Micro CTD Sensor

User's Manual

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1 INTRODUCTION

This manual describes the Applied Microsystems Ltd. 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 G 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: Micro CTD Sensor with Optional Stainless Steel Pressure Case

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 exact configuration of the instrument is detailed in *Appendix A.*

1.1.1 Component Descriptions

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 Beryllium Copper (BeCu) 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 an 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. On power up the instrument will automatically detect baud rates from 2400 to 38400 baud. The baud rate is automatically determined when the sensor receives an <**ENTER**> or <**RET**>. Alternatively, the instrument can be programmed to respond only to a specific baud rate. The RS-485 binary protocol option allows the instruments to be individually addressed permitting multiple instruments to be daisy-chained together.

The data output may be configured to display either unprocessed analog to digital converter 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 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 of water pressure. The standard bulkhead connector used on the Micro series of instrumentation is the Impulse™ MCBH-8FS rated to 6800 meters of water.

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

Note: If the instrument has a custom configuration the additional specifications will be listed in *Appendix A.*

Conductivity:	Patented platinized 4 electrode	
	Range:	0 - 7.0 S/m
	Accuracy:	0.001 S/m
	Resolution:	0.00015 S/m
	Time constant:	25 ms typically
Temperature Sensor:	Precision aged thermistor in beryllium copper housing	
	Accuracy:	±0.005ºC
	Resolution:	0.001ºC
	Time constant:	100 ms (optional 85 ms)
Pressure Sensor:	Semiconductor strain gauge	
	Range:	0 to 2, 5, 10, 20, 50, 100, 200, 400, 600 and 1000 bar
	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
Output Format:	Standard:	RS-232C autobaud communications
	Baud rate:	2400 to 38400, 8 data bits, no parity, 1 stop bit.
	Data type:	ASCII text
	Optional:	RS-485 communications
	Baud rate:	Factory set between 2400 to 38400 baud, 8 data, no parity, 1 stop bit.
	Data type:	ASCII text
Sample Rate:	On command or continuous. Continuous has programmable sampling rates from 25 scans / second to 1 scan per day.	
Power:	Standard:	External power
	Range:	9 to 16 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:	16, 32, and 64 Mbytes

Pressure Housings:	Material:	acetal (standard)
	Max Pressure:	500 meters
	Optional:	T-316 Stainless steel (optional) Max Pressure: 4500 meters
	Dimensions:	50.3 mm (1.98 in) Ø 297 mm (11.7 in)
	Weight:	400 g (0.88 pounds) in air for Acetal 0 g (0.0 pounds) in water for Acetal
Environment:	Operating Temperature:	-2 to 40ºC (28 to 104ºF)
	Storage Temperature:	-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:	IMPULSE™ MCBH-8FS with 24 AWG
	Dummy Plug:	IMPULSE™ MCDC-8-MP
	Shorting plug:	IMPULSE™ MCDC-8-MP/S, pins 6 and 7 are shorted, molded red
	Com Cable Connector:	IMPULSE™ PMCIL-8MP, pins 6,7 and 8 are shorted and pins 4 and 5 are shorted, 2 meter cable length, 22 AWG with DB-25 connector
	Retainer Ring:	IMPULSE™ DLSMC-F
	Materials:	Stainless steel, neoprene, polyurethane, acetal
	External Sensor Connectors:	Used on instrument and external sensors.
	Bulkhead Connector:	IMPULSE™ IE55-6-BCR with 24 AWG
	Bulkhead Dummy Plug:	IMPULSE™ IE55-6-SCP
	Cable Dummy Plug:	IMPULSE™ IE55-6-SCR
	Cable Connector:	IMPULSE™ IE55-6-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*.

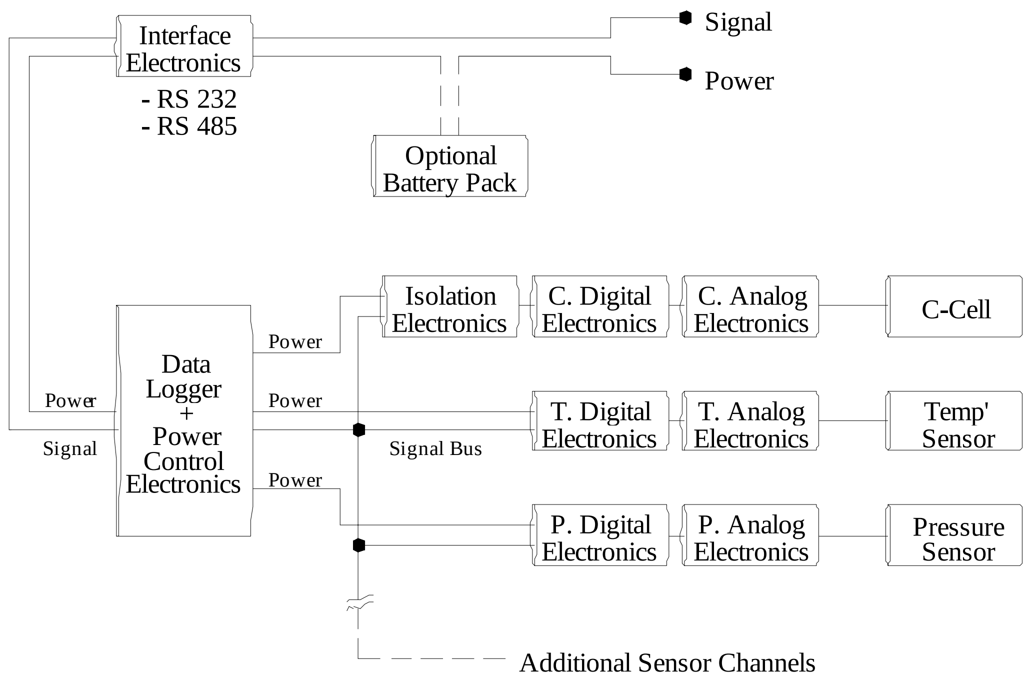


Figure 3-1 Micro CTD Sensor Block Diagram

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 with a date/time stamp and supply voltage, 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.

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 in Appendix C. At one end of the cable is a DB25 or 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

The Micro CTD Sensor is normally powered externally via the communications cable. Refer to the wiring diagram in *Appendix C*. 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 9 and 16 volts, measured at the instrument.

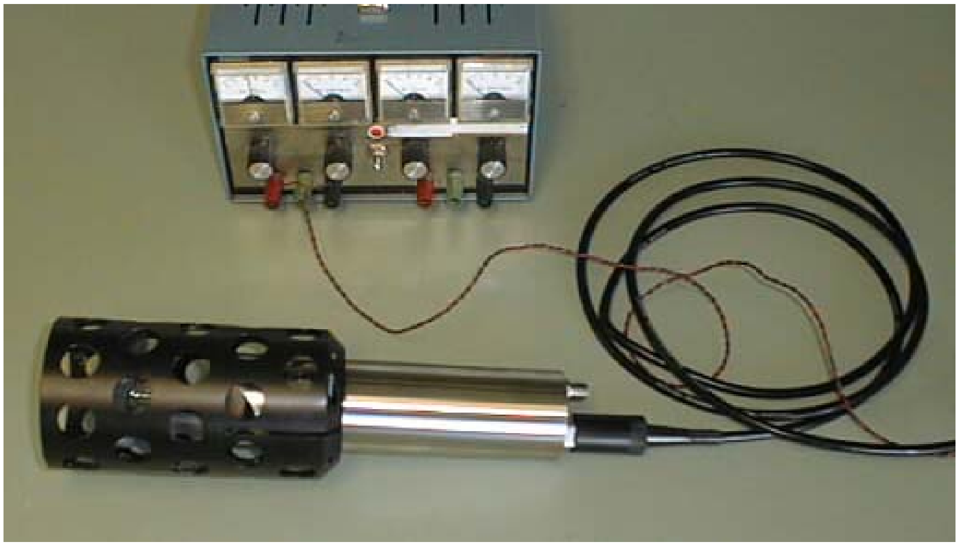


Figure 4.3.A The Micro CTD connected to an external power source.

The Micro CTD Sensor can also be powered from the optional external battery pack. Refer to the wiring diagram in *Appendix C*. 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.B The Micro CTD with battery pack and external sensor connected to an external power supply.

4.3.1 Micro CTD Logging Option

If the Micro CTD has been purchased with the logging option it will be shipped with a battery pack. This configuration of the Micro CTD can be powered three ways:

- As described above for the standard instrument
- From the battery pack
- Externally via the data cable while still connected to the battery pack

The connections for powering a Micro CTD with a battery pack are illustrated in *Appendix C*. When a battery pack is used the instrument is powered only when a data cable or shorting plug is plugged into the battery pack.

Before the instrument can be used to log data the instrument must be programmed with the correct sampling parameters. This is done by plugging the supplied data cable into the Micro CTD bulkhead connector, if powered through the cable, or plugging the supplied data cable into the battery pack if the Micro CTD is already connected to the battery pack. When the communications cable has been connected to a computer's serial port, SmartTalk, ISS or a terminal program may be used to communicate with and program the instrument. Unplugging the communications cable from the battery pack's bulkhead connector will turn the battery power off. After the instrument's logging parameters have been set, the communications cable is replaced with the red Shorting Plug. The red Shorting Plug is used to turn on the instrument, making it ready for deployment. See *Section 5.1.3* for more information.

NOTE: Plugging the communications cable or shorting plug into the battery pack powers up the instrument. To avoid depleting the batteries, unplug the cable or shorting plug when not in use.

Figure 4.3.1 Micro CTD, battery pack and shorting plug

4.3.2 Changing Batteries

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 cir-clip 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.

Figure 4.3.1 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 7.3*.

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 or help files 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
- Select a baud rate between 2400 and 38400 baud
- Apply power to the instrument
- Press the <**enter**> key

The Micro CTD Sensor will respond with its header information. 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*.

5 COMMUNICATIONS

5.1 RS-232 ASCII Communications

5.1.1 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 5.1.2* for commands.

5.1.1.1 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.

Example header:

Micro CTD Sensor V2.07 SN:4426-CTD
Copyright© 2001-2003, Applied Microsystems Ltd.
0MB of Memory

5.1.1.2 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), pressure (in dbar), conductivity (in mS/cm), temperature (in °C), calculated salinity (in psu) and a carriage return/line feed (end of scan).

Example scan:

03/05/01 14:23:06:02 000.40 36.999 11.793 32.263

The above example reads;

Date:	Month/Day/Year
Time of scan:	2:23 pm and 6.02 seconds
Pressure:	0.4 dbar
Conductivity:	36.999 mS/cm
Temperaure:	11.793°C
Calculated salinity:	32.263 psu (practical salinity units)

NOTE: A positive sign is not displayed for positive temperatures.

5.1.1.3 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 and appendix B to convert the raw data values to engineering data. The raw counts for Npt, Np, Nc, and Nt are integers between 0 and 65535. The raw count for Nct is an integer between 0 and 255. 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), Npt, Np, Nct, Nc, Nt and a carriage return/line feed (end of scan).

Example scan:

03/09/01 14:23:08.06 63002 15032 00158 16897 13487

5.1.2 Command Summary

All 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.

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” command. To discontinue the monitor command the break key or the space bar can be depressed.

NOTE: **This command is not available with the binary format instruments.**

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

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 one sample every 5 seconds.
SE S CONTINUOUS	This sets the sample rate at the maximum of 25 scans per second.

Command: **SET INCREMENT [INC]**

This command sets the pressure increment that the Micro CTD uses when logging data.
Units are in dBars. (Note: dBars are approximately equal to meters).

Example:

SET INC 10	This will set the instrument to log a scan of data into memory every 10 dBars.
SET INC .5	Log every 0.5 dBars.

Note: 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.

Command: **TIME [T]**

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

Example:

TIME 13:44:12.65

Command: **DATE [DA]**

This command sets the date using the format mm/dd/yy.
Example:
DATE 03/11/01 (March 11, 2001)

Command: **VERSION [V]**

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

```
>version
Micro CTD Sensor V2.07 SN:4426-CTD
Copyright© 2001-2003, Applied Microsystems Ltd.
0MB of Memory
```

Command: **DIS S**

This command displays the current scan rate.
Example:

```
>DIS S
sample rate is 1 seconds
```

Command: **DIS INC**

This will display the current pressure increment setting

Command: **DUMP**

This command dumps the instrument's logged data from memory. The data will be dumped as REAL data and is in the following format.

Example:

```
>DUMP [ret]

New Cast
03/05/01 14:23:06:02 000.40 36.999 11.793 32.263
03/05/01 14:23:07:02 001.40 36.999 10.232 32.444
03/05/01 14:23:08:02 002.00 36.999 09.567 32.678
03/05/01 14:23:09:02 002.40 36.999 08.573 32.567
>
```

Command: **INIT**

This command clears the instruments memory.

5.1.3 Advanced Commands

5.1.3.1 Display Commands

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

This command will display the current scan options.
Example:

```
>dis scan
Scan delay is 100
Display salinity: no
Display time: yes
Display date: no
Analog 2 board is installed with 1 channel
```

Command: **DIS STARTUP [D 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: **DIS MEMORY [D M]**

This command will display the current memory status.
Example:

```
>dis m
Memory is not installed
```

Or if there is memory

```
>dis m
Memory is 005.00% used
```

NOTE: Use the VER command to display total memory available to the system.

5.1.3.2 Set Commands

Command: **SET SN** nnnn

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

Example:

>set sn 7245

To display the serial number,

>ver
Micro CTD Sensor V2.07 SN:7245-CTD
Copyright© 2001-2003, Applied Microsystems Ltd.
0MB of Memory

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

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

Where

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

This command sets the detection mode of the instrument on power up.
The DETECT command can be used to set the Micro CTD 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 represents 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.

Specific values of ‘b’ and the corresponding baud rates are outlined in the table below.

b value	Baud rate
1	1200
2	1200
3	2400
4	4800
5	9600
6	19200
7	38400

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 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**

Enables reception of characters at the next power up.

Command: **SET TIMEOUT nn [SE T 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.

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)*

NOTE: Power the Micro CTD off, then on to exit the logging mode.

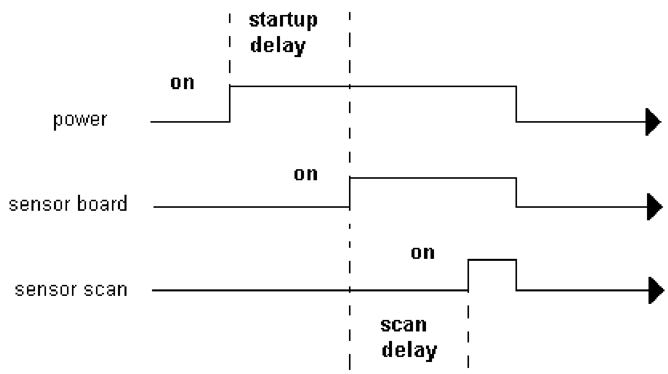
5.1.3.3 Set Scan Options

Command: **SET SCAN DELAY nnn [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.



Micro CTD power up timing diagram

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.

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.

5.1.3.4 Analog Board Commands

The Micro CTD can be configured for two additional analog channels. These channels may be used to incorporate additional sensors such as Ph, Do2 or any other sensor outputting a voltage. When the Micro CTD is equipped with an analog board, the following commands can be used to configure the extra channels.

NOTE: Data will not be logged from an analog channel that is turned off. Please refer to section 1.2 for information on the Micro SVP&T's channel configuration.

Command: **SET ANALOG ON [SE A O]**

This command enables the display and logging of the analog channel/s. This command is only effective if the optional analog board is installed.

Command: **SET ANALOG OFF [SE A OF]**

This command disables the displaying of the analog channel/s. Data from the analog board will not be logged. This command is only effective if the optional analog board is installed.

Command: **SET ANALOG 1 [SE A 1]**

This command will enable the displaying of analog channel #1 when the analog board has been enabled with the SET ANALOG ON command. Analog channel #2 data will not be displayed or logged.

Command: **SET ANALOG 2 [SE A 2]**

This command will enable the displaying of analog channels #1 and #2 when the analog board has been enabled with the SET ANALOGON command.

5.1.3.5 Set Startup Options

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

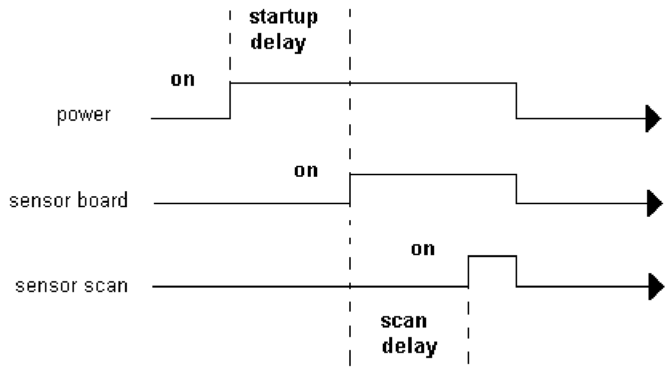
The Startup Delay time is defined as the time difference between the logger board powered up, and when the sensor boards are powered up. The time (nnn) is entered in 0.02-second intervals. Maximum *startup delay* is 255, or 5 seconds.
This command may be used for a "gentle power on", to power up the 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.



Micro CTD power up timing diagram

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

Display the header at power on.

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

Do not display the header at power on.

Command: **SET STARTUP MONITOR [SE S 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.

>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 SCAN [SE S 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).

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…
03/05/01 14:23:06:02 000.40 36.999 11.793 32.263
>

Command: **SET STARTUP PROMPT [SE S 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.

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)*

5.1.3.6 Accessing the Calibration Coefficients

Refer to *Section 8* and *Appendices A* and *B* for more information.

The instruments calibration coefficients are stored in the Micro CTD's memory. Accessing the coefficients for viewing or editing 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	**Address**
Pressure & Temperature	200
Sound Velocity	203
Analog	202

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.

Command: **TALK n [TA n]**

This command, used in conjunction with the DIS or SET commands, allows access to the instruments calibrations coefficients for viewing or editing. "n" is the address of the sensor board as described below. To exit the *talk mode*, use the CTRL C command.

Sensor board	**Address**
Pressure & Temperature	200
Conductivity	201
Analog	202

Example:

>talk 200 *(talk to the pressure and temperature board)*

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

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

This command, used in conjunction with the TALK command, will display the sensor's calibration coefficients. To exit the *talk mode*, use the CTRL C command.

Example:

>talk 201 *(enter talk mode with the conductivity board)*
Entering talk mode
Conductivity Micro Sensor V1.4 SN:0002-C1

>dis c *(display the conductivity sensor coefficients)*
Conductivity
A=-9.605145E-03 B=-7.329993E-06 C= 6.251580E-08 D=-1.762546E-10
E=2.313018E-05 F=-4.348461E-10 G= 0.000000E+00 H= 0.000000E+00

Command: **CTRL-C**

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

5.1.3.7 Editing the Calibration Coefficients

The instruments calibration coefficients are stored in the Micro CTD's memory. Accessing the coefficients for viewing or editing 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	**Address**
Pressure & Temperature	200
Conductivity	201
Analog	202

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.

Conductivity

Command: **SET n = c**

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

Example:
>talk 201 *(enter talk mode with the conductivity board)*
Entering talk mode
Conductivity Micro Sensor V1.30 SN:0002-C1

>set a=-9.605145e-03 *(set the a coefficient)*

>dis c *(display the conductivity sensor coefficients)*
Conductivity
A=-9.605145E-03 B=-7.329993E-06 C= 6.251580E-08 D=-1.762546E-10
E= 2.313018E-05 F=-4.348461E-10 G= 0.000000E+00 H= 0.000000E+00

Press ctrl-c to exit the talk mode

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 200 *(enter talk mode with the Pressure and Temperature board)*
Entering talk mode
Pressure and Temperature Micro Sensor V1.4 SN:0001-P

>set pa=1.234567E+00 *(set the a coefficient)*

>dis c *(display the calibration coefficients)*
Pressure
A= 1.234567E+00 B= 0.000000E+00 C= 0.000000E+00 D= 0.000000E+00
E= 0.000000E+00 F= 0.000000E+00 G= 0.000000E+00 H= 0.000000E+00
I= 0.000000E+00 J= 0.000000E+00 K= 0.000000E+00 L= 0.000000E+00
Temperature
A=0.000000+00 B=0.000000+00 C=0.000000+00 D=0.000000+00
E=0.000000+00 F=0.000000+00 G=0.000000+00

Temperature

Command: SET Tn=c

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

Example:

>talk 200 *(enter talk mode with the Pressure and Temperature board)*
Entering talk mode
Pressure and Temperature Micro Sensor V1.4 SN:0001-P

>set ta=1.234567e+00

>dis c *(display the calibration coefficients)*
Pressure
A= 1.234567E+00 B= 0.000000E+00 C= 0.000000E+00 D= 0.000000E+00
E= 0.000000E+00 F= 0.000000E+00 G= 0.000000E+00 H= 0.000000E+00
I= 0.000000E+00 J= 0.000000E+00 K= 0.000000E+00 L= 0.000000E+00
Temperature
A=1.234567+00 B=0.000000+00 C=0.000000+00 D=0.000000+00
E=0.000000+00 F=0.000000+00 G=0.000000+00

Analog Board

Refer to Appendices A and B for instrument channel configurations.

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 202 *(enter the talk mode with the analog board)*
Entering talk mode
Analog Micro Sensor V1.4 SN:0002-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.

5.1.3.8 Setting the Fluorometer Sensor Gain

Accessing the gain control options for a gain-selectable fluorometer can be achieved by talking to the analog board directly using the TALK command. Once communications is established with the analog board, the user can set the gain of the fluorometer by using the SET GAIN command.

Command: **TALK n [TA n]**

This command, used in conjunction with the SET GAIN command, allows access to the instrument's gain control options for a fluorometer. "n" is the address of the sensor board as described in the example below. To exit the *talk mode*, use the CTRL C command.

Sensor board	**Address**
Analog	202

Command: **SET GAIN n**

This command allows the user to choose between four gain selection options. Please refer to the truth table below for selectable settings. The connector style and pin allocation are dependent on the fluorometer manufacturer and are determined at the factory for each specific Micro CTD/fluorometer combination. Each gain-selectable fluorometer manufacturer provides a gain switching table identifying the correct combination of high and low voltage settings corresponding to a specific fluorometer range. For example: two +5Volt signal levels applied to the two gain selection pins on the fluorometer would set the range of the fluorometer to 0-500 ug/L, whereas, +5 Volts to one pin and 0 Volts to the other would set the range of 0-50 ug/L.

GAIN SETTING	Fluorometer connector Pin X	Fluorometer connector Pin Y
4	+5V	+5V
3	0V	+5V
2	+5V	0V
1	0V	0V

Example:

>talk 202 *(enter talk mode with the analog board)*
Entering talk mode
Analog Micro Sensor V1.44 SN:0202-A

>set gain 4 *(set the gain selection to 4)*
Gain set to 04

Press ctrl-c to exit the talk mode.

5.1.4 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.

5.1.4.1 Untethered Logging

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

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 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.

5.1.4.2 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.

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, including the timeout command
- Do not communicate to the instrument for the prescribed timeout period, the instrument will then start logging
- Turn off power to the instrument by removing the data/power cable from the

instrument or battery pack to stop logging

- Reconnect the data/power cable
- Reset the timeout interval to 0 to disable the logging mode using a terminal program
- Capture the logged data by using the Micro CTD's DUMP command

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, power is applied via the shorting plug or data/power cable and communications have been idle for the timeout period.

5.1.5 Using Integrated System Software (ISS)

Integrated System Software is a comprehensive, MS Windows 95™ 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.

5.1.6 Using SmartTalk

SmartTalk is an easy to use, MS Windows 95™ 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.

5.1.7 Using a Terminal Emulation Program

Terminal emulation programs (such as HyperTerminal, ProComm or Commo) can be used to communicate with the Micro CTD Sensor. The terminal emulation programs can communicate with RS-232 equipped Micro CTD Sensors.

Connect the Micro CTD Sensor to a serial port on the computer (refer to *Section 4.2*). Launch the terminal emulation program and select the communications port to which the instrument is attached. Select 8 bits, no parity, 1 stop bit and the desired baud rate. Power the instrument and then press <**enter**>. The instrument will respond with an identification header and then a prompt. Commands can then be sent to the instrument as desired.

Appendices have been added to this manual to describe the use of several common terminal emulation programs.

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 which are electrically coupled to the water, such as the conductivity sensor, are power and signal isolated to ensure there are no DC connections to the water. This will eliminate the majority of electrical interference problems.

6.2.2 Acoustic Interference

The standard configuration of the Micro CTD Sensor has no acoustic sensors and is therefore immune to acoustic interference. All optional acoustic based Micro Sensors are tuned to a specific frequency to avoid interference from other sources. To avoid interference to and from other sources operating near the same frequency the acoustic Micro Sensors are highly directional. In addition the acoustic frequencies used in the Micro Sensors are in the 1 to 4 MHz region which is attenuated very quickly in the water.

6.2.3 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.

6.3 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 Applied Microsystems Ltd. service staff.

Phone: 250-656-0771
800-663-8721 (toll free in Canada and the US)
Fax: 250-655-3655
E-mail: mailto:service@appliedmicrosystems.com
Mail: Applied Microsystems Ltd.
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 +9 to +16 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 Smart 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 as well as a short between pins 4 and 5. 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 +9 to +16 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 is 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

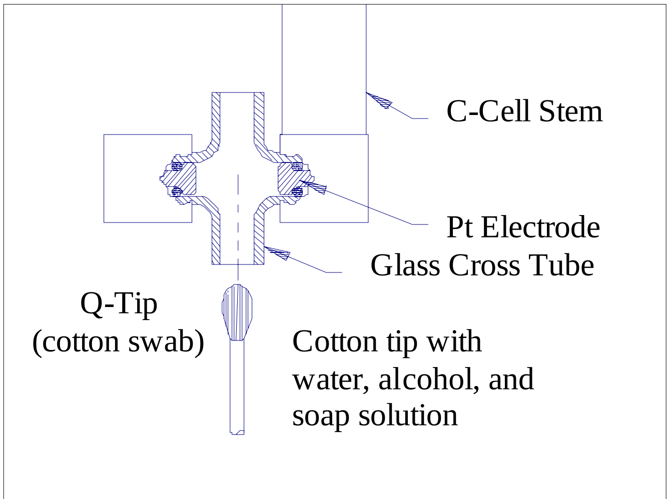


Figure 7-1 Conductivity Cell Cleaning

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 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

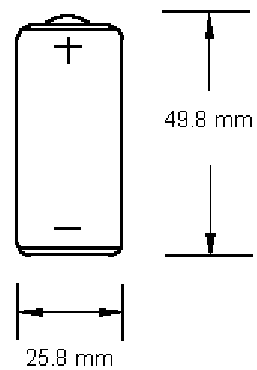
7.3.2 Recommended Battery rating for the Micro CTD

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. 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 is 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 located in the *User Documentation Package*. 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):

$$T = A + B*Nt + C*Nt^2 + D*Nt^3 + E*Nt^4 + F*Nt^5$$

Where: T = temperature in ºC.
Nt = raw value
A through F 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

9 WARRANTY

Warranty and limit of liability

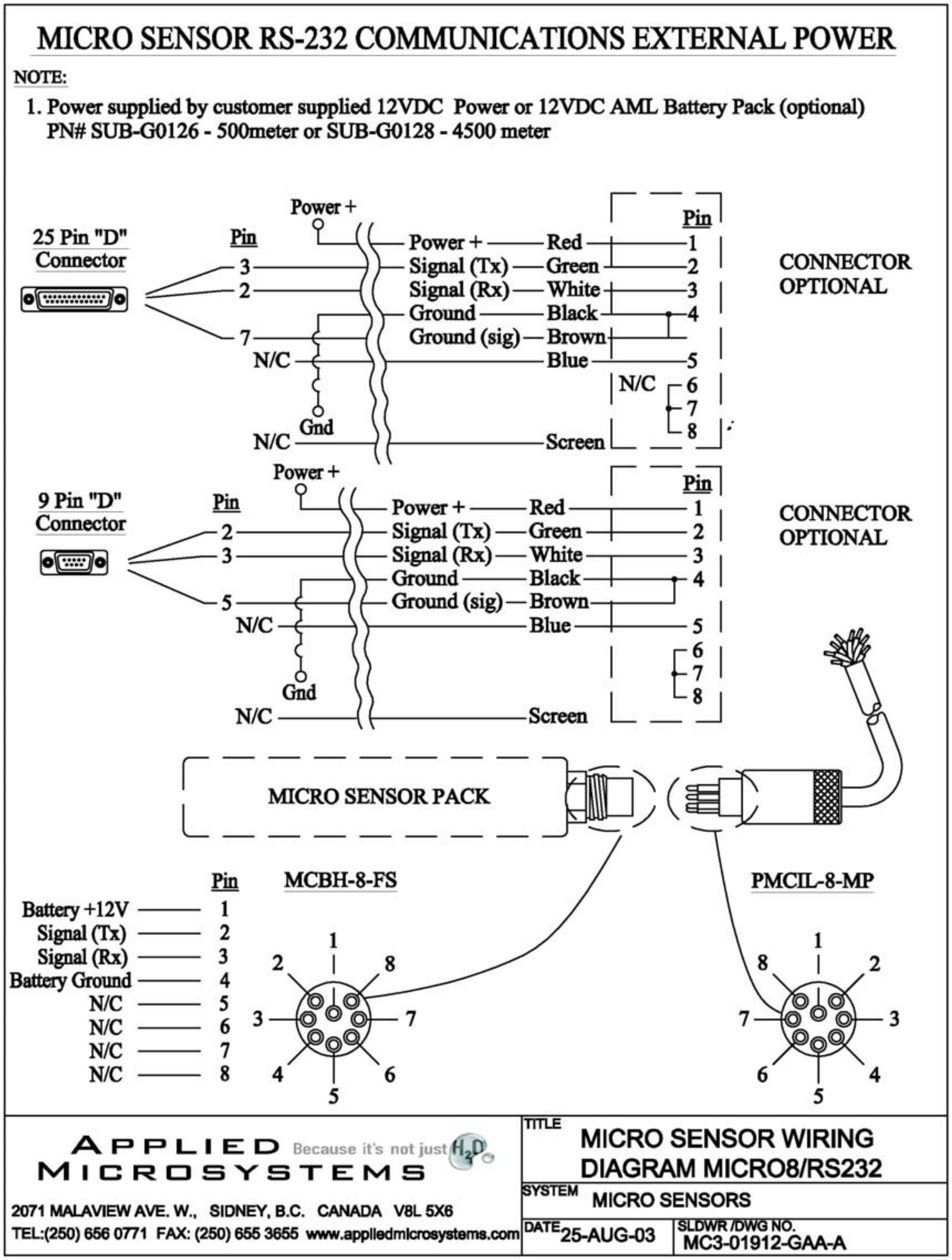
AML warrants the instrument for a period of one year from the date of delivery. AML will repair or replace, at its option and at no charge, components that prove to be defective. The warranty applies only to the original purchaser of the instruments. The warranty does not apply if the instrument has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

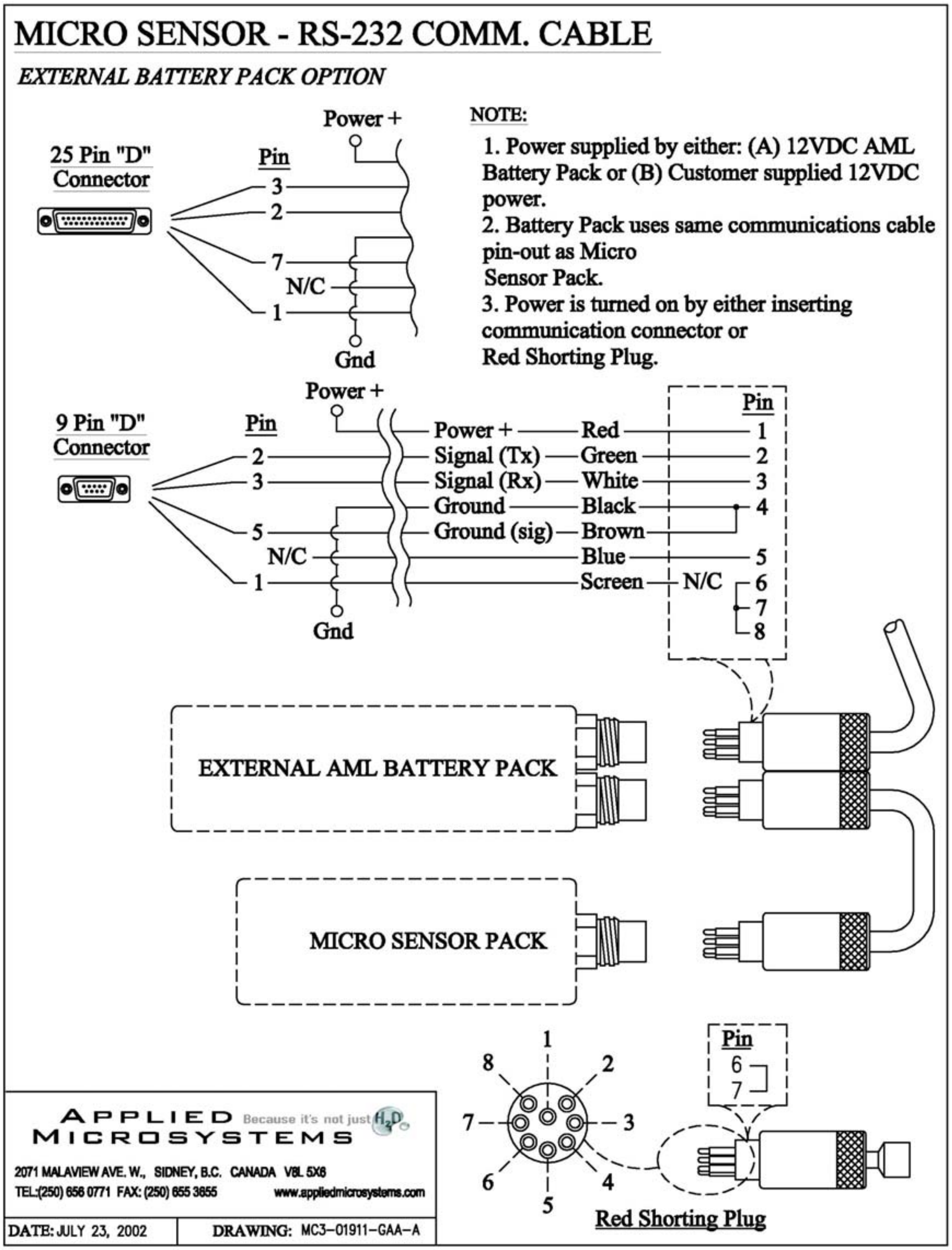
This warranty is the only warranty given by AML. No warranties implied by law, including but not limited to the implied warranties of merchantability and fitness for a particular purpose shall apply. In no event will AML be liable for any direct, indirect, consequential or incidental damages resulting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

Disclaimer

AML 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': " Drawings "




MICRO SENSOR - RS-232 COMM. CABLE
EXTERNAL BATTERY PACK OPTION
NOTE:
1. Power supplied by either: (A) 12VDC AML Battery Pack or (B) Customer supplied 12VDC power.
2. Battery Pack uses same communications cable pin-out as Micro Sensor Pack.
3. Power is turned on by either inserting communication connector or Red Shorting Plug.
25 Pin "D" Connector
Pin
Power +
3
2
7
N/C
1
Gnd
9 Pin "D" Connector
Pin
Power +
2
3
5
N/C
1
Gnd
Power + Red 1
Signal (Tx) Green 2
Signal (Rx) White 3
Ground Black 4
Ground (sig) Brown
Blue 5
Screen N/C 6
7
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EXTERNAL AML BATTERY PACK
MICRO SENSOR PACK
1
2
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Pin
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Red Shorting Plug
APPLIED MICROSYSTEMS Because it's not just H2O
2071 MALAVIEW AVE. W., SIDNEY, B.C. CANADA V8L 5X6
TEL:(250) 656 0771 FAX: (250) 655 3855 www.appliedmicrosystems.com
DATE: JULY 23, 2002
DRAWING: MC3-01911-GAA-A

APPENDIX 'B': " 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.

Using Hyperterminal

Connect the Micro CTD Sensor to the data/power cable. Connect the data/power cable to the serial port of the computer. Connect the data/power 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

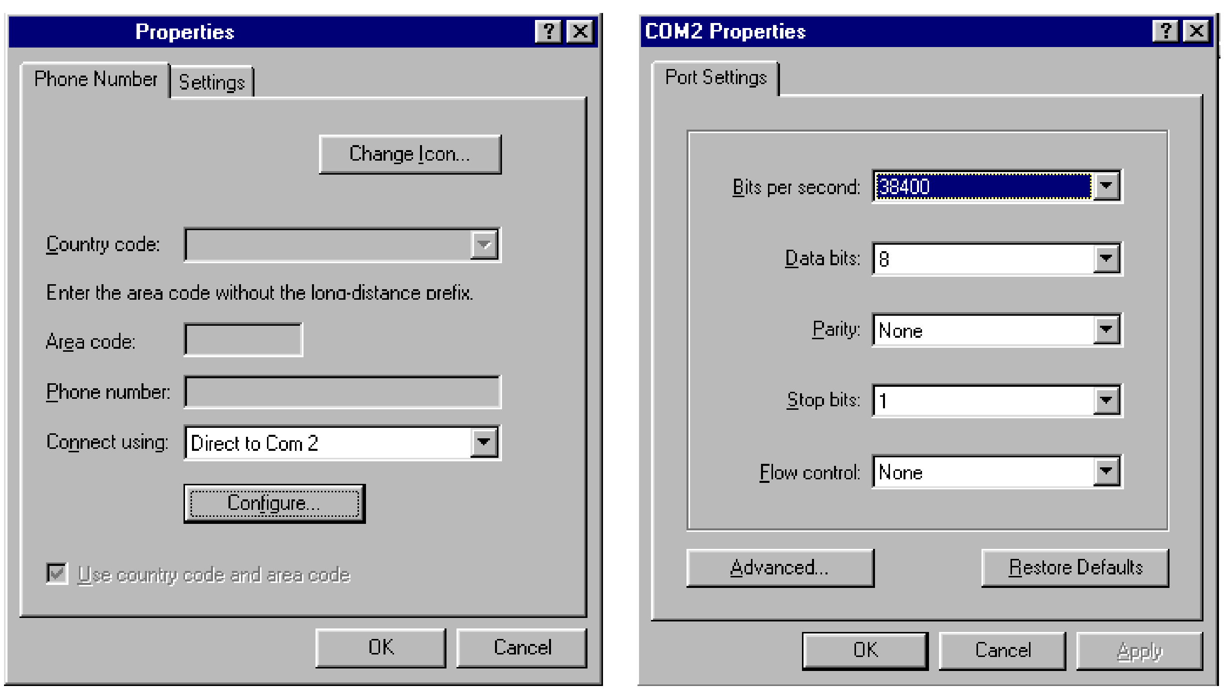

Figure D-1 Properties Windows in Hyperterminal.

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 been chosen, the instrument will respond with a header and then the prompt (>):

Micro CTD Sensor V1.4 SN:4462-CTD
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0MB of Memory

>

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 ‘C’: Micro CTD Quick Reference Guide

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

Connections: Externally powered instrument

- Connect the Micro CTD Sensor to the computer by plugging the data/power cable into the Micro CTD and the RS-232 port of the computer.
- Connect the data/power cable red and black power wires to a DC power source (9 to 16 volts DC, 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.
- Start a communications program, ISS, SmartTalk or a terminal emulation program such as HyperTerminal or Procomm. Refer to the program specific instructions below.
- Place the instrument in the water to be sampled.

Connections: Battery pack powered instrument

- Connect the Micro CTD Sensor to the battery pack using the interconnect cable. Either connector can be used on the battery pack.
- Connect the Battery pack to the computer by plugging the data/power cable into the remaining battery pack connector and the RS-232 port of the computer. **Note:** Inserting the data/power cable plug into the battery pack turns on the power to the instrument.
- To save battery power, connect the data/power cable red and black power wires to a DC power source (12 to 16 volts DC, 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.
- Start a communications program, ISS, SmartTalk or a terminal emulation program such as HyperTerminal or Procomm. Refer to the program specific instructions below.
- Place the instrument in the water to be sampled.

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. Conductivity is given in mS/cm, temperature is given in ºC, pressure is given in dbar, and salinity is given in psu.
- To monitor the data as fast as possible type <**m**> followed by <**enter**>. The instrument will respond with a continuous stream of data with each scan on a new line. Conductivity is given in mS/cm, temperature is given in ºC, pressure is given in dbar, and salinity is in psu.