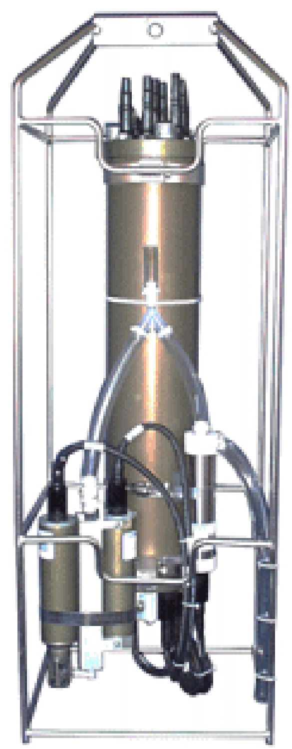
User manual

SBE 9plus CTD

Conductivity, Temperature, Depth sensor



Document No.	SBE9plus
Release Date:	2023-04-13
Version:	A
Software:	Seasoft V2

425-643-9866
seabird.com

Table of Contents

Section 1 Safety information

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

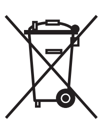
1.1 Hazard information

NOTICE

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

1.2 Equipment labels

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

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

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

Section 2 SBE 9plus quick start guide

⚠ 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

The pressure housing contains Electrostatic Discharge (ESD) sensitive parts and assemblies that are susceptible to damage from ESD. Follow ESD protocols:

- Put on protective eye wear before you open the pressure housing.
- Any electrostatic charge on the body of the human operator must be released before the pressure housing is opened: put a hand on a grounded surface, or better, wear a grounded antistatic wrist strap.
- At a minimum, wear short-sleeved antistatic clothing, such as cotton, or better, wear an antistatic smock for this service activity. *Do not wear a sweater, fleece or polyester-based clothing.*
- At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. *Do not use a workstation with a synthetic or polymeric-based tabletop.*

This quick start guide and user manual applies to the SBE 9plus CTD.

What's in the box:

- Stainless steel cage
- SBE 9plus with aluminum or titanium pressure housing
- SBE 5T pump with titanium pressure housing
- SBE 4C conductivity sensor with aluminum or titanium pressure housing
- SBE 3plus temperature sensor with aluminum or titanium pressure housing
- CD or USB drive with software, calibration files, documentation
- Dummy plugs and lock collars for each bulkhead connector
- Data I/O cable to connect the sensor to a PC
- Conductivity cell tubing and storage kit
- Non-ionic surfactant to clean sensor flow path
- Spare hardware and O-ring kit.
- Digiquartz® pressure sensor
- TC duct, so that temperature and conductivity are measured on the same parcel of water
- Eight 12-bit A/D differential input, low pass-filtered channels for auxiliary sensors
- 300 baud modem for water sampler control of the SBE 32 Carousel or G.O. 1015
- Pressure sensor oil fill kit

Optional equipment:

- Secondary temperature and conductivity sensors and pump
- Auxiliary sensors for dissolved oxygen, pH, fluorescence, PAR, turbidity, and more
- Bottom contact switch
- Pressure sensor is available in five ranges from 2000–15,000 psia
- Additional electronics for G.O. 1015 water sampler interface, RS232 serial output interface, or RS232 serial data uplink.

1. Install the manufacturer-supplied software on a PC. Refer to Install software and test sensor on page 17 for details.
2. Connect the data I/O cable to the sensor and the PC and double-click on **SeatermV2.exe** to start the software.
3. Configure the data collection settings. Refer to Configure and set up system for deployment on page 21 for details.
4. Install dummy plugs and lock collars on bulkhead connectors that are not used.
5. If necessary, remove the end-to-end loop of Tygon® tubing from around the conductivity cell. It is used when the SSBE 9plus is in storage.
6. If necessary, connect the tubing from the pump to the conductivity cell.
7. Connect the SBE 9plus to the 11plus Deck Unit or the 17plus Searam.
8. Deploy the sensor. For most applications, make sure the connector is at the bottom (lowest point).
9. Immediately after the sensor is recovered from a deployment:
   a. Transmit data from the SBE 17plus to a PC. Refer to Transmit and save data on page 23 for details.
   b. Turn off the system.
   c. Flush the sensor with fresh water.
   d. Keep the SeaCAT out of direct sunlight between deployments.

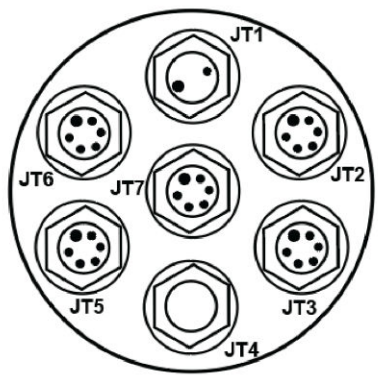
Section 3 Specifications

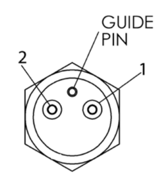
3.1 Mechanical

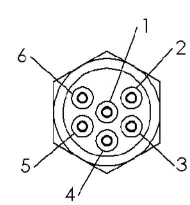
	Aluminum	Titanium
Depth rating	6800 m	10500 m
Weight in air, water	25 kg, 16 kg	29 kg, 20 kg

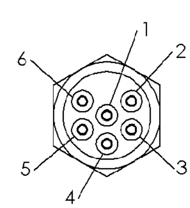
3.1.1 Bulkhead connectors

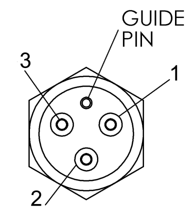
3.1.1.1 Top end flange bulkhead connectors

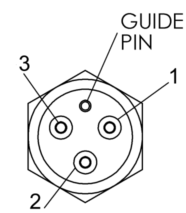


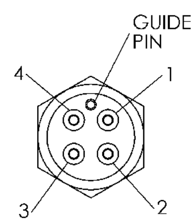
Connector	Contact	Function	MCBH2MP
JT1 (sea cable)	1	-	
	2	+	

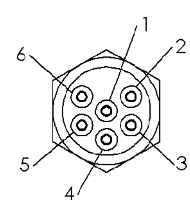
Connector	Contact	Function	MCBH6MP
JT2 (aux. sensor)	1	Return	
	2	V0 signal	
	3	V0 return	
	4	V1 signal	
	5	V1 return	
	6	15 V out	

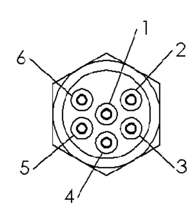
Connector	Contact	Function	MCBH6MP
JT3 (aux. sensor)	1	Return	
	2	V2 signal	
	3	V2 return	
	4	V3 signal	
	5	V3 return	
	6	15 V out	

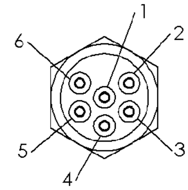
Connector	Contact	Function	MCBH3MP
JT4, Option 1 (G.O. 1015 rosette)	1	+	
	2	-	
	3	NC	

Connector	Contact	Function	MCBH3MP
JT4, Option 2 (serial output)	1	Common	
	2	RS232 data output	
	3	12–16 V in	

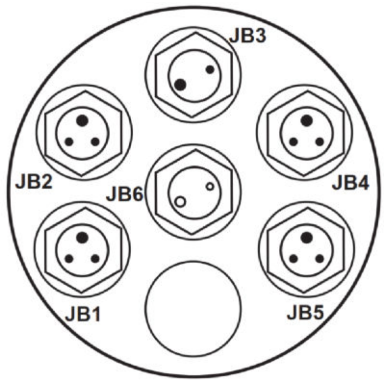
Connector	Contact	Function	MCBH4MP
JT4, Option 3 (serial uplink)	1	Common	
	2	RX from serial sensor	
	3	TX to serial sensor	
	4	15 V out	

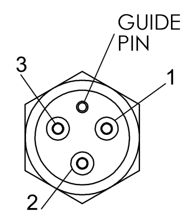
Connector	Contact	Function	MCBH6MP
JT5 (aux. sensor)	1	Return	
	2	V4 signal	
	3	V4 return	
	4	V5 signal	
	5	V5 return	
	6	15 V out	

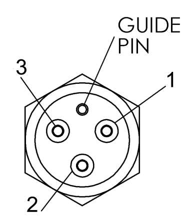
Connector	Contact	Function	MCBH6MP
JT6 (aux. sensor)	1	Return	
	2	V6 signal	
	3	V6 return	
	4	V7 signal	
	5	V7 return	
	6	15 V out	

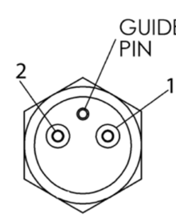
Connector	Contact	Function	MCBH6MP
JT7 (water sampler or SEARAM)	1	Return	
	2	RS232 out to water sampler	
	3	RS232 in from water sampler	
	4	Data to SEARAM	
	5	NC	
	6	15 V out/in	

3.1.1.2 Bottom end flange bulkhead connectors

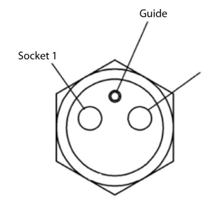


Connector	Contact	Function	MCBH3MP
JB1 (temperature sensor 1) JB4 (temperature sensor 2)	1	Common	
	2	Signal	
	3	V in	

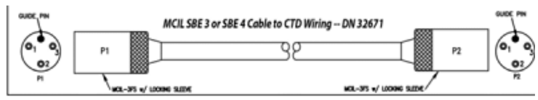
Connector	Contact	Function	MCBH3MP
JB2 (conductivity sensor 1) JB5 (conductivity sensor 2)	1	Common	
	2	Signal	
	3	V in	

Connector	Contact	Function	MCBH2MP
JB3 (pump)	1	-	
	2	+	

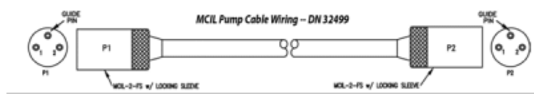
Specifications

Connector	Contact	Function	MCBH2FS
JB6	1	Common	
	2	Signal	

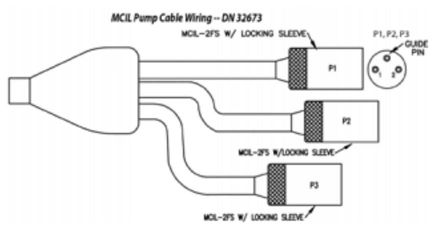
3.1.2 Cables



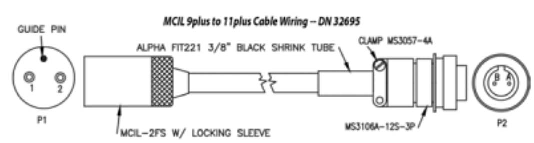
JB1 or JB4 to SBE 3 temperature sensor, or
JB2 or JB5 to SBE 4 conductivity sensor.



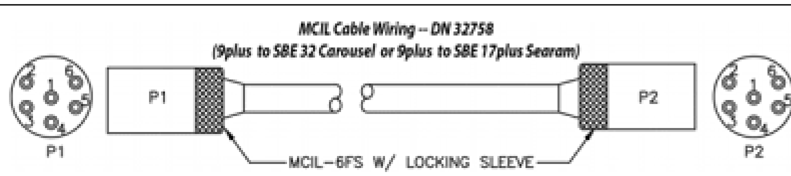
JB3 to SBE 5T pump.



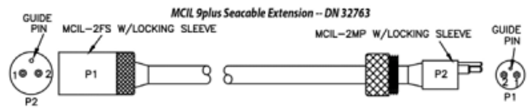
JB3 to two SBE 5T pumps.



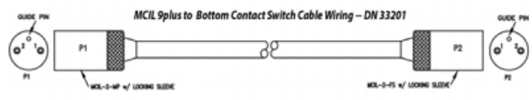
JT1 to SBE 11plus deck unit.



JT7 to SBE 32 Carousel Water Sampler, or SBE 17plus Searam.

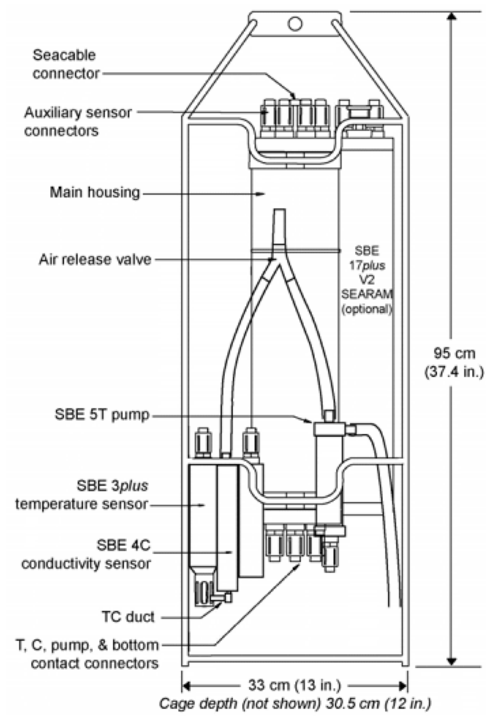


JT1 to sea cable or test cable.



JB6 to bottom contact switch cable.

3.1.3 SBE 9plus system dimensions



3.2 Electrical

Input	9–24 VDC
Current draw, operation	0.29 watts
Current draw, low power	30 µA
Current draw, communication	4.3 mA
Auxiliary sensors	1 amp at + 14.3 V available
Sea cable	Single-or multi-core armored cable to 10000 m with inner core resistance to 350 ohms

3.3 Communication

	Temperature	Conductivity	Pressure
Sample rate	24 Hz		
Time response	0.065 seconds		0.015 seconds
Master clock error[1]	0.00016 °C	0.00005 S/m	0.3 dbar[2]

[1] based on worst-case error budget, including ambient temperature influence of 1 ppm total over -20 to 70 °C, plus 1 ppm first year drift plus 4 additional years' drift at 0.3 ppm/year.

[2] 6800 m (10,000 psia) pressure sensor.

3.4 Analytical

	Temperature	Conductivity	Pressure	A/D inputs
Measurement range	-5–35 °C	0–7 S/m	0–full scale range	0–5 V
Accuracy	±0.001 °C	±0.0003 S/m	±0.015% of full scale range	±0.005 V
Stability	0.0002 °C/month	0.0003 S/m/month	0.02% of full scale range per year	0.001 V/month
Resolution, 24 Hz	0.0002 °C	0.00004 S/m	0.001% of full scale range	0.0012 V
Calibration	-1.4–32.5 ºC	2.6–6 S/m	Paroscientific calibration manufacturer temp. correction	—

Section 4 Overview

4.1 Operation overview

The SBE 9plus continuously measures conductivity, temperature, pressure, and parameters from up to eight auxiliary sensors in salt or fresh water at depths to 10,500 m. It is designed to take vertical profiles at 24 scans/second.

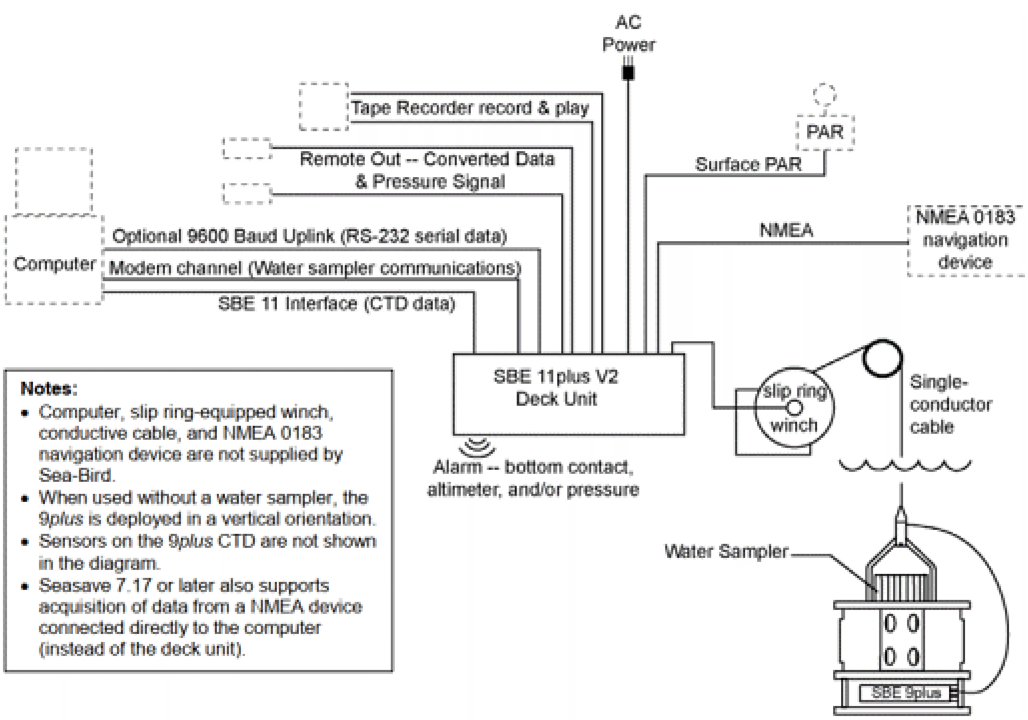
The main housing contains the data collection electronics, telemetry circuitry, and a Paroscientific Digiquartz® pressure sensor. The pump-controlled, TC-ducted flow reduces spikes in salinity caused by ship heave. The system's slower descent rate improves the resolution of water column features in calm waters.

Use the system for either real-time or autonomous operation.

4.1.1 Real-time data acquisition and control

The 9plus is controlled by the SBE 11plus deck unit, which supplies power to the submerged part of the system. The deck unit also decodes the data and passes it to a connected PC in either IEEE488 or RS232 protocol. Features of the deck unit include:

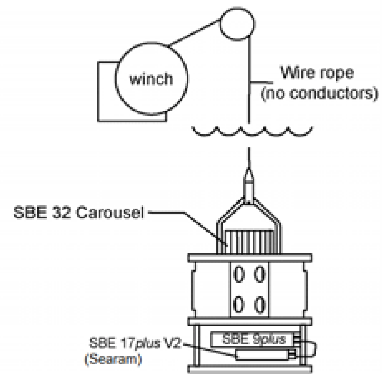
- 120 or 240 VAC at 50-60 Hz input power
- NMEA interface to integrate position data with collected data
- A/D converter for surface PAR sensor
- Tape recorder interface
- Remote output
- Audible alarm
- 300 baud modem interface for power and real-time control of a water sampler (SBE 32 carousel or G.O. 1015 or 1016 rosette) without data interruption, or a remote serial output device. On the 32 or G.O. 1016, bottles can be closed at any depth, in any order, without data interruption. Make sure the modem interface is installed on the 9plus and the 11plus.
- Install the RS232 Serial Data Uplink interface in both the 9 and the 11.



4.1.2 Autonomous operation

The 9plus is mounted near the 17plus, the Searam, which supplies power to the 9plus and stores the data collected by the 9plus. The 17plus also supplies power to and operates the SBE 32 Carousel Water Sampler. The Searam uses pressure data from the

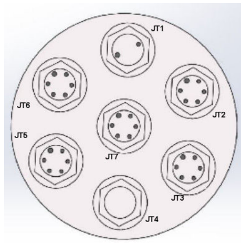
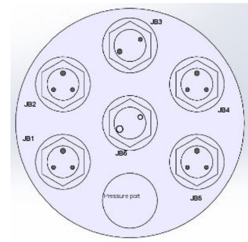
9plus and a programmable table of bottle-close pressures to control the Carousel so the bottles close upon upcast. Built-in logic and user-input parameters control when an upcast starts, so that bottles will not accidentally close if there are temporary upward movements during a downcast. After recovery, the data stored in the Searam is transmitted to a PC through an RS232 connection. The Searam can store 9plus data at the same time data is transmitted in real-time through the 11plus deck unit as a backup.



Notes: The manufacturer does not supply the winch and cable. Deploy the 9plus vertically if no water sampler is used.

Section 5 Set up sensor and verify operation

5.1 Cable connections from 9plus

	
9plus top bulkhead connectors	9plus bottom bulkhead connectors

5.1.1 11plus Deck Unit

⚠ DANGER

Life-threatening voltages of over 250 VDC are on the sea cable and the Deck Unit when it is on, and will persist for up to 1 minute after it is turned off.

The manufacturer supplies a test cable to use for setup and in the laboratory. For deployment, the manufacturer supplies a pigtail cable that can be spliced into if the user does not have an appropriately terminated cable. The manufacturer recommends the use of cable armor for the CTD power-data return.

To make a waterproof splice:

- Positive, the inner conductor, goes to the black wire on the pigtail.
- Negative and cable armor, goes to the white wire on the pigtail.

Refer to the Deck Unit manual for details about the connection of the sea cable to the Deck Unit and the wiring of the Deck Unit to the PC, power, and auxiliary equipment. On a ship, a qualified electrician should install cables over 3 m in grounded metal conduit.

5.1.2 Auxiliary sensors

Connect JT2, JT3, JT5, and JT6 to the auxiliary sensors (up to 8). Two sensors can be supported by each connector. The connections must be the same as the sensor configuration in the .xmlcon or .con file.

5.1.3 Water sampler

- SBE 32 carousel: connect JT7 to the 6-contact bulkhead connector at the bottom of the carousel electronics.
- G.O. 1015 rosette: connect JT4 to the rosette. The G.O. 1015 has "normal" and "reverse" polarity setting. "Reverse" is the typical setting, especially with an MK III CTD. From the 9plus, use
  - cable P/N 17533 for normal
  - cable P/N 17196 for reverse
    If necessary, change the polarity setting on the G.O. 1015.
- G.O. 1016 rosette: connect JT7 to the rosette.

5.1.4 17plus Searam

NOTICE

The voltage supplied to the 9plus and attached auxiliary sensors will damage input-limited sensors such as *ECO*.

The voltage supplied to the 9plus from the Searam is the same voltage the auxiliary sensors attached to the 9plus will get. To prevent damage to voltage-input-limited sensors such as ECO, use 12 fully charged NiMH or Ni-Cad batteries to supply 14.4 V. Twelve alkaline batteries supply 18 V.

9plus to Searam

Connect JT7 to the Searam.

9plus to auxiliary sensors

Connect JT2, JT3, JT5, and JT6 to the auxiliary sensors (up to 8). Two sensors can be supported by each connector. The connections must be the same as the sensor configuration in the .xmlcon or .con file.

9plus to water sampler

Connect the water sampler to the Searam (**not** the 9plus). A 300 baud modem interface is required in the 9plus for operation with a water sampler.

5.1.5 11plus and 17plus

The user can use the Searam to record 9plus data at the same time that data is transmitted in real-time through the 11plus Deck Unit to make a data back-up. Start data collection through the Deck Unit and then push the switch plunger on the Searam to save data to the Searam. The Searam is not used to control the water sampler in this application. If a water sampler is used, it is controlled via the Deck Unit or software.

9plus to Deck Unit

The manufacturer supplies a test cable to use for setup and in the laboratory. For deployment, the manufacturer supplies a pigtail cable that can be spliced into if the user does not have an appropriately terminated cable. The manufacturer recommends the use of cable armor for the CTD power-data return.

To make a waterproof splice:

- Positive, the inner conductor, goes to the black wire on the pigtail.
- Negative and cable armor, goes to the white wire on the pigtail.

Refer to the Deck Unit manual for details about the connection of the sea cable to the Deck Unit and the wiring of the Deck Unit to the PC, power, and auxiliary equipment. On a ship, a qualified electrician should install cables over 3 m in grounded metal conduit.

9plus to auxiliary sensors

Connect the auxiliary sensors (up to 8) to JT2, JT3, JT5, and JT6. Two sensors can be supported by each connector. The connections must be the same as the sensor configuration in the .xmlcon or .con file.

9plus to Searam and water sampler

With a Carousel Water Sampler: use a Y-cable to connect JT7 (pins 1 and 4) to the Searam. Connect JT7 (pins 1, 2, 3, and 6) to the bottom of the carousel.

Without a water sampler: Connect JT7 to the Searam.

5.1.6 RS232 sensors

A SBE 9plus with RS232 serial output can transmit 9plus data from JT4 at 19200 baud, 8 data bits, and no parity. This is configuration is typical when an AUV/ROV supplies power to the 9plus and stores the collected data. A PC with the Seasave software will show and save the data directly from the 9plus; no Deck Unit is necessary.

9plus to data logger and power supply

Connect JT4 to the sensor that saves the data collected by the 9plus. The voltage supplied to the 9plus is the same voltage supplied to all sensors connected to the 9plus. Make sure the appropriate voltage is supplied. Note that the 9plus can have power supplied through the sea cable JT1 connector as an alternative to JT4.

9plus to auxiliary sensors

Connect JT2, JT3, JT5, and JT6 to the auxiliary sensors (up to 8). Two sensors can be supported by each connector. The connections must be the same as the sensor configuration in the .xmlcon or .con file.

5.2 Install software and test sensor

Make sure that the sensor is connected to a power supply and PC through the serial connector on the supplied cable. Most PCs no longer have serial ports, and a serial-to-USB adapter is necessary. Make sure that the USB driver software is installed on the PC so that there is communication between the sensor and the PC.

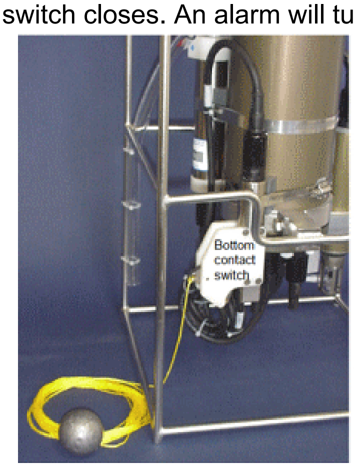
1. Install the Seasoft V2 software from the manufacturer-supplied CD or USB drive. The software is also available on the manufacturer's website.
2. Remove the dummy plug from the sensor.
3. Connect the I/O cable to the sensor and to the PC and a power supply (9–24 VDC).
4. Supply power to the sensor.
5. Double-click on **SeatermV2.exe** to start the launcher. If this is the first time the software is opened, a Serial Port Configuration window opens. The software automatically connects at the default baud rate but will try others if necessary. The software automatically looks for the serial port number of the connected sensor.
6. At the **Instruments** menu item, select the software version associated with the communication protocol of the sensor.
7. Push **OK** to close this window.
   The main window opens. The area on the left shows available commands. The large area on the right shows commands and the responses from the sensor to those commands.

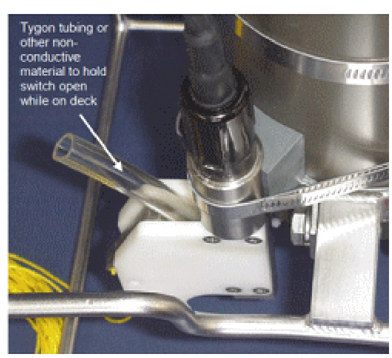
5.3 Bottom contact switch

An optional bottom contact switch can be used with the 9plus system that gives an early warning that the system is near the ocean floor. Components include:

- switch
- installation options for the 9plus, or the Carousel Water Sampler frame
- A 0.9 kg lead ball
- length of heavy line, cut to length based on how much warning the user wants that the system is near the bottom.

The switch stays open with no current flow when the lead ball pulls on the arm of the switch. When the ball touches the bottom, the pull of the weight is removed and the switch closes. An alarm will turn on at the 11plus Deck Unit.





To keep the alarm off when the system is on deck, insert a piece of non-conductive material such as Tygon tubing on the switch to keep the contacts open. Remember to remove this before deployment. Carefully lower the lead ball into the water, and use similar care on recovery.

5.4 Pump operation

The control logic for pump operation is based on the output from the primary conductivity connection (JB2). If the 9plus has redundant sensors and is to be deployed with the primary conductivity sensor removed, connect the secondary temperature and conductivity sensors to JB1 and JB2.

5.4.1 Conductivity frequency pump control

Pump operation for most salt water applications is controlled by the conductivity frequency when two conditions are met:

1. Raw conductivity frequency is more than the minimum conductivity frequency. The typical power-on value is approximately 3500 Hz. The pump is built to turn on at a value above the zero conductivity raw frequency.
2. Pump power-on delay time has passed. The delay lets all the air in the Tygon tubing and pump to escape after the system is submerged. If there is air in the impeller housing when the pump turns on, the prime and the flow rate are not certain.

Before deployment, let the system sit just under the surface of the water for 1 minute before the downcast, so the two conditions above are met. Without sufficient "soak" time, data from any sensors plumbed with the pump will be poor quality. For a vertical deployment, the tubing above the air-bleed hole has a small quantity of water that keeps the prime in the pump for up to 1 minute. **Do not let the pump inlet or outlet come above the surface of the water, or the pump will lose its prime.** If this happens, turn off the power to the system, then restore power and submerge the system completely for 1 minute and then start the downcast.

5.4.2 Manual pump control

Pump operation for fresh water deployments lets the user turn the pump on and off manually with software commands through the Deck Unit.

At the start of a deployment, let the system stay in water above the pump intake for 1 minute before a downcast. This lets air escape from the CTD plumbing so that the pump operates correctly.

There are two ways to turn the pump on or off:

1. Select "Pump On" or "Pump Off" from the **Real-Time Control** menu.
2. Push Ctrl-F2 to turn the pump on. Push Ctrl-F4 to turn the pump off.
   The pump status on the Deck Unit thumbwheel switch will show either 0**11****1** manual pump control installed, pump on, OR 0**11****0** manual pump control installed, pump off.

5.4.3 Water contact switch pump control

Pump operation for either fresh or salt water lets the pump automatically turn on one minute after the contact pin is submerged in water. The pump automatically turns off when the pin is removed. This can be useful for fresh water deployments since the pump control is independent of water conductivity. The contact pin is on a special dummy plug that connects to JB6. Note that if JB6 is wired for a contact pin, the bottom contact switch is disabled.

5.5 Add ballast weights

If the user will do deep casts, work in heavy seas, or on large ships with heavy-duty winches, use additional weight on the 9plus frame. Attach the weights to the sides of the frame as close to the bottom as possible. Make sure to remove the weights before the frame is shipped.

Section 6 Deployment and recovery

6.1 Component positions for deployment

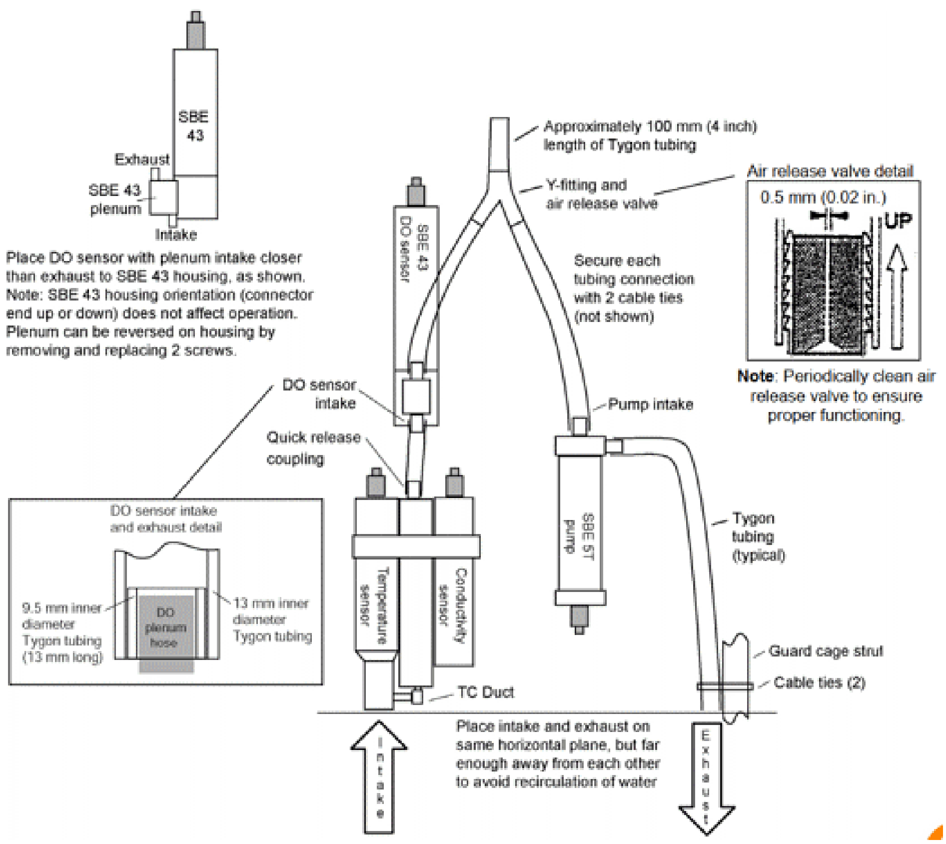
The 9plus is typically deployed in a vertical position. When used with a 17plus/32 Carousel Water Sampler, the 9plus is deployed horizontally. The system is delivered by the manufacturer as specified by the user at the time of purchase.

Note that if the pump and plumbing are not placed in the correct position, they can trap air and will not operate correctly.

6.1.1 Autonomous (vertical) deployment

The diagram below shows the correct plumbing connections for an autonomous, vertical deployment.

- The Tygon® tubing used to plumb the system is 13 x 19 mm OD.
- Put the intake and exhaust at the same height. Attach the exhaust tubing from the pump to the frame. Make sure to connect the exhaust tubing correctly or water can flow too quickly into the plumbing which can cause errors in conductivity data.
- Put the exhaust as far as possible from the intake so that exhaust water is not pulled into the intake. If the intake pulls in the warmer exhaust water, the temperature data may have errors.
- Put a 13 mm long piece of 9.5 mm ID Tygon tubing at the (optional) SBE 43 dissolved oxygen (DO) intake and exhaust. Slide the larger diameter Tygon tubing (13 mm ID) over the smaller diameter tubing to make a tight seal.
- It the system does not have a DO sensor, connect the tubing from the conductivity cell to the Y-fitting.

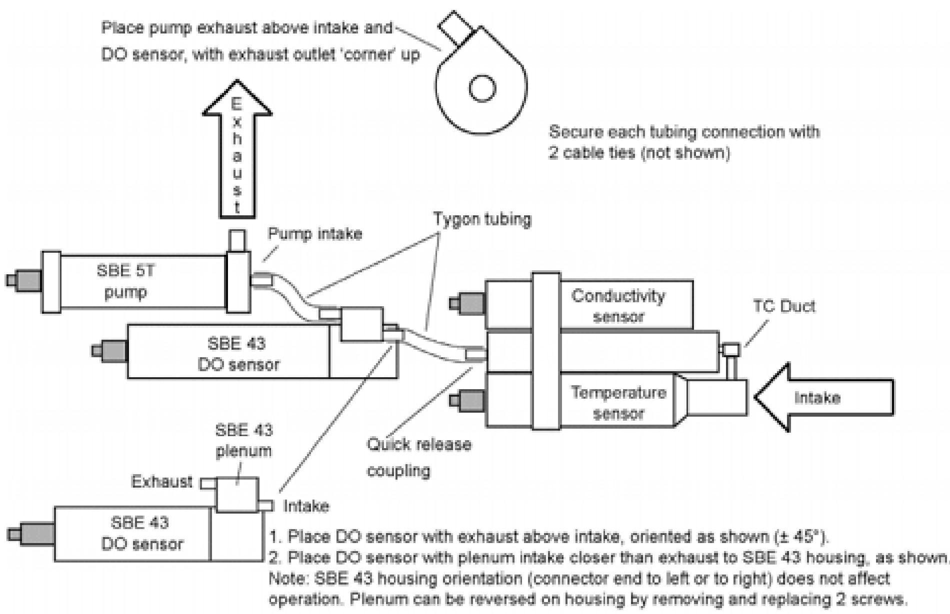


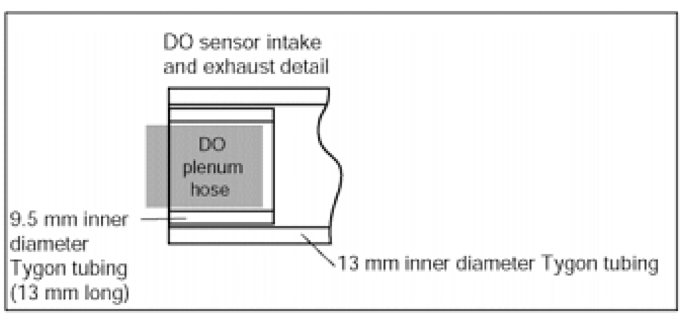
6.1.2 Real-time (horizontal) deployment

The diagram below shows the correct plumbing connections for a real-time, horizontal deployment.

- The Tygon® tubing used to plumb the system is 13 x 19 mm OD.

- Put the (optional) DO sensor intake above the conductivity sensor exhaust.
- Put the pump intake above the DO sensor exhaust.
- Put the pump exhaust outlet corner up.
- Put a 13 mm long piece of 9.5 mm ID Tygon tubing at the (optional) SBE 43 dissolved oxygen (DO) intake and exhaust. Slide the larger diameter Tygon tubing (13 mm ID) over the smaller diameter tubing to make a tight seal.
- If the system does not have a DO sensor, connect the tubing from the conductivity sensor directly to the pump intake.





6.2 Recommendations for quality data

These are general guidelines to help users get the best quality data from a deployment. Note that sea-state conditions and winch and deck gear configurations may require some changes to get the best quality data and prevent mechanical problems.

The 9plus is designed to profile at rates of 0.5–2 m/second. One m/second is usually the best compromise between data quality and profile resolution. The pump keeps a constant flow rate so that the system response times are independent of the descent rate. Adjust the descent rate based on the amount of ship motion that affects the cable, and the size, weight, and drag of the system at the end of the cable. In general, use a faster descent rate in rougher seas so that the system is not as affected by turbulent wakes that move downward as the ship heaves up. "Shed wakes" are an error source from which all CTDs suffer. In a calm sea, the system can descend at a rate of 10 to 20 cm/second for better vertical resolution.

Common 9plus configurations are for downcast data. The system is set up so the T-C Duct inlet passes through relatively undisturbed water as the CTD descends. If the plan is to sample on an upcast as well, attach the redundant T and C sensors on the upper and lower ends of the cage: one pair moves through undisturbed water on the downcast, and the other pair moves through undisturbed water on the upcast.

In a horizontal configuration with a Carousel Water Sampler, for example, the upcast data is better because the sensors are attached to the outside edge of the system. Make sure to put other sensors on the system so that they do not thermally contaminate the water that flows to the sensors and the T-C Duct inlet.

If the water temperature at the deployment is very different from the temperature at which the 9plus has been stored, let the 9plus sit near the surface of the water for 3–5 minutes and then start the profile. This will reduce the thermal effect of the sensor housing on the water that enters the cell.

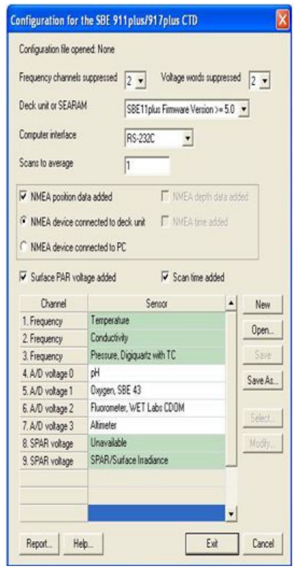
When heavy seas cause dangerous ship motion, the 9plus descent may stop or go in the opposite direction if the ship heaves upward faster than the system can descend. This can cause loops in the real-time temperature trace. In addition, if the winch payout rate is too fast, a loop of wire can form under water when the descent is slowed or stopped by ship heave but the winch has not stopped. The loop gets out of phase with the heave and closes on itself, which causes a kink. Systems with water samplers have more drag than only the 9plus, so the possibility of a loop is greater. If 100–200 kg of weight are added, the effect of drag will be reduced. The system will descend faster and stay in line below the overboarding sheave.

"Spiking" is caused by a response time mismatch of conductivity and temperature measurements, when the descent rate in non-uniform. Most spikes are removed when the data is synchronized in time, and the Deck Unit will do this automatically based on user inputs to align time for selected sensors. The 17plus will automatically roughly align temperature and conductivity data. Use the Data Processing software to align data more precisely. A data set can be improved if the user removes the data collected when the pressure did not increase.

6.3 Configure and set up system for deployment

Make sure that the **.xmlcon** or **.con** configuration file agrees with the 9plus configuration. This file defines the system—the auxiliary sensors, channels, serial numbers, and calibration dates and coefficients. The Seasave and SBE Data Processing software use the configuration file to process the raw data. Make sure to update the file if the configuration is changed or a sensor is recalibrated, or the software will not correctly read and process raw data.

1. Start the Seasave software.
2. Select **Configure Inputs...** menu.
3. Push **Open** on the *Instrument Configuration* tab.
4. Select either the .xmlcon or the .con file, then push **Open**.



a. **Frequency channels suppressed**:
   - 0 = 3plus or 4C connected to JB5 (COND 2).
   - 1 = 3plus or 4C connected to JB4 (TEMP 2) and not JB5.
   - 2 = no redundant temperature or conductivity sensors.

b. **Voltage words suppressed**:
   - Total voltage words = 4. Each word has data from two 12-bit A/D channels. The 11plus suppresses words above the highest numbered voltage word used. The number of words to keep is set by the highest numbered external voltage input that is not a spare: words to suppress = 4.
     - external voltage 0 or 1, connector JT2, AUX1, words to keep: 1.
     - external voltage 2 or 3, connector JT3, AUX2, words to keep: 2.
     - external voltage 4 or 5, connector JT5, AUX3, words to keep: 3.
     - external voltage 6 or 7, connector JT6, AUX4, words to keep: 4.

c. **Deck unit or SEARAM**:
   - 11plus > 5.0—Software sends **AddSpar=** to the 11plus.
   - 11plus < 5.0—Surface PAR is set in the 11plus with dip switch.
   - 17plus—Real-time data collection not available. Only stored data will show.
   - None—No use of 11plus or 17plus.

d. **Computer interface**: IEEE448 or RS232C.

e. **Scans to average**: Set to 1 for full rate 24 Hz data.

f. **NMEA**: Select if NMEA device is used, connected either to the 11plus or PC.

g. **Surface PAR voltage added**: Select if a PAR sensor is used. If 11plus firmware <5.0, the setting must agree with the Deck Unit setup.

h. **Scan time added**: Select for the software to append the time to each data scan. This is seconds since 1/1/1970 GMT.

i. **Channel, Sensor** area:
   - Sensors with shaded backgrounds cannot be changed.
   - Push **Select** to change a sensor. A dialog box with a list of sensors shows, then the calibration coefficients show. Make sure the Frequency channels suppressed and Voltage words suppressed have been specified.
   - Push **Modify** to see or change the calibration coefficients for the selected sensor.

5. Configure the system for deployment:

- Use Seaterm software for the 11plus Deck Unit and the 9plus.
- Use Seaterm AF software for the 17plus Searam and the 9plus.

6. Install a cable or dummy plug on each bulkhead connector on the 9plus.
7. If necessary, connect the appropriate sensors to the 9plus.
8. Verify that the hardware and external fittings are attached correctly.
9. If necessary, remove the Tygon tubing that was looped around the conductivity cell for storage. Connect the conductivity cell to the 9plus plumbing again.
10. Refer to the 11plus or 17plus user manual for details to start data collection. The system is ready to go in the water.

6.4 Recover system

DANGER

If the system stops while under water or shows other signs of damage, it may be flooded. The end flange may be ejected from the pressure housing with lethal force. Upon recovery, carefully secure it away from people, and slowly loosen the end flange (½ turn of each screw) until the pressure is released.

If there is internal pressure, the end flange will follow the screws out and they will be difficult to turn. Loosen one bulkhead connector one turn very slowly to release internal pressure. Let the pressure release until there is no hiss or water leak from the sensor.

When the system is on deck and secured, rinse all of the sensors with fresh water.

Refer to the Maintenance on page 25 for details about system maintenance.

6.5 Transmit and save data

If the user has deployed the 9plus with a 17plus Searam, data must be transmitted to a PC. If an 11plus Deck Unit is used, the collected data will be saved to a connected PC. The output from the RS232 interface looks the same as the output from the 11plus.

1. If the 9plus was deployed with the Searam (17plus), transmit the data from the Searam memory to a PC.
2. Make sure to look at the data transmitted to the PC before the data is erased from the Searam.
3. Use the Data Processing software to process the .hex data from the Deck Unit or the Searam. Note that older versions of Seasave created a binary .dat file type.

Data from the 9plus is 36 bytes as described below.

Byte	Description	Connector
1	8 MSB of pressure sensor temperature compensation	—
2	4 LSB of pressure sensor temperature compensation. Status bits for pump, bottom contact, G.O. Rosette confirmation bit, modem	—
3	Modulo count	—
4–6	Primary temperature frequency	JB1
7–9	Primary conductivity frequency	JB2
10–12	Pressure frequency	—
13–15	Secondary temperature frequency	JB4
16-18	Secondary conductivity frequency	JB5
19–21	Voltage output from A/D channels 0–1 (12 bits each)	JT2

22–24	Voltage output from A/D channels 2–3 (12 bits each)	JT3
25–27	Voltage output from A/D channels 4–5 (12 bits each)	JT5
28–30	Voltage output from A/D channels 6–7 (12 bits each)	JT6
31–36	Expansion (all zeros)	—

The Searam and Deck Unit do not show channels that are not used, based on the setup of the configuration file.

The DeckUnit and Searam do not show frequency words above the highest numbered frequency word used. Two examples:

- If a secondary sensor is connected to JB4 but not to JB5, bytes 16–18 will not show.
- If a secondary sensor is connected to JB5 but not to JB4, bytes 13–15 will be all zeros because there is no sensor connected to JB4.

The total number of voltage words is 4. Each word has data from 2 12-bit A/D channels, 3 bytes per word. The Deck Unit and Searam do not show words above the highest numbered voltage word used. One example:

- If auxiliary sensors connected to JT2 (auxiliary sensor connector 1) and JT5 (auxiliary sensor connector 3), only voltage word 4 (bytes 28–30) will not show. Voltage word 2 (bytes 22–24) will have all zeros because there are no sensors connected to it.

Section 7 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.

7.1 Corrosion precautions

Make sure to rinse all of the sensors and flush the SBE 9plus system with fresh water after each deployment and before it is put in storage.

Aluminum pressure housing

The pressure housing is insulated from the stainless steel cage and sea cable power circuits, which prevents corrosion. Do not attach metal objects to the pressure housing. All stainless steel screws that are exposed to salt water have a molybdenum lubricant (Blue Moly™) that has nickel powder and zinc oxide in it. After each cruise, remove these screws and apply more lubricant to them. Note that this lubricant is electrically conductive. Make sure it does not get on circuit boards.

The 9 plus has three large zinc anodes attached to the top end flange of the pressure housing. Make sure they are secure and have no corrosion. Replace the zinc anodes when there is less than 50% remaining.

Remove the stainless steel hose clamps and PVC mounting brackets annually to clean the entire surface of the pressure housing. The manufacturer recommends that the user replace the clamps at regular intervals. Apply Teflon™ tape or equivalent between the clamps and the anodized pressure housing.

Titanium pressure housing

No corrosion precautions are required, but do not let different types of metal contact the titanium pressure housing.

Attached sensors and auxiliary equipment

The temperature, conductivity, and auxiliary sensors from the manufacturer that have an aluminum pressure housing also have a zinc anode ring. Make sure to look at the anodes at regular intervals to make sure they are secure and have no corrosion.

The CTD power and signal common lines can be connected to the pressure housings of auxiliary sensors. Do not connect the auxiliary sensor housings to the 9 plus 15 V power supply. This can cause damage to the conductivity cell electrodes.

7.2 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.

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.
- Manufacturer-supplied tubing and syringe to clean the plumbing.

Procedure notes:

Use warm 30 °C (86 °F) 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 anti-fouling assembly if necessary.

1. Remove the pH sensor (if so-equipped) and store it in the white plastic holder with KCl solution or de-ionized (DI) water if non-ionic surfactant or bleach is necessary to clean the flow path. The pH sensor can stay installed on the sensor if DI water is used. Do not expose the pH sensor to air for longer than a few minutes. Refer to "Prepare pH sensor for storage" for details to remove the pH sensor.
2. Remove the copper assembly and anti-fouling devices from the sensor.
3. Use a 3/16-inch hex wrench to remove the flushing port plug, a ¼-20 x 1 inch socket head screw.
   Keep the plug to install again.
4. Put the instrument in a container with the bulkhead connector face-up.
5. If a cleaning solution is necessary, pull approximately 30 ml of DI water into the syringe.
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.
    The sensor is ready for a functional test in the laboratory or a deployment.

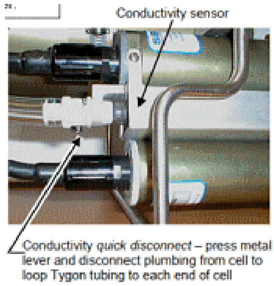
7.3 Conductivity cell

NOTICE
Do not put a brush or any object inside the plumbing to clean it. The conductivity cells can be damaged, which changes the calibration. Do not store the sensor with water in the plumbing. The conductivity cells can break and the oxygen sensor can be damaged if they freeze.

Note:

The manufacturer ships the SBE 4C conductivity cell with no water in the cell to prevent freezing.

Use the quick-disconnect to disconnect the conductivity cell, then use the manufacturer-supplied conductivity cell kit to clean the cell.



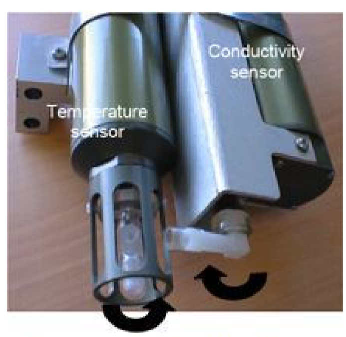
7.3.1 Disassemble and reassemble TC duct

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.

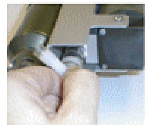
Prepare the temperature and conductivity duct to send back to the manufacturer for calibration, or to clean. Disconnect the C duct from the T duct and remove both from the conductivity cell. Send the temperature sensor with the guard attached to prevent damage to the thermistor.

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.



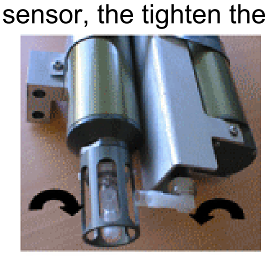
Temperature sensor guard rotated 90° counterclockwise while C Duct rotated clockwise slightly

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. Prepare sensors to be shipped:
    - 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. Don 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 counter-clockwise, 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, the 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.

7.4 Clean pressure sensor

NOTICE

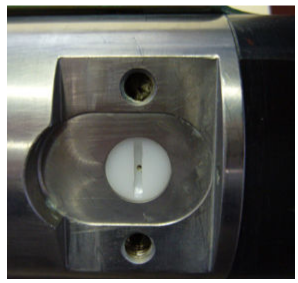
Do not put a brush or any object in the pressure port. It may damage or break the pressure sensor.

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.

7.5 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:

Any corrosion.		
Cracks, scratches, or other damage on the rubber pins or in the sockets.		

Separation of the rubber from the pins.	
Swelled or bulging rubber pins.	

6. Use a silicone-based lubricant on each of the contacts of the bulkhead connector. The manufacturer recommends any of the products listed below.
   - 3M™ Spray Silicone Lubricant (3M ID# 62-4678-4930-3). Make sure to let it dry.
   - Dow Corning Molykote® III Compound (DC III)
   - Dow Corning High Vacuum Grease® (DC 976 V)
   - Dow Corning 4 Electrical Insulating Compound® (DC 4)
   - Dow Corning Molykote 44 High Temperature Grease® (DC 44)

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

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

7.6 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.

7.7 Spare parts and accessories

Part number	Description	Quantity
171669	Cable from 3plus or 4C to 9plus, 0.7 m, MCIL3FS to MCIL3FS	1
171503	Cable from 5T to 9plus, 1.1 m, MCIL2FS to MCIL2FS	1
171741	Cable from 9plus JT7 to 32, 2 m, carousel water sampler	1
171743	Cable extension for sea cable, 2 m	1
171744	Cable extension for sea cable, 3 m	1

Table 1 Seaspares kit, aluminum SBE 9plus (P/N 50321)

171512	Cable, MCIL2FS, 2.4 m with lock sleeve
171192	Lock sleeve, MCDLSF
171497	MCDC2F dummy plug
171500	MCDC3F dummy plug
171498	MCDC6F dummy plug
172023	MCBH2MAS bulkhead connector
171724	MCBH3MAS bulkhead connector
172026	MCBH6MAS bulkhead connector
20042	Deck unit fast-blow fuse, 3AG-1/2A, for sea cable
20045	Deck unit slow-blow fuse, 3AG-1A, for 230 VAC line
20046	Deck unit slow-blow fuse, 3AG-2A, for 115 VAC line
23041	Anode ring for T sensor
23548	Anode ring for C sensor
30044	Anode for main housing end flange
23908	Dual sensor retainer strap for T and C sensor
231957C	Cage clamp set for 9plus to cage
31339	Hose clamp, AWAB 316 SS to secure pump, DO, or pH sensor
30384	Tubing, 7/16" diameter, 1/16" wall for C sensor soaker hose
30388	Tygon tubing, ¾ x ½" for main CTD plumbing
30389	Cable tie, 4" to attach plumbing to plastic fittings
30458	Cable tie, 15" to attach plumbing, cables, to CTD or cage
30409	Teflon tape to insulate insides of hose clamps
30411	Triton X-100 to clean C cell
30457	Parker Super O-Lube for O-rings
50029	Pressure sensor capillary for pressure port
50025	Kit, pressure sensor oil fill
50070	Kit, 9plus O-ring
50347	Kit, 9plus hardware
50089	Kit, 9plus jackscrew
50086	Kit, 11plus V2 deck unit cable connector

Table 1 Seaspares kit, aluminum SBE 9plus (P/N 50321) (continued)

50087	Kit, T/C duct fill and storage
90088	Kit, T/C duct tubing

Table 2 Seaspares kit, titanium SBE 9plus (P/N 50322)

171512	Cable, MCIL2FS, 2.4 m with lock sleeve
171192	Lock sleeve, MCDLSF
171497	MCDC2F dummy plug
171500	MCDC3F dummy plug
171498	MCDC6F dummy plug
172019	MCBH2M-WB titanium bulkhead connector
171720	MCBH3M-WB titanium bulkhead connector
172022	MCBH6M-WB titanium bulkhead connector
20042	Deck unit fast-blow fuse, 3AG-1/2A, for sea cable
20045	Deck unit slow-blow fuse, 3AG-1A, for 230 VAC line
20046	Deck unit slow-blow fuse, 3AG-2A, for 115 VAC line
23041	Anode ring for T sensor
23548	Anode ring for C sensor
30044	Anode for main housing end flange
231922	Dual sensor retainer strap for T and C sensor
231957C	Cage clamp set for 9plus to cage
31339	Hose clamp, AWAB 316 SS to secure pump, DO, or pH sensor
30384	Tubing, 7/16" diameter, 1/16" wall for C sensor soaker hose
30388	Tygon tubing, ¾ x ½" for main CTD plumbing
30389	Cable tie, 4" to attach plumbing to plastic fittings
30458	Cable tie, 15" to attach plumbing, cables, to CTD or cage
30409	Teflon tape to insulate insides of hose clamps
30411	Triton X-100 to clean C cell
30457	Parker Super O-Lube for O-rings
50029	Pressure sensor capillary for pressure port
50025	Kit, pressure sensor oil fill
50070	Kit, 9plus O-ring
50348	Kit, 9plus titanium hardware
50089	Kit, 9plus jackscrew
50086	Kit, 11plus V2 deck unit cable connector
50087	Kit, T/C duct fill and storage
90088	Kit, T/C duct tubing

Section 8 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.

8.1 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 27 to remove the TC duct from the system so that it can be returned for calibration.

8.2 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.

8.3 Pressure

The Paroscientific Digiquartz® pressure sensor is immune to environmental effects, so it requires less frequent maintenance.

There are two options if the user wants to make corrections to the slope and offset calibration coefficient values of the sensor: use a barometer or a dead-weight pressure generator.

Let the system equilibrate for at least 5 hours with power on in a constant-temperature environment. The manufacturer builds sensors that are thermally decoupled from the body of the instrument, but there is still a small effect in their response to changes in temperature.

- Look at the local barometric pressure and compare the zero pressure output from the sensor.
- For applications that require more accurate output, look at the full scale response of the sensor with a dead-weight pressure generator.

Use a barometer to calculate the offset value

1. Put the system in its deployment position, either vertical or horizontal.
2. Use the software to set the pressure offset to 0.0.
3. Collect data and show the pressure sensor output in decibars.
4. Compare the pressure sensor output to a good quality barometer at the same elevation.
5. Calculate the offset. Offset = barometer value - 9plus output.
6. Enter this value in the .xmlcon or .con file.

Example offset correction:

Absolute pressure as measured by a barometer = 1010.5 mbar. 1010.5 × 0.01= 10.1050 dbars.

Pressure value from the sensor = -2.5 dbars.

Seasave software output value (gauge pressure) = 14.7 psi.

The software converts psia to decibars: Decibars = (psia - 14.7) × 0.

Convert the 9plus from gauge to absolute: add 14.7 psia:

-2.5 dbars + (14.7 psi × 0.689476dbar/psia) = -2.5 + 10.13 - 7.635 dbars.

Offset = 10.1050 - 7.635 = 2.47 dbars. Enter this value in the .xmlcon or .con file.

Use a dead-weight pressure generator to calculate slope and offset values

1. Remove the nylon fitting from the 9plus. There is silicon oil in the fitting and some may spill.
2. Use a fitting with an O-ring face seal such as Swagelok 200-1-OR as a connector. The bore in the end flange is 5/16-24 straight thread.
3. Use the software to set the pressure slope to 1.0 and the pressure offset to 0.0 in the .xmlcom or .con files.
4. Use different pressures with the dead-weight pressure generator and collect data with the 9plus. Show the output in decibars.
5. Do a linear regression on the data to calculate slope and offset.
6. Enter the calculated values in the .xmlcon or .con configuration file.
7. Fill the pressure port fitting with silicon oil from the manufacturer-supplied kit.

Section 9 General 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.

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

9.1 Service and support

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

1. Complete the online Return Merchandise Authorization (RMA) form or contact the manufacturer.
   ***Note:** The manufacturer is not responsible for damage to the sensor during return shipment.*
2. Remove all batteries from the sensor, if so equipped.
3. 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-butyltin, marine anti-fouling paint, ablative coatings, etc.*
4. Use the sensor's original ruggedized shipping case to send the sensor back to the manufacturer.
5. Write the RMA number on the outside of the shipping case and on the packing list.
6. Use 3rd-day air to ship the sensor back to the manufacturer. Do not use ground shipping.
7. The manufacturer will supply all replacement parts and labor and pay to send the sensor back to the user via 3rd-day air shipping.

9.2 Warranty

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

9.3 China RoHS disclosure table

Name of Part	Hazardous substance or element in product					
	Pb	Hg	Cd	Cr(VI))	PBB	PBDE
PCBs	X	O	O	O	O	O
Conductivity cell	X	O	O	O	O	O
Battery pack	O	O	O	O	O	O
Cables	X	O	O	O	O	O
Housing	O	O	O	O	O	O
Plumbing	O	O	O	O	O	O
Frame	O	O	O	O	O	O
Mounting hardware	O	O	O	O	O	O
Accessories	O	O	O	O	O	O

This table is compiled to the SJ/T 11364 standard.
O: This hazardous substance is below the specified limits as described in GB/T 26572. X: This hazardous substance is above the specified limits as described in GB/T 26572.

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