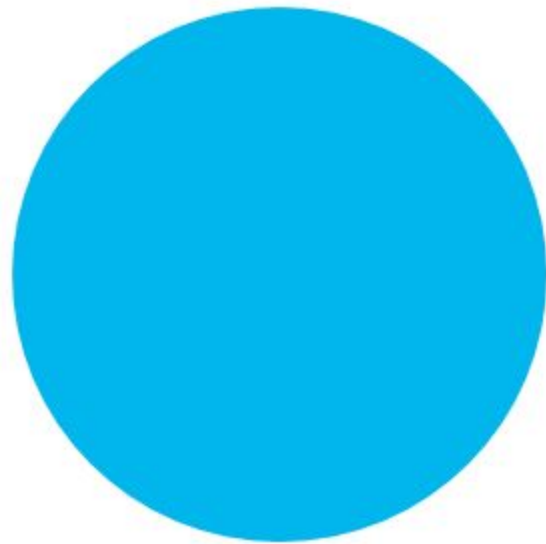




Phins Subsea

Technical Description

Revision History

Edition	Date	Comments
A	07/2019	Creation
B	03/2020	Navigation data & settling time chapters updated
C	08/2022	NTP and data logging added

Copyright

All rights reserved. No part of this manual may be reproduced or transmitted, in any form or by any means, whether electronic, printed manual or otherwise, including but not limited to photocopying, recording or information storage and retrieval systems, for any purpose without prior written permission of iXblue.

Disclaimer

iXblue specifically disclaims all warranties, either expressed or implied, including but not limited to implied warranties about merchantability and fitness for a particular purpose with respect to this product and documentation. iXblue reserves the right to revise or to make changes or improvements to this product or documentation at any time without notifying any person of such revision or improvements.

In no event shall iXblue be liable for any consequential or incidental damages, including but not limited to loss of business profits or any commercial damages, arising out of the use of this product.

Trademarks

Microsoft, MS-DOS and Windows are registered trademarks of Microsoft Corporation.

Intel and Pentium are registered trademarks and Celeron is a trademark of Intel Corporation.

Export Control

This product is subject to export control regulations. Please refer to the commercial offer or contact iXblue for details about the applicable export control regulations and restrictions.

Phins Subsea Documentation

The following documents give all the information you need in order to understand and to use your product.

- **Phins Subsea Technical Description** (*ref.: MU-PHIN6TD-AN-001*)
 - > Phins Subsea and iXblue technology presentation
 - > Technical specifications
 - > Certification and qualification, life cycle
 - > Mechanical, electrical and communication interface description
- **Phins Subsea Installation & Setup Guide** (*ref.: MU-PHIN6ISG-AN-001*)
 - > Conventions
 - > Physical and electrical installation
 - > Connecting to the Web-Based Graphical User Interface
 - > Setup the Phins Subsea
 - > Contacting iXblue support
- **Phins Subsea Operation Guide** (*ref.: MU-PHIN6OG-AN-001*)
 - > Introduction to the Inertial Navigation System
 - > Start-up Phases
 - > Web-Based Graphical User Interface description
 - > Configuring the navigation parameters & managing the external information
 - > Viewing the system information
 - > Recording data
- **Phins Subsea Interface Library** (*ref.: MU-PHIN6IL-AN-001*)
 - > NMEA frames
 - > Digital input and output protocols
 - > Pulses interfaces specification
 - > Control commands
- **Phins Subsea Quick Start Guide**
 - > Pack content verifying
 - > Installing and connecting Phins Subsea
 - > Configuring and operating Phins Subsea
- **SEACON 12 PIN TI 1M Pigtail Cable - Product Description** (Ref.: MU-PDCABLES-AN-001)
 - > cable and pinout of the SEACON 12 pins Pigtail Cable
- **SEACON 19 PIN TI 1M Pigtail Cable - Product Description** (Ref.: MU-PDCABLES-AN-002)
 - > cable and pinout of the SEACON 19 pins Pigtail Cable
- **SEACON 26 PIN TI 1M Pigtail Cable - Product Description** (Ref.: MU-PDCABLES-AN-003)
 - > cable and pinout of the SEACON 26 pins Pigtail Cable
- **SEACON 26 PIN TI 1M Pigtail Cable - Product Description** (Ref.: MU-PDCABLES-AN-009)
 - > cable and pinout of the SEACON 26 pins Pigtail Cable
- **Subsea Inertial Products - Maintenance Manual** (*ref.: MU-SUBSEAMM-AN-001*)
 - > Troubleshooting
 - > Corrective maintenance
- **Subsea Inertial Products - Illustrated Part Catalog** (*ref.: MU-SUBSEADP-AN-001*)

- > Detailed part list
- > Alphanumerical Index
- **Application Note - INS+DVL Calibration** (*ref.: MU-DVLINS-AN-001*)
 - > Configuring the calibration
 - > Calibrating the DVL+INS
- **Application Note - Installation and Configuration of AHRS and INS for Seabed Mapping Measurements** (*ref.: MU-HEAVAPN-AN-001*)
 - > Using heave compensation on seabed mapping
 - > Effect of vehicle transient movements

Phins Subsea Technical Description Overview

This document must be read and understood prior to using the product.

The manufacturer shall in no case be held liable for any application or use that does not comply with the stipulations in this manual.

The Phins Subsea Technical Description is divided into several parts:

- **Part 1: Phins Subsea Description**

This part contains the description of the main product parts and the presentation of iXblue technology.

- **Part 2: Technical Specification**

This part gives details on the technical specifications, the certification, qualifications and the life cycle.

- **Part 3: Mechanical Description**

This part describes mechanical aspect of Phins Subsea, except connectors.

- **Part 4: Electrical interface Description**

This part gives the detail of the electrical interface (connector, pinout description and electrical levels).

- **Part 5: Communication Interface Description**

This part details the interfaces to communicate with Phins Subsea.

Abbreviations and Acronyms

ACC	Accelerometer
CTD	Conductivity, Temperature, Depth sensor
DVL	Doppler Velocity Log
EGNOS	European Geo-stationary Navigation Overlay Service
GALILEO	European Satellite Navigation System
GGA	Essential fix data which provide 3D location and accuracy data
GLONASS	Global Navigation Satellite System (operated by the Russian Space Forces)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System (operated by the United States Department of Defense)
GST	GPS Pseudo-range Noise (PRN) statistics (The GST message is used to support Receiver Autonomous Integrity Monitoring)
GUI	Graphical User Interface
HRP	Heading, Roll, Pitch
IMU	Inertial Measurement Unit
INS	Inertial Navigation System
IP	Internet Protocol
LVA	Lever Arms
PPS	Pulse Per Second
SD	Standard Deviation
UTC	International acronym for Coordinated Universal Time (CUT)
UTM	Universal Transverse Mercator
ZUPT	Zero velocity UPdaTe

Table of Contents

1	PHINS SUBSEA DESCRIPTION	11
1.1	IXBLUE TECHNOLOGY	11
1.2	PHINS SUBSEA DESIGN	13
1.3	PHINS SUBSEA DATA AVAILABILITY	16
1.4	EXTERNAL SENSORS	17
2	TECHNICAL SPECIFICATION	18
2.1	PERFORMANCE PREREQUISITES	18
2.2	EQUIPMENT DATA DYNAMIC RANGE	19
2.3	EXTERNAL SENSORS	19
2.4	NAVIGATION DATA	20
2.5	INPUT / OUTPUT	21
2.6	POWER SUPPLY	21
2.7	EXPORT LIMITATIONS	22
2.8	SETTLING TIME	23
2.9	QUALIFICATIONS	25
2.10	LIFE CYCLE	26
2.10.1	Packaging, Handling, Storage, Transportation requirements	26
2.10.2	Auto-calibration	26
2.10.3	Built-in-test	26
2.10.4	Reliability & maintainability	26
3	MECHANICAL DESCRIPTION	27
3.1	PHINS SUBSEA STAND ALONE	27
3.2	PHINS SUBSEA DVL READY	27
3.3	MECHANICAL ALIGNMENT	27
3.4	REFERENCE FRAME CENTER	28
4	ELECTRICAL INTERFACE DESCRIPTION	31
4.1	OVERVIEW OF ELECTRICAL INTERFACE	31
4.2	LISTING OF INTERFACES	32
4.3	ETHERNET CONNECTOR SPECIFICATION	33
4.3.1	Definition	33
4.3.2	Connector & Pin out	34
4.4	PORT A&B CONNECTOR (CENTRAL CONNECTOR) SPECIFICATIONS	35
4.4.1	Definition	35
4.4.2	Connector and Pinout	36
4.5	PORT X (X BEING C, D, OR E) CONNECTOR SPECIFICATIONS	38
4.5.1	Definition	38
4.5.2	Connector and Pinout	39
4.6	PHINS SUBSEA POWER NETWORK	40
4.6.1	Power Supply Definition	40
4.6.2	Power Supply Pinout	40
4.7	RECOMMENDED WIRING	41
4.8	RS232/RS422 INPUT AND OUTPUT CHARACTERISTICS	45
4.9	INPUT PULSES ELECTRICAL CHARACTERISTICS	46
4.10	OUTPUT PULSES ELECTRICAL CHARACTERISTICS	47
5	COMMUNICATION INTERFACE DESCRIPTION	48
5.1	COMMUNICATION LINK	48

5.2	SOFTWARE INTERFACES AND LIBRARY	49
5.3	WEB-BASED GRAPHICAL USER INTERFACE	50
5.4	CONTROL COMMAND	51

1 Phins Subsea Description

1.1 iXblue technology

iXblue Phins Subsea design is based on fiber-optic gyros (FOG) and quartz accelerometers. iXblue's fiber-optic gyros are the result of more than 40 years of research and development, and they address the most demanding applications with performance from 0.1 deg/h to 0.001 deg/h. All main components are designed and manufactured by iXblue. This vertical integration is a key to achieve the high performances, higher quality standards and obsolescence management.

iXblue technology is an interferometric closed loop FOG. It is a high end design made to reach the highest spectrum of gyroscope performances. It has demonstrated superior reliability and navigation performance over many years and thousands of units. iXblue navigation systems have been chosen as the primary and secondary gyrocompass and INSS by the world's leading navies.

FOG Definition

FOG is a solid state / strap-down optical gyroscope technology based on the Sagnac effect (one of the physical effects used to create gyroscopes). A FOG is a 2-wave ring interferometer made of a multi-turn fiber coil (see Figure 1). It includes no moving parts or anything that will wear out or require any maintenance.

The Sagnac effect

The Sagnac Effect is a physical phenomenon of relativistic type.

Understanding it requires a good grasp of Special Relativity. However, it is possible to provide a simplified (although representative) physical interpretation of the effect with Newtonian physics.

Let us consider a Multi-Integrated Optical Circuit (MIOC) and a coil of optical fiber (Figure 1). The light entering in the MIOC is separated in two equivalent pulses of light which propagate in opposite direction in the fiber coil.

At rest, the two pulses of light travel at the same velocity (speed of light) along the same path in opposite directions in the coil. As their optical path is equivalent, they return "in phase" at the end of the coil and no signal is measured.

When the FOG is rotating, we can consider that the exit point of light has moved during the travel of light. Thus, the pulse propagating in the opposite direction of the FOG rotation will be late, and a "phase shift" between the two pulses is measured.

FOG Description

Dedicated signal processing allows conversion of the information on optical phase, (carrying information on rotation), into a digital signal useable by a computer.

The difference of transit time is proportional to the product of the rotation rate and the area A enclosed by the coil (calculated as the diameter of the coil multiplied by the number of times the fiber is wound around the coil).

As such the FOG performance improves as FOG diameter increases and the total optical path length increases. For example, increasing the fiber length results in a longer optical path length that will translate into a larger time shift between waves for a given rotation speed.

The fiber optic gyroscope (FOG) is a flexible technology that can meet diverse requirements. It has no moving parts which reduce maintenance and recalibration operations. It provides a very wide dynamic range and can tolerate extremely demanding mechanical environments without compromise to its performance.

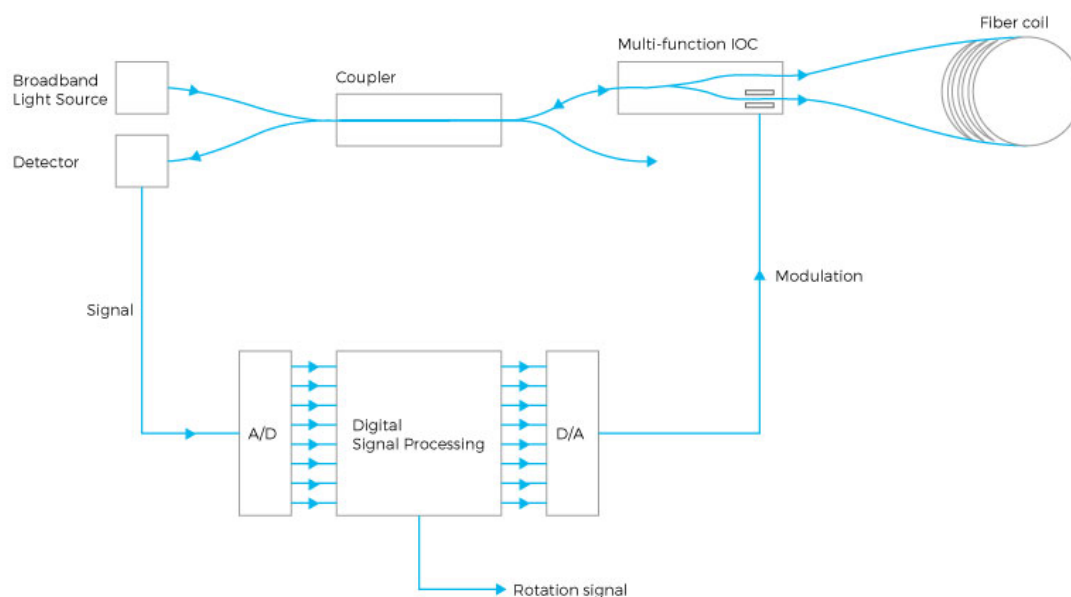


Figure 1 - Optical gyroscope technology

1.2 Phins Subsea Design

Phins Subsea is an Inertial Navigation System (INS). It delivers heading and attitude information as well as position and speed, to other systems and displays. It can receive data from other sensors to improve its accuracy.

Phins Subsea is a state-of-the-art inertial navigation systems, designed to meet the demands of high performance subsea INS in harsh deep water applications in terms of compactness and accuracy.

While preserving the subsea vehicle upload, Phins Subsea allows for accurate survey and autonomous navigation for subsea applications, providing very accurate heading, roll, pitch, speed and position in USBL, LBL, Sparse Array positioning as well as DVL only navigation.



Figure 2 - Phins Subsea

Due to the very high precision of its IMU, Phins Subsea is subject to export regulations.

Phins Subsea and DVL

One of the most valuable external sensors for Phins Subsea is a Doppler Velocity Log (DVL) which provides consistent and reliable speed information (in bottom tracking mode).

Since Phins Subsea and DVL must be calibrated before use, iXblue offers “Phins Subsea DVL-ready” which comprises Phins Subsea, a DVL (several models available depending on frequency) and relevant mounting and connecting hardware.

The system so formed is ready to use upon delivery and can be moved from one subsea vehicle to the other without further INS-DVL calibration.

To get more information about installing & calibrating the DVL kit option, refer to the Phins Subsea flash drive to get:

- Phins Subsea and DVL mechanical drawings
- INS+DVL Calibration - Application Note

**Phins Subsea
and USBL
Configuration**

USBL (Ultra Short Base Line) positioning system is commonly used for quick and efficient tracking tool for subsea vehicle tracking (ROV, AUV, towed body, etc...). Although USBL technology allows good performance it is subject to several native limitations in terms of robustness (tracking range limit, noisy environment, poor acoustic propagation conditions) and position refresh rate.

Phins Subsea ideally complements USBL thanks to its capacity to provide a stable position between each acoustic interrogation. It will maintain reliable position output during short acoustic data outages, and smooths out USBL positioning noise by at least a factor 3.

In addition to a better and stable high recurrence position Phins Subsea provides full attitude of the subsea vehicle (heading, pitch and roll data).

Combination of USBL + INS (or better USBL + INS + DVL) makes GNSS-like subsea positioning a reality.

Phins Subsea naturally interfaces with iXblue acoustic positioning systems (GAPS, RAMSES) but also includes communication protocols compatible with most industry standard subsea positioning systems.

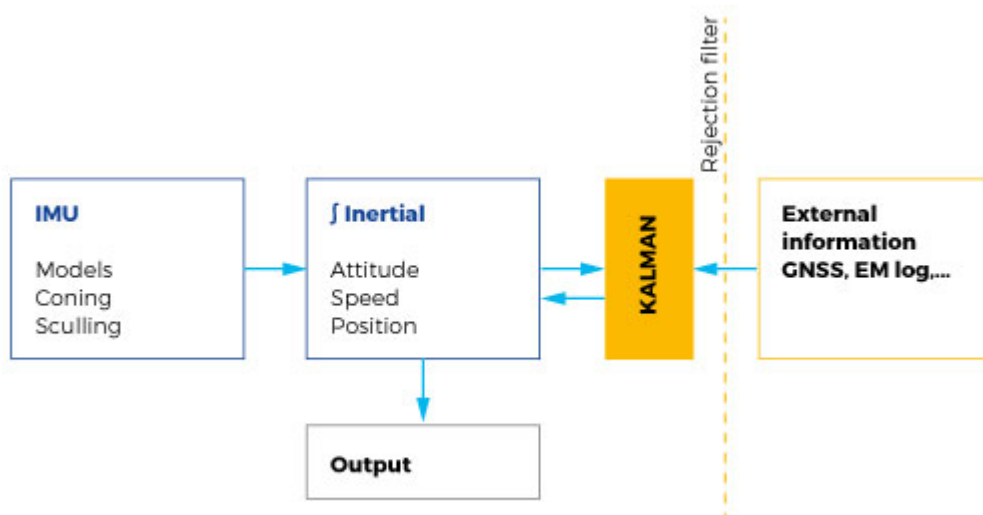
Being a fully strap down system based on gyroscopes without any moving parts, Phins Subsea requires no scheduled maintenance to provide the best performance during the full length of its lifetime. Its modern design integrating state of the art technologies (Ethernet, Web-Based Graphical User Interface, high baud rate ...) allows easy installation and interfacing to most standard external sensors and vehicle control systems.

To deliver the best during operations, Phins Subsea is designed to:

- Align at sea
- Auto-calibrate its internal sensors during navigation
- Integrate data from GNSS, USBL, LBL positioning systems when available and reject inconsistent data
- Navigate with Sparse Array input
- Navigate using only DVL or EM Log data

Phins Subsea is a strap-down all in one INS that contains:

- An IMU with 3 fiber optic gyroscopes (FOGs) and 3 quartz accelerometers
- A rejection filter
- A Kalman filter
- A Built In Test (BIT)
- A real-time digital signal processor (DSP) supporting the navigation software
- An interface board that manages input and output protocol conversion
- An embedded Web-Based Graphical User Interface



Phins Subsea navigation algorithm is based on a very advanced Kalman filter that enables the unit to constantly autocalibrate, using any external information that can be provided.

Connection is available both through serial and Ethernet connections.

Phins Subsea can be connected to any GNSS receiver (GPS, Glonass, Galileo or other) or any other external sensor (Doppler Velocity Log, Depth sensor, USBL, LBL) providing position, speed or time or to work in a pure inertial mode.

1.3 Phins Subsea Data availability

Phins Subsea provides the subsea vehicle survey package and/or subsea vehicle control system with full navigation data:

- Position (Latitude, Longitude, Altitude)
- Speed (North, East, Vertical Speed and ship speeds)
- Depth
- Roll/Pitch and Heading
- Polar Heading, Latitude, Longitude, Speed
- Rate of turn and Accelerations (all three axis)
- Heave, Surge, Sway
- True course (depends on availability of external sensors)
- Current speed and direction (depends on availability of external sensors)
- Standard deviation of computed data
- Built In Test Status data

The exhaustive list of output data is detailed in the Phins Subsea Interface Library.

Heave measurement/ Center of Gravity of the vehicle (COG)

Phins Subsea can output two distinct heave measurements:

- Specific Heave which provides heave in real-time.
- Smart Heave™ which provides a measurement of heave with a fixed 100 s delay. In this case heave is compensated for error due to high pass filtering distortions and is more accurate.

To avoid the effect of transient subsea vehicle movement on the heave measurement, you can define the position of the center of gravity (COG) of the subsea vehicle. When this is done, Phins Subsea will compute heave at the COG and add the heave induced by lever arms from the COG to external monitoring points. For more details refer to Phins Subsea Installation & Setup Guide .

UTC/Time synchro

All data is accurately time stamped with respect to internal reference time, GNSS time or any autonomous external clock.

Phins Subsea internal clock can be synchronized with data coming from an external reference clock (i.e., GNSS clock or autonomous external clock). In this case, internal reference time is synchronized with the input coming from the selected interface with the appropriate protocol.

Phins Subsea clock can also be synchronized with NTP (network time protocol) servers.

For more details on time synchronization setting, refer to Phins Subsea Installation & Setup Guide.

Availability of full quality check data

Phins Subsea provides a numeric quality checks indicator (RMS/CEP50/CEP95) for all main navigation data:

- Position standard deviation estimation Latitude and Longitude
- Depth standard deviation estimation
- Speed standard deviation estimation (North, East and Vertical Speed)
- Roll/Pitch and Heading standard deviation estimation
- Altitude or Depth standard deviation estimation

1.4 External sensors

Phins Subsea uses external sensor data to improve its own estimates of position, speed, attitude and heading. The following external sensors can be connected to Phins Subsea:

- GNSS
- LBL
- USBL
- Sparse Array (range meter)
- EM Log
- DVL
- CTD/SVP
- Depth Sensor

Phins Subsea can simultaneously use all the sensors described above and its Kalman Filter will manage them without any manual intervention.

The system constantly and automatically uses the information from the external sensors when it is available and runs in full free inertial mode when no external information is available. As soon as external information is back, the system will use it. Phins Subsea also integrates a rejection filter that will prevent inconsistent data to be sent to the Kalman Filter.

Phins Subsea also allows the user to provide a manual input position either at the start or during the navigation sequence.

Phins Subsea can be operated over serial or Ethernet through its embedded Web-Based Graphical User Interface or through a third-party system interface via a control command link.

For more details on:

- Electrical connection of the external sensors: refer to section 4
- The configuration of the external sensors: refer to the Phins Subsea Installation & Setup Guide.
- The available input protocols for external sensors: refer to Phins Subsea Interface Library.

2 Technical Specification

2.1 Performance prerequisites

The performances listed hereafter are achieved at sea under the following conditions (which complements the environmental conditions stated in section 1).

- **subsea vehicle's motion does not exceed:**

	Amplitude	Period (sinusoidal)
Heading	$\pm 10^\circ$	10 s
Roll	$\pm 40^\circ$	9 s
Pitch	$\pm 15^\circ$	6 s

As some external sensors do not provide any quality indicator with the provided data, some hypothesis of performance have been made in the system for those sensors. This can be manually modified using the advanced filtering page, refer to Phins Subsea Installation & Setup Guide.

- **EM Log sensor**

Log speed accuracy: 0.5 m/s RMS (with respect to water)

Ocean current stability: 1 kn (One sigma) 3 hours correlation time

To ensure EM Log performance, it must be calibrated after installation.

Log sensor must only be used outside of harbors. During harbor maneuvers erroneous EM Log data could be sent to Phins Subsea, e.g., while working tug boats produce strong local currents over the EM Log sensor, and these erroneous inputs would adversely affect Phins Subsea performance.

- **Doppler Velocity Log (DVL) sensor:**

Performance using any other technology (i.e.: Correlation Velocity Log [CVL]) should be submitted to qualification testing to evaluate their impact on navigation performance.

For example CVL technology does not have the same performance as DVL. Navigation performance would be degraded.

EM Log can be used by selecting an extra DVL input and choosing the corresponding protocol (e.g. EM Log VBW)

2.2 Equipment Data Dynamic Range

Heading	0° to 360°
Roll	-180° to +180°
Pitch	-90° to +90°
Roll / Pitch / Heading Rate	± 750°/s
Geodetic Latitude	90° S to 90° N
Geodetic Longitude	180° E to 180° W
Altitude (above sea level)*	up to 4000 m
Speed	up to 80 knots
Linear Acceleration	± 15 g

* No limitation for negative altitude.

2.3 External Sensors

External Sensors	
GNSS	up to 2
DVL	up to 2
EM Log	1
CDT/ SVP	1
Depth Sensor	1
USBL	Up to 3 beacons
LBL (range meter) Sparse Array	Up to 10 simultaneous beacons
UTC	Up to 2

2.4 Navigation Data

GPS or USBL or LBL & DVL	DVL (Bottom Track mode)	EM Log	No aiding
Position (Latitude and Longitude) accuracy			
2 to 3 times better than aiding sensor	0.05 % (CEP50) of distance travelled	2 Nm/8 h (TRMS)	0.06 m after 1min (CEP50) 2 m after 5 min (CEP50) 0.21Nm/h after 1 hour (CEP50)
Speed (North and East) accuracy			
0.01 knot (RMS)		0.1 knot (RMS)	0.6 knot (RMS)
Heading accuracy			
0.01° seclat (RMS)	0.025° seclat (RMS)		
Attitude (Roll and Pitch) accuracy			
0.01° (RMS)			

With or without aiding:

Dynamic stability⁽¹⁾	
Heading rate accuracy	0,001° / s RMS
Roll rate accuracy	0.001° / s RMS
Pitch rate accuracy	0.001° / s RMS
Heave Surge Sway	
Heave ⁽²⁾	5 cm or 5% of movement full amplitude
Smart Heave™ ⁽³⁾	2.5 cm or 2.5% of movement full amplitude
Surge and Sway ⁽⁴⁾	5 cm or 5% of movement full amplitude

(1) According to the dynamics stated in the prerequisites in section 2.1.

(2) Whichever is higher for wave periods up to 25 s.

(3) Whichever is higher for wave periods up to 30 s.

(4) Whichever is higher for wave periods up to 15 s.

2.5 Input / Output

Baud rate	600 bauds to 460 kbauds
Data output rate	0.1 Hz to 200 Hz
Data input rate	Up to 5 Hz (1 Hz recommended)
Time stamping accuracy	< 100 μ s

(1) 200 Hz update rate for attitude data (Heading, roll, pitch, surge, sway).

Update rate for position is performed at 100 Hz.

	Serial (All)	Ethernet 1	Ethernet 2	Ethernet 3	Ethernet 4	Ethernet 5
Jitter	< 200 μ s	< 400 μ s	< 800 μ s			
Fixed Latency	2.35 ms	2.95 ms	3.45 ms	3.95 ms	4.45 ms	4.95 ms
	Input	Output	Configuration & Repeater			
Serial RS232	5	5	1			
Ethernet⁽²⁾	7	5	1			
Max (Serial & Ethernet)	7	5	1			
Pulse Port	3	2	-			

Ethernet⁽²⁾	UDP (Unicast, multicast and broadcast)/ TCP client / TCP server (10 / 100 Mbits)
-------------------------------	--

Pulse port	5 V (TTL level)
-------------------	-----------------

Input / output formats	Industry standards: NMEA 0183, ASCII, BINARY
-------------------------------	--

(2) All inputs and outputs are available on the Ethernet link. Output can be duplicated both on serial and Ethernet port.

2.6 Power Supply

Power supply / consumption	24 V _{DC} (20 to 32 V) / < 20 W ⁽¹⁾
-----------------------------------	---

(1) Typical value @ 24 V and ambient temperature.

2.7 Export Limitations

Phins Subsea is a dual use product and is thus submitted to export limitations on the provided data, and to export restrictions to some countries.

	Limitations
Rotation rate resolution ⁽¹⁾	3.6° / h
Acceleration resolution	1 mg
Heading, Roll, Pitch resolution	0.001°
Speed saturation	80 knots
Altitude saturation	4,000 m
Acceleration saturation	±15 g
Rotation rate saturation	750° / s
Post-processing data output	Available

⁽¹⁾ Additional export restrictions may apply regarding the availability of raw IMU data (set to 0 in output telegrams).

2.8 Settling Time

Important

To achieve the highest performance, during the alignment procedure, it is recommended that the systems generating stationary magnetic fields be put into operation before starting the Phins Subsea and left running as long as it is operational. High magnetic fields can temporarily disturb the Phins Subsea. The Kalman filter used in the Phins Subsea constantly estimates the bias of the sensors produced by this magnetic field. If this interference is stationary, the unit can compensate for the presence of this field.

Power Up	Power up is automatic, as soon as power is applied to the system.
Restart or Power Down	Equipment can be restarted either through the embedded Web-Based Graphical User Interface, in the maintenance menu or by sending a start command. To power down the equipment, you need to disconnect it from its power source.
Initialization:	The system must be initialized before it will provide fully accurate information. This initialization is performed using external sensor data, during several phases.
Alignment Phases	Coarse Alignment Coarse alignment phase is the first step of the alignment of the Phins Subsea. The algorithm determines the vertical and north directions. The “Coarse alignment” can be performed at quay or at sea with GNSS/USBL/LBL inputs at constant speed and heading or stationery under DP (Dynamic Position). This alignment can also to be aided by a speed sensor (DVL instead). Phins Subsea coarse alignment must be performed with position information (GNSS or manual position with ZUPT “Manual Position”). Heave initialization During the heave filter initialization phase, the heave, surge and sway outputs have not reached full accuracy. Once the heave filter completes its initialization, it will accurately measure any variations of Phins Subsea positions in the three directions (heave, surge and sway). Fine Alignment After the coarse alignment phase, Phins Subsea is ready for navigation (free to move). Phins Subsea switches to the “fine alignment” phase to improve accuracy on attitude, position and speed by having the Kalman filter estimate the residual biases of accelerometers and gyroscopes. The legacy ‘Fine alignment’ phase is raised when heading standard deviation gets below 0.1° (no seclat). When fine alignment is completed, the system is ready, it does not reach its full performance.

- **Optimal alignment**

Optimal alignment means that the system is reaching the specified heading performance. Optimal Alignment completes when heading standard deviation is below 0.02° seclat RMS.

When optimal alignment is completed, the system is ready and gives all the data with full performance.

	Static (GNSS, USBL, LBL, ZUPT)	At sea (USBL or LBL & EM Log or DVL)
Data availability	5 min	5 min
Roll/ Pitch 0.01° RMS	5 min	5 min
Heading 0.1° RMS	20 min	10 min
Heading 0,02° seclat RMS	N/ A	45 min*

(*) At a speed of 3 kt and including a heading change of at least 90° and linear acceleration.

2.9 Qualifications

Temperature		
Operating	ISO 8728:2014(E) ISO1638:2014(E)	- 20°C to +55°C
Transport and Storage	-40 °C to + 80 °C (7 cycles of 24h with steps at -40°C and 80°C)	
Vibration		
Vibration in operating	ISO 8728:2014(E) ISO1638:2014(E)	5-40Hz 0.51g sinus max
Shock		
Shocks in operation	27g 15 ms damped shock – 1 shock per direction	
Magnetic Field		
Operating	1 Gauss	
Water Tightness		
Operating	6,000 m (NFX 10-812 class C)	

2.10 Life Cycle

2.10.1 PACKAGING, HANDLING, STORAGE, TRANSPORTATION REQUIREMENTS

During storage and transportation, Phins Subsea should be kept locked in its transportation case, it shall have its protective caps installed on its connectors.

2.10.2 AUTO-CALIBRATION

At each start up, and continuously while aided, Phins Subsea is calibrating its internal gyrometer and accelerometer sensors using external sensors information and its advanced Kalman Filter. Therefore there is no need to recalibrate the system periodically.

2.10.3 BUILT-IN-TEST

Phins Subsea includes a Continuous Built-In Test (CBIT) that covers internal sensor status verification, system status and algorithm status. The Interface Library document details the complete list of parameters that are monitored. Refer to Phins Subsea Interface Library for further detail.

2.10.4 RELIABILITY & MAINTAINABILITY

Due to the technology used in its design, Phins Subsea is a fully strap-down / solid-state equipment. It does not use any gas filled cavity that could leak nor any moving mechanical part that would wear out. As a consequence, Phins Subsea requires no scheduled maintenance.

Phins Subsea does not have any life limited parts and as such, it has no predicted life limitation.

The entire Phins Subsea is a Line Replacement Unit (LRU).

MTBF

- 100,000 hours (System observed)
- 500,000 hours (FOG + Accelerometers)

End-of-life product management

When the product reaches the end of its life, it must be returned to iXblue where it will be sent to a treatment facility meeting the requirements of the directive on waste electrical and electronic equipment (WEEE).

3 Mechanical Description

3.1 Phins Subsea Stand Alone

Dimensions (Ø x h)	Ø 255 mm x h 288mm
Weight (Air / Water)	23 kg / 13 kg
Depth rating	6000 m
Construction	Titanium

3.2 Phins Subsea DVL Ready

Dimensions (Ø x h)	Ø 298 mm x h 543 mm (WHN300/600) Ø 298 mm x h 542 mm (WHN1200)
Weight (Air / Water)	48.5 kg / 28.5 kg (WHN300/600K6) 41.5 kg / 23.7 kg (WHN300/600K3) 43.7 kg / 27 kg (WHN1200K6) 38.1 kg / 21 kg (WHN1200K3)
Depth rating	6000 m
Construction	Titanium

3.3 Mechanical Alignment

The Phins Subsea base plate is designed with two holes for alignment of Phins Subsea axis X1 with a reference direction on the matching adaptation plate fixed onboard.

The accuracy of this mechanical alignment is ± 0.01 degree. The adaptation plate should be designed with two pins $\phi 6$ g6 maximum height is 6 mm and with a flatness better than 0.05 mm on the fixing area.

The Phins Subsea base plate is designed with two holes for alignment of Phins Subsea axis X2 with a reference direction on the matching adaptation plate fixed onboard.

For mechanical and installation recommendations, refer to Phins Subsea Installation & Setup Guide.

For mechanical and installation recommendations, refer to Phins Subsea Installation & Setup Guide.

3.4 Reference Frame Center

All data is calculated at the Phins Subsea reference frame center 'P point'. This is the reference point from which all of the external sensor lever arms must be measured. The P point is also the reference frame center for the intersection of the three reference axis X1, X2 and X3.

The Phins Subsea reference frame center, P, is:

- the sensing point of all product measurements
- to be used as a reference point to the determination of Phins Subsea and external sensor lever arms

The reference frame center is shown in figure next page, the measures are in mm.

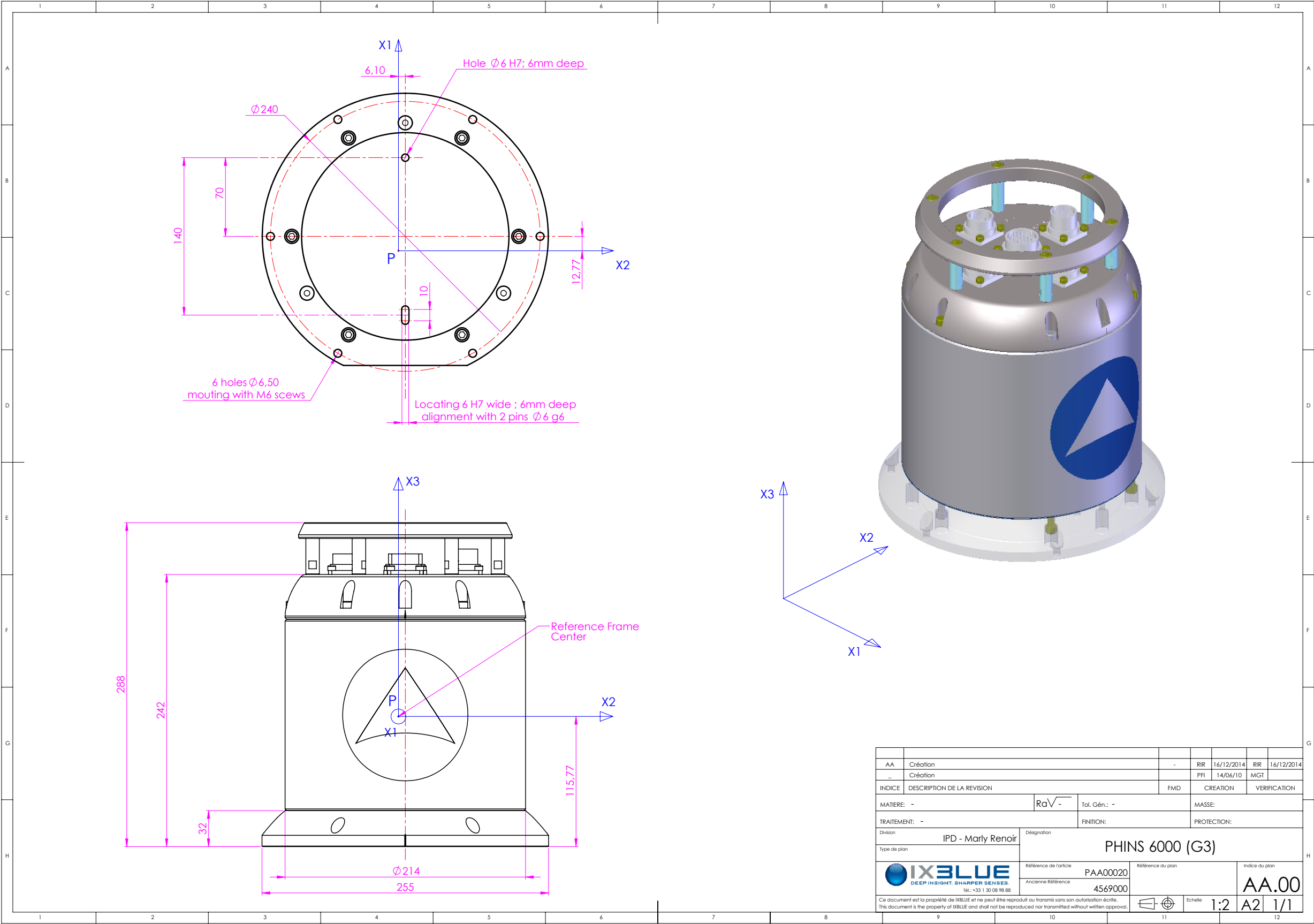


Figure 3 - Phins Subsea housing dimensions and centre point P

PAGE INTENTIONALLY LEFT BLANK

4 Electrical Interface Description

4.1 Overview of electrical interface

Five connectors are available on the top panel of Phins Subsea. These connectors are referenced and identified by markings on the unit. They are all different and fool-proof to avoid any misconnection.



It is very important to screw the product connectors tight. You might feel resistance, make sure they are tightly screwed otherwise the sealing is not guaranteed.

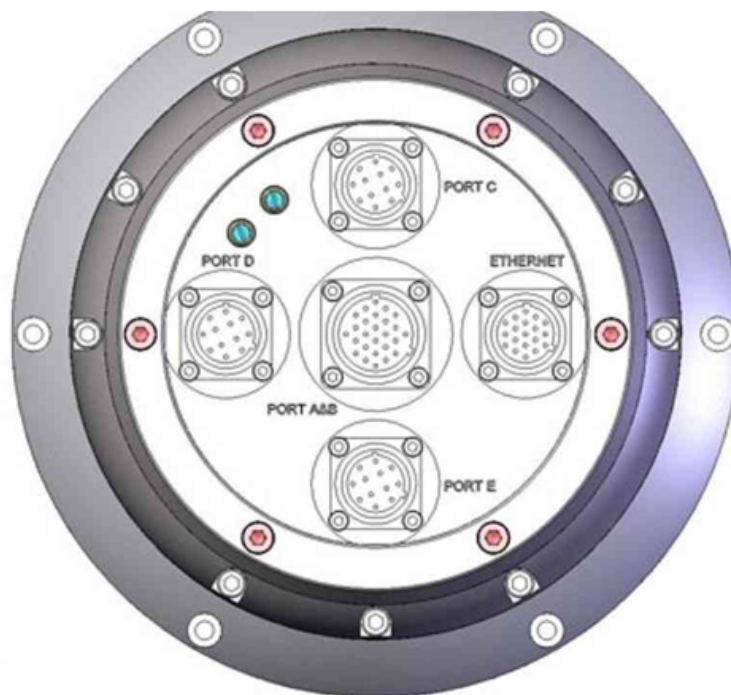


Figure 4 - Phins Subsea connector panel

The connector types are the following

- 1 Ethernet FCR bulkhead SEACON MINK-FCR, size K 19#22 (19 pins).
The reference of the corresponding plug to be plugged directly to the Ethernet connector is MINK-19#22-CCP-TI.
- 3 FCR bulkheads SEACON MINK-FCR, size K 12#22 (12 pins) dedicated to external sensors marked as Port C, Port D and Port E.
The reference of the corresponding plug to be plugged directly to the "Port C", "Port D" or Port E" connector is MINK-12#22-CCP-TI.
- 1 central FCR bulkhead (marked as Port A&B) SEACON MINM-FCR, size M 26#20 (26 pins) for powering, external sensors and configuration. The reference of the corresponding plug to be plugged directly to the central connector is MINM-26#20-CCP-TI.

4.2 Listing of Interfaces

Phins Subsea is fitted with 5 connectors configured to provide the following:

	Ethernet connector	Central connector A&B	Peripheral connector C / D / E
Power system supply	X	X	
2 independent power lines for external sensor allowing to power sensors with different voltages: for example, a DVL powered in 24 V and a SVP sensor powered with 12 V	IN	IN	OUT
1 Repeater and configuration port either through the Ethernet connector or through the Port A&B one (in both RS232 and 422)	X	RS232 or RS422	
Ethernet inputs	7		
Ethernet outputs	5		
RS232 or RS422 inputs		2	1 each
RS232 or RS422 outputs		2	1 each
3 user-configurable pulse Inputs A, B and C	Pulse B	Pulse A	Pulse C on Port C only
2 user configurable pulse Outputs A and B	Pulse B	Pulse A	
1 external pulse (coming from the surface through the central connector and then dispatched to all other connectors): it can be used to output a trigger for the DVL (i.e., to allow the DVL to ping at chosen time)	IN	IN	OUT

The I/O port configuration is done through embedded Phins Subsea Web-Based Graphical User Interface accessible via PC web browser or through a third party system interface via a control command link.



Do not use two power supplies on the main connector (A&B) and the secondary (Ethernet) in order to prevent product damage.

Refer to Phins Subsea Installation & Setup Guide (Ref.: MU-PHIN6ISG-AN-001) for details.

4.3 Ethernet Connector Specification

4.3.1 DEFINITION

The Ethernet connector provides the following inputs and outputs:

- 1 Ethernet 10/100Mbit port used to transport up to 7 input/ 5 output streams user-configured either with UDP or TCP. Configuration is made through the Web-Based Graphical User Interface.
- 1 repeater serial port in RS232 used to monitor system state and send configuration commands in serial mode.
- 1TTL input pulse user-configurable, usually used to send PPS time synchronization.
- 1 TTL output pulse user-configurable
- 1 Ext pulse to trigger external sensors (common to the other connectors external pulse)
- System power supply (+24V)
- 2 different power supplies (Ext sensor 1 Out (+V1) and Ext sensor 2 Out (+V2)) for powering external sensors

These interfaces are user configurable (except for the dedicated configuration I/O) through the Web-based Graphical User Interface or through a third party system interface via a control command link. For details, refer to the documents:

- Installation & Setup Guide (Ref.:MU-PHIN6ISG-AN-001)
- Interface Library (Ref.: MU-PHIN6IL-AN-001)



Do not use both the Ethernet link and the serial one to configure Phins Subsea in the same time. The use of the supplied power supply converter should be restricted to situations where the mains power supply is stable and filtered out. In particular, it is not recommended for use outside land grid, on board a vehicle.

Important

RS232/RS422 ports have to be wired with twisted shielded pairs.

4.3.2 CONNECTOR & PIN OUT

The Phins Subsea Ethernet connector is a SEACON MINK-FCR, size K 19#22 (19 pins). Refer to the following figure for the corresponding wiring.

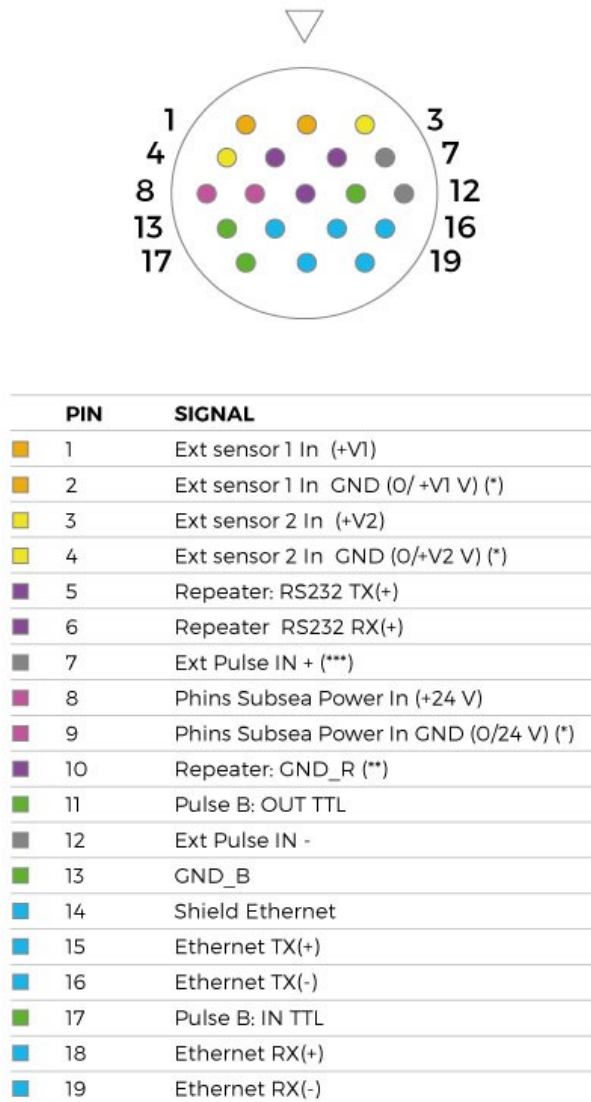


Figure 5 - Ethernet connector pin definition

(*) Phins Subsea and Ext sensor 1 (resp.2) power lines are insulated from each other. Ext sensor 1 (resp. 2) pins of every connector are linked together. If Ext sensor 1 (resp. 2) is powered from 19-pin connector this voltage will be present on 26-pin and 12-pin connectors.

(**) Serial GND and Pulse GND are common for a given port (i.e., GND_A for port A, GND_R for repeater port).

(***) The external trigger lines are insulated. They can be used for example to trigger acoustic emission of a DVL connected to the Phins Subsea. These lines are connected to the external trigger lines of the other connectors to dispatch the signal.

4.4 Port A&B Connector (Central Connector) Specifications

4.4.1 DEFINITION

The central connector can be used as an alternative to the Ethernet connector. It provides power and connection of the Phins Subsea to a PC for installation, for configuration and display purposes through the Web-Based Graphical User Interface which is embedded in the unit.

In this configuration, the Web server connection will need to be configured in PPP (TCP/IP over serial port). Alternatively control commands can be sent through the “repeater port”, refer to Phins Subsea Interface Library.

The Central connector provides the following inputs and outputs:

- 1 repeater serial port in RS232 or RS422 used to monitor system state and send configuration commands in serial mode.
- 2 user-configurable serial input (RX). Pin assignment in RS232 or RS422 electrical levels is detailed in Table 2 RS232 input signal should provide a voltage min ± 5 V to ± 20 V when loaded.
- 2 user-configurable serial output (TX). Pin assignment in RS232 or RS422 electrical levels is detailed in Table 2 RS232 output signal level is ± 5 V min when load is 3 k Ω .
- 1 TTL input pulse user-configurable, usually used to send PPS time synchronization.
- 1 TTL output pulse user-configurable
- 1 Ext pulse coming from the central connector to trigger external sensors (common with other connector external pulse)
- System power supply (+24 VDC)
- 2 different power supplies (Ext sensor 1 Out (+V1) and Ext sensor 2 Out (+V2)) for powering external sensors



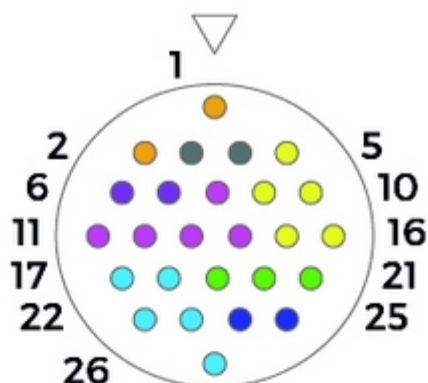
Do not use both the Ethernet link and the serial one to configure Phins Subsea in the same time. The use of the supplied power supply converter should be restricted to situations where the mains power supply is stable and filtered out. In particular, it is not recommended for use outside land grid, on board a vehicle.

Important

RS232/RS422 ports have to be wired with twisted shielded pairs.

4.4.2 CONNECTOR AND PINOUT

Phins Subsea central connector is configured as shown in the following figure.



PIN	SIGNAL
1	System Power In (+24 V)
2	System Power In GND (0/24 V)
3	Ext sensor 1 In (+V1) (*)
4	Ext sensor 1 In GND (0/+V1 V) (*)
5	Repeater: GND_R (**)
6	Ext sensor 2 In (+V2)
7	Ext sensor 2 In GND (0/+V2 V) (*)
8	Port A: GND_A (**)
9	Repeater: RS422 TX (+)(B) / RS232 TX (+)
10	Repeater: RS422 TX (-)(A)
11	Port A: RS422 TX (+)(B) / RS232 TX (+)
12	Port A: RS422 TX (-)(A)
13	Port A: RS422 RX (-)(A) / RS232 RX (+)
14	Port A: RS422 RX (+)(B)
15	Repeater: RS422 RX(-)(A) / RS232 RX(+)
16	Repeater: RS422 RX(+)(B)
17	Port B: RS422 TX(+)(B) / RS232 TX(+)
18	Port B: RS422 TX(-)(A)
19	Pulse A : OUT TTL
20	Pulse A: IN TTL
21	Pulse A: GND_A (**)
22	Port B: RS422 RX(-)(A) / RS232 RX(+)
23	Port B: RS422 RX(+)(B)
24	Ext Pulse IN + (***)
25	Ext Pulse IN -
26	Port B: GND_B(**)

Figure 6 - Central connector

(*) Phins Subsea and Ext sensor 1 (resp.2) power lines are isolated from each other.

Ext sensor 1 (resp. 2) pins are linked together. If Ext sensor 1 (resp. 2) is powered from 19 pin connector this voltage will be present on 26 pin and 12 pin connectors.

(**) Serial GND and Pulse GND are common for a given port (i.e., GND_A for port A, GND_R for repeater port).

(***) The external trigger lines are isolated. They can be used for example to trigger acoustic emission of a DVL connected to the Phins Subsea.

4.5 Port X (X being C, D, or E) Connector Specifications

4.5.1 DEFINITION

The Port C, Port D and Port E connectors are used to connect external sensors and system to Phins Subsea.

These inputs/outputs are user-configurable through the embedded Web-Based Graphical User Interface, refer to Phins Subsea Installation & Setup Guide for details on Phins Subsea configuration with this Web-Based Graphical User Interface.

The Port X (for C, D and E) connector provides the following inputs and outputs:

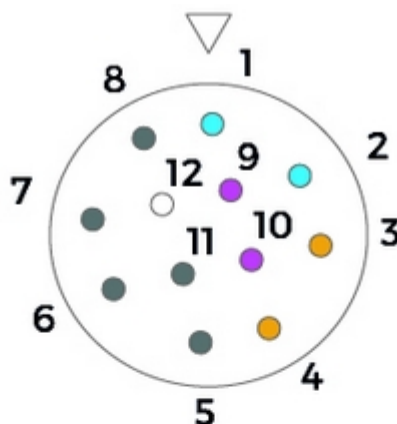
- 1 user-configurable serial input (RX). RS232 input signal should provide a voltage min ± 5 V to ± 20 V when loaded.
- 1 user-configurable serial output (TX). RS232 output signal level is ± 5 V min when load is 3 k Ω .
- 1 TTL pulse input. This pulse is only available on the Port C.
- 1 Ext pulse coming from the central connector
- 2 different power supplies (Ext sensor 1 Out (+V1) and Ext sensor 2 Out (+V2)) for powering external sensor. These lines are common to all other connectors.

Important

RS232/RS422 ports have to be wired with twisted shielded pairs.

4.5.2 CONNECTOR AND PINOUT

Phins Subsea Port X connector is configured as shown in the following figure.



PIN	SIGNAL
1	Ext sensor 1 Out (+V1)
2	Ext sensor 1 Out GND (0/+V1 V) (*)
3	Ext sensor 2 Out (+V2)
4	Ext sensor 2 Out GND (0/+V2 V) (*)
5	Port X: RS422 TX(+)(B)/RS232 TX(+)
6	Port X: RS422 TX(-)(A)
7	Port X: RS422 Rx(-)(A) / RS232 Rx(+)
8	Port X: RS422 Rx(+)(B)
9	Ext Pulse OUT + (***)
10	Ext Pulse OUT -
11	Port X: GND_X (**)
12	Reserved except if X=C : Pulse C: IN TTL (****)

Figure 7 - Central connector

(*) Phins Subsea and Ext sensor 1 (resp.2) power lines are isolated from each other.

Ext sensor 1 (resp. 2) pins are linked together. If Ext sensor 1 (resp. 2) is powered from 19 pin connector this voltage will be present on 26 pin and 12 pin connectors.

(**) Serial GND and Pulse GND are common for a given port (i.e., GND_A for port A, GND_R for repeater port).

(***) The external trigger lines are isolated. They can be used for example to trigger acoustic emission of a DVL connected to the Phins Subsea.

(****) Pulse C only on Port C, Pin 11 common for Pulse and Port C.

4.6 Phins Subsea Power Network

4.6.1 POWER SUPPLY DEFINITION

Phins Subsea is equipped with two external sensor power circuitry, see figure below. They are dedicated to supply power to external sensors, such as DVL or Depth Sensor, which are connected directly to the Phins Subsea. The principle is to use a single cable/connector between ROV control unit/bottle and Phins Subsea. This cable would have to handle three power supplies: Phins Subsea, External Sensor 1 and External Sensor 2. The two last are wired to satellite connectors to power individually each external sensor.

4.6.2 POWER SUPPLY PINOUT

Phins Subsea power network is configured as shown in the following figure.

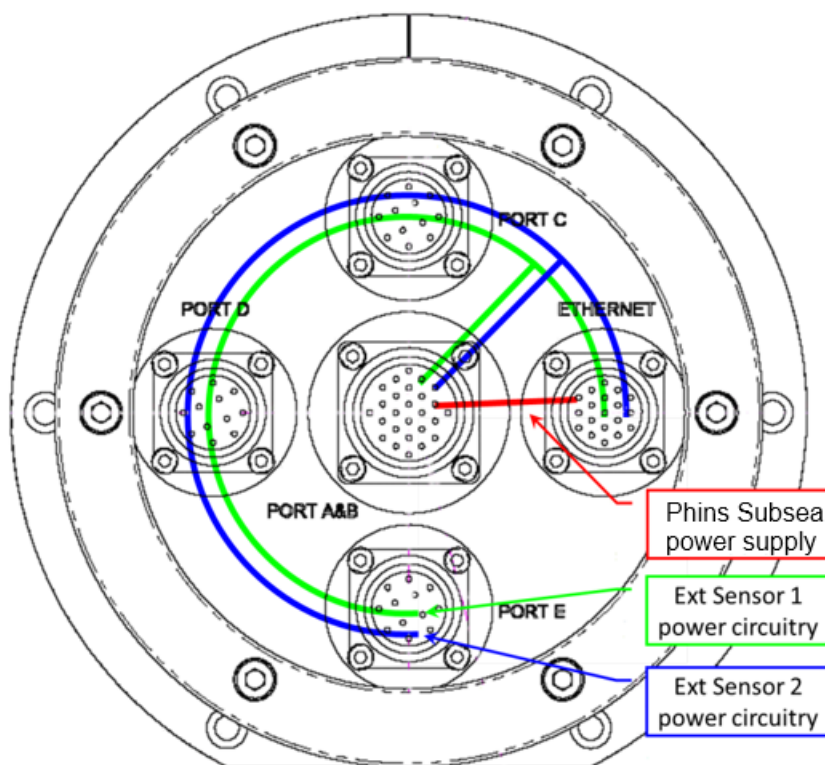


Figure 8 - Power network for the external sensors

To power external sensors to power circuitry can be used:

- with external sensor 1 connected:
 - > on pin 3 and 4 of central connector
 - > or on pin 1 and 2 of Ethernet connector
- with external sensor 2 connected:
 - > on pin 6 and 7 of central connector
 - > or on pin 3 and 4 of Ethernet connector

On these pins, the total maximum current is 3 A and the maximum voltage is 250 V.

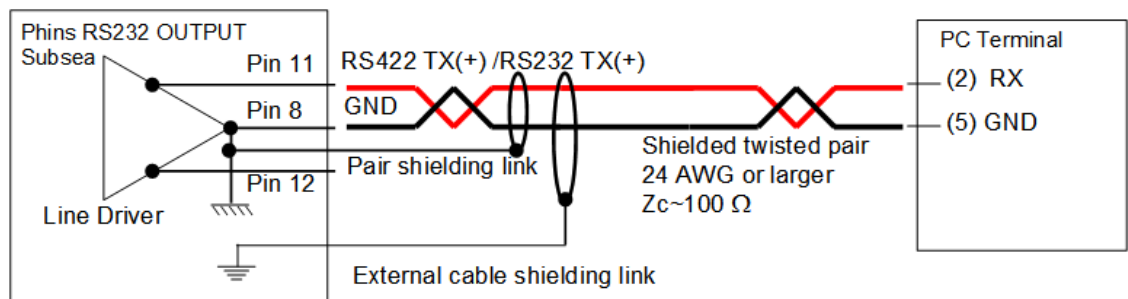
4.7 Recommended Wiring

The recommended wiring with Shielded Twisted Pairs for RS232 (Output and Input), RS422 (Output and Input), and Pulse (Output and Input) cables are described hereafter.

Important

If you do not use shielded multi-twisted pairs, you may encounter cross-talk problems between input and output, and this may give error or dysfunction. Shield link should be done at one end only to avoid ground loops unless shield is used as an electrical ground.

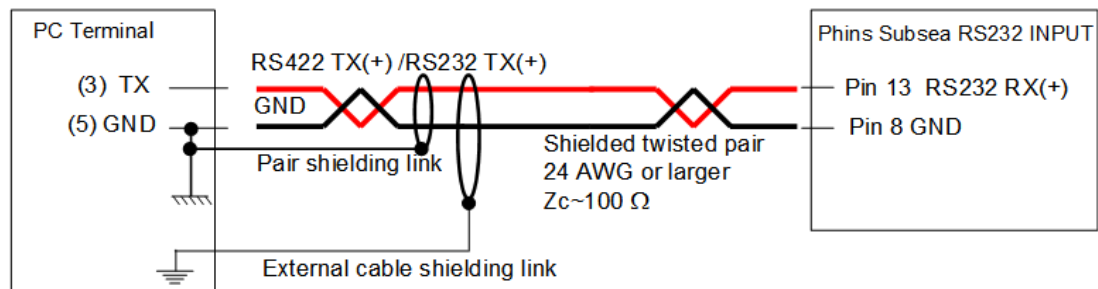
It is recommended to link external cable shielding to mechanical ground. It is recommended to link the wires not used to the mechanical ground of the related port.



All pins marked GND are common electrical ground and can be used indifferently.

Mechanical GND connection is recommended through connector backshell.

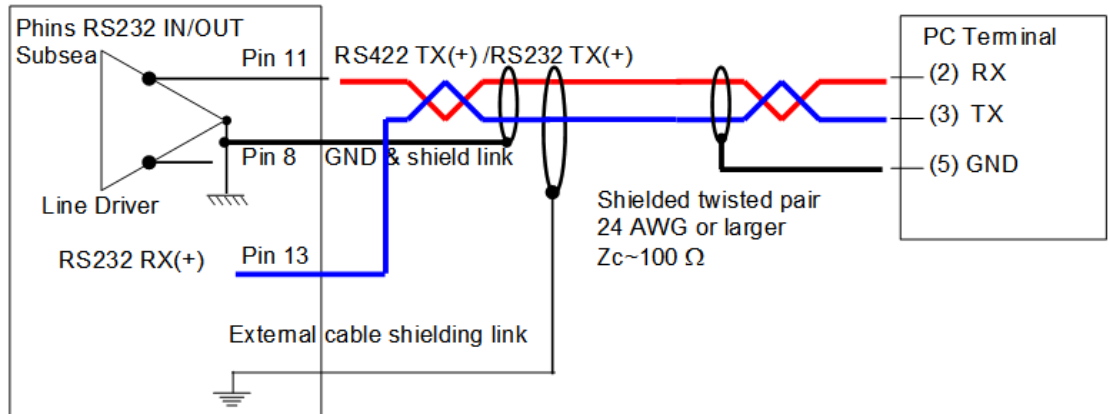
Figure 9 - Description of mono-directional RS232 Output wiring (Port A example)



All pins marked GND are common electrical ground and can be used indifferently.

Mechanical GND connection is recommended through connector backshell

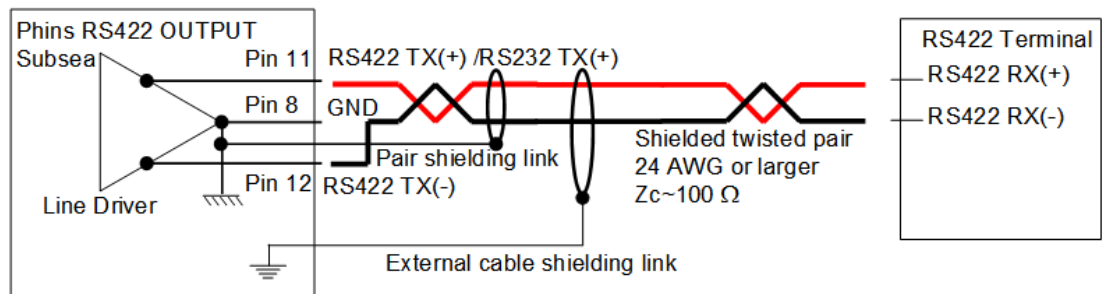
Figure 10 - Description of mono-directional RS232 Input wiring (Port A example)



⏏ All pins marked GND are common electrical ground and can be used indifferently.

⏏ Mechanical GND connection is recommended through connector backshell.

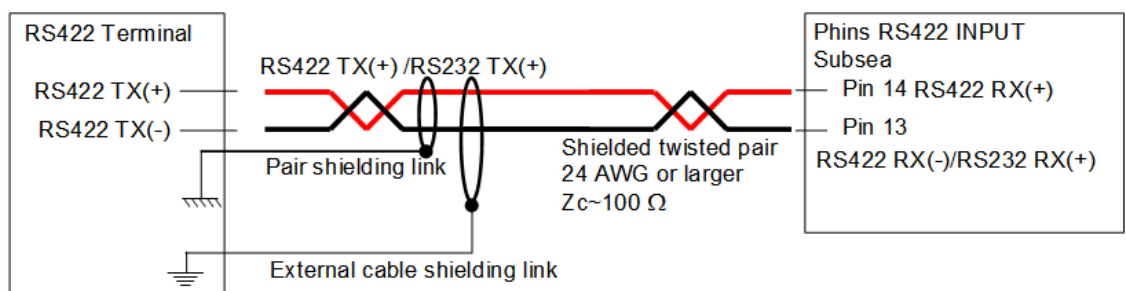
Figure 11 - Description of bi-directional RS232 Output wiring (Port A example)



⏏ All pins marked GND are common electrical ground and can be used indifferently.

⏏ Mechanical GND connection is recommended through connector backshell.

Figure 12 - Description of the RS422 Output wiring with a Shielded Twisted Pair (Port A example)



⏏ All pins marked GND are common electrical ground and can be used indifferently.

⏏ Mechanical GND connection is recommended through connector backshell.

Figure 13 - Description of the RS422 Input wiring with a Shielded Twisted Pair (Port A example)

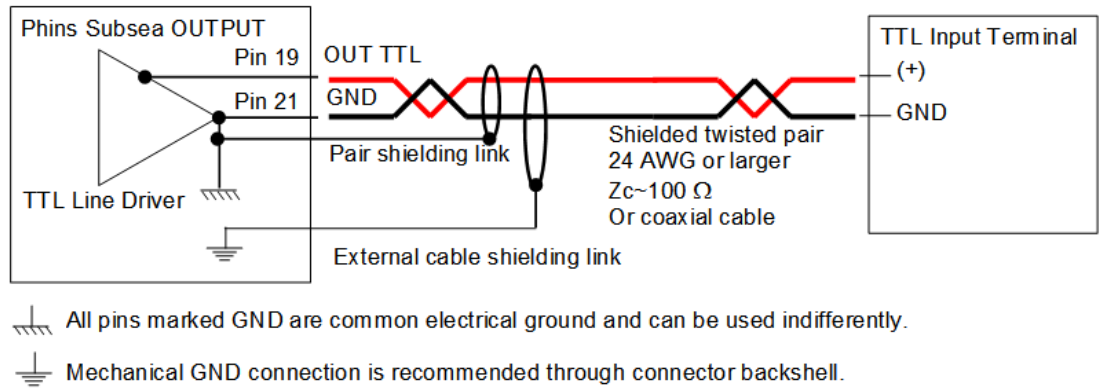


Figure 14 - Description of the Pulse Output wiring with a Shielded Twisted Pair (Pulse A example)

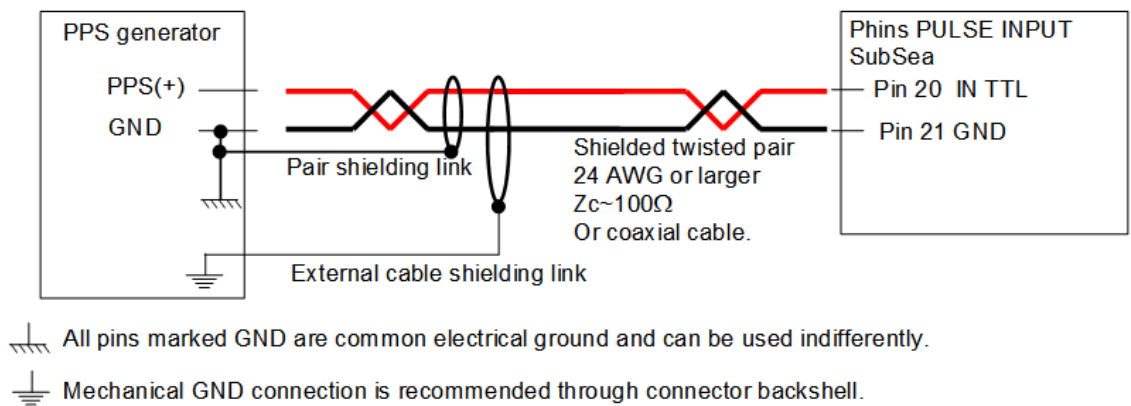


Figure 15 - Description of the Pulse Input wiring with a Shielded Twisted Pair (Port A example)

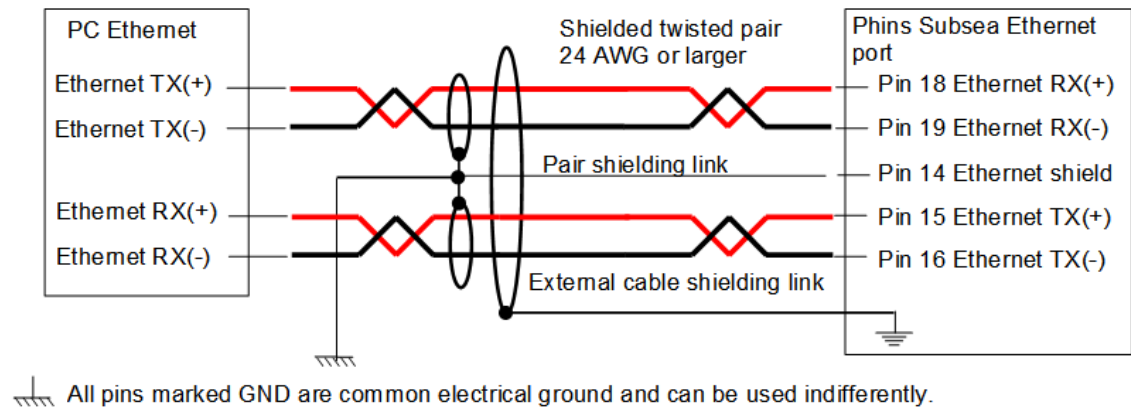
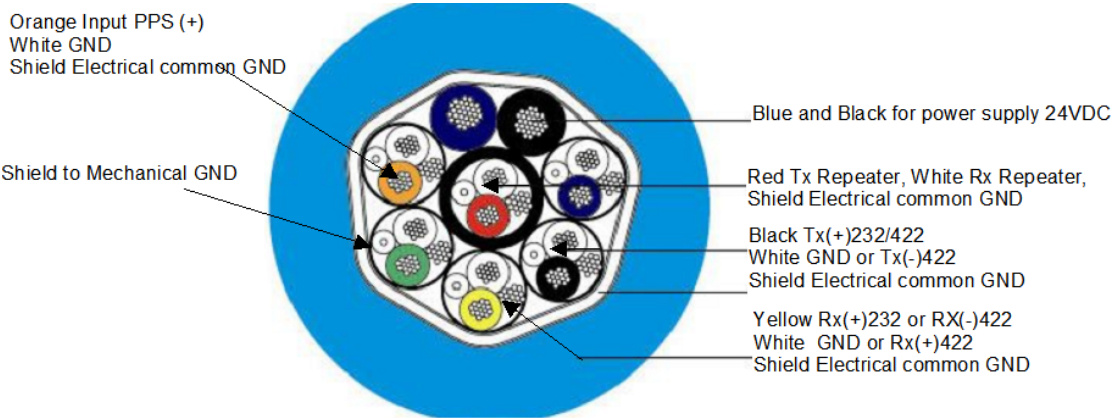


Figure 16 - Description of the Ethernet wiring with Shielded Twisted Pairs

Example of cabling with a multi twisted pair MacArtney ref. 4622



4.8 RS232/RS422 Input and Output Characteristics

Each RS232 and RS422 input and output is based on a separate MAX3160 driver powered by its own DC/DC converter and isolated from each other and from the internal digital power by an ISO7220AD isolator.

The following table details input impedance of each port and voltage requirements for each port:

Table 1 - RS232/RS422 Input characteristics

	RS232	RS422
Input impedance	5 k Ω	48k Ω
Minimum input LOW threshold	0.8 V	N/ A
Maximum input HIGH threshold	2.4 V	N/ A
Minimum differential threshold	N/ A	200 mV

The following table details output impedance of each port and maximal output current that can be delivered by each port driver.

Table 2 - RS232/RS422 Output characteristics

	RS232	RS422
Output impedance	100 Ω	40 Ω
Max. output drive current	110 mA	260 mA
Output voltage (no load)	± 11 V	10.4 V differential
Output voltage (loaded)	10.8 V (3 k Ω)	7.5 V differential (100 Ω)

4.9 Input Pulses Electrical Characteristics

Following table details input pulse characteristics:

Table 3 - Input Pulse Electrical Characteristics

	Symbol	Min	Max	Unit
Input pulse width	TW	1	-	μs
Low to High transition voltage	VLH	2	-	V
High to Low transition voltage	VHL	-	0.8	V
Input voltage	VIN	- 0.5	5.5	V
Input current	IIN	- 10	10	μA
Pulse internal latency	TL	-	10	μs

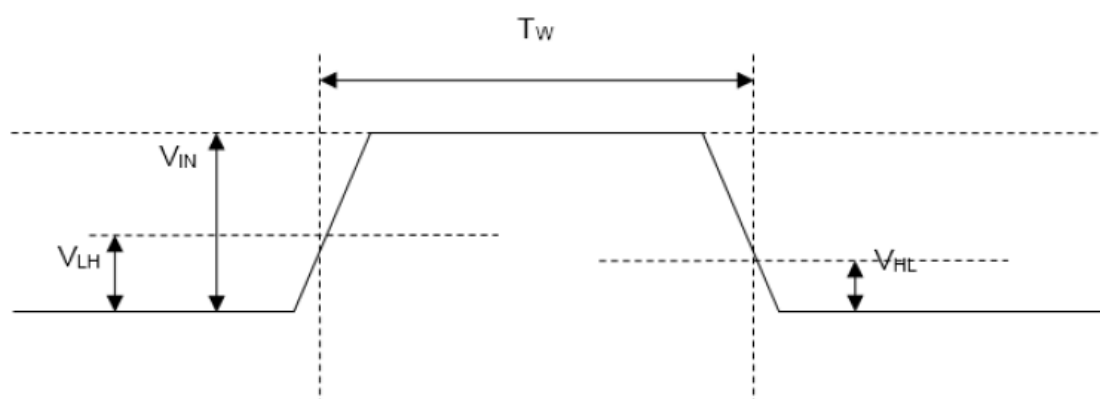


Figure 17 - Input Pulse Diagram

4.10 Output Pulses Electrical Characteristics

Following table details output pulse characteristics:

Table 4 - Output Pulse Electrical Characteristics

	Symbol	Min	Max	Unit
Output voltage at logic low	VL	0	0.4	V
Output voltage at logic high	VH	4.8	5	V
Output current	IOUT	-	4	mA

5 Communication Interface Description

5.1 Communication Link

Phins Subsea is able to receive and transmit data through 5 configurable asynchronous serial communication lines (digital I/O):

- Baud rates, parity and number of stop bits can be configured independently for each of the 5 serial links
- Electrical level (RS-232 or RS-422) can be configured independently for each of the 5 serial links

Phins Subsea is able to receive and transmit data through a 10/100 Mbits/s Ethernet link:

- TCP/IP and UDP protocols are available
- 7 input / 5 output virtual ports can be opened simultaneously

The output frequency can be selected as presented in the Interface Library document.

Phins Subsea can be connected to a PC for configuration, installation and display purposes through the Web-Based Graphical User Interface. The I/O signal is available:

- Either through the Ethernet connector (see section 4.3).
- Or through the digital I/O connector (see section 4.4).

In default configuration, access to the Web-Based Graphical User Interface is only possible through the Ethernet connector.

On RSXX2 serial link, the Installation and Repeater output has to be configured in PPP mode to have access to the Web-Based Graphical User Interface (refer to Phins Subsea Installation & Setup Guide for more details).

For the Ethernet link, the following parameters are defined by default:

- IP Address: 192.168.36.1xx, xx being the last two numbers of the Phins Subsea serial number
- Connection through http web server (port 80)
- Repeater flow available in TCP (port 8110)

By default, serial repeater link is configured as follows:

- Protocol used : PHINS Standard, refer to Phins Subsea Interface Library for a description of PHINS Standard data frame output
- Baudrate : 57.6 kBauds
- Flow Control : Odd, 2 stop bits
- Refresh rate : 5 Hz (200 ms)

5.2 Software Interfaces and Library

Input and output digital interfaces are user-configurable with a comprehensive set of protocols (or formats) to be selected from the digital interface library.

Digital protocols in binary format and NMEA compliant ASCII format are available for input and output data.

To get details on protocols, please refer to Phins Subsea Interface Library.

System configuration and operation can be performed either through the Web-Based Graphical User Interface (refer to Phins Subsea Installation & Setup Guide) or with text control command (refer to Phins Subsea Interface Library).

5.3 Web-Based Graphical User Interface

Phins Subsea is delivered with iXblue established Web-Based Graphical User Interface. It runs either on a workstation or on a laptop and allows system configuration. The embedded Web-Based Graphical User Interface has been optimized and qualified with PC running Windows 10 operating system.



Figure 18 - Phins Subsea Web-based Graphical User Interface

An USB flash drive is provided with the Phins Subsea, it contains web browser software, Phins Subsea user manuals and mechanical drawings.

5.4 Control Command

The control commands give access to the following features:

- Installation
 - > Misalignment configuration
 - > Level arms configuration
 - > Communication link configuration (physical parameter and software parameters)
 - > External sensor configuration
- Operation
 - > Software reset
 - > User position fix
 - > Software activation / deactivation of external sensor
 - > Data display (including all navigation and quality check data)
 - > Data logging



Refer to Phins Subsea Interface Library to get details on the control commands.

iXblue CONTACT - SUPPORT

For non-URGENT support:

- by email: support@ixblue.com
- using the form on the iXblue web site www.ixblue.com

For 24/7 URGENT SUPPORT:

- North America / NORAM
+1 617 861 4589
- Europe Middle-East Africa Latin-America / EMEA-LATAM
+33 1 30 08 98 98
- Asia Pacific / APAC
+65 6747 7027