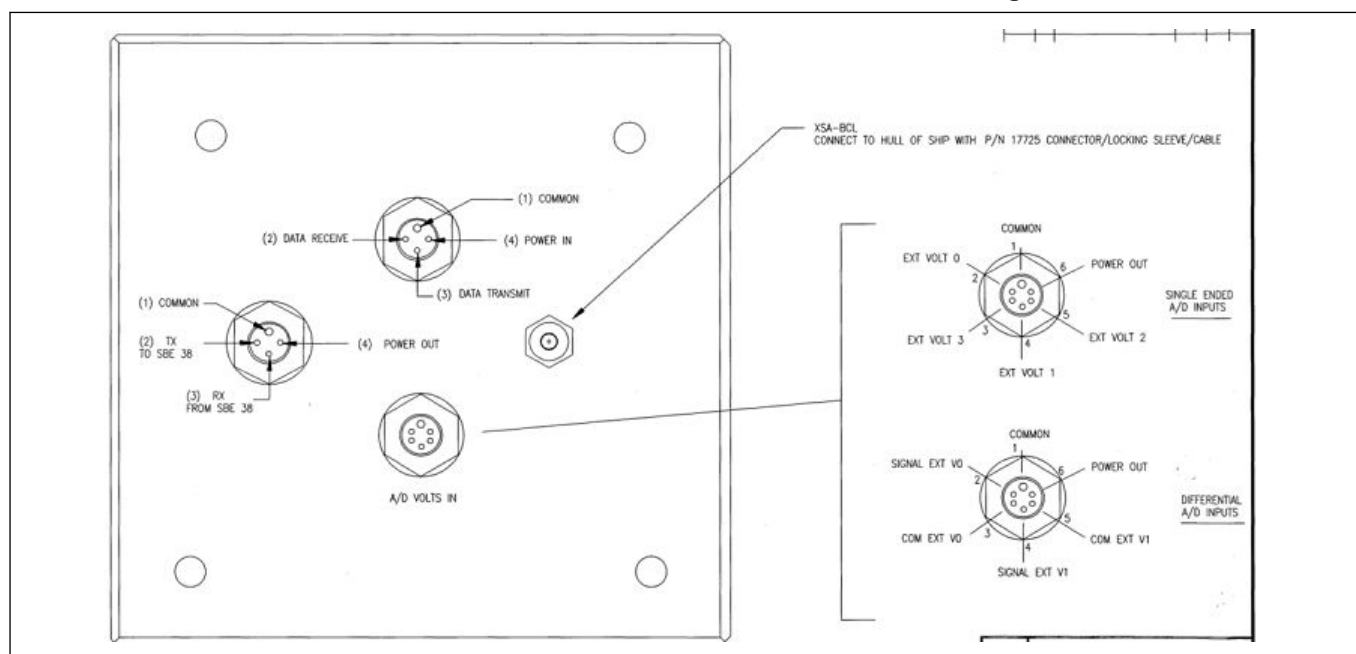
| Contact | Function | AG306-HP-SS |
|---------|---------------------------|--|
| 1 | Ground |  |
| 2 | Signal external voltage 0 | |
| 3 | Comm external voltage 0 | |
| 4 | Signal external voltage 1 | |
| 5 | Comm external voltage 0 | |
| 6 | Voltage out | |

Table 5 Location of bulkhead connectors on end flange



Section 4 System description

The SBE 21 SeaCAT thermosalinograph (TSG) is an externally powered, high-accuracy, conductivity and temperature monitor to be used on ships.

The SeaCAT TSG connects to the Navigation Interface Box (PN 90488.2S), an AC-powered unit that supplies isolated DC power and an RS232 data interface to the TSG. The Interface Box also supplies power and an NMEA 0183 device. Data from an (optional) NMEA device is appended to the SBE 21 data. The Seasave software supports data collection from an NMEA device connected directly to the PC as an alternative to the Interface Box.

Proximity effects are prevented by the internal-field geometry of the platinum-electrode glass conductivity cell. This is important for thermosalinographs because the cell must operate in the confined volume of the water jacket.

The PVC base or back plate can be drilled to attach to the ship. The connectors are standard PVC pipes with 1-inch standard NPT threads. The manufacturer supplies female fittings that can easily be adapted to locally available pipe sizes.

Real-time data is transmitted over an internal three-wire RS232C link. Communication settings are 4800 baud, 7 data bits, 1 stop bit, and even parity. Commands to the SBE 21 include show status, set up data collection, transmit data, and diagnostic tests. The output format is raw hexadecimal data. The user can choose either Continuous or Pre-programmed data collection:

- Continuous at 4 Hz: At pre-programmed intervals from between 3 and 600 seconds, the SBE 21 averages all of the data within the sample interval, saves that value in memory, and transmits it to the PC through the Interface Box.
- Pre-programmed: at pre-programmed intervals from between 3 and 600 seconds, the SBE 21 collects one sample, saves that value in memory, and transmits it to the PC through the Interface Box.

The SBE 21 can record the output of an optional SBE 38 remote temperature sensor, so sea surface temperature can be measured with minimum thermal contamination from the hull of the ship. A stainless steel and plastic inline pipe attachment is available to safely install the remote temperature sensor below the waterline.

4.1 Optional remote temperature sensor

The optional Interface Box can append the output of an optional SBE 38 temperature sensor to the data from the SeaCAT TSG. Place the remote temperature sensor in a location that gives an accurate measurement of the sea surface water temperature. The best location for the remote sensor is at the seawater intake, before the pump, near the bow of the ship. This decreases contamination of the surface temperature caused by the ship's thermal mass.

Use the data from the temperature sensor on the SeaCAT TSG, not the SBE 38, to calculate salinity. Since conductivity has a strong thermal coefficient, it is important to know the temperature of the water when the conductivity sensor measures it to correctly calculate salinity. On a typical installation there may be 20–30 meters of plumbing between the remote temperature sensor and the SeaCAT TSG, which causes the temperature to change, so that the data from the remote temperature sensor is not accurate when the water gets to the conductivity sensor.

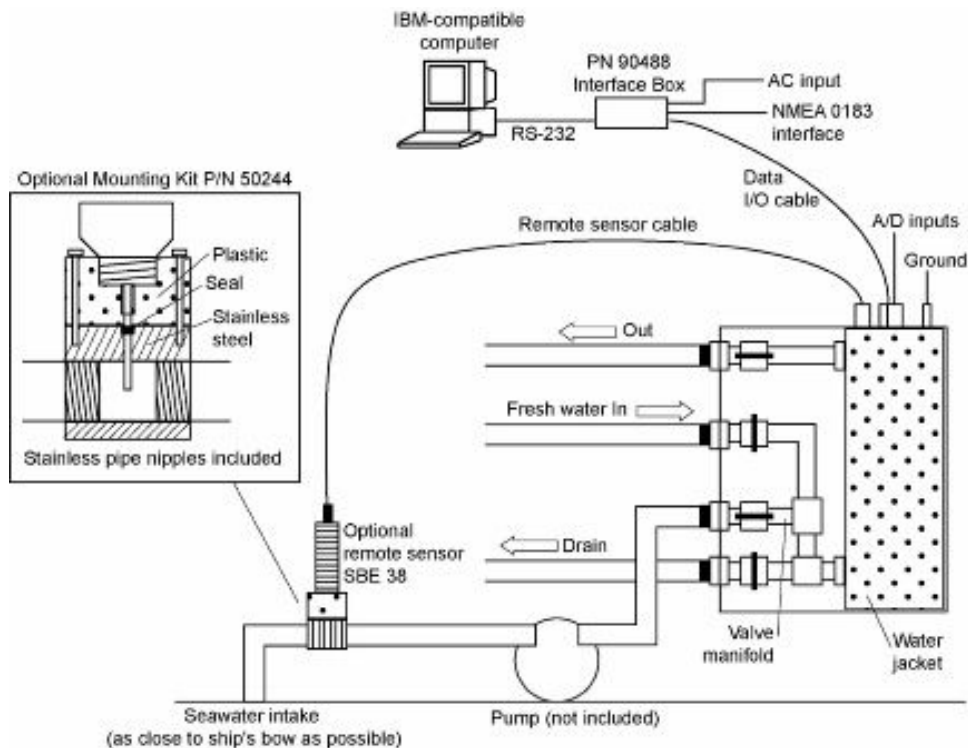
Use the remote temperature sensor to report only the surface temperature, and to calculate density and sound velocity.

Section 5 Install SeaCAT system

5.1 System schematic and guidelines to install

The SeaCAT shipment includes the Navigation Interface Box. If the system is tested without the Interface Box, supply 9–14 VDC power.

5.1.1 System schematic



5.1.2 Guidelines to install SBE 21

Because each ship and installation is different, the manufacturer gives guidelines as an alternative to instructions to install the SBE 21. The SBE 21 should be installed by qualified shipfitters, with oversight by a competent ship designer or naval architect.

Points to think about:

Location

- The SBE 21 can be installed anywhere it will fit and can easily be accessed for maintenance.
- Install the SBE 21 above the water line for safety. If no remote temperature sensor is used, install the SBE 21 as close to the seawater intake as possible. If a remote temperature sensor is used the SBE 21 can be installed in the laboratory of the ship or other convenient location.
- Cable routing should stay away from electric motors, generators, and other sources of noise. Cables over 3 meters should be installed by an electrician inside a grounded metal conduit. The maximum cable length from the SBE 21 to the Interface Box is 100 meters.
- If possible, install the optional SBE 38 remote temperature sensor outside the hull in the remote sensor installation kit, which has 1-inch pipe threads on each end. Install the SBE 38 kit as close to the seawater intake as possible, and before the pump, near the bow of the ship. Since this installation is below the water line, speak with the engineer or naval architect of the ship or with the shipyard about the actual installation.
- The SBE 21 can record voltage data from up to four auxiliary sensors.
 - Make sure to install the sensors in a flow-through chamber that receives the outflow from the SBE 21.

Install SeaCAT system

- Design the flow-through chamber so that sensors can be removed and replaced for service and calibration.
- Protect the auxiliary sensors from biofouling.

Pump

- The manufacturer does not recommend or supply a specific pump.
- A pump must supply 1 L/second.
- The SBE 21 is limited to 34.5 decibars (50 psi) of pressure.
- Bubbles in the plumbing of a flow-through system are common and will cause "noisy" salinity data. Keep bubbles to a minimum: use the pump below the water line to push, not lift, water. Keep the SeaCAT intake as far as possible from bow wake, propellers, and other sources of bubbles.
- It may be necessary to install a de-bubbler, but that device can cause temperature errors for the primary temperature sensor. A de-bubbler may be required for best quality salinity data. Large single-point salinity spikes can be removed with the Wild Edit module in the SBE Data Processing software.

5.2 Install system hardware

Install the SBE 21 at the selected location. Make sure that the bulkhead connectors are at the top, provide 22 inches of clearance at the top to remove the sensor and electronics module from the water jacket. Use machine bolts to attach the PVC base or the backplate to the ship.

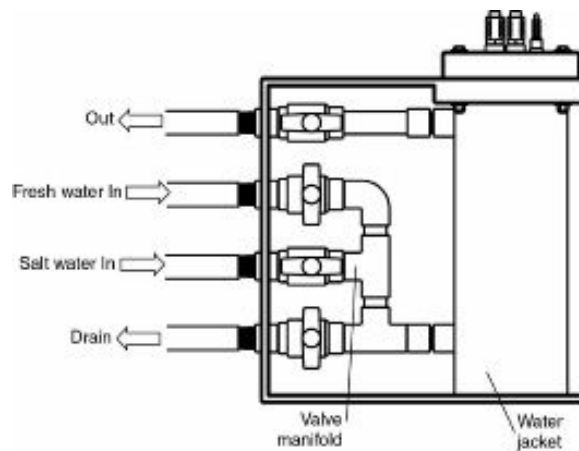
1. Install the pipe connections to the SBE 21. The connectors are 1-inch National (USA) threads.

The manufacturer supplies fittings and glue to connect to the PVC plastic pipe. They can be changed if necessary to use plumbing that is already installed.



2. Connect the "Out" fitting to the shipboard drain or to the low-pressure side of the saltwater supply.
3. Connect the "Fresh water In" fitting to the shipboard fresh water supply.
4. Connect the "Salt water In" fitting to the shipboard sea surface water intake line.
5. Connect the "Drain" fitting to the shipboard drain.
6. Set the valves as shown below.
The valve is open when the handle is horizontal, and closed when the handle is vertical.

| Valve | Normal use | Fresh water flush | Store, clean, or remove modules |
|----------------|------------|-------------------|---------------------------------|
| Out | Open | Open | Closed |
| Fresh water in | Closed | Open | Closed |
| Salt water in | Open | Closed | Closed |
| Drain | Closed | Closed | Closed |



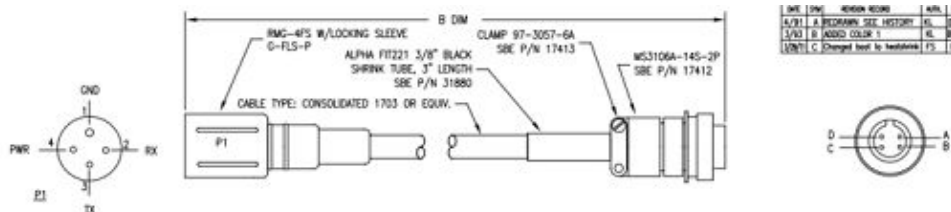
5.3 Install electrical connections

The Interface Box is included with the SBE 21. If the SBE 21 is tested without the Interface Box, make sure to supply 9–14 VDC. The system requires three connections:

- SBE 21 to Interface Box
- SBE 21 to power ground and auxiliary sensors
- Interface Box to PC

5.3.1 Connect the SBE 21 to the Interface Box

1. Install the Interface Box near the PC.
If the distance between the SBE 21 and the Interface Box is longer than the manufacturer-supplied 10 meter cable, cut this cable and splice it into the ship's cable. The ship's cable should have three conductors, with at least the RS232 TX and RX shielded, in case of EM interference.



2. Unscrew the lock collar from the 4-contact I/O connector.
3. Remove the dummy plug from the I/O connector.
4. Lightly lubricate the inside of the cable connector with DC-4 or equivalent silicone grease.
5. Attach the cable connector to the SBE 21: gently squeeze the top of the connector to remove any trapped air.
6. Attach the lock collar again to finger-tight only.
7. Connect the MS-style metal shell connector on the I/O cable to "SBE 21" on the Interface Box.

5.3.2 Connect the SBE 21 to ground and auxiliary sensors

1. Connect the SBE 21 1-contact ground connector to the ship's ground.
2. Optional: install the cable between the SBE 21 and the SBE 39 Remote Temperature Sensor.
3. Optional: install the cable(s) for the auxiliary sensors. Refer to [Bulkhead connector](#) on page 7 for details.

5.3.3 Connect the Interface Box to the PC

1. Connect the DB9S to DB9P cable to the SERIAL connector on the Interface Box and to the PC.
2. Connect the UL/IEC-approved power cord to the "AC Input" connector on the Interface Box and to a standard 3-prong (grounded) AC outlet.
3. Optional: connect the 5-contact MS connector on the Interface Box to an NMEA device.

The MS3106A14S-5P pinouts:

| Interface Box | Function |
|---------------|---|
| Pin A | Optional power return |
| Pin B | NMEA A, signal |
| Pin C | NMEA B, signal return |
| Pin D | No connect |
| Pin E | Optional +12 DC power out, up to 2 amps |

Section 6 Set up system and verify functionality

6.1 Install software

Make sure that the sensor is connected to the PC through the serial connector on the supplied cable.

1. Install the Seasoftware V2 software from the manufacturer-supplied CD.
2. Double-click on **SeatermV2.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 but will try others if necessary. The software automatically looks for the serial port number of the connected sensor.
 - It is also possible to send direct commands from a terminal program such as Tera Term or HyperTerm.
3. At the **Instruments** menu item, select the connected sensor.
4. Push **OK** to close this window.
The main window opens. The menus and toolbars are at the top. The large area below them shows commands and the responses from the sensor to those commands.

6.2 Set up and test communication

The user can use the manufacturer-supplied software or a terminal emulator such as Tera Term to communicate with the SBE 21.

1. If necessary, connect the SBE 21 to the Interface Box.
2. If necessary, connect the Interface Box to the PC.
3. Start the software.
4. From the **Configure** menu, select *SBE 21*.
The Seaterm software opens.

Table 6 Toolbar menu buttons

| Description | Command |
|--|---|
| Connect enables communication with the sensor | Enter key |
| Status shows the current settings | DS |
| Headers shows the header number, date and time, first and last sample, and sample interval. A new header is made at the start of data collection and every subsequent 10,000 scans. | DH |
| Init Log sets data pointers and cast numbers. Use this command AFTER stored data has been transmitted from the SBE 21. | IL |
| Capture captures sensor response on the screen to a file with a .cap extension. Push Capture again to turn off this function. | — |
| Upload transmits stored data. Use a .hex file format. First use the Configure menu to configure upload and header parameters and send QL to stop data collection. | DD Upload to the SBE Data Processing software |
| Diagnostics will do tests of the SBE 21. Tests with this command do not overwrite any current settings. | DS, FR, VR |
| Stop will end any current operation | Esc key or Ctrl C |
| Disconnect the sensor so the COM port on the PC is available again | — |

5. Change any settings in the **SBE 21 Configuration Options** window.
 - a. Select the applicable COM port.
 - b. Baud rate: 9600 is default.

Set up system and verify functionality

- c. Data bits: 7.
 - d. Parity: even.
 - e. Mode: RS232 Full Duplex.
 - f. Push **OK** to save the settings.
6. Turn on power to the Interface Box.
The red PWR LED shows. The display shows:
Interface box V 3.1b setup:
PC baud rate = 9600
SEACAT baud rate = 4800
7 data bits, even parity
NMEA baud rate = 4800
start mode = Echo characters to and from the instrument NMEA
message to decode = GGA, GLL, RMA, TRF, DBT, DPT
Press @ to change the interface box setup
This shows that the Interface Box and the PC communicate correctly. If the system does not show the above, make sure the SBE 21 was selected in the Configure menu and that the settings were entered correctly. Make sure that the Interface Box and PC are connected correctly.
7. If necessary, enter @ to open the **Setup** menu.
The display looks like this:
Interface Box set up menu:
Modes:
 1. Echo characters to and from the instrument
 2. Add Lat/Lon to the real-time HEX data from the instrument
 3. Transmit Lat/Lon only**Options:**
 4. Add NMEA Depth to the real-time HEX/Lat/Lon data
 5. Do not add NMEA Depth to the real-time HEX/Lat/Lon data**Communications:**
 6. Change communication settings and start mode
 7. Display communication settings and start mode**Diagnostics:**
 8. Enable diagnostic level 1
 9. Enable diagnostic level 2the current mode = 1. Echo characters to and from the instrument
enter 1, 2, 3, 4, 5, 6, 7, 8, or 9 followed by Enter, or press @ to exit the set up menu
selection =
8. Enter 1 then push **Enter**.
The display shows the current mode as 1. This mode is required to communicate with the SBE 21 for setup.
9. Enter @ to exit the **Setup** menu.
10. Select **Connect** or push **Enter** several times.
If **Connect** was selected, the display shows:
*ds
sc21, 4300, 5.0a, 0, 0, 6, N

4300 is the SBE 21 serial number. 5.0a is the firmware version. 0 is the number of samples in memory. 0 is the number of headers in memory. 6 is the number of bytes in each scan. N is not logging.

If the system does not respond, 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.

- 11. Select **Status** on the toolbar to see the SBE 21 status information:**

```
SEACAT THERMOSALINOGRAPH V5.0a SERIAL NO.  
4300 12/15/2009 14:23:14  
  
ioper = 50.7 ma, vmain = 11.4, vlith = 8.8  
samples = 0, free = 1096637  
sample interval = 5 seconds, no. of volts sampled = 0  
output format = SBE21  
start sampling when power on = no  
average data during sample interval = yes  
logging data = no  
voltage cutoff = 7.5 volts
```

- 12. Enter **TS** then push **Enter** to take a sample.**

If the settings above are used:

```
23.7658, 0.00019
```

where 23.7658 = temperature in °C, and 0.00019 is conductivity in S/m. This value should be approximately the ambient temperature.

- 13. If the status response shows that data collection is on, push **Enter** and send **QL**. It may be necessary to send **QL** several times to stop the SBE 21.**

```
ql
```

```
logging stopped, stop command
```

- 14. Enter **TS**, then push **Enter** to take a sample.**

The display looks like this if output format=SBE 21, number of volts sampled=0, and there is no external temperature sensor:

```
78610428
```

```
7861 = raw hex temperature data
```

```
0428 = raw hex conductivity data
```

- 15. Set up the SBE 21 with the necessary settings.**

- 16. Enter **QS**, then **Enter** to command the SBE 21 into a low power "sleep" mode.**

- 17. Turn off power to the Interface Box.**

6.3 Set up communications parameters in Interface Box

The Interface Box is shipped with default settings that are compatible with the SBE 21:

- 9600 baud, Interface Box to PC
- 4800 baud, SBE 21 to Interface Box
- 7 data bits, even parity, SBE 21 to Interface Box and Interface Box to PC
- 4800 baud, NMEA device to Interface Box.

The baud rate between the Interface Box and PC must be equal to or higher than the baud rate between the SBE 21 and the Interface Box.

6.4 Set up the NMEA interface

The Navigation Interface Box has an NMEA 0183 interface that merges NMEA data of latitude, longitude, and depth with the SBE 21 data. Data is transmitted at 4800 or 9600 baud, 8 data bits, no parity, and one stop bit.

NMEA data is appended to the SBE 21 data and transmitted to a PC. The yellow "TX NMEA" LED flashes each time a NMEA message is received, which should be at the same rate that the NMEA device transmits data. For example, if the NMEA device transmits a message once every 5 seconds, The yellow LED flashes every 5 seconds and the same message is appended to each scan of SBE 21 data within those 5 seconds.

6.4.1 NMEA operation modes

The Interface Box has three operation modes, two diagnostic modes and two NMEA depth options, in addition to options to set up and show communications parameters and startup procedures. Select the mode in the setup menu of the Seaterm software.

Use the @ character to open and close the setup menu. To use the diagnostic modes, put the Interface Box in Mode 3, then enter either 8 or 9 at the mode selection prompt. To close the diagnostic mode, turn off power to the Interface Box.

| Type | Mode | Description |
|--|--|---|
| Operation | 1. echo only | Characters to and from the SBE 21 pass through the Interface Box. Not NMEA data is transmitted. Useful to set up the SBE 21. |
| | 2. add Lat/Lon to hex data | Seven bytes of hex latitude/longitude data is added to each line of hex data from SBE 21. Used when position data is required with SBE 21 data. |
| | 3. transmit Lat/Lon only | Data from SBE 21 is not transmitted. Hex latitude/longitude data is converted to ASCII text whenever a new position is transmitted from the NMEA device. If NMEA message RMC is decoded the data and time show on the next line (DDMMYY HHMMSS) |
| NMEA depth options | 4. add NMEA depth to real-time hex and Lat/Lon data | Three bytes of depth data is added to each line of hex data from the SBE 21, after Lat/Lon data. |
| | 5. do not add NMEA depth to real-time hex and Lat/Lon data | NMEA depth data is not added. |
| Communication settings and start modes | 6. change communications settings and start mode | Set baud rates, data bits, and parity, NMEA baud rate and start mode when Interface Box starts in Mode 1 or 2 or when power is supplied. |
| | 7. show communications settings and start mode | Show the settings that were entered in mode 6. |
| Diagnostic | 8. transmit raw NMEA message only | All NMEA messages are transmitted to the PC in raw form. |
| | 9. transmit decoded NMEA message | All NMEA messages are transmitted are decoded by the Interface Box and show on the PC. If Mode 8, then Mode 9 are selected, the Interface Box transmits raw data, then decoded data. |

6.4.2 Set up and test NMEA

After the NMEA device, Interface Box, PC, and SBE 21 are connected, start the Seaterm software. If necessary, do steps 1—4 in [Set up and test communication](#) on page 15.

1. Turn on power to the Interface Box. The display shows:

```
Interface box V 3.1b setup:
```

```
PC baud rate = 9600
```

```
SEACAT baud rate = 4800
```

```
7 data bits, even parity
```

NMEA baud rate = 4800
start mode = echo characters to and from the instrument
NMEA message to decode = GCA, GLL, RMA, RMC, TRF, DBT, DPT
Press @ to change the interface box setup

2. Enter @ to open the setup menu. The display shows:

Interface Box set up menu:

Modes:

1. Echo characters to and from the instrument
2. Add Lat/Lon to the real-time hex data from the instrument
3. Transmit Lat/Lon only

Options:

4. Add NMEA Depth to the real-time hex/Lat/Lon data
5. Do not add NMEA Depth to the real-time hex/Lat/Lon data

Communications

6. Change communication settings and start mode
7. Display communication settings and start mode

Diagnostics:

8. enable diagnostic level 1
9. enable diagnostic level 2

the current mode = 1. Echo characters to and from the instrument

Enter 1, 2, 3, 4, 5, 6, 7, 8, or 9 followed by Enter, or press @ to exit the set up menu

selection =

3. If the NMEA baud rate in the message in Step 2 does not agree with the NMEA device, enter 6 then push **Enter to change communications settings. The display shows:**

PC baud rate = X, new value = (enter a value, then push **Enter**)

SEACAT baud rate = X, new value = (enter a value, then push **Enter**)

parity = X, new value = even parity or no parity [e/n] (enter e or n, then push **Enter**)

NMEA baud rate = X, new value = (enter a value, then push **Enter**)

Start mode = X, new value = echo or add Lat/Lon [e/a] (enter e or a, then push **Enter**)

The display shows the new selections. Enter @ to go back to the setup menu.

4. Enter 3, then push **Enter to change to mode 3. The display shows:**

Interface Box set up menu:

Modes:

1. Echo characters to and from the instrument
2. Add Lat/Lon to the real-time hex data from the instrument
3. Transmit Lat/Lon only

Options:

4. Add NMEA Depth to the real-time hex/Lat/Lon data
5. Do not add NMEA Depth to the real-time hex/Lat/Lon data

Communications

6. Change communication settings and start mode
7. Display communication settings and start mode

Set up system and verify functionality

Diagnostics:

8. enable diagnostic level 1

9. enable diagnostic level 2

the current mode = 3. Transmit Lat/Lon only

Enter 1, 2, 3, 4, 5, 6, 7, 8, or 9 followed by Enter, or press @ to exit the set up menu

selection =

5. Enter @ to close the setup menu.
Position data shows in Seaterm. Each time position data is received, the yellow "TX NMEA" LED flashes. If the data is correct and is updated correctly, the Interface Box works.
6. Turn off power to the Interface Box.

Section 7 Operation

7.1 Configure and set up system for deployment

Make sure that the **.xmlcon** or **.con** configuration file agrees with the SBE 21 configuration. This file defines the system—the auxiliary sensors, channels, serial numbers, and calibration dates and coefficients. The Seasave and SBE Data Processing software use the configuration file to process the raw data. Make sure to update the file if the configuration is changed or a sensor is recalibrated, or the software will not correctly read and process raw data.

1. Start the Seasave software.
2. Select **Configure Inputs...** menu.
3. Push **Open** on the *Instrument Configuration* tab.
4. Select either the **.xmlcon** or the **.con** file, then push **Open**.
 - a. "Remote temperature": if an SBE 38 is connected, select that sensor.
 - b. "External voltage channels" must agree with the SBE 21 setup for SV=.
 - c. "Sample interval seconds" must agree with SI= in the SBE 21 setup.
 - d. **NMEA**: Select if NMEA device is used, connected either to the Interface Box or PC.
 - e. "Scan time added": Select for the software to append the time to each data scan. This is seconds since 1/1/1970 GMT.
 - f. **Channel, Sensor** area:
 - Sensors with shaded backgrounds cannot be changed.
 - Select **New** to make a new **.xmlcon** or **.con** file for the CTD.
 - Select **Open** to see a different configuration file.
 - Push **Select** to change a (non-shaded) sensor. A dialog box with a list of sensors shows, then the calibration coefficients show. Select the sensors after the number of voltage and frequency channels have been specified above.
 - Push **Modify** to see or change the calibration coefficients for the selected sensor.
 - Push **Save** or **Save As** to save any changes made to calibration coefficients.
5. Push **Exit** to close the Configuration window.
6. Verify that the hardware and external fittings are attached correctly.

7.2 Data storage

The SBE 21 has 64 MB of flash data storage. Note that when the memory is full, the SBE 21 will continue to collect and transmit data, but it will not be stored because the SBE 21 does not write over data in memory. Two examples of capacity are given below.

| No auxiliary sensors | Four auxiliary sensors and an SBE 38 |
|--|--|
| Temperature = 3 bytes/sample | Temperature = 3 bytes/sample |
| Conductivity = 3 bytes/sample | Conductivity = 3 bytes/sample |
| Memory = 64,000,000 samples | Auxiliary sensors = 2 bytes/sample/sensor |
| $64,000,000 \div 6 \text{ bytes} = 10,666,666 \text{ samples}$ | SBE 38 = 3 bytes/sample |
| | Memory = 64,000,000 samples |
| | $64,000,000 \div 17 \text{ bytes} = 3,764,705 \text{ samples}$ |

7.3 Data formats

The SBE 21 data is in raw hexadecimal format. Sensors must be enabled for the data to show. The SBE 21 always transmits an even number of voltage characters: if one or three voltage sensors are enabled, a zero is added to the data before the last voltage.

- If remote temperature and three voltages are enabled, the output format is
ttttcccrrrrr0www or
#ttttcccrrrrruuuvvv0wwwnnn

Use SBE 21 Format, F1, to use Seasave to collect real-time data or SBE Data Processing to process the data:

ttttcccrrrrruuuvvvwwwxxx

Use SBE 16 Format, F2, for custom applications:

#ttttcccrrrrruuuvvvwwwxxnnnn

Where

tttt = primary temperature

rrrr = remote temperature from the SBE38

uuu, vvv, www, xxx = voltage output from 0, 1, 2, and 3

= attention character

nnnn = lineal sample count

Data is transmitted in the order listed with no spaces or commas between parameters. The number of digits shows with each parameter. The parameter is calculated from the data as shown below. Use the decimal equivalent of the hex data in the equations.

1. Temperature frequency, Hz = $(tttt \div 19) + 2100$
2. Conductivity frequency, Hz = square root $[(cccc \times 2100) + 6250000]$
3. SBE 38 secondary temperature, if SBE38=Y. SBE 38 temperature *pseudo* frequency, Hz = $rrrr \div 256$
4. External voltage 0, if one or more external voltages are defined with SV=x. External voltage 0 = $uuuu \div 819$
5. External voltage 1, if two or more external voltages are defined with SV=x. External voltage 1 = $uuuu \div 819$
6. External voltage 2, if three or more external voltages are defined with SV=x. External voltage 2 = $uuuu \div 819$
7. External voltage 3, if four external voltages are defined with SV=x. External voltage 3 = $uuuu \div 819$

Example: SBE 21 with SBE 38 and two external voltage sensors, ttttcccrrrrruuuvvv = A80603DA1B58001F5A21

- temperature = tttt = A806 (43014 decimal); temperature frequency = $(43014 \div 19) + 2100 = 4363.89$ Hz
- conductivity = cccc = 03DA (986 decimal); conductivity frequency = square root $[986 \times 2100 + 6250000] = 2884.545$ Hz
- SBE 38 = rrrr = 1B5800 (1,792,000 decimal); temperature *pseudo* frequency, Hz = $(1,792,000 \div 256) = 7000$ Hz
- first external voltage = uuu = 1F5 (501 decimal); voltage = $501 \div 819 = 0.612$ volts
- second external voltage = vvv = A21 (2593 decimal); voltage = $2593 \div 819 = 3.166$ volts

7.4 Operate the system

The baud rate of the PC must agree with that of the Interface Box (the default is set by the manufacturer to 9600 baud).

1. Turn on power to the Interface Box.

- If AutoRun=Y, the SBE 21 automatically starts to collect and save data. Data will show in the Seasave software when it is set to start real-time data collection (below).
 - If AutoRun=N, the SBE is not set up to collect data when power is turned on. Start Seaterm and send **GL** or **RL** to start data collection, then close the software.
2. Start the Seasave software.
 3. Do any necessary setup in the **Configure Inputs**, **Configure Outputs**, and **Display** menus.
 4. In the **Real-time Data** menu, push **Start** and select the applicable options.
 - a. In the Data Archiving Options area:
 - Save data immediately.
 - Save data when the "Start Archiving" command is sent.
 - Do not save data for this cast. Real-time data will still show in the display.
 - b. Push **Select Output Data File Name** to enter a file name and location to save the data.
 - c. In the Configuration Options area, the current configuration file shows. To change input settings such as the input configuration, serial ports, TCP/IP ports and more, push **Configure Inputs**. To change output settings such as serial data, serial ports, TCP/IP ports and more, push **Configure Outputs**.
 - d. At "Timeout seconds at startup," enter the number of seconds to wait before the first scan is received. If data is not received within this time, the software will "time out" and not try to collect data.
 - e. At "Timeout in seconds between scans," enter the maximum interval between scans after the first scan is received.
 - f. "Reset deck unit to state 1 when acquisition stops" will show if the configuration file is set up to add NMEA data. Put a check in the box so that the software will set the deck unit to State 1 when data collection stops. No NMEA data is sent.
 5. Push **Start**.
 - a. If one of the options to save data is selected, and "Prompt for Header Information" is selected in the Header Form setup of the **Configure Outputs** menu, fill in any header information necessary and push **OK**.
 - b. If "NMEA position data added" is selected in the configuration file, the software starts NMEA communications. The software automatically sends a command to put the Interface Box in one of three modes from the setup chosen in the SBE 21 configuration file:
 Mode 1—do not transmit NMEA data
 Mode 2—Append position data to SBE 21 data
 Mode 2 with Option 4—append NMEA position and depth data to CTD data.
 - c. If "Check Scan Length" is selected in the **Options** menu, the software verifies that the scan length specified in the configuration file agree with the SBE 21. If a "Scan length error" shows, verify—
 - the correct configuration file is used.
 - the configuration file has been updated as necessary to show the correct number and type of sensors.
 - d. The software sends "Waiting for data" and will time out if data is not received within the specified seconds at "Timeout in seconds at startup."
 - e. Data starts to show on the screen display.
 6. Push **Stop** in the **Real-time Data** menu to stop data collection.
 7. Close the Seasave software.
 8. Start the Seaterm software.

9. Push the **Enter** key several times to start communications with the SBE 21.
10. Send **QL** to stop data collection. It may be necessary to send this command several times.
11. To transmit data from the SBE 21, refer to [Transmit data from the SBE 21](#) on page 24.
12. Send **QS** to put the SBE 21 into a low power mode.
13. Turn off power to the Interface Box.

7.5 Transmit data from the SBE 21

1. Start the SeaTerm software.
2. In the **Configure** menu, select SBE 21.
3. Select the *Upload Settings* tab.
 - a. Select the baud rate. This must agree with the baud rate on the *COM Settings* tab.
 - b. In the Upload data area, select either "All as a single file" or "By scan number range."
4. Push **OK**.
5. Select the *Header Information* tab.
 - "Prompt for header information" asks the user to fill in the header form.
 - "Include default header from the upload file" has the user-specified default header form that is in the upload file. There is no option to add any information when data is transmitted.
6. Push **OK** to save the selected settings.
7. In the **Configure** menu, select *Header Form* to add information to the header. The fields are free-form, 0 to 12 lines long. If "Prompt for header information" in step 5 was selected, the user can enter header information. If "Include default header form in upload file" in step 5 was selected, the default header information will be included in the transmitted data.
8. Push **OK**.
9. Turn on power to the Interface Box.
 - Enter @ to open the setup menu.
 - Enter 1, then push **Enter** to echo characters from the SBE 21.
 - Enter @ to close the setup menu.
10. Select **Connect** on the toolbar or push **Enter** several times. If **Connect** was used, the display shows:

```
*ds
sc21, 4300, 5.0a, 50000, 6, N, where 4300 is the serial number, 5.0a is the
firmware version, 50000 is the number of samples in memory, 50 is the number of
headers in memory, 6 is the number of bytes in each scan, and L or N is logging or
not logging.
```
11. Select **Status** on the toolbar to show the SBE 21 status information:

```
SEACAT THERMOSALINOGRAPH v5.0a SERIAL NO.
4300 12/15/09 14:02:13
ioper = 50.7 ma vmain = 11.4, vlith = 8.8
samples = 50000, free = 10666357
sample interval = 5 seconds, no. of volts sampled = 0
output format = SBE 21
start sampling when power on = no
```

```
average data during sample interval = yes
logging data = no
voltage cutoff = 7.5 volts
```

12. If the status shows that data collection is on, push **Enter** and send **QL**. It may be necessary to send this command several times.
13. If `output format = SBE 16` in the status display and you plan to use the SBE Data Processing software, send **F1** to change the output format to SBE 21. Select **Status** on the toolbar to verify the output format.
14. Select **Upload** on the toolbar to transmit stored data that can be used by the Data Processing software. The software responds:
 - a. The software sends the status (DS) command, shows the response, and writes the command and response to the file to be transmitted.
 - b. The software sends the header (DH) command, shows the response and writes the command and response to the file to be transmitted. DH gives information about the number of samples in each cast, the date and time the cast started, and sample interval.
 - c. If "By scan number range" was selected in the Configuration Options area, the software will prompt for the range.
 - d. If "Prompt for header information" was selected in the Configuration Options area, the software will prompt the user to enter any header information.
 - e. In the Open area, enter the name of the file to be transmitted and push **OK**. The file has a .hex extension.
 - f. The software sends the data upload (DDb,e) command.
15. Make sure that all data is transmitted from the SBE 21.
 - a. Use Seasave to see the raw hexadecimal data from the SBE 21 in engineering units.
 - b. Use the Data Processing software to process and make a plot of the data.
16. After all the data is transmitted, send **IL** to erase the data and make the entire memory available.
17. Send **QS** to put the SBE 21 in a low power mode until data collection is started again.
18. Turn off power to the Interface Box.

7.6 Process data

Version 7.20 and newer of the SBE Seasave and Data Processing software let the user open and save a .con or .xmlcon file.

To convert the data in the Conversion module of the Data Processing software, the software uses the .con or .xmlcon file to read and process the data so the user can convert the raw .hex file from the SBE 21 to a .cnv file in engineering units.

Use the other modules in the Data Processing software to align, filter, calculate derived variables and more.

7.6.1 Edit data file

Some users want to edit the raw .hex file before it is processed, to remove "soak time" data at the start of the file, or edit the header, or to add notes about the cast.

The manufacturer recommends that the user first convert the data to a .cnv file with the Data Conversion module in the SBE Data Processing software, and then edit the .cnv file.

Edits to the .hex file can corrupt the data so that it cannot be processed further with the SBE software.

NOTICE

This product is not equipped with antifouling technology. Contact Technical Support for recommendations if antifouling is necessary.

Clean the SBE 21 after use and before it is put into storage:

- Monthly during continuous use.
 - Before it is put into storage. The conductivity cell must be flushed between uses to prevent salt crystals on the platinized electrode surfaces. Accuracy may be temporarily affected until the salt crystals dissolve.
 - If the data looks incorrect. "Noisy" data may be caused by debris in the cell. "Smooth" data may be caused by a blocked flow path. Shifted data may be caused by fouling in the cell.
1. Remove the sensor-electronics module from the SBE 21 water jacket:
 - a. Close all four valves.
The valves are closed when they are in a vertical position.
 - b. Remove the four bolts, washers, and nuts that attach the square end cap to the SBE 21 top plate.
 - c. Lift the square end straight up and remove the sensor-electronics module from the water jacket.
 - d. Make sure to prevent any damage or contamination to the O-ring on the top plate.
 2. Flush with fresh water and drain:
 - a. Put the valves in the positions listed below.
Out—open
Fresh water in—open
Salt water in—open
Drain—closed
 - b. Drain any water and remove any debris.
Put the valves in the positions listed below.
Out—closed
Fresh water in—closed
Salt water in—closed
Drain—open
 3. Examine and clean the water jacket:
 - a. Close all four valves.
 - b. Remove the sensor/electronics module from the water jacket.
 - c. Use a flashlight to examine the flushing chamber and conductivity cell. If there is no debris or sediment, clean the bottom plate assembly.
 - d. Carefully spray fresh water into the chamber to remove any debris. Make sure not to hit the conductivity cell with the spray hose.
 - e. Use paper towels to remove any deposits inside the water jacket.
 4. Flush the inside of the conductivity cell:
 - a. Remove the subassemblies at each end of the conductivity cell.
 - b. Do a series of slow back flushes into the OUT port (the reverse of normal operation flow) to clean the inside of the conductivity cell. Collect the drained water in a bucket.
 - c. If the SBE 21 will be put in storage, carefully blow-dry the conductivity cell with clean air. Do not use compressed air, which typically contains oil vapor

- d. Attach the subassemblies on each end of the conductivity cell again. Make sure a 0.7-inch blank ("dummy") device is installed in each.



Do not put a brush or any object in the cell, and do not spray any solutions into the open end of the cell.

5. Install the electronics module again:
 - a. Carefully examine the top plate O-ring and contact surfaces for any dirt, nicks, or cuts. Clean or replace if necessary.
 - b. Apply a light coat of silicone-based lubricant on the contact surfaces and the O-ring.
 - c. Carefully replace the sensor-electronics module into the water jacket.
 - d. Align the bolt holes on the square end cap and top plate.
 - e. Install the bolts, washers, and nuts to attach the end cap to the top plate.
 - f. If the SBE 21 will not be used immediately, leave all valves in the closed position.
 - g. For normal use, put the valves in the positions listed below:
 Out—open
 Fresh water in—closed
 Salt water in—open
 Drain—closed
 If the data still looks incorrect after cleaning, look for:
 - a problem with the electrical connections
 - a problem with the circuit boards inside the sensor-electronics module
 - internal fouling in the conductivity cell that was not removed when the cell was flushed
 - a sensor that needs to be calibrated again.

8.1 Replacement parts

| Part number | Description |
|-------------|---|
| 90488.2S | Navigation Interface Box |
| 50298 | Thermosalinograph spares kit, SBE 38 interface—has connectors, O-rings, titanium hardware and maintenance items |
| 23388.2 | SBE 21 top end flange cap, to seal flow chamber when sensors are removed |
| 80438 | Data I/O cable, RMG4FS to MS3106A, 10 m |
| 23188.2 | PVC water jacket assembly, spare |
| 171887 | DB9P to DB9S RS232 serial cable, 3 m |
| 70271 | Vortex debubbler, MSRC VDB-1, 3-inch diameter |
| 231515 | Blank ("dummy") device for antifouling subassembly |

8.2 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 of 100% silicone grease or spray in the sockets or on the pins. Use the mating plug or cable to help distribute the lubricant. 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.

8.3 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.

Section 9 Reference: command descriptions

This is a reference for advanced users. The values of these commands are stored in the sensor until the user changes them. Notes about terminal commands are listed below.

- Commands are not case-sensitive. Push **Enter** to store a command.
- The sensor sends an error message if a command is invalid.
- When OutputExecutedTag=N and the SeaCAT does not show an S> prompt after a command is executed, push Enter to see the S> prompt.
- The argument Y and 1 are both "Yes" and N and 0 are both "No." For example, Volt0=y and Volt0=1 are equivalent.
- The sensor will go into a low power mode if no command is sent for 2 minutes. Select *Connect* in the **Communications** menu to start communication again or push Enter.
- Push the **Esc** key or enter **^C**, then **Enter** to stop the sensor as it transmits data.
- Samples must have the same number of data fields. If the number of data fields is changed, the sensor must start data collection again. This sets the sample number and cast number to 0, so all of the memory is available to record data with the new number of data fields. **Make sure to transmit all stored data to a PC before the SeaCAT starts again, or data will be lost.** Commands that change the number of data fields are MM, MP, Ptype=, Volt0=, Volt1=, Volt2=, Volt3=, Volt4=, Volt5=, SBE63=, SBE38=, WetLabs=, GTD=, DualGTD=, Optode=. The user is prompted to verify the command so stored data is not overwritten.
- During data collection, the SeaCAT responds to GetCD, GetSD, GetCC, GetEC, ResetEC, GetHD, DS, DCal, TS, SL, SLT, GetLastSamples:x, QS, and Stop. If for example, the user sends DS while the sensor collects data, it will temporarily stop. In Moored mode, data collection starts again when the sensor goes into low power mode because QS was sent or 2 minutes have passed. In Profiling mode, the sensor starts data collection immediately. (The sensor does not respond to TS, SL, SLT or GetLastSamples:x during data collection.)
- If StartLater was sent and the SeaCAT has not yet started data collection, it will respond only to GetCD, GetSD, GetCC, GetEC, ResetEC, GetHD, DS, DCal, TS, SL, SLT, GetLastSamples:x, QS, and Stop.
- To send any other commands, send Stop, then send any commands to change the setup and then send StartLater.

9.1 Status

| | |
|-------|-------------------------|
| GetCD | Show configuration data |
|-------|-------------------------|

Example for SBE 21, user entries in **boldface**:

GETCD

```
<ConfigurationData DeviceType='SBE21' SerialNumber='02106001'>
<SampleMode>
SI=                                <SampleInterval>15</SampleInterval>
AutoRun=                          <AutoRun>no</AutoRun>
Average=                          <Average>no</Average>
</SampleMode>
<DataChannels>
SV=                                <ExtVolt0>yes</ExtVolt0>
SV=                                <ExtVolt0>yes</ExtVolt0>
SV=                                <ExtVolt1>yes</ExtVolt1>
```

Reference: command descriptions

```

SV=                <ExtVolt2>yes</ExtVolt2>
SV=                <ExtVolt3>yes</ExtVolt3>
SBE38=             <SBE38>no</SBE38>
</DataChannels>

Fx                 <OutputFormat>SBE 21</OutputFormat>
OutputExecutedTag= <OutputExecutedTag>no</OutputExecutedTag>
</ConfigurationData> </MooredMode>

```

| | |
|-------|--|
| GetSD | Show status data |
| | Sensor model, S/N |
| | DateTime= format of date and time yyyy-mm-ddThh:mm:ss |
| | Data collection status |
| | Event counter, set with ResetEC |
| | Voltages and current draw <ul style="list-style-type: none"> • external power • back-up lithium • current draw during operation • external voltage sensor current for channels 0 and 1; shows if 1 or more channels are enabled • RS232 sensor current draw; shows if channel is enabled. |
| | Memory: number of bytes in memory, number of samples in memory, number of additional samples that can be saved in memory, number of bytes in each sample, number of casts in memory if in Profiling mode. Set with IL. |

| | |
|-------|--|
| GetCC | Show calibration coefficients. Voltage channel offsets and slopes, and conductivity zero frequency |
|-------|--|

| | |
|-------|--|
| GetEC | Show event counter. Some events include: |
| | Power fail: main batteries or external voltage below cutoff |
| | EEPROM read or EEPROM write: all power removed (main batteries removed, and back-up lithium batteries are dead) |
| | AD7730 timeout: delayed response from temperature and pressure A/D converter. Typical if a command is sent during data collection. |
| | AD7714 timeout: delayed response from voltage channel A/D converter. Typical if a command is sent during data collection. |
| Flash | Out of memory. Data collection continues but no additional data is stored |
| | Correctable error: single bit error in a page that self-corrects. Does not affect data |
| | ECC error: does not affect data |
| | Timeout: problem with flash |
| | Ready: problem with flash, timeout error |
| | Erase failed: problem with flash |
| | Write failed: problem with flash |
| | Uncorrectable: problem with flash. 2 or more bits of errors on a page |
| | Block overrun: problem with flash |
| | New bad block: problem with flash. Write or Erase failed, or an uncorrectable error |

| | |
|---------|---------------------------------------|
| ResetEC | Erase all events in the event counter |
|---------|---------------------------------------|

| | |
|-------|---|
| GetHD | Show hardware data |
| | Sensor model, serial number |
| | Manufacturer |
| | Firmware version |
| | Firmware date |
| | PCB serial and assembly numbers |
| | Manufacture date |
| | Internal sensor types and serial numbers |
| | External voltage sensor models and serial numbers |

| | |
|----|--|
| DS | Show operation status and setup parameters |
| | Firmware version, serial number, date and time. DateTime= |
| | Current draw during operation, mA, external power voltage, lithium battery voltage |
| | Number of samples saved and available space in memory |
| | Sample interval (SI=) and number of external voltages enabled (SV=) |
| | Enable SBE 38 remote temperature sensor data collection |
| | Output format (Fx) |
| | Start data collection when external power is supplied (AutoRun=) |
| | Average data during sample interval (Average=) |
| | Data collection status |
| | Power cutoff voltage |

Note: The DS command is equivalent to the responses from GetSD and GetCD, with a different format.

| | |
|------|---|
| Dcal | Calibration coefficients in a different format from GetCC |
|------|---|

9.2 General setup

| | |
|---------------------|--|
| DateTime=x | Set real-time clock. Format is mmddyyyyhhmmss. |
| Baud=x | 600, 1200, 2400, 4800, 9600, 19200, 38400. Default is 9600. |
| OutputExecutedTag=x | x=Y: Show XML tags during and after execution. Default. x=N: do not show XML tags. Tags show one or more times during execution if the response to the command requires additional time. |
| SBE38=x | x=Y: Enable the SBE 38 to collect data. x=N: do not enable SBE 38. |
| SV=x | x= Number of external voltages (0, 1, 2, 3, or 4). If differential A/D channels are installed, the maximum is 2. |
| Fx | x=1: Set data format to SBE 21. Output is raw hex data, primary temperature, conductivity, remote temperature, voltages. x=2: Set data format to SBE 16 (custom applications that do not use the manufacturer's software). Raw data is output in hex, # (attention character), primary temperature, conductivity, remote temperature, voltages, linear count (starts at 0). |
| QS | Puts sensor in low power mode. Current draw is 30 μ A. |

Notes:

- The baud rate of the sensor must be the same as the baud rate in the software.
- You must also set up SBE 38 to interface with SBE 21. Connect SBE 38 directly to the PC, and set SBE 38 baud to same baud as SBE 21. Set the interface to RS232. Data collection starts when power is supplied (AutoRun=Y). Set the format to Format=C for converted data. See the SBE 38 manual for command details
- The .xmlcon file must agree with the selection of the SBE 38.
- If SBE38= or SV=x commands are sent, the SBE 21 will ask the user to verify the command. Send the command again and push **Enter**.
- To use the manufacturer's data processing software, set the format to SBE 21 (F1).

9.3 Operation

These commands configure the SBE 21 to collect data at user-specified intervals. If the SBE 21 is set to AutoRun=Y, and started with a **GL** or **RL** command, the SBE 21 collects data as shown below.

| Average=Y | Average=N |
|--|--|
| 1. Collect samples continuously at 4 Hz and average the samples collected within each sample interval. | 1. Collect 1 sample every sample interval (SI=) seconds. |
| 2. Save the averaged data in flash memory and transmit it in real-time. | 2. Save the data in flash memory and transmit it in real-time. |
| 3. Write a header to memory that records the start date and time, sample interval and sample number range. A new header is written after every 10,000 samples, to a maximum of 1000. | |

| | |
|------|---|
| SI=x | x=Interval between samples, 3–600 secs. |
| IL=x | Transmit all stored data from the SBE 21, then send IL to make the memory available for data collection. The IL command sets the sample number and header number to 0 internally. |

If AutoRun=Y and IL is not sent, data is collected and stored. The sample number is not set to 0.

If AutoRun=N, send GL to start data collection and save data at the start of the memory. Send RL to continue data collection and save data after the last sample.

The IL and SampleNumber=0 are the same. Either command will initialize logging.

Make sure to transmit all saved data before IL is sent. If IL is sent accidentally, set SampleNumber=a and HeaderNumber=b to recover data. The "a" and "b" are estimates of the number of samples and headers in memory. Transmit the data and inspect it carefully, then erase any bad data. The user can increase "a" and "b" and transmit data again, to see if there is additional valid data in memory.

| | |
|----------------|--|
| SampleNumber=x | x= Sample number for the first sample when data collection starts. This command is typically used if the IL command is accidentally sent before saved data has been transmitted to the PC. |
| HeaderNumber=x | x= Sample number for the first sample when data collection starts. This command is typically used if the IL command is accidentally sent before saved data has been transmitted to the PC. |
| GL | Start data collection now. The SBE 21 overwrites any saved data and headers in memory. Command must be verified. The first sample starts 3 seconds after this command is verified. |
| RL | Start ("resume") data collection now. The SBE 21 does not overwrite any saved data and headers in memory. Command must be verified. The first sample starts 3 seconds after this command is verified. |

| | |
|-----------|--|
| AutoRun=x | x=Y: Automatically start data collection when power is supplied. Saved data is not overwritten. The user must turn the power to the SBE 21 off, then on again to start data collection. x=N: Do not automatically start data collection when power is supplied. |
| QL | Stop data collection. Push Enter , then send QL. It may be necessary to send this command several times. If there is no response from the SBE 21, enter Ctrl Z several times, then enter the QL command again. |

9.4 Transmit data

To transmit data from the SBE 21 to a PC, make sure to stop data collection first. Use the **Upload** menu in the SBE Data Processing software. A manually entered command does not have the required header information for the SBE software to process the data. Use the **Capture** menu to save data to a file, then send the DD or DH commands.

| | |
|---|--|
| DDb,e | Transmit data from sample b to sample e . If b and e are not entered, all data is transmitted. |
| DH | Transmit all headers. A new header is written when data collection starts and every 10,000 samples afterward. Header information has the header number, month, day, year, hour, minute, second, and the first and last sample for the header. Header also includes the interval between samples and the reason data collection is stopped. |
| Example DH: hdr 1 10 Jul 2009 12:30:33 samples 0 to 4, int = 60 sec, stop = stop cmd hdr 2 10 Jul 2009 13:02:12 samples 5 to 10, int = 60 sec, stop = stop cmd | |

9.5 Take sample

These commands are to collect a single sample. The SBE 21 stores data for the most recent sample in its buffer.

| | |
|----|--|
| SS | Show the last sample from the buffer (sample from TS, or the latest from data collection). |
| TS | Collect data for 1 second at 4 Hz (four samples), average the data and store it in the buffer, then show the averaged data. Data is not stored in the flash memory. |

9.6 Diagnostics

The SBE 21 transmits 100 samples for each diagnostic test. Data is not stored in the flash memory. Push **Esc** or **Stop** to stop the test.

| | | |
|----|---|---|
| FR | Show frequencies | |
| | Column | Output |
| | 1 | Raw temperature, A/D counts |
| | 2 | Raw conductivity frequency |
| | 3 | Temperature frequency converted for SBE 21 with firmware version < 4.0 |
| | 4 | Conductivity frequency converted for SBE 21 with firmware version < 4.0 |
| VR | Show voltages with offset and scale factors | |
| | Column | Output |
| | 1 | External auxiliary sensor voltage 0 |
| | 2 | External auxiliary sensor voltage 0 |
| | 3 | External auxiliary sensor voltage 0 |
| | 4 | External auxiliary sensor voltage 0 |

Reference: command descriptions

| | | |
|-----|---|--|
| | 5 | External power voltage ÷ 11 |
| | 6 | Backup lithium battery voltage ÷ 3.741 |
| | 7 | Operational current ÷ 333.33 |
| T38 | Show output from SBE 38 remote temperature sensor | |

9.7 Hardware configuration

The commands below are to set the date of manufacture, PCB serial numbers, PCB assembly numbers, auxiliary channel sensor types and serial numbers.

| |
|--|
| Manufacturer settings—do not change in the field |
| SetMfgDate= |
| SetPcbSerialNum1= |
| SetPcbSerialNum2= |
| SetPcbSerialNum3= |
| SetPcbSerialNum4= |
| SetPcbAssembly1= |
| SetPcbAssembly2= |
| SetPcbAssembly3= |
| SetPcbAssembly4= |

| |
|--|
| Auxiliary sensor settings—can be changed in the field for changes to auxiliary sensors connected to the SBE 21 |
| SetVoltType0= |
| SetVoltSN0= |
| SetVoltType1= |
| SetVoltSN1= |
| SetVoltType2= |
| SetVoltSN2= |
| SetVoltType3= |
| SetVoltSN3= |

Section 10 Troubleshooting

10.1 Cannot communicate with Interface Box

The Interface Box setup message shows that there is communication between the Interface Box and the PC. Enter @ several times to verify communication. If there is no message, try the solutions listed below.

Cause: The I/O cable is not connected correctly.

Solution: Make sure that the cable is connected at the PC and the Interface Box.

Cause: The communications settings were not entered correctly.

Solution: Make sure that the software settings agree with the setup of the Interface Box. Select the SBE 21 in the **Configure** menu and verify the settings in the Configuration Options area. If necessary, change the setting in the Interface Box.

10.2 Cannot communicate with sensor

If OutputExecutedTag=N, the S> prompt shows that there is communication between the sensor and PC through the Interface Box. If the S> prompt does not show, Select **Connect** on the Seaterm toolbar, or push **Enter** several times.

Cause: The I/O cable is not connected correctly.

Solution: Make sure the cable is connected at the PC and the sensor.

Cause: The sensor communication settings or the Interface Box settings were not entered correctly in the software.

Solution: Select the SBE 21 in the **Configure** menu and make sure that the settings in the Configuration Options area agree with the values on the Configuration Sheet that shipped with the sensor, and that the settings in the Interface Box agree with the settings in the software.

Cause: The I/O cable is not the correct cable.

Solution: Verify that the cable is correct.

Cause: The SBE 21 was set to AutoRun=Y.

Solution: Send the QL command several times to stop data collection. Communication should then be possible.

10.3 Cannot see data in Seasave

The manufacturer recommends that the user enable *Check scan length* in the Seasave **Options** menu. The software looks at the data scan length and the expected length and gives a warning that there is an error if the two lengths do not agree.

Cause: The scan length does not agree with the selected configuration file. This could occur, for example, if the configuration file has NMEA position data added through an NMEA device connected to the PC, but the device was not connected. The software will continue to collect data, but will not show or make a plot of that data in the Seasave display. The data quality is not affected and the configuration file error can be corrected in the Data Processing software.

Solution: Make sure that the settings in the configuration file agree with the current CTD configuration.

10.4 Scan length error in Data Processing software

Cause: If the scan length in the data file does not agree with the configuration file, the Data Processing software will not process the data. This could occur, for example, if the configuration file shows that NMEA position data was added, but the data file does include NMEA data.

Solution: Select *Diagnostics* in the Data Conversion software **Options** menu, then select **Display Log File** in the *Diagnostics* area. Look at the Diagnostics file for a "scan length error." Look at the configuration file and the header in the data file and correct the configuration file as necessary.

10.5 No data is saved

Cause: The SBE 21 has no more available memory. No additional data will be saved. Send the DS command and if the response shows `free = 0` or `1`, the memory is full.

Solution: Transmit all previous data, then send IL to set the memory to 0. Send the DS command and make sure that the response is `samples = 0`.

10.6 Nonsense data

A data file has nonsense values, such as 9999.99, or values that are outside the expected range of data.

Cause: An incorrect configuration in the configuration file, such as sensors that are set up in the configuration file but are not actually installed.

Solution: Make sure that the settings in the configuration file agree with the Configuration Sheet for a given sensor.

Cause: A data file that has unreasonable values for temperature, conductivity, or other parameters may be caused by incorrect calibration coefficients in the sensor's configuration file.

Solution: Make sure that the calibration coefficients in the configuration file agree with the Configuration Sheet for a given sensor.

10.7 Low salinity values

Cause: The conductivity cell is dirty, broken, or there is an object in the cell.

Solutions:

1. Clean the conductivity cell. Refer to [Maintenance](#) on page 27 for details.
2. Blow *clean* air through the cell to remove large drops of water from the cell.
3. Look at the raw conductivity frequency. It should be within 1 Hz of the zero conductivity value on the Calibration Sheet. If it is not, the cell is probably damaged.

10.8 Corrupt program

Cause: In rare cases, a severe static shock or other problem can corrupt the program that controls the SBE 21 microprocessor.

Solution: Remove the J1 jumper on the Power circuit board to set the program again.

1. Transmit all stored data from the SBE 21.
2. If necessary, turn off the SBE 21 and remove the sensor-electronics module from the water jacket. Refer to [Maintenance](#) on page 27 for details.
3. Remove the J1 jumper from the top circuit board in the assembly. This jumper is used to disconnect the backup lithium battery from the electronics.
4. Keep the jumper disconnected for several minutes, then connect it again.
5. Start communications again. Refer to [Set up and test communication](#) on page 15 for details.
6. Send IL, then set the date and time with `DateTime=`.
7. Send DS to verify that the date, time, and sample number are correct.
8. Install the sensor-electronics module in the water jacket again.

Section 11 General information

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

11.1 Warranty

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

11.2 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.

11.3 China RoHS disclosure table

| Name of Part | Hazardous substance or element in product | | | | | |
|---|---|----|----|--------|-----|------|
| | Pb | Hg | Cd | Cr(VI) | PBB | PBDE |
| PCBs | X | O | O | O | O | O |
| This table is compiled to the SJ/T 11364 standard. | | | | | | |
| O: This hazardous substance is below the specified limits as described in GB/T 26572. | | | | | | |
| X: This hazardous substance is above the specified limits as described in GB/T 26572. | | | | | | |

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

