TECHNICAL DESCRIPTION

POSIDONIA II

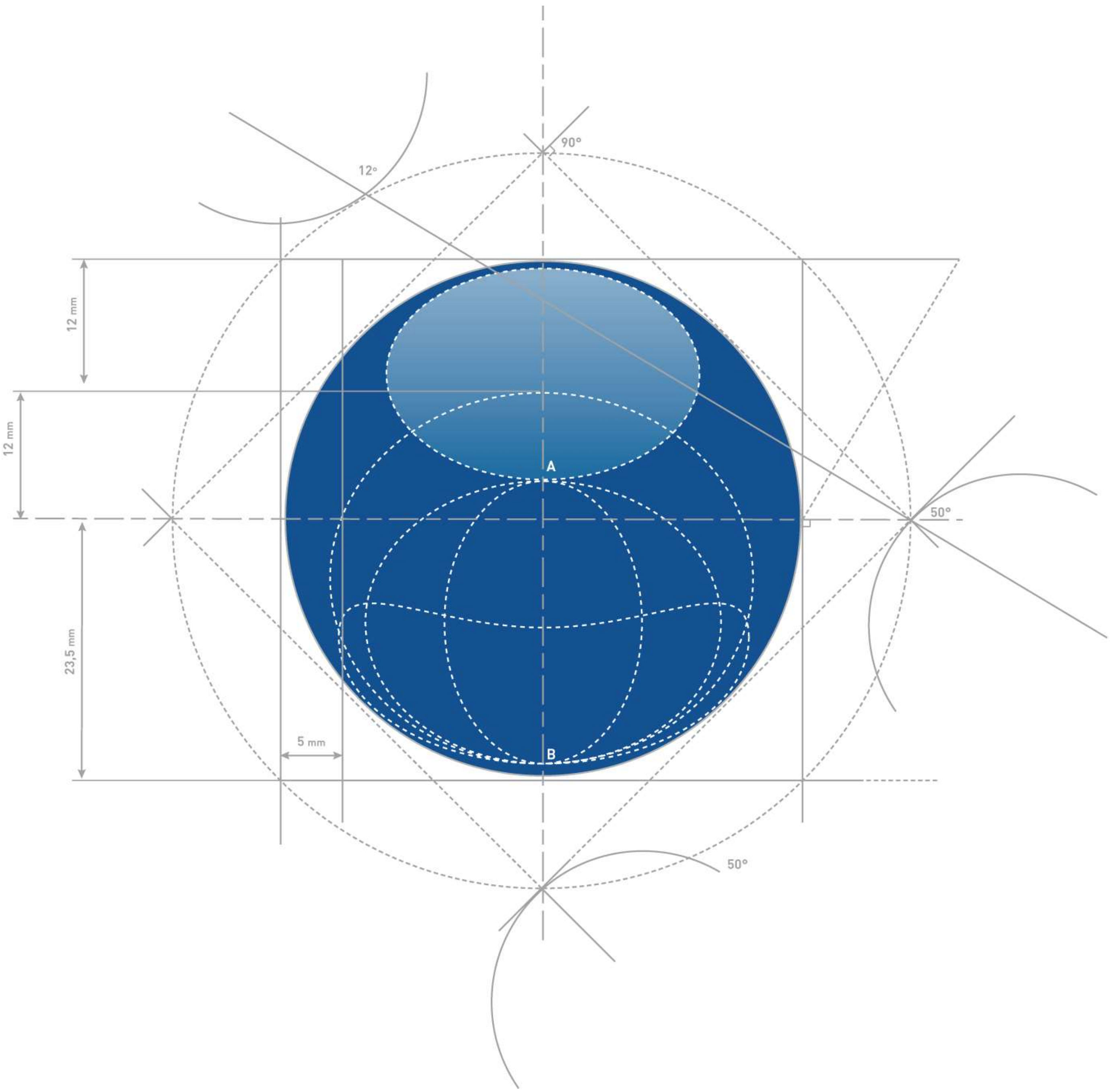


Table of contents

1. Introduction 4
1.1. Technology 4
1.2. General Concept 4
1.3. System standard configuration 6
1.4. Detailed item description 7
1.4.1. Acoustic Array 7
1.4.2. Main Processing & command/control Unit: USBL-box 7
1.4.3. Transponder, Acoustic telecommand 8
1.4.4. POSIDONIA II MMI (Man Machine Interface software) 9
1.4.5. Display software 10
2. Installation, calibration, setting to work 11
2.1. Disclaimer: initial installation note 11
2.2. Installation 11
2.2.1. Acoustic array installation 11
2.2.2. POSIDONIA II electronics installation 13
2.3. Calibration 13
3. POSIDONIA II system Performance & Specifications 14
3.1. Standard configuration performance 14
3.2. How to maintain or improve the performance 14
3.2.1. Use directional transducer 14
3.2.2. Use high accuracy heading and motion sensor 15
3.2.3. Use PRESSURE Sensor 16
3.2.4. Use POSIDONIA II coupled to PHINS + DVL Subsea 17
3.3. Other Characteristics 19
3.3.1. acoustic array and main cable 19
3.3.2. Electronic cabinet (USBL-box) 19
4. Scope of supply 21
4.1. Standard product pack, Deployable antenna version 21
Including sub-references as indicated here below: 21
4.2. Standard product pack, FLUSH antenna version 22
Including sub-references as indicated here below: 22
5. References 23
5.1. Acoustic positioning systems references 23
5.2. Inertial Navigation System (INS) 24
5.3. Combined Acoustic and Inertial navigation systems 24
6. Appendix 25
6.1. Deployable acoustic array 25
6.2. Flush acoustic array 26
6.3. USBL-Box electronic cabinet 27

6.4. Main junction cable (deployable antenna) 28
6.5. Main junction cable (Flush antenna) 29

1. Introduction

1.1. Technology

Based on unique CHIRP technology and proprietary sophisticated signal processing algorithm POSIDONIA II is the iXBlue's Ultra Short Base Line (USBL) system featuring extreme long range and designed to operate in most difficult conditions:

- Extreme long range, proven at sea (10,000 m under nominal conditions)
- In a noisy environment
- With strong immunity to reflection and reverberation

Since its first introduction on the market in the late 90's POSIDONIA II has constantly been maintained to operational conditions, with a number of worldwide applications for deep sea vehicle/long range tracking up to deepest seas.

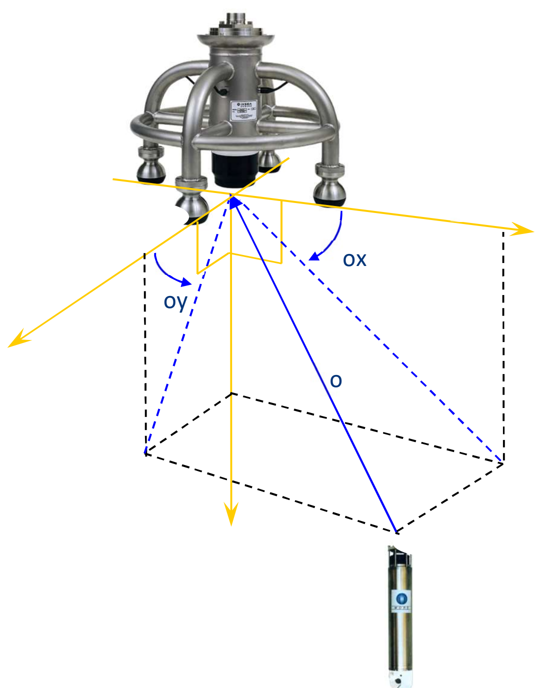
A major redesign of the topside electronics has recently been carried out with the release of the so called USBL-box replacing the previous one. POSIDONIA II is now based on most recent electronics and software/digital signal processing techniques, derived from our famous GAPS USBL tracking system, and taking benefits of all accumulated experience and development over the past years.
Using the same proven acoustic arrays, significant improvements in terms of range, accuracy and robustness are available, together with a new user interface (iXBlue common WEB-based interface) for unrivalled ease of operation.

1.2. General Concept

The operation is based on the two-way acoustic communication between the USBL acoustic array and the subsea transponders, with an electrical data link capability through cables connecting a specific transponder and the ship. To localize the transponder, the system measures the slant distance with sound velocity profile corrections, and two bearing angles, derived from the two orthogonal baselines in the hull or pole mounted acoustic array.

More specifically...

- To calculate the position of an acoustic transponder POSIDONIA II sends an interrogation pulse or chirp (either acoustic or through a cable).
- The transponder replies by emitting an acoustic chirp. (A chirp is a wideband signal optimized for performance; the wider the band the better the accuracy).
- The chirp travels through the water column (In difficult environments, many multipath signals due to reflections might also arrive to the surface acoustic array)
- The signal is received on each of the four hydrophones of the acoustic array. Then the signal on each hydrophone is compared to the chirp motif (a perfect copy of the signal emitted by the transponder): the two signals are correlated using Fast Fourier

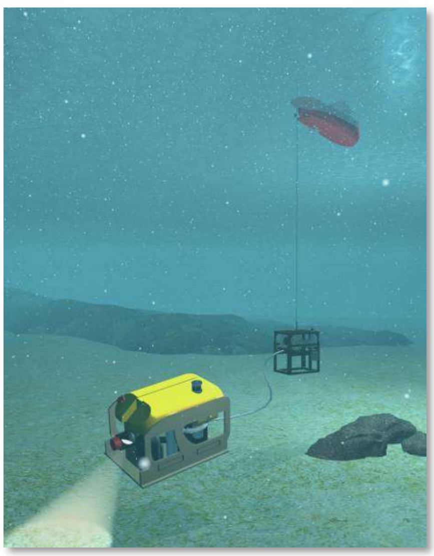


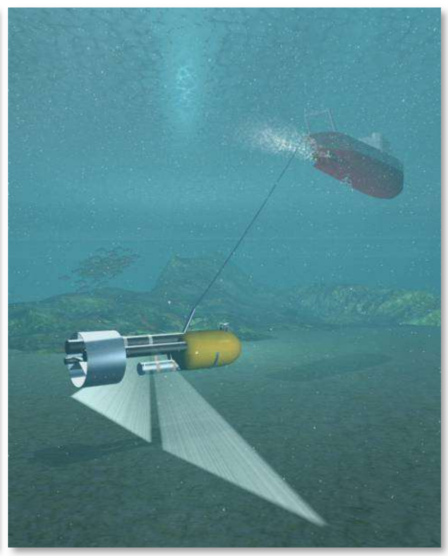
Transforms and the time and phase of arrival of the signal on the hydrophone are estimated (a powerful digital signal processing has been developed to remove multipaths).

- Given the time and phase of arrival of the signal on the four hydrophones, the reception angle and the range between the acoustic array and the transponder are calculated.
- External motion sensor is used to compensate from the acoustic array horizontal position at time of signal reception so that an absolute angle is calculated, GPS input is used to convert into an absolute geographical position of the target.

Up to 8 transponders can be tracked with POSIDONIA II within the same interrogation cycle. This number of transponders, acoustically managed in a single operation without mechanical scanning, implies the need for coding of the signals. This coding process provides transponder identification and an improved signal to noise ratio due to the correlation process. Furthermore, it improves accuracy and counteracts acoustic multipaths.

Each transponder is field programmable. When the system is delivered, the user can change or re-initialize a set of parameters according to his own need for a specific operation. To do so, he uses the electric standard interface connected to the Main Processing Unit or an independent PC.





1.3. System standard configuration

Unless otherwise specified and agreed at time of project discussion a standard POSIDONIA II USBL positioning system comprises the following sub-assemblies:

Main Equipment

- One (1) off acoustic array (portable version equipped with preamplifiers, shipped in wooden box)
- One (1) off main interconnect cable (50 m long standard supply)
- One (1) off main Electronic acoustic processor hardware (USBL-BOX) comprising
  - 19’’-2U rack-mountable cabinet
    - Acoustic Power Transmit Amplifier PCB & Power supply
    - Signal processing PCB
    - Processor PCB for Controlling Navigation data, providing protocol and data position messages to be used by third party Navigation and Display/Charts packages
  - Web-Based User Interface for System & Transponder and Navigation set-up
  - USBL system calibration software
  - DELPH RoadMap navigation display software
  - Shipped in re-usable transit case
- User Documentation in English
- Quality control certificates
- Setting to Work Services which are compulsory for completion of system acceptance

The following parts and services are not included in the standard configuration:

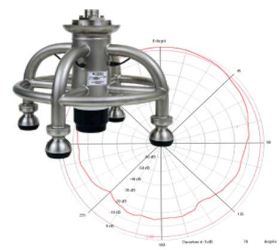
- Acoustic Releasable Transponder (OCEANO RT series) and telecommand
- Deep-water floatation package & rigging for transponder
- Operator PC-based Working station (for Web Interface, USBL Calibration Software, DELPH RoapMap podition display software)
- Pole or hoisting system for Acoustic Array
- DGPS & attitude (Pitch/Roll/heading) sensors: OCTANS or PHINS recommended
- Shipyard work on the hull
- Installation on board (Main antenna and peripheral cables installation)
- Setting to Work Services which are compulsory for completion of system acceptance
- Spare parts (quoted on option)

1.4. Detailed item description

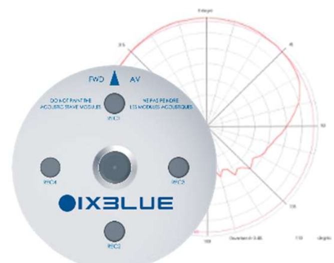
1.4.1. Acoustic Array

The Acoustic Array is available in two versions:

- The «deployable» acoustic unit.
  Designed to be deployed through an existing moon pool or on a side pole, this version is offered for vessel of opportunity and can easily be transferred from one vessel to the other. Optionnaly this antenna can be mechanically coupled to an HARS (Heading and attiture reference sensor; OCTANS) so that the complete assembly is precalibrated once for all allowing easy and quick installation / re-installation.



- The «flush» (mounted) acoustic.
  Designed for permanent installation under the ship with no protruding part and excellent acoustic baffling (machinery noise and vibrations) the flush acoustic array allows similar performances as the deployable but higher operating speed, together with safe navigation.
  Such principle does not require the use of sophisticated and expensive deployment machine, saving significant money and improving the global reliability of the system with no moving part.



Each acoustic array is composed of a central emission transducer and four reception hydrophones. The task devoted to the acoustic unit is to receive the acoustic signals transmitted by the transponder. After filtering and pre-amplification, the signals are transferred to the Main Processing Unit for digital signal processing.

1.4.2. Main Processing & command/control Unit: USBL-box

The whole electronics is now integrated in a compact 19’’ rackmount topside, integrating all required hardware and software to smoothly interface to external sensors (antenna, HARS, GPS, data output, synchro, etc) and computing power for calculating the final position of the tracked subsea vehicles.

Main features:

- Longer range, improved accuracy, wider antenna aperture
- Full wideband modulation on all channels, interrogation and reception with up to 8 beacons in the field and processed during the same interrogation cycle
- Improved multipath rejection algorithms to enable operation in challenging conditions (noise, multipath, high elevation targets)
- Adaptive gain control with real time monitoring of ambient noise
- External sensor direct interface (heading/pitch/roll, GPS, etc…) through Ethernet local network or serial fully configurable communication ports
- Kalman filter on position output (can be disabled) to increase position output rate
- Immediate acquisition of the target even at long distance
- Multiple data output port (Ethernet, serial) with choice of different communication protocols for data distribution and interconnection to various peripherals
- iXBlue new WEB-based interface for easy configuration and control of the system

1.4.3. Transponder, Acoustic telecommand

The transponder (also named "beacon") is installed on the tracked vehicle(s) and replies to each surface acoustic array interrogation by sending a coded wideband signal used for the surface deck unit to calculate the position.
A releasable OCEANO RT series transponder is also required to be used at time of system calibration to provide a fixed reference (deployed on sea bed) during initial setting to work, and every time the acoustic array is moved from its current installation.
Although POSIDONIA II is able to interrogate releasable transponder and send command codes an iXBlue TT801 portable deckset telecommand unit is recommended for separate and easy configuration and preparation / recovery of mooring lines.

OCEANO RT2500S Light /R
(protective cage and responder plug not shown)

TT801 acoustic telecommand and dunking transducer

A range of transponders is available including:

- Self-contained expandable transponders with internal battery for long term deployment
- Recoverable transponders fitted with release mechanism
- Miniature transponders for installation of small vehicles
- Options for internal pressure sensor, remote or integral transducer head, directional beam pattern remote transducer head, external plug for responder mode and/or external power supply

- Shallow water or full ocean water depth,
- 500 kg to 300 tons SWL (Safe Working Load)

1.4.4. POSIDONIA II MMI (Man Machine Interface software)

Most components in the subsea positioning solution (PHINS, POSIDONIA II, RAMSES) are delivered with iXBlue new WEB-based graphic user interface which is progressively installed to the full range of products, providing a common look-and-feel to all products.

Directly Ethernet compatible, this new MMI greatly improves the ease of installation and operation of the equipment thanks to its interactive menu screens and network characteristics. The products are easily interfaced to any TCP/IP network, and running the WEB-based MMI is achieved with any terminal with WEB brower installed (PC computer, MAC, pocket PC's, etc…): dedicated PC and software is no longer required.

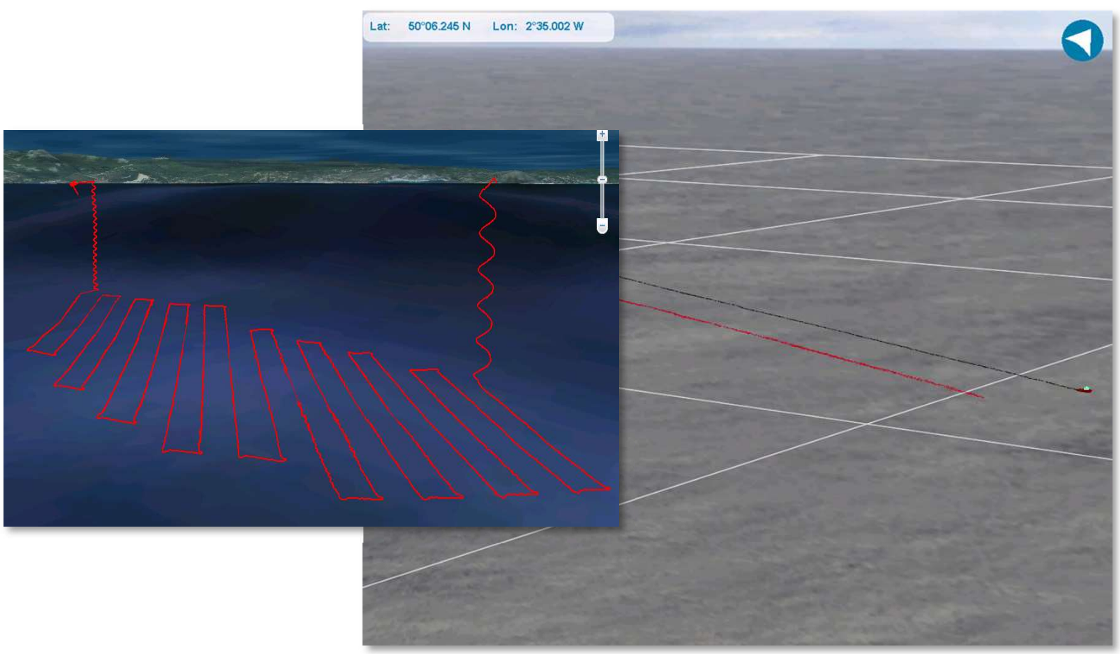
Using graphic and conversational menu screens the WEB-based GUI allows:

- Defining the installation parameters i.e., the parameters that do not change from one mission to another, for instance orientation and misalignment of AHRS with respect to the antenna (MECHANICAL PARAMETERS option), lever arms for external monitoring points, the INPUTS (external sensors, UTC), the OUTPUTS and the IP address, network mask (NETWORK option)
- Defining the set-up parameters i.e., the parameters that may vary from one mission to another or even during the same mission: transponders interrogation and reply frequencies, etc…
- Monitoring each subsystem operations such as:
  - Follow the navigation sequence
  - Display in real time data delivered or used
  - Be informed of the Status
  - Record data
- Performing maintenance tasks including:
  - System restart
  - Firmware updates
  - Parameters reset
  - Support contact

1.4.5. Display software

POSIDONIA II system provides data telegrams with each transponder's position for use with any third party navigation package, with various communication protocols.
Several outputs are available (Ethernet and RS232 format) which allow data distribution to different peripherals.
Industry standard data telegrams are provided to easily interface each sensor to standard navigation packages from the market place such as Winfrog, Quinsy, etc.

Additionally iXBlue offers USBL – RoadMap, a display package for visualisation of the tracked vehicles in several modes (2D, 3D) with basic tools to interact of the screen plots.



2. Installation, calibration, setting to work

The initial deployment and operation of POSIDONIA II is a 3 step procedure: Installation, calibration, use of the system.

2.1. Disclaimer: initial installation note

Unless otherwise agreed on a case by case basis iXBlue does not proceed to electrical & hardware installation of the system and will not be responsible for damaged or incorrect performances resulting from non-compliant initial deployment.
POSIDONIA II has been designed to be easy to install and operate; iXBlue will provides all required standard information to do so, including advises based on its own experience or past deployment with other users

However:

1/ Some mechanical work such as antenna deployment mechanism (if not supplied by iXBlue), hull work, antenna and peripheral cables routing, etc… are strictly under shipyard responsibility.
2/ Initial setting to work, necessary adjustments due to local equipment characteristics such as interfacing to on-board peripherals, setting beacons in transponder mode, etc… may require deeper knowledge of the system.
3/ First calibration of the system and performances vs. onboard sensors and environment/acoustic propagation characteristics must be supervised by iXBlue field operator during commissioning of the system.
4/ A complete training is recommended for efficient deployment and use of the system

Considering all the above it is **compulsory** to include in the global POSIDONIA II budget 5 (five) working days for one iXBlue operator for a comprehensive installation, training and commissioning of the system.

2.2. Installation

This first step depends on the configuration of the system.
It mainly comprises of the acoustic array installation (under the ship's hull for a flush acoustic array, inside a moon pool or an a side pole for deployable array), main antenna cable routing between acoustic array and control room, installation of the electronic package and (third party) external sensors such as heading and motion sensor (HARS) + GPS.

2.2.1. Acoustic array installation

Most of the time every single installation is specific to each customer and the vessel.
iXBlue already assisted many customers and can provide recommendations and assistance for a fast and effective deployment.

Here after are several typical pictures:
deployable and flush arrays installations, and a last interesting method making the system calibration free after the initial installation (OCTANS heading and motion sensor installed together with the acoustic array):

i/ Deployable array … Installed on a deployment machine (iXBlue optional supply), side pole, or installed on a lockable moon pool structure

Deployable array on a hoisting system.

Deployable array on a rotating side pole.

Deployable array in a moon pool

ii/ one-shot calibration system … the acoustic array is installed together with OCTANS heading and motion sensor close to it. After initial calibration of the system to compensate from mechanical misalignments the system is calibrated once for all and can easily be move from one vessel to the other

Deployable array and OCTANS on side pole.

Deployable array and OCTANS on small rigid frame

Deployable array and OCTANS on deployment machine

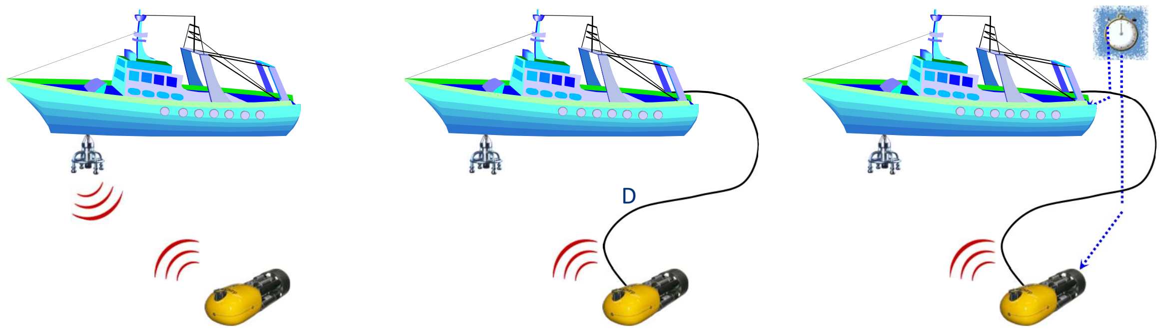
iii/ Flush mount acoustic array under the ship's hull

Close view, Flush array

View of acoustic pod including flush array

2.2.2. POSIDONIA II electronics installation

The topside electronics consists in a single 19’’ electronic rack including all interface to peripheral and external sensors.
No specific knowledge is required for this part and the operation can be achieved in a very short time.
POSIDONIA II already interfaces to most of the heading and motion sensors and GPS available on the market with a large library of communication protocols. (NMEA0183 based) POSIDONIA II allows operations in transponder mode (interrogates and receives through the water column or in responder mode (interrogation through umbilical in case of ROV or tow fish operation) Special attention is recommended when interfacing transponders in responder mode in order to preserve signal integrity through umbilical.

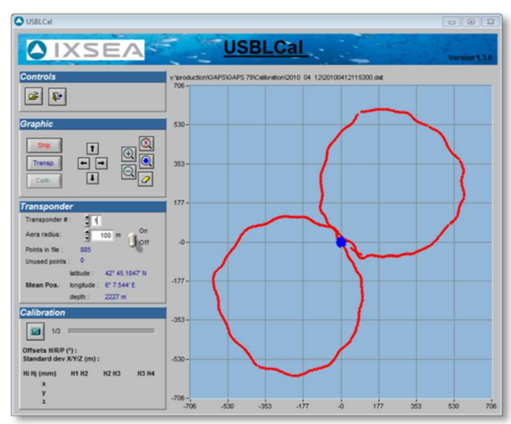


2.3. Calibration

USBL principle requires a perfect knowledge of the attitude of the acoustic array (both in heading and P/R) to measure angles to the tracked targets and calculate position.
The calibration procedure is used to measure and compensate the mechanical misalignments between the acoustic array, the heading/motion sensor and the horizontal plan.

It mainly consists in the following steps:

- Deploy a recoverable transponder on the sea bed with sufficient water depth (OCEANO RT2500 light is part of the package)
- Collect sufficient readings (positions) of this fixed transponder while navigating above it. (Ideally figure of eight)
- Run the calibration algorithm which will ultimately produce a set of calibration coefficients that will be used as long as the alignment between the acoustic array and the motion sensor has not been modified
- Check calibration; recover the mooring line and transponder.



3. POSIDONIA II system Performance & Specifications

3.1. Standard configuration performance

The performances (range and accuracy) of a USBL acoustic positioning system is depending on several factors which can dramatically change expected results. Among them Heading and motion sensor (P/R) used to compensate acoustic array attitude as well as acoustic environment (ambient noise level, propagation conditions) are the most sensitive parameters.

Although some existing solutions are available to improve performances in case of difficult acoustic environment (see next chapter), the standard POSIDONIA II configuration performances are defined with the following conditions:

Positioning accuracy (1)	0.2% x slant range
Measurement repeatability	+/-3m
Operating range (1)	10,000m
Operating frequency	16kHz (central frequency) +/-4kHz bandwidth
Position refresh rate	2 second min (acoustic, depends on range) 10 Hz with predictive filter
Communication protocol	Serial communication link NMEA proprietary GAPS protocol Multiple other NMEA or binary data telegrams Native compatibility with iXBlue products

(1) Range and accuracy of the system depend on ambient acoustic propagation conditions, water depth and signal to noise ratio (SNR) and GPS grade.
The accuracy and range are nominal with the following conditions:
- sea state 5 maximum, ship noise < 60dB at 16kHz
- vessel speed 3 knots in operation
- target below the antenna +/-30deg
- Heading / Pitch / Roll : 0.15 deg
- Sound Velocity Profile ideally compensated
- System calibrated (antenna v.s. HARS aligned)

3.2. How to maintain or improve the performance

3.2.1. Use directional transducer

In case the system is operated with higher noise level (ship's noise, ambient noise), the maximum range can be significantly reduced.

Rather than having higher radiated power at the subsea transponder level, which leads to additional although different problems (energy consumption, size of electronics), the use of a directional transducer with a reduced beam pattern (+/- 30deg) allows focusing the energy toward the surface receiver.
iXBlue transducer PET861-DIR60 is using a Tonpiltz technology and high efficiency transducer assembly which provides an additional 6dB minimum compared to a standard hemispherical standard transducer.
This simple and easy solution allows 2,000 to 3,000m additional range.
Note:
Electronic impedance matching for directional transponder requires special setting of the electronic board in the transponder itself.

3.2.2. Use high accuracy heading and motion sensor

The position to the target is calculated using slant distance and bearing angles (X & Y).
Since the acoustic array is installed on a moving platform (surface ship) its absolute position must be known with sufficient accuracy (calibration procedure) and its motion carefully monitored and compensated (AHRS sensor) in order to get the best performances out of the POSIDONIA II system.

Depending on the version (Flush mount or deployable array) and mode of operation (permanent installation or vessel of opportunity) a mechanical structure must be prepared such as …

- side pole with portable acoustic array at the end
- flush acoustic array permanently installed under the vessel (must be dry-docked)
- electromechanical hoisting system for deployment of the acoustic array when required
- etc…

Whatever the installation method is the relative positions of the acoustic array and heading/motion sensor must be rigid, repeatable and stable over the system operation time.

An accuracy of 0,15 deg or better for heading and 0.05deg for Pitch & Roll is recommended in order to reach nominal performances of the POSIDONIA II USBL system.
iXBlue manufactures a high grade Fiberoptic Gyroscope and Motion sensor, OCTANS, which is a perfect match with POSIDONIA II requirements:

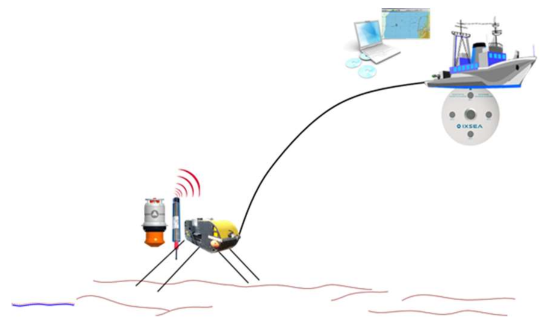
- ✓ **heading accuracy : 0.1deg (x secant latitude)**
- ✓ **pitch and roll accuracy : 0.01 deg**
- ✓ **refresh rate : up to 100Hz**

3.2.3. Use PRESSURE Sensor

In case of high elevation of the target the angle measurement accuracy decreases. (Woodward law, physics characteristics).
If a pressure information is available POSIDONIA II automatically integrate this additional information into the algorithm to improve the depth information, which in turns allow the system to better estimate bias in X/Y data and correct it.
POSIDONIA II can use either optional pressure sensor installed in the iXBlue transponder (optional, data retrieved through umbilical or through the acoustic channel) or third party pressure sensor if available on the tracked vehicle.

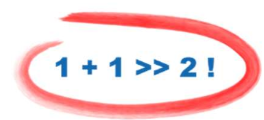
iXblue

3.2.4. Use POSIDONIA II coupled to PHINS + DVL Subsea



POSIDONIA II is fully manufactured by iXBlue and as such nicely interfaces to other company products such as PHINS / PHINS subsea / PHINS-DVL ready.
The use of an Inertial Navigation System (INS) on the towed vehicle will provide the highest position data rate, filtered and robust to acoustic hazards.
A typical configuration as shown below provides the best position accuracy and performances, together with all attitude of the towed vehicle including heading, pitch and roll.

i/ Positioning method: data fusion
Subsea positioning has been achieved until now by using one technology: LBL, USBL…. Because each technology has advantages but also drawbacks, most modern positioning techniques involve a combination of technologies and data fusion, notably with INS.



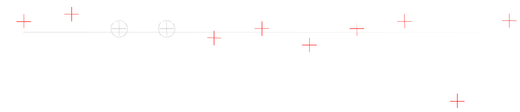
The purpose of data fusion is to use different sources bringing the same type of information: it allows cross-correlating the different data, and thus estimating some of the imperfections of each sensor. As such, data fusion is particularly interesting when using different technologies, as it allows a real compensation of the drawbacks of one technology by the assets of the other one. Only the advantages of each technology are kept; it improves the performances and provides new operational features.
The mathematical tool used to perform this data fusion is a Kalman filter – it is embedded into the PHINS (INS).

Using data fusion between PHINS, POSIDONIA II and other optional sensors benefits:

- Advantages of POSIDONIA II acoustic systems: the positions remains stable and accurate on the long term;
- Advantages of the PHINS inertial system: the output is smooth and at a very high recurrence, with an extreme accurate position on the short term. Above all, the acoustic (and GPS) noise is filtered, thus improving the accuracy. It makes the system robust to environmental conditions (GPS or acoustic dropouts…) – potential wrong values in case of acoustic noise are rejected, and the INS provides the real position even in case of acoustic outage for some time.

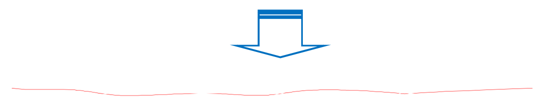
iXblue

Positioning output with POSIDONIA II alone (no INS coupling and data fusion)



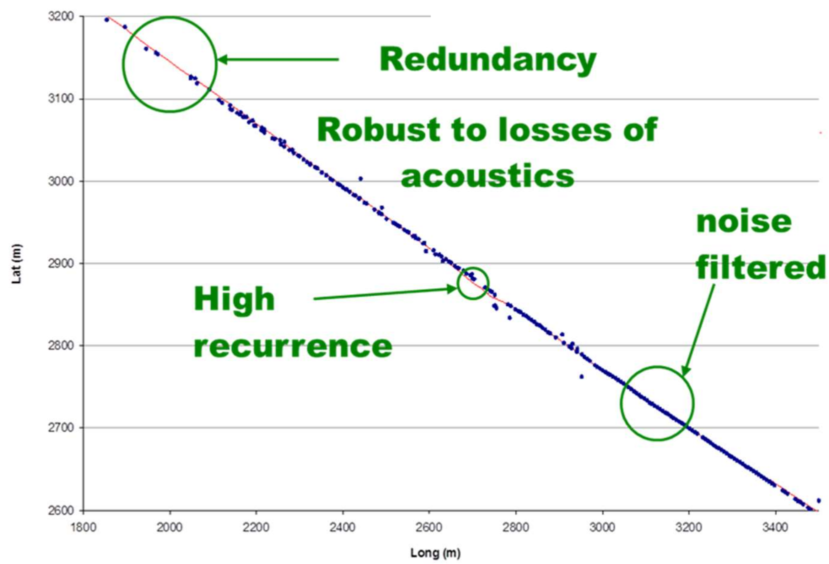
Positioning output with data fusion with INS and other sensors:

- *Smooth, high data rate*
- *Noise filtered*
- *Robust to GPS and ACOUSTIC outages*
- *Higher accuracy and range*



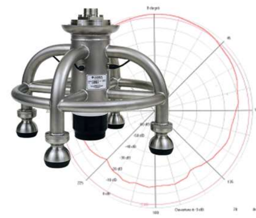
ii/ example: GAPS + PHINS + DVL

Real field data, collected in La Ciotat bay - France, using such an integrated system. Both pure acoustic (blue) and coupled system (red) outputs are shown below, where the signal to noise ratio of the acoustic signal was evolving. It demonstrates all the advantages of the iXBlue integrated solution.



3.3. Other Characteristics

3.3.1. acoustic array and main cable



Reception		
sensitivity (OCV)	-195 dB Vrms/µPa +/-3 dB	-195 dB Vrms/µPa +/-3 dB
frequency	16 kHz +/- 3 kHz bandwidth	16 kHz +/- 3 kHz bandwidth
Beam aperture / channel ($2\Theta_{-3dB}$)	-3 dB: 65 deg +/-5 deg -10 dB: 140 deg	-3 dB: 120 deg +/-5 deg -10 dB: 140 deg
Acoustic accuracy (1 sig)	60 deg cone: +/-0.3 deg	60 deg cone: +/-0.3 deg
Transmission		
Acoustic power	188 dB ref 1µPa @ 1m	185 dB ref 1µPa @ 1m
frequency	8 kHz to 16 kHz (-3 dB)	8 kHz to 16 kHz (-3 dB)
Beam aperture	200 deg @ 3 dB	200 deg @ 3 dB
Mechanical		
Diameter (mm)	580	800
Height (mm)	410	245
Weight (kg in air)	34	180
Weight (kg in water)	25	150
Electrical		
Mating socket	Burton	Jupiter (right angle)
Main cable		
length	50 m	50 m
diameter (mm)	26 +/-0.5	26 +/-0.5
Plug diameter	63 mm	63 mm
Plug length	305 mm	305 mm
Min bending radius	156 mm	156 mm

3.3.2. Electronic cabinet (USBL-box)

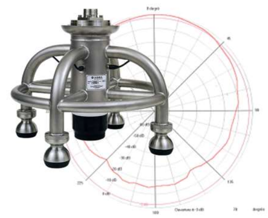
Dimension	483 mm x 89 mm
Weight	5.8 kg
Operating temperature	0 to +50 deg C
Storage temperature	-20 to +70 deg C
Power supply	100~240 VAC / 50~60 Hz
Power consumption	15 W continuous 80 W peak

iXblue

Front panel	(test purpose)
Console	RS232 serial link (DB9 – factory testing only)
Synchro OUT	Synchro OUT main & secondary (BNC)
Synchro IN	Trigger input (BNC)
HYDRO 1 to 4	Antenna connected: signal received from the antenna Without antenna: simulation for test purpose (factory only)
Power consumption	15W continuous 80W peak
Rear panel	
Power supply	External power supply (110~240 VAC)
Synchro OUT	Synchro OUT main & secondary (BNC, id front panel)
Synchro IN	Trigger input (BNC, id front panel)
PPS	PPS (Pulse Per Second) synchronisation input
Serial 1 to 4	Standard RS232 / RS422 input output communication port User programmable. ancillary sensors and data communication
Ethernet	True Ethernet communication port for programming, sensors interface and data distribution
Acoustic array	Connector to the acoustic array

4. Scope of supply

4.1. Standard product pack, Deployable antenna version



Qty.	Designation	Ordering code
1	POSIDONIA II standard package configuration Including: • Box #1 (wooden box) One (1) off acoustic array (portable version equipped with preamplifiers, • Box #2 (wooden box) One (1) off main interconnect cable (50 m long standard supply) • Box #3 (transit case) One (1) off main Electronic acoustic processor hardware (USBL-BOX) One (1) off USBL system calibration software One (1) off DELPH RoadMap navigation display software One (1) User Documentation in English on CD One (1) printed Quick Start Guide One (1) Quality control certificates set	KAA00497

Including sub-references as indicated here below:

Qty.	Designation	Ordering code
1	POSIDONIA II portable acoustic array	KAA00159
1	USBL-Box electronic cabinet	KAA00235
1	Main antenna cable (50m, BURTON plug)	KAA00180

4.2. Standard product pack, FLUSH antenna version

Qty.	Designation	Ordering code
1	POSIDONIA II standard package configuration Including: • Box #1 (wooden box) One (1) off acoustic array (Flush version equipped with preamplifiers, • Box #2 (wooden box) One (1) off main interconnect cable (50 m long standard supply) • Box #3 (transit case) One (1) off main Electronic acoustic processor hardware (USBL-BOX) One (1) off USBL system calibration software One (1) off DELPH RoadMap navigation display software One (1) User Documentation in English on CD One (1) printed Quick Start Guide One (1) Quality control certificates set	KAA00498

Including sub-references as indicated here below:

Qty.	Designation	Ordering code
1	POSIDONIA II flush acoustic array	KAA00160
1	USBL-Box electronic cabinet	KAA00235
1	Main antenna cable (50m, JUPITER plug)	KAA00181

5. References

iXBlue has a long history in acoustic positioning and inertial navigation systems.

5.1. Acoustic positioning systems references

Acoustic Positioning Systems is one of the core activities at iXBlue. The first systems have been designed in the 70's (Oceano Instruments) mainly for the Oil&Gas offshore industry, with a full range of products comprising of LBL (Long BaseLine) and SBL (Short BaseLine) in low, medium and high frequency.

With the use of powerful modern electronics and digital signal processing technology iXBlue introduced the first long range/high accuracy USBL (Ultra Short BaseLine) system in the early 2000 which led to the still unique 10,000 m range 0.2% accuracy, POSIDONIA II.

Some recent references for LBL positioning system:

- **CPPM** (France). ANTARES project (European neutrino telescope in Mediterranean sea)
- **NESTOR** (Greece). The Greek counterpart of the same neutrino telescope project
- **IFREMER** (France). French Research Institute for Sea Sciences
  The iXBlue LBL system is operated by IFREMER for the positioning of subsea vehicle when higher accuracy within a limited navigation area is required.
- **Oil & Gas offshore industry.**
  iXSurvey UK Ltd operated LBL system on a rental basis for Oil & Gas projects and marine construction

Some recent references for USBL POSIDONIA:

- **IFREMER** (France) - French Research Institute for Sea Sciences.
  All fleet equipped with POSIDONIA II for positioning of deep sea manned submarine (NAUTILE) and deep sea ROV (Victor) + general use;
  AWI (Alfred Wegener Institute), **IFM-GEOMAR**, **IFM HAMBURG** (Germany).
  All scientific fleet equipped with POSIDONIA. AWI is operating POSIDONIA in arctic seas to track deep sea mooring under the ice before release operation. IFM and GEOMAR are operating deep tow fish for seismic and geology surveys
- **YUZHMORGEO** (Russia).
  POSIDONIA installed on R/V Yuzhmorgeologia for deep sea sonar tracking. A second system is operated for the same company onboard R/V Gelendzhik
- **IPEV** (French Polar Research Institute).
  POSIDONIA installed on R/V Marion Dufresnes for all positioning applications. Operated on behalf of CEA (French Atomic Agency) for deployment of the subsea permanent (10 years life mooring) acoustic observatory in the scope of the CTBT (Comprehensive Nuclear Test Ban Treaty)
- **EPSHOM** (French Navy hydrographic service)
  POSIDONIA installed on last Beautemps-Beaupres R/V vessel for general purpose
- **CSIC** (Spain).
  To be installed in November 06 on the new R/V vessel for deep tow operation tracking.
- **COMRA** (China)
  Tow fish tracking. Maximum range of 9,600m reached.
- **BGR** (Germany)
  The German Federal Institute for Geosciences and Natural Resources deploys POSIDONIA during its main mission related to groundwater, hydrogeological and geoscience projects
- **Williamson Associates** (USA)
  A private company offering geophysical consulting services including deep tow tracking capability with POSIDONIA since 2011

5.2. Inertial Navigation System (INS)

Inertial Navigation System based on FOG (Fiber Optic Gyroscopes) has been introduced in the market early 2001. Using its internal sensors (FOG, Accelerometers) and an embedded Kalman Filter blending internal data and external aiding data, PHINS (Photonic Inertial System) is the smallest, leanest and fully integrated only system which is now used in most AUV's and subsea vehicles throughout the world.

Here below is a non-exhaustive list of ROV's and AUV's application for PHINS:

- **FRANCE**
  - ✓ IFREMER : ASTER'X, AUV for scientific applications
  - ✓ ECA: HALIODSTAR, AUV for the Oil&Gas industry, Sea bed mapping and object recognition
  - ✓ French Navy: REDERMOR, AUV for military application, mine hunting
- **United Kingdom**
  - ✓ NOC (National Oceanographic Center): AUV for scientific applications
  - ✓ SUBSEA 7: Oil & Gas industry, sea bed mapping
- **NORWAY**
  - ✓ KONGSBERG MARITIME: multiple applications with HUGIN AUV
  - ✓ OCEANEERING for workclass ROV's (MIMIC project, multiple units installed and operated)
- **JAPAN**
  - ✓ JAMSTEC: R2D2 subsea vehicle for scientific applications
  - ✓ University Tokyo: scientific subsea vehicle
- **North America**
  - ✓ DERA (Canadian MoD)
  - ✓ ISE (Canada)
  - ✓ John Hopkins University (US)
  - ✓ Bluefin

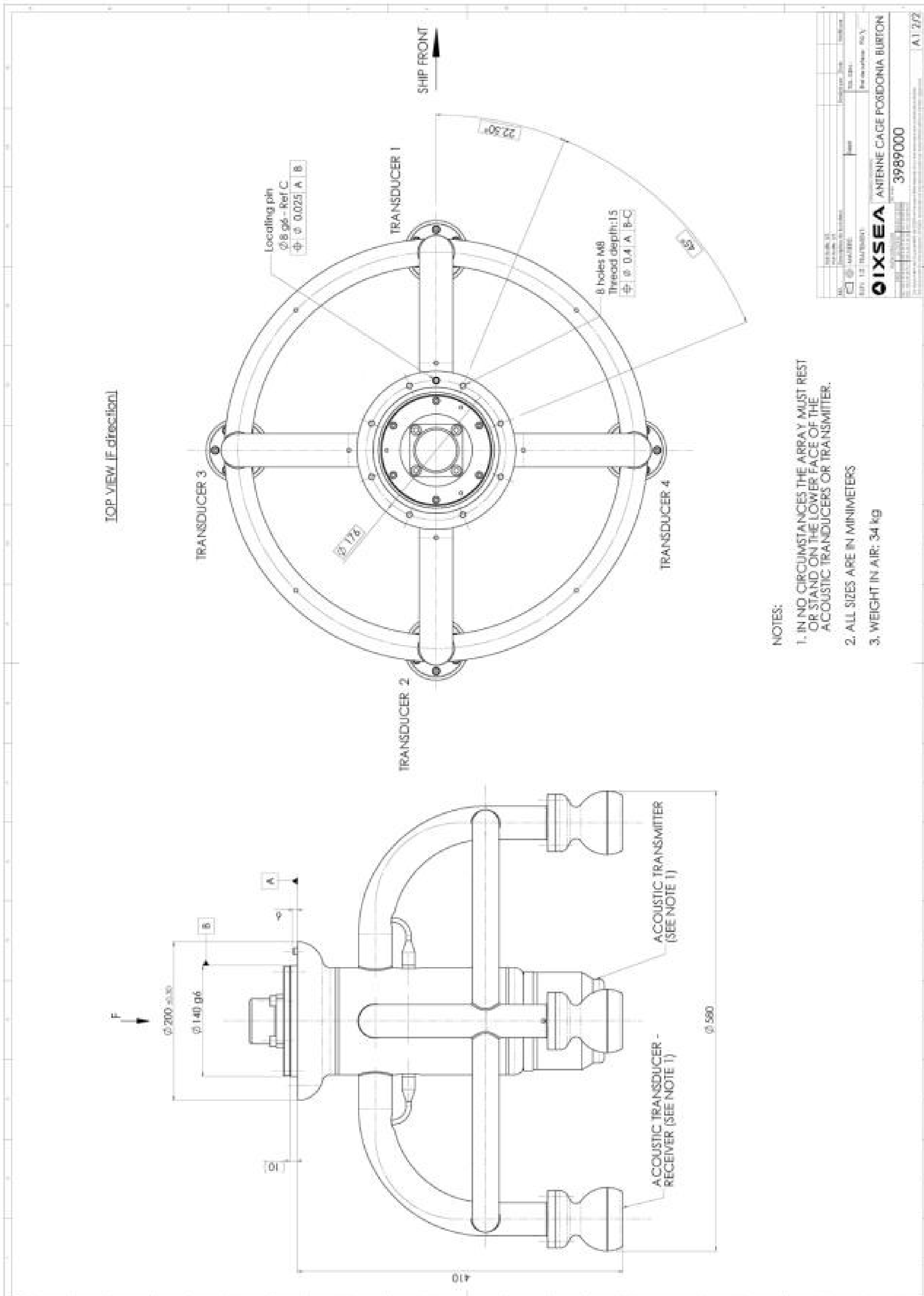
5.3. Combined Acoustic and Inertial navigation systems

Some significant references for GAPS (or POSIDONIA II) and INS combined solutions:

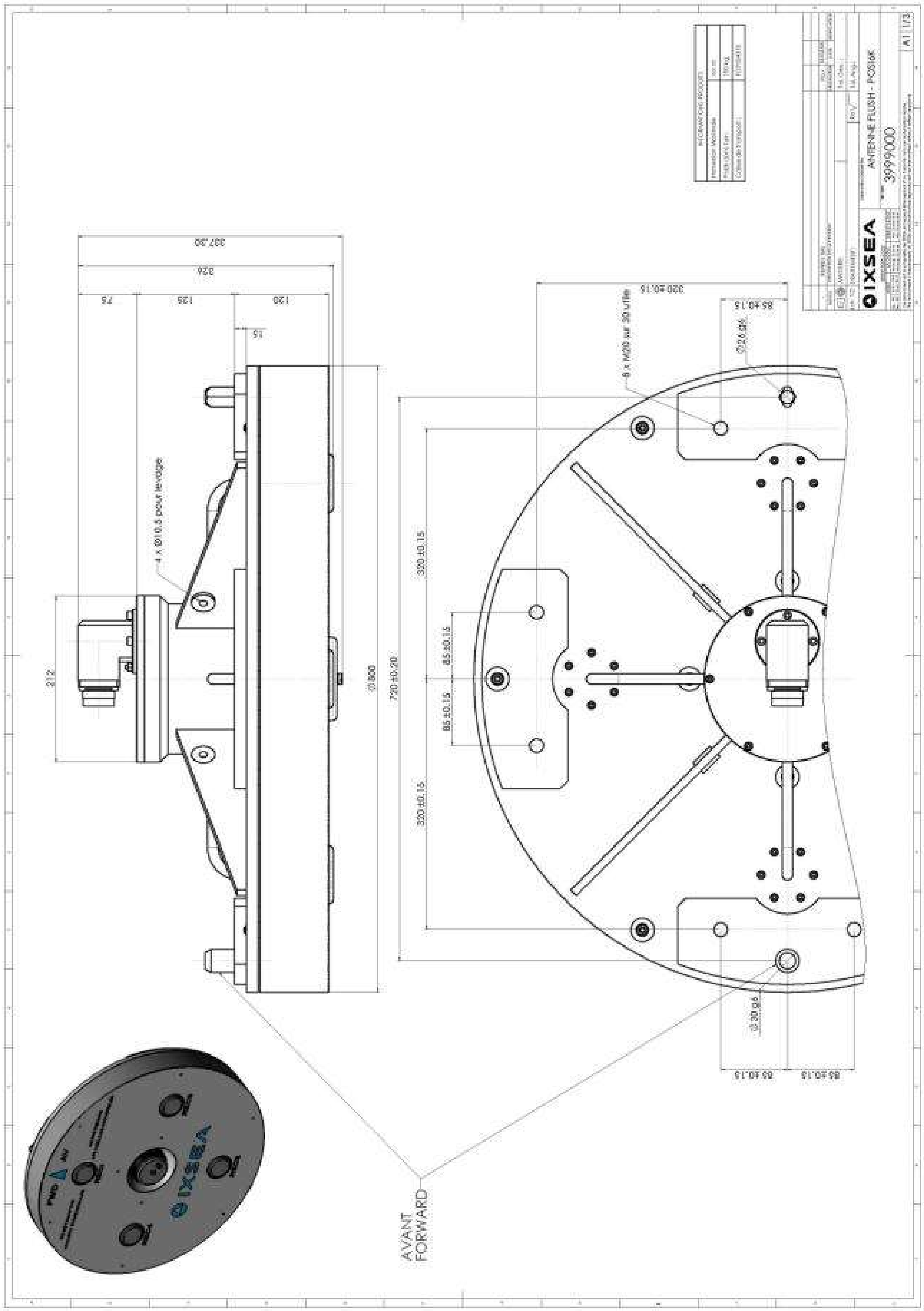
- **NIOT** (India)
  The ATS (Acoustic Tracking System) system is based on a POSIDONIA II + PHINS/DVL solution to provide a full monitoring of the deep sea vehicle at high refresh rate, extend the range beyond POSIDONIA II limits, and improve the accuracy.
- **SUBSEA Resources** (France – UK)
  SubSea Resources has been formed to salvage cargoes from cargo ships that have been lost in deep water. (down to 6,000 m). Such operations require accurate and long range positioning of sonar first, and ROV for salvaging.

6. Appendix

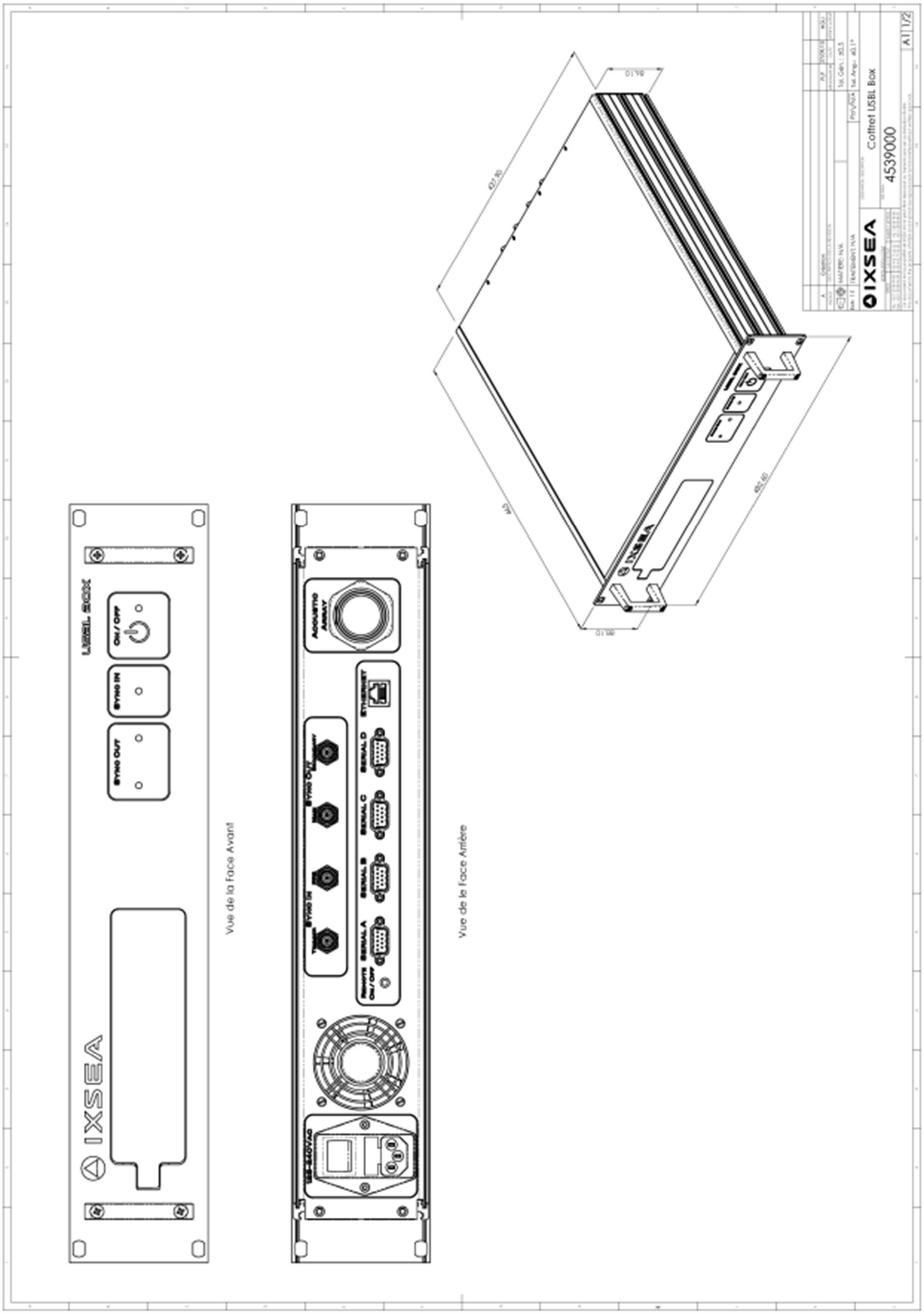
6.1. Deployable acoustic array



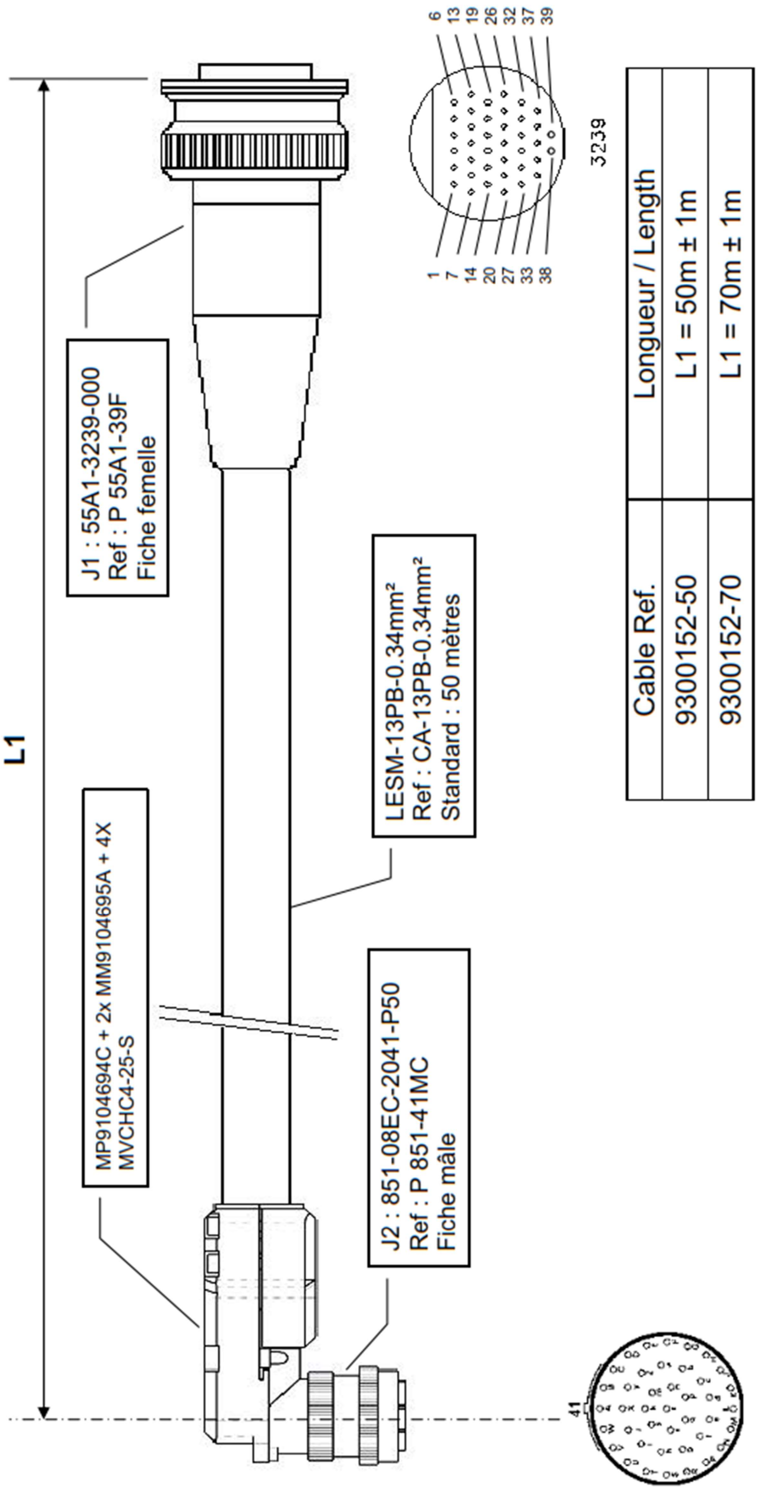
6.2. Flush acoustic array



6.3. USBL-Box electronic cabinet

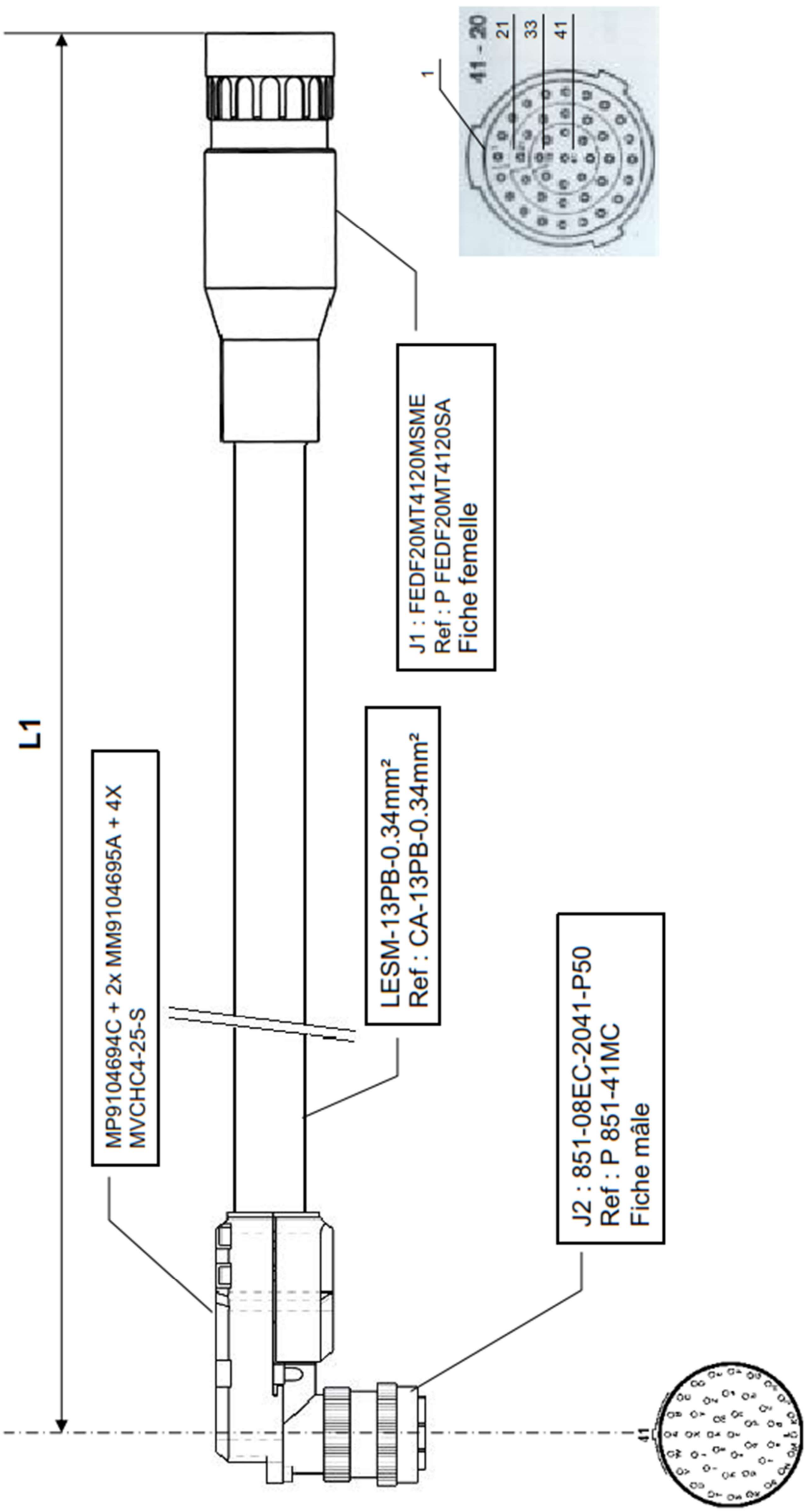


6.4. Main junction cable (deployable antenna)



Cable Ref.	Longueur / Length
9300152-50	L1 = 50m ± 1m
9300152-70	L1 = 70m ± 1m

6.5. Main junction cable (Flush antenna)



Cable Ref.	Longueur / Length
9300157-**50**	L1 = 50m ± 1m
9300157-**70**	L1 = 70m ± 1m