SBE 37-SIP MicroCAT

Conductivity and Temperature Monitor
with RS-485 Interface and Integral Pump

For most applications, deploy in orientation shown (connector end down) for proper operation

Shown with standard titanium housing;
optional ShallowCAT plastic housing available

User's Manual

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Manual Version #005, 06/14/07
Acquisition Firmware Version 2.3b and later
Communication Firmware Version 1.2 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 MicroCAT shipment.

About this Manual

This manual is to be used with the SBE 37-SIP MicroCAT Conductivity and Temperature Monitor (pressure optional) with **RS-485 S**erial **I**nterface and integral **P**ump.

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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(1600 to 0100 Universal Time)
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 MicroCAT.
The manual provides step-by-step details for performing each task:

1. Test power and communications (*Section 3: Preparing MicroCAT for Deployment*).
2. Deploy the MicroCAT (*Section 4: Deploying and Operating MicroCAT*):
   A. Set date and then time.
   B. Establish setup and operating parameters.
   C. Remove protective plugs from anti-foulant device cup, and verify AF24173 Anti-Foulant Devices are installed. Leave protective plugs off for deployment.
   D. Install I/O cable connector and locking sleeve.
   E. Deploy MicroCAT, using optional Sea-Bird mounting hardware or customer-supplied hardware. For **most** applications, mount the MicroCAT with the connector at the bottom for proper operation.
   F. Save real-time data to a file, using Capture on SEATERM's Toolbar or your own software.

Unpacking MicroCAT

Shown below is a typical MicroCAT shipment.

SBE 37-SIP MicroCAT

I/O cable

25-pin to 9-pin adapter
(for use with computer
with DB-25 connector)

Spare hardware
and o-ring kit

Conductivity cell cleaning
solution (Triton-X)

MicroCAT User Manual

Software, and Electronic Copies of
Software Manuals and User Manual

Section 2: Description of MicroCAT

This section describes the functions and features of the SBE 37-SIP MicroCAT, including specifications, dimensions, end cap connector, and sample timing.

System Description

For most applications, deploy in orientation shown (connector end down) for proper operation – see Optimizing Data Quality / Deployment Orientation in Section 4: Deploying and Operating MicroCAT

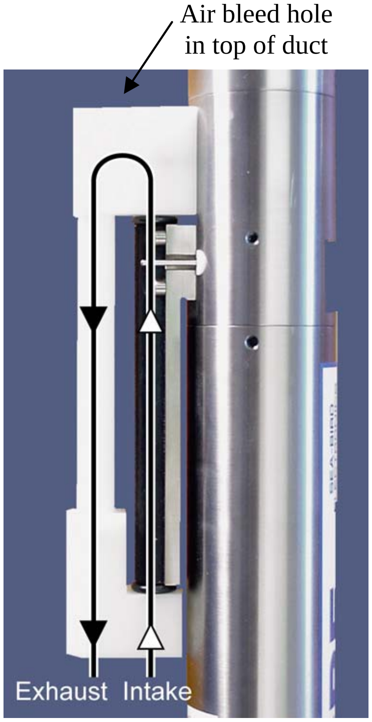
The SBE 37-SIP MicroCAT is a high-accuracy, externally powered, conductivity and temperature (pressure optional) monitor, which includes an **RS-485 serial interface** and integral pump. Designed to be incorporated into oceanographic sensing systems, MicroCATs have non-corroding titanium housings rated for operation to 7000 meters (23,000 feet) or pressure sensor full-scale range. An optional plastic *ShallowCAT* housing rated for 250 meters (820 feet) is also available.

Communication with the MicroCAT is over a 2-wire, RS-485 link. Commands can be sent to the MicroCAT to provide status display, data acquisition setup, and diagnostic tests. A command to take a sample can be sent globally to all MicroCATs on the RS-485 line or to an individual MicroCAT. Each MicroCAT then holds the data in a buffer until it receives a command to transmit the data.

Calibration coefficients stored in EEPROM allow the MicroCAT to transmit data in engineering units. The MicroCAT retains the temperature and conductivity sensors used in the SBE 16 SEACAT C-T Recorder, but has improved acquisition electronics that increase accuracy and resolution, and lower power consumption. The MicroCAT's aged and pressure-protected thermistor has a long history of exceptional accuracy and stability (typical drift is less than 0.002 °C per year). Electrical isolation of the conductivity electronics eliminates any possibility of ground-loop noise.

The MicroCAT's internal-field conductivity cell is immune to proximity errors and unaffected by external fouling. A plastic cup with threaded cover at each end of the cell retains the expendable AF24173 Anti-Foulant Device.

Air bleed hole in top of duct



Shown with conductivity cell guard removed

The MicroCAT's integral pump runs for 0.5 seconds each time the MicroCAT takes a sample, providing the following advantages over a non-pumped system:

- Improved conductivity response – The pump flushes the previously sampled water from the conductivity cell and brings a new water sample quickly into the cell.
- Reduced fouling – Water does not freely flow through the conductivity cell between samples, minimizing fouling.

Note that the MicroCAT was designed to be deployed as shown, with the intake/exhaust in an inverted U-shape. This orientation prevents sediment from being trapped in the pump impeller housing. An air bleed hole in the top of the duct allows air to escape from the plumbing, so the pump will prime. See *Optimizing Data Quality / Deployment Orientation* in *Section4: Deploying and Operating MicroCAT.*

CAUTION:
Do not run the pump dry. The pump is water lubricated; running it without water will damage it. If briefly testing your system in dry conditions, orient the MicroCAT to provide an upright U-shape for the plumbing. Then fill the inside of the pump head with water via the pump exhaust tubing. This will provide enough lubrication to prevent pump damage during brief testing.

The MicroCAT's optional pressure sensor, developed by Druck, Inc., has a superior new design that is entirely different from conventional 'silicon' types in which the deflection of a metallic diaphragm is detected by epoxy-bonded silicon strain gauges. The Druck sensor employs a micro-machined *silicon diaphragm* into which the strain elements are implanted using semiconductor fabrication techniques. Unlike metal diaphragms, silicon's crystal structure is perfectly elastic, so the sensor is essentially free of pressure hysteresis. Compensation of the temperature influence on pressure offset and scale is performed by the MicroCAT's CPU.

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

The MicroCAT is supplied with a powerful Win 2000/XP software package, SEASOFT-Win32. SEASOFT-Win32 includes SEATERM, a terminal program for easy communication and data retrieval. SEATERM can send commands to the MicroCAT to provide status display, data acquisition setup, data display and capture, and diagnostic tests. Note that SEATERM **does not process the data**.

Specifications

Note:
Pressure ranges are expressed in meters of deployment depth capability.

	Temperature (°C)	Conductivity (S/m)	Optional Pressure
Measurement Range	-5 to +35	0 to 7 (0 to 70 mS/cm)	0 to full scale range: 20 / 100 / 350 / 600 / 1000 / 2000 / 3500 / 7000 meters
Initial Accuracy	0.002	0.0003 (0.003 mS/cm)	0.1% of full scale range
Typical Stability (per month)	0.0002	0.0003 (0.003 mS/cm)	0.004% of full scale range
Resolution *	0.0001	0.00001 (0.0001 mS/cm)	0.002% of full scale range
Sensor Calibration	+1 to +32	0 to 6; physical calibration over the range 2.6 to 6 S/m, plus zero conductivity (air)	Ambient pressure to full scale range in 5 steps
Counter Time-Base	Quartz TCXO, ±2 ppm per year aging; ±5 ppm vs. temperature (-5 to +30 °C)		
Real-Time Clock	Watch-crystal type 32,768 Hz; corrected for drift and aging by comparison to MicroCAT counter time-base to produce overall ± 5 ppm accuracy (±2.6 minutes/year)		
External Input Power	0.5 Amps at 7-24 VDC. See *Power and Cable Length* in *Section 4: Deploying and Operating MicroCAT*. Quiescent Current: 30 microamps Sampling Current: 35 milliamps (nominal, excluding pump) • 34.3 milliamps at 9 V • 32.8 milliamps at 11 V • 31.9 milliamps at 13 V • 31.4 milliamps at 15 V Communication Current: 1.1 milliamps Pump current / sample: 0.13 amp-second		
Housing and Depth Rating	*Standard:* Titanium housing rated at 7000 m (23,000 ft) *Optional:* Plastic housing rated at 250 m (820 ft)		
Weight (without pressure sensor or clamps)	*Standard titanium housing:* In air: 4.2 kg (9.2 lbs) In water: 2.8 kg (6.2 lbs) *Optional plastic housing:* In air: 3.1 kg (6.9 lbs) In water: 1.7 kg (3.8 lbs)		

CAUTION:
See *Section 5: Routine Maintenance and Calibration* for handling instructions for the plastic *ShallowCAT* housing.

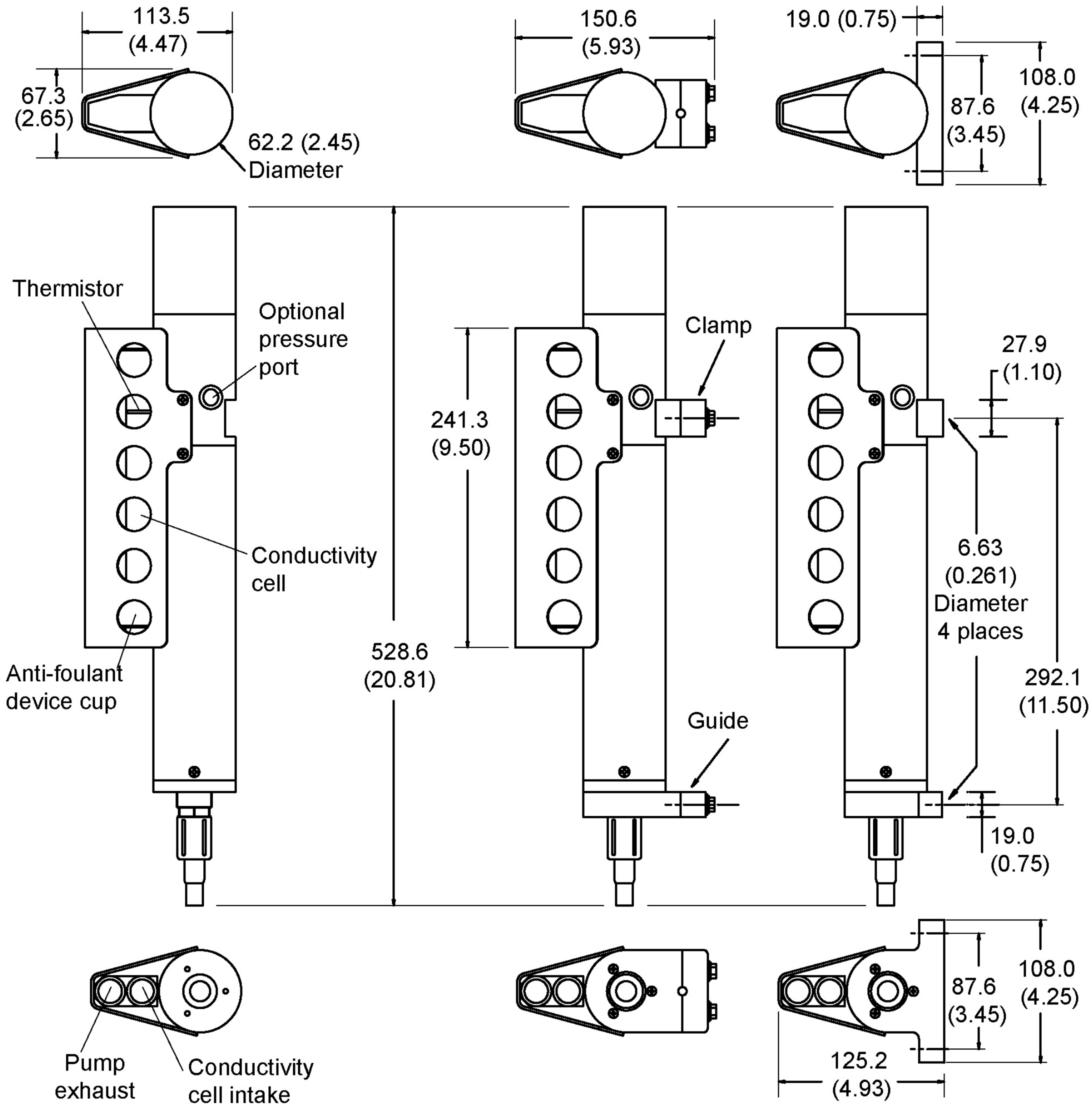
***Resolution**
Typical RMS noise with fixed resistors on the temperature and conductivity inputs (Tnom = 9.6, Cnom = 3.4):

#iiNCycles	Temperature (°C)	Conductivity (S/m)
2	0.000193	0.000042
4	0.000124	0.000023
8	0.000095	0.000018
16	0.000078	0.000015

See *Section 4: Deploying and Operating MicroCAT* for a description of **#iiNCycles**.

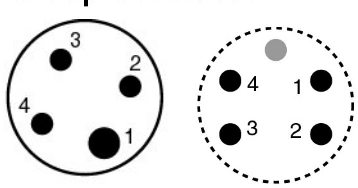
Dimensions

Notes:
- Dimensions in millimeters (inches).
- **For most applications, deploy in the orientation shown (connector end down) for proper operation.**



Standard Without Mounting Hardware | **Optional Wire Mounting Clamp and Guide** | **Optional Flat Surface Mounting Brackets**

End Cap Connector



Pin	Signal
1	Common
2	RS-485 **A**
3	RS-485 **B**
4	External power (7 – 24 VDC)

The MicroCAT comes standard with a 4-pin XSG connector. An optional MCBH (wet-pluggable) connector is available.

○ = standard XSG-4-BCL-HP-SS connector

◌ = optional MCBH-4MP (WB), TI (3/8” length base, ½-20 thread) connector

Sample Timing

Notes:

- The pump runs for 0.5 seconds before each sample measurement.
- Acquisition time shown does not include time to transmit data, which is dependent on baud rate. See *Cable Length, Baud Rate, and Data Transmission Rate* in *Section 4: Deploying and Operating MicroCAT*.
- For the date and time output with the data, time is the time at the **start** of the sample, after a small amount of time for the MicroCAT to wake up, run the pump, and prepare to sample. For example, if the MicroCAT is programmed to wake up and sample at 12:00:00, the displayed time will indicate 12:00:01 or 12:00:02.
- See *Specifications* above for the effect of **#iiNCycles** on RMS noise. See *Section 4: Deploying and Operating MicroCAT* for a description of **#iiNCycles**.

Acquisition (power-on) Time for **#iiTS** or **#iiTSR** command:

Pressure Sensor?	#iiNCycles	Time (seconds)
With Pressure Sensor	1	2.1
	2	2.2
	4	2.6
	8	3.3
Without Pressure Sensor	1	1.8
	2	1.9
	4	2.2
	8	2.7

Communications Timing, which is the time to request and transmit data from each MicroCAT to the computer/controller: 0.5 seconds

Section 3: Preparing MicroCAT for Deployment

This section describes:
- installing software
- testing power and communications for the MicroCAT, and setting the MicroCAT ID

Software Installation

Recommended minimum system requirements for running SEASOFT-Win32: Windows 2000 or later, 500 MHz processor, 256 MB RAM, and 90 MB free disk space for installation.

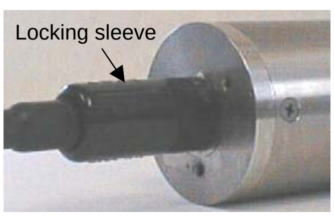
If not already installed, install SEATERM and other Sea-Bird software programs on your computer using the supplied software CD:

1. Insert the CD in your CD drive.
2. Double click on **Seasoft-Win32.exe**.
3. Follow the dialog box directions to install the software.

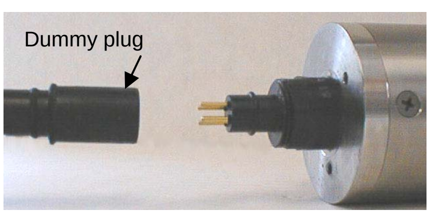
The default location for the software is c:/Program Files/Sea-Bird. Within that folder is a sub-directory for each program. The installation program allows you to install the desired components. Install all the components, or just install SEATERM (terminal program).

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

Test Setup



1. Remove the dummy plug:
   A. By hand, unscrew the locking sleeve from the MicroCAT's bulkhead connector. **If you must use a wrench or pliers, be careful not to loosen the bulkhead connector instead of the locking sleeve**.
   B. Remove the dummy plug from the MicroCAT's I/O bulkhead connector by pulling the plug firmly away from the connector.



2. Install the Sea-Bird I/O cable connector:
   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 MicroCAT (XSG connector shown below). **OR**
   MCBH Connector – Install the I/O cable connector, aligning the pins
3. Connect the I/O cable connector to your computer's serial port.
4. Connect the I/O cable connector's red (+) and black (-) wires to a power supply (7-24 VDC).

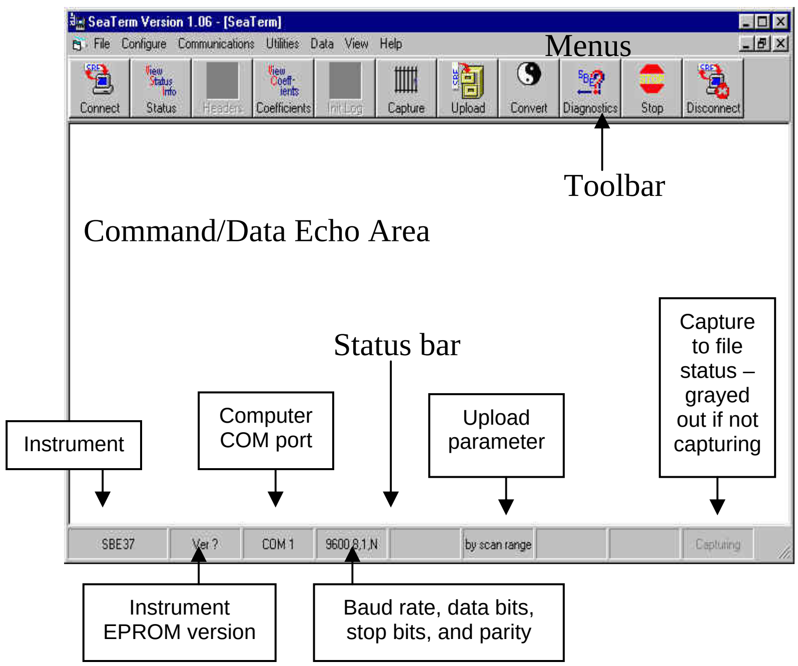
Test and Setting ID

Note:
See SEATERM's Help files.

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

Select the instrument type (SBE 37) and the computer COM port for communication with the MicroCAT. 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 Connect 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 through 5 below), to update the Status bar:
- on the Toolbar, click Status; or
- from the Utilities menu, select Instrument Status.

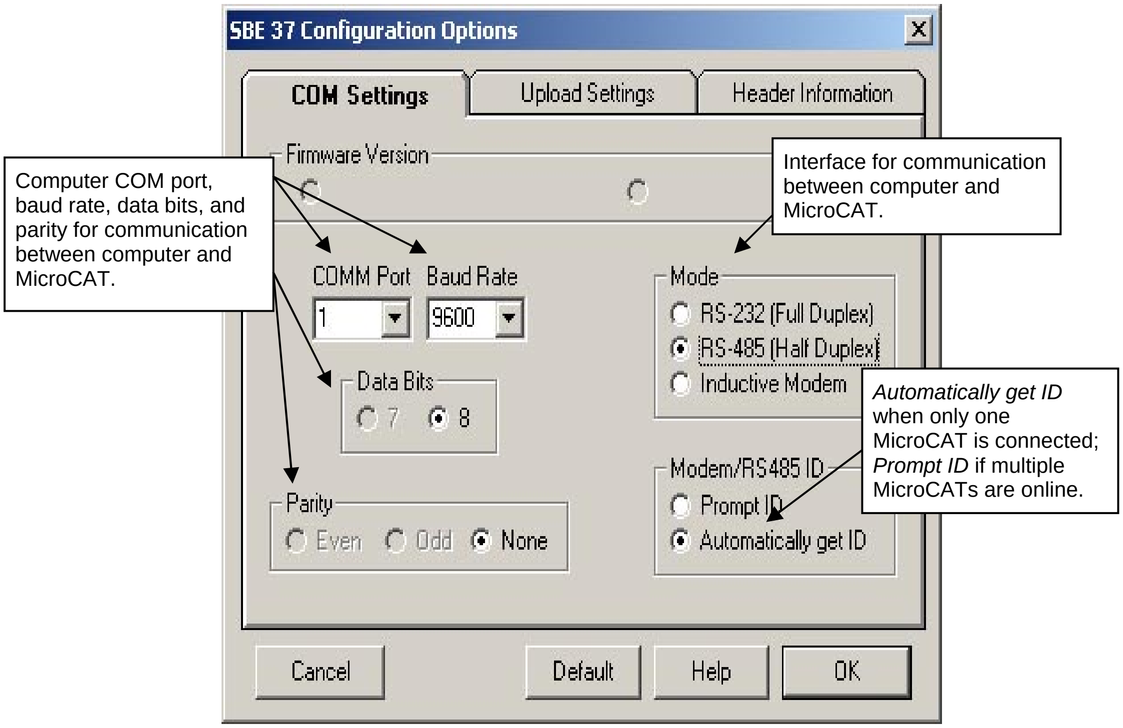
SEATERM sends the status command, which displays in the Command/Data Echo Area, and updates the Status bar.

Following are the Toolbar buttons applicable to the MicroCAT::

Toolbar Button	**Description**	**Equivalent Command***
Connect	Re-establish communications with MicroCAT. Computer responds with S> prompt. MicroCAT *goes to sleep* after 2 minutes without communication from computer have elapsed.	—
Status	Display instrument setup and status.	**#iiDS**
Coefficients	Display calibration coefficients.	**#iiDC**
Capture	Capture instrument responses on screen to file. **As MicroCAT has no internal memory, you must capture before sampling begins to save data for future processing**. File has .cap extension. Press Capture again to turn off capture. Capture status displays in Status bar.	—
Diagnostics	Perform one or more diagnostic tests on MicroCAT. Diagnostic test(s) accessed in this manner are non-destructive – they do not write over any existing instrument settings.	**#iiDS**, **#iiDC**, **#iiTS**, and **#iiTSR**
Stop	—	Not applicable to MicroCAT with RS-485 interface
Disconnect	Free computer COM port used to communicate with MicroCAT. COM port can then be used by another program. Note that MicroCAT must be connected to COM port for data to be obtained.	—

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

3. In the Configure menu, select SBE 37. The dialog box looks like this:



Note:
- SEATERM's baud rate must be the same as the MicroCAT baud rate (set with **!iiBaud=**). Baud is factory-set to 9600, but can be changed by the user (see *Command Descriptions* in *Section 4: Deploying and Operating MicroCAT*).
- When you click OK, SEATERM saves the Configuration Options settings to the SeaTerm.ini file in your Windows directory. SeaTerm.ini contains the last saved settings for **each** instrument. When you open SEATERM and select the desired instrument (SBE 37, 39, etc.) in the Configure menu, the Configuration Options dialog box shows the last saved settings for that instrument.

Make the selections in the Configuration Options dialog box:
- **COMM Port**: 1 through 10, as applicable
- **Baud Rate**: 9600 (documented on Configuration Sheet in manual)
- **Data Bits**: 8
- **Parity**: None
- **Mode**: RS-485 (Half Duplex)
- **Modem/RS 485 ID**: Automatically get ID

Click OK to save the settings.

4. In the Communications menu, select *Options / Cycle baud when connecting*.

5. Click Connect on the Toolbar. SEATERM tries to connect to the MicroCAT at the baud set in Step 3. If it cannot, it cycles through all other possible baud rates to try to connect. When it connects:
   - If Configuration Options dialog box was set to *Automatically get ID*: SEATERM automatically sends **ID?** to get the MicroCAT's ID number.
   - If Configuration Options dialog box was set to *Prompt ID*: SEATERM asks the user to input the MicroCAT's ID number.

When the MicroCAT is ready, the display looks like this:

S>

This shows that correct communications between the computer and MicroCAT has been established.

If the system does not respond as shown:
- Click Connect 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 in this manual.
- Check cabling between the computer and MicroCAT.

6. Confirm the MicroCAT has responded to the wake-up signal by typing **ID?** and pressing the Enter key. The display looks like this:

```
id=01
```

where 01 is the number set at the factory or by the previous user. See the Configuration Sheet for the factory-set identification (ID) number. Note that the ID is stored in the MicroCAT's EEPROM and can be changed so that multiple MicroCATs on a single RS-485 line each have a unique ID.

Press the Enter key to get the S> prompt.

Notes:
- The status display indicates *SBE37-SI* because the 37-SIP uses the same firmware as the 37-SI.
- The MicroCAT has a timeout algorithm. If it does not receive a command or sample data for 2 minutes, it powers down its communication circuits, placing it in quiescent (sleep) state and drawing minimal current. If the system does not appear to respond, click Connect on the Toolbar to reestablish communications.
- For reliable operation, all commands ***may*** need to be preceded with two @ characters in order to clear the communication microcontroller receive buffers.
  Example (take sample command for MicroCAT with ID=01):
  S>@@#01TS

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

```
S>#iiDS          (where ii=MicroCAT ID)
SBE37-SI 485 V 2.3 SERIAL NO. 0011 01 Jan 1980 00:19:08
sample interval = 30 seconds     (not applicable to SBE 37-SIP, RS-485)
do not output salinity with each sample
do not output sound velocity with each sample
do not output density with each sample
do not output depth with each sample
latitude to use for depth calculation = 0.00 deg
A/D cycles to average = 4
internal pump is installed
temperature = 7.54 deg C
S>
```

CAUTION:
Do not run the pump dry. The pump is water lubricated; running it without water will damage it. If briefly testing your system in dry conditions, orient the MicroCAT to provide an upright U-shape for the plumbing. Then fill the inside of the pump head with water via the pump exhaust tubing. This will provide enough lubrication to prevent pump damage during brief testing.

8. Command the MicroCAT to take a sample by typing **#iiTS** (**ii** = MicroCAT ID) and pressing the Enter key. The display looks like this (if optional pressure sensor installed, **#iiFormat=1**, and *do not output salinity*, *sound velocity*, *density*, *or depth with each sample* displayed in response to the status command):

```
12345, 23.7658, 0.00019 0.062, 01 Jan 1980, 00:30:43
```

where 12345 = MicroCAT serial number
23.7658 = temperature in degrees Celsius
0.00019 = conductivity in S/m
0.062 = pressure in decibars
01 Jan 1980 = date (default upon power-up is 01 Jan 1980)
00:30:43 = time (default upon power-up is 00:00:00)

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

Note:
If more than one MicroCAT is on-line when you set the ID, all MicroCATs will be set to the same ID.

9. Each MicroCAT on an RS-485 line must have a unique ID for communicating with the computer. Set the ID as described below, first verifying that only one MicroCAT is on-line before you set the ID:
   A. Set the MicroCAT ID by typing ***ID=ii** (ii = user-assigned ID number) and pressing the Enter key.
   B. The computer responds by requesting verification, requiring you to again type ***ID=ii** and press the Enter key.
   C. Record the ID for future reference.
   D. Press the Enter key to get the S> prompt.
   E. Click Connect on the Toolbar. This allows the system to use the *Automatically get I.D.* feature when using Toolbar buttons or menus.

10. Command the MicroCAT to go to sleep (quiescent state) by typing **PwrOff** and pressing the Enter key.

The MicroCAT is ready for programming and deployment.

Section 4: Deploying and Operating MicroCAT

This section includes:

- System operation
- Example sets of operation command
- Baud rate, cable length, power, and data transmission rate limitations
- Cable termination information
- Timeout description
- Detailed command descriptions
- Data output formats
- Optimizing data quality / deployment orientation
- Deploying and recovering the MicroCAT

Operation Description

Notes:
The MicroCAT remains awake following response to the following commands: **StartSample**, **GSample**, **MMDDYY=**, and **DDMMYY=**.The MicroCAT goes to sleep after responding to any other command, minimizing power consumption.

The MicroCAT's internal functions are supervised by two internal microcontrollers. The acquisition microcontroller supervises measurement acquisition, and setup and sampling functions. The communication microcontroller supervises communication between the MicroCAT and computer. These two microcontrollers allow for independent control of power usage by the communications and acquisition circuits. Acquisition consumes more power, but for shorter duration. Communications protocols take proportionately more time, but can be controlled separately and are operated at lower power. This also prevents communications protocols from interfering with measurement acquisition timing.

Commands can be directed to the MicroCAT communication microcontroller or its acquisition microcontroller. A command prefix (**!ii** or **#ii**) is used to direct commands to a MicroCAT with the same ID (ii = ID):

- **!ii** directs command to Communication Microcontroller
- **#ii** directs command to Acquisition Microcontroller

Global commands do not require a prefix and are recognized by all MicroCATs attached to the RS-485 interface.

MicroCAT Communication Microcontroller

- Get Data
- Set and get MicroCAT ID
- Status
- Global commands to get data, set clock, and power off
- Set baud rate
- Set timeouts

↔

MicroCAT Acquisition Microcontroller

- Status
- Setup
- Polled sampling
- Averaging
- Testing
- Calibration coefficients

CAUTION:
Do not run the pump dry. The pump is water lubricated; running it without water will damage it. If briefly testing your system in dry conditions, orient the MicroCAT to provide an upright U-shape for the plumbing. Then fill the inside of the pump head with water via the pump exhaust tubing. This will provide enough lubrication to prevent pump damage during brief testing.

Each time the MicroCAT takes a sample, its integral pump runs for 0.5 seconds before sampling. The pump flushes the previously sampled water from the conductivity cell and brings a new water sample quickly into the cell. Water does not freely flow through the conductivity cell between samples, minimizing fouling.

Setup and Sampling Example

An example follows for a system with three MicroCATs (IDs 01, 02, and 03) online. Note that the MicroCATs' response to each command is not shown in the example. Review the commands described in *Command Descriptions* and the example below before setting up your system.

Example: (user input in bold)

Wake up all MicroCATs. Globally set date and time to November 7, 2004, 09:43:00. Set up all MicroCATs to output salinity, and then put all MicroCATs in quiescent (sleep) state

(Click Connect on Toolbar to wake up all MicroCAT communication microcontrollers.)
S>**MMDDYY=110704**
S>**HHMMSS=094300**
S>**#01OUTPUTSAL=Y**
S>**#01DS** (to verify setup)
S>**#02OUTPUTSAL=Y**
S>**#02DS** (to verify setup)
S>**#03OUTPUTSAL=Y**
S>**#03DS** (to verify setup)
S>**PWROFF**

When ready to take a sample, wake up all MicroCATs. Command all MicroCATs to take a sample and hold data in buffer, and then command each MicroCAT to transmit data from buffer. Put all MicroCATs in quiescent (sleep) state. Repeat as desired.
(Click Connect on Toolbar to wake up all MicroCAT communication microcontrollers.)
S>**STARTSAMPLE** (All pumps run for ½ second, and all MicroCATs take a sample.)
S>**DATA01**
S>**DATA02**
S>**DATA03**
S>**PWROFF**
(Repeat Connect through **PWROFF** sequence as desired.)

When ready to get the average, wake up all MicroCATs. Request all MicroCATs to get average data and hold average in buffer, and start next averaging cycle, and then command each MicroCAT to transmit average data from buffer. Put all MicroCATs in quiescent (sleep) state.
(Click Connect on Toolbar to wake up all MicroCAT communication microcontrollers.)
S>**ADATA**
S>**DATA01**
S>**DATA02**
S>**DATA03**
S>**PWROFF**

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

Notes:
- Baud rate is set with **!iiBaud=**.
- Output format is set with **#iiFormat=**.

See *Command Descriptions*.

Cable Length, Baud Rate, and Data Transmission Rate

The MicroCAT can transmit data over up to 1200 meters of twisted pair wire cable, 26 AWG or smaller gauge (larger diameter).

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

Time 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*). 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 (**#iiFormat=1** or **2**), include decimal points, commas, and spaces when counting characters.

See *Sample Timing* in *Section 2: Description of MicroCAT* for information on sampling time.

Example – How long does it take to transmit data with **Dataii** with a baud rate of 1200 for a MicroCAT with optional pressure sensor, **#iiFormat=1**, **#iiOutputDepth=Y**, **#iiOutputSal=Y**, **#iiOutputSV=Y**, and **#iiOutputDensity=Y**, (output depth, salinity, sound velocity, and density, as well as C, T, P, and date and time)?

Number of characters (see *Data Output Formats*) = 2(ID) + 2(comma & space) + 5(serial number) + 1(comma) + 8(T) + 1(comma) + 8(C) + 2(comma & space) + 8(P) + 2(comma & space) + 8(depth) + 2(comma & space) + 8(salinity) + 2(comma & space) + 8(sound velocity) + 2(comma & space) + 8(density) + 2(comma & space) +11(date) + 2(comma & space) + 8(time)+ 2(carriage return & line feed) = 102
Time required to transmit data = (102 characters * 10 bits/character) / 1200 = 0.85 seconds

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

Power and Cable Length

A consideration in determining maximum cable length is supplying enough power at the power source so that sufficient voltage is available, after IR loss in the cable (***from the 0.5 Amp turn-on transient, two-way resistance***), to power the MicroCAT. Provide at least 7 volts, after IR loss.

$$V - IR \geq 7 \text{ volts}$$

where I = MicroCAT turn-on transient (0.5 Amps; see *Specifications*).

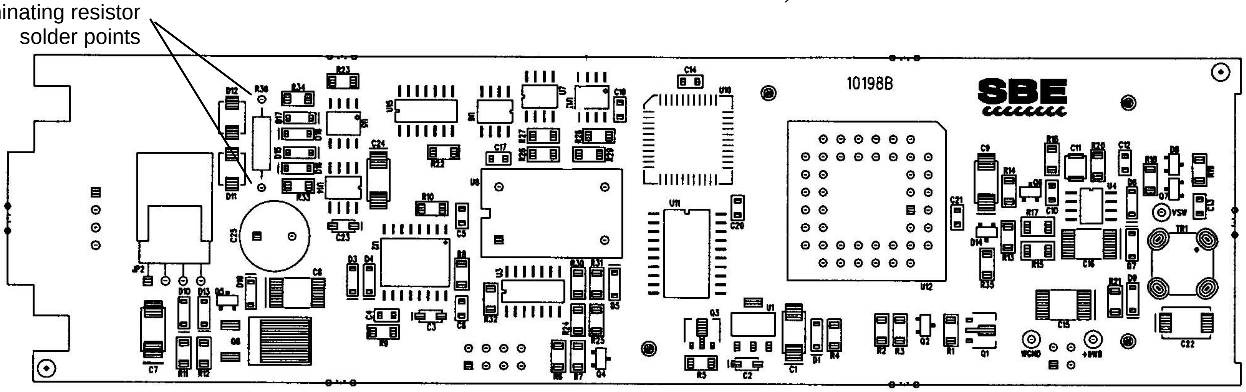
Example 1 – For 20 gauge wire, what is maximum distance to transmit power to MicroCAT if using 12 volt power source?
V - IR ≥ 7 volts   12 volts - (0.50 Amps) * (0.0107 ohms/foot * 2 * cable length) ≥ 7 volts
5 volts ≥ (0.50 Amps) * (0.0107 ohms/foot * 2 * cable length)   Cable length ≤ 467 ft = 142 meters
Using a higher voltage power supply or a different wire gauge would increase allowable cable length.

Example 2 – Same as above, but there are 4 MicroCATs powered from same power supply.
V - IR ≥ 7 volts   12 volts - (0.50 Amps * 4 MicroCATs) * (0.0107 ohms/foot * 2 * cable length) ≥ 7 volts
5 volts ≥ (0.50 Amps * 4 MicroCATs) *(0.0107 ohms/foot * 2 * cable length)
Cable length ≤ 116 ft = 35 meters (to MicroCAT furthest from power source)

Cable Termination

The MAX1483 transceivers used in the MicroCAT are designed for bi-directional data communications on multi-point bus transmission lines. To minimize reflections, terminate the line at both ends in its characteristic impedance. Also, keep stub lengths off the main line as short as possible (although the slew-rate-limited MAX1483 is more tolerant of imperfect termination than standard RS-485 ICs).

Optional RS-485 terminating resistor solder points



Timeout Description

The MicroCAT has a timeout algorithm. If the MicroCAT does not receive a command for 2 minutes, it powers down its communication circuits. This places the MicroCAT in quiescent state, drawing minimal current. **To re-establish control, click Connect on the Toolbar.** The system responds with the S> prompt.

Command Descriptions

Note:
For reliable operation, all commands ***may*** need to be preceded with two @ characters to clear the communication microcontroller receive buffers.
Example (status command for MicroCAT 01):
`S>@@#01DS`

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

When entering commands:

- Input commands to the MicroCAT in upper or lower case letters, and register commands by pressing the Enter key.
- The MicroCAT sends `? CMD` if an invalid command is entered.
- If the system does not return an S> prompt after executing a command, press the Enter key to get the S> prompt.
- If a new command is not received within 2 minutes after the completion of a command, the MicroCAT returns to the quiescent (sleep) state.
- If in quiescent state, re-establish communications by clicking Connect on the Toolbar to get an S> prompt.

MicroCAT Communication Microcontroller Commands

> **Note:**
> Global sampling commands (**AData**, **GData**, **StartSample**, and **GSample**) cause all MicroCATs to sample at the same time. Because of the large sampling turn-on transient (0.5 Amps), if you use these commands while powering more than one MicroCAT from the same power source, the power source must be able to supply 0.5 Amps for each MicroCAT simultaneously. See *Power and Cable Length* above for power calculations.

Global Commands

AData	Command **all** MicroCATs to get **average** data from acquisition units and start next averaging cycle. Communication microcontrollers send **#iiSACG** (send averaged, converted data and start new average) to acquisition microcontrollers. Averaged data is held in communication microcontroller buffers until receiving **Dataii**.
GData	Command **all** MicroCATs to get one sample. Communication microcontrollers send **#iiTS** to acquisition microcontrollers to take sample. Data is held in communication microcontroller buffers until receiving **Dataii**.
StartSample	Command **all** MicroCATs to get 1 sample. Communication microcontrollers send **#iiTS** to acquisition microcontrollers to take sample, and **leave power on**. Data is held in communication microcontroller buffers until receiving **Dataii**. Send this command once before using **GSample**.
GSample	Command **all** MicroCATs to get last sample and then take new sample. Communication microcontrollers send **#iiSL** to acquisition microcontrollers, send **#iiTS** to acquisition microcontrollers once **#iiSL** reply is received, and **leave power on**. Data from last sample is held in communication microcontroller buffers until receiving **Dataii**; data from new sample is held in acquisition microcontroller buffers.

> **Notes:**
> - Date and time are reset to 01 Jan 1980 when power is first applied. If you wish to use the built-in real-time clock, set the date and time.
> - **DDMMYY=** and **MMDDYY=** are equivalent. Either can be used to set the date.
> - **Always set date and then time.** If a new date is entered but not a new time, the new date will not be saved. If a new time is entered without first entering a new date, the date will reset to the last date it was set for with **MMDDYY=**, **DDMMYY=**, **#iiMMDDYY=**, or **#iiDDMMYY=**.

MMDDYY=mmddyy	Set real-time clock month, day, and year for **all** MicroCATs. Must be followed by **HHMMSS=** to set time.
DDMMYY=ddmmyy	Set real-time clock day, month, and year for **all** MicroCATs. Must be followed by **HHMMSS=** to set time.
HHMMSS=hhmmss	Set real-time clock hour, minute, and second for **all** MicroCATs.
PwrOff	Quit session and place **all** MicroCATs in quiescent (sleep) state. Main power is turned off.

Note:
In SEATERM, to save data to a file, click Capture on the Toolbar before getting data.

Get Data Command

Dataii — Get data obtained with **GData**, **AData**, **StartSample**, or **GSample** from MicroCAT with ID = ii.

MicroCAT ID Commands

Only one MicroCAT can be online when sending these commands.

ID? — Get MicroCAT ID (ID = ii, where ii= 0-99).

***ID=ii** — Set MicroCAT ID to ii, where ii= 0-99. ***ID=ii** must be sent twice, because the computer requests verification. **If more than one MicroCAT is online when sending this command, all MicroCATs online will be set to same ID**.

Note:
The status display indicates *SBE37-SM* because the 37-SIP uses the same communication microcontroller firmware as the 37-SM.

Miscellaneous Commands

All these commands are preceded by **!ii**, where **ii**=MicroCAT ID (0-99).

!iiDS — Display MicroCAT communication microcontroller firmware version and timeouts.

Example: (user input in bold, command used to modify parameter shown in parentheses).

```
S>!01DS
SBE37 SM-485 COMM V 1.2
rxdelay = 25 msec                                  [!iiRxDelay=]
txdelay = 25 msec                                  [!iiTxDelay=]
serial line sync mode disabled     [!iiSyncMode=N; only valid setting for RS-485 37-SIP]
```

!iiRxDelay=x — **x=** delay after MicroCAT receives a command until transmitter is enabled (1 – 500 msec). Default 25 msec.

!iiTxDelay=x — **x=** delay after MicroCAT transmits a reply until transmitter is disabled (1 – 500 msec). Default 25 msec.

!iiSyncMode=x — **x=N**: Disable serial line sync mode; only valid setting for RS-485 37-SIP.

Notes:
The MicroCAT's baud rate (set with **!iiBaud=**) must be the same as SEATERM's baud rate (set in the Configure menu).

!iiBaud=x — **x=** baud rate (1200, 2400, 4800, or 9600).

!ii*EETest — Test EEPROM. **This test erases all calibration coefficients and user-programmed parameters.**

MicroCAT Acquisition Microcontroller Commands

All Acquisition Microcontroller Commands are preceded by **#ii**, where **ii**= MicroCAT ID (0-99).

Status Command

Notes:
- The status display indicates *SBE37-SI* because the 37-SIP uses the same firmware as the 37-SI.
- If the external voltage is below 6.15 volts, the following displays in response to the status command: `WARNING: LOW BATTERY VOLTAGE!!`

Note:
The 37-SI and 37-SIP use the same firmware. The internal pump is applicable to the 37-SIP only.

#iiDS

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

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

- firmware version, serial number, date and time [**MMDDYY=** or **DDMMYY=**, and **HHMMSS=**; or **#iiMMDDYY=** or **#iiDDMMYY=**, and **#iiHHMMSS=**]
- sample interval time (not applicable to SBE 37-SIP with RS-485 interface)
- output salinity with each sample? [**#iiOutputSal=**]
- output sound velocity with each sample? [**#iiOutputSV=**]
- output density with each sample? [**#iiOutputDensity=**]
- output depth with each sample? [**#iiOutputDepth=**]
- latitude for depth calculation [**#iiLatitude=**]
- reference pressure [**#iiRefPress=**]; only displays if no pressure sensor installed
- A/D cycles to average per sample [**#iiNCycles=**]
- whether internal pump is installed (always installed in 37-SIP) [**#iiPumpInstalled=Y**]
- current temperature

Example: Display status for MicroCAT with ID=01 (user input in bold).

```
S>#01DS
SBE37-SI 485 V 2.3 SERIAL NO. 0011  07 Aug 2004  08:49:08     [#iiMMDDYY=, #iiHHMMSS=]
sample interval = 30 seconds                                  (not applicable to SBE 37-SI, RS-485)
output salinity with each sample                              [#iiOutputSal=]
output sound velocity with each sample                        [#iiOutputSV=]
output density with each sample                               [#iiOutputDensity=]
output depth with each sample                                 [#iiOutputDepth=]
latitude to use for depth calculation = 0.00 deg              [#iiLatitude=]
reference pressure = 0.0 db                                   [#iiRefPress=]
A/D cycles to average = 4                                     [#iiNCycles=]
internal pump is installed                                    [#iiPumpInstalled=Y, only valid setting for 37-SIP]
temperature = 7.54 deg C
```

Setup Commands

Notes:
- Date is reset to 01 Jan 1980 when power is first applied. If you wish to use the built-in real-time clock, set the date and time.
- **#iiDDMMYY=** and **#iiMMDDYY=** are equivalent. Either can be used to set the date.
- **Always set date and then time.** If a new date is entered but not a new time, the new date will not be saved. If a new time is entered without first entering a new date, the date will reset to the last date it was set for with **#iiMMDDYY=** or **#iiDDMMYY=**.

#iiMMDDYY=mmddyy — Set real-time clock month, day, and year. Must be followed by **#iiHHMMSS=** to set time.

#iiDDMMYY=ddmmyy — Set real-time clock day, month, and year. Must be followed by **#iiHHMMSS=** to set time.

#iiHHMMSS=hhmmss — Set real-time clock hour, minute, and second.

Example: Set current date and time for MicroCAT with ID=01 to 10 January 2005 12:00:00 (user input in bold).

S>**#01MMDDYY=011005**
S>**#01HHMMSS=120000**

or

S>**#01DDMMYY=100105**
S>**#01HHMMSS=120000**

Note:
See *Data Output Formats*.

#iiFormat=x — **x=0**: output raw hex data, for diagnostic use at Sea-Bird

x=1 (default) – output converted data: date format dd mmm yyyy, hh:mm:ss

x=2 – output converted data: date format mm-dd-yyyy, hh:mm:ss

#iiOutputSal=x — **x=Y:** Calculate and output salinity (psu) with each sample.

x=N (default)**:** Do not.

#iiOutputSV=x — **x=Y:** Calculate and output sound velocity (m/sec) with each sample, using Chen and Millero formula (UNESCO Technical Papers in Marine Science #44).

x=N (default)**:** Do not.

#iiOutputDepth=x — **x=Y:** Calculate and output depth (meters) with each sample.

x=N (default)**:** Do not.

#iiOutputDensity=x — **x=Y:** Calculate and output local density sigma (kg/m^3) with each sample, based on salinity, temperature, and pressure. Sigma (s, t, p) = density - 1000 kg/m^3

x=N (default)**:** Do not.

#iiLatitude=x — **x =** latitude (degrees) to use in depth calculation. Applicable only if **#iiOutputDepth=Y**.

Setup Commands (*continued*)

#iiRefPress=x	**x** = reference pressure (gauge) in decibars. MicroCAT without installed pressure sensor uses this reference pressure in conductivity, salinity, sound velocity, depth, and density calculations. Entry ignored if MicroCAT has pressure sensor.
#iiNCycles=x	**x=** number of A/D cycles to average (range 1 - 127; default 4). For each measurement, thermistor and (optional) pressure sensor sample **#iiNCycles** times in rapid succession, and average values are recorded; during this time conductivity measurement is also integrated and average is recorded. Increasing **#iiNCycles** increases measurement resolution and time (and power) required for measurement. Sea-Bird recommends keeping **#iiNCycles** at default of 4, providing optimum trade-off between low RMS noise and power requirements. See *Specifications* and *Sample Timing* in *Section 2: Description of MicroCAT.*
#iiPumpInstalled=x	**x=Y**: Internal pump is installed **(only valid setting for 37-SIP).** **x=N:** Not applicable to 37-SIP.

Polled Sampling Commands

Note:
The MicroCAT has a buffer that stores the most recent data sample. Data in the buffer is erased upon removal or failure of power.

These commands are used by an external controller to request a sample from the MicroCAT.

#iiTS	Run pump, take sample, and output converted data.
#iiTSR	Run pump, take sample, and output raw data.
#iiTSS	Run pump, take sample, and output converted data.
#iiSL	Output converted data from last sample.
#iiSLT	Output converted data from last sample, then run pump and take new sample.

Averaging Commands

Note:
These commands related to averaging are typically used only for customized acquisition. **AData** and **Dataii** more easily start averaging and get averaged data. See *MicroCAT Communication Microcontroller Commands* above.

These commands are used by an external controller to request a sample from the MicroCAT.

#iiGA	Start averaging data.
#iiSACG	Output averaged data, converted. Start new average.
#iiSARG	Output averaged data, raw. Start new average.
#iiSAC	Output averaged data, converted. Continue averaging.
#iiSAR	Output averaged data, raw. Continue averaging.

Testing Commands

Note:
#iiTC and **#iiTCR** report conductivity from essentially the same sample of water for all 30 measurements, because the pump does not run between measurements and water does not freely flow through the conductivity cell.

CAUTION:
Do not run the pump dry. The pump is water lubricated; running it without water will damage it. If briefly testing your system in dry conditions, orient the MicroCAT to provide an upright U-shape for the plumbing. Then fill the inside of the pump head with water via the pump exhaust tubing. This will provide enough lubrication to prevent pump damage during brief testing.

#iiTT	Measure temperature 30 times, output converted data.
#iiTC	Measure conductivity 30 times, output converted data.
#iiTP	Measure pressure 30 times, output converted data.
#iiTTR	Measure temperature 30 times, output raw data.
#iiTCR	Measure conductivity 30 times, output raw data.
#iiTPR	Measure pressure 30 times, output raw data.
#iiTR	Measure real-time clock frequency 30 times, output data.
#iiSS	Send averaged data statistics.
#iiPumpOn	Run pump for 5 seconds. **#iiPumpOn** can be used to test pump or to run it to remove sediment from inside conductivity cell.

Notes:
- Dates shown are when calibrations were performed. Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with MicroCAT.
- See individual Coefficient Commands below for definitions of the data in the example.
- The calibration display indicates *SBE37-SI* because the 37-SIP uses the same firmware as the 37-SI.

Calibration Coefficients Commands

#iiDC	Display calibration coefficients. Equivalent to Coefficients on Toolbar.

Example: Display coefficients for MicroCAT with ID=03, which does not have a pressure sensor (user input in bold).

```
S>#03DC
SBE37-SI  485 V 2.3  0011
temperature:      08-apr-96
   TA0 =  -9.420702e-05
   TA1 =  2.937924e-04
   TA2 =  -3.739471e-06
   TA3 =  1.909551e-07
conductivity:     09-apr-96
   G =  -1.036689e+00
   H =  1.444342e-01
   I =  -3.112137e-04
   J =  3.005941e-05
   CPCOR =  -9.570001e-08
   CTCOR =  3.250000e-06
   WBOTC =  1.968100e-05
rtc:          11-apr-96
   RTCA0 =  9.999782e-01
   RTCA1 =  1.749351e-06
   RTCA2 =  -3.497835e-08
```

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

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

#iiTCalDate=S	**S**=Temperature calibration date
#iiTA0=F	**F**=Temperature A0
#iiTA1=F	**F**=Temperature A1
#iiTA2=F	**F**=Temperature A2
#iiTA3=F	**F**=Temperature A3
#iiCalDate=S	**S**=Conductivity calibration date
#iiCG=F	**F**=Conductivity G
#iiCH=F	**F**=Conductivity H
#iiCI=F	**F**=Conductivity I
#iiCJ=F	**F**=Conductivity J
#iiWBOTC=F	**F**=Conductivity wbotc
#iiCTCOR=F	**F**=Conductivity ctcor
#iiCPCOR=F	**F**=Conductivity cpcor
#iiPCalDate=S	**S**=Pressure calibration date
#iiPA0=F	**F**=Pressure A0
#iiPA1=F	**F**=Pressure A1
#iiPA2=F	**F**=Pressure A2
#iiPTCA0=F	**F**=Pressure ptca0
#iiPTCA1=F	**F**=Pressure ptca1
#iiPTCA2=F	**F**=Pressure ptca2
#iiPTCB0=F	**F**=Pressure ptcb0
#iiPTCB1=F	**F**=Pressure ptcb1
#iiPTCB2=F	**F**=Pressure ptcb2
#iiPOffset=F	**F**=Pressure offset
#iiRCalDate=S	**S**=Real-time clock calibration date
#iiRTCA0=F	**F**=Real-time clock A0
#iiRTCA1=F	**F**=Real-time clock A1
#iiRTCA2=F	**F**=Real-time clock A2

Data Output Formats

Each scan ends with a carriage return <CR> and line feed <LF>. The exact format of the output varies, depending on the command sent, the user's selection for **#iiFormat**, and whether additional parameters (salinity, sound velocity, etc.) are calculated with the data.

- **#iiFormat=0**: raw hexadecimal data, intended only for diagnostic use at Sea-Bird
- **#iiFormat=1** or **2**: see below

Notes (for **#iiFormat=1** or **2**):
ii = MicroCAT ID
m = MicroCAT serial number
t = temperature (°C, ITS-90)
c = conductivity (S/m)
p = pressure (decibars); sent only if optional pressure sensor installed
d = depth (meters), sent only if **#iiOutputDepth=Y**
s = salinity (psu); data sent only if #**iiOutputSal=Y**
v = sound velocity (meters/second); sent only if **#iiOutputSV=Y**
r = density sigma (kg/m^3), data sent only if **#iiOutputDensity=Y**
dd mmm yyyy = day, month (Jan, Feb, Mar, etc.), year
mm-dd-yyyy = month, day, year
hh:mm:ss = hour, minute, second
n = number of samples in average; sent only if average data was requested

- There is a comma but no space between serial number, temperature, and conductivity. All other data is separated with a comma and space.
- Leading zeros are suppressed, except for one zero to the left of the decimal point.
- The MicroCAT'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 **decibars**, the MicroCAT outputs pressure relative to the ocean surface (i.e., at the surface the output pressure is 0 decibars). The MicroCAT uses the following equation to convert psia to decibars:
  pressure (db) =
  [pressure (psia) - 14.7] * 0.689476

Data Output after sending Dataii

- **#iiFormat=1** (default)
  ii, mmmmm,ttt.tttt,cc.ccccc, pppp.ppp, dddd.ddd, sss.ssss, vvvv.vvv, rrr.rrrr, dd mmm yyyy, hh:mm:ss, n
- **#iiFormat=2**
  ii, mmmmm,ttt.tttt,cc.ccccc, pppp.ppp, dddd.ddd, sss.ssss, vvvv.vvv, rrr.rrrr, mm-dd-yyyy, hh:mm:ss, n

Example: Sample output from **Data02** when pressure sensor not installed, **#02Format=1, #02OutputDepth=N**, **#02OutputDensity=N**, **#02OutputSal=N**, and **#02OutputSV=N**:

02, 12345, 23.7658, 0.00019, 07 Aug 2004, 16:30:43
(ID, serial number, temperature, conductivity, date, time)

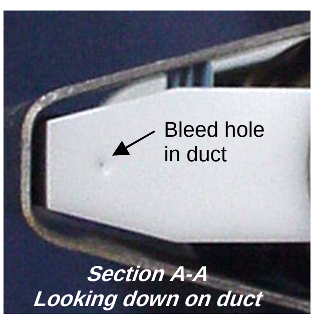
Data Output after sending Polled Sampling Command (#iiTS, #iiTSR, #iiTSS, #iiSL, #iiSLT)

- **#iiFormat=1** (default)
  mmmmm,ttt.tttt,cc.ccccc, pppp.ppp, dddd.ddd, sss.ssss, vvvv.vvv, rrr.rrrr, dd mmm yyyy, hh:mm:ss
- **#iiFormat=2**
  mmmmm,ttt.tttt,cc.ccccc, pppp.ppp, dddd.ddd, sss.ssss, vvvv.vvv, rrr.rrrr, mm-dd-yyyy, hh:mm:ss

Optimizing Data Quality / Deployment Orientation

Note:
A pump clogged with sediment results in poor flushing, causing poor quality data.

Shown with conductivity cell guard removed



Background Information

Sea-Bird's general recommendation is to deploy the MicroCAT with the plumbing in an **inverted** U-shape, to reduce the ingestion of sediment. A small bleed hole in the duct provides a way for air to exit the plumbing, so that the pump will prime and operate. In considering the effect of air on the pump, it can be instructive to look at the amount of air in the water column:

- **Case 1**: The top ~2 meters of the water column may contain a continuous supply of bubbles injected into the system by breaking waves. In this area, the ability to continuously eliminate air from the system, throughout the deployment, is of prime concern.
- **Case 2:** The next ~30 meters of the water column is not typically affected by bubbles from breaking waves. *Without a bleed hole*, it could take a few days to weeks after deployment for the air to clear out of the system in an inverted U-shape. However, once the air was bled, no more air would be injected into the plumbing.
- **Case 3:** Below ~30 meters, *without a bleed hole*, it could take only a few hours to a day for the air to clear out of the system in an inverted U-shape. As in Case 2, once the air was bled, no more air would be injected into the plumbing.

Note that the bleed hole, while providing a way for air to exit the plumbing, also provides a little more ventilation of the system; this ventilation will cause a slight decrease in the concentration of anti-foulant in the water held in the plumbing between samples. In our judgment, and the experience of customers, the risk of poor data due to sediment accumulation is usually greater than the risk of slightly reduced effectiveness of the anti-foulant, or is at least a reasonable trade-off.

Deployment Recommendations

- **Most deployments** – Deploy the MicroCAT with the plumbing in an **inverted** U-shape (as shown in the photos), allowing air to exit the plumbing through the bleed hole.
- **Deployments where severe bio-fouling is the main concern and sediment is not an issue** –

  Case A: You need accurate data immediately upon deployment - Plug the bleed hole. Deploy the MicroCAT with the plumbing in an **upright** U-shape, providing maximum bio-foul protection but leaving the MicroCAT vulnerable to ingestion of sediment.

  Case B: You can skip some initial data, allowing time for trapped air to dissolve into the water and the pump to prime properly – **Plug the bleed hole**. Deploy the MicroCAT with the plumbing in an **inverted** U-shape, providing maximum bio-foul protection as well as protection from the ingestion of sediment. This deployment method will provide good data within a day if the deployment is deeper than ~30 meters. Eliminate scans associated with the initial deployment by evaluating the conductivity data; minimal changes in conductivity are an indication that the pump flow is not correct because air in the plumbing has prevented the pump from priming.
- **Deployments where air bubbles are the main concern and sediment is not an issue** - **Plug the bleed hole**. Deploy the MicroCAT with the plumbing in an **upright** U-shape. This orientation provides better bleeding of air from the plumbing than can be achieved with the small bleed hole, but leaves the MicroCAT vulnerable to ingestion of sediment.

Setup for Deployment

Notes:
- Date and time are reset to 01 Jan 1980 when power is applied. If you wish to use the built-in real-time clock, set the date and time.
- **Always set date and then time.** If a new date is entered but not a new time, the new date will not be saved. If a new time is entered without first entering a new date, the date will reset to the last date it was set for with **MMDDYY=**, **DDMMYY=**, **#iiMMDDYY=**, or **#iiDDMMYY=**.

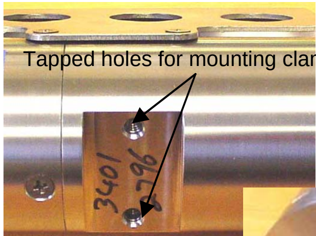
Program the MicroCAT for the intended deployment (see *Section 3: Preparing MicroCAT for Deployment* for connection information; see information in this section on commands):

1. Set the date and time. Note that the date and time can be set globally for all MicroCATs online (**MMDDYY=** or **DDMMYY=** to set date; **HHMMSS=** to set time), or individually for each MicroCAT (**#iiMMDDYY=** or **#iiDDMMYY=** to set date; **#iiHHMMSS=** to set time).

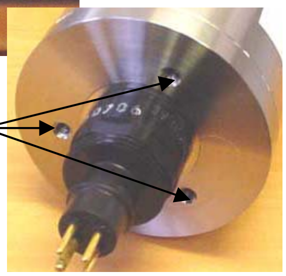
2. Establish the setup parameters.

3. If the system will have multiple MicroCATs online, verify the MicroCAT is set to *Prompt ID* to allow use of the Toolbar buttons and Menus:
   A. In the Configure menu, select SBE 37.
   B. Click on the COM Settings tab.
   C. For Modem/RS485 ID, click on *Prompt ID*.
   D. Click OK.

Deployment



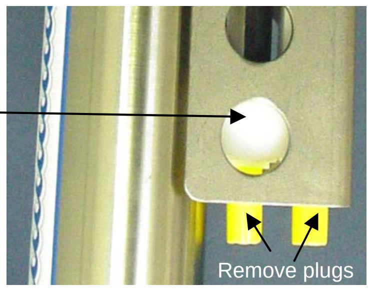
Tapped holes for mounting guide



The MicroCAT can be mounted with customer-supplied hardware or can be ordered with pre-installed Sea-Bird mounting brackets.

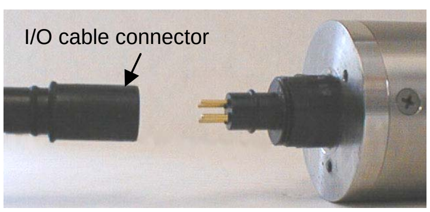
1. Install customer-supplied mounting equipment (if Sea-Bird mounting clamp and guide or brackets are not pre-installed):
   A. Install a mounting bracket that attaches to the tapped holes in the MicroCAT. Use titanium hardware to attach the mounting bracket to the MicroCAT, and place non-metallic material between the titanium housing and any dissimilar metal in the bracket. **Do not drill any holes in the MicroCAT**.
   B. Ensure the mounting scheme does not transfer mooring through-tension to the end cap, which could pull off the end cap.

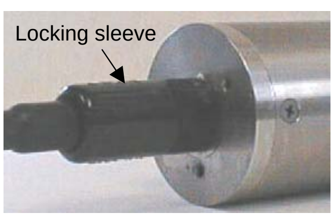
Anti-foulant device cup



2. New MicroCATs are shipped with AF24173 Anti-Foulant Devices and protective plugs pre-installed
   A. Remove the protective plugs, if installed, from the anti-foulant device cup. **The protective plugs must be removed prior to deployment or pressurization.** If the plugs are left in place during deployment, the sensor will not register conductivity. If left in place during pressurization, the cell may be destroyed.
   B. Verify that the anti-foulant device cup contains AF24173 Anti-Foulant Devices (see *Section 5: Routine Maintenance and Calibration*).

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





3. Install the I/O cable on the MicroCAT:
   A. Lightly lubricate the inside of the cable connector with silicone grease (DC-4 or equivalent).
   B. **Standard Connector** (shown in photos) - Install the cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the MicroCAT. 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 connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

For most applications, deploy in orientation shown (connector at bottom)

Optional Sea-Bird mounting clamp and guide – loosen hardware to separate clamp/guide halves and mount on mooring cable

4. Attach the mounting equipment to the mooring cable or support. See *Optimizing Data Quality / Deployment Orientation* for deployment recommendations.

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

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

7. Click Capture on SEATERM's Toolbar before you begin sampling. The data displayed in SEATERM will be saved to the designated .cap file. Process the data as desired. Note that the .cap file **cannot be processed by Sea-Bird software, as it does not have the required headers and format.**

Recovery

> ***WARNING!***
> **If the MicroCAT stops working while underwater, is unresponsive to commands, or shows other signs of flooding or damage, carefully secure it away from people until you have determined that abnormal internal pressure does not exist or has been relieved.** Pressure housings may flood under pressure due to dirty or damaged o-rings, or other failed seals. When a sealed pressure housing floods at great depths and is subsequently raised to the surface, water may be trapped at the pressure at which it entered the housing, presenting a danger if the housing is opened before relieving the internal pressure. Instances of such flooding are rare. However, a housing that floods at 5000 meters depth holds an internal pressure of more than 7000 psia, and has the potential to eject the end cap with lethal force.
> A housing that floods at 50 meters holds an internal pressure of more then 85 psia; this force could still cause injury.
> If you suspect the MicroCAT is flooded, point it in a safe direction away from people, and loosen the bulkhead connector very slowly, at least 1 turn. This opens an o-ring seal under the connector. Look for signs of internal pressure (hissing or water leak). If internal pressure is detected, let it bleed off slowly past the connector o-ring. Then, you can safely remove the end cap.

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

2. Reinsert the protective plugs in the anti-foulant device cup.

Section 5: Routine Maintenance and Calibration

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

Corrosion Precautions

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

All exposed metal is titanium; other materials are plastic. No corrosion precautions are required, but avoid direct electrical connection of the MicroCAT housing to mooring or other dissimilar metal hardware.

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 cable connector with silicone grease (DC-4 or equivalent).

2. **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 MicroCAT. 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.

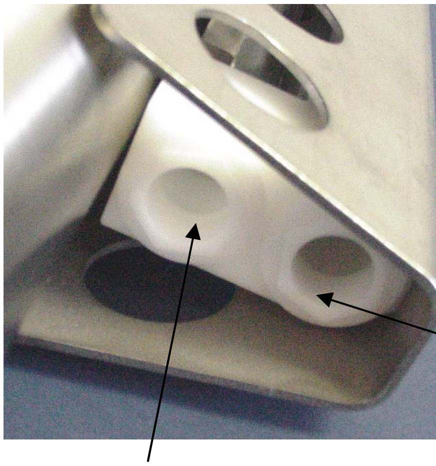
3. Place the locking sleeve over the cable connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

Verify that a cable is installed on the MicroCAT before deployment.

Conductivity Cell Maintenance

CAUTIONS:

- **Do not put a brush or any object inside the conductivity cell to 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 MicroCAT with water in the conductivity cell.** Freezing temperatures (for example, in Arctic environments or during air shipment) can break the conductivity cell if it is full of water.



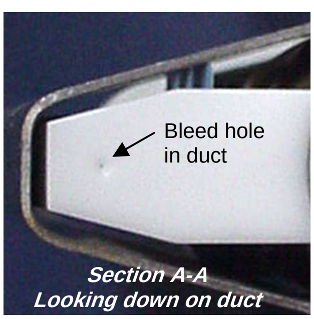
The MicroCAT's conductivity cell is shipped dry to prevent freezing in shipping. **Refer to *Application Note 2D: Instructions for Care and Cleaning of Conductivity Cells* for conductivity cell cleaning procedures and cleaning materials.**

- The Active Use (after each cast) section of the application note is not applicable to the MicroCAT, which is intended for use as a moored instrument.

To rinse or fill the conductivity cell and pump exhaust plumbing:

- Place Tygon tubing in the end of the anti-foulant device cap on the conductivity cell.
- Hold or clamp the MicroCAT with the intake and exhaust up, so that the plumbing is in a U-shape.
- Pour the water or solution through the Tygon, conductivity cell, and pump exhaust plumbing with a syringe or wash bottle.

Plumbing Maintenance



Before each deployment, clean the bleed hole with 0.4 mm diameter wire, 13 mm long (0.016 inch diameter wire, 0.5 inches long) (you can use #26 AWG wire), and blow through it to ensure it is open. A clogged bleed hole can trap air, preventing the pump from functioning properly; this will affect the data quality.

Handling Instructions for Plastic *ShallowCAT* Option

The MicroCAT's standard 7000-meter titanium housing offers the best durability with a modest amount of care. The *ShallowCAT* option, substitution of a 250-meter plastic housing, saves money and weight. However, more care and caution in handling is required. To get the same excellent performance and longevity for the plastic-housing version, and if you need to access the electronics and/or remove the screws securing the conductivity cell guard to the housing (not typically done by the customer), observe the following precautions:

- The MicroCAT's end caps are retained by screws through the side of the housing. The screw holes are close to the end of the housing. Particularly in a cold environment, where plastic is more brittle, the potential for developing a crack around the screw hole(s) is greater for the plastic housing than for the titanium housing.
  Observe the following precautions –

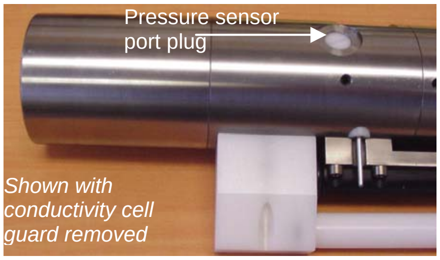
  - When removing end caps (to access the electronics), be careful to avoid any impact in this area of the housing.
  - When reinstalling end caps, do not use excess torque on the screws. Sea-Bird recommends tightening the screws to 15 inch-lbs. Alternatively, tighten the screws finger-tight, and then turn each screw an additional 45 degrees.

- A plastic housing is more susceptible to scratches than a titanium housing. Do not use screwdrivers or other metal tools to pry off the end caps.

  - Of primary concern are scratches on O-ring mating and sealing surfaces. Take extra precaution to avoid a scraping contact with these surfaces when re-seating the end cap.
  - Also take care to keep the O-ring lubricated surfaces clean – avoid trapping any sand or fine grit that can scratch the critical sealing surfaces. If the O-ring lubricant does accumulate any material or grit that can cause a leak or make a scratch, it must be carefully cleaned and replaced with fresh, clean lubricant (Parker Super O Lube).
  - Shallow, external scratches are cosmetic only, and will not affect the performance of the MicroCAT. However, deep external scratches can become points of weakness for deep deployments or fracture from impact during very cold weather.

See *Appendix II: Electronics Disassembly / Reassembly* for detailed step-by-step procedures for removing the MicroCAT's end caps.

Pressure Sensor (optional) Maintenance



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

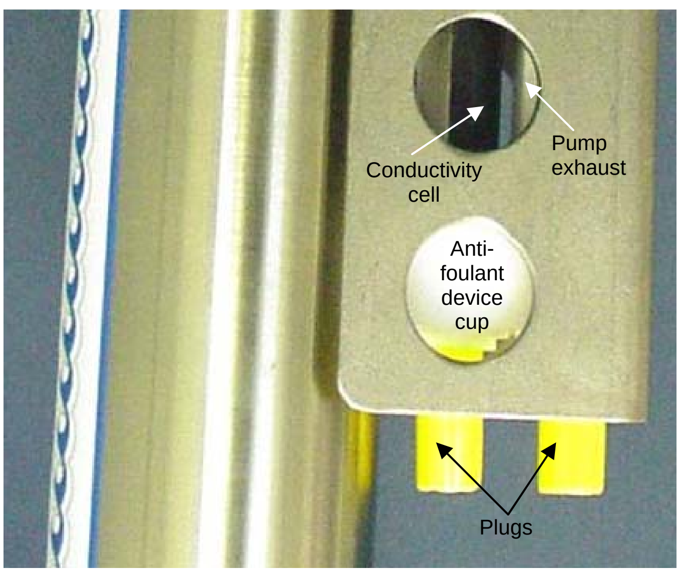
The pressure port plug has a small vent hole to allow hydrostatic pressure to be transmitted to the pressure sensor inside the instrument, while providing protection for the pressure sensor, keeping most particles and debris out of the pressure port.

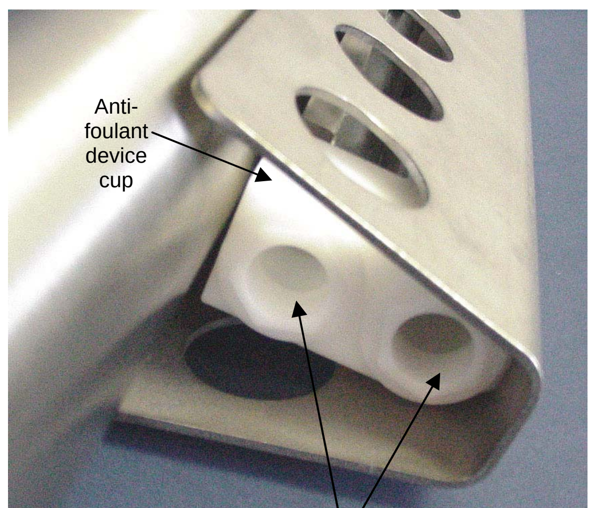
Periodically (approximately once a year) inspect the pressure port to remove any particles, debris, etc:

1. Unscrew the pressure port plug from the pressure port.
2. Rinse the pressure port with warm, de-ionized water to remove any particles, debris, etc.
3. Replace the pressure port plug.

Replacing Anti-Foulant Devices – Mechanical Design Change

The AF24173 Anti-Foulant Devices are installed in an anti-foulant device cup that attaches to the conductivity cell intake and the pump exhaust. Details are provided below on replacing the AF24173 Anti-Foulant Devices. This page provides the mechanical details for the SBE 37-SIP MicroCAT. The following page, which was developed for a MicroCAT that does not include an integral pump, provides the precautions and handling details.





Anti-foulant device caps
(plugs removed)

CAUTION:
The anti-foulant device cup is attached to the guard and connected with tubing to the cell. **Removing the guard without disconnecting the cup from the guard will break the cell.** If the guard must be removed:
1. Remove the two screws connecting the anti-foulant device cup to the guard.
2. Remove the four Phillips-head screws connecting the guard to the housing and sensor end cap.
3. Gently lift the guard away.

Replacing Anti-Foulant Devices (SBE 37-SI, SM, IM)

AF24173
Anti-Foulant
Device

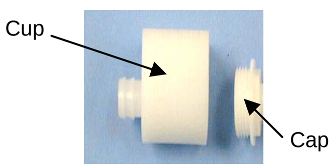
The MicroCAT has an anti-foulant device cup and cap on each end of the cell. New MicroCATs are shipped with an Anti-Foulant Device and a protective plug pre-installed in each cup.

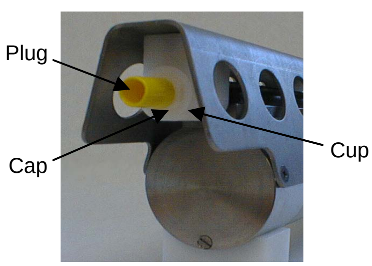
> ***WARNING!***
>
> **AF24173 Anti-Foulant Devices contain bis(tributyltin) oxide. Handle the devices only with rubber or latex gloves. Wear eye protection. Wash with soap and water after handling.**
>
> **Read precautionary information on product label (see Appendix IV) before proceeding.**
>
> **It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

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

1. Remove the protective plug from the anti-foulant device cup;
2. Unscrew the cap with a 5/8-inch 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;
   - If necessary, remove the guard to provide easier access.

   Place the new Anti-Foulant Device in the cup;
4. Rethread the cap onto the cup. Do not over tighten;
5. If the MicroCAT is to be stored, reinstall the protective plug. **Note that the plugs must be removed prior to deployment or pressurization.** If the plugs are left in place during deployment, the cell will not register conductivity. If left in place during pressurization, the cell may be destroyed.





> **CAUTION:**
> Anti-foulant device cups are attached to the guard and connected with tubing to the cell**. Removing the guard without disconnecting the cups from the guard will break the cell.** If the guard must be removed:
>
> 1. Remove the two screws connecting each anti-foulant device cup to the guard.
> 2. Remove the four Phillips-head screws connecting the guard to the housing and sensor end cap.
> 3. Gently lift the guard away.

Sensor Calibration

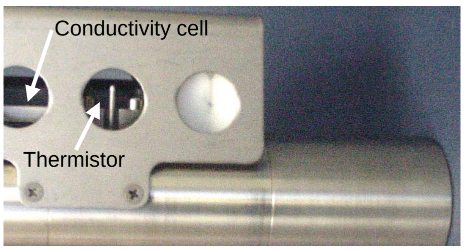
Note:
Please remove AF24173 Anti-Foulant Devices from the anti-foulant device cup before returning the MicroCAT to Sea-Bird. Store them for future use. See *Replacing Anti-Foulant Devices* for removal procedure.

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 optional pressure sensors on the MicroCAT are supplied fully calibrated, with coefficients printed on their respective Calibration Certificates (see back of manual). These coefficients have been stored in the MicroCAT's EEPROM.

We recommend that MicroCATs 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 sensors be calibrated before and after deployment, but particularly when the cell has been exposed to contamination by oil slicks or biological material.

Temperature Sensor Calibration

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

Pressure Sensor (optional) Calibration

The optional strain-gauge pressure sensor is a mechanical diaphragm type, with an initial static error band of 0.05%. Consequently, the sensor is capable of meeting MicroCAT's 0.10% error specification with some allowance for aging and ambient-temperature induced drift.

Pressure sensors show most of their error as a linear offset from zero. A technique is provided below for making small corrections to the pressure sensor calibration using the *offset* (**#iiPOffset=**) calibration coefficient term by comparing MicroCAT pressure output to readings from a barometer.

Note:
The MicroCAT's pressure sensor is an absolute sensor, so its **raw** output (**#iiFormat=0**) 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 MicroCAT outputs pressure relative to the ocean surface (i.e., at the surface the output pressure is 0 decibars). The MicroCAT uses the following equation to convert psia to decibars:
Pressure (db) =
[pressure (psia) - 14.7] * 0.689476

Allow the MicroCAT to equilibrate in a reasonably constant temperature environment for at least 5 hours before starting. Pressure sensors exhibit a transient change in their output in response to changes in their environmental temperature. Sea-Bird instruments are constructed to minimize this by thermally decoupling the sensor from the body of the instrument. However, there is still some residual effect; allowing the MicroCAT to equilibrate before starting will provide the most accurate calibration correction.

1. Place the MicroCAT in the orientation it will have when deployed.

2. In SEATERM:
   A. Set the pressure offset to 0.0 (**#iiPOffset=0**).
   B. Send **#iiTP** to measure the MicroCAT pressure 30 times and transmit converted data (decibars).

3. Compare the MicroCAT output to the reading from a good barometer at the same elevation as the MicroCAT's pressure sensor.
   Calculate *offset* = barometer reading – MicroCAT reading

4. Enter the calculated offset (positive or negative) in the MicroCAT's EEPROM, using **#iiPOffset=** in SEATERM.

Offset Correction Example
Absolute pressure measured by a barometer is 1010.50 mbar. Pressure displayed from MicroCAT is -2.5 dbars.
Convert barometer reading to dbars using the relationship: mbar * 0.01 = dbar
Barometer reading = 1010.50 mbar * 0.01 = 10.1050 dbar
The MicroCAT's internal calculations output gage pressure, using an assumed value of 14.7 psi for atmospheric pressure. Convert MicroCAT reading from gage to absolute by adding 14.7 psia to the MicroCAT's output:
-2.5 dbars + (14.7 psi * 0.689476 dbar/psia) = -2.5 + 10.13 = 7.635 dbars
Offset = 10.1050 – 7.635 = + 2.47 dbars
Enter offset in MicroCAT.

For demanding applications, or where the sensor's air ambient pressure response has changed significantly, calibration using a dead-weight generator is recommended. The pressure sensor port uses a 7/16-20 straight thread for 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 MicroCAT, and provides the most common causes and solutions.

Problem 1: Unable to Communicate with MicroCAT

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

Cause/Solution 1: The I/O cable connection may be loose. Check the cabling between the MicroCAT 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 the *SBE 37* 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 between the MicroCAT and computer may not be the correct one.

Problem 2: Unreasonable T, C, or P 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 (i.e., out of the expected range) values for temperature, conductivity, or pressure may be caused by incorrect calibration coefficients in the MicroCAT. Send **#iiDC** to verify the calibration coefficients in the MicroCAT match the instrument Calibration Certificates.

Cause/Solution 2: Minimal changes in **conductivity** are an indication that the pump flow is not correct. Poor flushing can have several causes:

- Air in the plumbing may be preventing the pump from priming. This can result from:
  - A clogged air bleed hole; clean the air bleed hole (see *Plumbing Maintenance* in *Section 5: Routine Maintenance and Calibration*).
  - Incorrect orientation for a shallow deployment in a location with breaking waves; see *Optimizing Data Quality / Deployment Orientation* in *Section 4: Deploying and Operating MicroCAT*.
- The pump may be clogged by sediment. Using a wash bottle, flush the plumbing to attempt to dislodge the sediment. If the sediment is impacted and you cannot flush it, return the MicroCAT to Sea-Bird for servicing. To minimize ingestion of sediment for future deployments, see *Optimizing Data Quality / Deployment Orientation* in *Section 4: Deploying and Operating MicroCAT*.

Problem 3: Salinity Spikes

Salinity is a function of conductivity, temperature, and pressure, and must be calculated from C, T, and P measurements made on the same parcel of water. Salinity is calculated and output by the 37-SIP if **#iiOutputSal=Y**.

[*Background information*: Salinity spikes in **profiling** (i.e., moving, fast sampling) instruments typically result from misalignment of the temperature and conductivity measurements in conditions with sharp gradients. This misalignment is often caused by differences in response times for the temperature and conductivity sensors, and can be corrected for in post-processing if the T and C response times are known.]

In **moored,** pumped instruments such as the 37-SIP MicroCAT, the pump flushes the conductivity cell at a faster rate than the environment changes, so the T and C measurements stay closely synchronized with the environment (i.e., even slow or varying response times are not significant factors in the salinity calculation). More typical causes of salinity spikes in a moored 37-SIP include:

Cause/Solution 1: Severe external bio-fouling can restrict flow through the conductivity cell to such an extent that the conductivity measurement is significantly delayed from the temperature measurement.

Cause/Solution 2: For a MicroCAT moored at shallow depth, differential solar heating can cause the actual temperature inside the conductivity cell to differ from the temperature measured by the thermistor. Salinity spikes associated mainly with daytime measurements during sunny conditions may be caused by this phenomenon.

Cause/Solution 3: For a MicroCAT moored at shallow depth, air bubbles from breaking waves or spontaneous formation in supersaturated conditions can cause the conductivity cell to read low of correct.

Glossary

Fouling - Biological growth in the conductivity cell during deployment.

MicroCAT – High-accuracy conductivity, temperature, and optional pressure Recorder/Monitor. A number of models are available:

- SBE 37-IM (**I**nductive **M**odem, internal battery and memory)
- SBE 37-IMP (**I**nductive **M**odem, internal battery and memory, integral **P**ump)
- SBE 37-SM (**S**erial interface, internal battery and **M**emory)
- SBE 37-SMP (**S**erial interface, internal battery and **M**emory, integral **P**ump)
- SBE 37-SI (**S**erial **I**nterface only, no internal battery or memory)
- SBE 37-SIP (**S**erial **I**nterface only, no internal battery or memory, integral **P**ump)

The -SM, -SMP, -SI, and -SIP are available with RS-232 (standard) or RS-485 (optional) interface.

PCB – Printed Circuit Board.

Scan - One data sample containing temperature, conductivity, optional pressure, and date and time, as well as optional derived variables (depth, salinity, sound velocity, and density).

SEASOFT-Win32– Sea-Bird’s complete Win 2000/XP software package, which includes software for communication, real-time data acquisition, and data analysis and display. SEASOFT-Win32 includes ***SEATERM***.

SEATERM - Sea-Bird’s Win 95/98/NT/2000/XP software used to communicate with the MicroCAT.

Super O-Lube – Silicone lubricant used to lubricate O-rings and O-ring mating surfaces. Super O-Lube can be ordered from Sea-Bird, but should also be available locally from distributors. Super O-Lube is manufactured by Parker Hannifin; see http://www.parker.com/ead/cm2.asp?cmid=3956 for details.

TCXO - Temperature Compensated Crystal Oscillator.

Triton X100 - Reagent grade non-ionic surfactant (detergent), used for cleaning the conductivity cell. Triton can be ordered from Sea-Bird, but should also be available locally from chemical supply or laboratory products companies. Triton is manufactured by Mallinckrodt Baker (see http://www.mallbaker.com/changecountry.asp?back=/Default.asp for local distributors).

Appendix I: Functional Description

Sensors

The MicroCAT 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 Sea-Bird's SEACAT family.

Note:
Pressure ranges are expressed in meters of deployment depth capability.

The MicroCAT's optional pressure sensor, developed by Druck, Inc., has a superior new design that is entirely different from conventional 'silicon' types in which the deflection of a metallic diaphragm is detected by epoxy-bonded silicon strain gauges. The Druck sensor employs a micro-machined silicon diaphragm into which the strain elements are implanted using semiconductor fabrication techniques. Unlike metal diaphragms, silicon's crystal structure is perfectly elastic, so the sensor is essentially free of pressure hysteresis. Compensation of the temperature influence on pressure offset and scale is performed by the MicroCAT's CPU. The pressure sensor is available in the following pressure ranges: 20, 100, 350, 600, 1000, 2000, 3500, and 7000 meters.

Sensor Interface

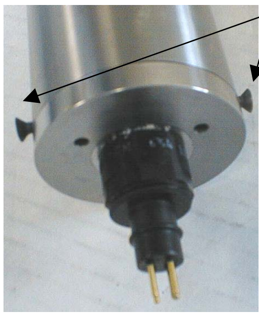
Temperature is acquired by applying an AC excitation to a hermetically sealed VISHAY reference resistor and an ultra-stable aged thermistor with a drift rate of less than 0.002°C per year. A 24-bit A/D converter digitizes the outputs of the reference resistor and thermistor (and optional pressure sensor).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

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

Appendix II: Electronics Disassembly/Reassembly

Disassembly

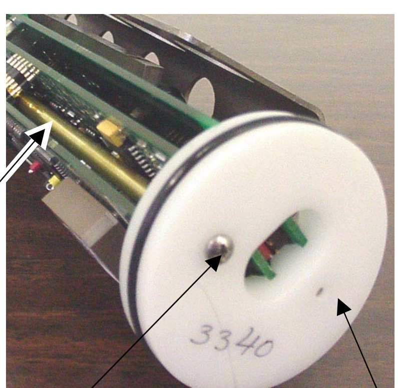
CAUTION:
See *Section 5: Routine Maintenance and Calibration* for handling instructions for the plastic *ShallowCAT* housing.



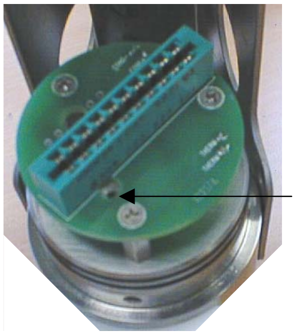
1. Remove the I/O connector end cap and disconnect the electronics from the end cap:
   A. Wipe the outside of the I/O connector end cap and housing dry, being careful to remove any water at the seam between them.
   B. Remove the two flat Phillips-head titanium machine screws. Do not remove any other screws from the housing.
   C. Remove the I/O connector end cap by pulling on it firmly and steadily. It may be necessary to rock or twist the end cap back and forth or use a non-marring tool on the edge of the cap to loosen it.
   D. The end cap is electrically connected to the electronics with a 4-pin Molex connector. Holding the wire cluster near the connector, pull gently to detach the female end of the connector from the pins.
   E. Remove any water from the O-ring mating surfaces inside the housing with a lint-free cloth or tissue.
   F. Put the end cap aside, being careful to protect the O-rings from damage or contamination.

2. Remove the housing from the electronics:
   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 two flat Phillips-head titanium machine screws connecting the guard to the housing and sensor end cap. Do not remove any other screws from the guard.
   C. Remove the flat Phillips-head titanium machine screw connecting the housing to the sensor end cap.
   D. Remove the housing by pulling it out firmly and steadily. It may be necessary to twist or rock the housing back and forth to loosen it.

3. The electronics are on a sandwich of three rectangular PCBs. These PCBs are assembled to a bulkhead. To remove the PCB assembly:
   A. Remove the Phillips-head screw on the bulkhead that fits inside the small diameter brass sleeve. The Phillips-head screw is a 198 mm (7.8 inch) threaded rod with Phillips-head.
   B. Pull out the PCB assembly by carefully grasping the bulkhead and pulling. The assembly will pull away from the 10-position edge connector used to connect to the cells.



Reassembly



Align brass sleeve with hole

Note:
If the rod will not tighten, the PCBs have not fully mated or are mated in reverse.

1. Reinstall the electronics:
   A. Align the brass sleeve with the hole for the Phillips-head screw, and push the PCB assembly into the 10-position edge connector.
   B. Drop the Phillips-head screw into the hole and tighten gently.

2. Reinstall the housing on the sensor end cap:
   A. Remove any water from the sensor end cap's 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 as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to the O-rings and mating surfaces.
   B. Carefully fit the housing onto the sensor end cap until the O-rings have fully seated.
   C. Reinstall the three flat Phillips-head screws that connect the housing to the sensor end cap and the guard.

3. Reinstall the I/O connector end cap on the housing:
   A. Remove any water from the I/O connector end cap's 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 as necessary. Apply a light coat of O-ring lubricant (Parker Super O Lube) to the O-rings and mating surfaces.
   B. Carefully fit the end cap into the housing until the O-rings have fully seated.
   C. Reinstall the two flat Phillips-head screws that connect the end cap to the housing.

Note:
Before delivery, a desiccant package is inserted 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 electronics chamber. 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.

Appendix III: Command Summary

Note:
See *Command Descriptions* in *Section 4: Deploying and Operating MicroCAT* for detailed information and examples.

FUNCTION	CATEGORY	COMMAND	DESCRIPTION
Communication Microcontroller Commands	**Global Commands**	**AData**	Command **all** MicroCATs to get **average** data from acquisition units and start next averaging cycle. Communication microcontrollers hold averaged data in buffer until receiving **Dataii**.
		GData	Command **all** MicroCATs to get 1 sample. Communication microcontrollers send command to acquisition microcontrollers to take sample. Communication microcontrollers hold data in buffer until receiving **Dataii**.
		StartSample	Command **all** MicroCATs to get 1 sample. Communication microcontrollers send command to acquisition microcontrollers to take sample and **leave power on**. Communication microcontrollers hold data in buffer until receiving **Dataii**. Send command once before using **GSample**.
		GSample	Command **all** MicroCATs to get last sample and then take new sample. Communication microcontrollers send command to acquisition microcontrollers to send last sample and then take new sample, **and leave power on**. Communication microcontrollers hold last sample data in buffer until receiving **Dataii**.
		MMDDYY=mmddyy	Set clock month, day, and year. Follow with **HHMMSS=** or it will not set date.
		DDMMYY=ddmmyy	Set clock day, month, and year. Follow with **HHMMSS=** or it will not set date.
		HHMMSS=hhmmss	Set clock hour, minute, and second.
		PwrOff	Enter quiescent (sleep) state. Main power turned off.
	Get Data Command	**Dataii**	Get data obtained with **GData**, **AData**, **StartSample**, or **GSample** from MicroCAT with ID=ii.
	MicroCAT ID Commands	**ID?**	Get MicroCAT ID (ID = ii, where ii= 0-99).
		***ID=ii**	Set MicroCAT ID to ii, where ii= 0-99. Must be sent twice, because computer responds by requesting verification.
	Miscellaneous Commands (**ii** = MicroCAT ID)	**!iiDS**	Display communication microcontroller firmware version for MicroCAT with ID=ii.
		!iiRxDelay=x	**x=** delay after MicroCAT receives command until transmitter is enabled (1 – 500 msec). Default 25 msec.
		!iiTxDelay=x	**x=** delay after MicroCAT transmits reply until transmitter is disabled (1 – 500 msec). Default 25 msec
		!iiSyncMode=x	**x=N**: Disable serial line sync mode; only valid setting for RS-485 37-SIP.
		!iiBaud=x	**x=** baud rate (1200, 2400, 4800, or 9600).
		!ii*EETest	Test EEPROM. **Erases all calibration coefficients and user-programmed parameters.**

FUNCTION	CATEGORY	COMMAND	DESCRIPTION
Acquisition Microcontroller Commands (**ii** = MicroCAT ID)	**Status**	**#iiDS**	Display status.
	Setup	**#iiMMDDYY= mmddyy**	Set clock month, day, year. Follow with **#iiHHMMSS=** or it will not set date.
		#iiDDMMYY= ddmmyy	Set clock day, month, year. Follow with **#iiHHMMSS=** or it will not set date.
		#iiHHMMSS= hhmmss	Set clock hour, minute, second.
		#iiFormat=x	**X=0**: Output raw hex data, for diagnostic use at Sea-Bird **x=1**: Output converted data, date dd mmm yyyy **x=2**: Output converted data, date mm-dd-yyyy
		#iiOutputSal=x	**x=Y:** Calculate and output salinity (psu). **x=N:** Do not.
		#iiOutputSV=x	**x=Y:** Calculate and output sound velocity (m/sec). **x=N:** Do not.
		#iiOutputDepth =x	**x=Y:** Calculate and output depth (meters). **x=N:** Do not.
		#iiOutputDensity =x	**x=Y:** Calculate and output density sigma (kg/m^3). **x=N:** Do not.
		#iiLatitude=x	**x**= latitude (degrees) to use in depth calculation.
		#iiRefPress=x	**x**= reference pressure (gauge) in decibars (used for conductivity, salinity, and sound velocity calculation when MicroCAT does not have pressure sensor).
		#iiNCycles=x	**x**= number of A/D cycles to average (1-127). Default 4.
		#iiPumpInstalled=x	**x=Y**: Internal pump is installed **(only valid setting for 37-SIP)**.
	Polled Sampling	**#iiTS**	Take sample, output converted data.
		#iiTSR	Take sample, output raw data.
		#iiTSS	Take sample, output converted data.
		#iiSL	Output converted data from last sample.
		#iiSLT	Output converted data from last sample, then take new sample.
	Averaging	**#iiGA**	Start averaging data.
		#iiSACG	Output averaged data, converted. Start new average.
		#iiSARG	Output averaged data, raw. Start new average.
		#iiSAC	Output averaged data, converted. Continue averaging.
		#iiSAR	Output averaged data, raw. Continue averaging.

FUNCTION	CATEGORY	COMMAND	DESCRIPTION
Continued … **Acquisition Microcontroller Commands** (**ii** = MicroCAT ID)	**Testing**	**#iiTT**	Measure temperature 30 times, output converted data.
		#iiTC	Measure conductivity 30 times, output converted data.
		#iiTP	Measure pressure 30 times, output converted data.
		#iiTTR	Measure temperature 30 times, output raw data
		#iiTCR	Measure conductivity 30 times, output raw data.
		#iiTPR	Measure pressure 30 times, output raw data.
		#iiTR	Measure real-time clock frequency 30 times, output data.
		#iiSS	Output averaged data statistics.
		#iiPumpOn	Run pump for 5 seconds.
	Calibration 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 MicroCATs	**#iiDC**	Display calibration coefficients; all coefficients and dates listed below are included. Use individual commands to modify a particular coefficient or date.
		#iiTCalDate=S	**S**=Temperature calibration date.
		#iiTA0=F	**F**=Temperature A0.
		#iiTA1=F	**F**=Temperature A1.
		#iiTA2=F	**F**=Temperature A2.
		#iiTA3=F	**F**=Temperature A3.
		#iiCCalDate=S	**S**=Conductivity calibration date.
		#iiCG=F	**F**=Conductivity G.
		#iiCH=F	**F**=Conductivity H.
		#iiCI=F	**F**=Conductivity I.
		#iiCJ=F	**F**=Conductivity J.
		#iiWBOTC=F	**F**=Conductivity wbotc.
		#iiCTCOR=F	**F**=Conductivity ctcor.
		#iiCPCOR=F	**F**=Conductivity cpcor.
		#iiPCalDate=S	**S**=Pressure calibration date.
		#iiPA0=F	**F**=Pressure A0.
		#iiPA1=F	**F**=Pressure A1.
		#iiPA2=F	**F**=Pressure A2.
		#iiPTCA0=F	**F**=Pressure ptca0.
		#iiPTCA1=F	**F**=Pressure ptca1.
		#iiPTCA2=F	**F**=Pressure ptca2.
		#iiPTCB0=F	**F**=Pressure ptcb0.
		#iiPTCB1=F	**F**=Pressure ptcb1.
		#iiPTCB2=F	**F**=Pressure ptcb2.
		#iiPOffset=F	**F**=Pressure offset.
		#iiRCalDate=S	**S**=Real-time clock calibration date.
		#iiRTCA0=F	**F**=Real-time clock A0.
		#iiRTCA1=F	**F**=Real-time clock A1.
		#iiRTCA2=F	**F**=Real-time clock A2.

Appendix IV: AF24173 Anti-Foulant Device

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

AF24173 ANTI-FOULANT DEVICE

FOR USE ONLY 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 anti-foulant devices

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

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

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

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 01-31-05

Appendix V: Replacement Parts

Part Number	Part	Application Description	Quantity in MicroCAT
801542	AF24173 Anti-Foulant Device	Bis(tributyltin) oxide device inserted into anti-foulant device cup	1 (set of 2)
232126	Anti-foulant device cup	Holds 2 AF24173 Anti-Foulant Devices	1
231505	Anti-foulant device cap	Secures AF24173 Anti-Foulant Device in cup	2
30984	Plug	Seals end of anti-foulant cap when not deployed, keeping dust and aerosols out of conductivity cell during storage	2
30411	Triton X-100	Octyl Phenol Ethoxylate – Reagent grade non-ionic cleaning solution for conductivity cell (supplied in 100% strength; dilute as directed)	1
30507	Parker 2-206N674-70 O-ring	O-ring between end of conductivity cell and anti-foulant device cup	2
60034	37-SI / -SIP spare hardware/ O-ring kit	Assorted hardware and O-rings, including: • 30859 Machine screw, 8-32 x 3/8" FH, PH, titanium (secures housing to I/O connector end cap, housing to sensor end cap, and guard to sensor end cap) • 30857 Parker 2-033E515-80 O-ring (I/O connector end cap and sensor end cap O-ring) • 30544 Machine screw, 8-32 x 1/2" FH, PH, titanium (secures guard to sensor end cap through holes that also secure housing to end cap) • 30860 Machine screw, 6-32 x ½ FH TI (secures cable clamp half to flat area of sensor end cap) • 30900 Machine screw, 1/4-20 x 2" hex head, titanium (secures mounting clamp) • 30633 Washer, 1/4" split ring lock, titanium (for screw 30900) • 30634 Washer 1/4" flat, titanium (for screw 30900) • 31019 O-ring 2-008 N674-70 (for screw 30900 – retains mounting clamp hardware) • 31040 Screw, 8-32 x 1 FH, TI (secures cable guide base to I/O connector end cap)	-

Continued on next page

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Part Number	Part	Application Description	Quantity in MicroCAT
801385	4-pin RMG-4FS (standard connector) to 9-pin DB-9S I/O cable with power leads, 2.4 m (8 ft)	From MicroCAT to computer	1
801206	4-pin MCIL-4FS (wet-pluggable connector) to 9-pin DB-9S I/O cable with power leads, 2.4 m (8 ft)	From MicroCAT to computer	1
171888	25-pin DB-25S to 9-pin DB-9P cable adapter	For use with computer with DB-25 connector	1
17046.1	4-pin RMG-4FS (standard connector) dummy plug with locking sleeve	For when cable not being used	1
171398.1	4-pin MCDC-4FS (wet-pluggable connector) dummy plug with locking sleeve	For when cable not used	1
17043	Locking sleeve for RMG cable	Locks cable/plug in place	1
171192	Locking sleeve for MCIL cable	Locks cable/plug in place	1

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