AML OCEANOGRAPHIC
Xchange your old ideas

Plus·X
User Manual

Version 1.78
13 April 2017

Revision History

Revision	Date	Description	Author
Version 1.4	26 February 2013	Added Turbidity•Xchange™, Configurations Table, Overview Drawings	Dustin Olender
Version 1.5	11 June 2013	Format revision and updates	Jehan Zouak
Version 1.6	26 August 2013	Minor edits	Jehan Zouak
Version 1.7	16 July 2014	Added Ordering Codes	Jehan Zouak
Version 1.71	06 Oct 2014	Added Calculated SV	Dustin Olender
Version 1.72	18 Mar 2015	Updated manual for SeaCast 4	Andrew Beak-Taylor
Version 1.73	30 April 2015	Data•Xchange and formatting edits	Jehan Zouak
Version 1.74	22 June 2015	Updated technical specifications	Jehan Zouak
Version 1.75	27 October 2015	Updated Alkaline Battery Replacement	Matt Tradewell
Version 1.76	25 November 2015	Updated manual to include CT•Xchange™ and updated product codes	Tony Nordstrom
Version 1.77	22 January 2016	Minor edits	Jehan Zouak
Version 1.78	13 April 2017	Added regulatory information, updated maintenance instructions	Andrew Beak-Taylor

Table of Contents

General Description of the Instrument

The AML Oceanographic X•Series instruments and Xchange™ sensors are a major advancement in ocean instrumentation. Swappable and interchangeable sensors dramatically improve the capabilities of ocean instrumentation in the following ways:

- Change the instrument sensor types while at sea within seconds, and without tools. A CTD can be changed to a sound speed profiler by exchanging sensor heads.
- To optimize the resolution and accuracy of sensor data, sensors can be swapped to change the measurement range. For example, a 6000 dBar P•Xchange pressure sensor can be swapped with a 500 dBar P•Xchange sensor; the salt water C•Xchange conductivity sensor can be swapped for a fresh water C•Xchange conductivity sensor.
- Sensors from one instrument can be swapped to another instrument to maintain mission-critical capabilities.
- Calibrated sensors can be sent from the factory to the instrument. The instrument is not pulled from active duty for calibration.
- Spare sensors ensure that an instrument can be immediately returned to active duty after sustaining damage.
- All calibration and traceability data resides within each Xchange™ sensor. Calibration data for all sensors is available from the instrument, and calibration certificates can be printed from AML Oceanographic SeaCast software when the instrument is connected.
- Logged data is stamped with sensor traceability and instrument configuration data.
- Only Xchange™ sensors are sent for calibration, leaving the instrument working in the field.

Plus•X is the largest multi-sensor data logging instrument of the X•Series family. It is designed primarily for deep, winch-deployed profiling operations. Plus•X is available in two configurations:

P1S3: Equipped with one primary Xchange™ sensor port (C•Xchange, CT•Xchange or SV•Xchange) and three secondary Xchange™ sensor ports (T•Xchange, P•Xchange, Tu•Xchange). Up to four additional analog ports can be added by the factory, if required.

P2S2: Equipped with two primary Xchange™ sensor ports (C•Xchange, CT•Xchange or SV•Xchange) and two secondary Xchange™ sensor ports (T•Xchange, P•Xchange, Tu•Xchange). Up to four additional analog ports can be added by the factory, if required.

Plus•X is capable of logging continuously for 49 hours with fresh alkaline batteries. The actual life varies somewhat depending on the sensors installed. Sampling rates are programmable by time (25 Hz to every 24 hours), by pressure (0.1 dbar or greater increments), or by sound speed (0.1 m/s or greater increments). When logging at time intervals of 25 seconds or more, Plus•X powers down between samples to conserve the batteries.

Supported communication protocols for Plus•X are RS-232 or RS-485. The instrument can be powered both internally and externally.

Like all AML logging instruments, Plus•X can be equipped with a Data•Xchange to add wireless capabilities and enhance data transfer rates.

Where Do I Start?

AML Oceanographic X•Series instruments ship with several manuals on the USB stick:

- An instrument manual (this Plus•X manual) providing an overview on how to use and maintain the instrument;
- A SeaCast manual providing instructions on how to use the software to configure the instrument and review instrument data;
- Xchange™ sensor manuals (C•Xchange™, CT•Xchange™, SV•Xchange™, P•Xchange™, T•Xchange™, and Turbidity•Xchange™) providing overviews on how to install and maintain each of the Xchange™ sensors;

If you are configuring an instrument for field use or lab testing, begin with the SeaCast manual.

If you are performing instrument maintenance, begin with the instrument manual.

If you are planning to swap an Xchange™ sensor, read the Xchange™ manual corresponding to your sensors.

If you will be using Data•Xchange with your instrument, refer to its manual beforehand.

Shipping & Receiving

Receiving an Instrument

When receiving an instrument, perform the following steps to ensure the instrument will be ready for deployment when required:

- Inspect the shipping container, looking for signs of damage. Damage to the shipping container could indicate damage to the instrument inside.
- The shipping package should include all of the following items
    - Plus•X instrument
    - Data•Xchange (if purchased)
    - Data/Power cable
    - Red shorting plug
    - Black dummy plug
    - One primary sensor blanking plug
    - Two secondary sensor blanking plugs
    - USB stick with manuals and documentation
- Inspect for damage
    - Check the cable for slices or gouges
    - Check the connector sockets for corrosion, dirt, and salt deposits
    - Check the pressure case for dents and scrapes
    - Check the sensors for cracks or bends
- Ensure all the Xchange™ sensors are installed tightly. The blue locking sleeve should be tight, and sitting less than 1 mm from the instrument end cap.
- Connect the instrument to a computer with the data cable and perform a scan or monitor if using SeaCast. Check the battery voltage on the output (normally the last column of data, unless calculated parameters have been enabled). It should be between 9.9 and 14 volts.

Returning an Instrument to the Factory

- If shipping for repair or recalibration, obtain an RMA number from the service centre.
- Pack the instrument in its original shipping box to prevent damage during shipping.

An RMA number can be requested using the contact options given in the Support section of this manual.

Using the Instrument

Pressure Ratings

Pressure ratings are given for Xchange™ sensors and the entire instrument. **Deployments should never exceed the lower of these two pressure ratings.** For example, a 500m instrument equipped with a 6000 dBar (0-6000m) P•Xchange™ sensor is limited to deployments of 500m depth or less. Similarly, a 6000m instrument equipped with a 500 dBar (0-500m) P•Xchange™ sensor is also limited to deployments of 500m depth or less.

It is desirable to optimize the accuracy of pressure measurements by using a P•Xchange™ sensor with a pressure range that closely matches the depth of the deployment.

Caution: Do not exceed the specified pressure ratings of the P•Xchange™ sensor, Turbidity•Xchange™ sensor, or the instrument housing. Overpressure can result in damage to the sensors and the instrument.

Pre-Deployment Procedures

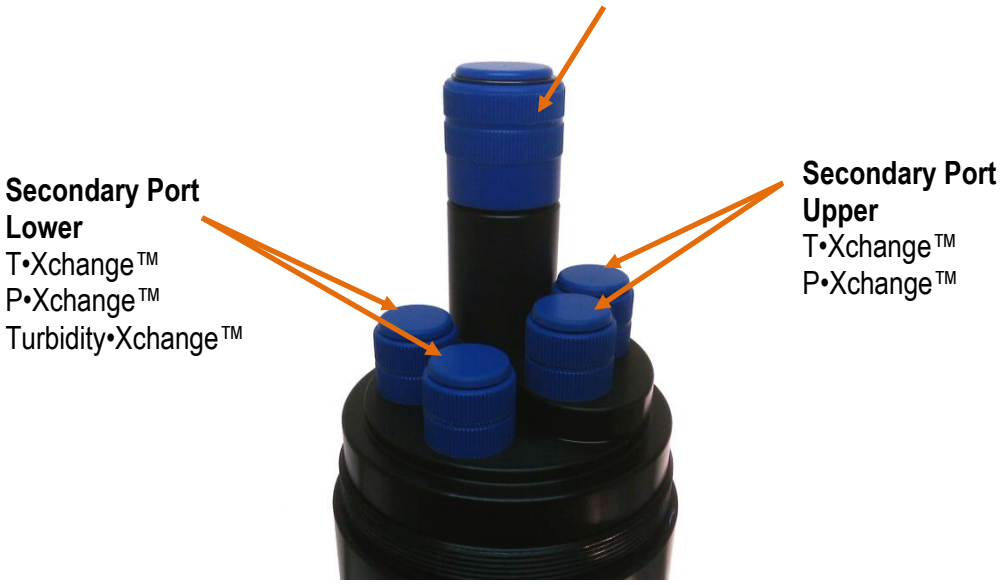
- Upon Receipt
  - Use the Shipping and Receiving instructions to verify the condition of the instrument.
  - Verify that all sensor calibrations are valid for the duration of the deployment. If not, swap the Xchange™ sensors for sensors with valid calibrations or send the Xchange™ sensors to a service centre for recalibration.
  - Lightly lubricate the underwater connectors with 3M silicone spray or equivalent.
- Before leaving the jetty
  - If applicable, verify the P•Xchange™ pressure range is correct for the deployment.
  - Connect the instrument to a computer using the data cable.
  - Check the instrument memory
    - Save any unsaved memory files.
    - Initialize the memory (Note: This deletes ALL files stored in the instrument memory. Be sure to have a copy of all important logged data before performing this step.).
      - If using SeaCast, click the *Clear Memory* box.
      - If using a Terminal Emulator, send instrument an *INIT* command.

Caution: Install blanking plugs in all unused sensor ports prior to deployment. Failure to install blanking plugs will result in damage to the connectors.

Primary Xchange™ mount blanking plug

Secondary Xchange™ mount blanking plug

Primary Port Elevated
C•Xchange™
CT•Xchange™
SV•Xchange™



Plus•X endcap with one primary and four secondary ports (abbreviated as P1S4). Blanking plugs shown installed. Plus•X endcaps are available with different combinations of ports to allow for a wide variety of sensor combinations.

Swappable sensors allow you to configure your instrument in a number of different ways. See the tables below for two endcap styles and popular sensor combinations. Note that not all supported sensor combinations are shown. It is possible, for example, to install two T•Xchange™ sensors, or two P•Xchange™ sensors simultaneously for cross verification, or in the case of Turbidity•Xchange™, using two different ranges to capture both high and low events accurately.

Supported Sensor Configurations

P2S2 Endcap				
Port Type	Primary (P2)		Secondary (S2)	
Port Level	Elevated ↑↑	Upper ↑	Upper ↑	Lower ↓
1	C	SV	T	P
2	C	SV	P	T
3	C	SV	T	Turbidity
4	C	SV	P	Turbidity
5	CT	SV	T	P

P1S4 Endcap					
Port Type	Primary (P1)	Secondary (S4)			
Port Level	Elevated ↑↑	Upper ↑	Upper ↑	Lower ↓	Lower ↓
1	C	T	P	Turbidity	Turbidity
2	C	P	T	Turbidity	Turbidity
3	SV	T	P	Turbidity	Turbidity
4	SV	P	T	Turbidity	Turbidity
5	CT	P	T	Turbidity	Turbidity

LED Indicator

The LED indicator is located next to the data/power connector on the instrument's top endcap.

- The LED indicator will be on whenever the data/power cable is plugged into the instrument.
- The LED indicator will turn on when the red shorting plug is inserted into the instrument. It will turn off after 5 minutes to conserve power.
- When the instrument is logging and is brought back to the surface, the LED indicator will resume for 5 minutes so that the operator can see that the instrument is still functioning after the cast.

The LED indicator displays are as follows:

- **LED is a constant green**: This indicates the instrument is on and the batteries have more than 20% capacity remaining for alkaline batteries, 5% for NiCad batteries.
- **LED is flashing green**: The instrument is logging data and the batteries have more than 20% capacity remaining for alkaline batteries, 5% for NiCad batteries.
  Note:
  - The flashing green LED will turn off after 5 minutes to conserve power.
  - The instrument will not start logging until it is immersed in water and it takes its first sample at the programmed sampling rate.
- **LED is a constant red**: This indicates the instrument is on and the batteries have less than 20% capacity remaining for alkaline batteries, 5% for NiCad batteries.
- **LED is flashing red**: The instrument is logging data and the batteries have less than 20% capacity remaining for alkaline batteries, 5% for NiCad batteries.
  Note:
  - The flashing red LED will turn off after 5 minutes to conserve power.
  - The instrument will not start logging until it is immersed in water and it takes its first sample at the programmed sampling rate.
- **LED off with data/power cable attached**: The instrument is not working properly. Consult the Troubleshooting section or call the service department.
- **LED off with the red shorting plug inserted**: If the shorting plug was inserted less than 5 minutes ago, the instrument is not working properly. Consult the Troubleshooting section or call the service department. If the LED was on for the first 5 minutes after inserting the shorting plug the instrument is functioning correctly and the LED has turned off to conserve power.

Configuring Sampling Parameters Using SeaCast

SeaCast is free software provided for use with AML Oceanographic instruments. It can be used to set up an instrument for profiling or monitoring data, as well as downloading, graphing, and exporting the collected data.

Full details on the instrument configuration process and the software's capabilities can be found in the SeaCast manual.

Configuring Sampling Parameters through the Terminal

Instruments can also be configured for deployment using a terminal emulation program like *HyperTerminal*, *RealTerm*, or *Tera Term*. Communications with the instrument must be established using the correct communications port and settings. The communications settings are 8 data bits, 1 stop bit, no parity, no flow control, and the desired baud rate.

The following steps must be completed by issuing text commands:

Step	Possible Commands
Initialize Memory (erases instrument memory)	INIT
Set Log File Name	SET LOG filename.txt
Set Instrument Time & Date	SET TIME hh:mm:ss SET DATE mm/dd/yy
Set Sampling Parameters	SET SAMPLE RATE CONTINUOUS SET SAMPLE RATE 5/s SET P INC 1 SET SOUND INC 2

The above table provides example commands only; many additional sampling regimes can be established using available commands. Please consult the Commands section of the Appendix for full syntax details on the commands you wish to use.

Accounting for Atmospheric Pressure Variations at the Surface

Climate and altitude changes can create fluctuations in atmospheric (barometric) pressure. AML's pressure sensors are sensitive enough to detect these variations. When this happens, the instrument's pressure channel may not read exactly zero when data is taken prior to submersion in the water. Nearly all absolute pressure sensors experience atmospheric pressure offsets if they are sufficiently sensitive.

To compensate for this atmospheric pressure offset, AML instruments have the ability to reset the pressure sensor's zero point. This can be initiated using AML Oceanographic SeaCast software or a Terminal emulator command. The compensation does not affect the calibration of the pressure sensor, and can be turned off or recalculated at any time. The compensation factor is applied through the entire calibrated pressure range. Note that this compensation cannot be applied to a built-in Paroscientific Digiquartz sensor, as found in bathyMetrec•X.

Once the atmospheric pressure compensation is applied, it will be applied to all pressure sensor data until it is turned off or recalculated. The setting is written to memory, so it remains set when the instrument is powered down.

Using SeaCast
Refer to the SeaCast User Manual for instructions on enabling "Zero Depth."

Using a Terminal Emulator

- Establish serial communications with the instrument on your computer. Refer to the Communications section of this manual for more information.
- Once a connection is established, ensure the instrument is stationary, and is not submerged in water.
- To turn ON Atmospheric pressure compensation, issue the *ZERO ON* command. This will calculate and apply the offset required to compensate for current atmospheric pressure conditions.
- To turn OFF Atmospheric pressure compensation, issue the *ZERO OFF* command. This will disable the offset.
- Issuing the *ZERO* command again will calculate a new offset based on current conditions.

Logging a Profile

- Ensure the pre-deployment procedures have been completed (see page 6).
- Plug the data/power cable into the instrument.
- Ensure that the desired sampling settings have been selected and applied.
- With the instrument in air (NOT submerged), use the *ZERO* command to zero the barometric pressure offset (P•Xchange™ only).
- Insert the red shorting plug to power the instrument. Insertion of the shorting plug tells the instrument to begin logging data once it is submerged. The instrument determines whether or not it is submerged by looking for valid conductivity or sound speed readings.
    - The green LED light should illuminate on the top of the instrument indicating the battery has more than 20% capacity remaining with alkaline batteries, 5% remaining with Ni-Cad batteries, and the instrument is ready to start logging.
    - If the LED light is red, the battery charge is less than 20% with alkaline batteries, 5% with Ni-Cad batteries, but the instrument is still ready to log.
    - If the LED light fails to illuminate, the instrument will not log. Refer to the Troubleshooting section of this manual if this occurs.
- Securely attach the lowering cable to the instrument shackle bar.
- Lower the instrument until it is just submerged. Keep the instrument at this depth for 2 minutes prior to beginning the cast. This allows the sensors time to wet and the pressure case to shed heat.
- Send the instrument down to the desired depth and return it to the surface.
- Note that with Plus•X in the typical, vertical orientation, the downcast data is usually more accurate than the upcast data since the downcast measurements are not contaminated by the thermal shedding from the pressure case.

Monitoring Real Time Data

- Ensure the pre-deployment procedures have been completed (see page 6).
- Ensure that the desired sampling settings have been selected and applied.
- Plug the data/power cable into the instrument. If you power the instrument externally over a long cable, please note the following:
    - Voltage drop due to cable resistance increases with cable length. The voltage drop on a standard AML cable, with a standard Plus•X, is about 2 volts per 100m of cable while sampling and 0 volts per 100m when in low power mode.
    - The instrument's low voltage warning has a default level of 9.9 volts.
    - The instrument's auto shutdown triggers when supplied with 8.0 volts or less.
    - The instrument's maximum voltage is 26 volts.
    - The voltage at the instrument, while sampling, must be above the shutdown level for the instrument to operate.
- With the instrument in air, use the *ZERO* command to zero the barometric pressure offset (P•Xchange™ only).
- Securely attach the lowering cable to the instrument shackle bar.
- Lower the instrument until the sensors are fully submerged; the LED should start to flash green. Keep the instrument at this depth for 2 minutes prior to beginning the cast. This allows the sensors time to wet, and the pressure case to shed heat.
- Begin monitoring data using SeaCast or HyperTerminal.
- Send the instrument down to the desired depth and return it to the surface.
- Note that with Plus•X in the typical vertical orientation, the downcast is usually more accurate than the upcast data since the downcast measurements are not contaminated by the thermal shedding from the pressure case.

Post-Deployment Procedures

- When the instrument is pulled from the water it should be rinsed with fresh water.
- Dry the area around the connectors with a clean cloth or compressed air prior to disconnecting the plugs or cables. Do not blow compressed air into the Pressure•Xchange™ sensor. Doing so may damage the sensitive pressure transducer diaphragm.
- Remove the shorting plug or cable. Place the dummy plug in the connector to protect it.
- Dry the instrument and stow it securely.

Viewing your Data

You may download and view data directly through the terminal, or automatically using SeaCast. The SeaCast manual has more information. Alternately, use the following instructions to access the data manually.

- Connect the instrument to the computer using the data/power cable.
- With the terminal, use the *DIR* command to list all the files on memory, then the *DUMP* command to retrieve the file of interest. For example:

```
Plus.X Version 4.09 SN:8221
AML Oceanographic Ltd.
968.5 MBytes installed

>dir
```

```
test    .raw       5598 02/24/10 14:41:55.00
data    .txt       3987 02/24/10 14:45:08.00

 960 MBytes free
   7 MBytes Used
   2 File(s) listed

>dump data.txt
[cast header]
InstrumentSN=08221
Date=02/24/10
Time=14:45:10.55
PressureOffset=0.09
UsePressureOffset=yes
Slot1Sensor1=SV-C.Xchange SV.X SN 131197 01/22/10
Slot2Sensor1=P-T.Xchange P.X SN 145721 08/21/09 T.X SN 400048 11/17/09

[Data]
02/24/10 14:45:10.66  1474.313  0000.015  17.447  008.18  00.034  0998.724
02/24/10 14:45:10.69  1474.334  0000.015  17.449  008.20  00.046  0998.733
02/24/10 14:45:11.19  1474.332  0000.027  17.451  008.20  00.037  0998.726
02/24/10 14:45:11.69  1474.326  0000.027  17.451  008.20  00.032  0998.722
02/24/10 14:45:12.19  1474.319  0000.027  17.457  008.20  00.011  0998.705
02/24/10 14:45:12.69  1474.321  0000.034  17.459  008.20  00.005  0998.700
02/24/10 14:45:13.19  1474.318  0000.023  17.457  008.20  00.008  0998.702
02/24/10 14:45:13.69  1474.321  0000.019  17.458  008.20  00.010  0998.704
02/24/10 14:45:14.19  1474.427  0000.019  17.459  008.20  00.100  0998.773
02/24/10 14:45:14.69  0000.000 -0000.015  17.601  008.20  00.000  0000.000
02/24/10 14:45:15.19  0000.000 -0000.030  17.655  008.20  00.000  0000.000
02/24/10 14:45:15.69  0000.000 -0000.011  17.651  008.20  00.000  0000.000
02/24/10 14:45:16.19  0000.000 -0000.015  17.632  008.20  00.000  0000.000
02/24/10 14:45:16.69  0000.000 -0000.015  17.624  008.20  00.000  0000.000
02/24/10 14:45:17.19  0000.000 -0000.015  17.622  008.20  00.000  0000.000
02/24/10 14:45:17.69  0000.000 -0000.015  17.618  008.20  00.000  0000.000
[cast header]
InstrumentSN=08221
Date=02/24/10
Time=14:45:21.85
PressureOffset=0.09
UsePressureOffset=yes
Slot1Sensor1=SV-C.Xchange SV.X SN 131197 01/22/10
Slot2Sensor1=P-T.Xchange P.X SN 145721 08/21/09 T.X SN 400048 11/17/09

[Data]
02/24/10 14:45:21.92  1474.309 -0000.019  17.598  008.20  00.000  0998.671
02/24/10 14:45:21.95  1474.308  0000.019  17.451  008.20  00.017  0998.711
02/24/10 14:45:22.44  1474.301  0000.023  17.453  008.20  00.005  0998.701
02/24/10 14:45:22.94  1474.297  0000.011  17.453  008.20  00.003  0998.699
02/24/10 14:45:23.44  1474.294  0000.019  17.451  008.20  00.005  0998.702
02/24/10 14:45:23.94  1474.314  0000.019  17.453  008.20  00.019  0998.711
02/24/10 14:45:24.44  1474.310  0000.027  17.453  008.20  00.015  0998.709
02/24/10 14:45:24.94  1474.307  0000.015  17.451  008.20  00.016  0998.709
02/24/10 14:45:25.44  1474.307  0000.027  17.453  008.20  00.009  0998.704
02/24/10 14:45:25.94  1474.308  0000.023  17.454  008.20  00.008  0998.703
02/24/10 14:45:26.44  1474.313  0000.023  17.451  008.20  00.021  0998.714
02/24/10 14:45:26.94  1474.294  0000.023  17.452  008.20  00.002  0998.699
02/24/10 14:45:27.44  1474.313  0000.023  17.453  008.20  00.015  0998.709
02/24/10 14:45:27.94  1474.303  0000.023  17.454  008.20  00.004  0998.700
02/24/10 14:45:28.44  1474.312  0000.023  17.453  008.20  00.015  0998.708
02/24/10 14:45:28.94  1474.319  0000.030  17.453  008.20  00.019  0998.712
02/24/10 14:45:29.44  1474.336  0000.027  17.450  008.20  00.045  0998.732
02/24/10 14:45:29.94  1474.314  0000.027  17.450  008.20  00.023  0998.715
```

```
02/24/10 14:45:30.44  1474.326  0000.027  17.451  008.20  00.032  0998.722
02/24/10 14:45:30.94  1474.320  0000.027  17.451  008.20  00.027  0998.718
02/24/10 14:45:31.44  1474.305  0000.023  17.454  008.20  00.006  0998.701
02/24/10 14:45:31.94  1474.312  0000.030  17.451  008.20  00.020  0998.713
02/24/10 14:45:32.44  1474.311  0000.034  17.453  008.20  00.014  0998.708
02/24/10 14:45:32.94  1474.312  0000.030  17.450  008.20  00.021  0998.714
02/24/10 14:45:33.44  0000.000 -0000.011  17.459  008.20  00.000  0000.000
02/24/10 14:45:33.94  0000.000 -0000.019  17.569  008.20  00.000  0000.000
02/24/10 14:45:34.44  0000.000 -0000.015  17.548  008.20  00.000  0000.000
02/24/10 14:45:34.94  0000.000 -0000.023  17.515  008.20  00.000  0000.000
02/24/10 14:45:35.44  0000.000 -0000.015  17.498  008.20  00.000  0000.000
02/24/10 14:45:35.94  0000.000 -0000.023  17.487  008.20  00.000  0000.000
02/24/10 14:45:36.44  0000.000 -0000.019  17.485  008.20  00.000  0000.000
>
```

Configuring the Instrument for Data on Power Up

Perform the following steps:

- Open a terminal emulation program such as HyperTerminal. Ensure the serial port has been selected in the program. If the instrument has been set to a specific baud rate with the *SET DETECT* command, the terminal emulation program must be configured for that baud rate.
- Connect the instrument to the computer using the data/power cable.
- Using the terminal emulation program, issue the following commands to the instrument:
    - *SET STARTUP NOHEADER* (disables the power up header information)
    - *SET STARTUP MONITOR* (enables data output on power up)
    - *SET SAMPLE RATE 2/S* (sets the desired sampling rate)
    - *SET DETECT 07* (sets fixed 38400 baud rate)

      Note: Details on the *SET DETECT* command can be found in the Appendix.
- Unplug the data/power cable from the instrument to turn the instrument off.
- Plug the data/power cable into the instrument to turn the instrument on.

Disabling Data on Power Up

Perform the following steps:

- Open a terminal emulation program such as HyperTerminal. Ensure the serial port has been selected in the program. If the instrument has been set to a specific baud rate with the *SET DETECT* command, the terminal emulation program must be configured for that baud rate.
- Connect the instrument to the computer using the data/power cable.
- Unplug the data/power cable from the instrument to turn the instrument off.
- Hold down the <ENTER> key.
- Plug the data/power cable into the instrument to turn the instrument on.
- Release the <ENTER> key once the prompt '>' is displayed.
- Using the terminal emulation program issue the following commands to disable data on power up:
    - *SET STARTUP HEADER* (enables the power up header information)
    - *SET STARTUP PROMPT* (disables data output on power up)
    - *SET SAMPLE RATE 2/S* (selects the desired sampling rate)
    - *SET DETECT A7* (sets 10 autobaud attempts then defaults to 38400 baud)

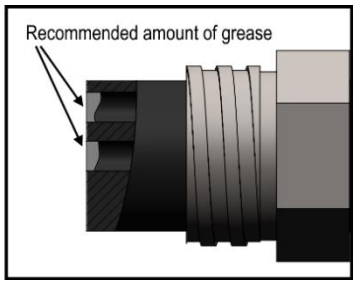
      Note: Details on the *SET DETECT* command can be found in the Appendix.
- Unplug the data/power cable from the instrument to turn the instrument off.

Maintaining the Instrument

Periodic Maintenance

Periodic preventative maintenance will prolong the life of the instrument. The following steps are recommended:

- If the instrument is very dirty or oily, allow it to soak in warm, soapy water before cleaning with a rag or soft brush. When finished, rinse with fresh water to remove any residual soap or dirt.
- Before each use:
  - Check for proper installation of all Xchange™ sensors.
  - Check for nicks and cuts on the cable.
- After each use:
  - Clean and rinse the instrument using fresh water.
  - Dry the instrument completely, and store it in a cool, dry place.
- Monthly:
  - Apply a layer of Molykote 44 medium silicone grease to the female half of the connection as shown and fully insert the plug. Wipe away any excess that squeezes out. This will lubricate both male and female connectors.



- Yearly:
  - Send the instrument or Xchange™ sensors to a service centre for diagnostics and re-calibration.

Battery Care

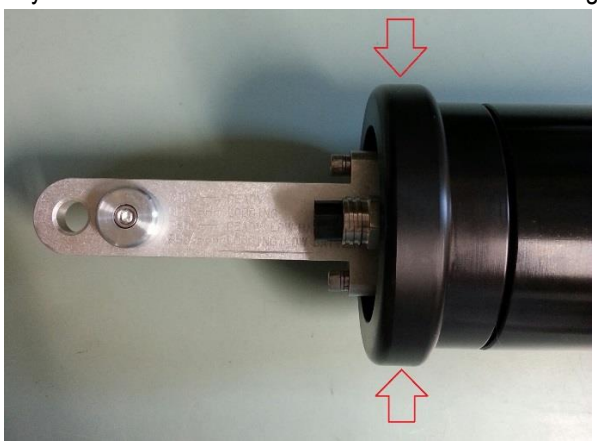
Incorrect care can reduce the life of the batteries. Below are some guidelines to prevent damage to the batteries:

- Do not leave either the data cable or the red shorting plug installed in the instrument. This turns the instrument on and depletes the battery.
- Before storing the instrument for several months, remove the alkaline batteries, or charge the Ni-Cad batteries. The Ni-Cad batteries will self-discharge, so extended storage durations can require recharging to protect the battery from fully depleting.

Replacing Alkaline Batteries:

The Plus•X pressure case must be opened to replace the batteries:

- Rinse Plus•X with fresh water and dry it.
- Lay the instrument on its side and unscrew the retaining ring.



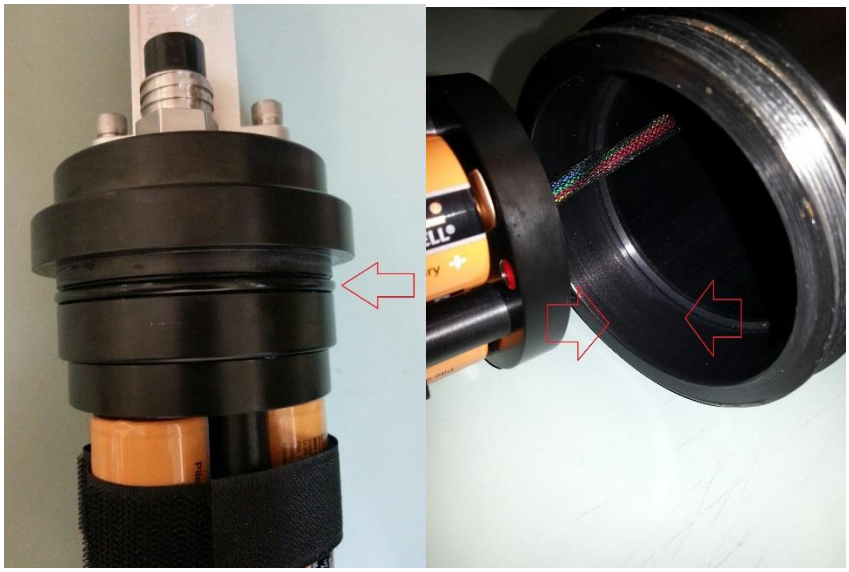
- Dry off any water that might have been underneath the retaining ring.

- Grasp the shackle, and pull the end cap straight out. A slight rocking motion will aid in removal of the end cap.

- Undo the Velcro straps, and remove the old batteries.
- Install the new batteries. **NOTE:** Be sure to match the + positive terminal of the battery with the red dot.

- Tighten the Velcro straps around the new batteries.

- Ensure that the O-ring and O-ring surface are free from dirt and debris.



- Slide the battery pack into the pressure case.
- Install the retaining ring.

Charging Ni-Cad Batteries:

Refer to the wiring diagram in the appendix, and perform the following steps:

- Ensure the instrument is dry.
- To avoid possible combustible gas build-up inside the instrument case, open the battery compartment prior to charging the batteries.
    - Unscrew the retaining ring on the shackle end cap.
    - Grasp the shackle bar and wiggle the endcap off the pressure case, opening the case by at least 3 cm.
- Plug the battery charging cable into the instrument.
- Plug the charger into the charging cable.
- Plug the charger into a 120 or 240 volt AC outlet.
- Turn the charger on with the power switch on the charger. The fast charge indicator light will turn on indicating the batteries are being charged.
- Allow the batteries to charge until the fast charge light on the charger turns off. A full charge requires approximately 6 hours.

Communications

PC Settings

Plus•X will communicate with both RS-232 and RS-485 serial connections. The computer to which the instrument is connected must be set up as follows:

- 8 bits
- 1 stop bit
- No parity
- No hardware flow control
- Baud rate of 600, 1200, 2400, 4800, 9600, 19,200, or 38,400 baud

After power up, Plus•X will wait for an ASCII carriage return. The instrument will automatically detect whether communications are RS-232 or RS-485 as well as the baud rate.

Output Formats

Output formats can be modified. If the required modifications are not supported by the commonly used command list in the next section, please contact the factory for support with custom output formats.

Formatting can be changed in the following ways:

- The number of decimal places for each channel
- Turn on or off
    - date and time
    - calculated parameters (Salinity and Density)
    - battery voltage
    - power up information (header)
    - automatic monitoring on power up

Default Output Format

The output from Plus•X is space delimited values.

The following table shows the output units for each Xchange™ sensor:

Sensor	Units	Default Format
SV•Xchange™	m/s	1234.567
Conductivity•Xchange™	mS/cm	12.346
C•Xchange™ Conductivity	mS/cm	12.345
C•Xchange™ Temperature	C	12.345
Pressure•Xchange™	dBar	1234.56
Temperature•Xchange™	C	12.345
Turbidity•Xchange™	NTU	1234.56

The default data channel outputs with all calculated parameters turned on are:
SV,P,T sensors

Date	Time	Sound velocity	Pressure	Temperature	Battery	Density	Salinity
mm/dd/yy	hh:mm:ss.ss	m/s	dbar	C	volts	kg/m^3	ppt

C,P,T sensors

Date	Time	Conductivity	Pressure	Temperature	Battery	Density	Salinity	Sound velocity
mm/dd/yy	hh:mm:ss.ss	mS/cm	dbar	C	volts	kg/m^3	ppt	m/s

Note: These are examples of the default configurations. Your data channel outputs will be entirely dependent on which Xchange™ sensors are installed.

Default Example Outputs

User inputs in the output capture shown below are in bold type.

```
Plus.X Version 4.09 SN:8221
AML Oceanographic Ltd.
968.5 MBytes installed

>scan
02/24/10 14:59:20.90  1474.372  0000.098  17.470  008.15  00.018  0998.708
>monitor
02/24/10 14:59:25.10  1474.374  0000.102  17.472  008.18  00.014  0998.705
02/24/10 14:59:25.60  1474.354  0000.106  17.474  008.18  00.000  0998.694
02/24/10 14:59:26.10  1474.386  0000.110  17.474  008.18  00.018  0998.708
02/24/10 14:59:26.60  1474.374  0000.102  17.473  008.18  00.010  0998.702
>dis options
[Instrument]
Type=Plus.X
EmulationMode=disabled
UseCustomHeader=yes
SN=8221
Firmware=V4.09
SampleUnits=/ second
SampleInterval=2
PressureInc=0.00
SoundInc=0.00
LogFile=data.txt
Date=02/24/10
Time=14:59:36
MemorySize=968.5 MB
MemoryUsed=7.6 MB
DisplayTime=yes
DisplayDate=yes
DisplaySalinity=yes
DisplayDensity=yes
DisplaySoundVelocity=no
DisplayBattery=yes
RelayMode=auto detection
RealtimeLogging=no
LoggingTimeout=0
StartupDelay=10
DisplayHeader=yes
StartupMode=prompt
CharacterReception=yes
LoggingBreakMode=no
DetectionMode=A5
```

```
BatteryACoefficient=+3.500000E-01
BatteryBCoefficient=+2.500000E-02
ShutDownVoltage=6.5
WarningVoltage=7.2
PressureOffset=0.00
UsePressureOffset=no
SoundVelocityThreshold=1375.00
DelimterMode=Space
SensorDetectionMode=Once
Traceability=yes
SkipPowerOff=no

[Slot 1]
SensorName=SV-C.Xchange SV.X SN 131197 01/22/10
BoardSN=65535

[Slot 2]
SensorName=P-T.Xchange P.X SN 145721 08/21/09 T.X SN 400048 11/17/09
BoardSN=65535
```

>**dir**

```
test    .raw       5598 02/24/10 14:41:55.00
data    .txt       3987 02/24/10 14:45:08.00

 960 MBytes free
   7 MBytes Used
   2 File(s) listed
```

>**dump data.txt**

```
[cast header]
InstrumentSN=08221
Date=02/24/10
Time=14:45:10.55
PressureOffset=0.09
UsePressureOffset=yes
Slot1Sensor1=SV-C.Xchange SV.X SN 131197 01/22/10
Slot2Sensor1=P-T.Xchange P.X SN 145721 08/21/09 T.X SN 400048 11/17/09

[Data]
02/24/10 14:45:10.66  1474.313  0000.015  17.447  008.18  00.034  0998.724
02/24/10 14:45:10.69  1474.334  0000.015  17.449  008.20  00.046  0998.733
02/24/10 14:45:11.19  1474.332  0000.027  17.451  008.20  00.037  0998.726
02/24/10 14:45:11.69  1474.326  0000.027  17.451  008.20  00.032  0998.722
02/24/10 14:45:12.19  1474.319  0000.027  17.457  008.20  00.011  0998.705
02/24/10 14:45:12.69  1474.321  0000.034  17.459  008.20  00.005  0998.700
02/24/10 14:45:13.19  1474.318  0000.023  17.457  008.20  00.008  0998.702
02/24/10 14:45:13.69  1474.321  0000.019  17.458  008.20  00.010  0998.704
02/24/10 14:45:14.19  1474.427  0000.019  17.459  008.20  00.100  0998.773
02/24/10 14:45:14.69  0000.000 -0000.015  17.601  008.20  00.000  0000.000
02/24/10 14:45:15.19  0000.000 -0000.030  17.655  008.20  00.000  0000.000
02/24/10 14:45:15.69  0000.000 -0000.011  17.651  008.20  00.000  0000.000
02/24/10 14:45:16.19  0000.000 -0000.015  17.632  008.20  00.000  0000.000
02/24/10 14:45:16.69  0000.000 -0000.015  17.624  008.20  00.000  0000.000
02/24/10 14:45:17.19  0000.000 -0000.015  17.622  008.20  00.000  0000.000
02/24/10 14:45:17.69  0000.000 -0000.015  17.618  008.20  00.000  0000.000
[cast header]
InstrumentSN=08221
Date=02/24/10
Time=14:45:21.85
PressureOffset=0.09
UsePressureOffset=yes
Slot1Sensor1=SV-C.Xchange SV.X SN 131197 01/22/10
Slot2Sensor1=P-T.Xchange P.X SN 145721 08/21/09 T.X SN 400048 11/17/09
```

```
[Data]
02/24/10 14:45:21.92  1474.309 -0000.019  17.598  008.20  00.000  0998.671
02/24/10 14:45:21.95  1474.308  0000.019  17.451  008.20  00.017  0998.711
02/24/10 14:45:22.44  1474.301  0000.023  17.453  008.20  00.005  0998.701
02/24/10 14:45:22.94  1474.297  0000.011  17.453  008.20  00.003  0998.699
02/24/10 14:45:23.44  1474.294  0000.019  17.451  008.20  00.005  0998.702
02/24/10 14:45:23.94  1474.314  0000.019  17.453  008.20  00.019  0998.711
02/24/10 14:45:24.44  1474.310  0000.027  17.453  008.20  00.015  0998.709
02/24/10 14:45:24.94  1474.307  0000.015  17.451  008.20  00.016  0998.709
02/24/10 14:45:25.44  1474.307  0000.027  17.453  008.20  00.009  0998.704
02/24/10 14:45:25.94  1474.308  0000.023  17.454  008.20  00.008  0998.703
02/24/10 14:45:26.44  1474.313  0000.023  17.451  008.20  00.021  0998.714
02/24/10 14:45:26.94  1474.294  0000.023  17.452  008.20  00.002  0998.699
02/24/10 14:45:27.44  1474.313  0000.023  17.453  008.20  00.015  0998.709
02/24/10 14:45:27.94  1474.303  0000.023  17.454  008.20  00.004  0998.700
02/24/10 14:45:28.44  1474.312  0000.023  17.453  008.20  00.015  0998.708
02/24/10 14:45:28.94  1474.319  0000.030  17.453  008.20  00.019  0998.712
02/24/10 14:45:29.44  1474.336  0000.027  17.450  008.20  00.045  0998.732
02/24/10 14:45:29.94  1474.314  0000.027  17.450  008.20  00.023  0998.715
02/24/10 14:45:30.44  1474.326  0000.027  17.451  008.20  00.032  0998.722
02/24/10 14:45:30.94  1474.320  0000.027  17.451  008.20  00.027  0998.718
02/24/10 14:45:31.44  1474.305  0000.023  17.454  008.20  00.006  0998.701
02/24/10 14:45:31.94  1474.312  0000.030  17.451  008.20  00.020  0998.713
02/24/10 14:45:32.44  1474.311  0000.034  17.453  008.20  00.014  0998.708
02/24/10 14:45:32.94  1474.312  0000.030  17.450  008.20  00.021  0998.714
02/24/10 14:45:33.44  0000.000 -0000.011  17.459  008.20  00.000  0000.000
02/24/10 14:45:33.94  0000.000 -0000.019  17.569  008.20  00.000  0000.000
02/24/10 14:45:34.44  0000.000 -0000.015  17.548  008.20  00.000  0000.000
02/24/10 14:45:34.94  0000.000 -0000.023  17.515  008.20  00.000  0000.000
02/24/10 14:45:35.44  0000.000 -0000.015  17.498  008.20  00.000  0000.000
02/24/10 14:45:35.94  0000.000 -0000.023  17.487  008.20  00.000  0000.000
02/24/10 14:45:36.44  0000.000 -0000.019  17.485  008.20  00.000  0000.000
>
```

Support

Troubleshooting

Instrument fails to communicate:

- Is the connector damaged?
- Check the cables
    - Is the data/power cable connected to the instrument and computer?
    - Are there any cuts in the cable?
    - If using a cable other than an AML cable, it should be configured as a null modem cable.
    - If using multiple cable lengths, the extensions should **not** be configured as null modem cables.
- If using external power over a long cable, check the voltage drop over the cable. Measure the voltage across a 10 watt, 27Ω resistor across pins 1 and 4 of the cable. The voltage should be between 9.9 and 26 volts.
- Are the communication settings in the program used on the computer correct?
    - Comm port selection
    - 8 bits
    - 1 stop bit
    - No parity
    - No hardware flow control
    - Baud rate between 600 and 38,400 baud
- Are the communication settings in the instrument correct?
    - Was the instrument specifically set to one baud rate last time? If so, use that baud rate to resume communications.
    - Was the instrument set to only RS-232 or only RS-485 last time? If so, resume communications in the required protocol.
    - Was the instrument set to *RX OFF* last time? If so, a carriage return must be sent to the instrument immediately after power is applied to interrupt this mode.
- Was the instrument set to monitor on power up mode? If so, a carriage return must be sent to the instrument immediately after power is applied to interrupt this mode. To interrupt monitor on power up, hold down the ENTER key while applying power to the instrument

Instrument fails to log:

- Verify the LED indicator status:
    - With the instrument in air (NOT submerged), insert the communication cable. The LED indicator should show solid green indicating the instrument is powered and ready
      Note: If neither a SV•Xchange™, CT•Xchange™ or Conductivity•Xchange™ sensor is installed, the instrument will begin logging in air.
    - Place the instrument's sensors in water. The LED indicator should remain green and begin flashing, indicating the instrument is powered and logging.
        - If the indicator shows red, increase the supply voltage to between 10 and 26 volts.

    - If the indicator does not light up, the instrument is not operating correctly. Continue with the remaining troubleshooting items.
- Allow at least two sample periods for the instrument to detect that it is immersed.
- Were the sound velocity increment, pressure increment and/or sample rate settings set to values that could prevent logging?
- Was the log file name set correctly?
- Is the connector damaged, dirty, or corroded?
- If all previous steps fail, reset the instrument. Send an *INIT* command to the instrument to re-initialize the memory.
- Note: The *INIT* command will completely erase all settings stored on the instrument.

Instrument generates noisy data:

- Is the connector damaged, dirty, or corroded?
- If connected to external power, is there noise on the power supply? Switch-mode power supplies are common sources of noise.
- Nearby EMI sources such as electric motors, generators, and transformers can create noise. If possible, move the instrument and its cables away from the noise source.
- Are there bubbles on the SV•Xchange™ sensor or in the CT•Xchange™ or C•Xchange™ sensor?
- Are the SV•Xchange™, CT•Xchange™ and C•Xchange™ sensors clean?
- Is the T•Xchange™ sensor damaged?
- Is there something nearby affecting the water temperature?

Ni-Cad batteries fail to fully charge:

- Is the charger connected to the charging cable?
- Is the power switch on the charger turned on?
- Is the charger plugged in to a 120 VAC or 240 VAC supply?
- Allow the charger to charge the batteries until the fast charge indicator light on the charger turns off.

SeaCast fails to recognize a sensor:

- Be sure to download the latest version of SeaCast
    - Turbidity•Xchange™ requires SeaCast version 3.0 or greater for full functionality

SV•Xchange does not match CTD-calculated SV:

- Owing to the error associated with each individual sensor and Chen and Millero's equation[1], sound velocity calculated from CTD values will fall within approximately ±0.4 m/s of the actual value 95% of the time. It is not uncommon to see differences of this size between directly measured sound velocity and CTD-calculated sound velocity.

[1] Chen-Tung Chen and Frank J. Millero, "Speed of sound in seawater at high pressures," *The Journal of the Acoustical Society of America* 62, no. 5 (1977): 1129-1135.

Contact AML Oceanographic

Service
To request an RMA or technical support

Email: service@AMLoceanographic.com
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Fax: 1-250-655-3655

Sales
For all general sales inquiries

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Phone: 1-800-663-8721 (NA)
Fax: 1-250-655-3655

Website
http://www.AMLoceanographic.com

Customer Portal
My AML Oceanographic is AML's online data centre. This secure area within our website is designed to offer one easy location for interested individuals and organizations - distributors, customers, prospects, and other members of our community - to manage their interactions with AML. *My AML Oceanographic* will allow you to:

- View and manage your assets (instruments and sensors)
- Consult instrument diagnostic summaries
- View and download calibration and conformity certificates
- View and manage your technical support cases
- Consult and download sales estimates, sales orders, and invoice copies
- View account balances and generate account statements
- Assess inventory availability at AML

To access the Customer Portal, please navigate to the *Support* button - located on the top right of the AML Oceanographic home page - select *Customer Centre* from the options on the drop down menu and follow the instructions provided.

Mailing and Shipping Address
AML Oceanographic
2071 Malaview Ave.
Sidney, BC, Canada
V8L 5X6

Appendices

Commands

When using SeaCast, the full command set is not usually necessary. However, text commands are available. Below is a listing of commonly used commands. Note that some commands are only available on instruments equipped with the appropriate Xchange™ sensors.

Communications Commands

Command	Description	Requires
SET FORCE 232	Sets com mode to RS-232. Power must be cycled for changes to take effect.	
SET FORCE 485	Sets com mode to RS-485. Power must be cycled for changes to take effect.	
SET FORCE AUTO	Sets for auto-detection of RS-232 or RS-485 comms. Note that if instrument is not connected to a com port on power up, it assumes RS-485 operation and will remain in that mode until powered down.	
DISPLAY FORCE	Displays current com mode (ie. RS232, RS485, AUTO)	
DISPLAY DETECT	Displays the baud rate detection settings.	
SET DETECT a b	Sets the baud rate detection. "a" sets the number of autobaud detection attempts before the instrument reverts to the default baud rate set by "b." Setting 'a'=0 forces the instrument to a fixed baud rate determined by "b." '"b"= 1 = 600 baud 4 = 4800 baud 7 = 38400 baud 2 = 1200 baud 5 = 9600 baud 8 = 57600 baud 3 = 2400 baud 6 = 19200 baud 9 = 115200 baud	

Sampling Rate Commands

Command	Description	Requires
DISPLAY SAMPLE RATE	Displays the time-based sampling rate	
SET SAMPLE n t	Sets the desired sampling rate. "n" is a number and "t" is the time units. Using the slash (/) character should be read as "per". For instance, 5 s means sampling happens every 5 seconds. 5/s means 5 samples per second. Examples are: SET S C sets the sampling to continuous (25 Hz) SET S 5 /s 5 samples per sec SET S 1 s Sample 1 time every 1 second SET S 2 /m 2 samples per minute SET S 5 m Sample 1 time every 5 minutes SET S 2 /h 2 samples per hour SET S 24 h Sample 1 time every 24 hours	
DISPLAY INCREMENT	Displays logging increment for pressure in dBars.	P•X
SET PRESSURE INCREMENT n	Sets logging by increment of pressure specified by n = increment value in dBar (resolution of 2 decimal places).	P•X
SET SOUND INCREMENT n	Sets logging by increment of SV specified by n = increment value in m/s (resolution of 1 decimal place).	SV•X
DISPLAY SOUND INCREMENT	Displays the logging increment for sound velocity in m/s.	SV•X

Output Format Commands

Command	Description	Requires
DISPLAY SCAN	Displays current scan options.	
SET SCAN NOBAT	Turns the battery channel off.	
SET SCAN BAT	Turns the battery channel on.	
SET SCAN NODENSITY	Turns the calculated density channel off.	C•X, T•X, and P•X, CT•X, and P•X, or SV•X, T•X, and P•X
SET SCAN DENSITY	Turns the calculated density channel on.	C•X, T•X, and P•X, CT•X, and P•X, or SV•X, T•X, and P•X
SET SCAN NOSALINITY	Turns the calculated salinity channel off.	C•X, T•X, and P•X, CT•X, and P•X, or SV•X, T•X, and P•X
SET SCAN SALINITY	Turns the calculated salinity channel on.	C•X, T•X, and P•X, CT•X, and P•X, or SV•X, T•X, and P•X
SET SCAN NOSV	Turns the calculated salinity channel off, removing it from the instrument output scans. Current salinity display status is viewable using DISPLAY SCAN.	C•X, T•X, and P•X or CT•X and P•X
SET SCAN SV	Turns the calculated sound velocity channel on, allowing it to be present in instrument output scans. Current salinity display status is viewable using DISPLAY SCAN. This is only available when C,P and T sensors are attached.	C•X, T•X, and P•X or CT•X and P•X
SET SCAN TIME	Enables displaying time in data scan.	
SET SCAN NOTIME	Disables time from being displayed in data scan.	
SET SCAN DATE	Enables displaying date in data scan.	
SET SCAN NODATE	Disables date from being displayed in data scan.	
DISPLAY STARTUP	Displays the power up output settings.	
SET STARTUP PROMPT	Sets the instrument to wait for user commands on power up.	
SET STARTUP SCAN	Sets the instrument to output one scan on power up and then wait for a user command.	
SET STARTUP MONITOR	Sets the instrument to start monitoring data on power up.	
SET STARTUP NOHEADER	Disables the instrument identification header output on power up.	
SET STARTUP HEADER	Enables the instrument identification header output on power up.	

Logging Commands

Command	Description	Requires
SET SCAN LOGGING	Enables simultaneous logging & real-time output. If real-time logging in air is desired, set instrument conductivity threshold and sound velocity and pressure increments to zero.	
SET SCAN NOLOGGING	Disables simultaneous real-time logging.	
SET TIMEOUT nn	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. Setting is viewable using DISPLAY STARTUP.	
LOG	Puts unit into logging mode from real-time mode. It will remain in logging mode until power is turned off.	
SET LOG tttttttt.ttt	Sets new log file name. tttttttt.ttt = log file name. Name can have up to 8 characters in length and 3 characters for file extension.	
INIT	Clears the instrument's logging memory.	
DIRECTORY	Displays list of files in instrument memory and memory status including amount of memory space free and used.	
DUMP tttttttt.ttt	Dumps the data of the specified logged file defined by tttttttt.ttt in REAL or RAW format depending on the current instrument mode.	
DELETE tttttttt.ttt	Erases specified logged file defined by tttttttt.ttt Maximum 8 character name with 3 character extension.	
DISPLAY LOG	Displays current log file name.	

General Commands

Command	Description	Requires
SCAN	Measures and outputs one scan of data.	
MONITOR	Scans at the set sampling rate.	
VERSION	Displays the instrument identification header.	
DISPLAY OPTIONS	Displays the instrument status and user settings.	
ZERO ON	Corrects the barometric offset to set zero pressure at surface for current barometric pressure.	P•X
ZERO OFF	Disables barometric offset.	P•X
DISPLAY TIME	Displays current time. Time format is hh:mm:ss.ss	
SET TIME hh:mm:ss.ss	Sets instrument time using 24 hour clock in format hh:mm:ss.ss	
DISPLAY DATE	Displays the current date.	
SET DATE mm/dd/yy	Sets date using mm/dd/yy format.	
DETECT	Checks each slot in logger board to identify what is plugged in and displays sensor / board type and serial number or "empty" for each slot.	
DISPLAY BATTERY	Displays battery channel coefficients and shutdown voltage.	
TALK n	Enables communications directly with a sensor board via the logger board, where n = value from 1-3 that identifies the slot number of the board to be communicated with. See *DETECT* command.	
CTRL+C	Press CTRL key and C key at same time to exit sensor board talk mode and return to logger communications.	

Technical Specifications

Sensors

Primary Xchange™ Sensors						
Type		Range	Accuracy	Precision	Resolution	Response Time
Conductivity•Xchange™		0 to 2 mS/cm	0.01 mS/cm	0.003 mS/cm	0.001 mS/cm	25 ms at 1 m/s flow rate
Conductivity•Xchange™		0 to 70 mS/cm	0.01 mS/cm	0.003 mS/cm	0.001 mS/cm	25 ms at 1 m/s flow rate
Conductivity•Xchange™		0 to 90 mS/cm	0.01 mS/cm	0.003 mS/cm	0.001 mS/cm	25 ms at 1 m/s flow
SV•Xchange™		1375 to 1625 m/s	0.025 m/s	0.006 m/s	0.001 m/s	47 µs
CT•Xchange™	Cond.	0 to 100 mS/cm	**0-90**: ±0.01 mS/cm **90-100**: <±0.05 mS/cm	0.003 mS/cm	0.001 mS/cm	25 ms at 1 m/s flow
	Temp.	-5 to 60 °C	**-5-45**: ±0.005 °C **45-60**: <±0.05 °C	0.003 °C	0.001 °C	100 ms

Secondary Xchange™ Sensors					
Type	Range	Accuracy	Precision	Resolution	Response Time
Temperature•Xchange™	-2°C to 32°C	0.005°C	0.003°C	0.001°C	100 ms
Temperature•Xchange™	-5°C to 45°C	0.005°C	0.003°C	0.001°C	100 ms
Temperature•Xchange™	0°C to 65°C	0.005°C	0.003°C	0.001°C	100 ms
Pressure•Xchange™	50, 100, 200, 500, 1000, 2000, 4000, 5000, 6000 dBar	0.05%FS	0.03%FS	0.02%FS	10 ms
Turbidity•Xchange™	0-100 NTU	0.1 NTU	0.1 NTU	0.01 NTU	< 0.7s
Turbidity•Xchange™	0-400 NTU	0.2 NTU	0.2 NTU	0.01 NTU	< 0.7s
Turbidity•Xchange™	0-1000 NTU	0.5 NTU	0.5 NTU	0.1 NTU	< 0.7s
Turbidity•Xchange™	0-3000 NTU	1 NTU	1 NTU	0.1 NTU	< 0.7s

Calculated Parameters				
Type	Required Sensors	Equation	Accuracy	Range
Salinity	C•X, T•X, P•X	TEOS10	±0.010 psu	0 to 42 psu
Salinity (from SV)	SV•X, T•X, P•X	AML '07	±0.035 ppt	0 to 42 ppt
Density	C•X, T•X, P•X	TEOS10	±0.027 kg/m^3	990 to 1230 kg/m^3
Density (from SV)	SV•X, T•X, P•X	TEOS10	±0.051 kg/m^3	990 to 1230 kg/m^3
SV (from CTD)	C•X, T•X, P•X	Chen & Millero '77[2]	0.5 m/s	---

Electrical

- Mother Board
  - Flash, non-volatile data memory (Minimum 1 GB)
  - 2 dedicated slots
    - Primary Xchange™ sensor slot
    - Secondary Xchange™ sensor slot
  - 5 expansion slots
- Sensor Boards
  - Sound Velocity, CT or Conductivity Xchange™ sensor board
  - Pressure and Temperature Xchange™ sensor board
- Auto detect RS232 or RS485 (½ duplex ASCII)
- Autobaud to 38,400

Power

- External Power Supply: 8 to 26 VDC
- Internal Power Supply
  - Standard: 9 D-cell Alkaline batteries
    - Capacity: 14.4 Ahrs
    - Voltage: 1.5 Volts/cell
  - Optional: 9 D-cell Ni-Cad batteries
    - Capacity: 4.4 Ahrs
    - Voltage: 1.2 Volts/cell
- Current Draw
  - 250 mA when sampling
  - 50 mA in standby mode
  - 60 µA when in low power mode
- Battery Voltage Limits
  - 14 volts: Full charge with alkaline batteries
  - 11.3 volts: Full charge with optional Ni-Cad batteries
  - 9.9 volts: Low battery warning

[2] Chen and Millero, "Speed of sound in seawater at high pressures," 1129-1135.

- 8.0 volts: Auto shutdown

Pressure Case

- Hard anodized aluminum
- Environmental Limits
  - Storage: -40°C to 60°C
  - Usage: -20°C to 45°C

Housing						
Status	Type	Depth Rating	Diameter	Length	Weight (in water)	Weight (in air)
Standard	6061-T6	5000 m	100mm (4.0")	881mm (34.9")	3.4 Kg (7.5 lbs)	7.7 Kg (17.0 lbs)
Optional	7075-T6	6000 m			3.4 Kg (7.5 lbs)	7.7 Kg (17.0 lbs)

Connector				
Type	Pins	Sex	Material	Manufacturer
Bulkhead	Micro 8	Female	SS316	Subconn

Sampling Capabilities

- Frequency
  - Time: Sample rates from 25 per second to 1 per 24 hours
  - Pressure: Specific pressure increments in 0.01 dbar steps
  - Sound Velocity: Specific sound velocity increments in 0.1 m/s steps
- Configurations
  - Single scan or continuous output
  - On command or autonomous on power up

Included Items

- Plus•X instrument
- Data•Xchange (if purchased)
- 2m Data/Power Pigtail
- Red shorting plug
- Black dummy plug
- Primary sensor blanking plugs
- Secondary sensor blanking plugs
- USB stick with manuals and documentation
- Battery charger and charging cable (if Ni-Cad batteries are ordered)

Software

- SeaCast

Ordering Codes

Instruments

PDC-PLX-P1S2-50	Plus• X, 5000 dBar, 6061-T6 pressure housing
PDC-PLX-P1S2-60	Plus• X, 6000 dBar, 7075-T6 pressure housing
PDC-PLX-P2S2-50	Plus• X, 5000 dBar, 6061-T6 pressure housing
PDC-PLX-P2S2-60	Plus• X, 6000 dBar, 7075-T6 pressure housing

Sensors

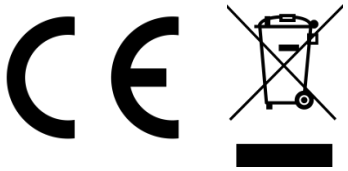
XCH-SV-STD	SV•Xchange™ (1375-1625m/s) Range
XCH-SV-1120	SV•Xchange™ (1100-2000m/s) Range
XCH-SV-0520	SV•Xchange™ (500-2000m/s) Range
XCH-CND-RA002	C•Xchange™ Right Angle, Ultra Freshwater (0-2mS/cm) Range
XCH-CND-RA070	C•Xchange™ Right Angle, Oceanographic (0-70mS/cm) Range
XCH-CND-RA090	C•Xchange™ Right Angle, Oceanographic (0-90mS/cm) Range
XCH-CND-ST002	C•Xchange™ Straight, Ultra Freshwater (0-2mS/cm) Range
XCH-CND-ST070	C•Xchange™ Straight, Oceanographic (0-70mS/cm) Range
XCH-CT-RA090-n545	CT•Xchange™ Right Angle, Oceanographic (0-90mS/cm, -5 to 45 C) Range
XCH-TMP-n232	T•Xchange™ (-2 to 32 C) Range
XCH-TMP-n545	T•Xchange™ (-5 to 45 C) Range
XCH-TMP-065	T•Xchange™ (0 to 65 C) Range
XCH-PRS-0050	P•Xchange™ 50 dBar
XCH-PRS-0100	P•Xchange™ 100 dBar
XCH-PRS-0200	P•Xchange™ 200 dBar
XCH-PRS-0500	P•Xchange™ 500 dBar
XCH-PRS-1000	P•Xchange™ 1000 dBar
XCH-PRS-2000	P•Xchange™ 2000 dBar
XCH-PRS-4000	P•Xchange™ 4000 dBar
XCH-PRS-5000	P•Xchange™ 5000 dBar
XCH-PRS-6000	P•Xchange™ 6000 dBar
XCH-PRS-6000-T065	P•Xchange™ 6000 dBar, Extended temperature calibration from 0-65 C
XCH-TRB-0100-03	Tu•Xchange™ (0-100 NTU) Range, 300m
XCH-TRB-0100-05	Tu•Xchange™ (0-100 NTU) Range, 500m
XCH-TRB-0400-03	Tu•Xchange™ (0-400 NTU) Range, 300m
XCH-TRB-0400-05	Tu•Xchange™ (0-400 NTU) Range, 500m
XCH-TRB-1000-03	Tu•Xchange™ (0-1000 NTU) Range, 300m
XCH-TRB-1000-05	Tu•Xchange™ (0-1000 NTU) Range, 500m
XCH-TRB-3000-03	Tu•Xchange™ (0-3000 NTU) Range, 300m
XCH-TRB-3000-05	Tu•Xchange™ (0-3000 NTU) Range, 500m

Accessories

DTX-MC8M-WG-10	Data•Xchange, wireless & GPS device
CSE-0024	Plus•X shackle extender for Data•Xchange
MBR-PLX-STD	Mounting Clamps for Plus•X and Metrec•X instruments. 1 Pair (2 clamps)
DFR-PLX-2PT	Instrument suspension bar, 2-point type A-P.
DFR-PLX-4PT	Instrument protection frame, 4-point, type C-P.
CSE-0001	Rechargeable Ni-Cad batteries, 120 VAC charger and charging cable
CSE-0002	Rechargeable Ni-Cad batteries, 240 VAC charger and charging cable

Regulatory Information

This product is compliant within the requirements of CE standards.

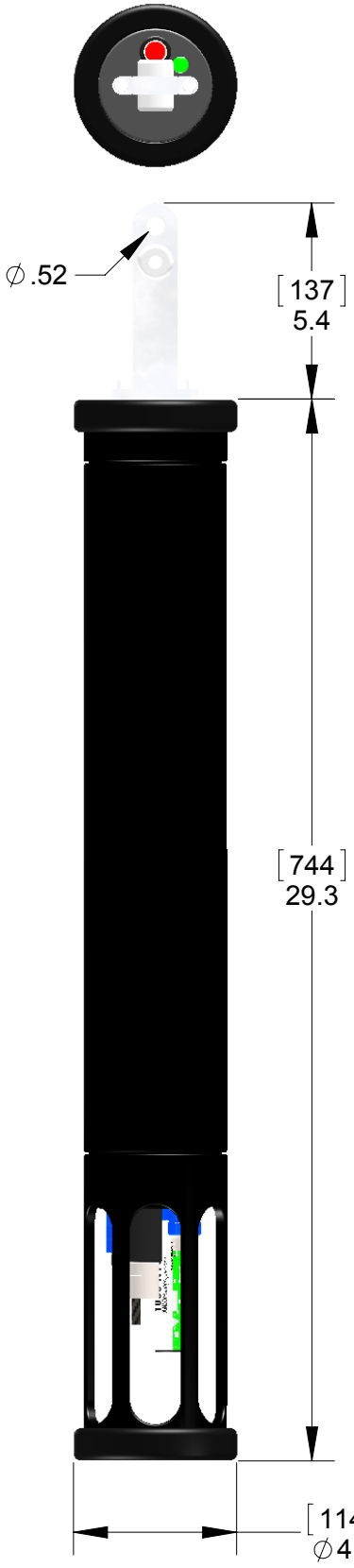


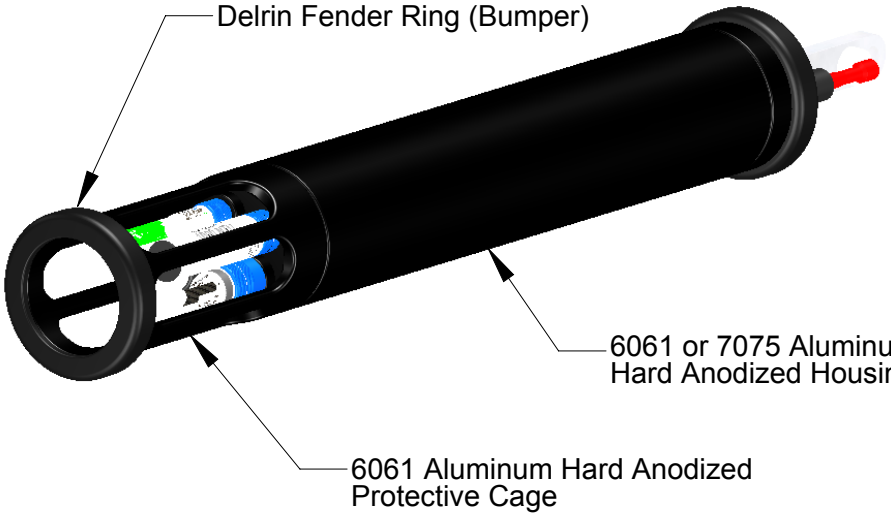
Warranty

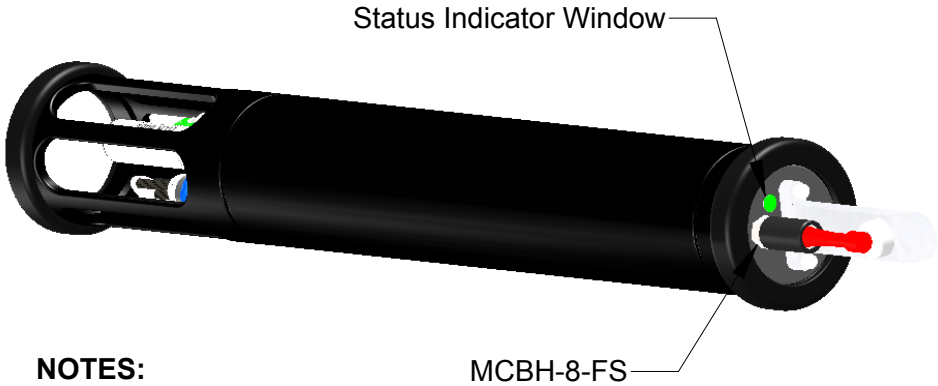
AML Oceanographic warrants the instrument for a period of two years from the date of delivery. AML will repair or replace, at its option and at no charge, components which are found to be defective. The warranty applies only to the original purchaser of the instruments. The warranty does not apply if the instrument has been damaged, by accident or misuse, and is void if repairs or modifications are made by any 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.

Technical Overview Drawings







NOTES:

1. **Dimensions in inches [millimeters]**
2. **Depth Rating: 5000m or 6000m**
3. **Weight (w/o sensors): 11.8 lbs (in air) 6.4 lbs (in water)**
4. **X-Series is available with two endcap configurations and depth ratings:**
   PDC-PLX-P2S2-50 PDC-PLX-P1S4-50
   PDC-PLX-P2S2-60 PDC-PLX-P1S4-60

where: PDC-MTX-P_S_-__

No. of Primary Mounts:
SV Xchange
C Xchange

Depth Rating:
5000m (50)
6000m (60)

No. of Secondary Mounts:
UV Xchange
P Xchange
T Xchange
TU Xchange
DO Xchange

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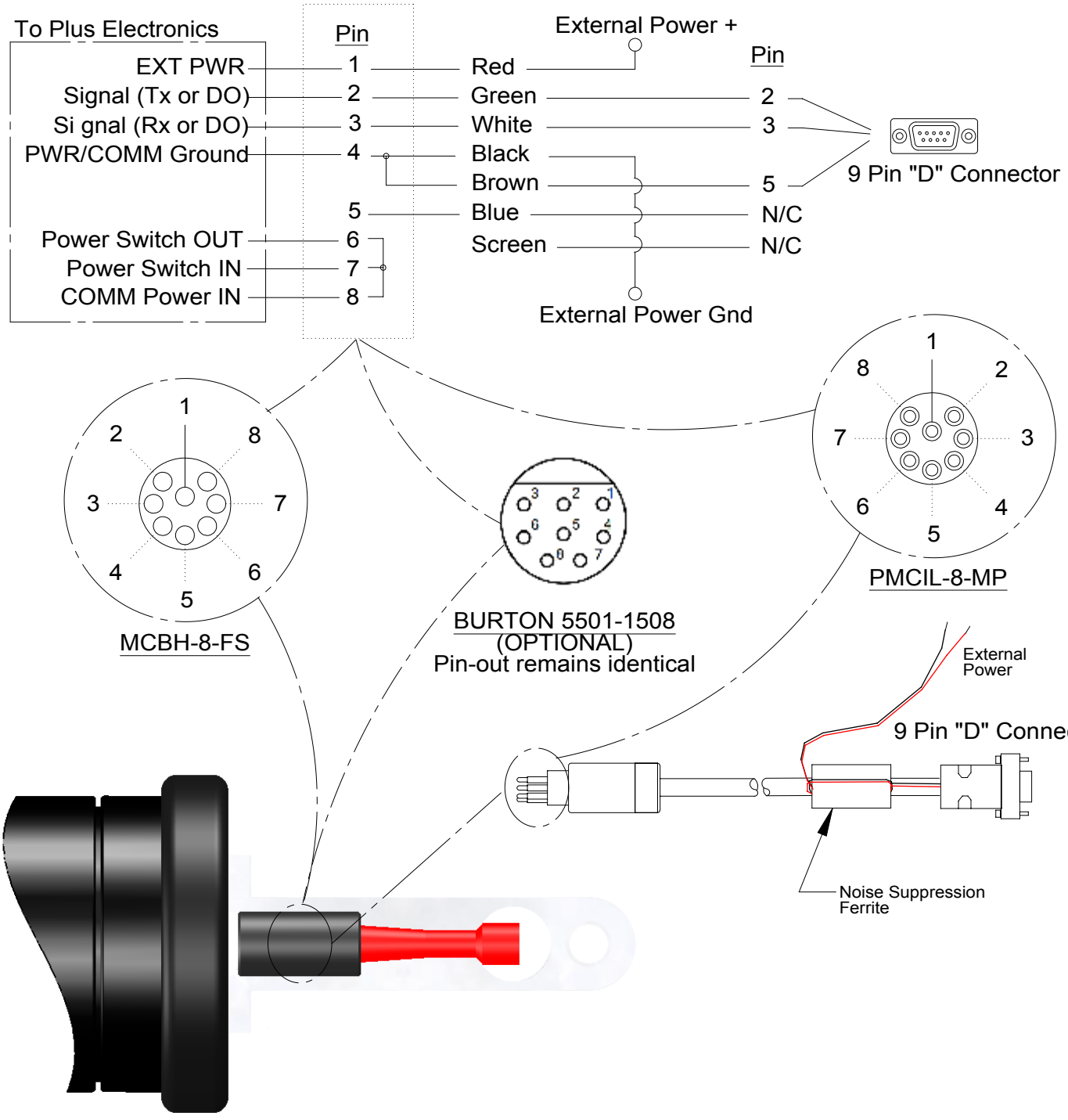
PH:(250) 656 0771 FAX: (250) 655 3655
www.AMLoceanographic.com

TITLE

PLUS, X-SERIES MECHANICAL OUTLINE

SYSTEM	*AML PART NO.*
PLUS	PDC-PLX-P1S4/P2S2-50/60
DATE	*SLDRW NO.*
01 MAR 2013	MC7-GA-03640-A

Micro 8 Provides RS232 or RS485 Serial Communications



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www.AMLoceanographic.com

TITLE

PLUS, X-SERIES
COMMS AND POWER INTERFACE

SYSTEM	*AML PART NO.*
PLUS	PDC-PLX-P1S4/P2S2-50/60
DATE	*SLDRW NO.*
01 MAR 2013	MC7-GA-03640-A