SBE 37-SI MicroCAT

Conductivity and Temperature Monitor with RS-485 Interface

User's Manual

Sea-Bird Electronics, Inc.
1808 136th Place NE
Bellevue, Washington 98005 USA
Tel: 425/643-9866
Fax:425/643-9954

Manual Version #006, 02/28/02
Firmware Version 2.2 and later

Limited Liability Statement

Extreme care should be exercised when using or servicing this equipment. It should be used or serviced only by personnel with knowledge of and training in the use and maintenance of oceanographic electronic equipment.

SEA-BIRD ELECTRONICS, INC. disclaims all product liability risks arising from the use or servicing of this system. SEA-BIRD ELECTRONICS, INC. has no way of controlling the use of this equipment or of choosing the personnel to operate it, and therefore cannot take steps to comply with laws pertaining to product liability, including laws which impose a duty to warn the user of any dangers involved in operating this equipment. Therefore, acceptance of this system by the customer shall be conclusively deemed to include a covenant by the customer to defend, indemnify, and hold SEA-BIRD ELECTRONICS, INC. harmless from all product liability claims arising from the use or servicing of this system.

Table of Contents

Section 1: Introduction 5
About this Manual 5
How to Contact Sea-Bird 5
Quick Start 5
Unpacking the MicroCAT 6

Section 2: Description of the MicroCAT 7
System Description 7
Specifications 8
Dimensions 9
End Cap Connector 9
Sample Timing 10

Section 3: Preparing the MicroCAT for Deployment 11
Anti-Foul Material Check 11
Power and Communications Test 12
Test Set-Up 12
Test 13

Section 4: Deploying and Operating the MicroCAT 17
Set-Up for Deployment 17
Deployment 18
Operation Description 19
Setup and Sampling Example 20
Timeout Description 20
Command Descriptions 20
MicroCAT Communication Microcontroller Commands 21
MicroCAT Acquisition Microcontroller Commands 23
Data Output Formats 28
Data Output after sending DATAii Command 28
Data Output after sending Operating Command (#iiTS, #iiTSR, #iiTSS, #iiSL, #iiSLT) 28
Recovery 29

Section 5: Routine Maintenance and Calibration 30
Corrosion Precautions 30
Conductivity Cell Maintenance 30
Routine Rinsing after Recovery 30
Cleaning 30
Sensor Calibration 32
Conductivity Sensor Calibration 32
Temperature Sensor Calibration 32
Pressure Sensor (optional) Calibration 32
Replacing Anti-Foul Cylinders 33

Glossary 34

Appendix I: Functional Description 35
Sensors 35
Sensor Interface 35
Appendix II: Electronics Disassembly/Reassembly 36
Disassembly 36
Reassembly 37
Appendix III: Command Summary 38
Appendix IV: Replacement Parts 41
Index 42

Warranty Policy
Service Information
Calibration Certificates
Pressure Test Certificate
Application Notes
Schematics

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-SI MicroCAT Conductivity and Temperature Monitor (pressure optional) with RS-485 interface.

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

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

Telephone:	425-643-9866
Fax:	425-643-9954
E-mail:	seabird@seabird.com
Website:	http://www.seabird.com

Business hours:
Monday-Friday, 0800 to 1700 Pacific Standard Time
(1600 to 0100 Universal Time)
Except from April to October, when we are on 'summer time'
(1500 to 0000 Universal Time)

Quick Start

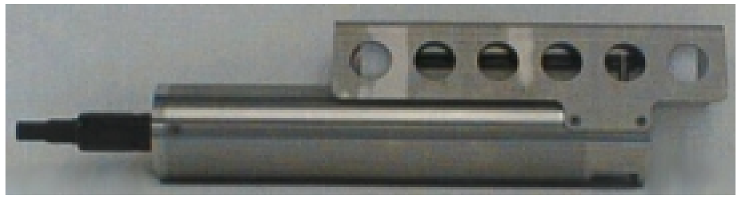
Follow these steps to get a Quick Start using the MicroCAT.
The manual provides step-by-step details for performing each task:

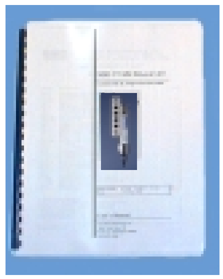
1. Test power and communications (see *Section 3: Preparing the MicroCAT for Deployment*).

2. Deploy the MicroCAT (see *Section 4: Deploying and Operating the MicroCAT*):
   A. Set date and then time.
   B. Establish setup parameters.
   C. Remove protective plugs from anti-foul cups, and verify anti-foul cylinders 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.

Unpacking the MicroCAT

Shown below is a typical MicroCAT shipment.


SBE 37-SI MicroCAT


User Manual


Software and Software Manuals


I/O Cable


9-pin adapter


Spare parts kit


Cell cleaning solution
(Triton-X)

Section 2: Description of the MicroCAT

This section describes the functions and features of the SBE 37-SI MicroCAT, including specifications and dimensions.

System Description

The SBE 37-SI MicroCAT is a high-accuracy, externally powered, conductivity and temperature (pressure optional) monitor, which includes an RS-485 interface. 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.

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. Expendable anti-fouling devices inhibit internal fouling. A plastic cup with threaded cover at each end of the cell retains the anti-foul material. The toxin quantity is typically sufficient for at least two year’s deployment.

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 MicroCAT is supplied with a powerful Win 95/98/NT 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**.

Notes:
- See SEATERM’s Help files for detailed information on the use of the program.
- Sea-Bird also supplies a DOS software package, SEASOFT-DOS, that can be used with the MicroCAT. However, this manual details only the use of the Windows software with the MicroCAT. A software manual on CD-ROM contains detailed information on the setup and use of SEASOFT-DOS.

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 / 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	9-24 VDC Quiescent Current: 30 microamps Sampling Current: 34.3 milliamps at 9 V 32.8 milliamps at 11 V 31.9 milliamps at 13 V 31.4 milliamps at 15 V Communicating Current: 1.1 milliamps		
Materials	Titanium pressure case rated at 7000 meters (23,000 feet)		
Weight (without pressure sensor)	In water: 1.9 kg (4.3 lbs) In air: 2.9 kg (6.5 lbs)		

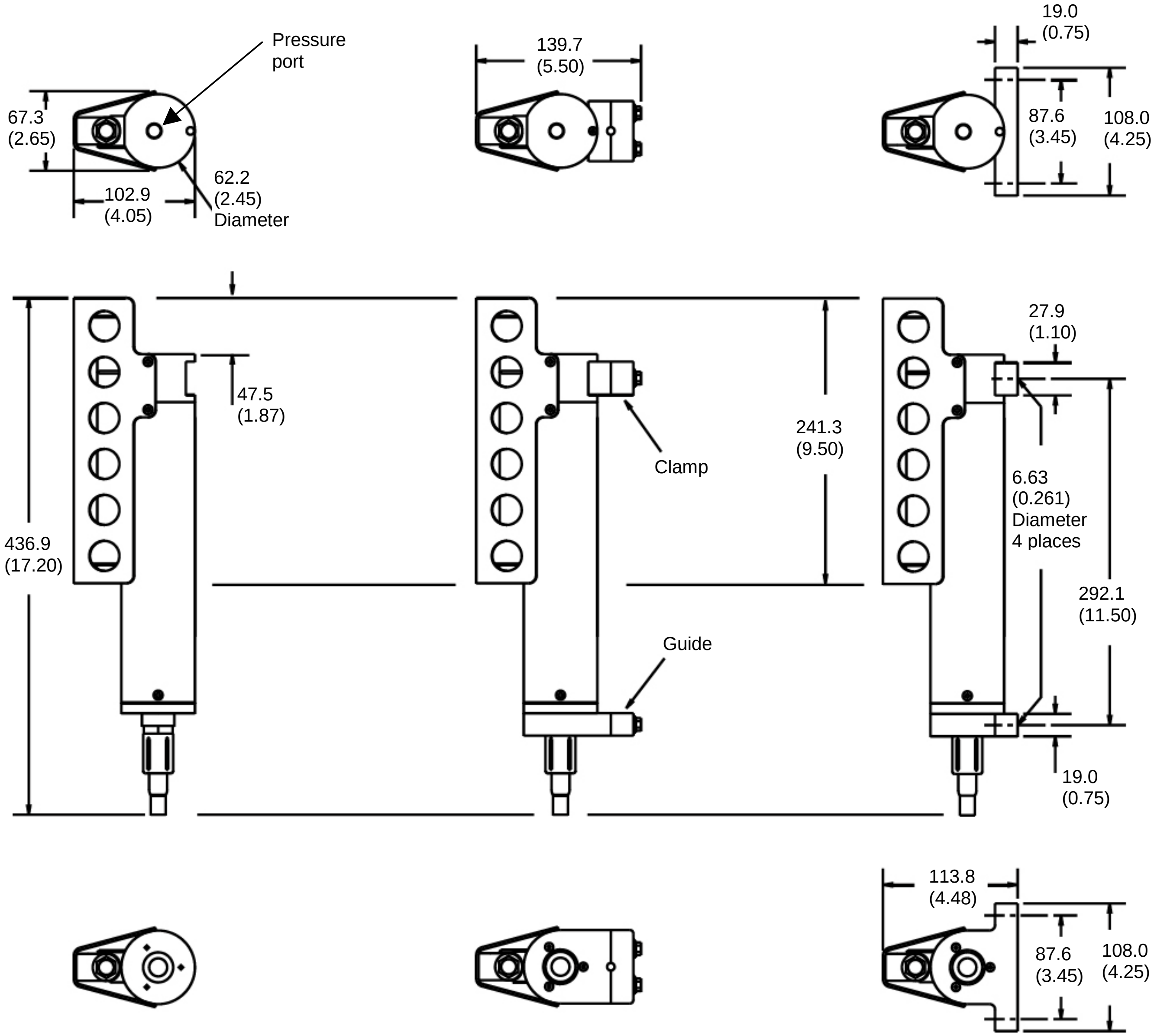
***Resolution**
Typical RMS noise with fixed resistors on the temperature and conductivity inputs (Tnom = 9.6, Cnom = 3.4):

NCYCLES	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 the MicroCAT* for a description of **NCYCLES**.

Dimensions

Dimensions in millimeters (inches)



Standard Without Mounting Hardware

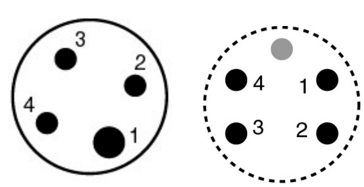
Optional Wire Mounting Clamp and Guide

Optional Flat Surface Mounting Brackets

End Cap Connector

◯ = standard XSG connector

◌ = optional MCBH connector



Pin	Signal
1	Common
2	RS-485 **A**
3	RS-485 **B**
4	External power (9-24 VDC)

Sample Timing

Note:
See *Section 4: Deploying and Operating the MicroCAT* for a description of **NCYCLES**.

Take Sample Timing, which is the end of the Take Sample command (**#iiTS** or **#iiTSR**) to the beginning of the reply:

Pressure Sensor?	NCYCLES	Time (seconds)
With Pressure Sensor	1	1.09
	2	1.25
	4	1.59
	8	2.26
Without Pressure Sensor	1	0.81
	2	0.94
	4	1.21
	8	1.74

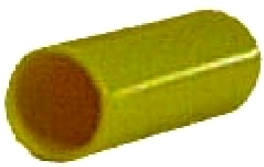
Power-On Time for each sample while logging:

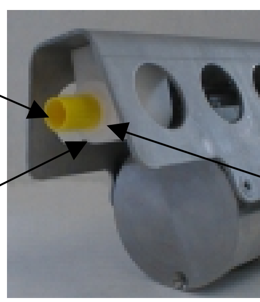
Pressure Sensor?	NCYCLES	Time (seconds)
With Pressure Sensor	2	2.44
	4	2.77
	8	3.44
	16	4.77
Without Pressure Sensor	2	2.07
	4	2.34
	8	2.87
	16	3.92

Section 3: Preparing the MicroCAT for Deployment

This section describes the pre-check procedure for preparing the MicroCAT for deployment. Checking anti-foul material and testing power and communications are discussed.

Anti-Foul Material Check





New MicroCATs are shipped with anti-foul cylinders and protective plugs pre-installed. Verify that the cylinders are in the anti-foul cups.
See *Section 5: Routine Maintenance and Calibration* for details on replacing the anti-foul cylinders.

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.

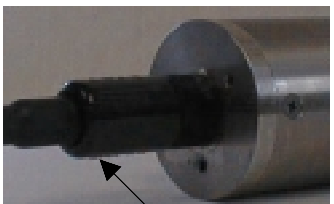
Power and Communications Test

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

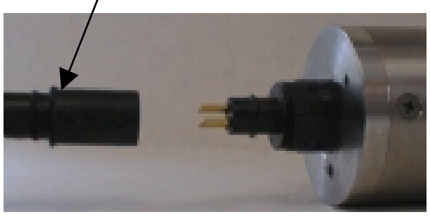
> **Note:**
> It is possible to use the MicroCAT without SEATERM by sending direct commands from a dumb terminal or terminal emulator, such as Windows HyperTerminal.

Test Set-Up

1. If not already installed, install SEATERM on your computer using the supplied software CD:
   A. Insert the CD in your CD drive.
   B. Double click on **Seasoft-Win32.exe**.
   C. Follow the dialog box directions to install the software.
   The default location for the software is c:/Program Files/Sea-Bird. Within that folder is a sub-directory for each program.



2. 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**.



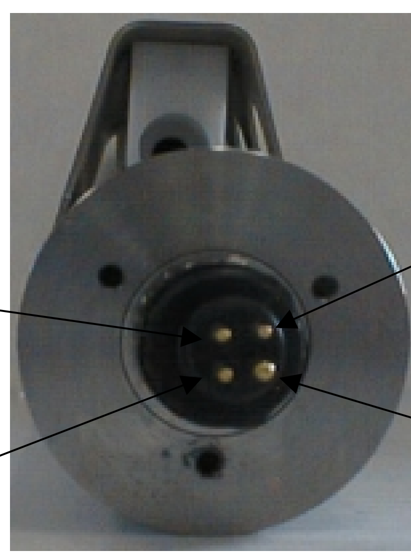
3. Remove the dummy plug from the MicroCAT's I/O bulkhead connector by pulling the plug firmly away from the connector.

4. 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.

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

6. Connect the I/O cable connector's red (+) and black (-) wires to a power supply (9-24 VDC).

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

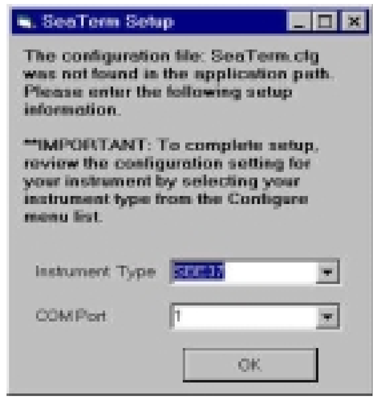


Test

Proceed as follows:

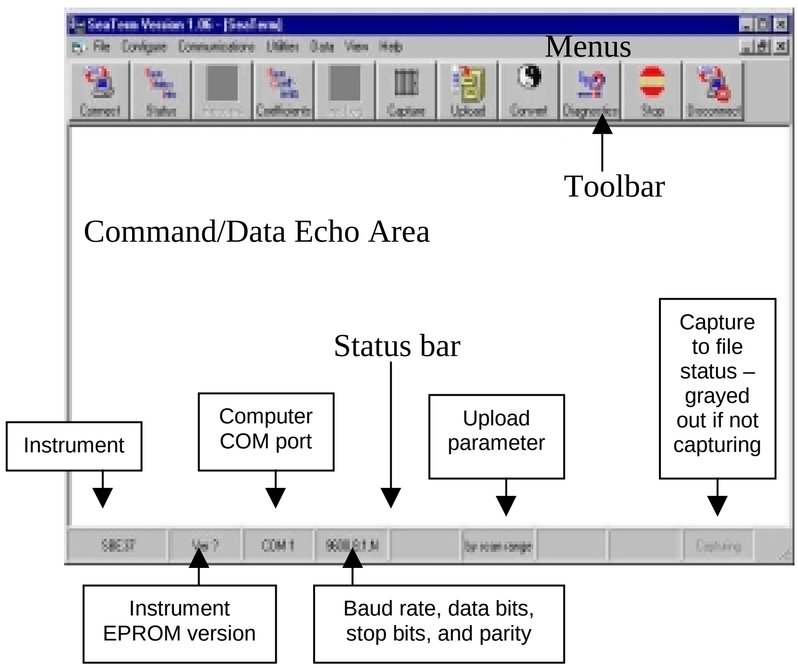
> **Note:**
> See SEATERM's help files for detailed information on the use of the program.

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



   Select the instrument type (SBE 37) and the computer COM port for communication with the MicroCAT. Click OK.

2. The main screen looks like this:



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

> **Note:**
> Once the system is configured and connected (Steps 3 and 4 below), to update the Status bar:
> - on the Toolbar, click Status; or
> - from the Utilities menu, select Instrument Status.
>
> SEATERM sends the status command, which displays in the Command/Data Echo Area, and updates the Status bar.

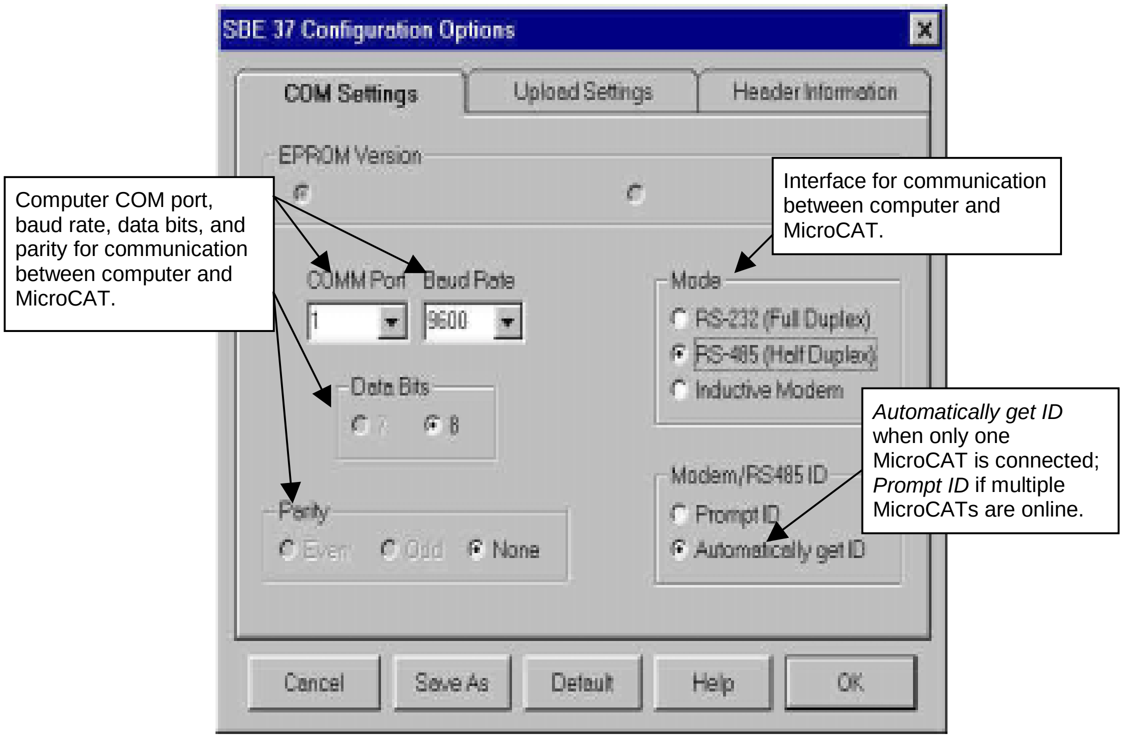
- Menus – Contains tasks and frequently executed instrument commands.
- Toolbar – Contains buttons for frequently executed tasks and instrument commands. All tasks and commands accessed through the Toolbar are also available in the Menus. To display or hide the Toolbar, select View Toolbar in the View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

Following are the Toolbar keys 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 two minutes without communication from computer have elapsed.	(press Enter key)
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	Interrupt and end current activity, such as a diagnostic test.	—
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 the MicroCAT*.

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



Make the selections in the Configuration Options dialog box:

- **COMM Port**: 1 through 10, as applicable
- **Baud Rate**: 9600 (documented on front cover of this manual)
- **Data Bits**: 8
- **Parity**: None
- **Mode**: RS-485 (Half Duplex)
- **Modem/RS 485 ID**: Automatically get ID

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

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

. . . Communication Established
S>

This shows that correct communications between the computer and MicroCAT has been established.
If the system does not respond as shown:

- Click the Connect button again or press the Enter key twice.
- 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 front cover of this manual.
- Check cabling between the computer and MicroCAT.

5. 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 manual front cover 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.

> **Note:**
> The MicroCAT has a timeout algorithm. If it does not receive a command or sample data for two minutes, it powers down its communication circuits, placing the MicroCAT in quiescent (sleep) state and drawing minimal current. If the system does not appear to respond, click Connect on the Toolbar to reestablish communications.

6. 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 2.2 SERIAL NO. 0011 07 Aug 2000 08:49:08
   sample interval = 30 seconds (not applicable to the 37-SI)
   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
   reference pressure = 0.0 db
   A/D cycles to average = 4
   temperature = 7.54 deg C
   S>

> **Note:**
> 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. Command the MicroCAT to take a sample by typing **#iiTS** (**ii** = MicroCAT ID) and pressing the Enter key. The display looks like this (if *do not output salinity, sound velocity, density, or depth with each sample* displayed in response to the status command in Step 6):
   12345, 23.7658, 0.00019 0.062, 07 Aug 2000, 16:30:43

   where 12345 = MicroCAT serial number
   23.7658 = temperature in degrees Celsius
   0.00019 = conductivity in S/m
   0.062 = pressure in dBars
   07 Aug 2000 = date (default upon power-up is 01 Jan 1980)
   16:30:43 = time (default upon power-up is 00:00:00)

   These numbers should be reasonable; i.e., room temperature, zero conductivity, barometric pressure (gauge pressure), current date and time (Pacific Daylight or Standard Time).

8. Command the MicroCAT to go to sleep (quiescent state) by typing **#iiQS** (**ii** = MicroCAT ID) and pressing the Enter key.

The MicroCAT is ready for programming and deployment.

Section 4: Deploying and Operating the MicroCAT

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

Set-Up 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.
- It is always necessary to set both date and then time. **If a new date is entered but not a new time, the new date will not be saved.**

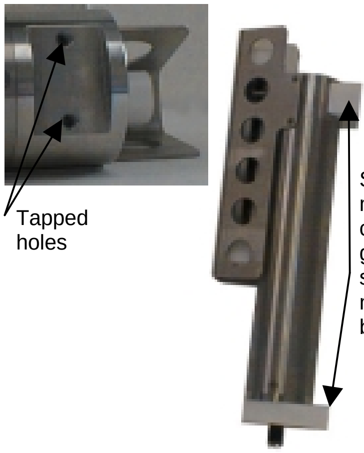
Program the MicroCAT for the intended deployment (see *Section 3: Preparing the MicroCAT for Deployment* for connection information; see information in this section on commands):

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

2. Establish the setup parameters.

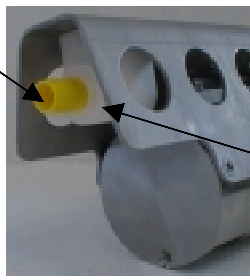
3. If the system will have multiple MicroCATs online, verify the MicroCAT is set to *Prompt ID* to allow use of the Toolbar buttons and Menus:
   A. In the Configure menu, select SBE 37.
   B. Click on the COM Settings tab.
   C. For Modem/RS485 ID, click on *Prompt ID*.
   D. Click OK or Save As.

Deployment

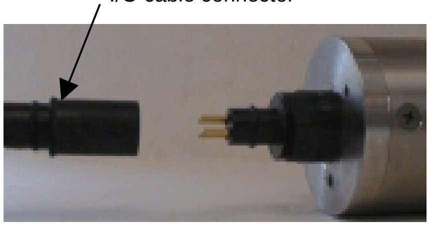


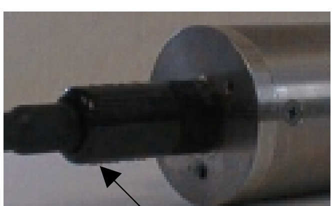
The MicroCAT can be mounted with customer-supplied hardware or can be ordered with pre-installed Sea-Bird mounting brackets.

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 sensor end cap. 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 sensor end cap, which could pull off the end cap.



2. Remove the protective plugs, if installed, from the anti-foul cups. Verify that the two plastic cups contain anti-foul cylinders (see *Section 5: Routine Maintenance and Calibration* for anti-foul cylinder replacement). Leave the protective plugs off for deployment.





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. 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.
   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.**

4. Attach the mounting equipment to the mooring cable or support.

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

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

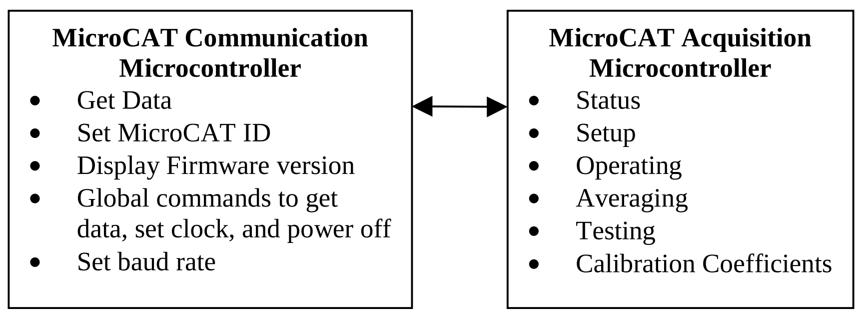
Operation Description

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.



Setup and Sampling Example

An example follows for a system with two MicroCATs (IDs 01 and 02) 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: Wake up all MicroCATs. Globally set date and time for all MicroCATs to September 7, 2000, 09:43:00. Set up all MicroCATs to output salinity. Command all MicroCATs to take a sample and hold data in buffer, and then command each MicroCAT to transmit data from buffer. Repeat sampling sequence a number of times. Request all MicroCATs to get average data and hold average in buffer, and start next averaging cycle. Then command each MicroCAT to transmit average data from buffer. Send power-off command to all MicroCATs.

(Click Connect on Toolbar to wake up all MicroCATs.)
S>MMDDYY=090700
S>HHMMSS=094300
S>#01OUTPUTSAL=Y
S>#02OUTPUTSAL=Y
S>STARTSAMPLE
S>DATA01
S>DATA02
(Repeat **STARTSAMPLE** through **DATA02** commands a number of times - If MicroCATs have gone to sleep between samples, click Connect on Toolbar to wake up.)
S>ADATA
S>DATA01
S>DATA02
S>PWROFF

Timeout Description

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

Command Descriptions

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

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

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 two minutes after the completion of a command, the MicroCAT returns to the quiescent (sleep) state.
- If in quiescent state, re-establish communications by pressing Connect on the Toolbar or pressing the Enter key to get an **S>** prompt.

MicroCAT Communication Microcontroller Commands

Global Commands

ADATA	Command **all** MicroCATs to get **average** data from acquisition units and start next averaging cycle. Communication microcontrollers send **SACG** command (send averaged, converted data and start new average) to acquisition microcontrollers. Averaged data is held in communication microcontroller buffers until receiving **DATAii** command.
GDATA	Command **all** MicroCATs to get one sample. Communication microcontrollers send command to acquisition microcontrollers to take sample and **turn power off**. Data is held in communication microcontroller buffers until receiving **DATAii** command.
STARTSAMPLE	Command **all** MicroCATs to get one sample. Communication microcontrollers send command to acquisition microcontrollers to take sample and **leave power on**. Data is held in communication microcontroller buffers until receiving **DATAii** command. Send this command once before using **GSAMPLE** command.
GSAMPLE	Command **all** MicroCATs to get last sample and then take new sample. Communication microcontrollers send **#iiSL** command to acquisition microcontrollers, and then send **#iiTS** command to acquisition microcontrollers once **#iiSL** reply is received. Data from last sample is held in communication microcontroller buffers until receiving **DATAii** command; data from new sample is held in acquisition microcontroller buffers.
MMDDYY=mmddyy	Set real-time clock month, day, and year for **all** MicroCATs. This must be followed by **HHMMSS=** command to set time.
DDMMYY=ddmmyy	Set real-time clock day, month, and year for **all** MicroCATs. This must be followed by **HHMMSS=** command 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.

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=** commands are equivalent. Either can be used to set the date.
- It is always necessary to set both date and then time. **If a new date is entered but not a new time, the new date will not be saved.**

Get Data Command

DATAii — Get data obtained with **GDATA**, **ADATA**, **STARTSAMPLE**, or **GSAMPLE** command 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. This command must be sent twice, because the computer requests verification. **Note that if more than one MicroCAT is online when sending this command, all MicroCATs online will be set to same ID**.

Miscellaneous Commands

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

!iiDS — Display MicroCAT communication microcontroller firmware version.

Notes:
The MicroCAT's baud rate (set with **!iiBAUD** command) 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

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

#iiDS

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

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

- firmware version, serial number, date and time [**#iiMMDDYY=** or **#iiDDMMYY=**, and **#iiHHMMSS=**]
- sample interval time (not applicable to SBE 37-SI)
- salinity output with each sample? [**#iiOUTPUTSAL=**]
- sound velocity output with each sample? [**#iiOUTPUTSV=**]
- density output with each sample? [**#iiOUTPUTDENSITY=**]
- depth output with each sample? [**#iiOUTPUTDEPTH=**]
- latitude for depth calculation [**#iiLATITUDE=**]
- reference pressure [**#iiREFPRESS=**]
- A/D cycles to average per sample [**#iiNCYCLES=**]
- current temperature

Example: Display status for MicroCAT with ID=01.

S>#01DS
SBE37-SI 485 V 2.2 SERIAL NO. 0011 07 Aug 2000 08:49:08
sample interval = 30 seconds (not applicable to SBE 37-SI)
output salinity with each sample
output sound velocity with each sample
output density with each sample
output depth with each sample
latitude to use for depth calculation = 0.00 deg
reference pressure = 0.0 db
A/D cycles to average = 4
temperature = 7.54 deg C

Setup Commands

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.
- **#iiDDMMYY=** and **#iiMMDDYY=** commands are equivalent. Either can be used to set the date.
- It is always necessary to set both date and then time. **If a new date is entered but not a new time, the new date will not be saved.**

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

#iiDDMMYY=ddmmyy Set real-time clock day, month, and year. This command must be followed by **#iiHHMMSS=** command 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 2000 12:00:00.

S>#01MMDDYY=011000
S>#01HHMMSS=120000

or

S>#01DDMMYY=100100
S>#01HHMMSS=120000

Notes:
See *Data Output Formats* below for details.

#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. Entry is ignored if **#iiOUTPUTDEPTH=N**.

Setup Commands (continued)

#iiREFPRESS=x — **x** = reference pressure (gauge) in decibars. MicroCAT without installed pressure sensor uses this reference pressure in conductivity, salinity, and sound velocity calculation. Entry is ignored if MicroCAT has pressure sensor.

#iiNCYCLES=x — **x=** number of A/D cycles to average (range 1 to 127; default 4). Increasing **#iiNCYCLES** increases measurement resolution and time required for measurement. See *Sample Timing* in *Section 2: Description of the MicroCAT*.

> **Note:**
> **When communicating with multiple instruments, use PWROFF to send a power off command to all MicroCATs simultaneously.** If the **#iiQS** command is sent sequentially to each MicroCAT, activity on the line may wake up a quiescent MicroCAT.

#iiQS — Quit session and place MicroCAT in quiescent (sleep) state. Main power is turned off. Equivalent to communication microcontroller **PWROFF** command, but applies only to specified MicroCAT.

Operating 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 — Take sample, output converted data, and leave power on.

#iiTSR — Take sample, output raw data, and leave power on.

#iiTSS — Take sample, output converted data, and **turn power off**.

#iiSL — Output converted data from last sample, and leave power on.

#iiSLT — Output converted data from last sample, then take new sample, and leave power on.

Averaging Commands

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

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

#iiTT	Measure temperature for 30 samples or until Esc key is pressed, output converted data.
#iiTC	Measure conductivity for 30 samples or until Esc key is pressed, output converted data.
#iiTP	Measure pressure for 30 samples or until Esc key is pressed, output converted data.
#iiTTR	Measure temperature for 30 samples or until Esc key is pressed, output raw data.
#iiTCR	Measure conductivity for 30 samples or until Esc key is pressed, output raw data.
#iiTPR	Measure pressure for 30 samples or until Esc key is pressed, output raw data.
#iiTR	Measure real-time clock frequency for 30 samples or until Esc key is pressed, output data.
#iiSS	Send averaged data statistics.

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.

Calibration Coefficients Commands

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

Example: Display coefficients for MicroCAT with ID=03, which does not have a pressure sensor.

S>#03DC
SBE37-SI 485 V 2.2 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 the **#iiFORMAT** command, 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, 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 Command

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

Example: Sample output from **DATA02** command when pressure sensor not installed, **#02FORMAT=1, #02OUTPUTDEPTH=N**, **#02OUTPUTDENSITY=N**, **#02OUTPUTSAL=N**, and **#02OUTPUTSV=N**:

02, 12345, 23.7658, 0.00019, 07 Aug 2000, 16:30:43
(ID, serial number, temperature, conductivity, date, time)

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

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

Recovery

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

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-foul cups.

Section 5: Routine Maintenance and Calibration

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

Corrosion Precautions

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

Conductivity Cell Maintenance

CAUTION:
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 and depletion of the anti-foul cylinders.

Routine Rinsing after Recovery

After each recovery, rinse the cell with clean de-ionized water, drain, and gently blow through the cell to remove larger water droplets. **Do not use compressed air**, which typically contains oil vapor. Re-insert the protective plugs in the anti-foul cups.

If the cell is not rinsed between usage, salt crystals may form on the platinized electrode surfaces. When the instrument is used next, sensor accuracy may be temporarily affected until these crystals dissolve.

Cleaning

CAUTION:
Do not put a brush or any object inside the conductivity cell to clean it. Putting an object inside the cell can damage and break the cell.

Cell cleaning removes foreign material coating the inside of the cell, partially restoring the cell to the original factory calibration. Decide whether to clean the cell after a deployment based on the following:

- **Do not clean the cell** if you will be sending the MicroCAT to Sea-Bird for a post-cruise calibration to establish the drift during the cruise.
- **Clean the cell** if you will not be performing a post-cruise calibration to establish the drift.

Routine Cleaning (inside of cell not visibly dirty)

1. Fill the cell with a 1% solution of Triton X-100 (included with shipment) and let it soak for 30 minutes.
2. Drain and flush with warm, clean, de-ionized water for 1 minute. Then:
   - Prepare for deployment, **or**
   - If being stored – drain and gently blow through the cell to remove larger water droplets. **Do not use compressed air**, which typically contains oil vapor. Replace the protective plugs in the anti-foul cups.

Acid Cleaning (visible deposits or marine growth on inside of cell)

Do not clean with acid more than once per week.

CAUTION:
Anti-foul cups are attached to the guard and connecting with tubing to the cell. **Removing the guard without disconnecting the cups from the guard will break the cell.**

1. Remove the MicroCAT guard:
   A. Remove the two screws attaching each anti-foul cup to the guard.
   B. Remove the four Phillips-head screws attaching the guard to the housing and sensor end cap.
   C. Gently lift the guard away.

2. Prepare for cleaning:
   A. Remove the small section of Tygon tubing and anti-foul cup from one end of the cell.
   B. Place a 0.6 m (2 ft) length of 7/16 in. ID, 9/16 in. OD Tygon tubing over the end of the cell.
   C. Clamp the MicroCAT so that the cell is vertical, with the 0.6 m (2 ft) Tygon tubing at the bottom end.
   D. Loop the Tygon tubing into a 'U' shape, and tape the open end of the tubing in place at the same height as the top of the glass cell.

WARNING!
Avoid breathing the acid fumes.

3. Clean the cell:
   A. Pour muriatic acid (37% HCl) into the open end of the tubing until the cell is nearly filled. **Let it soak for 1 to 2 minutes only**.
   B. Drain the acid from the cell and flush for 5 minutes with warm (not hot), clean, de-ionized water.
   C. Rinse the exterior of the instrument to remove any spilled acid from the surface.
   D. Fill the cell with a 1% solution of Triton X-100 (included with shipment) and let it stand for 5 minutes.
   E. Drain and flush with warm, clean, de-ionized water for 1 minute.
   F. Carefully remove the 0.6 m (2 ft) length of Tygon tubing.

4. Reinstall the anti-foul cup and the guard:
   A. Carefully reinstall the small section of Tygon tubing and anti-foul cup on the end of the glass cell.
   B. Carefully place the guard over the housing, aligning all holes.
   C. Reinstall the two screws attaching each anti-foul cup to the guard.
   D. Reinstall the four Phillips-head screws attaching the guard to the housing and sensor end cap.

5. Prepare for deployment, **or**
   If being stored – gently blow through the cell to remove larger water droplets. **Do not use compressed air**, which typically contains oil vapor. Replace the protective plugs in the anti-foul cups.

Sensor Calibration

Note:
Please remove anti-foul cylinders from the anti-foul cups before returning the MicroCAT to Sea-Bird. Store them for future use. See *Replacing Anti-Foul Cylinders* for the cylinder 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.

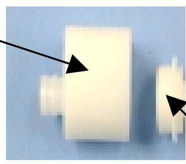
For demanding applications, or where the sensor's air ambient pressure response has changed significantly, calibration using a dead-weight generator is recommended. The pressure sensor port uses a 7/16-20 straight thread for mechanical connection to the pressure source.
(Refer to Application Note 12-1, found on Sea-Bird's website, for the general calibration procedure. The pressure sensor port thread size in the Application Note is not applicable to the MicroCAT.)

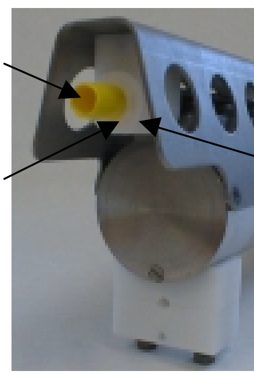
Replacing Anti-Foul Cylinders

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

The MicroCAT has an anti-foul cup and cap on each end of the cell. New MicroCATs are shipped with an anti-foul cylinder and a protective plug pre-installed in each cup.

Anti-foul cylinders have a useful deployment life of approximately 2 years. Sea-Bird recommends that you keep track of how long the cylinders have been deployed, to allow you to purchase and replace the cylinders when needed.





Handling the cylinders with gloves, follow this procedure to replace each anti-foul cylinder (two):

1. Remote the protective plug from the anti-foul cup.
2. Unscrew the cap with a 5/8-inch socket wrench.
3. Remove the old anti-foul cylinder. If the old cylinder is difficult to remove:
   - Use needle-nose pliers and carefully break up material.
   - If necessary, remove the guard to provide easier access.
4. Place the new anti-foul cylinder in the cup.
5. Rethread the cap onto the cup. Do not over tighten.
6. If the MicroCAT is to be stored, re-install 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-foul 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-foul 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.

Notes:
- Please remove anti-foul cylinders from the anti-foul cups before returning MicroCATs to Sea-Bird.
- Store removed anti-foul cylinders in a plastic bag, and keep them in a cool place.

Glossary

Anti-foul cylinders - Expendable devices saturated with a tri-butyl-tin based toxin placed inside the anti-foul cups, located at the ends of the conductivity cell.

Fouling - Biological growth in the conductivity cell during deployment.

MicroCAT - High-accuracy conductivity, temperature, and optional pressure recorder/monitor. Three models are available: SBE 37-IM (**I**nductive **M**odem with internal battery and memory), SBE 37-SM (**S**erial interface with internal battery and **M**emory), and SBE 37-SI (**S**erial **I**nterface only). The SBE 37-SM and 37-SI are available with RS-232 or RS-485 interface.

PCB – Printed Circuit Board.

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

SEASOFT-DOS - Sea-Bird's complete DOS software package, which includes software for communication, real-time data acquisition, and data analysis and display.

SEASOFT-Win32– Sea-Bird's complete Win 95/98/NT software package, which includes software for communication, real-time data acquisition, and data analysis and display. SEASOFT-Win32 includes ***SEATERM***, SeatermAF, SEASAVE, SBE Data Processing, and Plot39. Only SEATERM is used with the SBE 37-SI MicroCAT.

SEATERM - Sea-Bird's WIN 95/98/NT software used to communicate with the MicroCAT.

TCXO - Temperature Compensated Crystal Oscillator.

Triton X100 - Concentrated liquid non-ionic detergent, used for cleaning the conductivity cell.

Appendix I: Functional Description

Sensors

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

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.

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, 1000, 2000, 3500, and 7000 meters.

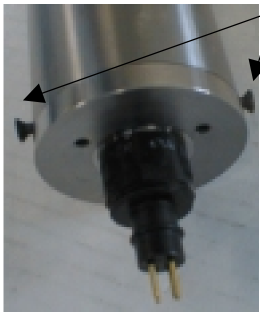
Sensor Interface

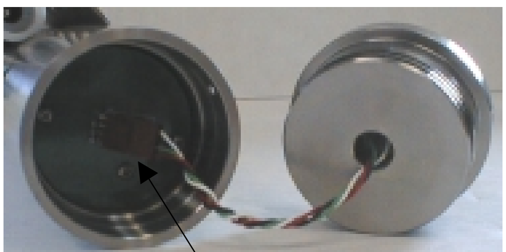
Temperature is acquired by applying an AC excitation to a hermetically sealed VISHAY reference resistor and an ultra-stable aged thermistor with a drift rate of less than 0.002°C per year. A 24-bit A/D converter digitizes the outputs of the reference resistor and thermistor (and optional pressure sensor).
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.

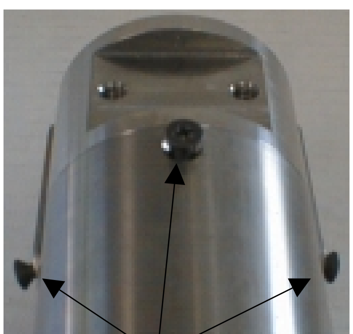
Appendix II: Electronics Disassembly/Reassembly

Disassembly

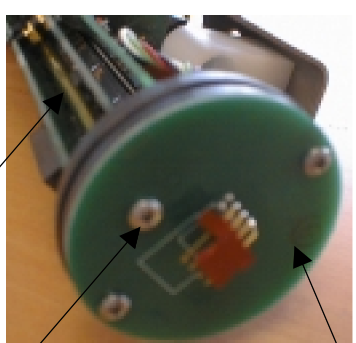




1. Remove the I/O connector end cap and disconnect the electronics from the end cap:
   A. Wipe the outside of the I/O connector end cap and housing dry, being careful to remove any water at the seam between them.
   B. Remove the two flat Phillips-head titanium machine screws. Do not remove any other 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.

Note:
Before delivery, desiccant packages are attached to the PCBs with string, and the electronics chamber is filled with dry Argon. These measures help prevent condensation.
If the electronics are exposed to the atmosphere, dry gas backfill with Argon. If the exposure is for more than 12 hours, also replace the desiccant package.

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.

Appendix III: Command Summary

Note:
See *Command Descriptions* in *Section 4: Deploying and Operating the 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 one sample. Communication microcontrollers send command to acquisition microcontrollers to take sample and **turn power off**. Communication microcontrollers hold data in buffer until receiving **DATAii**.
		STARTSAMPLE	Command **all** MicroCATs to get one 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 **#iiSL** command to acquisition microcontrollers. Communication microcontrollers then send **#iiTS** command to acquisition microcontrollers once reply to **#iiSL** command is received. 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. Command 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.
		!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.
		#iiQS	Enter quiescent (sleep) state.
	Operating	**#iiTS**	Take sample, output converted data, and leave power on.
		#iiTSR	Take sample, output raw data, and leave power on.
		#iiTSS	Take sample, output converted data, and turn power off.
		#iiSL	Output converted data from last sample, leave power on.
		#iiSLT	Output converted data from last sample, then take new sample, and leave power on.
	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 for 30 samples or until Esc key is pressed, output converted data.
		#iiTC	Measure conductivity for 30 samples or until Esc key is pressed, output converted data.
		#iiTP	Measure pressure for 30 samples or until Esc key is pressed, output converted data.
		#iiTTR	Measure temperature for 30 samples or until Esc key is pressed, output raw data
		#iiTCR	Measure conductivity for 30 samples or until Esc key is pressed, output raw data.
		#iiTPR	Measure pressure for 30 samples or until Esc key is pressed, output raw data.
		#iiTR	Measure real-time clock frequency for 30 samples or until Esc key is pressed, output data.
		#iiSS	Output averaged data statistics.
	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: Replacement Parts

Part Number	Part	Application Description	Quantity in MicroCAT
24173	Anti-foul cylinder	Anti-foul poison tubes inserted into anti-foul cups	2
231070	Anti-foul cup	Holds anti-foul cylinder	2
231505	Anti-foul cap	Secures anti-foul cylinder in cup	2
30984	Anti-foul plug	Seals end of anti-foul assembly when not deployed	2
30859	Machine screw, 8-32 x 3/8" FH, PH, titanium	Secures housing to I/O connector end cap (2), housing to sensor end cap (1), and guard to sensor end cap (2)	5
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	2
30857	Parker 2-033E515-80 O-ring	I/O connector end cap and sensor end cap O-ring	4
50091	Triton X-100	Conductivity cell cleaning solution	1
801046	4-pin I/O cable	From MicroCAT to computer	1
17130	25-pin to 9-pin adapter	Connects I/O cable to 9-pin COM port on computer	1
17043	Locking sleeve	Locks I/O cable or dummy plug in place	1
17046	4-pin dummy plug	For use when I/O cable not being used	1
60034	Spare hardware/ O-ring kit	Assorted hardware and O-rings	-

Index

A

About Sea-Bird · 5
Anti-foul
  cylinder check · 11
  cylinder removal before shipping to Sea-Bird · 32
  plugs · 11
  replacing cylinders · 33
Application notes · *See* attachments at end of manual

C

Calibration · 32
  certificates · *See* attachments at end of manual
Cleaning · 30
Clock · 8
Command summary · 38
Commands
  acquisition microcontroller · 23
  averaging · 26
  coefficients · 27
  communication microcontroller · 21
  communication microcontroller miscellaneous · 22
  descriptions · 20
  get data · 22
  global · 21
  MicroCAT ID · 22
  operating · 25
  output format · 24
  setup · 24
  status · 23
  testing · 26
Communication defaults · 15
Connector · 9
Corrosion precautions · 30

D

Data output format · 24, 28
Deployment
  installation · 18
  preparing for · 11
  setup · 17
Description · 7
Dimensions · 9

E

Electronics disassembly/reassembly · 36
Example
  setup and sampling · 20

F

Format
  data output · 28
Functional description · 35

G

Glossary · 34
Guard
  removing · 33

L

Limited liability statement · 2

M

Maintenance · 30

O

Operation description · 19

P

Parts
  replacement · 41
Power · 8
Pressure test
  certificate · *See* attachments at end of manual

Q

Quick start · 5

R

Recovery · 29
Replacement parts · 41

S

Sample timing · 10
Sampling example · 20
Schematics · *See* attachments at end of manual
SEASOFT-DOS · 7
SEASOFT-Win32 · 7, 12
SEATERM · 7, 12, 13
  main screen · 13
  toolbar buttons · 14
Sensors · 8
Service information · *See* attachment at end of manual
Setup example · 20
Software · 7
Specifications · 8
Storage · 30
System description · 7

T

Testing · 12
Timeout description · 20

U

Unpacking MicroCAT · 6

W

Warranty · *See* attachment at end of manual
Wiring · 12