SBE 45 MicroTSG (Thermosalinograph)

Conductivity and Temperature Monitor with RS-232 Interface

User's Manual

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Table of Contents

Section 1: Introduction

This section includes contact information, Quick Start procedure, and photos of a standard SBE 45 MicroTSG shipment.

About this Manual

This manual is to be used with the SBE 45 MicroTSG Conductivity and Temperature Monitor.

It is organized to guide the user from installation through operation and data collection. We've included detailed specifications, command descriptions, maintenance and calibration information, and helpful notes throughout the manual.

A feedback questionnaire is located at the end of the manual. Please take a few moments to let us know how you like the manual contents and format. Either use the form or e-mail comments to dbresko@seabird.com. Your feedback will help *us* provide you with a complete and comprehensive User's Manual.

How to Contact Sea-Bird

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(1600 to 0200 Universal Time)
Except from April to October, when we are on 'summer time'
(1500 to 0100 Universal Time)

Quick Start

Follow these steps to get a Quick Start using the MicroTSG.
The manual provides step-by-step details for performing each task:

1. Perform pre-check procedures:
   A. On the product configuration sheet (on the manual front cover), check the factory-set power-up mode jumper setting. For a description of how the jumper setting affects operation, see *Power-Up Jumper Check* in *Section 3: Preparing the MicroTSG for Deployment*.
   B. Test power and communications (see *Power and Communications Test* in *Section 3: Preparing the MicroTSG for Deployment).*

2. Deploy the MicroTSG (see *Section 4: Deploying and Operating the MicroTSG)*:
   A. Verify the anti-foul cylinder is installed.
   B. Install the MicroTSG.
   C. Send commands to run the system.

Unpacking the MicroTSG

Shown below is a typical MicroTSG shipment.

MicroTSG

I/O Cable

User Manual

Software

Spare parts kit

Cell cleaning solution (Triton X-100)

9-pin adapter

Section 2: Description of the MicroTSG

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

System Description

The SBE 45 MicroTSG is an externally-powered, high-accuracy, conductivity and temperature monitor, designed for shipboard determination of sea surface (pumped-water) conductivity and temperature.

Communication with the MicroTSG is over an internal, 3-wire, RS-232C link, providing real-time data transmission. Commands can be sent to the MicroTSG to provide status display, data acquisition setup, data retrieval, and diagnostic tests. User-selectable operating modes include:

- **Polled sampling** – The MicroTSG takes one sample and sends the data to the computer.
- **Autonomous sampling** – At pre-programmed intervals, the MicroTSG samples and sends the data to the computer. The MicroTSG does not enter quiescent (sleep) mode between samples.
- **Serial Line Sync** - A pulse on the serial line causes the MicroTSG to wake up, sample, and enter quiescent mode automatically.

Calibration coefficients stored in EEPROM allow the MicroTSG to transmit data in engineering units. The MicroTSG retains the temperature and conductivity sensors used in the SBE 21 Thermosalinograph, but has improved acquisition electronics that increase accuracy and resolution, and lower power consumption. The MicroTSG's aged and pressure-protected thermistor has a long history of exceptional accuracy and stability (typical drift is less than 0.002 °C per year). Electrical isolation of the conductivity electronics eliminates any possibility of ground-loop noise.

The MicroTSG's internal-field conductivity cell is unaffected by external fouling, and uses an expendable anti-fouling device to inhibit internal fouling. A plastic cup with O-ring retainer at one end of the cell retains the anti-foul material. The anti-foulant is typically effective for at least one year of deployment.

Note:
See SEATERM's help files for detailed information on the use of the program.

The MicroTSG is supplied with SEATERM©, a powerful terminal program for easy communication and data retrieval. SEATERM can send commands to the SBE 45 to provide status display, data acquisition setup, data display and capture, and diagnostic tests. Note that SEATERM **does not process the data**. SEATERM is a Windows 95/NT application.

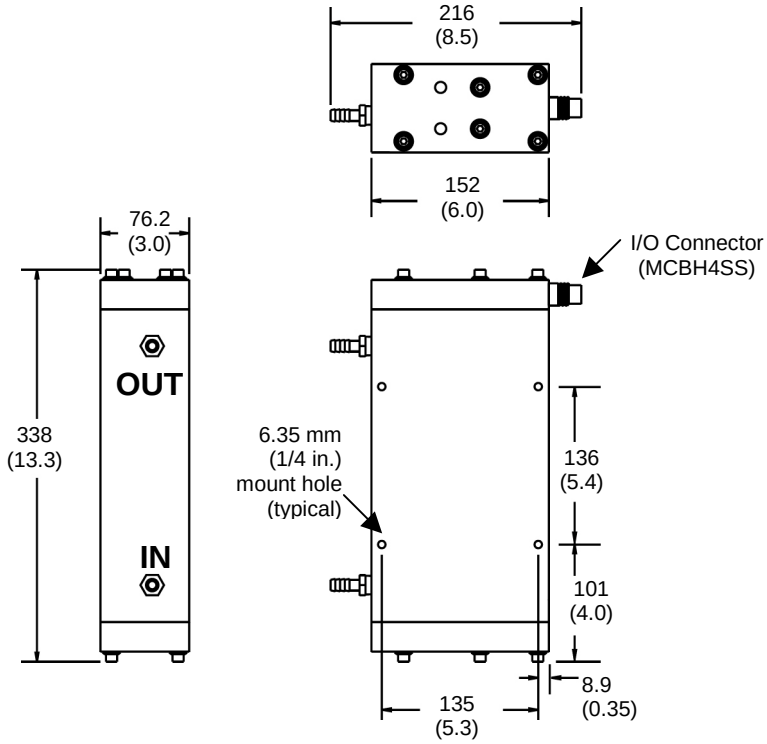
MicroTSG Specifications

	Temperature (°C)	Conductivity (S/m)	Salinity (PSU), typical
Measurement Range	-5 to +35	0 to 7 (0 to 70 mS/cm)	-
Initial Accuracy	0.002	0.0003 (0.003 mS/cm)	0.005
Typical Stability (per month)	0.0002	0.0003 (0.003 mS/cm)	0.003
Resolution *	0.0001	0.00001 (0.0001 mS/cm)	0.0002
Sensor Calibration Range	+1 to +32	0 to 6; physical calibration over the range 2.6 to 6 S/m, plus zero conductivity (air)	-
Counter Time-Base	Quartz TCXO, ±2 ppm per year aging; ±5 ppm vs. temperature (-5 to +30 °C)		
Input Power	8 - 30 VDC Quiescent Current: 10 microamps Operating Current: 34 milliamps at 8 VDC 30 milliamps at 12-30 VDC		
Materials	PVC housing		
Recommended Flow Rate	10 to 30 milliliters/second (0.16 to 0.48 gallons/minute)		
Maximum Safe Operating Pressure	34.5 decibars (50 psi)		
Weight	4.6 kg (10.2 lbs)		

***Resolution**
Typical RMS noise with fixed resistors on the temperature and conductivity inputs:

NCYCLES	Temperature (°C)	Conductivity (S/m)	Salinity (psu)	Sound Velocity (m/sec)
1	0.000190	0.000014	0.00027	0.00066
2	0.000170	0.000010	0.00016	0.00057
4	0.000150	0.000005	0.00015	0.00055
8	0.000087	0.000005	0.00009	0.00033
16	0.000078	0.000004	0.00007	0.00025

MicroTSG Dimensions in millimeters (inches)



Sample Timing

The time to acquire the temperature and conductivity varies, depending on the mode of operation.

Polled Sampling Mode
Polled Sampling Mode is in effect when:
- PCB J1 jumper is set to Normal or Autopower, and
- **AUTORUN=N**

Time from end of take sample command to beginning of reply (seconds)
= (**NCYCLES** *0.1336) + 0.459

Autonomous Sampling Mode
Autonomous Sampling Mode is in effect when:
- PCB J1 jumper is set to Normal or Autopower, and **AUTORUN=Y** and **SINGLESAMPLE=N**, or
- PCB J1 jumper is set to Normal (pins 2 and 3), and **AUTORUN=N** and **SINGLESAMPLE=N**

Time to acquire temperature and conductivity (seconds)
= (**NCYCLES** *0.1336) + 0.287

Serial Line Sync Mode
Serial Line Sync Mode is in effect when:
- PCB J1 jumper set to Normal (pins 2 and 3), and
- **AUTORUN=Y** and **SINGLESAMPLE=Y**

Time from wake-up to beginning of reply (seconds)
= (**NCYCLES** *0.1336) + 1.643

Total Sampling Time

Once temperature and conductivity are acquired, the time to calculate the desired parameters is not a function of the mode of operation:
- Time to compute temperature = 8.8 msec
- Time to compute conductivity = 15.4 msec
- Time to compute salinity = 83 msec
- Time to compute sound velocity = 35 msec

Total time required for sample =
time to acquire temperature and conductivity
+ time to compute selected parameters
+ time to transmit computed parameters (dependent on baud rate)

Note:
If the total time required for the sample is greater than the user-input sample interval (**INTERVAL**), the MicroTSG begins the next sample as soon as it finishes transmitting the current sample.

Section 3: Preparing the MicroTSG for Deployment

This section describes the pre-check procedure for preparing the MicroTSG for deployment. Checking the power-up mode jumper setting and testing power and communications are discussed.

Power-Up Jumper Check

The MicroTSG's Printed Circuit Board (PCB) has a jumper that controls how the MicroTSG wakes up:

- Jumper set for Autopower (default) – The MicroTSG wakes up when power is applied. System capability is dependent on the *external* wiring configuration:
  - Three wires – **This configuration is useful in simple systems where a controller applies power, waits for data, and then removes power**. Only three of the four wires (Power, Ground, and Transmit) are needed for operation, since it is not necessary to command the MicroTSG to take samples. Note that the MicroTSG **does not respond to any commands in this configuration**, so initial setup of the system must be performed with all four wires in place (see *Command Descriptions* in *Section 4: Deploying and Operating the MicroTSG*).
  - Four wires – With all four wires (Power, Ground, Receive, and Transmit), the MicroTSG *can* receive and respond to most commands. Note that the MicroTSG does not respond to the **QS** command in this configuration.

- Jumper set for Normal – The MicroTSG powers up (wakes up) when there is a pulse on the serial interface lines. In this configuration, the MicroTSG can be controlled using the documented commands and can be commanded into a quiescent (sleep) mode with the **QS** command.

Note:
For a three-wire external wiring configuration, set:
- J1 jumper to Autopower
- **AUTORUN=Y**, and
- **SINGLESAMPLE=N**

See *Section 4: Deploying and Operating the MicroTSG* for details.

Verify the jumper setting in one of the following ways:

- Check the MicroTSG configuration sheet (on the manual front cover) for the factory-setting, or

- Connect the MicroTSG to the computer as described in *Power and Communications Test*, set the appropriate communications settings, wake up the MicroTSG with the Connect button, and then enter the **QS** command after the **S>** prompt. The response indicates whether the jumper is in the Normal or Autopower configuration:
  - Autopower – system returns **S>** prompt, indicating that the MicroTSG is not in quiescent (sleep) mode.
  - Normal – system does not return **S>** prompt, indicating that the MicroTSG is in quiescent (sleep) mode.

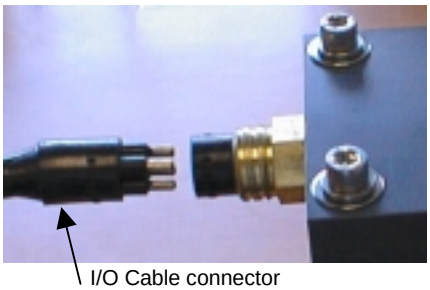
Note:
See *Appendix II: Electronics Disassembly/Reassembly* for details on accessing the PCB to change the jumper setting.

Power and Communications Test

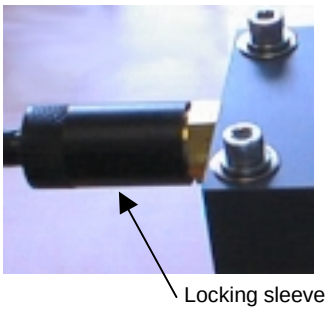
The power and communications test will verify that the system works, prior to deployment.

Test Set-Up

1. If not already installed, install SEATERM on your computer using the supplied software:
   A. Insert Disk 1 in your floppy disk drive.
   B. Double click on **Setup.exe**.
   C. Follow the dialog box directions to install the software.
   (Note: It is possible to use the MicroTSG without SEATERM by sending direct commands from a dumb terminal or terminal emulator, such as Windows HyperTerminal.)



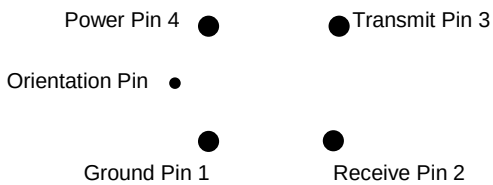
2. Install the I/O cable:
   A. Lightly lubricate the sides of the rubber prongs on the cable connector with silicone grease (DC-4 or equivalent).
   B. Install the cable connector, aligning the long pin with the small hole on the MicroTSG's bulkhead connector.
   C. Place the locking sleeve over the connector. Tighten the sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**



3. Connect the I/O cable connector to your computer's serial port. A 25-to-9 pin adapter is supplied for use if your computer has a 9-pin serial port.

4. Connect the I/O cable connector's red (+) and black (-) wires to a power supply (8-30 VDC).

Note:
Refer to the Schematics at the back of the manual for I/O Cable pin-outs.



Ground pin = Computer data common (pin 1)
Receive pin = RS-232C receive data transmitted from computer (pin 2)
Transmit pin = RS-232C transmit from MicroTSG to computer (pin 3)
Power pin = 8-30 VDC (pin 4)

Note:
See SEATERM's help files for detailed information on the use of the program.

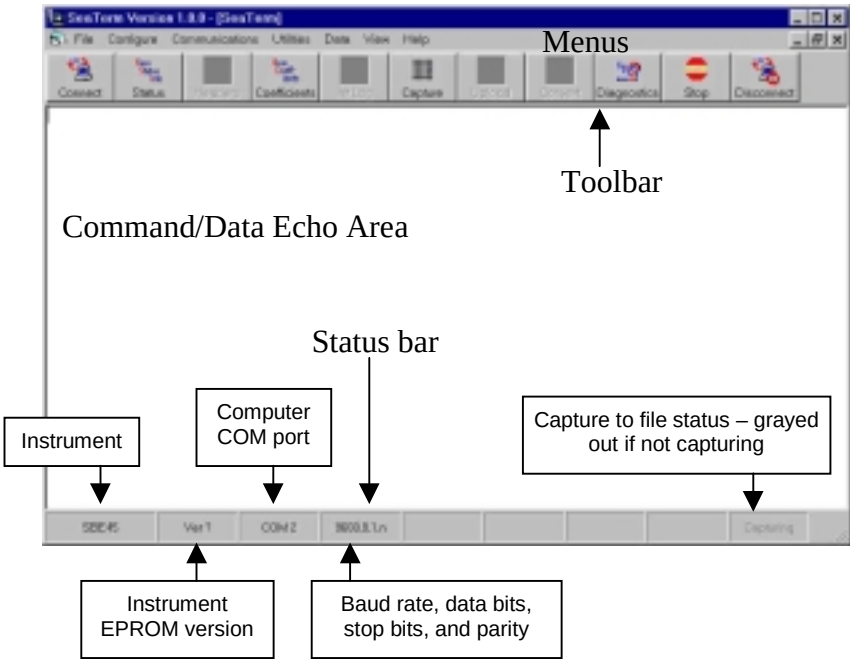
Test

Proceed as follows:

1. Double click on the SEATERM icon. If this is the first time the program is used, the configuration dialog box appears:

Select the instrument type (SBE 45 TSG) and the computer COM port for communication with the MicroTSG. Click OK.

2. The main screen looks like this:



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

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

Note:
Once the system is configured and connected (Steps 3 and 4 below), to update the Status bar:
- on the Toolbar, click Status; or
- from the Utilities menu, select Instrument Status.

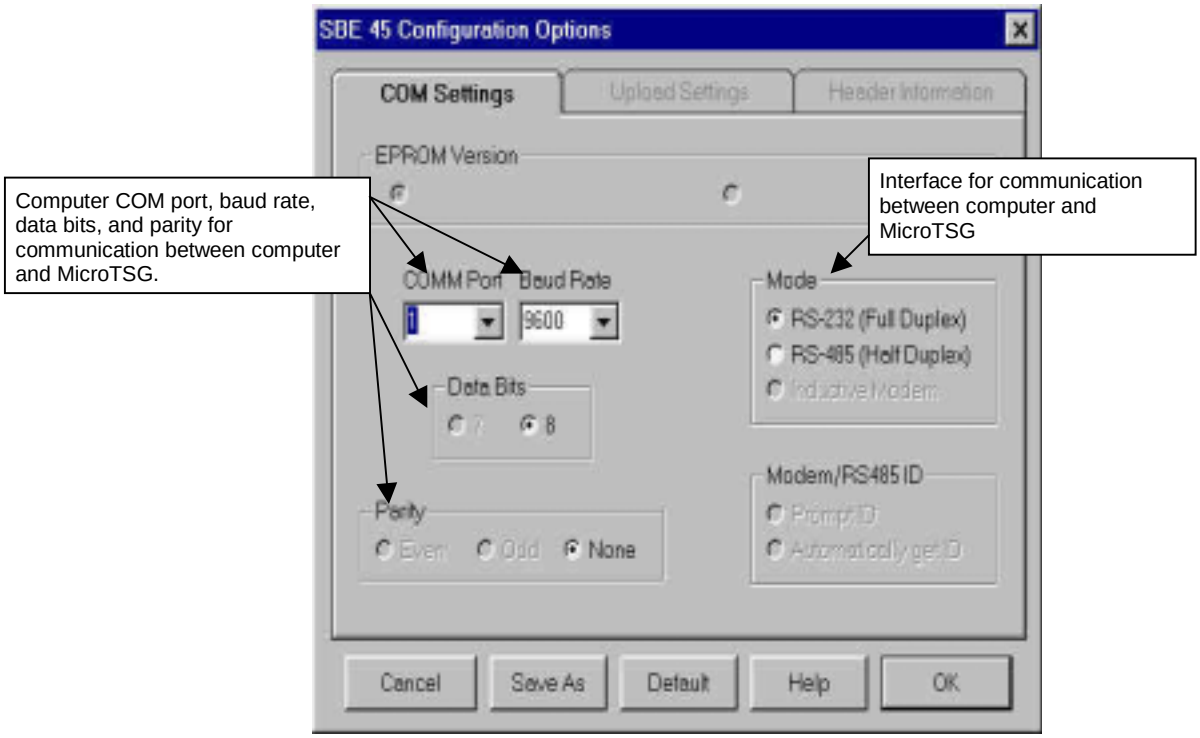
SEATERM sends the status command, which displays in the Command/Data Echo Area, and updates the Status bar.

Following are the Toolbar keys applicable to the MicroTSG:

Toolbar Keys	**Description**	**Equivalent Command***
Connect	Re-establish communications with MicroTSG. Computer responds with **S>** prompt.	(press Enter key)
Status	Display instrument status.	**DS**
Coefficients	Display calibration coefficients.	**DC**
Capture	Capture instrument responses on screen to file. **As MicroTSG has no internal memory, you must capture before sampling begins to save data for future review and processing**. File has .CAP extension. Press Capture again to turn off capture. Capture status displays in Status bar.	**—**
Diagnostics	Perform one or more diagnostic tests on MicroTSG. Diagnostic test(s) accessed in this manner are non-destructive – they do not write over any existing instrument settings.	**DS, DC, TS,** and **TSR**
Disconnect	Free computer COM port used to communicate with MicroTSG. COM port can then be used by another program. Note that MicroTSG must be connected to COM port for data to be obtained.	**—**

*See *Command Descriptions* in *Section 4: Deploying and Operating the MicroTSG*.

3. In the Configure menu, select SBE 45 TSG. The dialog box looks like this:



Make the selections in the Configuration Options dialog box:

- Baud Rate: 9600 (documented on front cover of this manual)
- Mode: RS-232 (Full Duplex)

Click OK to overwrite an existing configuration file, or click Save As to save the configuration as a new filename.

4. Click Connect on the Toolbar. The display looks like this:

   S>SBE45 V 1.0
   S>

   This shows that correct communications between the computer and the MicroTSG has been established. If the system does not respond as shown:
   - Press Connect again to attempt to establish communications.
   - Verify the correct instrument was selected in the Configure menu and the settings were entered correctly in the Configuration Options dialog box.
   - Check cabling between the computer and the MicroTSG.

5. Display MicroTSG status information by clicking Status on the Toolbar. The display looks like this:

   SBE45 V 1.0 SERIAL NO. 1258
   not logging data
   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

6. Command the MicroTSG to take a sample by typing **TS** and pressing the Enter key. The display looks like this (if *output conductivity with each sample*, *do not output salinity with each sample*, and *do not output sound velocity with each sample* displayed in response to the status command in Step 5) :

   23.7658, 0.00019

   where 23.7658 = temperature in degrees Celsius
   0.00019 = conductivity in S/m

   These numbers should be reasonable; i.e., room temperature and zero conductivity.

7. Command the MicroTSG to go to sleep (quiescent mode) by typing **QS** and pressing the Enter key. The response indicates whether the PCB's J1 jumper is in the Normal or Autopower configuration:
   - Autopower – system returns **S>** prompt.
   - Normal – system does not return **S>** prompt.

   If necessary, remove the PCB and move the jumper to the desired pins.

The MicroTSG is ready for deployment.

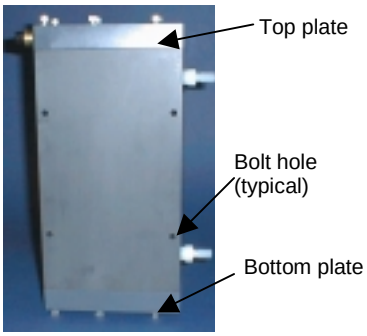
Notes:
- See *Power-Up Jumper Check* for a description of Autopower and Normal.
- See *Appendix II: Electronics Disassembly/Reassembly* to access the PCB and move the jumper.

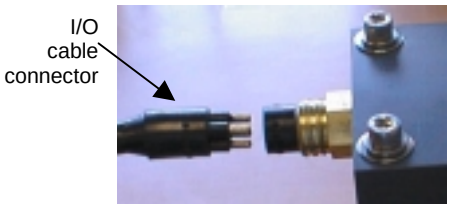
Section 4: Deploying and Operating the MicroTSG

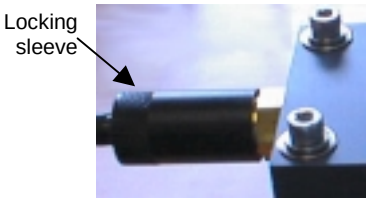
Note:
See SEATERM's help files for detailed information on the use of the program.

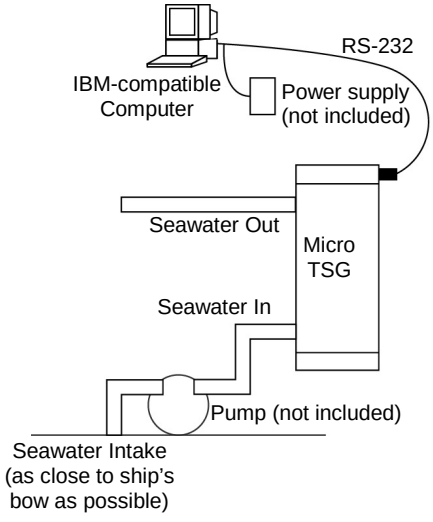
This section provides instructions for deploying the MicroTSG. It also includes a discussion of system operation, example sets of operation commands, and detailed command descriptions.

Deployment









Physical Handling

1. New MicroTSGs are shipped with an anti-foul cylinder pre-installed. Verify that the cylinder is in the anti-foul cup (see *Section 5: Routine Maintenance and Calibration* for access to and replacement of the anti-foul cylinder).

2. Mount the MicroTSG, with the electrical connector at the top, using the four 1/4-inch bolt holes on the sides. Provide clearance as follows:
   - Bottom — 152 mm (6 inches) clearance for removal of the bottom plate, to allow access for replacing the anti-foul cylinder and cleaning.
   - Top — 305 mm (12 inches) clearance for removal of the top plate, to allow access for removing sensors and electronics.
   - Sides — small clearance by using washers with the mounting hardware, to prevent binding when removing the top or bottom plate.

3. Install the I/O cable:
   A. Lightly lubricate the sides of the rubber prongs on the cable connector with silicone grease (DC-4 or equivalent).
   B. Install the cable connector, aligning the long pin with the small hole on the MicroTSG's bulkhead connector.
   C. Place the locking sleeve over the connector. Tighten the sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

4. Install the piping connections to the MicroTSG. The housing is tapped with 3/8-inch U.S. standard NPT threads. Nylon hose barb fittings for 1/2-inch tubing are provided.

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

6. Connect the MicroTSG to the computer and power supply. (See *Power and Communications Test* in *Section 3: Preparing the MicroTSG for Deployment.*)

Note:
See *Power and Communications Test* in *Section 3: Preparing the MicroTSG for Deployment* for starting SEATERM and configuring it for the MicroTSG.

Set-Up for Operation

1. Press Connect on the Toolbar to wake up the MicroTSG and get an **S>** prompt.
2. Establish the sampling scheme, after reviewing the information in this section on sampling modes and commands.
3. Deploy the MicroTSG.

Sampling Modes

The MicroTSG has three basic sampling modes for obtaining data: Polled Sampling, Autonomous Sampling, and Serial Line Synchronization Sampling. However, commands and the J1 jumper setting on the MicroTSG's PCB can be used in various combinations to provide a high degree of operating flexibility.

Shown below are descriptions and examples of the three basic sampling modes. Note that the MicroTSG's response to each command is not shown in the examples. Review the operation of the basic sampling modes and the commands described in *Command Descriptions* before setting up your system.

Polled Sampling Mode

The MicroTSG takes one sample of data and sends the data to the computer.

Examples: ***Polled Sampling Mode***

Example 1*:* J1 jumper in Normal position (pins 2 and 3).
Wake up MicroTSG. Set up MicroTSG to wait for command each time MicroTSG wakes up, and send salinity with data. Send power-off command after all parameters are entered.

(Press Connect on Toolbar to wake up.)
S>AUTORUN=N
S>OUTPUTSAL=Y
S>QS

When ready to take a sample, wake up MicroTSG. Command MicroTSG to take a sample, send sample data to computer, and output converted data. Send power-off command when done.

(Press Connect on Toolbar to wake up.)
(Press Capture on Toolbar to capture data to a file – program requests file name for data to be stored.)
S>TS
S>QS

Example 2*:* J1 jumper in Autopower position (pins 1 and 2).
Wake up MicroTSG. Set up MicroTSG to wait for command each time MicroTSG wakes up, and send salinity with data. Remove power after all parameters are entered.

(Apply power to wake up.)
S>AUTORUN=N
S>OUTPUTSAL=Y
(Remove power.)

When ready to take a sample, wake up MicroTSG. Command MicroTSG to take a sample, send sample data to computer, and output converted data. Remove power when done.

(Apply power to wake up.)
(Press Capture on Toolbar to capture data to a file – program requests file name for data to be stored.)
S>TS
(Remove power.)

Autonomous Sampling Mode

The MicroTSG samples data at pre-programmed intervals, defined by the **INTERVAL** command, and sends the data to the computer. The MicroTSG does not enter quiescent (sleep) mode between samples.

Examples: ***Autonomous Sampling Mode***

Example 1*:* J1 jumper in Normal position (pins 2 and 3)**, AUTORUN=Y, SINGLESAMPLE=N.**
Set up to take samples every 20 seconds. Send power-off command after all parameters are entered.

(Press Connect on Toolbar to wake up.)
S>SINGLESAMPLE=N
S>INTERVAL=20
S>AUTORUN=Y
S>QS

When ready to begin sampling:
(Press Capture on Toolbar to capture data to a file – program requests file name for data to be stored.)
(Press Connect on Toolbar to wake up – sampling begins automatically.)

When ready to stop sampling and power-off:
(Press Enter key to get **S>** prompt.)
S>STOP
S>QS

Example 2*:* J1 jumper in Normal position (pins 2 and 3)**, AUTORUN=N, SINGLESAMPLE=N.**
Set up to take samples every 20 seconds. Send power-off command after all parameters are entered.

(Press Connect on Toolbar to wake up.)
S>SINGLESAMPLE=N
S>INTERVAL=20
S>AUTORUN=N
S>QS

When ready to begin sampling:
(Press Capture on Toolbar to capture data to a file – program requests file name for data to be stored.)
(Press Connect on Toolbar to wake up.)
S>GO

When ready to stop sampling and power-off:
(Press Enter key to get **S>** prompt.)
S>STOP
S>QS

Example 3*:* J1 jumper in Autopower position (pins 1 and 2).
Set up to take samples every 20 seconds. Remove power after all parameters are entered.

(Apply power and press Connect on Toolbar to wake up.)
S>SINGLESAMPLE=N
S>INTERVAL=20
S>AUTORUN=Y
(Remove power.)

When ready to begin sampling:
(Press Capture on Toolbar to capture data to a file – program requests file name for data to be stored)
(Apply power to wake up – sampling begins automatically.)

When ready to stop sampling:
(Remove power.)

Serial Line Synchronization Mode (Serial Line Sync)

In Serial Line Sync Mode, a simple pulse (a single character) on the RS-232 line causes the MicroTSG to wake up, take and output a single sample, and automatically power-off (enter quiescent mode). This mode is enabled if **AUTORUN=Y**, **SINGLESAMPLE=Y**, and the PCB's J1 jumper is in the Normal position (pins 2 and 3).

Example: ***Serial Line Sync Mode***
(J1 jumper in Normal position – pins 2 and 3)

Set up to take a sample upon receipt of any character and then automatically power-off. Send power-off command to MicroTSG after all parameters are entered – system automatically wakes up and powers down for each sample upon receipt of a character.

(Press Connect on Toolbar to wake up.)
S>SINGLESAMPLE=Y
S>AUTORUN=Y
S>QS

When ready to take a sample (repeat as desired):

(Press Capture on Toolbar to capture data to a file – program requests file name for data to be stored)
(Press Enter key to wake up, sample, and power-off.)

When ready to stop sampling or change operation:

(Press Enter key several times to get **S>** prompt)
S>STOP
S>(Enter desired commands)

Timeout Description

The MicroTSG has a timeout algorithm when jumpered in the Normal configuration (PCB J1 pins 2 and 3). If the MicroTSG does not receive a command or sample data for two minutes and **AUTOFF=Y**, it powers down its communication circuits. This places the MicroTSG in quiescent mode, drawing minimal current. **To re-establish control (wake up), press Connect on the Toolbar or the Enter key.** The system responds with the **S>** prompt.

Command Descriptions

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

When entering commands:

- Input commands to the MicroTSG in upper or lower case letters and register commands by pressing the Enter key.
- The MicroTSG sends '**? CMD'** if an invalid command is entered.
- If the system does not return an **S>** prompt after executing a command, press the Enter key to get the **S>** prompt.
- If in quiescent mode, re-establish communications by pressing Connect on the Toolbar or the Enter key to get an **S>** prompt.

Note:
If the external voltage is below 6.15 volts, the following displays in response to the status command: **WARNING: LOW BATTERY VOLTAGE!!**

Status Command

DS — Display operating status:
firmware version
serial number
logging status
sample interval time
conductivity output with each sample?
salinity output with each sample?
sound velocity output with each sample?
start sampling when power on?
power off after taking single sample?
power off after 2 minutes of inactivity?
A/D cycles to average per sample.

Logging status can be: logging data, not logging data, or unknown status.

Equivalent to Status button on Toolbar.

Example: Display status for MicroTSG.

```
S>DS
SBE45 V 1.0  SERIAL NO. 1258
not logging data
sample interval = 10 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
```

Setup Commands	
BAUD=x	**x=** baud rate (1200, 2400, 4800, 9600, 19200, or 38400)
OUTPUTCOND=x	**x=Y** (default) – calculate and output conductivity (S/m) **x=N** – do not calculate and output conductivity
OUTPUTSAL=x	**x=Y** – calculate and output salinity (psu) **x=N** (default) – do not calculate and output salinity
OUTPUTSV=x	**x=Y** – calculate and output sound velocity (m/sec), using Chen and Millero formula (UNESCO Technical Papers in Marine Science #44) **x=N** (default)– do not calculate and output sound velocity
NCYCLES=n	**n=** number of A/D cycles to average (default = 4). Increasing **NCYCLES** increases measurement resolution and time required for measurement. See *Sample Timing* in *Section 2: Description of the MicroTSG*.
QS	Quit session and place MicroTSG in quiescent (sleep) mode. Sampling stops. Applicable only if PCB J1 jumper is in Normal position.

Operating Mode Commands

Operating Mode commands configure the MicroTSG's response upon waking up, and direct the MicroTSG to sample data once or at pre-programmed intervals.

Note:
If the total time required for the sample is greater than **INTERVAL**, the MicroTSG begins the next sample as soon as it finishes transmitting the current sample.

INTERVAL=n

Set interval between samples to n seconds (maximum 32767 seconds). MicroTSG samples at this interval, and does not enter quiescent (sleep) mode between samples. Minimum time between samples determined by **NCYCLES**, desired calculated parameters (salinity, etc.), and baud rate; see *Sample Timing* in *Section 2: Description of the MicroTSG*.

AUTOOFF=x

(Functional only if J1 jumper on PCB is in Normal position)
x=Y – Automatically power-off (enter quiescent mode) if 2 minutes have elapsed without receiving a command or without sampling data.

x= N – Do not automatically power-off.

AUTORUN=x

x=Y or **N** – This command interacts with **SINGLESAMPLE** and J1 jumper setting, as described in table below.

SINGLESAMPLE=x

x=Y or **N** – This command interacts with **AUTORUN** and J1 jumper setting, as described in table below.

Note:
If the MicroTSG is sampling data and the external voltage is less than 6.15 volts for ten consecutive scans, the MicroTSG halts logging and displays **WARNING: LOW BATTERY VOLTAGE** in response to the status (**DS**) command.

GO

Start sampling, as defined by **SINGLESAMPLE** and **INTERVAL**. Only applicable if:

- **AUTORUN=N**, or
- **AUTORUN=Y** and you previously sent **STOP** command to stop sampling.

STOP

Stop sampling.

PCB's J1 Jumper	AUTORUN	SINGLESAMPLE	Effect
Normal (pins 2 and 3)	**N**	**Y** or **N**	Wake up when Enter key pressed while in quiescent (sleep) mode and wait for command.
	Y	**N**	Wake up when Enter key pressed while in quiescent (sleep) mode and sample at rate specified by **INTERVAL**. To stop sampling and get **S>** prompt, type **STOP** and press Enter key.
	Y	**Y**	Wake up when Enter key pressed while in quiescent (sleep) mode, take and output a single sample, and automatically power-off (enter quiescent mode). To wake up and get **S>** prompt, type **STOP** and press Enter key. Referred to as **Serial Line Sync Mode**.
Autopower (pins 1 and 2)	**N**	**Y** or **N**	Wake up when power applied and wait for command.
	Y	**N**	Wake up when power applied and sample at rate specified by **INTERVAL** until power removed. **These are the required settings for running MicroTSG in 3-wire (power, ground, and transmit) configuration**.
	Y	**Y**	Wake up when power applied and take and output a single sample. Wait for another command until power removed.

Sampling Commands

These commands are used to request a sample from the MicroTSG. The MicroTSG stores data for the most recent sample in its RAM. The MicroTSG does not automatically power off after executing these commands. Do not send these commands if the MicroTSG is sampling data at pre-programmed intervals (defined by **INTERVAL** and **SINGLESAMPLE**).

TS	Take sample, hold converted data in RAM, output converted data.
TSR	Take sample, hold raw data (temperature and conductivity only) in RAM, output raw data.
SLT	Send last sample from RAM, output converted data, then take new sample and hold converted data in RAM.
TH	Take sample, hold converted data in RAM.
SH	Send held converted data from RAM.

Testing Commands

TT	Measure temperature for 100 samples or until Esc key is pressed, output converted data.
TC	Measure conductivity for 100 samples or until Esc key is pressed, output converted data.
TTR	Measure temperature for 100 samples or until Esc key is pressed, output raw data.
TCR	Measure conductivity for 100 samples or until Esc key is pressed, output raw data.

Coefficients Command	
DC	Display calibration coefficients. Equivalent to Coefficients button on Toolbar.

Notes:
1. See individual Coefficient Commands below for definitions of the data in the example.
1. Dates shown are when calibrations were performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with MicroTSGs.

Example: Display coefficients for MicroTSG.

```
S>DC
SBE45   V 1.0   0011
temperature:      08-apr-96
TA0 =    -9.420702e-05
TA1 =     2.937924e-04
TA2 =    -3.739471e-06
TA3 =     1.909551e-07
conductivity:     09-apr-96
G =              -1.036689e+00
H =               1.444342e-01
I =              -3.112137e-04
J =               3.005941e-05
CPCOR =          -9.570001e-08
CTCOR =           3.250000e-06
WBOTC =           1.968100e-05
```

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

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

TCALDATE=S	Temperature calibration date
TA0=F	Temperature A0
TA1=F	Temperature A1
TA2=F	Temperature A2
TA3=F	Temperature A3
CCALDATE=S	Conductivity calibration date
CG=F	Conductivity G
CH=F	Conductivity H
CI=F	Conductivity I
CJ=F	Conductivity J
WBOTC=F	Conductivity wbotc
CTCOR=F	Conductivity ctcor
CPCOR=F	Conductivity cpcor

Data Output Format

The output data format is:

ttt.tttt, cc.ccccc, sss.ssss, vvvvv.vvv

where
t = temperature (degrees Celsius, ITS-90)
c = conductivity (S/m), data sent only if **OUTPUTCOND=Y**
s = salinity (psu), data sent only if **OUTPUTSAL=Y**
v = sound velocity (meters/second), data sent only if **OUTPUTSV=Y**
All data is separated with a comma and a space.

Example: Sample data output when **OUTPUTCOND=Y**, **OUTPUTSAL=N**, and **OUTPUTSV=N**:

23.7658, 0.00019
(temperature, conductivity)

Section 5: Routine Maintenance and Calibration

This section reviews corrosion precautions, cell cleaning and storage, sensor calibration, and replacement of the anti-foul cylinder. The accuracy of the MicroTSG is sustained by the care and calibration of the sensors and by establishing proper handling practices.

Corrosion Precautions

All hardware exposed to seawater is titanium; the housing is plastic. No corrosion precautions are required. The MicroTSG should be cleaned as described below after use and prior to storage.

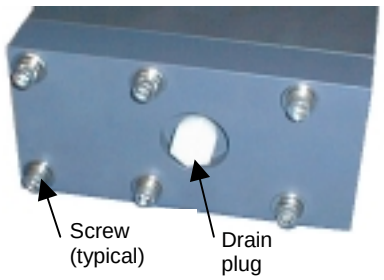
Cleaning and Storage

CAUTION:
The MicroTSG's conductivity cell is shipped dry to prevent freezing in shipping and depletion of the anti-foul cylinder. **Do not store the MicroTSG with water in the conductivity cell.** Freezing temperatures (for example, in Arctic environments or during air shipment) can break the cell if it is full of water.

Clean the MicroTSG and conductivity cell:

- Monthly (during sustained use)
- Before periods of non-use – If the cell is not rinsed between usage, salt crystals may form on the platinized electrode surfaces. When the instrument is used next, sensor accuracy may be temporarily affected until these crystals dissolve.
- If the data looks incorrect –
  - Unusually *noisy* data may be caused by debris going through the cell.
  - Unusually *smooth* data may be caused by a blockage in the flow path or in the cell.
  - Shifted data may be caused by fouling inside the cell.

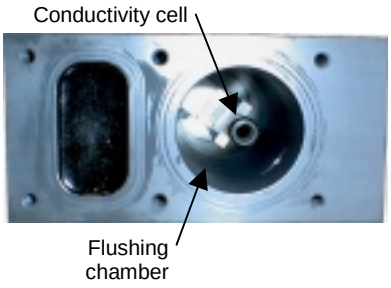
Follow this cleaning procedure:



Step 1: Clean Out Drain

A. Keeping the MicroTSG in an upright position, remove the drain plug from the housing's bottom plate.

B. Allow any water to drain out and remove any sediment or debris from the drain.



Step 2: Inspect Flushing Chamber

A. Remove the bottom plate:
   i. Remove the six 1/4-inch socket head screws, lock washers, and flat washers securing the bottom plate to the housing body. Hold the bottom plate as you remove the hardware, to prevent the plate from falling.
   ii. Pull the bottom plate straight down from the housing body, being careful not to damage the conductivity cell, which sits in the housing.

B. Use a flashlight to inspect the flushing chamber and conductivity cell for debris or fine deposits. If this is a routine monthly maintenance, and there is no evidence of debris or fine deposits, proceed to *Step 5: Clean Bottom Plate Assembly*.

CAUTION:
1. **Do not put a brush or any object inside the cell.**
1. **Do not spray any solutions directly into the open end of the cell.**

If fouling remains in the conductivity cell after these procedures, return the MicroTSG to Sea-Bird for internal cleaning and recalibration.

Step 3: Clean Flushing Chamber

A. Gently spray fresh water up into the chamber to remove any fine deposits inside the housing. Be careful not to hit the conductivity cell with the spray hose.

Step 4: Flush Inside of Conductivity Cell

A. Remove the external plumbing connecting the seawater intake and drain lines to the MicroTSG.

WARNING!
Use protective eyewear and wear gloves when working with hydrochloric acid. Avoid breathing the acid fumes. Dilute and rinse any spills with fresh water, or neutralize large spills with baking soda (sodium bicarbonate powder).

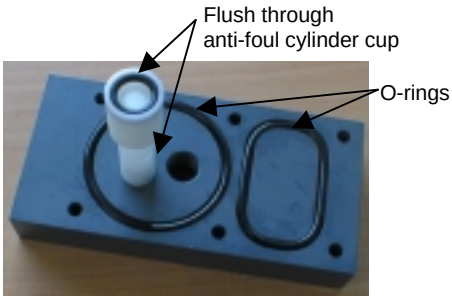
Produce 1-normal hydrochloric acid as follows:
1. Start with muriatic acid, which is 31.45% HCl (20 degrees Baume) by weight.
1. Dilute 0.1 liters of muriatic acid into 0.9 liters of fresh water.

B. Clean the inside of the conductivity cell with a series of slow back flushes into the **OUT** port (reverse of the normal operation flow). Collect the drainage in a bucket held below the open housing:
   i. Fresh water to remove debris and deposits
   ii. 1 liter of 1-normal hydrochloric acid, slow flow through the cell
   iii. 10 liters of fresh water to rinse the acid
   iv. (optional) 1 liter of 1% solution of Triton X-100 (Triton X-100 is included with shipment)

C. Rinse the exterior of the instrument to remove any spilled acid from the surface.

D. If the MicroTSG is being stored, gently blow-dry the conductivity cell and flushing chamber.

E. Reinstall the external plumbing connecting the seawater intake and drain lines to the MicroTSG.



WARNING!
Wear gloves if touching or handling the anti-foul cylinder.

Step 5: Clean Bottom Plate Assembly

A. Remove the two O-rings on the bottom plate. Put the O-rings aside, being careful to protect them from damage or contamination.
B. Flush the anti-foul cylinder cup on the bottom plate with fresh water, to remove any debris or fine deposits. See *Replacing Anti-Foul Cylinder* for details on handling the anti-foul cylinder if you want to replace it.
C. Rinse the bottom plate with fresh water.
D. Remove water from the O-rings and the bottom plate with a lint-free cloth or tissue.
E. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to the O-rings and mating surfaces.
F. Replace the O-rings on the bottom plate.

CAUTION:
1. If you remove sensors and electronics from the housing to troubleshoot, **avoid getting anything on the PCB**, which can be damaged by water or other materials. See *Appendix II: Electronics Disassembly/ Reassembly* for details.
1. **Do not put any object inside the conductivity cell to clean it.** Return the MicroTSG to Sea-Bird for internal cleaning and recalibration.

Step 6: Reinstall Bottom Plate

A. Align the bottom plate with the housing body, ensuring the end of the anti-foul cylinder cup is aligned with the conductivity cell. Slowly position the bottom plate on the housing.
B. Re-secure the bottom plate to the housing body with the six 1/4-inch socket head screws, lock washers, and flat washers.
C. Reinstall the drain plug in the bottom plate.

If the data still looks incorrect after cleaning, 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 by flushing
- sensors that need to be recalibrated

Sensor Calibration

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

We recommend that MicroTSGs be returned to Sea-Bird for calibration.

Note:
Do not disassemble the MicroTSG to send the sensors to Sea-Bird for recalibration. Package the entire MicroTSG for shipment, after removing the anti-foul cylinder (see *Replacing Anti-Foul Cylinder*). Store the anti-foul cylinder for future use.

Conductivity Sensor Calibration

The conductivity sensor incorporates a fixed precision resistor in parallel with the cell. When the cell is dry and in air, the sensor's electrical circuitry outputs a frequency representative of the fixed resistor. This frequency is recorded on the Calibration Certificate and should remain stable (within 1 Hz) over time.

The primary mechanism for calibration drift in conductivity sensors is the fouling of the cell by chemical or biological deposits. Fouling changes the cell geometry, resulting in a shift in cell constant.

Accordingly, the most important determinant of long-term sensor accuracy is the cleanliness of the cell. We recommend that the conductivity sensors be calibrated before and after deployment, but particularly when the cell has been exposed to contamination by oil slicks or biological material.

Temperature Sensor Calibration

The primary source of temperature sensor calibration drift is the aging of the thermistor element. Sensor drift will usually be a few thousandths of a degree during the first year, and less in subsequent intervals. Sensor drift is not substantially dependent upon the environmental conditions of use, and — unlike platinum or copper elements — the thermistor is insensitive to shock.

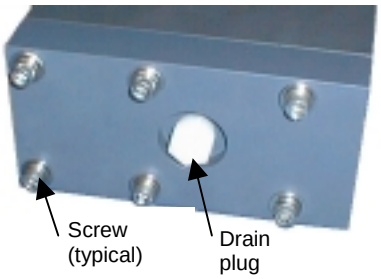
Replacing Anti-Foul Cylinder

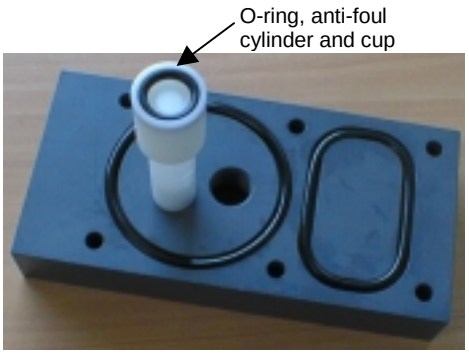
WARNING!

1. **Anti-foul cylinders contain tri-butyl tin oxide (TBTO). Handle the cylinder with gloves. If the cylinder comes in contact with skin, wash with soap and water immediately. Dispose of gloves properly. Refer to the Material Safety Data Sheet in the shipment for details.**
1. Anti-foul cylinders are **not** classified by the U.S. DOT or the IATA as hazardous material, in the quantities used by Sea-Bird.

The MicroTSG has an anti-foul cup inside the housing. New MicroTSGs are shipped with an anti-foul cylinder pre-installed in the cup.

The anti-foul cylinder has a useful deployment life in the MicroTSG of approximately 6 months. Sea-Bird recommends that you keep track of how long the cylinder has been deployed, to allow you to purchase and replace the cylinder when needed.





Handling the cylinder with gloves, follow this procedure:

1. Keeping the MicroTSG in an upright position, remove the drain plug from the housing's bottom plate. Allow any water to drain out and remove any sediment or debris from the drain before proceeding.

2. Remove the bottom plate:
   A. Remove the six 1/4-inch socket head screws, lock washers, and flat washers securing the bottom plate to the housing body. Hold the bottom plate as you remove the hardware, to prevent it from falling.
   B. Pull the bottom plate straight down from the housing body, being careful not to damage the conductivity cell, which sits in the housing at the end of the anti-foul cup.

3. Remove the anti-foul cylinder:
   A. Place the bottom plate on a horizontal surface. Remove the small O-ring securing the anti-foul cylinder in the anti-foul cup.
   B. Remove the old anti-foul cylinder. If it is difficult to remove, use needle-nose pliers and carefully break up the material.

4. Clean the bottom plate assembly:
   A. Remove the two O-rings on the bottom plate. Put the O-rings aside, being careful to protect them from damage or contamination.
   B. Rinse the bottom plate and flush the inside of the anti-foul cup and post with fresh water to remove sediment or debris.
   C. Remove water from the O-rings and the bottom plate with a lint-free cloth or tissue.
   D. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to the O-rings and mating surfaces.
   E. Replace the O-rings on the bottom plate.

5. Place the new anti-foul cylinder in the cup, and replace the O-ring.

6. Reinstall the bottom plate:
   A. Align the bottom plate with the housing body, ensuring the end of the anti-foul cylinder cup is aligned with the conductivity cell. Slowly position the bottom plate on the housing.
   B. Re-secure the bottom plate to the housing body with the six 1/4-inch socket head screws, lock washers, and flat washers.
   C. Reinstall the drain plug in the bottom plate.

Glossary

Anti-foul cylinder – Expendable device saturated with a tri-butyl-tin based toxin placed inside the anti-foul cup, located at the end of the conductivity cell.

Fouling – Biological growth in the conductivity cell during deployment.

PCB – Printed Circuit Board.

Scan – One data sample containing temperature and conductivity, as well as derived variables (salinity and sound velocity).

SBE 45 MicroTSG – High-accuracy conductivity and temperature monitor.

SEATERM – Terminal program used to communicate with the MicroTSG. SEATERM can send commands to the SBE 45 to provide status display, data acquisition setup, data display and capture, and diagnostic tests. SEATERM is a Windows 95/NT application.

TCXO – Temperature Compensated Crystal Oscillator.

Triton X-100 – Concentrated liquid non-ionic detergent, used for cleaning the conductivity cell.

Appendix I: Functional Description

Sensors

The MicroTSG embodies the same sensor elements (3-electrode, 2-terminal, borosilicate glass cell, and pressure-protected thermistor) previously employed in Sea-Bird's modular SBE 3 and SBE 4 sensors, in the SEACAT family, and in the SBE 37 MicroCAT family.

Sensor Interface

Temperature is acquired by applying an AC excitation to a hermetically-sealed VISHAY reference resistor and an ultra-stable aged thermistor with a drift rate of less than 0.002 °C per year. A 24-bit A/D converter digitizes the outputs of the reference resistor and thermistor. AC excitation and ratiometric comparison using a common processing channel avoids errors caused by parasitic thermocouples, offset voltages, leakage currents, and reference errors.

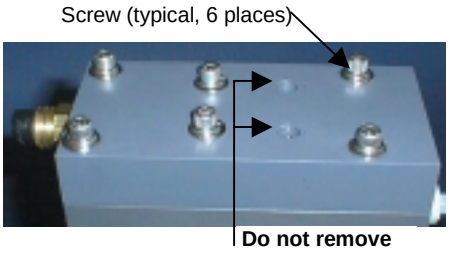
Conductivity is acquired using an ultra-precision Wein Bridge oscillator to generate a frequency output in response to changes in conductivity. A high stability TCXO reference crystal with a drift rate of less than 2 ppm/year is used to count the frequency from the Wein Bridge oscillator.

Appendix II: Electronics Disassembly/Reassembly

Note:
Do not disassemble the MicroTSG to send the sensors or PCB to Sea-Bird for recalibration or repair. Package the entire MicroTSG for shipment, after removing the anti-foul cylinder (see *Section 5: Routine Maintenance and Calibration*).

Do not disassemble the MicroTSG electronics unless:
- moving the J1 jumper on the PCB to change operation from Autopower (default) to Normal, or vice versa, or
- troubleshooting a problem, and need to access the PCB or sensors

Disassembly



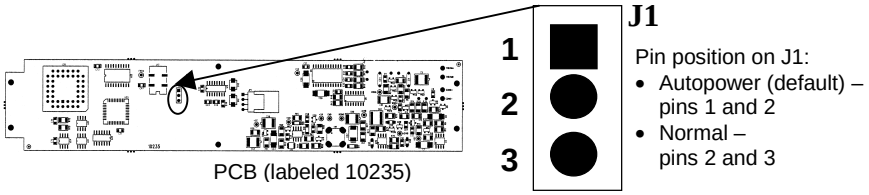
CAUTION:
Avoid getting anything on the PCB, which can be damaged by water or other materials.

1. Remove the six 1/4-inch socket head screws, lock washers, and flat washers securing the top plate to the housing body. **Do not remove the two screws that are recessed in the top plate – these secure the electronics to the top plate**.

2. Remove the top plate by pulling up on it firmly and steadily. It may be necessary to **slightly** twist the top plate back and forth to loosen it. Lift the top plate vertically off the housing body, **being careful not to hit the conductivity cell on the housing body.**

3. Remove any water from the O-ring mating surfaces on the top plate assembly and on the housing with a lint-free cloth or tissue.

4. If applicable, see drawing below for J1 jumper setting information.



Pin position on J1:
- Autopower (default) – pins 1 and 2
- Normal – pins 2 and 3

Reassembly

Note:
Before delivery, a desiccant package is attached to the PCB with string, and the electronics chamber is filled with dry Argon. These measures help prevent condensation. **If the electronics are exposed to the atmosphere for more than an hour, allow the desiccating process to continue inside the reassembled housing for one week before performing calibrations or other critical work. If this is not done, conductivity readings may be in error by as much as 0.001 S/m.**

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

2. Align the top plate with the housing body, with the conductivity cell's round end cap aligned with the round opening in the housing body. Slowly lower the top plate, checking that it remains aligned with the housing body. You will feel resistance as the O-rings on the sensor end cap enter the housing.

3. Re-secure the top plate to the housing body with the six 1/4-inch socket head screws, lock washers, and flat washers.

Appendix III: Command Summary

CATEGORY	COMMAND	DESCRIPTION
Status	**DS**	Display status.
Setup	**BAUD=x**	**x=** baud rate (1200, 2400, 4800, 9600, 19200, or 38400)
	OUTPUTCOND=x	**x=Y** (default): output conductivity (S/m) with data **x=N**: do not output conductivity with data
	OUTPUTSAL=x	**x=Y**: output salinity (psu) with data **x=N** (default): do not output salinity with data
	OUTPUTSV=x	**x=Y**: output sound velocity (m/sec) with data **x=N** (default): do not output sound velocity with data
	NCYCLES=n	**n** = number of A/D cycles to average (default=4)
	QS	Quit session and place MicroTSG in quiescent (sleep) mode. Sampling stops. Applicable only if PCB J1 jumper in Normal position.
Operating Mode PCB's J1 jumper interacts with these commands: • Autopower – pins 1 and 2 • Normal – pins 2 and 3	**INTERVAL=n**	Set interval between samples to n seconds (maximum 32767). Minimum time between samples determined by **NCYCLES**, desired parameters (salinity, etc.), and baud rate.
	AUTOOFF=x	**(Functional only if J1 jumper in Normal position)** **x=Y**: Power-off (enter quiescent mode) if 2 minutes have elapsed without receiving a command or without sampling data. **x=N**: Do not automatically power-off.
	J1 jumper - Normal **AUTORUN=N** **SINGLESAMPLE=** **Y** or **N**	Wake up when Enter key pressed while in quiescent (sleep) mode, wait for a command.
	J1 jumper - Normal **AUTORUN=Y** **SINGLESAMPLE=N**	Wake up when Enter key pressed while in quiescent (sleep) mode, sample at rate specified by **INTERVAL**. To stop sampling and get **S>** prompt, type **STOP** and press Enter key.
	J1 jumper - Normal **AUTORUN=Y** **SINGLESAMPLE=Y**	Wake up when Enter key pressed while in quiescent (sleep) mode, take and output a single sample, automatically power-off. To wake up and get **S>** prompt, type **STOP** and press Enter key.
	J1 jumper - Autopower **AUTORUN=N** **SINGLESAMPLE=** **Y** or **N**	Wake up when power applied, wait for a command.
	J1 jumper - Autopower **AUTORUN=Y** **SINGLESAMPLE=N**	Wake up when power applied, sample at rate specified by **INTERVAL** until power removed. **These are the required settings for running MicroTSG in 3-wire (power, ground, and transmit) configuration**.
	J1 jumper - Autopower **AUTORUN=Y** **SINGLESAMPLE=Y**	Wake up when power applied, take and output a single sample. Wait for another command until power removed.
	GO	Start sampling, as defined by **SINGLESAMPLE** and **INTERVAL**. Applicable if **AUTORUN=N**, or **AUTORUN=Y** and you previously sent **STOP** command to stop sampling.
	STOP	Stop sampling.

CATEGORY	COMMAND	DESCRIPTION
Sampling Do not send these commands if MicroTSG is sampling data at pre-programmed intervals.	**TS**	Take sample, hold converted data in MicroTSG's RAM, output converted data
	TSR	Take sample, hold raw data in MicroTSG's RAM, output raw data.
	SLT	Send converted data from last sample in MicroTSG's RAM, then take new sample and hold converted data in RAM.
	TH	Take sample, hold converted data in MicroTSG's RAM.
	SH	Send held converted data from MicroTSG's RAM.
Testing	**TT**	Measure temperature for 100 samples or until Esc key is pressed, output converted data.
	TC	Measure conductivity for 100 samples or until Esc key is pressed, output converted data.
	TTR	Measure temperature for 100 samples or until Esc key is pressed, output raw data
	TCR	Measure conductivity for 100 samples or until Esc key is pressed, output raw data.
Coefficients (F=floating point number; S=string with no spaces) Dates shown are when calibrations were performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with MicroTSGs.	**DC**	Display calibration coefficients; all coefficients and dates listed below are included in display. Use individual commands below to modify a particular coefficient or date.
	TCALDATE=S	Temperature calibration date.
	TA0=F	Temperature A0.
	TA1=F	Temperature A1.
	TA2=F	Temperature A2.
	TA3=F	Temperature A3.
	CCALDATE=S	Conductivity calibration date.
	CG=F	Conductivity G.
	CH=F	Conductivity H.
	CI=F	Conductivity I.
	CJ=F	Conductivity J.
	WBOTC=F	Conductivity wbotc.
	CTCOR=F	Conductivity ctcor.
	CPCOR=F	Conductivity cpcor.

Appendix IV: Replacement Parts

Part Number	Part	Application Description	Quantity in MicroTSG
30593	Screw, 1/4-20 x 1 3/4" socket, stainless steel	Secures top and bottom plates to housing body	12
30254	Washer, 1/4" split ring lock, stainless steel	For screw 30593 (secures top and bottom plates to housing body)	12
30570	Washer, 1/4" flat, stainless steel	For screw 30593 (secures top and bottom plates to housing body)	12
24173	Anti-foul cylinder	Anti-foul poison tube inserted into anti-foul cup	1
30507	O-ring, Parker 2-206N674-70	Seal for conductivity cell end, secures anti-foul cylinder in cup	1
31057	O-ring, Parker 2-229N674-70	Round seal between bottom plate and housing	1
31060	O-ring, Parker 2-225N674-70	Rectangular seal between bottom plate and housing	1
31058	O-ring, Parker 2-239N674-70	Large seal for top plate to housing body	1
30818	O-ring, Parker 2-203N674-70	Seal for top plate to housing body center screws	2
31060	O-ring, Parker 2-225N674-70	Seal between sensor end cap and round cavity in housing body	2
50091	Triton X-100	Conductivity cell cleaning solution	1
801204	4-pin I/O cable	From MicroTSG to computer	1
17130	25-pin to 9-pin adapter	Connects I/O cable to 9-pin COM port on computer	1
60036	Spare hardware/ O-ring kit	Assorted hardware and O-rings	-

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