Washington State Department of Ecology

Environmental Assessment Program

Standard Operating Procedures for Marine Waters Oxygen and Supporting Sensor Performance Assessment – Lab Procedures

Version 2.0

EAP086

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Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)
9/8/2013	1.0	Initial Publication	all	Bill Kammin
8/24/2016	2.0	Updated references, links, and mooring bath log sheet.	all	Suzan Pool
8/24/2016	2.0	Footer for recert, cover page	all	Bill Kammin

1.0 Purpose and Scope

1.1 This document is the Environmental Assessment Program (EAP) Standard Operating Procedure (SOP) for the laboratory procedures verifying sensor performance for marine mooring and flight dissolved oxygen (DO) sensors.

1.2 The DO sensor verification uses a salt water enclosure "lab bath" under controlled laboratory conditions and is a routine check of the sensor performance to determine precision, stability, and electrical drift of sensors prior to being used in the field. We conduct verification baths so that we can determine and determine quality criteria of the start point status of instruments before they are transported into and deployed in the field.

1.3 While the specific purpose of this SOP is to quantify dissolved oxygen sensor performance, we also use this SOP as a guide for sensor performance checks to assessment of temperature, conductivity, and pressure variables that are used to calculate dissolved oxygen concentrations. In addition, it will be used to assess the temperature, conductivity, and pressure variables.

2.0 Applicability

2.1 This SOP should be followed for all laboratory based sensor verification activities performed by the Marine Monitoring Unit for flight and mooring instruments.

3.0 Definitions

3.1 Anti-foulants: Plastic cylinders impregnated with bis-tributylin installed on oceanographic sensors. Their purpose is to reduce biofouling of sensors during deployments.

3.2 Artificial Seawater: The bath is filled with artificial seawater with a salinity of at least 10 psu and made with filtered tap water and food-grade salt.

3.3 Conductivity-Temperature-Depth (CTD) sensor: Electronic equipment that measures conductivity, temperature, and depth in the water. It is commonly used in both marine and freshwater applications.

3.4 Dissolved Oxygen (DO): The amount of gaseous oxygen (O_2) dissolved in water. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement), and as a product of photosynthesis. DO levels are used as an indicator of water quality.

3.5 Greenwich Mean Time (GMT): Global time standard used for CTD instruments. GMT is 7 hours ahead of local time in summer, 8 hours ahead in winter; currently November-March).

3.6 Lab Bath: A 187 gallon 5' x 3' rectangular, fiberglass tank that is used to conduct sensor performance checks in the laboratory. The tank is filled with artificial seawater to the top of a Plexiglas window that allows monitoring of the instruments underwater, and has circulation pumps and aeration pumps in the water to achieve near gas saturation levels.

3.7 Material Safety Data Sheet (MSDS): MSDSs provide both field staff and emergency personnel with proper procedures for handling or working with a particular substance. MSDSs include information such as physical data (e.g., melting pint, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill/leak procedures.

3.8 Sea-Bird Electronics, Inc. (SBE) 16*plus*: Manufacturer and model of CTD sensors that are used for moored applications. All computer, software, and instrument configuration and communications are conducted according to manufacturer protocols. Specific information on these procedures is found in the manufacturer's "User's Manual" for the SBE 16*plus* at: www.seabird.com/old-manuals/SBE_16plus/16plus_RS-232/1.8c_Firmware_017-018Manual/16plus_rs232_018.pdf

3.9 SBE 25: Manufacturer and model of profiling CTD used for monitoring marine water quality on marine flights.

3.10 SBE 37-SMP-IDO (37 IDO): Manufacturer and model of CTD sensor that is used in the laboratory and is the reference instrument for field instruments. This instrument is not to be deployed in the field and is considered "pristine."

3.11 SBE 37-SM: Manufacturer and model of CTD sensor with firmware 2.6b currently used in moored deployments for monitoring marine water quality.

3.12 SBE 37-SMP: Manufacturer and model of CTD sensor with firmware 2.6a currently used in moored deployments for monitoring marine water quality.

3.13 SBE 43: Manufacturer and model of DO sensor currently used in moored and profiling instruments for monitoring marine water quality.

3.14 Synchronized Winkler Collection: Collection of DO seawater samples from a field bath is synchronized with CTD and DO sensor measurements to obtain independent verification of DO sensor performance. Note that a water pump on the CTD package turns on 30 seconds prior to measurements and that the CTD takes measurements every 60 seconds. DO seawater samples are collected ideally every 120 seconds at the same time the CTD takes a measurement of the seawater.

3.15 Winkler Samples: Water samples collected for determinations of DO concentrations. These samples are analyzed by colorimetric titration in the lab. Data from these samples are used to confirm the validity of DO sensor performance.

4.0 Personnel Qualifications/Responsibilities

4.1 All laboratory staff must comply with the requirements of the EAP Safety Manual (Environmental Assessment Program, 2012)

4.2 Experience with seawater sampling, particularly dissolved oxygen and salinity samples.

4.3 Lab-bath lead responsible for implementation and adherence to Marine Waters Sensor Performance Assessment SOP procedures and requirements. This staff member is trained in the use of the SBE 37-SMP- IDO and the most current SBE SeaTermV2 program.

4.4 Field lead experienced with conducting a sensor performance assessment and trained in the use of Sea-Bird Electronics equipment and software, particularly SBE SeaTerm and SeaSaveV7.

5.0 Equipment, Reagents, and Supplies

5.1 General Equipment and Supplies

- DO lab bath
- Artificial seawater (filtered tap water, food-grade salt)
- Large transparent Tygon tubing (15 feet, 1/2" ID, for filling the bath)
- DO transparent Tygon tubing (3 feet, 5/16" ID, for purging air bubbles)
- SBE 37 SMP IDO
- Laptop equipped with SBE software
- CTD communication cables
- Water circulation pumps (2)
- Ultraviolet (UV) sterilization pump
- Aeration pump and air stones (2)
- Bungee cords
- Several sets of nitrile or long gloves
- 100 ml plastic syringes
- Cleaning agents for sensors
    - 1:50 bleach solution
    - Triton-X detergent
    - Deionized (DI) water

5.2 Dissolved Oxygen Sampling Supplies

- Glass flasks and stoppers for collection of dissolved oxygen samples
- Transparent Tygon tubing (1 foot, 5/16" ID)
- 3 M Manganese chloride ($MnCl_2$) (obtained from the University of Washington's Marine Chemistry Lab). This chemical is stable for 2 years when stored in sealed

plastic bottles and kept in the dark. The MSDS can be found at www.avantormaterials.com/Documents/MSDS/USA/SAP/00015677.PDF.

- 8 N Sodium hydroxide-sodium iodide-sodium azide ($NaOH$-NaI-NaN_3; also named as alkaline iodide azide) obtained from the University of Washington's Marine Chemistry Lab. This chemical is stable for 2 years when stored in sealed plastic bottles and kept in the dark. The Safety Data Sheet can be found at www.spectrumchemical.com/MSDS/LC10690.pdf.
- De-ionized water
- Bottle-top dispensing or 1 mL automatic pipettes with tips for safely dispensing chemicals

5.3 Salinity Sampling Supplies

- Opaque brown 125-ml polyethylene bottles with previous seawater sample still in them to maintain osmotic equilibration of the plastic.

5.4 Lab Bath Log Form

- Log form used for recording DO lab bath activities.

6.0 Summary of Procedure

6.1 Saltwater Management

6.1.1. Artificial Seawater: Make artificial seawater by filling the DO bath with filtered tap water. In the marine lab, the sink assigned as "dead" has a water filter under the cold water spout. This filter excludes heavy metals, cysts, and other large particles. The bath is about 1,060 L. To make at least 10 psu water in the bath, use 10 g salt per liter (10,600 g or 23.4 lbs.).

6.1.2. Seawater Maintenance and Cleanliness: Keep the bath water uncontaminated and free of chemicals. It is also important to minimize direct skin contact with the water. Before putting clean instruments in the bath, inspect the bath water for oily sheens or films while the circulation pump is off. Remove all oily films from the bath by skimming the surface and wiping off any matter adhering to the side of the bath vessel. Oily substances and other biological matter may affect sensor sensitivity and enhance microbial respiration in the bath. Biological activity can be further restricted by using a UV filter. Replace the water every month or as necessary. The inside of the tank should be wiped down when drained and cleaned with 1:50 bleach solution.

6.1.3. Bath Circulation and Aeration: Keep two water circulation pumps and aeration pumps in the bath at all times. This ensures that DO concentrations are kept near full saturation. Circulation pumps should be pointing upwards to allow for vertical mixing. During a bath, circulation pumps should be kept on, but aeration pumps can be turned off as to minimize air bubbles.

6.1.4. Instrument Cleanliness: Clean all instruments thoroughly inside and out and remove

anti-foulants prior to putting an instrument in the bath. This is especially important for moored instruments which can have extensive biofouling.

6.2 Lab Bath Setup

6.2.1. Instrument height in the bath: Ensure that the water intake openings of two or more instruments in the bath are as close to each other in height as possible. Spatial constraints within the bath and design differences between instruments may preclude a close match in instrument intake height. Water level within the bath must be as high as possible and instruments lowered as much as possible in the bath. Water intake differences are lessened by having the water well mixed by using pumps.

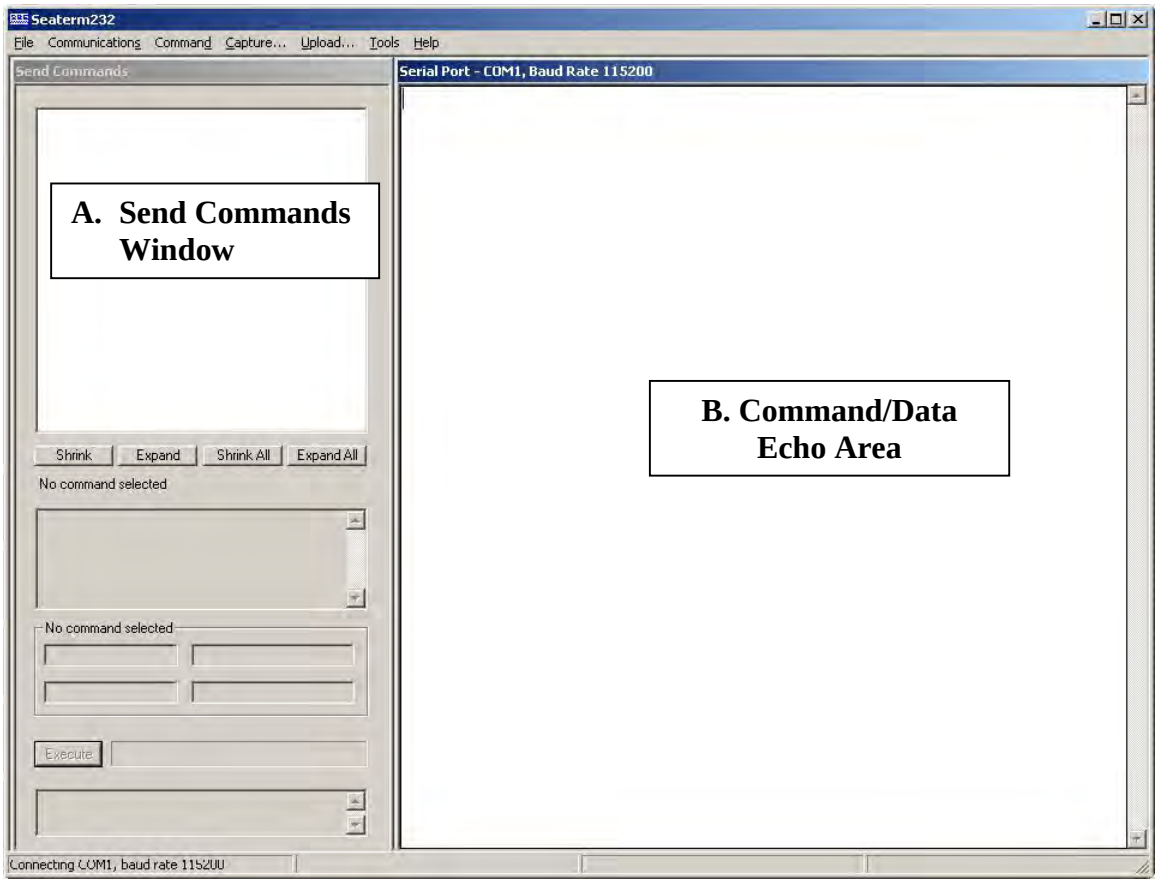
6.2.2. Air bubble removal: Remove air bubbles from the instrument plumbing to ensure accurate DO readings. This should be done for all instruments in the bath as air bubbles inside instruments detrimentally affect DO data. For moored instruments and the SBE 25, attach DO tubing to the intake with a syringe on the end of the tubing. While the instrument is in the water, push water back and forth through the plumbing with the syringe and gently rock the instrument. Do this until air bubbles stop coming out of the instrument's water exhaust. For the 37 IDO, gently rock the instrument vertically and horizontally until air bubbles stop coming out of the air bleed hole. Air bubble removal success is reflected in stable DO readings as well as salinity measurements.

6.3 SBE 37-SMP-IDO Lab Bath Procedures

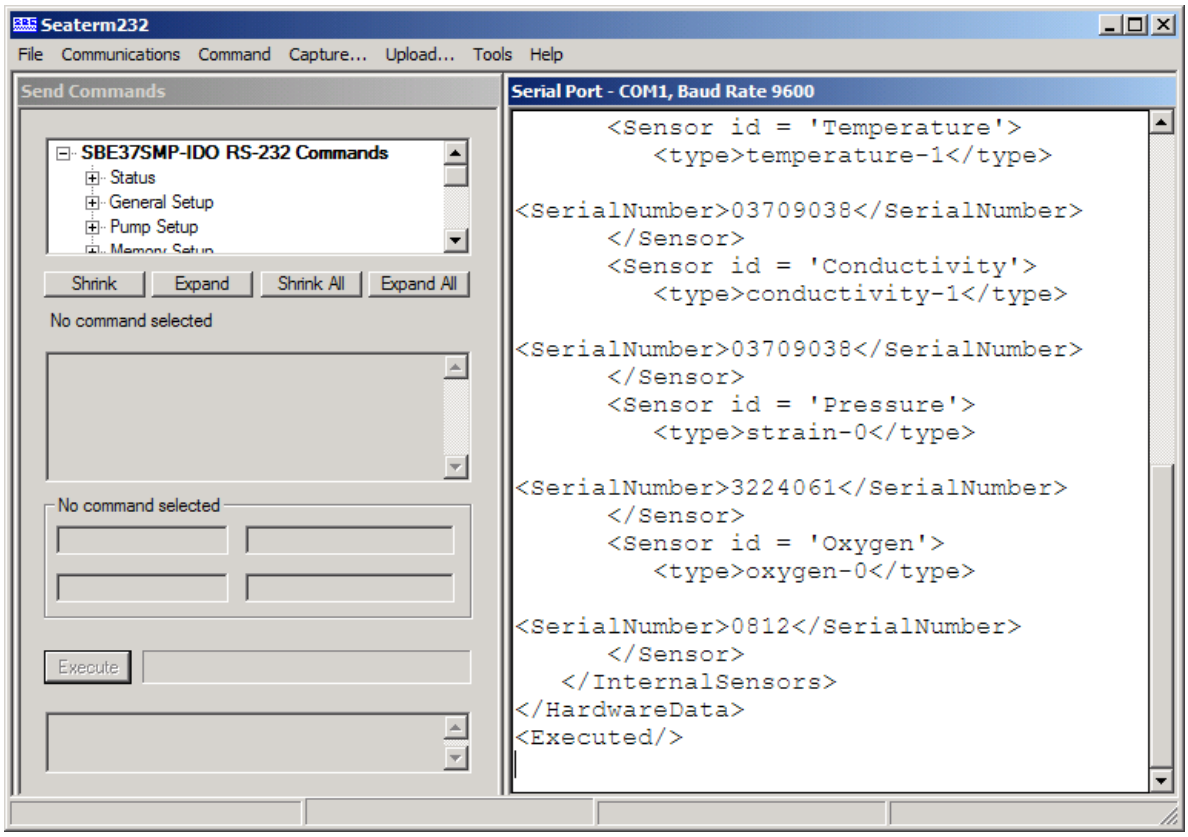
6.3.1. Attach the communication cable from the 37 IDO to a computer.
6.3.2. Hang it in the bath with a bungee cord.
6.3.3. Expel air bubbles by gently rocking the instrument up and down. The instrument should sit in the bath for at least half an hour prior to sampling in order to ensure proper air bubble expulsion.
6.3.4. Open SeatermV2. In the insturment menu select **G. SBE 37 RS232**.

6.3.5 There are two windows in SeatermV2;

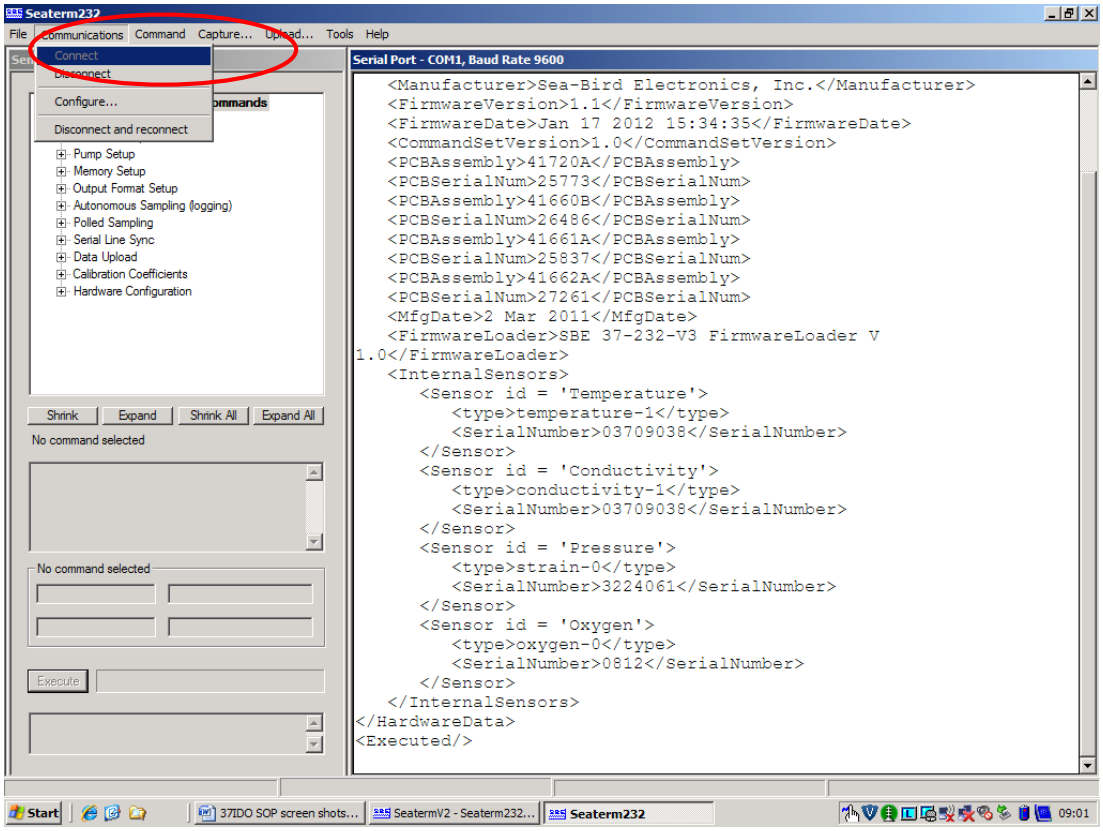
A. Send commands window.
B. Command/data echo area.



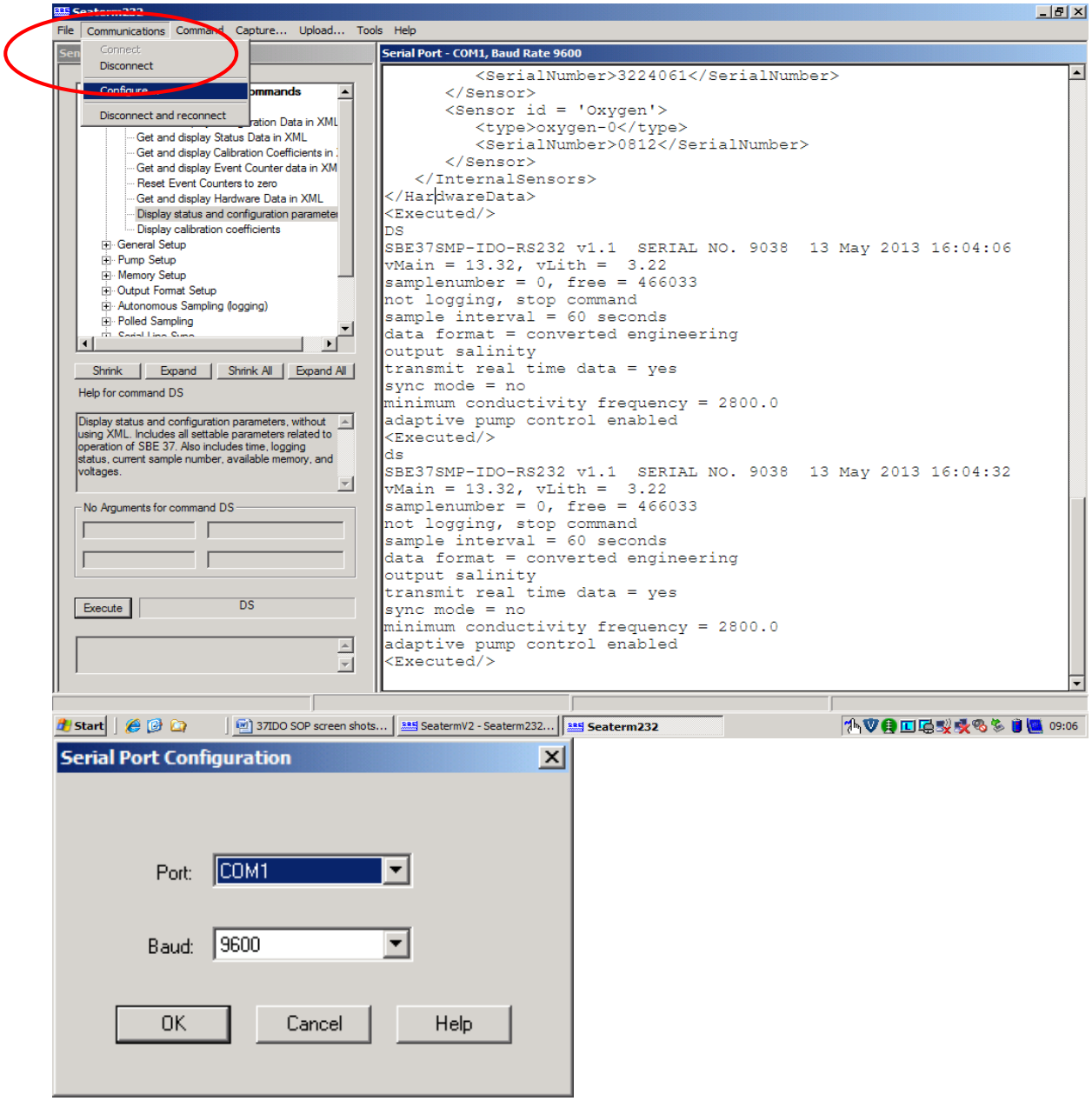
6.3.6 SeatermV2 should automatically connect to the sensor and send **GetHD** command. The 37 IDO will scroll instrument type, serial number, and firmware version in the data echo area.



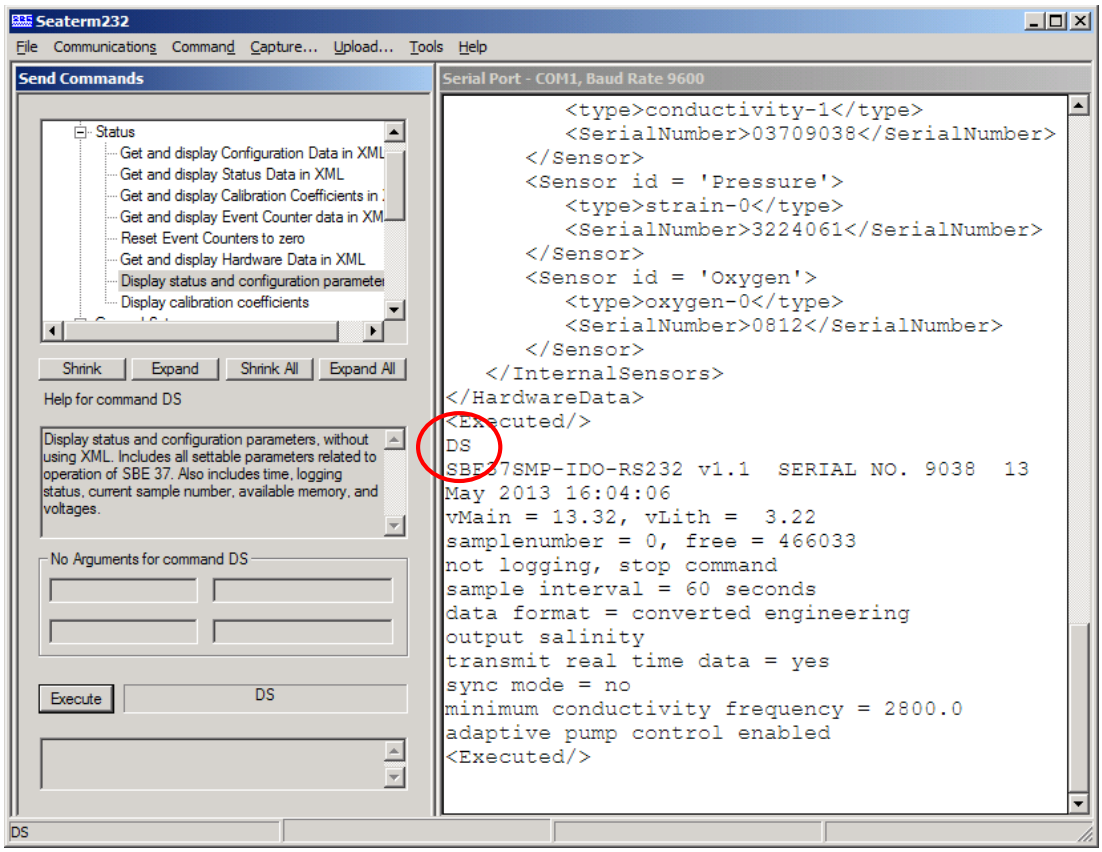
6.3.7 If it doesn't automatically connect, go to the **Communications** drop down menu and select **Connect** (or disconnect and connect again).



6.3.8 To confirm baud rate and communication port settings, go to the **Communications** drop down menu and select **Configure**. Choose **COM1** and **9600**.



6.3.9 Type **DS** in the data echo area *or* go to the send commands window, select **Status → Display status and configuration parameters** and click **Execute**. The instrument settings will echo back.



6.3.10 Check the vMain and vLith. The vMain needs to be greater than 11.3 volts. If vMain is below criterium, change the batteries following the instructions in the current manual. Only use lithium batteries per the manufacturer's recommendation. The vLith needs to be above 7.0 volts.

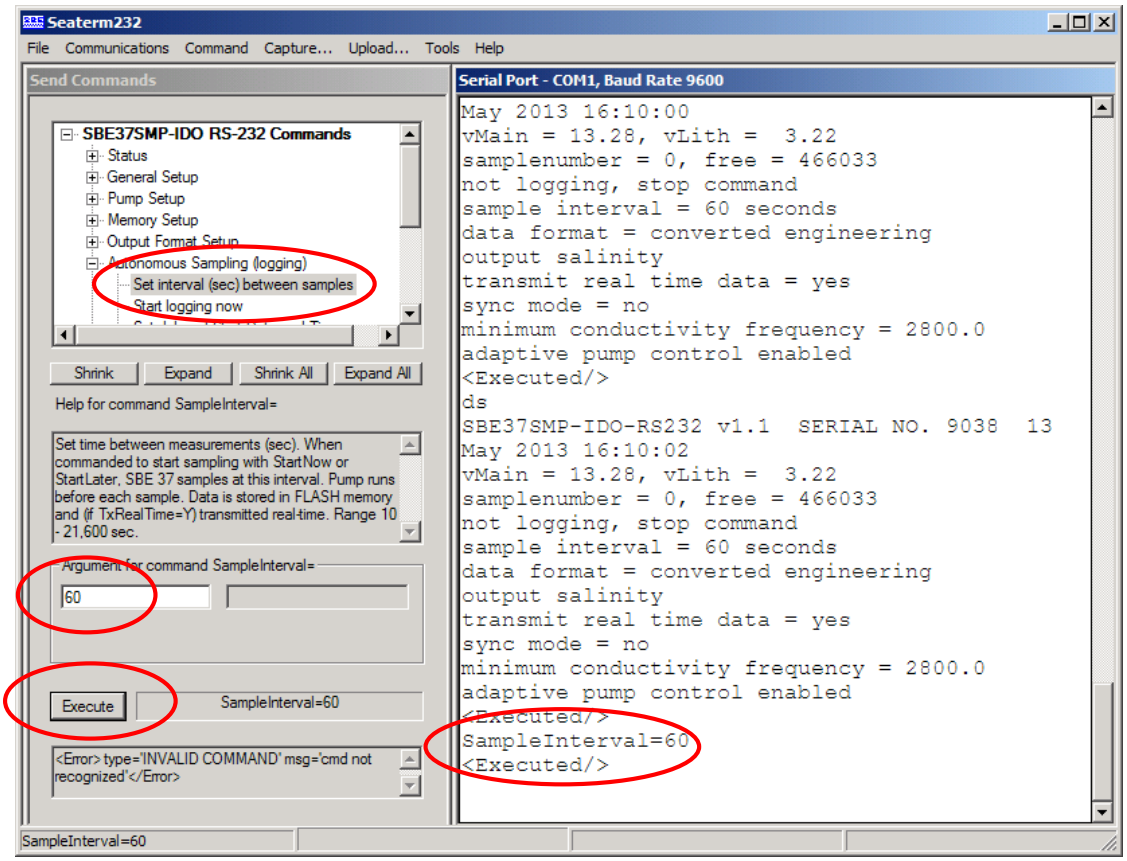
6.3.11 In the DS command echo, check the following settings (the 37 IDO will retain its settings from previous use):

A. Date and time (GMT)
B. Sample interval = 60 seconds
C. Data format = converted engineering
D. Output salinity
E. Real time data = yes
F. Sync mode = no
G. Minimum conductivity frequency = 2800
H. Adaptive pump control enabled

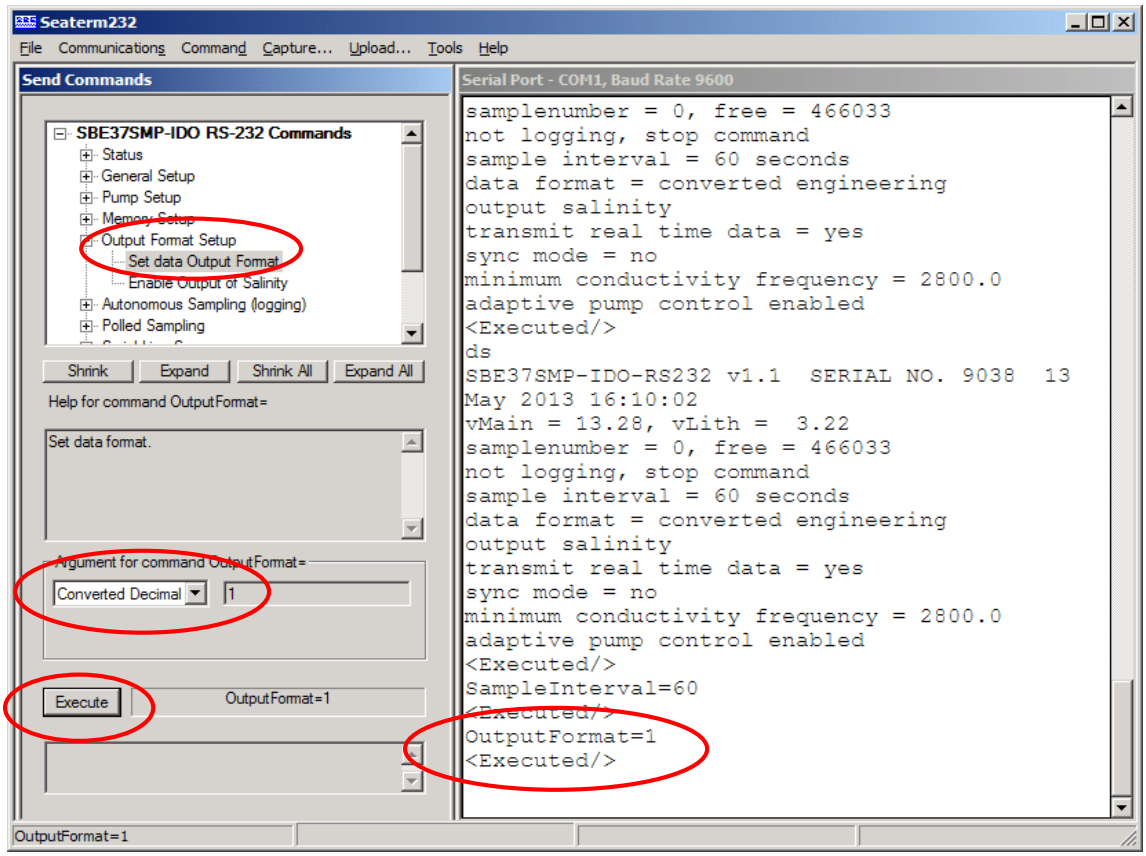
6.3.12 To correct or change the settings, follow instructions in section 6.3.13 A-F. When a setting is changed successfully, the 37 IDO will confirm by echoing back **<Executed/>**. If you do not see <Executed/> enter the command again until it echos <Executed/>.

6.3.13 If, at any time, you enter a command and see this error message: **<Error type='INVALID COMMAND' msg=smd not recognized'>**, enter the command again and it should work.

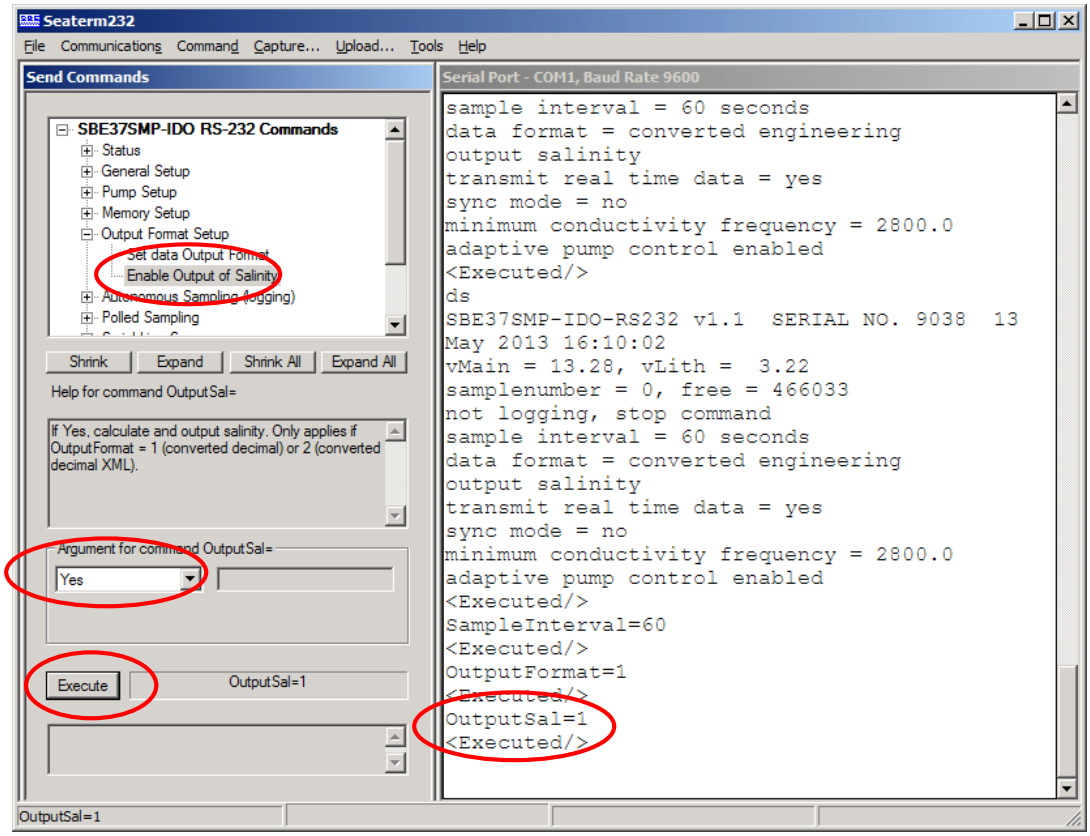
A. In the Send Commands window, go to **Autonomous Sampling (logging),** select **Set interval (sec) between samples,** and type **60** (or other desired interval) in the **Argument for command SampleInterval=** box . Click **Execute**. The 37 IDO will echo <Executed/> in the data echo area. Do not choose a sample interval that is faster than 30 seconds.



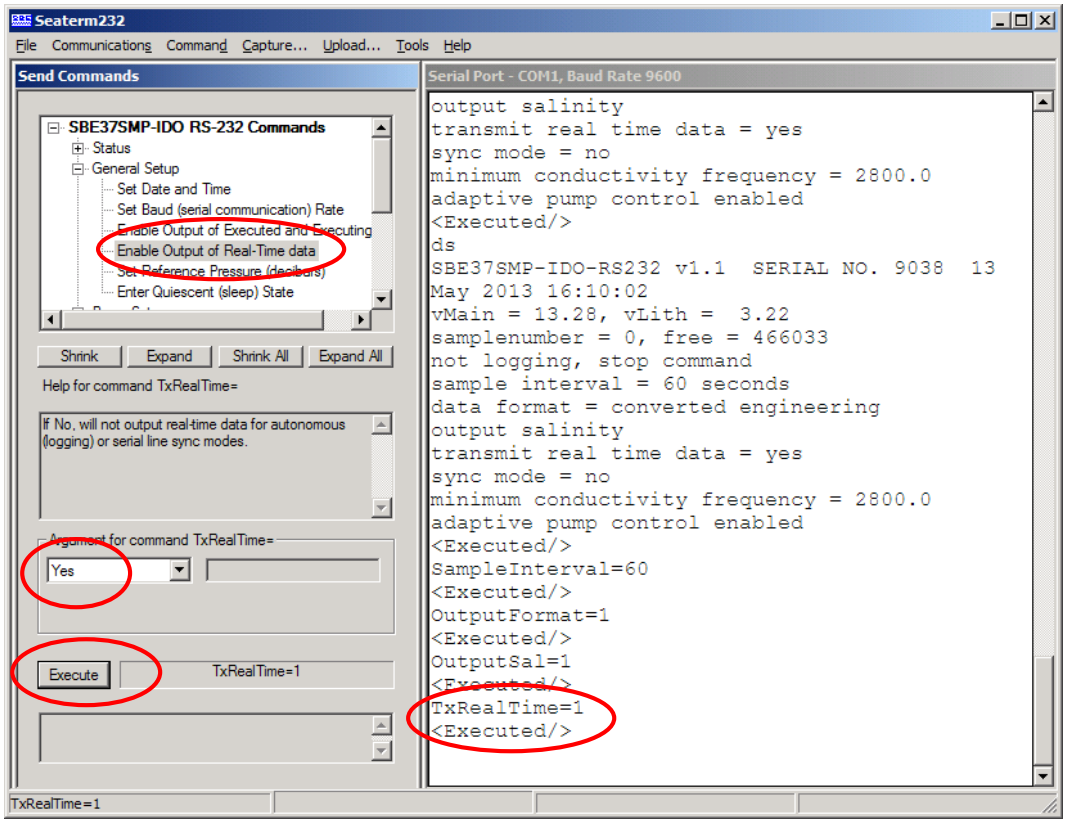
B. In the Send Commands window, go to **Output Format Setup,** select **Set data Output Format,** and choose **converted decimal** (**1).** Click **Execute.** The 37 IDO will echo <Executed/> in the data echo area.



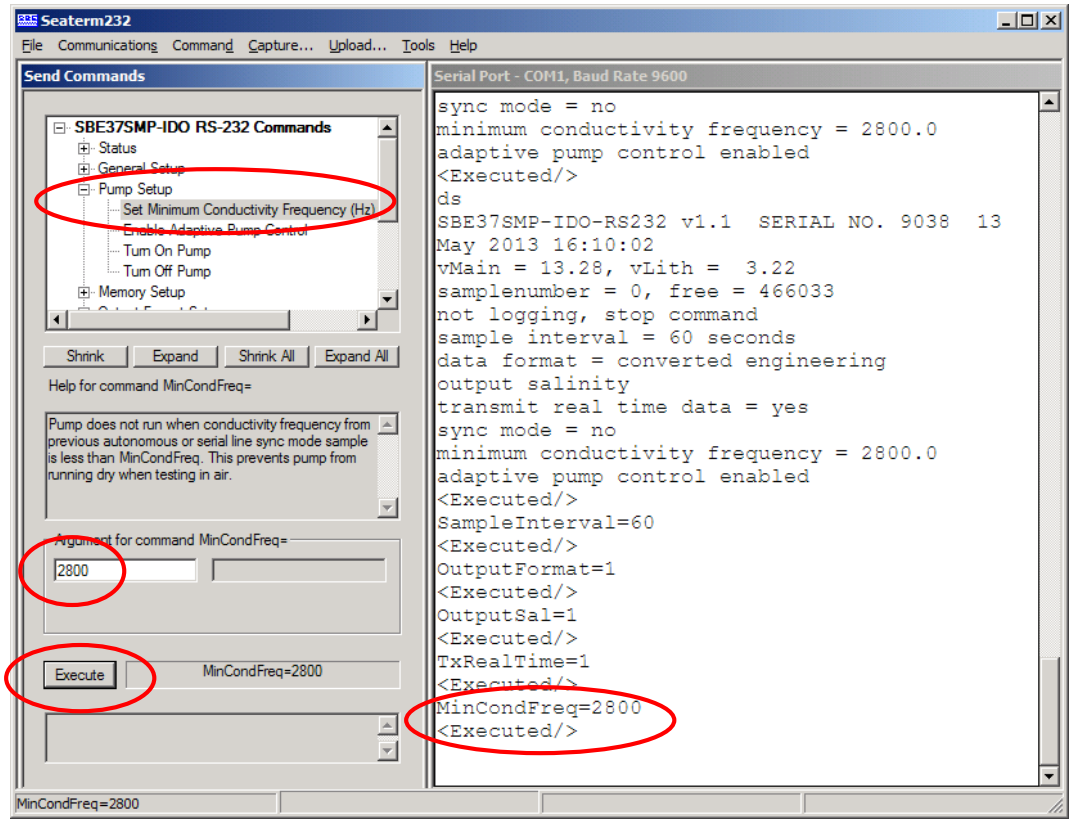
C. In the Send Commands window, go to **Output Format Setup,** select **Enable output of salinity,** and choose **Yes**. Click **Execute**. The 37 IDO will echo <Executed/> in the data echo area.



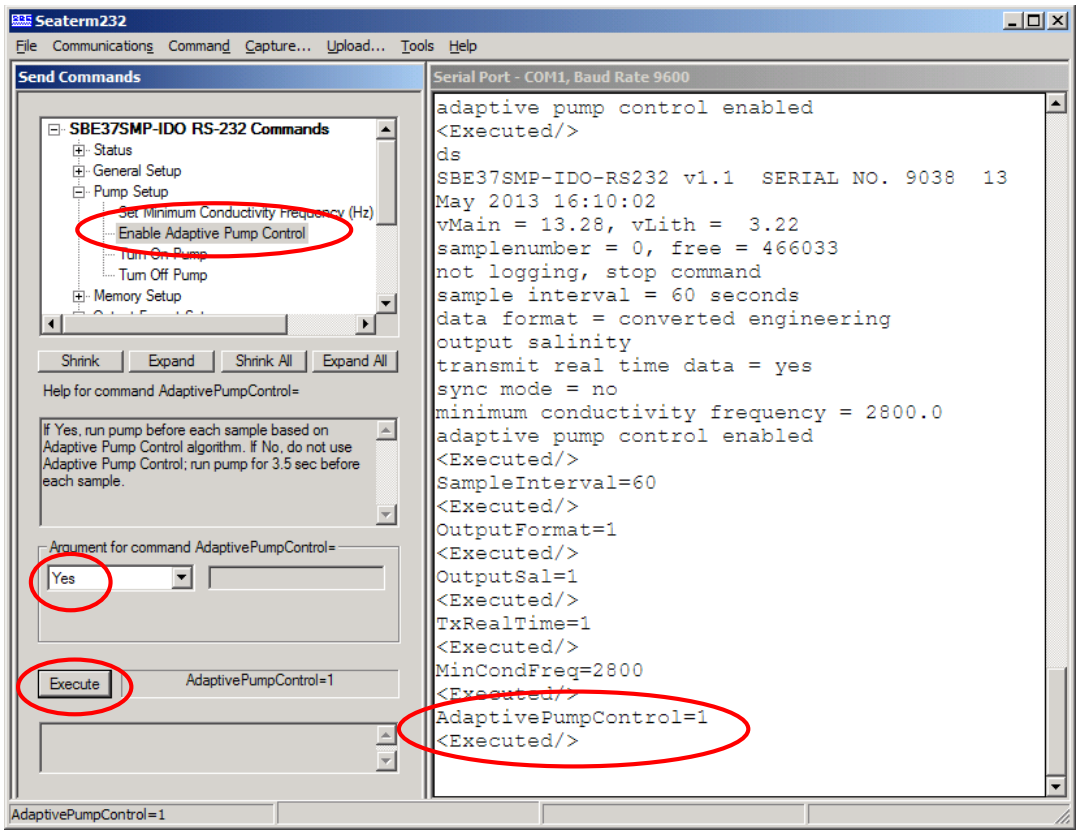
D. In the Send Commands window, go to **General Setup**, select **Enable Output of Real-Time Data,** and choose **Yes**. Click **Execute**. The 37 IDO will echo <Executed/> in the data echo area.



E. In the Send Commands window, go to **Pump Setup**, select **Set Minimum Conductivity Frequency,** and type **2800** into the argument for command box. Click **Execute.** The 37 IDO will echo <Executed/> in the data echo area.

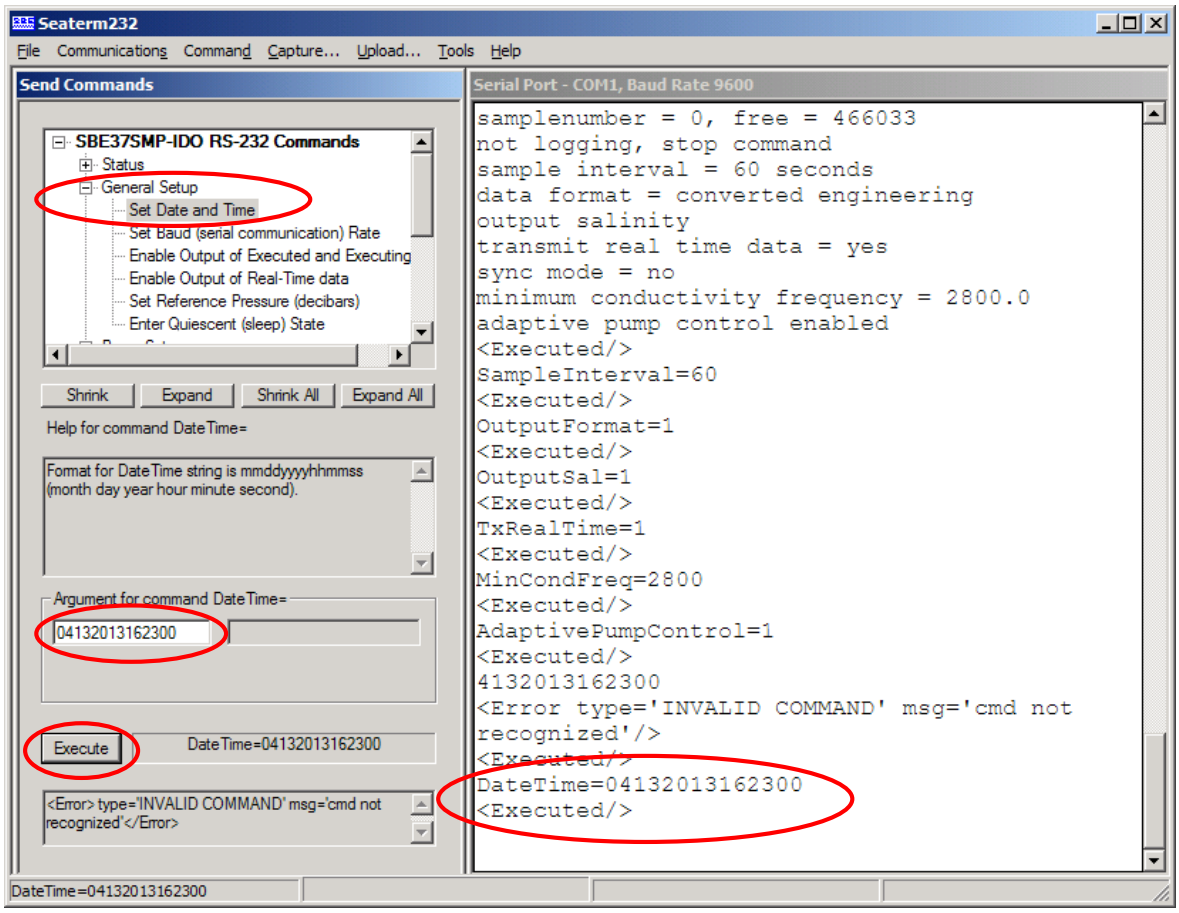


F. In the Send Commands window, go to **Pump Setup,** select **Enable Adaptive Pump Control,** and choose **Yes**. Click **Execute**. The 37 IDO will echo <Executed/> in the data echo area. This runs the pump before each sample based on an adaptive pump control algorithm.



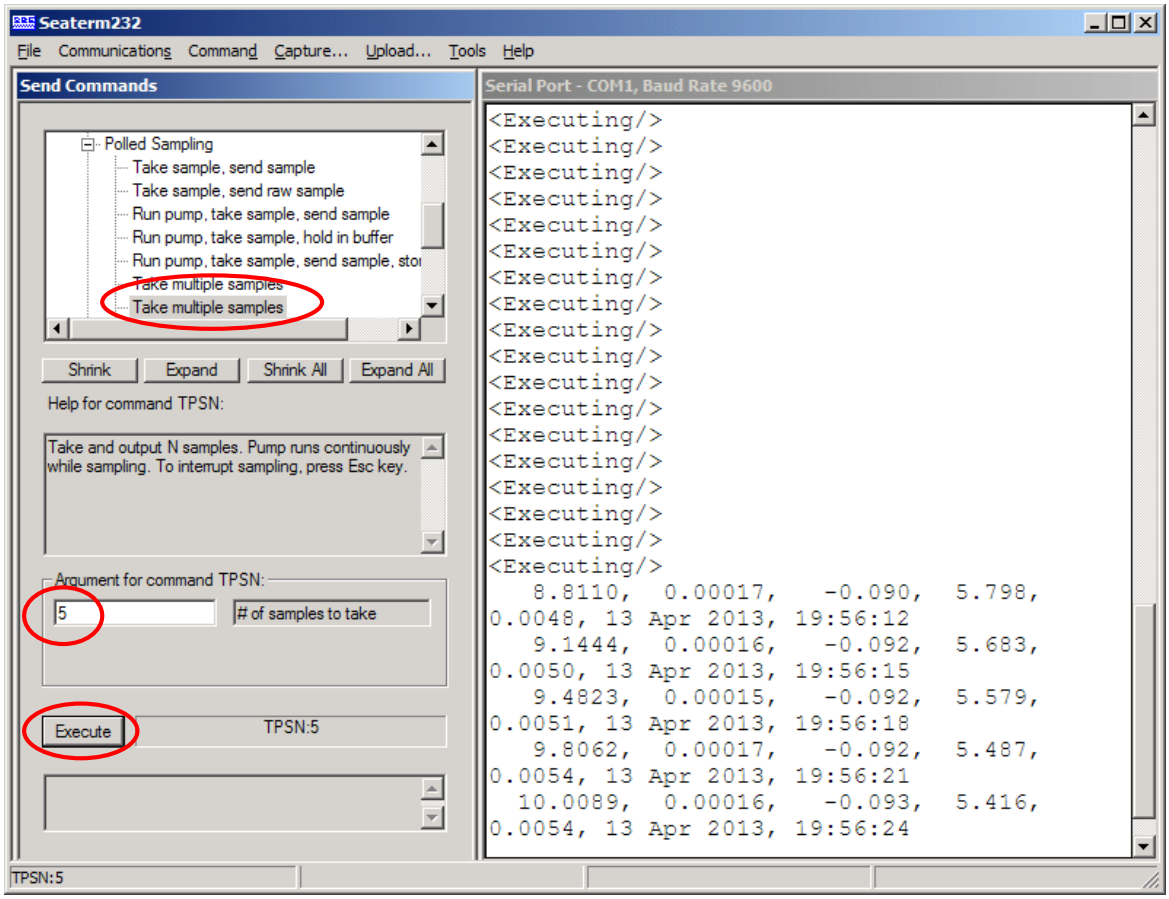
6.3.14 If the 37 IDO is in the bath with another instrument(s), synchronize the date and time (GMT) between all instruments. This can be done using a clock on a cell phone or digital watch.

6.3.15 To change the date and time, go to the the send commands window, select **General Setup**, select **Set Date and Time**. Type **MMDDYYYYHHMMSS** and click **Execute**. Use GMT only (7 hours ahead in summer, 8 hours in winter; currently November-March). To synchronize date and time for two or more instruments, execute the date/time change at the same time. If the time was accepted, the 37 IDO will echo <Executed/> in the data echo area.



6.3.16 Confirm all settings by entering a **DS** command into the command/data echo area.

6.3.17 Check the 37 IDO for air bubbles and data stability by taking multiple samples while the pump is running. In the Send Commands window, go to **Polled Sampling**, select the second **Take multiple samples** option which runs the pump while taking samples. Type **5** to take 5 samples, click **Execute**. It will scroll <Executing/> many times while the pump runs, and then it will output five samples on the screen. Data output order on the screen is temperature, conductivity, pressure, oxygen (ml/l), salinity, date, time. DO voltage is not displayed until processed.



6.3.18 If the data are unstable, purge air bubbles again by gently rocking the instrument. Take samples to check data stability. Repeat this process until the data are stable and oxygen values are near saturation.

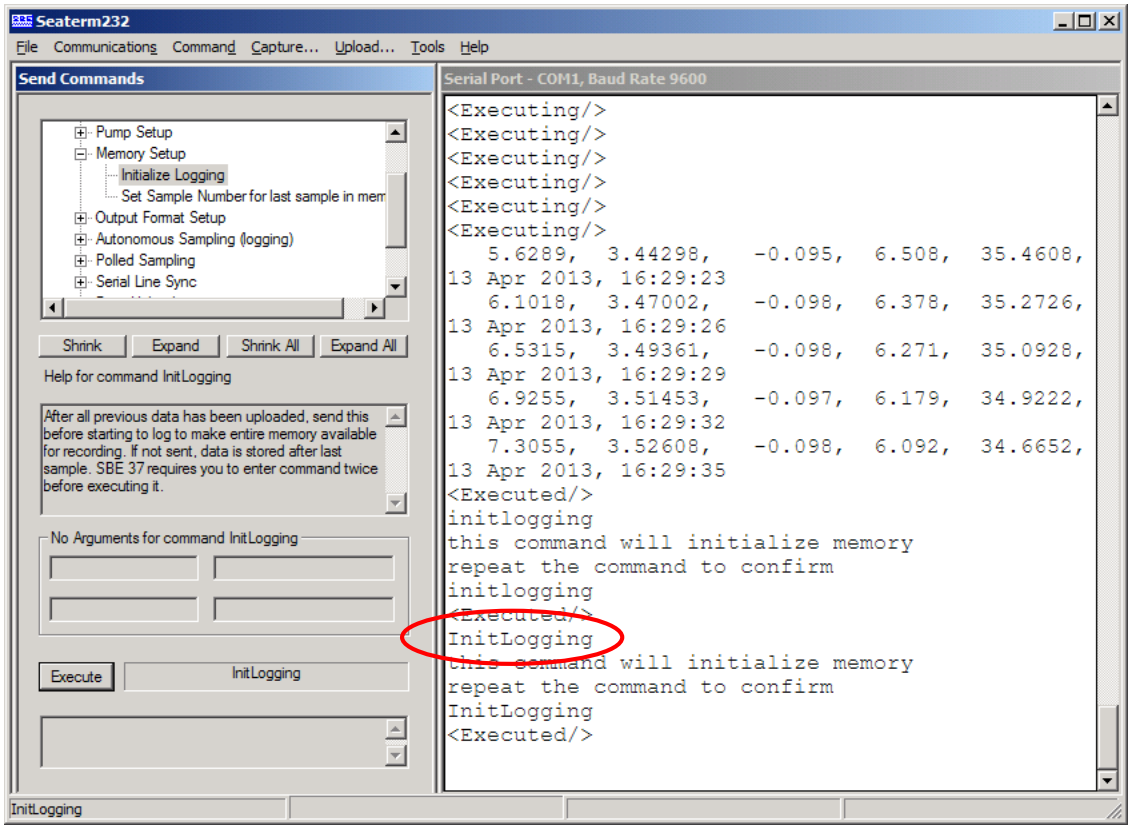
6.3.19 Once the sensor data are stable and other instruments are ready for assessment, compare measurements between the 37 IDO and the instrument(s) in the bath.

6.3.20 To confirm instrument stability, take three individual samples with the 37 IDO and field instrument(s) simultaneously and record the data on the lab bath log sheet. Compare temperature, pressure, and salinity. Use the same method as mentioned above to take samples with the 37 IDO. Salinity and temperature should be comparable within 0.02 psu and 0.05°C, respectively.

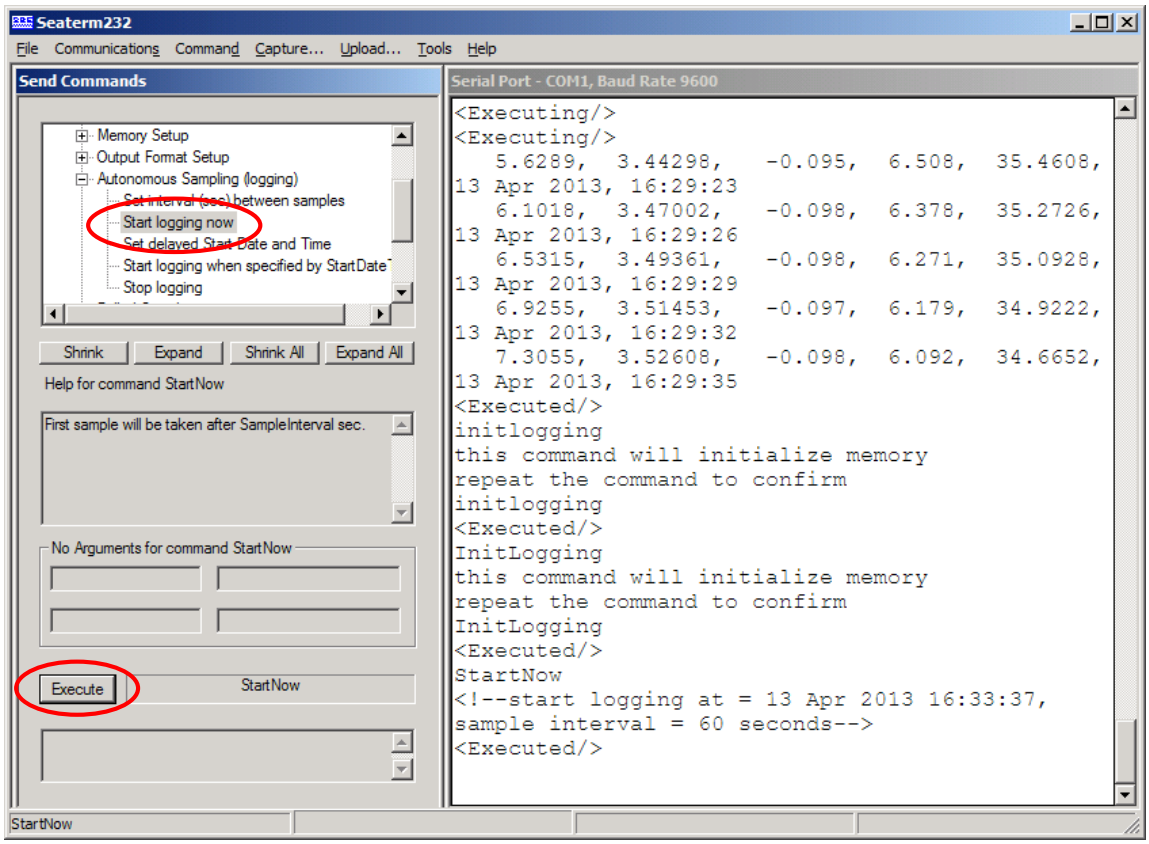
6.3.21 If data are not comparable, gently rock the instruments to dislodge any air bubbles and continue to take samples and compare data.

6.3.22 When you have purged any remaining air, proceed with the bath only if the salinity and temperature data are within 0.02 psu or deg C, respectively, of each other.

6.3.23 Clear the 37 IDO's memory by typing **initlogging** in the command/data echo area. This command must be entered twice, and it will say <Executed/> if the command was successful.



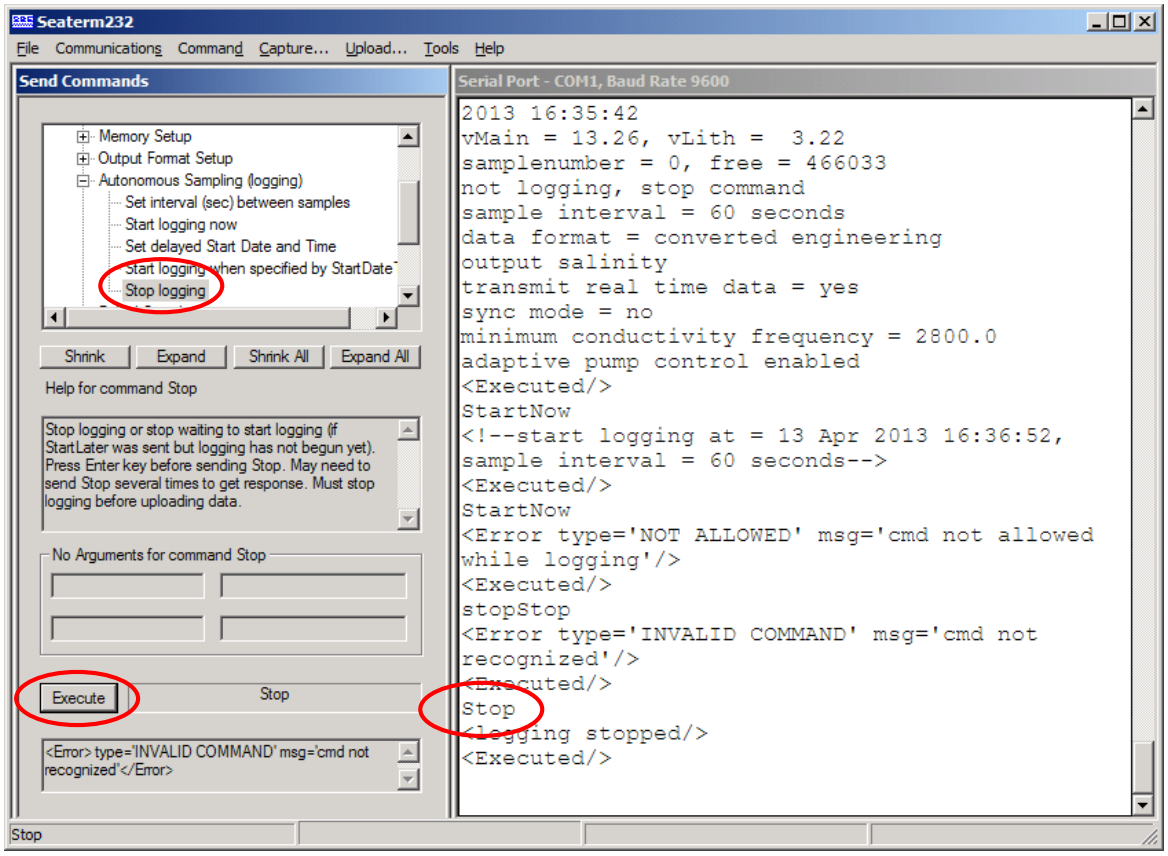
6.3.24 The 37 IDO and field instrument(s) should start logging at the same time. In the 37 IDO's send commands window, go to **Autonomous Sampling**, select **Start Logging Now.** Click **Execute** to start logging. The command/data echo window will display <Executed/>. If it does not, re-enter the command. All instruments should start logging simultaneously.



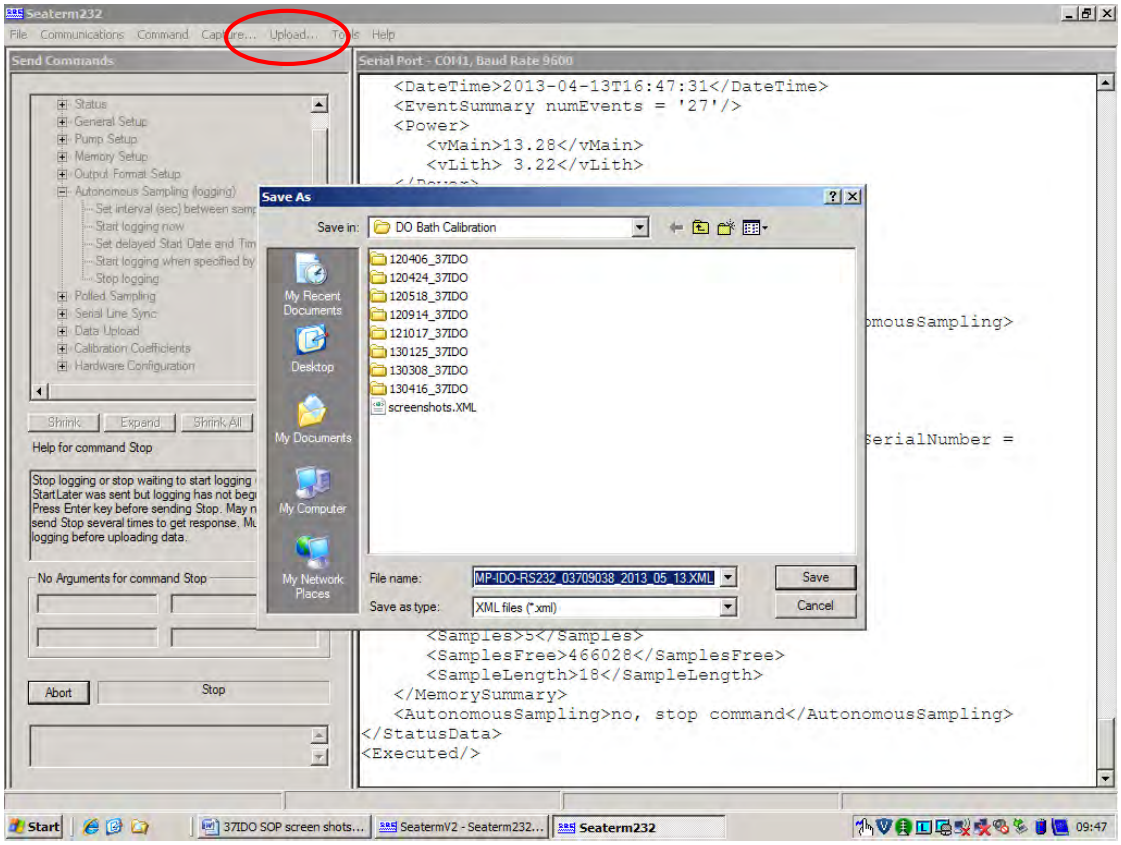
6.3.25 Once all instruments have started logging, leave them in the bath undisturbed for the desired number of samples, at least 15 minutes or until all Winklers have been collected.

6.3.26 Winklers should be collected quarterly to ensure that the 37 IDO is meeting its specified sensor accuracy near Do saturation. For Winkler collections, synchronize Winkler samples with the 37 IDO samples. Start running the water to rinse the bottle when the CTD pumps start running (30 seconds before the CTD sample), and finish taking the sample when the CTD sample is taken. Take a series of one Winkler every two minutes for a total of six samples. More detail on Winkler collection can be found in section 6.4 (SBE 16*plus* Lab Bath Procedures).

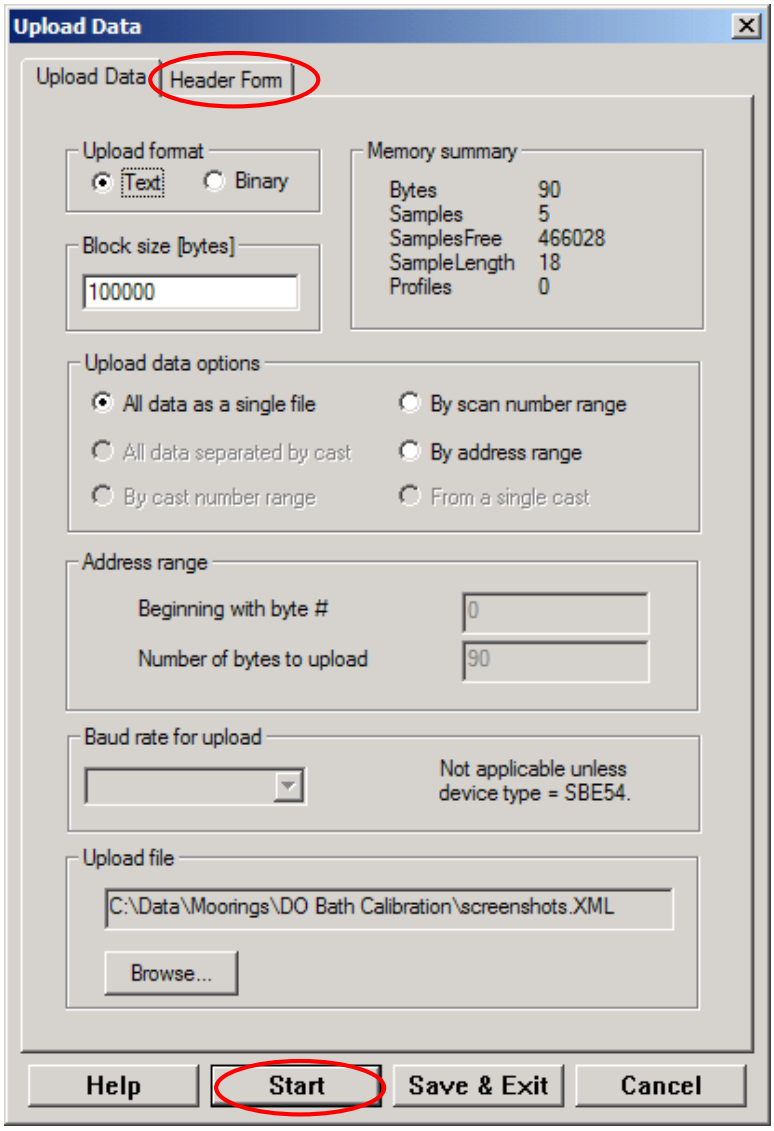
6.3.27 When finished with the assessment, stop the instruments from sampling. In the data echo area, type the **Stop** command. Alternately, in the send commands window, go to **Autonomous Sampling**, and select **Stop Logging.** Click **Execute**. If the pump is running when you enter stop, it will scroll <Executing/> and you will have to wait until the sample is taken to enter the stop command again. If logging is stopped successfully, it will say <Executed/>.



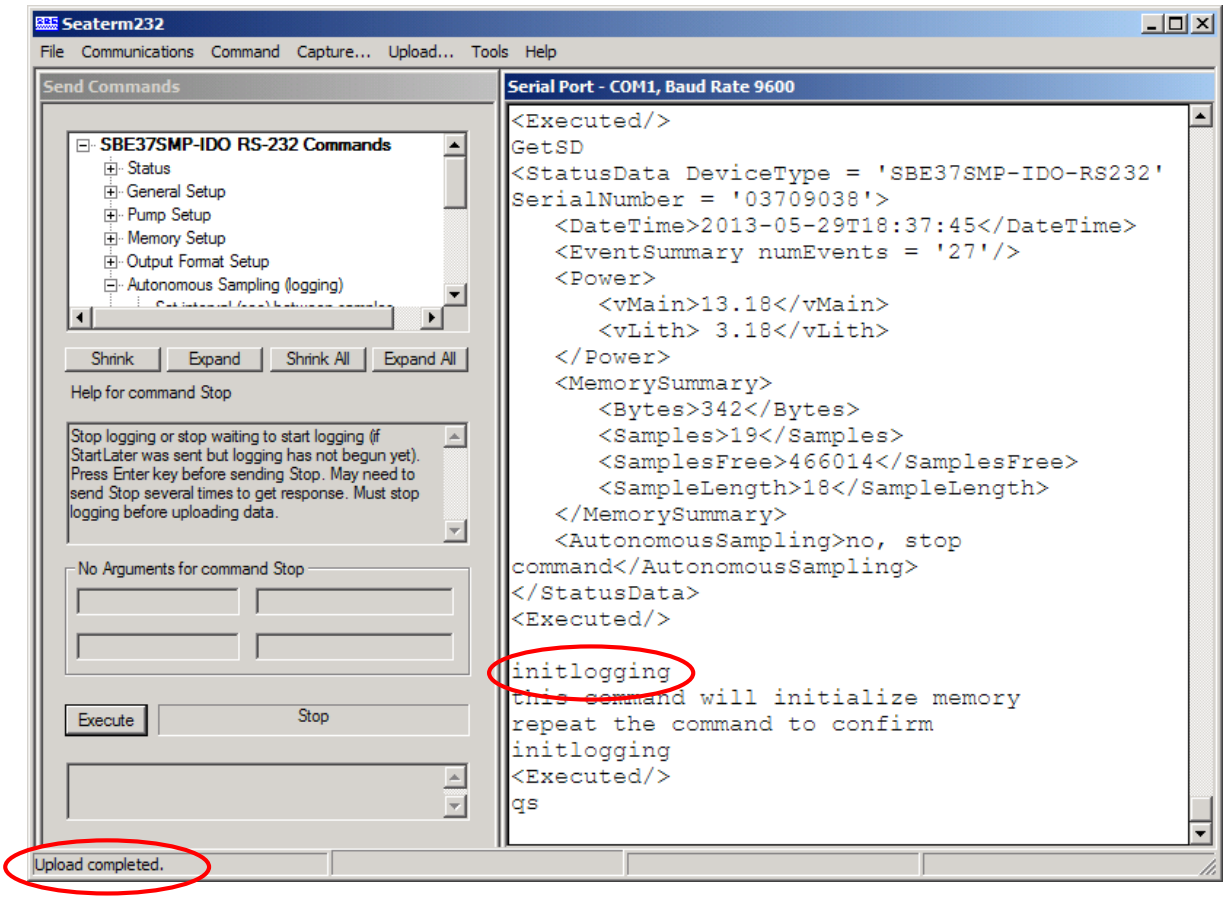
6.3.28 To upload data of the synchronized instrument sampling, click the **Upload** menu at the top of the screen. Seaterm232 responds by sending **GetSD** and displays the instrument status and number of samples in memory. A **Save As** dialog box appears. Enter the desired upload file name (YYMMDD_37IDO_AP where YYMMDD is the format and date of the bath, 37IDO is short for SBE 37-SMP-IDO, and AP is short for assessment point). Select **Save**.



6.3.29 An **Upload Data** dialog box appears. Upload data as text. In the **Header Form** tab, type in any information needed in the header, such as the file name. Click **Start**. The upload progress status will be displayed on the bottom left side of the screen.



6.3.30 The bottom left of the screen will say **Upload Completed** when the upload was successful. After data have been uploaded and confirmed to be on the laptop, erase the memory by entering **initlogging** into the command/data echo area. This command must be entered twice.



6.3.31 Enter **QS** into the command/data echo area.

6.3.32 Take the 37 IDO out of the water and disconnect the communications cable from the instrument and laptop.

6.3.33 Transfer data files from the laptop to the designated folder on a network server.

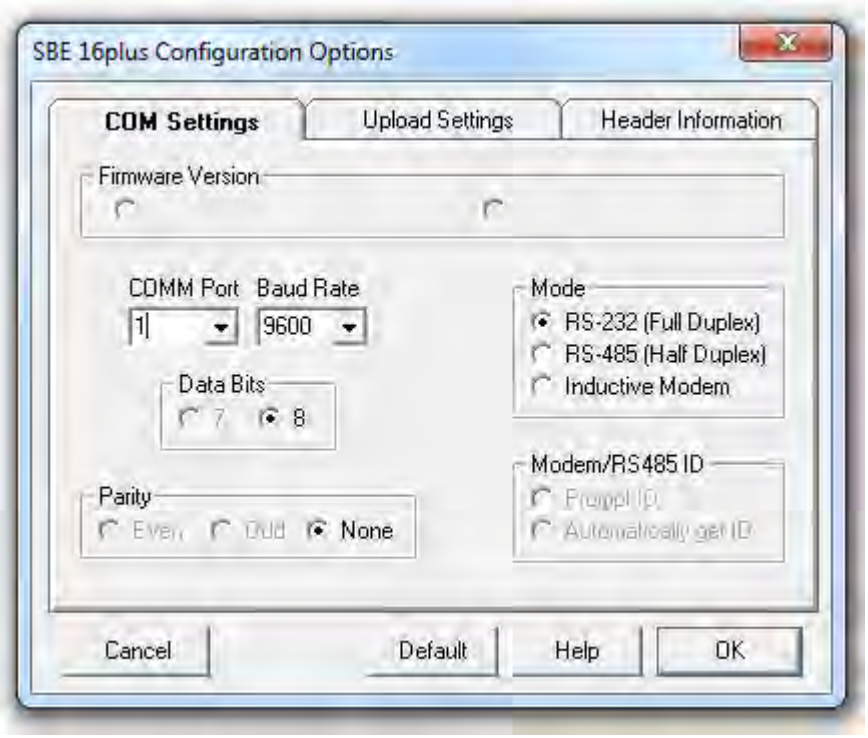
6.3.34 Clean the 37 IDO. Rinse the outside and the intake and exhaust openings liberally with tap water. While the instrument is horizontal, fill the sensor plumbing with 1:50 bleach solution for one minute, followed by a 5-minute rinse with DI water. If there was an oil sheen in the bath, do a 1-minute rinse with 10% Triton-X solution before using the bleach solution.

6.3.35 Clean the bleed hole with a 0.4 mm diameter wire, 13 mm long.

6.3.36 Store the instrument horizontally with DI water in the intake with the air bleed hole taped closed.

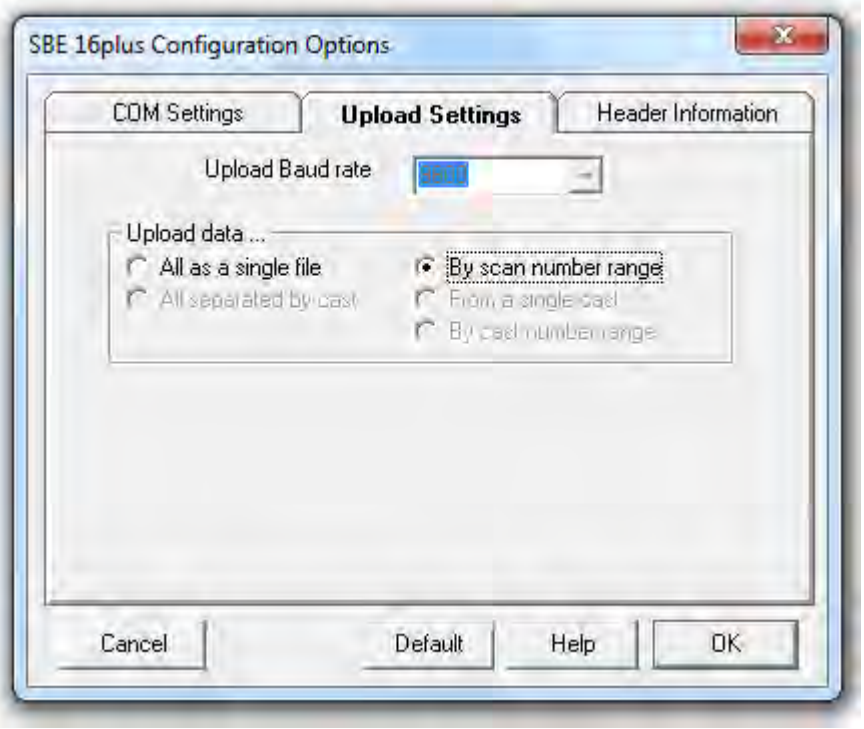
6.4 SBE 16*plus* Lab Bath Procedures

6.4.1 Open the program SeaTerm.
6.4.2 Go to menu **Configure** and select **SBE 16plus…**
6.4.3 Making this selection will open the **SBE 16plus Configuration Options**.
6.4.4 In the **COM Settings** tab, confirm:
   a. correct **COMM** port is selected
   b. **Baud** rate is **9600**
   c. **Parity** is **none**
   d. **Mode** is **RS-232 (Full duplex)**

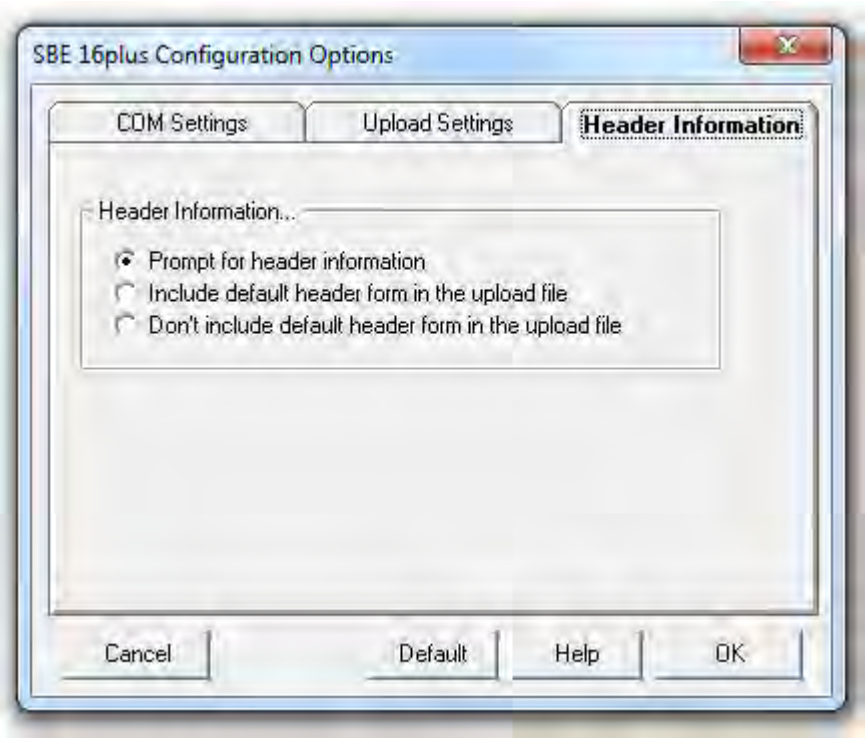


6.4.5 In the **Upload Settings** tab, confirm:

a. **Upload Baud** rate is **9600**
b. **Upload data** selection is **By scan number range**



6.4.6 In the **Header Information** tab, confirm that **Prompt for header information** is selected.

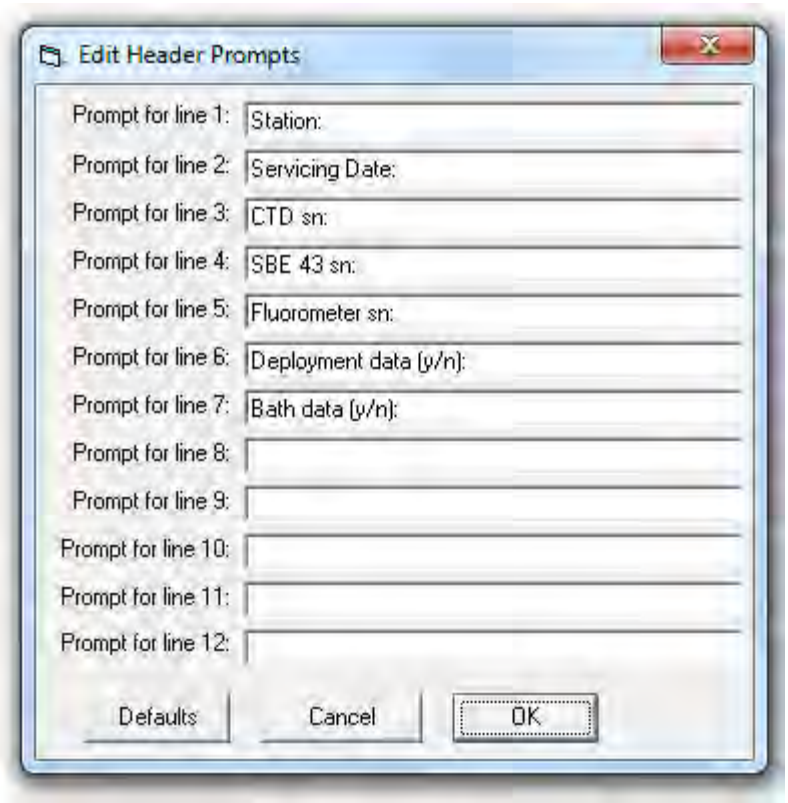


6.4.7 Click on **OK** in the dialog box.

6.4.8 Go to menu **Configure** and select **Header Form…** at the bottom of the list.

6.4.9 Confirm that the **Edit Header Prompts** dialog box has these entries in the **Prompt for** lines:

a. Station:
b. Servicing Date:
c. CTD sn:
d. SBE 43 sn:
e. Fluorometer sn:
f. Deployment data (y/n):
g. Bath data (y/n):



6.4.10 Click on **OK**.
6.4.11 Record serial numbers of the CTD and DO sensors.
6.4.12 Confirm that sensors are cleaned, both on the exterior and the plumbing.
6.4.13 Connect the 4-pin end of a computer-to-CTD communication cable to each CTD.
6.4.14 Connect the serial end of the communication cable to the laptop. The serial end can also be connected to a serial-to-USB adapter and the USB end plugged into the laptop.

6.4.15 Use the SBE SeaTerm software to confirm that each CTD's battery power is sufficient for running the sensor performance test.

a. Open SeaTerm.
b. Click on the **Connect** button.
c. Type **ds** for display status.
d. In the status lines, check what the **vmain** or **vbatt** is (each represents the CTD's voltage).

```
S>ds
SBE 16plus V 1.6g  SERIAL NO. 4828    06 Dec 2012  23:07:31
vbatt = 11.7, vlith =  7.5, ioper =  62.2 ma, ipump = 153.9 ma,
iext01 =   5.3 ma
iext23 =   0.5 ma

status = not logging
sample interval = 60 seconds, number of measurements per sample = 4
samples = 3060, free = 361662
run pump during sample, delay before sampling = 30.0 seconds
transmit real-time = yes
battery cutoff =  7.5 volts
pressure sensor = strain gauge, range = 508.0
SBE 38 = no, SBE 50 = no, Gas Tension Device = no
Ext Volt 0 = yes, Ext Volt 1 = yes, Ext Volt 2 = yes, Ext Volt 3 = yes
echo commands = yes
output format = converted decimal
output salinity = yes, output sound velocity = no
serial sync mode disabled
append UCSD sigma-t, V, I
```

6.4.16 If CTD battery power is low (<11.3 volts), replace the CTD batteries before proceeding with the bath.

6.4.17 Connect a 5-foot length of transparent Tygon tubing (R-3603 with 1/2-inch outer diameter, 3/8-inch inner diameter) to the intake of the conductivity cell.

6.4.18 To this tubing, insert a 6-inch length of Tygon tubing with a slightly smaller diameter connected to a 100 or 60 ml plastic syringe on the other end. This second length of tubing is to adjust for the difference in diameter between the conductivity cell's intake and the syringe.

6.4.19 Attach a bungee cord to the top of the CTD (i.e., exterior battery cap).

6.4.20 Lower CTD into the bath, ensuring that the syringe remains out of water.

6.4.21 Secure one end of bungee cord to the bath.

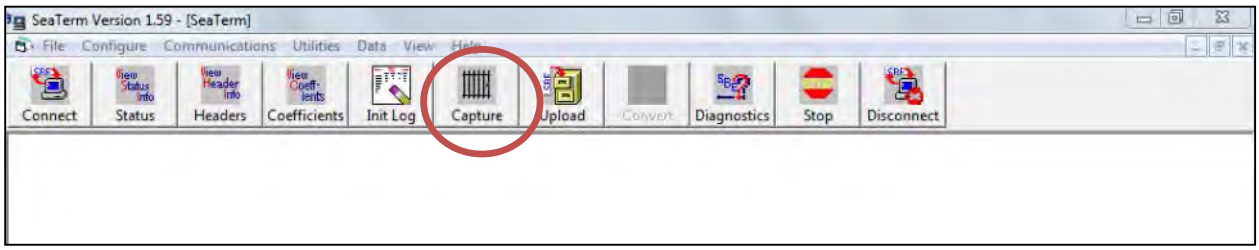
6.4.22 While keeping the CTD submerged, gently rock the CTD package up and down and sideways.

6.4.23 Using the syringe and transparent Tygon tubing, which was previously inserted into the conductivity cell intake, push and pull the stopper in the syringe several times to move air bubbles. Ensure that air is eliminated from the tubing and not pumped into the conductivity cell intake.

6.4.24 Repeat the pumping until air bubbles are no longer visibly coming out of the CTD pump exhaust or present in the transparent Tygon tubing.

6.4.25 Using a long stick with a notch on one end, remove the Tygon tubing from the conductivity cell intake and then from the bath.

6.4.26 Verify Air Bubble Removal. Click on the **Capture** button or go to menu **Communications** and select **Capture to File…**



6.4.27 In the dialog box, enter file name following this format: YYMMDD_DOSN_EP_STANM where:

a. YYMMDD (example: 121217 for 17 Dec 2012).
b. DOSN = 4-digit serial number of DO sensor.
c. EP = acronym for end point bath assessment.
d. STANM = station name, e.g., ADM01 for Admiralty Reach station.

6.4.28 Click **OK** to close dialog box.

6.4.29 Type **ds** for displaying the CTD's status.

6.4.30 Confirm that CTD date is current and time is set to Greenwich Mean Time (GMT). Otherwise, reset them by following these steps:

e. Type **mmddyy = today's date**, e.g., 121712 for 17 Dec 2012.
f. Type **hhmmss = next minute in GMT**, e.g., 180000 for 10:00 a.m. Pacific Standard Time. Use local time + 7 hours to convert to GMT for Pacific Daylight Time and local time + 8 hours to convert to GMT for Pacific Standard Time.

CTD's current date and time (GMT)

```
S>ds
SBE 16plus V 1.6g  SERIAL NO. 4828    06 Dec 2012  23:07:31
vbatt = 11.7, vlith =  7.5, ioper =  62.2 ma, ipump = 153.9 ma,
iext01 =   5.3 ma
iext23 =   0.5 ma

status = not logging
sample interval = 60 seconds, number of measurements per sample = 4
samples = 3060, free = 361662
run pump during sample, delay before sampling = 30.0 seconds
transmit real-time = yes
battery cutoff =  7.5 volts
pressure sensor = strain gauge, range = 508.0
SBE 38 = no, SBE 50 = no, Gas Tension Device = no
Ext Volt 0 = yes, Ext Volt 1 = yes, Ext Volt 2 = yes, Ext Volt 3 = yes
echo commands = yes
output format = converted decimal
output salinity = yes, output sound velocity = no
serial sync mode disabled
append UCSD sigma-t, V, I
```

6.4.31 Check the sensor stability by testing voltage readings for the DO sensor until readings stabilize to a difference of 0.005 volts or less between readings. Follow these steps:

g. Type **pumpon** to turn on the auxiliary pump.
h. Immediately type **tv** to test the voltages.
i. Read voltages in first column (i.e., voltage from auxiliary sensor channel 0) which is typically the external voltage channel configured for DO sensors.
j. Record approximate voltages on field log sheet.

First column represents voltage channel to which a SBE 43 is connected to a SBE 16*plus*. (Not all data are shown in this example which was truncated.)

```
S>pumpon
S>tv
  0.0016  0.0005  0.0005  0.0003
  2.0062  0.0007  0.0005  0.0002
  2.2882  0.0006  0.0003  0.0003
  2.4998  0.0006  0.0004  0.0004
  2.5821  0.0003  0.0005  0.0004
  2.6213  0.0003  0.0004  0.0004
  2.6401  0.0003  0.0004  0.0006
  2.6491  0.0004  0.0007  0.0005
  2.6533  0.0008  0.0003  0.0006
  2.6555  0.0004  0.0005  0.0003
  2.6568  0.0003  0.0003  0.0002
  2.6571  0.0005  0.0004  0.0003
  2.6575  0.0007  0.0002  0.0002
  2.6577  0.0005  0.0003  0.0005
  2.6580  0.0002  0.0006  0.0004
  2.6596  0.0006  0.0006  0.0005
  2.6586  0.0003  0.0003  0.0003
  2.6596  0.0005  0.0004  0.0005
  2.6593  0.0004  0.0003  0.0004
  2.6607  0.0004  0.0003  0.0003
  2.6612  0.0004  0.0004  0.0002
```

6.4.32 Confirm sensor and bath stability. Type **sampleinterval=60** to set the CTD to take measurements every 60 seconds.

6.4.33 Type **outputformat=3** to generate a converted decimal output on the SeaTerm command screen.

6.4.34 Synchronize sample collection between the field instruments and the 37 IDO. Type **ts** for the "taking sample" command. Expect data to be displayed in the following column order:

a. Temperature (°C)
b. Conductivity (Siemens/meter)
c. Pressure (decibars)
d. Voltage from auxiliary sensor channel 0
e. Voltage from auxiliary sensor channel 1
f. Voltage from auxiliary sensor channel 2
g. Voltage from auxiliary sensor channel 3
h. Salinity (psu)
i. Date
j. Time

6.4.35 Type **ts** 2 more times to generate multiple samples.

6.4.36 Compare temperature, voltage 0 (i.e., DO sensor voltage), and salinity readings among each sample to confirm stability. The values for these parameters should be reasonable based on ambient bath conditions. The goal for confirming bath and sensor stability is to have:

a. Pressure near 1.0 decibars.
b. Temperature stable to within 0.05 °C.
c. Salinity stable to within 0.02 psu.

d. DO sensor voltage stable to within 0.005 volts.

```
S>ts
  8.5587,  3.18458,    0.699, 2.2536, 0.0004, 0.0004, 0.0004,  29.8707, 06 Dec 2012, 23:10:26
S>ts
  8.5525,  3.18395,    0.697, 2.2537, 0.0005, 0.0003, 0.0004,  29.8694, 06 Dec 2012, 23:12:44
S>ts
  8.5500,  3.18390,    0.703, 2.2534, 0.0003, 0.0005, 0.0004,  29.8710, 06 Dec 2012, 23:13:25
```

6.4.37 Winklers need to be taken quarterly. If Winklers need to be taken, synchronize DO Sensor and DO Winkler Sampling.

6.4.38 Record CTD sampling time, scan line numbers, and bottle numbers on the lab bath log sheet.

6.4.39 Set up chemicals, DO bottles, and pipettes for Winkler collection.

6.4.40 Connect about three feet of tubing to a water pump for water collection.

6.4.41 To collect DO Winkler samples and take synchronized CTD measurements every 120 seconds, the following steps should be taken:

a. On the laptop, check in SeaTerm to confirm that the capture file for each CTD remains open.
b. Have a digital hand-held timer ready to start.
c. Type **startnow** to start CTD sampling measurements of the bath water.
d. Hit the "Enter" key for the CTDs at the same time as the "pristine" SBE 37-SMP-IDO so that all instruments start as simultaneously as possible.
e. Watch SeaTerm and start a handheld timer when the first sample is displayed.
f. The data are displayed in the following column order:
    i. Temperature (°C)
    ii. Conductivity (Siemens/meter)
    iii. Pressure (decibars)
    iv. Voltage from auxiliary sensor channel 0
    v. Voltage from auxiliary sensor channel 1
    vi. Voltage from auxiliary sensor channel 2
    vii. Voltage from auxiliary sensor channel 3
    viii. Salinity (psu)
    ix. Date
    x. Time
    xi. Density (kg/m^3)
    xii. CTD battery voltage
    xiii. Operating current (milliamps)

```
S>startnow
start now

#  8.5464,  3.18363,    0.682, 2.2435, 0.0004, 0.0003, 0.0004,  29.8713, 06 Dec 2012, 23:15:25,
23.1718, 10.8, 174.9

#  8.5443,  3.18348,    0.672, 2.2471, 0.0004, 0.0004, 0.0004,  29.8714, 06 Dec 2012, 23:16:25,
23.1722, 10.8, 163.6

#  8.5410,  3.18323,    0.658, 2.2476, 0.0003, 0.0002, 0.0003,  29.8717, 06 Dec 2012, 23:17:25,
23.1728, 10.8, 173.4

#  8.5388,  3.18298,    0.644, 2.2475, 0.0004, 0.0003, 0.0004,  29.8709, 06 Dec 2012, 23:18:25,
23.1725, 10.8, 140.8

#  8.5370,  3.18288,    0.633, 2.2471, 0.0004, 0.0003, 0.0003,  29.8714, 06 Dec 2012, 23:19:25,
23.1732, 10.8, 180.0

#  8.5335,  3.18254,    0.616, 2.2473, 0.0003, 0.0003, 0.0004,  29.8708, 06 Dec 2012, 23:20:25,
23.1732, 10.7, 146.7

#  8.5322,  3.18226,    0.607, 2.2472, 0.0004, 0.0004, 0.0003,  29.8691, 06 Dec 2012, 23:21:25,
23.1721, 10.7, 144.9

#  8.5277,  3.18200,    0.600, 2.2470, 0.0003, 0.0004, 0.0004,  29.8702, 06 Dec 2012, 23:22:25,
23.1735, 10.7, 146.7

#  8.5251,  3.18186,    0.585, 2.2471, 0.0003, 0.0003, 0.0003,  29.8709, 06 Dec 2012, 23:23:25,
23.1745, 10.7, 135.3
```

g. Compare the timer reading with the second CTD sample to confirm that the timer reading is on zero seconds and synchronizing with display of reading of each CTD. This time comparison indicates that water flow will need to begin on minute and 30 seconds.
h. Note that each CTD will sample every <u>1 min</u> whereas the DO Winkler sample will be collected on every <u>2 min</u>.
i. Determine when to start the DO seawater flow for rinsing and sample collection. The objective is to start water flow 30 seconds prior to display of reading of each CTD and collect the sample itself at approximately the same time.
j. Let both CTDs take one or two more samples before beginning collection of DO Winkler samples.
k. On pre-determined timer reading, collect a DO Winkler sample following the SOP for Seawater Sampling with the exception of using the field bath in place of a Niskin bottle sampler.
l. Record the flask number and CTD sample time on the field log sheet when the sample is taken.
m. Repeat until 3 DO Winkler samples are collected.

6.4.42 Collect a salinity sample. After DO sample collection is complete, watch the timer reading for the next 2-min interval and collect one salinity sample from the lab bath water.

6.4.43 Once all water samples are collected, stop each CTD by one of following methods:

a. Press **Enter** key until the S> command prompt appears and then type **stop**. This may require a few tries.
b. Click on the **Stop** button and then **OK** in the dialog box that appears.
c. Press **ESC** key until the S> command prompt appears.
d. Press **Ctrl** and **C** keys and then **Enter** key to get the S> command prompt.

6.4.44 Type **ds** to display the status and verify:

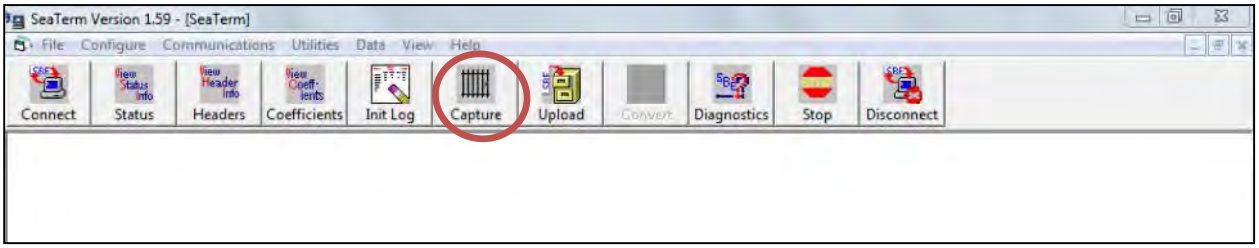
a. **status = not logging** which indicates CTD is no longer sampling.
b. **vmain** or **vbatt** which indicates the CTD's battery power.

6.4.45 **samples** for number of samples in CTD's memory.

```
S>ds
SBE 16plus V 1.6g  SERIAL NO. 4828    06 Dec 2012  23:24:55
vbatt = 11.4, vlith =  7.5, ioper =  62.2 ma, ipump = 152.9 ma,
iext01 =   5.4 ma
iext23 =   0.6 ma

status = not logging
sample interval = 60 seconds, number of measurements per sample = 4
samples = 3070, free = 361652
run pump during sample, delay before sampling = 30.0 seconds
transmit real-time = yes
battery cutoff =  7.5 volts
pressure sensor = strain gauge, range = 508.0
SBE 38 = no, SBE 50 = no, Gas Tension Device = no
Ext Volt 0 = yes, Ext Volt 1 = yes, Ext Volt 2 = yes, Ext Volt 3 = yes
echo commands = yes
output format = converted decimal
output salinity = yes, output sound velocity = no
serial sync mode disabled
append UCSD sigma-t, V, I
```

6.4.46 Stop the capture file by clicking on the **Capture** button.



6.4.47 Upload lab bath data, note the scan range for the bath data to distinguish between any deployment or field bath data still saved in CTD memory and then enter the scan range for the lab bath data and subsequent header prompts.

When uploading data, SeaTerm displays header lines listing sample groups. This box represents sampling intervals of 900 seconds, or whatever interval was set for the deployment. This means that these CTD samples are *deployment* data.

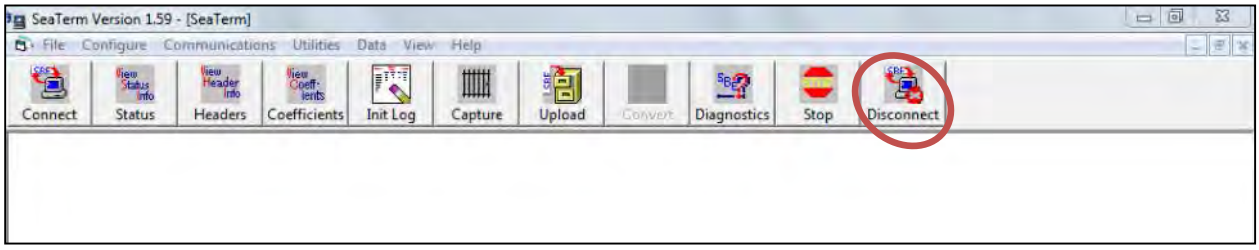
```
* hdr  36 23 Oct 2012 16:15:01 samples 3330 to 3521, int = 900, stop = stop cmd
* hdr  37 25 Oct 2012 16:15:01 samples 3522 to 3617, int = 900, stop = stop cmd
* hdr  38 26 Oct 2012 16:15:01 samples 3618 to 3713, int = 900, stop = stop cmd
* hdr  39 27 Oct 2012 16:15:01 samples 3714 to 3809, int = 900, stop = stop cmd
* hdr  40 28 Oct 2012 16:15:01 samples 3810 to 3922, int = 900, stop = stop cmd
* hdr  41 29 Oct 2012 20:30:01 samples 3923 to 3999, int = 900, stop = logging
* hdr  42 30 Oct 2012 16:00:35 samples 4001 to 4001, int = 900, stop = stop cmd
* hdr  43 30 Oct 2012 16:15:01 samples 4002 to 4097, int = 900, stop = stop cmd
* hdr  44 31 Oct 2012 16:15:01 samples 4098 to 4193, int = 900, stop = stop cmd
* hdr  45 01 Nov 2012 16:15:01 samples 4194 to 4289, int = 900, stop = stop cmd
* hdr  46 02 Nov 2012 16:15:01 samples 4290 to 4385, int = 900, stop = stop cmd
* hdr  47 03 Nov 2012 16:15:01 samples 4386 to 4485, int = 900, stop = stop cmd
* hdr  48 04 Nov 2012 17:15:01 samples 4486 to 4581, int = 900, stop = stop cmd
* hdr  49 05 Nov 2012 17:15:01 samples 4582 to 4677, int = 900, stop = stop cmd
* hdr  50 06 Nov 2012 17:15:01 samples 4678 to 4686, int = 900, stop = stop cmd
* hdr  51 06 Nov 2012 20:41:20 samples 4687 to 4716, int = 60, stop = stop cmd
```

In this row, samples were collected at 60-sec intervals which indicate they are from the *field bath*. Therefore, upload data using scan range 4687 to 4716.

6.4.48 For each CTD, save file as YYMMDD_DOSN_XP_STANM.hex where:

i. YYMMDD, e.g., 121217 for 17 Dec 2012.
ii. DOSN = 4-digit serial number of DO sensor.
iii. XP = 2-letter acronym for sensor performance assessment; EP for "end point" and SP for "start point".
iv. STANM = station name, e.g., ADM01 for Admiralty Reach station.

6.4.49 Confirm using either Notepad or SeaSave software that all bath data were uploaded.
6.4.50 Type **qs** to put the CTD into quiescent state.
6.4.51 Click on the **Disconnect** button to close the laptop port that the communication cable is plugged into.



6.4.52 Copy lab bath data files onto a memory stick. This will insure that there are at least two copies of data in the event that one copy is lost until data are copied onto a designated network server.
6.4.53 Remove each CTD from the field bath, disconnect communication cables, and plug in SBE dummy plugs to protect pins on all cables.
6.4.54 Rinse each CTD with tap water and then fill CTD plumbing with DI water.
6.4.55 After all DO Winkler samples have settled for 15-20 minutes, re-shake each sample and seal the stopper following the SOP for Seawater Sampling.

6.5 SBE 25 Lab Bath Procedures

6.5.1 Put the current configuration file (.con file) onto the laptop that will be used for the bath. If sensors have been removed, make a .con file with appropriate voltage channels.

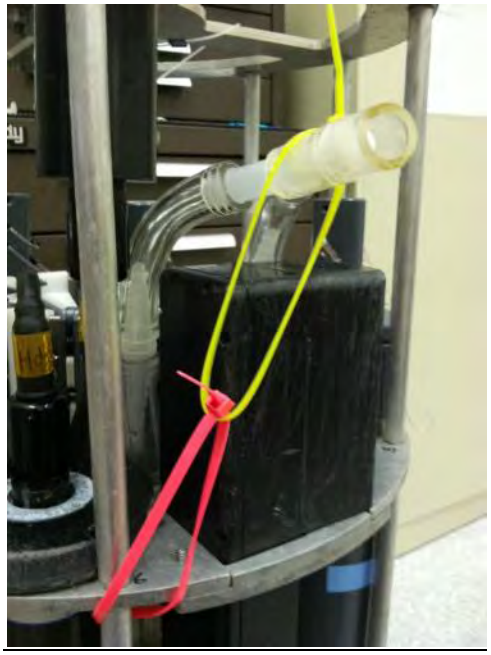
6.5.2 Print the DO bath log sheet from the designated network server location. There is an example of the log sheet at the end of this document.

6.5.3 Record atmospheric conditions and water temperature on the log sheet to get theoretical oxygen values.

6.5.4 Prepare the marine flight CTD for the bath; remove the pH buffer, open the Niskin bottles, and remove fluorometer and PAR caps and the syringe.

6.5.5 Put the y-valve adapter on the y-valve. The adapter is longer tubing that extends and points the y-valve upwards so air can purge when the package is on its side.

6.5.6 Once the adapter is on the package, the tubing needs to be held in place using rope or cable ties. The top of the y-valve should be pointing near or at perpendicular to the package.

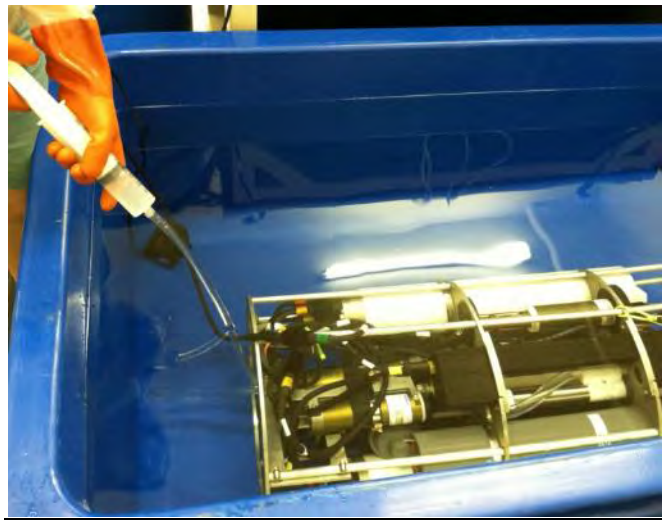


6.5.7 Attach a few feet of DO tubing and a syringe to the intake to purge air bubbles.

6.5.8 Plug a communication (comm) cable directly into the CTD communication cable (bypass AFM). Put a dummy plug on the open-ended cable. Connect to a laptop.

6.5.9 At this point, you should put the CTD into the bath on its side with the "on" switch accessible and y-valve facing up. Make sure the comm cable and syringe do not fall into the bath.

6.5.10 Purge air bubbles by pushing water through the plumbing using the syringe. Try to get all of the air bubbles out. The package may be gently rocked to aid in this process. Repeat this process until you are confident that no air bubbles remain. Remove the tubing after air is purged.



6.5.11 Open SeaTerm.

6.5.12 Connect to CTD.

6.5.13 Give **DS** command check the header for:

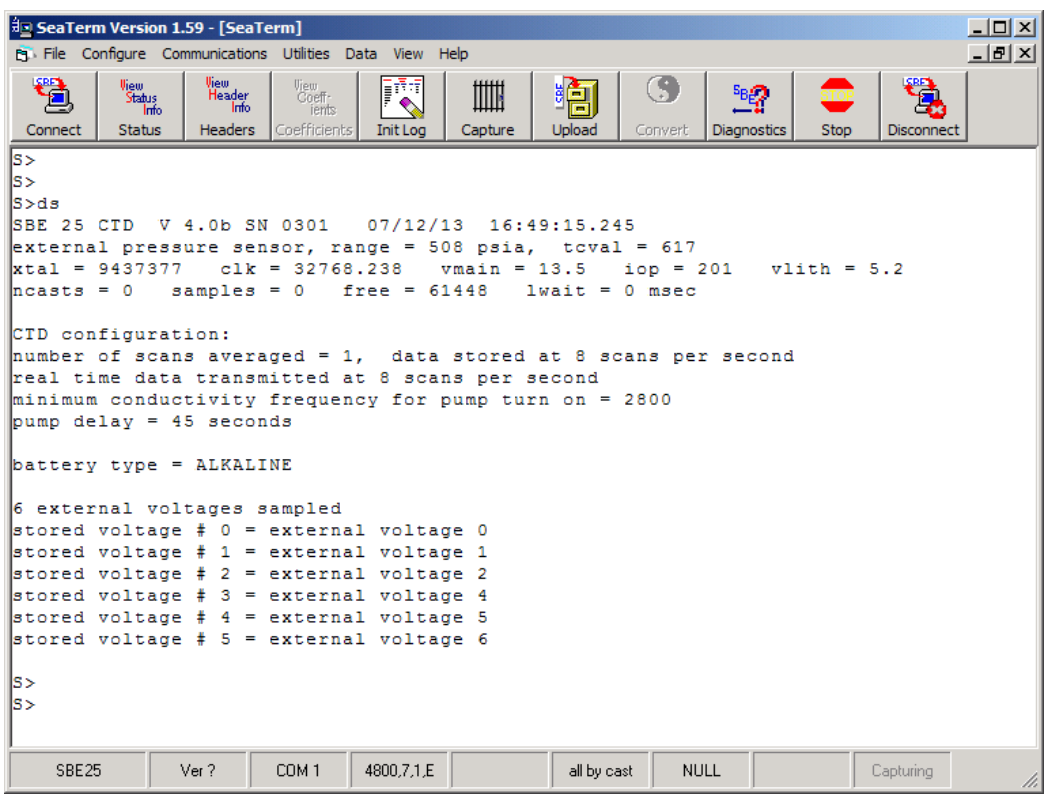
a. Battery voltage (indicated as vmain) should be between 13.5 and 11.5. If vmain is less than 11.5 change batteries before proceeding

b. Pump delay (seconds) = 45

c. Minimum conductivity frequency for pump turn on = 2800

d. Ncasts = 0

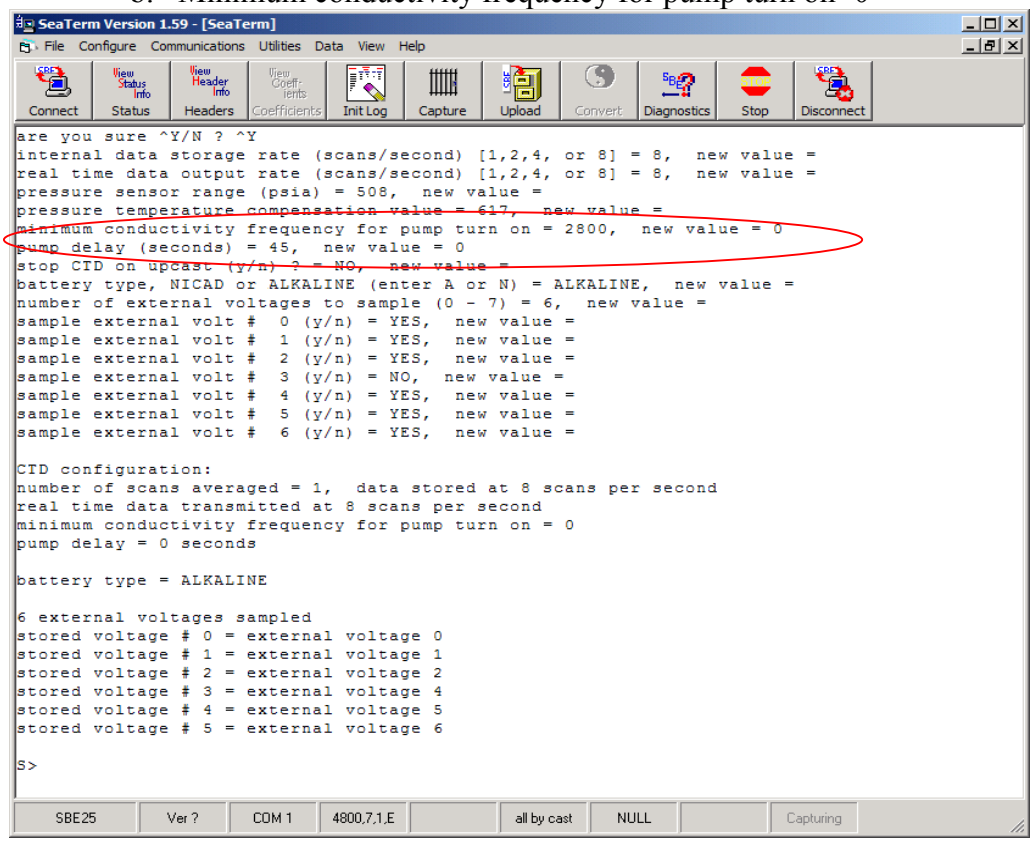
e. Samples = 0



6.5.14 Check the date and time (GMT). Date and time must be synchronized with the 37 IDO.

6.5.15 To use a profiling instrument like the SBE 25 in a lab bath, you must change the following settings by entering the **cc** command:

a. Pump delay=0
b. Minimum conductivity frequency for pump turn on=0



6.5.16 If you have changed the CTD configuration, you will need to change the external voltages to match. For example, if you only have the dissolved oxygen, pressure, temperature and conductivity sensors on you will need to turn off 5 of the 6 voltage channels normally in use. Normally we use 6 external voltages.

Note: Real-time data collection will not work if your voltages in your .con file and CTD configuration do not match.

stored voltage # 0 = external voltage 0	DO
stored voltage # 1 = external voltage 1	pH
stored voltage # 2 = external voltage 2	Transmissometer
stored voltage # 3 = external voltage 4	Fluorometer
stored voltage # 4 = external voltage 5	Turbidity
stored voltage # 5 = external voltage 6	PAR

6.5.1 To change the number of external voltages to sample, enter the cc command. When setting up the new voltage channel enter **n** to turn off a voltage and **y** to turn on. Give the IL (initiate logging) command after changing voltage channels.

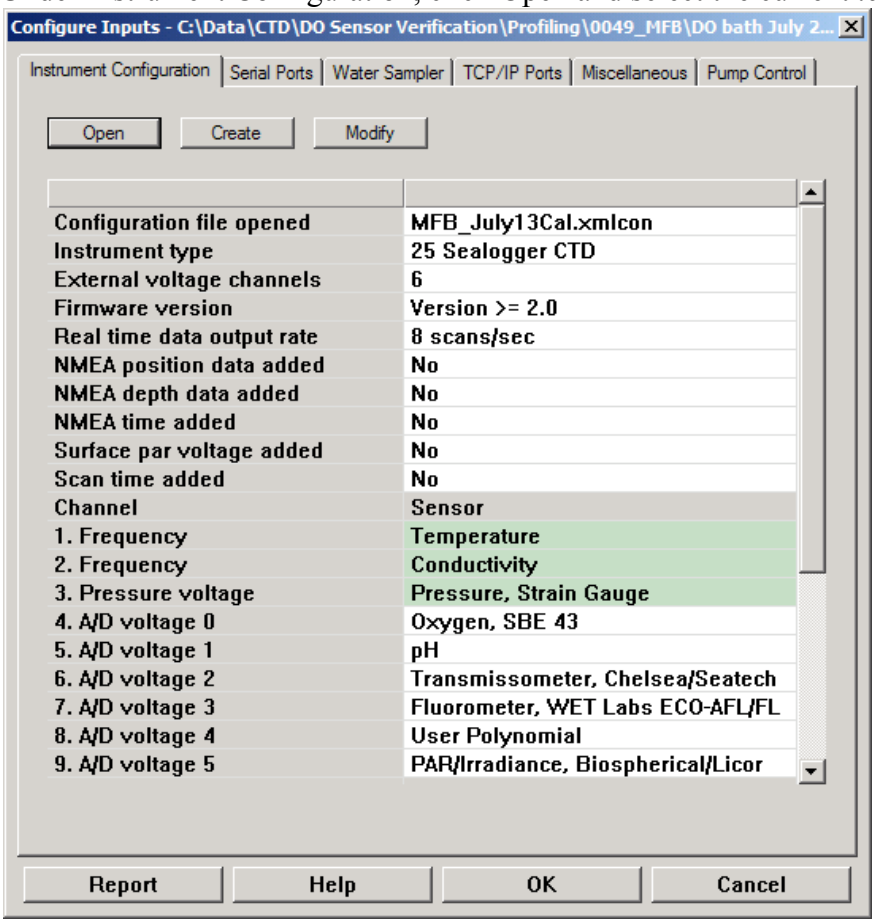
6.5.2 Once you have made all the necessary changes give the DS command to confirm your changes.

6.5.3 Give the QS command and close SeaTerm.

6.5.4 Open SeasaveV7.

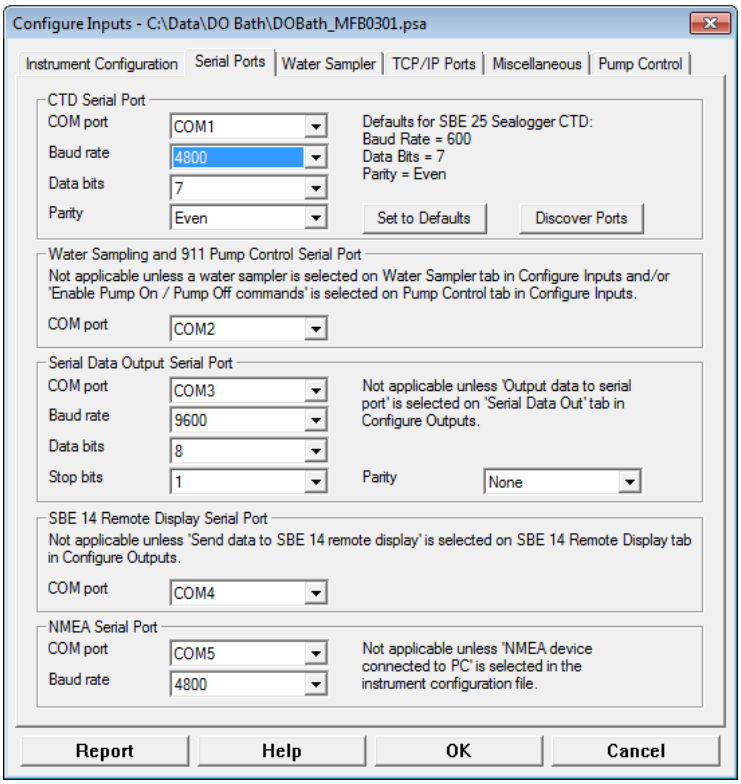
6.5.5 Open configure inputs.

6.5.6 Under Instrument Configuration, click Open and select the current .con file.



6.5.7 Under Serial Ports, choose:

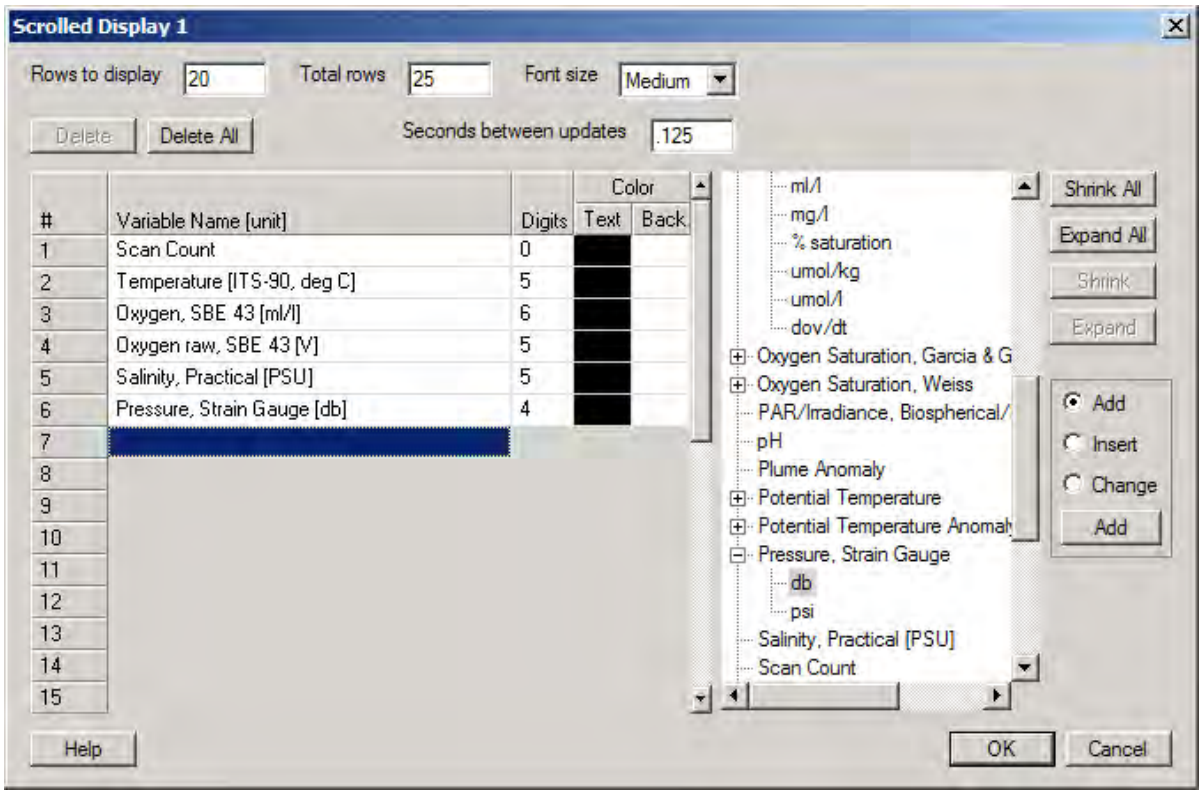
- COM Port: COM1.
- Baud Rate: 4800.
- Data bits: 7.
- Parity: Even.
- Click OK.



6.5.8 Under Display, choose Add New Scrolled Display Window, rows to display = 20, total rows = 25, font size = medium, seconds between updates = 0.125.

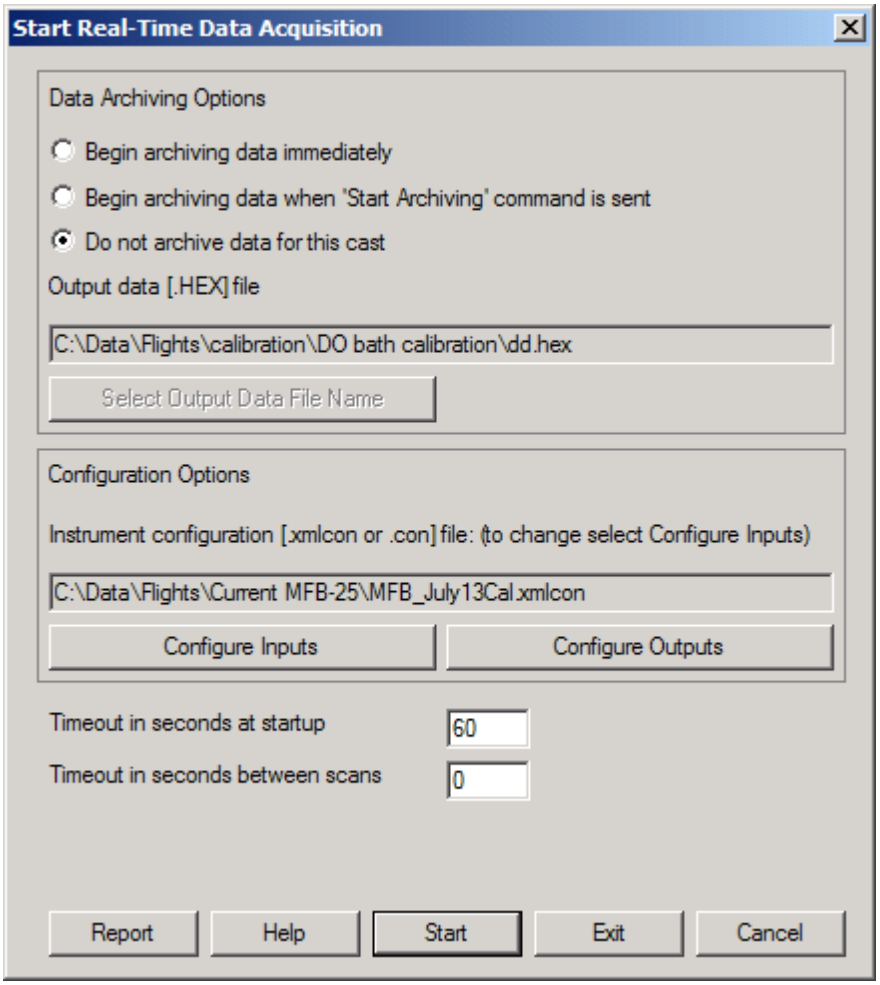
6.5.9 Add variables to display:

a. Scan Count
b. Temperature C [ITS-90, deg C]
c. Oxygen SBE43[ml/l] (use ml/l so data is comparable to 37 IDO)
d. Oxygen raw voltage SBE43[V]
e. Salinity [PSU]
f. Pressure, Strain Gauge [db]



6.5.10 Go to Real-Time data and click **start**.

6.5.11 Before checking "Do not archive.." click on "Begin archiving …" and select output data file name. For some reason there has to be a file name or else the scans won't start! Then, click back on "Do not archive.." start. This will prompt you to turn on the magnetic switch on the SBE 25.



6.5.12 The SBE 25 and 37 IDO must be started at the same time. When SeaSave prompts you to turn the SBE 25 on, be ready to turn the 37 IDO on as well.

6.5.13 Turn the SBE 25 on. The package can be rotated to do this but make sure the y-valve is pointing up afterwards.

6.5.14 You should see your data start scrolling. Note: Even if you have the correct settings you will get an error message, "RS-232 communication timeout. Please check the magnetic switch. You may try again or cancel data acquisition." If you cancel or close the error message window, your data acquisition will stop. So, keep the window open and ignore it.

6.5.15 If Winklers need to be collected, take three sets of three Winklers every 15 minutes for a total of 9 Winklers. The three replicates should be taken every two minutes at the same time the 37 IDO samples.

a. With a one-minute sample interval (on the 37 IDO), start running the water 30 seconds before the sample is taken and stop the water when the sample is taken.
b. For each Winkler, record the bottle number, the 37 IDO scan number and the SBE 25 scan range and time.

6.5.16 When the Winklers are all taken, collect a salinity sample in conjunction with a 37 IDO sample. Start running the water for the sample while the pump is running and stop the water when the 37 IDO takes the sample. Record the scan number and bottle number.

6.5.17 When you are done with the bath, turn the SBE 25 off. SeaSave will tell you that real time data acquisition has stopped. Save your setting as MF_DO BATH_2012.psa

6.5.18 Open SeaTerm again and upload the SBE 25 data. Save it in the appropriate folder labeled Date_MFX_DOserial# (example: 130702_MFB_0049).

6.5.19 Reconfigure the SBE 25 so that the pump delay = 45 and minimum conductivity frequency for pump turn on = 2800 to have appropriate settings for field sampling

6.5.20 Give the **IL** and **QS** command. Close SeaTerm.

6.5.21 Save the SBE 25 .hex file to the designated network server.

7.0 Records Management

7.1 Lab Bath Log Form: An example of the lab-bath log form is at the end of the SOP. The lab bath portion of the log sheet should be filled out for every sensor performance assessment conducted in the laboratory. Information from the lab bath log is transferred to an electronic file which is stored on a secure, frequently backed-up agency server. The paper field log is stored in an organized paper file system and when data are finalized, archived according to agency protocols.

7.2 Tracking of Sensor Performance Assessments: It is critical to maintain and organize information from sensor assessment tests. Such information include, but is not limited to,

1. Test date.
2. Sensor sampling times.
3. Sensor serial numbers.
4. Digital file names.
5. DO Winkler sample collection.

7.3 This information and data from bath assessments are used to assess sensor performance based on analysis and comparison with start point lab bath assessments, factory calibrations, and other related information. This analysis is then used to determine if electrical drift, physical or biological fouling, or any other event affected DO sensor performance during deployment. In

addition, similar analysis will verify uncompromised sensor performance during transport of an instrument into the field.

7.4 Computer Files

7.5.1 Sensor Performance Assessment Files

a. All file naming formats described in earlier sections of this SOP should be followed.
b. All files will be transferred to a designated network server.

7.5.2 Database Management

c. Sensor data collected using the CTD (i.e., hexadecimal or ASCII data) are processed using Sea-Bird Electronics' data processing software and protocols and then transferred to the designated database.
d. Laboratory results of DO Winkler samples are entered into the database and then calculated and checked.

8.0 Quality Control and Quality Assurance Section

8.1 Manufacturer Calibrations

Calibration of the 37 IDO and field instruments is performed by the manufacturer after one year of use or deployments, in the case of moored instruments.

8.2 Sea-Bird Electronics Software

For the 37 IDO, SeaTermV2 software is used. For the SBE 16*plus* and SBE 25 instruments, SeaTerm is used. The latest versions of these programs can be found on the Sea-Bird website:
www.seabird.com/software/software

8.3 Sensor Cleaning and Maintenance

Manufacturer recommendations for cleaning oceanographic sensors should be followed. Instructions for cleaning and maintaining the 37 IDO, SBE 25 and SBE 16*plus* instruments can be found in the current manual on the Sea-Bird Electronics website:
www.seabird.com/products/ModelList.htm.

8.4 Replicate DO Winkler Samples

Collecting 6 consecutive DO Winkler samples during a lab bath assessment assures high quality data from replication that will determine and improve accuracy of sample collection and analysis.

9.0 Safety

9.1 Follow general procedures for safety found in the *Environmental Assessment Program Safety Manual*.

9.2 Gloves and safety glasses should be worn when handling $MnCl_2$ and NaOH-NAI-Azide.

10.0 References

10.1 Bos, Julia. 2010. Standard Operating Procedures for Seawater Sampling, version 2.0. Washington Department of Ecology, Olympia, WA. www.ecy.wa.gov/programs/eap/quality.html

10.2 Sea-Bird Electronics, Inc. 2009. SBE 25 Sealogger CTD. User's Manual. Sea-Bird Electronics, Bellevue, WA. www.seabird.com/old-manuals/SBE_25/4.1c_Firmware_015-017Manual/25_017.pdf

10.3

10.4 Sea-Bird Electronics, Inc. 2013a. Application Note No. 64, SBE 43 Dissolved Oxygen Sensor – Background Information, Deployment Recommendations, and Cleaning and Storage, revised June 2013. Sea-Bird Electronics, Inc., Bellevue, WA. www.seabird.com/document/an64-sbe-43-dissolved-oxygen-sensor-background-information-deployment-recommendations

10.5 Sea-Bird Electronics, Inc. 2013b. Frequently Asked Questions (FAQs)-*Software.* Sea-Bird Electronics, Bellevue, WA. www.seabird.com/FAQs/FAQsSoftware.htm

10.6 Sea-Bird Electronics, Inc. 2013c. SBE-37-IDO MicroCAT User's Manual. Manual revision #005. Sea-Bird Electronics, Bellevue, WA. www.seabird.com/old-manuals/SBE_37/SBE_37-SMP-IDO/37-SMP-IDO_RS-232/1.2_Firmware_004-007Manual/37SMP-IDO_RS232_005.pdf

10.7 Sea-Bird Electronics, Inc. 2013d. Seasoft V2: SBE Data Processing. User's Manual. Manual revision 7.22.4. Sea-Bird Electronics, Bellevue, WA. www.seabird.com/old-manuals/Software_Manuals/SBE_Data_Processing/SBEDataProcessing_7.22.4.pdf

10.8 Washington State Department of Ecology. 2015. Environmental Assessment Program Safety Manual. March 2015. Washington State Department of Ecology. 193 pp.

DO Lab Bath Log

Date:		Technicians:	

MOORING CTDs ON MMU SHELF		
CTD #	SBE 43 #	Comments

CTD & SBE 43 TO ASSESS								
	CTD #	SBE 43 #	SP / EP / AP	start vmain	vlith	.cap file name (yymmdd_DOsn_XP_stn)	sampling interval	end vmain
1								
2								
3								
4								
5								

CONFIRM MINIMAL VARIATION								
			sample 1		sample 2		sample 3	
	CTD #	Avg DO volts	DO volts diff	temp	sal	temp	sal	temp	sal
1									
2									
3									
4									
5									

WINKLER SAMPLES INFO			
	Collector		
	Bottle#	Line # in capture file	CTD Time
1			
2			
3			
4			
5			
6			
7			
8			
			Time
SALINITY	bottle #		

COMMENTS

Y:\Seabird\Moorings\Sensor Assessments\Master DO Lab Bath Log 140611.xlsx

DO Bath Log for Profiling Sensors.

CTD Calibration Log - Dissolved Oxygen		Date:		Prepared by:	
CTD INFO		**Lab Conditions**	***Before equilibration:***	**Lab Conditions**	***During 11:50 AM***
CTD Type:		Local atm pressure:	in. of Hg	Local atm pressure:	in. of Hg
S/N:		*33.86 =	millibar	*33.86 =	millibar
SBE-43 SN:		Air temp	ºC	Air temp	ºC
Annual Calibration date:		Water temp, NBS thermometer	ºC	Water temp, NBS thermometer	ºC
Previous Verification date:					
CTD On Time:					
SBE 25 Filename:					
37 IDO Filename					
CTD Off Time					
Comments:					

Verification Checkpoint #1		Verification Checkpoint #2		Verification Checkpoint #2	
Bottle Number:		Bottle Number:		Bottle Number:	
Scan Range (25):		Scan Range (25):		Scan Range (25):	
Scan Number (37IDO):		Scan Number (37IDO):		Scan Number (37IDO):	
Time:		Time:		Time:	
Bottle Number:		Bottle Number:		Bottle Number:	
Scan Range (25):		Scan Range (25):		Scan Range (25):	
Scan Number (37IDO):		Scan Number (37IDO):		Scan Number (37IDO):	
Time:		Time:		Time:	
Bottle Number:		Bottle Number:		Bottle Number:	
Scan Range (25):		Scan Range (25):		Scan Range (25):	
Scan Number (37IDO):		Scan Number (37IDO):		Scan Number (37IDO):	
Time:		Time:		Time:	
Comments:		Comments:		Comments:	

FINAL RESULTS ***(after calculations & CTD file processing)***					
Verification #1					
Winkler DO (mean of 3+):	(mg/L)	25 CTD DO (w/ factory cal'b coeff):	(mg/L)	37 CTD DO (w/ factory cal'b coeff):	(mg/L)
Verification #2					
Winkler DO (mean of 3+):	(mg/L)	25 CTD DO (w/ factory cal'b coeff):	(mg/L)	37 CTD DO (w/ factory cal'b coeff):	(mg/L)
Verification #3					
Winkler DO (mean of 3+):	(mg/L)	25 CTD DO (w/ factory cal'b coeff):	(mg/L)	37 CTD DO (w/ factory cal'b coeff):	(mg/L)