



SEA-BIRD
SCIENTIFIC

User manual

SBE 52-MP Moored Profiler CTD

with optional DO sensor



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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.

WARNING



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

CAUTION

AF24173 anti-fouling devices contain bis(tributyltin) oxide. Wear rubber or latex gloves and eye protection to replace these devices on the sensor if it is so equipped. Wash hands with soap and water when finished.

Read the precautions on the product label.

It is a violation of US federal law to use this product in a manner that is inconsistent with its label.

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.

Safety information

	<p style="text-align: center;">ATTENTION! Remove sticker before deployment!</p> <p>This sticker protects your instrument during shipping. REMOVE BEFORE DEPLOYMENT; if it is not removed, your instrument will not operate properly and you may cause severe damage to the conductivity cell. The conductivity cell is made of glass and will break if mishandled or frozen while filled with water. Apply new sticker to protect instrument when not in use (see spares kit).</p> <p>NOTICE: Sticker may have come in contact with the AF24173 Anti-foulant device, which contains TBTO. Dispose of the removed sticker. See SDS for handling precautions.</p>
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	<p>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.</p>
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	<p>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.</p>
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Section 2 SBE 52 quick start guide

This quick start guide gives the steps necessary to make sure that the SBE 52 sensor operates correctly and collects data before it is deployed.

What's in the box:

- SBE 52
 - CD—has software, calibration files, documentation
 - Spare parts kit
 - I/O cable to connect the sensor to a PC.
1. Install the manufacturer-supplied software on a PC. Refer to [Install software](#) on page 11 for details.
 2. Connect the sensor to the PC and start the software.
 3. Set up the sensor for deployment. Refer to [Set up and test communication](#) on page 11 for details.
 - a. Remove the protective caps from the T-C Duct and pump exhaust.
 - b. If necessary, make sure that all data stored in the sensor is transmitted to a PC.
 - c. Set the date and time (DateTime)
 - d. Configure the data collection settings.
 - e. Send the DS and DC commands to verify the setup.
 4. Put the 52-MP in the water.
 5. Supply power when the sensor is in the water.
 6. Send any character to put the sensor in standby mode, then send the **StartProfile** command.
 7. Immediately after the sensor is recovered from a deployment:
 - a. Use the software to turn off the sensor.
 - b. Rinse the sensor with fresh water.
 - c. Keep the sensor out of direct sunlight between deployments.
 8. Transmit data from the sensor to a PC.
 9. To store the sensor:
 - a. Rinse the sensor thoroughly, then dry.
 - b. Leave the batteries in the sensor for storage up to a year.

Section 3 Specifications

3.1 Electrical

Input	3 watts at 7–16 VDC
Current draw @ 10V	
Low power	0.008 mA
Standby	5.2 mA
Turn-on transient	300 mA
Operation	62 mA (includes pump)

3.2 Communication

Communication interface	RS232 or Logic Level
Data collection rate	1 Hz (1 sample/second)
Firmware version	2.5 and newer

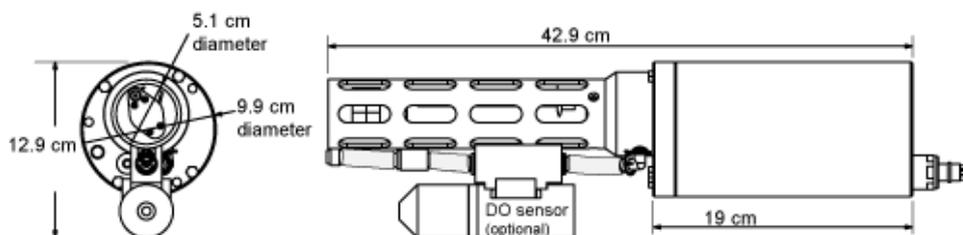
3.3 Analytical

Parameter	Range	Accuracy	Stability	Resolution	Calibration
Temperature	-5–35 °C	± 0.002 °C	0.0002 °C/mo	0.001 V/month	1–32
Conductivity	0–9 S/m	±0.0003 S/m	0.000 S/m/mo	0.00005 S/m	zero conductivity, air plus 2.6 to 6 S/m
Pressure	not more than the SBE 52 rated depth	±0.1%	0.05% full scale range/yr	0.002% full scale range	Ambient pressure to full scale range in 5 steps
Dissolved Oxygen (optional)	120% surface saturation	± 2% of saturation	0.5%/1000 hours (clean membrane)	0.035% of saturation	1, 4, 7 ml/L at 2, 6, 12, 20, 26, 30 °C

3.4 Mechanical

	Plastic	Titanium
Depth rating	600 m	7000 m
Weight in air, water	3.2, 1.5 kg	5.3, 3.7 kg

3.4.1 Dimensions

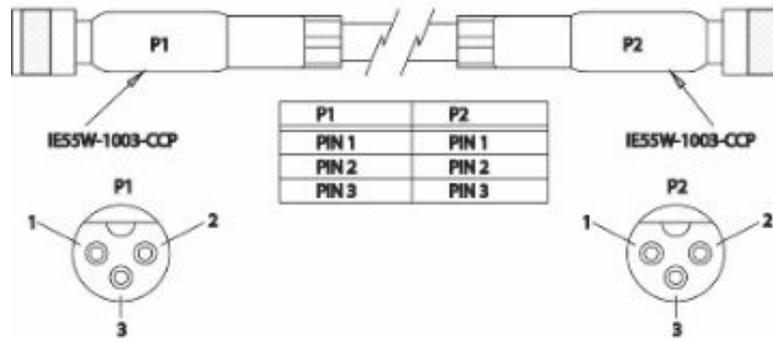


Specifications

3.4.2 Cable and connectors

3.4.2.1 Dissolved Oxygen cable and connectors

SBE 52-MP to DO Sensor Cable Wiring -- DN 32561



3.4.2.2 Bulkhead connector

Contact	Function	MCBH-4-MP
1	Ground	
2	Rx RS485 A	
3	Tx RS485 B	
4	Voltage in	

Section 4 Overview

The SBE 52-MP is a conductivity, temperature, depth (pressure) sensor (CTD), designed for moored profiling applications. The SBE 52-MP makes vertical profile measurements from a device that travels vertically beneath a buoy, or from a buoyant sub-surface sensor package that is winched up and down from a bottom-mounted platform. The 52-MP uses a pump-controlled, TC-ducted flow to minimize salinity spikes. On typically slow-moving packages (20–50 cm/sec), the sample rate of once per second provides good spatial resolution of oceanographic structures and gradients. The 52-MP is intended for use in marine or fresh-water environments at depths to 600 or 7000 meters.

The 52-MP can be configured with a Dissolved Oxygen sensor module (SBE 43F). The SBE 43F is a frequency-output version of the SBE 43 Dissolved Oxygen sensor, and has the same specifications.

The 52-MP uses the same thermistor, conductivity cell, and pressure sensor that are used in the MicroCAT and Argo Float products. Data is stored in the EEPROM, and stored calibration coefficients let the user transmit data in ASCII engineering units (mmho/cm, °C, decibars, ml/L). The user can transmit data in hexadecimal or binary.

The 52-MP is externally powered, and temporarily stores data in static RAM memory. When power is removed, any data stored in memory is lost. However, the user-programmable setup is stored in non-volatile RAM, and is kept when power is removed.

The integral pump on the SBE 52-MP operates during data collection with several advantages over a non-pumped system:

- Improved conductivity and oxygen response—The pump brings a new water sample into the system at a constant flow rate, so that the time constants give maximum dynamic accuracy. The pump flushes the previously sampled water from the conductivity cell and oxygen sensor plenum. For polled data collection, the operation time for the pump for best dissolved oxygen accuracy is a function of temperature and pressure, and is automatically determined by the 52-MP (55 seconds, maximum).
- Reduced fouling—When the SBE 52 is in standby mode, the U-shaped flow path and pump impeller restrict flow to keep an effective concentration of anti-foulant *inside* the conductivity cell to minimize biofouling.

An SBE 52-MP is supplied with:

- Plastic housing for depths to 600 meters, or titanium housing for depths to 7000 meters
- Conductivity, temperature, and pressure sensors in eight full scale ranges from 20 to 7000 decibars
- Optional anti-fouling devices
- Integrated T-C Duct and internal pump for flow-controlled conductivity, temperature, and dissolved oxygen sensor response
- Manufacturer-set RS232 or 0 - 3.3 volt logic level interface
- IE-55 bulkhead connector for optional SBE 43F Dissolved Oxygen sensor
- 3/8-16 hole in the sensor end flange to attach to a McLane MMP moored profiler
- The integral pump is for use with the SBE 52-MP only. Other sensors on a moored profiler require separate pump(s).

4.1 RS232 or logic level communications

The SBE 52-MP communicates with a manufacturer-set 0–3.3 volt logic level link **or** RS232 interface. Communication protocol is 9600 baud, 8 data bits, 1 stop bit, and no parity.

Note that the Seaterm software does not include the 52-MP. Select the SBE 49 in the **Configure** menu as an alternative: the SBE 49 uses the same data bits, stop bit, and parity.

Section 5 Set up sensor and verify operation

5.1 Install software

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

1. Install the software from the manufacturer-supplied USB drive, CD, or the website.
2. Start the software. It automatically connects at the default baud rate of 9600 but will try others if necessary. The software automatically looks for the serial port number of the connected sensor.
3. Select the connected sensor.

5.2 Set up and test communication

Use the Seaterm software to set up the 52-MP if an RS232 interface or a logic level-to-RS232 converter is used.

1. Select Seaterm.exe and if necessary, select the SBE 49 and the COM port.
2. Push **OK**.
3. At the **Instruments** menu, select the connected sensor.
4. Push **OK** to close the 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. From left to right, the information in the "Status Bar" at the bottom of the window shows—
 - Connected sensor
 - EPROM version of sensor
 - COM port used by the PC
 - Baud rate, data bits, stop bits, parity
 - Capture to file status. This is grayed out if not in use.
5. 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.

Toolbar button	Description	Command
Connect	Start communications with the sensor. An S> prompt shows.	any character
Status	Show setup and status	DS
Coefficients	Show calibration coefficients	DC
Capture	Save the sensor responses to a file with a .cap filetype. Capture status shows in the Status bar. Push Capture again to turn off capture.	—
Diagnostics	Do one or more diagnostics tests. Tests accessed here do not overwrite any current settings.	DS, DC, TS
Stop	Stop current activity, such as data collection or diagnostic test.	Esc or Ctrl-C
Disconnect	Disconnect the COM port on the PC so it can be used by another program.	—

6. From the **Configure** menu, select *SBE 49*. In the *COM Settings* tab:
 - a. COMM Port: 1–10, as applicable
 - b. Baud Rate: 9600, from Configuration Sheet
 - c. Data Bits: 8
 - d. Parity: None

Set up sensor and verify operation

- e. Mode: RS232 (full duplex)

Push **OK** to save the settings.

- 7. From the **Communications** menu, select *Options/Cycle baud with connecting*.

- 8. Push **Connect** on the toolbar.

The software tries to connect to the sensor at the baud rate set above. If it cannot, it will try other possible baud rates to try to connect. When it connects, an *S>* prompt shows.

If the system does not show an *S>* prompt, push **Connect** again. Make sure that the correct sensor was selected in the **Configure** menu and that the settings were entered correctly in the *COM Settings* tab of the **Configuration Options** window. Verify the 52-MP is correctly connected to the PC.

- 9. Look at the status information: select **Status** on the toolbar.

The display looks like this:

```
SBE 52 MP CTD 2.5 SERIAL NO. 0004
DO installed = yes
output CTDO when profiling
stop profile when pressure is less than = 5.0 decibars
automatic bin averaging when p < 5.0 disabled
number of samples = 10500
number of bins = 39
top bin interval = 10
top bin size = 10
top bin max = 100
middle bin interval = 50
middle bin size = 50
middle bin max = 1000
bottom bin interval = 100
bottom bin size = 100
do not include two transition bins
oxygen frequency multiplier = 1.00
```

- 10. Enter **TS** or **PTS**, then **Enter** to command the 52-MP to take one sample.

Note that the **PTS** command turns the pump on. The pump should not be operated in dry conditions. If necessary, fill the inside of the pump head with water through the pump exhaust tubing to provide enough lubrication to prevent damage to the pump during tests.

The display shows:

```
34.4789, 6.9892, 182.25, 6.768
```

where 34.4789 is conductivity, mmho/cm; 6.9892 is temperature, °C; 182.25 is pressure, decibars; 6.768 is dissolved oxygen, ml/L.

The SBE 52-MP is ready to be configured and deployed.

Section 6 Deployment and operation

The SBE 52-MP collects data in either autonomous mode (typical), or polled (controlled) mode. Note that the sensor does not show ("echo") characters transmitted from the PC. If, for example, the user sends the **DS** command, it will not show in the software display. Autonomous and polled commands are shown below as examples.

6.1 Autonomous operation

In autonomous mode, the 52-MP operates continuously. Data is collected at 1 Hz, or 1 scan/second, and stored to memory. The 52-MP can transmit the parameters listed below in real-time:

- pressure in decibars
- sample number
- pressure in decibars, **and** sample number
- conductivity in mmho/cm, temperature in °C, pressure in decibars, and (optional) oxygen in Hz **OR**
- conductivity in Hz, temperature in A/D counts, pressure in A/D counts, and (optional) oxygen in Hz.

Example setup

52-MP with RS232 interface, or RS232 converter for logic level: Use Seaterm software in the lab to set up 52-MP to sample on the upcast from 1000 m to 10 m, to automatically stop data collection at 10 m, and to calculate bins automatically when data collection stops. To average bins: set up a top section from 10 to 100 m with 10 m bins, a middle section from 100 to 300 m with 20 m bins, and a bottom section from 300 to 1000 m with 50 m bins, and also calculate transition bins. Set up 52-MP for real-time pressure output. Verify setup with status command. Remove power.

(Supply power, then send any character put the 52-MP in standby mode.)

```
S>PCUTOFF=10
```

```
S>AUTOBINAVG=Y
```

```
S>TOP_BIN_INTERVAL=10
```

```
S>TOP_BIN_SIZE=10
```

```
S>TOP_BIN_MAX=100
```

```
S>MIDDLE_BIN_INTERVAL=20
```

```
S>MIDDLE_BIN_SIZE=20
```

```
S>MIDDLE_BIN_MAX=300
```

```
S>BOTTOM_BIN_INTERVAL=50
```

```
S>BOTTOM_BIN_SIZE=50
```

```
S>INCLUDETRANSITIONBIN=Y
```

```
S>OUTPUTPRESSURE=Y
```

```
S>DS (to verify setup)
```

Remove power.

Configure a controller to monitor real-time pressure output to determine when autonomous data collection has stopped, and to send transmit data commands (**DD** for all data, and **DA** for bin-averaged data) after some delay to give the 52-MP time to calculate the bin averages.

To start data collection, put the 52-MP in the water, send it down to 1000 m, supply power, send any character to put the 52-MP in standby mode, and enter **S>STARTPROFILE**.

Autonomous data collection stops automatically at 10 m (**PCutoff=**), and the 52-MP calculates bins. The controller sends **DD** (unaveraged data) and **DA** (bin-averaged data) to transmit data.

6.2 Polled operation

On command, the SBE 52-MP takes one sample and transmits the data real-time.

Deployment and operation

Use the **PTS** command to operate the pump before data collection to make sure that the conductivity and optional dissolved oxygen measurement is based on a new water sample.

Oxygen sensor response time, and the length of time that the pump needs to operate before data collection, depends on temperature and pressure. The oxygen sensor response time increases with increased pressure and decreased temperature. Therefore, the 52-MP takes a *preliminary* measurement of temperature and pressure (but does not store these values in memory), uses those values to calculate the required pump time, operates the pump, and then takes a new measurement of all parameters.

Use the **TS** or **TSR** command to take a single sample. The pump does operate automatically before data collection. To operate the pump before a sample is taken, send **PumpOn** to turn the pump on before the **TS** or **TSR** command is sent. Send **PumpOff** to turn the pump off after the sample is taken.

Example setups

Example 1—Apply power and send any character to put the 52-MP in standby mode. Command the 52-MP to take a sample and transmit the data in ASCII engineering units with the **PTS** command (automatically operates the pump for the sample). Remove power. Repeat as necessary.

Supply power, then send any character to put the 52-MP into standby mode.

```
S>PTS
```

Remove power.

Example 2—Supply power and send any character to put the 52-MP into standby mode. Command 52-MP to turn pump on, take a sample and transmit raw data, then turn the pump off. Remove power. Repeat as necessary.

Supply power, then send any character to put the 52-MP into standby mode.

```
S>PUMPON
```

```
S>TSR
```

```
S>PUMPOFF
```

Remove power.

6.3 Data formats

The data format is related to the command sent to transmit data to the PC. Each line of data ends with a carriage return and line feed.

Data transmitted from memory:

- DDsf and DAsf commands—engineering units in decimal
- DDHsf and DAHsf commands—engineering units in hexadecimal (but raw oxygen)
- DDBsf and DABsf commands—engineering units in binary (but raw oxygen)

Real-time data:

- Autonomous data collection with OutputPressure=Y (real-time pressure in engineering units, TFP command)
- OuptutSN=Y (real-time sample number)
- OutputSN=Y and OutputPressure=Y (real-time C, T, and P in engineering units, O in Hz)
- OutputCTDORaw=Y (raw real-time C, T, P, and O)

Note that the pressure sensor for the 52-MP is an absolute sensor, so its raw data includes the effect of atmospheric pressure (14.7 psi). The 52-MP calibration information is in terms of psia. When pressure data is in engineering units, the 52-MP transmits pressure data relative to the ocean surface (0 decibars). The 52-MP converts psia to decibars with:

$$\text{Pressure (db)} = [\text{pressure (psia)} - 14.7] \times 0.689476.$$

6.3.1 Data transmitted from memory

6.3.1.1 DDSf and DASf commands

Data output is in the order listed, with a comma between each parameter. The number of digits and placement of the decimal point are shown with each parameter. Leading zeros are suppressed except for one zero to the left of the decimal point.

1. Conductivity in mmho/cm = ccc.cccc
2. Temperature in °C, ITS-90 = ttt.tttt
3. Pressure in decibars = ppppp.pp
4. Oxygen (optional) in ml/L=oo.oo (=0.00 if SetDOInstalled=N)

Example scan—
 = ccc.cccc,ttt.tttt,ppppp.pp.oo.oo
 = 37.4277, 0.8070, 1665.66, 7.31

6.3.1.2 DDHsf and DAHsf commands

Data output is in the order listed, with no spaces or commas between parameters. Shown with each parameter are the number of digits, and how to calculate the parameter from the data (use the decimal equivalent of the binary data in the equations).

1. Conductivity (mmho/cm) = (ccccc ÷ 10,000) - 0.5
 If ccccc < 0.5 decimal, ccccc is set to 00000.
 If ccccc > 95.0 decimal, ccccc is set to FFFFF.
2. Temperature (°C, ITS-90) = (ttt ÷ 10,000) - 5
 If tttt < -5 decimal, tttt is set to 00000.
 If tttt > 35.0 decimal, tttt is set to FFFFF.
3. Pressure (decibars) = (ppppp ÷ 100) - 10
 If ppppp < -10 decimal, ppppp is set to 00000.
 If ppppp > 7000 decimal, ppppp is set to FFFFF.
4. Oxygen (optional), in Hz = oooo (=0 if SetDOInstalled=N)

Example scan
 = ccccttttpppppoooo
 = 5C98D0E2D628E8E3056

- Conductivity = ccccc = 5C98D (379277 decimal); conductivity (mmho/cm) = (379277 ÷ 10,000) - 0.5 = 37.4277
- Temperature = tttt = 0E2D6 (58070 decimal); temperature (°C, ITS-90) = (58070 ÷ 10,000) - 5 = 0.8070
- Pressure = ppppp = 28E8E(166566 decimal); pressure (decibars) = (167566 ÷ 100) - 10 = 1665.66
- Oxygen = oooo = 3056 (12374 decimal) oxygen (Hz) = 12374

6.3.1.3 DDBsf and DABsf commands

Data output is in the order listed, with no spaces or commas between parameters. Shown with each parameter are the number of digits, and how to calculate the parameter from the data (use the decimal equivalent of the binary data in the equations).

1. Conductivity (mmho/cm) = (ccc ÷ 10,000) - 0.5
 If ccc < 0.5 decimal, ccc is set to 00000 (hex).
 If ccc > 95.0 decimal, ccc is set to FFFFF (hex).
2. Temperature (°C, ITS-90) = (ttt ÷ 10,000) - 5
 If ttt < -5 decimal, ttt is set to 00000 (hex).
 If ttt > 35.0 decimal, ttt is set to FFFFF (hex).
3. Pressure (decibars) = (ppp / 100) - 10
 If ppp < -10 decimal, ppp is set to 00000 (hex).

Deployment and operation

If ppp > 7000 decimal, ppp is set to FFFF (hex).

4. Oxygen (optional), in Hz = oo (=0 if SetDOInstalled=N)

Example scan

= cccttpppoo

= 000001011100100110001101000000011100010110101100000001010001110100011100011000001010110

- Conductivity = ccc = 000001011100100110001101 (379277 decimal); conductivity (mmho/cm) = $(379277 \div 10,000) - 0.5 = 37.4277$
- Temperature = ttt = 000000001110001011010110 (58070 decimal); temperature ($^{\circ}$ C, ITS-90) = $(58070 \div 10,000) - 5 = 0.8070$
- Pressure = ppp = 000000101000111010001110 (166566 decimal); pressure (decibars) = $(167566 \div 100) - 10 = 1665.66$
- Oxygen = oo = 0011000001010110 (12374 decimal) oxygen (Hz) = 12374

6.3.2 Data transmitted in real-time

6.3.2.1 OutputPressure=Y (real-time pressure in engineering units) or TFP command

Shown is the number of digits and the placement of the decimal point. Leading zeros are suppressed, except for one zero to the left of the decimal point.

Pressure (decibars) = ppppp.pp

Example scan = ppppp.pp = 1665.66

Pressure (decibars) = ppppp.pp = 1665.66

6.3.2.2 OutputSN=Y (real-time sample number)

Sample number = nnnnn

Example: sample number = 16689

6.3.2.3 OutputSN=Y and OutputPressure=Y

Data output is in the order listed, with a comma between the sample number the pressure. Shown with each parameter are the number of digits and the decimal point.

1. Sample number nnnnn
2. Pressure in decibars = ppppp.pp

Example scan = nnnnn, ppppp.pp = 16689, 166.66

6.3.2.4 OutputCTDO=Y

Data output is in the order listed, with a comma between each parameter. Shown with each parameter are the number of digits and the decimal point.

1. Conductivity in mmho/cm = ccc.cccc
2. Temperature in $^{\circ}$ C, ITS-90 = ttt.tttt
3. Pressure in decibars = ppppp.pp
4. Oxygen (optional) in Hz = ooooo.o (= 0.0 if SetDOInstalled=N)

example scan

= ccc.cccc,ttt.tttt,ppppp.pp,ooooo.o

= 35.4791, 6.9892, 182.25, 5134.8

- Conductivity in mmho/cm = ccc.cccc = 35.4791
- Temperature in $^{\circ}$ C, ITS-90 = ttt.tttt = 6.9892
- Pressure in decibars = ppppp.pp = 182.25
- Oxygen (optional) in Hz = ooooo.o = 5134.8

6.3.2.5 CTDORaw=Y

Data output is in the order listed, with a comma between each parameter. Shown with each parameter are the number of digits and the decimal point. Leading zeros are suppressed except for on zero to the left of the decimal point.

1. Conductivity in Hz = cccc.ccc
2. Temperature in A/D counts = tttt.t
3. Pressure in A/D counts = pppppp.p
4. Pressure temperature in A/D counts = vvvvv.v
5. Oxygen (optional) in Hz = ooooo.o (= 0.0 if SetDOInstalled=N)

example scan

```
= cccc.ccc, tttt.t, pppppp.p, vvvvv.v, ooooo.o
= 5970.384, 524372.4, 32768.0, 2690.0, 5138.3
```

6.4 Recommended procedures to collect quality data

Procedures to collect the best quality data that are recommended by the manufacturer are given in this section. Note that some of these procedures may conflict with the goals of a specific deployment, the user should be aware of the tradeoffs between quality data and deployment goals.

6.4.1 SBE 52-MP recommended orientation

- Minimize the thermal contamination of water that flows past the 52-MP: As the moored profiler passes through the water, it slightly warms the water. If the 52-MP sensor passes through the water after the rest of the moored profiler, it will measure the temperature of this warmed water instead of the *in situ* temperature. Therefore, mount and orient the 52-MP so that the sensor intake is at the leading edge of the moored profiler. This is not possible if data is to be collected on both upcasts and downcasts. As an alternative, mount and orient the 52-MP so that the sensor intake is at some (horizontal) distance from the main body of the moored profiler.
- Equalize the Bernoulli pressures to maintain a constant flow through plumbing. Differential Bernoulli pressures on the intake and exhaust can cause the flow of water in the plumbing to increase. This overrides the constant flow provided by the pump so the data can be difficult to align because the flow rates change. Thus, mount and orient the 52-MP so that the intake and exhaust are on the same horizontal plane to equalize Bernoulli pressures.
- Equalize the Bernoulli pressures to maximize effectiveness of anti-fouling devices. The U-shape plumbing of the 52-MP is designed to stop water flow between profiles, which lets small amounts of anti-foulant concentrate inside the plumbing to keep the sensors clean. Bernoulli pressures on the intake and exhaust can cause an increased flow of water in the plumbing between profiles that reduces the effectiveness of the anti-foulant. Thus, mount and orient the 52-MP so that the intake and exhaust are on the same horizontal plane to equalize Bernoulli pressures.
- Release any initial air to get a constant flow through the plumbing. The pump of the 52-MP is a magnetically coupled impeller type that does not self-prime. Optimal orientation for the 52-MP is vertical with the U intake and exhaust at the top, or horizontal with the intake below the exhaust to let the air that is in the 52-MP while on deck be quickly expelled when it is submerged. If bubbles collect in the pump, it will fail to prime. If bubbles collect in the conductivity cell and/or dissolved oxygen plenum, the signals from those sensors will be in error. Failure to make a path for the air to escape may cause problems in the first 0 to 10 meters (depending on conditions, up to 30 meters) of data collection. Beyond that depth, the bubbles usually collapse sufficiently for the system to operate correctly. If doing deep profiles, air in the system may not be an issue, because it will affect only the beginning of the very first downcast in the deployment. If doing shallow profiles, air in the system may take

Deployment and operation

up to several days to dissipate if the 52-MP is not oriented correctly: this can result in several days of poor data at the beginning of the deployment.

6.4.1.1 52-MP oriented horizontally

If the user wants both upcast and downcast data, mount the 52-MP with a horizontal orientation.

Although the 52-MP can collect downcast data in a horizontal orientation, the commands for the 52-MP were designed to collect upcast data. In particular, the 52-MP automatically stops autonomous operation when the measured pressure is less than **PCutoff=** (i.e., **PCutoff=** defines the top of the upcast). If downcast data is collected, make sure to set **PCutoff=** above the top of the cast, or the 52-MP will turn off immediately after data collection starts. *Example:* To sample on downcast so that each profile starts at 5 decibars, set **PCutoff=3** (decibars) for correct operation.

Orient the sensors as described below.

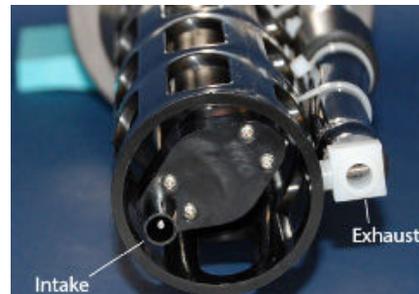
Deep profiles

Orient the 52-MP with the **temperature sting at the same level as the plumbing sensor exhaust**. With the intake and exhaust on the same level, Bernoulli pressures are equalized, and the flow of water into the plumbing is minimized. While this orientation does not provide an upward path to the system plumbing, it does provide a *neutral* path. The top 0 to up to 30 meters of data of the first downcast only is suspect, because the pump may not operate correctly until the air bubbles collapse due to water pressure.



Shallow profiles

If the 52-MP is oriented so that air cannot be easily released, the top 0 to 30 meters of data is suspect, because the pump may not operate correctly until the air bubbles collapse due to water pressure. If the moored profiler operates only at shallow depths, it may take days for the air bubbles to completely dissipate on their own. Thus, for shallow profile applications, orient the 52-MP with the **temperature sting slightly below the plumbing exhaust**; this orientation provides an upward path from intake to exhaust, which lets air to be quickly released during a brief soak below the surface, so that the pump operates correctly for all casts. Although Bernoulli pressures are not equalized for this orientation, the difference in elevation, and the pressure differential that results, is small.



6.4.1.2 52-MP oriented vertically Upcast data collection

The 52-MP is designed to collect upcast data when deployed in a vertical, sensors-up orientation. This orientation, with the intake and exhaust at the same elevation, provides a U-shape to the plumbing that lets air leave the system so that the pump primes correctly, and the Bernoulli pressures are equalized on the intake and exhaust.



Downcast data collection

The 52-MP can be used to collect downcast data when deployed in a vertical, sensors-down orientation. This orientation, with an inverted U-shape to the plumbing, makes it more difficult for air to leave the system. The top 0 to 30 meters of data is suspect because the pump may not operate correctly until the air bubbles are collapsed from water pressure. For deployments where the 52-MP will be doing many deep profiling cycles, the issue of removal of air from the system for optimal pump performance may not be critical. The 52-MP may collect many tens or hundreds of profiles, and only the data for the shallow part of the first profile would be affected by air in the plumbing. If doing shallow profiles, air in the system may take up to several days to completely dissipate on its own. The result can be several days of poor data at the start of the deployment.

Although the 52-MP can collect downcast data in this orientation, the commands for the 52-MP were designed to collect upcast data. In particular, the 52-MP automatically stops autonomous data collection when the measured pressure is less than **PCutoff=** (i.e., **PCutoff=** defines the top of the upcast). If data is collected for a downcast, make sure to set **PCutoff=** above the top of the cast, or the 52-MP will turn off immediately after data collection starts. *Example:* To sample on downcast so that each profile starts at 5 decibars, set **PCutoff=3** (decibars) for correct operation.



6.5 Deployment and pump operation

The conductivity cell, Tygon tubing, DO sensor, and exhaust Tygon tubing of the 52-MP provides a U-shape to the system plumbing. The U-shape and the good seals on the 52-MP, combined with *optimal pump operation*, keep surface oils and other contaminants out of the plumbing and conductivity cell. **These oils and contaminants are the primary cause of calibration drift in conductivity sensors and dissolved oxygen sensors.**

When not in use, store the 52-MP dry. Just before deployment, fill the plumbing system (conductivity cell, optional dissolved oxygen sensor, and exhaust plumbing) with clean water. **Deploy the 52-MP with the water, and hold the 52-MP in a vertical orientation, sensors up.** As the 52-MP breaks the surface, oils and other surface contaminants will *float* on the water at the intake and exhaust, preventing contaminants from getting into the plumbing and conductivity cell. Once the 52-MP is below the contaminated surface layer of water, orient the 52-MP for deployment to mount on the moored profiler. When the

controller sends the command to turn the pump on, the 52-MP will pump any water from the system and draw in seawater.

Deployment steps

1. Install the data I/O cable on the 52-MP.
2. Connect the other end of the I/O cable to the controller and power supply of the moored profiler.
3. Make sure that all hardware and fittings are attached correctly, and that the oxygen sensor cable is installed, or, if no oxygen sensor is used, the dummy plug is installed.
4. If necessary, remove the red and black plastic protective caps from the end of the T-C duct and the exhaust.
5. Install the 52-MP on the mooring. Refer to [Recommended procedures to collect quality data](#) on page 17 for details to mount the 52-MP.
6. To start a profile, supply power, send any character to the 52-MP, then send **StartProfile**, **StartProfileN**, **ResumeProfile**, or **ResumeProfileN**.

6.6 Recover sensor

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

Turn off the pump before the 52-MP reaches the surface (for autonomous operation, stop data collection to turn off the pump). Hold the 52-MP in a vertical orientation, sensors up; seawater will be held in the U-shaped plumbing. As the 52-MP breaks the surface, oils and other surface contaminants will *float* on the seawater at the intake and exhaust, and keep contaminants from the plumbing and conductivity cell. Turn over the 52-MP when it is on deck and empty the seawater from the conductivity cell and exhaust plumbing, so any oil that floats on the intake and exhaust surfaces does not get into the system.

Flush the 52-MP with fresh water. Refer to the [Maintenance](#) on page 31 section for procedures to clean and store the conductivity cell and dissolved oxygen sensor.

Process data

Spikes are sometimes seen in the derived values for salinity, density, or sound velocity. Spikes result largely from a response time that does not agree with the conductivity and temperature sensors, especially when the profiling rate is non-uniform. The amount of spiking depends on the temperature gradient, and is much worse when coupled surface motion causes the instrument to stop—or even reverse—its vertical movement. When very heavy seas cause severe buoy motion and result in periodic reversals of the 52-MP vertical movement, the data set can be greatly improved by removing scans taken when the pressure change (dP/dt) reverses. **Note that corrections to the data can only be done if the full data set has been transmitted to the PC. Bin-averaged data cannot be corrected.**

Note that the manufacturer does not supply software that is compatible with the data from the 52-MP.

Section 7 Command descriptions

This section gives commands and shows examples of output for the 52-MP.

- Enter commands to the 52-MP in upper or lower case letters and push **Enter** to send commands.
- The 52-MP sends ?CMD if an invalid command is entered.
- If the system does not return an S> prompt after a command is executed, push **Enter** to get the S> prompt.
- Push **Connect** on the toolbar of the software to start communications, or send any character to get the S> prompt.
- To stop the 52-MP during data collection, send **StopProfile**, push **Stop** on the toolbar, or enter **Ctrl Z**. Push **Enter** or send any character to get the S> prompt.
- The 52-MP responds only to **SLP** and **StopProfile** during data collection.

Entries made with the commands are permanently stored in the 52-MP in non-volatile RAM and remain in effect until the user changes them. The user-configured setup is not affected when power is removed.

7.1 Status

Command	Description
	firmware version, serial number

Command	Description
SetDOInstalled=x	oxygen sensor enabled?
PCutoff=x	x= pressure cutoff in decibars 52-MP automatically stops autonomous data collection when pressure is less than PCutoff
OverWriteMem=x	x=Y: reset sample number and bin number to 0 when memory is full. Sensor continues to sample and overwrites earlier data in memory. x=N: do not. Sensor automatically stops data collection when memory is full.
InitProfile	Do not use unless all previous data has been transmitted from the 52-MP. InitProfile sets the sample number for the first sample to 0 and bin number for the first bin to 0. The 52-MP starts to save data to the start of the memory so that the entire memory is available for recording. if the user uses StartProfile or StartProfileN to start autonomous data collection, these commands automatically reset the sample number and bin number to 0 before data collection starts
OxMultiplier=x	x=oxygen sensor frequency multiplier. 0 < OxMultiplier <= 4.0. Typical value is approximately 0.25. Multiplies measured frequency by a factor to convert to sensor output. Refer to the 52-MP Configuration sheet for the appropriate value for a specific sensor.
QS	Quit Session and put the 52-MP in quiescent (low power) mode. Power to the digital and analog electronics is turned off. Data in memory is not affected. Note that the sensor will enter low power mode if it does not receive a command for 2 minutes, or if it is during data collection

7.2 Real-time output

Real-time output can be **one** of the below:

- Pressure (**OutputPressure=Y**)
- Sample number (**OutputSN=Y**)
- Sample number **and** pressure (**OutputSN=Y** and **OutputPressure=Y**) where the output is sample number, pressure
- Conductivity, temperature, and pressure in engineering units; optional oxygen in raw units (**OutputCTDO=Y**)
- Conductivity, temperature, pressure, pressure temperature, and optional oxygen in raw units (**OutputCTDORaw=Y**)

Command descriptions

Command	Description
OutputPressure=x	x=Y: send real-time pressure in ASCII engineering units (ppppp.pp decibars) during data collection x=N: do not
OutputSN=x	x=Y: send five-digit real-time sample number during data collection. x=N: do not
OutputCTDO=x	x=Y: send real-time conductivity ccc.cccc mmho/cm, temperature ttt.ttt °C, pressure in ASCII engineering units ppppp.pp decibars, and optional oxygen frequency ooooo.o Hz during data collection. x=N: do not
OutputCTDORaw=x	x=Y: send real-time conductivity cccc.ccc Hz, temperature tttt.t A/D counts, pressure pppppp.p A/D counts, pressure temperature vvvvv.v A/D counts, optional oxygen ooooo.o Hz) during data collection. x=N: do not

7.3 Bin averaging

The SBE 52-MP can average data into bins, based on pressure ranges, after a profile is completed. The 52-MP processes approximately 52 scans per second to calculate the bins. The 52-MP stores bin averaged data in a separate part of the memory than where the full data set is stored. The user can transmit the full data set, the bin averaged data, or both.

The algorithm the 52-MP uses for bin averaging is described below.

For each bin:

$$\text{BinMin} = \text{bin center value} - (\text{bin size} \div 2)$$

$$\text{BinMax} = \text{bin center value} + (\text{bin size} \div 2)$$

1. Add together valid data for scans with $\text{BinMin} < \text{pressure} \leq \text{BinMax}$.
2. Divide the sum by the number of valid data points to get the average.
3. Interpolate as follows, and write the interpolated value to memory:
 P_p = average pressure of previous bin
 X_p = average value of variable in previous bin
 P_c = average pressure of current bin
 X_c = average value of variable in current bin
 P_i = center value for pressure in current bin
 X_i = interpolated value of variable (value at center pressure P_i)

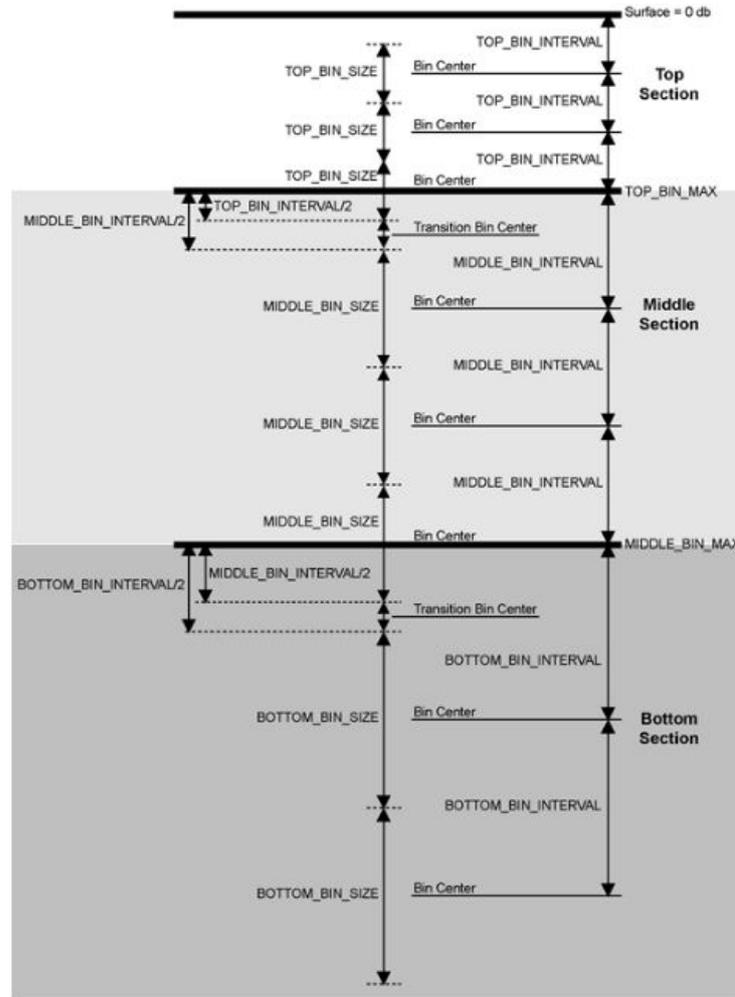
$$= [(X_c - X_p) \times (P_i - P_p) \div (P_c - P_p)] + X_p$$
4. Repeat Steps 1 through 3 for each variable.
5. Compute the center value and repeat steps 1 through 4 for the next bin.

Values for the first bin are interpolated *after* averages for the second bin are calculated; values from the *next* (second) bin instead of the *previous* bin are used in the equations.

Start bin averaging	
Command	Description
AutoBinAvg=x	x=Y: automatically average stored data into bins when autonomous data collection is stopped because pressure < PCutoff x=N: do not
BinAverage	average the stored data into bins now. Send StopProfile to stop autonomous data collection and then send this command.

Set bin averaging parameters

The 52-MP lets the user define a top, middle, and bottom section of the profile. Each section can have different bin sizes and bin intervals. The user can also define a transition bin between each of the sections.



Command	Description
Top_Bin_Interval=x	x= space between bin centers for top section, in decibars (db) <i>Example:</i> top bin interval is 10 db, the top section bin centers are at 0, 10, 20, etc.
Top_Bin_Size=x	x= bin size for top section, in decibars. Scans from the bin center to (\pm Top_Bin_Size \div 2) are included in data for bin. For typical use, set Top_Bin_Size equal to Top_Bin_Interval. <i>Example 1:</i> interval is 10 db and bin size is 10 db, the first bin is centered at 10 and goes from 5 to 15. Second bin is centered at 20 and goes from 15 to 25, etc. <i>Example 2:</i> interval is 10 db and bin size is 8 db, the first bin is centered at 10 and goes from 6 to 14. Second bin is centered at 20 and goes from 16 to 24, etc.
Top_Bin_Max=x	x= maximum pressure for top section, in decibars. For best results, set so the center of last top bin is at Top_Bin_Max.
Middle_Bin_Interval=x	x= space between bin centers for middle section, in decibars <i>Example:</i> top section maximum pressure is 100 db and middle bin interval is 20 db, the middle section bin centers are at 120, 140, etc.

Command descriptions

Middle_Bin_Size=x	x= bin size for middle section, in decibars (db).Scans from the bin center to (\pm Middle_Bin_Size \div 2) are included in data for bin. For typical use, set Middle_Bin_Size equal to Middle_Bin_Interval. <i>Example 1:</i> top section maximum pressure is 100 db, middle bin interval is 20 db, the first middle bin size is 20 db, the first middle bin is centered at 120 and goes from 110 to 130. Second bin is centered at 140 and goes from 130 to 150, etc. <i>Example 2:</i> top section maximum pressure is 100 db, middle bin interval is 20 db and middle bin size is 16 db, the first bin is centered at 120 and goes from 112 to 128. Second middle bin is centered at 140 and goes from 132 to 148, etc.
Middle_Bin_Max=x	x= maximum pressure for middle section, in decibars. For best results, set so the center of last middle bin is at Middle_Bin_Max.
Bottom_Bin_Interval=x	x= space between bin centers for bottom section, in decibars (db) <i>Example:</i> middle section maximum pressure is 1000 db, bottom bin interval is 50 db, the bottom section bin centers are at 1050, 1100, etc.
Bottom_Bin_Size=x	x= bin size for bottom section, in decibars (db).Scans from the bin center to (\pm Bottom_Bin_Size \div 2) are included in data for bin. For typical use, set Bottom_Bin_Size equal to Bottom_Bin_Interval. <i>Example 1:</i> middle section maximum pressure is 1000 db, bottom bin interval is 1000 db, the first bottom bin size is 50 db, the first bottom bin is centered at 1050 and goes from 1025 to 1075. Second bottom bin is centered at 1100 and goes from 1075 to 1125, etc. <i>Example 2:</i> middle section maximum pressure is 100 db, bottom bin interval is 50 db and bottom bin size is 40 db, the first bin is centered at 1050 and goes from 1030 to 1070. Second bottom bin is centered at 1100 and goes from 1080 to 1120, etc.
IncludeTransitionBin=x	x=Y: calculate the transition bin between top and middle section, and between middle and bottom section. Transition bins: (last top bin center + Top_Bin_Interval \div 2) to (last top bin center + Middle_Bin_Interval \div 2) and (last middle bin center + Middle_Bin_Interval \div 2) to (last middle bin center + Bottom_Bin_Interval \div 2) x=N: do not <i>Example:</i> Top_Bin_Interval=Top_Bin_Size=10 db Middle_Bin_Interval=Middle_Bin_Size=100 db Top_Bin_Max=100 db If there is no transition bin, there is a gap in the bins from 105 to 150 db.

Section	Bin center	Bin Range
Top
	90	85–95
	100	95– 105
Middle	200	150 –250
	300	250–350

A transition bin will fill that gap:

Start of transition bin = last top bin center + Top_Bin_Interval \div 2 = 100 + 10 \div 2 = 105 db

End of transition bin = last top bin center + Middle_Bin_Interval \div 2 = 100 + 100 \div 2 = 150 db

7.4 Autonomous data collection

The 52-MP turns on the pump and samples conductivity, temperature, pressure, and optional oxygen continuously at 1 Hz. The pump operates at fast speed for 2.5 seconds, and then continuously at slow speed. Fast speed removes any debris from the system

and rapidly brings in new water; once the system is cleared, the slow speed flushes the system while minimizes the power required.

The 52-MP can be set up to transmit in real-time: pressure, sample number, or sample number and pressure; or conductivity, temperature, pressure, and optional oxygen in converted or raw units. Refer to [Real-time output](#) on page 21 for details.

Do not remove power from the 52-MP before data is transmitted. If power is removed, any data in memory will be lost.

Send StartProfile, StartProfileN, ResumeProfile, or ResumeProfileN to turn on the pump.

Do not operate the pump without water: The pump is water-lubricated; it will be damaged if operated without water (except for very short periods). To test the system in dry conditions, fill the inside of the pump head with water through the pump exhaust tubing. This will provide enough lubrication to prevent pump damage during tests.

Command	Description
StartProfile	Do not use unless all previous data has been transmitted. set sample number for first sample to 0 and bin number for first bin to 0, start pump, and start autonomous data collection.
StartProfileN	Do not use unless all previous data has been transmitted. set sample number for first sample to 0 and bin number for first bin to 0, start pump and let pump operate for N seconds , and, with the pump in operation, start autonomous data collection.
ResumeProfile	start pump and start autonomous data collection. New data is stored to memory after previously saved data.
ResumeProfileN	start pump and let pump operate for N seconds . While the pump operates, start autonomous data collection. New data is stored to memory after previously saved data.
StopProfile	stop pump and stop autonomous data collection. Push the Enter key to get an <i>S></i> prompt. Then enter StopProfile.
SLP	send last sample of pressure data from memory in ASCII engineering units (ppppp.pp decibars). 52-MP responds to SLP only while it autonomously collects data.
DTDP	transmit last calculated value for dt/dp. 52-MP calculates dt/dp each time the user sends StopProfile, if autonomous data collection was started with ResumeProfile or ResumeProfileN. $dt/dp = (t - t_{OLD}) \div (p_{OLD} - p)$ <i>where</i> t = temperature from last sample before StopProfile is received; p = pressure from last sample before StopProfile is received; t _{OLD} = temperature from last sample before previous StopProfile is received; p _{OLD} = pressure from last sample before previous StopProfile is received.

Example:

The user wants to deploy the 52-MP on a deep mooring, and it will sample on upcast from 7000 db to 5 db. However, to conserve power, you don't want to sample continuously through deep water, where measured parameters are likely to change very little. Program the controller to send **StartProfile** at 7000 db, then **StopProfile** at 6980 db; **ResumeProfile** at 6900 db, then **StopProfile** and **DTDP** at 6880 db; **ResumeProfile** at 6800 db, then **StopProfile** and **DTDP** at 6780 db; etc. Each time **StopProfile** is sent, the 52-MP calculates dt/dp, which is then transmitted to the controller when **DTDP** is sent. Program the controller to do a check for when dt/dp reaches a threshold value (i.e., it indicates that there are significant temperature changes) and to sample continuously after that point is reached (i.e., the controller does not send **StopProfile** beyond that point). Program the 52-MP with **PCutoff=5** and **AutoBinAvg=Y**, so autonomous data collection stops automatically at 5 db and bins for the entire profile are calculated when the 52-MP reaches 5 db.

7.5 Fast pressure sampling

Command	Description
TFP	measure pressure at approximately 4 Hz (0.25 seconds/sample), transmit ASCII converted data (pppp.ppp decibars), one measurement per line, followed by a carriage return and line feed. Data is not stored in SRAM. Push Esc or Stop on toolbar to stop fast pressure data collection.

7.6 Data upload

Command	Description
<i>All data, not averaged</i>	
DDN	show number of data sample in memory, up to five characters followed by a carriage return and line feed
DDs,f	transmit all data from sample s to sample f , in ASCII engineering units. If s and f are omitted, all data is transmitted. First sample number is 0.
DDHs,f	transmit all data from sample s to sample f , in hex. If s and f are omitted, all data is transmitted. First sample number is 0.
DDBs,f	transmit all data from sample s to sample f , in binary. If s and f are omitted, all data is transmitted. First sample number is 0.

Note:

If OverWriteMem=Y, and the memory is full and has started to overwrite, use of **DD**, **DDH**, or **DDB** will provide new data, followed by older data. Example: Overwrote the first 10,000 samples of the 28,000 memory. Samples 1–10,000 are data that was measured **after** samples 10,001-28,000.

Command	Description
<i>Bin averaged data</i>	
DAN	show number of averaged bins in memory, up to four characters followed by a carriage return and line feed
NBin	show number of averaged bins in memory, label plus up to four characters followed by a carriage return and line feed. For example: Number of bins = 3500
DAs,f	Transmit bin averaged data from bin s to bin f , in ASCII engineering units. If s and f are omitted, all data is transmitted. First sample number is 0.
DAHs,f	Transmit all data from bin s to bin f , in hex. If s and f are omitted, all data is transmitted. First sample number is 0.
DABs,f	Transmit all data from bin s to bin f , in binary. If s and f are omitted, all data is transmitted. First sample number is 0.

7.7 Polled data collection

Command	Description
PTS	operate pump. Take 1 sample of all parameters; transmit data in ASCII engineering units (conductivity ccc.cccc mmho/cm, temperature ttt.tttt °C, pressure ppppp.pp decibars, optional oxygen oo.ooo ml/l); and turn pump off. Length of time that pump operates: Oxygen sensor response time, and the related length of time pump needs to operate before a sample is taken, depends on temperature and pressure. 52-MP takes <i>preliminary</i> measurement of T and P, uses those values to calculate pump time (but does not store T and P values in memory), operates pump, and then takes a new measurement of all parameters. Pump time increases as P increases and T decreases. <i>For example, if: T=0 °C, P=1000 db, total pump time=44.6 sec; T=30 °C, P=0 db, total pump time=9.8 seconds:</i> Maximum total pump time to operate is 55 seconds. Total pump time is fast speed (to remove any debris from the system and rapidly bring in a new water sample) followed by slow speed (to provide an adequate flush of system while the required power is minimized); 52-MP calculates optimal time for pump to operate at each speed.
TS	take 1 sample of all parameters and transmit data in ASCII engineering units (conductivity ccc.cccc mmho/cm, temperature ttt.tttt °C, pressure ppppp.pp decibars, optional oxygen oo.ooo ml/l). This command does not operate the pump before data collection. To turn the pump on and off, send a <i>pump command</i> before and after TS .
TSR	take 1 sample of all parameters and transmit ASCII raw data (conductivity cccc.ccc Hz, temperature tttttt.t A/D counts, pressure ppppp.p A/D counts, pressure temperature vvvvv.v A/D counts, optional oxygen ooooo.o Hz). This command does not operate the pump before data collection. To turn the pump on and off, send a <i>pump command</i> before and after TSR .
FP	take 1 sample of pressure and transmit data in ASCII engineering units (ppppp.pp decibars)

Note:

TS and **TSR** do not automatically turn the pump on. To get conductivity and optional oxygen from a new sample, send **PumpOn** some time before **TS** or **TSR**, then send **PumpOff** when the data has been received. **Do not operate the pump without water.**

7.8 Pump

The pump operates automatically for autonomous data collection and for the **PTS** command.

Use the pump commands before a **TS** or **TSR** polled data collection command is sent, or **TC**, **TCR**, **TO**, or **TOR** test commands, to get pumped conductivity/optional oxygen data, or to test the pump.

Do not operate the pump without water. If necessary, use the pump exhaust tubing to fill the inside of the pump head with water. This will provide enough lubrication to prevent damage to the pump during a test.

Command	Description
PumpOn	turn on pump. The pump automatically operates at fast speed for 2.5 seconds, then goes to slow speed. Fast speed removes any debris from the system and brings in a new water sample. When the system is cleared, the slow speed provides a system flush and minimizes the power required.
PumpFast	turn pump on at fast speed
PumpSlow	turn pump on at slow speed
PumpOff	turn pump off

7.9 Tests

The 52-MP collects 100 samples and transmits data in ASCII engineering units. Data is not stored in SRAM. Push the **Esc** key or **Stop** on the toolbar to stop a test.

Command descriptions

Note that these commands do not automatically turn on the pump: conductivity and oxygen values are sent from the same volume of water for all 100 measurements because the pump does not operate and the plumbing prevents water flow through the conductivity cell and DO sensor. Send **PumpOn** before a test command to get new water for test samples.

Command	Description
TC	measure conductivity, transmit ASCII converted data in format cc.ccccc mmho/cm
TT	measure temperature, transmit ASCII converted data in format ttt.tttt °C
TP	measure pressure and pressure temperature, transmit ASCII converted data in format pppp.ppp decibars, tttt.ttt °C
TO, TOR	measure oxygen, transmit ASCII raw data in format ooooo.oo Hz
TCR	measure conductivity, transmit ASCII raw data in format cccc.ccc Hz
TTR	measure temperature, transmit ASCII raw data in format tttt.t A/D counts
TPR	measure pressure, transmit ASCII raw data in format pppppp.p A/D counts. Measure pressure temperature, format tttttt A/D counts.

7.10 Calibration coefficients

F = floating point number. S = String with no spaces.

Calibration coefficients are set by the manufacturer and should be agree with the Calibration Certificates that ship with the 52-MP.

Command	Description
DC	Show calibration coefficients. All coefficients and dates are included in the display. Use the commands below to change a specific coefficient or date. Equivalent to Coefficients on the software toolbar.
Temperature	
TCalDate=S	S=temperature calibration date
TA0=F	F=temperature A0
TA1=F	F=temperature A1
TA2=F	F=temperature A2
TA3=F	F=temperature A3
Conductivity	
CCalDate=S	S=conductivity calibration date
CG=F	F=conductivity G
CH=F	F=conductivity H
CI=F	F=conductivity I
CJ=F	F=conductivity J
CPCor=F	F=conductivity pcor
CTCor=F	F=conductivity tcor
WBOTC=F	F=conductivity temperature
Pressure	
PCalDate=S	S=pressure calibration date
PA0=F	F=pressure A0

PA1=F	F=pressure A1
PA2=F	F=pressure A2
PTCA0=F	F=pressure temperature compensation ptca0
PTCA1=F	F=pressure temperature compensation ptca1
PTCA2=F	F=pressure temperature compensation ptca2
PTCB0=F	F=pressure temperature compensation ptcb0
PTCB1=F	F=pressure temperature compensation ptcb1
PTCB2=F	F=pressure temperature compensation ptcb2
PTHA0=F	F=pressure temperature a0
PTHA1=F	F=pressure temperature a1
PTHA2=F	F=pressure temperature a2
POffset=F	F=pressure offset correction, decibars
Optional Oxygen	
OCalDate=S	S=oxygen calibration date
OXSOC=F	F=oxygen SOC
OXFOF=F	F=oxygen F offset
OXA=F	F=oxygen A
OXB=F	F=oxygen B
OXC=F	F=oxygen C
OXE=F	F=oxygen E
ResetOffset	<p>collect pressure samples for 1 minute. Convert raw pressures to decibars, and calculate average. Set POffset= to sum of current POffset and calculated average.</p> <p><i>Example</i></p> <p>with the 52-MP POffset=1 (db) programmed in its EEPROM, the sensor at atmospheric pressure at sea level, send ResetOffset. The 52-MP calculates the average pressure as 0.5 db, then sets POffset=1.5 (1 db + 0.5 db).</p>

Command descriptions

Example: Show coefficients (user input in bold).

S>**dc**

SBE 52 MP 2.5 SERIAL NO. 0002

temperature: 18-feb-15

TA0 = 1.587068e-05

TA1 = 2.734145e-04

TA2 = -2.120419e-06

TA3 = 1.513452e-07

conductivity: 18-feb-15

G = -1.034209e+00

H = 1.415599e-01

I = -3.702509e-04

J = 4.596847e-05

CPCOR = -9.570001e-08

CTCOR = 3.250000e-06

WBOTC = -9.102695e-06

pressure S/N = 7418, range = 10153 psia: 18-feb-15

PA0 = 5.793196e+00

PA1 = 5.649696e-01

PA2 = -6.067437e-07

PTCA0 = 9.975864e+00

PTCA1 = 5.241532e-01

PTCA2 = -3.319472e-03

PTCB0 = 2.456025e+01

PTCB1 = 5.000000e-05

PTCB2 = 0.000000e+00

PTHA0 = -7.034930e+01

PTHA1 = 4.924383e-02

PTHA2 = 9.952137e-08

POFFSET = 0.000000e+00

oxygen S/N = 2347, 18-feb-15

Soc = 2.282700e-04

Foffset = -7.967825e+02

A = -3.317500e-03

B = 3.028800e-04

C = -5.600400e-06

E = 3.600000e-02

Section 8 Maintenance

⚠ WARNING

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

The manufacturer recommends that the user returns the sensor for calibration at regular intervals. The measurement accuracy of the sensor may decrease if the sensor is stored unused for long periods of time.

8.1 Remove or replace conductivity cell devices

⚠ CAUTION

AF24173 anti-fouling devices contain bis(tributyltin) oxide. Wear rubber or latex gloves and eye protection to replace these devices on the sensor if it is so equipped. Wash hands with soap and water when finished.
Read the precautions on the product label.
It is a violation of US federal law to use this product in a manner that is inconsistent with its label.

Sensors equipped with conductivity cells have a subassembly with a holder for either an anti-fouling device or a blank device. Make sure to remove the device to thoroughly flush the conductivity cell. Install the device again after the cell is clean so that the conductivity cell operates correctly. (The steps below are from the SBE-37 MicroCAT.)

Table 1 Conductivity cell devices

	
AF24173 anti-fouling device	Blank device

1. If necessary, remove the yellow protective plugs.
2. Remove the two screws that connect each device cup to the conductivity cell guard.



3. Remove the four Phillips screws that attach the conductivity cell guard to the pressure housing and carefully remove the cell guard.



4. Remove the protective plug from the device holder.
5. Use a 5/8-inch socket wrench to unscrew the device cap from the device cup.



6. Remove the AF24173 or the blank device from the cup.
7. Use a toothpick to lift each of the devices out of the holder. If necessary, use needle-nose pliers to carefully break up the AF24173 device.

Option	Procedure
To deploy sensor	Insert new devices into the holders, then install the cap onto the cup. Do not tighten too tight. Attach the copper assembly to the sensor again.
To clean or store sensor	Do not install new anti-fouling devices. Do install the blank device. Install the protective plug. Make sure to remove the plug before the next deployment or pressurization of the sensor. Damage to the conductivity cells can be caused if the plugs are not removed.

8. Attach the conductivity cell guard again.

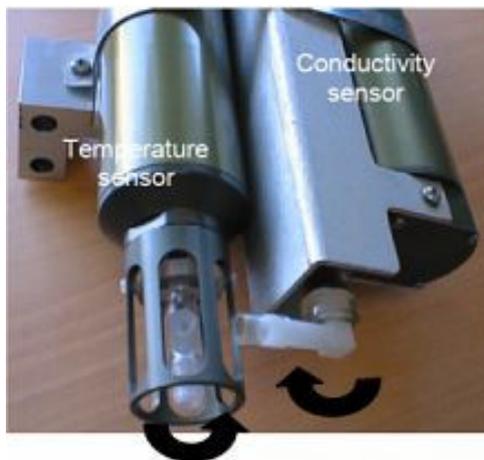
8.2 Disassemble and reassemble TC duct

NOTICE

Use slow, deliberate movements to disassemble or assemble the TC duct to prevent damage to the temperature or conductivity sensor. Do this procedure in a laboratory, not on a ship.

Prepare the temperature and conductivity duct to send back to the manufacturer for calibration, or to clean. Disconnect the C duct from the T duct and remove both from the conductivity cell. Send the temperature sensor with the guard attached to prevent damage to the thermistor.

1. Put the system cage on its side.
2. If necessary, disconnect the bulkhead connectors from the temperature and conductivity sensors.
3. Push the quick disconnect lever to disconnect the conductivity cell from the main housing.
4. Remove the conductivity and temperature sensors from the main pressure housing.
5. Slowly rotate the temperature sensor guard counter-clockwise approximately 90 degrees. At the same time, rotate the C duct slightly clockwise. The Tygon tube that connects the ducts comes off the T duct.



Temperature sensor guard rotated 90° counterclockwise while C Duct rotated clockwise slightly

6. Carefully rotate the C duct clockwise again to remove the C duct. Do not use force, or the conductivity cell may break. Gently pull the C duct straight out from the conductivity cell. Pour water over the duct area to loosen contamination if it is difficult to rotate.



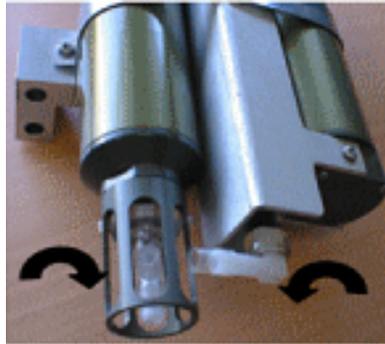
Rotate C Duct clockwise



Pull C Duct straight out from conductivity cell

7. Keep the C duct to assemble again.
8. Tighten the temperature sensor guard by hand.
9. If the sensors will be returned to the manufacturer, prepare them to be shipped, otherwise, go to the next step to assemble the temperature and conductivity cells again:
 - If both sensors will be shipped, it is not necessary to remove them from the mounting bracket.
 - If one sensor will be shipped, loosen the mounting bracket strap screw and move the sensor(s) out of the bracket.
 - Flush the cell with clean DI water and blow clean air through the cell to remove larger droplets of water. Do not use compressed air—it typically has oil vapor.
 - Attach a length of Tygon tubing from one end of the cell to the other to prevent contamination.
10. Assemble the temperature and conductivity sensors again:
 - a. If necessary, move sensors into the mounting bracket. Make sure the end of the temperature sensor guard extends approximately one inch past the conductivity guard. Tighten the mounting strap screw.
 - b. Rotate the temperature sensor guard approximately 90 degrees counterclockwise, so the T duct is out of the way.
 - c. Install the C duct on the conductivity cell. Keep it in the rotated position.

- d. Slowly rotate the temperature sensor guard into position, and insert the end of the T duct into the Tygon tubing on the C duct. Continue to rotate both the temperature sensor guard and the C duct until they align. If the ducts do not align, loosen the mounting strap screw and carefully rotate or move the temperature sensor, then tighten the screw and try to connect the ducts again.



Rotate temperature sensor guard
and C Duct into place

- e. Align the Tygon tubing on the joint between the C duct and T duct.
11. Install the conductivity and temperature sensors and the mounting bracket on the main housing.
12. Connect the quick-release plug on the conductivity cell.
13. Connect the cables and lock collars.

8.3 Clean flow path

⚠ WARNING

Bleach is caustic. Wear nitrile gloves and safety glasses and work in a well ventilated area to use bleach. Wash hands after use.

⚠ CAUTION

Do not mix bleach with water > 1 PSU salinity or let bleach into a sensor that has not been flushed with clean, fresh (< 1 PSU) water.

The manufacturer recommends that the user thoroughly clean the flow path before and after a deployment to make sure that the sensor continues to collect accurate, high-quality data. Correct maintenance of the flow path is critical for the multi-parameter measurement capabilities.

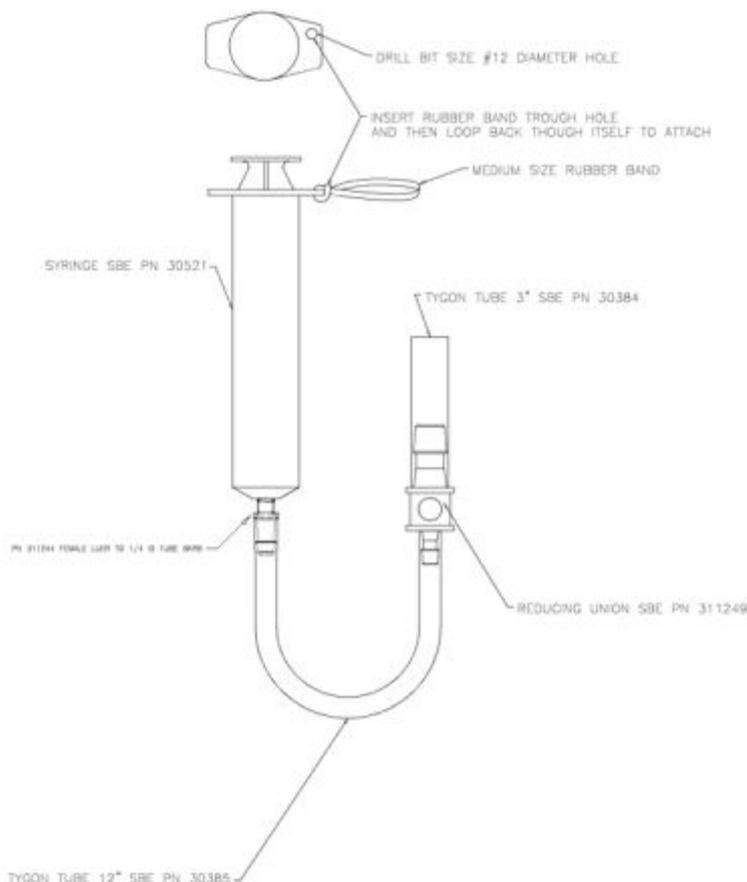
1. If necessary, remove the copper assembly and anti-fouling or blank devices from the sensor.
2. Use a 3/16-inch hex wrench to remove the flushing port plug, a ¼-20 x 1 inch socket head screw.

Supplies:

- 500 ml bottle of DI water
- Container for waste water
- Container for sensor
- De-ionized or distilled water. If unavailable, use fresh tap water. Do not use shipboard fresh water because it can have traces of oil in it.
- Non-ionic surfactant. The manufacturer supplies this with each sensor. It is a secondary alcohol ethoxylate, a non-ionic detergent that is biodegradable. Make sure that any alternative detergent that is used is scientific grade, with no colors, perfumes, glycerins, lotions, etc.

- Bleach mixed 50:1—Household bleach is usually 4–7% (40,000–70,000 ppm) sodium hypochlorite with stabilizers.

Part number	Description
30384	Tygon tube, 7/16 inch ID, 1/16 inch wall
30385	Tygon tube, ¼ inch ID, 3/8 inch OD, 1/16 inch wall
30521	60 cc syringe
311244	Female Luer thread to ¼ inch ID tubing barb
311249	Nylon reducer union, ½ to ¼ inch



Procedure notes:

Use warm, 40 °C water and 1% non-ionic surfactant to flush the flow path for one minute.

It may be necessary to do these steps up to five times to clean the flow path.

If there is bio-fouling on the sensor it may be necessary to fill the flow path with the non-ionic surfactant solution for approximately 12 hours to loosen debris.

Make sure to remove the blank or anti-fouling device if necessary.

Keep the plug to install again.

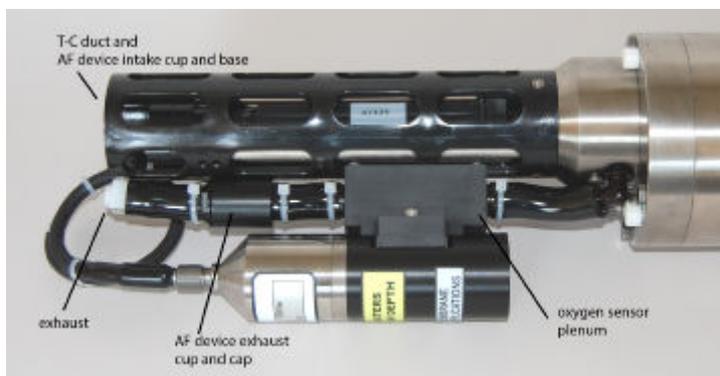
3. Put the instrument in a container with the bulkhead connector face-up.
4. If a cleaning solution is necessary, pull approximately 30 ml into the syringe.
5. Attach the syringe to the tubing, PN 30385.
6. Push the syringe plunger to fill the sensor flow path until 3–5 cm of solution shows in each tube.
7. Push and pull the plunger to mix the solution in the flow path. Do this 2–3 times.

8. Drain the solution from the sensor into a waste container. Push the syringe plunger to help remove all of the solution from the sensor.
9. Remove the tubing and shake the sensor.
10. If the flow path is still not clean, do the above steps again with the bleach solution.
11. Flush the flow path with DI water.
12. Install the flushing port plug again.
13. Install either the blank or AF24173 device again.
The sensor is ready for a functional test in the laboratory or a deployment.

8.4 Maintain and store oxygen sensor

The manufacturer recommends—

1. A short wash with the supplied non-ionic surfactant (Tergitol™ detergent)
2. A short wash with a dilute bleach solution to reduce biological growth
3. Store the sensor in an anoxic (or near zero oxygen) condition.



Preventive field maintenance between profiles

After each cast, flush with a **0.1%** solution of detergent. Use a 60 cc syringe (see *Application Note 34*). Rinse thoroughly with fresh water. Between casts, make sure that the sensor is protected from direct sunlight and stays cool and humidified. Plug the inlet and exhaust of the plumbing after a rinse to trap sufficient humidity.

Routine (post-cruise) maintenance (no visible deposits or marine growths on sensor)

1. Flush the sensor for 1 minute with a 1% solution of detergent warmed to 30 °C (86 °F). Drain and flush with warm (not hot) fresh water for 5 minutes.
2. Soak the sensor for 1 minute in a 500–1000 ppm solution of bleach. Drain and flush with lukewarm (not hot) fresh water for 5 minutes.

Severely fouled sensor maintenance (visible deposits or marine growths on sensor)

1. Soak the sensor in de-ionized water overnight to loosen deposits.
2. Do the *Routine maintenance* steps up to five times. Do **not** use high pressure to clean the membrane or wipe or touch the membrane.

Materials

- **Non-ionic surfactant (detergent):** Tergitol detergent is included with every CTD shipment and can be ordered from the manufacturer. Use only scientific grades that have no colors, perfumes, glycerins, lotions, etc.
- **Bleach:** Commercially available bleach is typically 4–7% (40,000 ppm to 70,000 ppm) sodium hypochlorite (Na-O-Cl) solution that includes stabilizers. **Dilute** concentrated household bleach, 50 parts water to 1 part bleach, to make the correct concentration to clean the oxygen sensor.

- **Water:** The manufacturer recommends de-ionized (DI) water because it is reliably pure, but commercially distilled water or fresh clean tap water is also sufficient. **On ships, fresh water can contain traces of oil and should not be used to rinse, clean, or store sensors, unless there is no alternative.** The oxygen membrane will be fouled by oil or grease, which causes a calibration shift toward incorrect, low output values.

Long-term storage (after field use)

The sensor is continuously polarized by an internal battery: oxygen in the plenum and tubing will continue to be consumed, and deplete the electrolyte and cause drift. Store the sensor in a zero-oxygen environment to stop calibration drift between uses. To minimize drift during storage, if possible, connect one end of the tubing loop to the plenum, displace the air in the plenum and tubing with nitrogen gas, and connect the other end of the tubing to the plenum. If tubing is not available, displace the air in the plenum with nitrogen gas and close off the plenum with a cap on each end (tape can be used if nothing else is available.) Do not put a cap or plug inside the plenum.

- Do not fill the tubing with water, detergent solution, or bleach solution.
- If there is no danger of freezing, loop tubing from inlet to outlet. Put a small piece of clean sponge, *slightly dampened* with fresh, clean water, in the center of the tubing (not near the membrane).
- If there is danger of freezing, shake all excess water out of the plenum and loop tubing from inlet to outlet, leaving the sensor membrane dry.

Notes:

- Do not let the sensor membrane come in contact with detergent for extended periods of time. It will harm the membrane and will cause the calibration of the sensor to drift.
- **During service and storage, maintain a temperature at or below 30 °C (86 °F).** If temperatures are above 40 °C (104 °F), sensors will show an increase in sensitivity of a few percent. This will return to historical sensitivity after a few days when temperatures return below 30 °C (86 °F).
- Do not use stronger solutions or longer wash times than recommended.
- Do not put concentrated detergent or bleach directly on the sensor membrane. A strong detergent solution can leave a film on the membrane and affect data.

8.5 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:

Maintenance

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

6. Use a silicone-based lubricant on each of the contacts of the bulkhead connector. The manufacturer recommends any of the products listed below.

- 3M™ Spray Silicone Lubricant (3M ID# 62-4678-4930-3). Make sure to let it dry.
- Dow Corning Molykote® III Compound (DC III)
- Dow Corning High Vacuum Grease® (DC 976 V)
- Dow Corning 4 Electrical Insulating Compound® (DC 4)
- Dow Corning Molykote 44 High Temperature Grease® (DC 44)

Use a finger to put a small quantity of 100% silicone grease or spray in the sockets or on the pins. Use the mating plug or cable to help distribute the lubricant. Do not use too much lubricant, as that will prevent a good seal.

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

8.6 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.

8.7 Clean pressure sensor

NOTICE

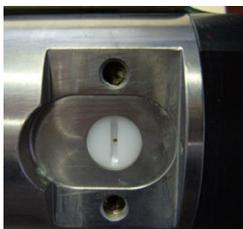
Do not put a brush or any object in the pressure port. It may damage or break the pressure sensor.

The nylon pressure capillary fitting has a pressure port fitting and an external capillary tube that is filled with silicone oil. The oil transmits hydrostatic pressure from the capillary tubing to the pressure sensor. The oil also prevents corrosion if the sensor is exposed to water.

Because of temperature and pressure changes over long time periods, some oil will slowly leak out of the external capillary tube. Use P/N 50025, Pressure Sensor Oil Refill Kit to refill the oil in the tube if no oil can be seen in the tube.

At regular intervals, or annually, inspect and clean the pressure port of sensors that are so equipped.

1. Use a flathead screwdriver to remove the pressure port plug.



2. Flush the pressure port with warm DI water to remove any contamination.
3. Replace the pressure port plug. Do not over-tighten the nylon screw.

8.8 Maintain pump

Sediment in the pump can cause data from the sensor to be of poor quality. To clean and maintain the pump, put the sensor in clean water and operate the pump for 15 minutes.

Section 9 Calibration

The manufacturer calibrates every sensor to known conditions and measures the response of the sensor. Calibration coefficients are calculated and are used to get engineering units.

9.1 Conductivity

The SBE 4C conductivity sensor has a fixed precision resistor in parallel with the cell. When the cell is dry and in air, the output frequency of the resistor is the same as the electrical circuitry of the cell. This value is reported on the Calibration page for the sensor and should be stable within 1 Hz over time.

Because the main cause of calibration drift in conductivity sensors is from biofouling, the manufacturer recommends that the user clean the temperature and conductivity duct before and after a deployment, but also when the cell has been in water contaminated by oil or biological material.

Refer to [Disassemble and reassemble TC duct](#) on page 32 to remove the TC duct from the system so that it can be returned for calibration.

9.2 Temperature

The main cause of calibration drift in temperature sensors is the age of the thermistor element. This drift is usually a few thousandths of a degree during the first year, and less after that. Environmental conditions have little effect on temperature sensors.

9.3 Pressure sensor calibration

The strain-gauge pressure sensor of the 52-MP meets the error specification of the sensor with some allowance for age and ambient-temperature induced drift.

Let the 52-MP equilibrate (with power on) in a reasonably constant temperature environment for at least 5 hours. Pressure sensors show a transient change in their output in response to changes in their environmental temperature. The manufacturer's sensors are built to minimize this since the sensor is thermally decoupled from the body of the instrument. However, there is still some residual effect; let the 52-MP equilibrate before doing a calibration to provide the most accurate calibration correction.

The strain-gauge pressure sensor has an initial static error band of 0.05%. Pressure sensors show most of their error as a linear offset from zero. Note that the pressure sensor is an "absolute" sensor, so the raw data includes the effect of atmospheric pressure of 14.7 psi. Engineering units, however, are relative to the ocean surface. The sensor uses the equations below to convert psia:

$$P(\text{db}) = P(\text{psi}) = P(\text{psia}) - 14.7$$

$$P(\text{dbar}) = [P(\text{psia}) - 14.7] \times 0.689476$$

The manufacturer recommends that the user uses the offset calibration coefficient to make small corrections to the pressure sensor calibration. Compare the pressure values to a barometer.

1. Let the sensor equilibrate in a constant temperature bath for at least 5 hours in the orientation in which it will be deployed.
2. Start the software.
3. Set the pressure offset to 0.0 ($P_{\text{Offset}}=0$).
4. Send **TP** to measure the 52-MP pressure 100 times and transmit converted data in engineering units (decibars).
5. Compare the sensor output to what a barometer at the same elevation as the pressure sensor port shows.

Calibration

- Calculate the offset: the barometer value - pressure sensor value.
6. Enter the calculated offset (positive or negative in the EEPROM of the 52-MP. Use POffset= in the software.

Offset Correction Example

Absolute pressure measured by a barometer is 1010.50 mbar. Pressure from 52-MP shows -2.5 db.

Convert the barometer measurement to decibars: $\text{mbar} \times 0.01 = \text{db}$

Barometer shows = $1010.50 \text{ mbar} \times 0.01 = 10.1050 \text{ db}$

The internal calculations of the 52-MP and processing software show gage pressure, which uses an assumed value of 14.7 psi for atmospheric pressure. Convert 52-MP reading from gage to absolute by adding 14.7 psia to the 52-MP's output:

$-2.5 \text{ db} + (14.7 \text{ psi} \times 0.689476 \text{ db/psia}) = -2.5 + 10.13 = 7.635 \text{ db}$

Offset = $10.1050 - 7.635 = + 2.47 \text{ db}$

Enter the offset in 52-MP.

Where the air ambient pressure response of the sensor has changed significantly, the manufacturer recommends that the user uses dead-weight generator. This provides more accurate results, but requires equipment that may not be readily available. The 7/16-20 straight thread of the sensor end flange permits mechanical connection to the pressure source. Use a fitting that has an O-ring tapered seal, such as Swagelok-200-1-4ST, which conforms to MS16142 boss.

9.4 Oxygen sensor

The optional oxygen sensor measures the flow of oxygen across a Teflon membrane. The primary cause of calibration drift is the fouling of the membrane by chemical or biological deposits. Fouling changes the membrane permeability, which causes a calibration shift. Thus, the most important determinant of long-term sensor accuracy is the cleanliness of the membrane. The manufacturer recommends that the oxygen sensor be calibrated before and after deployment, but particularly when the sensor has been exposed to contamination by oil slicks or biological material.

Application Note 64-2, *Dissolved Oxygen Sensor Calibration and Data Corrections using Winkler Titrations* gives details to make small corrections to the oxygen sensor calibration. This application note was written for an SBE 43 Dissolved Oxygen Sensor, a voltage output sensor, incorporated with a profiling CTD integrated with a water sampler. However, the basic technique can be adapted for use with the 52-MP, which incorporates the SBE 43F, a frequency output version of the SBE 43.

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 No real-time data shows

Cause: The I/O cable is loose.

Solution: Make sure all cables are connected correctly.

Cause: Communications settings are incorrect.

Solution: Make sure that the communications settings in the software are correct. Make sure the COM port is correct.

10.3 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.

10.4 Salinity spikes

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

Solutions:

1. Clean the conductivity cell. Refer to [Maintain sensor flow path](#) for details.
2. Blow *clean* air (not compressed) through the cell to remove large drops of water from the cell.
3. Enter the **TCR** command to 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.

10.5 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.

Section 11 Convert from RS232 to logic level

The SBE 52-MP is configured by the manufacturer to the ordered communication interface. To change this configuration, send a command and move two jumpers on the digital PCB.

Access the electronics

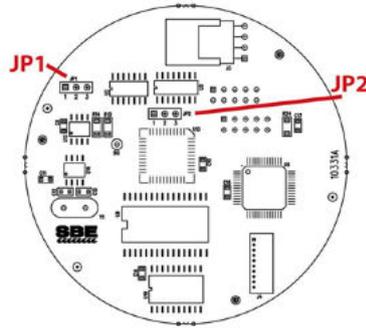
Use the manufacturer-supplied jackscrew kit (two hex wrenches, three jackscrews, and two spare plastic socket hex-head screws) to remove the sensor end flange.

1. Verify that all data in memory has been transmitted to a PC. **When power is removed, data stored in memory is lost.** The 52-MP should retain the user-input parameters; however, as a precaution, send the status command (**DS**) to have a record of the setup.
2. Send ***RS232=Y** to switch from logic level to RS232, or send ***RS232=N** to switch from RS-232 to logic level. Note that you **must send the appropriate command before you move the jumper.**
3. Remove power to the 52-MP.
4. Remove the sensor end cap and attached electronics PCB assembly:



5. Wipe the outside of the end flange and housing dry. Be careful to remove any water at the seam between them.
6. Remove the four titanium hex-head screws that attach the sensor end flange to the housing.
7. Use the larger hex wrench to remove the three plastic hex-head screws from the end flange.
8. Insert the three jackscrews in these three holes in the end flange. When you start to feel resistance, use the smaller hex wrench to continue to turn the screws. Turn each screw 1/2 turn at a time. As you turn the jackscrews, the end flange will push away from the housing. When the end flange is loosened, carefully pull it and the PCB assembly out of the housing.
9. Remove any water from the O-rings and mating surfaces inside the housing with a lint-free cloth or tissue.
10. Disconnect the Molex connector that connects the PCB assembly to the data I/O bulkhead connector.
11. Be careful to protect the O-rings from damage or contamination.
12. On the **digital PCB (10331A)**, move the JP1 and JP2 jumpers as shown in the table below:

Interface	JP1	JP2
Logic Level	1-2	1-2
RS232	2-3	2-3



Before delivery, the manufacturer installs a desiccant pack in the housing, and the electronics chamber is filled with dry Argon gas. These measures help prevent condensation. To make sure that the 52-MP operates correctly:

1. Install a new desiccant bag each time the housing is opened. If a new bag is not available, refer to Application Note 71, *Desiccant Use and Regeneration (drying)* for details to use a desiccant pack again.
2. If possible, dry gas backfill each time the housing is opened. If this is not possible, wait at least 24 hours to deploy the sensor again, to let the desiccant to remove any moisture from the housing.

Assemble electronics

1. Remove any water from the end flange O-rings and mating surfaces in the housing with a lint-free cloth or tissue.
2. Inspect the O-rings and mating surfaces for dirt, nicks, and cuts. Clean or replace as necessary. Apply a light coat of Parker Super O Lube™ lubricant to the O-rings and mating surfaces.
3. Connect the Molex connector to the data I/O bulkhead connector again. Verify that the pins are correctly aligned and the connection is tight.
4. Carefully fit the PCB assembly into the housing: align the holes in the end flange and housing.
5. Install the 4 titanium hex-head screws again to attach the end cap to the housing.
6. Install the 3 plastic hex head screws again in the end flange.
7. No user-programmable setup parameters should have been affected by the electronics disassembly (send **DS** to verify).

Section 12 General information

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

12.1 Warranty

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

12.2 Service and support

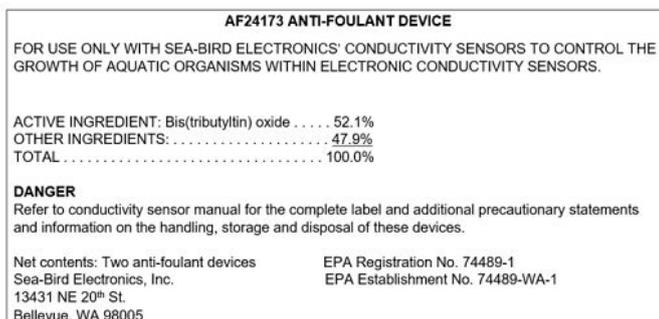
The manufacturer recommends that sensors be sent back to the manufacturer annually to be cleaned, calibrated, and for standard maintenance.

Refer to the website for FAQs and technical notes, or contact the manufacturer for support at support@seabird.com. Do the steps below to send a sensor back to the manufacturer.

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

12.3 AF24173 anti-foulant device

AF24173 Anti-Foulant Devices supplied for user replacement are supplied in polyethylene bags displaying the following label:



AF24173 ANTI-FOULANT DEVICE

FOR USE ONLY WITH SEA-BIRD ELECTRONICS CONDUCTIVITY SENSORS TO CONTROL THE GROWTH OF AQUATIC ORGANISMS WITHIN ELECTRONIC CONDUCTIVITY SENSORS.

ACTIVE INGREDIENT: Bis(tributyltin) oxide 52.1%
OTHER INGREDIENTS: 47.9%
TOTAL 100.0%

DANGER

See Precautionary Statements for additional information.

General information

FIRST AID	
If in eyes	<ul style="list-style-type: none">• Hold the eye open and rinse slowly and gently with water for 15–20 minutes.• Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.• Call a poison control center or doctor for treatment advice.
If on skin or clothing	<ul style="list-style-type: none">• Take off contaminated clothing.• Rinse skin immediately with plenty of water for 15–20 minutes.• Call a poison control center or doctor for treatment advice.
If swallowed	<ul style="list-style-type: none">• Call poison control center or doctor immediately for treatment advice.• Have person drink several glasses of water.• Do not induce vomiting.• Do not give anything by mouth to an unconscious person.
HOT LINE NUMBER	
Note to Physician	Probable mucosal damage may contraindicate the use of gastric lavage.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For further information, call National Pesticide Telecommunications Network (NPTN) at 1-800-858-7378.	

Net contents: Two anti-foulant devices

Sea-Bird Electronics, Inc.

13431 NE 20th St.

Bellevue, WA 98005

EPA Registration No. 74489-1

EPA Establishment No. 74489-WA-1

PRECAUTIONARY STATEMENTS HAZARD TO HUMANS AND DOMESTIC ANIMALS

Danger:

Corrosive—Causes irreversible eye damage and skin burns. May be fatal if swallowed or absorbed through the skin. Do not get in eyes, on skin, or on clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco, or using the toilet. Remove and wash contaminated clothing before reuse.

PERSONAL PROTECTIVE EQUIPMENT

Users must wear: protective gloves (rubber or latex), goggles or other eye protection, long-sleeved shirt, long pants, and shoes plus socks.

USER SAFETY RECOMMENDATIONS

Users should:

- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Follow the manufacturer's instructions for cleaning and maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

ENVIRONMENTAL HAZARDS

Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of EPA. This material is toxic to fish. Do not contaminate water when cleaning equipment or disposing of equipment washwaters.

PHYSICAL OR CHEMICAL HAZARDS

Do not use or store near heat or open flame. Avoid contact with acids and oxidizers.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

For use only in Sea-Bird Electronics conductivity sensors. Read installation instructions in the applicable Conductivity Instrument Manual.

Intended for professional use by military, government, academic, commercial, and scientific personnel.

STORAGE AND DISPOSAL

PESTICIDE STORAGE: Store in original container in a cool, dry place. Prevent exposure to heat or flame. Do not store near acids or oxidizers. Keep container tightly closed.

PESTICIDE SPILL PROCEDURE: In case of a spill, absorb spills with absorbent material. Put saturated absorbent material into a labeled container for treatment or disposal.

PESTICIDE DISPOSAL: Pesticide that cannot be used according to label instructions must be disposed of according to Federal or approved State procedures under Subtitle C of the Resource Conservation and Recovery Act.

CONTAINER HANDLING: Nonrefillable container. Do not reuse this container for any other purpose. Offer for recycling, if available.

12.4 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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