SBE 37-SM MicroCAT

Conductivity, Temperature, and (optional) Pressure Recorder with RS-232 *Interface*

**Shown with standard titanium housing;
optional ShallowCAT plastic housing available**

User's Manual

CE

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.

Declaration of Conformity

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005 USA

DECLARATION OF CONFORMITY

Manufacturer's Name: **Sea-Bird Electronics**
Manufacturer's Address: 13431 NE 20th Street
                                       Bellevue, WA 98005, USA

The Authorized Representative located within the Community is:
                                       OTT MESSTECHNIK GmbH & Co.KG
                                       P.O.Box: 2140 / 87411 Kempten / Germany
                                       Ludwigstrasse 16 / 87437 Kempten
                                       Internet: http://www.ott.com
                                       Phone: +49 831 5617 – 100
                                       Fax: +49 831 5617 - 209

Device Description: Various Data Acquisition Devices and Sensors

Model Numbers:

3S	3F	3plus	4C	4M	5T	5P	5M	7
8	9plus	11plus	14	16plus V2	16plus-IM V2		17plus V2	18
19plus V2	21	25plus	26plus	27	29	32	32C	32SC
33	35	35RT	36	37-IMP	37-IM	37-SMP	37-SM	37-SIP
37-SI	38	39	39-IM	39plus	41	41CP	43	43F
44	45	49	50	52-MP	53BPR	54	55	56
63	SIM	ICC	IMM	PDIM	AFM	90488	90204	90402
90504	Glider Payload CTD	NiMH Battery Charger and Battery Pack						

Applicable EU Directives: Machinery Directive 98 / 37 /EC
                                         EMC Directive 2004 / 108 /EC
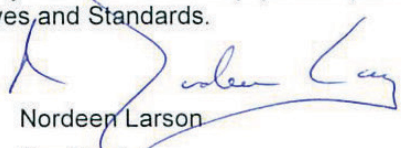   Low Voltage Directive (73 / 23 /EEC) as amended by (93 / 68 /EEC)

Applicable Harmonized Standards:
                                       EN 61326-1:2006 Class A Electrical Equipment for Measurement, Control, and Laboratory Use, EMC Requirement – Part 1: General Requirements
                                       (EN 55011:2007 Group 1, Class A)

                                       EN 61010-1:2001, Safety Requirements for Electrical Equipments for Measurement, Control, and Laboratory Use – Part 1: General Requirements

Declaration based upon compliance to the Essential Requirements and Letter of Opinion from CKC Certification Services, LLC., Notified Body 0976

I, the undersigned, hereby declare that the equipment specified above conforms to the above European Union Directives and Standards.

Authorized Signature:

                 Name: Nordeen Larson
     Title of Signatory: President
                 Date: 3 September 2013
                 Place: Bellevue, WA

Table of Contents

Section 1: Introduction

This section includes a Quick Start procedure, photos of a standard MicroCAT shipment, and battery shipping precautions.

About this Manual

This manual is to be used with the SBE 37-SM MicroCAT Conductivity and Temperature Recorder (pressure optional) with **RS-232** 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 contact us with any comments or suggestions (seabird@seabird.com or 425-643-9866). Our business hours are Monday through Friday, 0800 to 1700 Pacific Standard Time (1600 to 0100 Universal Time) in winter and 0800 to 1700 Pacific Daylight Time (1500 to 0000 Universal Time) the rest of the year.

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. Install batteries and test power and communications (*Section 3: Preparing MicroCAT for Deployment*).

2. Deploy the MicroCAT (*Section 4: Deploying and Operating MicroCAT*):
   A. Install new batteries if necessary.
   B. Ensure all data has been uploaded, and then send **InitLogging** to make entire memory available for recording if desired.
   C. Set date and time, and establish setup and logging parameters.
   D. Check status (**DS**) and calibration coefficients (**DC**) to verify setup.
   E. Set MicroCAT to start logging now or in the future.
   F. Remove protective plugs from anti-foulant device cups, and verify AF24173 Anti-Foulant Devices are installed. Leave protective plugs off for deployment.
   G. Install dummy plug or cable connector, and locking sleeve.
   H. Deploy MicroCAT, using Sea-Bird or customer-supplied hardware.
   I. Upload data from memory.

Unpacking MicroCAT

Shown below is a typical MicroCAT shipment.

SBE 37-SM MicroCAT

Batteries

I/O cable

Spare hardware
and o-ring kit

Cell cleaning solution
(Triton-X)

Software, and Electronic Copies of
Software Manuals and User Manual

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Shipping Precautions

> **DISCLAIMER / WARNING:**
> The shipping information provided in is a general overview of lithium battery shipping requirements; it does not provide complete shipping information. The information is provided as a courtesy, to be used as a guideline to assist properly trained shippers. These materials do not alter, satisfy, or influence any federal or state requirements. These materials are subject to change due to changes in government regulations. Sea-Bird accepts no liability for loss or damage resulting from changes, errors, omissions, or misinterpretations of these materials. **See the current edition of the *IATA Dangerous Good Regulations* for complete information on packaging, labeling, and shipping document requirements.**

WARNING!
Do not ship assembled battery pack.

Assembled battery pack

For its main power supply, the MicroCAT uses twelve 3.6-volt AA lithium batteries (Saft LS14500). The MicroCAT was shipped from the factory with the batteries packaged separately within the shipping box (not inside MicroCAT).

BATTERY PACKAGING
Batteries are packed in heat-sealed plastic, and then placed in bubble-wrap outer sleeve and strong packaging for shipment.

If the shipment is not packaged as described above, or does not meet the requirements below, the shipment is considered Dangerous/Hazardous Goods, and must be shipped according to those rules.

	1-5 MicroCATs and associated batteries, but no spares	1-5 MicroCATs and associated batteries, plus up to 2 spare battery sets/MicroCAT	Spares (without MicroCATs) – **Note new rules as of January 1, 2013**
UN #	UN3091	UN3091	
Packing Instruction (PI) #	969	969	
Passenger Aircraft	Yes	**No**	Must be shipped as **Class 9 Dangerous Goods**. If re-shipping spares, you must have your own Dangerous Goods program.
Cargo Aircraft	Yes	Yes	
Labeling Requirement	1 **	1, 2 **	
Airway Bill (AWB) Requirement	Yes *	Yes *	

* AWB must contain following information in Nature and Quantity of Goods Box: "Lithium Metal Batteries", "Not Restricted", "PI #"
** Labels are defined below:

1 – Shipper must provide an emergency phone number

2

Note:
Remove the batteries before returning the MicroCAT to Sea-Bird. Do not return used batteries when shipping the MicroCAT for calibration or repair. All setup information is preserved when the batteries are removed.

Install batteries in the MicroCAT for testing (see *Battery Installation* in *Section 3*). **If you will re-ship the MicroCAT after testing:**
1. Remove the battery pack assembly from the MicroCAT.
2. Remove the batteries from the battery pack assembly.
3. Pack the batteries properly for shipment, apply appropriate labels, and prepare appropriate shipping documentation.

Section 2: Description of MicroCAT

This section describes the functions and features of the SBE 37-SM MicroCAT, including specifications, dimensions, end cap connectors, sample timing, battery endurance, and external power.

System Description

The SBE 37-SM MicroCAT is a high-accuracy conductivity and temperature recorder (pressure optional) with internal battery and non-volatile memory, and a standard **RS-232** serial interface. Designed for moorings and other long-duration, fixed-site deployments, 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 350 meters (1150 feet) is also available.

Communication with the MicroCAT is over an internal, 3-wire, RS-232C link. Over 50 different commands can be sent to the MicroCAT to provide status display, data acquisition setup, data retrieval, and diagnostic tests. User-selectable operating modes include:

- **Autonomous sampling** – At pre-programmed intervals, the MicroCAT wakes up, samples, stores data in its FLASH memory, and goes to sleep. If desired, real-time data can also be transmitted.
- **Polled sampling** – On command, the MicroCAT takes one sample and transmits the data. Polled sampling is useful for integrating the MicroCAT with satellite, radio, or wire telemetry equipment.
- **Serial line sync** – In response to a pulse on the serial line, the MicroCAT wakes up, samples, stores the data in its FLASH memory, and goes to sleep. If desired, real-time data can also be transmitted. Serial line sync provides an easy method for synchronizing MicroCAT sampling with other instruments such as Acoustic Doppler Current Profilers (ADCPs) or current meters, without drawing on their battery or memory resources.

The MicroCAT can be deployed in two ways:

- Cable installed – The MicroCAT can be remotely controlled, allowing for polled sampling or serial line sync, or for periodic requests of data from the MicroCAT memory. If desired, data can be periodically uploaded while the MicroCAT remains deployed. Additionally, the MicroCAT can be externally powered.
- Dummy plug installed – The MicroCAT cannot be remotely controlled. Autonomous sampling is programmed before deployment, and data is uploaded after recovery.

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 Seacat and Seacat *plus* family. 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.

Standard titanium housing

Optional plastic *ShalowCAT* housing

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.

The MicroCAT's optional strain-gauge pressure sensor is available in the following pressure ranges: 20, 100, 350, 600, 1000, 2000, 3500, and 7000 meters. Compensation of the temperature influence on pressure offset and scale is performed by the MicroCAT's CPU.

Future upgrades and enhancements to the MicroCAT firmware can be easily installed in the field through a computer serial port and the bulkhead connector on the MicroCAT, without the need to return the MicroCAT to Sea-Bird.

Notes:
- Help files provide detailed information on the software.
- A separate software manual on CD-ROM contains detailed information on the setup and use of SBE Data Processing.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our FTP site. See our website (www.seabird.com) for the latest software version number, a description of the software changes, and instructions for downloading the software from the FTP site.

The MicroCAT is supplied with a powerful software package, Seasoft$^©$ V2, which includes:

- **Deployment Endurance Calculator**– program for determining deployment length based on user-input deployment scheme, instrument power requirements, and battery capacity.

- **SeatermV2** – terminal program for easy communication and data retrieval. SeatermV2 is a *launcher*, and launches the appropriate terminal program for the selected instrument (**Seaterm232** for RS-232 instruments such as this MicroCAT).

- **SBE Data Processing** - program for calculation and plotting of conductivity, temperature, pressure (optional), and derived variables such as salinity and sound velocity.

Specifications

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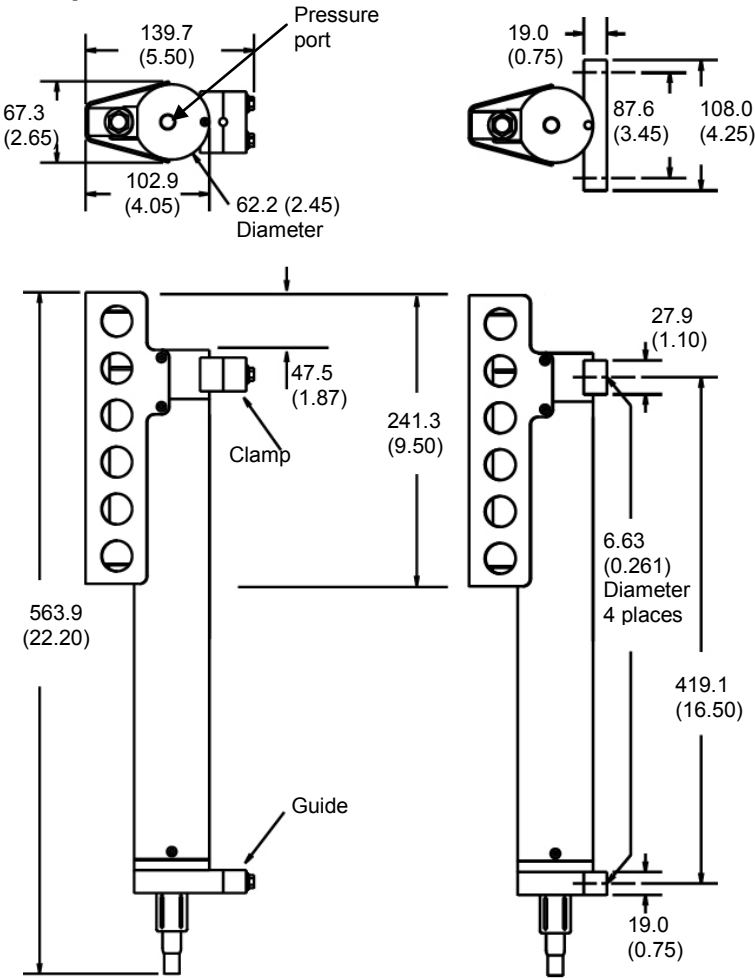Pressure ranges are expressed in meters of deployment depth capability.

	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	0.0002 per month	0.0003 (0.003 mS/cm) per month	0.05% of full scale range per year
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 range 2.6 to 6 S/m, plus zero conductivity (air)	Ambient pressure to full scale range in 5 steps
Memory	8 Mbyte non-volatile FLASH memory		
Data Storage	Conductivity & temperature: 6 bytes per sample (3 bytes each) Time: 4 bytes per sample. Pressure (optional): 5 bytes per sample. **Recorded Parameters** **Memory Space (number of samples)** C, T, and time 800,000 C, T, P, and time 533,000		
Real-Time Clock	32,768 Hz TCXO accurate to ±1 minute/year.		
Internal Batteries	Nominal 10.6 Amp-hour pack consisting of 12 AA Saft LS 14500 lithium batteries (3.6 V and 2.45 Amp-hours each). Capacity for more than 630,000 samples for a typical sampling scheme (see *Battery Endurance* for example calculation). See *Shipping Precautions* in *Section 1: Introduction*. Note: Saft batteries can be purchased from Sea-Bird or other sources. See Saft's website for suppliers (www.saftbatteries.com). Alternatively, substitute either of the following: - Tadiran TL-4903, AA (3.6 V and 2.4 Amp-hours each) (www.tadiran.com) - Electrochem 3B0064/BCX85, AA (3.9 V and 2.0 Amp-hours each) (www.electrochemsolutions.com)		
External Input Power	0.5 Amps at 9-24 VDC. To avoid draining internal batteries, use external voltage greater than 10 VDC. See *External Power*.		

Power Requirements	• Quiescent current: 30 microAmps.
	• Communication current: 4.3 milliAmps.
	• Acquisition current:
	   - 15 milliAmps if transmitting real-time data.
	   - 13 milliAmps for autonomous sampling if not transmitting real-time data.
	Acquisition time: 1.8 – 2.6 seconds/sample (depends on sampling mode and inclusion of pressure sensor, see *Sample Timing*).		

Housing and Depth Rating	*Standard:* Titanium housing, 7000 m (23,000 ft) *Optional:* Plastic *ShallowCAT* housing, 350 m (1150 ft)		
Weight (without pressure sensor)	*Standard titanium housing:* In air: 3.8 kg (8.3 lbs) In water: 2.3 kg (5.1 lbs) *Optional plastic ShallowCAT housing:* In air: 2.7 kg (6.0 lbs) In water: 1.2 kg (2.7 lbs)		

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

Dimensions and End Cap Connector

Dimensions in millimeters (inches)

Pressure port

139.7 (5.50)

67.3 (2.65)

102.9 (4.05)

62.2 (2.45) Diameter

19.0 (0.75)

87.6 (3.45)

108.0 (4.25)

47.5 (1.87)

Clamp

241.3 (9.50)

27.9 (1.10)

563.9 (22.20)

6.63 (0.261) Diameter 4 places

419.1 (16.50)

Guide

19.0 (0.75)

Connector

Standard Wire Mounting Clamp and Guide

113.8 (4.48)

87.6 (3.45)

108.0 (4.25)

Alternate Flat Surface Mounting Brackets

Wet-Pluggable
MCBH-4MP (WB), TI
(3/8" length base,
1/2-20 thread)

XSG-4-BCL-HP-SS

Pin	Signal
1	Common
2	RS-232 data receive
3	RS-232 data transmit
4	9-24 VDC (optional external power)
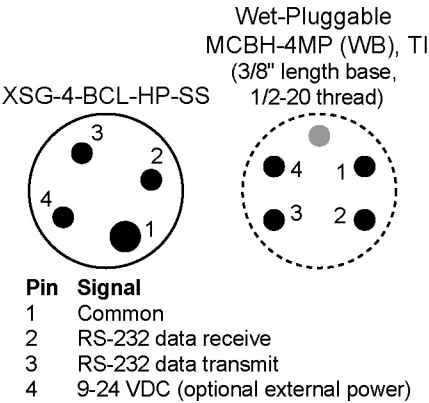
Cables and Wiring

RMG Connector Cable Wiring -- DN 32277

RMG-4FS W/LOCKING SLEEVE

PN17096 DB-9S FEMALE CONNECTOR
PN17097 DB9 CONNECTOR HOOD

1 WHITE
4 RED — 2 BLACK
3 GREEN
P1

P1

P2

1 6
5 9
P2

P1 RMG-4FS		P2 DB-9S	BLK/RED PAIR
PIN 1	WHITE	PIN 5	BLK
PIN 2	BLACK	PIN 3	
PIN 3	GREEN	PIN 2	
PIN 4	RED		RED

BLK#20 (-)
RED#20 (+)
BLK/RED TWISTED PAIR
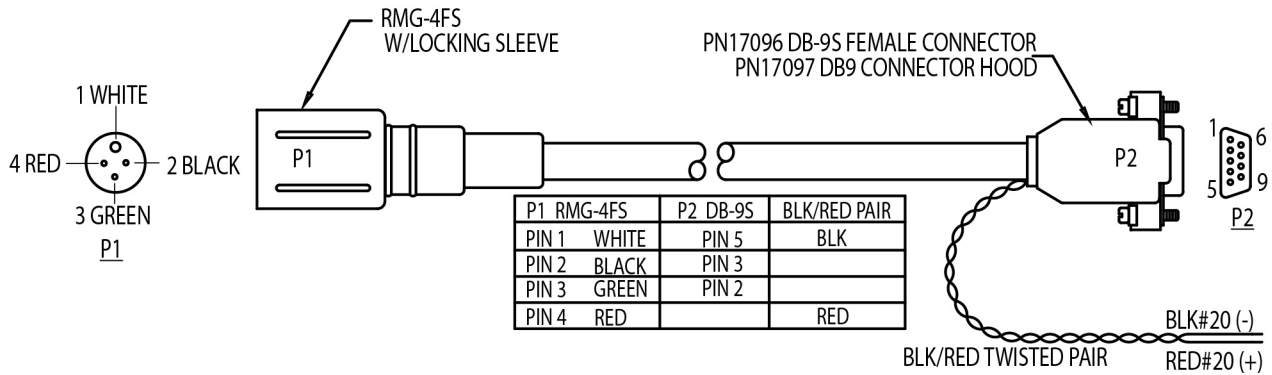
MCIL Wet-Pluggable Connector Cable Wiring -- DN 32366

MCIL-4FS W/LOCKING SLEEVE

LOCATING PIN
1 BLACK   4 GREEN
2 WHITE   3 RED
P1

P1

P1 MCIL-4FS		P2 DB-9S	BLK/RED PAIR
PIN 1	BLACK	PIN 5	BLK
PIN 2	WHITE	PIN 3	
PIN 3	RED	PIN 2	
PIN 4	GREEN	---	RED
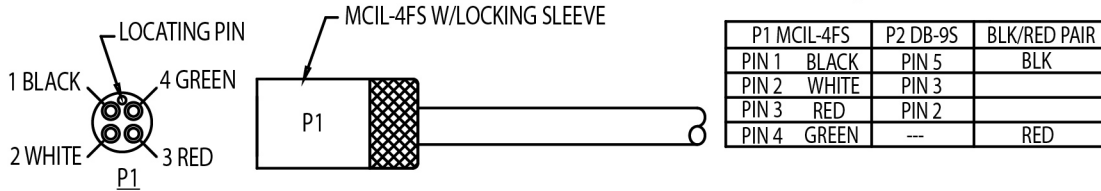
172293, DF11 CONNECTOR, 6 PIN

234533, CONNECTOR KEY

XSG Connector Wiring -- DN 41717

PIN 3 (GRN)
PIN 1 (WHT)
PIN 2 (BLK)
PIN 4 (RED)

2 1
4 3
6 5
BACK SIDE
DF11
(VIEW B-B)

BACK SIDE
KEY
(VIEW B-B)

SIDE VIEW
DF11+KEY

'O' RING 2-017, PN 30072

IMPULSE XSG-4BCL-HP-SS
1/2-20, PN 17654

WHT
1
BLK 2   4 RED
3
GRN
VIEW A-A
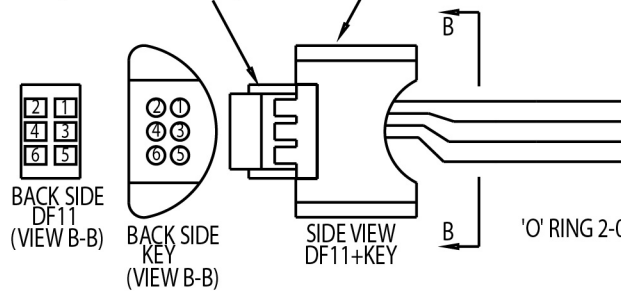
MCBH Wet-Pluggable Connector Wiring -- DN 41718
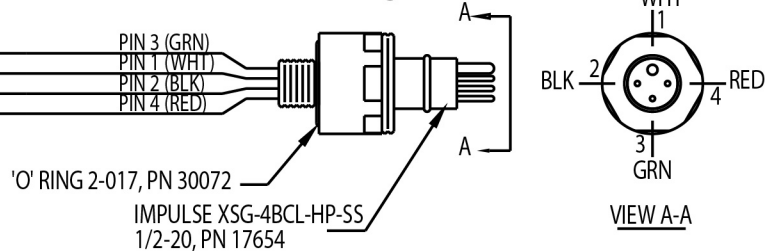
DF11 CONNECTOR	BULKHEAD CONNECTOR	FUNCTION
PIN 1	PIN 3 (GRN)	TX TO PC
PIN 2	PIN 1 (WHT)	COMMON
PIN 3	PIN 2 (BLK)	RX FROM PC
PIN 4	PIN 4 (RED)	EXTERNAL PWR
PIN 5		
PIN 6		

PIN 3 (GRN)
PIN 1 (WHT)
PIN 2 (BLK)
PIN 4 (RED)

'O' RING 2-015, PN 30325

CONN, MCBH-4MP(WB), TI,
1/2-20,IMPULSE, PN 172021

GUIDE PIN
RED   WHT
4   1
3   2
GRN   BLK
VIEW A-A
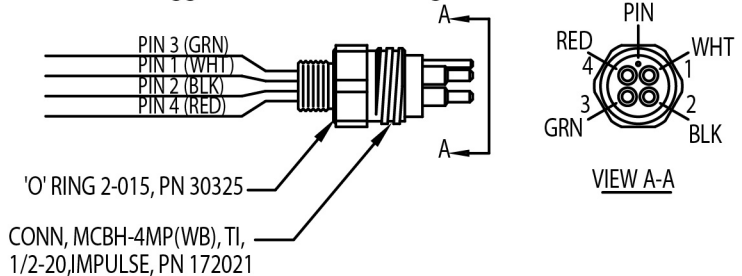
Sample Timing

> **Notes:**
> - Acquisition time shown does not include time to transmit real-time data, which is dependent on baud rate (**BaudRate=**) and number of characters being transmitted (defined by **OutputFormat=**, **OutputSal=**, and **OutputSV=**).
> - Time stored and output with the data is the time at the **start** of the sample, after a small amount of time for the MicroCAT to wake up and prepare to sample. For example, if the MicroCAT is programmed to wake up and sample at 12:00:00, the stored and displayed time will indicate 12:00:01 or 12:00:02.

Sample timing is dependent on several factors, including sampling mode and whether the MicroCAT has an optional pressure sensor.

Autonomous Sampling (time between samples = **SampleInterval**)
Power on time for each sample while logging:
- **Without pressure**: power-on time = 1.8 seconds
- **With pressure**: power-on time = 2.4 seconds

Polled Sampling or Serial Line Sync Sampling
Time from end of take sample command to beginning of reply:
- **Without pressure**: power-on time = 2.0 seconds
- **With pressure**: power-on time = 2.6 seconds

Battery Endurance

> **Notes:**
> - If the MicroCAT is logging data and the battery voltage is less than 6.15 volts for five consecutive scans, the MicroCAT halts logging.
> - Sea-Bird recommends using the capacity value of 8.8 Amp-hours for the Saft batteries as well as for the alternate battery types (Tadiran TL-4903 and Electrochem 3B0064/BCX85 AA).
> - This MicroCAT uses a battery pack with a **red** cover plate. Some MicroCATs use a battery pack with a yellow cover plate; those packs are wired differently, and will not work properly in this MicroCAT.
> - **See *Specifications* above for data storage limitations.**

The battery pack has a nominal capacity of 10.6 Amp-hours. This is lower than the Saft factory capacity rating (2.45 Amp-hours * 6 = 14.7 Amp-hours), because the battery holder includes voltage up-conversion circuitry that consumes some battery capacity. For planning purposes, to account for the MicroCAT's current consumption patterns and for environmental conditions affecting battery performance, **Sea-Bird recommends using a conservative value of 8.8 Amp-hours**.

Acquisition current varies, depending on whether the MicroCAT is transmitting real-time data: 15 mA if transmitting real-time data, 13 mA if not. Quiescent current is 30 microAmps (0.26 AH per year).

Acquisition time is shown above in *Sample Timing*. The time required for each sample is dependent on the user-programmed sampling mode, and inclusion of a pressure sensor in the MicroCAT. So, battery endurance is highly dependent on the application. An example is shown below. **You can use the Deployment Endurance Calculator** to determine the maximum deployment length, instead of performing the calculations by hand.

> *Example:* A MicroCAT with pressure sensor is set up to sample autonomously every 10 minutes (6 samples/hour), and is not transmitting real-time data. How long can it be deployed?
>
> **Sampling** time (autonomous sampling, with pressure sensor) = 2.4 seconds
> Sampling current consumption = 0.013 Amps * 2.4 seconds = 0.031 Amp-seconds/sample
> In 1 hour, sampling current consumption = 6 * 0.031 Amp-seconds/sample = **0.19 Amp-seconds/hour**
> **Quiescent** current = 30 microAmps = 0.03 mA
> In 1 hour, quiescent current consumption ≈ 0.03 mA * 3600 seconds/hour = **0.11 Amp-seconds/hour**
> **Total** current consumption / hour = 0.19 + 0.11 = **0.3 Amp-seconds/hour**
> Capacity = (8.8 Amp-hours * 3600 seconds/hr) / (0.3 Amp-seconds/hour) = 105,000 hours = 4400 days = 12 years!
> ***However, Sea-Bird recommends that batteries should not be expected to last longer than 2 years in the field.***
> Number of samples = 105,000 hours * 6 samples/hour = 630,000 samples

External Power

The MicroCAT can be powered from an external source that supplies 0.5 Amps at 9 – 24 VDC. The internal lithium pack is diode-OR'd with the external source, so power is drawn from whichever voltage source is higher. The MicroCAT can also be operated from the external supply without having the lithium batteries installed. Electrical isolation of conductivity prevents ground loop noise contamination in the conductivity measurement.

Cable Length and External Power

Note:
See *Real-Time Data Acquisition* in *Section 4: Deploying and Operating MicroCAT* for baud rate limitations on cable length if transmitting real-time data.

There are two issues to consider if powering the MicroCAT externally:
- Limiting the communication IR loss to 1 volt **if transmitting real-time data**; higher IR loss will cause the instrument to transmit data that does not meet the RS-232 communication standard.
- Supplying enough power at the power source so that sufficient power is available at the instrument after considering IR loss.

Each issue is discussed below.

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

Limiting Communication IR Loss to 1 Volt if Transmitting Real-Time Data
The limit to cable length is typically reached when the maximum *communication* current times the power common wire resistance is more than 1 volt.

$$V_{limit} = 1 \text{ volt} = IR_{limit}$$

Maximum cable length = R_{limit} / wire resistance per foot

where I = communication current required by MicroCAT (4.3 milliAmps; see *Specifications*).

Example 1 – For 20 gauge wire, what is maximum distance to transmit power to MicroCAT if transmitting real-time data?
For 4.3 milliAmp communications current, R_{limit} = V_{limit} / I = 1 volt / 0.0043 Amps = 232 ohms
For 20 gauge wire, resistance is 0.0107 ohms/foot.
Maximum cable length = 232 ohms / 0.0107 ohms/foot = 21734 feet = 6626 meters

Example 2 – Same as above, but there are 4 MicroCATs powered from the same power supply.
For 4.3 milliAmp communications current, R_{limit} = V_{limit} / I = 1 volt / (0.0043 Amps * 4 MicroCATs) = 58 ohms
Maximum cable length = 58 ohms / 0.0107 ohms/foot = 5433 feet = 1656 meters (to MicroCAT *furthest* from power source)

Supplying Enough Power to MicroCAT
Another 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. The power requirement varies, depending on whether *any* power is drawn from the batteries:
- Provide at least 10 volts, after IR loss, to prevent the MicroCAT from drawing **any** power from the batteries (if you do not want to draw down the batteries):   V - IR $\geq$ 10 volts
- Provide at least 9 volts, after IR loss, if allowing the MicroCAT to draw down the batteries or if no batteries are installed: V - IR $\geq$ 9 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 and deploying MicroCAT with no batteries?
V - IR $\geq$ 9 volts   12 volts - (0.50 Amps) * (0.0107 ohms/foot * 2 * cable length) $\geq$ 9 volts
     3 volts $\geq$ (0.50 Amps) * (0.0107 ohms/foot * 2 * cable length)   Cable length $\leq$ 280 ft = 85 meters
Note that 85 m << 6626 m (maximum distance if transmitting real-time data), so IR drop in power is controlling factor for this example. 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 $\geq$ 9 volts   12 volts - (0.50 Amps * 4 MicroCATs) * (0.0107 ohms/foot * 2 * cable length) $\geq$ 9 volts
     3 volts $\geq$ (0.50 Amps * 4 MicroCATs) * (0.0107 ohms/foot * 2 * cable length)
Cable length $\leq$ 70 ft = 21 meters (to MicroCAT *furthest* from power source)

Section 3: Preparing MicroCAT for Deployment

This section describes the pre-check procedure for preparing the MicroCAT for deployment. Installation of the battery pack, installation of Sea-Bird software, and testing power and communications are discussed.

Battery Installation

> **WARNING!**
> **Do not ship the MicroCAT with batteries installed. See *Shipping Precautions* in *Section 1: Introduction*.**

Batteries in heat-sealed plastic, bubble-wrap outer sleeve, and strong packaging.

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

Screws securing connector end cap (screws shown partially removed)

Cable mounting guide

Molex connector   O-rings

Description of Batteries and Battery Pack

Sea-Bird supplies twelve 3.6-volt AA lithium batteries, shipped with the MicroCAT in a heat-sealed plastic bag placed in bubble wrap and a cardboard box. The empty battery holder is installed inside the MicroCAT for shipment.

No soldering is required when assembling the battery pack.
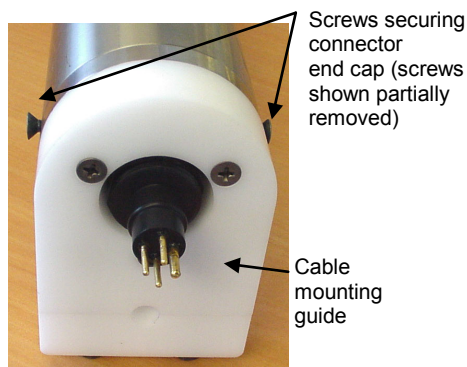
Installing Batteries

1. Remove the I/O connector end cap:
    A. Wipe the outside of the I/O end cap and housing dry, being careful to remove any water at the seam between them.
    B. Remove the 2 flat Phillips-head titanium machine screws. Do not remove any other screws from the housing.
    Note: For plastic-housing MicroCATs shipped or retrofitted after July 2008, these are hex screws instead of Phillips-head screws. Sea-Bird ships the MicroCAT with a 9/64-inch Allen wrench for these screws.
    C. Remove the I/O end cap by pulling firmly and steadily on the plastic cable mounting guide. It may be necessary to twist or rock 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 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.

Loosen captured screw

Handle
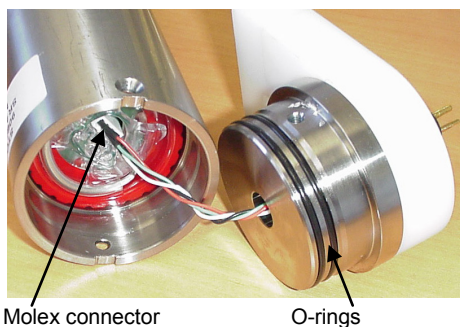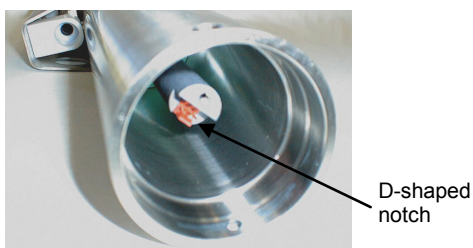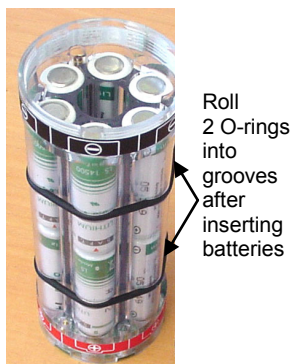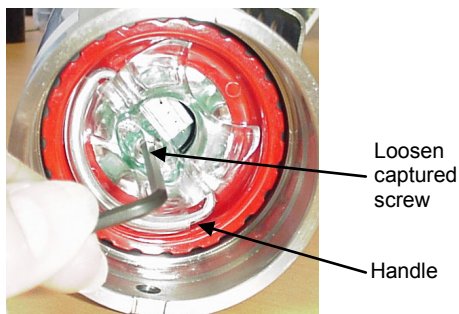
2. Remove the battery pack assembly from the housing:
    A. Loosen the captured screw from the battery cover plate, using the 7/64-inch Allen wrench included with the shipment.
    B. Lift the battery pack assembly straight out of the housing, using the handle.

3. Keep the handle in an upright position. Holding the edge of the **red** cover plate, unscrew the cover plate from the battery pack assembly.
    Note: Some MicroCATs use a battery pack with a yellow cover plate; the wiring of that pack is different from this one, and **cannot be used with this MicroCAT**.

Roll 2 O-rings out of grooves

4. Roll the 2 O-rings on the outside of the battery pack out of their grooves.
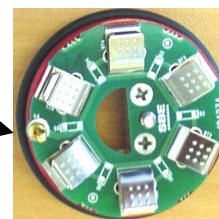
5. Insert each battery into the pack, **positive end (+) first**.

6. Roll the 2 O-rings on the outside of the battery pack into place in the grooves. The O-rings compress the side of the battery pack and hold the batteries tightly in place in the pack.

Roll 2 O-rings into grooves after inserting batteries

7. Reinstall the battery pack cover plate:
    A. Align the pin on the battery cover plate PCB with the post hole in the battery pack housing.
    B. Place the handle in an upright position. Screw the red cover plate onto the battery pack assembly. Ensure the cover is tightly screwed on to provide a reliable electrical contact.

Align pin in cover plate with post hole in battery pack

8. Replace the battery pack assembly in the housing:
    A. Align the D-shaped opening in the cover plate with the D-shaped notch on the shaft. Lower the assembly slowly into the housing, and once aligned, push gently to mate the banana plugs on the battery compartment bulkhead with the lower PCB. A post at the bottom of the battery compartment mates with a hole in the battery pack's lower PCB to prevent improper alignment.
    B. Secure the assembly to the shaft with the captured screw, using the 7/64-inch Allen wrench. Ensure the screw is tight to provide a reliable electrical contact.

D-shaped notch

9. Reinstall the I/O connector end cap:
    A. Remove any water from the 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. Plug the female end of the Molex connector onto the pins, with the flat portion of the female end against the flat portion of the 'D' cutout. Verify the connector is properly aligned – a backward connection will prevent communication with the computer.
    C. Carefully fit the end cap into the housing until the O-rings are fully seated.
    D. Reinstall the 2 flat Phillips-head titanium screws to secure the end cap.

Software Installation

Notes:

- Help files provide detailed information on the software. A separate software manual on the CD-ROM contains detailed information on SBE Data Processing.
- It is possible to use the MicroCAT without the SeatermV2 terminal program by sending direct commands from a dumb terminal or terminal emulator, such as Windows HyperTerminal.
- Sea-Bird supplies the current version of our software when you purchase an instrument. As software revisions occur, we post the revised software on our FTP site. See our website (www.seabird.com) for the latest software version number, a description of the software changes, and instructions for downloading the software from the FTP site.

Seasoft V2 was designed to work with a PC running Windows XP service pack 2 or later, Windows Vista, or Windows 7.

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

1. Insert the CD in your CD drive.

2. Install software: Double click on **SeasoftV2.exe**. Follow the dialog box directions to install the software. The installation program allows you to install the desired components. Install all the components, or just install Deployment Endurance Calculator (battery endurance calculator), SeatermV2 (terminal program *launcher* for the MicroCAT), and SBE Data Processing (data processing).

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

Power and Communications Test

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

Test Setup

Locking sleeve
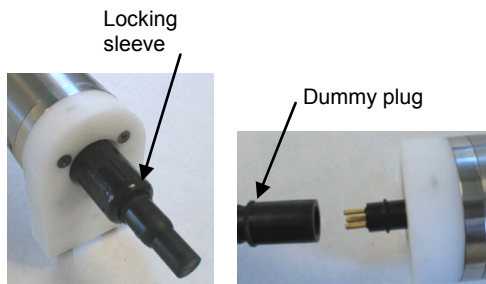
Dummy plug

1. Remove dummy plug (if applicable):
   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. **Standard Connector** - Install the I/O cable connector, aligning the raised bump on the side of the connector with the large pin (pin 1 - ground) on the MicroCAT.   **OR**
   MCBH Connector – Install the I/O cable connector, aligning the pins.

3. Connect the I/O cable to your computer's serial port.

Note:
See SeatermV2's Help files.

Test

1. Double click on **SeatermV2.exe**. The main screen looks like this:
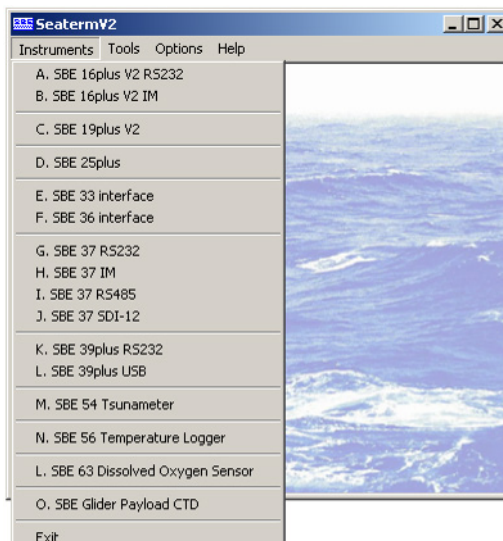
SeatermV2 is a *launcher*, and launches the appropriate terminal program for the selected instrument.

Note:
See Seaterm232's Help files.

2. In the Instruments menu, select *SBE 37 RS232*.
   Seaterm232 opens; the main screen looks like this:
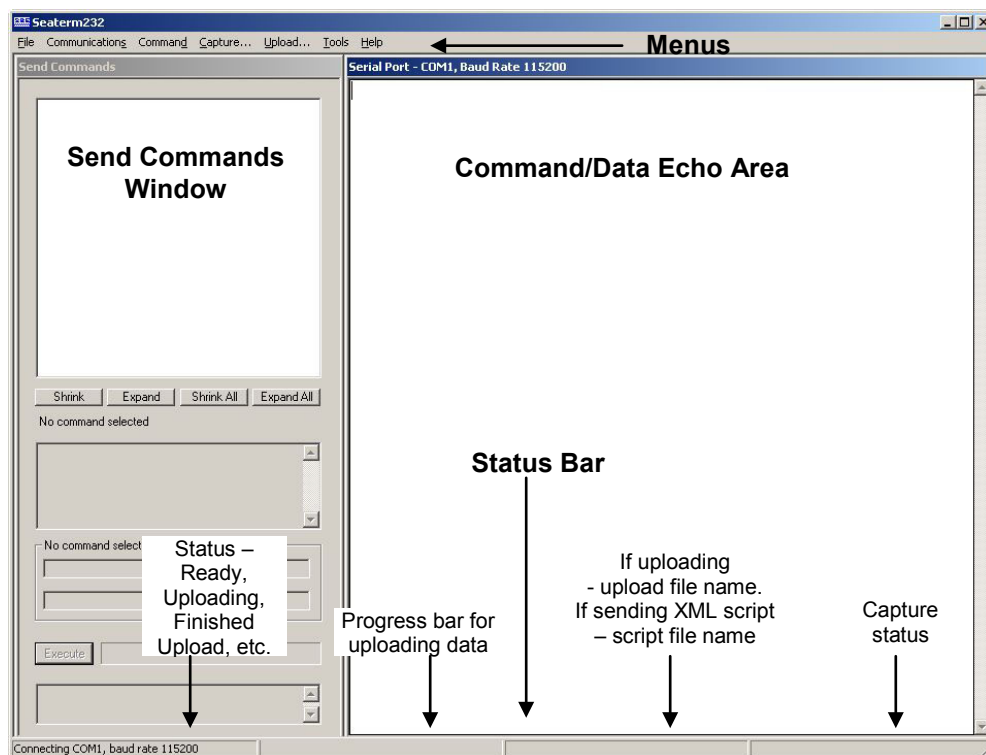
- Menus – For tasks and frequently executed instrument commands.
- Send Commands window – Contains commands applicable to your MicroCAT. The list appears after you connect to the MicroCAT.
- Command/Data Echo Area – Title bar of this window shows Seaterm232's current comm port and baud rate. Commands and the MicroCAT responses are echoed here. Additionally, a command can be manually typed or pasted (ctrl + V) here. Note that the MicroCAT must be *connected* and *awake* for it to respond to a command.
- Status bar – Provides connection, upload, script, and capture status information.

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Following is a description of the menus:

Menu	Description	Equivalent Command*
File	• Load command file – opens selected .XML command file, and fills Send Commands window with commands. • Unload command file – closes command file, and removes commands from Send Commands window. • Exit - Exit program.	-
Communications	• Configure – Establish communication parameters (comm port and baud rate). • Connect – connect to comm port. • Disconnect – disconnect from comm port. • Disconnect and reconnect – may be useful if instrument has stopped responding.	-
Command	• Abort – interrupt and stop MicroCAT's response. • Send 5 second break (for use with Serial Line Sync mode). • Send stop command. • Set local time– Set date and time to time sent by timekeeping software on your computer; accuracy ± 25 msec of time provided by computer. • Set UTC Time (Greenwich Mean Time) – Set date and time to time sent by timekeeping software on your computer; accuracy ± 25 msec of time provided by computer.	• (press Esc key several times for Abort) • **Stop** • **DateTime=** • **DateTime=**
Capture	Capture instrument responses on screen to file, to save real-time data or use for diagnostics. File has .cap extension. Click Capture menu again to turn off capture. Capture status displays in Status bar.	—
Upload	Upload data stored in memory, in a format that Sea-Bird's data processing software can use. Uploaded data has .xml extension, and is then automatically converted to a .hex and a .xmlcon file that can be used in SBE Data Processing's Data Conversion module. Before using Upload: **stop logging** by sending **Stop**.	Several status commands and appropriate data upload command as applicable to user selection of range of data to upload (use Upload menu if you will be processing data with SBE Data Processing)
Tools	• Diagnostics log - Keep a diagnostics log. • Convert .XML data file – Using Upload menu automatically does this conversion; tool is available if there was a problem with the automatic conversion. • Send script – Send XML script to MicroCAT. May be useful if you have a number of MicroCATs to program with same setup.	-

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

Note:
Set local time and *Set UTC time* are disabled if the baud rate in Seaterm232 is set to 115200, because the software cannot reliably set the time at that baud.

Note:
SeatermV2 with version < 1.1 did not convert the uploaded .xml data file to a .hex and .xmlcon file. *Convert .XML data file* in the Tools menu was used to convert the .xml data file to a .cnv file, which could be processed in SBE Data Processing. We recommend that you update your SeatermV2 software to 1.1b or later.

3. If this is the first time Seaterm232 is being used, the configuration dialog box displays:

Computer COM port and baud rate for communication between computer and MicroCAT. Seaterm232 tries to connect at this baud rate, but if unsuccessful will cycle through all available baud rates.

Update COM Port pulldown to include connected USB ports.
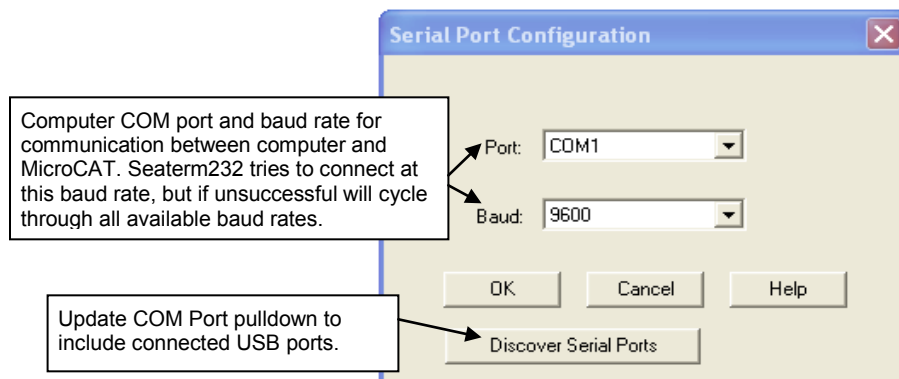
Make the desired selections, and click OK.

Note:
Seaterm232's baud rate must be the same as the MicroCAT baud rate (set with **BaudRate=**). Baud is factory-set to 9600, but can be changed by the user (see *Command Descriptions* in *Section 4: Deploying and Operating MicroCAT*). Other communication parameters – 8 data bits, 1 stop bit, and no parity – cannot be changed.

4. Seaterm232 tries to automatically connect to the MicroCAT. As it connects, it sends **GetHD** and displays the response, which provides factory-set data such as instrument type, serial number, and firmware version. Seaterm232 also fills the Send Commands window with the correct list of commands for your MicroCAT.

If there is no communication:

A. In the Communications menu, select *Configure*. The Serial Port Configuration dialog box appears. Select the Comm port and baud rate for communication, and click OK. Note that the factory-set baud rate is documented on the Configuration Sheet.

B. In the Communications menu, select *Connect* (if *Connect* is grayed out, select *Disconnect and reconnect*). Seaterm232 will attempt to connect at the baud specified in Step A, but if unsuccessful will then cycle through all other available baud rates.

C. If there is still no communication, check cabling between the computer and MicroCAT, and try to connect again.

D. If there is still no communication, repeat Step A with a different comm port, and try to connect again.

Note:
If **OutputExecutedTag=Y**, the MicroCAT does **not** provide an S> prompt after the <Executed/> tag at the end of a command response.

After Seaterm232 displays the **GetHD** response, it provides an S> prompt to indicate it is ready for the next command.

Taking a look at the Send Commands window:

Note:
The Send Commands window includes commands for pump setup because the 37-SMP (pumped MicroCAT) uses the same firmware as the 37-SM. However, these commands are not applicable to the 37-SM.

Click on desired command description in list.

Help box describes selected command in more detail.

Enter any command arguments (such as starting and ending sample number for upload) in these boxes.

Click Execute when ready to send selected command.

Send Commands

Commands
- Status
- General Setup
- Pump Setup
- Memory Setup
- Output Format Setup
- Autonomous Sampling (logging)
- Polled Sampling
- Serial Line Sync
- Data Upload
  - Upload data from FLASH memory
  - Upload data from FLASH memory
- Calibration Coefficients
- Hardware Configuration

Shrink | Expand | Shrink All | Expand All

Help for command GetSamples:

Upload selected data from FLASH memory in format defined by OutputFormat=. If starting and ending sample numbers are omitted, all data is uploaded.

Arguments for command GetSamples:

Starting sample number

Ending sample number

Execute | GetSamples:

This box shows selected command.

You can use the Send Commands window to send commands, or simply type the commands in the Command/Data Echo area if desired.

Note:

The MicroCAT automatically enters quiescent (sleep) state after 2 minutes without receiving a command. This timeout algorithm is designed to conserve battery energy if the user does not send **QS** to put the MicroCAT to sleep. If the system does not appear to respond, select *Connect* in the Communications menu to reestablish communications.

5. Display MicroCAT status information typing **DS** and pressing the Enter key. The display looks like this:

```
SBE37SM-RS232 3.1  SERIAL NO. 9999  20 Aug 2012 00:48:50
vMain =  8.08, vLith =  3.08
samplenumber = 77, free = 559163
not logging, stop command
sample interval = 15 seconds
data format = converted engineering
transmit real-time = yes
sync mode = no
pump installed = no
```

6. Command the MicroCAT to take a sample by typing **TS** and pressing the Enter key. The display looks like this (if optional pressure sensor installed, **OutputFormat=1**, and you are not outputting salinity or sound velocity):

```
 23.7658,  0.00019,    0.062, 20 Aug 2012, 00:51:30
```

where   23.7658 = temperature in degrees Celsius
            0.00019 = conductivity in S/m
            0.062 = pressure in decibars
            20 Aug 2012 = date
            00:51:30 = time

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

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

The MicroCAT is ready for programming and deployment.

Section 4: Deploying and Operating MicroCAT

This section includes:
- system operation with example sets of operation commands
- baud rate and cable length considerations
- timeout description
- detailed command descriptions
- data output formats
- deploying and recovering the MicroCAT
- uploading and processing data from the MicroCAT's memory

Sampling Modes

The MicroCAT has three basic sampling modes for obtaining data:
- Polled Sampling – On command, the MicroCAT takes one sample.
- Autonomous Sampling – At pre-programmed intervals, the MicroCAT wakes up, samples, stores data in memory, and goes to sleep.
- Serial Line Synchronization – In response to a pulse on the serial line, the MicroCAT wakes up, samples, stores data in memory, and goes to sleep.

Commands can be used in various combinations to provide a high degree of operating flexibility.

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

Polled Sampling

On command, the MicroCAT takes a measurement and sends the data to the computer. Storing of data in the MicroCAT's FLASH memory is dependent on the particular command used.

---

*Example: **Polled Sampling** (user input in bold)*
Wake up MicroCAT. Set current date and time to December 1, 2012 9 am. Set up to send data in converted decimal form, and include salinity with data. Command MicroCAT to take a sample, and send data to computer (do not store data in MicroCAT's memory). Send power-off command.

(Select *Connect* in Seaterm232's Communications menu to connect and wake up.)
DATETIME=12012012090000
OUTPUTFORMAT=1
OUTPUTSAL=Y
GETCD   (to verify setup)
TS
QS

When ready to take a sample (repeat as desired): wake up MicroCAT, command it to take a sample and output data, and send power-off command.

(Before first sample, click Capture menu to capture data to a file – Seaterm232 requests file name for data to be stored.)
(Select *Connect* in Seaterm232's Communications menu to connect and wake up.)
TS
QS

Autonomous Sampling (Logging commands)

At pre-programmed intervals (**SampleInterval=**) the MicroCAT wakes up, samples data, stores the data in its FLASH memory, and goes to sleep (enters quiescent state). Logging is started with **StartNow** or **StartLater**, and is stopped with **Stop**. Transmission of real-time data to the computer is dependent on **TxRealTime**.

The MicroCAT has a *lockout* feature to prevent unintended interference with sampling. If the MicroCAT is logging or waiting to start logging (**StartLater** has been sent, but logging has not started yet), the MicroCAT will only accept the following commands: **GetCD**, **GetSD**, **GetCC**, **GetEC**, **GetHD**, **DS**, **DC**, **TS**, **TSH**, **SL**, **SLT**, **QS**, and **Stop**.

Additionally, if the MicroCAT is logging, **it cannot be interrupted during a measurement** to accept any commands. If the MicroCAT is logging and appears unresponsive, it may be in the middle of taking a measurement; continue to try to establish communications.

If transmitting real-time data, keep the signal line open circuit or within ± 0.3 V relative to ground to minimize power consumption when not trying to send commands.

Notes:
- If the FLASH memory is filled to capacity, sampling continues, but excess data is not saved in memory (i.e., the MicroCAT does not overwrite the data in memory).
- Use **Stop** to:
  - ➢ stop logging.
  - ➢ stop waiting to start logging (after **StartLater** has been sent).
  Once **Stop** is sent, the MicroCAT will accept all commands again.

Example: Autonomous Sampling (user input in bold).
Wake up MicroCAT. Initialize logging to overwrite previous data in memory. Set current date and time to May 1, 2012 9 am. Set up to sample every 60 seconds. Do not transmit real-time data to computer. Set up to automatically start logging on 10 May 2012 at 12:00:00. Send power-off command after all parameters are entered – system will automatically wake up and go to sleep for each sample.

(Select *Connect* in Seaterm232's Communications menu to connect and wake up.)
INITLOGGING
DATETIME=05012012090000
SAMPLEINTERVAL=60
TXREALTIME=N
STARTDATETIME=05102012120000
STARTLATER
GETCD   (to verify setup)
GETSD   (to verify status is *waiting to start logging*)
QS

After logging begins, look at data from last sample to check results, and then go to sleep:

(Select *Connect* in Seaterm232's Communications menu to connect and wake up.)
SL
QS

When ready to upload all data to computer, wake up MicroCAT, stop sampling, upload data, and then go to sleep:
(Select *Connect* in Seaterm232's Communications menu to connect and wake up.)
STOP
(Click Upload menu – Seaterm232 leads you through screens to define data to be uploaded and where to store it.)
QS

Serial Line Synchronization (Serial Line Sync)

> **Note:**
> Use **GetCD** or **DS** to view Serial Line Sync enable/disable status.

Serial Line Sync allows a simple pulse (a single character) on the RS-232 line to initiate a sample. This mode provides easy integration with ADCPs or current meters, which can synchronize MicroCAT sampling with their own without drawing on their battery or memory resources.

If this mode is enabled (**SyncMode=Y**), sending a pulse causes the MicroCAT to wake up, take a sample, and store the data in FLASH memory. Transmission of real-time data to the computer is dependent on **TxRealTime**.

Keep the signal line open circuit or within ± 0.3 V relative to ground to minimize power consumption when not trying to send a pulse to take a sample.

> **Note:**
> *Send 5 second break* holds the RS-232 RX line in space state (greater than 3 volts) for 5 seconds.

To disable serial line sync, the MicroCAT must be in the space state when the sample is finished. Disable serial sync mode using one of the following methods:
- Send three Esc characters, or
- In Seaterm232's Command menu, select *Send 5 second break*.

This sets sync mode to no in the MicroCAT. Then press any key to wake up the MicroCAT. Once serial line sync mode is disabled (**SyncMode=N**), you can communicate with the MicroCAT using the full range of commands (polled sampling, logging, upload, etc.).

---

*Example: **Serial Line Sync** (user input in bold)*
Wake up MicroCAT. Initialize logging to overwrite previous data in memory. Set current date and time to May 1, 2012 9 am. Set up to send data in converted decimal format, and include salinity with data. Set up to transmit real-time data. Enable serial line sync mode. Send power off command.

(Select *Connect* in Seaterm232's Communications menu to connect and wake up.)
INITLOGGING
DATETIME=05012012090000
OUTPUTFORMAT=1
OUTPUTSAL=Y
TXREALTIME=Y
SYNCMODE=Y
GETCD   (to verify setup)
QS

When ready to take a sample:

(To save real-time data, click Capture menu to capture data to a file – Seaterm232 requests file name for data to be stored.)
Send a pulse – press any key – to wake up, take and transmit 1 sample, store in memory, and go to sleep.
Repeat as desired.

When ready to upload all data to computer, disable serial line sync mode, and then upload data and go to sleep:

(In Seaterm232's Command menu, select *Send 5 second break*. MicroCAT disables serial line sync mode [sets **SyncMode=N**]. Then press any key.)
GETCD   (to verify MicroCAT is communicating, and that sync mode is set to no)
(Click Upload menu – Seaterm232 leads you through screens to define data to be uploaded and where to store it.)
QS

Real-Time Data Acquisition

Notes:
- Baud rate is set with **BaudRate=**. Set **TxRealTime=Y** to output real-time data. See *Command Descriptions* in this section for command details.
- If using external power, see *External Power* in *Section 2: Description of MicroCAT* for power limitations on cable length.

The length of cable that the MicroCAT can drive is dependent on the baud rate. Check the capability of your computer and terminal program before increasing the baud; high baud requires a short cable and good PC serial port with an accurate clock. The allowable combinations are:

Maximum Cable Length (meters)	Maximum Baud Rate
1600	600
800	1200
400	2400
200	4800
100	9600
50	19200
25	38400
16	57600
8	115200

If acquiring real-time data with Seaterm232, click the Capture menu; enter the desired file name in the dialog box, and click Save. Begin sampling. The data displayed in Seaterm232 will be saved to the designated file. Process the data as desired. Note that this file **cannot be processed by SBE Data Processing, as it does not have the required headers and format for Sea-Bird's processing software**. To process data with SBE Data Processing, upload the data from the MicroCAT's memory.

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 to prevent exhaustion of the batteries. This places the MicroCAT in quiescent state, drawing minimal current. **To re-establish control (wake up), select *Connect* in Seaterm232's Communications menu or press the Enter key.**

Command Descriptions

This section describes commands and provides sample outputs. Entries made with the commands are permanently stored in the MicroCAT and remain in effect until you change them. See *Appendix III: Command Summary* 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. Note that commands are shown with a mix of upper and lower case for ease in reading (for example**, InitLogging**), but do not need to be entered that way.

- The MicroCAT sends an error message if an invalid command is entered.

- 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 (sleep) state, re-establish communications by selecting *Connect* in Seaterm232's Communications menu or pressing the Enter key.

- If the MicroCAT is transmitting data and you want to stop it, press the Esc key or type ^C. Then press the Enter key. Alternatively, select *Abort* in Seaterm232's Command menu.

- The MicroCAT responds only to **GetCD**, **GetSD**, **GetCC**, **GetEC**, **GetHD**, **DS**, **DC**, **TS**, **TSH**, **SL**, **SLT**, **QS**, and **Stop** while sampling autonomously (**StartNow** has been sent). If you wake the MicroCAT while it is sampling (for example, to send **DS** to check on progress), it temporarily stops sampling. Autonomous sampling resumes when it goes back to sleep (either by sending **QS** or after the 2-minute timeout).

- The MicroCAT responds only to **GetCD**, **GetSD**, **GetCC**, **GetEC**, **GetHD**, **DS**, **DC**, **TS**, **TSH**, **SL**, **SLT**, **QS**, and **Stop** while waiting to start autonomous sampling (**StartLater** has been sent). To send any other commands, send **Stop**, send the desired commands to modify the setup, and then send **StartLater** again.

Status Commands

> **Note:**
> **GetCD** output does not include calibration coefficients. To display calibration coefficients, use the **GetCC** command.

> **Note:**
> The 37-SM and 37-SMP use the same firmware. The internal pump is applicable to the 37-SMP only.

GetCD Get and display configuration data, which includes parameters related to MicroCAT setup. Most of these parameters can be user-input/modified. List below includes, where applicable, command used to modify parameter:

- Device type, Serial number
- Optional pressure sensor installed?
- Reference pressure to use in calculations if no pressure sensor installed (only appears if pressure sensor not installed) [**ReferencePressure=**]
- Pump installed? Always no for 37-SM
- Output data format [**OutputFormat=**]
- Output salinity with each sample [**OutputSal=**]?
- Output sound velocity with each sample [**OutputSV=**]?
- Transmit autonomous and serial line sync data real-time [**TxRealTime=**]?
- Interval between samples for continuous sampling [**SampleInterval=**]
- Serial sync mode state [**SyncMode=**]

Example: MicroCAT with a pressure sensor (user input in bold, command used to modify parameter in parentheses).
```
GETCD
<ConfigurationData DeviceType = 'SBE37SM-RS232' SerialNumber = '03709999>
   <PressureInstalled>yes</PressureInstalled>              (inclusion of optional pressure sensor set at factory)
   <PumpInstalled>no</PumpInstalled>                                  [only valid setting for 37-SM]
   <SampleDataFormat>converted Decimal</SampleDataFormat>                        [OutputFormat=]
   <OutputSalinity>yes</OutputSalinity>                                          [OutputSal=]
   <OutputSV>yes</OutputSV>                                                      [OutputSV=]
   <TxRealTime>yes</TxRealTime>                                                  [TxRealTime=]
   <SampleInterval>15</SampleInterval>                                           [SampleInterval=]
   <SyncMode>no</Syncmode>                                                       [SyncMode=]
</ConfigurationData>
```

Status Commands (*continued*)

GetSD	Get and display status data, which contains data that changes while deployed. List below includes, where applicable, command used to modify parameter:

- Device type, Serial number
- Date and time [**DateTime=**] in ISO8601-2000 extended format (yyyy – mm-ddThh:mm:ss)
- Number of recorded events in event counter [reset with **ResetEC**]
- Voltages – main battery voltage and back-up lithium battery voltage
- Memory – [reset with **InitLogging**]
  - Number of bytes in memory
  - Number of samples in memory
  - Number of additional samples that can be placed in memory
  - Length (number of bytes) of each sample
- Logging status – yes or no (to indicate whether it is currently logging data); if applicable, reason that logging has stopped

Example: (user input in bold, command used to modify parameter in parentheses)
```
getsd
<StatusData DeviceType = 'SBE37SM-RS232' SerialNumber = '03709999'>
   <DateTime>2012-08-20T00:48:32</DateTime>                          [DateTime=]
   <EventSummary numEvents = '0'/>                               [can clear with ResetEC=]
   <Power>
      <vMain> 7.41</vMain>
      <vLith> 3.16</vLith>
   </Power>
   <MemorySummary>
      <Bytes>0</Bytes>
      <Samples>0</Samples>                                    [can clear with InitLogging]
      <SamplesFree>559240</SamplesFree>                        [can clear with InitLogging]
      <SampleLength>15</SampleLength>
   </MemorySummary>
   <AutonomousSampling>no, stop command</AutonomousSampling>    [StartNow or StartLater, Stop]
</StatusData>
```

Status Commands (*continued*)

Note:
Dates shown are when calibrations were performed.

GetCC

Get and display calibration coefficients, which are initially factory-set and should agree with Calibration Certificates shipped with MicroCAT.

```
Example: MicroCAT with a pressure sensor (user input in bold, command used to modify coefficient in parentheses)
getcc
<CalibrationCoefficients DeviceType = 'SBE37SM-RS232' SerialNumber = '03709999'>
   <Calibration format = 'TEMP1' id = 'Temperature'>
      <SerialNum>03709999</SerialNum>
      <CalDate>04-Aug-12</CalDate>                                    [TCalDate=]
      <A0>6.947802e-05</A0>                                           [TA0=]
      <A1>2.615233e-04</A1>                                           [TA1=]
      <A2>-1.265233e-06</A2>                                          [TA2=]
      <A3>1.310479e-07</A3>                                           [TA3=]
   </Calibration>
   <Calibration format = 'WBCOND0' id = 'Conductivity'>
      <SerialNum>03709999</SerialNum>
      <CalDate>04-Aug-12</CalDate>                                    [CCalDate=]
      <G>-1.009121e+00</G>                                            [CG=]
      <H>1.410162e-01</H>                                             [CH=]
      <I>-2.093167e-04</I>                                            [CI=]
      <J>3.637053e-05</J>                                             [CJ=]
      <PCOR>-9.570000e-08</PCOR>                                      [CTCor=]
      <TCOR>3.250000e-06</TCOR>                                       [CPCor=]
      <WBOTC>1.954800e-05</WBOTC>                                     [CWBOTC=]
   </Calibration>
   <Calibration format = 'STRAIN0' id = 'Pressure'>
      <SerialNum>2478619</SerialNum>
      <CalDate>28-Jul-12</CalDate>                                    [PCalDate=]
      <PA0>1.729067e+00</PA0>                                         [PA0=]
      <PA1>1.415754e-01</PA1>                                         [PA1=]
      <PA2>1.246912e-08</PA2>                                         [PA2=]
      <PTCA0>2.243971e+00</PTCA0>                                     [PTCA0=]
      <PTCA1>1.055267e+00</PTCA1>                                     [PTCA1=]
      <PTCA2>-2.276308e-02</PTCA2>                                    [PTCA2=]
      <PTCB0>1.003849e+02</PTCB0>                                     [PTCB0=]
      <PTCB1>1.014510e-02</PTCB1>                                     [PTCB1=]
      <PTCB2>-2.057110e-04</PTCB2>                                    [PTCB2=]
      <PTEMPA0>5.669780e+01</PTEMPA0>                                 [PTempA0=]
      <PTEMPA1>-5.474043e-02</PTEMPA1>                                [PTempA1=]
      <PTEMPA2>1.267908e-05</PTEMPA2>                                 [PTempA2=]
      <POFFSET>0.000000e+00</POFFSET>                         [POffset= (decibars)]
      <PRANGE>0.000000e+00</PRANGE>                               [PRange= (psi)]
   </Calibration>
</CalibrationCoefficients>
```

Status Commands (*continued*)

GetEC	Get and display event counter data, which can help to identify root cause of a malfunction. Event counter records number of occurrences of common timeouts, power-on resets, etc. Can be cleared with **ResetEC**. Possible events that may be logged include:

- WDT reset – unexpected reset
- PON reset - power cycled on (each time power is applied)
- ErrorADC12TimeOut – response delayed from A/D converter that measures main power and back-up lithium battery power
- ErrorUART0TimeOut – timeout for transmitter to finish transmitting previous character via RS-232
- ErrorAD7714TimeOut – response delayed from temperature and pressure A/D converter
- ErrorInvWakeUpFlag – unexpected wakeup
- ErrorFLASHTimeOut – problem with writing data to FLASH memory
- Alarm long - time to take next sample is too far in future
- Alarm short - woke up MicroCAT to send a command while logging, and missed taking a sample
- LoggingRestartNoAlarm – no sample taken for 8 hours while logging, restart logging
- LoggingRestartPON – power cycled while logging, logging restarted

---

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

```
getec
<EventCounters DeviceType = 'SBE37SM-RS232' SerialNumber = '03709999'>
   <EventSummary numEvents = '0'/>                              [can clear with ResetEC]
</EventCounters>
```

ResetEC	Delete all events in event counter (number of events displays in **GetSD** response, and event details display in **GetEC** response).

Status Commands (*continued*)

GetHD   Get and display hardware data, which is
                                   fixed data describing MicroCAT:
- Device type, Serial number
- Manufacturer
- Firmware version
- Firmware date
- PCB assembly number
- Manufacture date
- Sensor types and serial numbers

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

```
gethd
<HardwareData DeviceType = 'SBE37SM-RS232' SerialNumber = '03709999'>
   <Manufacturer>Sea-Bird Electronics, Inc.</Manufacturer>
   <FirmwareVersion>3.1</FirmwareVersion>
   <FirmwareDate>20 January 2012</FirmwareDate>
   <PCBAssembly>41609A</PCBAssembly>
   <PCBAssembly>41610A</PCBAssembly>
   <PCBAssembly>41611B</PCBAssembly>
   <MfgDate>28 Feb 2012</MfgDate>
   <FirmwareLoader>SBE 37 FirmwareLoader V 1.0</FirmwareLoader>
   <InternalSensors>
      <Sensor id = 'Temperature'>
         <type>temperature-1</type>
         <SerialNumber>03709999</SerialNumber>
      </Sensor>
      <Sensor id = 'Conductivity'>
         <type>conductivity-1</type>
         <SerialNumber>03709999</SerialNumber>
      </Sensor>
      <Sensor id = 'Pressure'>
         <type>strain-0</type>
         <SerialNumber>2478619</SerialNumber>
      </Sensor>
   </InternalSensors>
</HardwareData>
```

Status Commands (*continued*)

Note:
The **DS** response contains similar information as the combined responses from **GetSD** and **GetCD**, but in a different format.

DS   Display operating status and setup.

List below includes, where applicable, command used to modify parameter.
- Firmware version, serial number, date and time [**DateTime=**]
- Main battery voltage and back-up lithium battery voltage
- Number of samples in memory [**SampleNumber=**] and available sample space in memory
- Logging status (logging not started, logging data, not logging, or unknown)
- Sample interval time [**SampleInterval=**]
- Output format [**OutputFormat=**]
- Output salinity with each sample [**OutputSal=**]? Only displays if set to yes
- Output sound velocity with each sample [**OutputSV=**]? Only displays if set to yes
- Transmit autonomous and serial line sync data real-time [**TxRealTime=**]?
- Serial sync mode state [**SyncMode=**]
- Pump installed? Always no for 37-SM
- Reference pressure to use in calculations if no pressure sensor installed (only appears if pressure sensor not installed) [**ReferencePressure=**]

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

Example: MicroCAT with a pressure sensor (user input in bold, command used to modify parameter in parentheses).
DS
```
SBE37SM-RS232 3.1  SERIAL NO. 9999  20 Aug 2012 10:55:45          [DateTime=]
vMain =  8.08, vLith =  3.08
samplenumber = 77, free = 559163                                 [SampleNumber=]
not logging, stop command
sample interval = 15 seconds                                     [SampleInterval=]
data format = converted engineering                             [OutputFormat=]
output salinity                                                 [OutputSal=]
output sound velocity                                            [OutputSV=]
transmit real-time = yes                                        [TxRealTime=]
sync mode = no                                                  [SyncMode=]
pump installed = no                                    [only valid setting for 37-SM]
```

Status Commands (*continued*)

Notes:
- The **DC** and **GetCC** responses contain the same information, but in different formats.
- Dates shown are when calibrations were performed.

DC   Display calibration coefficients, which are initially factory-set and should agree with Calibration Certificates shipped with MicroCAT.

Example: MicroCAT with a pressure sensor (user input in bold, command used to modify parameter in parentheses).

```
DC
SBE37SM-RS232 V 3.1 9999
temperature: 04-aug-12                                              [TCalDate=]
TA0 = 6.947802e-05                                                  [TA0=]
TA1 = 2.615233e-04                                                  [TA1=]
TA2 = -1.265233e-06                                                 [TA2=]
TA3 = 1.310479e-07                                                  [TA3=]
conductivity: 04-aug-12                                             [CCalDate=]
G = -1.036689e+00                                                   [CG=]
H = 1.444342e-01                                                    [CH=]
I = -3.112137e-04                                                   [CI=]
J = 3.005941e-05                                                    [CJ=]
CPCOR = -9.570001e-08                                               [CPCor=]
CTCOR = 3.250000e-06                                                [CTCor=]
WBOTC = 1.968100e-05                                                [CWBOTC=]
pressure S/N 2478619, range = 2901 psia, 03-aug-12   [PRange= (psi), PCalDate=]
    PA0 = 0.000000e+00                                              [PA0=]
    PA1 = 0.000000e+00                                              [PA1=]
    PA2 = 0.000000e+00                                              [PA2=]
    PTCA0 = 0.000000e+00                                            [PTCA0=]
    PTCA1 = 0.000000e+00                                            [PTCA1=]
    PTCA2 = 0.000000e+00                                            [PTCA2=]
    PTCB0 = 0.000000e+00                                            [PTCB0=]
    PTCB1 = 0.000000e+00                                            [PTCB1=]
    PTCB2 = 0.000000e+00                                            [PTCB2=]
    PTEMPA0 = 0.000000e+00                                          [PTempA0=]
    PTEMPA1 = 0.000000e+00                                          [PTempA1=]
    PTEMPA2 = 0.000000e+00                                          [PTempA2=]
    POFFSET = 0.000000e+00                                 [POffset= (decibars)]
```

General Setup Commands

DateTime=mmddyyyyhhmmss	Set real-time clock month, day, year, hour, minute, second.

Example: Set current date and time to 10 September 2012 12:00:00 (user input in bold).
DATETIME=09102012120000

Notes:
- The MicroCAT baud rate (set with **BaudRate=**) must be the same as Seaterm232's baud rate (set in the Communications menu).
- **BaudRate=** must be sent twice. After the first entry, the MicroCAT changes to the new baud, and then waits for the command to be sent again at the new baud (In the Communications menu, select *Configure*. In the dialog box, select the new baud rate and click OK. Then retype the command.). This prevents you from accidentally changing to a baud that is not supported by your computer. If it does not receive the command again at the new baud, it reverts to the previous baud rate.

BaudRate=x	**x=** baud rate (600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200). Default 9600. Check capability of your computer and terminal program before increasing baud; high baud requires a short cable and good PC serial port with accurate clock. **Command must be sent twice to change rate.**

Length of cable that MicroCAT can drive is dependent on baud. See *Real-Time Data Acquisition*. |
| **OutputExecutedTag=x** | **x=Y**: Display XML Executing and Executed tags. Executed tag displays at end of each command response; Executing tag displays one or more times if MicroCAT response to command requires additional time.

x=N: Do not. |

Example: Set MicroCAT to output Executed and Executing tags (user input in bold).
outputexecutedtag=y
```
<Executed/>getcd
. . .     (GetCD response)
<Executed/>
```
(Note: `<Executed/>` tag at end of command response takes place of S> prompt.)

Notes:
- The MicroCAT always outputs real-time data for polled sampling.
- **TxRealTime** does not affect storing data to memory, but slightly increases current consumption and time needed to sample (and then transmit) data.
- To capture real-time data to a file, do the following *before* starting logging:
  1. Click the Capture menu in Seaterm232.
  2. Enter the desired file name in the dialog box. The *capture* status displays in the status bar at the bottom of the screen.

TxRealTime=x	**x=Y:** Output real-time data while sampling autonomously or in serial line sync mode. Data is transmitted immediately after it is sampled. For autonomous sampling, do not set **SampleInterval** < 10 seconds if transmitting real-time data (see *Sample Timing* in *Section 2: Description of MicroCAT*).

x=N: Do not output real-time data. |
| **ReferencePressure=x** | **x** = reference pressure (gauge) in decibars. MicroCAT without installed pressure sensor uses this reference pressure in conductivity (and optional salinity and sound velocity) calculations. Entry ignored if MicroCAT includes pressure sensor. |

Note:
The MicroCAT automatically enters quiescent state after 2 minutes without receiving a command. This timeout algorithm is designed to conserve battery energy if the user does not send **QS** to put the MicroCAT to sleep.

QS	Quit session and place MicroCAT in quiescent (sleep) state. Main power is turned off. Data logging and memory retention are not affected.

Memory Setup Commands

<table>
<tr><td>

Note:
If the FLASH memory is filled to capacity, sampling continues, but excess data is not saved in memory (i.e., the MicroCAT does not overwrite the data in memory).

</td></tr>
</table>

<table>
<tr><td>

Note:
Do not send InitLogging or SampleNumber=0 until all data has been uploaded. These commands do not delete the data; they just reset the data pointer. **If you accidentally send one of these commands before uploading**, recover the data as follows:
1. Set **SampleNumber=x**, where **x** is your estimate of number of samples in memory.
2. Upload data. If **x** is more than actual number of samples in memory, data for non-existent samples will be bad, random data. Review uploaded data file carefully and delete any bad data.
3. If desired, increase **x** and upload data again, to see if there is additional valid data in memory.

</td></tr>
</table>

InitLogging

Initialize logging – after all previous data has been uploaded, initialize logging before starting to sample again to make entire memory available for recording. **InitLogging** sets sample number (**SampleNumber=**) to 0 (sampling will start with sample 1). If not set to 0, data will be stored after last recorded sample. **Do not send InitLogging until all existing data has been uploaded.**

SampleNumber=x

x= sample number for last sample in memory. **SampleNumber=0** is equivalent to **InitLogging**. **Do not send SampleNumber=0 until all existing data has been uploaded.**

Output Format Setup Commands

<table>
<tr><td>

Notes:
- See *Data Formats* after the command descriptions for complete details.
- The MicroCAT does not *store* salinity and sound velocity in memory if **OutputSal=Y** and **OutputSV=Y**. It calculates and outputs the values real-time or as data is uploaded; therefore, outputting these parameters has no effect on the number of samples that can be stored in memory.
- Salinity and sound velocity can also be calculated in SBE Data Processing, from data uploaded from the MicroCAT's memory.

</td></tr>
</table>

OutputFormat=x

x=0: output raw decimal data.

x=1 (default): output converted decimal data.

x=2: output converted decimal data in XML.

x=3: output converted decimal data, alternate format.

OutputSal=x

x=Y: Calculate and output salinity (psu) with each sample. Only applies if **OutputFormat=1**, **2**, or **3**.

x=N: Do not.

OutputSV=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). Only applies if **OutputFormat=1**, **2**, or **3**.

x=N: Do not.

Autonomous Sampling (Logging) Commands

Logging commands direct the MicroCAT to sample data at pre-programmed intervals and store the data in its FLASH memory.

Notes:
- Do not set **SampleInterval=** to less than 10 seconds if transmitting real-time data (**TxRealTime=Y**).
- If the MicroCAT is logging data and the battery voltage is less than 6.15 volts for five consecutive scans, the MicroCAT halts logging.
- If the FLASH memory is filled to capacity, sampling continues, but excess data is not saved in memory (i.e., the MicroCAT does not overwrite the data in memory).

SampleInterval=x   **x=** interval (seconds) between samples (6 – 21,600). When commanded to start sampling with **StartNow** or **StartLater**, at **x** second intervals MicroCAT takes a measurement, stores data in FLASH memory, transmits real-time data (if **TxRealTime=Y**), and goes to sleep.

StartNow   Start logging now, at rate defined by **SampleInterval=**. Data is stored in FLASH memory. Data is transmitted real-time if **TxRealTime=Y**.

Notes:
- After receiving **StartLater**, the MicroCAT displays `not logging: waiting to start` in reply to **DS**. Once logging has started, the reply displays `logging`.
- If the delayed start date and time has already passed when **StartLater** is received, the MicroCAT executes **StartNow**.
- If the delayed start date and time is more than 30 days in the future when **StartLater** is received, the MicroCAT assumes that the user made an error in setting the delayed start date and time, and it executes **StartNow**.

StartDateTime= mmddyyyyhhmmss   Set delayed logging start month, day, year, hour, minute, second.

StartLater   Start logging at time set with delayed start date and time command, at rate defined by **SampleInterval=**. Data is stored in FLASH memory. Data is transmitted real-time if **TxRealTime=Y**.
If you need to change MicroCAT setup after **StartLater** has been sent (but before logging has started), send **Stop**, change setup as desired, and then send **StartLater** again.

Example: Program MicroCAT to start logging on 20 September 2012 12:00:00 (user input in bold).
STARTDATETIME=09202012120000
STARTLATER

Note:
You may need to send **Stop** several times to get the MicroCAT to respond. This is most likely to occur if sampling with a small **SampleInterval** and transmitting real-time data (**TxRealTime=Y**).

Stop   Stop logging (that was started with **StartNow** or **StartLater**) or stop waiting to start logging (if **StartLater** was sent but logging has not begun yet). Press any key before entering **Stop**. **Stop** must be sent before uploading data from memory.

Polled Sampling Commands

These commands are used to request 1 or more samples from the MicroCAT. Unless noted otherwise, the MicroCAT does not store the data in FLASH memory.

TS	Take sample, store data in buffer, output data.
TSH	Take sample, store data in buffer (do not output data).
TSS	Take sample, store data in buffer and in **FLASH memory**, and output data. Note: MicroCAT ignores this command if sampling data (**StartNow** or **StartLater** has been sent).
TSN:x	Take **x** samples and output data. To interrupt this sampling, press Esc key. Note: MicroCAT ignores this command if sampling data (**StartNow** or **StartLater** has been sent).
SL	Output last sample stored in buffer.
SLT	Output last sample stored in buffer. Then take new sample and store data in buffer (do not output data from new sample).

Serial Line Sync Commands

SyncMode=x	**x=Y:** Enable serial line synchronization. When a simple pulse (a single character) is transmitted, MicroCAT takes a sample, stores data in FLASH memory, and goes to sleep. Data is transmitted real-time if **TxRealTime=Y**.
	x=N: Disable serial line synchronization.

Data Upload Commands

<table>
<tr><td valign="top">

Notes:
- **Use Seaterm232's Upload menu to upload data that will be processed by SBE Data Processing**. Manually entering a data upload command does not produce data with the required header information for processing by our software. These commands are included here for reference for users who are writing their own software.
- **If not using the Upload menu** - To save data to a file, click Capture before entering a data upload command.
- See *Data Formats*.

</td><td valign="top">

Stop sampling (send **Stop**) before uploading data.

</td></tr>
</table>

GetSamples:b,e	Upload data from scan **b** to scan **e**, in format defined by **OutputFormat=**. First sample is number 1. As data is uploaded, screen first displays `start time =` `start sample number =` These are start time and starting sample number for last set of logged data; can be useful in determining what data to review.
DDb,e	Upload data from scan **b** to scan **e**, in alternate converted decimal form (**OutputFormat=3**) (regardless of **OutputFormat=**). First sample is number 1. As data is uploaded, screen first displays `start time =,` `start sample number =.` These are start time and starting sample number for last set of logged data; can be useful in determining what data to review.

Example: Upload samples 1 to 200 to a file (user input in bold).
(Click Capture menu and enter desired filename in dialog box)
GETSAMPLES:1,200
  or
DD1,200

Calibration Coefficients Commands

Calibration coefficients are initially factory-set and should agree with Calibration Certificates shipped with the MicroCAT

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

Temperature

TCalDate=S	**S**=Temperature calibration date
TA0=F	**F**=Temperature A0
TA1=F	**F**=Temperature A1
TA2=F	**F**=Temperature A2
TA3=F	**F**=Temperature A3

Conductivity

CCalDate=S	**S**=Conductivity calibration date
CG=F	**F**=Conductivity G
CH=F	**F**=Conductivity H
CI=F	**F**=Conductivity I
CJ=F	**F**=Conductivity J
WBOTC=F	**F**=Conductivity wbotc
CTCor=F	**F**=Conductivity ctcor
CPCor=F	**F**=Conductivity cpcor

Pressure

PCalDate=S	**S**=Pressure calibration date
PA0=F	**F**=Pressure A0
PA1=F	**F**=Pressure A1
PA2=F	**F**=Pressure A2
PTCA0=F	**F**=Pressure ptca0
PTCA1=F	**F**=Pressure ptca1
PTCA2=F	**F**=Pressure ptca2
PTCB0=F	**F**=Pressure ptcb0
PTCB1=F	**F**=Pressure ptcb1
PTCB2=F	**F**=Pressure ptcb2
PTempA0=F	**F**=Pressure temperature a0
PTempA1=F	**F**=Pressure temperature a1
PTempA2=F	**F**=Pressure temperature a2
POffset=F	**F**=Pressure offset (decibars)

Data Formats

Notes:
- Time is the time at the **start** of the sample.
- When **TxRealTime=Y**, real-time autonomous data and real-time serial line sync data transmitted to the computer is preceded by a **#** sign.
- 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

Each scan ends with a carriage return <CR> and line feed <LF>.

- **OutputFormat=0**: raw decimal data, intended for diagnostic use at Sea-Bird
  tttttt, cccc.ccc, pppppp, vvvv, dd mmm yyyy, hh:mm:ss

  where
  tttttt = temperature A/D counts.
  cccc.ccc = conductivity frequency (Hz).
  pppppp = pressure sensor pressure A/D counts; sent only if optional pressure sensor installed.
  vvvv = pressure sensor pressure temperature compensation A/D counts; sent only if optional pressure sensor installed.
  dd mmm yyyy = day, month, year.
  hh:mm:ss = hour, minute, second.
  Note that salinity and sound velocity are not sent, regardless of the setting for those parameters. All data is separated with a comma and a space.

Example: Sample data output when pressure sensor is installed, **OutputFormat=0**, **OutputSal=Y**, and **OutputSV=Y**:
```
524276,  2886.656, 785053, 2706, 20 Aug 2012, 09:01:34
```
(temperature, conductivity, pressure sensor pressure, pressure sensor temperature compensation, date, time)

- **OutputFormat=1** (default): converted decimal data
  tttt.tttt,ccc.ccccc,ppppp.ppp,ssss.ssss,vvvvv.vvv, dd mmm yyyy, hh:mm:ss

  where
  tttt.tttt = temperature (°C, ITS-90).
  ccc.ccccc = conductivity (S/m).
  ppppp.ppp = pressure (decibars); sent only if optional pressure sensor installed.
  ssss.ssss= salinity (psu); sent only if **OutputSal=Y**.
  vvvvv.vvv = sound velocity (meters/second); sent only if **OutputSV=Y**.
  dd mmm yyyy = day, month, year.
  hh:mm:ss = hour, minute, second.

  Leading zeros are suppressed, except for one zero to the left of the decimal point. All data is separated with a comma; date and time are also preceded by a space.

Example: Sample data output when pressure sensor is installed, **OutputFormat=1**, **OutputSal=Y**, **OutputSV=Y**:
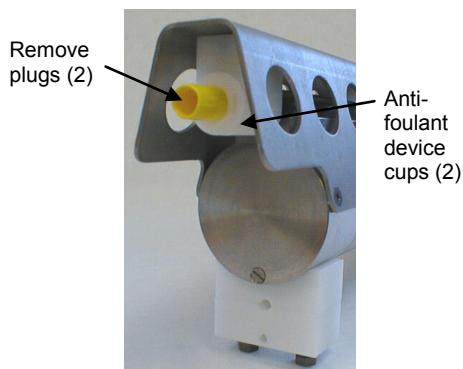```
   8.5796, 0.15269, 531.316,   1.1348, 1451.478, 20 Aug 2012, 09:01:44
```
(temperature, conductivity, pressure, salinity, sound velocity, date, time)

---

- **OutputFormat=2**: converted decimal data in XML

```
<?xml version="1.0"?>
<datapacket>
<hdr>
<mfg>Sea-Bird</mfg>
<model>37sm</model>
<sn>nnnnnnnn</sn>
</hdr>
<data>
<t1>ttt.tttt</t1>
<c1>cc.ccccc</c1>
<p1>pppp.ppp </p1>
<sal>sss.ssss</sal>
<sv>vvvv.vvv</sv>
<dt>yyyy-mm-ddThh:mm:ss</dt>
</data>
</datapacket>
```

Note:
For ease in reading, the data structure is shown with each XML tag on a separate line. However, there are no carriage returns or line feeds between tags (see example below).

where
nnnnnnnn = MicroCAT serial number.
ttt.tttt = temperature (°C, ITS-90).
cc.ccccc = conductivity (S/m).
pppp.ppp = pressure (decibars); sent only if optional pressure sensor installed.
sss.ssss= salinity (psu); sent only if **OutputSal=Y**.
vvvv.vvv = sound velocity (meters/second); sent only if **OutputSV=Y**.
yyyy-mm-ddThh:mm:ss = year, month, day, hour, minute, second.

Leading zeros are suppressed, except for one zero to the left of the decimal point.

Example: Sample data output when pressure sensor is installed, **OutputFormat=2**, **OutputSal=Y**, **OutputSV=Y**:

```
<?xml version="1.0"?><datapacket><hdr><mfg>Sea-Bird</mfg><model>37SM</model>
<sn>03709999</sn></hdr><data><t1>  8.5796</t1><c1> 0.15269</c1><p1> 531.316</p1>
<sal>   1.1348</sal><sv>1451.478</sv><dt>2012-08-20T09:01:44</dt></data></datapacket>
CRLF
```
(temperature, conductivity, pressure, salinity, sound velocity, date and time)

- **OutputFormat=3**: converted decimal data, *alternate*
ttt.tttt,cc.ccccc, pppp.ppp, sss.ssss, vvvv.vvv, dd mmm yyyy, hh:mm:ss

Note:
This format is identical to the format from an SBE 37-SM with *firmware < 3.0* and **Format=1**.
It is provided for compatibility with systems programmed for those older instruments.

where
ttt.tttt = temperature (°C, ITS-90).
cc.ccccc = conductivity (S/m).
pppp.ppp = pressure (decibars); sent only if optional pressure sensor installed.
sss.ssss= salinity (psu); sent only if **OutputSal=Y**.
vvvv.vvv = sound velocity (meters/second); sent only if **OutputSV=Y**.
dd mmm yyyy = day, month, year.
hh:mm:ss = hour, minute, second.

Leading zeros are suppressed, except for one zero to the left of the decimal point. There is a comma but no space between temperature and conductivity. All other data is separated with a comma and a space.

Example: Sample data output when pressure sensor is installed, **OutputFormat=3**, **OutputSal=Y**, **OutputSV=Y**:

```
  8.5796, 0.15269,  531.316,   1.1348, 1451.478, 20 Aug 2012, 09:01:44
```
(temperature, conductivity, pressure, salinity, sound velocity, date, time)

Setup for Deployment

1. Install new batteries (see *Section 5: Routine Maintenance and Calibration*) or ensure the existing battery pack has enough capacity to cover the intended deployment..

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

   A. Ensure all data has been uploaded, and then send **InitLogging** to make the entire memory available for recording. If **InitLogging** is not sent, data will be stored after the last recorded sample.

   B. Set the date and time (**DateTime=**).

   C. Establish the setup and logging parameters.

   D. Use **one** of the following command sequences to initiate sampling:
      - **StartNow** to start logging now, taking a sample every **SampleInterval=** seconds.
      - **StartDateTime=** and **StartLater** to start logging at the specified date and time, taking a sample every **SampleInterval=** seconds.
      - **SyncMode=Y** to place the MicroCAT in serial line sync mode, so that a simple pulse on the RS-232 line will initiate a sample.

Deployment

The MicroCAT comes standard with a pre-installed Sea-Bird wire mounting clamp and guide.

Remove plugs (2)

Anti-foulant device cups (2)

1. 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 cups. **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 cups contain 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.

Dummy plug or I/O cable connector (as applicable)

2. Install the dummy plug or I/O cable (for external power and/or serial communication during deployment):
   A. Lightly lubricate the inside of the dummy plug or cable connector with silicone grease (DC-4 or equivalent).
   B. **Standard Connector** (shown in photos) - Install the dummy plug or cable connector, aligning the raised bump on the side of the plug/connector with the large pin (pin 1 - ground) on the MicroCAT. Remove any trapped air by *burping* or gently squeezing the plug/connector near the top and moving your fingers toward the end cap.   **OR**
   MCBH Connector – Install the plug/cable connector, aligning the pins.
   C. Place the locking sleeve over the plug/connector. Tighten the locking sleeve finger tight only. **Do not overtighten the locking sleeve and do not use a wrench or pliers.**

Locking sleeve

3. Attach the mounting clamp and guide to the mooring cable.

Standard mounting clamp and guide – loosen hardware to separate clamp/guide halves and mount on mooring cable

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

5. Deploy the MicroCAT.

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 than 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 cups.

3. If the batteries are exhausted, new batteries must be installed before the data can be extracted. Stored data will not be lost as a result of exhaustion or removal of batteries. See *Section 5: Routine Maintenance and Calibration* for replacement of batteries.

4. If immediate redeployment is not required, you can leave the MicroCAT with batteries in place and in a quiescent state (**QS**). Because the quiescent current required is only 30 microAmps, the batteries can be left in place without significant loss of capacity (less than 6% loss per year).

Uploading and Processing Data

> **Note:**
> Data may be uploaded during deployment or after recovery. If uploading after recovery, connect the I/O cable as described in *Power and Communications Test* in *Section 3: Preparing MicroCAT for Deployment*.

1. Double click on **SeatermV2.exe**. The main screen appears.

2. In the Instruments menu, select *SBE 37 RS232*. **Seaterm232** opens.

3. Seaterm232 tries to automatically connect to the MicroCAT. As it connects, it sends **GetHD** and displays the response. Seaterm232 also fills the Send Commands window with the correct list of commands for your MicroCAT. **If there is no communication**:

   A. In the Communications menu, select *Configure*. The Serial Port Configuration dialog box appears. Select the Comm port and baud rate for communication, and click OK. Note that the factory-set baud rate is documented on the Configuration Sheet.

   B. In the Communications menu, select *Connect* (if *Connect* is grayed out, select *Disconnect and reconnect*). Seaterm232 will attempt to connect at the baud specified in Step A, but if unsuccessful will then cycle through all other available baud rates.

   C. If there is still no communication, check cabling between the computer and MicroCAT.

   D. If there is still no communication, repeat Step A with a different comm port, and try to connect again.

> **Note:**
> You may need to send **Stop** several times to get the MicroCAT to respond.

4. If sampling autonomously, command the MicroCAT to stop logging by pressing any key, typing **Stop**, and pressing the Enter key.

5. Display MicroCAT status information by typing **DS** and pressing the Enter key. The display looks like this:

```
SBE37SM-RS232 3.1  SERIAL NO. 9999  20 Aug 2012 00:48:50
vMain =  8.08, vLith =  3.08
samplenumber = 6, free = 559234
not logging, stop command
sample interval = 15 seconds
data format = converted engineering
transmit real-time = yes
sync mode = no
pump installed = no
```

   Verify that the status is　　**not logging.**

> **Note:**
> **BaudRate=** must be sent twice. After the first entry, the MicroCAT changes to the new baud, and then waits for the command to be sent again at the new baud (In Seaterm232's Communications menu, select *Configure*. In the dialog box, select the new baud rate and click OK. Then retype the command.). If it does not receive the command again at the new baud, it reverts to the previous baud rate.

6. If desired, increase the MicroCAT's baud rate for data upload.

7. Click the Upload menu to upload stored data. Seaterm232 responds as follows:
   A. Seaterm232 sends **GetHD** and displays the response, verifying that it is communicating with the 37-SM.
   B. Seaterm232 sends **OutputExecutedTag=Y**; this setting is required for the upload.
   C. Seaterm232 sends **GetSD** and displays the response, providing information on the number of samples in memory.
   D. In the Save As dialog box, enter the desired upload file name and click Save. The upload file has a .XML extension.
   E. An Upload Data dialog box appears:

Note:

If binary upload is selected, Seaterm232 uploads the data in binary and then converts it to ASCII text, resulting in a data file that is identical to one uploaded in ASCII text.

Select number of bytes uploaded in each block. Seaterm232 uploads data in blocks, and calculates a checksum at end of each block. If block fails checksum verification, Seaterm232 tries to upload block of data again, cutting block size in half.

Defines data upload type and range:
- All data as a single file – All data is uploaded into 1 file.
- By scan number range – Enter beginning scan (sample) number and total number of scans. All data within range is uploaded into 1 file.

To change upload file name selected in Step D above, click Browse to navigate to desired upload file path and name. Upload file has a .xml extension. After Seaterm232 uploads data into .xml data file, it creates .hex data file and .xmlcon configuration file that are compatible with SBE Data Processing. These files are placed in same directory as .xml data file, and have same name (but different extensions).

Make the desired selections.

8. Click the Header Form tab to customize the header:

Defines header information
included with uploaded data:
- Prompt for header information –
  As data is uploaded, user is
  prompted to fill out user-defined
  header form.
- Include default header form in
  upload file – User-defined
  default header form included in
  upload file. User is not
  prompted to add any
  information when data is
  uploaded.
- Don't include default header
  form in upload file – Header
  information not included in
  upload file.

Upload Data

Upload Data | Header Form

Header Choice	Prompt for Header Information
Prompt for line # 01	Mooring Description:
Prompt for line # 02	Latitude:
Prompt for line # 03	Longitude:
Prompt for line # 04	Deployment Start Date:
Prompt for line # 05	Deployment Recovery Date:
Prompt for line # 06	
Prompt for line # 07	
Prompt for line # 08	
Prompt for line # 09	
Prompt for line # 10	
Prompt for line # 11	
Prompt for line # 12	

The entries are free form, 0 to 12 lines long. This dialog box establishes:
- the header prompts that appear for the user to fill in when uploading
  data, if *Prompt for header information* was selected
- the header included with the uploaded data, if *Include default header
  form in upload file* was selected

Enter the desired header/header prompts.

9. Click Upload; the Status bar at the bottom of the window displays the
    upload progress:
    A. Seaterm232 sends several status commands providing information
        regarding the number of samples in memory, calibration coefficients,
        etc., and writes the responses to the upload .xml file.
    B. **If you selected *Prompt for header information* in the Upload Data
        dialog box** – a dialog box with the header form appears. Enter the
        desired header information, and click OK. Seaterm232 writes the
        header information to the upload .xml file.
    C. Seaterm232 sends the data upload command, based on your selection
        of upload range in the Upload Data dialog box, and writes the data to
        the upload .xml file.
    D. From the information in the .xml file, Seaterm232 creates a .hex data
        file and .xmlcon configuration file that are compatible with SBE Data
        Processing for processing and plotting the data. These files are placed
        in the same directory as the .xml data file and have the same name
        (but different extensions).

Note:
SeatermV2 with version < 1.1 did not
convert the uploaded .xml data file to a
.hex and .xmlcon file. *Convert .XML data
file* in the Tools menu was used to
convert the .xml data file to a .cnv file,
which could be processed in SBE Data
Processing. We recommend that you
update your SeatermV2 software to 1.1b
or later.

Notes:
- Ensure all data has been uploaded from the MicroCAT by reviewing the data in SBE Data Processing.
- If you do not run Data Conversion now, you can run it later by opening SBE Data Processing.
- See the SBE Data Processing manual and/or Help for details.

.

10. After the data has been uploaded, Seaterm232 prompts you to run SBE Data Processing's Data Conversion module if desired. Data Conversion converts the .hex (raw data) file to a .cnv file, which can then be processed by other modules in SBE Data Processing.
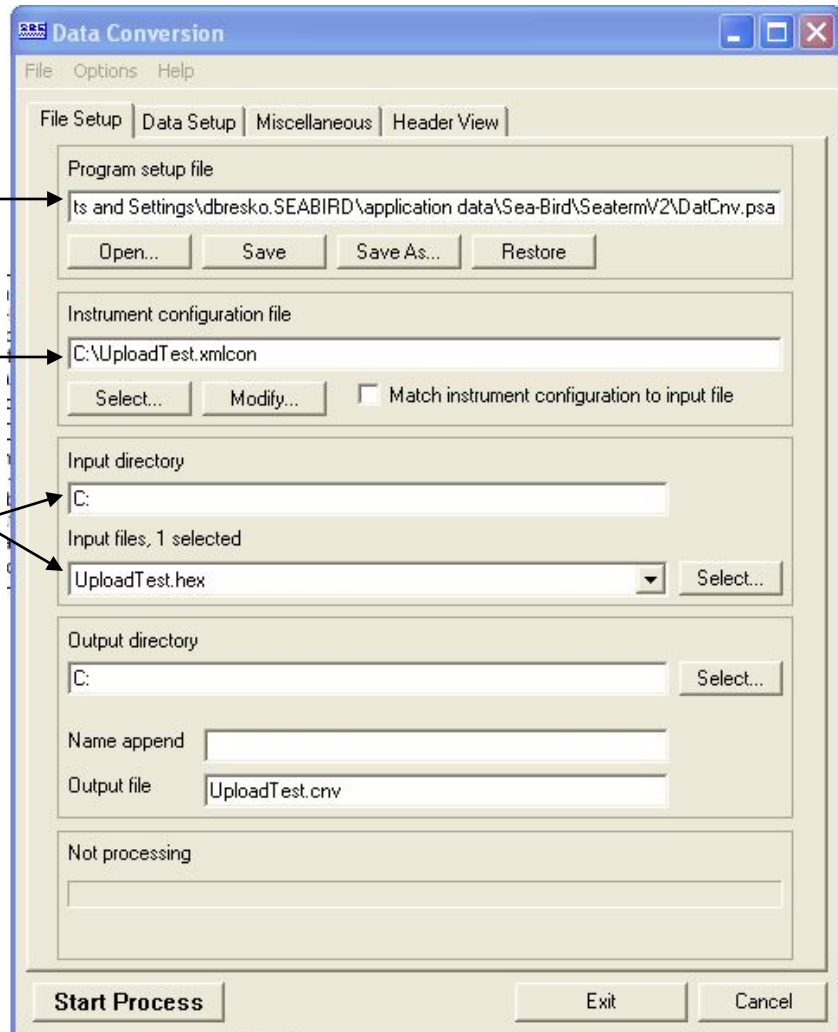
Convert raw data to engineering units

Convert the uploaded .hex file (raw data) to a .cnv file (engineering units) in SBE Data Processing's Data Conversion module.

SBE Data Processing version 7.21c or greater is required.

Launch the Data Conversion module now?

☐ Do not show this dialog again.

      Yes   No

A. If you click Yes, Seaterm232 opens SBE Data Processing's Data Conversion module, and fills in the appropriate instrument configuration (.xmlcon) file and data (.hex) file on the File Setup tab.
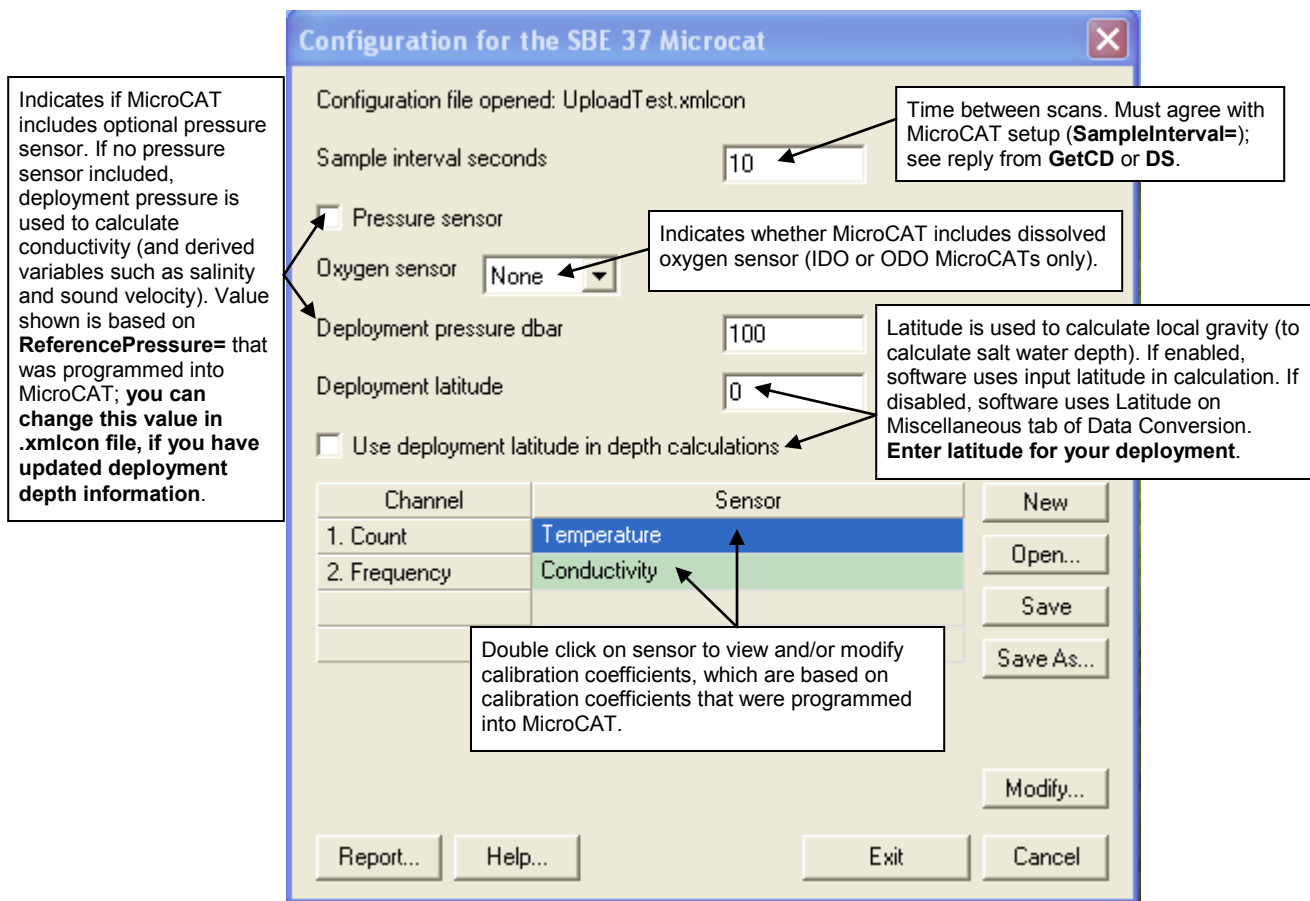
Data Conversion

File   Options   Help

File Setup | Data Setup | Miscellaneous | Header View |

Location to store all setup information. Default is directory with SeatermV2 application data, when Data Conversion is launched from Seaterm232.

Program setup file

ts and Settings\dbresko.SEABIRD\application data\Sea-Bird\SeatermV2\DatCnv.psa

Open...   Save   Save As...   Restore

Instrument configuration (.xmlcon) file location, which is created by Seaterm232, and contains MicroCAT's calibration coefficients (see dialog box below).

Instrument configuration file

C:\UploadTest.xmlcon

Select...   Modify...   ☐ Match instrument configuration to input file

Input directory

C:

Directory and file name for raw data (.hex) file created by Seaterm232 from uploaded data.

Input files, 1 selected

UploadTest.hex   ▼   Select...

Output directory

C: Select...

Name append

Output file   UploadTest.cnv

Not processing

Start Process   Exit   Cancel

The Configuration dialog box (which appears if you click *Modify* on the File Setup tab) looks like this:

Indicates if MicroCAT includes optional pressure sensor. If no pressure sensor included, deployment pressure is used to calculate conductivity (and derived variables such as salinity and sound velocity). Value shown is based on **ReferencePressure=** that was programmed into MicroCAT; **you can change this value in .xmlcon file, if you have updated deployment depth information**.

Time between scans. Must agree with MicroCAT setup (**SampleInterval=**); see reply from **GetCD** or **DS**.

Indicates whether MicroCAT includes dissolved oxygen sensor (IDO or ODO MicroCATs only).

Latitude is used to calculate local gravity (to calculate salt water depth). If enabled, software uses input latitude in calculation. If disabled, software uses Latitude on Miscellaneous tab of Data Conversion. **Enter latitude for your deployment**.

Double click on sensor to view and/or modify calibration coefficients, which are based on calibration coefficients that were programmed into MicroCAT.

Configuration for the SBE 37 Microcat

Configuration file opened: UploadTest.xmlcon

Sample interval seconds   10

☐ Pressure sensor

Oxygen sensor   None

Deployment pressure dbar   100

Deployment latitude   0

☐ Use deployment latitude in depth calculations

Channel	Sensor
1. Count	Temperature
2. Frequency	Conductivity

New
Open...
Save
Save As...
Modify...
Report...   Help...   Exit   Cancel

The settings in the .xmlcon file created by Seaterm232 are based on the setup of the MicroCAT.

- Review the deployment latitude, and modify as needed.
- If your MicroCAT does not have a pressure sensor, review the deployment pressure, and modify as needed.

Click Save if you made any changes, and then click Exit.

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B. Click on the Data Setup tab.
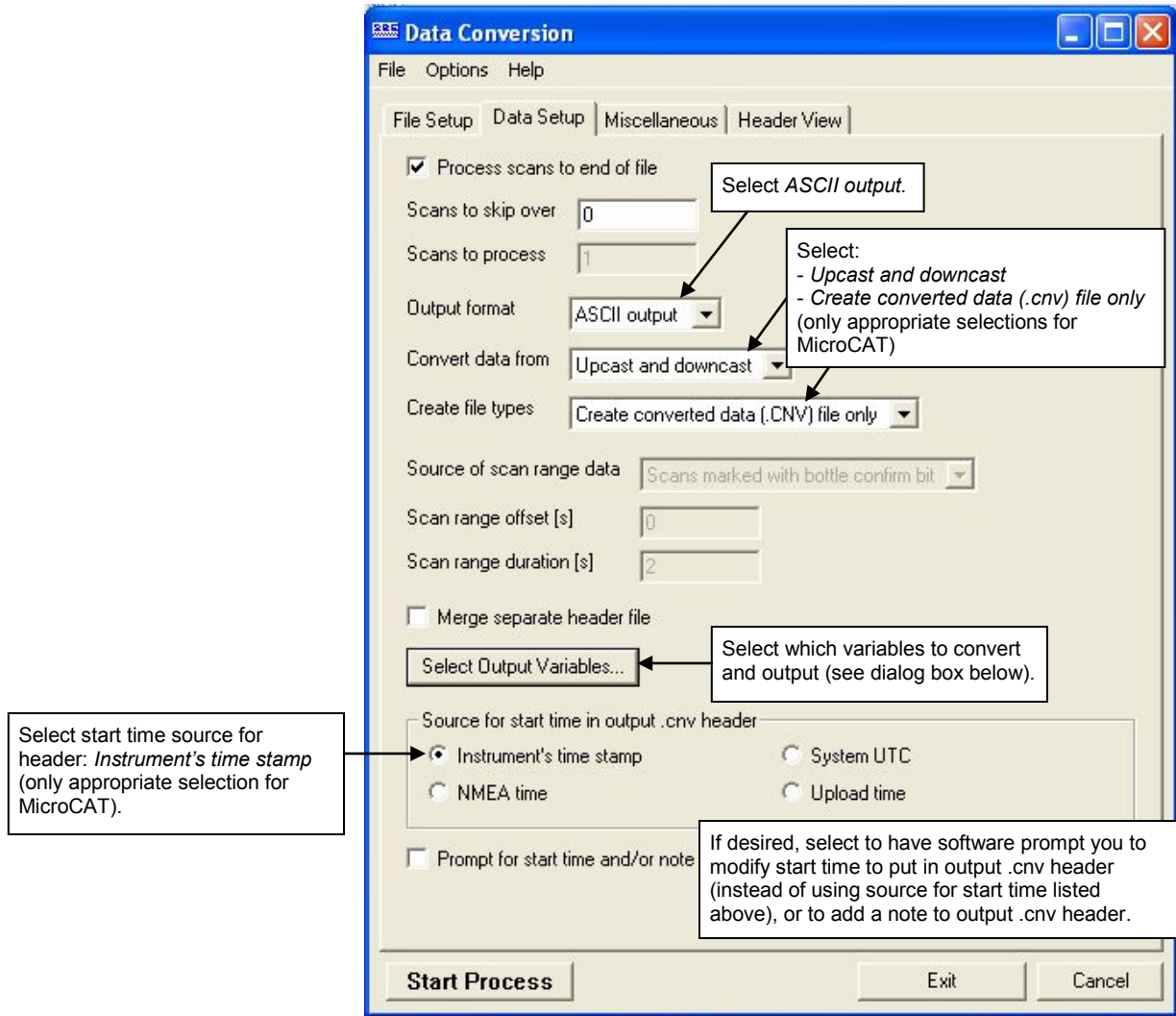
The Select Output Variables dialog box (which appears when you click *Select Output Variables* on the Data Setup tab) looks like this:
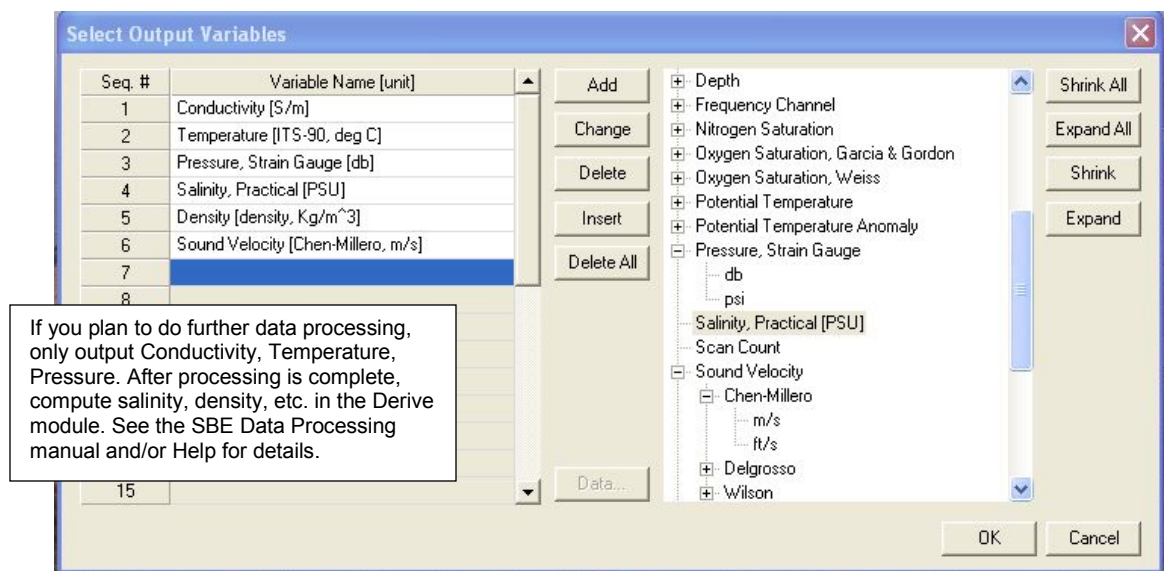
Select Temperature, Conductivity, and Pressure (optional), as well as desired derived variables such as salinity, sound velocity, etc. Click OK.

C. At the bottom of the Data Conversion dialog box, click Start Process to convert the .hex file to a .cnv file.

Notes:

To prepare for re-deployment:

1. After all data has been uploaded, send **InitLogging**. If this is not sent, new data will be stored after the last sample, preventing use of the entire memory.
2. Do *one* of the following:
   - Send **QS** to put the MicroCAT in quiescent (sleep) state until ready to redeploy. Quiescent current is only 30 microAmps, so the batteries can be left in place without significant loss of capacity.
   - Use **StartNow** to begin logging immediately.
   - Set a date and time for logging to start using **StartDateTime=** and **StartLater**.

11. Once the data is converted to a .cnv file, use the other SBE Data Processing modules as desired:
    - Derive module - Calculate additional derived variables.
    - Sea Plot module - Plot data.

Editing Raw Data File

Sometimes users want to edit the raw .hex data file before beginning processing, to remove data at the beginning of the file corresponding to instrument *soak* time, remove blocks of bad data, edit the header, or add explanatory notes . **Editing the raw .hex file can corrupt the data, making it impossible to perform further processing using Sea-Bird software.** Sea-Bird strongly recommends that you first convert the data to a .cnv file (using the Data Conversion module in SBE Data Processing), and then use other SBE Data Processing modules to edit the .cnv file as desired.

The procedure described below for editing a .hex data file has been found to work correctly on computers running Windows 98, 2000, and NT. **If the editing is not performed using this technique, SBE Data Processing may reject the edited data file and give you an error message.**

Note:
Although we provide this technique for editing a raw .hex file, **Sea-Bird's strong recommendation, as described above, is to always convert the raw data file and then edit the converted file.**

---

1. **Make a back-up copy of your .hex data file before you begin.**

2. Run **WordPad**. In the File menu, select Open. The Open dialog box appears. For *Files of type*, select *All Documents (*.*)*. Browse to the desired .hex file and click Open.

3. Edit the file as desired, **inserting any new header lines after the System Upload Time line**. Note that all header lines must begin with an asterisk (*), and *END* indicates the end of the header. An example is shown below (for an SBE 21), with the added lines in bold:

    ```
    * Sea-Bird SBE 21 Data File:
    * FileName = C:\Odis\SAT2-ODIS\oct14-19\oc15_99.hex
    * Software Version Seasave Win32 v1.10
    * Temperature SN = 2366
    * Conductivity SN = 2366
    * System UpLoad Time = Oct 15 1999  10:57:19
    * Testing adding header lines
    * Must start with an asterisk
    * Place anywhere between System Upload Time & END of header
    * NMEA Latitude = 30 59.70 N
    * NMEA Longitude = 081 37.93 W
    * NMEA UTC (Time) = Oct 15 1999  10:57:19
    * Store Lat/Lon Data = Append to Every Scan and Append to .NAV
    File When <Ctrl F7> is Pressed
    ** Ship:        Sea-Bird
    ** Cruise:      Sea-Bird Header Test
    ** Station:
    ** Latitude:
    ** Longitude:
    *END*
    ```

4. In the File menu, select Save (**not** Save As). If you are running Windows 2000, the following message displays:
    ```
    You are about to save the document in a Text-Only format, which
    will remove all formatting. Are you sure you want to do this?
    ```
    Ignore the message and click *Yes*.

5. In the File menu, select Exit.

Section 5: Routine Maintenance and Calibration

This section reviews corrosion precautions, connector mating and maintenance, conductivity cell cleaning and storage, pressure sensor maintenance, plastic housing handling instructions, replacement of batteries, 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 direct electrical connection of the MicroCAT housing to mooring or other dissimilar metal hardware should be avoided.

Connector Mating and Maintenance

> **Note:**
> See *Application Note 57: Connector Care and Cable Installation*.

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

Clean and inspect the connectors, cable, and dummy plug before every deployment and as part of your yearly equipment maintenance. Inspect connectors that are unmated for signs of corrosion product around the pins, and for cuts, nicks or other flaws that may compromise the seal.

When remating:

1. Lightly lubricate the inside of the dummy plug/cable connector with silicone grease (DC-4 or equivalent).

2. **Standard Connector** - Install the plug/cable connector, aligning the raised bump on the side of the plug/cable connector with the large pin (pin 1 - ground) on the MicroCAT. Remove any trapped air by *burping* or gently squeezing the plug/connector near the top and moving your fingers toward the end cap. **OR**
MCBH Connector – Install the plug/cable connector, aligning the pins.

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

Verify that a cable or dummy plug is installed 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.

A conductivity cell filling and storage kit is available from Sea-Bird. The kit (PN 50087.1) includes a syringe and tubing assembly, and two anti-foulant device caps with hose barbs. The tubing cannot attach to an anti-foulant device cap that is not barbed.

Cleaning and storage instructions require use of the syringe and tubing assembly at the intake end of the cell (requiring one barbed cap), and looping Tygon tubing from end to end of the cell (requiring two barbed caps). Remove the installed anti-foulant device cap(s) and replace them with the anti-foulant device cap(s) with hose barbs **for cleaning and storage only**. Remember to reinstall the original anti-foulant device cap(s) before deployment. **Deploying a MicroCAT with barbed anti-foulant device cap(s) in place of the installed caps is likely to produce undesirable results in your data.** See *Replacing Anti-Foulant Devices* for safety precautions when handling the AF24173 Anti-Foulant Devices.

Remove plug

Unscrew cap, and replace with barbed cap for cleaning and storage

Barbed caps for cleaning and storage
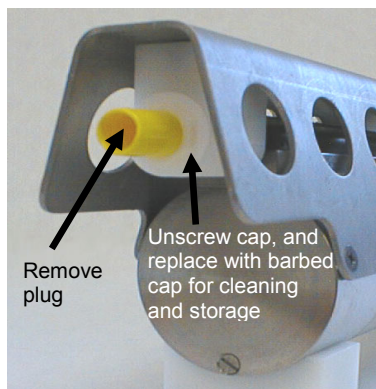
Pressure Sensor (optional) Maintenance

Pressure sensor port plug

> **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.

Handling Instructions for Plastic *ShallowCAT* Option

See detail
below

Hex screw securing battery /
connector end cap (one each side)

Detail - Battery/connector end cap

The MicroCAT's standard 7000-meter titanium housing offers the best durability with a modest amount of care. The *ShallowCAT* option, substitution of a 350-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:

- The MicroCAT's battery end cap is retained by two 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 the end cap (to replace the batteries and/or access the electronics), be careful to avoid any impact in this area of the housing.
  - ➢ When reinstalling the end cap, 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 cap.
  - ➢ Of primary concern are scratches on O-ring mating and sealing surfaces. Take extra precaution to avoid a scraping contact with these surfaces when replacing batteries and/or 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.
- If you remove the screws securing the conductivity cell guard to the housing (not typically done by the customer), follow the same precautions as described above for removing and replacing the battery end cap.

See *Battery Installation* in *Section 3: Preparing MicroCAT for Deployment* and *Appendix II: Electronics Disassembly / Reassembly* for detailed step-by-step procedures for removing the MicroCAT's end cap.

Replacing Batteries

Notes:
- For details and photos, see *Installing Batteries* in *Section 3: Preparing MicroCAT for Deployment*.
- **Only use the battery pack with the red cover plate**. Some MicroCATs use a battery pack with a yellow cover plate; those packs are wired differently, and will not work properly in this MicroCAT.
- Batteries must be removed before returning the MicroCAT to Sea-Bird. Do not return used batteries when shipping the MicroCAT for repair.
- See *Shipping Precautions* in *Section 1: Introduction*.

1. Remove the 2 screws holding the I/O connector end cap to the MicroCAT housing, and remove the end cap.
2. Loosen the captured screw holding the battery pack in the housing, and remove the battery pack from the housing.
3. Place the handle in an upright position. Unscrew the red cover plate from the top of the battery pack assembly.
4. Roll the 2 O-rings on the outside of the pack out of their grooves.
5. Remove the existing batteries. Install new batteries, positive end (+) first.
6. Roll the O-rings into place in the grooves on the side of the battery pack.
7. Place the handle in an upright position. Reinstall the battery pack cover plate.
8. Replace the battery pack assembly in the housing, and secure the assembly with the captured screw. Plug in the Molex connector, and reinstall the MicroCAT end cap.

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.

Cup

Cap

Plug

Cap

Cup
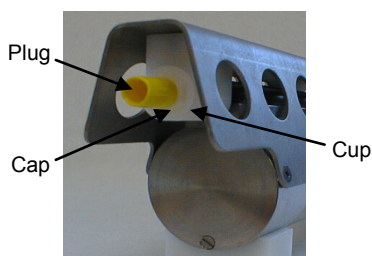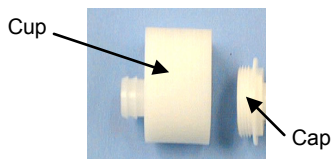
CAUTION:
Anti-foulant device cups are attached to the guard and connected with tubing to the cell**. Removing the guard without disconnecting the cups from the guard will break the cell.** If the guard must be removed:

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

Notes:
- Batteries must be removed before returning the MicroCAT to Sea-Bird. Do not return used batteries to Sea-Bird when shipping the MicroCAT for recalibration or repair.
- Please remove AF24173 Anti-Foulant Devices from the anti-foulant device cups 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 and temperature 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 sensor be calibrated before and after deployment, but particularly when the cell has been exposed to contamination by oil slicks or biological material.

Temperature Sensor Calibration

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

Pressure Sensor (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 the 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* (**POffset=**) calibration coefficient term by comparing MicroCAT pressure output to readings from a barometer.

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.

> **Note:**
> The MicroCAT's pressure sensor is an absolute sensor, so its **raw** output (**OutputFormat=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

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

2. In Seaterm232:
    A. Set the pressure offset to 0.0 (**POffset=0**).
    B. Set the output format to converted decimal (**OutputFormat=1**), so the pressure output will be in decibars.
    C. Send **TSN:100** to take 100 samples and transmit data.

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

4. Enter the calculated offset (positive or negative) in the MicroCAT's EEPROM, using **POffset=** in Seaterm232.

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

If **OutputExecutedTag=N**, the S> prompt indicates that communications between the MicroCAT and computer have been established. Before proceeding with troubleshooting, attempt to establish communications again by selecting *Connect* in the Communications menu in Seaterm232 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 communication settings may not have been entered correctly in Seaterm232. Verify the settings in the Serial Port Configuration dialog box (Communications menu -> *Configure*). 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. The I/O cable supplied with the MicroCAT permits connection to standard 9-pin RS-232 interfaces.

Problem 2: No Data Recorded

Cause/Solution 1: The memory may be full; once the memory is full, no further data is recorded. Verify that the memory is not full using **GetSD** or **DS** (*free = 0* or *1* if memory is full). Sea-Bird recommends that you upload all previous data before beginning another deployment. Once the data is uploaded, send **InitLogging** to reset the memory. After the memory is reset, **GetSD** or **DS** will show *samples = 0*.

Problem 3: Unreasonable T, C, or P Data

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

Cause/Solution 1: A data file 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 **GetCC** to verify the calibration coefficients in the MicroCAT match the instrument Calibration Certificates. Note that calibration coefficients do not affect the raw data stored in MicroCAT memory.
- If you have not yet overwritten the memory with new data, you can correct the coefficients and then upload the data again.
- If you have overwritten the memory with new data, you can manually correct the coefficients in the .xmlcon configuration file, and then reprocess the data in SBE Data Processing's Data Conversion module.

Problem 4: 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-SM if **OutputSal=Y**. Alternatively, salinity can be calculated in SBE Data Processing's Data Conversion module from the data uploaded from memory (.hex file) or in SBE Data Processing's Derive module from the converted (.cnv) file.

[*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,** free-flushing instruments such as the 37-SM MicroCAT, wave action, mooring motion, and currents flush 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-SM 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

> **Note:**
> The 37-SM battery pack has a **red** cover plate. Some MicroCATs use a battery pack with a yellow cover plate; the wiring of that pack is different from this one, and cannot be used with this MicroCAT.

> **Note:**
> All Sea-Bird software listed was designed to work with a computer running Windows XP service pack 2 or later, Windows Vista, or Windows 7.

> **Note:**
> **IDO** MicroCATs are integrated with SBE 43F DO sensors (Clark polarographic membrane type).
> **ODO** MicroCATs are integrated with SBE 63 Optical DO sensors.

Battery pack – 12 AA lithium batteries in a battery holder that connects 2 cells in series and each series string in parallel. Battery pack uses:

- Saft LS 14500, AA, 3.6 V and 2.45 Amp-hours each (www.saftbatteries.com) (**recommended**),
- Tadiran TL-4903, AA, 3.6 V and 2.4 Amp-hours each (www.tadiran.com), or
- Electrochem 3B0064/BCX85, AA, 3.9 V and 2.0 Amp-hours each (www.electrochemsolutions.com)

Deployment Endurance Calculator – Sea-Bird's Windows software used to calculate deployment length for moored instruments, based on user-input deployment scheme, instrument power requirements, and battery capacity.

Fouling – Biological growth in the conductivity cell during deployment.

MicroCAT (SBE 37) – High-accuracy conductivity, temperature, and optional pressure Recorder/Sensor. A number of models are available:

- 37-IM (**I**nductive **M**odem, internal battery and memory)
- 37-IMP (**I**nductive **M**odem, internal battery and memory, integral **P**ump)
- 37-IMP-IDO (**I**nductive **M**odem, internal battery and memory, integral **P**ump, **I**ntegrated **D**issolved **O**xygen sensor) – includes internal RS-232 interface
- 37-IMP-ODO (**I**nductive **M**odem, internal battery and memory, integral **P**ump, **O**ptical **D**issolved **O**xygen sensor) – includes internal RS-232 interface
- 37-SM (**S**erial interface, internal battery and **M**emory)
- 37-SMP (**S**erial interface, internal battery and **M**emory, integral **P**ump)
- 37-SMP-IDO (**S**erial interface, internal battery and **M**emory, integral **P**ump, **I**ntegrated **D**issolved **O**xygen sensor)
- 37-SMP-ODO (**S**erial interface, internal battery and **M**emory, integral **P**ump, **O**ptical **D**issolved **O**xygen sensor)
- 37-SI (**S**erial **I**nterface, memory, no internal battery) *
- 37-SIP (**S**erial **I**nterface, integral **P**ump, memory, no internal battery) *
- 37-SIP-IDO (**S**erial **I**nterface, integral **P**ump, **I**ntegrated **D**issolved **O**xygen sensor, memory, no internal battery)
- 37-SIP-ODO (**S**erial **I**nterface, integral **P**ump, **O**ptical **D**issolved **O**xygen sensor, memory, no internal battery)

The serial interface versions are available with RS-232 (standard) or RS-485 (optional) interface. Some serial interface versions are also available with an SDI-12 interface.
* Note: Version 3.0 and later of the 37-SI and 37-SIP include memory; earlier versions did not include memory.

PCB – Printed Circuit Board.

SBE Data Processing - Sea-Bird's Windows data processing software, which calculates and plots temperature, conductivity, and optional pressure, and derives variables such as salinity and sound velocity.

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

Seasoft V2 – Sea-Bird's complete Windows software package, which includes software for communication, real-time data acquisition, and data analysis and display. Seasoft V2 includes ***Deployment Endurance Calculator, SeatermV2***, and ***SBE Data Processing***.

SeatermV2 – Windows terminal program *launcher*, which launches the appropriate terminal program for the selected instrument (Seaterm232 for this MicroCAT).

Seaterm232 – Windows terminal program used with Sea-Bird instruments that communicate via an RS-232 interface, and that were developed or redesigned in 2006 and later. The common feature of these instruments is the ability to output data in XML.

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 (www.parker.com/ead/cm2.asp?cmid=3956).

TCXO – Temperature Compensated Crystal Oscillator.

Triton X-100 – 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 Avantor Performance Materials (www.avantormaterials.com/commerce/product.aspx?id=2147509608).

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 our modular SBE 3 and SBE 4 sensors and in the Seacat and Seacat *plus* family.

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

The MicroCAT's optional strain-gauge pressure sensor is available in the following pressure ranges: 20, 100, 350, 600, 1000, 2000, 3500, and 7000 meters. Compensation of the temperature influence on pressure offset and scale is performed by the MicroCAT's CPU.

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.

Real-Time Clock

To minimize power and improve clock accuracy, a temperature-compensated crystal oscillator (TCXO) is used as the real-time-clock frequency source. The TCXO is accurate to ± 1 minute per year (0 ºC to 40 ºC).

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 end cap and battery pack following instructions in *Section 3: Preparing MicroCAT for Deployment*. **Do not remove the titanium guard!**

2. The electronics are on a sandwich of three rectangular PCBs. These PCBs are assembled to a bulkhead that can be seen at the bottom of the battery compartment. To remove the PCB assembly:
   A. Use a long screwdriver (#1 screwdriver) to remove the Phillips-head screw at the bottom of the battery compartment. The Phillips-head screw is a 198 mm (7.8 inch) threaded rod with Phillips-head.
   B. Pull out the PCB assembly using the PVC pylon (post with Molex connector). The assembly will pull away from the 10-position edge connector used to connect to the sensors.

Reassembly

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

> **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.
> Note that opening the battery compartment does not affect desiccation of the electronics.

1. Sight down into the MicroCAT housing to find the hole into which the Phillips-head screw threads. The hole is at the bottom of the housing, next to the edge connector. The small-diameter brass sleeve between two of the PCBs guides the screw into the hole. Align this sleeve with the hole.

2. Guide the PCB assembly into the housing and push the assembly until the edge connector is fully inserted. A gentle resistance can be felt during the last 3 mm ($1/8$ inch) of insertion as the PCB assembly mates to the edge connector.

3. Drop the Phillips-head screw into the hole and tighten gently.

4. If it is difficult to align the cards, obtain a 305mm (12 inch) length of 6-32 threaded rod.
   A. Thread the end of this rod into the hole at the bottom of the housing (next to the edge connector).
   B. Slide the PCB assembly's small diameter brass sleeve down the rod. The rod will help guide the assembly into the proper position.
   C. Push the assembly until the edge connector is fully inserted. After the PCB assembly has been fully inserted, remove the rod.
   D. Drop the Phillips-head screw into the hole and tighten gently.

5. Reinstall the battery pack and end cap following instructions in *Section 3: Preparing MicroCAT for Deployment*.

Appendix III: Command Summary

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

CATEGORY	COMMAND	DESCRIPTION
Status	**GetCD**	Get and display configuration data.
	GetSD	Get and display status data.
	GetCC	Get and display calibration coefficients.
	GetEC	Get and display event counter data.
	ResetEC	Reset event counter.
	GetHD	Get and display hardware data.
	DS	Get and display status and configuration data.
	DC	Get and display calibration coefficients.
General Setup	**DateTime= mmddyyyyhhmmss**	Set real-time clock month, day, year, hour, minute, second.
	BaudRate=x	**x=** baud rate (600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200). Default 9600.
	OutputExecutedTag= x	**x=Y**: Display XML Executing and Executed tags. **x=N**: Do not.
	TxRealTime=x	**x=Y**: output real-time data while sampling autonomously or in serial line sync mode. **x=N**: do not.
	ReferencePressure=x	**x=** reference pressure (gauge) in decibars (used for conductivity computation when MicroCAT does not have pressure sensor).
	QS	Enter quiescent (sleep) state. Main power turned off, but data logging and memory retention unaffected.
Memory Setup	**InitLogging**	Initialize logging to make entire memory available for recording.
	SampleNumber=x	**x=** sample number for last sample in memory. **SampleNumber=0** equivalent to **InitLogging**.
Output Format Setup	**OutputFormat=x**	**x=0**: output raw decimal data. **x=1**: output converted decimal data **x=2**: output converted decimal data in XML. **x=3**: output converted decimal data, alternate format.
	OutputSal=x	**x=Y**: calculate and output salinity (psu). Only applies if **OutputFormat=1, 2**, or **3**. **x=N**: do not.
	OutputSV=x	**x=Y**: calculate and output sound velocity (m/sec). Only applies if **OutputFormat=1, 2**, or **3**. **x=N**: do not.
Autonomous Sampling (Logging)	**SampleInterval=x**	**x=** interval (seconds) between samples (6 - 21600). When commanded to start sampling with **StartNow** or **StartLater**, at **x** second intervals MicroCAT takes sample, stores data in FLASH memory, transmits real-time data (if **TxRealTime=Y**), and goes to sleep.
	StartNow	Start logging now.
	StartDateTime= mmddyyyyhhmmss	Delayed logging start: month, day, year, hour, minute, second.
	StartLater	Start logging at delayed logging start time.
	Stop	Stop logging or stop waiting to start logging. Press Enter key before entering **Stop**. Must send **Stop** before uploading data.
Polled Sampling	**TS**	Take sample, store in buffer, output data.
	TSH	Take sample, store in buffer (do not output).
	TSS	Take sample, store in buffer and in FLASH memory, output data.
	TSN:x	Take **x** samples and output data.
	SL	Output last sample stored in buffer.
	SLT	Output last sample stored in buffer, then take new sample and store in buffer (do not output data from new sample).

Note:
Do not set **SampleInterval=** to less than 10 seconds if transmitting real-time data (**TxRealTime=Y**).

Note:
Use Seaterm232's Upload menu to upload data that will be processed by SBE Data Processing. Manually entering a data upload command does not produce data with the required header information for processing by SBE Data Processing.

CATEGORY	COMMAND	DESCRIPTION
Serial Line Sync	**SyncMode=x**	**x=Y**: Enable serial line sync mode. **x=N**: Disable serial line sync mode.
Data Upload (send **Stop** before sending upload command)	**GetSamples:b,e**	Upload scan **b** to scan **e**, in format defined by **OutputFormat=**.
	DDb,e	Upload scan **b** to scan **e**, in alternate converted decimal form (**OutputFormat=3**) (regardless of setting for **OutputFormat=**).
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. View all coefficients with **GetCC** or **DC**.	**TCalDate=S**	**S**=Temperature calibration date.
	TA0=F	**F**=Temperature A0.
	TA1=F	**F**=Temperature A1.
	TA2=F	**F**=Temperature A2.
	TA3=F	**F**=Temperature A3.
	CCalDate=S	**S**=Conductivity calibration date.
	CG=F	**F**=Conductivity G.
	CH=F	**F**=Conductivity H.
	CI=F	**F**=Conductivity I.
	CJ=F	**F**=Conductivity J.
	WBOTC=F	**F**=Conductivity wbotc.
	CTCor=F	**F**=Conductivity ctcor.
	CPCor=F	**F**=Conductivity cpcor.
	PCalDate=S	**S**=Pressure calibration date.
	PA0=F	**F**=Pressure A0.
	PA1=F	**F**=Pressure A1.
	PA2=F	**F**=Pressure A2.
	PTCA0=F	**F**=Pressure ptca0
	PTCA1=F	**F**=Pressure ptca1.
	PTCA2=F	**F**=Pressure ptca2.
	PTCB0=F	**F**=Pressure ptcb0.
	PTCB1=F	**F**=Pressure ptcb1.
	PTCB2=F	**F**=Pressure ptcb2.
	PTempA0=F	**F**=Pressure temperature a0.
	PTempA1=F	**F**=Pressure temperature a1.
	PTempA2=F	**F**=Pressure temperature a2.
	POffset=F	**F**=Pressure offset (decibars).

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: …………………………….....   <u>47.0%</u>
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.   EPA Registration No. 74489-1
13431 NE 20th Street   EPA Establishment No. 74489-WA-1
Bellevue, WA 98005

AF24173 Anti-Foulant Device

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

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

DANGER
See Precautionary Statements for additional information.

FIRST AID	
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for15-20 minutes. • Call a poison control center or doctor for treatment advice.
If swallowed	• Call poison control center or doctor immediately for treatment advice. • Have person drink several glasses of water. • Do not induce vomiting. • Do not give anything by mouth to an unconscious person.
If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
HOT LINE NUMBER	
Note to Physician	Probable mucosal damage may contraindicate the use of gastric lavage.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For further information call National Pesticide Telecommunications Network (NPTN) at 1-800-858-7378.	

Net Contents: Two anti-foulant devices

Sea-Bird Electronics, Inc.　　　　　　　　　　　　EPA Registration No. 74489-1
13431 NE 20th Street　　　　　　　　　　　　　　EPA Establishment No. 74489-WA-1
Bellevue, WA 98005

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

<div style="border:1px solid">

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.

</div>

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

Sea-Bird Electronics/label revised 01-28-10

Appendix V: Replacement Parts

Part Number	Part	Application Description	Quantity in MicroCAT
50441	AA Saft Lithium battery set (12)	Power MicroCAT	1
801797	Battery holder for MicroCAT	Holds batteries. Note: This battery holder has a **red** cover plate. Some MicroCATs use a battery holder with a yellow cover plate; those packs are wired differently, and will not work properly in this MicroCAT.	1
801542	AF24173 Anti-Foulant Device	Bis(tributyltin) oxide device inserted into anti-foulant device cup	1 (set of 2)
233539	Anti-foulant device cup	Holds AF24173 Anti-Foulant Device	2
233540	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)	-
50087.1	Conductivity cell filling & storage device with hose barb caps	For cleaning and storing conductivity cell	-
801385	4-pin RMG-4FS to 9-pin DB-9S I/O cable with power leads, 2.4 m (8 ft)	From MicroCAT to computer	1
17043	Locking sleeve (for RMG)	Locks cable/plug in place	1
17046.1	4-pin RMG-4FSD-LP dummy plug with locking sleeve	For when cable not used	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
171192	Locking sleeve (wet-pluggable connector)	Locks cable/plug in place	1
171398.1	4-pin MCDC-4-F dummy plug with locking sleeve, wet-pluggable connector	For when cable not used	1
171888	25-pin DB-25S to 9-pin DB-9P cable adapter	For use with computer with DB-25 connector	1
30507	Parker 2-206N674-70 O-ring	O-ring between end of conductivity cell and anti-foulant device cup	2

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Part Number	Part	Application Description	Quantity in MicroCAT
60049	Spare hardware/O-ring kit for 37-SM / -SMP with titanium housing	Assorted hardware and O-rings, including: • 30900 Bolt, $^1/4$-20 x 2" hex head, titanium (secures mounting clamp) • 30633 Washer, $^1/4$" split ring lock, titanium (for 30900) • 30634 Washer $^1/4$" flat, titanium (for 30900) • 31019 O-ring Parker 2-008 N674-70 (for 30900, retains mounting clamp hardware) • 31040 Screw, 8-32 x 1 FH, titanium (secures cable guide base to connector end cap) • 30860 Screw, 6-32 x ½ FH, titanium (secures cable clamp half to flat area of sensor end cap) • 30544 Screw 8-32 x ½ FH, titanium (secures cell guard to housing) • 30859 Screw, 8-32 x $^3/8$" FH, titanium (secures housing to connector end cap) • 30857 Parker 2-033E515-80 O-ring (connector end cap and sensor end cap O-ring) • 31749 Hex key, 7/64 inch, long arm (secures battery pack in housing with captured screw) • 31322 O-ring Parker 2-130 N674-70 (for grooves on side of battery pack) • 30858 O-ring Parker 2-133 N674-70 (for battery pack cover plate)	-
60053	Spare hardware/O-ring kit for 37-SM / -SMP with plastic housing	Assorted hardware and O-rings, including: • 30900 Bolt, $^1/4$-20 x 2" hex head, titanium (secures mounting clamp) • 30633 Washer, $^1/4$" split ring lock, titanium (for 30900) • 30634 Washer $^1/4$" flat, titanium (for 30900) • 31019 O-ring Parker 2-008 N674-70 (for 30900, retains mounting clamp hardware) • 31040 Screw, 8-32 x 1 FH, titanium (secures cable guide base to connector end cap) • 30860 Screw, 6-32 x ½ FH, titanium (secures cable clamp half to flat area of sensor end cap) • 30544 Screw 8-32 x ½ FH, titanium (secures cell guard to housing) • 31755 Cap screw, 8-32 x 1/4" SH, titanium (secures connector end cap to housing) • 31516 Hex key, 9/64 inch long arm (for installing 31755) • 30857 Parker 2-033E515-80 O-ring (connector end cap and sensor end cap O-ring) • 31749 Hex key, 7/64 inch, long arm (secures battery pack in housing with captured screw) • 31322 O-ring Parker 2-130 N674-70 (for grooves on side of battery pack) • 30858 O-ring Parker 2-133 N674-70 (for battery pack cover plate)	-

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Appendix VI: Manual Revision History

Manual Version	Date	Description
012	10/99	• Rewrite.
013	12/99	• Design change from potted to modular (take apart).
014	09/00	• Changes related to firmware version 2.1. • Change to Druck pressure sensor. • Incorporate SEATERM. • Correct pressure port size. • Add information and drawing of brackets. • Add information on optional pump. • Correct serial line sync voltage. • Remove 'optically-isolated' from description. • Add information to limit Interval to more than 10 seconds if transmitting real-time data..
015	01/01	• Minor update to specifications for consistency with new data sheet. • Add discussion of Deployment Pressure dialog box for Seaterm's Convert process. • Add references to SBE Data processing.
016	02/02	• Add 2000 m pressure sensor. • Add connector diagram for wet-pluggable connector.
017	12/02	• Add caution that setting time without date resets date to last date set with **ddmmyy=** or **mmddyy=**. • Revise description of Convert process. • Add information on baud rate, sampling time, and cable length. • Add power endurance information. • Correct pressure port maintenance. • Correct pressure sensor calibration fitting. • Anti-foul information: use EPA-approved descriptions and labels.
018	01/03	• Add AF label information in appendix.
019	05/03	• Firmware version 2.4: added **NAvg** and removed **NCycles**. • Remove information on optional pump; option now unavailable because 37-SMP introduced.
020	11/03	• Firmware 2.5: added **OutputSal=** and **OutputSV=**. • Add 600 baud. • Add information on maximum cable length for external power. • Add information on minimum time between samples for take sample commands.
021	02/04	• Update power and cable length section.
022	06/04	• Firmware 2.6: new board layout, new power specifications. • Update power consumption / cable length calculations. • Add updated information on shipping restrictions for lithium batteries
023	05/05	• Add 600 m Druck pressure sensor. • Update cleaning recommendations to correspond to revised application note 2D. • Update AF24173 Anti-Foulant Device appendix to current label. • Add troubleshooting section. • Update battery shipping precautions. • Add details on how to process MicroCAT data in SBE Data Processing's Derive module.
024	05/06	• Update wet-pluggable connector information. • Add more information to Recovery Warning.
025	11/06	• Add option for plastic housing. • Add more explanation of **NAvg=**. • Update pressure port maintenance – SBE no longer putting silicon oil in port.
026	06/07	• Add handling precautions for plastic housing.

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027	04/08	• Update for Version 3 firmware changes: many commands changed, power specifications changed. • Change stability specification for pressure to per year instead of per month. • Update connector maintenance information for consistency with application note 57. • Add information that **POffset** is in decibars.
028	07/08	• Firmware revision 3.0c: - If no P sensor is installed, reference pressure now appears in **GetCD** instead of **GetCC**, and appears in **DS** instead of **DC**. - Minimum conductivity frequency line removed from **GetCD** response if **PumpInstalled=n**. - **SetPCBSerialNum1=**, etc. removed. • Update battery installation procedure, specifications, endurance, and shipping instructions for new battery packs (12 AA lithium cells). • Correct cable length and external power example.
029	08/08	• Firmware revision 3.0f: - Add new output format to match firmware < 3.0. **DDb,e** now uploads in new format. - If **StartLater**>90 days in future, does **StartNow**. • Manufacturing change: for plastic housing, 2 phillips-head screws at connector end cap end and 1 at sensor end cap end are replaced with hex screws. 9/64" allen wrench shipped with instrument.
030	01/09	• Update for SeatermV2 terminal program. • Add information about compatibility with Vista. • Correction: Add PTempA0, PTempA1, PTempA2 to calibration coefficient commands.
031	01/10	• Add information about Deployment Endurance Calculator. • Change Seasoft-Win32 to Seasoft V2, update file name to SeasoftV2_*date*.exe. • SBE Data Processing 7.20a: Add information about .xmlcon file. • Add CE mark. • Update SBE address. • Update anti-foul label in Appendix with new Container Handling requirement and new address.
032	07/10	• Firmware 3.0j: Fix bug related to **StartDateTime=**. Previously, when **StartLater** was sent, register ignored month in **StartDateTime**, and started at the next day and time corresponding to the day and time (example: if it is July 1 and you set it to start on August 15, it ignored August part of date, and started July 15). Documentation said could be started 90 days out, but this actually limited it to 30 days out. Now, it provides a message saying it will start logging in 5 seconds if start date is more than 30 days out. • Add 60053 spares kit for plastic housing.
033	10/10	• Update for changes to SeatermV2 version 1.1 (upload now converts .xml file to .hex and .xmlcon files, which are used in Data Conversion to convert to .cnv file for further processing). • Remove references to Druck sensors (pressure sensors can be supplied by other manufacturers).
034	03/11	• SeatermV2 1.1b changes: - Update upload procedure, Seaterm232 automatically starts SBE Data Processing after upload - Update SeatermV2 Instruments list screen capture • Add information about compatibility with Windows 7
035	08/12	• Update Shipping Precautions for latest IATA rules. • Add Declaration of Conformity. • Add cable and wiring diagrams. • Add more information on selecting output variables for data processing of uploaded data. • Triton – update company name (Avantor Performance Materials) and link. • Remove factory-set commands: **SetPressureInstalled=**, **SetMfgDate=**, **SetPCBAssembly=**, **SetPCBSerialNum=**. • Glossary - Add information on ODO MicroCATs • Sampling Mode examples -- Add setting date/time to all examples, and add setting output format to sync mode example. • Update configuration dialog box in SBE Data Processing. • Clarify information on correct battery pack to use with this MicroCAT. • Fix typos.

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036	01/13	• Update battery shipping restrictions to meet 2013 requirements. • Update Serial Port Configuration dialog box. • Update Upload dialog box. • Update software compatibility information. • Add information about limitations with 115200 baud rate.
037	09/13	• Update plastic housing depth rating to 350 meters. • Update SeatermV2 screen capture and Upload dialog box. • Add information on editing raw .hex files. • Clarify that accuracy specifications are ±. • Glossary - Add information on SDI-12 MicroCATs. • Update Declaration of Conformity. • Fix typos.

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