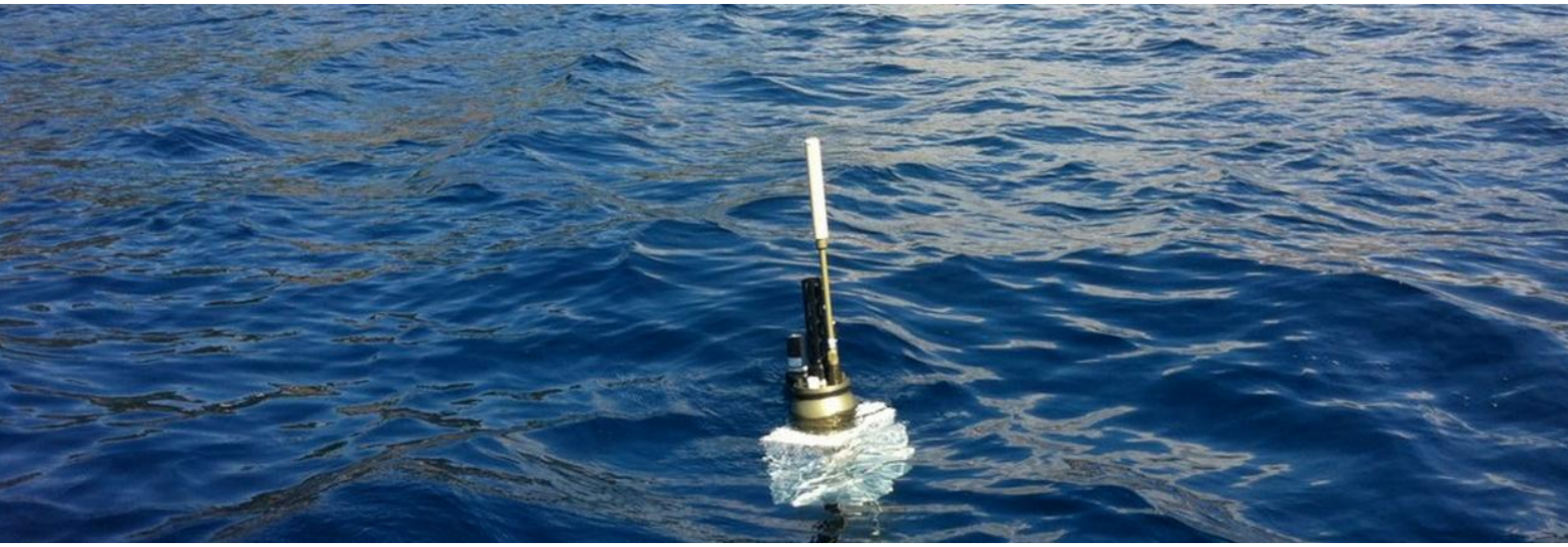
APMT Profiler – Sensors

AUTOMATED **M**ULTI-**T**ASK **P**ROFILER



33-16-055_APMT_Sensors
Revision 1.7 (2021-05-28)

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1. Revision history

Revision	Release date	Notes	Author
1.0	2019-05-02	Original	C. SCHAEFFER
1.1	2020-01-20	Adding sensor's specific information	C. SCHAEFFER
1.2	2020-04-10	Adding ECOv2 and RAMSES sensor	C. SCHAEFFER
1.3	2020-04-27	Adding sensor pressure offset compensation	C. SCHAEFFER
1.4	2020-06-18	Updating RAMSES sensor information	C. SCHAEFFER
1.5	2020-10-15	Updating OPUS sensor information	C. SCHAEFFER
1.6	2021-04-07	Updating MPE sensor information	C. SCHAEFFER
1.7	2021-05-28	Updating UVP6-TAXO information	C. SCHAEFFER

2. Standard sensors

2.1.SBE41 – Argo CTD

2.1.1. Sensor characteristics

APMT float uses Sea-Bird SBE41-CP sensor which provides Temperature, Conductivity and Pressure with long-term stability. The sensor is designed to perform a continuous profile of pressure, temperature and salinity parameters.

	Range	Initial accuracy	Resolution
Salinity	0 to 40 psu	±0.002 psu	0.001 psu
Temperature	-2 to +35°C	±0.002°C	0.001°C
Pressure	0 to 250 bar	±0.2 bar	0.01 bar

2.1.2. Specific configuration [SENSOR_01]

To ensure proper operation, the configuration of the APMT software driver must be adapted to the sensor. The following settings are recommended:

No.	Comment	Default
50	Sensor warm-up time (ms)	4800 (fixed)
51	Sensor shut down time (ms)	5000 (fixed)
52	Discard the first N samples	0 (fixed)
54	"Cut-off" pressure (dbar)	5
55	Enable/disable fast sampling period (1 Hz)	True

2.1.3. Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution.

	Range	Resolution
Salinity	0 to +50 psu	0.001 psu
Temperature	-5 to +40°C	0.001°C
Pressure	-100 to +2500 dbar	0.1 dbar

Example:
The SBE41 data size associated to **1000** averaged records in ascent stage is approximately **7.8 KB**.

2.2.DO – Oxygen

2.2.1. Sensor characteristics

APMT float can embed Aanderaa Optode 4330 or 4835 sensors. The sensor is designed to measure absolute oxygen concentration and saturation.

	Range	Accuracy	Resolution
O2 concentration	0 to 1000 µM	< 2 µM or 1.5 %	< 0.1 µM
O2 air saturation	0 to 300 %	< 1.5 %	0.05 %

2.2.2. Specific configuration [SENSOR_02]

To ensure proper operation, the configuration of the APMT software driver must be adapted to the sensor. The following settings are recommended:

No.	Comment	Default
50	Sensor warm-up time (ms)	1500
51	Sensor shut down time (ms)	6000
52	Discard the first N samples	0 (fixed)

2.2.3. Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution.

The data is referenced with external pressure of the closest Argo CTD sample over time.

	Range	Resolution
C1 Phase	-90 to +90 deg	0.001 deg
C2 Phase	-90 to +90 deg	0.001 deg
Temperature	-5 to +40°C	0.001°C
Pressure (SBE41)	-100 to +2500 dbar	0.1 dbar

Example:
The DO data size associated to **1000** averaged records in ascent stage is approximately **13.7 KB**.

2.3.OCR – Radiometry

2.3.1. Sensor characteristics

APMT float can embed Satlantic OCR-500 series (4, 7 or 14 wavelength) multispectral radiometers. The sensor is designed to make irradiance and/or radiance measurements.

	Bandwidth range	Spectral bandwidth	Noise equivalent I/R
Irradiance	400 to 865 nm	10 to 20 nm	2.5x10-3 µW.cm^{-2}.nm^{-1}
Radiance	400 to 865 nm	10 to 20 nm	300x10-3 µW.cm^{-2}.nm^{-1}

2.3.2. Specific configuration [SENSOR_03]

To ensure proper operation, the configuration of the APMT software driver must be adapted to the sensor. The following settings are recommended:

No.	Comment	Default
50	Sensor warm-up time (ms)	1900
51	Sensor shut down time (ms)	4000
52	Discard the first N samples	0 (fixed)

2.3.3. Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution.

The data is referenced with external pressure of the closest Argo CTD sample over time.

	Range	Resolution
Channel A/D counts	0 to +4294967295	1
Pressure (SBE41)	-100 to +2500 dbar	0.1 dbar

Example:
The OCR504 data size associated to **300** averaged records in ascent stage is approximately **5.9 KB**.

2.4.ECO - Fluorescence and scattering

2.4.1. Sensor characteristics

APMT float can embed WET Labs ECO (1, 2 or 3 wavelength) multichannel sensors. The sensor is designed to measure parameters concentrations by directly measuring the amount of fluorescence emission in a sample of water.

	Wavelength	Range	Sensitivity
Chlorophyll-a	470/695 nm	0 to 30 µg/L	0.15 µg/L
CDOM	370/460 nm	0 to 375 ppb	0.18 ppb
Backscatter	700 nm	3 m^{-1}	0.15 m^{-1}

2.4.2. Specific configuration [SENSOR_04]

To ensure proper operation, the configuration of the APMT software driver must be adapted to the sensor. The following settings are recommended:

No.	Comment	Default
50	Sensor warm-up time (ms)	5800
51	Sensor shut down time (ms)	4000
52	Discard the first N samples	0 (fixed)

2.4.3. Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution.

The data is referenced with external pressure of the closest Argo CTD sample over time.

	Range	Resolution
Channel A/D counts	-64 to +4130	1
Pressure (SBE41)	-100 to +2500 dbar	0.1 dbar

Example:
The ECO3 data size associated to **300** averaged records in ascent stage is approximately **2.9 KB**.

2.5.ECOv2 - Fluorescence and scattering

2.5.1. Sensor characteristics

APMT float can embed Seabird ECOv2 (1, 2, 3 or 4 wavelength) multichannel sensors. The sensor is designed to measure parameters concentrations by directly measuring the amount of fluorescence emission in a sample of water.

	Wavelength	Range	Sensitivity
Chlorophyll-a	470/695 nm	0 to 30 µg/L	0.015 µg/L
CDOM	370/460 nm	0 to 375 ppb	0.28 ppb
Backscatter	700 nm	3 m^{-1}	0.0015 m^{-1}
NTU	700 nm	0 to 1000 NTU	0.013 NTU

2.5.2. Specific configuration [SENSOR_12]

To ensure proper operation, the configuration of the APMT software driver must be adapted to the sensor. The following settings are recommended:

No.	Comment	Default
50	Sensor warm-up time (ms)	1000
51	Sensor shut down time (ms)	500
52	Discard the first N samples	0 (fixed)

2.5.3. Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution.

The data is referenced with external pressure of the closest Argo CTD sample over time.

	Range	Resolution
Channel A/D counts	0 to +65000	1
Pressure (SBE41)	-100 to +2500 dbar	0.1 dbar

Example:
The ECO3v2 data size associated to **300** averaged records in ascent stage is approximately **2.9 KB**.

2.6.SBEPH – pH

2.6.1. Sensor characteristics

APMT float can embed Sea-Bird LOV pH sensor. The sensor is designed inside the Argo CTD sensor and measures the level of acids and bases in the water.

	Range	Accuracy	Resolution
pH	6.5 to 9.0	±0.05	±0.05

2.6.2. Specific configuration [SENSOR_05]

To ensure proper operation, the configuration of the APMT software driver must be adapted to the sensor. The following settings are recommended:

No.	Comment	Default
50	Sensor warm-up time (ms)	500
51	Sensor shut down time (ms)	5000
52	Discard the first N samples	0 (fixed)

2.6.3. Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution.

The data is referenced with external pressure of the closest Argo CTD sample over time.

	Range	Resolution
pH	-2500 to +2500 mV	0.001 mV
Pressure (SBE41)	-100 to +2500 dbar	0.1 dbar

Example:
The SBEPH data size associated to **1000** averaged records in ascent stage is approximately **7.8 KB**.

2.7.CROVER – Transmittance

2.7.1. Sensor characteristics

APMT float can embed WET Labs C-Rover transmissometer sensors. The sensor is designed to measure the amount of a transmitted light received by a detector and calculate the ration with the signal in clean water.

	Wavelength	Range	Sensitivity
Beam attenuation	450/532/650 nm	90 m^{-1}	0.001 m^{-1}

2.7.2. Specific configuration [SENSOR_06]

To ensure proper operation, the configuration of the APMT software driver must be adapted to the sensor. The following settings are recommended:

No.	Comment	Default
50	Sensor warm-up time (ms)	1100
51	Sensor shut down time (ms)	2000
52	Discard the first N samples	0 (fixed)

2.7.3. Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution.

The data is referenced with external pressure of the closest Argo CTD sample over time.

	Range	Resolution
Corrected Signal Raw	0 to +32767	1
Pressure (SBE41)	-100 to +2500 dbar	0.1 dbar

Example:
The CROVER data size associated to **300** averaged records in ascent stage is approximately **1.8 KB**.

2.8.SUNA – Nitrate

2.8.1. Sensor characteristics

APMT float can embed Satlantics Deep SUNA sensors. The sensor is designed to take sample and process data on direct request from the float. APMT float supports APF frame format.

	Spectral range
Nitrate	190 to 370 nm

2.8.2. Specific configuration [SENSOR_07]

To ensure proper operation, the configuration of the APMT software driver must be adapted to the sensor. The following settings are recommended:

No.	Comment	Default
50	Sensor warm-up time (ms)	5300
51	Sensor shut down time (ms)	3000
52	Discard the first N samples	0 (fixed)

2.8.3. Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution. Data are encoded in 45 or 90 wavelengths spectrum packets.

The data is referenced with external pressure of the closest Argo CTD sample over time.

	Range	Resolution
Internal Temp	-5 to +40°C	0.001°C
Spectrometer Temp	-5 to +40°C	0.001°C
Relative Humidity	0 to +127 %	0.5 %
Dark Spectrum M	0 to +6553.5	0.1
Dark Spectrum SD	-327.68 to +327.67	0.01
Nitrate	IEEE 754 float	IEEE 754 float
Absorbance FR	IEEE 754 float	IEEE 754 float
Output spectrum	0 to +65535	1
Salinity (SBE41)	0 to 50 psu	0.001 psu
Temperature (SBE41)	-5 to +40°C	0.001°C
Pressure (SBE41)	-100 to +2500 dbar	0.1 dbar

Example:
The SUNA data size associated to **100** raw records (45 pixels output spectrum) in ascent stage is approximately **11.2 KB**.

2.9.UVP6 – Particles

2.9.1. Sensor characteristics

APMT float can embed Hydroptic UVP6-LP (CNRS patent) vision profiler. The sensor is designed to study large (> 100 µm) particles and zooplankton and quantify them in a known volume of water.

	Image frequency	Resolution	Field of view
Particles	1.3 Hz (max.)	5 MPixels / 0.73 µM	180 x 151 nm

2.9.2. Specific configuration [SENSOR_08]

To ensure proper operation, the configuration of the APMT software driver must be adapted to the sensor. The following settings are recommended:

No.	Comment	Default
50	Sensor warm-up time (ms)	1500
51	Sensor shut down time (ms)	3500
52	Discard the first N samples	0 (fixed)
61	Parking depth drift – Image count for average	5
62	Parking depth drift – Sampling period (s)	10

2.9.3. LPM Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution.

The data is referenced with external pressure of the closest Argo CTD sample over time.

	Range	Resolution
Internal Temp	-5 to +40°C	0.001°C
Particle number / class	IEEE 754 float	IEEE 754 float
Mean grey Level	0 to +255	1
Pressure (SBE41)	-100 to +2500 dbar	0.1 dbar

Example:
The LPM data size associated to **250** averaged records in ascent stage is approximately **23.9 KB**.

2.9.4. BLACK Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution.

The data is referenced with external pressure of the closest Argo CTD sample over time.

	Range	Resolution
Internal Temp	-5 to +40°C	0.001°C
Object count / class	0 to +65535	1
Pressure (SBE41)	-100 to +2500 dbar	0.1 dbar

Example:
The BLK data size associated to **100** raw records in ascent stage is approximately **1.8 KB**.

2.9.5. TAXO Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution.

The data is referenced with external pressure of the closest Argo CTD sample over time.

	Range	Resolution
Object ID	0 to 39	1
Mean size	IEEE 754 float	IEEE 754 float
Mean grey Level	0 to +255	1
Pressure (SBE41)	-100 to +2500 dbar	0.1 dbar

Example:
The TAXO data size associated to **100** averaged records (with 10 objects in each) in ascent stage is approximately **6.5 KB**.

2.10. RAMSES - Radiometry

2.10.1. Sensor characteristics

APMT float can embed TRIOS RAMSES hyper spectral radiometer. The sensor is designed to make irradiance and radiance measurements.

	Wavelength	Channels	Sensitivity
ACC VIS	320 to 950 nm	190	0.4 $\mu W.m^{-2}.nm^{-1}$

2.10.2. Specific configuration [SENSOR_14]

To ensure proper operation, the configuration of the APMT software driver must be adapted to the sensor. The following settings are recommended:

No.	Comment	Default
50	Sensor warm-up time (ms)	6000
51	Sensor shut down time (ms)	1000
52	Discard the first N samples	0 (fixed)
54	Pixel start	1
55	Pixel stop	200
56	Pixel binning	2

2.10.3. Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution.

The data is referenced with external pressure of the closest Argo CTD sample over time.

	Range	Resolution
Dark mean value	0 to +65535	1
Pixel value	0 to +65535	1
Integration time	0 to +65535	1
Depth	-100 to +2500 dbar	0.05 dbar
Inclination	0 to +360°	0.01°
Pressure (SBE41)	-100 to +2500 dbar	0.1 dbar

Example:
The RAMSES data size associated to **100** raw records (100 channels spectrum) in ascent stage is approximately **21.2 KB**.

2.11. OPUS - Nitrate

2.11.1. Sensor characteristics

APMT float can embed TRIOS OPUS UV spectral sensor. The sensor is designed to measure nitrogen and carbon compounds.

	Spectral range
Nitrate (10 mm path)	0.13 to 44 mg/L

2.11.2. Specific configuration [SENSOR_15]

To ensure proper operation, the configuration of the APMT software driver must be adapted to the sensor. The following settings are recommended:

No.	Comment	Default
50	Sensor warm-up time (ms)	3000
51	Sensor shut down time (ms)	1000
52	Discard the first N samples	0 (fixed)
54	Pixel start	35
55	Pixel pivot	65
56	Pixel stop	217
57	Pixel binning	8

2.11.3. LGT Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution.

The data is referenced with external pressure of the closest Argo CTD sample over time.

	Range	Resolution
Spectrum type	Calibrated/Raw	-
Averaging	0 to +25.0	0.1
Flash count	0 to +25.0	0.1
Internal Temp	-5 to +40°C	0.001°C
Output spectrum	0 to +65535	1
Pressure (SBE41)	-100 to +2500 dbar	0.1 dbar

Example:
The LGT data size associated to **100** raw records (50 channels spectrum) in ascent stage is approximately **10.8 KB**.

2.11.4. BLK Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution.

The data is referenced with external pressure of the closest Argo CTD sample over time.

	Range	Resolution
Averaging	0 to +25.0	0.1
Flash count	0 to +25.0	0.1
Internal Temp	-5 to +40°C	0.001°C
Dark Spectrum M	IEEE 754 float	IEEE 754 float
Dark Spectrum SD	IEEE 754 float	IEEE 754 float
Pressure (SBE41)	-100 to +2500 dbar	0.1 dbar

Example:
The BLK data size associated to **100** raw records in ascent stage is approximately **1.8 KB**.

2.12. MPE – Radiometry

2.12.1. Sensor characteristics

APMT float can embed BSI MPE radiometer. The sensor is designed to make irradiance measurements.

	Bandwidth range	Noise equivalent I/R
PAR	400 to 700 nm	9x10-3 µE.cm^{-2}.s^{-1}

2.12.2. Specific configuration [SENSOR_17]

To ensure proper operation, the configuration of the APMT software driver must be adapted to the sensor. The following settings are recommended:

No.	Comment	Default
50	Sensor warm-up time (ms)	2500
51	Sensor shut down time (ms)	1000
52	Discard the first N samples	0 (fixed)

2.12.3. Data encoding (RUDICS format)

Data samples are transmitted after lossless compression so as to reduce the amount of data transmitted. This is achieved by adapting values according to their range and resolution.

The data is referenced with external pressure of the closest Argo CTD sample over time.

	Range	Resolution
Voltage	-5.0e-3 to 1.6e+5 xV	IEEE 754 float
Temperature	-5 to +40°C	0.001°C
Pressure (SBE41)	-100 to +2500 dbar	0.1 dbar

Example:
The MPE data size associated to **300** averaged records in ascent stage is approximately **2.9 KB**.

3. Specific sensors

3.1.Acoustic noise

3.1.1. Sensor characteristics

APMT float can embed a hydrophone with an additional acquisition board dedicated to acoustic noise measurement.

	Range	Initial accuracy	Sensitivity
Acoustic noise	6.3 Hz to 10 kHz 12.5 Hz to 20 kHz	<= 2.5 dB	40 dB to 165 dB (re 1 µPa)

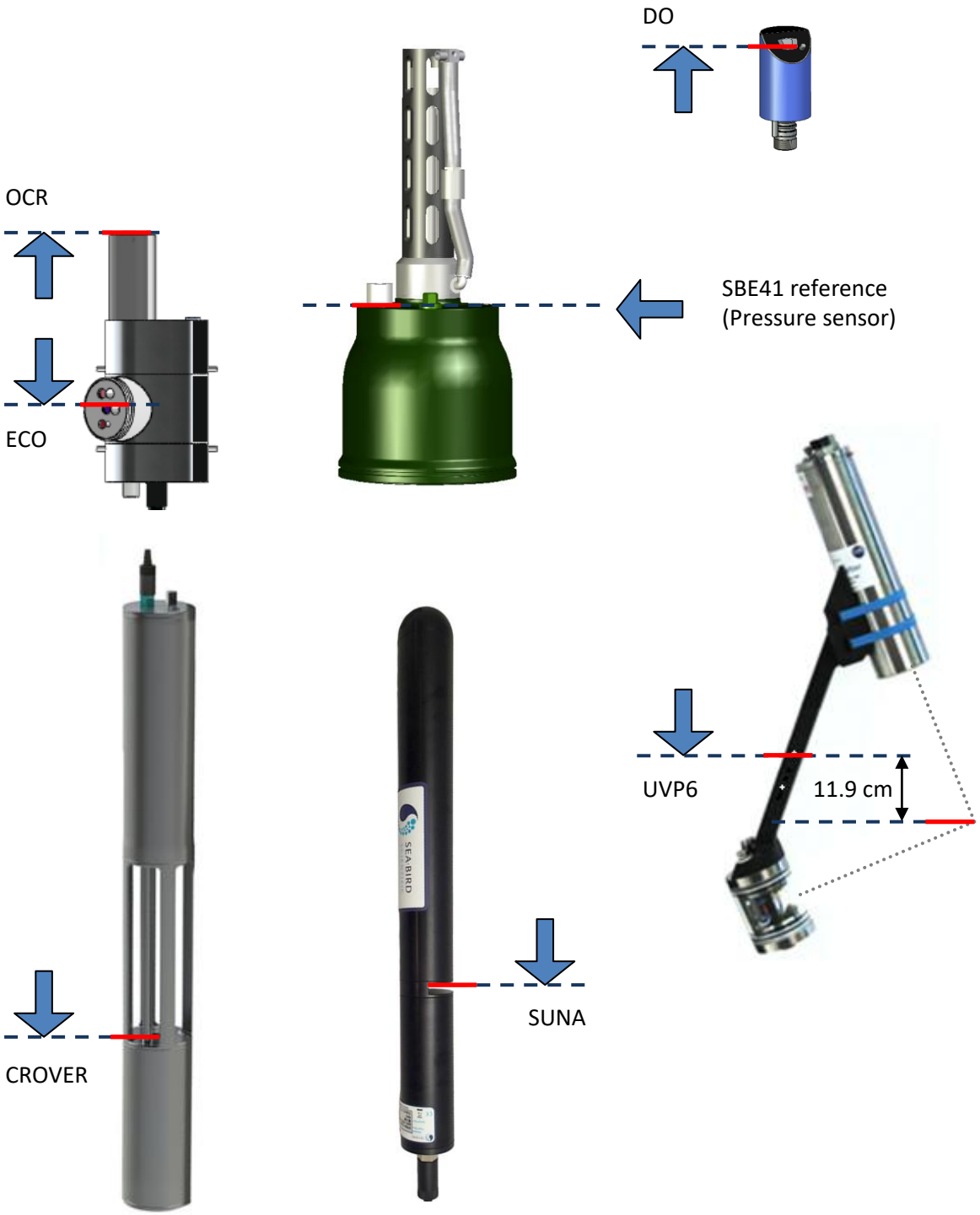
Values available:

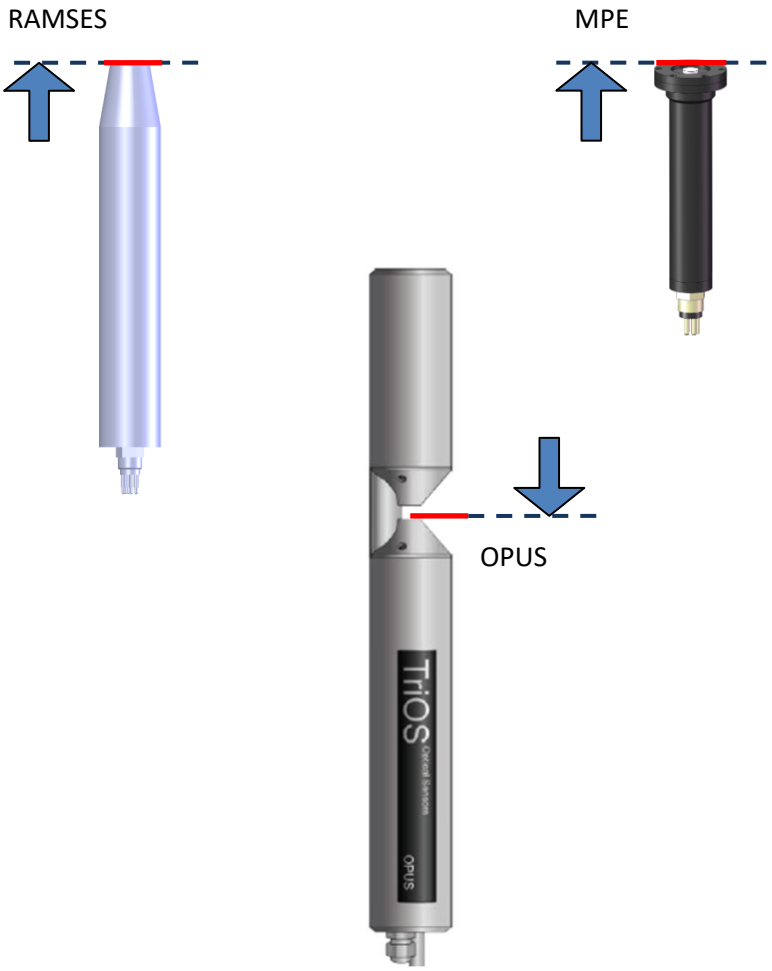
- 1/3 octave frequencies:
  20 kHz/16 kHz/12.5 kHz/10 kHz/8 kHz/6.3 kHz/5 kHz/4 kHz/3.15 kHz/2 kHz/1.6 kHz/1.25 kHz/1 kHz/800 Hz/630 Hz/500 Hz/400 Hz/315 Hz/250 Hz/200 Hz/160 Hz/125 Hz/100 Hz/80 Hz/63 Hz/50 Hz/40 Hz/31.5 Hz/25 Hz/20 Hz/16 Hz/12.5 Hz/10 Hz/8 Hz/6.3 Hz
- Sound pressure level (RMS)
- Sound pressure level (Peak)
- Sound exposure level (SEL)

4. Appendices

4.1.Pressure offset compensation

Sensors are referenced with the main pressure sensor from the CTD. Post-processing can be achieved in order to compensate the distance from the sensor to the reference. The distances between the sensors are indicated in the factory documentation supplied with the profiling float.

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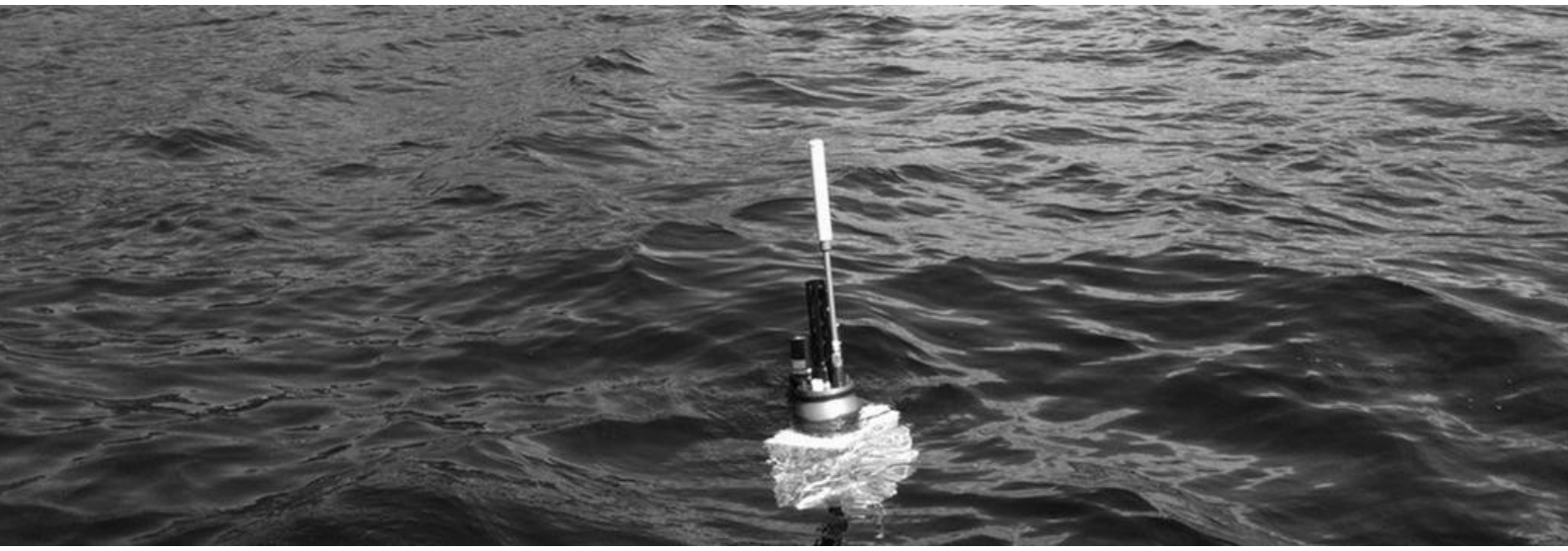
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