SBE 25 SEALOGGER CTD

OPERATING MANUAL

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1-1 INTRODUCTION

SEALOGGER CTD model SBE 25 uses Sea-Bird's standard modular SBE 3 and SBE 4 sensors to measure electrical conductivity and temperature versus pressure. CTD data (and signals from other sensors, if installed) is recorded in battery-backed CMOS memory at 8, 4, 2, or 1 scan per second (user programmable) giving 1, 2, 4, or 8 hours of memory endurance (CTD only; less with additional sensors). Optically isolated real time data can be transmitted to a computer's serial port at the same rate it is recorded in memory or subsampled at a lower rate. The baud rate is programmable (600, 1200, 4800, or 9600 baud) to allow the user to choose a real time update rate that is compatible with the cable length.

The SBE 25 is powered by 9 alkaline (optionally rechargeable nickel-cadmium) batteries which provide an operating endurance ranging from 4 hours (fully loaded system including fluorometer operating at 0 degrees) to 24 hours (CTD only). Set-up, check-out, and data extraction are performed without opening the housing. SEASOFT CTD software is supplied and derives salinity, density, sound velocity, and other ocean parameters from stored or real time CTD values and may be used for data analysis, plotting, and archival.

The SBE 25 can be configured to be used with the SBE 36 CTD deck unit and underwater power and data interface (PDIM). This configuration provides surface power the SBE 25 and allows an 8 scan per second real time update rate when using single or multi-core armored cable up to 10,000 meters long.

1-2 PHYSICAL CONFIGURATION

The Sealogger CTD is supplied in a protective steel guard cage with a lifting eye (ring) at the top. Acquisition electronics, microprocessor controller, memory, and batteries are in the large (3.9 inch / 99 mm) diameter housing (subsequently called the 'main housing'). Bulkhead connectors for the modular sensors are mounted on the bottom end cap of this housing as shown in drawing 30920.

The small (1.5 inch / 38 mm diameter) module mounted near the bottom of the guard cage is a pump (SBE 5LD) used to flush the conductivity cell and (optional) dissolved oxygen sensor. There is a Y-Cable (PN 17709, dwg 31551) that is used to provide power to the pump and to communicate with the SBE 25. There is a RMG-4MP connector strapped to the main CTD housing near the top of the cage (remove the dummy cap from this connector to connect your computer to the Sealogger CTD using the RMG-4FS to DB25 cable supplied).

The temperature and conductivity sensors are mounted with a single clamp to the lower cage crossbar. The conductivity cell is under the rectangular aluminum guard and is mounted parallel to the module housing. The cell entrance is at the bottom and is co-planar with the tip of the temperature sensor element's protective steel sheath.

1-3 PUMP OPERATION AND PLUMBING

WATER ROUTING - VERTICAL ORIENTATION: The SBE 25 SEALOGGER CTD was shipped with the plumbing configured for operation while the cage is vertical unless it was shipped with a SBE 32 Carousel Water Sampler in which case the plumbing was configured for use in with the cage in the horizontal position. When the pump is operating in the vertical configuration, water is drawn in at the bottom of the conductivity cell (or at the tip of the temperature sensor if using the optional 'TC Duct') and travels upward through the cell. Then it flows though tubing leading from the top of the cell (passing through the optional oxygen sensor plenum) up to an inverted 'Y' fitting, and continues downward to the pump intake. Finally, the water exits from the side of the pump and travels down through a small-diameter tube and is exhausted into the ocean. An inertial-balance is achieved by placing the intake and outlet at the same level, avoiding variation in flow rate when ship motion is coupled to the CTD. The top of the inverted 'Y' fitting has a small hole that allows air to bleed out of the system so that the pump can prime. The hydrodynamic resistance of the bleed hole is high, however, and has little effect on the pumped flow rate.

WATER ROUTING - HORIZONTAL ORIENTATION: If the SBE 25 SEALOGGER CTD was delivered with a SBE 32 Carousel Water Sampler, the plumbing was configured for use while the cage is mounted horizontally in the Carousel extension stand. In this configuration there is no 'Y' fitting in the plumbing and no exhaust tube on the pump. The pump is positioned higher than the conductivity cell and optional oxygen sensor if present so that there are no loops or low spots in the plumbing that would allow air to be trapped in the tubing. The outlet of the pump is pointed up so that all the air can escape from the plumbing system.

PROTECTIVE TUBING: To keep airborne particulates from fouling the cell, the Sealogger CTD is shipped with a length of tubing connected to the conductivity cell inlet (to the duct inlet when the 'TC Duct' is installed); the other end of this tubing is folded over and tucked inside the top of the cell guard. **THIS TUBING MUST BE REMOVED BEFORE DEPLOYMENT OF THE CTD**. For storage, disconnect the tubing leading from the top of the conductivity cell to the inverted 'Y' and fit the original storage tube to the bottom of the cell; fill it with deionized water and then fit its upper end to the top of the cell. Put a small amount of water in the oxygen sensor plenum (a few ccs will be fine) and loop a short length of tubing from the plenum's inlet to outlet. This ensures a high humidity environment as needed to prolong the life of the (optional) dissolved oxygen sensor. **IF THERE IS DANGER OF FREEZING, OMIT THE WATER FROM THE CONDUCTIVITY CELL TUBING OR THE CELL WILL BE DAMAGED**.

PUMP PRIMING: Normally, in order for the pump to run, the conductivity cell must be in seawater. After the cell enters the water, there is also a time delay before turn-on so that all the air in the pump tubing can escape. If the pump motor turns on when there is air in the pump's impeller housing, the pump will not prime and a proper water flow will not occur.

PUMP TURN ON: Power is not applied to the pump until 45 seconds after the frequency output of the conductivity channel exceeds the minimum value that has been entered into the Sealogger CTD using the CC command. The output of each SBE 4 conductivity sensor while it is in air is a unique and constant number. This '0' conductivity frequency is located on the conductivity calibration sheet located in the calibration section of the CTD manual and is typically between 2700 and 3100 Hz. For work in salt water the pump turn on frequency is typically set to 3500 Hz. This insures that the pump will not operate during tests when the unit is not in the water. The pump requires water for lubrication and therefore should not be run for any length of time while in air or damage will occur. For deployment in freshwater or very low salinity water the pump start frequency should be set to 5 Hz above the '0' conductivity frequency value. If the set point is made too close to the '0' conductivity value, the pump may inadvertently turn on as a result of small drifts in the electronics; some experimentation may be required.

If for some reason you want the pump to run continuously, set a frequency lower that the '0' conductivity frequency. In this case, the pump will start running about 45 seconds after data logging begins, whether the conductivity cell is in water or not.

The necessary conditions for proper pump operation are as follows:

1. Conductivity sensor frequency is greater than **'minimum conductivity frequency for pump turn on'** as will be true if the sensor is in seawater or if the pump turn on frequency has been set below the minimum value;

2. If used vertically, all air has bled out through the 'air bleed hole' at the top of the 'Y' tubing; or if used horizontally, all air has bleed from the pump exhaust port.

3. More than 45 seconds have passed since condition (1) was met.

The entries made using the 'CC' command will be permanently stored in the Sealogger CTD and will remain in effect until you change them (by running 'CC' again). The only exception is in the event of *complete* initialization of the Sealogger CTD. This will occur only with disassembly of the electronics from the housing (along with disconnection of the battery connector to the electronics card set) or if the toggle switch at the bottom of the battery compartment is placed in the 'reset' position.

2-1 PREPARATION FOR DEPLOYMENT

Sealogger CTDs are supplied from the factory with the necessary data channels programmed and with the clock set to Pacific Standard Time (see Section 5-3 for instructions on reprogramming). Remove the dummy cover from the MAIN I/O connector located on the PN 17709 Y-cable (drawing 31551). Connect the I/O connector to a serial port on an IBM PC/XT/AT or compatible using the supplied serial I/O cable (use the 25 to 9 pin adapter cable with laptop or AT class computers). Run the TERM25 terminal program which will interrogate and wake up the Sealogger CTD. When this has occurred the message 'communications established' and the prompt 'S>' should appear on the CRT screen. Enter ST and press Enter and follow the instructions to set the date and time. Enter DS and press Enter to display CTD status can be displayed (see section 5-3.3 for a description of how to configure the SEALOGGER CTD using the CC command; section 5-3 contains a complete description of SEALOGGER commands). The pump will be turned on 45 seconds after the conductivity cell is in salt water. **NOTE: To reduce the surge current required from the batteries at pump turn-on, power is not applied to auxiliary connector J5 until the pump starts running and has had time to stabilize. A fluorometer, transmissometer, or other instrument connected to J5 will accordingly not begin operating until after the pump has started**.

2-1.1 DEPLOYMENT (OCEANIC AND ESTUARINE WATERS)

Obtain the S> display. If previously recorded data has been downloaded, use the IL command to reset the memory (data in the SEALOGGER CTD will be overwritten). Otherwise, use the DS command to determine that sufficient memory remains to accommodate the planned cast; the number will be incremented and the data will be appended to the existing data. Confirm that date and time are correct and battery voltage is sufficient (minimum 10.2 volts). Enter QS followed by Enter to place the CTD in quiescent mode. Do not press any other keys as this will wake up the microprocessor and prevent CTD operation. Slide the magnetic switch to the ON position which will initiate logging. After a few seconds you will see ASCII HEX data scrolling on the screen; this is confirmation that the Sealogger is working properly. Press Function Key F10 to exit TERM25.

Disconnect the data I/O cable from the Sealogger's MAIN I/O connector. **IMPORTANT: Replace the dummy cover on the MAIN I/O connector, and be sure to 'burp' all the air out (squeeze the sides of the connector firmly)**. Replace the plastic lock sleeve (do not overtighten; the sleeve cannot always be fully 'bottomed out' on its threads). Lower the CTD into the water until the tubing above the air bleed 'Y' fitting is submerged; air will begin to bubble up through the bleed hole. After all the air has bled out, the tubing extending above the air-bleed hole will contain a small reserve of water which will maintain the pump prime for up to one minute (the length of time depends on the length of tubing above the air-bleed) even though the Sealogger CTD is lifted up so that the cell inlet and pump outlet are just below the water surface. This allows beginning the actual profile very near the top of the water column (if desired). Remember that the cell inlet and pump outlet must not come above the water surface or the prime will be lost.

The pump is turned on 45 seconds after the conductivity cell enters the water. Power to optional sensors connected to J5 is turned on 55 seconds after the conductivity cell enters the water. To avoid loss of near-surface data, **THE CTD MUST BE KEPT AT THE SURFACE FOR A FULL 55 SECONDS**. Optimum lowering rates are 0.5 To 1.5 Meters per second.

2-1.2 DEPLOYMENT (FRESH WATER)

Before operating in fresh water it will be necessary to reprogram the Sealogger CTD for proper control of the pump. For deployment in freshwater or very low salinity water the pump start frequency should be set to 5 Hz above the '0' conductivity frequency value using the CC command. If the set point is made too close to the '0' conductivity value, the pump may inadvertently turn on as a result of small drifts in the electronics; some experimentation may be required. See Section 5-3 for complete information on the CC command and section 1-3 for additional information on pump operation. Section 2-1.1 contains additional information that is applicable to both salt water and fresh water operations.

2-1.3 MULTIPLE DEPLOYMENTS

If it is known that sufficient memory will be available, it is not necessary to reconnect the Sealogger CTD to a computer before beginning subsequent casts. Recover the CTD and slide the magnetic switch to the off position. Another cast can be recorded by waiting at least 10 seconds and then setting the magnetic switch to ON. Cast number, time, and date will be recorded to a header file (check using the DH command at the S> prompt); the maximum number of casts is 100. When the memory is full, the CTD will continue to operate (and transmit real time data) but the data will not be recorded nor previously recorded data overwritten.

For deployments where there are repetitive short casts with minimum time between casts the SBE 25 contains a standby mode where power to external sensors is not turned off between casts. This mode is an advantage when an oxygen sensor is being used because of the required 2 minute warmup time. Section 5-3.4 contains additional information on the standby mode.

2-1.4 REAL TIME DATA SET UP

The rate that real time data can be transmitted is dependent on the rate that data is stored in memory and the serial data baud rate. The length of cable that the SBE 25 can drive is dependent on the baud rate.

The SRn command is used to set the data rate to 600, 1200, 4800, or 9600 baud.

The CC command is used to set the internal data storage rate to 1, 2, 4, or 8 scans per second and to set the real time data output rate. See section 5-3.3 for a description of the SRn and CC commands.

The allowable combinations are:

baud rate	data storage (scans / sec)	real time output (scans / sec)
600	8	1
	4	1
	2	1
	1	1
1200	8	1 or 2
	4	1 or 2
	2	1 or 2
	1	1
4800	8	1, 2, 4, or 8
	4	1, 2, or 4
	2	1 or 2
	1	1
9600	8	1, 2, 4, or 8
	4	1, 2, or 4
	2	1 or 2
	1	1

baud rate	length of cable the SBE 25 can drive
600	6,000 meters
1200	3,000 meters
4800	750 meters
9600	375 meters

When using the SBE 36 CTD deck unit set the baud rate to 4800 baud. The SBE 36 data telemetry link can drive 10,000 meters of cable while accepting 4800 baud serial data.

SEASAVE set up:

Select:

Acquire and Display Real Time Data
Misc Run Parameters
COMM Port Configuration

Verify:

That the 'CTD Data COMM Port' is set to the port that the SBE 25 is connected to and that the 'CTD Data Baud Rate' is set to the baud rate used to communicate with the SBE 25.

When using the SBE 36 CTD deck unit the CTD Data Baud Rate is set with a DIP switch inside the SBE 36; typically 9600 baud.

2-1.5 REAL TIME DISPLAY

Start logging as described above. If you are running TERM25, press Function Key 10 to return to DOS. Type SEASAVE and select the real time data option. Set up the particular screen display that is desired and when ready press the F10 key. The real time data will appear on the screen at one second intervals. Data will be stored internally in the SEALOGGER CTD at 1, 2, 4, or 8 scans per second depending on how the SEALOGGER CTD is configured. See sections 5-3 and 1-3 for additional information concerning pump control and CTD configuration.

To use the Sealogger CTD on a conventional single-core armored cable, terminate the cable with an RMG-4FS connector. Wire the cable armor to pin 1 (large pin) and the inner conductor to pin 3 (opposite large pin). On deck, wire the slip-ring lead from the armor to pin 7 of your computer's 25 pin serial port (pin 5 on AT and laptop computers having 9 pin ports). Wire the slip-ring lead from the cable inner conductor to pin 3 of your serial port (pin 2 on AT and laptop computers). With the Sealogger running and TERM25 active, you can see ASCII HEX data scrolling on the screen. For a display in engineering units, exit TERM25 (Function Key F10) and run SEASAVE. Choose 'real time data'. The prompt 'turn on Sealogger CTD using magnetic switch' can be ignored. See the SEASOFT manual for a complete description of display options.

2-1.6 LOG DATA: COMPUTER INITIATED

Run TERM25 and after the 'communications established' message and the S> prompt is displayed set the magnetic switch to the ON position. To start logging data enter GL. Enter y followed by Enter in response to the prompt 'start logging (y/n) ?'. Press ^y [press Cntl and Y simultaneously] in response to the prompt 'are you sure (^y/n) ?'. You should see HEX data displayed on the screen after a few seconds. To stop logging either set the magnetic switch to the OFF position or press the HOME key. To record multiple casts send the RL command instead of the GL command. Data acquired with the GL command will start at scan 0 and overwrite and existing data. Data acquired with the RL command with be appended to the existing data.

2-1.7 RETRIEVE DATA

Stop logging and press Enter until the 'S>' prompt is displayed. Send the DH command to display header information. Press Function key 9 to initiate the data dump. The resulting file will be in hexadecimal format with a .HEX extension and can be processed with SEASAVE or DATCNV. See the SEASOFT manual for a complete description of the SEASOFT modules.

2-2 CTD RECOVERY AND DATA TRANSFER

Turn off the CTD using the magnetic switch. Unless another cast is to be performed immediately, hose down the CTD with fresh water. Disconnect the Tygon tubing between pump and conductivity sensor, and loop a length of tubing containing deionized water from end to end of the cell. If the CTD has an oxygen sensor, the loop should be through that sensor also.

Connect your computer to the Sealogger CTD MAIN I/O port. Run TERM25 and confirm that the Sealogger CTD has been found and woken up by observing the 'communications established' message and the S> prompt. Use the DS command to check that the proper number of casts have been written. Use the DH command to determine the start time of each cast.

Press Function Key F9 and enter a descriptive file name for the data. Note: if you choose the option to 'dump all casts', your file name should be 6 characters long (or less). TERM25 will automatically add 00, 01, 02, etc to your filename so as to create a unique file for each cast). Dots will write on the screen (each represents a complete CTD data scan). When all the data has been transferred, 'done' will appear. Press Function Key F10 to exit TERM25. The data may be read using SEASAVE (choose 'archived' data). See the SEASOFT manual for a complete description of display options.

2-3 COMMON PROBLEMS AND THEIR CURES

The most common difficulties with the SEALOGGER involve improper set up of the SEASOFT routines in the companion computer. Read the software manual for general guidance and consult the configuration section at the beginning of this manual for instrument specific information.
SEALOGGERS are shipped with the software set up to match the configuration of your instrument, and have the calibration coefficients already entered in the SEASOFT.CON file on the original software disks. We recommend that you make copies of the SEASOFT disks supplied with your CTD, place write protect stickers on the originals and store them in a secure place. Then do your actual work using the copies.

2-3.1 UNABLE TO COMMUNICATE WITH SEALOGGER

The I/O cable supplied with SEALOGGER will permit connection to the DB-25P input connectors used on 'IBM Asynchronous Adapter Cards', i.e., standard RS-232 interfaces. If you are using an IBM PC or equivalent and cannot establish communication (the **S>** is not displayed in response to multiple [CR]s), turn off the magnetic switch and verify the setup parameters in TERM25. Press Function Key 2 to enter the set up form and select Communication Set Up. Set the COMM port to the port that the SBE 25 is connected to. Set the number of data bits to 7 and the parity to even. The baud rate is 600, 1200, 4800, or 9600 baud. Press Function Key 6 in the TERM25 main form to automatically try the different baud rates.

2-3.2 NO DATA RECORDED

SEALOGGER must be in quiescent mode before it will respond to the magnetic switch and begin taking data. Quiescent mode is entered by 1) entering QS[CR] when communicating with a computer or terminal, or 2) waiting about 3 minutes after the last keyboard command. It is best to always use the QS command when ending a data readout, diagnostic, or set-up session with a computer or terminal.

Also, check to see that the memory is not full (using the DS command, you will see 'free = 0' if memory is full). Once the memory is full, no further data will be recorded. It is generally best to down-load all previous data before beginning another deployment. Then use the IL command to reset the memory. After the IL is implemented, DS will show 'samples = 0' and 'free = 42958' (or 'free = some other number', depending on the memory capacity of your unit).

2-3.3 NONSENSE DATA

If the display of a down-loaded data file yields nonsense values (9999.99, for example), the problem is usually an incorrect value in the instrument configuration or firmware version as entered in SEACON. **See the INSTRUMENT CONFIGURATION section at the beginning of your manual for the correct configuration of your CTD system**.

If the TERM25 program fails to correctly upload the data, verify that the firmware version and the data upload baud rate in the TERM25 setup (F2 key) are set correctly.

Unreasonable values for temperature, conductivity, etc are usually the result of incorrect entries in the calibration coefficients section of SEACON. Check that the values entered agree with the calibration certificates supplied with your unit.

2-3.4 RESETTING THE SEALOGGER'S INTERNAL MEMORY

In rare cases the memory resident program that controls the microprocessor in the SEALOGGER can be corrupted by a severe static shock or other problem. This program can be reloaded from the EPROM located in the SEALOGGER by removing all power from the internal circuitry. When the main batteries are removed or exhausted the small lithium batteries located on the internal board set keep memory alive. If the lithium battery power is removed from the circuitry then the SEALOGGER will loose all memory. When power is reapplied a fresh copy of the firmware is loaded into volatile memory from the EPROM.

On the battery side of the bulkhead located in the SEALOGGER housing is a small two position switch. This switch can be used to disconnect the internal lithium batteries from the electronics. Access to this switch is through the battery compartment. When the main batteries are removed this switch is visible on the battery bulkhead. To reset the SEALOGGER move the switch to the reset position and leave it there for 5 minutes to allow several capacitors to drain. Then move the switch back to the on position. Reinstall the main batteries and communicate with the SEALOGGER using the TERM25 program.
NOTE: All contents of memory will be lost when the SEALOGGER is reset. This includes data stored in memory and all variable parameters that are user configurable.

Use the ST command to reset the date and time, the CC command to configure the data acquisition parameters.

2-4 SEASOFT SUMMARY

SEASOFT modules (SEACON, SEASAVE, DATCNV, DERIVE and SEAPLOT) are executable files which may be run by typing the name of the module followed by a Enter. The SEASOFT manual that came with the software contains detailed information on the set up and use of these and the other programs in the SEASOFT software package.

With the software that accompanies each Sea-Bird SBE 25 is a file, SEASOFT.CON that contains the instrument configuration and calibration coefficients for all of the sensors that were supplied with the CTD. This file is used by the SEASOFT modules to decode and calibrate the data. This file must be present for the SEASOFT programs to work correctly. The SEACON program is used to create and to modify the settings in the SEASOFT.CON file.

3-1 SPECIFICATIONS

The conductivity and temperature sensors produce variable frequency outputs. To obtain the high encoding speed and resolution required by profiling applications, a 'hybrid' period counting technique is used. Each sensor has its own counting electronics circuit, so that all sensors are sampled simultaneously. Two 12-bit counters are used for each sensor - one counter accumulates the integral number of sensor counts during the sample interval (1/36) second, and the other counter measures the time from the beginning of the measurement period until the first positive-going zero crossing of the sensor frequency, i.e., determines the 'fractional' count.

The pressure sensor is a strain gauge type and is powered with a 5 volt reference. The resulting output voltage is amplified and then digitized with a 12 bit A/D converter using the same 5 volt reference.

3-1.1 SENSOR FREQUENCY RANGES ALLOWED

Each counter can handle 4096 counts. The maximum time that the N_r counter will be gated "on" will be $1/F_s$. Since the N_r counter runs at 9,437,184 Hz, the minimum allowable F_s is given by 9,437,184/4096, or 2304 Hz. The maximum allowable sensor frequency is determined by the size of the N_s counter - no more than 4096 counts may be accumulated during the measurement interval. Thus F_s max = 4096/(1/36) = 147,456 Hz.

3-1.2 RESOLUTION (CT CHANNELS)

Resolution = 36 * F_s/F_r, (Hz/bit) where

F_s is the sensor frequency, and

F_r is the CTD reference frequency (9,437,184 Hz).

At 2 kHz and the resolution is 0.0076 Hz/bit, and at 50 kHz the resolution is 0.191 Hz/bit. To get resolution in engineering units, we need to divide by "sensitivity", for example, Hz/(Degree Celsius). To compute nominal values of resolution in engineering units, we use the approximate values for sensitivity (Sen) from the sensor specification sheets. The values given here are for illustrative purposes only - the user's computer must use the more exact equations and the specific calibration constants for each sensor installed in order to make the conversions to engineering units.

Temperature: At -1 deg C, F_s = 6 kHz and Sensitivity = 146 Hz/(deg C)
At 31 deg C, F_s = 12 kHz and Sensitivity = 233 Hz/(deg C)

Resolution = 0.00016 deg C per bit at -1 deg C
= 0.00020 deg C per bit at 31 deg C

Conductivity: At 1.4 Siemens/meter (S/m), F_s = 5kHz and Sensitivity = 1900 Hz/(S/m)
At 5.8 S/m, F_s = 11 kHz and Sensitivity = 960 Hz/(S/m)

Resolution = 0.00001 S/m per bit at 1.4 S/m
= 0.00004 S/m per bit at 5.8 S/m

3-1.3 ACCURACY (CT CHANNELS)

The accuracy of the system is determined by the accuracy of the sensors used and by the accuracy of the crystal oscillator used to generate the reference frequency F_r. F_r is stable to within 5 ppm over the temperature range of 0 to 50 deg C. Any error in Fr causes a corresponding error in computed sensor frequency F_s. A 5 ppm error in Fr would cause a 0.06 Hz error if F_s = 12,000 Hz. This in turn would result in a 0.0004 deg C maximum error in temperature, or a 0.00007 S/m maximum error in conductivity. At lower sensor frequencies, the errors would be smaller. At 40,000 Hz, the frequency error would be 0.2 Hz, and the corresponding depth error would be 0.10 meter (for a 3,000 psi depth gage). These errors are well below those typical of the sensors (0.004 deg C, 0.0003 S/m, and 2 meters). The sensor accuracies are detailed in their spec sheets, which are included in the calibration section of the manual.

3-1.4 AUXILIARY SENSOR VOLTAGE RANGES

Up to 7 auxiliary voltages with the range 0 to 5 volts DC may by acquired by the SBE 25 CTD. The 2 channels at J5 are differentially processed as required when using the Sea Tech Fluorometer and other high-current demand instruments.

3-1.5 ACCURACY and RESOLUTION (PRESSURE and VOLTAGE CHANNELS)

Overall accuracy of the PAINE pressure sensor is 0.25% full scale range (0.15% for 3000 psi and higher). Pressure resolution is 0.015% full scale range. The 5 volt reference used by the A/D converter is a Precision Monolithics REF-02EZ with a maximum output voltage temperature coefficient of 8.5 ppm/°C. The 12 bit A/D converter is a National Semiconductor ADC1205CCJ-1 with a linearity error of ±1 LSB. The 12 bit A/D converter resolution is (5 / 4096) or 0.0012 volts per bit.

4-1 DATA FORMAT

Eight to nineteen bytes are stored per CTD scan depending on the number of external voltages sampled. For EPROM versions 2.0 or greater the data format is:

No external volts sampled:

ttttttccccccsppp

One external voltage sampled:

ttttttccccccsppp0uuu

Two external voltages sampled

ttttttccccccspppuuuvvv

Three external voltages sampled

ttttttccccccspppuuuvvv0www

Four external voltages sampled

ttttttccccccspppuuuvvvwwwxxx

Five external voltages sampled

ttttttccccccspppuuuvvvwwwxxx0yyy

Six external voltages sampled

ttttttccccccspppuuuvvvwwwxxxyyyzzz

Seven external voltages sampled

ttttttccccccspppuuuvvvwwwxxxyyyzzz0aaa

tttttt	three bytes of temperature frequency
cccccc	three bytes of conductivity frequency
ppp	12 bits representing pressure
uuu	12 bits representing the first stored voltage
vvv	12 bits representing the second stored voltage
www	12 bits representing the third stored voltage
xxx	12 bits representing the fourth stored voltage
yyy	12 bits representing the fifth stored voltage
zzz	12 bits representing the sixth stored voltage
aaa	12 bits representing the seventh stored voltage
s	sign character for pressure
0	4 bits all zero

frequency = (BYTE0 * 256) + BYTE1 + (BYTE2 / 256)
if the sign character = 0: pressure number = decimal equivalent of ppp
if the sign character = 4: pressure number = decimal equivalent of -ppp
voltage = decimal equivalent of uuu / 819
Example: two external voltages sampled

scan = 1FE780281D1904293F2D1E

tttttt = 1FE780, temperature frequency = (31 * 256) + 231 + (128 / 256) = 8167.500 Hz
cccccc = 281D19, conductivity frequency = (40 * 256) + 29 + (25 / 256) = 10269.098 Hz
ppp = 429, pressure number = 1065
uuu = 3F2, voltage = 1010 / 819 = 1.233 volts
vvv = D1E, voltage = 3358 / 819 = 4.100 volts

5-1 RS-232C INTERFACE PROTOCOL

SEALOGGER CTD receives set-up instructions and outputs diagnostic information or previously recorded data via a 3-wire RS-232C link, and is factory configured for 600 baud, 7 data bits, 1 stop bit, and even parity. RS-232 levels generated and accepted by SEALOGGER are directly compatible with standard serial interface cards.

The following table describes the keyboard symbols used in this manual:

Symbol	Description	ASCII	HEX	Key Sequence
(CR)	Carriage Return (Enter)	CR	0D	Enter (carriage return)
^	Control Key	--	--	Ctrl
^C	Escape Function	ETX	03	Ctrl + C or
^C	Escape Function	ESC	1B	Esc

When running TERM25, the Esc Key must be used to perform the Escape Function.

SEALOGGER CTD will send **^C** whenever a Escape Function is received and SEALOGGER is in terminal mode.

* Commands followed by * alter SEALOGGER memory and will prompt the user twice before executing. (* is not part of the command) To execute the command enter Y in response to **'message' Y/N** then hold down the Ctrl key and enter Y in response to **are you sure ^Y/N**. Any other responses will abort the command.

[] Braces indicate optional parameters of the command. Items enclosed in braces need not be entered.

The following keys are used to edit entries to SEALOGGER.

Description	ASCII	HEX
Enter: enters the command or line	CR	0D
Backspace: deletes the previous character	BS	08
Kill line: Ctrl X	CAN	18
Kill line: Escape	ESC	1B
Kill line: Ctrl C	ETX	03

Commands to SEALOGGER may be entered in upper or lower case letters. Responses made by SEALOGGER are indicated in bold type. SEALOGGER will send **#** whenever an invalid command is entered. If a new command is not received within 2 minutes after completion of the last command, SEALOGGER will return to the standby mode.

If the SEALOGGER CTD has been completely disassembled for any reason, the date and time should be set with the st (set time) command before further set-up, diagnostics, or other communications functions are undertaken.

5-2 TERMINAL PROGRAM

TERM25 is a terminal emulation program designed to communicate with SEALOGGER CTD: characters typed on the keyboard are sent to SEALOGGER CTD and characters sent by SEALOGGER CTD are displayed on the console. The baud rate is set to 600 baud when the program is started. In addition the following Function Keys are active:

F1	Help - selects the TERM25 help function
F2	Enters the TERM25 set up menu. Used to set firmware and communications parameters
F3	Sends a DS (display status) command to the CTD
F4	Sends a DH (display headers) command to the CTD
F5	Capture data to disk, echo characters to CRT
F6	Wake up the CTD
F7	Change baud rate
F8	Sends a IL (initialize logging) command to the CTD then exits TERM25
F9	Dump data (by cast) from SEALOGGER CTD to disk
F10	Exit and return to DOS
ESC	Sends a break character to SEALOGGER CTD
HOME	Sends NULL character to SEALOGGER. Used to stop computer initiated logging.

NOTES:

The file name created with F9 is given the extension .HEX. The data may not actually be written to disk until TERM25 is exited via function key 10. SEALOGGER CTD will automatically send ^S and ^Q characters if the computer does not keep up with the data sent by SEALOGGER CTD. If multiple casts are dumped with F9 two digits will be added to the filename. 00 will be added to the first cast. 01 will be added to the second cast and so on.
TERM25 allows the use of higher speed baud rates in uploading data from the CTD. These baud rates can only be used over short cables (less than 100 meters for 9600 baud).

5-3 COMMANDS

5-3.1 DIAGNOSTICS

TM(CR)*^C Memory test. **WARNING, ALL DATA IN SEALOGGER CTD WILL BE DESTROYED!** Same as extended memory test except that the test concludes after pass 0 is completed.

TE(CR)*^C Extended memory test. **WARNING, ALL DATA IN SEALOGGER CTD WILL BE DESTROYED!** An incrementing pattern is written into all locations of each RAM. Data in the RAM is then compared to the pattern. Each pass the pattern is incremented by one. The test concludes after 10 passes.

pass x
ram 0, OK
ram 1, OK
ram 2, OK
ram 3, OK
ram 4, OK
ram 5, OK
ram 6, OK
ram 7, OK

At the conclusion of the test or when an Escape Function character is received SEALOGGER will display:

ram test passed with no errors

FR(CR)^C Display corrected and uncorrected frequencies.

Example: FR(CR) SEALOGGER will send:

t = aaaaa.aaa c = bbbbb.bbb

aaaaa.aaa is the temperature frequency
bbbbb.bbb is the conductivity frequency

VR(CR)^C Display voltages. Voltages read by the Analog to Digital converter are displayed.

Example: VR(CR) SEALOGGER will send:

a.aaa b.bbb c.ccc d.ddd

a.aaa corresponds to main battery voltage. Main battery voltage = a.aaa * 5.0161 volts.
b.bbb corresponds to lithium battery voltage. Lithium battery voltage = b.bbb * 3.873 volts.
c.ccc corresponds to pressure voltage.
d.ddd corresponds to pressure temperature voltage

If external voltages are selected they will be displayed following the pressure voltage.

5-3.2 STATUS

DS(CR) Display operating status and CTD configuration: software version, serial number and current time; AP counter crystal frequency; real time clock frequency, operating current (milliamps), main battery voltage, lithium battery voltage, operating current, number of stored casts,number of stored samples, number of samples free in memory, and number of milliseconds to wait after sending a carriage return line feed (provides extra time for slow computers).

Example: DS(CR) SEALOGGER will send:

ds
SBE 25 CTD V 4.0 SN 0115 01/18/95 14:26:54.954
external pressure sensor, range = 300 psia, tcval = 527
xtal = 9437423 clk = 32768.123 vmain = 10.4 iop = 165 vlith = 5.7
ncasts = 1 samples = 198 free = 130380 lwait = 0 msec

CTD configuration:
number of scans averaged = 1, data stored at 8 scans per second
real time data transmitted at 4 scans per second
minimum conductivity frequency for pump turn on = 3500
battery type = ALKALINE

3 external voltages sampled

stored voltage # 0 = external voltage 4
stored voltage # 1 = external voltage 5
stored voltage # 2 = external voltage 6

5-3.3 SETUP

CC(CR)* Configure CTD. The Sealogger will prompt you by displaying the current value and asking for a new value. To accept any current value without change, press Enter.

internal data storage rate (scans / sec) [1,2,4, or 8] =
enter 1, 2, 4, or 8. The number of scans averaged = 8 / data storage rate.

real time data output rate (scans / sec) =
enter the desired rate. See Section 2-1.4 for a discussion of the allowable choices.

minimum conductivity frequency for pump turn on =
A typical entry would be 3500. When logging the pump will not turn on until 45 seconds after the conductivity frequency is greater than the entered number. This allows the pump to be submerged before turning on. If the pump is started in air it may not prime properly until the CTD is several meters deep.

Pressure sensor range (psia) = , new value =
Enter the sensor range of the SBE 29 sensor module presently installed. Check the sensor's serial number and compare this with pressure sensor calibration sheet to confirm the proper range.

Pressure temperature compensation value = , new value =
Enter the "Temperature Compensation (TC) value" given on the calibration sheet.

Stop CTD on upcast (y/n) ? = NO, new value =
The CTD will operate until stopped by a turning off the magnetic switch, or by a command via TERM25. The purpose is to maximize battery endurance by recording only the downcast data. If 'y' is entered you will be prompted:

Stop upcast when CTD ascends x % of FSR, x = 10 new x =
The CTD will turn off on the up cast if the cast is a least 20% of FSR deep. The upcast is considered to have begun when the pressure sensor reading is x % of FSR less than the maximum value of pressure reached during the downcast.

battery type, NICAD or ALKALINE (enter A or N) =
Enter 'a' to select ALKALINE. Enter 'n' to select NICAD.
If the battery type is NICAD logging is halted when the battery drops below 7.4 volts or when the battery voltage is less than 10.2 volts and the voltage drop is greater than 1 volt per minute as determined by two 30 second moving averages. This reduces the battery load to quiescent current (200 microamps) once the first cell in the battery pack is exhausted.

number of external voltages to sample (0 - 7) = 3, new value =
Enter the number of external voltages you wish to sample. The initial factory configuration can be found in the configuration section at the beginning of this manual. If the number of voltages is changed, run SEACON, select change instrument configuration, and enter the correct number when prompted for the number of external voltages sampled.

If the number of external voltages is greater than 0 you will be asked:
sample external volt # 0 (y/n) = YES, new value =
answer 'y' for the voltages you wish to sample.

When finished a summary of the CTD configuration will be displayed. If 3 external voltages were selected the configuration will be similar to:

3 external voltages sampled
stored voltage # 0 = external voltage 4
stored voltage # 1 = external voltage 5
stored voltage # 2 = external voltage 6

The STORED voltage number corresponds to the voltage # specified in SEACON. The EXTERNAL voltage number refers to the standard wiring assignments of specific sensors to specific input channels on the SBE 25. For example if stored voltage #1 = external voltage 5 (fluorescence) the correct answer to the prompt 'fluorometer volt #' in SEACON is 1. The END CAP connector drawing in the 'schematics' section of this manual shows where to plug in the various sensors.

Standard wiring for the SBE 25 SEALOGGER CTD is as follows:

External Volt 0 is DO current

External Volt 1 is DO temperature
External Volt 2 is pH
External Volt 3 is a spare input
External Volt 4 is light transmission
External Volt 5 is fluorescence
External Volt 6 is PAR log amp

LWN(CR) Set wait interval of N milliseconds after each line of data; normally N = 0; increase for slower computers. Nmax = 65535.

MC(CR) Set mode to computer (SEALOGGER does not echo commands)

MT(CR) Set mode to terminal (SEALOGGER echoes commands)

ST(CR) Set date and time as prompted

Example: ST(CR)
date (MMDDYY) = 042387(CR)
time (HHMMSS) = 191026(CR)

The date is set to April 23, 1987. The time is set to 19:10:26.

SRn(CR) This command is used to change the baud rate used by the SEALOGGER during normal communications.

Upon initial power up or reset the SEALOGGER will default to communicating at 600 baud. This command allows the user to change this baud rate to one of the values listed below. When this command is given the SEALOGGER will immediately change its baud rate and all subsequent communication will be at the new baud rate. This baud rate will be retained by the SEALOGGER until power is removed from the circuit boards (caused by disassembly or by using the reset button located on the battery bulkhead) or until a new SR command is entered. The new baud rate is retained while the SEALOGGER is in quiescent mode between samples. This setting does not affect the baud rate controlled by the DD, DC, DA, DB and DE commands for uploading data from the SEALOGGER.

The possible values are:

n = 1 600 baud

n = 2 1200 baud
n = 3 9600 baud
n = 4 4800 baud

Example: SR4 set baud rate to 4800
(remember to press Function Key 7 to switch TERM25 to the new baud rate)

<u>IR(CR)*^C</u> Initialize memory: **WARNING, ALL DATA WILL BE DESTROYED!** All data bits are set to 0. Sample number, header number and data pointers, are set to 0. Memory initialization is optional, as SEALOGGER will write over previously recorded information when the gl command (see below) is used. Knowledge of the initial memory contents (i.e., all zeros) can be a useful cross check when data is retrieved.

<u>QS(CR)</u> Quit session. Puts SEALOGGER in quiescent mode (50 microamps). Use this command and then wait 3 seconds before turning on the magnetic switch.

5-3.4 LOGGING

Data logging can occur in one of two modes, Normal and Standby.

NORMAL MODE

In Normal Mode real time HEX data is transmitted when the switch is turned ON while the CTD is in the quiescent state or when the RL or GL commands are entered at the S> prompt while the switch is ON. The pump and external power are turned on 50 seconds after the conductivity frequency is greater than the minimum set with the 'CC' configure CTD command. The header is written when the first data point is stored.

Setting the magnetic switch to the OFF position ends the cast and puts the SBE 25 into quiescent mode. Pressing the HOME key in TERM25 ends the cast and leaves the SBE 25 active.

STANDBY MODE

In Standby Mode real time HEX data is transmitted when the SB command is entered at the S> prompt. A cast is initiated when ever the magnetic switch is set to the ON position. The pump and external power are turned on 50 seconds after the conductivity frequency is greater that the minimum set with the CC command. The cast header is written when the first data point is stored.

Setting the magnetic switch to the OFF position ends the cast but does not halt transmission of HEX data or power off the SBE 25.

Multiple casts can be acquired in Standby mode by turning the magnetic switch OFF for a minimum of 2 seconds. The next cast will begin once the switch has been turned back ON and the conductivity frequency has been greater than the minimum for 50 seconds.

The Sealogger CTD will remain in Standby Mode drawing power from the batteries until the HOME key or Ctrl-Z is pressed. **Failure to exit Standby Mode will result in the rundown of the main battery supply.**

The Standby mode is designed for work where there are repetitive short casts. In Normal Mode power to the auxiliary sensors is turned off at the end of each cast. In the cast of Dissolved Oxygen which has a warmup time of approximately 2 minutes this may not be desirable when casts are made in rapid succession.

<u>IL(CR)*</u> Initialize logging. Use this command to reset data pointers and the cast number **after existing data has been removed from SEALOGGER** and prior to recording new data. Then send the QS command and then wait at least 3 seconds. Then when the magnetic switch is turned on, recording will begin immediately. The first time the switch is turned on after receipt of the IL command the data recording will start at the beginning of memory and any previously recorded data will be written over, whether the memory has been initialized or not. When the switch is subsequently turned off, recording will stop. Each time the switch is turned on again, recording will continue with new data stored after the previously recorded data and a new header written to indicate the time, date, incremented cast number and sample numbers contained in the cast. Up to 100 casts may be taken until the memory is full.

<u>GL(CR)*</u> Go log. Start logging data. For this command to work the magnetic switch must be on. The first scan is set to 0 so any previously recorded data will be written over, whether the memory has been initialized or not. This command is useful for laboratory testing of SEALOGGER.

<u>RL(CR)*</u> Resume logging data. Same as gl command except that the sample number is not reset. Previously recorded data will not be over-written.

<u>SB(CR)*</u> Start Standby Mode. Real time HEX data will be started. The pump and external power will be switched on 50 seconds after the switch is turned ON and the conductivity is greater than the minimum set with the CC command. Multiple casts may be obtained by turning the magnetic switch OFF for a minimum of 2 seconds. HOME or Ctrl-Z exits standby mode. **Failure to exit Standby Mode will result in the rundown of the main battery supply.**

5-3.5 STOP LOGGING

NORMAL MODE

Turn off the magnetic switch will terminate the cast and data logging. Logging may also terminated by sending a NULL character (CONTROL Z or HOME KEY in TERM25) character to SEALOGGER.

STANDBY MODE

Turning off the magnetic switch will terminate the cast but data logging and the real time transmission of HEX data will continue until the HOME key or Cntrl-Z is used to exit Standby mode.

5-3.6 DATA RETRIEVAL

DC[n](CR) Display raw data from cast n using the standard baud rate. If n is omitted, data from cast 0 displayed. The first line consists of 'Y' (valid cast number) or 'N' (invalid cast number). Subsequent lines have the format described in section 4-1.

Example: DC1(CR) SEALOGGER will send:

Y Valid cast number
aaaaaaaaaaaaaaaaaaaaaa
bbbbbbbbbbbbbbbbbbbbbb
aaaaaaaaaaaaaaaaaaaaaa scan 0 data
bbbbbbbbbbbbbbbbbbbbbb scan 1 data

DA[n](CR) Same as DC except that data will be displayed at 38400 baud.

DB[n](CR) Same as DC except that data will be displayed at 9600 baud.

DE[n](CR) Same as DC except that data will be displayed at 19200 baud.

DD[[n1],n2](CR)^C Raw data is displayed in HEX. If n1 and n2 are omitted logged data is displayed. If only n1 is entered data for sample n1 is displayed; n1,n2 displays samples n1 through n2. The format is described in section 2-3.

Example: DD100(CR) SEALOGGER will send: (standard system)

aaaaaaaaaaaa scan 100 data

Note: the DD command is primarily used for test and trouble diagnosis. Use the DC command for routine data extraction.

DH[[n1],n2](CR)^C Display headers. If n1 and n2 are omitted all headers are displayed. If only n1 is entered, header number n1 is displayed. Entering n1 and n2 displays headers n1 through n2.

A new header is written when data logging is started or resumed.

Example: DH(CR) SEALOGGER will send:

cast N MM/DD HH:MM:SS samples X to Y nv = V avg = A stp = ZZZ

N	cast number	
MM/DD HH:MM:SS	month, day, hour, minute and second read from real time clock when this cast was initiated.	
X	first sample in this cast	
Y	last sample in this cast	
V	number of external voltages sampled in this cast	
A	number of scans averaged for this cast	
ZZZ	reason logging halted:	
	batfail	battery voltage too low
	switch off	magnetic switch turned off
	recv cmd	received NULL or CNTL Z character
	timeout	error condition
	unknown	error condition
	??????	error condition

Sample: DH(CR)

cast 0 11/05 08:01:15 samples 0 to 3540 nv = 3 avg = 1 stp = recv cmd
cast 1 11/05 12:30:33 samples 3541 to 8795 nv = 3 avg = 4 stp = recv cmd
cast 2 11/05 15:45:11 samples 8795 to 10816 nv = 3 avg = 8 stp = switch off

6-1 BATTERY INSTALLATION

Unthread the battery compartment end-cap (this is the end cap without any connectors on it). If using a nickel-cadmium battery pack, the AC charger can be connected to the red and black pin jacks without further disassembly (plug the charger into the AC socket before connecting the pins). To replace alkaline 'D' cells (or loose nickel-cadmium cells), remove the three phillips-head machine screws from the battery retainer plate immediately inside the pressure housing. If loose cells have been installed, the battery retainer plate can be lifted clear and the cells dumped out. If your unit has a nickel-cadmium battery pack, the entire pack may be lifted free once the 3 screws have been removed.

Batteries are installed with the + terminal against the flat battery contacts, and the - terminal against the spring contacts. Insert a new nickel-cadmium pack or drop the new loose batteries into their respective slots. Align the retainer plate so that the flat and spring contacts are over the + and - battery contacts respectively, and re-install the plate. **These screws must be fully tightened or else the battery power to the circuitry will be intermittent**. Check the 'O'-ring(s) and their mating surfaces and rethread the battery compartment end cap. Run TERM25 and use the DS command to confirm that battery voltage is correct (approximately 13.5 volts with fresh alkaline batteries, 11.2 volts with nickel-cadmium types).

If changing from one type of battery to another, run 'CC' (see Section 5-3) and enter the A or N (for alkaline or nickel-cadmium) as appropriate.

6-2 STORAGE

Unless another cast is to be performed immediately, hose down the CTD with fresh water. Disconnect the Tygon tubing between pump and conductivity sensor, and loop a length of tubing containing deionized water from end to end of the cell. If the CTD has an oxygen sensor, there should be a loop containing a small amount of water around that sensor also.

6-3 PROTECTION FROM GALVANIC CORROSION

SEALOGGER CTDs for 3400 or 6800 meter depths have aluminum housings which are insulated from the stainless steel guard cage, and from the sea cable power circuits. This insulation is important to prevent heavy corrosion of the housing, and other direct attachments of metal objects to the CTD housing must be avoided.

Auxiliary equipment powered from all Sea-Bird CTDs (including those with plastic housings) should ideally also have a 'floating' housing relative to their power circuits. In many cases, it is permissible to have the CTD power and/or signal common lines connected to the auxiliary housing. However, it is mandatory that the auxiliary equipment housing not be connected to the CTD's - 10.5 volt power source as this can damage the platinized surfaces of the conductivity cell electrodes.

6-4 MAINTENANCE

The most important element in the effective maintenance of the Sea-Bird CTD (or most any other oceanographic instrument) is to avoid storing the unit wet with salt water, or in a salt-spray environment. Additional steps which will increase the life of the CTD are outlined below.

6-4.1 CORROSION PRECAUTIONS

Aluminum units have a large zinc anode screwed into the lower end cap of the underwater unit main housing. This anode should be checked from time to time to see that it is securely fastened, and that it has not been eaten away. All the stainless steel screws used on the underwater unit and which are exposed to salt water have been generously lubricated with NEVER SEEZ Blue Moly (available through marine hardware stores). After a cruise, it would be a good idea to remove these screws and re-lubricate them with a similar compound. This compound is electrically conductive, so care should be used not to get it on circuit boards. The modular sensors have ring-shaped anodes which should be checked and replaced if seriously depleted.

The underwater unit should be hosed down with fresh water after use and dried with a clean rag prior to storage.

Periodic (yearly) cleaning of the entire housing surface and will prevent long-term breakdown of the hard-coated surface.

6-4.2 CONNECTOR MATING AND MAINTENANCE

Mated connectors do not require periodic disassembly or other attention. Connectors that are unmated should be inspected for signs of corrosion product around the pins. When remating, apply a light coating of silicon grease (Dow Corning DC-4 or equal) around the shoulder 'O'-ring area of the bulkhead connector. Grasp the female rubber-molded connector firmly, and press it straight down on to the bulkhead, noting the alignment of the large pin with the raised nub on the side. Squeeze the mated connector to force out any entrapped air. **Failure to eject entrapped air can cause the connector to leak**.

6-4.3 CONDUCTIVITY CELL STORAGE

When possible, keep the conductivity cell in deionized water during periods of non-use by looping a length of water-filled Tygon tubing end to end. It is normally not necessary to do any cleaning of the conductivity cells during a cruise, unless you have evidence that the sensors have been fouled by passing through an oil slick on surface of the water, for example. If it is not practical to leave the conductivity cell stored with deionized water in it (due to the danger of freezing, for example) merely rinse the cell with deionized water after each use (to remove salt water), then blow lightly through the cell to insure that no water is trapped inside. This is easily done using the Tygon tubes supplied. Loop the tubing end to end of the cell to keep out airborne contaminants. If the cell has been stored dry, wet with a 1% solution of Triton X100 (or other non-ionic detergent) before use.

The Triton solution is also an effective cleaner for cells that have been exposed to oil slicks or mild biologic fouling. Do not use organic solvents (especially alcohol) for cell cleaning.

7-1 SENSOR CALIBRATION

Sea-Bird sensors are calibrated by subjecting them to known physical conditions, and measuring the sensor responses. Then coefficients are computed which may be used with appropriate algorithms to obtain engineering units. The conductivity and temperature sensors on SEALOGGER CTD are supplied fully calibrated, with coefficients as printed on their respective Calibration Certificates.

SEALOGGER CTD may be returned to Sea-Bird for calibration through the Northwest Regional Calibration Center, sent directly to NRCC, or calibrated using standard laboratory equipment and methods. If the latter two approaches are elected, Sea-Bird can supply software for coefficient generation.

Because temperature is varied to yield a wide range of conductivities from baths of just two salinities, performance of a conductivity calibration on SEALOGGER CTD will always yield a temperature calibration as well.

If SEALOGGER CTD is recalibrated, run SEACON and enter the new calibration coefficients in response to the menu prompts.

7-1.1 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 will output 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; the effect is to change the cell geometry resulting in a shift in cell constant. A second drift mechanism is associated with change in the quality of the platinized electrodes, and this effect is also induced by fouling. Accordingly, the most important determinant of long-term sensor accuracy is the state of cleanliness of the cell, and it is for this reason that storage in deionized water is suggested.

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

7-1.2 TEMPERATURE SENSOR CALIBRATION

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

8-1 O-RING SIZES

O-RING SIZES (600 METER CASE SEALOGGER)

Battery end-cap (piston) seal: Parker 2-234N674-70

Sensor end-cap (piston) seal: Parker 2-233N674-70

I/O bulkhead connector: Parker 2-017N674-70

Sensometrics adapter: Parker 2-019N674-70

O-RING SIZES (3400 METER CASE SEALOGGER)

Battery end-cap (piston) seal: Parker 2-234N674-70

Sensor end-cap (piston) seal: Parker 2-233N674-70

I/O bulkhead connector: Parker 2-017N674-70

Sensometrics seal: Parker 3-904N674-70

O-RING SIZES (6800 METER CASE SEALOGGER)

Battery end-cap (piston) seal: Parker 2-234N674-70

Battery end-cap (face) seal: Parker 2-153N674-70

Sensor end-cap (piston) seal: Parker TP-033

I/O bulkhead connector: Parker 2-017N674-70

Sensometrics seal: Parker 3-904N674-70