SBE 49 FastCAT

Conductivity, Temperature, and Pressure Sensor with RS-232 Interface

User's Manual

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Firmware Version 1.1 and later

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Table of Contents

Section 1: Introduction

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

About this Manual

This manual is to be used with the SBE 49 FastCAT Profiler Conductivity, Temperature, and Pressure Sensor.

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

Sea-Bird welcomes suggestions for new features and enhancements of our products and/or documentation. Please e-mail any comments or suggestions to seabird@seabird.com.

How to Contact Sea-Bird

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Except from April to October, when we are on *summer time*
(1500 to 0000 Universal Time)

Quick Start

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

1. Test power and communications (*Section 3: Power and Communications Test*).

2. Deploy the FastCAT (*Section 4: Deploying and Operating FastCAT*):
   A. Establish setup and sampling parameters.
   B. Install I/O cable connector and locking sleeve. Connect other end of cable to computer/controller and to power supply.
   C. Verify hardware and external fittings are secure.
   D. Remove caps from end of T-C Duct and pump exhaust tee.
   E. Apply power.
      - If **AUTORUN=Y**, FastCAT will start sampling automatically.
      - If **AUTORUN=N**, send **START** command to start sampling.
   F. Deploy FastCAT.

Unpacking FastCAT

Shown below is a typical FastCAT shipment.

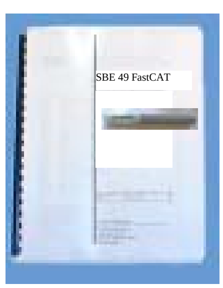
SBE 49 FastCAT

I/O Cable

9-pin adapter

Spare parts kit

Cell cleaning solution
(Triton-X)



FastCAT User Manual

Software, and Electronic Copies of
Software Manuals and User Manual

Section 2: Description of FastCAT

This section describes the functions and features of the SBE 49 FastCAT, including specifications and dimensions.

System Description

The SBE 49 FastCAT is an integrated CTD sensor intended for towed vehicle, ROV, AUV, or other autonomous profiling applications in marine or fresh-water environments at depths up to 7000 meters (22,900 feet). The FastCAT's pump-controlled, TC-ducted flow minimizes salinity spiking, and its 16 Hz sampling provides very high spatial resolution of oceanographic structures and gradients.

The FastCAT's temperature thermistor and conductivity cell are the same as used in our premium 911*plus* CTD system. Its pressure sensor (offered in seven full scale ranges from 20 to 7000 dbars) is the superior, micro-machined, silicon strain-gauge recently developed by Druck, Inc. Sophisticated interface circuitry provides very high resolution and accuracy — entirely comparable to the 911*plus*.

The FastCAT is an easy-to-use, light, and compact instrument ruggedly made of titanium and other low-maintenance (plastic) materials; it is well suited to even the smallest vehicle. There are straightforward commands for continuous (full rate or averaged) or single sample acquisition. EEPROM-stored calibration coefficients permit data output in ASCII engineering units (degrees C, Siemens/m, decibars, Salinity [PSU], and sound velocity [m/sec]), or the user can select raw data output if desired.

The FastCAT is externally powered, and its data is telemetered by its RS-232C interface. The FastCAT has no memory or internal batteries, and does not support auxiliary sensor inputs.

The FastCAT samples in two modes:

- **Autonomous sampling** –The FastCAT runs continuously and samples at sixteen scans per second (16 Hz). It can be set to average up to 255 samples, transmitting only the averaged data. The FastCAT can be programmed to begin autonomous sampling when power is applied or on command.

- **Polled sampling** – On command, the FastCAT takes one sample and transmits the data.

Note:
The FastCAT's pump is not designed to be used to pump water through other sensors. **Other sensors requiring pumped water require a separate pump.**

A standard FastCAT is supplied with:

- Titanium housing for depths to 7000 meters (22,900 feet)
- Strain-gauge pressure sensor
- Integrated T-C Duct
- Internal pump for flow-controlled conductivity and temperature response
- XSG 4-pin I/O bulkhead connector

FastCAT options include:

- MCBH Micro *wet-pluggable* connector in lieu of XSG connector
- Expendable Anti-Foulant Devices for long deployments

The FastCAT is supplied with a powerful Win 95/98/NT/2000/XP software package, SEASOFT-Win32, which includes:

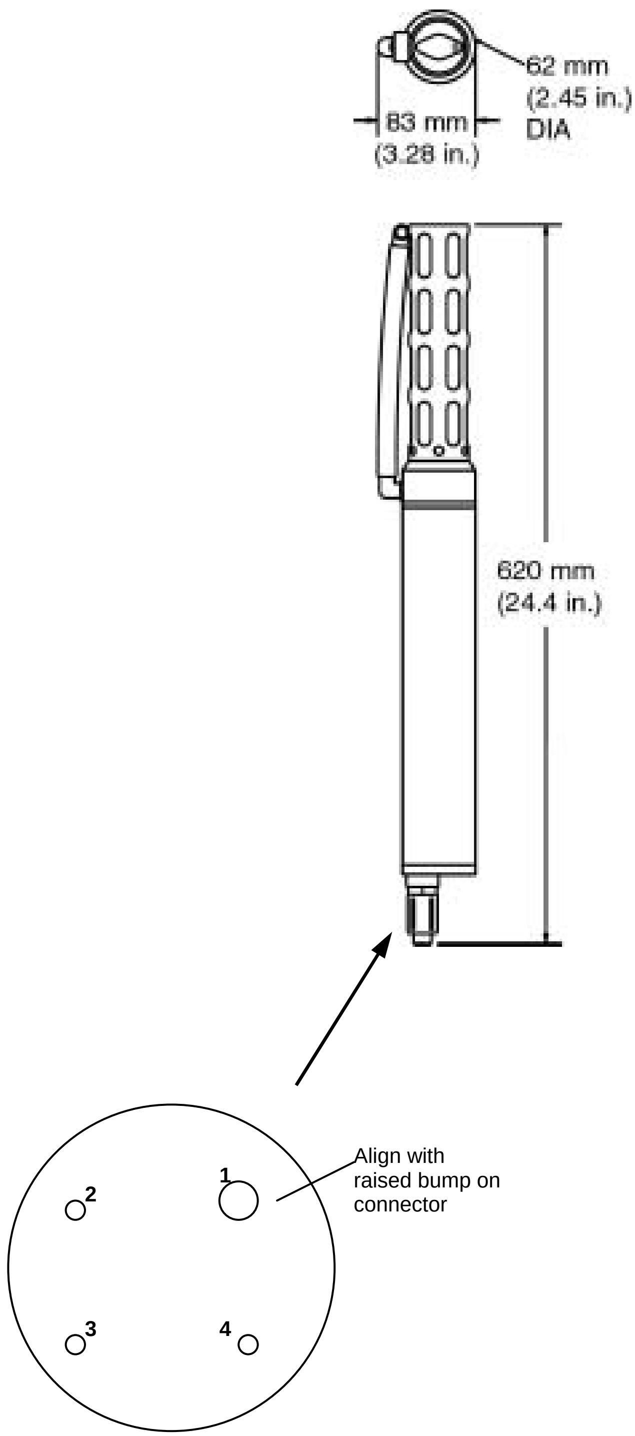
- **SEATERM** - terminal program for instrument setup and communication.
- **SEASAVE** - program for real-time acquisition and display of data. SEASAVE can be used for real-time data acquisition only if the FastCAT is directly connected to the computer (not connected to an AUV, ROV, etc.).
- **SBE Data Processing** - program for calculation and plotting of conductivity, temperature, pressure, and derived variables such as salinity and sound velocity.

Notes:
- Help files provide detailed information on the use of SEATERM, SEASAVE, and SBE Data Processing.
- Separate software manuals on CD-ROM provide detailed information on the use of SEASAVE and SBE Data Processing.
- Sea-Bird also supplies a DOS software package, SEASOFT-DOS. However, the DOS software is not compatible with the FastCAT.

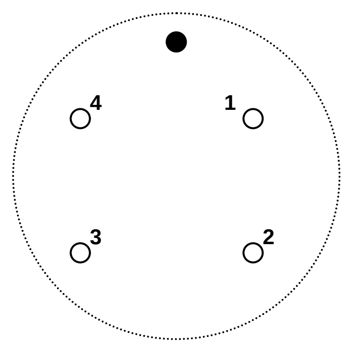
Specifications

	Temperature (°C)	Conductivity (S/m)	Pressure
Measurement Range	-5 to +35	0 to 9	0 to full scale range: 20 / 100 / 350 / 1000/ 2000 / 3500 / 7000 meters
Initial Accuracy	0.002	0.0003	0.1% of full scale range
Typical Stability (per month)	0.0002	0.0003	0.004% of full scale range
Resolution	0.0001	0.00005 (oceanic waters; resolves 0.4 ppm in salinity) 0.00007 (high salinity waters; resolves 0.4 ppm in salinity) 0.00001 (fresh waters; resolves 0.1 ppm in salinity)	0.002% of full scale range
Sensor Calibration (measurement outside these ranges may be at slightly reduced accuracy due to extrapolation errors)	+1 to +32	0 to 9; physical calibration over the range 1.4 to 6 S/m, plus zero conductivity (air)	Ambient pressure to full scale range in 5 steps
Power Requirements	Standard 9-24 VDC; Optional 12-28 VDC 3.5 Watts at 9 - 28 VDC; 0.8 Watts pump off		
Housing Material	3AL/2.5V Titanium		
Depth Rating	7000 meters (22,900 feet)		
Weight	*In air*: 2.7 kg (6 lbs) *In water*: 1.4 kb (3 lbs)		

Dimensions and End Cap Connector



Standard Connector



Optional MCBH Connector

Pin	**Description**
1	Ground
2	RS-232C Receive from computer
3	RS-232C Transmit to computer
4	Power (9-24 VDC standard; 12-28 VDC optional)

Data I/O

The FastCAT receives setup instructions and outputs data and diagnostic information via a three-wire RS-232C link, and is factory-configured for 9600 baud, 8 data bits, 1 stop bit, and no parity. FastCAT RS-232 levels are directly compatible with standard serial interface cards (IBM Asynchronous Communications Adapter or equal). The communications baud rate can be changed using the **BAUD=** command (see *Section 4: Deploying and Operating FastCAT* for details).

Section 3: Power and Communications Test

This section describes the pre-check procedure for preparing the FastCAT for deployment. The power and communications test will verify that the system works, prior to deployment.

Test Setup

Note:
It is possible to use the FastCAT without SEATERM by sending direct commands from a dumb terminal or terminal emulator, such as Windows HyperTerminal.

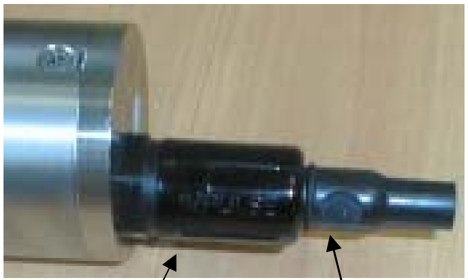
1. If not already installed, install SEATERM and other Sea-Bird software programs on your computer using the supplied software CD:

   A. Insert the CD in your CD drive.

   B. Double click on **Seasoft-Win32.exe**.

   C. Follow the dialog box directions to install the software.

   The default location for the software is c:/Program Files/Sea-Bird. Within that folder is a sub-directory for each program.



2. Remove the dummy plug and install the I/O cable:

   A. By hand, unscrew the locking sleeve from the FastCAT's I/O connector. If you must use a wrench or pliers, be careful not to loosen the I/O connector instead of the locking sleeve.

   B. Remove the dummy plug from the FastCAT's I/O connector by pulling the plug firmly away from the connector.

   C. **Standard Connector** - Install the Sea-Bird I/O cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the FastCAT. **OR**
   MCBH Connector – Install the cable connector, aligning the pins.

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

4. Connect the I/O cable connector's red (+) and black (-) wires to a power supply (9-24 VDC standard, 12-28 VDC optional). See *Section 2: Description of FastCAT*, for the connector details.

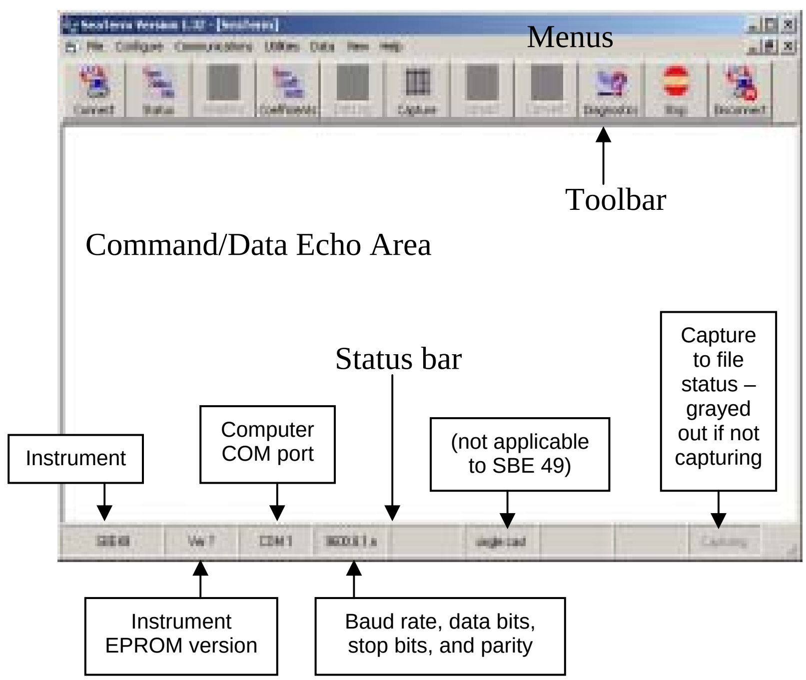
Test

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

1. Double click on SeaTerm.exe. If this is the first time the program is used, the setup dialog box appears:

Select the instrument type (*SBE 49*) and the computer COM port for communication with the FastCAT. Click OK.

2. The main screen looks like this:



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

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

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

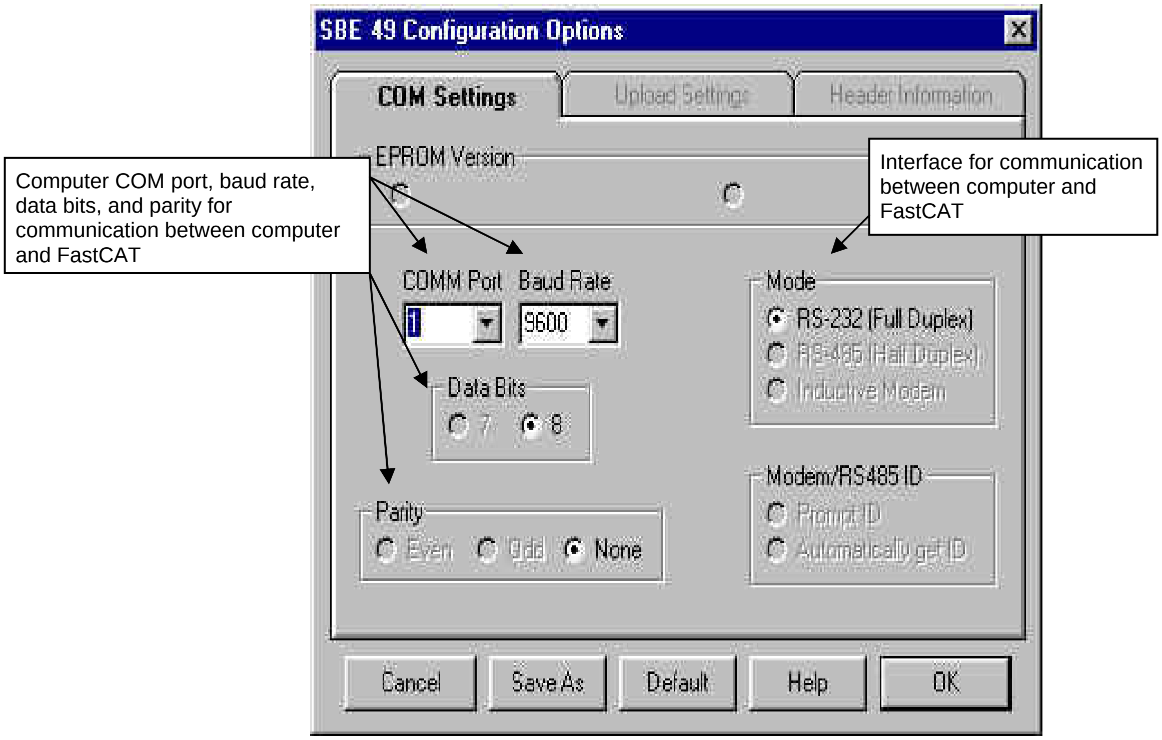
SEATERM sends the status command, which displays in the Command/Data Echo Area, and updates the Status bar.

Following are the Toolbar buttons applicable to the FastCAT:

Toolbar Button	**Description**	**Equivalent Command***
Connect	Re-establish communications with FastCAT. Computer responds with S> prompt.	(press Enter key)
Status	Display instrument setup and status (configuration and setup parameters, whether FastCAT is sampling, etc.).	**DS**
Coefficients	Display calibration coefficients.	**DCAL**
Capture	Capture instrument responses on screen to file; useful for diagnostics. File has .cap extension. Capture status displays in Status bar. Press Capture again to turn off capture. **As FastCAT has no internal memory, if you are using SEATERM to acquire data you must capture before sampling begins to save data for future review and processing**. (Note: The .cap file does not have the required header information for processing by SBE Data Processing. Use SEASAVE to acquire data that will be processed by SBE Data Processing.)	—
Diagnostics	Perform one or more diagnostic tests on FastCAT. Diagnostic test(s) accessed in this manner are non-destructive – they do not write over any existing instrument settings.	**DS, DCAL,** and **TS**
Stop	Interrupt and end current activity, such as sampling or diagnostic test.	(press Esc key or Ctrl C)
Disconnect	Free computer COM port used to communicate with FastCAT. COM port can then be used by another program.	—

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

3. In the Configure menu, select *SBE 49*. The dialog box looks like this:



Make the selections in the Configuration Options dialog box:

- **COMM Port**: COM 1 through COM 10, as applicable
- **Baud Rate**: 9600 (documented on Configuration Sheet)
- **Data Bits**: 8
- **Parity**: None
- **Mode**: RS-232 (Full Duplex)

Click OK to overwrite an existing COM Settings (.ini) file, or click Save As to save the settings as a new filename.

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

S>

This shows that correct communications between the computer and the FastCAT has been established.
If the system does not respond with the S> prompt:

- Click the Connect button again.
- Verify the correct instrument was selected in the Configure menu and the settings were entered correctly in the Configuration Options dialog box. Note that the baud rate is documented on the Configuration Sheet.
- Check cabling between the computer and FastCAT.

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

```
SBE 49 FastCAT V 1.1  SERIAL NO. 0003
number of scans to average = 1
pressure sensor = strain gauge, range = 1000.0
minimum cond freq = 3000, pump delay = 60 sec
start sampling on power up = no
output format = converted decimal
output salinity = no, output sound velocity = no
```

6. Command the FastCAT to take a sample by typing **TS** and pressing the Enter key. The display looks like this (with converted decimal output format, and no output salinity or sound velocity):

```
23.7658, 0.00019, 0.062
```

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

These numbers should be reasonable; i.e., room temperature, zero conductivity, barometric pressure (gauge pressure).

The FastCAT is ready for programming and deployment.

Section 4: Deploying and Operating FastCAT

Note:
Help files contain detailed information on setup and use of Sea-Bird software.

This section includes discussions of:

- Sampling modes, including pump operation and example commands
- Command descriptions
- Data output formats
- Optimizing data quality
- Setup for deployment
- Deployment
- Recovery - physical handling
- Processing FastCAT data

Sampling Modes

The FastCAT has two sampling modes for obtaining data:

- Autonomous sampling
- Polled sampling

Descriptions and examples of the sampling modes follow. Note that the FastCAT's response to each command is not shown in the examples. Review the operation of the sampling modes and the commands described in *Command Descriptions* before setting up your system.

Autonomous Sampling

The FastCAT runs continuously, sampling data at sixteen scans per second (16 Hz) and transmitting the data real-time. The FastCAT can be set to average up to 255 samples, transmitting only the averaged data. The **AUTORUN** command defines how autonomous sampling starts and stops:

If	To Start Sampling	To Stop Sampling
AUTORUN=Y	Turn on power.	• Turn off power, or • Send **STOP** command, click Stop on SEATERM's Toolbar, or type Ctrl Z. (Stopping this way allows you to then send commands to check or modify the setup.)
AUTORUN=N	Send **START** command.	

After the conductivity cell enters the water there is a user-programmable delay before pump turn-on so that all the air in the pump tubing can escape. If the pump motor turns on when there is air in the impeller housing, priming is uncertain and a proper flow rate cannot be ensured. **The cell inlet and pump outlet must not come above the water surface or the prime will be lost.**

- If prime is lost, stop sampling. Wait at least 5 seconds, then restart sampling, submerge the FastCAT completely, and wait for the pump delay time before beginning the profile.

Pump turn-on occurs when two user-programmable conditions have been met:

- **Raw conductivity frequency exceeds the minimum conductivity frequency (MINCONDFREQ=)**
  Set the minimum conductivity frequency for pump turn-on above the instrument's *zero conductivity raw frequency* (shown on the FastCAT Configuration Sheet), to prevent the pump from turning on when the FastCAT is in air.
  - For salt water and estuarine applications -
    typical value = *zero conductivity raw frequency* + 500 Hz
  - For fresh/nearly fresh water -
    typical value = *zero conductivity raw frequency* + 5 Hz

  If the minimum conductivity frequency is too close to the *zero conductivity raw frequency*, the pump may turn on when the FastCAT is in air as result of small drifts in the electronics. Some experimentation may be required, and in some cases it may be necessary to rely only on the pump turn-on delay time to control the pump. If so, set a minimum conductivity frequency lower than the *zero conductivity raw frequency*.

- **Pump turn-on delay time has elapsed (PUMPDELAY=)**
  Set the pump turn-on delay time to allow time for the pump to fill with water after the FastCAT is submerged. Determine the turn-on delay by immersing the FastCAT (power off / not sampling). Measure the time needed to completely fill the pump exhaust tubing (20 seconds is typical) and set the delay to approximately 1.5 times longer (30 seconds). When actually using the FastCAT, be sure to *soak* the instrument just under the surface for at least the time required for pump turn-on.

Pump turn-off occurs when the conductivity frequency falls below the minimum conductivity frequency (**MINCONDFREQ=**).

Note:
Sea-Bird ships the FastCAT with **AUTORUN=N** (it will not start sampling when power is applied). If you send the **AUTORUN=Y** command, turn power off and then on again to start sampling, or send the **START** command.

*Example 1: Autonomous Sampling Setup for **AUTORUN=N*** (user input in bold)

Apply power and wake up FastCAT. Set up to average every 4 samples, and output data in raw hexadecimal format. Set up with a 60-second pump turn-on delay after pump enters water to ensure pump is primed before turning on. Verify setup with status (**DS**) command (verify that **AUTORUN=N**). Remove power.

(Apply power, then click Connect on Toolbar to wake up)
S>**NAVG=4**
S>**OUTPUTFORMAT=0**
S>**PUMPDELAY=60**
S>**DS** (to verify setup)
(Remove power)

When ready to begin sampling:
(Apply power, then click Connect on Toolbar to wake up)
S>**START**
Put FastCAT in water, and allow to soak for at least time required for pump turn-on (**PUMPDELAY=60**) before beginning cast.

When cast is complete, stop sampling.
S>**STOP**

*Example 2: Autonomous Sampling Setup for **AUTORUN=Y*** (user input in bold)

Apply power. Set up to average every 4 samples, and output data in raw hexadecimal format. Set up with a 60-second pump turn-on delay after pump enters water to ensure pump is primed before turning on. Set up to start sampling upon power up. Verify setup with status (**DS**) command.

(Apply power, then click Connect on Toolbar to wake up)
S>**NAVG=4**
S>**OUTPUTFORMAT=0**
S>**PUMPDELAY=60**
S>**AUTORUN=Y**
S>**DS** (to verify setup)
(Remove power)

When ready to begin sampling:
Apply power.
Put FastCAT in water, and allow to soak for at least time required for pump turn-on (**PUMPDELAY=60**) before beginning cast.

When cast is complete, remove power or send **STOP** command to stop sampling (send **STOP** command if you want to view and/or modify FastCAT's setup immediately after you stop sampling).

Polled Sampling

On command (**TS**), the FastCAT takes one sample and transmits the data real-time.

The pump does not turn on automatically for polled sampling (**MINCONDFREQ=** and **PUMPDELAY=** commands do not apply). To run the pump before taking a sample, send a command (**PUMPON**) to turn the pump on before sending the Take Sample (**TS**) command. Send a command to turn the pump off (**PUMPOFF**) after taking the sample.

Example: Polled Sampling (user input in bold)

Apply power and wake up FastCAT. Set up to output data in decimal engineering units format, and output salinity and sound velocity as well as C, T, and pressure. Verify setup with status (**DS**) command (verify that **AUTORUN=N**). Remove power.

(Apply power, then click Connect on Toolbar to wake up)
S>**OUTPUTFORMAT=3**
S>**OUTPUTSAL=Y**
S>**OUTPUTSV=Y**
S>**DS** (to verify setup)
(Remove power)

When ready to take a sample, put FastCAT in water. Apply power and wake up FastCAT. Command FastCAT to turn pump on, take a sample, and turn pump off. Remove power. Repeat sequence as desired.

(Apply power, then click Connect on Toolbar to wake up)
S>**PUMPON**
S>**TS**
S>**PUMPOFF**
(Remove power)

Baud Rate, Cable Length, Power, and Data Transmission Rate

Notes:
- Baud rate is set with the **BAUD=** command.
- Real-time output rate is set with the **NAVG=** command.
- Output format is set with the **OUTPUTFORMAT=** command.

See *Command Descriptions* in this section for command details.

Baud Rate, Cable Length, and Data Transmission Rate

The rate that real-time data can be transmitted from the FastCAT is dependent on the amount of data to be transmitted per scan and the serial data baud rate:

Time required to transmit data =
(number of characters * 10 bits/character) / baud rate

where

Number of characters is dependent on the included data and output format (see *Data Output Formats* in this section).
Add 2 to the number of characters shown in the output format, to account for the carriage return and line feed at the end of each scan.
For decimal output (**OUTPUTFORMAT=2** or **3**), include decimal points, commas, and spaces when counting the number of characters.

Time required to transmit data must be less than the real-time output rate. Minimum baud rates are compiled below for 16 Hz sampling (**NAVG=1**) and 8 Hz sampling (**NAVG=2**): (see *Example* below for calculation examples)

NAVG	OUTPUTFORMAT	Minimum Baud
1	0	4800
	1	4800
	2	9600
	3 *	9600
2	0	2400
	1	2400
	2	4800
	3 *	4800

* Including output of salinity and sound velocity.

The length of cable that the FastCAT can drive to transmit real-time data is also dependent on the baud rate. The allowable combinations are:

Maximum Cable Length (meters)	Maximum Baud
1600	600
800	1200
400	2400
200	4800
100	9600
50	19200
25	38400

Example 1 - What is fastest rate you can transmit real-time data over 800 m with **OUTPUTFORMAT=0** (raw hex data)?

With 800 meters of cable, the FastCAT requires a baud rate of 1200 or less.
Number of characters for **OUTPUTFORMAT=0** (from *Data Output Formats*) =
6 (T) + 6 (C) + 6 (P) + 4 (P temperature compensation) + 2 (carriage return & line feed) = 24
Time required to transmit data = (24 characters * 10 bits/character) / 1200 =
0.2 seconds > 0.0625 seconds (16 Hz, maximum sampling rate).
Therefore, set **NAVG=4**, averaging 4 measurements/sample and transmitting 1 sample every 0.25 seconds.

Example 2 – Same as above, but **OUTPUTFORMAT=3** (engineering units in decimal), and **OUTPUTSV=Y** and **OUTPUTSAL=Y** (output calculated salinity and sound velocity along with pressure, temperature, and conductivity).

Number of characters for **OUTPUTFORMAT=3** (from *Data Output Formats*) =
8 (T) + 2 (comma & space) + 8 (C) + 2 (comma & space) + 8 (P) + 2 (comma & space) +
8 (salinity) + 2 (comma & space) + 8 (sound velocity) + 2 (carriage return & line feed) = 50
Time required to transmit data = (50 characters * 10 bits/character) / 1200 =
0.42 seconds > 0.0625 seconds (16 Hz, maximum sampling rate).
Therefore, set **NAVG=7**, averaging 7 measurements/sample and transmitting 1 sample every 0.4375 seconds.

Power and Cable Length

Note:
Common wire resistances:

Gauge	Resistance (ohms/foot)
12	0.0016
14	0.0025
16	0.0040
18	0.0064
19	0.0081
20	0.0107
22	0.0162
24	0.0257
26	0.0410
28	0.0653

The limit to cable length is typically reached when the maximum current times the power common wire resistance is more than 1 volt.

V_{limit} = 1 volt = IR_{limit}
Where I is the current required by the FastCAT.
Maximum cable length = R_{limit} / wire resistance per foot

Example – For 9 volt power supply and 18 gauge wire, what is the maximum distance to transmit power to the FastCAT?
The FastCAT requires 3.5 Watts at 9-28 VDC (from *Specifications* in *Section 2: Description of FastCAT*).
Calculating current required by FastCAT for a 9 volt power supply:
I = P / V = 3.5 Watts / 9 volts = 0.39 amps

R_{limit} = V_{limit} / I = 1 volt / 0.39 amps = 2.56 ohms
For 18 gauge wire, resistance is 0.0064 ohms/foot.
Therefore, maximum cable length is 2.56 ohms / 0.0064 ohms/foot = 400 feet = 122 meters.
Note that 122 meters < 800 meters (limit to distance FastCAT can transmit data at 1200 baud, as shown in previous example), so cable is limited to 122 meters because of power constraints. Alternatively, you can transmit data over 800 meters but provide a power source closer to the FastCAT.

Command Descriptions

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

When entering commands:

- Input commands to the FastCAT in upper or lower case letters and register commands by pressing the Enter key.
- The FastCAT sends `?CMD` if an invalid command is entered.
- If the system does not return an `S>` prompt after executing a command, press the Enter key to get the `S>` prompt.
- Establish communications by pressing Connect on the Toolbar or the Enter key to get an `S>` prompt.
- If the FastCAT is transmitting data and you want to stop it, send the **STOP** command, click Stop on the Toolbar, or type Ctrl Z. Press the Enter key to get the `S>` prompt.
- The FastCAT responds only to the **DS**, **DCAL**, and **STOP** commands while sampling. If you interrupt the FastCAT while it is sampling (for example, to send the **DS** command), it will temporarily stop sampling. Sampling will resume after it responds to the command.

Entries made with the commands are permanently stored in the FastCAT and remain in effect until you change them.

Status Command

DS

Display operating status and setup parameters.
Equivalent to Status button on Toolbar.

List below includes, where applicable, command used to modify parameter.

- firmware version, serial number
- number of scans to average [**NAVG=**]
- pressure sensor type [**PTYPE=**] and range [**PRANGE=**]
- minimum conductivity frequency for pump turn-on [**MINCONDFREQ=**] and pump turn-on delay [**PUMPDELAY=**]
- start autonomous sampling automatically when power applied [**AUTORUN=**]?
- output format [**OUTPUTFORMAT=**]
- output salinity [**OUTPUTSAL=**] and sound velocity [**OUTPUTSV=**] with each sample? (only if **OUTPUTFORMAT=3**)

Example: Status (DS) command (user input in bold)

```
S>DS
SBE 49 FastCAT V 1.1  SERIAL NO. 0003
number of scans to average = 1
pressure sensor = strain gauge, range = 1000.0
minimum cond freq = 3000, pump delay = 60 sec
start sampling on power up = no
output format = converted decimal
output salinity = no, output sound velocity = no
```

Notes:
- The FastCAT's baud rate (set with **BAUD=**) must be the same as SEATERM's baud rate (set in the Configure menu).
- The minimum baud rate for transmitting data is dependent on sampling rate (**NAVG=**) and output format (**OUTPUTFORMAT=**). See *Baud Rate, Cable Length, Power, and Data Transmission Rate* and *Data Output Formats* for details.

Note:
Sea-Bird's real-time data acquisition software (SEASAVE) requires data to be in raw hexadecimal (**OUTPUTFORMAT=0**).

Before beginning a cast:
- If you will be using **SEASAVE** to view and save real-time data for future processing by SBE Data Processing - **You must set output format to raw hex**.
- If you will be using **SEATERM** to view and capture real-time data (cannot be processed by SBE Data Processing) - Set output format to converted decimal for ease in viewing data.

Setup Commands

BAUD=x

x= baud rate (600, 1200, 2400, 4800, 9600, 19200, or 38400). Default 9600.

PTYPE=x

Pressure sensor type.

x= 1: Strain-gauge pressure sensor.

OUTPUTFORMAT=x

x= 0: Output raw frequencies, A/D counts, and voltages in Hexadecimal form. **Must use this format for acquiring, viewing, and saving real-time data in SEASAVE. SEASAVE creates a data file that can be processed with SBE Data Processing.**

x= 1: Output converted (engineering units) data in Hexadecimal form.

x= 2: Output raw data in decimal form.

x= 3: Output converted (engineering units) data in decimal form. Must use this format to output salinity or sound velocity, and to output data that can be processed by SBE Data Processing.

OUTPUTSAL=x

x= Y: Calculate and output salinity (psu). Only applies if **OUTPUTFORMAT=3**.

x= N: Do not calculate and output salinity.

OUTPUTSV=x

x= Y: Calculate and output sound velocity (m/sec), using Chen and Millero formula (UNESCO Technical Papers in Marine Science #44). Only applies if **OUTPUTFORMAT=3**.

x= N: Do not calculate and output sound velocity.

Note:
In SEATERM, to save real-time data to a file, click the Capture button on the Toolbar before beginning sampling.

Autonomous Sampling Commands

Autonomous sampling directs the FastCAT to sample data at 16 Hz and transmit the data real-time. The FastCAT can be set to average up to 255 samples, transmitting only the averaged data. The **AUTORUN** command defines how autonomous sampling starts and stops:

IF	To Start Sampling	To Stop Sampling
AUTORUN=Y	Turn on power.	• Turn off power, or • Send **STOP** command, click Stop on SEATERM's Toolbar, or type Ctrl Z. (Stopping this way allows you to then send commands to check or modify the setup.)
AUTORUN=N	Send **START** command.	

NAVG=x

x= number of samples to average (default 1, maximum 255). FastCAT samples at 16 Hz (every 0.0625 seconds) and averages **NAVG** samples; averaged data is transmitted real-time.

Example: If **NAVG=8**, FastCAT averages data from 8 samples (= 1 average/0.5 second) and transmits averaged data real-time.

MINCONDFREQ=x

x= minimum conductivity frequency (Hz) to enable pump turn-on, to prevent pump from turning on before FastCAT is in water. Pump stops when frequency drops below **MINCONDFREQ**.

FastCAT Configuration Sheet lists uncorrected (raw) frequency output at 0 conductivity. Typical value (and factory-set default) for **MINCONDFREQ** for salt water and estuarine application is: (0 conductivity frequency + 500 Hz). Typical value for **MINCONDFREQ** for fresh water applications is: (0 conductivity frequency + 5 Hz).

PUMPDELAY=x

x= time (seconds) to wait after minimum conductivity frequency (**MINCONDFREQ**) is reached before turning pump on. Pump delay time allows time for tubing and pump to fill with water after FastCAT is submerged. Typical value is 30 seconds. Pump starts **PUMPDELAY** seconds after conductivity cell's frequency output is greater than **MINCONDFREQ**. Default 60 seconds.

Autonomous Sampling Commands continued

> **Notes:**
> After you send **AUTORUN=Y**,
> to start sampling immediately:
> - turn power off and then on again, or
> - send the **START** command

AUTORUN=x

x=N: Wait for a command when power is applied. Default.

x=Y: Start autonomous sampling automatically when power is applied.

START

Start autonomous sampling now (applicable if **AUTORUN=N** or if you just sent **AUTORUN=Y** command).

> **Notes:**
> - You may need to send the **STOP** command several times to get the FastCAT to respond.
> - You can also stop autonomous sampling by clicking the Stop key on the Toolbar, typing Ctrl Z, or removing power.

STOP

Stop autonomous sampling. Press Enter key to get S> prompt before entering this command.

Polled Sampling Commands

PUMPON

Turn pump on. Use this command:
- Before sending **TS** command to obtain pumped conductivity data, or
- To test pump

PUMPOFF

Turn pump off.

TS

Take **one** sample and transmit data.

Testing Commands

The FastCAT takes and transmits data for 100 samples for each test. Press the Esc key or Stop on the Toolbar to stop a test.

TT

Measure temperature, transmit converted data.

TC

Measure conductivity, transmit converted data.

TP

Measure pressure, transmit converted data.

TTR

Measure temperature, transmit raw data.

TCR

Measure conductivity, transmit raw data.

TPR

Measure pressure, transmit raw data.

Coefficients Commands

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

DCAL — Display calibration coefficients. Equivalent to Coefficients button on Toolbar.

Example: Display coefficients for FastCAT (user input in bold).

```
S>dcal
SBE 49 FastCAT V 1.1  SERIAL NO. 0003
temperature:  26-apr-01
    TA0 = -3.178124e-06
    TA1 = 2.751603e-04
    TA2 = -2.215606e-06
    TA3 = 1.549719e-07
    TOFFSET = 0.000000e+00
conductivity:  26-apr-01
    G = -9.855242e-01
    H = 1.458421e-01
    I = -3.290801e-04
    J = 4.784952e-05
    CPCOR = -9.570000e-08
    CTCOR = 3.250000e-06
    CSLOPE = 1.000000e+00
Pressure S/N = 023674, range = 1000 psia:  25-apr-01
    PA0 = -6.893561e-01
    PA1 = 1.567975e-02
    PA2 = -6.637727e-10
    PTCA0 = 5.246558e+05
    PTCA1 = -4.886082e+00
    PTCA2 = 1.257885e-01
    PTCB0 = 2.489275e+01
    PTCB1 = -8.500000e-04
    PTCB2 = 0.000000e+00
    PTEMPA0 = -6.634546e+01
    PTEMPA1 = 5.093069e+01
    PTEMPA2 = -1.886260e-01
    POFFSET = 0.000000e+00
```

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

Use the commands listed below to modify a particular coefficient or date:

Temperature	
TCALDATE=S	**S**=calibration date
TA0=F	**F**=A0
TA1=F	**F**=A1
TA2=F	**F**=A2
TA3=F	**F**=A3
TOFFSET=F	**F**=offset correction
Conductivity	
CCALDATE=S	**S**=calibration date
CG=F	**F**=G
CH=F	**F**=H
CI=F	**F**=I
CJ=F	**F**=J
CPCOR=F	**F**=pcor
CTCOR=F	**F**=tcor
CSLOPE=F	**F**=slope correction
Pressure	
PCALDATE=S	**S**=calibration date
PRANGE=F	**F**=sensor full scale range (psi)
POFFSET=F	**F**=offset correction
PA0=F	**F**=A0
PA1=F	**F**=A1
PA2=F	**F**=A2
PTEMPA0=F	**F**=pressure temperature A0
PTEMPA1=F	**F**=pressure temperature A1
PTEMPA2=F	**F**=pressure temperature 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

Data Output Formats

Notes:
See *Baud Rate, Cable Length, Power, and Data Transmission Rate* in this section for the interaction of output format, data transmission rate, baud rate, and cable length.

Output format is dependent on the **OUTPUTFORMAT (=0, 1, 2, or 3)** parameter. Each line of data is ended with a carriage return and line feed.

Notes:
- If you will be using SEASAVE to acquire real-time data, you must set **OUTPUTFORMAT=0**.
- Our software uses the equations shown to perform these calculations; alternatively, you can use the equations to develop your own processing software.
- The FastCAT's pressure sensor is an absolute sensor, so its **raw** output includes the effect of atmospheric pressure (14.7 psi). As shown on the Calibration Sheet, Sea-Bird's calibration (and resulting calibration coefficients) is in terms of psia. However, when outputting pressure in **engineering units**, the FastCAT outputs pressure relative to the ocean surface (i.e., at the surface the output pressure is 0 decibars). The FastCAT uses the following equation to convert psia to decibars:

Pressure (db) =
[pressure (psia) - 14.7] * 0.689476

OUTPUTFORMAT=0 (raw data in Hexadecimal)

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

1. Temperature A/D counts = tttttt
2. Conductivity frequency (Hz) = cccccc / 256
3. Pressure sensor pressure A/D counts = pppppp
4. Pressure sensor temperature compensation voltage = vvvv / 13,107

Example: example scan = ttttttccccccppppppvvvv = 0A53711BC7220C14C17D82
- Temperature = tttttt = 0A5371 (676721 decimal);
  temperature A/D counts = 676721
- Conductivity = cccccc = 1BC722 (1820450 decimal);
  conductivity frequency = 1820450 / 256 = 7111.133 Hz
- Pressure = pppppp = 0C14C1 (791745 decimal);
  pressure A/D counts = 791745
- Pressure temperature compensation =
  vvvv = 7D82 (32,130 decimal);
  pressure temperature = 32,130 / 13,107 = 2.4514 volts

OUTPUTFORMAT=1 (engineering units in Hexadecimal)

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

1. Temperature (°C, ITS-90) = (tttttt / 100,000) - 10
2. Conductivity (S/m) = (cccccc / 1,000,000) - 1
3. Pressure (decibars) = (pppppp / 1,000) - 100

Example: example scan = ttttttccccccpppppp = 3385C40F42FE0186DE
- Temperature = tttttt = 3385C4 (3376580 decimal);
  temperature (°C, ITS-90) = (3376580 / 100,000) - 10 = 23.7658
- Conductivity = cccccc = 0F42FE (1000190 decimal);
  conductivity (S/m) = (1000190 / 1,000,000) - 1 = 0.00019
- Pressure = pppppp = 0186DE (100062 decimal);
  pressure (decibars) = (100062 / 1,000) - 100 = 0.062

OUTPUTFORMAT=2 (raw data in decimal)

Data is output in the order listed, with a comma followed by a space between each parameter. Shown with each parameter are 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.

1. Temperature A/D counts = tttttt
2. Conductivity frequency (Hz) = cccc.ccc
3. Pressure sensor pressure A/D counts = pppppp
4. Pressure sensor temperature compensation voltage = v.vvvv

Example: example scan = tttttt, cccc.ccc, pppppp, v.vvvv = 676721, 7111.133, 791745, 2.4514

- Temperature = tttttt = 676721;
  temperature A/D counts = 676721
- Conductivity = cccc.ccc = 7111.133;
  conductivity frequency = 7111.133 Hz
- Pressure = pppppp = 791745;
  Pressure A/D counts = 791745
- Pressure temperature compensation = v.vvvv = 2.4514;
  Pressure temperature = 2.4514 volts

OUTPUTFORMAT=3 (engineering units in decimal)

Data is output in the order listed, with a comma followed by a space between each parameter. Shown with each parameter are 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.

1. Temperature (°C, ITS-90) = ttt.tttt
2. Conductivity (S/m) = cc.ccccc
3. Pressure (decibars) = pppp.ppp
4. Salinity (psu) = sss.ssss (if **OUTPUTSAL=Y**)
5. Sound velocity (meters/second) = vvvv.vvv (if **OUTPUTSV=Y**)

Example: FastCAT with **OUTPUTSAL=N**, **OUTPUTSV=N**
example scan = ttt.tttt, cc.ccccc, pppp.ppp = 23.7658, 0.00019, 0.062

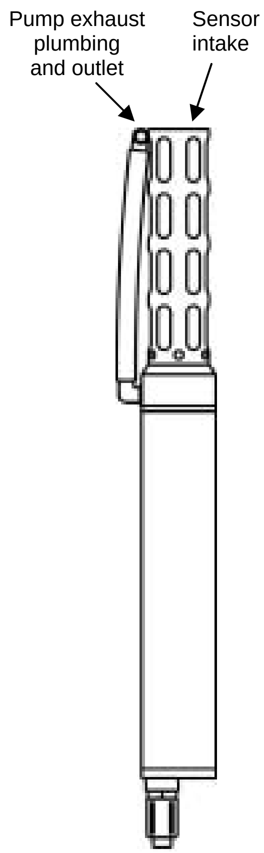
- Temperature = ttt.tttt = 23.7658;
  temperature (°C, ITS-90) = 23.7658
- Conductivity = cc.ccccc = 0.00019;
  conductivity (S/m) = 0.00019
- Pressure = pppp.ppp = 0.062;
  pressure (decibars) = 0.062

Optimizing Data Quality

This section contains guidelines for obtaining the best quality data. Some of these guidelines may conflict with the goals of a particular application, but you should be aware of the tradeoffs of data quality vs. mission goals.

FastCAT Orientation and Pump Use

Vertical Orientation, Upcast Data



The FastCAT is designed for obtaining upcast data when deployed in a vertical, sensors-up orientation. This orientation, combined with the external pump exhaust plumbing, provides a U-shape to the system plumbing. The U-shape and the FastCAT's good seals, combined with *optimal pump operation*, can prevent surface oils and other contaminants from getting into the plumbing and conductivity cell. **These oils and contaminants are the primary cause of calibration drift in conductivity sensors**.

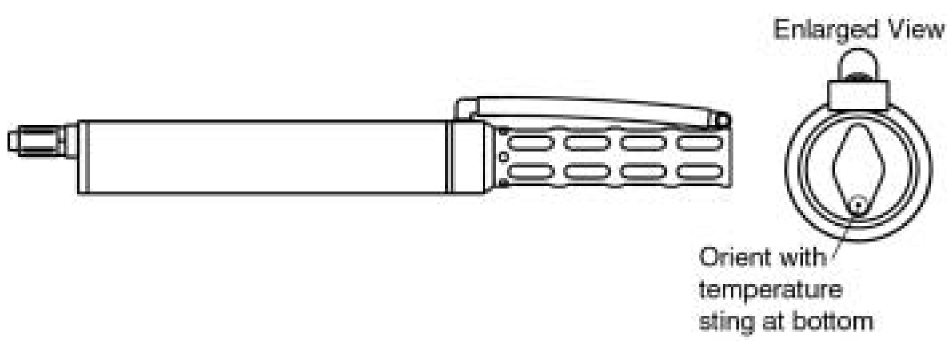
Pump operation to prevent intrusion of surface oils and contaminants follows:

1. On Deployment -
   When not in use, the FastCAT should be stored with the conductivity cell and pump exhaust plumbing filled with a 0.1% solution of Triton X-100 (see *Section 5: Routine Maintenance and Calibration*). **Deploy the FastCAT without removing the Triton solution**. As the FastCAT breaks the surface, oils and other surface contaminants will *float* on the Triton solution at the intake and exhaust, preventing them from getting into the plumbing and conductivity cell. Hold the FastCAT below the surface until the pump turns on, expelling the Triton solution and drawing in seawater.

2. On Recovery -
   Turn off the pump before the FastCAT reaches the surface (if sampling autonomously, stop sampling to turn off the pump). Water will be held in the U-shaped plumbing. As the FastCAT breaks the surface, oils and other surface contaminants will *float* on the water at the intake and exhaust, preventing them from getting into the plumbing and conductivity cell.

Horizontal Orientation, Downcast Data

The FastCAT is intended for obtaining upcast data, and will not generally give best quality results on the downcast. If you must have good quality downcast data, mount the FastCAT horizontally, with the temperature sting at the bottom, as shown. This orientation provides an upward path from intake to exhaust, allowing air to leave the system.



Positioning Relative to Other Instruments

Position the FastCAT so that other instruments and hardware do not thermally contaminate the water that flows past the sensors.

Profiling Speed

A profiling speed of approximately 1 meter/second usually provides good quality data. However, the amount of ship motion, and the dynamic effect it has on data quality, must be considered as operating conditions change. In rough seas or other conditions (small boats) where the ship's dynamic motion is large, increase the profiling speed to as much as 2 to 3 meters/second to reduce dynamic errors (spiking) caused by the rapidly changing ascent/descent rate of the FastCAT (yo-yo effect).

In an unpumped CTD, slow profiling speeds can cause reduced flushing of the conductivity cell, and *salinity spiking* can be severe in areas of strong temperature gradients. **Since the FastCAT's pump creates and maintains a constant and optimum flow, the FastCAT can be raised slowly to give greater vertical resolution in the data**, especially on lakes or protected bays, or in other calm conditions. Adjust the ascent rate according to the amount of ship motion (i.e., sea state). On a very calm lake, 10 cm/second is feasible if used with a constant winch speed.

Note:
See the SBE Data Processing Help files and/or manual for information on data processing modules that can align conductivity and temperature data, and correct data for the influences of ship motion and minimize salinity spiking.

Spiking is sometimes seen in the derived values for salinity, density, or sound velocity. Spiking results largely from a response time mismatch of 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 descent. In the event of heavy ship motion, it may be worth letting the instrument *free-fall*. When very heavy seas cause severe ship motion and result in periodic reversals of the instrument descent, the data set can be greatly improved by removing scans taken when the pressure is not increasing.

Temperature Equilibration

Where the water temperature is very different from the temperature at which the FastCAT has been stored, better results are obtained if the FastCAT is allowed to equilibrate to the water temperature at the surface (soak) for several minutes before beginning the profile. The reason is not that the electronics are temperature sensitive - they are not - but that the thermal influence of the instrument housing on the water entering the cell will be reduced. If the difference between water and storage temperature is extreme, allow more *soak time*.

Setup for Deployment

Program the FastCAT for the intended deployment using SEATERM (see *Command Descriptions* in this section).

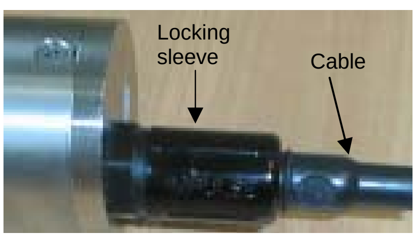
- SEASAVE, our real-time data acquisition program, generates a data file with data format and header information that is compatible with our SBE Data Processing post-processing software. If the FastCAT will be connected directly to the computer and you will be using **SEASAVE** to acquire and view real-time data, you must set **OUTPUTFORMAT=0** (output raw hexadecimal data).

- If the FastCAT will be connected directly to the computer and you will be using **SEATERM** to view real-time data, you must press the Capture button on the Toolbar to save the data to a .cap file. Note that SEATERM **does not** generate a data file that is compatible with SBE Data Processing. For ease in viewing data, set **OUTPUTFORMAT=3** (output decimal engineering units).

- If the FastCAT will be connected to an **ROV, AUV**, etc., the vehicle must include a **data logger** for the FastCAT data. Typically, this data will not be in a format that is compatible with SBE Data Processing. However, if the data logger saves the FastCAT data to a verbatim (unaltered) file, preserving the exact data format output by the FastCAT, the file can be processed with SBE Data Processing, after some additional file manipulation to add required header information. To generate a file that you can ultimately use in SBE Data Processing, you must set **OUTPUTFORMAT=3** (output decimal engineering units).

Deployment

CAUTION:
Do not use WD-40 or other petroleum-based lubricants, as they will damage the connectors.



1. Install the data I/O cable on the FastCAT end cap:
   A. Lightly lubricate the inside of the cable connector with silicone grease (DC-4 or equivalent).
   B. **Standard Connector** - Install the cable connector, aligning the raised bump on the side of the cable connector with the large pin (pin 1 - ground) on the FastCAT. Remove any trapped air by *burping* or gently squeezing the connector near the top and moving your fingers toward the end cap. **OR**
   MCBH Connector – Install the cable connector, aligning the pins.
   C. Place the locking sleeve over the cable connector and tighten it finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

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

3. Connect the I/O cable connector's red (+) and black (-) wires to a power supply (9-24 VDC standard, 12-28 VDC optional).

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

5. Remove the caps from the end of the T-C Duct and the pump exhaust tee.

6. Immediately prior to deployment, start sampling:
   - Apply power. If **AUTORUN=Y**, this will start FastCAT sampling.
   - If **AUTORUN=N**, send the **START** command (in SEATERM).

Acquiring and Processing Data with Sea-Bird Software

Notes:
- When we ship a new instrument, we include a .con file that reflects the current instrument configuration *as we know it*. The .con file is named with the instrument serial number, followed with the .con extension. For example, for an instrument with serial number 2375, we name the .con file *2375.con*. You may rename the .con file if desired; this will not affect the results.
- The .con file can be viewed and modified in SEASAVE **or** in SBE Data Processing.

Verifying Contents of .con File

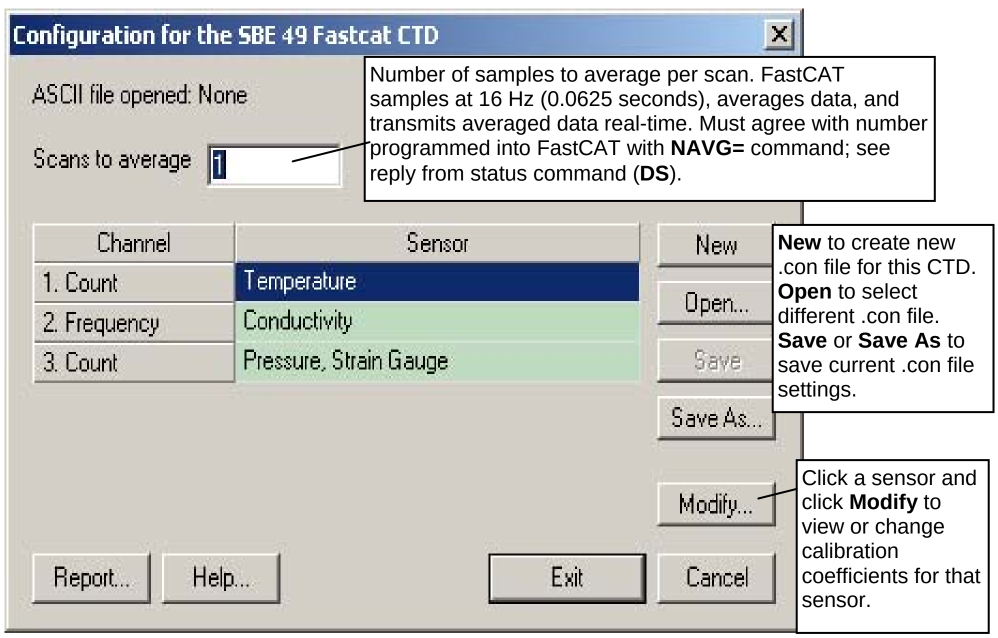
SEASAVE, our real-time data acquisition and display program, and SBE Data Processing, our data processing software, require a .con file. The .con file defines the instrument – data output rate, and serial numbers, calibration dates, and calibration coefficients for the sensors (conductivity, temperature, and pressure). SEASAVE and SBE Data Processing use the information in the .con file to interpret and process the raw data. **If the .con file does not match the actual instrument configuration, the software will not be able to interpret and process data correctly.**

Review the .con file:

1. Double click on Seasave.exe.

2. In the Configure menu, select *New Style Instrument Configuration / Select Instrument Configuration*. In the dialog box, select the appropriate .con file and click Open.

3. In the Configure menu, select *New Style Instrument Configuration / Modify Selected Instrument Configuration*. The configuration dialog box appears. Verify that the calibration coefficients for all the sensors are up-to-date.



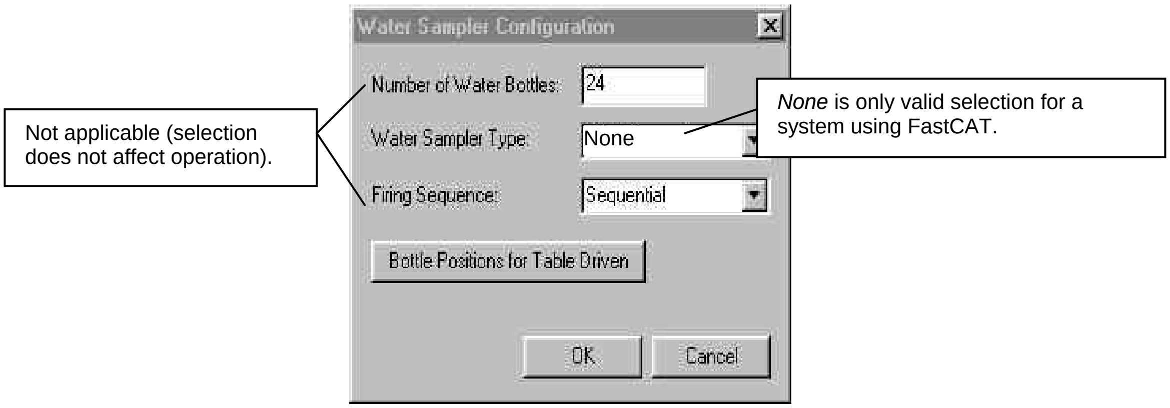
4. Click *Save* or *Save As* to save any changes to the .con file. Click Exit when done reviewing / modifying the .con file.

Acquiring Real-Time Data with SEASAVE

1. Start FastCAT sampling:
   - If **AUTORUN=Y**: Turn on power. FastCAT will start sampling and transmitting data to the computer. Note that the data will not appear in SEASAVE until you tell SEASAVE to start real-time data acquisition below.
   - If **AUTORUN=N**: Run SEATERM, command the FastCAT to start sampling (**START**), click SEATERM's Disconnect button, and then close SEATERM.

2. Double click on Seasave.exe.

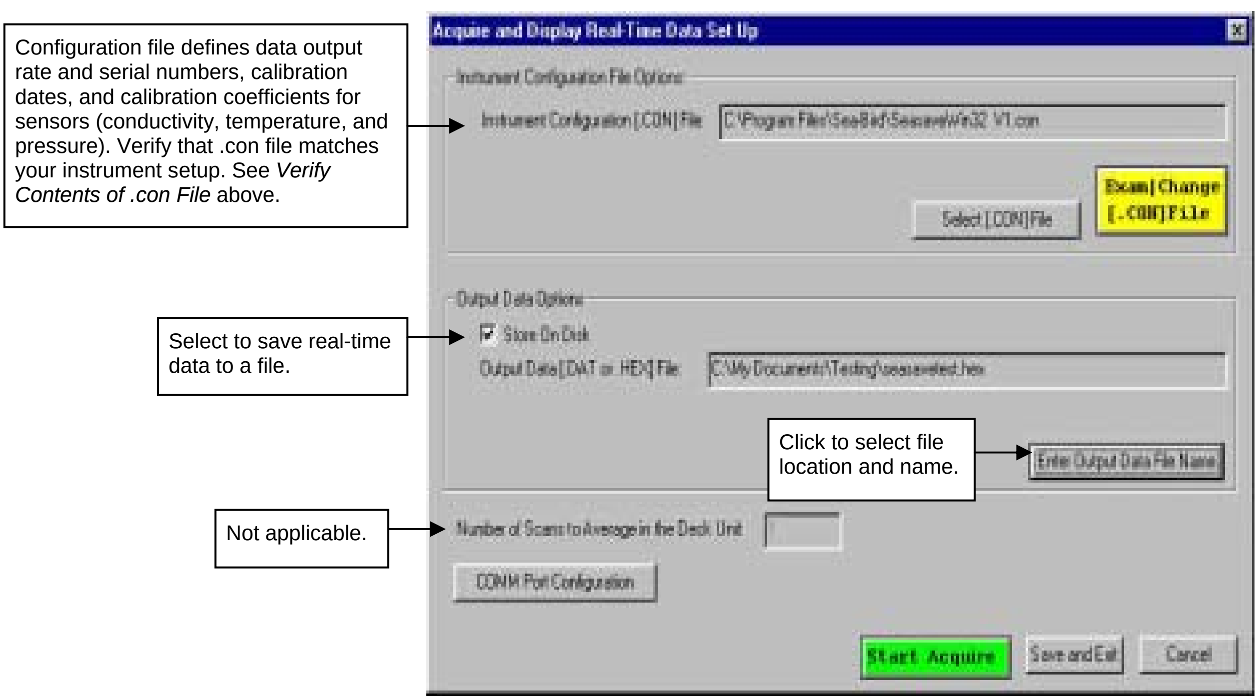
3. In the Configure menu, select *Water Sampler Configuration*. The dialog box looks like this:



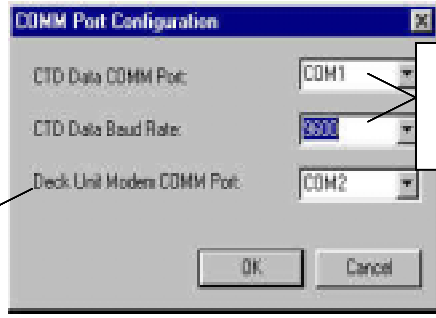
   Select *None* for water sampler type, and click OK.

4. Perform any other desired setup in the Configure and ScreenDisplay menus.

5. In the RealTime Data menu, select *Start Acquisition*. The dialog box looks like this:



6. Click *COMM Port Configuration*. The dialog box looks like this:



COMM Port and baud rate for communication between FastCaT and computer. Baud rate must match baud rate set in FastCAT with **BAUD=** command.

Not applicable (selection does not affect operation).

Make the desired selections and click OK.

7. In the Acquire and Display Real Time Data Set Up dialog box, click *Start Acquire*.
   A. If SEASAVE was set up to prompt for header information (Configure menu / Header Form), the Header Information dialog box appears. Fill in the desired information to be added to the data file header, and click OK.
   B. SEASAVE prompts *Waiting for data*. Data then starts appearing in the screen display(s). SEASAVE will *time out* if data is not received from the FastCAT within 60 seconds.

8. When done acquiring data, in the RealTime Data menu, select *Stop Acquisition*.

9. Close SEASAVE.

10. Stop sampling:
    - If **AUTORUN=Y**: Remove external power.
    - If **AUTORUN=N**: Send the **STOP** command in SEATERM.

Processing Data with SBE Data Processing

Note:
See the SBE Data Processing manual and/or help files for details on processing the data.

1. In SBE Data Processing's File menu, select DATA CONVERSION to convert the raw hex (.hex) data file to engineering units (.cnv file).
   - DATA CONVERSION and some other processing modules require the instrument configuration (.con) file for input. See *Verifying Contents of .con File* above for a description of the .con file, which is used in both SEASAVE and in SBE Data Processing.

2. The .cnv file can be further processed and plotted in SBE Data Processing's other modules.

Acquiring Real-Time Data with ROV, AUV, etc. for Processing by Sea-Bird Software

Sea-Bird's SBE Data Processing post-processing software typically converts FastCAT .hex file from SEASAVE to a .cnv file, and then uses the .cnv file in all additional processing steps. A method to obtain data in the appropriate format for SBE Data Processing, when data is logged to an ROV, AUV, etc. instead of acquired with SEASAVE, is presented below. This method requires an ROV, AUV, etc. to save the FastCAT data to a verbatim (unaltered) file, preserving the exact data format output by the FastCAT:

1. Verify that the FastCAT is set to **OUTPUTFORMAT=3** (output decimal engineering units) and **AUTORUN=Y** (begin sampling when power is applied).

2. Begin sampling (turn on power to FastCAT).

3. Stop sampling (turn off power to FastCAT).

4. Recover the FastCAT data file from the ROV, AUV, etc.

5. Open the data file with a text editor (such as Wordpad, Notepad, or Word). Delete any command lines (lines with S> prompt on them) and any lines with partial scans. Save the file as a text (.txt) file and close the file.

6. Rename the .txt file with a .asc extension (for example, test.rov was saved as text.txt, and then renamed as test.asc).

7. In SBE Data Processing's File menu, select ASCII IN. Select the .asc file as the input file, and enter the desired output (.cnv) file name. On the Data Setup tab, enter the scan interval (0.0625 seconds for 16 Hz data, 0.125 seconds for 8 Hz data, etc.). Click Select Column Names, and select:
   A. Column 1 - Temperature [ITS-90, deg C]
   B. Column 2 - Conductivity [S/m]
   C. Column 3 - Pressure, Strain Gauge [db]
   D. Column 4 - Salinity [psu] (if **OUTPUTSAL=Y**)
   E. Column 5 - Sound Velocity [Chen-Millero, m/s] (if **OUTPUTSV=Y**)

   Click Start Process. ASCII IN will create a .cnv file from the input .asc file and the information on the Data Setup tab.

8. Use other modules in SBE Data Processing to further process and plot the .cnv file as desired. Note that some processing modules require the instrument configuration (.con) file as well as the data file for input. See *Verifying Contents of .con File* in *Acquiring and Processing Data with Sea-Bird Software* above for a description of the .con file, which is used in both SEASAVE and SBE Data Processing.

Note
If **OUTPUTSAL=N** and **OUTPUTSV=Y**, select sound velocity for column 4.

Recovery

WARNING!
Pressure housings may flood under pressure due to dirty or damaged o-rings, or other failed seals, causing highly compressed air to be trapped inside. If this happens, a potentially life-threatening explosion can occur when the instrument is brought to the surface.
If the FastCAT is unresponsive to commands or shows other signs of flooding or damage, carefully secure the instrument in a location away from people until it has been determined that abnormal internal pressure does not exist.
Contact Sea-Bird for assistance with procedures for safely relieving internal pressure.

Rinse the conductivity cell with fresh water. (See *Section 5: Routine Maintenance and Calibration* for cell cleaning and storage.)

- Place Tygon tubing over the end of the T-C Duct. Pour the water through the Tygon, conductivity cell, and exhaust tubing with a syringe or wash bottle.

Section 5: Routine Maintenance and Calibration

This section reviews corrosion precautions, connector mating and maintenance, conductivity cell storage and cleaning, pressure sensor maintenance, replacing optional AF24173 Anti-Foulant Devices, and sensor calibration. The accuracy of the FastCAT is sustained by the care and calibration of the sensors and by establishing proper handling practices.

Corrosion Precautions

Rinse the FastCAT with fresh water after use and prior to storage.

All exposed metal is titanium. No corrosion precautions are required, but direct electrical connection of the titanium to dissimilar metal hardware should be avoided.

Connector Mating and Maintenance

CAUTION:
Do not use WD-40 or other petroleum-based lubricants, as they will damage the connectors.

A mated connector does not require periodic disassembly or other attention. Inspect a connector that is unmated for signs of corrosion product around the pins. When remating:

1. Lightly lubricate the inside of the dummy plug/cable connector with silicone grease (DC-4 or equivalent).
2. **Standard Connector** - Install the plug/cable connector, aligning the raised bump on the side of the plug/cable connector with the large pin (pin 1 - ground) on the FastCAT. Remove any trapped air by *burping* or gently squeezing the plug/connector near the top and moving your fingers toward the end cap. **OR**
   MCBH Connector – Install the plug/cable connector, aligning the pins.
3. Place the locking sleeve over the plug/cable connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

Verify that a cable or dummy plug is installed before deployment.

Conductivity Cell Maintenance

CAUTIONS:
- **Do not put a brush or any object inside the conductivity cell to dry it or clean it.** Touching and bending the electrodes can change the calibration. Large bends and movement of the electrodes can damage the cell.
- **Do not store the FastCAT with water in the conductivity cell.** Freezing temperatures (for example, in Arctic environments or during air shipment) can break the cell if it is full of water.

The FastCAT's conductivity cell is shipped dry to prevent freezing in shipping. Sea-Bird recommendations follow for three situations:

- Active use - storing for one day or less between uses
- Storage - storing for longer than one day
- Cleaning

Note:
To rinse or fill the conductivity cell and pump exhaust plumbing:
- Place Tygon tubing over the end of the T-C Duct.
- Pour the water or solution through the Tygon, conductivity cell, and exhaust plumbing with a syringe or wash bottle.

Active Use (storing for one day or less)

1. After each recovery, rinse the cell and pump exhaust plumbing with clean, de-ionized water and drain.
   - If the cell is not rinsed between uses, salt crystals may form on the platinized electrode surfaces. When the instrument is used next, sensor accuracy may be temporarily affected until these crystals dissolve.
2. Fill the cell and pump exhaust plumbing with a **0.1%** solution of Triton X-100 (included with shipment).
   - The Triton X-100 solution is a mild, non-ionic detergent that keeps contamination from ocean surface film, aerosols, and spray/wash on the ship deck from harming the cell calibration.
3. Place a cap over the end of the T-C Duct and the pump exhaust tee to prevent dust and aerosols from entering the cell during storage.

Storage (storing for longer than one day)

1. Rinse the cell and pump exhaust plumbing with clean, de-ionized water and drain.
2. Place a cap over the end of the T-C Duct and the pump exhaust tee to prevent dust and aerosols from entering the cell during storage.
3. When ready to deploy again - Fill the cell with a **0.1%** solution of Triton X-100 for 1 hour before deployment.

Cleaning

The rinse and soak procedure recommended for Active Use is generally sufficient. However, occasionally the cell becomes contaminated and requires more intensive cleaning. We recommend two procedures, depending on the type of contamination:

Triton Cleaning

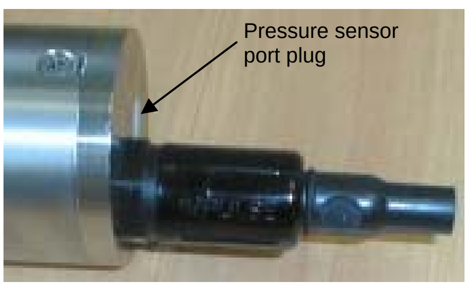
1. Heat a stronger (**1%-2%**) solution of Triton X-100 to less than 60 °C.
2. Agitate the warm solution through the cell and pump exhaust plumbing many times in a washing action. This can be accomplished with Tygon tubing and a syringe kit.
3. Fill the cell and pump exhaust plumbing with the solution and let it soak for 1 hour.
4. Drain and flush with clean, de-ionized water for 1 minute. Then:
   - Prepare for deployment, **or**
   - Follow recommendations above for storage.

Repeat this procedure a few times for reluctant contamination. Return to Sea-Bird for cleaning if three rinses do not restore the cell's calibration.

Acid Cleaning

Sea-Bird recommends that you do not perform acid cleaning on a fully assembled FastCAT. We recommend that you return the FastCAT to Sea-Bird for servicing if acid cleaning is required.

Pressure Sensor Maintenance

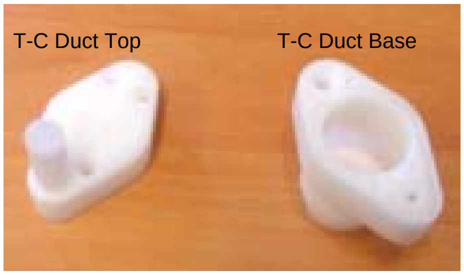


CAUTION:
Do not put a brush or any object in the pressure port. Doing so may damage or break the pressure sensor.

At the factory, the pressure sensor and pressure port were filled with a silicon oil, and a pressure port plug was used to retain the oil. The oil transmits hydrostatic pressure to the pressure sensor inside the instrument. Because of the viscosity of the silicone oil, the oil does not run out of the pressure sensor port plug. However, due to temperature and pressure cycling over long periods, it is normal for some oil to slowly leak out of the plug. **It is not necessary to refill the oil**.

Periodically (approximately once a year) inspect the pressure port to remove any particles, debris, etc:
1. Unscrew the pressure port plug from the pressure port. The fitting may contain silicon oil from the factory, so there may be some spillage.
2. Rinse the pressure port with warm, de-ionized water to remove any particles, debris, etc.
3. Replace the pressure port plug.

Replacing Optional Anti-Foulant Devices – Mechanical Design Change



As an option, the FastCAT is supplied with anti-foulant device fittings and AF24173 Anti-Foulant Devices.

The following two pages provide details on replacing the Anti-Foulant Devices. However, due to a change in the mechanical design of the T-C Duct assembly, Steps 1 – 4 and 7 – 9 in *Anti-Foulant Device in T-C Duct Assembly* are no longer applicable. See the revised details below:

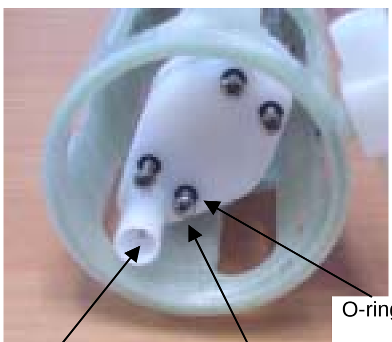
Removing T-C Duct Top (replaces Steps 1 – 4)

A. Remove the four small Phillips-head screws with o-rings securing the T-C Duct top to the T-C Duct base.

B. Carefully pull the T-C Duct top straight out – **do not apply any sideways motion or you may damage the temperature sting**.

Replacing T-C Duct Top (replaces Steps 7 – 9)

C. Carefully replace the T-C Duct top on the base, reinstalling the four small Phillips-head screws and o-rings.



O-rings (4)

Temperature sting

Phillips-head screws (4), shown partially removed

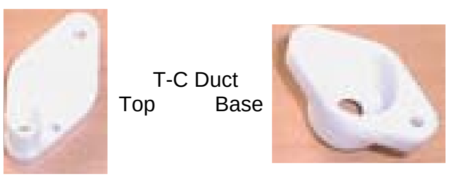
Temperature sting

T-C Duct Base remains attached and sealed to top of conductivity cell - do not remove

Replacing Optional Anti-Foulant Devices (SBE 49)

AF24173
Anti-Foulant
Device

> ***WARNING!***
>
> **AF24173 Anti-Foulant Devices contain bis(tributyltin) oxide. Handle the devices only with rubber or latex gloves. Wear eye protection. Wash with soap and water after handling.**
>
> **Read precautionary information on product label (see Appendix IV) before proceeding.**
>
> **It is a violation of US Federal Law to use this product in a manner inconsistent with its labeling.**



As an option, the FastCAT is supplied with anti-foulant device fittings and Anti-Foulant Devices. The Anti-Foulant Devices are installed:

- in the T-C Duct assembly;
- in the anti-foulant device cup and cap (part of the external pump exhaust tubing).

Wearing rubber or latex gloves, follow this procedure to replace each Anti-Foulant Device (two):

Anti-Foulant Device in T-C Duct Assembly

1. Remove the large screw securing the T-C Duct to the mast.
2. Gently pull the T-C Duct straight out - you will feel some resistance as the seals disengage. **Do not twist the T-C Duct or apply any sideways motion, or you may damage the conductivity cell.**
3. Remove the two small Phillips-head screws securing the T-C Duct top to the T-C Duct base.
4. Pull the T-C Duct top off of the base.
5. Remove the old Anti-Foulant Device. If the old device is difficult to remove, use needle-nose pliers and carefully break up material.
6. Place the new Anti-Foulant Device in the T-C Duct base.
7. Replace the T-C Duct top on the base, reinstalling the two small Phillips-head screws.
8. **Carefully** slide the T-C Duct assembly over the temperature sting, aligning the large screw hole with the screw hole in the mast. Push the assembly onto the end of the conductivity cell - you will feel some resistance as the seals engage. **Do not twist the T-C Duct or apply any sideways motion, or you may damage the conductivity cell.**
9. Reinstall the large screw to secure the assembly to the mast.

Anti-Foulant Device in Pump Exhaust Tubing

1. Carefully cut the cable tie securing the Tygon tubing to the anti-foulant device cap. Slip the Tygon tubing off of the anti-foulant device cap.

2. Unscrew the cap with a socket wrench.

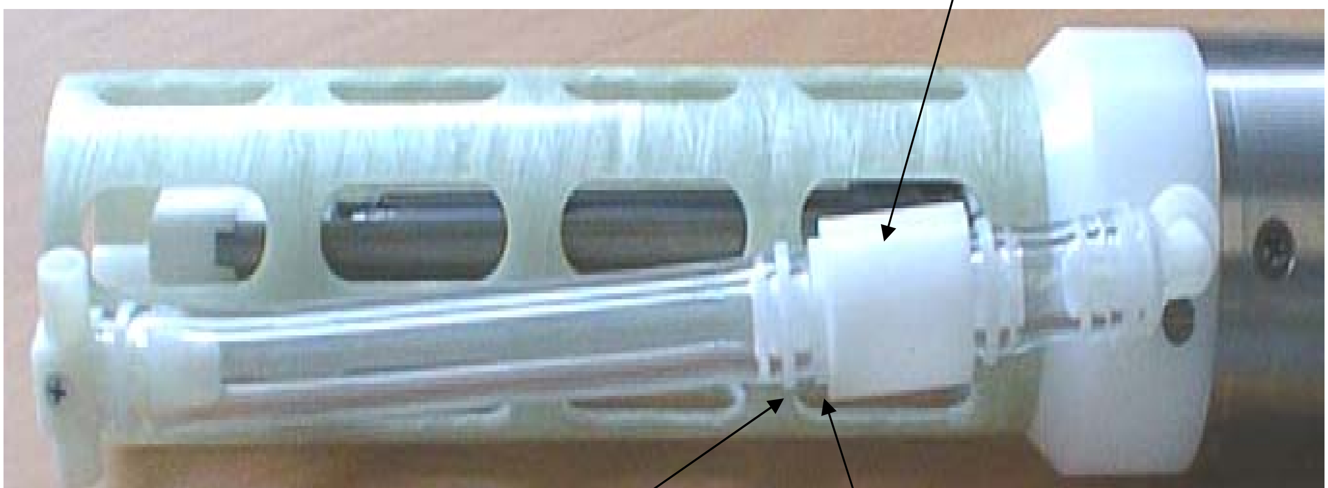
3. Remove the old Anti-Foulant Device. If the old device is difficult to remove, use needle-nose pliers and carefully break up material.

4. Place the new Anti-Foulant Device in the cup.

5. Rethread the cap onto the cup. Do not over tighten.

6. Slip the Tygon tubing back onto the cap. Secure with a new cable tie.

Anti-foulant device cup holds Anti-Foulant Device



Cut cable tie and slip Tygon tubing off of anti-foulant device cap

Unscrew anti-foulant device cap from anti-foulant device cup

Sensor Calibration

Note:
After recalibration, Sea-Bird enters the new calibration coefficients in the FastCAT's EEPROM, and ships the instrument back to the user with Calibration Certificates showing the new coefficients. **The user must enter the coefficients in the instrument configuration (.con) file in the Configure menu in SEASAVE or SBE Data Processing**.

Sea-Bird sensors are calibrated by subjecting them to known physical conditions and measuring the sensor responses. Coefficients are then computed, which may be used with appropriate algorithms to obtain engineering units. The conductivity, temperature, and pressure sensors on the FastCAT are supplied fully calibrated, with coefficients stored in EEPROM in the FastCAT and printed on their respective Calibration Certificates.

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

Conductivity Sensor Calibration

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

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

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

Temperature Sensor Calibration

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

Pressure Sensor Calibration

The FastCAT's strain-gauge pressure sensor is capable of meeting the FastCAT's error specification with some allowance for aging and ambient-temperature induced drift.

For demanding applications, or where the sensor's air ambient pressure response has changed significantly, calibration using a dead-weight generator is recommended. The end cap's $^{7}/_{16}$-20 straight thread 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.

Section 6: Troubleshooting

This section reviews common problems in operating the FastCAT, and provides the most likely causes and solutions.

Problem 1: Unable to Communicate with FastCAT

The S> prompt indicates that communications between the FastCAT and computer have been established. Before proceeding with troubleshooting, attempt to establish communications again by clicking the Connect button on SEATERM's toolbar or hitting the Enter key several times.

Cause/Solution 1: The I/O cable connection may be loose. Check the cabling between the FastCAT and computer for a loose connection.

Cause/Solution 2: The instrument type and/or its communication settings may not have been entered correctly in SEATERM. Select *SBE 49* in the Configure menu and verify the settings in the Configuration Options dialog box. The settings should match those on the instrument Configuration Sheet.

Cause/Solution 3: The I/O cable may not be the correct one. The I/O cable supplied with the FastCAT permits connection to the DB-25P input connectors used on IBM Asynchronous Adapter Cards, i.e., standard RS-232 interfaces. (Sea-Bird also supplies a 25-to-9 pin adapter, for use if your computer has a 9-pin serial port.)

- FastCAT Pin 1 goes to DB-25 pin 7 (ground)
- FastCAT pin 2 goes to DB-25 pin 2
- FastCAT pin 3 goes to DB-25 pin 3

See *Section 2: Description of FastCAT*, for the connector details.

Problem 2: Unreasonable Data

The symptom of this problem is data that contains unreasonable values (for example, values that are outside the expected range of the data).

Cause/Solution 1: Data with unreasonable values may be caused by:

- Incorrect calibration coefficients in the instrument's EEPROM (if looking at data output from the FastCAT in converted format). Verify the calibration coefficients in EEPROM match the instrument Calibration Certificates, using the **DCAL** command in SEATERM.
- Incorrect calibration coefficients in the .con file (if looking at data obtained through SEASAVE). Verify the calibration coefficients in the .con file match the instrument Calibration Certificates.

Problem 3: Salinity Lower than Expected

Cause/Solution 1: A fouled conductivity cell will report lower than correct salinity. Large errors in salinity indicate that the cell is extremely dirty, has something large lodged in it, or is broken. Proceed as follows:

1. Clean the conductivity cell as described in *Cleaning and Storage* in *Section 5: Routine Maintenance and Calibration*.
2. Remove larger droplets of water by blowing through the conductivity cell. **Do not use compressed air**, which typically contains oil vapor.
3. Running the FastCAT in air, use the **TCR** command to look at the raw conductivity frequency. It should be within 1 Hz of the zero conductivity value printed on the conductivity cell Calibration Sheet. If it is significantly different, the cell is probably damaged.

Glossary

FastCAT – High-accuracy conductivity, temperature, and pressure sensor.

Fouling – Biological growth in the conductivity cell during deployment.

PCB – Printed Circuit Board.

SBE Data Processing – Sea-Bird's Win 95/98/NT/2000/XP data processing software, which calculates temperature, conductivity, and pressure; derives variables such as salinity and sound velocity; and plots data.

Scan – One data sample containing temperature, conductivity, and pressure.

SEASAVE – Sea-Bird's Win 95/98/NT/2000/XP software used to acquire, convert, and display real-time or archived raw data.

SEASOFT-DOS – Sea-Bird's complete DOS software package, which includes software for communication, real-time data acquisition, and data analysis and display. SEASOFT-DOS is **not compatible** with the FastCAT.

SEASOFT-Win32– Sea-Bird's complete Win 95/98/NT/2000/XP software package, which includes software for communication, real-time data acquisition, and data analysis and display. SEASOFT-Win32 includes **SEATERM**, SeatermAF, **SEASAVE**, **SBE Data Processing**, and Plot39.

SEATERM – Sea-Bird's Win 95/98/NT/2000/XP terminal program used to communicate with the FastCAT.

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

Appendix I: Functional Description and Circuitry

Sensors

The SBE49 embodies the same sensor elements (3-electrode, 2-terminal, borosilicate glass cell, and pressure-protected thermistor) previously employed in Sea-Bird's modular SBE 3 and SBE 4 sensors and in the SEACAT and SEACAT*plus*. The FastCAT uses three independent channels to digitize temperature, conductivity, and pressure concurrently.

The pressure sensor is a Druck strain-gauge sensor.

Sensor Interface

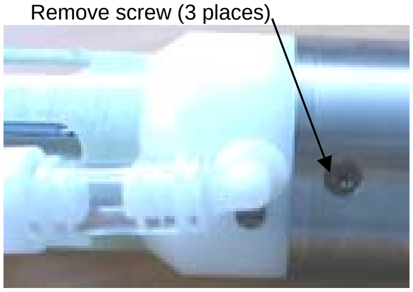
Temperature is acquired by applying an AC excitation to a bridge circuit containing an ultra-stable aged thermistor with a drift rate of less than 0.002 ºC per year. The other elements in the bridge are VISHAY precision resistors. A 24-bit A/D converter digitizes the output of the bridge. AC excitation and ratiometric comparison avoids errors caused by parasitic thermocouples, offset voltages, leakage currents, and reference errors.

Conductivity is acquired using an ultra-precision Wien-Bridge oscillator to generate a frequency output in response to changes in conductivity.

Strain-gauge pressure is acquired by applying an AC excitation to the pressure bridge. A 24-bit A/D converter digitizes the output of the bridge. AC excitation and ratiometric comparison avoids errors caused by parasitic thermocouples, offset voltages, leakage currents, and reference errors. A silicon diode embedded in the pressure bridge is used to measure the temperature of the pressure bridge. This temperature is used to perform offset and span corrections on the measured pressure signal.

Appendix II: Electronics Disassembly/Reassembly

Disassembly



1. Remove the connector end cap:
   A. Wipe the outside of the end cap and housing dry, being careful to remove any water at the seam between them.
   B. Remove the two Phillips-head screws holding the connector end cap to the housing.
   C. Using straight screwdrivers in the slots, carefully pry off the end cap. Note that the end cap and electronics are electrically connected with edge connectors, and **the end cap will not twist off**.
   D. Remove any water from the O-rings and mating surfaces inside the housing with a lint-free cloth or tissue.
   E. Be careful to protect the O-rings from damage or contamination.

2. Remove the housing:
   A. Wipe the outside of the sensor end cap and housing dry, being careful to remove any water at the seam between them.
   B. Remove the three Phillips-head screws holding the housing to the sensor end cap.
   C. Slide the end cap and attached electronics out of the housing.
   D. Remove any water from the O-rings and mating surfaces inside the housing with a lint-free cloth or tissue.
   E. Be careful to protect the O-rings from damage or contamination.

Reassembly

Note:
Before delivery, a desiccant package is placed in the housing, and the electronics chamber is filled with dry Argon gas. These measures help prevent condensation. To ensure proper functioning:
1. Install a new desiccant bag each time you open the housing. If a new bag is not available, see *Application Note 71: Desiccant Use and Regeneration (drying)*.
2. If possible, dry gas backfill each time you open the housing. If you cannot, wait at least 24 hours before redeploying, to allow the desiccant to remove any moisture from the housing.

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

2. Reinstall the housing:
   A. Carefully fit the end cap and electronics into the housing until the O-rings are fully seated.
   B. Reinstall the three screws to secure the housing to the sensor end cap.

3. Reinstall the connector end cap:
   A. Line up the alignment pin with the notch in the end cap. Verify the pin/notch and screw holes are properly aligned.
   B. Carefully fit the end cap into the housing until the edge connectors mate and the O-rings are fully seated.
   C. Reinstall the two screws to secure the housing to the end cap.

4. No user-programmable setup parameters should have been affected by the electronics disassembly (send the **DS** command to verify).

Appendix III: Command Summary

CATEGORY	COMMAND	DESCRIPTION
Status	**DS**	Display status and setup parameters.
Setup	**BAUD=x**	**x=** baud rate (1200, 2400, 4800, 9600, 19200, or 38400). Default 9600.
	PTYPE=x	**x=1**: Strain-gauge pressure sensor.
	OUTPUTFORMAT=x	**x=0**: output raw data in Hex. **x=1**: output converted data in Hex. **x=2**: output raw data in decimal. **x=3**: output converted data in decimal.
	OUTPUTSAL=x	**x=Y**: Calculate and output salinity (psu). Only applies if **OUTPUTFORMAT=3**. **x=N**: Do not calculate and output salinity.
	OUTPUTSV=x	**x=Y**: Calculate and output sound velocity (m/sec). Only applies if **OUTPUTFORMAT=3**. **x=N**: Do not calculate and output sound velocity.
Autonomous Sampling	**NAVG=x**	**x=** number of samples to average. FastCAT samples at 16 Hz and averages **NAVG** samples. Default =1.
	MINCONDFREQ=x	**x=** minimum conductivity frequency (Hz) to enable pump turn-on. Pump stops when frequency drops below **x**.
	PUMPDELAY=x	**x=** time (seconds) to wait after minimum conductivity frequency is reached before turning pump on. Default 60 seconds.
	AUTORUN=x	**x=N**: Wait for a command when power applied. Default. **x=Y**: Start autonomous sampling automatically when power applied.
	START	Start autonomous sampling now.
	STOP	Stop autonomous sampling. Press Enter key to get S> prompt before entering command.
Polled Sampling	**PUMPON**	Turn pump on.
	PUMPOFF	Turn pump off.
	TS	Take **one** sample and output data.
Testing Takes and outputs 100 samples for each test. Press Esc key or Stop on Toolbar to stop test.	**TT**	Measure temperature, transmit converted data.
	TC	Measure conductivity, transmit converted data.
	TP	Measure pressure, transmit converted data.
	TTR	Measure temperature, transmit raw data
	TCR	Measure conductivity, transmit raw data.
	TPR	Measure pressure, transmit raw data.

CATEGORY	COMMAND	DESCRIPTION
Coefficients (F=floating point number; S=string with no spaces) Dates shown are when calibrations were performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with FastCAT.	**DCAL**	Display calibration coefficients; all coefficients and dates listed below are included in display. Use individual commands below to modify a particular coefficient or date.
	TCALDATE=S	**S=**Temperature calibration date.
	TAO=F	**F=**Temperature A0.
	TA1=F	**F=**Temperature A1.
	TA2=F	**F=**Temperature A2.
	TA3=F	**F=**Temperature A3.
	TOFFSET=F	**F=**Temperature offset correction.
	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.
	CSLOPE=F	**F=**Conductivity slope correction.
	PCALDATE=S	**S=**Pressure calibration date.
	PRANGE=F	**F=**Pressure sensor full scale range (psi).
	POFFSET=F	**F=**Pressure offset correction.
	PA0=F	**F=**Pressure A0.
	PA1=F	**F=**Pressure A1.
	PA2=F	**F=**Pressure A2.
	PTEMPA0=F	**F=**Pressure temperature A0.
	PTEMPA1=F	**F=**Pressure temperature A1.
	PTEMPA2=F	**F=**Pressure temperature 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.

Appendix IV: AF24173 Anti-Foulant Device

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

AF24173 ANTIFOULANT DEVICE

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

ACTIVE INGREDIENT:
Bis(tributyltin) oxide…………..…………………………..... 53.0%
OTHER INGREDIENTS: ……………………………….... 47.0%
Total……………………………………………………….... 100.0%

DANGER

See the complete label within the Conductivity Instrument Manual for Additional Precautionary Statements and Information on the Handling, Storage, and Disposal of this Product.

Net Contents: Two antifoulant devices (7.14 g)

EPA Registration No. 74489-1
EPA Establishment No. 74489-WA-1

Sea-Bird Electronics, Inc
1808 - 136th Place NE
Bellevue, WA 98005

AF24173 Anti-Foulant Device

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

ACTIVE INGREDIENT:
Bis(tributyltin) oxide…………..…………………………..... 53.0%
OTHER INGREDIENTS: ……………………………….... 47.0%
Total……………………………………………………….... 100.0%

DANGER
See Precautionary Statements for additional information.

FIRST AID	
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for15-20 minutes. • Call a poison control center or doctor for treatment advice.
If swallowed	• 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.
If in eyes	• Hold 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.
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 (7.14 g)

Sea-Bird Electronics, Inc.
1808 - 136th Place Northeast
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. Harmful if swallowed. Harmful if absorbed through the skin or inhaled. Prolonged or frequently repeated contact may cause allergic reactions in some individuals. Wash thoroughly with soap and water after handling.

PERSONAL PROTECTIVE EQUIPMENT

USER SAFETY RECOMMENDATIONS

Users should:

- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Wear protective gloves (rubber or latex), goggles or other eye protection, and clothing to minimize contact.
- Follow 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.
- Wash hands with soap and water before eating, drinking, chewing gum, using tobacco or using the toilet.

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.

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 to 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 DISPOSAL: Dispose of in a sanitary landfill or by other approved State and Local procedures.

Sea-Bird Electronics/label revised 10-5-02

Appendix V: Replacement Parts

Part Number	Part	Application Description	Quantity in FastCAT
30857	Parker 2-033N674-70	Connector end cap and sensor end cap to housing O-ring seals	4
30859	Screw, 8-32 x 3/8 flat Phillips-head, titanium	Secures connector end cap and sensor end cap to housing	5
801046	4-pin to 25-pin I/O cable with power leads, 2.4 m (8 ft) long *	From FastCAT to computer/ controller and power supply	1
17130	25-pin to 9-pin adapter	Connects I/O cable to 9-pin COM port on computer	1
17043	Locking sleeve *	Locks I/O cable or dummy plug in place	1
17046	4-pin dummy plug *	For storage when I/O cable not used	1
801206	4-pin (wet-pluggable connector) to 9-pin I/O cable with power leads, 2.4 m (8 ft long)	From FastCAT to computer/ controller and power supply	1
171398	4-pin dummy plug, wet-pluggable connector	For storage when I/O cable not connected	1
171192	Locking sleeve (wet-pluggable connector)	Locks I/O cable or dummy plug in place	1
50091	Triton X-100	Conductivity cell cleaning solution	1
801347	AF24173 Anti-Foulant Device	bis(tributyltin) oxide device inserted into anti-foulant device cup	2
231513	Anti-foulant device cup on pump exhaust plumbing	Holds optional AF24173 Anti-Foulant Device	1
231514	Anti-foulant device cap on pump exhaust plumbing	Secures optional AF24173 Anti-Foulant Device in cup	1
232055	T-C Duct top	T-C Duct, also secures optional AF24173 Anti-Foulant Device in base	1
232056	T-C Duct base	T-C Duct, holds optional AF24173 Anti-Foulant Device	1
30992	Screw, 2-56 x 5/8 Phillips-head, stainless	Secures T-C Duct top to base	4
31076	Parker 2-003E515-80 O-rings	For 30992 screws	4
31182	Parker 2-021 O-ring	T-C Duct base to top o-ring seal	1
231408	Pump exhaust tee	Exhaust fitting, mounts to sensor guard	1
30132	Screw, 4-40 x 3/4 flat Phillips-head, stainless	Secures pump exhaust tee to sensor guard	1
30239	Washer, #4 nylon WN-4	For 30132 screw, placed between tee and sensor guard	2
60037	Spare parts kit	Assorted o-rings and hardware	-

*For standard bulkhead connector.

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