Micro CTD

User Manual

Version 2.6
Aug 2007

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1   INTRODUCTION

This manual describes the AML Oceanographic Micro CTD Sensor. If additional items such as sensors or software are used in conjunction with the Micro CTD Sensor the manuals for these items should also be consulted. Examples of additional manuals commonly supplied are:

>   SmartTalk software manual
>   Transmissometer sensor manual
>   Dissolved oxygen sensor manual

This manual covers the standard specifications, operation, use, communication, troubleshooting, and maintenance of the Micro CTD Sensor. In addition, appendices at the back of the manual detail any unique configurations for the instrument. Unique configurations include such things as calibration coefficients, additional sensors, custom communication formats and custom wiring configurations. Also included in Appendix E is a quick reference guide that describes the basic operating procedures on one sheet for ease of use in the field.

1.1   THE INSTRUMENT

Figure 1.1: The Micro CTD Sensor

The standard Micro CTD Sensor is a three parameter, self contained, intelligent sensor. The basic configuration includes the following:

>   conductivity sensor and electronics
>   temperature sensor and electronics
>   pressure sensor and electronics
>   communications electronics
>   data logger electronics
>   waterproof pressure case
>   connector cable

The conductivity sensor is a small volume, four electrode, patented design which offers fast flushing times and low thermal hysteresis. The signal conditioning electronics feature low thermal coefficient reference resistors, ratio metric A/D converter, and synchronous sampling to provide accurate and stable operation over the operating range. The conductivity sensor uses a dedicated RISC microprocessor to control the sensor excitation and communicate with the data logger electronics. The conductivity sensor electronics are electrically isolated for both the power and signal lines from the rest of the electronics. This allows the sensor to be used in conjunction with other sensors that are electrically connected to the water without interference.

The temperature sensor is a precision, aged thermistor within a T316 Stainless Steel capillary tube to eliminate pressure effects while still allowing fast time response. The temperature sensor uses a dedicated RISC microprocessor to control the sensor excitation and communicate with the data logger electronics.

The pressure sensor is a semiconductor strain gauge protected by a stainless steel diaphragm. Various pressure ranges from 2 to 1000 bar are available. The pressure sensor is fully temperature compensated over the range of -2 to 32°C. The pressure sensor uses a dedicated RISC microprocessor to control the sensor excitation and communicate with the data logger electronics.

The data logger and power control electronics use a RISC microprocessor running at 19.6 MHz to control the sampling and power program as well as to communicate with the sensors and communications interface board.

The communications interface board is normally an RS-232C board. Optional communication boards include RS-485 and TTL. Through the communications board, the instrument will, on power up, automatically detect baud rates from 2400 to 38400 baud. The baud rate is automatically determined when the sensor receives an **<ENTER>** or **<RET>**. The data output may be configured to display either unprocessed integers, or computed engineering values. The Micro CTD Sensor has the option of sampling on command or monitoring continuously with programmable sampling rates. The latter is not available with the binary protocol. The RS-485 binary protocol option allows the instruments to be individually addressed permitting multiple instruments to be daisy-chained together.

The standard pressure case is acetal with a depth rating of 500 meters of water. Optionally, the 316 stainless steel pressure case is rated to 4500 meters and the titanium case is rated to 6000 metres. The standard bulkhead connector used on the Micro series of instrumentation is the Impulse™ MCBH-8-FS rated to 6800 meters of water.

The 0 to 65°C temperature range option uses the same sensor but utilizes custom electronics, and a higher order calibration equation. (Note the extended temperature range does not apply to the conductivity and pressure sensors.)

1.2   THE USER

This manual has been written with the following assumptions:

• The user has had some exposure to MS Windows compatible computers, and is moderately computer literate with a working knowledge of computer operation and terminology.

• The user is familiar with the operation and function of standard communications packages.

While it is possible to operate the Micro CTD Sensor without these qualifications, some computer experience will greatly assist the user to pass through the learning curve more rapidly.

2 STANDARD SPECIFICATIONS

Conductivity: Patented platinized 4 electrode
     Range: 2 - 70 mS/cm
     Accuracy: 0.01 mSc/m
     Resolution: 0.0015 mS/cm
     Time constant: 25 ms typically

Temperature Sensor: Precision aged thermistor in 316 SS housing
     Range: -2 to 32 ºC
     Accuracy: ±0.005ºC
     Resolution: 0.001ºC
     Time constant: 100ms

Pressure Sensor: Semiconductor strain gauge
     Range: 0 to 2, 5, 10, 20, 50, 100, 200, 400, 600 and 1000 bar
     Temperature range: Temperature compensated from -2 to 35C
     Accuracy: ±0.05 % full scale
     Resolution: 0.1 dbar for ≥ 100 bar FS sensors, 0.01dbar for <100 bar FS sensors
     Time constant: 10 ms

Optional Fresh Water Conductivity: Patented platinized 4 electrode
     Range: 0 - 9 mS/cm
     Temperature range: 0 to 40C
     Accuracy: 0.01 mS/cm
     Resolution: 0.0015 mS/cm
     Time constant: 25 ms typically

Optional Dual Range Conductivity: Patented platinized 4 electrode
     Range: 0 - 70 mS/cm
     Temperature range: -2 to 40C
     Accuracy: 0.01 mS/cm
     Resolution: 0.0015 mS/cm
     Time constant: 25 ms typically

Optional 65 ºC Temperature Sensor: Precision aged thermistor in 316 SS housing
     Range: -2 to 65 ºC
     Accuracy: ±0.01ºC
     Resolution: 0.002ºC
     Time constant: 100ms

Output format:
     Standard: RS-232C fixed baud or autobaud communications
     Baud rate: 2400 to 115200 baud, 8 data bits, no parity, 1 stop bit (autobaud up to 38400 baud)
     Data type: ASCII text

Optional:	RS-485 fixed baud or autobaud communications
Baud rate:	2400 to 115200 baud, 8 data bits, no parity, 1 stop bit (autobaud up to 38400 baud)
Data type:	ASCII text

Optional:	RS-485 fixed baud communications
Baud rate:	2400 to 115200 baud, 8 data bits, no parity, 1 stop bit
Data type:	Addressable binary network format

Sample Rate: On command or continuous.

Continuous has programmable sampling rates from 25 scans / second to 1 scan per day.

Note that fast sampling rates may be degraded by the baud rate and output formats chosen.

Power:

Standard:	External power
Range:	8 to 24 volts D.C.
Nominal:	12 volts D.C.
Current:	100 mA

(electronics are galvanically isolated from the water)

Optional:	External battery pack (3 C lithium cells, 7000 mAhr)
	Recommended batteries are; Saft, LSH 14, C cell, 3.6 volt, lithium

Memory:

Standard:	No memory
Options:	128M, 256M, 512M, and 1 G bytes

Pressure Housing:

Dimensions:	50.3 mm (1.98 in) Ø
	297 mm (11.7 in)
Material:	acetal (standard)
Max Pressure:	500 meters

Optional:	T-316 Stainless steel (optional)
Max Pressure:	4500 meters

Optional:	Gr 5 titanium (optional)
Max Pressure:	6000 meters

Weight:

    536 g (1.18 pounds) in air for Acetal
    78 g (0.17 pounds) in water for Acetal

    2244 g (4.94 pounds) in air for stainless steel option
    1786 g (3.93 pounds) in water for stainless steel option

    1320 g (2.90 pounds) in air for titanium option
    862 g (1.90 pounds) in water for titanium option

Environment:

Operating:	-2 to 40ºC (28 to 104ºF)
Storage:	-40 to 60ºC (-40 to 140ºF)
Pressure:	Limited by pressure case or pressure sensor which ever is shallower.

Connectors:

Power/Data Connectors: Used on instrument and battery pack
Bulkhead Connector: IMPULSEtm MCBH-8-FS with 24 AWG
Dummy Plug: IMPULSEtm MCDC-8-MP
Shorting plug: IMPULSEtm MCDC-8-MP/S, pins 6 and 7 are shorted, molded red
Com Cable Connector: IMPULSEtm PMCIL-8-MP, pins 6,7 and 8 are shorted, 2 meter cable length, 22 AWG with DB-25 connector
Retainer Ring: IMPULSEtm DLSMC-F
Materials: Stainless steel, neoprene, polyurethane, acetal

External Sensor Connectors:

Used on instrument and external sensors.
Bulkhead Connector: IMPULSEtm IE55-1206-BCR with 24 AWG
Bulkhead Dummy Plug: IMPULSEtm IE55-1206-SCP
Cable Dummy Plug: IMPULSEtm IE55-1206-SCR
Cable Connector: IMPULSEtm IE55-1206-CCP
Materials: Titanium, polyurethane

3   DESCRIPTION

3.1   FUNCTIONAL DESCRIPTION

The Micro CTD Sensor has three separate sensors, refer to *Figure 3.1*, each of which responds to a specific property of the water environment.

- •The conductivity sensor (used to calculate the salinity) monitors the electrical conductivity of the water by passing a constant AC current through a known volume of water and measuring the resulting voltage developed across the water. The higher the salt content of the water the lower the resistance will be and the lower the voltage across the sensor.
- •The pressure sensor responds to pressure by monitoring the stress on a silicon chip exposed to the ambient pressure. The silicon chip is fabricated as a Wheatstone bridge and the differential voltage output across the bridge is a function of the stress exerted by the ambient pressure.
- •The temperature sensor responds to the ambient temperature by passing a very small constant current through the thermistor junction and measuring the resulting voltage developed across the junction. The voltage is inversely proportional to the ambient temperature.

Each sensor requires an excitation signal and synchronous sampling of the sensor output voltage. The conductivity and pressure sensors also incorporate thermal compensation. The output voltage must be converted to a digital signal (raw output) and then the calibration coefficients must be applied to calculate the output in engineering units. All of these requirements are controlled by a dedicated microprocessor for each sensor. Each sensor has a dedicated electronics board to provide this functionality. Each board is composed of an analog section, a digital section, and in the case of any sensor electrically coupled to the water, an isolation section is also included. Refer to *Figure 3.1*.
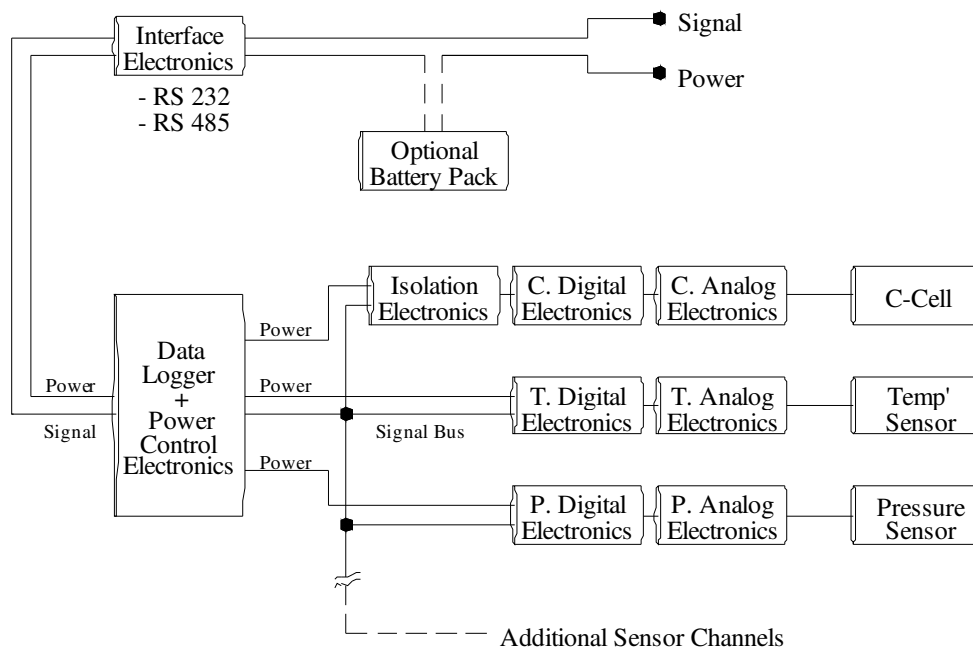
Figure 3-1 Micro CTD Sensor Block Diagram

All of the sensor boards, including any additional sensors, plug into the data logger board. The data logger has a common signal bus for communicating with the sensor boards and provides individually controlled power to each of the primary sensors. A microprocessor on the data logger board controls all the communications and power to the sensors, collates the sensor data, including supply voltage, with a date/time stamp, stores the data to flash memory if required, and outputs the data to the external world via the communications board.

The communications board converts the incoming commands from, and the outgoing data to, the chosen external communications format. The standard external format is RS-232C ASCII, which is also the standard serial communications protocol for personal computers.

4   PREPARATION FOR USE

4.1   INSPECTING THE INSTRUMENT

At AML we do our best to package our instrumentation to avoid damage during shipping, as should the user. However accidents do happen, so an inspection of the Micro CTD Sensor before each use will assist in spotting problems that could lead to inaccurate data or possible failure.

- •Examine the outside of the shipping case for evidence of heavy impacts during transport.
- •If signs of damage are visible continue with the inspection as follows and notify the carrier and the factory of any damage found.
- •Check that the communications and power connector is not loose and that there is no dirt or grit in the connector(s).
- •Examine the cable for cuts or wear and check the connector ends for visible damage.
- •Check for a cracked or chipped conductivity cell, as this will change the calibration of the sensor.
- •Check the temperature probe for signs of damage to the capillary tube.

4.2   CONNECTION TO A COMPUTER

The user communicates with the Micro CTD Sensor via any IBM or compatible computer or data collection device. An AML supplied data cable will link the two. Refer to the wiring diagram on the user's CD. At one end of the cable is a DB9 female connector that plugs into the computer's serial port and at the other end is a 8 pin plug that is inserted into the communications port of the Micro CTD Sensor. When this connection has been made and 12 volts applied, the instrument is powered up and ready to communicate with the computer.

> **WARNING:**
> **A plug or cable must be installed in the connector at all times when the instrument is immersed in water. Failure to do so will cause corrosion to the connectors and may cause water damage in the electronics housing**.

4.3   POWERING THE MICRO CTD SENSOR

4.3.1   External Power

The Micro CTD Sensor is normally powered externally via the communications cable. Refer to the wiring diagram on the user's CD. If an AML data cable is used attach the red wire to the positive side of the power supply and the black wire to ground. The power should be a DC voltage between 8 and 24 volts, measured at the instrument.   The instrument has reverse voltage protection but the instrument will not function if the power leads are connected with reverse polarity.
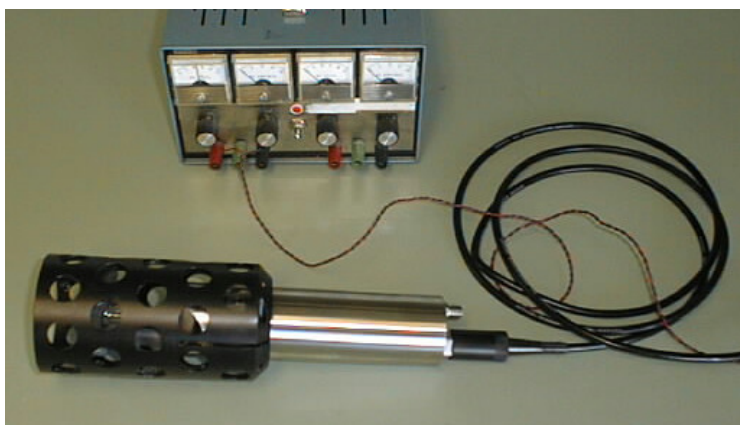
Figure 4.3.1   Micro instrument connected to an external power source

4.3.2   Micro CTD logging option

If the Micro CTD has been purchased with the logging option it will be equipped with internal memory and an external battery pack.   Refer to the wiring diagram on the user's CD. If the battery pack is used, the instrument is connected to either connector on the battery pack with an interconnect cable. The remaining connector on the battery pack is then connected to the data/power cable, which is connected to the computer. For logging data when not connected to the computer the red shorting plug must be inserted into the battery pack to turn the power on to the instrument. Power for the Micro CTD sensor is turned off if the there is no shorting plug or data/power cable plugged in to the battery pack.

Figure 4.3.2 Micro instrument with battery pack and external sensor connected to external power

4.3.2.1 Micro Battery Pack

Figure 4.3.2.1 The Battery pack

The replacement batteries should be three, good quality, C size, lithium, 3.6 volt batteries. Saft, LSH 14, C cell, 3.6 volt, lithium batteries are recommended. For more details on battery recommendations refer to section 7.2 .

Insert all three batteries into the brass housing positive end first. Replace the battery cap on the brass housing.

Check the O-ring seals. The O-rings should be clean, have no nicks, and should be lightly greased. Slide the battery assembly back into the pressure case and screw down the retaining ring.

4.4   SOFTWARE SETUP

If SmartTalk or ISS software has been supplied with the instrument refer to the appropriate manual for the installation and configuration of these programs. Both of these programs are supplied with Install Shield to simplify installation.

If a terminal emulation program such as Hyperterminal (Windows 95) or Procomm (DOS) is to be used launch the program. Select the appropriate com port (to which the instrument is connected), set the communications format to 8 bits, no parity, 1 stop bit and select a baud rate between 2400 and 38400 baud. Apply power to the instrument and press the **<enter>** key. The standard Micro CTD Sensor will respond with its header information. Note that some units may be configured for custom outputs and may not respond with a header. This header identifies the sensor type, serial number and firmware version. The sensor is then ready to accept commands. If the sensor does not respond refer to the trouble-shooting guide in section 6.3.

The command summary for communicating with the instrument is given in section 5.3.2.

5   COMMUNICATIONS

The Micro CTD is designed to be used with an IBM-compatible computer running a terminal emulation program or AML Oceanographic SmartTalk or ISS software packages, although it can be integrated into or used with other systems or vehicles with custom data collection applications.

When communicating with the instrument via the data / power connector, the instrument can bi-directionally, communicate via RS-232 or RS-485 at data rates up to 115.2K (38.4k auto baud). The instrument is normally configured at the factory to operate in RS-232 only mode unless RS-485 only or auto-detect operation was specified at the time of purchase. The setting can be changed in the field by the user. The setting is saved and becomes the default on power-up.

Note: In auto-detect mode, if nothing is connected (and ready to communicate) on the non-instrument end of the cable, the instrument communications will default to RS-485 mode. If RS-232 is the intended communications format, then the instrument needs to be turned off and back on after the other communications device is powered and ready in order to auto-detect RS-232.

For connection to a computer, AML Oceanographic normally supplies a cable with a DB9 female connector at one end that plugs into the computer's serial port and the appropriate connector for the instrument at the other end. When this connection has been made and power applied, the instrument is powered up and ready to communicate with the computer.

WARNING: A **plug or cable must be installed in the data/power connector** at all times when the instrument is immersed in water. Failure to do so will cause corrosion to the connectors and may cause water damage in the electronics housing.

5.1   RS-232/ RS-485 VIA THE DATA/POWER CABLE

When communicating with the Micro CTD via the data / power connector, the instrument can communicate via RS-232 or RS-485 at data rates from 600 to 115.2K baud. The baud rate can be auto-detected to bauds rates up to 38.4K baud.

5.1.1   RS-232 Capability

The RS-232 capability provided on the Micro CTD is defined as follows:
- Full-duplex
- 8 data bits, 1 stop bit, no parity, asynchronous
- Standard ASCII Code (128 characters)
- Logic 1 ("mark") is a voltage between -5 and -25 VDC referenced to ground
- Logic 0 ("space") is a voltage between +5 and +25 VDC referenced to ground
- Not compatible with TTL
- Line idles at "mark"
- Each data byte is framed by a logic 0 start bit and a logic 1 stop bit
- Baud detection on power up (to baud rates of 38.4Kbaud)
- Instrument is idle after baud detection (waiting for a command).
- Advanced user programmable settings available via AML Oceanographic's defined command and response set (refer to Commands Summary section).

5.1.2 RS-485 Capability

The RS-485 capability provided on the Micro CTD is defined as follows:
- Half-duplex, differential transmission (no ground reference)
- Termination resistor = characteristic impedance of the line
- 8 data bits, 1 stop bit, no parity, asynchronous
- Standard ASCII Code (128 characters)
- Logic 0 ("mark") is a voltage between -0.2 and -6 VDC referenced to ground
- Logic 1 ("space") is a voltage between +0.2 and +6 VDC referenced to ground
- Not compatible with TTL
- Each data byte is framed by a logic 0 start bit and a logic 1 stop bit
- Baud detection on power up (to baud rates of 38.4Kbaud)
- Instrument is idle after baud detection (waiting for a command).
- Advanced user programmable settings available via AML Oceanographic's defined command and response set (refer to Commands Summary section).

> Note: To match the impedance of the instrument communications circuit, a 120 ohm resistor should be soldered between the Tx and Rx pins at the computer end of the communications cable. Without this resistor, communications errors may occur.

5.2 SOFTWARE

There are a number of options for communicating with the Micro CTD. For communication via the data/power interface:
- AML Oceanographic provides two MS Windows-based applications called Smart Talk and Integrated System Software (ISS) with the instrument that operate on an IBM-compatible computer.
- The user also has the ability to use a terminal emulation program running on a computer or a custom application.

5.2.1 SmartTalk

SmartTalk is an easy to use, MS Windows based program that allows the user to program the instrument, view data, log data to the computer's hard drive, and export data for use in other programs such as MS Excel™.

Refer to the SmartTalk Manual for detailed instructions on the use of this program.

5.2.2 ISS

Integrated System Software is a comprehensive, MS Windows based program that allows the user to program the instrument, view, log, edit, graph, analyze, export and print the data from multiple instruments.

Refer to the ISS manual for detailed instructions on the use of this program.

5.2.3   Terminal Emulators and Custom Applications

Terminal emulation programs (such as HyperTerminal, ProComm or Commo) or custom applications can be used to communicate with the Micro CTD instrument. This may be necessary for diagnostic or integration purposes. To support the use of either type of communication program, the following information is provided in the Appendices of this manual:

1. Set up for a terminal emulation program, specifically HyperTerminal (Appendix A).
2. Set up for a terminal emulation program, specifically Procomm (Appendix B).
3. The 32-bit CRC Calculations and Table (Appendix D).

A cycle redundancy check (CRC) capability is available to improve communications integrity. When CRC is enabled all input must be validated with a 32-bit CRC value and all strings are displayed with a 32-bit CRC at the end of the line. The instrument is normally shipped from the factory with the CRC capability disabled. It is recommended that CRC be disabled while using Terminal Emulation programs but can be a useful capability for real-time, integration with custom applications. The CRC capability is enabled and disabled using SET CRC enable/disable command. The CRC setting is saved and used until again changed using the SET CRC command. There is no default setting.

5.3   ASCII COMMUNICATIONS

5.3.1   Standard Output Data format

The standard data format is for RS-232C ASCII based sensors. Custom data outputs and formats are listed in appendix A. The Micro CTD Sensor can output data in Raw or Real modes. The mode can be changed by supplying the appropriate command. Refer to section 5.3.2 for commands.

5.3.1.1 Header Output

When a standard Micro CTD Sensor is first powered up it monitors the communications line. If a data cable is connected the instrument will monitor the signal line for a carriage return/line feed (i.e. the **<enter>** key) from the external computer. The instrument automatically determines the baud rate and configures itself to match. The instrument then responds with the header information. The header identifies the sensor type, firmware version and serial number of the instrument and memory size if installed.

Example header:
>Micro CTD MC3 Version 3.11 Aug 26/07 SN:7444
Copyright(c) 2005-2007, AML Oceanographic
968.5 MBytes installed

5.3.1.2 Real Output Mode

The Real mode outputs only the final calculations of date/time and sensor readings in engineering units. The output is sent as space delimited ASCII characters in the following format:

Date (Month/Day/Year) Time (hh:mm:ss:and hundredths of seconds), conductivity (in mS/cm), pressure (in dbar), temperature (in °C), voltage (in volts) and a carriage return/line feed (end of scan).

Example scan:
09/24/07 10:15:46.30 31.869 0000.04 -00.103 010.43 35.802

The above example reads
Date:	Month/Day/Year
Time of scan:	1:59 pm and 57.92 seconds
Conductivity:	31.869 mS/cm
Pressure:	0.04 dbar
Temperaure:	-0.103°C
Voltage:	10.43 volts
Salinity:	35.802 psu

Note: a positive sign is not displayed for positive temperatures.

5.3.1.3 Raw Output Mode

The Raw mode shows the outputs from the analog to digital converters for each sensor. No compensation or manipulation of the data is performed in Raw mode. Refer to section 8 to convert the raw data values to engineering data. The raw counts for Nl, Nsv, Nh, Npt, Np, Nt and Nb are integers between 0 and 65535. The output is sent as space delimited ASCII characters in the following format:

The standard Micro CTD has the following raw output format
Date(Month/Day/Year) Time (hh:mm:ss:and hundredths of seconds), Nct, Nc, Npt, Np, Nt, Nb and a carriage return/line feed (end of scan).

Example scan:
06/29/07 10:16:16.02 084 29513 45937 03490 15555 000452

5.3.2   Command Summary
Most commands are in the form of standard English words. Commands can be entered in upper or lower case letters followed by an **<ENTER>**. The minimum letters of the command that the instrument will recognize are enclosed in brackets.

5.3.2.1 Basic Set Up Commands

Command: **RAW [R]**

> This command will set the instrument to output RAW uncorrected data when using the MONITOR or SCAN commands.

Command: **REAL [RE]**

> This command will set the instrument to output REAL corrected engineering data when using the MONITOR or SCAN commands.

Command: **/ [/]**

> This command is used to toggle RAW and REAL modes of operation.

Command: **SCAN [S]**

> This command outputs one scan of data.

Command: **MONITOR [M]**

> This command sets the instrument to output multiple scans continuously at the scan rate set by the "SET SAMPLE RATE" command. To discontinue the monitor command the break key or the space bar can be depressed.

Note:
1. This command is not available with the binary format instruments.
2. In real-time and logging mode, if an error occurs when the instrument tries to open the log file, the MONITOR command is terminated and the "Error opening or appending to log file" is displayed.
3. Note that fast sampling rates may be degraded by the baud rate and output formats chosen.

Command: **SET SAMPLE RATE [SE S]** num units

> This command sets the rate at which the instrument will take samples (or scans). The sample rate is in the form of a number followed by the time units. The allowable time units are listed below:
>
> > CONTINUOUS [C]
> > /SECONDS [/S]
> > SECONDS [S]

MINUTES [M]
HOURS [H]

The following examples demonstrate some of the possible permutations of this command.

SET SAMPLE 6 HOUR	This will set the sample rate for one sample every 6 hours.
SE SA 30 SEC	This will set the sample rate for one sample every 30 seconds.
SET S 5/S	This will set the sample rate for 5 samples per second.
SE S CONTINUOUS	This sets the sample rate at the maximum of 25 scans per second.

Note:
1. Care should be exercised when setting both the SAMPLE RATE and the pressure INCREMENT. For example, if the Sample rate is set to 1 minute and the pressure increment is set to 1 dBar, every 1 minute the instrument will check for a 1 dBar change in pressure.
2. Note that fast sampling rates may be degraded by the baud rate and output formats chosen.

Command: **SET TIME [SE T]** hh:mm:ss.ss

This command sets the real time clock in the instrument. This command uses the 24 hour clock with a format of hh:mm:ss.ss

Example:
    SET TIME 13:44:12.65

Command: **SET DATE [SE DA]** mm/dd/yy

This command sets the date using the format mm/dd/yy.

Example:
    SET DATE 03/11/07   *(March 11, 2007)*

Command: **SET SN [SE SN]** nnnn

This command sets the serial number of the instrument. This command is intended to facilitate integration into OEM equipment. To display the instrument's serial number use the VER command.
Example:

    >SET SN 7245

Note: To display the serial number use the DISPLAY VERSION command.

Warning: Changing the instruments serial number will adversely effect the operation of Smart Talk or ISS software.

Command: **DETECT [D]**

This command checks each slot in the motherboard to identify what is plugged in and displays the sensor / board type and serial number or empty for each slot. This information is required for talking to individual sensor boards as described in the section entitled "SENSOR BOARD GENERAL COMMANDS".

Example:
>DETECT
Detecting Sensors
1: Micro C SN: 02408
2: empty
3: Micro P&T SN: 01515
Detection complete
>

5.3.2.2 Basic Display Commands

Command: **DISPLAY VERSION [V]**

This command displays the current version of the firmware, instrument type and the serial number of the instrument

Example:
>DIS V

Micro CTD MC3 Version 3.11 Aug 26/07 SN:7444
Copyright(c) 2005-2006, AML Oceanographic
128MB of Memory *(added only if flash memory card is available)*

Note: If flash memory card is installed but there is a problem detecting the card, an error message will be displayed.

Command: **DISPLAY SAMPLE RATE [DIS S]**

This command displays the current scan rate.

Example:
>DIS S

Sample rate is 1 seconds

Command: **DISPLAY INCREMENT [DIS INC]**

This will display the current pressure increment setting in dBar.

Example:
>DIS INC

Pressure increment set to 5

Command: **DISPLAY SCAN [DIS SC]**

This command will display the current scan options.
Example:
>DIS SCAN
Scan delay is 5
Display salinity: yes
Display time: yes
Display date: yes
Realtime logging enabled: yes
Display battery: yes
>

Command: **DISPLAY STARTUP [DIS ST]**

This command will display the current startup options.

Example:
>DIS STARTUP

Logging timeout is disabled
Startup delay is 0
Header is displayed
Start up in prompt mode
Characters reception is enabled

Command: **DISPLAY BATTERY [DIS B]**

This command displays the battery channel coefficients and specified battery shut down voltage. The battery voltage is displayed in the scan data.

Example:
> DIS B

Battery
A= 2.608054E-01 B= 2.499812E-02
Shut down voltage is 8.0 volts
>

Command: **DISPLAY COEFFICIENTS [DIS C]**

When the instrument is not in TALK mode, the DISPLAY COEFFICIENTS command also displays the battery channel coefficients. The battery voltage is displayed in the scan data.

Example:
> DIS C

Battery
A= 2.608054E-01 B= 2.499812E-02
Shut down voltage is 8.0 volts
>

5.3.2.3 Communications Set-up Commands

Command: **SET FORCE [SE F]** mode

Where
mode = 232, 485 or auto (auto representing auto-detect)

Note: The instrument is normally configured at the factory to operate in RS-232 only mode unless RS-485 only or auto-detect operation was specified at the time of purchase.

This command sets the communications interface to auto-detect RS-232 or RS-485 communications (auto), or to RS-232 (232) or RS-485 (485) only mode. It is a saved setting that becomes the default on power-up.

Example 1:
>SET FORCE auto

>Communications is set for auto detection
Example 2:
>SET FORCE 232

>Communications is set for RS-232 mode.

Warning: In auto-detect mode, if nothing is connected (and ready to communicate) on the non-instrument end of the cable, the instrument communications will default to RS-485 mode. If RS-232 is the intended communications format, then the instrument needs to be turned off and back on after the other communications device is powered and ready in order to auto-detect RS-232.

Command: **DISPLAY FORCE [DIS F]**

This command displays the current mode of communications as either auto detection, RS-232 or RS-485.

Example:
>DIS FORCE

>Communications is set for RS-485 mode.

Command: **SET DETECT [SE DE]** ab

Where
   a = a Hex number between 0-F
   b = a Hex number between 0-7

   This command sets the detection mode of the instrument on power up to start up in the *Auto baud mode* or to set the instrument to default to a specific baud rate at power up.

   The 'a' value defines how many times the Micro CTD will try to determine the baud rate (when the enter key is pressed) before it defaults to the baud rate set by the value of 'b'. If a = 0 the Micro CTD will not auto baud and will default to the baud rate specified by the value of 'b" at each power up.

   The 'b' value defines the baud rate to be used, if auto-baud detection fails or if a specific baud rate is required, as described in the following table:

b value	Baud rate
1	600
2	1200
3	2400
4	4800
5	9600
6	19200
7	38400
8	57600
9	115200

Note: There is no auto detect for baud rates above 38400. Use the SET BAUD command to set for 57600 and 115200 baud rates.

   Example 1:
      >SET DETECT 97

   In the above example, the Micro CTD will try 9 times to auto baud. If the instrument is not able to establish a baud rate, it will default to 38400 baud.

   Example 2:
      >SET DETECT 05

   In the above example, the Micro CTD will *not* try to auto baud, but will simply default to 9600 baud on power up.

Command: **SET SENSOR DETECT ONCE**

   This command sets the instrument to check for new or missing sensors only on power up.

Command: **SET SENSOR DETECT ALWAYS**

This command sets the instrument to check for new or missing sensors every time the instrument takes a scan.

Command: **SET BAUD [SE BAU]** value **(NOPROMPT)**

The SET BAUD command is a temporary setting and is lost on power down of the instrument. When the instrument is powered on again it will revert to the setting last defined by the SET DETECT command.

This command will set the instrument to a fixed baud rate defined by the value. Where value can be: 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200. The NOPROMPT part of the command is optional. If this option is not used, then the SET BAUDRATE command returns a prompt indicating that the baud rate has been changed but the communications is idle awaiting a carriage return before being activated, giving the user an opportunity to adjust the baud rate on the other end, if required. The baud rate can be changed immediately without prompt by adding the NOPROMPT option on the command line.

Example 1:
>SE BAU 115200

Baud rate is now set to 115200. Press Return to continue.
>

Example 2:
>SE BAU 9600 NOPROMPT

Command: **SET CRC** enable/disable

This command enables or disables the cycle redundancy check (CRC) checking option.

Note: CRC must be disabled when using SmartTalk and ISS software. For ease of use, CRC should be disabled when using a terminal emulation program.

When CRC is enabled, all input must be validated with a 32-bit CRC value and all strings are displayed with a 32-bit CRC at the end of the line. The instrument is normally shipped from the factory with the CRC capability disabled. The CRC setting is saved and used until again changed using the SET CRC command. There is no default setting.

Example 1:
>SET CRC enable
CRC mode is enabled.

Example 2:
>SET CRC disable081874FF
Or

>SET CRC disB4CEC0CC
CRC mode is disabled.

A lookup table and function to compute the running total of a 32-bit CRC is provided in Appendix D. When CRC is enabled, the CRC value can be obtained for any command by typing a ? at the end of the command. The CRC value will be returned.

For example:
>SET CRC DISABLED ?

The CRC value 1D9598C0 will be displayed at the end of the command line

>SET CRC DISABLED 1D9598C0
CRC mode is disabled

Note: The CRC is case sensitive. When using the ? to request the CRC, the CRC is displayed for the command as it appears. When retyping the command with the CRC included, the command must be entered exactly as before. Put the CRC value in the exact position as the ? was placed (i.e. space or no space after the command characters). All letters in the CRC must be entered as UPPERCASE characters.

Command: **SET RXOFF [SE RXOFF]**

This command will disable the reception of characters at the next power up. The RXOFF command instructs the Micro CTD to ignore any communications from the computer and is used to assure spurious signals due to external noise or long cable lengths do not interrupt the Micro CTD.

On power up, the Micro CTD will wait for 200ms before entering into the RXOFF mode and during this time sending a carriage return will disable the RXOFF features. To exit the RXOFF mode, hold down the carriage return key and power up the unit, then from the prompt, issue the SET RXON command.

Command: **SET RXON [SE RXON]**

Enables reception of characters at the next power up.

Command: **SET TIMEOUT [SE TIMEO] nn**

Where 'nn' is time in minutes and represents an integer value from 0 to 30
This command instructs the Micro CTD to enter a logging mode after a specified time interval has passed in which the instrument has been idle. A time interval of 0 will deactivate the command. Use the DIS ST command to view the timeout value.

NOTE: you can exit logging mode by either:
- Power the Micro CTD off, then on, or
- press a keyboard key if the SET BREAK ON is enabled.

Example:

>SET TIMEOUT 10

The above example will instruct the Micro CTD to enter the logging mode if it sits idle at the command prompt for more than ten minutes.

>SET TIMEOUT 0 *(disable the timeout feature)*

5.3.2.4 Set Scan Options Commands

Command: **SET SCAN DELAY [SE SC D]** nnn

The *scan delay* is defined as the time between the sensor board power up and a scan of data. The time (nnn) is entered in 0.2-second intervals. Maximum *scan delay* is 255, or 51 seconds.

This command is used for sensors that have a slower power up response time.

Example:
>SET SCAN DELAY 150 *(sets the scan delay to 30 seconds)*

In the example below, the Micro CTD would power up the sensor boards, wait 30 seconds, then take a scan of data.
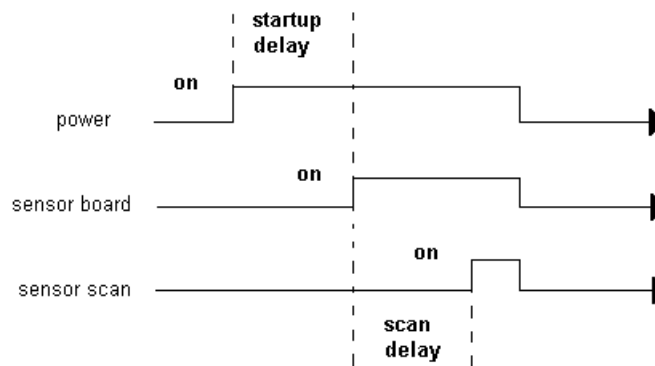
Figure D- 1 Micro CTD Power-up Timing Diagram

Command: **SET SCAN TIME [SE SC T]**

This command enables the displaying of time during a data scan.

Command: **SET SCAN NOTIME [SE SC NOT]**

This command disables the displaying of time during a data scan.

Command: **SET SCAN DATE [SE SC DA]**

This command enables the displaying the date during a data scan.

Command: **SET SCAN NODATE [SE SC NOD]**

This command disables the displaying of the date during a data scan.

Command: **SET SCAN LOGGING [SE SC L]**

This command enables simultaneous logging and real-time output. This setting is stored and becomes the real-time default on power up.

Command: **SET SCAN BATTERY [SE SC BAT]**

This command turns the battery channel on, allowing it to be present in instrument output scans. Current battery display status is viewable using DIS SCAN.

Command: **SET SCAN NOBATTERY [SE SC NOBAT]**

This command turns the battery channel off, removing it from the instrument output scans. Current battery display status is viewable using DIS SCAN.

Command: **SET SCAN NOLOGGING [SE SC NOL]**

This command disables simultaneous logging and real-time output. This setting is stored and the real-time output only becomes the default real-time mode on power up.

Command: **SET SCAN NOSALINITY [SE SC N]**

This command will disable the displaying of the salinity channel during a data scan.

Command: **SET SCAN SALINITY [SE SC S]**

This command will enable the displaying of salinity channel during a data scan.

Please note: Salinity is calculated from depth, temperature and conductivity and is not stored in the Micro CTD's memory.

5.3.2.5 Set Start-up Options Commands

Command: **SET STARTUP DELAY [SE ST D]** nnn

The Startup Delay time is defined as the time difference between the logger board powered up, and when the sensor boards are powered up. The time (nnn) is entered in 0.02-second intervals. Maximum *startup delay* is 255, or 5 seconds.
This command may be used for a "gentle power on", to power up the instrument in stages thus avoiding large power up current spikes that may result when using long cables or batteries with high internal resistances.

Example:
>SET STARTUP DELAY 200   *(set the startup delay to 4 seconds)*

In the above example, 4 seconds after the Micro CTD is powered up the sensor boards will be powered up.
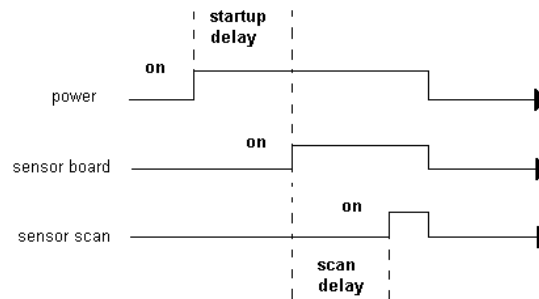
Figure D- 2 Micro CTD Power-up Timing Diagram

Command: **SET STARTUP HEADER [SE ST H]**

Display the header at power on.

Use SET STARTUP NOHEADER to disable header

Command: **SET STARTUP NOHEADER [SE ST N]**

Do not display the header at power on.

Use SET STARTUP HEADER to enable header

Command: **SET STARTUP SCAN [SE ST S]**

This command sets the Micro CTD to automatically output one scan of data at power on. If the auto baud feature has not been disabled, the Micro CTD will wait for a *carriage return* before it outputs data. (See SET DETECT command).

Use the SET STARTUP MONITOR and SET STARTUP PROMPT commands for alternative startup options

Example:
>SET DETECT 05   *(disable the auto baud and default to 9600 baud at power up)*
>SET STARTUP NOHEADER   *(do not display a header at power up)*
>SET STARTUP SCAN

On power up…
09/24/07 10:15:46.30 31.869 0000.04 -00.103 010.43 35.802
>

Command: **SET STARTUP MONITOR [SE ST M]**

This command sets the Micro CTD to automatically output scans at power on.
If the auto baud feature has not been disabled, the Micro CTD will wait for a *carriage return* before it outputs data. (See SET DETECT command). The following example sets the Micro CTD to output data at power up with a baud rate of 9600.

Use the SET STARTUP SCAN and SET STARTUP PROMPT commands for alternative startup options

Example:
>SET DETECT 05   *(disable the auto baud and default to 9600 baud at power up)*
>SET STARTUP NOHEADER   *(do not display a header at power up)*
>SET STARTUP MONITOR

At power up the Micro CTD will continuously output Real data at 9600 baud.

Note: To return to the prompt, hold down the RETURN key while powering up the Micro CTD.
Use the SET STARTUP PROMPT command to return the Micro CTD to the prompt mode.

Command: **SET STARTUP PROMPT [SE ST P]**

This command instructs the Micro CTD to display a prompt at power on.
If the auto baud feature has *not* been disabled, the Micro CTD will wait for a
 carriage return before it outputs a prompt. (See SET DETECT command).
The following example instructs the Micro CTD to go directly to a prompt at power up.

Use the SET STARTUP SCAN and SET STARTUP MONITOR commands for alternative startup options

Example:
>SET DETECT 07   *(disable the auto baud feature and set the baud rate to 38400)*
>SET STARTUP NOHEADER   *(disable the header)*
>SET STARTUP PROMPT   *(places the Micro CTD in the prompt mode)*

Command: **SET TIMEOUT [SE TIMEO] nn**

This command affects the startup conditions of the instrument as well. Refer to section 5.3.2.3 for this command.

5.3.2.6 Sensor Board General Commands

The Micro CTD allows intelligent sensor and output data boards to be plugged into a selection of board slots on the motherboard. The motherboard can detect and identify the board and/or sensor type located in each slot. Each board stores serial number, calibration coefficients, configuration and status information, as applicable.   Based on the suite of sensors identified and other configuration information, the motherboard creates the data output and storage format and coordinates communications to and from the plug boards and the sensors. The user can communicate with individual boards through the motherboard by first requesting access using the TALK command. Once communications is established with the individual sensor and/or board, the user can use other commands specific to the board.

Command: **TALK [TA]** n

> Where,

> > n = an integer 1 – 3 that identifies the slot number of the board to be communicated with

> The DETECT command described in the Basic Display Commands sections is used to identify which board is in which slot number.

> On a standard instrument the boards are placed in the following order.

> | Sensor board slot | Address |
> |---|---|
> | Conductivity | 1 |
> | Spare | 2 |
> | Pressure & Temperature | 3 |

> To exit the *talk mode*, use the CTRL C command.

NOTE: While in the talk mode other commands such as MONITOR, VERSION and SCAN may be used.

> Example 1:
> > >talk 1   *(enter talk mode with the conductivity board in slot 1)*
> > Entering talk mode 1
> > Conductivity Micro Sensor V2.07 SN:2408-C
> > Copyright(c) 2000-2005, AML Oceanographic

> > >dis c
> > Conductivity (salt)
> > A=-1.098624E-02 B= 6.103991E-07 C=-4.971455E-09 D= 1.567713E-11
> > E= 2.560894E-05 F=-1.422841E-09 G= 1.158846E-11 H=-3.654345E-14
> > Threshold = 500

> > Conductivity (fresh)
> > A=-6.805635E+38 B=-6.805635E+38 C=-6.805635E+38 D=-6.805635E+38

E=-6.805635E+38 F=-6.805635E+38 G=-6.805635E+38 H=-6.805635E+38
Threshold = 2000

Using salt water coefficients

>SET R F *(set the conductivity range to fresh)*

Using fresh water coefficients

>**<CTRL C>** *(exit talk mode)*
Exiting talk mode
>

Example2 :
>talk 3
Entering talk mode 3
Pressure and Temperature Micro Sensor V2.07 SN:5942-PT
Copyright(c) 2000-2005, AML Oceanographic

>dis c *(display the P&T coefficients)*
Pressure
A=-2.953012E+03 B= 2.119312E-01 C=-4.793926E-06 D= 3.247081E-11
E=-1.197257E-01 F= 8.347287E-06 G=-1.402603E-10 H= 7.296969E-16
I=-1.232459E-05 J= 7.839810E-10 K=-1.662577E-14 L= 1.175001E-19
Temperature
A=-4.555392E+01 B= 5.209653E-03 C=-2.014843E-07 D= 5.588565E-12
E=-8.685370E-17 F= 6.885006E-22 G=-1.782784E-27

>s *(scan the PT sensors in real mode)*
 0000.96 23.903

>/ *(toggle to raw mode)*
Raw Mode

>s *(scan the PT sensors in raw mode)*
46844 05402 28906

Command: **CTRL-C**

This command exits the talk mode.
(Press the 'ctrl' key and the 'c' key at the same time)

Command: **DISPLAY COEFFICIENTS [DIS C]**

This command, while in TALK mode, displays the coefficients of the sensor board that communications is established with.

Command: **VERSION [V]**

This command, while in TALK mode, displays the current version of the firmware, board type and the serial number of the sensor board that communications is established with.

Example:
> V
MC3 Version 3.05 Jun 25/07 SN:7444
Copyright(c) 2005-2007, AML Oceanographic
968.5 MBytes installed

Command: **SET RANGE FRESH [SET R F]**

This command, while in TALK mode with the conductivity board, will set the conductivity range from 0 to 9 mS/cm (0 to 10 psu). The sensor's fresh water calibration coefficients will be used to calculate conductivity. To view the range setting after selection the DISPLAY C command can be used. To exit the *talk mode*, use the CTRL C command.

Example:
>TALK 1 *(enter talk mode with the conductivity board in slot 1)*

Entering talk mode 1
Conductivity Micro Sensor V2.02 SN:7134-C
Copyright(c) 2000-2004, AML Oceanographic
>

>SET R F *(set the conductivity range to fresh)*

Using fresh water coefficients
>

>DIS C *(display both sets of conductivity coefficients)*

Conductivity (salt)
A=-1.137264E-02 B=-2.584538E-05 C= 3.955218E-07 D=-1.737175E-09
E= 3.799872E-06 F= 2.835281E-09 G=-1.493990E-10 H= 8.650976E-13
Threshold = 500

Conductivity (fresh)
A=-1.167051E-02 B=-2.837877E-06 C= 3.370388E-08 D=-1.163657E-10
E= 3.409089E-06 F= 1.322281E-09 G=-1.344379E-11 H= 4.273783E-14
Threshold = 3470

Using fresh water coefficients
>

Command: **SET RANGE SALT [SET R S]**

This command, while in TALK mode with the conductivity board, will set the conductivity range from 2 to 70 mS/cm (2 to 40 psu). The sensor's salt water calibration coefficients will be used to calculate conductivity. To view the range setting after selection the DISPLAY C command can be used. To exit the *talk mode*, use the CTRL C command.

Example:
    >TALK 1 *(enter talk mode with the conductivity board in slot 1)*

    Entering talk mode 1
    Conductivity Micro Sensor V2.02 SN:7134-C
    Copyright(c) 2000-2004, AML Oceanographic
    >

    >SET R S *(set the conductivity range to salt)*

    Using salt water coefficients
    >

    >DIS C *(display both sets of conductivity coefficients)*

    Conductivity (salt)
    A=-1.137264E-02 B=-2.584538E-05 C= 3.955218E-07 D=-1.737175E-09
    E= 3.799872E-06 F= 2.835281E-09 G=-1.493990E-10 H= 8.650976E-13
    Threshold = 500

    Conductivity (fresh)
    A=-1.167051E-02 B=-2.837877E-06 C= 3.370388E-08 D=-1.163657E-10
    E= 3.409089E-06 F= 1.322281E-09 G=-1.344379E-11 H= 4.273783E-14
    Threshold = 3470

    Using salt water coefficients

Command: **SET FORMAT *AB* [SET FOR *AB*]**

This command, while in TALK mode with a single sensor board such as conductivity or sound velocity, will set the real output format. A is the number of digits ahead of the decimal place and B is the number of digits after the decimal place. To exit the *talk mode*, use the CTRL C command.

After exiting *talk mode* use the *detect* command to update the formats on the logger board as well. Powering down the instrument will also update the logger board.

Example:
    >TALK 1 *(enter talk mode with the conductivity board in slot 1)*
    Entering talk mode 1

Conductivity Micro Sensor V2.07 SN:3675-C
Copyright(c) 2000-2005, AML Oceanographic

>s
 00.001

>SET FOR 41 *(set the conductivity output format to xxxx.x)*

>s
-0000.0

>SET FOR 32 *(set the conductivity output format to xxx.xx)*

>s
 000.00

><CTRL+C>
Exiting talk mode

Command: **SET *X*FORMAT AB [SET *X*FOR *AB*]**

This command, while in TALK mode with a dual sensor board such as the PT board or analog board, will set the real output format. X is the sensor designator, I.e. P for pressure, T for temperature, 1 for analog channel 1 and 2 for analog channel 2. A is the number of digits ahead of the decimal place and B is the number of digits after the decimal place. To exit the *talk mode*, use the CTRL C command.

After exiting *talk mode* use the *detect* command to update the formats on the logger board as well. Powering down the instrument will also update the logger board.

Example:
   >TALK 3 *(enter talk mode with the PT board in slot 3)*
   Entering talk mode 3
   Pressure and Temperature Micro Sensor V2.07 SN:3718-PT
   Copyright(c) 2000-2005, AML Oceanographic

   >S
    0000.09 23.455

   >SET PFOR 31 *(set the pressure output format to xxx.x)*

   > SET TFOR 32

   >S
    000.0 023.56

   > SET PFOR 42

> SET TFOR 23

>S
 0000.06 23.565

>**<CTRL+C>**
Exiting talk mode

5.3.2.7 Editing the Calibration Coefficients

The instruments calibration coefficients are stored in the Micro CTD's memory. The battery voltage coefficients can be accessed by sending commands to the instrument. Accessing the coefficients for viewing or editing all other sensor can be achieved by talking to the individual sensor boards using the TALK command. The addresses of the sensor boards are as follows,

Sensor board slot	Address
Conductivity	1
Spare	2
Pressure & Temperature	3

Once communications is established with the individual sensor board the user can view or edit the calibration coefficients by using the DIS COEFFICIENTS or SET commands.

The following describes the method to edit the Calibration coefficients for each parameter of the Micro CTD using the SET command. Refer to the TALK command for accessing the coefficients.

The calibration equations for the sensors can be found in section 8.

<u>Conductivity</u>

Command: **SET r n = c**

      Where r = conductivity range FRESH or SAL
            n = the coefficient letter A through H
            c= calibration coefficient

      Example:
      >talk 1   *(enter talk mode with the conductivity board in slot 1)*
      Entering talk mode 1
      Conductivity Micro Sensor V2.07 SN:2408-C
      Copyright(c) 2000-2005, AML Oceanographic

      >set sal a=-1.098624E-02   *(set the salt A coefficient)*
      >set fresh a=-3.055426E-04   *(set the fresh A coefficient)*

>dis c *(display the conductivity sensor coefficients)*
Conductivity (salt)
A=-1.098624E-02 B= 6.103991E-07 C=-4.971455E-09 D= 1.567713E-11
E= 2.560894E-05 F=-1.422841E-09 G= 1.158846E-11 H=-3.654345E-14
Threshold = 500

Conductivity (fresh)
A=-3.055426E-04 B=-6.805635E+38 C=-6.805635E+38 D=-6.805635E+38
E=-6.805635E+38 F=-6.805635E+38 G=-6.805635E+38 H=-6.805635E+38
Threshold = 2000

Using salt water coefficients

>
Press ctrl-c to exit the talk mode

Command: **SET SALT THRESHOLD n [SE SAL THRESH n]**

This command sets the logging threshold for the raw conductivity (Nc) channel when in salt water mode. Above this count the instrument will assume an 'in water' condition and begin logging if it is in configured to log. Note that this command must be used while in TALK mode with the conductivity sensor

Example:
>SET SALT THRESHOLD 500

Command: **SET FRESH THRESHOLD n**

This command sets the logging threshold for the raw conductivity (Nc) channel when in fresh water mode. Above this count the instrument will assume an 'in water' condition and begin logging if it is in configured to log. Note that this command must be used while in TALK mode with the conductivity sensor

Example:
>SET FRESH THRESHOLD 450

In air the conductivity count is typically 0. Typical count thresholds for salt and fresh are 500 and 450 counts respectively.

Pressure and Temperature

Pressure

Command: **SET Pn=c**

Where n = coefficient letter a,b,c,d,e,f,g,h,i,j,k,l
        c = calibration coefficient

Example:
>talk 3
Entering talk mode 3
Pressure and Temperature Micro Sensor V2.07 SN:5942-PT
Copyright(c) 2000-2005, AML Oceanographic

>set pa=-2.953012E+03   *(set the pressure A coefficient)*

>dis c   *(display the calibration coefficients)*
Pressure
A=-2.953012E+03 B= 2.119312E-01 C=-4.793926E-06 D= 3.247081E-11
E=-1.197257E-01 F= 8.347287E-06 G=-1.402603E-10 H= 7.296969E-16
I=-1.232459E-05 J= 7.839810E-10 K=-1.662577E-14 L= 1.175001E-19
Temperature
A=-4.555392E+01 B= 5.209653E-03 C=-2.014843E-07 D= 5.588565E-12
E=-8.685370E-17 F= 6.885006E-22 G=-1.782784E-27

>
Press ctrl-c to exit the talk mode

Temperature

Command: **SET Tn=c**

Where n = coefficient letter a,b,c,d,e,f,g
        c = calibration coefficient

Example:
>talk 3 *(enter talk mode with the Pressure and Temperature board)*
Entering talk mode 3
Pressure and Temperature Micro Sensor V1.30 SN:0001-PT

>set ta=-4.555392E+01

>dis c *(display the calibration coefficients)*
Pressure
A=-2.953012E+03 B= 2.119312E-01 C=-4.793926E-06 D= 3.247081E-11
E=-1.197257E-01 F= 8.347287E-06 G=-1.402603E-10 H= 7.296969E-16
I=-1.232459E-05 J= 7.839810E-10 K=-1.662577E-14 L= 1.175001E-19
Temperature
A=-4.555392E+01 B= 5.209653E-03 C=-2.014843E-07 D= 5.588565E-12
E=-8.685370E-17 F= 6.885006E-22 G=-1.782784E-27

>
Press ctrl-c to exit the talk mode

Optional Analog board

Analog channel 1

Command: **SET 1n=c**
　　　　Where n = coefficient letter a,b,c,d
　　　　　　c = calibration coefficient

Analog channel 2

Command: **SET 2n=c**
　　　　Where n = coefficient letter a,b,c,d
　　　　　　c = calibration coefficient

　　　　Example:
　　　　　　>talk 2 *(enter the talk mode with slot 2, the analog board)*
　　　　　　Entering talk mode 2
　　　　　　Analog Micro Sensor V1.30 SN:0003-A

　　　　　　>set 1a=1 *(set the a coefficient of channel 1)*
　　　　　　>set 2a=2 *(set the a coefficient of channel 2)*

　　　　　　>dis c *(display the calibration coefficients)*
　　　　　　Channel 1
　　　　　　A= 1.000000E+00 B= 0.000000E+00 C= 0.000000E+00 D= 0.000000E+00
　　　　　　Channel 2
　　　　　　A= 2.000000E+00 B= 0.000000E+00 C= 0.000000E+00 D= 0.000000E+00

　　　　Press 'crtl-c' to exit the talk mode.

Battery voltage
　　Command: **SET BATTERY n = c [SET BAT n=c]**
　　　　Sets the battery voltage coefficients. Where n = coefficient letter a or b and c =
　　calibration coefficients for battery voltage
　　　　Example:
　　　　>SET BAT A = 1.4352E-3
　　　　>SET BAT B = 3.75325E-1

　　Command: **SET BATT SHUT x.x**
　　　　Sets the battery voltage level below which the instrument will shut down when in
　　　　battery pack & shorting plug untethered logging mode, where x.x = the voltage to
　　　　1 decimal place.
　　　　Example:
　　　　>SET BATT SHUT = 8.0

5.3.2.8 Logging Commands

Command: **SET** sensor **INCREMENT** value **[SE** sensor **INC** value**]**

This command sets the logging by increment function of the instrument to a specific sensor and increment value, where:

Sensor = P (Pressure)

Value = an integer or real value with 1 decimal place.

Example:
>SE P INC 0.1

Command: **DISPLAY INCREMENT [DIS INC]**

This command displays the logging increment for pressure in dBars. (dBars are approximately equal to meters).

Example:
>DIS INC

Logging pressure increment is 0.00
>

Command: **LOG [L]**

This command forces the instrument to go into logging mode from real-time mode. It will remain in logging mode until the power is turned off.

Example:
>L

Note: There is no user command to change the mode back to real-time if SET BREAK ON is not enabled

Command: **SET LOG [SE L]** filename

This command creates a file in memory with the name set by filename for the instrument's logged data. The default file name is log.raw. The filename can be up to 8 characters for the name and 3 characters for the extension. The file size is limited only by the size of the memory.

Example:
>SE L filename

Command: **SET BREAK ON**

> This command sets an option to break out of forced logging by sending a any character from the keyboard.

> > Example:
> > >SET BREAK ON

Command: **SET BREAK OFF**

> This command disables the SET BREAK ON option.

Command: **SET SALT THRESHOLD n [SE SAL THRESH n]**

> This command sets the logging threshold for the raw conductivity (Nc) channel in salt water mode. Above this count the instrument will assume an 'in water' condition and begin logging if it is in configured to log. Refer to the conductivity coefficient commands in section 5.3.2.7

Command: **SET FRESH THRESHOLD n**

> This command sets the logging threshold for the raw conductivity (Nc) channel in fresh water mode. Above this count the instrument will assume an 'in water' condition and begin logging if it is in configured to log. Refer to the conductivity coefficient commands in section 5.3.2.7

Command: **SET TIMEOUT n**

> 'nn' is time in minutes from 0 to 30. Enters logging mode after the specified time interval has passed in which the instrument has been idle. Power the unit off, then on to exit the logging mode. A time interval of 0 will deactivate the command. Refer to section 5.3.2.3.

Command: **SET SCAN PWRON**

> Leaves power to sensor board slots on after scanning. This command is not retained when the instrument is powered down and defaults back to the SCAN PWROFF setting on power up.

Command: **SET SCAN PWROFF**

> Turns power to sensor board slots off between scans. This setting is the default on instrument power up. Note that when monitoring or when logging in time out or forced (command) logging modes, instruments are continuously powered regardless of this default setting.

Command: **SET BATT SHUT x.x**

> Sets the voltage below which the instrument will shut down when in logging mode. Refer to the battery coefficient commands in section 5.3.2.7

Command: **SET SCAN LOGGING [SE SC L]**

> This command enables simultaneous logging and real-time output. This setting is stored and becomes the real-time default on power up. If real-time logging in air is desired, set instrument conductivity threshold and sound velocity & pressure increments to zero.

Note: Logging will not occur unless the conductivity is above the logging threshhold.

Command: **SET SCAN NOLOGGING [SE SC NOL]**

> This command disables simultaneous logging and real-time output. This setting is stored and the real-time output only becomes the default real-time mode on power up.

Command: **INIT**

> This command clears the instruments memory.

Warning: This command will erase all data in the instrument's memory.

Command: **DIRECTORY [DI]**

> This command displays a list of the files in the instrument memory and the status of the memory including amount of memory space free and used, and number of files.

> Example:
> > DI
>
> test   .raw   2580 05/16/05 20:15:54.00
> test2   .raw   645 05/16/05 20:31:09.00
>
>   60 MBytes free
>   0 MBytes Used
>   2 File(s) listed
> >

Command: **DUMP [DU]** filename

This command dumps the instrument's logged data from memory. The data will be dumped in REAL or RAW formats according to the current setting of the instrument.

In battery pack & shorting plug, command (LOG) or TIMEOUT logging modes, the logged data will be separated by a 'New Cast' header each time logging resumes from a non logging state. These transitions occur when the instrument's power is cycled or when the defined raw conductivity threshold value of the active conductivity threshold (salt or fresh) is exceeded due to a change in external environmental conditions (ex. Air to salt water) transitioning the instrument from a non logging state to a logging state.

In real time logging mode, the data is only separated by a 'New Cast' header when the instrument's power is cycled, despite running transitions from non logging to logging states.
Example:
>DUMP filename

New Cast
07/10/07 10:15:55.74 31.910 0000.04 02.454 008.00 35.907
07/10/07 10:15:55.76 31.912 0000.04 02.455 008.00 35.909
07/10/07 10:15:55.79 31.912 0000.05 02.455 008.00 35.909

Command: **DELETE [DEL]** filename

This command erases the logged file identified by filename.

Example:
>DEL filename

Command: **DISPLAY LOG [DIS L]**

This command displays the contents of the current log file.

Example:
>DIS L

Depending on the data format mode (REAL or RAW) set in the instrument, the data output will be in standard REAL or RAW format.

Command: **SET TIMEOUT [SE TIMEO] nn**

This command affects the logging conditions of the instrument as well. Refer to section 5.3.2.3 for this command.

5.3.2.9 Optional Current Loop Data Output Board Commands

The following SET commands require the user to enter 'TALK' mode and communicate directly with the Current Loop board (refer to Sensor Board General Commands in section 5.3.2.6). The Current Loop board is normally located in slot 2. The board slot can be confirmed using the DETECT command (refer to Basic Set-Up Commands section in section 5.3.2.1).

Once in TALK mode, the following commands can be used to set-up or change the minimum and maximum REAL values that are to be associated with 4mA and 20mA current output values.

Command: **SET Loop1 Max=nnnnn**

> This command sets the maximum value expected from the sensor associated with current loop 1 of the instrument.

Command: **SET Loop1 Min=nnnnn**

> This command sets the minimum value expected from the sensor associated with current loop 1 of the instrument.

Command: **SET Loop2 Max=nnnnn**

> This command sets the maximum value expected from the sensor associated with current loop 2 of the instrument.

Command: **SET Loop2 Min=nnnnn**

> This command sets the minimum value expected from the sensor associated with current loop 2 of the instrument.

> Example:
> >SET Loop1 Max=500   (set the maximum pressure to 500 dBars)
> >SET loop1 min=0   (set the minimum pressure to 0 dBars)
> >SET Loop2 Max=1600   (set the maximum sound velocity to 1600 m/s)
> >SET loop2 min=1400   (set the minimum sound velocity to 1400 m/s)
> >Dis c   (display both loop settings)
> Current Loop 1
> Max= 5.000000E+02 Min= 0.000000E+00
> Current Loop 2
> Max= 1.600000E+03 Min=-1.400000E+03

Command: **SET Loop(1 or 2) Data=nnnnn**

> This command sets the state of the current loop. The value must be within the maximum and minimum values specified for the loop. Values entered beyond the maximum or minimum settings will be clipped to those values. The equivalent current output for the data value can be calculated using the general formula below.

Current output (in mA) = $\dfrac{(Data - LoopMin)}{(LoopMax - LoopMin)}$ * 16(current span) + 4(mA)

Example:
With loop 1 representing pressure, Loop1 Max=500, Loop1 Min=0.

>Set loop1 data=250   (set the current loop data to 250)

The equivalent current output would be:

Current output (in mA) = (250-0)/(500-0) * 16 + 4
= (0.5) * 16 + 4
= 12 mA

5.3.3 Logging data

If the Micro CTD Sensor has been configured with the "Logging Option", the instrument will have the capability of storing data in its non-volatile memory. There are two methods for logging data, untethered using the external battery pack or tethered using the data/power cable.

5.3.3.1 Untethered Logging

Untethered logging is using the instrument to collect data without requiring a cable to the surface. Untethered logging requires a battery pack, interconnect cable and shorting plug.

A typical logging sequence would be as follows:

- Connect the Micro CTD to a computer and power supply via the communications cable
- Establish communications with the Micro CTD using a terminal program
- Program the instrument's logging parameters
- Unplug the communications cable from the Micro CTD
- Connect the Micro CTD to the Battery Pack using the interconnect cable
- Insert the Red Shorting plug into the Battery Pack (this turns on power to the instrument.
- Deploy and recover the instrument
- Remove the Shorting Plug to power down the instrument
- Connect the Micro CTD to a computer and power supply via the communications cable
- Capture the logged data using SmartTalk, ISS or by using the Micro CTD's DUMP command using a terminal program

> **Note: The Micro CTD Sensor will not log data into its memory unless the instrument's conductivity sensor detects that it is in salt water and power is applied via the shorting plug or data/power cable. Refer to the SET SALT THRESHOLD command in section 5.3.2.7**

5.3.3.2 Tethered Logging

Tethered logging is using the instrument to collect data while the data/power cable is connected. Tethered logging can be done using external power via the data/power cable or it can be done with the instrument connected to a battery pack that is connected to a computer via the data/power cable.

There are three modes of tethered logging operation.
- Real Time Logging (SET SCAN LOGGING)
- Command Logging (LOG) and
- TIMEOUT Logging.

Refer to the commands in section 5.3.2 to enter each of these logging modes

A typical TIMEOUT logging sequence would be as follows:

- Connect the Micro CTD to a computer and power supply via the communications cable
- Establish communications with the Micro CTD using a terminal program
- Program the instrument's logging parameters, including the timeout command
- Do not communicate to the instrument for the prescribed timeout period, the instrument will then start logging. Refer to the SET TIMEOUT command in section 5.3.2.3 .
- Turn off power to the instrument by removing the data/power cable from the instrument or battery pack to stop logging or hit key if SET BREAK ONis enabled.
- Reconnect the data/power cable
- Reset the timeout interval to 0 to disable the logging mode using a terminal program
- Capture the logged data using SmartTalk, ISS or by using the Micro CTD's DUMP command

---

Note: For timeout logging the Micro CTD Sensor will not log data into its memory unless the instrument's conductivity sensor detects that it is in water (threshold) , and communications have been idle for the timeout period.

---

6   PRECAUTIONS AND TROUBLESHOOTING GUIDE

6.1   PRECAUTIONS

6.1.1   Conductivity Cell Precautions

As the conductivity cell has platinized metal electrodes (refer to figure 7-1) there will be a wetting time before the cell will give accurate data. If the cell has been left to dry, the wetting time could be as long as one hour at atmospheric pressure. To accelerate the wetting time, the conductivity cell electrodes should be rinsed with a dilute non-ionic soap solution. This will reduce the surface tension of the water allowing the water to penetrate the porous platinum coating in addition to removing any oil film on the inside of the glass. It is best to store the conductivity cell in distilled water if possible to eliminate the wetting time.

Prior to storing the Micro CTD, the conductivity cell must be washed thoroughly in fresh water before the cell is allowed to dry. This will prevent the build up of salt deposits on the electrode's platinum coating.

Do not locate any objects within 3 cm of the glass tubes on the conductivity cell. Objects in close proximity to the glass tubes can disturb the electric field generated by the sensor and cause an error in the sensor's output.

6.1.2   Pressure Sensor Precautions

Though the pressure sensor can survive pressures of 1.5 times the full-scale pressure rating of the sensor a recalibration of the sensor will be required.

Caution, the burst pressures of the sensors are as follows:
> **0 to 200 bar full scale sensors   3000 PSI**
> **400 to 1000 bar sensors   15000 PSI**

6.1.3   Optional Sensor Precautions

DO_2 Sensor Precautions

The YSI DO_2 sensor must be properly stored when not in use and re-calibrated and maintained regularly to compensate for sensor drift. Refer to the YSI sensor manual for details.

The DO2 sensor must not be exposed to pressures greater than 70 dbar (100 psi).

pH Sensor Precautions

The pH sensor must be properly stored in a buffer solution when not in use. The sensor should be re-calibrated and maintained regularly to compensate for sensor drift. Refer to the pH sensor manual for details.

The pH sensor must not be exposed to pressures greater than 2000 dbar (2900 psi).

Optical and Acoustic Sensor Precautions

These sensors must be kept clean and the sensing volume must be kept clear of obstructions. Any objects within the sensing volume will cause errors in the sensor's output. The sensing volume is shown in the sensor manual.

6.2   SENSOR INTERACTIONS

The Micro CTD Sensor does not have any interaction between sensors in the standard configuration.   Since additional sensors can be added to the Micro CTD Sensor, or other machinery and sensors can be located near or electrically connected to the Micro CTD Sensor, care should be exercised to ensure that interference is minimized.

6.2.1   Electrical Interference

All Micro sensors that are electrically coupled to the water, such as conductivity, DO_2 and pH sensors, are power and signal isolated to ensure there are no DC connections to the water. This will eliminate the majority of electrical interference problems.

Some sensors such as the sound velocity sensor are AC coupled to the water to reduce low frequency electrical noise in the environment. High frequency electrical noise can sometimes cause errors in the data.

6.2.2   Magnetic Interference

The standard configuration of the Micro CTD Sensor has no magnetic sensors and is therefore immune to low frequency magnetic interference.   Strong, nearby, high frequency magnetic fields may induce noise in the electronic circuitry and thus create noise in the data readings. Placing the Micro CTD Sensor near this type of interference source is not advised.

6.2.3   Radio Interference

Due to the small board size of the Micro sensors they are less susceptible to radio interference than many other instruments. However, they are not immune. Tests show the Micro CTD can withstand a 5 Watt, 144 MHz RF transmitter operating 2 metres away from the instrument without any degradation in performance.

6.3   TROUBLESHOOTING GUIDE

The following section outlines some of the most common problems encountered by users of the Micro CTD Sensors. A brief list of suggested solutions has been provided. If the difficulties persist, please do not hesitate to contact the AML Oceanographic service staff.

> Phone: 250-656-0771
> Fax: 250-655-3655
> E-mail: service@AMLoceanographic.com
> Mail: AML Oceanographic.
>   2071 Malaview Avenue
>   Sidney, BC
>   Canada
>   V8L 5X6

Problem:

Micro Sensor does not communicate with the computer.

Solutions:

• Incorrect power is being applied to the instrument. Check with a volt meter for proper supply voltage and polarity. The voltage range is from +8 to +24 VDC. Please refer to the appendix 'C' Electrical Wiring Diagram.

• The serial port chosen is incorrect. Most IBM computers have only one serial port, therefore the user should choose the COM1 setting. However, if a COM2 port exists, the user must take care in determining which port the cable has been connected to and choose the appropriate baud rate/port combination.

• The communications set up of the computer is incorrect. The Micro Sensor will be factory set to no parity, 1 stop bit, 8 data bits and will automatically determine the baud rate after the reception of an **<Enter>** or **<Ret>**.

• The baud rate of the computer was changed after the sensor was powered up. Turn the power supply for the sensor off for at least 2 seconds and then back on. Hit the **< Enter >** key. The instrument should then return a header.

• The communications cable has been inserted incorrectly. Check the cable connections at the computer and the sensor. Examine the pins on the sensor connector for bent or corroded pins.

Problem:

The instrument communications are intermittent.

Solutions:
• The communications cable has been inserted incorrectly. Check the cable connections at the computer and the instrument. Examine the pins on the instrument connector for bent or corroded pins.

• The communications cable has a fault. Check the continuity of the cable with an ohmmeter while flexing the cable. Short cables (< 3 meters) should have less than ½ ohm from end to end on each conductor. The cable should have a short between pins 6,7 and 8. Refer to the wiring diagram in Appendix B. If any of these conditions are not met replace the cable.

• Incorrect power is being applied to the instrument. Check with a volt-ohm-meter for proper supply voltage. The voltage range is from +8 to +24 VDC. Please refer to the appendix 'C' Electrical Wiring Diagram.

Problem:

The sensor readings are noisy.

Solutions:
• There are nearby electromagnetic noise sources. Move the instrument to a new location or move the noise source. Refer to section 6.2.

• If only one sensor reading is noisy determine which sensor channel it is and refer to the "_____ sensor readings are incorrect" section for that sensor, which are listed below.

• The power supplied to the instrument is noisy. Change the power supply to a more regulated power supply or use a battery.

Problem:

The conductivity sensor readings are incorrect.

Solutions:
• The conductivity sensor has a bubble in the glass tube. Shake the instrument to clear the bubble.

• The conductivity sensor has completely dried out and has not been allowed to fully wet before use. Rinse the conductivity sensor with a dilute solution of water, alcohol and dish soap then rinse the sensor with fresh water and let it sit in the water sample for 5 minutes before taking a reading.

• The conductivity sensor is faulty. Examine the conductivity cell for cracks in the glass. If the glass is cracked the sensor must be repaired and re-calibrated. Examine the sensor for deposits of dirt or marine growth within the glass. Clean the glass tubes as described in the section 7.2.

• The platinum electrodes have been damaged. The electrodes must be re-plated and the instrument re-calibrated.

Problem:

> **The pressure sensor readings are incorrect.**

Solutions:

> • The pressure range of the sensor may have been exceeded. The pressure sensor may require re-calibration or replacement. Contact the factory for support.
>
> • The pressure sensor is faulty. Examine the stainless steel diaphragm of the pressure sensor for dents or scrapes. If any are found the sensor will have to be replaced. Contact the factory for support.

Problem:

> **The temperature sensor readings are incorrect.**

Solutions:

> • The temperature sensor is faulty. Examine the capillary tube of the temperature sensor for bends, pits or cracks. If any are found the sensor will have to be replaced. Contact the factory for support.

7   MAINTENANCE

7.1   GENERAL MAINTENANCE

The Micro CTD Sensor has been designed to minimize user maintenance. To keep the instrument in top condition the following maintenance is required:

• After each deployment, the Micro CTD Sensor case should be washed thoroughly with distilled or fresh water. Ideally the cell should be stored in distilled water to minimize wetting times.
• Dry all electrical connections and replace the dummy connector prior to storage.
• The electrical connector should be lubricated with 3M Silicone Spray or equivalent on a regular basis depending on use.
• Do not grease connectors

7.2   CONDUCTIVITY SENSOR MAINTENANCE

The conductivity sensor must be carefully maintained to provide precise conductivity measurements. After each deployment, the sensor (and the entire instrument) should be rinsed with fresh water. Any dirt or other foreign material visible inside the glass tubes can be loosened by soaking the sensor end of the instrument in warm soapy water and then flushing the sensor with fresh water. The inside diameter of the glass tubes can be cleaned with a dilute soap

C-Cell Stem

Pt Electrode
Glass Cross Tube

Q-Tip
(cotton swab)

Cotton tip with
water, alcohol, and
soap solution

Figure 7-1 Conductivity Cell Cleaning

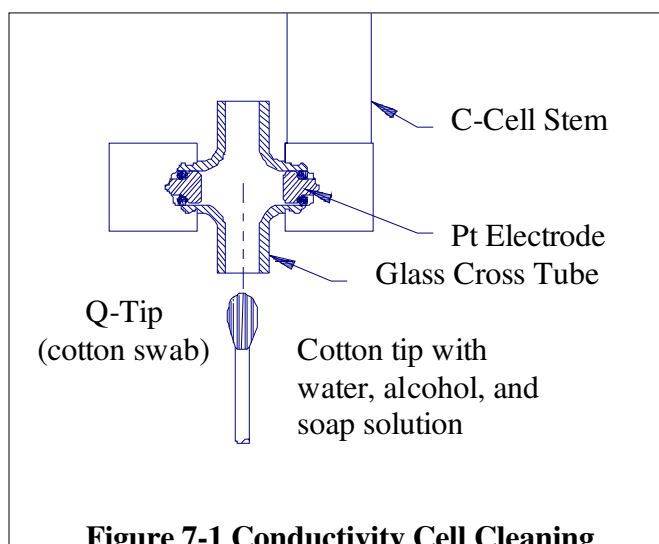solution soaked cotton swab. Care must be taken not to touch the electrodes (refer to *Fig. 7-1*). The sensor should also be inspected for chips and cracks in the glass as these will permanently shift the sensor's calibration and could possibly lead to flooding of the pressure case. If the sensor is damaged please contact the factory for instructions.

7.3   REPLACING THE BATTERIES

NOTE: For custom battery configurations please refer to *Appendix C*.

 Figure 7-2 Battery compartment

NOTE: The end cap contains o-rings. Take care to avoid scratching or getting dirt
                 on the o-ring surfaces.

Wipe dry the battery pack if it is wet to avoid dripping water into the battery pack. Remove
the cables or shorting plug from the bulkhead connectors on the battery pack end cap.

Do not remove the stainless steel circlip on the battery pack. Unscrew the acetal retaining
ring. This removes the battery assembly from the pressure case. Unscrew the battery cap
from the brass housing. The spent batteries can be removed by tipping the assembly and
allowing the batteries to slide out of the brass housing.

The replacement batteries should be three, good quality, C size, lithium , 3.6 volt batteries.
Saft, LSH 14, C cell, 3.6 volt, lithium batteries are recommended.

Insert all three batteries into the brass housing positive end first. Replace the battery cap on
the brass housing.

Check the O-ring seals. The O-rings should be clean, have no nicks, and should be lightly
greased.   Slide the battery assembly back into the pressure case and screw down the
retaining ring.

7.3.1   Battery considerations for the Micro CTD
Care should be observed when choosing replacement lithium batteries for the Micro
CTD. Battery characteristics such as physical size, current capacity, voltage capacity and
maximum current sourcing capability should be considered.
The Micro CTD is shipped with lithium batteries manufactured by SAFT.
Internet: http://www.saftbatteries.com

7.3.2 Recommended Battery rating for the Micro CTD
Battery size: C cell
Voltage capacity: 3.6v
Amp hour rating: 5.5Ah or better
Maximum continuous current rating: 800ma or better

Please refer to the Battery specifications outlined in the following documentation when considering a replacement lithium battery for the Micro CTD.

7.3.3 Battery dimensions
Due to the space constraints of the Micro CTD battery assembly close attention to the battery size must be observed. Dimensions can very from one manufacture to another. The diagram shows the recommended size of the lithium batteries for the Micro CTD.
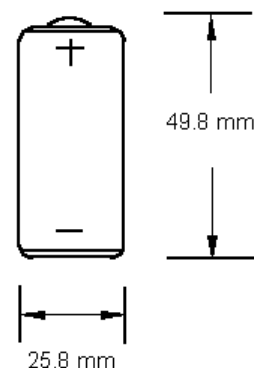
7.3.4 Voltage capacity
A nominal voltage of 3.6 volts is recommended but battery voltage will vary with temperature, usually the lower the temperature the lower the voltage output by the battery. Typically, lithium battery voltage will remain fairly constant until they are near the end of their capacity. When the voltage starts to drop off rapidly it is a good indication that the batteries need replacing very soon.

7.3.5 Current Capacity
The nominal current capacity of lithium batteries will be specified in Amp Hours (Ah) and this figure is used to indicate how long the batteries will last. The higher the Amp Hour rating, the longer the battery will last and the more it will cost. Current capacity not only varies with temperature, but also with the load (how much current the instrument draws).
A rough calculation for battery life is hours = Ah/load.
Where

Hours = hours of battery use
Ah = Amp Hour rating of the battery
Load = how much current the instrument draws in Amps

7.3.6 Maximum current sourcing capabilities
The maximum current sourcing capabilities of a lithium battery defines how much current the battery can source before its voltage will drop significantly. Batteries with a low rating of Maximum recommended continuous currents (below 800ma) may produce a sharp voltage drop when the Micro CTD demands a burst of current such as when it powers up or when an optional sensor or pump is turned on. If the voltage drops below the Micro CTD's operational voltage, the instrument may reset itself or behave erratically.

8   CALIBRATION

The instrument was calibrated at the factory at the time of manufacture. This should remain within published specifications for periods of 1 to 2 years, depending on the amount of use and other conditions occurring in the deployment environment. The sensor accuracies are also dependent upon proper care and maintenance by the user. AML Oceanographic recommends recalibrating the instrument annually, however some standards agencies specify semi-annually for all sensors used in bathymetry work. Re-calibration of these sensors must be done at the factory or an authorized service facility. Contact the factory for the location of the nearest facility.

The Micro Sensors are calibrated by recording the instrument's raw data at known reference points. This data is applied to a curve fitting algorithm to produce calibration coefficients. Each set of coefficients are permanently stored in the instrument's memory.

Calibration coefficients are not interchangeable. Each set is unique to each instrument. The calibration coefficients for the instrument to which this manual belongs are stored in PDF format on the accompanying USER DOCUMENTATION CD. The user will need these coefficients if the instrument is to be used in the RAW mode for post processing purposes.

8.1   CONDUCTIVITY

The conductivity sensor is calibrated against conductivity ratio. The following equations are used to convert raw data to engineering units:

$$C_r = A + B*Nct + C*Nct^2 + D*Nct^3 + (E + F*Nct + G*Nct^2 + H*Nct^3)*Nc$$

$Cond = C_r * 42.914$
Where: C_r = conductivity ratio
      $Cond$ = conductivity in mS/cm
      Nct , Nc = raw values
      A through H are calibration coefficients determined at the factory.

Refer to Appendix `F', The Practical Salinity Scale, to convert conductivity and temperature to salinity.

8.2   TEMPERATURE

The temperature electronics use the following formula to convert raw data to engineering units (ºC):
$$T = A + B*Nt + C*Nt^2 + D*Nt^3 + E*Nt^4 + F*Nt^5 + G*Nt^6$$

Where: T = temperature in ºC.
      Nt = raw value
      A through G are calibration coefficients determined at the factory

8.3 PRESSURE

The pressure electronics use the following formula to convert raw data to engineering units (dbar):

$$P = A + B*Npt + C*Npt^2 + D*Npt^3 + (E + F*Npt + G*Npt^2 + H*Npt^3)*Np + (I + J*Npt + K*Npt^2 + L*Npt^3)*Np^2$$

Where: P = pressure in dbar.

Npt, Np = raw values

A through L are calibration coefficients determined at the factory

8.4 BATTERY/EXTERNAL VOLTAGE

The voltage measurement is done on the logger board and uses the following formula to convert raw data to engineering units (volts):

$$V = A + B*Nb$$

Where: V = voltage in volts.

Nb = raw value

A and B are calibration coefficients determined at the factory

8.5 OPTIONAL 65 ºC TEMPERATURE

The temperature electronics use the following formula to convert raw data to engineering units (ºC):

$$T = A + B*Nt + C*Nt^2 + D*Nt^3 + E*Nt^4 + F*Nt^5 + G*Nt^6 + H*Nt^7 + I*Nt^8$$

Where: T = temperature in ºC.

Nt = raw value

A through I are calibration coefficients determined at the factory

9   WARRANTY

Warranty and limit of liability

AML oceanographic warrants the instrument for a period of one year from the date of delivery.   AML oceanographic will repair or replace, at its option and at no charge, components that prove to be defective.   The warranty applies only to the original purchaser of the instruments.   The warranty does not apply if the instrument has been damaged, by accident or misuse, and is void if repairs or modifications are made by other than authorized personnel.

This warranty is the only warranty given by AML oceanographic. No warranties implied by law, including but not limited to the implied warranties of merchantability and fitness for a particular purpose shall apply.   In no event will AML oceanographic be liable for any direct, indirect, consequential or incidental damages resulting from any defects or failure of performance of any instrument supplied by AML oceanographic.

Disclaimer

AML oceanographic reserves the right to make any changes in design or specifications at any time without incurring any obligation to modify previously delivered instruments. Manuals are produced for information and reference purposes and are subject to change without notice.

APPENDIX 'A': " Using Hyperterminal "

To communicate with the Micro CTD Sensor the terminal emulation program Hyperterminal may be used. Hyperterminal is supplied with the MS Windows 95 and later operating systems. This program provides the mechanism of communication between the instrument and an IBM compatible computer.

This section describes the configuration of the Hyperterminal program for the Micro CTD Sensor.

A.1   USING HYPERTERMINAL

Connect the Micro CTD Sensor to the data cable. Connect the data cable to the serial port of the computer. If the Micro CTD Sensor is externally powered connect the data cable power leads to a 12 volt DC supply.

Launch Hyperterminal by selecting the program from the start menu under programs. Under the File menu select properties, the Properties window will then open. Under 'Connect Using' select direct to com 2 (or the port the sensor is connected to). Click on the Configure button to open the COM2 Properties window and enter the following:

Bits per second: 38400 (or the desired baud rate)
Data Bits: 8
Parity: none
Stop Bits: 1
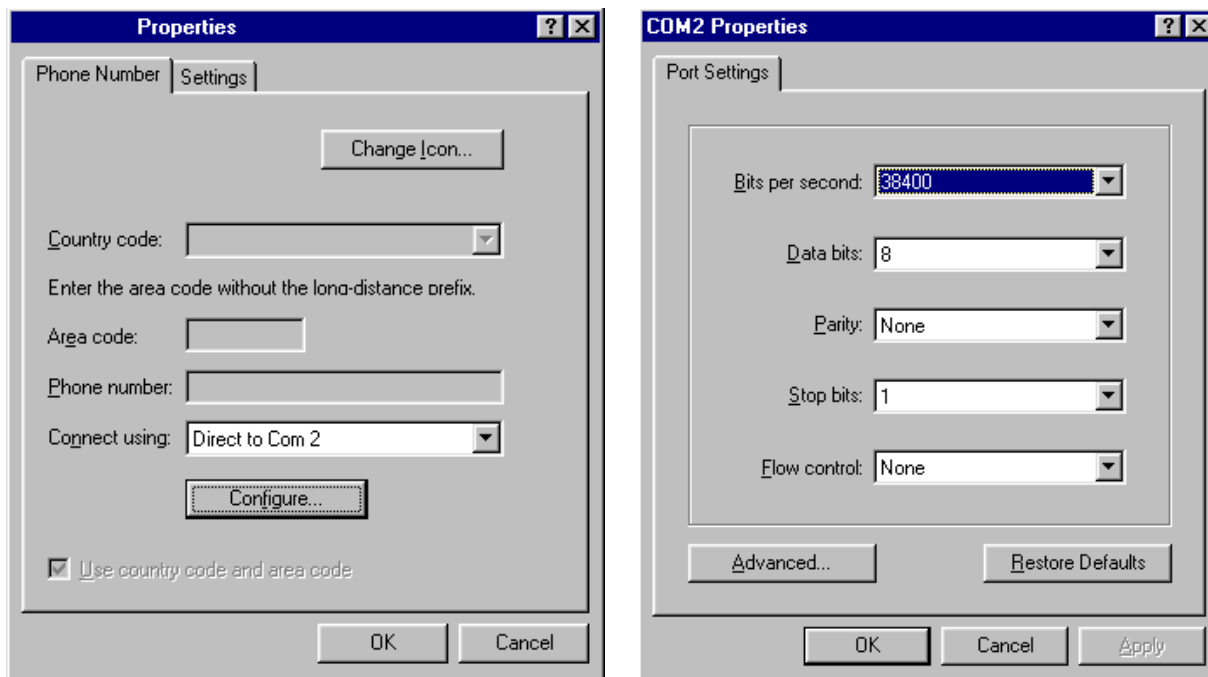Flow Control: none

Figure A-1 Properties Windows in Hyperterminal.

Select OK in the COM2 Properties window. Select OK in the Properties window.

Hit the **<Enter>** key. If all cables have been connected properly and the appropriate baud

rate/serial port combination chosen, the instrument will respond with a header and then the prompt (**>**), eg:

MC3 Version 3.04 Apr 13/07 SN:7455
Copyright(c) 2005-2006, AML Oceanographic

>

Once the prompt appears, the Micro CTD Sensor is ready to accept instructions. Refer to the RS-232 Command Summary, section 5.1.2.

Caution: Some versions of Hyperterminal have a bug which does not allow the properties to be changed unless the disconnect command is selected under the Call menu before changing the properties. The affected programs will always show the property changes in the status bar but the changes are not actually implemented unless the program is disconnected prior to the property changes being made. Select the Connect command after the changes are made.

APPENDIX 'B': " Using PROCOMM "

To communicate with the Micro CTD Sensor a terminal emulation program such as PROCOMM can be supplied. This DOS based program provides the mechanism of communication between the instrument and an IBM compatible computer.

This section describes the installation and use of the shareware program "PROCOMM" as a method of communicating with the Micro CTD Sensor.

Note:

PROCOMM is a shareware program. It has been supplied free of charge and if it is found to be useful the user should register this software. Registration information can be found in the file LICENSE.DOC.

B.1   INSTALLING PROCOMM

PROCOMM should be installed on the computer's hard disk. The installation program will create a sub-directory named PROCOMM on the selected drive. To install PROCOMM on Drive C, place the disk labelled PROCOMM in the appropriate floppy drive. Log to that drive, then type:

INSTALL C:

B.2   USING PROCOMM

To use PROCOMM enter the following commands:

C:
CD \PROCOMM
PROCOMM

PROCOMM comes configured with the following parameters.

Communications port: COM1	
Baud rate:	9600
Parity:	None
Bits:	8
Protocol:	None

If the instrument has been connected to COM1 then no changes are necessary. To display the communication line setting menu type <ALT>P . This will display the screen as shown in figure 3-1. Enter the number that corresponds to the parameter to be changed (eg. entering 21 <RET> would select COM2). The baud rate can also be changed in the same manner. Any changes made should be saved to disk by entering 24<RET>. The parity, data bits, and stop bits must not be changed. Press the ESC key to exit this menu and return to the communications screen.

```
┌──────────────────────────────────────────────────────────┐
│                      LINE SETTINGS                         │
│                                                            │
│    CURRENT SETTINGS:        2400,N,8,1,COM1                │
│                                                            │
│      1)     300,E,7,1                7)      300,N,8,1      │
│      2)    1200,E,7,1                8)     1200,N,8,1      │
│      3)    2400,E,7,1                9)     2400,N,8,1      │
│      4)    4800,E,7,1               10)     4800,N,8,1      │
│      5)    9600,E,7,1               11)     9600,N,8,1      │
│      6)   19200,E,7,1               12)    19200,N,8,1      │
│                                                            │
│     Parity              Data Bits          Stop Bits       │
│     13)  ODD            16)  7 bits         18)  1 bit      │
│     14)  MARK           17)  8 bits         19)  2 bits     │
│     15)  SPACE                                             │
│                                                            │
│     20) COM1     21) COM2      22) COM3     23) COM4        │
│                                                            │
│     24)   Save Changes          YOUR CHOICE:               │
│                                                            │
│                   Press ESC to return                      │
└──────────────────────────────────────────────────────────┘
```

Figure B-1 Communication parameters window in PROCOMM.

If all cables have been connected properly and the appropriate baud rate/serial port combination chosen, the instrument will respond with a header and then the prompt (**>**), eg:

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>

Once the prompt appears, the Micro CTD Sensor is ready to accept instructions. Refer to the RS-232 Command Summary in section 5.1.2.

To leave PROCOMM, the **<ALT>X** key combination is used.

APPENDIX 'C': " Wiring Diagram "

See Instrument Wiring Diagram included on the *User Documentation CD*.

APPENDIX 'D': " 32-Bit CRC Calculation and Table "

Crc 32 Calculation
==================

Below is a look up table and function to compute the running total of a 32 bit crc

```
const long int Crc32Table[256] PROGMEM =
{
0x00000000, 0x77073096, 0xee0e612c, 0x990951ba, 0x076dc419, 0x706af48f, 0xe963a535, 0x9e6495a3,
0x0edb8832, 0x79dcb8a4, 0xe0d5e91e, 0x97d2d988, 0x09b64c2b, 0x7eb17cbd, 0xe7b82d07, 0x90bf1d91,
0x1db71064, 0x6ab020f2, 0xf3b97148, 0x84be41de, 0x1adad47d, 0x6ddde4eb, 0xf4d4b551, 0x83d385c7,
0x136c9856, 0x646ba8c0, 0xfd62f97a, 0x8a65c9ec, 0x14015c4f, 0x63066cd9, 0xfa0f3d63, 0x8d080df5,
0x3b6e20c8, 0x4c69105e, 0xd56041e4, 0xa2677172, 0x3c03e4d1, 0x4b04d447, 0xd20d85fd, 0xa50ab56b,
0x35b5a8fa, 0x42b2986c, 0xdbbbc9d6, 0xacbcf940, 0x32d86ce3, 0x45df5c75, 0xdcd60dcf, 0xabd13d59,
0x26d930ac, 0x51de003a, 0xc8d75180, 0xbfd06116, 0x21b4f4b5, 0x56b3c423, 0xcfba9599, 0xb8bda50f,
0x2802b89e, 0x5f058808, 0xc60cd9b2, 0xb10be924, 0x2f6f7c87, 0x58684c11, 0xc1611dab, 0xb6662d3d,
0x76dc4190, 0x01db7106, 0x98d220bc, 0xefd5102a, 0x71b18589, 0x06b6b51f, 0x9fbfe4a5, 0xe8b8d433,
0x7807c9a2, 0x0f00f934, 0x9609a88e, 0xe10e9818, 0x7f6a0dbb, 0x086d3d2d, 0x91646c97, 0xe6635c01,
0x6b6b51f4, 0x1c6c6162, 0x856530d8, 0xf262004e, 0x6c0695ed, 0x1b01a57b, 0x8208f4c1, 0xf50fc457,
0x65b0d9c6, 0x12b7e950, 0x8bbeb8ea, 0xfcb9887c, 0x62dd1ddf, 0x15da2d49, 0x8cd37cf3, 0xfbd44c65,
0x4db26158, 0x3ab551ce, 0xa3bc0074, 0xd4bb30e2, 0x4adfa541, 0x3dd895d7, 0xa4d1c46d, 0xd3d6f4fb,
0x4369e96a, 0x346ed9fc, 0xad678846, 0xda60b8d0, 0x44042d73, 0x33031de5, 0xaa0a4c5f, 0xdd0d7cc9,
0x5005713c, 0x270241aa, 0xbe0b1010, 0xc90c2086, 0x5768b525, 0x206f85b3, 0xb966d409, 0xce61e49f,
0x5edef90e, 0x29d9c998, 0xb0d09822, 0xc7d7a8b4, 0x59b33d17, 0x2eb40d81, 0xb7bd5c3b, 0xc0ba6cad,
0xedb88320, 0x9abfb3b6, 0x03b6e20c, 0x74b1d29a, 0xead54739, 0x9dd277af, 0x04db2615, 0x73dc1683,
0xe3630b12, 0x94643b84, 0x0d6d6a3e, 0x7a6a5aa8, 0xe40ecf0b, 0x9309ff9d, 0x0a00ae27, 0x7d079eb1,
0xf00f9344, 0x8708a3d2, 0x1e01f268, 0x6906c2fe, 0xf762575d, 0x806567cb, 0x196c3671, 0x6e6b06e7,
0xfed41b76, 0x89d32be0, 0x10da7a5a, 0x67dd4acc, 0xf9b9df6f, 0x8ebeeff9, 0x17b7be43, 0x60b08ed5,
0xd6d6a3e8, 0xa1d1937e, 0x38d8c2c4, 0x4fdff252, 0xd1bb67f1, 0xa6bc5767, 0x3fb506dd, 0x48b2364b,
0xd80d2bda, 0xaf0a1b4c, 0x36034af6, 0x41047a60, 0xdf60efc3, 0xa867df55, 0x316e8eef, 0x4669be79,
0xcb61b38c, 0xbc66831a, 0x256fd2a0, 0x5268e236, 0xcc0c7795, 0xbb0b4703, 0x220216b9, 0x5505262f,
0xc5ba3bbe, 0xb2bd0b28, 0x2bb45a92, 0x5cb36a04, 0xc2d7ffa7, 0xb5d0cf31, 0x2cd99e8b, 0x5bdeae1d,
0x9b64c2b0, 0xec63f226, 0x756aa39c, 0x026d930a, 0x9c0906a9, 0xeb0e363f, 0x72076785, 0x05005713,
0x95bf4a82, 0xe2b87a14, 0x7bb12bae, 0x0cb61b38, 0x92d28e9b, 0xe5d5be0d, 0x7cdcefb7, 0x0bdbdf21,
0x86d3d2d4, 0xf1d4e242, 0x68ddb3f8, 0x1fda836e, 0x81be16cd, 0xf6b9265b, 0x6fb077e1, 0x18b74777,
0x88085ae6, 0xff0f6a70, 0x66063bca, 0x11010b5c, 0x8f659eff, 0xf862ae69, 0x616bffd3, 0x166ccf45,
0xa00ae278, 0xd70dd2ee, 0x4e048354, 0x3903b3c2, 0xa7672661, 0xd06016f7, 0x4969474d, 0x3e6e77db,
0xaed16a4a, 0xd9d65adc, 0x40df0b66, 0x37d83bf0, 0xa9bcae53, 0xdebb9ec5, 0x47b2cf7f, 0x30b5ffe9,
0xbdbdf21c, 0xcabac28a, 0x53b39330, 0x24b4a3a6, 0xbad03605, 0xcdd70693, 0x54de5729, 0x23d967bf,
0xb3667a2e, 0xc4614ab8, 0x5d681b02, 0x2a6f2b94, 0xb40bbe37, 0xc30c8ea1, 0x5a05df1b, 0x2d02ef8d
};

void Crc32Compute( unsigned long *Crc, unsigned char byte )
{
  *Crc =  ( &Crc32Table[(*Crc & 0xff) ^ byte] ) ^ ( *Crc >> 8 );
}
```

APPENDIX 'E': "Quick Guide"

Micro CTD Sensor

Caution: Do not exceed the maximum pressure rating of this instrument.

Connections: Externally powered instrument
- Connect the Micro CTD Sensor to the computer by plugging the communications cable between the Micro CTD and the RS-232 port of the computer.
- If the Micro CTD Sensor does not have a battery pack, connect the data cable wires to a DC power source (8 to 24 volts, 12 volts nominal). The red wire should be connected to the positive side of the supply and the black wire to the negative side of the supply.

If using ISS:
- Launch ISS. Configure the program for the correct port and apply the following settings: 8 bits, no parity, 1 stop bit. Select the desired baud rate.
- Select the desired sampling rate and logging rate.
- Select the monitor button in the toolbar. ISS will then start displaying and storing data.

If using SmartTalk:
- Launch SmartTalk. Configure the program for the correct port and apply the following settings: 8 bits, no parity, 1 stop bit. Select the desired baud rate.
- Select the desired sampling rate and logging rate.
- Select the connect command. Smart talk will then start displaying data.
- To log data select the capture command. SmartTalk will display a capture window. Provide a file name for the data and select OK. Logging will then commence. To stop logging deselect the capture command.

If using a terminal emulation program:
Examples include Hyperterminal, ProComm and Commo.
- Launch a communications program. Configure the program for the correct port and apply the following settings: 8 bits, no parity, 1 stop bit. Select the desired baud rate.
- Press **<enter>**. The instrument will respond with an identification header.
- To see one scan of data type **<s>** followed by **<enter>**. The instrument will respond with one scan of data in engineering units. Pressure is given in dbar, sound velocity is given in m/s and temperature is given in ℃.
- To monitor the data continuously type **<m>** followed by **<enter>**. The instrument will respond with a continuous stream of data with each scan on a new line. Pressure is given in dbar, sound velocity is given in m/s and temperature is given in ℃.