# AML-3 and AML-6 RTS: User Manual

Multiparameter Real Time Streaming Instrument


For more information visit AMLoceanographic.com or call +1 250-656-0771

# Revision History

| Revision | Date | Description |
|---|---|---|
| 1.0 | Aug 31, 2022 | Document Created |
| 1.09 | Mar 31, 2023 | Addition of monitoring display/format settings |
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# 1 Introduction

The AML RTS series is a highly configurable family of multiparameter sondes designed for a wide range of data collection applications. This series includes both the AML-3 RTS and the AML-6 RTS, where the ‘3’ and ‘6’ designations refer to the number of sensors that may be simultaneously installed on the instrument’s endcap. Additional sensors may be connected externally, allowing up to 4 and 8 sensors respectively in total.

There are three primary configurations of instruments in the AML-3 and AML-6 family: the AML LGR, a self-powered instrument designed for profiling applications, the AML RTS, an externally powered instrument intended for Real Time Streaming applications, and the AML XC (Xtra Connector), a hybrid instrument with both Logging and Real Time capabilities. While nearly identical in size and form factor, the three configurations differ in a few key features which specialize them for their respective applications.

Instruments with the LGR designation 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 such as CTD, SVP, etc.

Real Time Streaming instruments, in contrast, are designed to stream data, with no ability to internally record the data. 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.

Instruments with the XC designation combine the strengths from both the LGR and RTS versions. Providing even more flexibility, it can internally record data and has the option of streaming data in real time via a waterproof connector located adjacent to the shackle. These instruments are used when both real time streaming and internal logging may be required.

This manual describes the operation of both the AML-3 and AML-6 Real-Time Streaming (RTS) version.

## 1.1 Instrument Overview

AML instruments are highly customizable and may be equipped with a wide range of user-specific sensors. 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-3 RTS.

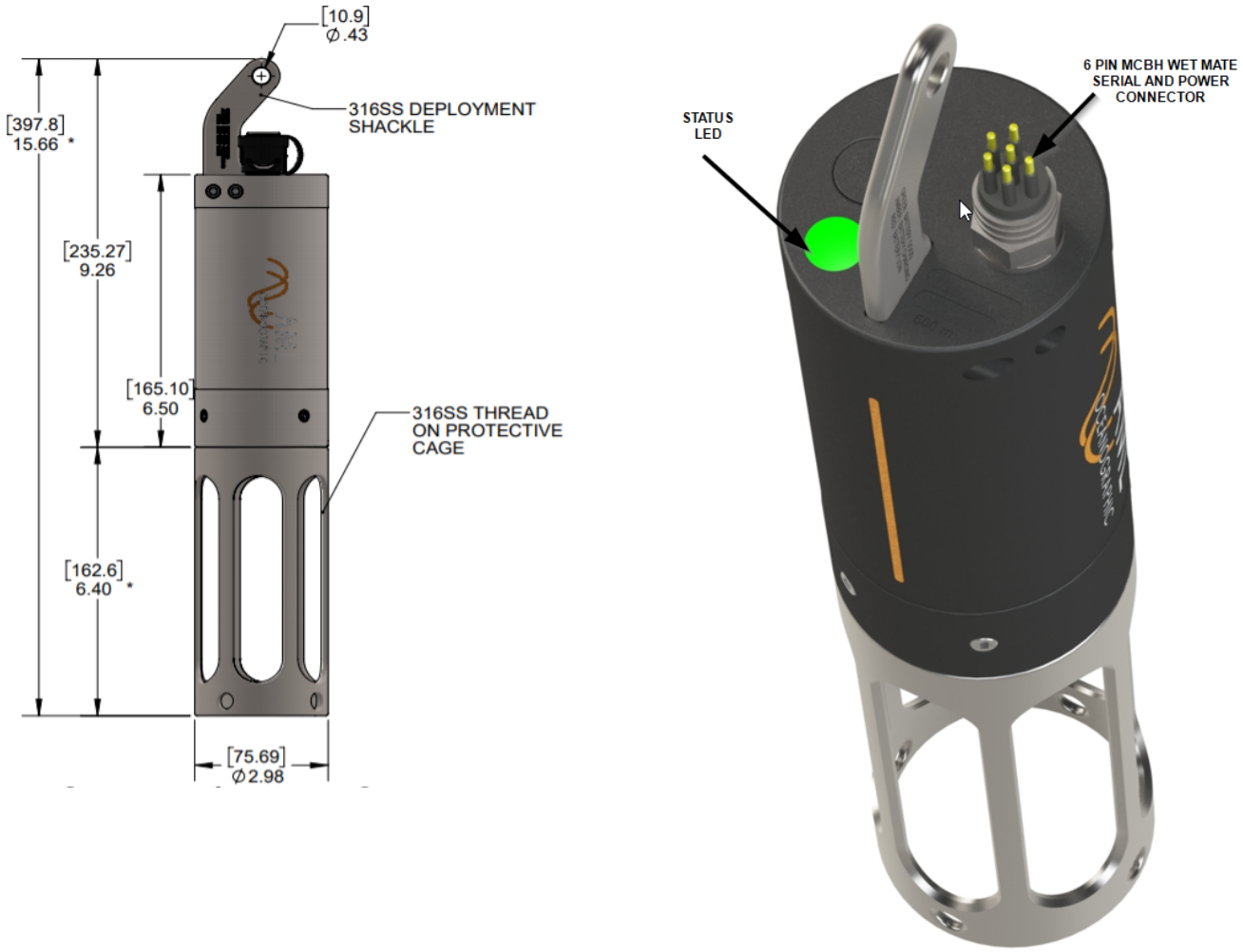



*Figure 1: A typical AML-3 RTS. At left, the 6000m, at right, the 500m. The instrument shown here is representative only and may differ from the Reader's instrument.*

Figure 2 depicts a typical AML-6 RTS.

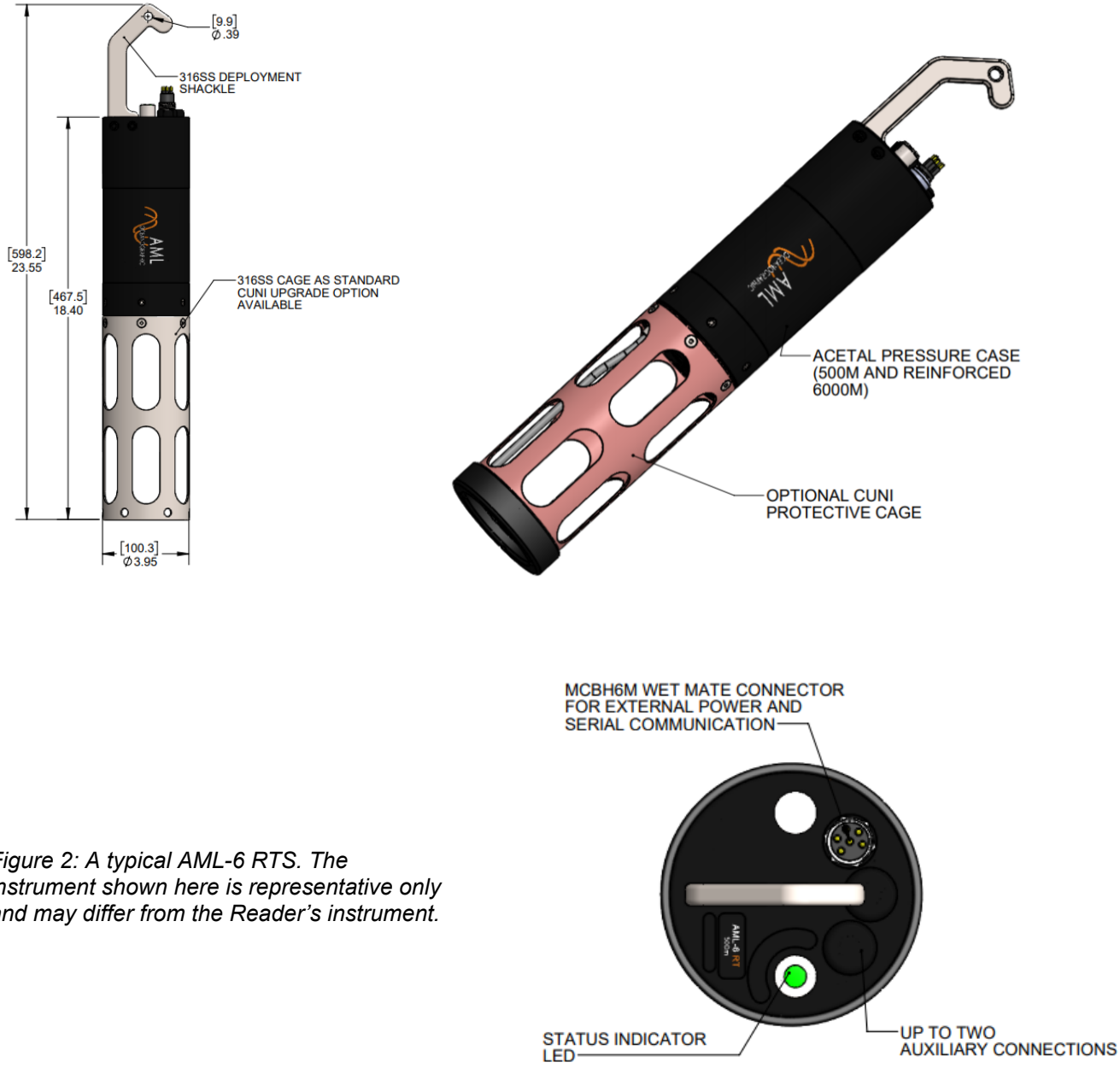



*Figure 2: A typical AML-6 RTS. The instrument shown here is representative only and may differ from the Reader's instrument.*

By default, both the AML-3 and AML-6 RTS instruments come equipped with a shackle, a waterproof MCBH connector, and a status indicator LED. The shackle has a hole coincident with the axis of the instrument to facilitate suspension during deployment. It is recommended the instruments be deployed vertically with the shackle end up. The AML-6 RTS shackle is also hook shaped to provide secure handling by a user.

The end of the instrument opposite the shackle houses the sensor payload which is mechanically protected by a cage. **The AML-3 utilizes a thread-on sensor cage, and the AML-6 utilizes a bolted-on sensor cage.** In some configurations the cage may be different lengths depending on the sensors installed (AML-3 only) or made from a copper alloy to prevent biofouling (AML-6 only). The default cage for both instruments uses stainless steel.

Typical specifications of an AML RTS are described in the table below.

**Specifications:**

| **Model** | 500m Variants (AML-3 or AML-6) | 6000m Variants (AML-3 or AML-6) |
|---|---|---|
| **Depth rating** | 500 meters [1640 feet] | 6000 meters [19685 feet] |
| **Materials** | AML-3: Acetal pressure case<br>AML-6: Acetal pressure case | AML-3: Titanium pressure case<br>AML-6: Acetal pressure case with internal metal reinforcement |
| **Software** | Sailfish | Sailfish |
| **Communication** | RS-232 or RS-485 (Factory set) | RS-232 or RS-485 (Factory set) |
| **Maximum Sample Rate** | 20 Hz<br><br>Note: Sampling by pressure or sound velocity increment is also available. | 20 Hz<br><br>Note: Sampling by pressure or sound velocity increment is also available. |
| **Power** | 8-30 VDC via MCBH connector<br>~3 W power draw (instrument only) | 8-30 VDC via MCBH connector<br>~3 W power draw (instrument only) |
| **Temperature** | -20 to +45°C (Operation)<br>-20 to +60°C (Storage) | -20 to +45°C (Operation)<br>-20 to +60°C (Storage) |
| **Dimensions** | AML-3:<br>Diameter: 7.6 cm / 3.0 in<br><br>Length:<br>Short Cage: 33.4 cm / 13.15 in (SVP set up)<br><br>Medium Cage: 39.8 cm / 15.66 in (CTD set up)<br><br>Long Cage: 46.4 cm / 18.26 in (UV Protected)<br><br>Weight*:<br>1.36 kg / 3.00 lb (air) | AML-3:<br>Diameter: 7.6 cm / 3.0 in<br><br>Length:<br>Short Cage: 33.4 cm / 13.15 in (SVP set up)<br><br>Medium Cage: 39.8 cm / 15.66 in (CTD set up)<br><br>Long Cage: 46.4 cm / 18.26 in (UV Protected)<br><br>Weight*:<br>2.5 kg / 5.6 lb (air) |

| | | |
|---|---|---|
| | .69 kg / 1.52 lb (water)<br><br>AML-6:<br>Diameter: 10.0 cm / 3.90 in<br>Length: 60.0 cm / 23.6 in<br><br>Weight**:<br>4.00 kg / 8.80 lb (air)<br>2.00 kg / 4.40 lb (water) | 1.9 kg / 4.1 lb (water)<br><br>AML-6:<br>Diameter: 10.0 cm / 3.90 in<br>Length: 60.0 cm / 23.6 in<br><br>Weight**:<br>5.80 kg / 12.80 lb (air)<br>3.80 kg / 8.40 lb (water) |

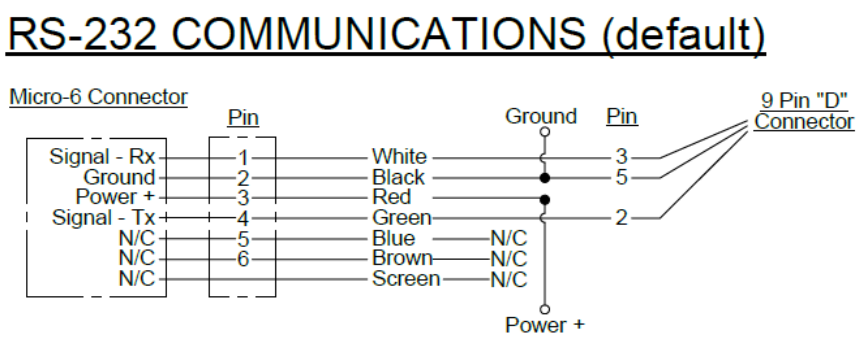
* With a medium cage and no sensors, deployed weights will vary
** With no installed sensors, deployment weight will vary.

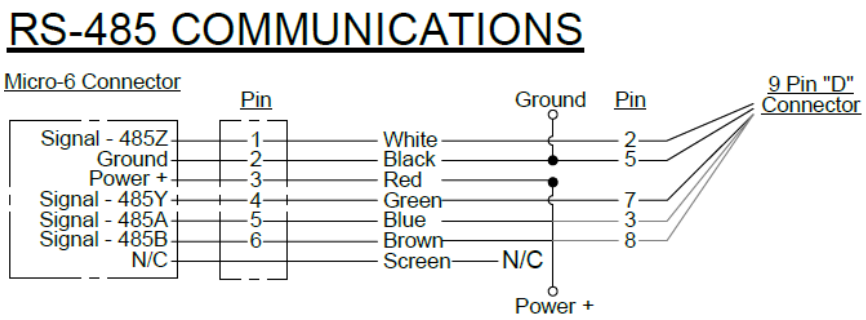
## 1.2 Connectors and Cables

AML RTS instruments come with one connector:

1. **A waterproof MCBH connector.**

    a. This connector is used to provide external power and serial communications to the instrument during deployment. The instrument can be factory set to either RS-232 or RS-485 full duplex. Its typical use is for the transmission of live measurements during deployment.




    b. AML RTS instruments are typically sold with a length of underwater cable which has an MCBH series connector at one end, and a serial DB9 connector with flying power leads at the other end. This cable provides a means to communicate serially with the instrument and apply external power in bench top settings.

c. If a serial communication cable longer than 3 metres is used then it is necessary to add surge protection.

## 1.3 Auxiliary Sensors

It is possible for AML instruments to be equipped with additional sensors which are not installed on the instrument sensor endcap. 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.

AML-3 RTS instruments can accommodate one auxiliary sensor and AML-6 RTS instruments can accommodate two auxiliary sensors for a maximum sensor load of 4 and 8 sensors, respectively.

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 and 2 do 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 or copper alloy guard.

## 1.4 UV biofouling control (500m Only)

AML RTS instruments are compatible with AML's UV biofouling control technology (rated to 500m). The embodiment of this technology is a streetlamp-shaped device installed adjacent to the sensors which blankets the sensor payload with UV, providing antifouling protection. All surfaces with a direct line of sight to the emitting 'head' of the device will receive biofouling protection, including the externally mounted auxiliary sensors. The UV biofouling system is a factory-equipped option.

UV-equipped instruments are factory-set to emit UV-C light on a pre-programmed duty cycle immediately on instrument powerup. **Do not expose bare skin or eyes to the emitted light.**

For most applications, AML RTS instruments are shipped from the factory with all sensors pre-installed and configured.

## 1.5 Indicator LED Flash Patterns

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

| | Steady (solid on) | Pulsing | Flashing |
|---|---|---|---|
| Green | Ready Battery good | - | - |
| Red | - | - | - |
| Orange/ White/ Blue | - | Boot up or boot down sequence. | - |
| White | - | - | Error state |

## 1.6 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 RTS instruments are 500m and 6000m.

# 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, and stream sensor measurements.

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

## 2.1 Deployment workflow

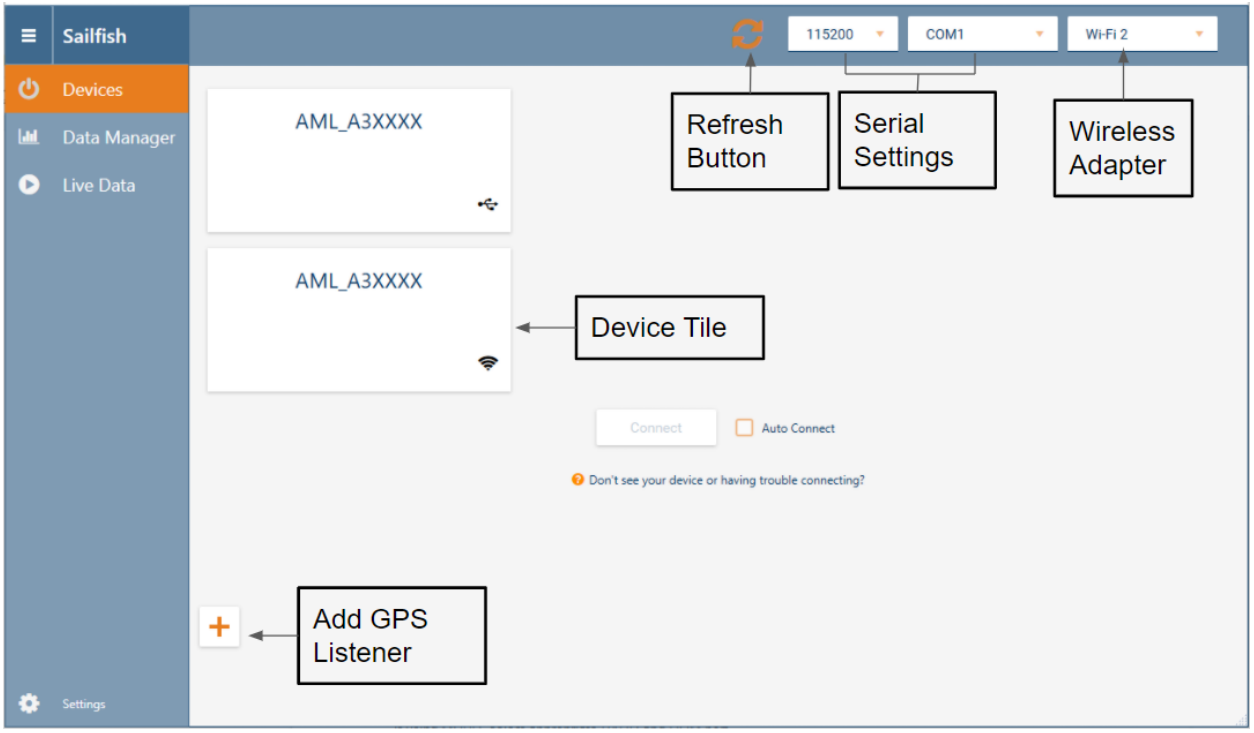
When deployed, power and communication must be administered via the waterproof MCBH connector. First-time users of an AML RTS instrument are encouraged to familiarize themselves with operation by following the workflow described below:

1. On a dry workbench, apply external power to the instrument (8-30 VCD via the MCBH connector) and connect the instrument to a PC using the serial cable. Use the provided software interface to explore the instrument configuration options. Details on this process are described in the following section: *Getting Started with Sailfish*.
2. After configuration, verify the desired functionality in an 'as-deployed' state by connecting to a serial terminal via the MCBH connector and streaming live data with the instrument submerged in a saltwater bath. This process is described in the following section: *Getting Started with Serial Communications*.

## 2.2 Getting started with Sailfish

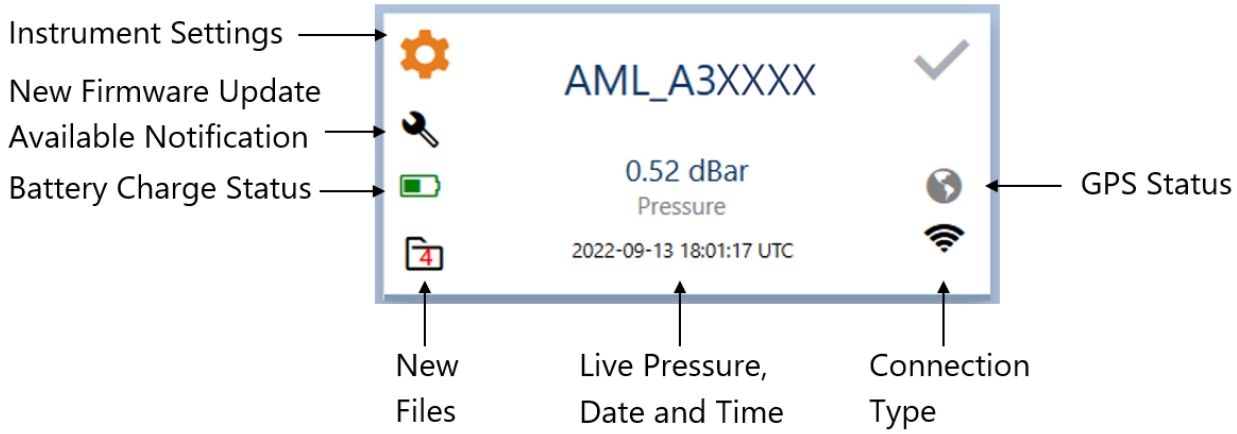
The preferred (but not the only) method of communicating with the instrument is via AML's software interface, Sailfish; a user-friendly GUI-based platform which allows users to easily configure an instrument, observe live sensor measurements (live data streaming), and download logged data. Sailfish may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

Sailfish provides the easiest means of adjusting the instrument's configuration. Advanced commands not accessible via the GUI exist and can be applied via command line. Refer to section *Configuring an Instrument* in this document for more details.




To use Sailfish to configure the AML-3 and AML-6 RTS instrument, follow the procedure described below:

1. Download the Sailfish install file from the website (or provided USB thumb drive) and follow the on-screen installation instructions. Sailfish is compatible with Windows 7, 8, 10 and 11.
2. Connect the serial cable and apply 8-30 VDC to the flying leads.
3. Connect the instrument to the PC via the serial connection. The instrument will typically take about 10 seconds to boot up upon the application of external power. The boot up sequence will be displayed on the LED.
4. Start Sailfish and wait for the software to load.
5. If you open Sailfish before connecting your instrument you will need to click on the 'Refresh' button for your instrument to appear.
6. If recognition is successful, Sailfish will display an instrument tile with serial number in the *Devices* tab. Select the corresponding tile, then press 'Connect' at the bottom of the tab to establish a connection.
7. Click the gear icon on the instrument tile (top left corner of the tile) to open the *Configuration* page. Follow the on-screen instructions to configure the instrument.




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.

8. The user is encouraged to explore the *Instrument Settings* page to familiarize themselves with typical settings.
9. A common step 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 simply unplug the serial cable, or click the Disconnect button.

## 2.3 Getting started with a Serial Terminal

While Sailfish provides a user-friendly means of interacting with the instrument in a benchtop environment, communication with a deployed instrument must be conducted via serial connection through the MCBH connector. This connection type provides a command-line means of configuring the instrument and streaming live measurements.

The command prompt also allows the use of advanced commands not available in Sailfish.

To connect to the instrument and establish serial communication:

1. Insert one end of the wet-mateable cable into the MCBH connector of the instrument. Connect the DB9 into the computer's serial port (or use a USB-RS232 adapter).
2. Apply 8-30V to the flying leads of the wet-mateable connector cable. The instrument will commence its boot sequence. Typical boot time is approximately 10 seconds.
3. Use a Serial Terminal to open the appropriate COM port and establish communication with the instrument. **The default baud is 115200** (8 data bits, no parity, 1 stop bit)**.** Sending a carriage return (enter key) will land the instrument at prompt.

### 2.3.1 Basic Command Line Functionality

The commands described in this section are intended to provide an overview of basic functionality in order to familiarize the user. There are many commands available, however, and

the reader is directed to the *Appendix* or *Configuration* section of this document for further details.

A list of commands is available by issuing the command

*>HELP*

### View information about installed sensors, parameters, and units

To see information about the installed sensors, issue the command:

*>DISPLAY SENSORS*

```
[SensorMetaData]
Columns=Port,Model,SerialNumber,Firmware,Parameter,Units,CalibrationDate,CalibrationTime,Accuracy,RangeMin,RangeMax

[SensorData]
1,CT.Xchange,450801,,Cond,mS/cm,2020-03-28,11:47:47,0.002,0,56
1,CT.Xchange,450801,,TempCT,C,2020-03-27,23:31:03,0.001,-5,45
2,P.X2,306207,1.00.1,Pressure,dbar,2020-04-28,11:28:06,0.007,0,48
3,Turbidity,600342,1.01.0,Turbidity,NTU,2020-05-05,12:12:12,0.000,0,0
4,SV.X2,206261,2.00.0,SV,m/s,2000-01-01,16:27:25,0.010,1375,1625
5,Idronaut pH,750105,1.00,pH,pH,2019-10-18,13:51:04,0.087,0,0
6,SVT.X2,220281,2.00.1,SV,m/s,2000-01-01,00:00:00,0.020,1375,1625
6,SVT.X2,220281,2.00.1,TempSVT,C,2000-01-01,00:00:00,0.003,-2,35

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

The *Sensor Meta Data* section provides information on how to interpret the results of the *Sensor Data* table immediately following. For reference, *Port* refers to the sensor port that a sensor is installed into on the instrument endcap (6 ports in total on an AML-6 RTS endcap, 3 ports on an AML-3 RTS endcap). Auxiliary sensor(s) will be listed as being installed on Port 7 or 8 on an AML-6 RTS, and port 4 on AML-3 RTS.

In this example there are 6 sensors installed on the AML-6 RTS instrument. Port 1 (as labeled on the endcap) has a combined Conductivity and Temperature sensor installed, so it is depicted as two sensors - one with a *Cond* parameter, and one with a *TempCT* parameter. Likewise, Port 6 has a combined sound velocity and temperature sensor installed.

The *Measurement Meta Data* section provides information on how to interpret the columns of measurements when the instrument is streaming data.

### Streaming live data (MONITORING)

Live data streaming is referred to as monitoring. To commence monitoring, issue the command

*>MONITOR*

```
2022-01-19,03:14:07.00,51.281,20.867,0.23,-1.19,1526.593,6.31,1526.677,10.000,0,0.23
2022-01-19,03:14:07.00,51.280,20.867,0.23,-1.17,1526.595,6.31,1526.677,10.000,0,0.23
```

2022-01-19,03:14:07.00,51.280,20.868,0.23,-1.13,1526.595,6.31,1526.677,10.000,0,0.23
2022-01-19,03:14:07.00,51.282,20.866,0.23,-1.14,1526.594,6.31,1526.677,10.000,0,0.23
2022-01-19,03:14:07.00,51.279,20.866,0.23,-1.13,1526.595,6.32,1526.677,10.000,0,0.23
2022-01-19,03:14:07.00,51.279,20.868,0.23,-1.14,1526.594,6.31,1526.677,10.000,0,0.23
2022-01-19,03:14:07.00,51.280,20.868,0.23,-1.16,1526.595,6.32,1526.677,10.000,0,0.23
2022-01-19,03:14:07.00,51.278,20.867,0.23,-1.12,1526.594,6.31,1526.676,10.000,0,0.23
2022-01-19,03:14:07.00,51.281,20.867,0.23,-1.06,1526.594,6.31,1526.676,10.000,0,0.23
...

The monitor command invokes the streaming of sensor measurements and derived parameters if configured to do so. The instrument will continue to stream data indefinitely until manually halted by command**. Monitoring is halted by sending a carriage return (pressing enter).** The instrument can be configured to cease monitoring only on transmission of specific key sequence, referred to as ROBUST MONITOR MODE. Refer to the *Configuration* section of this document for details.

The *Measurement Metadata* table contextualizes the provided data columns with respective parameters and units. In this case, column 3 (first measurement 51.281) is for parameter *Cond* (conductivity) in units of mS/cm.

Monitor behaviour and output format is configurable.Refer to the *Configuration* section of this document for more details.

### Application note on monitor formats

While columns of data are easy to read by humans, in instances where the streaming data will be interpreted by machines (ie. other logging devices, software, telemetry modules, etc), users are strongly encouraged to utilize AML's extensible format, referred to as AMLx. Refer to Appendix B for more information.

# 3 Configuration

Commands can be sent to the instrument via command prompt, or with Sailfish when connected over serial. Sailfish provides a user-friendly method of configuring basic instrument settings, but command line-based configuration provides access to a wider range of configuration.

## 3.1 Configure with Sailfish

To configure with Sailfish please reference the Getting Started with Sailfish section.

## 3.2 Configure with a terminal

Advanced commands can be sent to the instrument via command prompt when connected via serial connection. The commands described in this section are not an exhaustive list. Refer to Appendix A for more details.

### 3.2.1 Baud Rate

Changing the instrument's baud rate will disconnect the terminal from the instrument and will require the terminal baud rate to be modified accordingly.

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

### 3.2.2 Sampling Settings

#### Burst Mode and Single Mode Sampling

The instrument can be configured in two different sampling modes: Single and Burst. In Single Mode, the instrument will output single samples at a configured interval. Burst Mode, in contrast, provides groups of samples at configured intervals. For example, an instrument in burst mode may be configured to output 6 samples at a rate of 2 samples/sec on 30 seconds intervals.

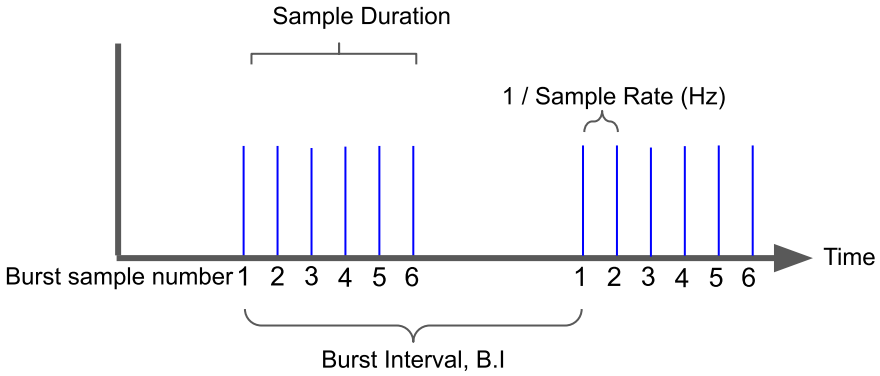



*Figure 3: Burst mode functionality. Blue bars indicate instrument samples.*

Burst mode behaviour is configured by prescribing the Number of Burst Samples, Burst Interval, and Sample Rate, as depicted in Figure 3. The Sample Rate (frequency with which sensor measurements are obtained) is common between Burst Mode and Single Mode.

**Example:**

To configure an instrument to output 6 samples at a rate of 2 samples/sec on 30 second intervals, use the following command sequence:

| | |
|---|---|
| *>SET SAMPLE 2/S* | *-set the sample rate to 2 samples per second.* ***Note that sample rate must be set prior to enabling burst mode.*** |
| *>SET SCAN MODE BURST* | *-Set the global instrument scan mode to Burst. Monitoring will now be in bursts.* |

```
Scan mode: Burst
Sample rate: 2 /sec
Burst interval: 30 secs
Burst samples: 10
Burst monitor: Samples
```

| | |
|---|---|
| *>SET BURST SAMPLES 6* | *-Prescribe 6 samples for each burst.* |
| *>SET BURST INTERVAL 30* | *-Commence the burst every 30 seconds.* |
| *>MONITOR* | *-Commence streaming measurements* |

```
>2020-05-29,17:56:50.32,-5.10,0.000
2020-05-29,17:56:50.82,-5.15,0.000
2020-05-29,17:56:51.32,-5.30,0.000
2020-05-29,17:56:51.82,-5.36,0.000
2020-05-29,17:56:52.32,-5.39,0.000
2020-05-29,17:56:52.82,-5.55,0.000
```

For the configuration of a Burst Mode to be valid, the Sample Duration of a given burst must be less than or equal to the burst interval, B.I. This is described in the following equation.

**Equation 1:** *Sample Duration* ≤ *B.I*, where $Sample\ Duration\ = \frac{n}{S.R}$

*S.R = sample rate (Hz), n=number of samples*

## Burst Averaging

The instrument may also be configured to report a single value representing the average of the samples within a burst (ref: *SET BURST MONITOR* [*SAMPLES* | *AVERAGE*] command). For example, an instrument in burst mode may be configured to obtain 6 samples at a rate of 2 samples per second on 30 seconds intervals. If burst-averaging is on, the instrument will output a single value for each parameter at 30 second intervals, where each value is the average of the 6 samples obtained during the burst.

Burst-averaging applies only to data output during monitoring.

| Command | Description |
|---|---|
| *set sample <rate> [/second \| /minute, /hour \| seconds \| minutes \| hours \| max]* | Set the rate at which the instrument 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 Sample Duration must be less than or equal to the Burst Interval (Equation 1) |
| *set burst interval <interval>* | Set the burst interval in seconds.<br><br>Minimum: 5<br>Maximum: 14400 |
| *set burst samples <samples>* | Set the number of samples taken per burst. Samples will be taken at the set sample rate.<br><br>Minimum: 2<br>Maximum: 1200 |
| *set burst monitor [samples \| average]* | Set whether the monitor output will display all the burst samples or an average of the samples. |
| *display burst* | Display the current burst mode settings. |

## Sleep Mode

The instrument can be configured to enter a low power state in between taking samples. The instrument will only enter sleep mode if the sleep and sampling settings are configured so that the sample period is longer than the minimum sleep time. By default the minimum time the

instrument is allowed to sleep is 40 seconds plus a 5 second delay after taking the sample. Sleep mode is also compatible with Burst Mode.

**Equation 2:** *Min Sleep Time + Sleep Delay ≤ Sample Period*

**Equation 3:** *Min Sleep Time + Sleep Delay ≤ Burst Interval - Sample Duration*

**Example 1:**

Minimum Sleep Time = 40 s (default)

Sleep Delay = 5 s (default)

| | |
|---|---|
| *>SET SCAN SLEEP Y* | *-enable sleep mode* |
| *>SET SAMPLE 2 MIN* | *-set sample period greater than 45 seconds* |
| 45 < 120 | *-Equation 2 is satisfied and instrument will sleep between taking samples* |

**Example 2:**

| | |
|---|---|
| *>SET SCAN MODE BURST* | *-enable burst mode* |
| *>SET BURST INTERVAL 60* | *-set burst interval to 60 seconds* |
| *>SET BURST SAMPLES 30* | *-set the number of burst samples to 30* |
| *>SET SAMPLE 5/S* | *-set sample rate fast enough so that burst interval - sample duration is greater than minimum sleep time* |
| 45 < 60 - 30 / 5<br>= 45 < 54 | *-Equation 3 is satisfied and instrument will sleep between bursts* |

| Command | Description |
|---|---|
| *set scan sleep [y \| n]* | Enable/disable sleep mode. |
| *set minsleeptime <seconds>* | Set the minimum number of seconds the instrument is allowed to sleep. **It is not recommended to change this.**<br><br>Default: 40 seconds<br>Min: 20 seconds |
| *set scan sleepdelay <seconds>* | Set the number of seconds the instrument will wait to sleep after taking a sample.<br><br>Default: 5 seconds |

### 3.2.3 Monitor Modes

Behaviour of monitor functionality is configurable.

| Command | Description |
|---|---|
| *set monitor robust [y \| n]* | Enable/disable robust monitor mode. When enabled, monitoring is halted via 3 carriage returns.<br><br>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.<br><br>Min value: 5<br><br>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.<br><br>This command applies only to monitoring via serial connection |
| *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 “*”.<br><br>Ex.<br>>mon<br>1450.132,14.543*2B<br>1451.122,15.133*29<br><br>Note that checksum does not appear in log files. |
| *display monitor* | Display the current monitor settings. |

Additional monitor commands are described in 5.2 Monitor commands.

### 3.2.4 Derived Parameters

| Command | Description |
|---|---|
| *set scan <parameter>* | Add a parameter to be included in the monitor output.<br><br>Optional Parameters:<br>date<br>time<br>dep (calculated depth)<br>sal (calculated salinity)<br>den (calculated density)<br>sound (calculated sound velocity)<br><br>Note: a parameter will only be provided if it is ALSO enabled. Refer 'SET DERIVE' command, below. |
| *set scan no<parameter>* | Remove a parameter from being included in the monitor output. |
| *set derive <parameter> [y \| n]* | Enable/disable a parameter to be calculated if the required sensors are installed.<br><br>Derived Parameters:<br>depth (from pressure)<br>salc (salinity from conductivity)<br>salsv (salinity from sound velocity)<br>density (requires salinity)<br>sv (sound velocity, requires salinity)<br><br>Note: a parameter will only be output if it is ALSO included in monitor scans. Refer 'SET SCAN' command, above. |

### 3.2.5 UV Antifouling

The following commands pertain only to an instrument with a UV antifouling system installed.

| Command | Description |
|---|---|
| *set uv time <ontime> <offtime>* | Set the duty cycle of the UV lantern in seconds.<br><br>Note: Setting UV time to 0 0 will disable light emission. |

### 3.2.6 Data Logging

Data logging is not supported with the AML RTS instrument series. If logging is required, please contact AML and inquire about our AML LGR or AML XC instrument series.

### 3.2.7 Help

The AML-3 RTS has a built-in help menu containing a complete list of all user commands.

| Command | Description |
|---|---|
| *display options* | Display a list of all configurable settings and their current values. |
| *help* | Display a menu of all user commands. |

# 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 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.<br><br>Minimum: 5<br>Maximum: 14400 |
| *set burst samples <samples>* | Set the number of samples taken per burst. Samples will be taken at the set sample rate.<br><br>Minimum: 2<br>Maximum: 1200 |
| *set burst monitor [samples \| average]* | Set whether the monitor output will display all the burst samples or an average of the 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.<br>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. |

## 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.<br><br>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.<br><br>Min value: 5<br><br>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.<br><br>This command applies only to monitoring via serial connection |
| *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 “*”.<br><br>Ex.<br>>mon<br>1450.132,14.543*2B<br>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.<br><br>Note that checksum does not appear in log files. |
| *set monitor sync [seconds]* | Synchronizes the start of monitoring to the nearest sync interval in seconds. When set to 0 the feature is disabled.<br>If enabled and the conditions for monitoring are met (auto/start/command), the first sample will start when the sync interval, referenced to the time, is aligned.<br>*Ex. Set Monitor Sync 600*<br>*When the instrument is monitoring, it will remain idle until the next 10 min mark. At this point the monitoring and data flow will begin.* |
| *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.<br><br>Optional Parameters:<br>date<br>time<br>bat (Battery)<br>vbat (Battery Voltage)<br>ibat (Battery Current)<br>vext (External Voltage)<br>iext (External Current)<br>chargestate (Charger Board Status)<br>sn (Serial Number)<br>dep (Calculated Depth)<br>sal (Calculated Salinity)<br>den (Calculated Density)<br>sound (Calculated Sound Velocity)<br>raw (Raw Values)<br><br>Note: Calculated parameters will output -99.9999 if outside of the valid range of the calculation formula. |

| | |
|---|---|
| *set scan <parameter>* | Remove a parameter from being included in the log file and monitor output.<br><br>Optional Parameters:<br>nodate<br>notime<br>nobat (Battery)<br>novbat (Battery Voltage)<br>noibat (Battery Current)<br>novext (External Voltage)<br>noiext (External Current)<br>nochargestate (Charger Board Status)<br>nosn (Serial Number)<br>nodep (Calculated Depth)<br>nosal (Calculated Salinity)<br>noden (Calculated Density)<br>nosound (Calculated Sound Velocity)<br>noraw (Raw Values) |
| *set derive <parameter> [y \| n]* | Enable/disable a parameter to be calculated if the required sensors are installed.<br><br>Derived Parameters:<br>depth (from pressure)<br>salc (salinity from conductivity)<br>salsv (salinity from sound velocity)<br>density (requires salinity)<br>sv (sound velocity, requires salinity)<br><br>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.<br><br>Note: Setting UV time to 0 0 will disable light emission. |

## 5.5 Help

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

## 5.6 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.<br><br>Note: This command takes immediate effect. Users must change the BAUD rate of their terminal program. |

## 5.7 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. |

## 5.8 System commands

| Command | Description |
|---|---|
| *set fulltime <yyyy-mm-dd> <hh:mm:ss>* | Set the system date and time. |
| *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. |
| *secure on* | Enables the user to send "secure" commands. Secure mode is not persistent through multiple telnet sessions or a power cycle. |

## 5.9 Power commands

| Command | Description |
|---|---|
| *poweroff* | Turn the instrument off indefinitely, until external power is 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.<br><br>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, the instrument will power down after the set timeout.<br>Setting the timeout to 0 disables this feature. |

# 6 Appendix B - Output Formats

AML RTS 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 RTS 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*

*>2022-05-27,18:59:26.03,5.122,24.044,10.09,1459.111,10.07*
...

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>**,**<RawValue>**,**<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-3 RTS and AML-6 RTS instruments have 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 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 Sensor Cage

The sensor cage on both AML-3 and AML-6 instruments can be removed to provide better access to the sensors if they need to be swapped.

All AML-3 instruments come with a sensor cage (small, medium or long) that is threaded onto the pressure housing. There are no screws installed which hold the sensor cage in place, therefore it can simply be removed by rotating it off the pressure housing. The image below is a depiction of how to remove the sensor cage from an AML-3.

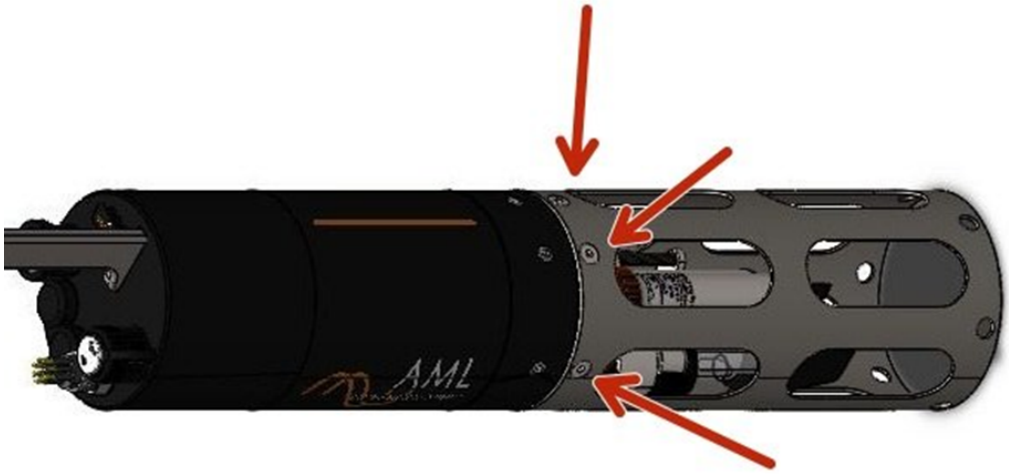
The AML-3 sensor cage is threaded onto the pressure housing, there are no screws holding the cage in place.


① If you are having trouble removing the AML-3 sensor cage, please place the shackle in a vice grip.

② Twist the sensor cage counterclockwise. Be sure to keep your fingers on the outside of the sensor cage so they do not get pinched

All AML-6 instruments come with either a stainless steel or copper sensor cage which is held in place by 6 screws. To remove the cage, use a 1/8” hex tool to remove the 6 screws holding the

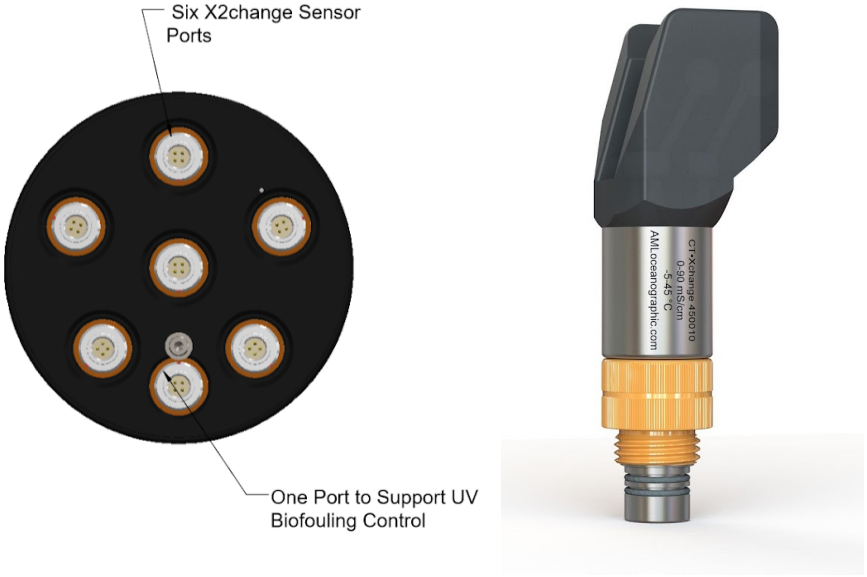
cage in place (not the 6 installed on the pressure housing) and slide it off the pressure housing.



Note: It is very important that the screws installed on the pressure housing are not removed. Performing this operation without AML authorization will void the warranty and may damage the instrument.

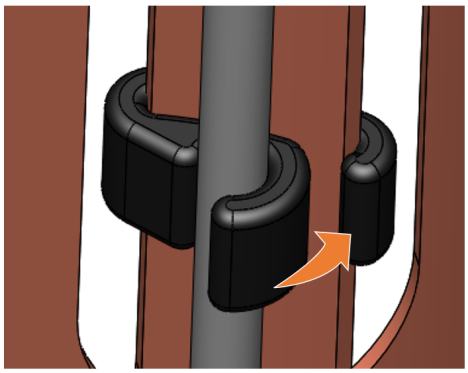
## 8.2 X2Change™ Sensors

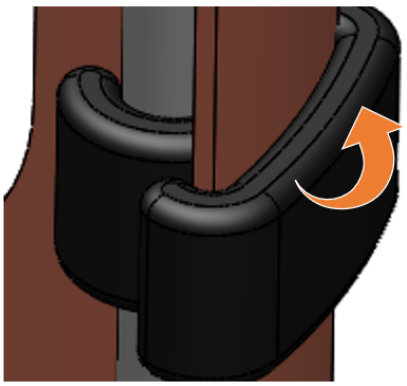
X2Change™ sensors are installed on the AML-3 or AML-6 sensor end cap. There are 3 sensor ports available on the AML-3 and 6 sensor ports available on the AML-6 (and 1 port for an optional UV Antifouling system). Sensors are installed or removed by hand with no special tools required. Most combinations of X2Change™ sensors are permitted (See notes on installing sensors). The image below is the depiction of an AML-6 sensor end cap with the optional UV Antifouling port.



### 8.2.1 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 (See notes on each instrument's 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.

### 8.2.2 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-3 and AML-6's orange sensor ports.

- Older AML Xchange™ sensors with blue locking sleeves are not compatible with the AML-3 and AML-6 line of instruments.
- CT X2Change™ should be installed in port 1 on both the AML-3 and AML-6 due to the mechanical fit between the sensor and the cage. All other X2Change™ sensors can be installed in any of the remaining sensor ports.
- A sensor riser (1.5” and 2.5” options available) may be required when installing a CT X2Change™ if other tall X2Change™ sensors are installed nearby.

## 8.3 Seals and Plugs

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

# 9 Appendix E - 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.