

SEACAT SBE 19

CONDUCTIVITY, TEMPERATURE, DEPTH RECORDER

OPERATING MANUAL

SEA-BIRD ELECTRONICS, INC.

1808 136th Place NE
Bellevue, Washington 98005 USA

Phone: (425) 643 9866

Fax: (425) 643-9954

Telex: 292915 SBEI

email: seabird@seabird.com

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SBE 19 SEACAT PROFILER

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ver 19.20 This manual is intended to be used with SBE 19 SEACAT PROFILERS with firmware versions 3.1d and above or versions 4.0b and above.

1-1 INTRODUCTION

The SBE 19 SEACAT Profiler is designed to measure electrical conductivity, temperature, and pressure in marine or fresh water environments to depths up to 10,500 meters. The standard SEACAT Profiler will operate in two modes, profiling and moored. Profiling mode is designed for applications where vertical profiles of the measured parameters are required. In profiling mode, the sample rate can be varied from twice a second to once every 4 minutes in half-second increments. Moored mode provides a means of acquiring time series measurements at sample rates of once every 15 seconds to once every 8 hours, adjustable in one-second increments.

Self-powered (9 D-size alkaline batteries provide 26 hours operation in profiling mode) and self-contained, the SBE 19 features the proven Sea-Bird conductivity and temperature sensors and a precision semiconductor strain-gauge pressure transducer. The 1024K byte CMOS static RAM will record 24 hours of conductivity, temperature, and pressure data while sampling at two scans per second (48, 96, or 192 hours with optional 2, 4, or 8 megabyte memories). Set-up, check-out, and data extraction are performed without opening the housing. Simultaneous real time monitoring is possible using the SEACAT Profiler's two wire RS-232C transmit capability. Sea-Bird's powerful SEASOFT CTD software derives salinity, density, sound velocity, and other ocean parameters from stored CTD values and may be used for data analysis, plotting, and archiving. External sensors may be powered and their frequency or voltage outputs acquired by the SBE 19.

Standard SEACAT Profilers are supplied with 1024K byte memory, 600 meter capability plastic housings, SBE 5M submersible pump for pumped conductivity, a second bulkhead connector wired for 4 single ended auxiliary A/D inputs, and alkaline batteries.

SEACAT Profiler options include:

- aluminum or titanium housings for use to 3400, 6800, or 10500 meters
- 2, 4, or 8 megabyte memories
- internal optical isolation and cable drivers for real time telemetry over cables up to 7000 meters long
- 2 differential input, 4 auxiliary A/D channels
- sensors for dissolved oxygen, pH, fluorescence, light (PAR), light transmission, and turbidity
- SBE 5T submersible pump for use with dissolved oxygen and/or pumped fluorometer sensors

The SEACAT Profiler can be used with the SBE 32 Carousel Water Sampler and the SBE 33 Carousel Deck Unit. The SBE 32 Carousel provides +15 VDC power to the SBE 19 and has ample power available for auxiliary sensors not normally supported by battery-powered CTDs. The CTD data from the SEACAT Profiler is converted into single wire telemetry for transmission over long (10,000 meter) seacables. Bottles may be closed at any depth without interrupting CTD data via software control using the SEASAVE program or from the front panel of the SBE 33 Deck Unit.

Also available for use with the SEACAT Profiler is the SBE 36 CTD Deck Unit and PN 90227 Power Data Interface Module (PDIM). These items provide real time power and data handling capabilities over single conductor seacables using the same method as employed in the SBE 32/SBE 33 Carousel Water Sampler. The PDIM is a small pressure housing that is mounted on or near the CTD. It provides +15 VDC power to the SEACAT Profiler and interfaces two way RS232 communications from the SEACAT Profiler to the telemetry used on the seacable.

1-2 FUNCTIONAL DESCRIPTION

1-2.1 SENSORS

SEACAT embodies the sensor elements (Pyrex cell and pressure-protected thermistor) and Wein-bridge oscillator interface technique previously employed in Sea-Bird's modular SBE 3 and SBE 4 sensors, but differs in using multiplexing to allow a single oscillator to service both temperature and conductivity measurements.

The pressure sensor is either a Paine strain-gauge sensor or a Paroscientific Digiquartz pressure sensor.

1-2.2 SENSOR INTERFACE

Temperature or conductivity dependent variable frequencies generated by the Wein-bridge are acquired (digitized) using a hybrid period counting technique (AP Counter) like that used in the Sea-Bird SBE 9 CTD. The AP Counter determines integer and fractional cycles of the variable frequency during a fixed time interval of 0.125 seconds (this period, and therefore the count accuracy, is determined using a precision quartz TCXO). The resulting count is offset and scaled in preparation for storage in CMOS static RAM. Drift associated with changes in ambient temperature or component aging is compensated in SEACAT by switching stable resistors (Vishay types) into the Wein-bridge oscillator once per minute. The resulting frequencies (representing the approximate upper and lower frequency limits of the oscillator) are measured and used to correct circuit drift. Consequently, the accuracy of SEACAT electronics is limited principally by the stability of the Vishay resistors and time-base quartz crystal.

The strain gauge pressure sensor is operated as a DC bridge. The amplified sensor output signal is acquired by a 12-bit plus sign A/D converter providing an effective resolution of 0.015%.

1-2.3 REAL-TIME CLOCK

To minimize battery current drain, a low power 'watch' crystal is used as the real-time-clock frequency source. Initial error, ambient temperature-induced drift, and aging of the 'watch' crystal is compensated by measuring its actual frequency against the TCXO each time SEACAT Profiler powers up. The measured discrepancy (if any) is used to arithmetically correct the low power clock.

Clock power is supplied by the main battery or the internal lithium back-up, depending on which voltage is higher. Even a 'dead' main battery will usually supply the very small clock power drain (less than 60 microamperes), so the back-up cells will last indefinitely.

1-2.4 MEMORY

Memory consists of eight low standby-power CMOS static 128K X 8 RAM chips. Each recorded CTD scan contains 6 bytes of data (standard units), and 4000 bytes are reserved for scratch-pad use, including storage of header information containing cast number (up to 150 casts), time/date, and beginning and ending sample number for the cast. SEACAT Profiler sample capacity may be predicted by use of the following relationships:

M = memory size 1,048,576 bytes (1024K memory)

Z = scratch-pad reserved area, approximately 4000 bytes

B = bytes per scan (6 in a standard system)

$S = \# \text{ scans recorded (samples)} = (M - Z) / B$

For the standard 1024K version, the memory can hold approximately 174,000 samples of C, T, and P.

Either the lithium back-up or the main battery (whichever has the higher voltage) will keep the memory intact. The main battery may be replaced without disturbing the memory contents.

1-2.5 MAGNETIC REED SWITCH

A magnetic switch is mounted on the conductivity cell guard. When SEACAT Profiler is quiescent (the CPU is not active) and set to profiling mode, sliding the switch to the 'on' position switches on power to the CPU. If the battery voltage is greater than 7.2 volts and there is room in memory for data, SEACAT Profiler will write a header containing real time and cast number, and begin storing CTD data in memory. When the magnetic switch is pushed to the 'off' position, SEACAT Profiler will quit logging data and enter its low power quiescent mode. The magnetic switch should be off (towards the connector end cap) when the SEACAT Profiler is not logging CTD data, i.e., during storage, set-up and diagnostic interrogation, or data extraction.

Operation of the magnetic switch while in moored mode has no effect.

1-2.6 DATA I/O

SEACAT Profiler 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 (1200 baud with optional Paroscientific pressure sensor), 7 data bits, 1 stop bit, and even parity. SEACAT Profiler RS-232 levels are directly compatible with standard serial interface cards (IBM Asynchronous Communications Adapter or equal). The communications baud rate can be changed to alternate values using the SBn command as documented in section 2-2.6.

1-2.7 BATTERIES

A standard SEACAT Profiler uses 9 'D'-cell alkaline batteries or rechargeable nickel cadmium batteries. If necessary, carbon-zinc or mercury cells can also be used, but **lithium 'D' cells with their higher terminal voltages must not be used.** On-board lithium batteries (non-hazardous units which are unrestricted for shipping purposes) are provided to backup the memory and the real time clock in the event of main battery failure or exhaustion. An auxiliary power source (10 - 15 volts DC) may be connected to the main I/O bulkhead to permit testing and data retrieval without affecting battery capacity on those units that do not have the optional optical isolation installed. The main batteries may be replaced without affecting either the real-time clock or memory.

1-2.8 HOUSING AND MECHANICAL DESIGN

The SEACAT Profiler main housing is a cylindrical pressure vessel having an outside diameter of 99 mm (3.9 inches) and flat end-caps. The sensor end cap is retained by a bolt-circle, while the battery end-cap is threaded on.

Main seals are single piston 'O'-rings grooved into the end caps. Aluminum-housed SEACAT Profilers are hard-coat anodized and designed for use to depths of 3400 or 6800 meters; titanium housings are used for up to 10,500 meters. The aluminum housings employ anodes for corrosion protection.

1-3 SPECIFICATIONS

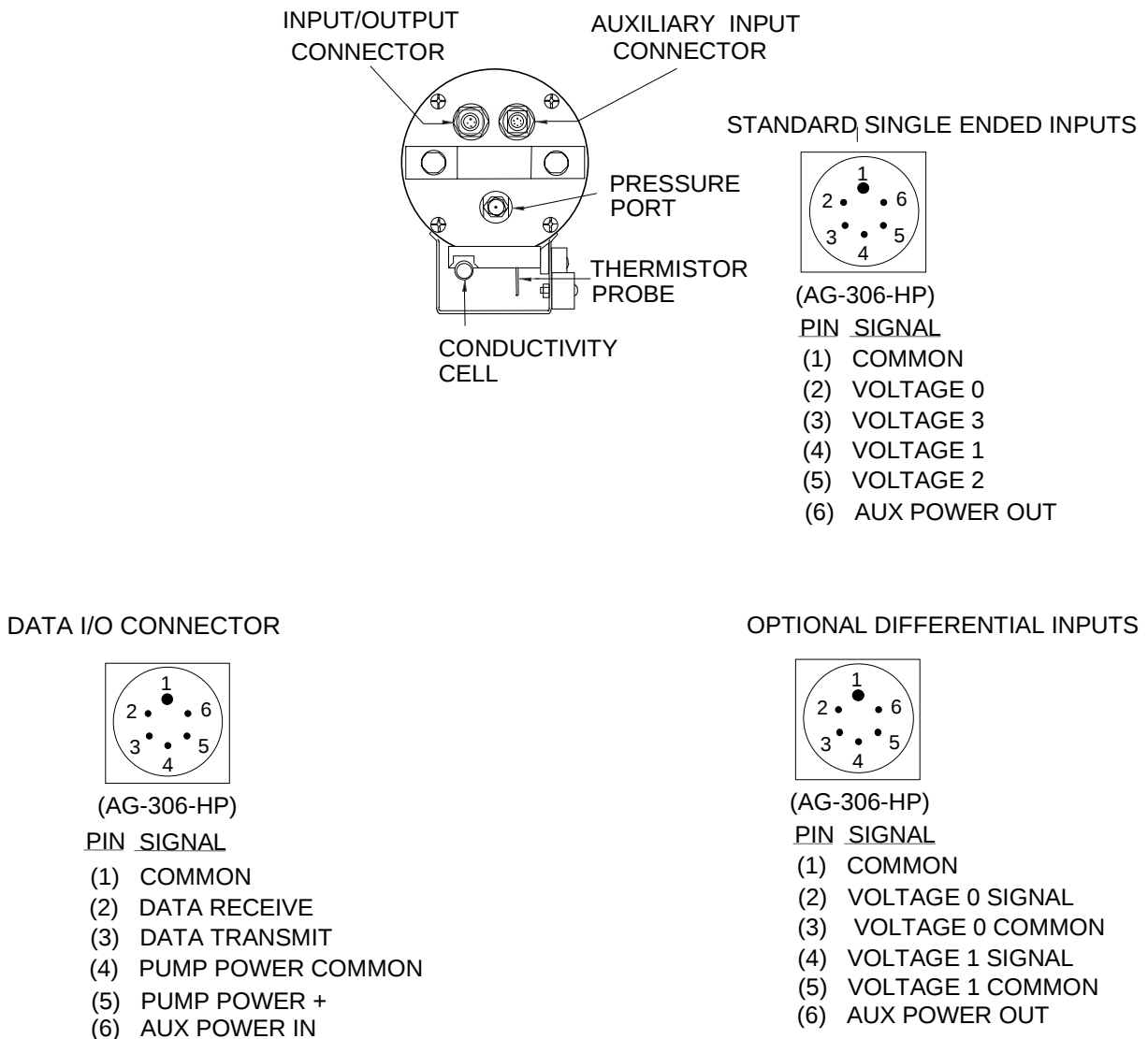
Measurement Range:	Temperature	-5 to +35 °C
	Conductivity	0 to 7 S/m (0 to 70 mmho/cm)
	Pressure	
	<i>Strain Gauge Sensor</i>	100, 150, 300, 500, 1000, 1500, 3000, 5000, 10000, or 15000 psia
	<i>Digiquartz Sensor</i>	100, 200, 300, 400, 1000, 2000, 3000, 6000, 10000, or 15000 psia
Accuracy:	Temperature	0.01 °C/6 months
	Conductivity	0.001 S/m/month
	Pressure	
	<i>Strain Gauge Sensor</i>	0.25% of full scale range (100 - 1500 psia) 0.15% of full scale range (3000 - 15000 psia)
	<i>Digiquartz Sensor</i>	0.02% of full scale range
Resolution:	Temperature	0.001 °C
	Conductivity	0.0001 S/m
	Pressure	
	<i>Strain Gauge Sensor</i>	0.015% of full scale range (100 - 15000 psia)
	<i>Digiquartz Sensor</i>	0.001%
Sensor Calibration:	Temperature	-1 to +31 °C (measurements outside this range may be at slightly reduced accuracy due to extrapolation errors)
	Conductivity	0 to 7 S/m. Physical calibration over the range 1.4 - 6 S/m. Measurements outside this range may be at slightly reduced accuracy due to extrapolation errors.
	Pressure	0 to full scale in 20% steps
Counter time-base:	Quartz TCXO, ± 2 ppm per year aging; ± 2 ppm vs. temperature (-5 to +30 °C).	
Memory:	CMOS static RAM, 1024K or (optional) 2, 4, or 8 Mbyte; battery-backed for minimum 3 years data retention.	
Real-time clock:	Watch-crystal type 32,768 Hz; battery-backed for minimum of 1 year operation irrespective of condition of main battery. Corrected for drift and aging by comparison to SEACAT counter time-base.	
Batteries:	9 alkaline 'D'-cells provide 8 amp-hours at 20 °C (5 amp-hours at 0 °C) and 3 year data retention reserve.	
Materials:	600 Meter Pressure Case, acetal copolymer (plastic)	
	3400 Meter Pressure Case, 6061-T6 anodized aluminum	
	6800 Meter Pressure Case, 7075-T6 anodized aluminum	
	7000 Meter Pressure Case, 3AL-2.5V titanium	
	10500 Meter Pressure Case, 6AL-4V titanium	

2-1 CONFIGURATION OPTIONS

The SEACAT Profiler's standard configuration includes an externally mounted SBE 5M submersible pump, used to provide a constant flow rate through the conductivity cell. Optionally, if configured with a dissolved oxygen sensor, pumped fluorometer, or SEACAT T-C Duct, the more powerful SBE 5T pump is used. In either case, the pump is powered via a Y-cable connected to the 6-pin Data I/O bulkhead connector on the end cap. Two pins provide power for the pump; the remaining four pins are for communication and external power (Figure 1). The Y-cable has 2 branches: one connecting to the pump, and the other providing the connection to a computer with a 4-pin male connector (RMG-4-MP) (figure 2). If the Profiler is configured without a pump, it is supplied with a 6-pin to 4-pin adapter cable to connect the Y-cable to the computer.

The SEACAT Profiler can be configured with a wide range of auxiliary sensors. A second 6-pin bulkhead connector on the end cap serves as the input port for the auxiliary sensor signal voltages and provides power to the sensors (Figure 1).

Figure 1 Connector Congurations for the SEACAT Profiler.



The SEACAT Profiler is configured with the SBE 5 pump to insure a reliable flow of water through the conductivity cell and optional dissolved oxygen sensor regardless of descent rate. Figure 2 shows the plumbing arrangement of a CTD equipped with a pump. Sections 2-2.6 and 3-1.2 of this manual contains additional information on the configuration and operation of the pump.

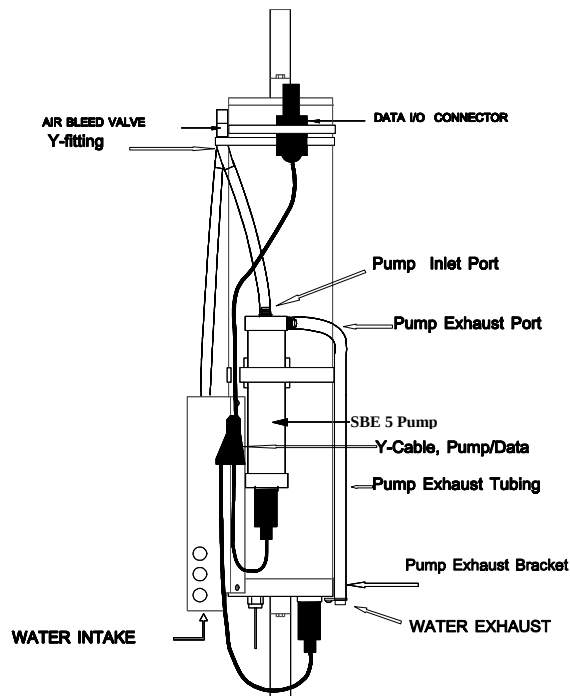


Figure 2 SBE 19 with SBE 5 pump

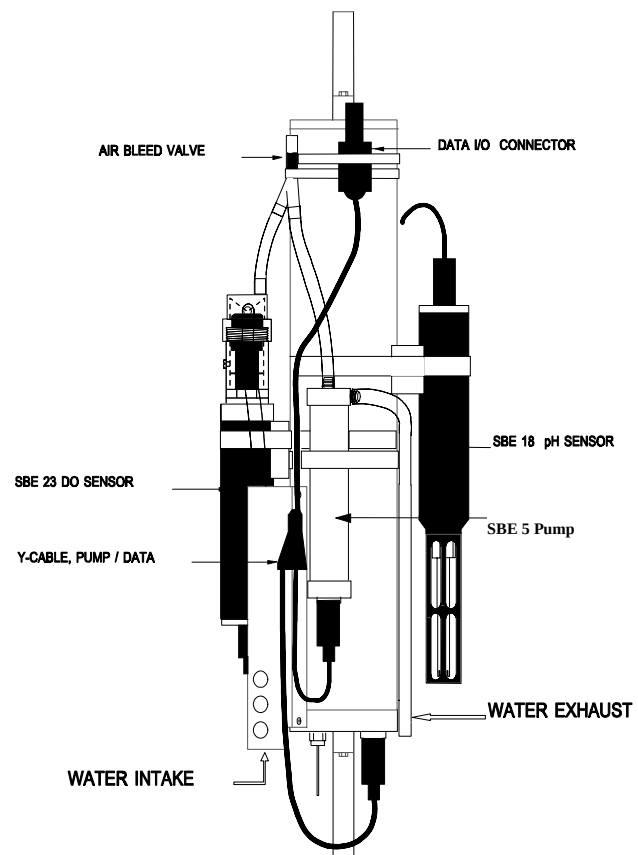


Figure 3 SBE 19 with pump, and optional dissolved oxygen and pH sensors

Figure 3 shows the SEACAT Profiler configured with the pump and the optional SBE 23 dissolved oxygen and SBE 18 pH sensors. Application note 29 included in this manual contains additional information concerning the configuration of the SEACAT Profiler with optional sensors.

2-2 SEACAT PROFILER COMMUNICATION FUNDAMENTALS

SEACAT Profiler is factory configured for: 600 baud (1200 baud with optional Paroscientific pressure sensor), 7 Data Bits, 1 Stop Bit, Even Parity. SEACAT Profiler outputs - and expects to receive - industry standard RS-232 levels. If the TERM19 program is used to communicate with the SEACAT Profiler use the F2 (function 2) key to set these parameters (see Section 2-5).

Remove the rubber cap from SEACAT Profiler's I/O bulkhead connector or from the I/O connector on the pump Y-cable by pulling it firmly upward. Install the Sea-Bird I/O cable connector, aligning the raised bump on the side of the connector with the large pin on the SEACAT connector. The other end of the I/O cable has a DB-25S for connection to your computer's serial port.

To begin communicating with SEACAT Profiler, the magnetic switch should be off. Mate the 4-pin test cable to the computer's serial port. If you are using Sea-Bird SEASOFT software, the serial port must be an IBM Asynchronous Communications Adapter, or equal. Run the TERM19 program and establish communications with the Profiler. SEACAT Profiler is now in command mode and may be queried for various responses as described in the following sections of this manual.

About two minutes of keyboard inactivity will cause SEACAT Profiler to time out and go into quiescent state. To regain control, press the enter or carriage return key (CR) several times until the **S>** is displayed again. After completing a session with SEACAT Profiler, enter **qs(CR)**. This will make SEACAT Profiler enter the quiescent state immediately.

If the board-mounted internal lithium battery has been removed, disconnected, or exhausted, set the date and time with the ST command, set the pump parameters with the SP command, and enable the acquisition of external voltages with the SV command if auxiliary sensors are installed.

2-2.1 COMMAND FORMAT

Commands to SEACAT Profiler can be entered in upper or lower case letters. Responses made by SEACAT Profiler are indicated in bold type. SEACAT Profiler will send # whenever an invalid command is entered.

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

Symbol	Description	ASCII	HEX	Key Sequence
(CR)	Carriage Return	CR	0D	Return
NULL	Null character	NULL	00	Home Key
^	Control Key	--	--	Ctrl
^C	Escape Function	ETX	03	Ctrl + C <u>or</u>
^C	Escape Function	ESC	1B	Esc

When running TERM19, the Esc Key must be used to perform the Escape Function.

- * Commands followed by * alter SEACAT Profiler 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.

2-2.2 EDITING

The following keys are used to edit entries to SEACAT Profiler.

Description	ASCII	HEX
Carriage return: 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

2-2.3 COMMAND SUMMARY

Type	Command	Description
Diagnostics	J	Measure standby current
	TE	Extended memory test
	TM	Memory test
	VR	Display voltages
	FR	Display frequencies
Status	DS	Display current status
Setup	CN	Set conductivity channel to narrow range (fresh water)
	CS	Set conductivity channel to standard range (salt water)
	IR	Initialize ram
	LW	Set time to pause after each line (0 is the default)
	MM	Set mode to moored
	MP	Set mode to profiling
	PN	Disable pump control logic
	QS	Quit session, enter quiescent state
	SB	Change default baud rate for communications and real time data
	SP	Enable and set pump control parameters
	SR	Set sampling rate (profiling mode)
	SI	Set sample interval (moored mode)
	ST	Set date and time
	SV	Set the number of external voltages to sample
	VD	Set time to delay before measuring voltages in moored mode
Logging	IL	Initialize logging
	GL	Start logging, overwrite existing data
	QL	Quit logging in moored mode
	RL	Resume logging, do not overwrite data
	HOME KEY or Ctrl-Z will halt logging in profiling mode	
Data Retrieval	DC	Dump data by cast
	DD	Dump data by scans
	DH	Display headers

2-2.4 DIAGNOSTICS

J(CR) Measure Standby current.

TE(CR)*^C Extended memory test. **WARNING, ALL DATA IN SEACAT PROFILER 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. Each pass takes approximately 20 seconds and the test concludes after 10 passes. For each pass SEACAT Profiler sends the following message:

pass x
ram 0, OK
ram 1, OK
ram 2, OK
etc.

At the test conclusion or when an Escape Function character is received, SEACAT Profiler displays:
ram test passed with no errors.

NOTE: TE command not available in Profiler firmware version 4.0b or greater.

TM(CR)*^C Memory test. **WARNING, ALL DATA IN SEACAT PROFILER WILL BE DESTROYED!** Same as extended memory test except that the test concludes after pass 0 is completed.
NOTE: TM command not available in Profiler firmware version 4.0b or greater.

VR(CR)^C Display voltages. The first column is the main battery voltage divided by 8.514. The second column is a voltage that represents the temperature in the pressure sensor The third column is the pressure sensor voltage. 0, 2 or 4 columns are added after the last column depending on how many external voltages are sampled.

CAUTION: After execution of the VR command, SEACAT will run continuously until the Escape Function is implemented. Unless an external power source is being used, the normal 170 mA current will be drawn from the battery during this time.

Example: VR(CR) SEACAT will send:

0.982 0.745 4.716

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

CAUTION: After execution of the FR command, SEACAT will run continuously until the Escape Function is implemented. Unless an external power source is being used, the normal 170 mA current will be drawn from the battery during this time.

Example: FR(CR) SEACAT will send:

aaaaa.aaa bbbbb.bbb ccccc.ccc ddddd.ddd eeeee.eee fffff.fff
aaaaa.aaa is the 400 ohm reference resistor frequency
bbbbb.bbb is the 5000 ohm reference resistor frequency
cccc.ccc is the frequency generated by the temperature sensor
dddd.ddd is the frequency generated by the conductivity cell
eeee.eee is the corrected temperature frequency
ffff.fff is the corrected conductivity frequency

2-2.5 STATUS

DS(CR) Display operating status: software version, serial number and current time; pressure sensor type, serial number, range and temperature compensation value for strain gauge sensors; real time clock frequency, operating current (milliamps), main battery voltage, lithium battery voltage; operating mode, number of stored casts; sample rate; 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); battery cut-off voltage; number of external voltages that are being sampled; and whether data is being logged or not (moored mode)

Example: DS(CR) SEACAT Profiler will send:

SEACAT PROFILER V3.1B SN 936 02/10/94 13:33:06.439
strain gauge pressure sensor: S/N = 12345, range = 1000 psia, tc = 240
clk = 32767.766 iop = 172 vmain = 8.1 vlith = 5.7
mode = PROFILE ncasts = 0
sample rate = 1 scan every 0.5 seconds
samples = 0 free = 174126 lwait = 0 msec
battery cutoff = 7.2 volts
number of voltages sampled = 0
logdata = NO

If the pump is installed and pump control is enabled via the SP command the pump control parameters will be displayed.

SEACAT PROFILER V3.1B SN 936 02/10/94 13:33:23.989
strain gauge pressure sensor: S/N = 12345, range = 1000 psia, tc = 240
clk = 32767.766 iop = 172 vmain = 8.1 vlith = 5.8
mode = PROFILE ncasts = 0
sample rate = 1 scan every 0.5 seconds
minimum raw conductivity frequency for pump turn on = 3206 hertz
pump delay = 40 seconds
samples = 0 free = 174126 lwait = 0 msec
battery cutoff = 7.2 volts
number of voltages sampled = 0
logdata = NO

In moored mode the voltage sample delay is displayed.

SEACAT PROFILER V3.1B SN 936 02/10/94 13:33:39.549
strain gauge pressure sensor: S/N = 12345, range = 1000 psia, tc = 240
clk = 32767.766 iop = 172 vmain = 8.2 vlith = 5.6
mode = MOORED
sample interval = 30 seconds
delay before measuring voltages = 4 seconds
samples = 0 free = 174126 lwait = 0 msec
battery cutoff = 7.2 volts
number of voltages sampled = 0
logdata = NO

If narrow range conductivity has been selected this is displayed in the header.

SEACAT PROFILER V3.1B SN 936 02/10/94 13:33:23.989
strain gauge pressure sensor: S/N = 12345, range = 1000 psia, tc = 240
Narrow Range Conductivity
clk = 32767.766 iop = 172 vmain = 8.1 vlith = 5.8
mode = PROFILE ncasts = 0
sample rate = 1 scan every 0.5 seconds
minimum raw conductivity frequency for pump turn on = 2000 hertz
pump delay = 40 seconds
samples = 0 free = 174126 lwait = 0 msec
battery cutoff = 7.2 volts
number of voltages sampled = 0
logdata = NO

2-2.6 SETUP

SEACAT Profiler functions both as a profiling instrument and a moored or time series instrument. The differences between these two modes involve how the data are stored and whether the SEACAT runs continuously or powers off between samples.

In profiling mode the instrument runs continuously, drawing the full operating current from the main battery supply. The unit samples at two samples per second. If the sample rate is set to a slower value, the unit continues to sample at two samples a second but only stores data at the specified rate. The longest period between samples is 4 minutes. Temperature and conductivity data are stored as uncorrected frequencies. The necessary reference frequencies to convert the data to corrected frequencies are stored every 120 samples. See Section 2-3 on data formats for additional information.

Commands that only affect profiling mode are:

PN	Disable pump control logic
SP	Set pump control parameters
SR	Set sampling rate
DC	Dump data by casts (see Section 2-2.9)

In moored mode the instrument powers down between samples. The fastest sample rate is once every 15 seconds. The default amount of time that SEACAT Profiler will provide power to external sensors before sampling them is 4.0 seconds. This value can be increased to a maximum of 32,000 seconds with the VD command for instruments such as the Sea Tech fluorometer that need a longer time to come to a stable value. In particular, dissolved oxygen sensors require between two and three minutes to polarize after application of power to the sensor. The voltage delay should be set to a minimum of 120 seconds and the sample interval to a minimum of 150 seconds if an oxygen sensor is installed. The pump will be powered for the entire time power is applied to the auxiliary sensors. The increased power going to pump will limit the number of samples that can be taken to between 350 and 400 when the voltage delay value is set to 120 seconds for an oxygen sensor. The temperature and conductivity data are stored as corrected frequencies.

Commands that only affect moored mode are:

SI	Set sample interval
VD	Set time to delay before measuring voltages in moored mode

All SEACAT Profilers are built with the capabilities to record external voltages. If the instrument was ordered without auxiliary sensors, the number of voltages that the unit acquires was set to zero to conserve memory usage. The SV command is used to enable this function if an auxiliary sensor is added at a later date. Corresponding changes to the software configuration files also have to be made for the SEASOFT software to recognize this change

CN(CR) Set conductivity channel to narrow range (fresh water 0 - 0.6 S/m)
If narrow range is set the line 'Narrow Range Conductivity' will displayed in the status.

CS(CR) Set conductivity channel to standard range (salt water 0 - 6.5 S/m)

IR(CR)*^C Initialize RAM (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. Allow 1.5 minutes to reset the entire memory. Memory initialization is optional, as SEACAT Profiler will write over previously recorded information when the gl command (see below) is used. However, knowledge of the initial memory contents (i.e., all zeros) can be a useful cross check when data is retrieved.

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

MM(CR) Set mode to moored.

MP(CR) Set mode to profiling.

PN(CR) Disable pump control logic.

QS(CR) Quit session. Puts SEACAT Profiler in quiescent mode (50 microamps). Use this command and then wait 3 seconds before turning on the magnetic switch when in profiling mode.

SBn(CR) Change baud rate used by the SEACAT during normal communications.

Upon initial power up or reset the SEACAT Profiler 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 SEACAT 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 SEACAT until power is removed from the circuit boards (caused by disassembly or by using the reset switch located on the battery bulkhead) or until a new SB command is entered. The new baud rate is retained while the SEACAT is in quiescent mode between samples. This setting does not affect the baud rate controlled by the DD and DC commands for uploading data from the SEACAT.

The possible values are:

- n = 1 600 baud
- n = 2 1200 baud
- n = 3 9600 baud
- n = 6 4800 baud (firmware version 3.1d and above in the 3.0 series; not applicable to the 4.0 series)

Example: SB3 set baud rate to 9600

SP(CR) For the pump to prime properly at the surface, it is necessary for the pump and tygon tubing to be filled with water before the pump is turned on. This command sets the pump turn on parameters. You will be asked:

minimum raw conductivity frequency for pump turn on = xxxx new value =

Enter a new value to change the minimum frequency or press carriage return to accept the current value. The configuration sheet at the beginning of the manual lists the uncorrected (raw) frequency output at 0 conductivity. For most salt water and estuarine applications, enter the 0 conductivity frequency + 500 Hz (factory default) as the minimum frequency. For fresh water, 5 Hertz above the 0 conductivity frequency is typically used.

pump delay time (seconds) = xxx, new value =

Enter a new value to change the delay time or press carriage return to accept the current value. A value of 30 to 45 seconds should give ample time for the tygon tubing and pump to fill with water after the Profiler has been submerged.

The pump will start after the delay time, and after the conductivity cell's frequency output is greater than the minimum raw conductivity frequency. The pump will stop as soon as the raw conductivity frequency drops below the minimum.

See Data Format (Section 2-3) for details on computing raw conductivity frequency from HEX data.

SR(CR) Set sample rate as prompted for profiling mode.

Example: SR(CR) SEACAT Profiler will prompt:

number of 0.5 sec intervals between samples = 1
the sample rate is 1 scan every 0.5 seconds

The maximum allowable number of 0.5 second intervals between samples is 480 (4 minutes between samples).

SI(CR) Set sample interval as prompted for moored mode.

Example: SI(CR) SEACAT Profiler will prompt:

number of seconds between samples = 60

sample interval = 60 seconds

The minimum sample interval is 15 seconds, the maximum is 32000 seconds.

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.

SVN(CR) Set the number of external voltages to sample as prompted.

Example: SV2(CR) will set the number of voltages to acquire to 2.

The possible values are 0, 2, or 4 voltages.

Enter a new value that reflects the number of external voltages that are to be recorded through the 6-pin auxiliary connector on the end cap. If the number of voltages is changed, a corresponding change must be made in the software configuration files for the SEASOFT software to recognize the change.

VDN(CR) Set the time to delay before measuring external voltages in moored mode.

Example: VD11(CR) will add 11 seconds to the default value of 4.0 seconds.

The default and minimum value is 4.0 seconds. The maximum value is 32000 seconds. N is entered in seconds. If a Sea Tech Fluorometer is installed, N should be 11 seconds (delay of 15 seconds). If an oxygen sensor is installed, N should be a minimum of 116 seconds (delay of 120 seconds).

2-2.7 LOGGING

In profiling mode, data logging can be initiated by turning on the magnetic switch while the SEACAT Profiler is in the quiescent state or by using the GL or RL commands when the CPU is active and the magnetic switch is on. Turning on the magnetic switch while the CPU is active will not start logging. If the switch is left on when the unit is put in the quiescent state (either by using the QS command or by timing out), the unit will start logging when the next attempt to establish communications is made. Logging commences approximately 5 seconds after the movement of the switch or the receipt of the GL or RL command. 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. The maximum number of casts that can be taken is 100.

In moored mode, logging is initiated by using the GL or RL commands. The switch should be left in the off position, but has no effect on logging. If the switch is turned on while the SEACAT profiler is in the quiescent state and in moored mode, the CPU will enter the active state but logging will not begin. If no communications are established the unit will time out and enter the quiescent state after 3 minutes.

In both profiling and moored mode, data is transmitted real time at 600 baud (1200 baud if the optional Paroscientific Digiquartz pressure sensor is installed), or at the baud rate specified with the SB command.

If memory is filled to capacity, data logging and the transmission of real time data will continue, but excess data will not be saved in memory.

IL(CR)* Initialize logging. Use this command to reset data pointers and the cast number **after existing data has been removed from SEACAT Profiler** and prior to recording new data.

GL(CR)* Go log. Start logging data. For this command to work in profiling mode, 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 SEACAT Profiler when in profiling mode.

QL(CR) Quit logging data in moored mode. When logging data in moored mode, SEACAT Profiler will respond only to the DS, QS and QL commands. The QL command is given when communications have been established with SEACAT Profiler and the **S>** prompt is present.

RL(CR)* Resume logging data. Same as gl command except that the sample number is not reset. Previously recorded data will not be overwritten. In profiling mode a new cast is started. In moored mode data is stored after the last previously stored sample.

2-2.8 STOP LOGGING

In profiling mode, turn off the magnetic switch. Logging may also be terminated in profiling mode by sending a NULL character (CONTROL Z or HOME KEY in TERM19) to SEACAT Profiler.

In moored mode, logging is terminated by establishing communications with the SEACAT Profiler and sending the QL command.

2-2.9 DATA RETRIEVAL

In TERM19 data retrieval is determined by the set up of the configuration file. TERM19 communicates with the SEACAT Profiler using the following commands. The SEACAT Profiler is capable of transmitting stored data at the following baud rates:

B = 1	600 baud	B = 2	1200 baud
B = 3	9600 baud	B = 4	19,200 baud
B = 5	38,400 baud		

B is the number used below to specify to SEACAT Profiler what baud rate to use to dump data.

DC[Bn](CR) Display raw data from cast n at the baud rate determined by B. If n is omitted, data from cast 0 displayed. If B is omitted the default baud rate is used. The first line consists of 'Y' (valid cast number) or 'N' (invalid cast number). Subsequent lines have the format described in section 2-3. This command is valid for profiling mode only.

Example: DC11(CR) SEACAT Profiler will send at 600 baud

Y Valid cast number
aaaaaaaaaaaa scan 0 data, cast # 1
bbbbbbbbbbbbbb scan 1 data, cast # 1
.
.
nnnnnnnnnnnnnn scan n data, cast # 1, where n + 1 is the total number of scans of data stored in cast # 1

DD[B[n1],n2](CR)^C Raw data is displayed in HEX at the baud rate specified by B. If B, n1 and n2 are omitted all logged data is displayed at the default baud rate. Entering n1,n2 displays samples n1 through n2. The data format is described in section 2-3. This command is valid for both moored and profiling modes.

Example: DD(CR) SEACAT Profiler will send:

aaaaaaaaaaaa scan 0 data
bbbbbbbbbbbbbb scan 1 data
.
.
nnnnnnnnnnnnnn scan n data, where n + 1 is the total number of scans of data stored in SEACAT Profiler

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

A new header is written when data logging is started or resumed in profiling mode. In moored mode a new header is written when data logging is initiated and every 1000 samples thereafter.

Example: DH(CR) SEACAT Profiler will send (moored mode)

cast N MM/DD HH:MM:SS samples X to Y sample interval = NNN seconds stop = 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
NNN	is the sample interval
ZZZ	is the reason logging was halted

Possible values for ZZZ are:	batfail	battery voltage too low
	switch off	magnetic switch turned off
	recv cmd	received NULL or CNTL Z character, or QL command
	timeout	error condition
	unknown	error condition
	??????	error condition

In profiling mode the sample rate is shown as the number of scans every NNN seconds.

Sample: DH(CR) (in profiling mode)

cast 0 11/05 08:01:15 samples 0 to 3540 sample rate = 1 scan every 0.5 seconds stop = recv cmd
cast 1 11/05 12:30:33 samples 3541 to 8795 sample rate = 1 scan every 0.5 seconds stop = recv cmd
cast 2 11/05 15:45:11 samples 8795 to 10816 sample rate = 1 scan every 0.5 seconds stop = switch off

2-3 DATA FORMAT

Data storage format in SEACAT Profiler varies depending on whether the instrument is in moored or profiling mode.

Data is retrieved from SEACAT Profiler and stored on the computer system in hexadecimal format using the program TERM19.

2-3.1 PROFILING MODE

Temperature and conductivity data are stored as uncorrected (raw) frequencies. The reference data that is used to convert to corrected frequencies is stored in the 5th and 6th scans. Subsequently, after every 120 scans two data scans are replaced by the two reference scans.

2-3.1.1 PAINE STRAIN GAUGE PRESSURE

Twelve ASCII HEX characters representing six bytes are transmitted per CTD scan. If two external voltages are sampled, 9 bytes will be transmitted. If four external voltages are sampled, 12 bytes will be transmitted. A carriage return and line feed follows the data from the last CTD scan.

The data format for CTD scans is:

aaaabbbbpppp

aaaa four HEX characters representing 2 bytes of temperature data
bbbb four HEX characters representing 2 bytes of conductivity data
pppp four HEX characters representing 2 bytes of pressure data

The data format for CTD plus two external voltages is:

aaaabbbbvvvvpppp

aaaa four HEX characters representing 2 bytes of temperature data
bbbb four HEX characters representing 2 bytes of conductivity data
vvv three HEX characters representing 12 bits of voltage data (V0)
vvv three HEX characters representing 12 bits of voltage data (V1)
pppp four HEX characters representing 2 bytes of pressure data

The data format for CTD plus four external voltages is:

aaaabbbbvvvvxxxxpppp

aaaa four HEX characters representing 2 bytes of temperature data
bbbb four HEX characters representing 2 bytes of conductivity data
vvv three HEX characters representing 12 bits of voltage data (V0)
www three HEX characters representing 12 bits of voltage data (V1)
xxx three HEX characters representing 12 bits of voltage data (V2)
yyy three HEX characters representing 12 bits of voltage data (V3)
pppp four HEX characters representing 2 bytes of pressure data

Temperature:

1. $T = \text{decimal equivalent of } aaaa$
2. Raw temperature frequency = $T / 17 + 1950$

Standard Conductivity:

1. $C = \text{decimal equivalent of } bbbb$
2. Raw conductivity frequency = $\sqrt{C * 2900 + 6250000}$

Narrow Range Conductivity:

1. C = decimal equivalent of bbbb
2. Raw conductivity frequency = $\sqrt{C * 303 + 6250000}$

Voltage:

1. V = decimal equivalent of uuu, vvv, xxx, or yyy
2. Volts = $V / 819$;

Pressure:

1. P = decimal equivalent of bits 0 through 13 of pppp. Bit 14 is the sign bit. If bit 14 is 0 the number is positive, if it is 1 the number is negative.
2. Pressure number = P;

If the most significant bit of pppp is a 1, then the CTD scan contains reference resistor frequency information.

The data format for references is:

xxrrrrrrpppp

if xx = 05 then the scan contains high frequency reference data and the conductivity range is Standard

if xx = 08 then the scan contains high frequency reference data and the conductivity range is Narrow Range

if xx = FF then the scan contains low frequency reference data

pppp is pressure data as described above

rrrrrr is the reference data

If external voltages are recorded they will appear between rrrrrr and pppp as described above.

High frequency reference frequency is the decimal equivalent of rrrrrr / 256.

Low frequency reference frequency is the decimal equivalent of rrrrrr / 256.

The references are read and stored every 120 samples.

Example:

scan 117 = 69CC43220EA4

scan 118 = 052A34398EA5

scan 119 = FF0B45808EA4

scan 120 = 69CE431E0EA5

scan 117 (CTD):

aaaa = 69CC, T = 27084, temperature frequency = 3543.177

bbbb = 4322, C = 17186, conductivity frequency = 7489.286

pppp = 0EA4, P = 3748, pressure number = 3748

scan 118 (High frequency reference)

xx = 05

rrrrrr = 2A3439, Refhi = 10804.225

pppp = 8EA5, P = 3749, pressure number = 3749

scan 119 (Low frequency reference)

xx = FF
rrrrr = 0B4580, Reflow = 2885.500
pppp = 8EA4, P = 3748, pressure number = 3748

scan 120 (CTD):

aaaa = 69CE, T = 27086, temperature frequency = 3543.177
bbbb = 431E, C = 17182, conductivity frequency = 7488.511
pppp = 0EA5, P = 3749, pressure number = 3749

The reference data is used to compute the corrected temperature and conductivity frequencies.

The algorithm for computing the corrected frequencies is:

fraw = raw frequency (input to correction algorithm)
fcor = corrected frequency (algorithm output)
fthisq = Refhi * Refhi
flowsq = Reflow * Reflow

$$fcor = \sqrt{\{[(fraw * fraw) - b] / a\} - PC}$$

where:

$$a = (fthisq - flowsq) / X3$$
$$b = flowsq - (a / X2)$$

using the following constants:

$$KK = 2.4018669e-11$$
$$X1 = 9.6036247e-9$$
$$X2 = 1.1949587e-7$$
$$X3 = (X2 - X1) / (X2 * X1)$$
$$PC = 1 / (1e6 * KK)$$

Use the corrected values for temperature frequency and conductivity to convert to temperature and conductivity according to the sensor calibration certificates.

2-3.1.2 PAROSCIENTIFIC DIGIQUARTZ PRESSURE SENSOR

18 ASCII HEX characters representing 9 bytes are stored per CTD scan. A carriage return line feed follows the data from the last CTD scan.

The data format for CTD scans is :

aaaabbbbppppppcccc

aaaa = four HEX characters representing 2 bytes of temperature data

bbbb = four HEX characters representing 2 bytes of conductivity data

pppppp = six HEX characters representing 3 bytes of Digiquartz pressure data

cccc = four HEX characters representing 2 bytes of pressure temperature data

The SEACAT has the capability to record up to four external voltages. If enabled, the voltage data will appear between the pressure and the pressure temperature data.

The data format for temperature, conductivity and external voltages is the same as for the strain gauge pressure sensor.

Pressure (Digiquartz):

1. P = decimal equivalent of pppppp
2. Pressure frequency = $P / 256.0$

Pressure Temperature:

1. C = decimal equivalent of cccc
2. Pressure Temperature Voltage = $C / 819.0$
3. Pressure Temperature = $(\text{Voltage} + 9.7917) * 23.6967 - 273.15$ (degrees Centigrade)

EXAMPLE

aaaabbbbppppppuuuvvvcccc = 69CC432268D1B8003005908AA

aaaa = 69CC, T = 27084, Temperature Frequency = 3525.474

bbbb = 4322, C = 17186, Conductivity Frequency = 6506.970

pppppp = 8D1B80, P = 9247616, Pressure frequency = 36123.5

uuu = 030, V0 = 48, Voltage 0 = 0.059

vvv = 059, V1 = 89, Voltage 1 = 0.109

cccc = 08AA, C = 2218, Pressure Temperature = 23.0

2-3.2 MOORED MODE

Moored mode temperature and conductivity data are stored as corrected frequencies. The reference information is not stored with the data. Otherwise, the data format is the same as profiling mode except for the conversion of temperature and standard range conductivity from hexadecimal numbers to decimal frequencies.

The correct scaling for moored mode temperature and standard range conductivity are:

Temperature:

1. $T = \text{decimal equivalent of } aaaa$
2. Temperature frequency = $T / 19 + 2100$

Standard Conductivity:

1. $C = \text{decimal equivalent of } bbbb$
2. Conductivity frequency = $\text{sqrt}(C * 2100 + 6250000)$

Narrow Range Conductivity:

1. $C = \text{decimal equivalent of } bbbb$
2. Raw conductivity frequency = $\text{sqrt}(C * 303 + 6250000)$

Use these values for temperature frequency and conductivity frequency to convert to temperature and conductivity according to the sensor calibration certificates.

The conversion of pressure and voltages are the same as profiling mode.

2-4 SEASOFT SOFTWARE CONFIGURATION FILES

The program TERM19 is used to communicate with and retrieve data from SEACAT Profiler. TERM19 creates the file TERM19.CFG to store its setup parameters so they do not have to be reentered every time. The file TERM19.CFG, with typical set-up parameters for using your SEACAT (assuming installation on C: drive) is included on the SEASOFT distribution disks that accompanied your SBE 19.

The program SEACON creates or modifies a file SEASOFT.CON, which is used by SEASOFT modules to obtain calibration coefficients and instrument configuration information. For new instruments this information was entered at the factory, and a correct copy of this file should have been included on the software distribution disks that accompanied your SBE 19. If the instrument is recalibrated or the configuration is changed (such as adding external sensors), SEACON must be run to either enter the new calibration information or to modify the instrument configuration settings.

Refer to the instrument "configuration page" and/or calibration certificates in this manual, and the SEASOFT software manual for additional information.

2-5 OPERATION USING TERM19

TERM19 is a terminal emulation program designed to communicate with SEACAT Profiler: characters typed on the keyboard are sent to SEACAT Profiler and characters sent by SEACAT Profiler are displayed on the console. TERM19 expects to find the file TERM19.CFG in the current directory.

SEACAT Profiler will automatically send ^S and ^Q characters if the computer does not keep up with the data sent by SEACAT Profiler.

The main terminal screen is shown below:

```
| SBE 19 Terminal Program 4.0          Thursday January 16, 1992 4:50 pm |
|
|  <F1> Help      <F2> Setup      <F3> Status   <F4> Headers  <F5> Capture
|  <F6> Wake Up   <F7> Baud Rate <F8> Init Log <F9> Upload  <F10> Exit
|
|
|
|
| <F1>Help <Ctrl-C>Halt Instr <Ctrl-F10 or Home>Stop Log Baud = 600  Capt = NO |
|
```

Press F2 and select Communication Set Up to set the COMM port and baud rate. Exit the Set Up form (press Esc) and press F6 to establish communications with the instrument. To abort the attempt to establish communications press the Esc Key.

Once communications have been established characters transmitted by the instrument will be displayed in the center portion of the main screen.

The active function keys are:

- | | |
|-----------|---|
| F1 | Display help screens. |
| F2 | Display the terminal set up form. |
| F3 | Display instrument status. |
| F4 | Display instrument headers. |
| F5 | Capture instrument responses to a file on disk (use F9 for data upload). |
| F6 | Reestablish communications with the instrument. The instrument will 'go to sleep' after two minutes without receiving any commands from the computer. |
| F7 | Change the baud rate. |
| F8 | Initialize logging. Reset the scan and cast pointers in the instrument to 0. Upload any data in the instrument before sending this command. |

- F9** Upload data from the instrument. The upload parameters are configured in the set up menu (Function Key 2).
- F10** Exit to DOS.
- Ctrl-C** Sends Ctrl-C to the instrument to halt the display voltages and display frequencies diagnostics.

Ctrl-F10 or Home Stop Logging (sends a Null character to the instrument).

On the bottom status line:

Baud = Displays the current baud rate

Capt = Displays the capture to disk status. If YES all replies from the instrument are being written to a file on disk.

The function keys are used to control various features of the terminal program and to send commands to the instrument for data uploading, initialization, and status information. If communications or instrument problems are encountered, refer to Section 2-2 for the diagnostic and data commands.

In particular, if the terminal program is not able to establish communications with the instrument by cycling through the baud rates and comm ports, set the baud rate (as documented on the configuration page) with the F7 key and verify the set up parameters accessed through the F2 key. Subsequent attempts at communicating with the instrument can be made by pressing the enter key or via the F6 key.

2-5.1 TERMINAL SET UP FORM

SBE 19 Terminal Program 4.0

Thursday January 16, 1992 4:50 pm

TERM19 Set Up Parameters

SBE 19 EPROM (Firmware) Version = 3.0 or Greater

Communication Set Up = <Press Enter To Modify>

Data Upload Set Up Parameters = <Press Enter To Modify>

Header = Prompt for Header Information

Header Form = <Press Enter To Modify>

<F1> Help; <Esc> Exit; <Enter> Modify the field

The EPROM Version is recorded on the configuration sheet of your instrument manual and also displayed in the first line of the reply to the display status (F3) reply.

The Communication Set Up Form is:

SBE 19 Terminal Program 4.0		Thursday January 16, 1992 4:51 pm	
-----------------------------	--	-----------------------------------	--

TERM19 Set Up Parameters			
--------------------------	--	--	--

SBE 19 EPROM (Firmware) Version = 3.0 or Greater			
--	--	--	--

Communi	Communication Set Up =		
---------	------------------------	--	--

Data Up	Serial Port =	COM1	
Header	Baud Rate =	300	
Header	Data Upload Baud Rate =	9600	
	Data Bits =	8 Data Bits	
	Parity =	No Parity	

<F1> Help; <Esc> Exit; <Enter> Modify the field

Standard instruments are set to 7 data bits, even parity

Firmware Versions Less than 3.0:

baud rate = 9600

upload baud rate = 9600

Firmware Versions 3.0 or greater:

baud rate = 600

upload baud rate is programmable to 600, 1200, 9600, 19200, or 38400

use slower upload baud rates with slow computers and long cables.

use 38400 baud with short cables and 386- or 486-based PCs.

2-5.2 DATA UPLOAD SETUP FORM

SBE 19 Terminal Program 4.0		Thursday January 16, 1992 4:51 pm	
TERM19 Set Up Parameters			
Data Upload Set Up Parameters =			
Upload =	Upload One Cast		
Echo During Upload =	Display One '.' Every 16th...		
Output HEX Data File Path =	C:\CTDDATA\		
Upload File Name Choice =	Prompt for File Name		
Default Upload File Name [.HEX] =	upld		
Upload Session Number [0-99] =	3		

The Upload choices are:

Upload All Data Separated by Casts:

All data will be uploaded. A separate file will be written for each cast.

Upload Data By Cast Number Range:

The user will be prompted for the beginning and ending cast numbers. A separate file will be written for each cast.

Upload One Cast:

The user will be prompted for the cast number range. One file will be written.

Upload All Data as One File:

The terminal program will send the 'DD' (dump data) command rather than the 'DC' dump cast command to the instrument. For diagnostic use only with SBE 19. One file will be written.

Upload Data By Scan Number Range:

The terminal program will prompt the user for the beginning and ending scan number and then send the 'DD' (dump data) command to the instrument. For diagnostic use only. One file will be written.

The Echo Choices are:

Echo Data During Upload:

The HEX data from the instrument is displayed on the screen as it is received

Display One '.' Every 16th scan during Upload:

Will shorten the time required to upload the data.

Output HEX Data File Path =

Enter the path where you wish the uploaded HEX file to be written.

Upload File Name Choice:

If one cast is uploaded at a time the upload file name can be up to 8 characters long. TERM19 will add a .HEX extension to the name.

If multiple casts are uploaded ('Upload All Data Separated by Casts' is selected in the set up form) then the filename can be up to 6 characters long. Term 19 will add 2 characters signifying the cast number to the name and add a .HEX extension to the name.

If the upload file name choice is 'Use Default File Name' then the uploaded file name is:

NNNNXXYY.HEX where

NNNN is the default upload file name (one to four characters)

XX is the upload session number

YY is the cast number

Header:

Include Default Header in Upload File:

The default header form is included in the upload file. The user is not prompted to add any information.

Prompt For Header Information:

Each time a cast is uploaded the user will be prompted to fill out the header form

Don't Include Header in Upload File:

Header information is not included in the upload file

Upload File Name Choice =

Use Default File Name:

The user is not prompted for the file name. The upload session number and cast number are added to the default file name to form the actual file name.

Prompt for File Name:

The user is prompted for the file name.

Default Upload File Name [.HEX] =

If the upload file name choice is 'Use Default File Name' then this default file name is used along with the upload session number and the cast number to form the complete upload file. The maximum length for the default file name is 4 characters. The file name extension need not be entered.

Upload Session Number [0 - 99] =

The upload session number is incremented each time data is uploaded (Function Key 9). It is reset by setting this field to 0.

Header Form:

The header form is customized by editing this form. The entries are free form and 0 to 12 lines may be entered. If header = 'Prompt for Header Information' this form will be displayed for the user to fill in. If header = 'Include Default Header', only this form will be included in the upload file.

2-5.3 TERMINAL PROGRAM: FIELD OPERATION

Connect the instrument to the computer's serial port. Run TERM19 (the file TERM19.CFG created during setup should be in the current directory). Press F6 to establish communications with the SBE 19 (...communications established... will be displayed when this occurs and the S> will show on the screen indicating that the SBE 19 is ready to accept commands). If communications are not established, press F2 and select Communication Set Up. Verify that the serial port, baud rate, data bits, and parity are correct for your configuration.

To upload data, press Function Key F9. The prompts that you see will be determined by the current setup read from TERM19.CFG. TERM19 will automatically obtain status and header information from the SBE 19 and then proceed to transfer the data to the upload file(s). When the upload is complete, the screen will display the message 'Data Upload is Complete, Press <ESC> to continue'. Press <ESC> to continue. If you wish to reset the memory pointers to initialize logging press Function Key 8. In addition to resetting the pointers TERM19 will put the SBE 19 in quiescent mode and then return to DOS.

2-6 DATA RECORDING AND READOUT: SAMPLE SESSIONS

These examples assume the software has been installed on the computer. Consult the SEASOFT manual for installation instructions.

Connect SEACAT Profiler to the serial port with the cable supplied.

There should be new (or freshly charged) batteries in SEACAT Profiler.

2-6.1 SAMPLE SESSION - PROFILING MODE

Verify that the file SEASOFT.CON is correct for your system by running the SEACON program and examining the instrument configuration and calibration information with that contained in this manual.

2-6.1.1 RECORD DATA WITH SEACAT PROFILER (COMPUTER INITIATED)

1. If the magnetic switch is on, turn it off.
2. Connect SEACAT Profiler test cable to SEACAT Profiler and the RS-232C port on an IBM PC/XT/AT or compatible. Type `cd \profiler` to change to the profiler subdirectory. Type `term19`.
3. Enter `DS(CR)` to display SEACAT Profiler status. A typical response would be:

```
SEACAT PROFILER V3.1B SN 936 02/10/94 13:33:06.439
strain gauge pressure sensor: S/N = 12345, range = 1000 psia, tc = 240
clk = 32767.766 iop = 172 vmain = 8.1 vlith = 5.7
mode = PROFILE ncasts = 0
sample rate = 1 scan every 0.5 seconds
samples = 0 free = 174126 lwait = 0 msec
battery cutoff = 7.2 volts
number of voltages sampled = 0
logdata = NO
```

4. Turn the magnetic switch on. Enter `GL(CR)` [go log command]. **Do not use this command if previously recorded data has not yet been removed from SEACAT Profiler.** Type `y(CR)` in response to the prompt **start logging Y/N ?**. Type `^y(CR)` [CTRL Y] in response to the prompt **are you sure ^Y/N ?**. (Note that the GL command automatically initializes SEACAT Profiler; it is not necessary to send the IL command before sending the GL command.)
5. After a few seconds you will see data (in HEX) displayed on the CRT at 2 scans per second. Wait a few minutes while 'cast 0' data is recorded by SEACAT Profiler.
6. Press the HOME key to end 'cast 0'. **S>** will be displayed.
7. To record a second cast repeat steps 4 - 6, entering `RL(CR)` [resume logging] instead of `gl(CR)` in step 4.

2-6.1.2 RECORD DATA WITH SEACAT PROFILER (MAGNETIC SWITCH INITIATED)

1. If the magnetic switch is turned on, turn it off.
2. Connect SEACAT Profiler test cable to SEACAT Profiler and the RS-232C port on an IBM PC/XT/AT or compatible. Type `cd \profiler` to change to the profiler subdirectory. Type `term19`.

3. Enter DS(CR) to display SEACAT Profiler status. A typical response would be:

```
SEACAT PROFILER V3.1B SN 936 02/10/94 13:33:06.439
strain gauge pressure sensor: S/N = 12345, range = 1000 psia, tc = 240
clk = 32767.766 iop = 172 vmain = 8.1 vlith = 5.7
mode = PROFILE ncasts = 1
sample rate = 1 scan every 0.5 seconds
samples = 505 free = 173616 lwait = 0 msec
battery cutoff = 7.2 volts
number of voltages sampled = 0
logdata = NO
```

4. Enter IL(CR) to 'initialize logging'. Type y(CR) in response to the prompt **initialize logging Y/N ?**. Type ^y(CR) [CTRL Y] in response to the prompt **are you sure ^Y/N ?**. **Do not use this command if previously recorded data has not yet been removed from SEACAT Profiler.**

5. Enter DS(CR) to display SEACAT Profiler STATUS. Check that ncasts = 0 and samples = 0.

6. Enter QS(CR) to 'quit session' and put SEACAT Profiler in quiescent mode.

7. Wait 3 seconds, then turn on the magnetic switch to begin logging data. After a few seconds you will see data (in HEX) displayed on the CRT at 2 scans per second. Wait a few minutes while 'cast 0' data is recorded by SEACAT Profiler.

8. Turn off the magnetic switch and wait a few seconds. This will terminate the recording of 'cast 0'. Turn on the magnetic switch again to resume data logging. Turn off the magnetic switch after a few minutes to end recording of 'cast 1'.

2-6.1.3 RETRIEVE DATA FROM SEACAT PROFILER

Before attempting to retrieve data, it will be necessary to record data in SEACAT Profiler by following the steps outlined in section 2-6.1.2 above. To retrieve the recorded data:

1. If the magnetic switch is turned on, turn it off.

2. Connect the SEACAT Profiler test cable to SEACAT Profiler and the RS-232C port on an IBM PC/XT/AT or compatible. Type cd \profiler to change to the profiler subdirectory. Type term19.

3. Enter DS(CR) to display SEACAT Profiler status. The following is typical:

```
SEACAT PROFILER V3.1B SN 936 02/10/94 13:33:06.439
strain gauge pressure sensor: S/N = 12345, range = 1000 psia, tc = 240
clk = 32767.766 iop = 172 vmain = 8.1 vlith = 5.7
mode = PROFILE ncasts = 2
sample rate = 1 scan every 0.5 seconds
samples = 1505 free = 172616 lwait = 0 msec
battery cutoff = 7.2 volts
number of voltages sampled = 0
logdata = NO
```

4. Enter DH(CR) to display headers.

cast 0 09/10 08:01:15 samples 0 to 924 sample rate = 1 scan every 0.5 seconds stop = recv cmd
cast 1 09/10 12:30:33 samples 925 to 1504 sample rate = 1 scan every 0.5 seconds stop = recv

5. Use the F2 key to verify the data upload parameters are set correctly.

6. Use the F9 key to upload the data into a hexadecimal file.

In each file (one per cast) will be stored the DS and DH command responses as well as the hexadecimal data itself. Each line of the DS or DH responses will be will have an asterisk in the first position.

7. Press F10 to return to DOS.

2-6.1.4 DISPLAY SEACAT PROFILER DATA USING SEASOFT

The program SEASAVE is used to display the 'raw' hexadecimal data output from SEACAT Profiler in engineering units, and compute derived variables. In the main screen of SEASAVE, select archived data to view recorded files, or select real-time data to log directly to a computer disk. In the next SEASAVE screen, the type of display and other parameters are set before the data are actually presented. Refer to the SEASOFT manual for detailed information on the use of the SEASAVE program, as well as the other programs used to analyze, process, and plot SBE 19 data.

3-1 INSTALLATION AND OPERATING INSTRUCTIONS

SEACAT Profilers are shipped with new alkaline batteries installed, unless rechargeable nickel cadmium batteries were ordered. **Rechargeable batteries should always be charged before using the SEACAT Profiler for the first time** (see Application note 21 in this manual for charging and use instructions). As delivered, the SEACAT Profiler will be in quiescent mode drawing 50 microamperes or less. The initialization routines described below will have been performed at the factory and the real-time clock will be running (set to Pacific Time).

To gain experience with SEACAT Profiler communications protocol, the Sample Set-up Sessions described in Section 2-6 may be followed at this time.

If a separate power supply is available and will be used for testing, connect the power supply to the 4 pin bulkhead connector (see Section 2-1 for hook-up instructions).

Power will be drawn from either the main batteries, the external power source, or the internal printed circuit-mounted lithium back-up cells (5.6 volts), depending on which voltage source is highest. **Avoid having the magnetic switch turned on when neither main battery nor external power sources are connected.**

If using a Sea-Bird junction box, connect the box to SEACAT Profiler using the 4-pin to MS cable provided. Connect the box to the computer serial port using the DB-25 cable. Connect AC mains power. Press the red power button to provide power to SEACAT Profiler. The junction box supplies about 15 volts, so SEACAT Profiler's batteries will not be depleted when the junction box is in use.

3-1.1 BATTERY INSTALLATION

Unthread the battery compartment end cap (end cap without any connectors). Remove the three Phillips-head machine screws from the battery retainer plate immediately inside the pressure housing. Lift this plate clear. Batteries are installed with the + terminal against the flat battery contacts and the - terminal against the spring contacts. Slide the 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. **The screws must be fully tightened, or battery power to the circuitry will be intermittent.** Check for battery voltage (approximately 9 volts) at the screw heads marked BAT POS and BAT NEG. If the magnetic switch is turned off, the Profiler will enter quiescent mode. In this mode, the clock runs and memory is kept alive, but the power drain is only about 50 microamperes. Check the 'O'-ring and mating surface and rethread the end cap.

3-1.2 PUMP OPERATION

Normally, the conductivity cell must be in water before the pump will run. After the cell enters the water, there is a 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 impeller housing, priming is uncertain and a proper flow rate cannot be ensured. The tubing extending above the air-bleed hole will contain a small reserve of water. This maintains the pump prime (for up to one minute, depending on the length of tubing above the air-bleed), even though the Profiler 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. **The cell inlet and pump outlet must not come above the water surface or the prime will be lost.** If this happens, turn the switch off. Wait at least 5 seconds, then turn the switch on, submerge the SEACAT completely, and wait for the pump delay time before beginning the profile.

Pump turn-on occurs when two conditions programmed using the SP (set pump) command have been met: 'raw frequency' from the conductivity interface circuit exceeds the minimum 0 conductivity frequency value entered, and the delay interval has elapsed.

For oceanic water in the 35 ppt range, enter the set point for the minimum 0 conductivity frequency as 3500 Hz, since actual in-water frequencies will always be higher. For fresh/nearly fresh water, the set point frequency must be only slightly higher (e.g., 5 Hz) than the 0 conductivity 'raw frequency' shown on the instrument configuration sheet. If the set point is too close to the 0 conductivity 'raw frequency,' the pump may turn on when the SEACAT is in air as result of small drifts in the electronics. Some experimentation may be required, and in some cases it may be necessary to rely only on the pump delay time to control the pump. If so, set a frequency lower than the '0 conductivity raw frequency' value.

The second entry made via the SP command sets the time delay. The necessary delay can be judged by immersing the Profiler (switch off, not running) just below the air-bleed hole at the top of the tygon tubing. Measure the time needed to completely fill the tubing (30 seconds is typical) and set the delay to about 1.5 times longer. When actually using the Profiler, be sure to 'soak' the instrument just under the surface for at least the time required for pump turn on.

Entries made with the SP command are permanently stored in the Profiler and remain in effect until you change them. The only exception is if the Profiler is completely reset. This occurs 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 (newer units only) is placed in the 'reset' position.

3-1.3 DEPLOYMENT

Check that the anodes have not been eroded away, and that hardware and external fittings are secure. Refer to Section 2 for information on programming SEACAT Profiler for the desired operating routine, and confirm that memory capacity is sufficient. Make sure that the self-diagnostic battery voltage is proper. A screen dump (to a printer) of SEACAT Profiler's response to the DS command makes a useful record of the instrument's pre-deployment condition.

In general, the following steps should be taken before putting the Profiler in the water:

1. Turn the magnetic switch off (slide towards connector end cap).
2. Use the IL command to initialize the memory.
3. Use DS to check that time, date, vbatt are satisfactory and that ncasts = 0 and samples = 0.
4. Use QS to return SEACAT Profiler to quiescent conditions. **If this step is omitted**, and the magnetic switch is turned on before auto power-down (about 2 minutes later) **Profiler will not take data!**
5. **Put a light coating of silicon grease** on the dummy cover and install it on SEACAT Profiler's bulkhead connector I/O port.
6. Remove the Tygon tubing (usually filled with deionized water) looped end-to-end around the conductivity cell.
7. Immediately prior to deployment, turn on the magnetic switch (slide towards the center of the case). The Profiler is ready to go into the water.

3-1.4 OPTIMIZING DATA QUALITY

Experience has shown that a profiling speed of about 1 meter/second is usually satisfactory. However, the magnitude of ship motion, and the dynamic effect it has on data quality, has to be considered as operating conditions change. Slow profiling speeds (especially with an unpumped CTD) causes degraded flushing of the conductivity cell, and 'salinity spiking' can be severe in areas of strong temperature gradients. In rough seas or other conditions (small boats) where the ship's dynamic motion is large, the profiling speed should be increased (up to as much as 2-3 meters/second) to reduce the dynamic errors ('spiking') caused by the rapidly changing rate of descent/ascent of the CTD (yo-yo effect).

In common with other CTD equipment, the Profiler is intended for obtaining downcast data, and will not generally give best quality results on the upcast. If you must have upcast data, invert the Profiler so that the sensors are at the top - in which case the downcast data should be ignored. **It is very important that the instrument not be positioned in a way that causes the water that will flow past its sensors to be thermally contaminated by other instruments, sample bottles, etc.** The sensors will respond to the temperature and conductivity of the water in which they are immersed, and it is quite remarkable how much this can be influenced by other objects! SEACATs equipped with the submersible pump are able to get better data with slow descent rates than unpumped SEACATs. Since the pump creates and maintains a constant and optimum flow, the SEACAT can be lowered more slowly to give greater vertical resolution in the profile data, especially on lakes, protected bays, or other calm conditions. The minimum descent rate for pumped SEACATs should be adjusted according to the magnitude of ship motion (i.e., sea state). On a very calm lake, 10 cm/second is feasible if used with a constant winch speed.

When a pumped SEACAT is installed on a water sampler, good conductivity (and optional dissolved oxygen) data can be collected, even when stopped to collect a water sample, because the water will continue to flow through the sensors. However, the manner in which the SEACAT is mounted on the

water sampler can have a dramatic effect on data quality. The optional SEACAT T-C Duct can be used to overcome dynamic errors induced by a poor mounting method or location (see Application Note 51).

Where the water temperature is markedly different from the temperature at which the Profiler has been stored, better results will be obtained if the Profiler is allowed to equilibrate to the water temperature at the surface (soak) for a minute or two before beginning the profile. The reason is not that the electronics are temperature sensitive - they are not - but that the thermal influence of the instrument housing on the water entering the cell will be reduced. In cases where the difference between water temperature and SEACAT storage temperature are extreme, more 'soak time' should be allowed.

'Spiking' is sometimes seen in the derived values for salinity, density, or sound velocity and results largely from response time mismatching of the conductivity and temperature sensors, especially when the profiling descent rate is non-uniform. This is a problem in all CTD work, and the suppression of the effect (it is never eliminated) has been the goal of instrument manufacturers and ocean researchers for many years. The greatest immunity to spiking will be found in premium CTD equipment such as the Sea-Bird SBE 9, which uses very fast sensors (0.07 second), high speed (24 Hz) parallel signal acquisition, and a pumped-flow (constant time response) conductivity sensor. SEACAT Profiler's static accuracy is the same as that achieved by the SBE 9, but its dynamic responses - owing to its simpler, less costly, and more compact design - are not as ideal.

The amount of 'spiking' with SEACAT Profiler will depend on the temperature gradient encountered, and will be much worse where coupled surface motion causes the instrument to stop - or even reverse - its descent. In the event of heavy ship motion, it may be worth letting the instrument 'free-fall'.

Where very heavy seas cause severe ship motion and result in periodic reversals of the instrument descent, it is possible to greatly improve the data set by removing those scans taken when the pressure signal is not increasing. Consult the SEASOFT manual for information on programs that can be used to correct data for the influences of ship motion and to minimize salinity spiking.

3-1.5 RECOVERY

CAUTION!! IMPROPERLY SEALED PRESSURE HOUSINGS MAY FLOOD IN SUCH A WAY AS TO TRAP AND COMPRESS THE AIR INSIDE. IF THIS HAPPENS, A POTENTIALLY LIFE-THREATENING EXPLOSION CAN OCCUR WHEN THE INSTRUMENT IS BROUGHT TO THE SURFACE.

ACCORDINGLY, A MALFUNCTIONING INSTRUMENT SHOULD BE TREATED WITH GREAT CAUTION UNTIL IT HAS BEEN DETERMINED THAT ABNORMAL INTERNAL PRESSURE DOES NOT EXIST, OR HAS BEEN RELIEVED.

IF THE SEACAT IS UNRESPONSIVE TO I/O COMMANDS OR SHOWS OTHER SIGNS OF FLOODING OR DAMAGE, LOOSEN EACH OF THE SENSOR END RETAINING HARDWARE 1/2 TURN. IF THERE IS INTERNAL PRESSURE, THE END CAP WILL 'FOLLOW' THE SCREWS OUT, AND THE SCREWS WILL NOT BECOME EASIER TO TURN. IN THIS EVENT, LOOSEN THE I/O BULKHEAD CONNECTOR AT LEAST TWO TURNS TO RELIEVE ANY INTERNAL PRESSURE.

Rinse the conductivity sensor with fresh water, and replace the distilled-water filled Tygon tubing.

Remove the dummy cover from the I/O port, and connect SEACAT to a computer serial port. If the main batteries are exhausted, they must be replaced before data can be read out.

The program TERM19 (supplied with SEACAT) may be used with an IBM PC/XT/AT or compatible to create MS-DOS files from the recorded data. **Make a back-up disk containing a copy of the MS-DOS file, put on a write-protect tab, and store the disk in a safe place!**

Leave the main batteries in place when storing SEACAT to prevent depletion of the back-up lithium cells by the real-time clock. Even an 'exhausted' main battery will power the clock (50 microamperes) almost indefinitely. Sea-Bird's SEASOFT CTD data acquisition software may be used to tabulate and plot the archived data set. See the SEASOFT Installation Instructions for further information.

3-1.6 STORAGE

SEACAT Profiler should be rinsed with fresh water after use and prior to storage. When possible, keep the conductivity cell in distilled water (see section 5-1.2 CONDUCTIVITY CELL STORAGE). If SEACAT Profiler is to be stored for long periods, the batteries should be left in place and changed yearly.

4-1 COMMON PROBLEMS AND THEIR CURES

The most common difficulties with SEACAT Profiler involve improper setup of the SEASOFT routines in the companion computer. Read the software manual for general guidance.

Profilers are shipped with the software set up to match the configuration of your instrument, and have the calibration coefficients already entered. We recommend that you make copies of the SEASOFT disks supplied, place write-protect stickers on the originals, and store them in a secure place. Then do your actual work using the copies.

4-1.1 UNABLE TO COMMUNICATE WITH PROFILER

The I/O cable supplied with Profiler will permit connection to the DB-25P input connectors used on 'IBM Asynchronous Adapter Cards', i.e., standard RS-232 interfaces. Pin 1 of the Profiler I/O bulkhead (large pin) goes to DB-25 pin 7 (ground). Profiler pin 2 (CCW from large pin) goes to DB-25 pin 2, and Profiler 3 (opposite the large pin) goes to DB-25 pin 3.

If you are using an IBM PC or equivalent and cannot establish communication (the **S>** is not displayed in response to multiple [CR]s), verify the setup parameters in TERM19. TERM19 permits choice of communications port 1 or 2 (must agree with your serial card configuration) and of the I/O baud rate which must be 600 baud, even parity, one stop bit for standard Profilors (1200 baud for Profilors with a Paroscientific Digiquartz pressure sensor). TERM19 writes a file called 'TERM19.CFG' to the current directory. **This file must be copied to the directory from which TERM19 is being run before communications may be established.**

4-1.2 NO DATA RECORDED

Profiler must be in quiescent mode before it will respond to the magnetic switch and begin taking data. Quiescent mode is entered by entering QS[CR] when communicating with a computer or terminal, or 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.

Verify that the memory is not full (use the DS command; 'free = 0' if memory is full). Once the memory is full, no further data will be recorded. It is generally best to upload all previous data before beginning another deployment. Then use the IL command to reset memory. DS will show 'samples = 0' and 'free = 42958' (or 'free = some other number', depending on the Profiler's memory capacity).

4-1.3 NONSENSE DATA

If an uploaded 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 INSTRUMENT CONFIGURATION at the beginning of the manual for the correct configuration of your CTD system.**

If the TERM19 program fails to correctly upload the data, verify that the firmware version (see configuration page) and the data upload baud rate in the TERM19 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.

4-1.4 RESETTING THE SBE 19's INTERNAL MEMORY

In rare cases the memory resident program that controls the microprocessor in the SBE 19 can be corrupted by a severe static shock or other problem. This program can be reloaded from the EPROM located in the SBE 19 by removing all power from the internal circuitry. When the main batteries are removed or exhausted, the small lithium batteries located on the internal circuit cards keep memory alive. If the lithium battery power is removed from the circuitry, the SBE 19 will lose 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 SBE 19 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 SBE 19, 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 SBE 19 using the TERM19 program.

NOTE: All contents of memory will be lost when the SBE 19 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 SV command to enable the acquiring of external voltages, and the SP command to reset the pump start parameters.

5-1 ROUTINE MAINTENANCE AND CALIBRATION

5-1.1 CORROSION PRECAUTIONS

On aluminum-housed units, there is a large zinc anode screwed into the battery end-cap, and a second on the conductivity cell guard is also used on plastic versions. These anodes should be checked from time to time to see that they are securely fastened, and have not been eaten away.

All the stainless steel screws that are exposed to salt water have been generously lubricated with NEVER SEEZ Blue Moly (available through marine hardware stores). After a deployment, it is wise 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.

SEACAT Profiler should be rinsed with fresh water after use and prior to storage.

5-1.2 CONDUCTIVITY CELL STORAGE

When possible, keep the conductivity cell in distilled water during periods of non-use by looping a length of water-filled Tygon tubing end to end. If it is not practical to leave the conductivity cell stored with distilled water in it (due to the danger of freezing, for example) merely rinse the cell with distilled 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. Triton X100 may be obtained through a medical supply distributor.

5-1.3 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 SEACAT Profiler are supplied fully calibrated, with coefficients as printed on their respective Calibration Certificates.

SEACAT Profiler may be returned to Sea-Bird for calibration or calibrated using standard laboratory equipment and methods. If the latter is 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 SEACAT Profiler will always yield a temperature calibration as well.

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

5-1.3.1 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 distilled 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.

5-1.3.2 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.

5-1.3.3 PRESSURE SENSOR CALIBRATION

The strain-gauge pressure sensor is a semi-conductor type, which is capable of meeting SEACAT Profiler's error specification with some allowance for aging and ambient-temperature induced drift. For demanding applications, or where the sensor's air ambient pressure response has changed significantly, calibration using a dead-weight generator is recommended. The end-cap's 5/16-24 straight thread permits mechanical connection to the pressure source. The pressure port uses an oil-filled capillary to buffer the pressure sensor against rapid thermal variations (a source of short-term error) and to prevent galvanic reactions in aluminum housed units.

To recalibrate the pressure transducer, remove the nylon fitting (with short attached 1/8-inch OD plastic tube) from the lower end cap of the sensor housing. There is silicon oil in this fitting, so there will be some spillage. The end cap is tapped with a 5/16-24 straight thread to accept your pressure fitting. Use a fitting that has an O-ring face seal, such as Swagelok-200-1-OR.

After calibration, turn the instrument so the lower end cap is facing up, remove the fitting and fill the cavity with silicon oil (such as Dow Corning DC200 fluid, with 200 centistokes viscosity). Use a 2-inch long 21 gauge hypodermic needle (supplied, with syringe) inserted as far as it will go into the small hole at the bottom of the cavity. Then replace the nylon fitting. The oil in the cavity should fill the nylon fitting and 1/8-inch tube as the fitting is screwed in.

6-1 DESCRIPTION OF SEACAT PROFILER CIRCUITRY

SEACAT Profiler circuitry is contained on three rectangular (approximately 75 X 250 mm) printed boards supporting analog, cpu, and memory functions. The cpu and memory boards are interconnected at several points by means of pin and socket SIP connectors to form a digital 'module'. A single DIP interboard connector is used to carry the 26 lines between the analog board and the digital module.

6-1.1 BATTERY WIRING AND POWER SUPPLY

SEACAT Profiler's main battery is a series connection of 'D'-cells that drop into the battery compartment as a cluster of three end-to-end stacks (three batteries each). The positive battery connections are contact areas on double-thick printed circuit disks that form the internal bulkhead and battery retainer plates. Battery negative contacts are heavy beryllium-copper springs. The three cell stacks are aligned by plastic insulated aluminum spacers which also serve as electrical interconnects. The battery-to-circuit card connection is made by means of a Molex-type 6-pin pc board connector (J6).

The Analog board contains two series-connected lithium cells (1/2 AA non-hazardous) which are diode OR'd with the main battery (and external power source, if used). The lithium supply is capable of supporting all SEACAT Profiler functions and serves to permit orderly shut-down in the event of failed or exhausted main batteries.

Whenever the main power switch is 'on', battery voltage is connected to a low-power regulator chip (Intersil 7663) used to supply 5 volts (+ 5C) to the real-time clock (RTC) and memory circuits. When a conductivity/temperature sample is to be taken, the RTC 'wakes up' the CPU by switching on a power MOSFET to connect battery voltage to the main supply regulator (National Semiconductor LM 2950, + 5volts). The CPU checks that main battery voltage is adequate (minimum 5.9 volts) before proceeding with the measurement routine.

6-1.2 SENSOR MULTIPLEXING

The conductivity cell and thermistor are sequentially connected to a single Wein-bridge oscillator circuit by means of mercury-wetted relays driven by NPN saturated switches under control of the CPU. The relays will retain their low (0.1 ohm) initial contact resistance within 0.005 ohms throughout a life-time of 200×10^6 operations minimum (over 3 years continuous operation of SEACAT Profiler). Every 120th scan substitutes two reference resistors to allow arithmetic cancellation of most of the electronic drift sources.

Relay coil power is derived directly from the unregulated battery line through emitter-follower Q7. The advantage is that the system regulator is not required to handle the (relatively large) and intermittent relay coil current.

6-1.3 WEIN-BRIDGE OSCILLATOR

The Wein-bridge oscillator (WBO) is configured as a controlled-gain amplifier using high-frequency bipolar transistors and low-valued load resistors to achieve minimum phase shift. An input FET provides high impedance to the WBO frequency-determining components (two fixed capacitors, a fixed resistor, and the unknown sensor resistance) while an emitter follower presents a low driving impedance to the MOSFET gain control element.

The WBO output of 0.16 volts p-p (small enough to avoid significant self-heating in the SEACAT Profiler sensors) is amplified to supply the higher AC level (approximately 1.2 volts p-p) needed to activate the AGC detector.

6-1.4 SQUARING CIRCUITS AND AP COUNTER

The amplified WBO output is squared by CMOS inverters connected as Schmidt-triggers. While the squared WBO signal is selected by the CPU controlled MUX, the AP counter circuit (on the Memory board) is used to count its frequency. A 12-bit CMOS counter (4040) acquires the integer count during a 0.125 second interval, while a second 4040 counts the TCXO frequency (2.097 MHz) to yield a number representing the 'fractional' cycle of the input frequency. The CPU uses the two counts to compute a single number representative of WBO frequency, at a resolution equal to $1/(0.125 \times 2.097e6)$ or 1/262,000. This is comparable to the counter resolution obtained with other Sea-Bird CTD equipment.

6-1.5 A/D CONVERTER (INTERNAL DIAGNOSTICS)

A 12-bit plus sign A/D converter (National Semiconductor ADC1205) is used on the CPU board to obtain diagnostic information relating to SEACAT Profiler status and functionality. A pre-amplifier and buffer (Precision Monolithics OP220) are used to condition the internal signal levels selected by the MUX. Main supply current is determined by measuring the voltage across a 0.5 ohm resistor, while main unregulated and lithium back-up voltages are sensed using resistive dividers. To assure ability of the back-up lithium supply to power SEACAT Profiler functions, its voltage is measured under typical load. SEACAT Profiler quiescent current (RTC and memory only supported) is also measured by the A/D.

6-1.6 CPU AND DATA I/O

SEACAT Profiler's CPU is configured around an 80C85 CMOS 8-bit microprocessor (CPU board), with program storage in CMOS EPROM (27C256, Memory Board). Communication with SEACAT Profiler is via RS-232 interface to the XR88C681 UART (CPU Board), while level conversion is handled by a LT1081; this chip serves a double role in supplying a source of ± 12 v power used to drive the A/D converter's precision 5 volt reference (PMI REF02).

A time-out signal is generated which resets the CPU after 5 seconds of cpu inactivity. The time-out feature is intended to protect against inadvertent incapacitation resulting from some unforeseen software 'loop'. The reset inhibit is detected on the CPU Board in response to periodically imbedded lines of code which cause a write instruction to location C1 HEX.

6-1.7 REAL-TIME CLOCK

RTC oscillator circuitry (Memory Board transistor oscillator, CMOS buffer/squaring) is on the Memory Board. A flip-flop converts the 3 v p-p squared oscillator output to the 5 volt level required for SEACAT Profiler's digital circuitry. The RTC oscillator frequency is counted during each data acquisition cycle using SEACAT Profiler's precision TCXO. The results are used to arithmetically correct the inter-sample interval and recorded time. The clock/calendar chip is on the CPU Board (National Semiconductor MM58167A). CPU Board uses tri-state buffers to protect the clock/calendar from inadvertent wake-alarm rewrite during power-up.

6-1.8 MEMORY

Eight low-power CMOS static RAM chips (Memory Board, Hitachi HM628128) are used for main data memory. Bank switching is used, and memory contents protected on power-up by tri-state latches.

7-1 DISASSEMBLY/REASSEMBLY INSTRUCTIONS

COMPLETE DISASSEMBLY WILL DESTROY ANY DATA PREVIOUSLY STORED IN SEACAT PROFILER!

Great care must be taken during assembly and reassembly to avoid breaking the conductivity cell. The cell is robust and well protected when the instrument is intact, but becomes extremely vulnerable during the disassembly/reassembly procedure.

Remove the four machine screws retaining the sensor guard to the housing and set the guard aside. Remove the small screw holding the upper (opposite end-cap) end of the conductivity cell to the housing. Now remove the four screws retaining the sensor end-cap to the cylindrical housing. The end-cap and attached electronics chassis may now be slid out of the pressure cylinder. The Molex connector toward the battery end of the analog electronics board (the board to which the yellow lithium batteries are mounted) must be unmated before the chassis/end-cap assembly may be fully removed.

For reassembly, reverse the disassembly process, being careful that the mating surfaces are clean and the 'O'-ring greased, undamaged, and properly positioned. Use a new desiccant package. Re-mate the Molex connector (be careful that the connector socket holes are lined up properly with respect to the mating header pins).

7-2 O-RING SIZES

O-RING SIZES (600, 3400, AND 6800 METER CASE PROFILERS)

Battery end-cap (piston) seal:	Parker 2-234E603-70
Battery end-cap (face) seal:	Parker 2-153N674-70
Sensor end-cap (piston) seal:	Parker 2-233E603-70
Sensor end-cap (crush) seal	Parker 5-374E603-70
I/O bulkhead connector:	Parker 2-017N674-70
Conductivity cell penetrator:	Parker LS-001

O-RING SIZES (7000 AND 10500 METER CASE PROFILERS)

Battery end-cap (piston) seal:	Parker 2-234E603-70
Battery end-cap (face) seal:	Parker 2-153N674-70
Sensor end-cap (piston) seal:	Parker 2-233E603-70
Sensor end-cap (crush) seal	Parker 5-374E603-70
I/O bulkhead connector:	Parker 2-017N674-70
Conductivity cell face seal:	Parker 2-110E603-70