AML-6 LGR: User Manual

Multiparameter Logger Instrument

Revision History

Revision	Date	Description
1.1	7 July 2020	Document Created
1.2	03 Feb 2021	Sleep Mode, GPS Offline Assist, GPS listener
1.3	25 Feb 2021	WiFi password
1.4	07 Sep 2021	Storage Recommendations, Additional Commands, USB FAQ
1.5	05 Nov 2021	Regulatory Information

1 Introduction

The AML-6 series of instruments is a highly configurable family of multiparameter sondes designed for a wide range of data collection applications. The '6' designation refers to the number of sensors that may be simultaneously installed on the instrument's endcap. Additional sensors may be connected externally, allowing up to 8 sensors in total.

There are two primary configurations of instruments in the AML-6 family: the AML-6 LGR, a self-powered instrument designed for profiling applications, and the AML-6 RT, an externally powered instrument intended for Real Time applications. While nearly identical in size and form factor, the two configurations differ in a few key features which specialize them for their respective applications.

Instruments with the LGR designation (ie. AML-6 LGR) are self-powered via a rechargeable internal battery and have a mechanical on/off switch adjacent to their shackle. These instruments are designed to internally log sensor measurements and transfer data post-deployment. These instruments are most commonly used for multiparameter profiling.

Real-Time instruments, in contrast, are designed to stream data while in-situ (though they have the ability to internally record data as well). Both power and communication to these instruments is facilitated via a waterproof connector located adjacent to the shackle. These instruments rely on external power for operation and the application of this power turns the instrument on in lieu of a mechanical switch These instruments are commonly used in moored applications, buoys, underwater observatories, and ROVs.

This manual describes the operation of the Logger version, the AML-6 LGR.

1.1 Instrument Overview

AML-6 instruments are highly customizable and so may be equipped with a wide range of user-specific sensors, functionality, and features. The instrument described here is intended to be a representative example of a typical setup and therefore may not be identical to the Reader's. The Reader is directed to any unit-specific supplementary documentation provided with their instrument for information on features and functionality not described here.

Figure 1 depicts a typical AML-6 LGR arrangement.
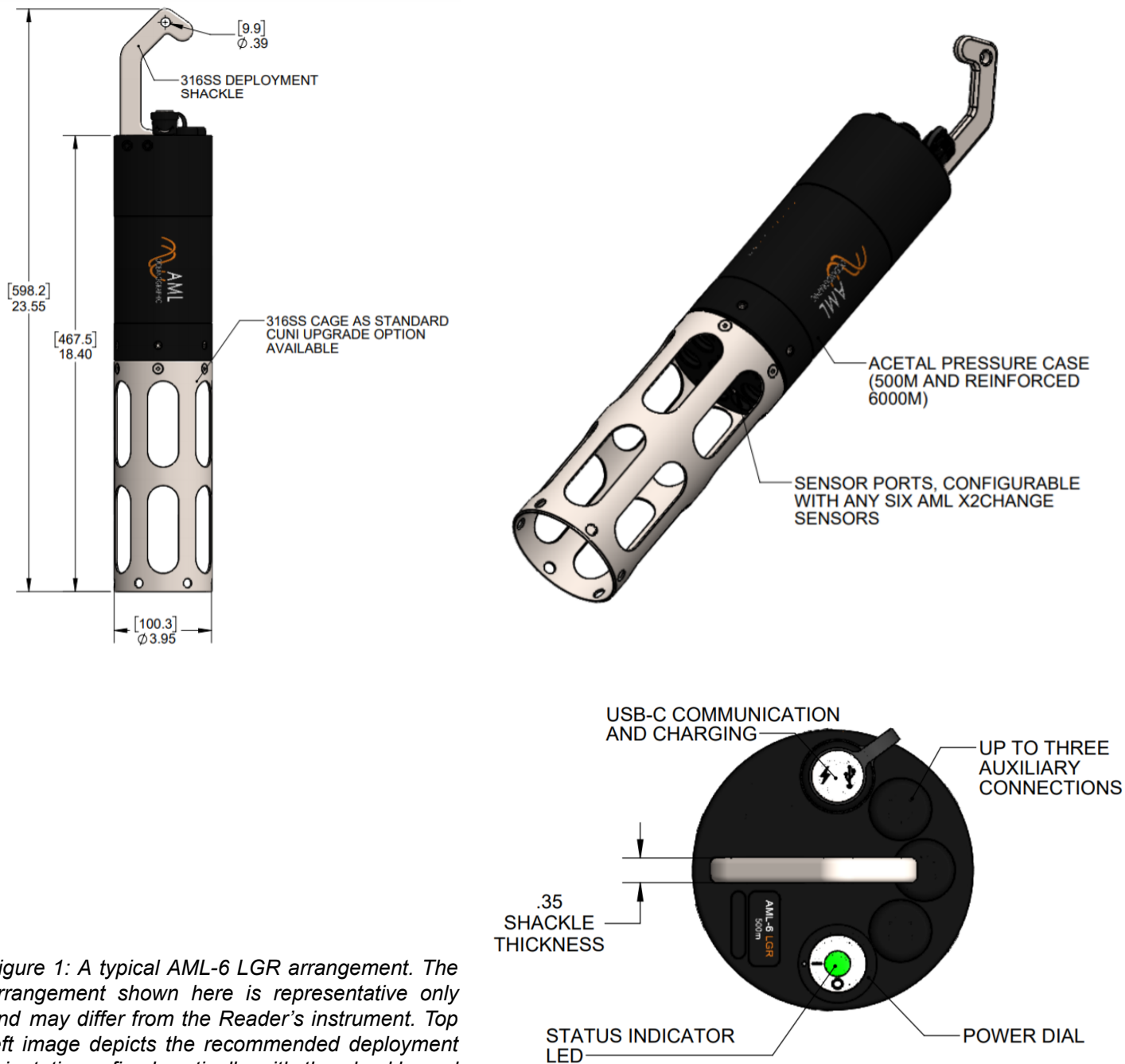
Figure 1: A typical AML-6 LGR arrangement. The arrangement shown here is representative only and may differ from the Reader's instrument. Top left image depicts the recommended deployment orientation - fixed vertically with the shackle end up.

By default, AML-6 LGR instruments come equipped with a shackle, a USB-C connector, a power switch, and a status indicator LED. The shackle has a hole coincident with the axis of the instrument to facilitate suspension during deployment. It is also hook-shaped to provide secure handling by a user.

The instrument end opposite the shackle houses the sensor payload which is mechanically protected by a bolted-on sensor cage. In some configurations the cage may be made from a copper alloy to prevent biofouling (optional upgrade) but the default configuration uses stainless steel.

Specifications:

Model	500m	6000m
Depth rating	500 meters / 1640 feet	6000m / 19685 feet
Material	Acetal, 316 stainless steel, titanium, polycarbonate	Acetal, 316 stainless steel, titanium, polycarbonate
Data storage	30 GB	30 GB
Software	Sailfish	Sailfish
Communication	USB-C Wifi	USB-C Wifi
Maximum Sample Rate	20 Hz Note: Sampling by pressure or sound velocity increment is also available.	20 Hz Note: Sampling by pressure or sound velocity increment is also available.
Power	8 cell internal battery 95Wh capacity PC or wall charging over USB (10W minimum) *Note: USB ports of some PC and laptops may not meet the minimum charging requirement of the instrument. It is highly recommended to use the included USB Wall Charger for charging the instrument.*	8 cell internal battery 95Wh capacity PC or wall charging over USB (10W minimum) *Note: USB ports of some PC and laptops may not meet the minimum charging requirement of the instrument. It is highly recommended to use the included USB Wall Charger for charging the instrument.*
Temperature Operation Storage	-20 to +45°C -20 to +60°C	-20 to +45°C -20 to +60°C
Dimensions Diameter Length	10.0 cm / 3.90 in 60.0 cm / 23.6 in	10.0 cm / 3.90 in 60.0 cm / 23.6 in

Weight*	4.00 kg / 8.80 lb	5.80 kg / 12.80 lb
Weight in water*	2.00 kg / 4.40 lb	3.80 kg / 8.40 lb

*With no installed sensors, deployment weight will vary.

1.2 Communicating with the Instrument

The preferred method of communication (setup, downloading data, etc.) is through the use of WiFi (500m only, for a 6000m use USB-C). By default, the instrument automatically sets up a WiFi hotspot upon startup, allowing WiFi-enabled computers, laptops, and tablets to directly connect.

The 500m versions of AML-3 LGRs contain a USB-WiFi dongle. Use of the dongle is not required (any WiFi adapter will connect to the instrument) but it does provide a convenient method for allowing a compatible PC to host two WiFi connections - the on-board WiFi adapter to remains connected with the local network, and the USB adapter to connects directly to the instrument. AML's software, Sailfish, allows the user to selectively use available WiFi adapters to connect to the instrument. If you want to connect over WiFi without Sailfish, the password is the serial number twice. For example, AML_A30001 has a password of A30001A30001. **Note: You should never be required to enter the password when connecting with Sailfish.**

AML-3 LGR instruments come equipped with a USB-C connector with a waterproof cover. This connector provides power to the instrument when connected to a compatible USB port or wall wart. This connector is also used as a secondary means for data transfer (downloading internally logged data) and may be configured via AML's interface software, Sailfish. **Note: This connector is only waterproof when the protective cover is installed. It is not intended for use when deployed. Do not remove the waterproof cover when the instrument is wet. Applying connector grease to the port can increase resistance to damage from a splash of water when the cover is off.**

AML-3 LGR instruments come with a USB-C to USB-A adapter cable to maximize PC compatibility. The instrument may be connected to any USB-C port using a standard USB-C interconnect cable, so if the provided cable is lost it is feasible to purchase an off the shelf replacement, provided the cable is rated to handle 5W. Generally speaking the shorter the cable the better.

See Appendix F - USB FAQ for USB-related questions.

1.3 Charging the Instrument

The AML-3 LGR instrument uses an internal battery for operation. The battery typically requires a charging top-up when the instrument is first received by the user.

The battery must be charged when the LED indicator flashes red, failure to maintain charge in the battery can cause damage to the instrument.

The instrument is charged via its USB-C connector, either through connection with a compatible USB port or via the provided wall wart (recommended). Note that it is common for USB ports to have insufficient power to simultaneously charge and operate the instrument, so it is recommended that the wall wart be used to charge the instrument. **The instrument body may get warm during charging.** This is normal and a result of the instrument's fast-charge capability.

Applying power through the USB-C connector does not automatically turn the instrument on, and the instrument may be charged with the switch in either the 'on' or 'off' position. Charging is fastest with the switch set to 'off' - typically on the order of 8hrs.

When deploying an AML-6 LGR Instrument where the indicator cannot be viewed directly, it is recommended the internal battery thresholds be modified to protect the internal battery from completely discharging, causing damage to the instrument. The command for this can be found in Section 5 under the power commands. AML recommends increasing the battery shutdown voltage to 6.9V in this deployment case.

1.4 Auxiliary Sensors

It is possible for AML-6 instruments to be equipped with sensors which are not installed on the instrument sensor endcap, such as Dissolved Oxygen (DO) and PAR sensors. These are referred to as auxiliary sensors and may be either fastened to the side of the instrument body or installed on adjacent moored equipment. In all cases, auxiliary sensors are connected to the instrument via a waterproof connector on the Connector Endcap, providing power and communication (note that Figure 1 does not show any auxiliary sensors).

It is typical for auxiliary sensors mounted on the side of the instrument to be protected by a stainless steel guard.

1.5 GPS Functionality (500m Only)

AML-6 LGR instruments come equipped with on-board GPS + GLONASS functionality. The instrument will automatically power its GPS module and begin signal acquisition immediately upon bootup. In general, lock times are expected to occur in 5 minutes or less after bootup, though they may take longer in challenging conditions. For best GPS performance, ensure the instrument is located outdoors and with a direct line of sight to the horizon and sky above. It is also recommended that the instrument be powered on in advance of taking a profile to allow sufficient time for signal acquisition.

Note that a GPS lock is not required for instrument functionality; data will be logged regardless of acquisition status.

It is possible to configure Sailfish to assign location coordinates to the instrument as provided by an external GPS broadcast on board a vessel. See the [Connecting a GPS Listener](#) section for more details.

Sailfish enables a feature called Offline Assist to improve GPS lock times. Details can be found in the [GPS Offline Assist](#) section.

1.6 Indicator LED Flash Patterns

The instrument is equipped with a multi-colour indicator LED, located adjacent to the shackle. The tables below describe the pattern and colour indications.

	Steady (solid on)	Double flash[3] __.__.	Pulsing	Flashing ...
Green	Ready[2] Battery good	GPS acquiring[1,2] Battery good	-	Logging
Red	Ready[2] Battery low	GPS acquiring[1,2] Battery low	-	Logging
Orange/ White/ Blue	-	-	Boot up or boot down sequence.	-
White	-	-	-	Error state
Orange	-	-	Charging	-

1 - The instrument may be deployed with GPS acquiring. Data will be recorded but location information will be absent. Flash patterns are specific to LGR instruments, RT instruments may display different indications.
2 - The instrument may be deployed in any of these states. Data will be logged.
3 - 6000m AML-6 LGR instruments do not have on board GPS. Double-flash will not occur.

1.7 Pressure Ratings

Pressure ratings may differ between installed sensors and the instrument body, and deployments should never exceed the shallower of these ratings. For example, a 500 m instrument equipped with a 6000 dBar pressure sensor is limited to deployments of 500 m depth

or less. Similarly, a 6000 m instrument equipped with a 500 dBar pressure sensor is also limited to deployments of 500 m depth or less.

The instrument pressure rating is identified on the end of the instrument, adjacent to the shackle. Typical ratings for AML-6 LGR instruments are 500m and 6000m (note that both ratings use plastic housings).

2 Getting Started

This section provides an overview of basic instrument operation and functionality under a factory-default setup. Specifically, this section describes how to connect to the instrument, change settings via interface software, stream sensor measurements, and record and download data.

Details describing how to change the instrument's configuration and behaviour are described in the *Configuration* section of this document.

2.1 Getting started with Sailfish via USB-C or Wifi Connection

The preferred (but not the only) method of communicating with the instrument is via AML's software interface, Sailfish; a user-friendly GUI-based platform which allows users to configure an instrument, observe live sensor measurements (live data streaming), and download logged data. Sailfish may be downloaded free of charge from the AML Oceanographic website (www.AMLoceanographic.com).

Sailfish provides the easiest means of adjusting the instrument's configuration. Advanced commands exist, however, and may be applied via command line. Refer to section *Configuring an Instrument* later in this document for more details.
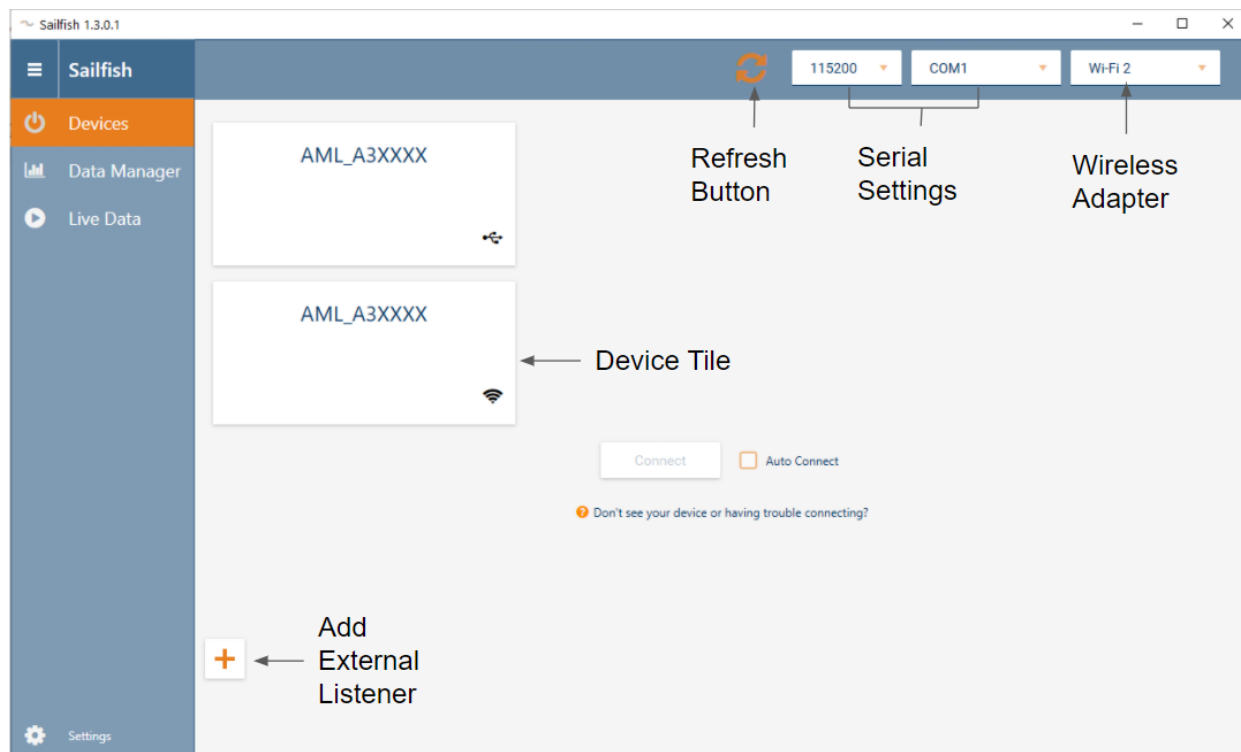
To use Sailfish to configure the AML-6 LGR instrument, follow the procedure described below:

1. Download the Sailfish install file from the AML website and follow the on-screen installation instructions. Sailfish is compatible with Windows 7, 8, and 10.
    a. Note: be sure to enable both private and public network access if prompted during installation.
2. Turn the instrument on using the power switch. When the switch is set to the 'on' position the instrument will commence its bootup sequence, indicated by an alternating colour pattern on the status indicator LED. The boot sequence is complete when the status LED is green. Typically boot duration is about 10 seconds.
3. Start Sailfish and wait for the software to load. When loaded, navigate to the *Devices* tab.
4. If you open Sailfish before connecting your instrument, you will need to click on the 'Refresh' button for your instrument to appear.
5. Connect the instrument to the PC via WiFi (preferred) or the included USB-C cable. If using the USB-C connector, the user's PC may produce the default USB-device connection chime when recognition and setup is successful.
    a. Note that if using the USB-C connection, the instrument may commence charging its internal battery. The instrument is equipped with fast-charge capabilities so it may become warm during this time.
    b. 6000m AML-6 LGR instruments do not have WiFi; connection must be done via USB-C.
6. A tile corresponding to available instrument connections will appear in the *Devices* tab of Sailfish. A small icon in the corner of the tiles denotes the corresponding connection method. Either WiFi or USB-C may be selected.
    a. Note: If connection difficulties are encountered, restart the PC. This solves the majority of connection issues.
7. Select the appropriate tile and click *'Connect'*.
8. Click the gear icon on the instrument tile to open the *Instrument Settings* page. Follow the on-screen instructions to configure the instrument as desired.

a. Note: A common action at this step is to tare the pressure sensor if required. This is achieved by clicking the Gear Icon and selecting Tare Pressure Sensor.

9. The user is encouraged to explore the *Instrument Settings* page to familiarize themselves with typical settings.

10. Optional: a common step for first time users is to commence real-time measurement (data) streaming from the instrument. This is achieved through the *Live Data* tab in Sailfish.

To disconnect the instrument, unplug the USB-C cable or click the 'Disconnect' button.

2.2 Conducting a Profile

The typical workflow for conducting a profile is as follows:

1. Turn the instrument on and connect it to Sailfish using either WiFi (preferred) or USB-C (refer Getting Started) and confirm the instrument's battery status and configuration. Be sure to tare the pressure sensor if required.

2. The instrument's indicator LED will flash if it is attempting to acquire a GPS signal. If GPS is locked, the instrument's LED will turn solid. Refer the LED Flash Patterns in Section 1.5 for more details.
   a. Note that an instrument may be deployed without a GPS lock. Data will still be logged, but the location data will be absent.
   b. In the absence of a GPS lock, an instrument may be manually provided with GPS coordinates in the *Instrument Settings* page.

3. If settings are correct, then ensure the instrument is ready for immersion by confirming that the USB-C connector cover is in place. **Do not deploy the instrument without the USB-C cover threaded completely onto the connector.**

4. The instrument may be deployed at any time. If connected via WiFi, there is no need to select the *Disconnect* button in Sailfish.

5. Lower the instrument into the water until its shackle sits just below the water line and its indicator LED is visible. In most applications, the instrument is suspended by its shackle from a downrigger, crab puller, or other mechanical device.

6. By default, the instrument will create a new log file and begin to record (log) data automatically upon water detection.
   a. Water detection is achieved by monitoring the measurements of an installed Sound Velocity or Conductivity sensor. This behaviour is configurable through advanced commands.

7. When in water and recording data, the instrument's indicator LED will flash, confirming operation. The instrument may then be lowered to the desired depth.

8. If the instrument was connected via WiFi then it's connection to Sailfish will be lost (by default, the instrument will turn its WiFi off when in water). Sailfish will recognize this action and sit idle, awaiting for the instrument to return to the surface.

9. When the desired depth is achieved, retrieve the instrument and pull it completely out of the water. The instrument will close it's log file when it detects that it is out of water.
10. When out of water the instrument will turn it's WiFi back on. Sailfish will automatically detect the return of the instrument and connect.
    a. Note: If the instrument's WiFi connection was manually disconnected from Sailfish prior to deployment (by pressing *Disconnect*), then the instrument will need to be manually re-connected to Sailfish by the user.
    b. **If re-connecting via USB-C, dry the instrument prior to removing the USB-C waterproof cover.**
11. Upon (re)-connection, Sailfish will recognize new log files available for download. Automatic downloads can be enabled in Sailfish, but this is not the default setting.
12. New log files may be viewed, plotted, and exported in various formats using the *Data Manager* tab in Sailfish.

2.3 Connecting a GPS Listener

Sailfish has the ability to connect to an external GPS listener so that GPS location data may be sent to an instrument. To set up an external listener, follow these steps:

1. Navigate to the *Devices* page and click on the 'Add Listener' button. Select 'GPS Listener.
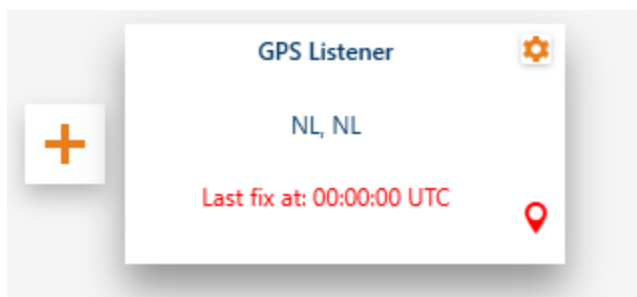
2. To configure the GPS listener settings, click the 'Gear Icon' on the listener tile.
3. Configure the settings according to your external GPS listener device. Both serial and UDP connections are supported. Sailfish will remember your GPS listener settings and

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automatically connect next time you add the listener.
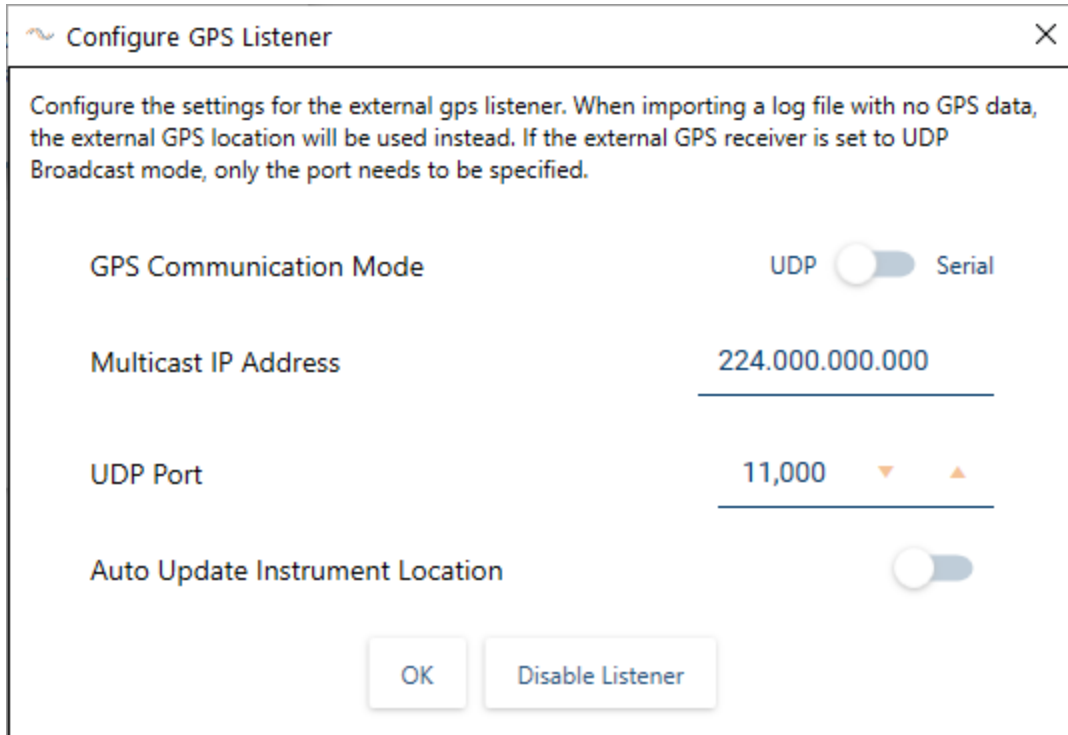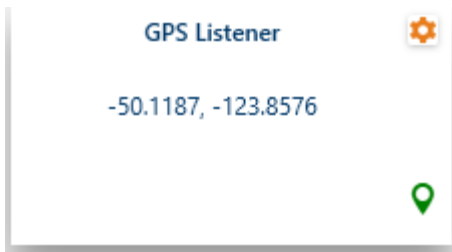

4. If the listener has been configured correctly, position data will be displayed in the tile and the location icon will turn green.

5. It is now possible to sync the external listener location to the instrument by clicking the 'Instrument Settings' icon on the *Device Tile* and selecting 'Sync GPS to Listener'
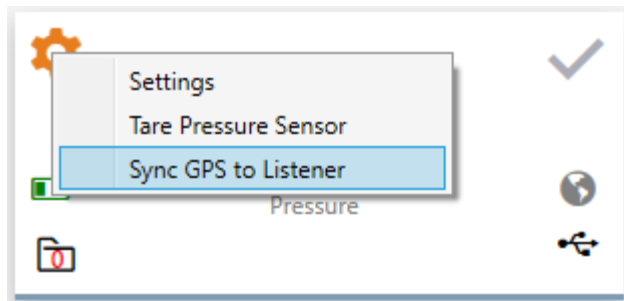
6. If your instrument's location mode was previously set to 'GPS', you will be prompted to set it to 'Manual'. Doing this will tell the instrument to ignore it's on-board GPS module.

This synced position information will be stored and used in newly created log files until the instrument's location is either synced again or the Location Mode is set back to 'GPS'. This can be done on the *Instrument Settings* page.

7. If connection to the GPS listener is lost, you can still sync to the last known location until you disable the GPS listener or close Sailfish.

8. To automatically sync your instrument to the GPS listener every time you reconnect to Sailfish, enable the 'Auto Update Instrument Location" setting.

3 Configuration using Sailfish

To configure with Sailfish, reference the [Getting Started with Sailfish](#) section.

Settings most commonly configured via Sailfish are detailed below.
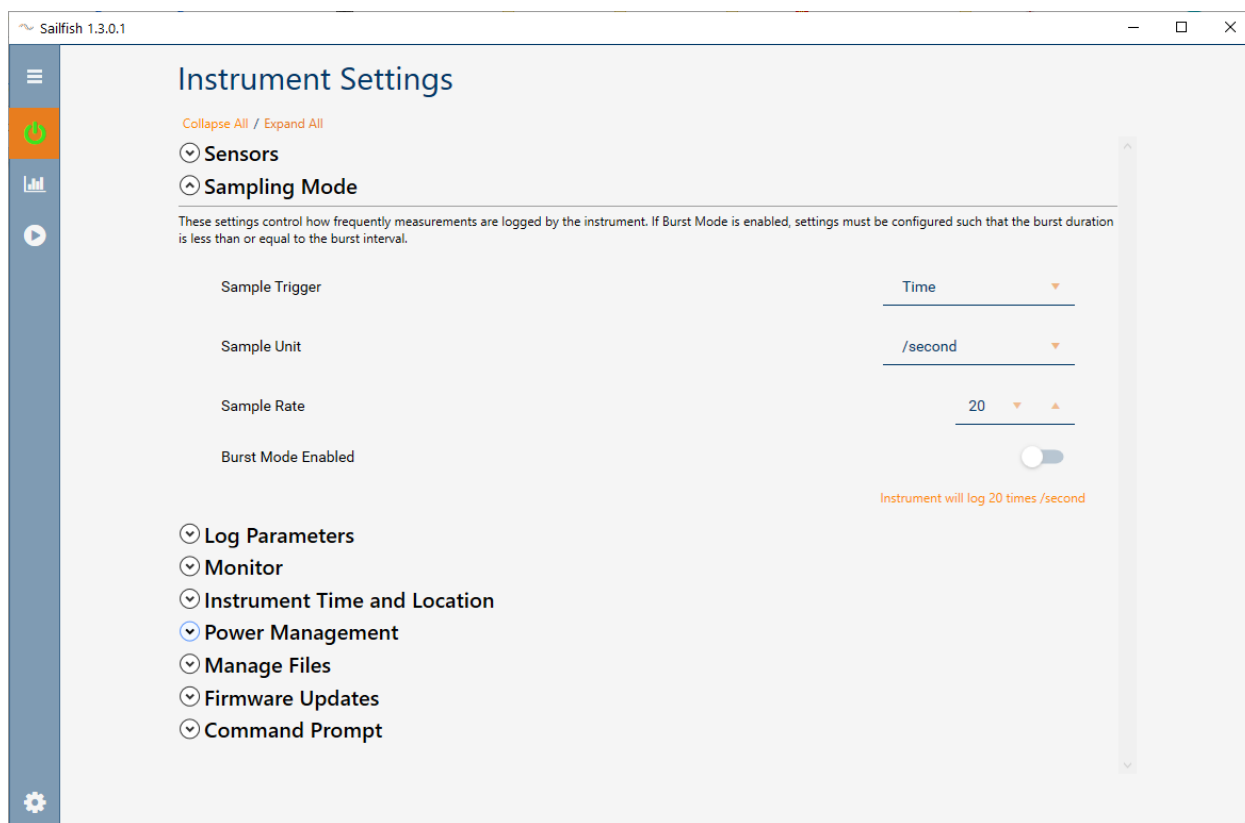
3.1 Sampling Mode

Setting	Description
Sample Trigger	Sets the variable that determines when a sample is taken. Options are time, pressure increment, sound velocity increment, and continuous (20Hz) sample rate.
Sample Unit	Available when time is selected as the sample trigger. Options are /second (per second), /minute (per minute), /hour (per hour), seconds, minutes and hours.
Sample Rate	Available when time is selected as the

	sample trigger. Works with Sample Unit setting to determine sample rate. For example, entering 10 with the sample unit set to seconds would result in a sample taken every 10 seconds. Changing the sample unit to /second would result in samples taken 10 times per second.
Pressure Increment	Available when pressure increment is set as the sample trigger. Sets the pressure increment (in dBar) when a sample should be taken.
Sound Increment	Available when sound velocity is selected as the sample trigger. Sets the sound velocity increment (in m/s) when a sample should be taken.

3.2 Log parameters

These settings control which parameters are included in the data stream and the generated log file. Note that some parameters require specific sensor configurations to be calculated. Options include date, time, density, salinity, calculated sound velocity, battery, depth, and raw values.

3.3 Instrument Time and Location

Setting	Description
Date and Time Source	Select the clock to synchronize the instrument to. Options are the connected computer's clock, or GPS.
Location Mode	Select the GPS source to synchronize the instrument to. Options are Instrument (internal GPS), manual (external GPS), and none.

3.4 Power Management

Setting	Description
In-Water WiFi Sleep	Specify if the WiFi chip should be disabled while underwater or not.

In-Water WiFi Sleep Timeout (secs)	The amount of time before the WiFi chip will be disabled once the instrument detects that it is underwater.
Power Timeout	Specify if the instrument should turn itself off if left idle.
Power Timeout (minutes)	The amount of minutes left idle before the instrument turns itself off.

3.5 Manage Files

View storage capacity and download or delete files stored on the device.

3.6 Firmware Updates

View current OS and controller firmware versions and check for and install updates.

3.7 Command Prompt

A command window for sending other commands to the instrument. See Appendix A for details on commands.

3.8 GPS Offline Assist

Enables Sailfish to transfer GPS satellite data files over to the instrument to improve GPS lock times. If enabled, Sailfish will download the latest GPS satellite position data once per day (requires internet connection) and transfer the Offline Assist data to the instrument upon connecting. The instrument will utilize the transferred satellite data during its next boot sequence to reduce GPS lock time.

Sailfish will download satellite data forecasted for the next 20 days, however data forecasted beyond approximately 5 days tends to be less accurate. For optimal performance, it is recommended that Sailfish be provided an internet connection daily to ensure up to date GPS information.

This setting is found in the Sailfish application settings.

Setting	Description
Enable Offline Assist	Enables Sailfish to download Offline Assist data from the internet and send it to the connected instrument. This can dramatically improve GPS lock times.
Offline Assist Last Download Date	Specifies the last day that Offline Assist data was downloaded.

4 Contact AML

Service

To request an RMA or technical support

Email: service@AMLoceanographic.com

Phone: 1-250-656-0771

Phone: 1-800-663-8721 (NA)

http://www.AMLoceanographic.com

Sales

For all general sales inquiries

Email: sales@AMLoceanographic.com

Phone: 1-250-656-0771

Phone : 1-800-663-8721 (NA)

http://www.AMLoceanographic.com

5 Appendix A - Full command list

All of the commonly utilized settings are accessible via GUI using Sailfish. However, Sailfish does not provide GUI access to the entire command set; advanced functionality beyond common settings exists. This advanced functionality is described here.

These commands are applied to the instrument via command line. This is achieved by using the *Advanced Commands* section of the bottom of the *Instrument Settings* page in Sailfish.

5.1 Sampling commands

Command	Description
*set sample <rate> [/second	/minute, /hour	seconds	minutes	hours	max]*	Set the rate at which the instrument logs and monitors data from the sensors. Maximum sample rate is 20 Hz.
*set scan mode [burst	single]*	Switch between single and burst mode. When the instrument is in burst mode it will sample in bursts at a set interval. Note that the burst duration must be less than or equal to the burst interval.
set burst interval <interval>	Set the burst interval in seconds. Minimum: 5 Maximum: 14400
set burst samples <samples>	Set the number of samples taken per burst. Samples will be taken at the set sample rate. Minimum: 2 Maximum: 1200
*set burst monitor [samples	average]*	Set whether the monitor output will display all the burst samples or an average of the samples. Note: averaging applies only to monitor data. Log files will record individual samples.
display burst	Display the current burst mode settings.
*set trigger [time	sound	pressure]*	Set the sampling trigger to sample by time, sound velocity increment or pressure increment.

	Sampling by sound or pressure increment is not supported in burst mode.
set sound inc <value>	Set sound velocity increment.
set pressure inc <value>	Set pressure increment.
set <detection parameter> threshold <value>	Set the threshold for water detection to begin automatic logging. Valid detection parameters are "conduct", "sound", and "pressure". By default pressure is set to 99999.99 and it is not recommended to detect water by pressure unless there are no sound velocity or conductivity sensors installed. Note: This is a secure command.

5.2 Monitor Configurations and commands

Command	Description
monitor	Start streaming data on the user terminal. Hit *<enter>* to exit monitor, hit *<enter>* three times to exit monitor when in robust mode.
mmonitor	Start streaming data in AMLx format.
scan	Print a single line of the latest sensor data.
mscan	Print a single line of the latest sensor data in AMLx format.
*set monitor robust [y	n]*	Enable/disable robust monitor mode. When enabled, monitoring is halted via 3 carriage returns. When disabled, a single carriage return will halt monitoring.
set monitor auto <seconds>	Monitoring will begin automatically after an interval of inactivity. Setting to "0" disables auto monitor. Min value: 5 This command applies only to monitoring via serial connection

set monitor startup [y | n]	Enable/disable monitoring on startup. When enabled the instrument will start monitoring when powered on. This command applies only to monitoring via serial connection
set monitor log [y | n]	Enable/disable monitor log mode. When enabled, the instrument will log data when monitoring. Stopping monitor will halt logging. Note: If LOG MODE is set to AUTO the instrument will commence logging when in water regardless of monitor status.
set monitor delimiter [comma | tab | space | colon]	Set the delimiter of the monitor output.
set monitor checksum [y | n]	Enable/disable a 8 bit XOR checksum in the monitor output. The checkum is appended to each scan preceded by a "*". Ex. >mon 1450.132,14.543*2B 1451.122,15.133*29
set monitor format [columns | amlx]	Set the monitor output format. See Appendix B for a description of the columns and AMLx formats. Note that checksum does not appear in log files.
display monitor	Print the current monitor settings.

5.3 Log File Format/Monitor Output

Command	Description
set scan <parameter>	Add a parameter to be included in the log file and monitor output. Optional Parameters: date time bat (Battery)

	dep (Calculated Depth) sal (Calculated Salinity) den (Calculated Density) sound (Calculated Sound Velocity) Note: Calculated parameters will output -99.9999 if outside of the valid range of the calculation formula.
set scan no<parameter>	Remove a parameter from being included in the log file and monitor output.
set derive <parameter> [y | n]	Enable/disable a parameter to be calculated if the required sensors are installed. Derived Parameters: depth (from pressure) salc (salinity from conductivity) salsv (salinity from sound velocity) density (requires salinity) sv (sound velocity, requires salinity) Note: a parameter will only be output if it is ALSO included in monitor scans. Refer 'SET SCAN' command, above.

5.4 UV Antifouling

Note that these commands apply only in the instance of a UV system installed on the instrument.

Command	Description
display uv	Print the current UV settings.
set uv time <ontime> <offtime>	Set the duty cycle of the UV lantern in seconds. Note: Setting UV time to 0 0 will disable light emission.

5.5 Data Logging

Command	Description
display status	Print the current logging status, including in-water status, number of samples recorded, log duration, and sample rate.

set logmode [auto | manual]	By default logmode will be set to "auto" and will automatically start logging when the water immersion is detected.
logon	Start logging when log mode is set to manual.
logoff	Stop logging when log mode is set to manual.
set filetype [columns | amlx | all]	Set the file type that data will be logged to. The columns format has file extension ".aml" while the amlx format has extension ".amlx". If ALL is selected, two files will be created, one in each format. See Appendix B for more details on these two formats.
dir	Display files present in the log directory.

5.6 Help

Command	Description
display options	Displays a full list of all configurable settings and their current values.
help	Displays a menu of all commands.

5.7 Communication commands

Command	Description
set baud <baud rate>	Set the serial baud rate for the instrument. All standard baud rates between 9600 and 115200 are accepted. Default is 115200. Note: This command takes immediate effect. Users must change the BAUD rate of their terminal program.

5.8 Sensor commands

Command	Description
display sensors	Print information about all connected sensors.
rawtalk <port>	Start a rawtalk session with a connected sensor. Send *<1s pause>+++<1s pause>* to exit the rawtalk session.

5.9 System commands

Command	Description
set fulltime <yyyy-mm-dd> <hh:mm:ss>	Set the system date and time.
reset factory	Restore the device's factory settings.
reset user	Restore the device's user settings.
display memory	Print the SD card's total and used memory in bytes.
display version	Print the version header, including the model name, firmware version, serial number, and total space of the installed SD card.
display volt	Print the current battery voltage.
secure on	Enables the user to send "secure" commands. Secure mode is not persistent through multiple telnet sessions or a power cycle.

5.10 GPS commands

Command	Description
set gnss mgadbd [y | n]	Enable/disable GPS database dump to enable GPS warm start. If enabled, the GPS module will store almanac data that will improve lock times after a recent fix has been lost. Enabling this feature generally improves GPS lock times. Note: This is a secure command.
set gnss offline [y | n]	Enable/disable GPS offline assist. Requires connecting to Sailfish with an active internet connection at least once every 5 days. Offline data will help improve lock times on power up. Note: This is a secure command.

5.11 Power commands

Command	Description
poweroff	Turn the instrument off indefinitely, until the power dial

	switch is toggled or external power cycled.
hibernate <minutes>	Turn the instrument off for a set amount of minutes.
set wakeonpower [y/n]	Once enabled, the instrument will stay on until a Power Off command is issued or poweroff timeout has occurred. Note: This is a secure command.
set powerofftimeout <minutes>	Set the instrument's idle timeout in minutes. If there is no user interaction and the instrument is idling, i.e. not streaming data or logging, the instrument will power down after the set timeout. Setting the timeout to 0 disables this feature.
set batwarning <voltage>	Set the threshold for the low battery warning to be triggered. If triggered the indicator led will turn red to notify users to charge the instrument. Note: This is a secure command.
set batshutdn <voltage>	Set the threshold for the low battery shutdown to be triggered. If the instrument's battery voltage drops below this threshold the instrument will shut down. It is not recommended to set this lower than 6.2 V. Note: This is a secure command.

6 Appendix B - Output Formats

AML-6 series instruments support two monitoring formats: a column-based format whereby all transmitted data is organized into vertical columns, and a proprietary self-describing format referred to as AMLx.

The commands to adjust monitor formats are described in 5.2 Monitor commands.

6.1 Column-Based Format

The factory default of an AML-6 instrument is column-based formatting, typically using a comma delimiter (the delimiter is configurable). This format is preferred for applications where human readability of the raw data is required as it is easy to quickly parse and interpret the scrolling columns of measurements.

The disadvantage of this format is that the user must have knowledge of the meta-data to correctly interpret the readings. The relevant meta-data is obtained by issue the following command:

>DIS SENSORS

[MeasurementMetadata]
Columns=Date,Time,Cond,TempCT,Pressure,SV,Depth
Units=yyyy-mm-dd,hh:mm:ss.ss,mS/cm,C,dbar,m/s,m

>MONITOR

>2020-05-27,18:59:26.03,5.122,24.044,10.09,1459.111,10.07
...

It is assumed the sensor meta-data is uniformly applicable to every line. that the number of columns, order of columns, and units of each measurement never change. This assumption makes the format extremely inflexible. **Users are strongly discouraged from creating drivers that rely on this output format.**

6.2 AMLx Format

The AMLx format is a proprietary self-describing string that does not rely on assumed static meta-data for interpretation. Each sentence contains sufficient information to contextualize the measurement data provided.

The general format of AMLx is:

msg**<MsgNumber>**{mux[meta=time,**<UnixEpochTime>**,s][data=uv,**<status>**],port**<PortNumber>**[data=**<ParameterName>**,**<Value>**,**<ParameterUnits>**][rawi=**<RawParameterName>**,**<Raw Value>**,**<RawUnits>**]]}

Sample output in this format is shown below.

>MONITOR

>msg138{mux[meta=time,1590605500.55,s],port1[data=Cond,0.000000,mS/cm][rawi=ADC,563,none][data=TempCT,23.881313,C][rawi=ADC,428710,none],port2[data=Pressure,0.071390,dbar][rawi=ADC,844470,2sComp],port3[data=SV,0.000000,m/s][rawf=NSV,0.000000,samples],derive[data=Depth,0.070998,m]}

In this format every measurement has, at minimum, an explicit unit, parameter, and port association. A driver written to interpret this format is able to understand output from every X2Change generation instrument regardless of specific sensor or derived parameter configuration. **Users are strongly encouraged to use drivers that rely on this output format.**

Parameter names:

Parameter name	Description
SV	Sound velocity
TempSVT	Temperature from an SVT.X2 sensor
Cond	Conductivity
TempCT	Temperature from a CT.X2 sensor.
Pressure	Pressure
Turbidity	Turbidity
Dissolved Oxygen	Dissolved Oxygen
DOM	CDOM/FDOM
Chloro-blue	Chlorophyll, blue excitation
Chloro-red	Chlorophyll, red excitation
pH	pH
Fluorescein	Fluorescein dye
Oil-crude	Crude oil
Oil-fine	Fine oil

Brighteners	Optical brighteners	
Phycocyanin	Phycocyanin (freshwater cyanobacteria)	
Phycoerythrin	Phycoerythrin (marine cyanobacteria)	
PTSA	PTSA	
Rhodamine	Rhodamine	
Tryptophan	Tryptophan	

7 Appendix C - Calculated Parameters

The AML-6 instrument has the ability to calculate certain parameters depending on your sensor configuration. Below is a table outlining the parameters that can be calculated.

Parameter	Required Sensors	Equation	Range
Salinity	C, T, P	Practical Salinity Scale 1978	0 - 90 PSU[1]
Salinity (from SV)	SV, T, P	AML	0 - 90 PSU
Density	C,T, P	TEOS10	0 - 2000 kg/m^3
Density (from SV)	SV,T, P	TEOS10	0 - 2000 kg/m^3
Sound Velocity*	C,T, P	Chen & Millero	0 - 3000 m/s
Depth	P	UNESCO	-20 - 12000 m

C - conductivity, T- temperature, SV - sound velocity, P- pressure

1 - Instrument will report 0-90 PSU, however PSS-78 equation is valid only from 2-50 PSU.

*Calculated salinity must be enabled for the calculated Sound Velocity to operate correctly

8 Appendix D - Equipping an Instrument

AML-6 instruments are shipped from the factory with sensors installed and configured. Users are generally not required to remove or install sensors in the course of normal operation. However, there are instances where a user may install or uninstall a sensor such as modifying a sensor payload, returning individual sensors to the factory for calibration, or sending a sensor in for service. AML series instruments and sensors are designed to be user-swappable for maximum flexibility.

8.1 X2Change™ Sensors

X2Change™ sensors are installed on the AML-6 sensor end cap. There are 6 sensor ports available and 1 port for an optional UV Antifouling system. Sensors are installed or removed by hand with no special tools required. Most combinations of X2Change™ sensors are permitted (See notes on installing sensors).
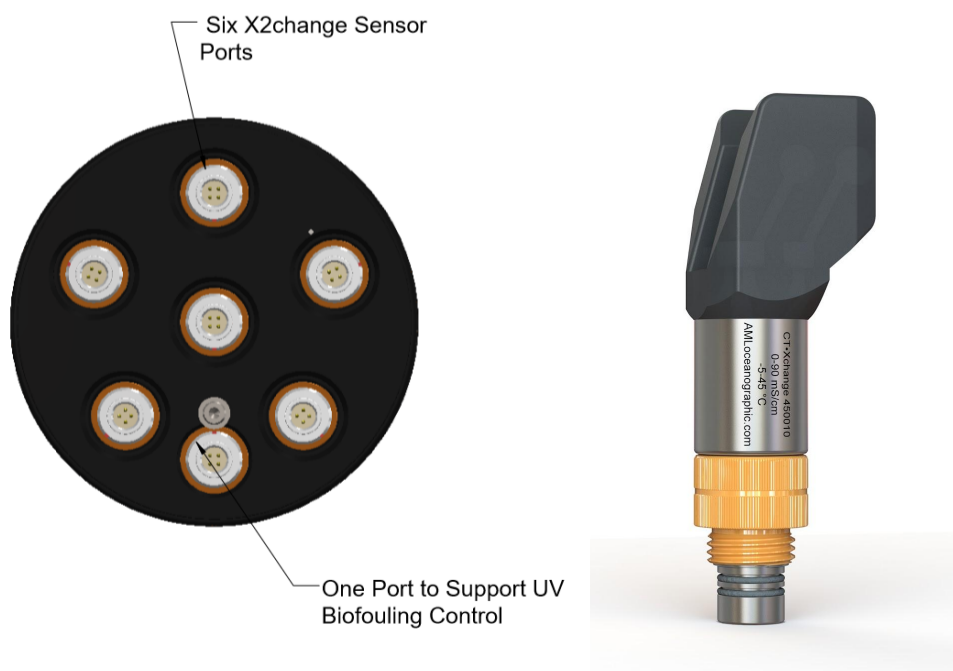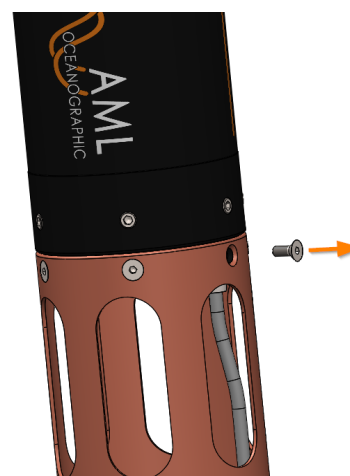

8.1.1 Removing Sensors

1. If a UV antifouling system is installed, the retaining clip must be removed prior to removing the sensor cage.

---
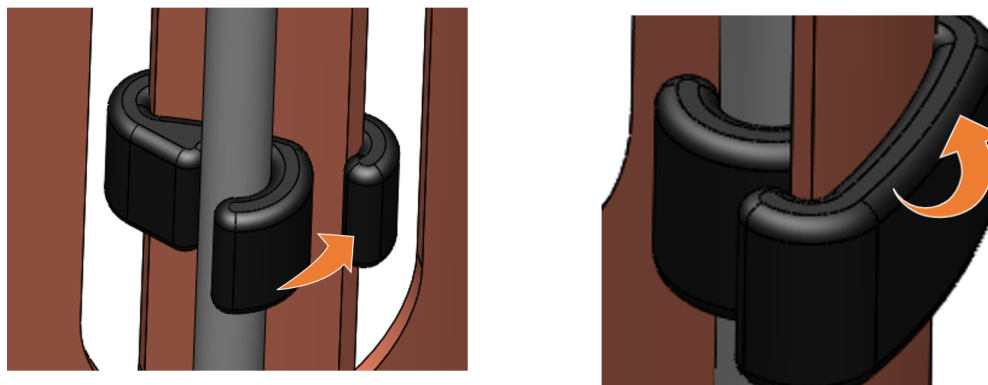
2. Configuring the sensors on the end cap is easiest when the sensor cage is removed. Use 1/8" hex tool to remove the screws when attaching or detaching the sensor cage.

3. Rotate the orange locking sleeve of the sensor you wish to remove counter-clockwise until you can gently pull the X2Change™ sensor from the sensor port.

8.1.2 Installing Sensors

1. Before installing X2Change™ sensors, ensure that the instrument socket is clean and dry.

2. Check the X2Change™ sensor's o-rings for cleanliness and replace if damaged. Apply o-ring grease to the new o-ring before replacing it.

3. Align the sensor with the sensor port so that the lock and key of the lemo connectors are aligned.

4. Place the sensor into the port.

5. Push the sensor until it drops down into the port enough to allow the orange locking sleeve threads to engage the port threads.

6. Screw down the orange locking sleeve until it stops. The bottom of the sleeve should be within 1 mm of the instrument end cap.

Notes:

- X2Change™ sensors are identified by their orange locking sleeve matching AML-6's orange sensor port.

- Older AML Xchange™ sensors with blue locking sleeves are not compatible with the AML-6 line of instruments.

- CT X2Change™ should be installed in AML-6 port 1 due to the mechanical fit between the sensor and the cage. All other X2Change™ sensors can be installed in any of the 6 sensor ports.

- A sensor riser may be required when installing a CT X2Change™ if other tall X2Change™ sensors are installed nearby.

8.2 Seals and Plugs

Before deployment, ensure that every empty X2Change™ sensor port is sealed with the X2Change™ Blanking Plug, the USB-C port is capped, and each MCBH is plugged with its dummy plug or cable. Contact AML Support to replace lost plugs or caps.

9 Appendix E - Long Term Storage Recommendations

AML recommends fully charging the internal battery of the instrument before storage, as well as re-charging the instrument fully every 6 months. Failure to maintain battery charge can damage the instrument.

10 Appendix F - USB FAQ

Question	Answer
Can I charge my instrument using my computer's USB port?	Yes, but note that some USB ports on computers cannot deliver the power that is required by the instrument for charging (10 Watts). We highly recommend using the included AC-DC Wall Adapter for charging your instrument.
I cannot communicate to the instrument via USB, what should I be checking?	1. Check if your computer's USB port is USB 3.1 or later. Some USB ports will tend to shut down due to the output power limit. 2. Use a powered USB hub that supports USB 3.1 connectivity. Contact AML for approved USB hubs that are tested with our instruments.
Can I use a different USB-C cable for charging/communicating to the instrument?	AML highly recommends using the factory-supplied USB cable. In cases where you have to use a different one, you may do so but AML cannot guarantee that it meets the required specification in order to work seamlessly with our instrument.

11 Appendix G - Regulatory Information

This product is compliant within the requirements of CE standards.

The WiFi adaptor used in this instrument is a certified radio module under the following regulatory bodies:

FCC Part 15.247 Intentional Radiator Certification	FC	FCCID: Z64-WL18SBMOD
Industry Canada RSS-210		IC ID: 451I-WL18SBMOD
Japan Certificates	⊜ R	201-135370

12 Appendix H - Warranty Statement

AML Warranty Policy: New Product (Instrumentation)

AML warrants the instrument and sensor for a period of TWO YEARS (24 months) from the date of delivery. AML will repair or replace, at its option and at no charge, components which prove to be defective. The warranty applies only to the original purchaser of the instruments and only to instruments and sensors manufactured by AML Oceanographic. The warranty of third party sensors will apply as per the specific vendor's warranty policy. 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 for new products 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.