



SEA-BIRD
SCIENTIFIC

User manual

SBE 45 MicroTSG 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 MicroTSG quick start guide

This quick start guide gives the steps necessary to make sure that the SBE 45 MicroTSG sensor operates correctly and collects data before it is deployed.

What's in the box:

- SBE 45
 - CD or USB drive—has software, calibration files, documentation
 - Spare parts kit
 - Conductivity cell cleaning kit
 - I/O cable to connect the sensor to a PC.
1. Install the MicroTSG in the hull of the ship.
Refer to [Install MicroTSG system](#) on page 13 for details.
 2. Set up the MicroTSG for deployment.
Refer to [Set up MicroTSG and verify functionality](#) on page 17 for details.
 3. Maintain the MicroTSG after each use and before it is put into storage.
Refer to [Maintenance](#) on page 25 for details.

Section 3 Specifications

3.1 Electrical

Input	8–30 VDC
Current draw, operation	34 mA at 8 VDC, 30 mA at 12–30 VDC
Current draw, low power	10 μ A

3.2 Communication

Communication interface	RS232
Data collection interval	1 second to 9 hours, user-programmable
Firmware version	1.1b

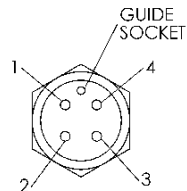
3.3 Analytical

Parameter	Range	Accuracy	Stability	Resolution	Calibration range
Conductivity, S/m	0–7	± 0.0003	0.0003	0.00001	0 to 6
Temperature, $^{\circ}$ C	-5 to 35	± 0.002	0.0002	0.0001	+1 to +32
Salinity, PSU	—	± 0.005	0.003	0.0002	—

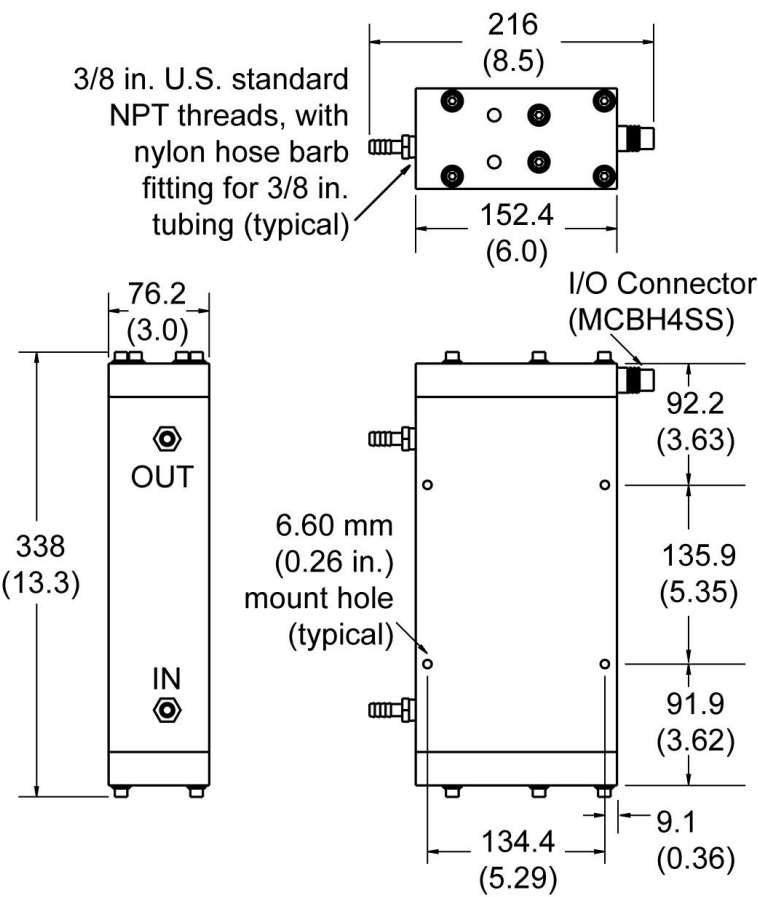
3.4 Mechanical

Maximum safe pressure to operate	34.5 decibars (50 psi)
Weight	4.6 kg
Recommended flow rate	10–30 ml/second
Counter time-base	Quartz TCXO, ± 2 ppm/year for age; ± 5 ppm vs. temperature of -5 to 30 $^{\circ}$ C
Pressure housing	PVC

3.4.1 Bulkhead connector

Contact	Function	MCBH-4-FS (ss)
1	Ground	
2	RS232 RX	
3	RS232 TX	
4	Voltage in	

3.4.2 Dimensions



3.4.3 Cables

Figure 1 I/O cable to PC

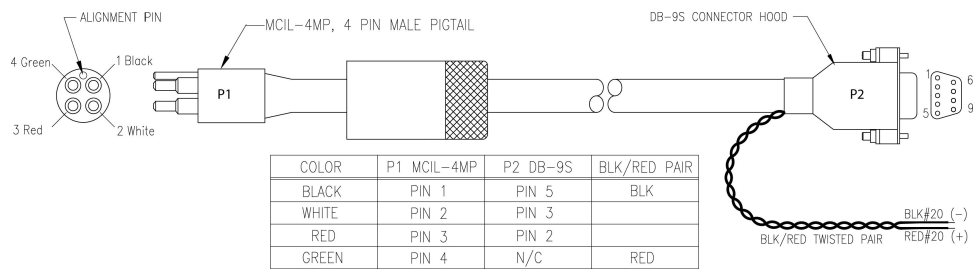
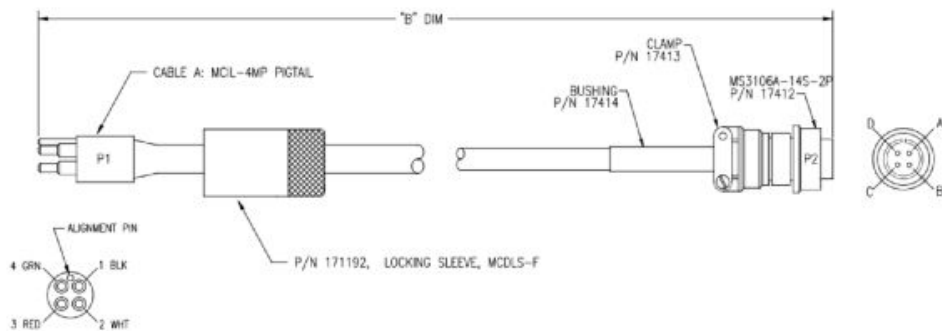


Figure 2 I/O cable to optional interface box



Section 4 Operation overview

The SBE 45 MicroTSG is an externally powered, high-accuracy, conductivity and temperature monitor to be used on ships.

The MicroTSG uses the temperature and conductivity sensors used by the SBE 21 thermosalinograph, but has improved electronics that increase accuracy and resolution, and decrease power consumption. The electrical isolation of the conductivity electronics prevents ground-loop noise. The internal-field conductivity cell is not affected by external fouling.

4.1 Optional Interface Box

The optional AC- or DC-powered power, navigation, and remote temperature Interface Box supplies:

- Power and an opto-isolated RS232C interface for the MicroTSG
- An opto-isolated optional NMEA receiver for an NMEA 0183 navigation device. Data can be transmitted in GGA, GLL, RMA, RMC, or TRF
- Power and an RS232C interface for an optional SBE 38 remote temperature sensor
- RS232C PC interface.



Decoded latitude, longitude, date, time, and SBE 38 temperature data are appended to the MicroTSG data in the Interface Box and transmitted to the connected PC. Send the **Connect45** command to put the Interface Box in a mode that communicates with the MicroTSG.

4.2 Optional remote temperature sensor

The optional Interface Box can append the output of an optional SBE 38 temperature sensor to the data from the MicroTSG. 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 MicroTSG, 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 MicroTSG, 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.

Note that the Interface Box must be in the correct mode to communicate with the MicroTSG: use the Connect45 command. Use the Connect38 command to set up communication between the Interface Box and the SBE38.

4.3 Sample times

The time to take a sample is affected by the mode of operation.

Controlled (polled) mode

This mode is in effect when the J1 jumper is set to Normal or Autopower, **AutoRun=N** and data collection is started with **Go** (if **SingleSample=Y**), or with a polled sample command.

Time from the end of the take sample command to the start of the response, in seconds = $(\text{NCycles} \times 0.1336) + 0.459$.

Autonomous mode

This mode is in effect when the J1 jumper is set to Normal or Autopower, **AutoRun=Y** and **SingleSample=N**,

OR

The J1 jumper is set to Normal, **AutoRun=N**, **SingleSample=N**, and data collection is started with **Go**.

Time collect temperature and conductivity, in seconds = $(\text{NCycles} \times 0.1336) + 0.287$.

Serial Line Sync mode

This mode is in effect when the J1 jumper is set to Normal, **AutoRun=Y**, **SingleSample=Y**.

Time from standby mode to start of response, in seconds = $(\text{NCycles} \times 0.1336) + 1.643$.

Total sample time

When temperature and conductivity data is collected, the time to calculate the user-selected parameters is depends on the baud rate. For autonomous mode, if the total time required for the sample is greater than the user-entered sample interval (**Interval=**), the next sample will start as soon as the current sample has been transmitted.

- time to calculate temperature = 8.8 msec
- time to calculate conductivity = 15.4 msec
- time to calculate salinity = 83 msec
- time to calculate sound velocity = 35 msec

4.4 Data transmission

Baud rate and data transmit rate

The rate that data can be transmitted from the MicroTSG is affected by the quantity of data transmitted per scan, and the serial data baud rate:

Time to transmit data = $(\text{number of characters} \times 10 \text{ bits per character}) \div \text{baud rate}$

The number of characters is the data and output format. Add 2 to the number of characters for the carriage return and line feed. Include decimal points, commas, and spaces in the total number of characters.

The MicroTSG transmits data after it completes the previous sample and before is starts the next sample.

What is the minimum transmission time over 100 m of cable with **OutputCond=y**, **OutputSal=Y**, and **OutputFormat=0**?
For 100 m of cable, the MicroTSG requires a baud rate of 9600 or less.

Number of characters = 8 (temperature) + 2 (comma and space) = 8 (conductivity) + 2 (comma and space) + 8 (salinity) + 2 (comma and space) + 8 (sound velocity) + 2 (carriage return and line feed) = 40

$(40 \text{ characters} \times 10 \text{ bits/character}) \div 9600 = 0.042 \text{ sec} = 42 \text{ msec}$

What is the minimum total time required per sample (**Interval=**), if 4 measurements/sample (**NCycles=4**) is averaged, and the MicroTSG is in Autonomous Mode?
Time to collect T and C (refer to [Sample times](#) on page 10 for value) = (**NCycles** × 0.1336) + 0.287 = (4 × 0.1336) + 0.287 = 0.82 seconds
Total sample time
= time to collect T and C + time to compute parameters + time to transmit data = 0.82 + (.0088 + .0154 + .083 + .035) + .042 = 1.00 second.
Set **Interval=1**, to transmit 1 sample every second.

Power supply and cable length

Calculate IR loss for real-time data collection when the MicroTSG is used with external power.

1. The communications IR loss should be 1 V or less when real-time data is transmitted. The 39plus 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.

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

$$\text{Maximum cable length} = R_{\text{limit}} \div \text{wire resistance/foot.}$$

I = required communications current of 6 mA.

Example 1:

What is the maximum cable length that can supply power to the SBE 45 with 18 gauge wire?

For 34 mA current, $R_{\text{limit}} = V_{\text{limit}} \div I = 1 \text{ V} \div 0.034 \text{ A} = 29 \text{ ohms}$

Maximum cable length = 29 ohms ÷ 0.0064 ohms/ft = 4531 ft (1381 m)

Example 2: Same as above, but an external power supply supplies four MicroTSG sensors.

$R_{\text{limit}} = V_{\text{limit}} \div I = 1 \text{ V} \div (0.034 \text{ A} \times 4) = 7.35 \text{ ohms}$

Maximum cable length = 7.35 ohms ÷ 0.0064 ohms/ft = 1148 ft (350 m) (furthest MicroTSG from power supply)

Table 1 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 2 Maximum cable length and baud rate

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

Supply sufficient power to MicroTSG

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 MicroTSG with 18 gauge wire and an 8.5 V power supply? The power spec for the MicroTSG is 8–30 V, so a 0.5 V drop would still supply enough power for the MicroTSG.

$$V = IR$$

$$0.5 \text{ V} = 0.034 \text{ A} \times (0.0064 \text{ ohms/ft} \times \text{cable length})$$

$$\text{Cable length} = 2297 \text{ ft (700 m)}.$$

Note that 700 m < 800 m, the maximum distance the MicroTSG can transmit data at 1200 baud, so the IR loss controls the distance. A higher voltage power supply or different wire gauge (12, 14, or 16 gauge) would supply enough power for an 800 m cable.

Example 2: Same as above, but an external power supply supplies four MicroTSGs.

$$0.5 \text{ V} - (0.034 \text{ A} \times 4) \times 0.0064 \text{ ohms/ft} \times \text{cable length}$$

$$\text{Cable length} = 574 \text{ ft (175 m)} \text{ (furthest MicroTSG from power supply).}$$

Section 5 Install MicroTSG system

5.1 Set up MicroTSG hardware

1. Use the four ¼-inch bolt holes to install the MicroTSG. Make sure that the bulkhead connector is at the top and there is sufficient clearance around the MicroTSG.
 - At the bottom, approximately 6 inches, so the bottom plate can be removed.
 - At the top, approximately 12 inches, so the top plate can be removed.
 - On the sides, enough clearance remove the top and bottom plates.
2. Connect the I/O cable to the MicroTSG.
3. Install the plumbing connectors.
The housing has 3/8-inch U.S. standard NPT threads and the manufacturer supplies nylon hose barb fittings for 3/8-inch tubing.
4. Connect to a power supply:
 - a. **With** the optional Interface Box, refer to Figure 2 below.
 - b. **Without** the Interface Box, connect the MicroTSG to a PC and power supply.

5.2 MicroTSG system diagrams

The diagrams below show the configuration of a MicroTSG system with and without remote sensors.

Figure 3 MicroTSG with remote sensors

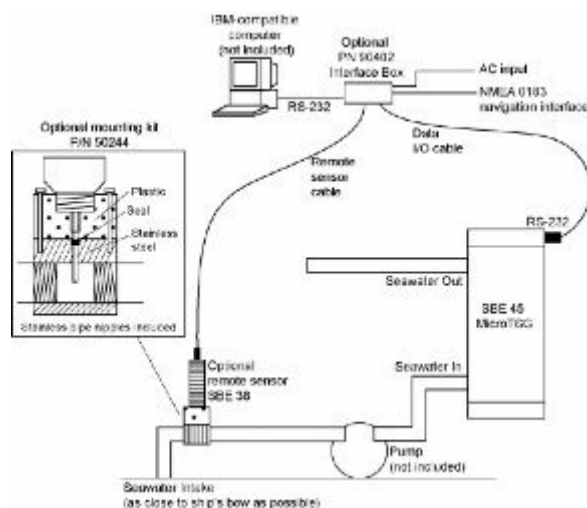
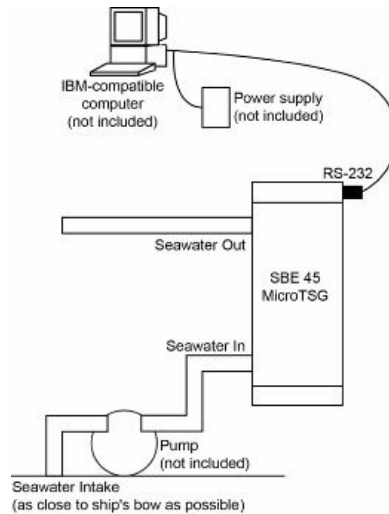


Figure 4 MicroTSG without remote sensors



5.3 Verify power-on setting

The circuit board in the MicroTSG has a jumper that controls how the unit turns on. The Configuration sheet that comes with the MicroTSG from the manufacturer shows this setting. Refer to [Operation](#) on page 30 to see the J1 jumper schematic.

Autopower (default)—the MicroTSG goes into standby mode when power is supplied.

Normal—the MicroTSG goes into standby mode when there is a pulse on the serial interface lines.

If the MicroTSG does not receive a command or collect a sample for two minutes, and AutoOff=Y, it goes into a low power mode. To put the MicroTSG in standby mode again, select **Connect** on the toolbar or push **Enter**.

For Autopower, the external wiring configuration controls the operation of the MicroTSG.

- Three wires—power, ground, and transmit—are used for operation, since it is not necessary to command the MicroTSG to take samples. This configuration is useful for simple systems where a controller supplies power, waits for data, then turns power off. The MicroTSG does not respond to any commands when three wires are used. **Use all four wires to do the initial setup.** Make sure to set **AutoRun=Y**, and **SingleSample=N** for a three-wire configuration.
- Four wires—power, ground, receive, and transmit—are used for the initial setup and to enable the MicroTSG to receive commands. Note that the MicroTSG does not respond to the **QS** command in this configuration.

5.4 Notes on installation

Because each ship and installation is different, the manufacturer gives guidelines as an alternative to instructions to install the SBE 45. The SBE 45 should be installed by qualified shipfitters, with oversight by a competent ship designer or naval architect.

Points to think about:

Location

- The SBE 45 can be installed anywhere it will fit and can easily be accessed for maintenance.
- Install the SBE 45 above the water line for safety. If no remote temperature sensor is used, install the SBE 45 as close to the seawater intake as possible. If a remote temperature sensor is used the SBE 45 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 optional SBE 38 remote temperature sensor is usually installed 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.

Pump

- The pump must supply 10–30 ml/second.
- The SBE 45 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 MicroTSG 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.

Section 6 Set up MicroTSG 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.
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

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 45 TSG**.
Seaterm232 opens.

Table 3 Toolbar menu buttons

Connect enables communication with the sensor
Status shows the current settings
Coefficients shows the calibration coefficients stored in the sensor
Capture captures sensor response on the screen to a file with a .cap extension. Push Capture again to turn off this function. The MicroTSG has no internal memory, so turn on Capture before data collection starts to save data to review and process.
Diagnostics will do tests of the MicroTSG. Tests with this command do not overwrite any current settings.
Disconnect the sensor so the COM port on the PC is available again

3. Change any settings in the **SBE 45 Configuration Options** window.
 - a. Select the applicable COM port.
 - b. Baud rate: 4800 is default.
 - c. Data bits: 8.
 - d. Parity: none.
 - e. Mode: RS232 Full Duplex.
 - 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 45 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 S>SBE 45 V 1.1b 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 45 status information:
SBE45 Vj 1.1b SERIAL NO. 1258
Not logging data

Set up MicroTSG and verify functionality

sample interval = 30 seconds
output conductivity with each sample
do not output salinity with each sample
do not output sound velocity with each sample
do not start sampling when power on
do not power off after taking a single sample
do not power off after two minutes of inactivity
A/D cycles to average = 4

7. 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.

8. Send **QS** then push **Enter**.

- If the MicroTSG is configured for Autopower, it returns the **S>** prompt.
- If the MicroTSG is configured for Normal, it does not return an **S>** prompt.

The SBE 45 is ready to deploy.

Section 7 Operation

7.1 Verify configuration file

The software from the manufacturer requires a configuration file that defines the MicroTSG. The software uses the configuration file to read and process the data. The configuration file must match the actual MicroTSG configuration or the software will not process data correctly.

1. Start the Seasave.exe software.
2. Select **Configure Inputs**. At the *Instrument Configuration* tab, select **Open**. In the dialog box, select the .xmlcon or .con file and push **Open**.
The configuration information shows on the *Instrument Configuration* tab.
3. Verify that the settings agree with the settings in the MicroTSG, and that the settings for the optional Interface Box, SBE 38, and NMEA also agree with the Configuration file.
4. To change the configuration, select **Modify** to open a dialog box. If necessary, send **DS** to see the settings.
 - a. "Sample interval seconds" must agree with the **Interval=** in the MicroTSG.
 - b. "Output conductivity" transmits conductivity data with each scan and must agree with **OutputCond=**.
 - c. "Output sound velocity" transmits sound velocity data and must agree with **OutputSV=**.
 - d. Put a check in "Use junction box" if data will be transmitted to the PC through an Interface Box.
 - e. Put a check in "SBE 38 temperature added" if "Use junction box" is selected and if the Interface Box is connected to an SBE 38 remote temperature sensor. The software uses this data to calculate density and sound velocity.
 - f. Put a check in "NMEA data added" if "Use junction box" is selected. Select this if an Interface Box is connected to a NMEA navigation device. The software automatically adds current latitude, longitude, and universal time code to the data header. In the **Configure** menu, select NMEA (Lat/Lon) Interface to control how this data is added to the output data.
5. Push **Save** or **Save As** to save any changes to the configuration file.
6. Push **Exit** to close the dialog box.

7.2 Set up for deployment

Use the Seasave software to configure the MicroTSG to collect data in real-time.

1. Supply power to the MicroTSG.
 - If **AutoRun=Y** and the J1 jumper is in the Autopower position, the MicroTSG starts to collect and transmit data to the PC, though data will not show in the software until it is commanded to start real-time data collection (below).
 - If **AutoRun=N** and the J1 jumper is in the Normal position, start Seaterm, select **Connect**, then Go. Select **Disconnect**, then close Seaterm.
2. Start Seasave.exe
3. Make any changes to the setup in the **Configure Inputs**, **Configure Outputs**, and **Display** menus.
Make sure the baud rate between the MicroTSG and the computer agree (**Configure Inputs**, *Serial Ports* tab.)
4. From the main menu in Seasave, select the **Real-Time Data Acquisition** menu.
 - a. Select the applicable option:
 - Save data immediately when the MicroTSG is turned on.

- Save data when the "Start Archiving" command is sent.
- Do not save data. This will have no effect on real-time data collection.
- b. Push **Select Output Data File Name** and enter the name of the file to save, or browse to a file name.
- c. To change the input or the output of the current .xmlcon configuration file, push the applicable button and enter those changes.
- d. If necessary, change the "Timeout" values.
 - "Timeout in seconds at startup" is the interval before the first sample is received from the MicroTSG. The sensor will not collect data if none is received within this time.
 - "Timeout in seconds between scans" is the maximum interval the MicroTSG will no longer collect if the time between samples is more than this value.
- 5. Push **Configure Outputs** or **Configure Inputs** to change configuration settings
- 6. Push **Start**.
 - a. If you selected "Begin archiving data immediately" or "Begin archiving when 'Start Archiving' is sent, and selected "Prompt for Header Information" in the Header Form Setup in **Configure Outputs**, enter any information to be included in the header, and push **OK**.
 - b. If you selected *Check Scan Length* in the **Options** menu, the software looks at the .xmlcon file to verify that the scan length of the configuration file agrees with the MicroTSG. If there is an error, verify that you have the correct .xmlcon file, and that it is updated if sensors or devices were added or removed.
 - c. The software sends *Waiting for data...* and will "time out" if data is not received within *timeout in seconds at startup*.
 - d. Real-time data shows in the display.
- 7. To stop the data collection, push **Stop** in the **Real-Time Data** menu.
- 8. Turn off power to the MicroTSG.
- 9. When data collection is complete, convert the .hex data file to a .cnv file with the Data Conversion module in the SBE Data Processing software.
The SBE Data Processing has other modules process data and see plots of data.

7.3 Data collection modes

The MicroTSG can collect data in one of three basic modes:

- Polled
- Autonomous
- Serial Line Synchronization.

7.3.1 Polled (controlled) mode

On command, the sensor collects one sample and transmits the data to the PC. Other options are available with different commands.

Example, user input in bold:

Autopower

Supply power to the sensor. Set up to wait for a command each time it goes into standby mode. Send salinity data with data. Send status command to verify setup. Remove power after all parameters are entered.

Supply power.

Select **Capture** to capture data to a file.

S>**AUTORUN=N**

S>**OUTPUTSAL=Y**

S>**DS** to verify setup

Remove power.

To collect a sample, put the MicroTSG in standby mode, command it to take a sample and transmit converted data to the PC.

S>**TS** Take Sample.

Remove power.

Normal

Supply power to the sensor. Set up to wait for a command each time it goes into standby mode. Send salinity data in converted decimal format. Send status command to verify setup. Send power-off command after all parameters are entered. With power always supplied:

Select **Connect** to put the MicroTSG in standby mode.

Select **Capture** to capture data to a file.

S>**AUTORUN=N**

S>**OUTPUTSAL=Y**

S>**DS** to verify setup

S>**QS**

To collect a sample, put the MicroTSG in standby mode, command it to take a sample and transmit converted data to the PC.

S>**TS** Take Sample.

S>**QS** Command sensor to low power mode.

7.3.2 Autonomous mode

The MicroTSG samples at pre-programmed intervals (Interval=), and transmits the data to the PC. The MicroTSG does not go into a low power mode between samples.

Example, user input in bold:

Autonomous, J1 jumper in Autopower position

Set up to collect data every 20 seconds. Send status command to verify setup. Select **Capture** in the software to capture data to a file. Remove power after all parameters are entered.

Supply power to the MicroTSG.

S>**SINGLESAMPLE=N**

S>**INTERVAL=20**

S>**AUTORUN=Y**

S>**DS**

To collect data, supply power. Every 20 seconds, the sensor collects a sample and transmits it to the PC.

To stop data collection and put the MicroTSG in low power mode, remove power.

To change the setup, supply power and push **Enter** several times to see the S> prompt.

S>**STOP**

Send commands, then remove power.

Operation

Autonomous, J1 jumper in Normal position, AutoRun=Y.

Set up to collect data every 20 seconds. Send status command to verify setup. Select **Capture** in the software to capture data to a file. Send power-off after all parameters are entered. With power always supplied:

Select **Connect** in the software. Data collection starts automatically.

S>**SINGLESAMPLE=N**

S>**INTERVAL=20**

S>**AUTORUN=Y**

S>**DS**

S>**QS**

To stop data collection and put the MicroTSG in low power mode, push **Enter**.

S>**Stop**

S>**QS**

Autonomous, J1 jumper in Normal position, AutoRun=N.

Set up to collect data every 20 seconds. Send status command to verify setup. Select **Capture** in the software to capture data to a file. Send power-off after all parameters are entered. With power always supplied:

Select **Connect** in the software. Data collection starts automatically.

S>**SINGLESAMPLE=N**

S>**INTERVAL=20**

S>**AUTORUN=N**

S>**DS**

S>**QS**

To stop data collection and put the MicroTSG in low power mode, push **Enter**.

S>**Stop**

S>**QS**

7.3.3 Serial line synchronization mode

Send a pulse, a single character, to put the sensor in standby mode. The MicroTSG collects and shows one sample, and goes into a low power mode.

This mode is enabled if AutoRun=Y, SingleSample=Y, and the J1 jumper is in the Normal position.

Example, user input in bold:

Set up to collect one sample after any character is sent, then automatically go into a low power mode. After all parameters are entered, send the power-off command. With power always supplied:

Select **Connect** to put the MicroTSG in standby.

Select **Capture** to capture data to a file.

S>**SINGLESAMPLE=Y**

S>**AUTORUN=Y**

S>**DS** to verify setup

S>**QS**

To stop data collection or to change the setup, push **Enter** several times.

S>**Stop**

S> Enter any changes to the setup.

S>**QS**

7.4 Data format

Each scan ends with a carriage return <CR> and line feed <LF>. Only the zero to the left of the decimal point shows. All data is separated with a comma and a space except as noted. Converted data formats:

- OutputFormat=0 (default)
`ttt.tttt, cc.ccccc, ss.ssss, vvvv.vvv`
- OutputFormat=1
`ttt.tttt,cc.ccccc, sss.ssss, vvvv.vvv`
- OutputFormat=2
`ttt.tttt, sss.ssss, cc.ccccc, vvvv.vvv` This format is not compatible with Seasave or SBE Data Processing software, or the optional Interface Box.

t= temperature, Celsius

c= conductivity, S/m. Data sent only if OutputCond=Y.

s= salinity, psu. Data sent only if OutputSal=Y.

v= sound velocity, m/sec. Data sent only if OutputSV=Y. If SVAAlgorithm=C, as calculated by Chen-Millero. If SVAAlgorithm=W, as calculated by Wilson.

Examples:

Data format when OutputFormat=0, OutputCond=Y, OutputSal=N, OutputSV=N:

23.7658, 0.00019

(temperature, conductivity)

Data format when OutputFormat=1, OutputCond=Y, OutputSal=N, OutputSV=N:

23.7658,0.00019


(temperature,conductivity)

Section 8 Maintenance

NOTICE

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

Clean the MicroTSG after use and before it is put into storage.

1. Clean the MicroTSG and conductivity cell:
 - 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.
2. Clean the drain:
 - a. Keep the MicroTSG vertical and remove the drain plug from the bottom plate of the housing.
 - b. Drain any water and remove any debris from the drain.
3. Examine and clean the flushing chamber:
 - a. Remove the six ¼-inch socket head screws, lock washers and flat washers that attach the bottom plate to the housing. Make sure to hold the plate to prevent it from falling.
 - b. Carefully pull the plate straight down to prevent damage to the conductivity cell, which sits in the housing.
 - c. Make sure that the 0.7-inch blank ("dummy") device (PN 231515) is installed and wipe clean if necessary, then install again.
 - d. Use a flashlight to examine the flushing chamber and conductivity cell. If there is no debris or sediment, clean the bottom plate assembly.
 - e. Carefully spray fresh water into the chamber to remove any debris. Make sure not to hit the conductivity cell with the spray hose.
4. Flush the inside of the conductivity cell:
 - a. Remove the external plumbing that connects the seawater intake and drain lines to the MicroTSG.
 - 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 MicroTSG 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 external plumbing that connects the seawater intake and drain lines to the MicroTSG.

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. Clean the bottom plate assembly:
 - a. Remove the O-ring from the bottom plate and be careful to prevent damage or contamination to it.

- b. Flush the anti-fouling device cup on the bottom plate with fresh water to remove any debris.
 - c. Rinse the bottom plate with fresh water and dry with a lint-free cloth or tissue.
 - d. Examine the O-ring for dirt, nicks, or cuts. O-rings must be pristine. Replace the O-ring if you are not sure of its condition. Clean as necessary. Apply a light coat of silicone-based lubricant to the O-ring.
 - e. Replace the O-ring on the bottom plate.
6. Install the bottom plate again:
 - a. Align the bottom plate with the housing body. Make sure that the end of the anti-fouling device cup is aligned with the conductivity cell. Carefully put the bottom plate on the housing.
 - b. Install the six ¼-inch socket head screws, lock washers, and flat washers.
 - c. Install the drain plug in the bottom plate.

If the data looks incorrect after the MicroTSG is cleaned, it may be caused by—

 - A problem with the electrical connections
 - A problem with the PCB
 - Internal fouling in the conductivity cell that was not removed when it was cleaned
 - Sensors that need to be recalibrated.

8.1 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.






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.

Section 9 Reference: command descriptions

9.1 Status

DS	Show status
----	-------------

Example, user entries in **boldface**:

DS

SBE45 V 1.1b SERIAL NO. 1258
not logging data

Interval= sample interval = 10 seconds
OutputCond= output conductivity with each sample
OutputSal= do not output salinity with each sample
OutputSV= and SVAlgorithm do not output sound velocity with each sample
AutoRun= do not start sampling when power on
Single Sample= do not power off after taking a single sample
AutoOff= do not power off after two minutes of inactivity
NCycles= A/D cycles to average = 4

DS	Show operation status and setup parameters
	Firmware version and serial number
	Data collection status (not started, started, no data collection, or unknown)
	Interval= time between samples for autonomous operation.
	OutputCond=transmit conductivity with each sample
	OutputSal= salinity output; shows if set to yes
	OutputSV= sound velocity; if yes, sound velocity algorithm
	AutoRun= start data collection when power is turned on
	SingleSample= go to low power after a single sample
	AutoOff= go to low power after two minutes of inactivity
	NCycles= A/D cycles to average per sample
	OutputFormat= format of data

9.2 General setup

Baud=x	x=baud rate. 1200, 2400, 4800, 9600, 19200, 38400. Default: 4800.
OutputFormat=x	x=0: data order is temperature, conductivity, salinity, sound velocity. Default. x=1: suppress space before conductivity data x=2: data order is temperature, salinity, conductivity, sound velocity. Does not work with Seasave or SBE Data Processing software, or the optional Interface Box.
Output Cond=x	x=Y: calculate and show conductivity. Default. x=N: do not
OutputSal=x	x=Y: calculate and show salinity in psu n=N: do not. Default.

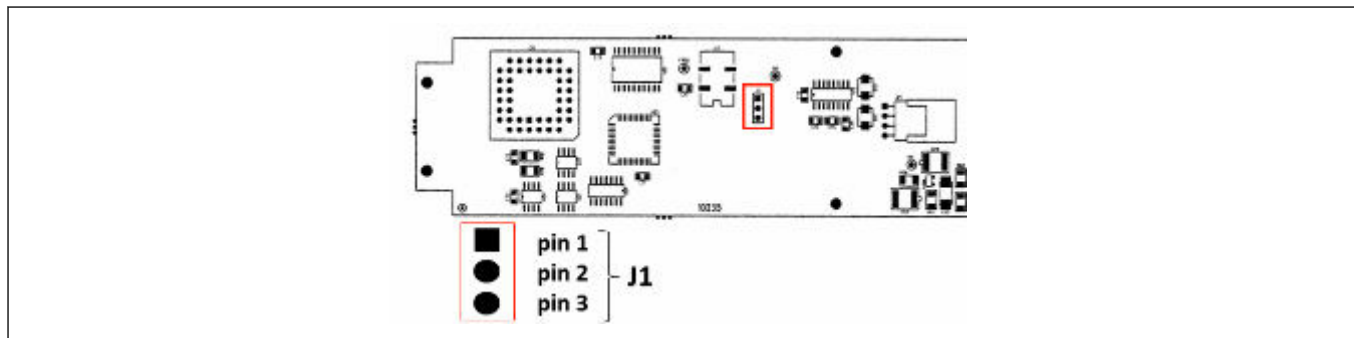
Reference: command descriptions

OutputSV=x	x=Y: calculate and show sound velocity in m/sec. Select SVAAlgorithm= x=N: do not. Default.
SVAAlgorithm=x	c=C: If OutputSV=Y, calculate sound velocity with Chen and Millero formula. Default. x=W: If OutputSV=Y, calculate sound velocity with Wilson formula Reference: UNESCO Technical Papers in Marine Science #44
NCycles=x	x=number of measurements to average per sample. Default = 4. If NCycles is increased the measurement resolution increases, as does the time required for measurement.
QS	Quit session and put the sensor into a low-power state. Data collection stops. Applies only if PCB J1 jumper is in Normal position.

9.3 Operation

Interval=x	x=interval between samples, 1–32767 secs. The SBE 45 collects samples at this interval. Does not go into low power mode between samples.
AutoOff=x	Only applies if J1 jumper is in Normal position. x=Y: go to low power mode if no command is sent or data is collected for 2 minutes x=N: do not automatically go to low power mode
AutoRun=x	x=Y or N: works with SingleSample= and J1 jumper setting. Refer to the table below for details.
SingleSample=x	x=Y or N: works with AutoRun= and J1 jumper setting. Refer to the table below for details.
Go	start data collection as defined by SingleSample= and Interval= applies if AutoRun=N or AutoRun=Y and the Stop command was sent.
Stop	stop data collection. Push Enter for S>, then enter Stop.

Table 4 J1 jumper on SBE 45 circuit board



J1 jumper	AutoRun	SingleSample	Effect
Normal	N	Y or N	Enters standby mode when Connect is selected or Enter key is pushed.
	Y	N	Enters standby mode when Connect is selected or Enter key is pushed and sample rate is specified by Interval=.
	Y	Y	Enters standby mode when Connect is selected or Enter key is pushed. Collect and transmit a single sample and automatically go to low power.
Autopower (default)	N	Y or N	Enters standby mode when power is supplied.
	Y	N	Enters standby mode when power is supplied. Collect data at a rate specified by Interval= until power is removed. Required setting for SBE 45 in three-wire configuration (power, ground and transmit) or when used with SBE 45 Interface Box.
	Y	Y	Enters standby mode when power is supplied. Collect and transmit a single sample. Waits for another command until power is removed.

9.4 Controlled ("polled") data collection

TS	collect a sample, hold converted data in RAM, and transmit
TSR	collect a sample, hold raw data (temperature and conductivity only) and transmit
SLT	transmit data from the last sample stored in the buffer, and then take a new sample
TH	collect a sample, hold converted data in RAM
SH	transmit held converted data from RAM

9.5 Test commands

TT	measure temperature for 100 samples or until the Esc key is pushed. The output is converted data.
TC	measure conductivity for 100 samples or until the Esc key is pushed. The output is converted data.
TTR	measure temperature for 100 samples or until the Esc key is pushed. The output is raw data.
TCR	measure conductivity for 100 samples or until the Esc key is pushed. The output is raw data.

Section 10 Troubleshooting

10.1 No communications with sensor

The `S>` prompt shows that there is communication between the sensor and PC. If the `S>` prompt does not show, 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 were not entered correctly in the software.

Solution: Make sure that the settings agree with the values on the Configuration Sheet that shipped with the sensor.

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

Solution: Make sure that the cable is a standard 9-pin RS232 cable.

10.2 Scan length errors

Cause: The software shows a scan length error and data does not show. This can occur, for example, if the configuration file has an NMEA device added, but the NMEA device is not physically connected to the PC. The software continues to collect data in real-time, but does not show the data.

Solution: The data quality is not affected and can be corrected later.

Solution: Make sure the configuration file and the .xmlcon file agree. Correct the configuration file as necessary.

10.3 Data looks incorrect

Cause: Data that looks incorrect, with values out of range, for example, may be caused by incorrect calibration coefficients in the sensor.

Solution: Make sure that the calibration coefficients in the sensor are the same as the Calibration Sheet from the manufacturer.

10.4 Low salinity values

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

Solutions:

1. Clean the conductivity cell. Refer to [Maintenance](#) on page 25 for details.
2. Blow *clean* air (not compressed) through the cell to remove large drops of water from the cell.
3. Enter the **TSR** command and look at the raw conductivity frequency. It should be within 1 Hz of the zero conductivity value on the Calibration Sheet. If it is very different, the cell is probably damaged.

Section 11 General information

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

11.1 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.

11.2 Warranty

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

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.						

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