USER GUIDE

OCTANS III

NAVIGATION
& POSITIONING

II. PART 2: OCTANS III SURFACE USER GUIDE

IXSEA

TABLE OF CONTENTS

II.1 INTRODUCTION

This document is the OCTANS III Surface User Guide. It gives a short description of the technology used in OCTANS. It provides information on OCTANS III Surface specifications, performances, mechanical and electrical interfaces. Conventions and definitions used for data output are given, and operational considerations are assessed.

II.2 DOCUMENT HISTORY

The current edition is applicable to OCTANS units using firmware versions higher than with firmware version higher than 10.88.x. Apart from a general text review, the following modifications and additions have been performed with respect to previous edition:

- Correction on wiring for RS422 and RS 232 serial inputs and outputs (applicable to all OCTANS units, whatever the firmware version)
- Description of the recommended wirings are added in section II.5.6.6. This is applicable to all OCTANS III, Surface whatever the firmware version.

The preceding edition is applicable to OCTANS units using firmware version 10.82.xx, with the following modifications with respect to previous document:

- A precision is added about the power supply (see section II.5.3).

II.3 OCTANS TECHNICAL DESCRIPTION

OCTANS is both a fibre-optic survey-grade IMO-certified gyrocompass and a Motion Reference Unit for marine applications. OCTANS provides true-heading, roll, pitch, yaw, heave, surge, sway, rates of turn and accelerations even in highly volatile environments. OCTANS is certified to meet the requirements of the International Maritime Organisation (IMO) for gyrocompasses. The core of OCTANS is a compact strapdown Inertial Measurement Unit (IMU), which contains three accelerometers, three fibre optic gyroscopes, and a real-time computer (see Figure II-1).

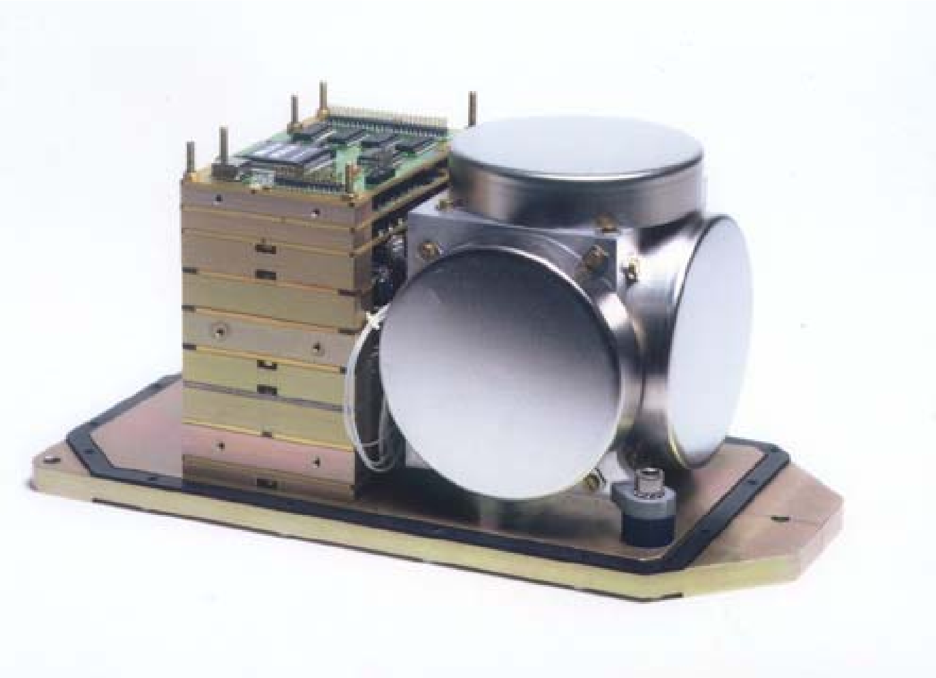


Figure II-1 : The “open” OCTANS unit (Surface Model)

The unit’s computer is a Digital Signal Processor (DSP) chip enabling complex real-time computation.

The heading search algorithm has been designed by iXSea. Heading and attitudes are computed whether the system is in movement or not, and without an external reference point. Computation is based on (filtered) measurement of shifts in local gravity as the Earth rotates. It involves angle integration using quaternion algebra, a heading search algorithm, and Coriolis force correction for vessel speed.

II.3.1 PERFORMANCES

II.3.1.1 GYROCOMPASS TECHNICAL PERFORMANCES

Dynamic accuracy (whatever sea-state)	0.1 deg Secant Latitude* RMS
Settle point error	0.05 deg Secant Latitude* RMS
Settling time (static conditions)	< 1 Minute
Settling time at sea :	< 3 Minutes
Repeatability	± 0.025 deg Secant Latitude* RMS
Resolution	0.01 deg

No Latitude nor speed limitation

(*) Secant Latitude = 1/cosine Latitude

II.3.1.2 MOTION SENSOR TECHNICAL PERFORMANCE

Heave, Surge & Sway:	
Accuracy	5 cm or 5% (whichever is highest)
Resolution	1 cm
Heave motion periods	0.03 to 40 s (self adaptive SAFE heave)
Roll & Pitch:	
Accuracy	0.01 deg RMS
Range	No limitation
Follow-up speed	Up to 500°/s

II.3.2 ENVIRONMENT

Operating temperature*:	-40°C to +60°C
Storage temperature:	-40°C to +80°C
Shocks:	30 g in 6 ms (operating)
	50 g in 11 ms (survival)
Vibrations:	1 g sine (5 to 50 Hz)
MTBF	30 000 Hours

*: OCTANS operates at temperatures below –10°C if started and first operated for a period > 1 hour at a temperature higher than –10°C.

OCTANS III is also available in underwater housings depth-rated to 3000 meters (OCTANS 3000) and 6000 meters (OCTANS 6000).

II.3.3 INTERFACE

II.3.3.1 DIMENSIONS

Shape: Rectangular box, splash proof(IP 66)

Dimensions (L x W x H, in mm): 276 x 136 x 148.5

Weight in air: 4.3 kg

Material: Aluminium

II.3.3.2 POWER REQUIREMENT

Input voltage: 20 to 30 V d.c. (24 V nominal)

Power consumption: 12 W (max.)

II.3.3.3 OUTPUTS

- Serial: 3 independent and configurable digital outputs
  To be selected from a complete set of existing protocols(refer to Part 4 of OCTANS User Guide), with RS 232 or RS 422 levels
  1 RS232 output for monitoring (repeater port)
- Analogue: 4 independent and configurable analogue outputs, 14 bits / ±10V
- Pulses: 2 pulse outputs
- Update rate: up to 100 Hz

II.3.3.4 INPUTS

- Serial: 3 independent and configurable digital inputs
  1 RS232 input for configuration (repeater port)
- Pulses: 2 pulse inputs
- Update rate: up to 100 Hz

II.3.3.5 REPEATER SOFTWARE

OCTANS is delivered with a powerful and easy-to-use Installation and Repeater software, which allows for a complete configuration (choice of baud-rates and frequencies, data frame protocols, scale factors for analogue I/O, multiple lever arms, filtering parameters….). Refer to Part 3 of the OCTANS User Guide for a full description of the software.

II.4 MECHANICAL INTERFACE

OCTANS III mechanical interface is fully compatible with previous OCTANS versions.

II.4.1 OCTANS III INTERFACE PLATE

OCTANS is installed using three M6 screws accessible from the top of the unit (see Figure II-2).

Alignment is carried out by means of two centering pins, located on the bottom plate of the OCTANS (accuracy of mechanical positioning with the centering pins is ±0.04 degree). These pins are located on the OCTANS centerline, as shown by grooves on the front and rear of the gyrocompass.

The mechanical tolerance in the manufacture of OCTANS bottom plate allows to have 0.01° of accuracy on the centerline of the unit.

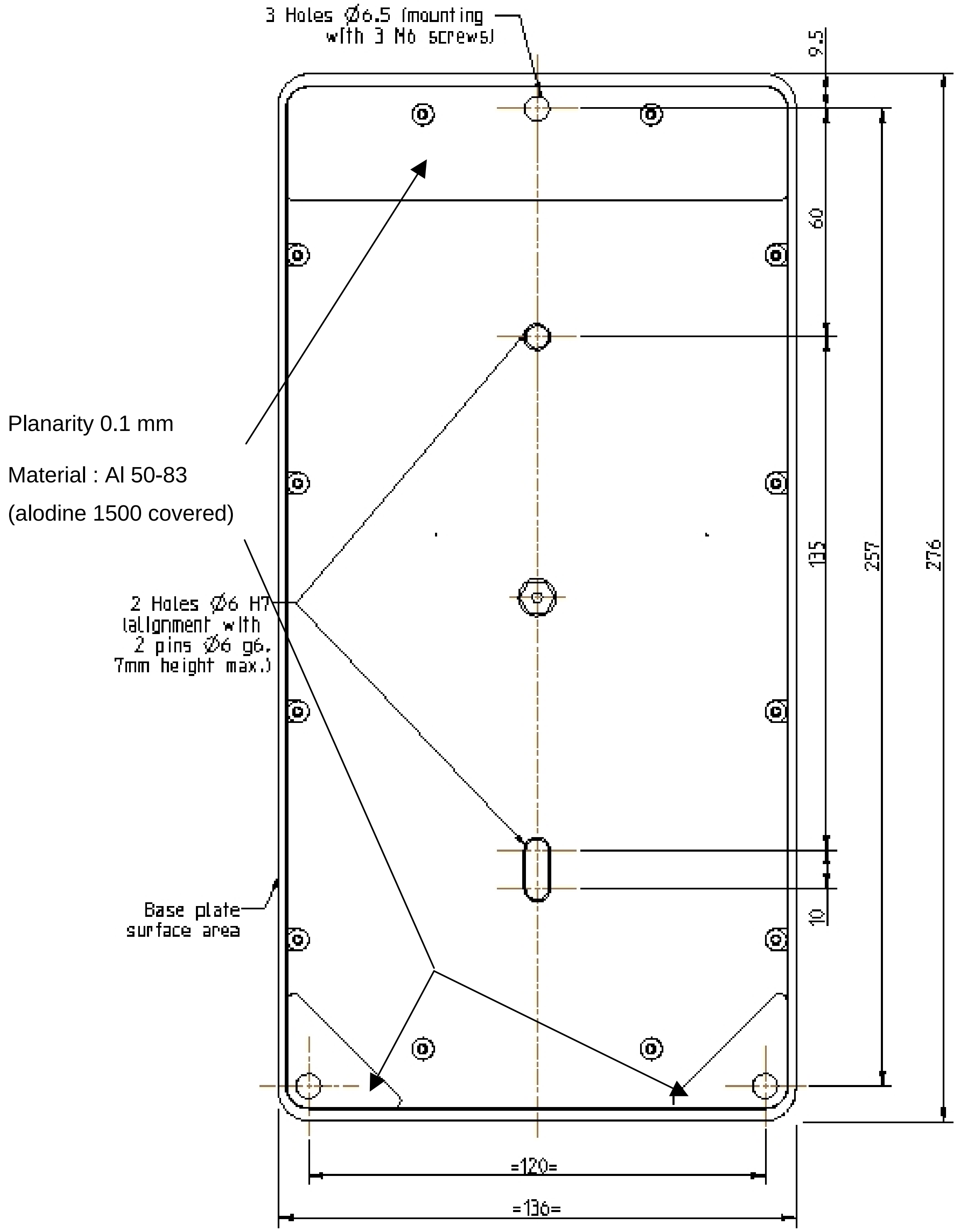


Figure II-2 : OCTANS mounting diagram

II.4.2 OCTANS III CENTRE OF MEASUREMENTS AND REFERENCE FRAME

All inertial measurements are default performed with respect to OCTANS reference frame (X1, X2, X3). This frame is defined in Figure II-3.

Motion sensing measurements are default measured at OCTANS III centre of measurements P, which is defined in Figure II-3.

Measurements can be performed at an external monitoring point. The position of this point has to be measured with respect to OCTANS III center of measurement and entered in the OCTANS Configuration through the Installation and Repeater Software.

Detail on external points monitoring is given in section II.7.1.3.

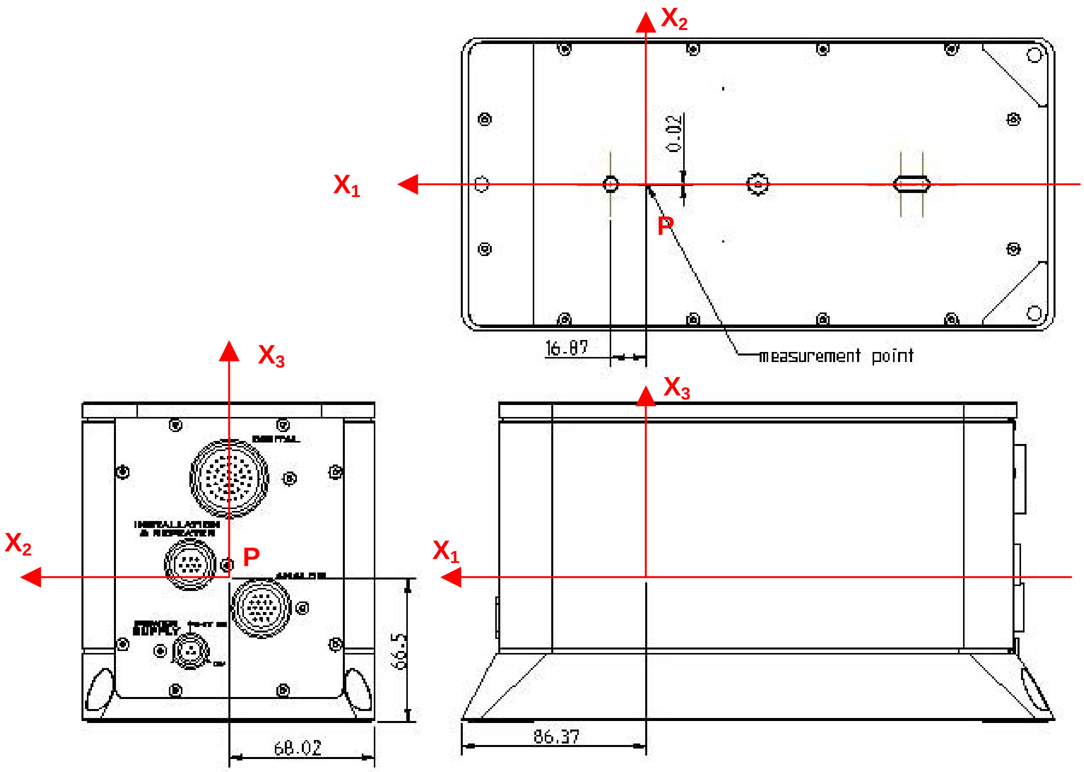


Figure II-3 : Position of OCTANS III centre of measurements P and definition of OCTANS reference frame

II.5 ELECTRICAL INTERFACE

OCTANS III electrical interface is fully compatible with previous OCTANS versions.

II.5.1 DESCRIPTION OF THE REAR PANEL

All OCTANS inputs/outputs are made via four sealed connectors. The rear panel of the OCTANS unit holding these connectors is shown in Figure II-4.

The connector references are as follows:

Amphenol Socapex

Power supply: PT02 YS 0833 P023

Repeater: PT02 YS 1210 P023

Analogue I/O: PT02 YS 1419 P023

Serial & pulses I/O: PT02 YS 2041 P023

Figure II-4 : OCTANS rear panel

II.5.2 LISTING OF INTERFACES

OCTANS is fitted with 4 connectors configured to provide the following:

- Power supply, described in II.5.3,
- Repeater and configuration port (only RS232 level), described in II.5.4 and II.5.6.5
- 4 analogue Outputs described in II.5.5.2,
- 3 Serial Inputs RS232/422 user-configurable, described in sections II.5.6.2 and II.5.6.3,
- 3 Serial Outputs RS232/422 user-configurable, described in sections II.5.6.2 and II.5.6.3,
- 2 pulse Inputs described in section II.5.6.4,
- 2 pulse Outputs described in section II.5.6.4.

I/O interfaces can be user configured. This is done with the Installation and Repeater Software installed on a PC connected to OCTANS. Refer to Part 3 of the OCTANS User Guide for detail.

II.5.3 POWER SUPPLY CONNECTOR

OCTANS is powered with a standard 24 V DC supply. It is possible however to supply power with any voltage between 20 V and 30 V. Maximal power consumption is 12 W in all cases.

OCTANS can be powered by 2 methods:

- Via the AC/DC converter provided with the local standard power supply. It is not recommended to use this converter to power OCTANS from another source of power than the country mains. In particular, **it is NOT recommended to use this converter onboard a vessel**.
- Via a 3-wire cable for direct connection to a 24 V power supply. Connector used is Amphenol Socapex PTG 55A 0833 S023. Wiring is detailed on Table II-1.

Pin	Signal
A	24 V DC (20 V to 30 V)
B	GROUND
C	Mechanical ground

Table II-1 : Configuration of power supply cable provided by IXSEA

Warnings:

- OCTANS does not possess an on/off switch. As soon as it is powered, it begins to seek geographical North. Any interruption of the power supply, even brief, will return the system to its initial condition and it will begin to seek North again. The alignment phase will start over.
- At powering, the power supply must have reached its operating voltage (20-30 V) in less than 100 ms.

II.5.4 INSTALLATION & REPEATER CONNECTOR

This connector is used for configuring OCTANS and / or to display data using the repeater software. Refer to Part 3 of the OCTANS User Guide for detail on the software.

II.5.4.1 CONNECTING OCTANS TO PC THROUGH THE REPEATER CONNECTOR

Connection between OCTANS and PC through the Installation and Repeater connector is made using the dedicated cable delivered with the unit:

- Connector reference is Amphenol Socapex PTG 55A 1210 S023 at one end to be plugged into OCTANS Installation and Repeater connector
- SUB D9 connector at the other end to be plugged into any PC serial port.

Table II-2 describes the connection between the Repeater connector pins and the SUB D9 connector.

OCTANS Repeater connector		**PC SUB D9 connector**	
Pin	Signal	Pin	Signal
A	ConfigOUT GND	5	PC GND
B	ConfigOUT +	2	PC Rx
D	ConfigIN GND	5	PC GND
E	ConfigIN -	5	PC GND
F	ConfigIN +	3	PC Tx

Table II-2 : Cable between OCTANS Repeater connector and PC subD9

Note: pins A and E need to be connected to Pin 5 of DB9 for proper transmission.

II.5.4.2 SPECIFICATIONS FOR COMMUNICATION BETWEEN OCTANS AND PC

OCTANS can be connected to a PC for configuration and monitoring. The I/O signal is available either through the Installation and Repeater connector (see section II.5.4.1) or through the Digital I/O connector (see section II.5.6). Whatever the way for connecting OCTANS to PC, data flows in and out in RS 232 format with the following characteristics:

- Protocol used: OCTANS Standard (see the OCTANS library documentation, Part 4)
- Baudrate: 19.2 kBauds
- Flow Control: Odd, 2 stop bits
- Refresh rate: 5 Hz (200 ms)

Warning:

It is not possible to use simultaneously the configuration line coming from the **digital** connector (see section II.5.6) and the one on the **repeater** connector.

II.5.5 ANALOGUE CONNECTOR

II.5.5.1 CONNECTOR PIN OUT

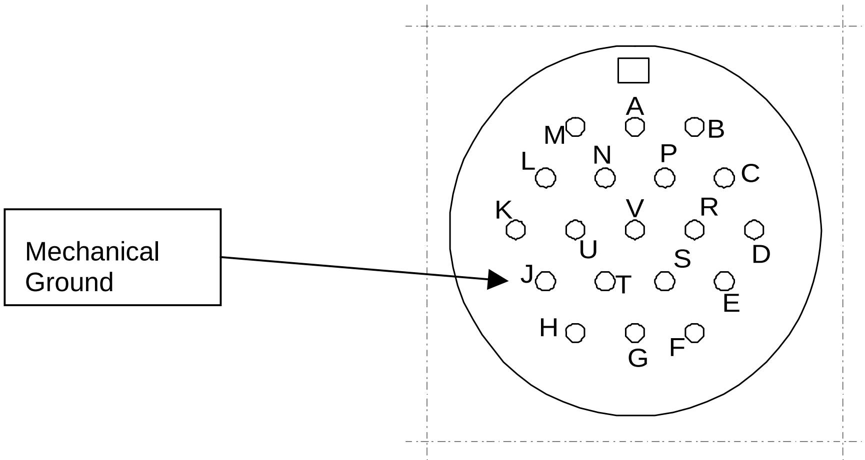


Figure II-5 : Drawing of the analogue connector

Pin	Signal	Pin	Signal
E	AnaOutASig	R	AnaOutAGnd
F	AnaOutBSig	S	AnaOutBGnd
G	AnaOutCSig	T	AnaOutCGnd
H	AnaOutDSig	U	AnaOutDGnd
J	Mechanical Ground	*V*	*Reserved*

Table II-3 : Configuration of the analog I/O connector

II.5.5.2 ANALOGUE OUTPUTS (PINS E, F, G, H, R, S, T AND U)

Four ±10 V analogue outputs are available on OCTANS. These outputs offer 14-bit resolution at 100 Hz and are identified by the signals AnaOut_Gnd and AnaOutXSig, X = A, B, C, D.

- Analogue Output A uses pins E (AnaOutASig) and R (AnaOutAGnd),
- Analogue Output B uses pins F (AnaOutBSig) and S (AnaOutBGnd),
- Analogue Output C uses pins G (AnaOutCSig) and T (AnaOutCGnd),
- Analogue Output D uses pins H (AnaOutDSig) and U (AnaOutDGnd).

The analogue outputs can be user configured (signal and scale factor). For detail on configuration, refer to the Part 3 of the OCTANS III user guide.

A female connector reference Amphenol Socapex PTG 55A 1419 S023 is available to directly connect the wires.

II.5.6 DIGITAL CONNECTOR

The digital I/O connector provides the following inputs and outputs:

- 3 digital inputs which can be user-configured either with RS232 or RS422 electrical levels. Configuration of electrical level is made through the wiring. Refer to Table II-5 and Table II-7 respectively for the corresponding wiring.
- 3 digital outputs user-configurable with RS232 or RS422 levels. Configuration of electrical level is made through the OCTANS Repeater Software. Refer to Table II-6 and Table II-8 respectively for the corresponding wiring.
- 2 pulse inputs, and 2 pulse outputs, which are described in section II.5.6.4.
- 1 digital input and 1 digital output dedicated to configuration and installation through connection to a computer (see section II.5.6.5).

These electrical interfaces are user configurable (except for the dedicated Config I/O) through the OCTANS Repeater software. Refer to Part 3 of OCTANS User Guide for detail.

They are used:

- For connection of external sensors to OCTANS: connecting a GPS to a serial input, connecting a log sensor to a pulse input to get respectively external input of latitude and speed into OCTANS
- For output of OCTANS data to external systems through serial ports
- For synchronisation purposes: synchronisation of OCTANS serial data output (using pulse inputs) or synchronisation of external systems to OCTANS serial data output (using pulse outputs)
- For configuration and display purposes through the digital connector.

II.5.6.1 DIGITAL CONNECTOR PIN OUT

All digital inputs and outputs are available through a single connector, illustrated in Figure II-6. The pins are designated from A to Z, and then from a to t. These pins match, according to the lettering, the “bare” socket connector, reference Amphenol Socapex PTG 55A 2041 S023, supplied as a standard with OCTANS.

The pin assignment is described in Table II-4.

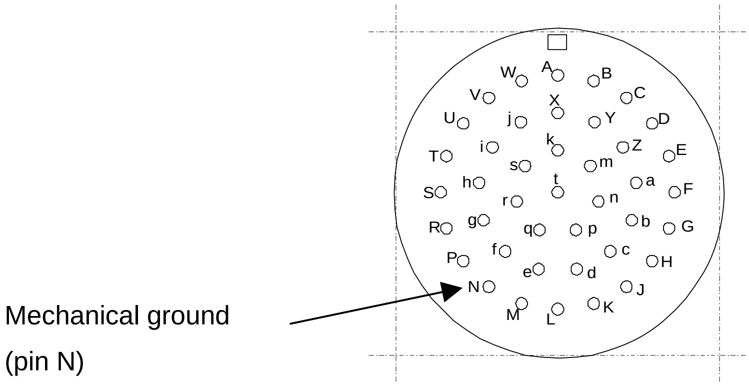


Figure II-6 : Diagram of the digital I/O connector

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
A	**Port A:** RS232TX(-)GND	M	*Reserved*	Z	**Port B:** RS422RX(+)/RS232RX(-)	k	*Reserved*
B	**Port A:** RS422TX(+)/RS232TX(+)	N	Mechanical GND	a	**Port B:** RS422RX(-)/RS232RX(+)	m	*Reserved*
C	**PortA**: RS422 TX(-)	P	*Reserved*	b	**Port C:** RS422RX(+)/RS232RX(-)	n	*Reserved*
D	**Port B**: RS232TX(-)GND	R	*Reserved*	c	**Port C:** RS422RX(-)/RS232RX(+)	p	*Reserved*
E	**Port B**: RS422TX(+)/RS232TX(+)	S	*Reserved*	d	**Repeater**: RS232RX(-)	q	*Reserved*
F	**Port B**: RS422TX(-)	T	**Pulse B:** GND	e	**Repeater**: RS232RX(+)	r	*Reserved*
G	**Port C:** RS232TX(-)GND	U	**Pulse B:** OUT TTL	f	*Reserved*	s	*Reserved*
H	**Port C:** RS422TX(+)/RS232TX(+)	V	**Pulse A**: GND	g	**Pulse B**: IN(-)	t	*Reserved*
J	**Port C**: RS422TX(-)	W	**Pulse A**: OUT TTL	h	**Pulse B**: IN(+)		
K	**Repeater:** RS232TX(-)GND	X	**Port A:** RS422RX(+)/RS232RX(-)	i	**Pulse A**: IN(-)		
L	**Repeater :** RS232TX(+)	Y	**Port A:** RS422RX(-)/RS232RX(+)	j	**Pulse A**: IN(+)		

Table II-4 : Digital I/O connector pin definitions

II.5.6.2 DEFINITION OF THE 3 INPUTS AND 3 OUTPUTS IN RS232 FORMAT

Assignment of the connector pins for the 3 digital I/O with RS232 electrical level is reported in Table II-5 (RS232 inputs) and Table II-6 (RS232 outputs).

RS 232	Ground	Signal +	Shield (optional)
Input A	pin X	pin Y	pin N
Input B	pin Z	pin a	pin N
Input C	pin b	pin c	pin N

Table II-5 : Pin assignment for the three digital inputs in RS232 format

RS 232	Ground	signal +
Output A	pin A	pin B
Output B	pin D	pin E
Output C	pin G	pin H

Table II-6 : Pin assignment for the three digital outputs in RS232 format

RS232 input signal should provide a voltage higher than 4 V when loaded.

RS232 output signal is ± 9 V level unloaded.

Note: all serial inputs are independent, but it is possible to link RS232TX(-)GND and RS232RX(-) to use a single SUB D9 connector.

II.5.6.3 DEFINITION OF THE 3 INPUTS AND 3 OUTPUTS IN RS422 FORMAT

Assignment of connector pins for the 3 digital I/Os with RS422 electrical level is reported in Table II-7 (for inputs) and Table II-8 (for outputs). The ground for the three RS 422 digital inputs/outputs is common to both the inputs and the outputs.

RS 422	Signal -	Signal +	Shield (optional)
Input A	pin Y	pin X	pin N
Input B	pin a	pin Z	pin N
Input C	pin c	pin b	pin N

Table II-7 : Pin assignment for the three digital inputs in RS 422 format

RS 422	output /+422	output /-422
Output A	pin B	pin C
Output B	pin E	pin F
Output C	pin H	pin J

Table II-8 : Pin assignment for the three digital outputs in RS 422 format

RS422 input signal should provide at least 4 V differential voltage when loaded.

RS422 output signal provides 5 V differential voltage unloaded.

II.5.6.4 DEFINITION OF THE 2 PULSE INPUTS/OUTPUTS

Assignment of connector pins for the 2 pulse I/Os is reported in Table II-9 (pulse inputs) and Table II-10 (pulse outputs).

Pulse	ground	signal	Shield (optional)
Input A	pin i	pin j	pin N
Input B	pin g	pin h	pin N

Table II-9 : Pin assignment for the two pulse inputs

Pulse	ground	signal
Output A	pin V	pin W
Output B	pin T	pin U

Table II-10 : Pin assignment for the two pulse outputs

Pulse input should be TTL. Refer to Part 4, Library Interface, of the OCTANS User Guide for further detail on the pulse input requirements.

The pulse outputs deliver 0 - +5 V signal with an output current lower than 1 mA.

II.5.6.5 DEFINITION OF THE CONFIGURATION AND REPEATER I/O SIGNAL

Assignment of connector pins for the configuration and repeater I/O is reported in Table II-11.

Repeater & Configuration	ground	input	Shield (optional)
Input	pin d	pin e	pin f
Output	pin K	pin L	

Table II-11 : Pin assignment for the configuration through the digital connector

Connection of OCTANS to a PC for installation, configuration and/or display purposes can be made by connecting pins K, L, d, E and f to a SubD9 connector following the wiring given in Table II-12.

OCTANS Digital I/O connector		**PC SUB D9 connector**	
Pin	Signal	Pin	Signal
K	RS232TX(-)GND	5	PC GND
L	RS232TX(+)	2	PC Rx
d	RS232RX(-)	5	PC GND
e	RS232RX(+)	3	PC Tx
N	*Mechanical Ground*	*5*	*PC GND (optional)*

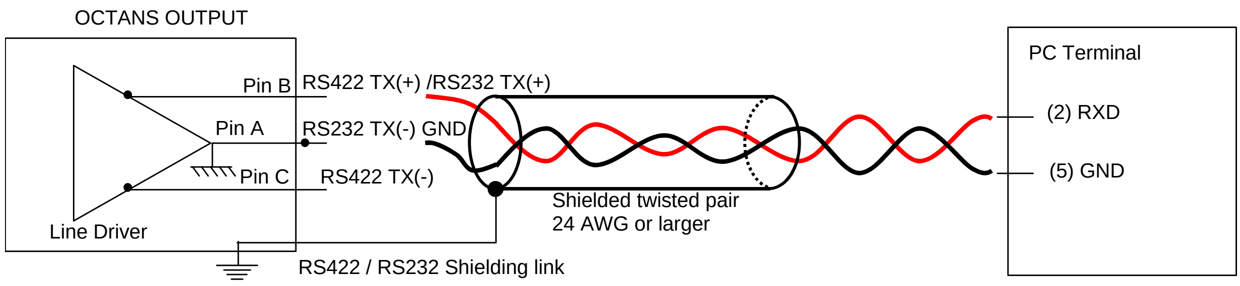
Table II-12 : Cable between OCTANS Digital I/O connector and PC SubD9

Warning:

The configuration and repeater I/O available on the Digital connector is internally connected to the configuration and repeater I/O available on the dedicated Installation and Repeater Connector (see section II.5.4). It is not recommended to use both connections, this could lead to a misfunctionning of the PC to OCTANS communication.

II.5.6.6 RECOMMENDED WIRINGS

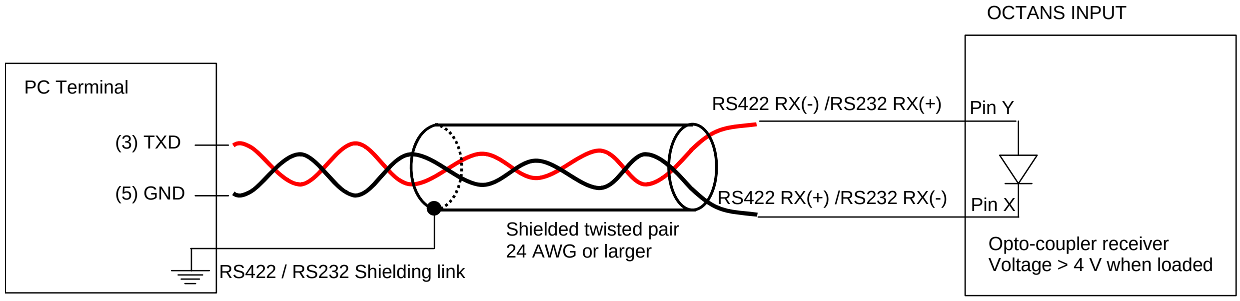
The recommended wirings with Shielded Twisted Pairs for RS232 (Output and Input), RS422 (Output and Input), and Pulse (Output and Input) cables are described hereafter.



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

Mechanical ground connection is recommended through connector backshell or pin N on Digital I/O connector

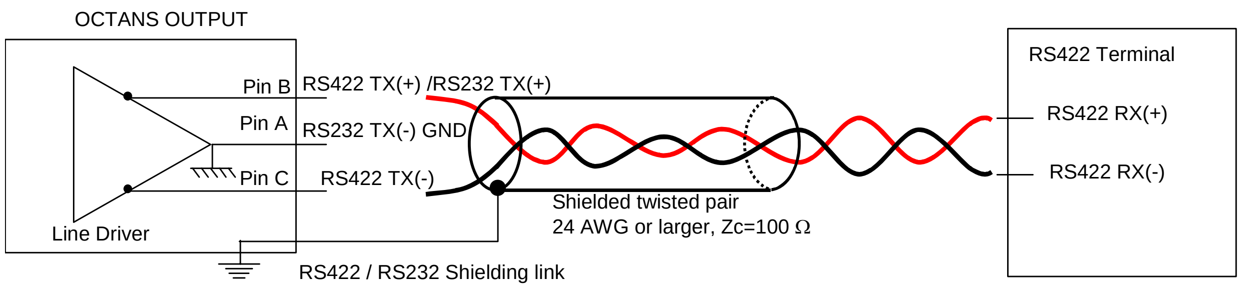
Figure II-7 - Description of the RS232 Output wiring with a Shielded Twisted Pair (Port A example)



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

Mechanical ground connection is recommended through connector backshell or pin N on Digital I/O connector

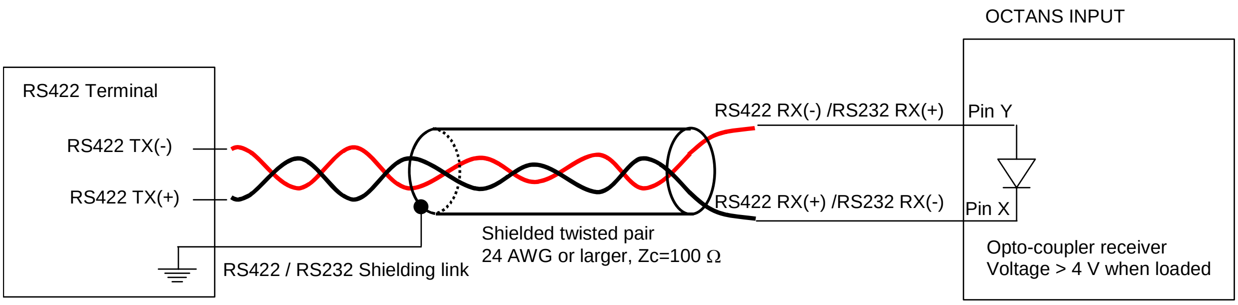
Figure II-8 - Description of the RS232 Input wiring with a Shielded Twisted Pair (Port A example)



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

Mechanical ground connection is recommended through connector backshell or pin N on Digital I/O connector

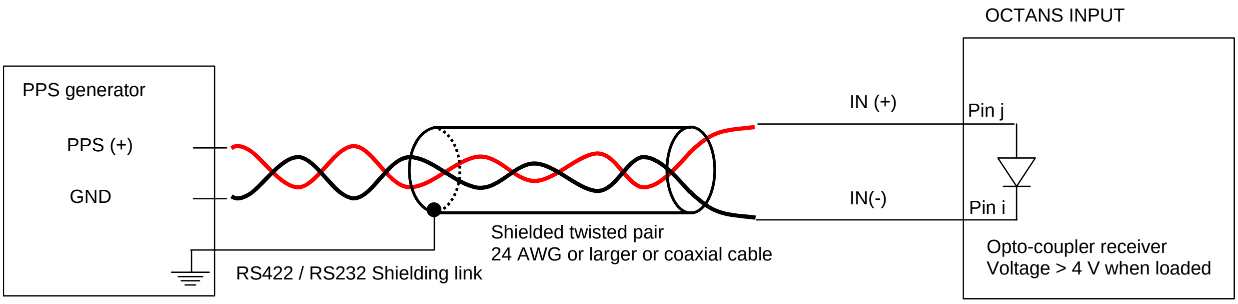
Figure II-9 - Description of the RS422 Output wiring with a Shielded Twisted Pair (Port A example)



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

Mechanical ground connection is recommended through connector backshell or pin N on Digital I/O connector

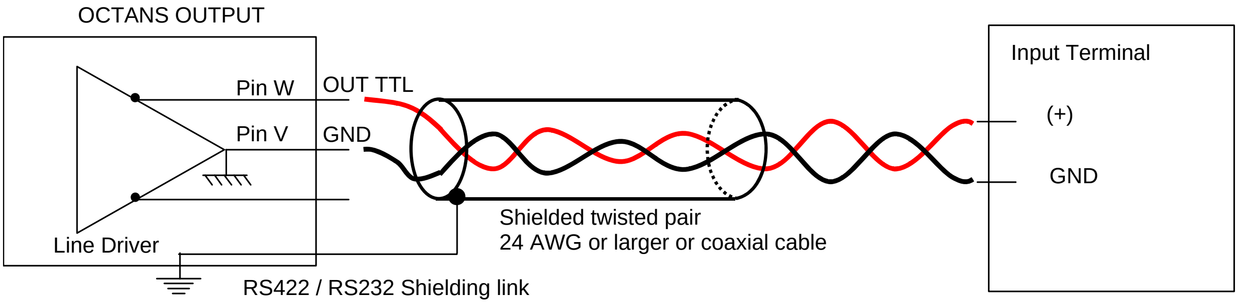
Figure II-10 - Description of the RS422 Input wiring with a Shielded Twisted Pair



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

Mechanical ground connection is recommended through connector backshell or pin N on Digital I/O connector

Figure II-11 - Description of the Pulse Output wiring with a Shielded Twisted Pair



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

Mechanical ground connection is recommended through connector backshell or pin N on Digital I/O connector

Figure II-12 - Description of the Pulse Input wiring with a Shielded Twisted Pair

II.6 CONVENTIONS AND DEFINITIONS FOR OCTANS DATA

This section gives the conventions which are used for OCTANS data output. Some interface protocols may use different conventions or definitions. When this is the case, it is duly specified in the interface protocol description (refer to Part 4 of the OCTANS User Guide).

II.6.1 DEFINITION OF HEADING, ROLL AND PITCH

II.6.1.1 FOREWORD

Heading and attitude are default measured by OCTANS with respect to the OCTANS reference frame (X_1, X_2, X_3) defined on **Erreur ! Source du renvoi introuvable.**.

As OCTANS can be located with any angular orientation with respect to the vessel, angular misalignment between OCTANS and vessel can be accounted for to output information relative to the vessel reference frame. For the sake of clarity, in this section, null angular misalignment between OCTANS and vessel is considered, so that the OCTANS reference frame (see **Erreur ! Source du renvoi introuvable.**) and the vessel reference frame (see Figure II-17) are superimposed. If non zero angular misalignment is set, the OCTANS reference frame should be replaced by the vessel reference frame in the following definitions for heading, roll and pitch. The definition of angular misalignment between OCTANS and vessel and the impact on OCTANS data output are further detailed in section II.7.1.2.

Roll, pitch and heading are the three Euler angles which transform the local geographic frame into the OCTANS reference frame. The local geographic frame is defined with the three axes (see Figure II-13):

- X_N, which lies in the horizontal plane, pointing towards geographical North,
- X_W, which lies in the horizontal plane, pointing towards West,
- X_{up}, parallel to the local vertical, pointing up.

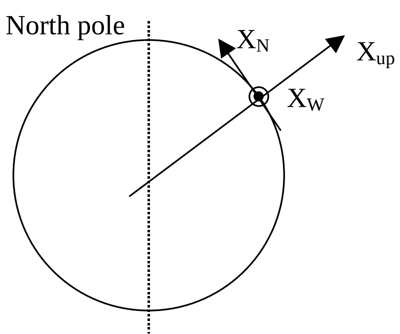


Figure II-13 : Definition of the local geographic frame

II.6.1.2 DEFINITION OF TRUE HEADING

The true heading is the angle between the vertical plane oriented in the North direction and the vertical plane passing through OCTANS axis X1. Heading is counted positive from North, varying from 0 to 360 degrees. The orientation of this angle is given in Figure II-14, in case of null pitch and roll.

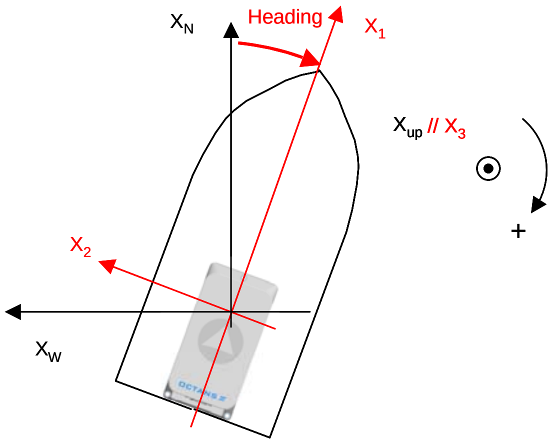


Figure II-14 : Definition of true heading

II.6.1.3 DEFINITION OF ROLL

Roll is defined as the angle of rotation performed around OCTANS axis X1 so that OCTANS axis X2 lies in the local horizontal plane. For small pitch values, the roll is the angle between the horizontal plane and the axis X2 of OCTANS. This angle is default defined positive in the direction of axis 1, i.e. when the boat's port side is up, varying from –180 to +180 degrees. Figure II-15 is an illustration of the roll angle with null pitch.

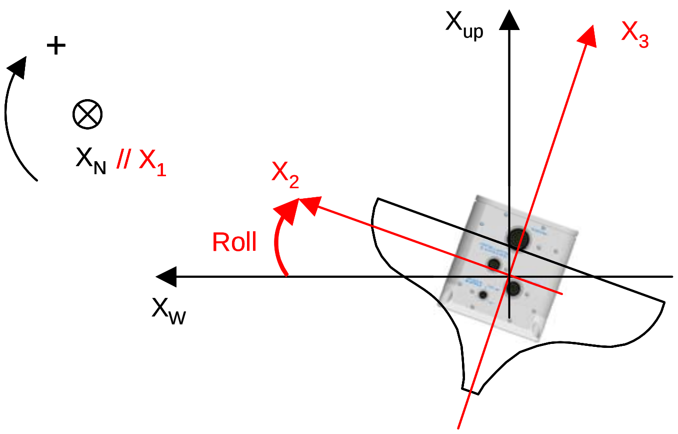


Figure II-15 : Definition of roll

II.6.1.4 DEFINITION OF PITCH

The pitch is the angle between the axis X1 of OCTANS and its projection in the local horizontal plane. This angle is default defined positive in the direction of axis X2, i.e. when the boat's bow is down, varying from -90 to +90 degrees. Figure II-16 is an illustration of pitch angle in case of null roll.

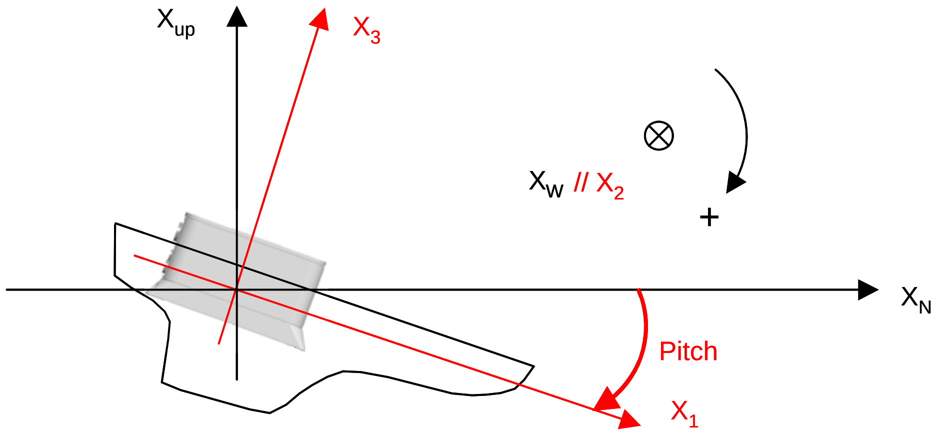


Figure II-16 : Definition of pitch

II.6.2 COMPUTATION OF HEAVE, SURGE, AND SWAY

II.6.2.1 DEFINITION OF HEAVE, SURGE, AND SWAY

The heave, or vertical motion of the vessel, is determined by the double integration of the vertical acceleration. As the vertical acceleration is measured with a small bias due to the physical limitations of the sensors, this double integration, which represents vertical position, can diverge to infinity very quickly with time. The best solution, used in every motion sensor, is to use a high-pass filter, which nulls out the bias component effect. By definition, the vertical amplitude of a movement which is filtered to cut-off the frequency around zero, is called "Heave". Respectively, the two horizontal positions filtered to cut-off the frequency around zero, are called the *surge* and the *sway.*

Since the heave (surge and sway) output is high-pass filtered, the output will always return to zero when OCTANS is static.

II.6.2.2 CONVENTIONS FOR HEAVE, SURGE AND SWAY MEASUREMENTS

The conventions for heave surge and sway measurements are:

- The heave is default defined positive up along the local vertical axis X_{up} (see Figure II-13)
- Surge and sway are measured in the local horizontal plane (perpendicular to the local vertical X_{up}). Surge measures the projection of forward motion (in the direction of vessel reference axis XV1) in the local horizontal plane. Sway measures the projection of leftwards motion (in the direction of vessel reference axis XV2) in the local horizontal plane. Refer to Figure II-17 for the definition of vessel reference frame (XV1, XV2, XV3).

II.6.2.3 DESCRIPTION OF THE HEAVE FILTER

The heave filter has been fully redesigned in OCTANS III, and is now automatically configured in terms of time constant: there is no need for the user to input any parameter.

Heave filter is initialized each time OCTANS is re-started. The duration of the heave initialization phase is roughly 5 minutes, and follows the 5-minute OCTANS alignment phase. Hence, heave, surge and sway deliver accurate value after a total initialization phase shorter than 10 minutes (see section II.7.4 for detail).

Once the heave filter has been automatically initialized, it will respond to variations of OCTANS positions in the three directions (heave, surge and sway) defined in section II.6.2.2.

II.6.2.3.1 Standard SAFE heave filter

As a default setting, OCTANS uses the standard SAFE heave filter to compute the heave, surge and sway outputs. The SAFE heave filter covers most sea conditions, and provides an accurate motion measurement for swell periods up to 40 s. After experiencing a step change in vertical position, OCTANS heave output will gradually return to zero within 1 to 2 minutes.

OCTANS III SAFE heave filter has been sea-proven. A copy of the test report may be sent to you on demand, please contact iXSea Customer Support (support@ixsea.com).

The SAFE heave filter is the default filter used by OCTANS. The value of heave displayed in the OCTANS Repeater main window (see Part 3 of the OCTANS III User Guide) is the value computed by the standard SAFE heave filter. It is recommended to use the SAFE heave filter as a standard for motion sensing, unless very specific sea conditions, such as described below, are encountered.

II.6.2.3.2 Specific heave filter for swells with short and long oscillations

As stated above, the self adaptive SAFE heave filter has been sea-proven to deliver accurate heave measurement under most sea conditions. However, the SAFE heave filter finds its limit in some very specific sea conditions. An additional heave filter, running in parallel with the standard SAFE heave filter, has been implemented, starting from OCTANS firmware version 10.46.22.32, to deliver accurate heave measurement in the following sea conditions:

high amplitude swell (> 50 cm), with both short and long (> 10 s) period oscillations

This specific heave output should be used only when such specific conditions are encountered, with vessel speed not higher than 5 knots.

II.6.3 LINEAR SPEEDS

Linear speeds are measured as surge, sway and heave speeds in meter per second. The reference axes are identical to the reference axes for surge, sway and heave output.

II.6.4 ACCELERATIONS AND ROTATION RATES

Accelerations are output along the 3 vessel reference axes XV1, XV2 and XV3 (see Figure II-17) in units of m/s^2. They are compensated from the earth gravity (accelerations are null when system is static) and are counted positive in the direction of the axes. To comply with export regulations, the resolution on acceleration output is restricted to 10^{-2} m/s^2.

Rotation rates measure the speed of roll, pitch and heading. They are default defined positive for direct (i.e. counterclockwise) rotation in the frame (XV1, XV2, XV3). **The heading speed is thus defined as the opposite of the heading derivative**. Units are degrees per second. To comply with export regulations, the resolution on rotation rate output is restricted to 10^{-2} deg./s.

Note:

When no angular biases are set, the vessel reference frame (XV1, XV2, XV3) is superimposed with the OCTANS reference frame (X1, X2, X3) – see **Erreur ! Source du renvoi introuvable.**. In such case, accelerations and rotation rates are output with respect to OCTANS reference frame (X1, X2, X3). Refer to section II.7.1.2 for detail on OCTANS to vessel angular misalignment.

Warning:

The reference axes for acceleration and rotation rates have been modified starting from OCTANS firmware version 10.46.22.32. In previous firmware versions, the misalignment between OCTANS and vessel was not accounted for, and accelerations and rotations rates were output in the OCTANS reference frame, whatever the misalignment with the vessel.

II.7 OPERATIONAL CONSIDERATIONS

II.7.1 ONBOARD OCTANS INSTALLATION

II.7.1.1 MINIMUM SAFE DISTANCE

OCTANS unit does not disrupt the electronic environment in terms of IEC 60945: 2002 (section 4.5.3 Interference-Compass Safe Distance) Standards. There is no specification for the minimum safe distance at which OCTANS may be mounted from a standard or a steering magnetic compass.

II.7.1.2 ANGULAR MISALIGNMENT COMPENSATION

OCTANS can be installed with any orientation with respect to the vessel and then, the OCTANS reference frame may be different from the vessel reference frame. In such case, heading and attitude outputs, as well as accelerations and rotation rates, can be compensated for angular misalignments of OCTANS relative to the vessel reference frame so that OCTANS provides outputs relative to the vessel.

This is done by setting misalignment bias for the three OCTANS reference axes X1, X2 and X3 with respect to the user-defined vessel reference frame.

The OCTANS reference frame is depicted in **Erreur ! Source du renvoi introuvable.**. The vessel reference frame is illustrated in Figure II-17:

- XV_1 is the vessel heading reference, lying in the vessel horizontal plane, from stern to bow

- XV_3 is the vessel vertical axis, perpendicular to the vessel horizontal plane, pointing upwards

- XV_2 lies in the vessel horizontal plane, perpendicular to XV_1, pointing portwards.

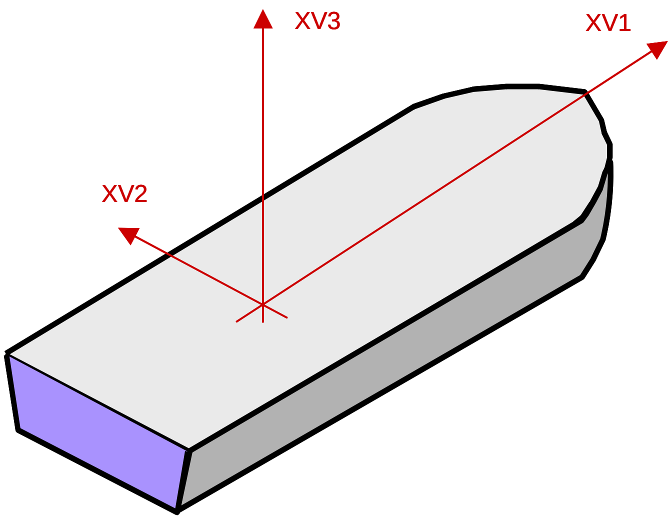


Figure II-17 : Vessel reference frame

The angular misalignment is defined by the three Euler angles misRoll, misPitch and misHeading (see Figure II-18) which transform the OCTANS reference frame into the vessel reference frame.

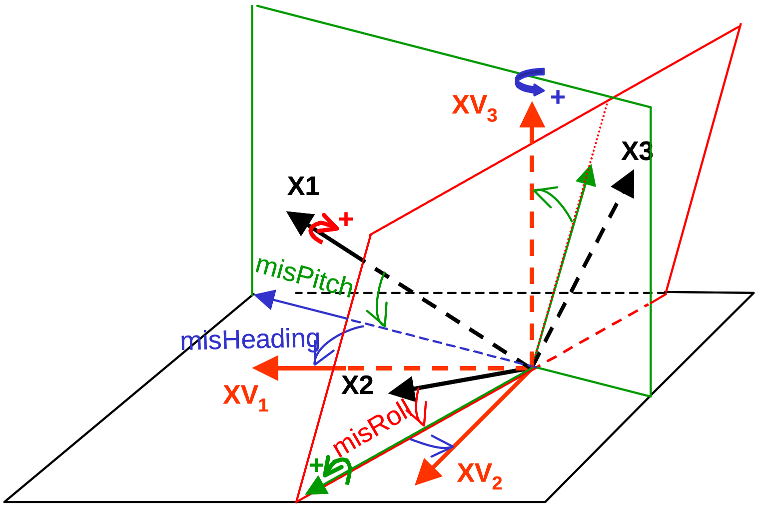


Figure II-18 : General definition of OCTANS (reference frame X1, X2, X3) to vessel (reference frame XV1, XV2, XV3) angular misalignment.

The definition of angular misalignment is given in the following sections, for pure roll (respectively pitch and heading) misalignment. These definitions are still valid when the misalignment between OCTANS and vessel frames is a combination of misalignments on the three angles, as soon as the angles remain small (order of magnitude is 1 degree).

Configuring angular misalignment bias into OCTANS is performed through the Installation and Repeater software (refer to Part 3 of the OCTANS User Guide).

Once angular misalignments have been set, OCTANS outputs data with respect to the vessel reference frame (XV_1, XV_2, XV_3). This is true for the heading and attitude output, as depicted in the following figures. Starting from firmware version 10.46.22.32 and higher, this is also true for the acceleration and rotation rate outputs, which are measured relative to the user-defined vessel reference frame XV1, XV2, XV3.

II.7.1.2.1 Roll misalignment bias

The roll misalignment bias is the angle of the rotation around OCTANS axis X1 which brings OCTANS axis X2 into the vessel horizontal plane (XV1, XV2). On Figure II-19, the roll misalignment bias is negative.

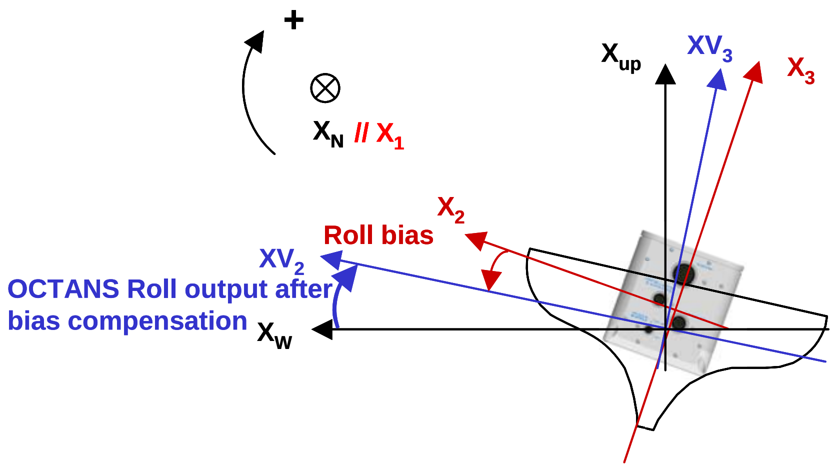


Figure II-19 : Roll misalignment bias (in case of null pitch and heading)

II.7.1.2.2 Pitch misalignment bias

Pitch misalignment bias is the angle between OCTANS axis X1 and its projection in the vessel horizontal plane (XV1, XV2). On Figure II-20, the pitch misalignment bias is negative.

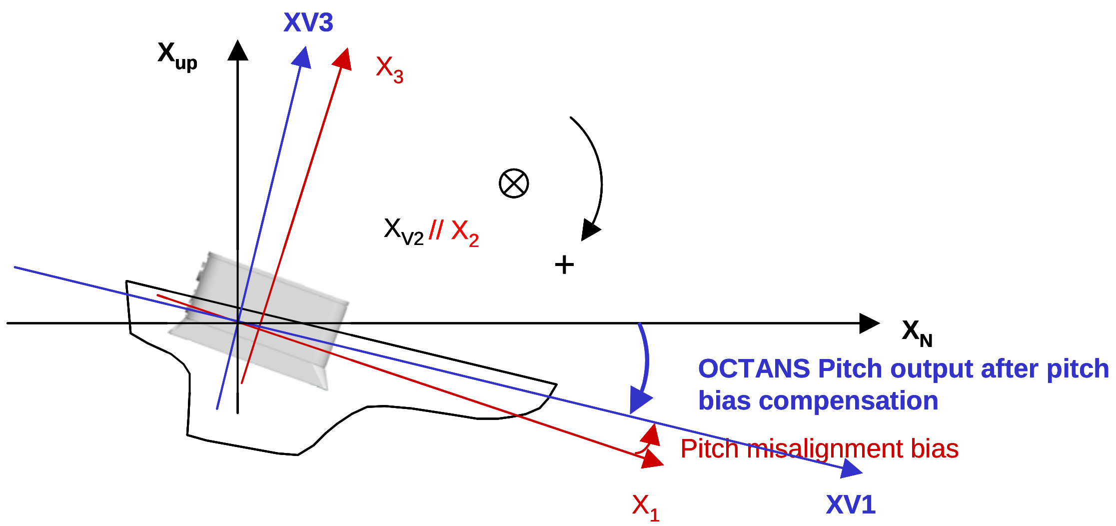


Figure II-20 : Pitch misalignment bias in case of null roll and heading.

II.7.1.2.3 Heading misalignment bias

The heading misalignment bias is the angle between the projection of OCTANS axis X1 into the vessel horizontal plane (XV1, XV2) and the vessel axis XV1. On Figure II-21, the heading misalignment bias is positive.

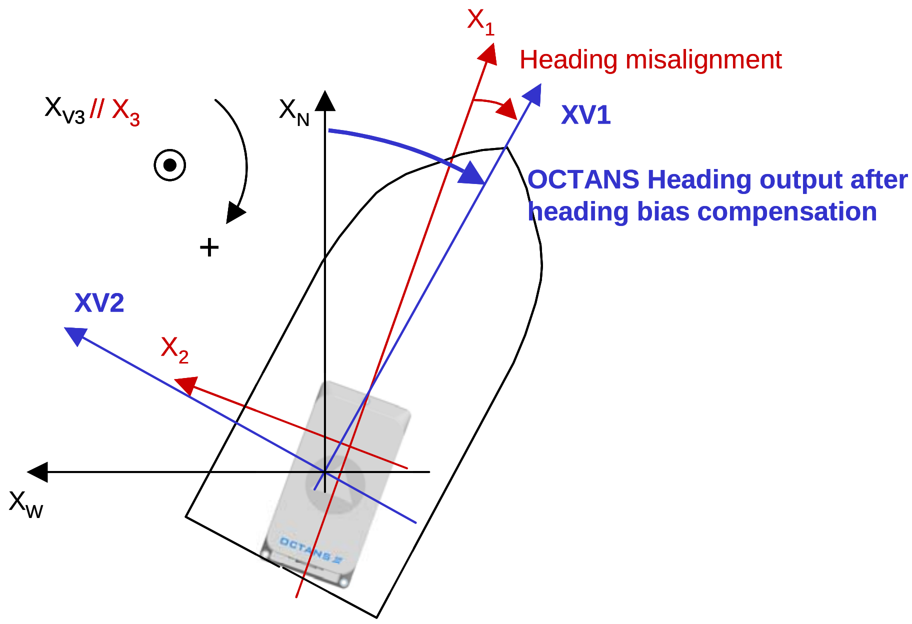


Figure II-21 : Heading bias misalignment in case of null roll and pitch

II.7.1.3 MONITORING EXTERNAL POINTS

All measurements are referenced to the convergence centre of the sensor axes P. This reference point is shown in Figure II-3. All installation offsets shall be considered respective to this point.

II.7.1.3.1 Principle

OCTANS is able to calculate the motion of several external monitoring points. Effective from firmware 4.1, one primary and three “secondary” monitoring points can be user-configured. For each of those external monitoring points, data can be output with different settings including serial or analogue I/O. In particular, at each location, a different protocol can be set. This allows, for instance, to drive a multibeam on one side of a vessel, to drive a single beam echo sounder at another location, to send analogue heave info to a sub-bottom profiler (see Figure II-22 for an illustration).

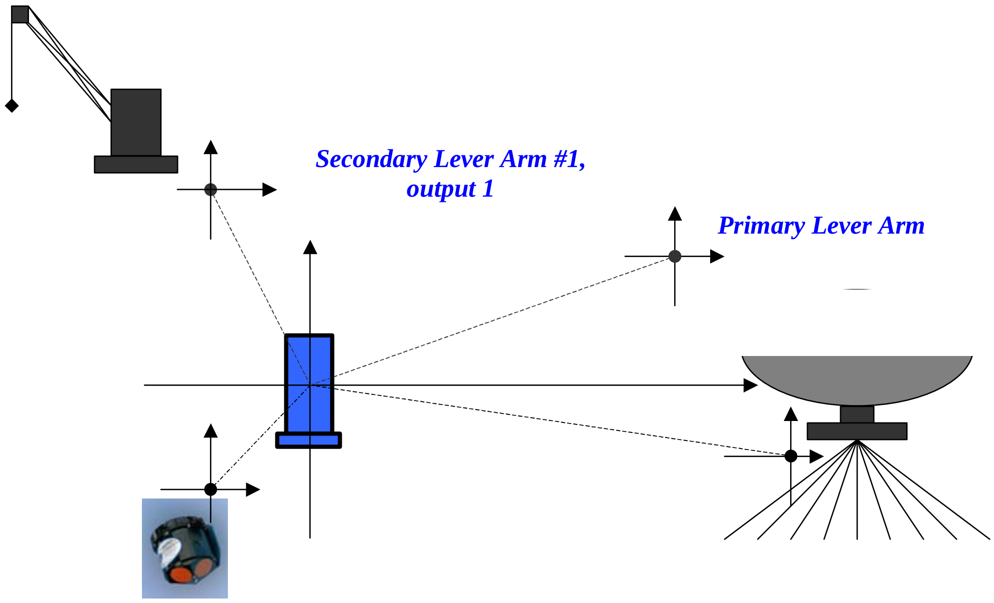


Figure II-22 : Monitoring different points with OCTANS III

II.7.1.3.2 Definition of Lever Arms

External monitoring points are defined by their “Lever Arm” to OCTANS centre of measurement P. This lever arm is the triplet of cartesian coordinates (LV1, LV2, LV3) defining the position of external monitoring point M with respect to OCTANS centre of measurements P in the user-defined vessel reference frame (XV1, XV2, XV3) – see Figure II-23.

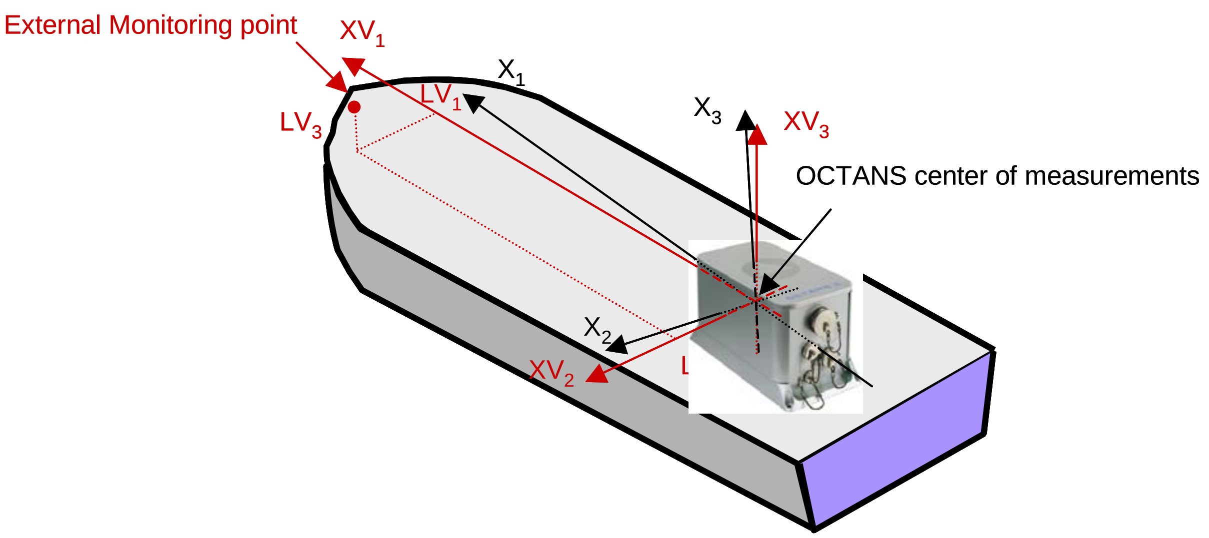


Figure II-23 : Definition of lever arm

Warning:

The reference axes for Lever Arm coordinates have been modified starting from OCTANS III firmware version 10.46.22.32. In previous firmware versions, the Lever Arm coordinates for external monitoring point were defined in OCTANS reference frame (X1, X2, X3) without taking into account the misalignment between OCTANS and vessel. In firmware versions higher than 10.46.22.32, the definition of Lever Arm coordinates has been modified to be better user-oriented: the reference frame is the vessel reference frame (XV1, XV2, XV3), centered at OCTANS centre of measurement.

II.7.1.3.3 Effect of a lever arm on the computation of heave

OCTANS can be located anywhere from the monitoring point. The heave measured at the monitoring point can be very different from the one measured at OCTANS centre of measurement, due to the lever arm. Figure II-24 illustrates a setting where OCTANS monitors an external point located ahead along the XV1 axis. The heave of OCTANS is null, however the heave at the monitoring point is not null when pitch angles are experienced.

To avoid this effect, it is recommended to locate OCTANS as close as possible to the monitoring point. Otherwise, it is possible to compensate for the effects of lever arms by computation. Lever arms can be configured into OCTANS for up to four external monitoring points (refer to Part 3 of the OCTANS User Guide).

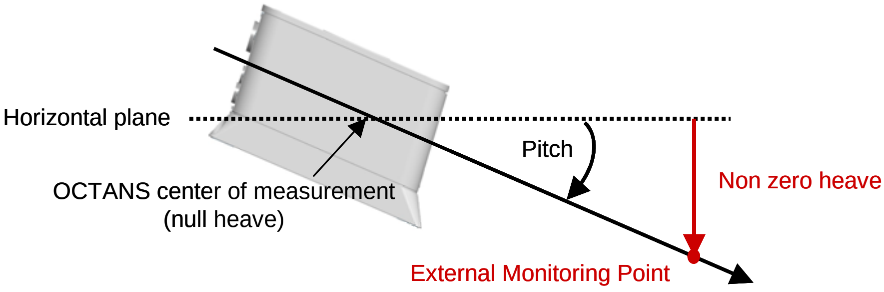


Figure II-24 : Effect of lever arm

II.7.2 IMPACT OF SPEED ON HEADING MEASUREMENT

All gyrocompasses, OCTANS included, are sensitive to the speed of the vessel. However very precise speed measurement is not imperative. The following section gives an insight of the error due to inaccurate speed input to OCTANS.

II.7.2.1 HEADING ERROR DUE TO THE SPEED LOG

The heading output of all gyrocompasses is sensitive to the speed of travel of the vessel towards North. The international standard (ISO 8728) defines that :

"Course error in degrees for a gyrocompass aligned north-south is determined by the formula V/5π x the secant of the latitude, where V is the North component of the speed in knots".

This speed correction applies whatever the technology used for the gyroscopes. Indeed, the linear speed of a boat travelling on the terrestrial "sphere" produces, with respect to the Earth and therefore with respect to the inertial frame of reference, a rotational speed V/R, where R is the radius of the Earth. This rotation speed (Coriolis force) has an influence on the measurement of the speed of rotation of the Earth and therefore on the detection of North.

Using the above formula, it is easy to compute the maximum speed $V\ North_{max}$ for which the heading error due to speed is higher than the heading accuracy specification. OCTANS dynamic accuracy is ±0.2 degree x secant of latitude and therefore we have:

$$V\ North_{max} = 0.2 \times 5\pi \approx 3{,}2 \text{ knots.}$$

The conclusion is that OCTANS will remain within specifications in terms of accuracy provided that the North component of the speed is known with an accuracy better than ± 3 knots.

II.7.2.2 ACCOUNTING FOR SPEED FOR ACCURATE HEADING MEASUREMENT

Even though the tolerance on speed measurement is large, it is recommended to enter the speed into OCTANS for automatic compensation of speed error and full accuracy performances of the gyrocompass.

Vessel speed can be input either manually or through an external Log sensor (see Part 3 of OCTANS User Guide for detail on OCTANS configuration).

When entered manually, the speed is entered in knots, and a few knots accuracy on speed is satisfactory.

Speed input from an external sensor (GPS or Log sensor) allows real-time update of the vessel speed. In case of external log sensor drop out for more than 10 seconds, OCTANS will use the speed stored into OCTANS PROM. Simultaneously, bit 24 of OCTANS status word $PHINF will be set to 1, and the corresponding message “Manual log used” will be displayed in the status panel window of the repeater software (Refer to Part 4 of the OCTANS user guide for a description of $PHINF status word, and to Part 3 for a description of the Repeater Software). When speed data from the log sensor is received again, OCTANS will update back the speed with the values from the sensor. Bit 24 will be reset to 0 and the corresponding message will not be displayed anymore in the Repeater status panel.

II.7.3 IMPACT OF LATITUDE ON HEADING MEASUREMENT

All gyrocompasses, OCTANS included, are sensitive to the current latitude. However latitude needs to be updated into OCTANS only if the ship changes latitude quite substantially. The following section gives an insight of the error due to inaccurate latitude input.

II.7.3.1 AMPLITUDE OF ERROR DUE TO LATITUDE DATA

Heading error depends on the secant of the latitude as a general physical rule – one cannot define heading at the geographical poles. However, it is not this error which is considered here, but rather intrinsic system inaccuracy when OCTANS uses inaccurate data for the latitude of the current location.

OCTANS has to know the latitude of its location in order to find geographical North rapidly. If the latitude information input is incorrect, OCTANS will produce an error. **This error is nevertheless very small.** The curve in Figure II-25 shows the heading error in degrees multiplied by the secant of the latitude versus the latitude of the current location, assuming that the latitude entered in OCTANS is incorrect by one degree.

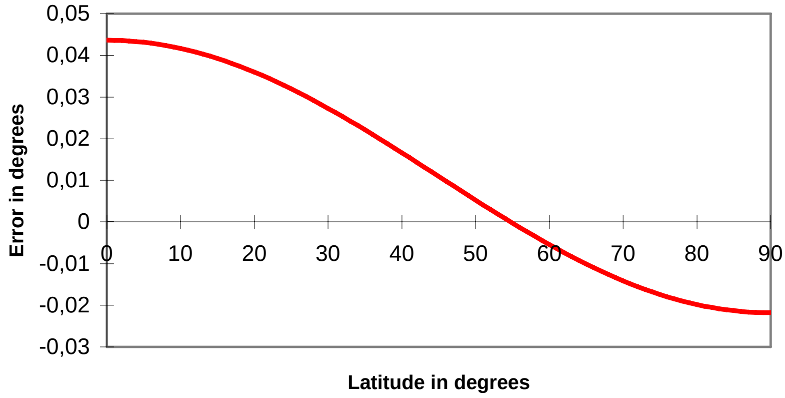


Figure II-25 : Heading error in degrees by secant of latitude (for a 1 degree latitude error)

Example: at 40° latitude, a 3 deg error in latitude will cause 3x0.02 = 0.06° sec.Lat error on heading

In practice, OCTANS needs to know the latitude only to an accuracy of 3 degrees at 45 degrees latitude. This dependency is more important at low latitudes.

II.7.3.2 ACCOUNTING FOR LATITUDE FOR ACCURATE HEADING MEASUREMENT

It is recommended to enter the current latitude in the system. Accuracy required on the latitude input depends on the current latitude as shown in Figure II-25. Standard figures are 3 degrees accuracy on latitude at 45 degrees latitude, and 1-degree accuracy for latitudes below 30 degrees.

Latitude can be updated into OCTANS during operation, either manually or by connecting an external GPS as an input. Refer to Part 3 of the OCTANS III User Guide for details.

When entered manually, the latitude is in degrees, positive for the northern hemisphere, and negative for the southern hemisphere.

Latitude input from an external GPS sensor allows real-time update of the vessel latitude. In case of external GPS sensor drop out, OCTANS will use the last latitude value received from GPS. When valid latitude data from GPS is received again, OCTANS will update the latitude with the value received from the sensor.

II.7.3.3 LATITUDE INPUT AT FIRST POWERING-ON

OCTANS is delivered with a default latitude setting which corresponds to iXSea's factory location.

At first powering-on, without external GPS connected, OCTANS will start seeking north with this latitude input, which may be quite different from the current OCTANS latitude.

Latitude has to be modified by the user (refer to Part 3 of OCTANS III User Guide). Once this modification is performed, it is recommended to save the current latitude into OCTANS PROM and re-start the OCTANS. This procedure allows for the OCTANS to enter the correct latitude value as an input in the North finder algorithm as soon as computation starts. OCTANS will then reach full accuracy after the 5 minutes alignment phase. Otherwise, time for OCTANS stabilization will be increased due to the wrong initial latitude input when computation starts.

This procedure should be done whenever a unit is delivered from factory, or whenever a new firmware has been re-loaded into the unit.

II.7.4 OCTANS SETTLING TIME

II.7.4.1 ALIGNMENT PHASE

When it is powered on or re-started, OCTANS finds the North and the vertical axis after a 5 minutes alignment phase (see Figure II-26). During this alignment phase, heading and attitude data are available, but have not reached full accuracy. Specified accuracy on heading, roll and pitch is reached at the end of the 5 minutes long alignment phase.

OCTANS Status Word bits 0 (Heading unvalid), 1 (Roll unvalid), 2 (Pitch unvalid), 3 (Heave init), 5 (OCTANS alignment) are set to 1 during alignment phase. This translates into the 2 last bytes of the $PHINF OCTANS status word set to “2F” during the alignment phase.

Refer to Part 4, Library Interface, of OCTANS User Guide for the definition of OCTANS Status word.

II.7.4.2 HEAVE FILTER INITIALISATION

Heave initialisation occurs at each OCTANS powering on or soft restart (see Figure II-26). It is performed in parallel with the OCTANS alignment phase, but is time set to 5 additional minutes. During the heave initialisation phase, the heave, surge and sway outputs have not reached full accuracy.

OCTANS Status Word bit 3 (Heave init) is set to 1 during heave initialisation phase. This translates into the 2 last bytes of the hexadecimal OCTANS status word $PHINF switching from “2F” to “08” after alignment, during the heave initialisation phase.

Once heave is initialised, the two last bytes of OCTANS Status word $PHINF are “00” under normal conditions.

Refer to Part 4, Library Interface, of OCTANS User Guide for the definition of OCTANS Status word.

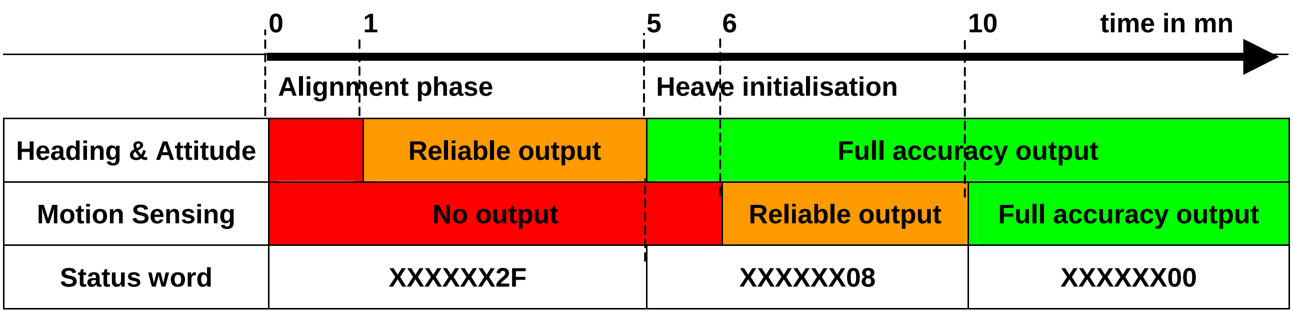


Figure II-26 : OCTANS starting sequence (at powering-on or restart)

II.7.5 LATENCY ON OCTANS OUTPUTS

OCTANS data output (digital and analog) have a constant latency of 25 ms, frequency independent.