EA-SDA14

Acoustic Recorder

Key features

- Autonomous and wired mode
- Until 4 hydrophones at the same time
- 24 bit data acquisition
- Selectable bandwidth acquisition
- Native 128 GB SD Card
- Programmable mission schedule
- Battery and attitude monitoring
- Calibration table for measurement accuracy
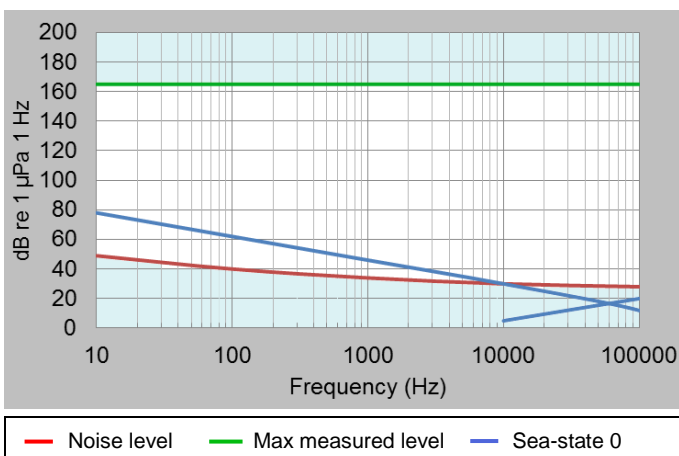- 300 or 700 m operating depth

Options

- 1 or 2 TB HDD or 600GB SSD memory
- Additional battery for larger autonomy
- Additional temperature / pressure sensors
- Low frequency acquisition module

Fields of application

- Offshore and environment
- Scientific instrumentation
- Autonomous passive recording
- Hydrophone network

Description

The EA-SDA14 is a compact autonomous recorder that can simultaneously acquire the data of 4 wideband hydrophones.

The Acoustic Recorder accepts both passive and preamplified active hydrophones. Its wide band analog input allows until 1 MHz with a dynamic range greater than 100 dB which guarantees an efficient signal to noise ratio.

The embedded digital signal processor allows high speed acquisition, filtering and storage.

In autonomous mode, the data are stored on either a SD Card or a HDD.

In wired mode, the data are stored then transferred with an Ethernet connection.

Its power consumption is between 0.6 to 2.5 W operating and less than 1 mW in standby.

The EA-SDA14 can be programmed with a mission schedule that includes the start date and the active / standby periods of the record cycles to improve battery life.

The configuration and monitoring are done through a web browser interface.

Short aluminum model characteristics:
Dimensions: Length 320 mm
Diameter 120 mm
Weight (air): 5 kg
Weight (water): 2 kg

Typical application

- Noise level
- Max measured level
- Sea-state 0

- Input gain: 14.7 dB
- High quality hydrophone with SH = - 174 dB re V/µPA

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❖ Technical characteristics

➢ Hydrophone inputs

The EA-SDA14 has two types of hydrophone inputs:
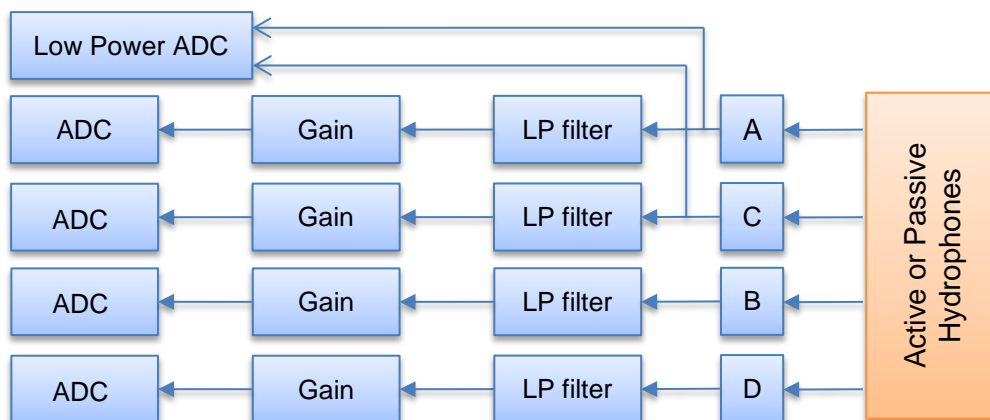- High quality input
- Low power input

Figure 1: Functional diagram of the hydrophone inputs

➢ High quality hydrophone inputs

The analog inputs are preamplified with a fixed gain and can either be single ended or differential. The inputs accept wide dynamic range signals from the hydrophone sensor.
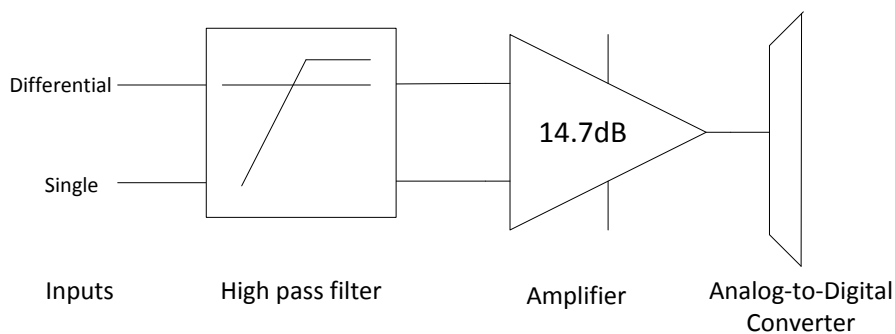

Figure 2: Input functional diagram with default 14.7dB gain

➢ Typical characteristics:

The following values correspond to a typical input amplifier gain of 14.7 dB
- Input impedance: 500 Ω *
- Max Input Level (MIL)   -10 dBV / 920 mVpp**
- Sensitivity: -123 dBV (0.7 µV RMS)
- High pass filter: 350 Hz at -3 dB*
- Surge peak to peak voltage: 300 V (Time < 10 ms)

* More values are available on request

** A spurious free dynamic range greater than 80 dB is guaranteed with hydrophone signals of $\frac{MIL}{2}$ dBV maximum

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➢ Digitizing

The analog to digital sampling frequency is configurable.
The table below shows the ENOB (Effective Number Of Bits) and the SNR (Signal to Noise Ratio).

Table 1 : Typical digitizing data

Acquisition speed	39.0625 kS/s	78.125 kS/s	156.25 kS/s	312.5 kS/s	625 kS/s	1.25 MS/s	2.5 MS/s
ENOB	20 bits	19.5 bits	19 bits	18.5 bits	18 bits	17.5 bits	17 bits
SNR	108 dB	105 dB	102 dB	99 dB	96 dB	93 dB	90 dB

➢ Programmable parameters

The digitization parameters of the hydrophones are:
- Acquisition channel selection: A and/or B and/or C and/or D
- Sampling frequency*:   2.5 MS/s, 1.25 MS/s, 625 kS/s, 312.5 kS/s,
                              156.25 kS/s, 78.125 kS/s, 39.0625 kS/s

* All these frequencies include an anti-aliasing filter of 90 dB minimum

➢ Configuration examples

Table 2 : Configuration examples

Most common applications	Gain (dB)	MIL (V)	S_h (dB V/µPa)	Max pressure level (dBµPa $_{pp}$)
Mammal Studies	14.7	+/- 0.46	-170	169.3
	0	+/- 2.5	-170	184
Noise monitoring	14.7	+/- 0.46	-155	154.3
	0	+/- 2.5	-155	169
Piling	0	+/- 2.5	-200	214
	-30	+/- 79	-200	244

➢ Low power hydrophone inputs

The analog inputs A and C are connected to two low power acquisition channels to allow the lowest power consumption.

The gain of these low power inputs is 0 dB.

Typical characteristics:
- Max Input Level (MIL)   1.4 dB V / 1170 mVpp*
- Sensitivity   :   -113 dB V (2 µV RMS)
- High pass filter (set value):   100 Hz at - 3 dB
- Surge peak to peak voltage: 300 V (Time < 10 ms)

* A spurious free dynamic range greater than 80dB is guaranteed with hydrophone signals of $\frac{MIL}{2}$ dB V maximum

The analog to digital sampling frequency is configurable.
The table below shows the ENOB (Effective Number Of Bits) and SNR (Signal to Noise Ratio).

Table 3 : Low power digitizing data

Acquisition speed Low Power(LP)	LP 48 kS/s	LP 96 kS/s	LP 192 kS/s
ENOB	16.5 bits	16 bits	15.5 bits
SNR	99 dB	96 dB	93 dB

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➢ Embedded sensors

Table 4 : Available sensors accuracy and functions

Sensor	Accuracy	Function
RTC (Real-Time Clock) with battery backup	+/-2 ppm	System clock Active and Standby
3 axis accelerometer	1 mG	3 axis acceleration measurement (XYZ) Inclinometer with pitch and roll
3 axis gyroscope	8.75 mdps	3 axis gyration measurement
Optional Sensor	*Accuracy*	*Function*
Temperature (analog)	+/-0.15 °C	Water temperature measurement
Pressure (analog)	+/- 0.1% Full Scale	Pressure measurement (Operating depth)
GPS	+/- 1.5 m	System position

➢ Monitoring

Table 5 : Monitoring functions

Measure	Accuracy	Function
Power voltage (Vin)	+/-10 mV	Power supply voltage monitoring
Power current (Iin)	+/-5 mA	Power supply current monitoring
Board temperature	+/- 1 °C	Board temperature monitoring

➢ Power supply

Table 6 : Power supply capacity

Power supply	Capacity*	Description
6 x D Size Li-SOCl2 Battery	216 Wh	Internal energy storage
Or 6 x D Size Alkaline Battery	91 Wh	Internal energy storage
Ethernet Cable + Power supply	-	Communication and power cable
Optional power supply	*Capacity**	*Description*
18 x D Size Li-SOCl2 Battery Extension	650 Wh	Extended room for 18 D Size Li-SOCl2 Batteries
54x D Size Li-SOCl2 Battery Extension	1950 Wh	Extended room for 54 D Size Li-SOCl2 Batteries
Li-Ion Battery	156 Wh	Rechargeable internal energy storage
Li-Ion Battery Extension	468 Wh.	Rechargeable internal energy storage

These are indicative values that depend on the battery specifications

➢ Data memory storage

Table 7: Data memory storage type and capacity

Minimum storage	Capacity	Description
SD Card (SD HC)	128 GB	WAV acoustic files recording
SD Card (SD HC)	256 GB	WAV acoustic files recording
Additional storage	*Capacity*	*Description*
Mass storage (SSD)	600 GB	WAV acoustic files recording
Hard drive 2.5'	1 TB	WAV acoustic files recording
Hard drive 2.5'	2 TB	WAV acoustic files recording

➢ Operating limits

- Operation / Storage max temperature: 0 to 70°C / -20 to 85°C
- Hydrophone preamplifier max current: 20 mA

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❖ Operation

The EA-SDA14 Acoustic Recorder is provided with a PoE box.

It uses an Ethernet connection to communicate. A web interface can be used for mission programming, data collection, monitoring and live analysis.

A LED push button indicates the recording status.

Figure 3 : View of the EA-SDA14 recorder

➤ Recording modes

Three recording modes are available:

- Manual: Preferred for fast in situ measurement. The Acoustic Recorder waits for the button to be engaged to start recording a pre-programmed mission schedule.

- Autonomous: The mission starts automatically at a programmed start time, and does several active / standby record cycles until it reaches its end date. The hydrophone signals are acquired and stored during the record phases.

- Wired: The Acoustic Recorder is connected to a computer through its underwater Ethernet cable (10 - 100 m). It starts once the button is engaged and a live analysis of the acoustic signal can be done through the web interface. The acoustic data can be displayed, recorded and downloaded in real-time.

➤ Data Format

The acquired data are stored in 16, 24 or 32 bit WAV files.

The WAV filenames are composed of the acquisition channel ID, the date and time.
All the acquisition channels (A, B, C and D) run at the same sampling frequency. The sampling rate is programmed with the user interface and the data are recorded on a multi-channel WAV file.

➤ Data storage

The Acoustic Recorder has 2 data storage locations:
- A 128 GB or 256 GB SD Card
- An optional high capacity HDD (Hard Drive Disk) or SSD (solid-state drive)

The user can select 2 strategies to store the data:
- SD Card only :
    - o Limits the battery consumption.
    - o Limited to 3 acquisition channels@625 kS/s or 4 acquisition channels@312 kS/s.
- Hybrid mode
    - o Allows high capacity storage and low power consumption.
    - o The data are stored on a SD Card then, transferred onto the high capacity HDD or SSD storage at the end of the record cycles.

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❖ Autonomy

The autonomy of the Acoustic Recorder depends on:
- The battery capacity
- The storage capacity
- The acquisition quality
    - High quality (Higher sampling rate and calibrated acquisition channels)
    - Low power
    - Low frequency

- The recording strategy
    - SD Card only
    - Hybrid mode

➢ Battery life

SD Card only continuous recording:

Table 8 : Battery life with SD Card recording

Configuration	1 channel	2 channels	3 channels	4 channels
6 Li-SOCl2 batteries	140 h	123 h	109 h	94 h

Hybrid mode recording, 50% duty cycle:

Table 9 : Battery life in hybrid mode

Configuration	1 channel	2 channels	3 channels	4 channels
18 Li-SOCl2 batteries	781 h (32 Days)	688 h (28 Days)	611 h (25 Days)	530 h (22 Days)
54Li-SOCl2 batteries	96 Days	84 Days	75 Days	66 Days

➢ Storage capacity

The indicative table below shows the necessary storage capacity* and the different sampling rates for 1 hydrophone channel acquisition. To respect the signal dynamics, the samples are saved as 16, 24 or 32 bit WAV files. In this example, the samples are saved as 24 bit files.

Table 10 : Storage capacity and sampling rate for 1 hydrophone channel acquisition on a 24 bit file

Acquisition speed	39.0625 kS/s	78.125 kS/s	156.25 kS/s	312.5 kS/s	625 kS/s	1.25 MS/s	2.5 MS/s
Per hour	421 MB	844 MB	1.68 GB	3.4 GB	6.8 GB	13.5 GB	27 GB
Per day	9.7 GB	19.3 GB	38.6 GB	77.3 GB	155 GB	324 GB	618 GB

* The necessary memory size depends on the number of active channels.

Data throughout (MB/s) = Nb of channels * Sampling freq $_{S/s}$ * Nb of Bytes / (1000 * 1000)

Recommendations:
- To maximize the battery life of the Acoustic Recorder, select the useful acquisition channels only.
- The mission schedule has to be set: start / end time and active / standby period of the record cycles.

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❖ Available options

➢ Pressure (depth) and temperature sensors

There are 2 sensors rated to 200 or 700 meter depth. These high precision sensors are calibrated at 0.1% or 0.2% of the full-scale depending on the depth.

Table 11 : Pressure and temperature sensor accuracy

Depth	Accuracy
200 m	0.1% / 0.2 m
700 m	0.2% / 0.7 m

➢ Hydrophone Adaptation Board

This option allows the adjustment of the voltage and impedance and the attenuation of specific hydrophones.

When ordering this option, please specify for each acquisition channel:
- The necessary voltage, until 24 V
- The necessary impedance, until 500 KΩ
- The necessary attenuation factor (0 dB, -10 dB, -20 dB, -30 dB)

Examples:

- Passive hydrophones that require to be charged with very high impedances
- High quality B&K or Reson hydrophones that require higher voltage power
- Piling application that requires passive hydrophones and attenuated acquisition channels

➢ GPS input

Once activated, this option acquires a GPS input from an external serial port and records NMEA data time logs in correlation with acoustic data.
A separate timestamp data file is recorded to correlate the recorded sounds with the position of the Acoustic Recorder.

When ordering this option, please specify if a dedicated 4 way SubConn input is necessary instead of a record acquisition channel.

➢ HDD option

This option allows the Acoustic Recorder to acquire a larger quantity of data and to record at a higher frequency.
The maximum recording speed ranges from 625 kS/s * 3 channels to 2.5 MS/s * 2 channels.

3 HDD options are available:
- 1 TB HDD
- 2 TB HDD
- 600GB SSD

➢ Mounting brackets

The mounting brackets are used to protect the Acoustic Recorder. They can be used to either mount the Acoustic Recorder onto a mooring line or to tow it from a boat.
The mounting brackets are specifically made to operate with tensile stress.

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➢ **Communication cable**

The Acoustic Recorder is sold with a standard 10 m communication cable.
This length can be customized to your needs until 100 m.
For applications that require a long range deployment until 1.5 km, see § Long range communication extension.

➢ **Long range communication extension**

Some applications require the long range remote monitoring of an acoustic environment.
RTSYS provides an extension system that allows the remote control of the Acoustic Recorder until 1.5 km.
The user can start the recording, monitor the behavior and acquire the data from the remote Acoustic Recorder while recording.

➢ **Low frequency acquisition module**

To get a better acquisition below 2 kHz, a low frequency option can be added in parallel to the four high frequency acquisition system. This option is used for passive hydrophone only and consists of a dedicated front-end with four high quality low frequency ADC.

❖ **Technical characteristics**
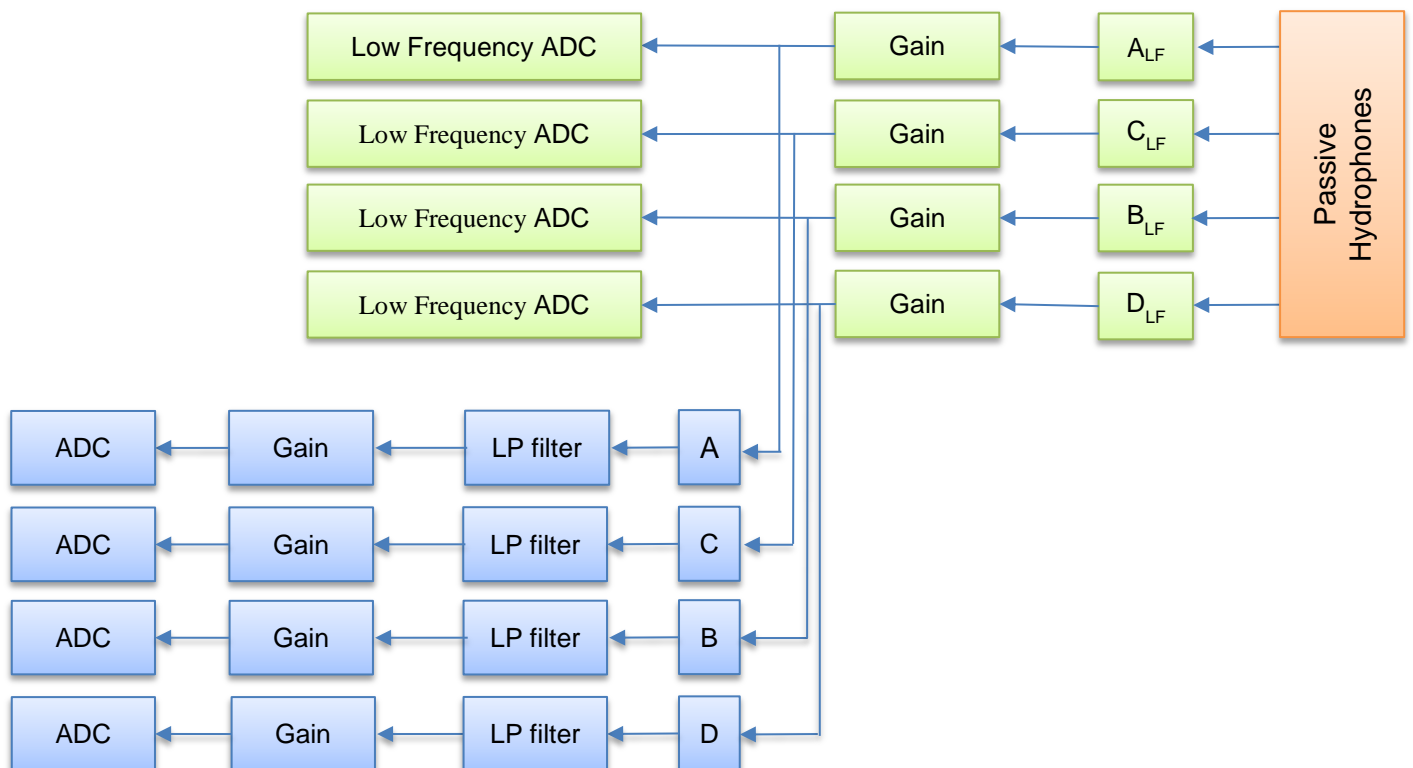
Hydrophone inputs

Figure 4 : Functional diagram of the hydrophone inputs with the low frequency option

This new Acoustic Recorder configuration can either acquire:
- 4 passive hydrophones with low frequency acquisition channels or
- 4 passive hydrophones with high frequency acquisition channels or
- 4 passive hydrophones with both low and high frequency acquisition channels

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High quality hydrophone inputs

The analog inputs are preamplified with a fixed gain and are made to be used with passive hydrophones. They accept a wide dynamic signal range from the hydrophone sensor.

Typical characteristics

The following values are related to a typical input amplifier gain of 14.7 dB
- Sensitivity: -130 dBV / 0.35 µV RMS
- Pass band ripple: 0.03 dB
- Stop band   135 dB
- INL (Integral No Linearity)   0.5 ppm
- SNR   130 dB
- THD (Total Harmonic Distortion)   -122 dB

❖ Digitizing

The analog to digital sampling frequency is configurable.
The table below shows the ENOB (Effective Number Of Bits) and SNR (Signal to Noise Ratio).

Table 12 : Low frequency digitizing data

Acquisition speed	*250 S/s*	*500 S/s*	*1 kS/s*	*2 kS/s*	*4 kS/s*
Bandwidth -3 dB From 0.3 Hz to :	112.5 Hz*	225 Hz*	450 Hz*	900 Hz*	1.8 kHz*
SNR	142 dB	136 dB	133 dB	130 dB	127 dB
ENOB	22 bits	21.5 bits	21 bits	20.5 bits	20 bits

* All these frequencies include an anti-aliasing filter of 135 dB minimum

❖ Programmable parameters

The digitization parameters of the hydrophones are:
- Selection of acquisition channel: A_{LF} and/or B_{LF} and/or C_{LF} and/or D_{LF}
- Sampling frequency: 4 kS/s, 2 kS/s, 1 kS/s, 500 S/s, 250 S/s

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❖ Example

The example bellow is a dynamic range test with a high level signal input. The signal injected has these characteristics:
- 125 Hz
- -3 dBV (707 mV)

This graph illustrates the high quality acquisition and the low noise floor despite the high level signal. It also shows the unexpected non-linearity of the signal generator HD2 (250Hz) and HD3 (375Hz).
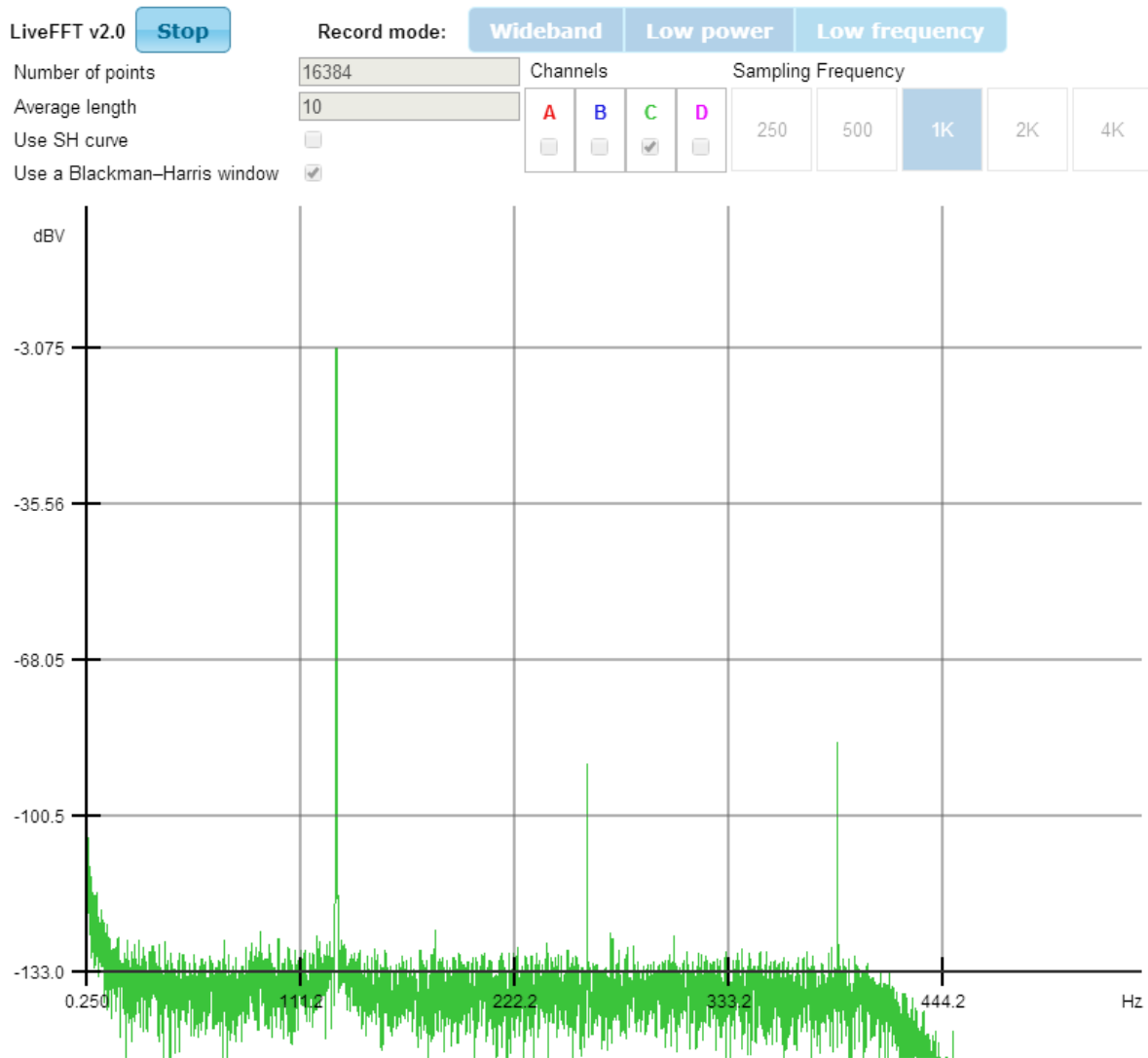
Figure 5: Measurement example – Spectral analysis on acquisition channel C at 1 kS/s

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❖ Mechanical characteristics

➢ Product overview

Figure 6: View of the model sizes of the EA-SDA14 Acoustic Recorder all operating until 700 m depth

The waterproof housing is either a hard-anodized aluminum or POM-C central tube. The end caps are manufactured in POM-C. The surrounding protections are made of 316 L stainless-steel. They protect the connectors and allow for the setting of the shackles. They can be removed or used as mounting brackets.

➢ Dimensions

The EA-SDA14 Acoustic Recorder is available in 3 model sizes: 1210mm, 550mm and 320mm.
This allows an increased autonomy for longer mission
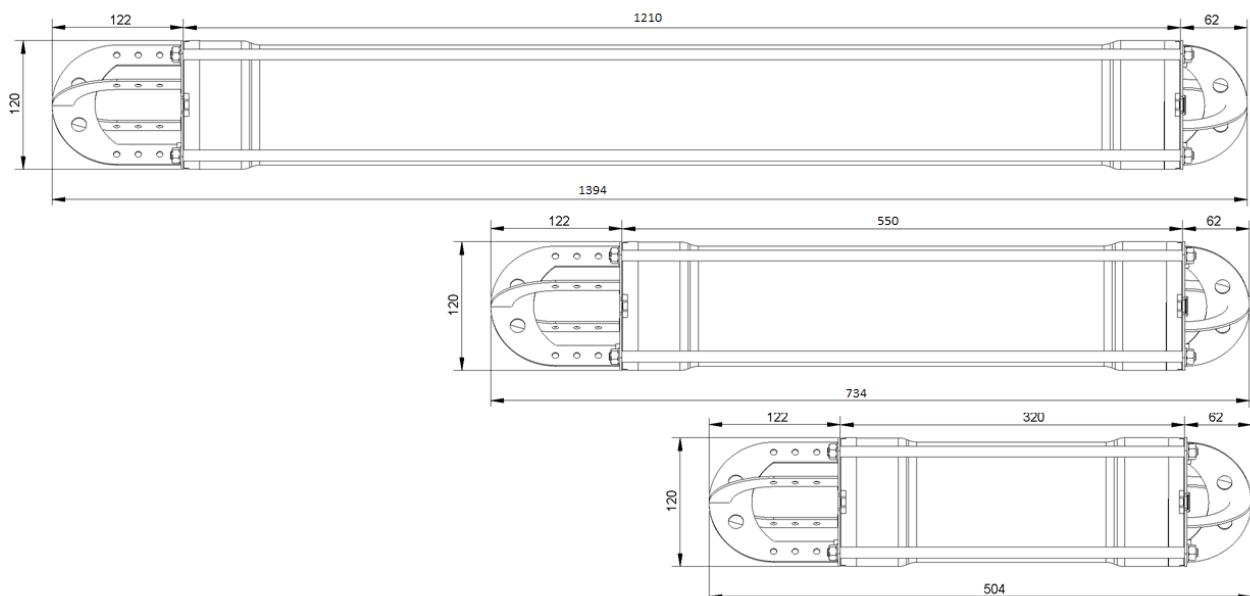
Figure 7: Dimension drawing of the EA-SDA14 Acoustic Recorder models

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Table 13 : Weight and dimensions of the Acoustic Recorder models

Model	Length	Diameter	≈ Weight in air Aluminum tube	Weight in air POM-C tube	≈ Weight in water
EA-SD14-320	320 mm	120 mm	5 kg	4.5 kg	½ weight in air
EA-SD14-550	550 mm	120 mm	9 kg	8.5 kg	½ weight in air
EA-SD14-1210	1210 mm	120 mm	20 kg	19 kg	½ weight in air

➢ **End caps**

Four different end caps are available, depending of the option chosen on the Acoustic Recorder (1 to 4 hydrophones, Ethernet connection).
Here are the 4 end cap settings: A, B, C and D.
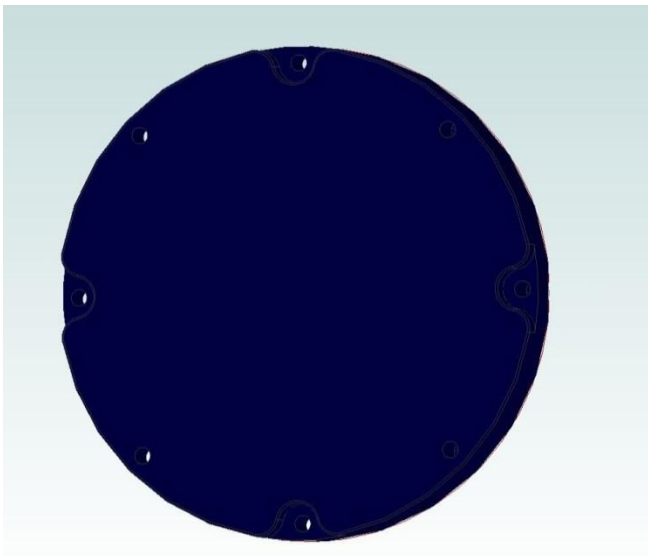
Figure 5.1: A End cap
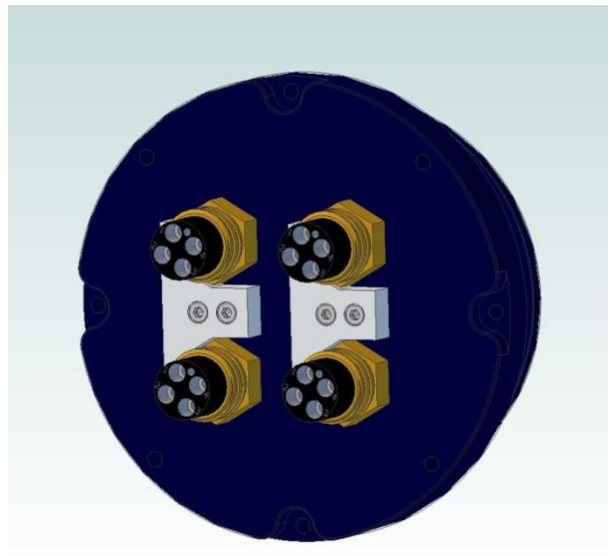
Figure 5.2: B End cap (here: 4 hydrophones)
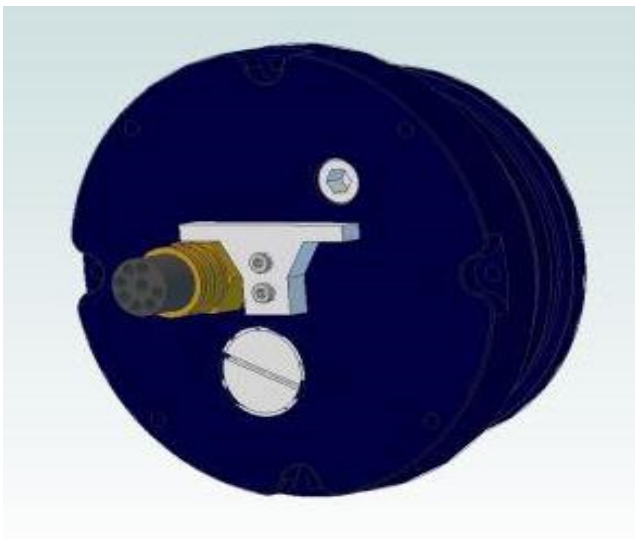
Figure 5.3: C End cap (here: Ethernet only
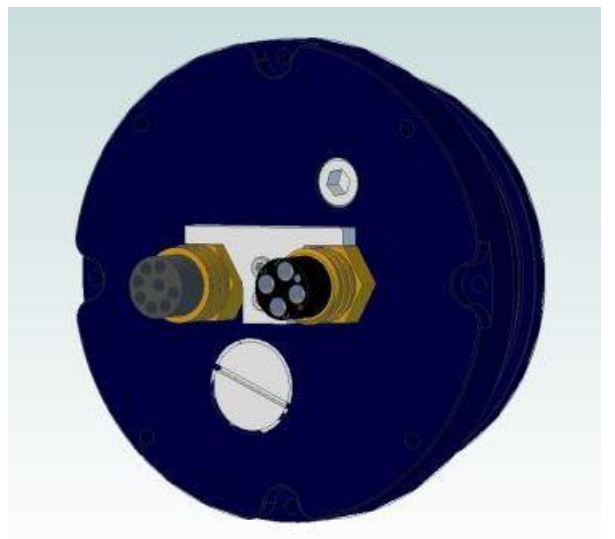
Figure 5.4: D End cap (here: Ethernet & 1 hydrophone)

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➢ **Packaging**

The EA-SDA14 is delivered inside a waterproof protection case.

The delivery includes:

- The EA-SDA14
- The hydrophone(s)
- A long Ethernet cable (10 m)
- The batteries (6 x LSH20 or 18 x LS33600 or 54 x LS33600)
- The User manual
- The software and the SD Card
- A calibration table

Figure 8 : The EA-SDA14 waterproof protection cases

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❖ Software

The software is configurable with a web browser through an Ethernet cable.
The web interface provides user-friendly access to the features of the Acoustic Recorder mother board.

➢ User interface

- Scripts
    - o Displays the live acquisition channels graph
    - o Displays the live FFT of each acquisition channel
    - o Activates a recording directly from the web interface for a quick analysis

- System configuration

    Date and time configuration
    - o System clock settings

    Mission schedule
    - o Programming the active / standby periods of the record cycle(s)
    - o Acquisition channels selection
    - o Sampling frequency

    Network configuration
    - o Fixed IP address or DHCP

- Recorded files (access to the recorded WAV files)
    - o Possibility to download the recorded data
    - o Possibility to erase the stored data

- Tools
    - o WAV file splitter, WAV header information
    - o Web browser and plugins
    - o Calibration table in pdf and excel format
    - o Datasheet in pdf format

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➢ **System configuration**

The system is configurable through the web interface:

Figure 6: System configuration tab

The mission schedule is defined with a start / end time and active / standby periods of the record cycle:

Figure 7: Mission schedule
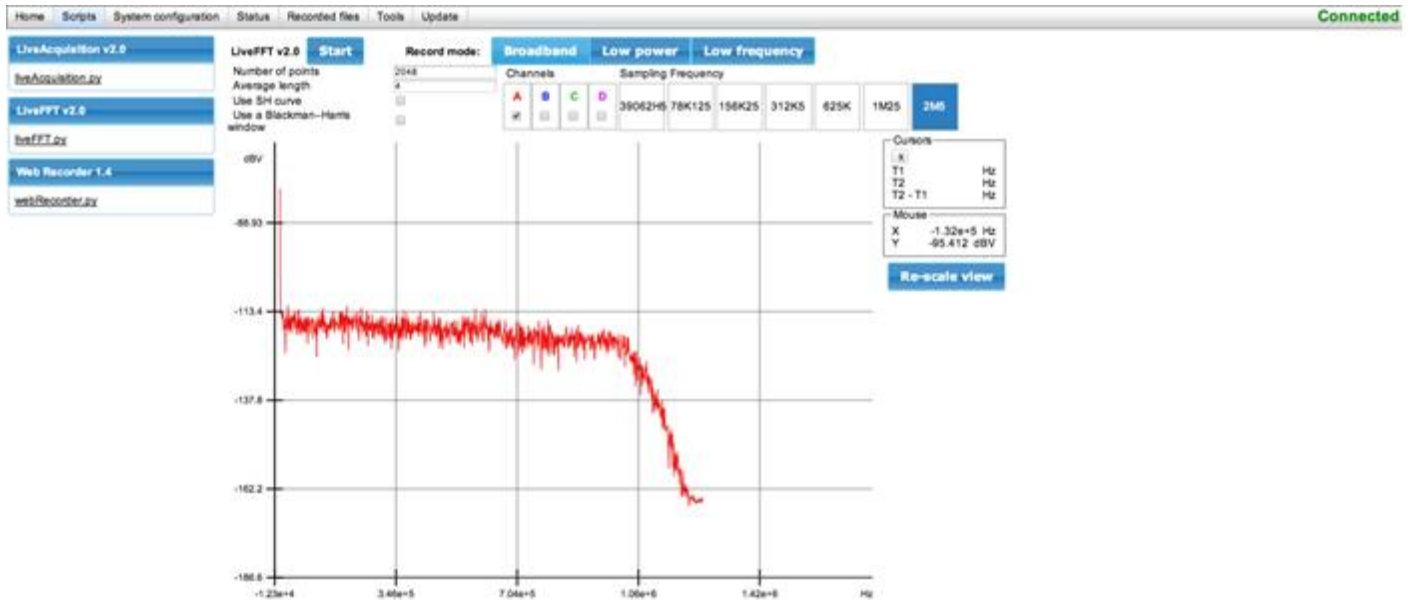
Figure 8: Live measure example – Spectral analysis on acquisition channel A at 2.5 MS/s

The Recorded files are listed on a dedicated tab. These files can be downloaded from the web interface or from a terminal (Command line).

Figure 9: Recorded files tab

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Figure 9: Status tab

There is also a Tools tab which allows the download of Firefox, Flash Player, RTWaveInfo, RTWaveSplit and EA-SDA14_Locator, the calibration table and the user manual. These pieces of software help the post analysis of recorded data.

Figure 10: Tools tab

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❖ Contact

➢ **RTSYS SAS**

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2012042859

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❖ Notes