Important

THIS INTERFACE LIBRARY DOCUMENT IS NOW COMMON TO ALL INERTIAL PRODUCTS.

THE PROTOCOL AVAILABILITY DEPENDS ON YOUR PRODUCT.

REFER TO THE TABLES OF THE SECTION 3.6.1 (FOR THE OUTPUT PROTOCOLS) AND TO THE TABLES OF SECTION 3.5.1 (FOR THE INPUT ONES) TO CHECK IF THE PROTOCOL YOU CHOOSE IS AVAILABLE FOR YOUR PRODUCT.

INS

INTERFACE LIBRARY

IXBLUE
DEEP INSIGHT. SHARPER SENSES.

Document Revision History

Edition	Date	Comments
E	10/2011	LRS, S40, DCN FAA, EMLOG VBW, EMLOG VHW added
F	02/2012	LONG BINARY NAV updated
G	03/2012	Status, input and output protocols quick guides updated
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I	04/2013	GPS LIKE SHORT ZZZ, LONG BINARY NAV SM, PRECISE ZDA, PEGASE NAV, PEGASE CMS, INSITU added
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S	05/2016	PHINS COMPACT C7 product added. Chapters 1.1.4 & 3.4 updated. Input and output protocols quick guides updated. APOS PSIMSSB, iXBlue standard bin, Ext sensor bin, USBL LBL CTD & Soc Autosub protocols updated.
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Italic	Italic text is the result of an action in the procedures. It is also used for referencing to other document titles.

Icons

The **Note** icon indicates that the following information is of particular interest and should be read with care.

Important

The **Important** mention indicates that the following information should be read to forbid or prevent a product dysfunction or a faulty operation of the equipment.

The **Caution** icon indicates that the following information should be read to forbid or prevent product damage.

The **Warning** icon indicates that possible personal injury or death could result from failure to follow the provided recommendation.

Abbreviations and Acronyms

Abbreviations and acronyms are described in document *Inertial Products – Principle and Conventions (Ref.: MU-INS&AHRS-AN-003)*

Overview

This document is the library documentation of the iXBlue inertial products.

It is divided into several parts:

- **Part 1: Introduction** – This part gives a detailed description of Inertial products, algorithm and user status words. These status words act as built-in test and control tools to check for Inertial products operation.
- **Part 2: NMEA frames** – This part gives definition of the different input and output NMEA frames.
- **Part 3: Digital Interfaces** – This part gives a detailed description of the different digital inputs and output protocols available.
- **Part 4: Pulse Interfaces** – This part gives a detailed description of the different pulse inputs and output protocols available.
- **Part 5: List of the Data provided by the INS** – This part lists the data provided by the INS: navigation data, their standard deviations and external sensor data.

A Table of Contents is available in the following pages to get quickly the dedicated information.

Table of Contents

1 INTRODUCTION

1.1 Conventions

1.1.1 EXPORT REGULATION LIMITATIONS

To comply with export regulations the iXBlue inertial product range complies with the following limitations:

Table 1 - Saturation levels

Applicable to	PHINS, PHINS 6000, ROVINS, HYDRINS, MARINS, QUADRANS PHINS COMPACT C3 PHINS COMPACT C7 ROVINS NANO	AIRINS ATLANS	LANDINS
Altitude (*)	4 000 m	15 km	4 000 m
Linear Speed (*)	41.66 m/s (150 km/h)	250 m/s (900 km/h)	100 m/s (360 km/h)

Applicable to following system type	PHINS ROVINS HYDRINS PHINS COMPACT C7	QUADRANS ATLANS	MARINS	PHINS COMPACT C3 ROVINS NANO
Rotation speed (*)	750°/s	750°/s	3 000°/s	250°/s
Acceleration(*) (**)	± 15 g	± 5 g	± 30 g	± 5 g

Table 2 - Resolution limitations on output data

Applicable to following system type	PHINS, ROVINS, HYDRINS, MARINS, AIRINS, LANDINS, MARINS BK-B, QUADRANS, ATLANS, PHINS COMPACT C3 PHINS COMPACT C7 ROVINS NANO	MARINS BK-A
Acceleration resolution (*)	1 mg	No limitation (**)
Rotation rates resolution (*)	3.6°/h	No limitation (**)
Heading/Roll/Pitch resolution (*)	0.001°	No limitation (**)

(*) Software limitation

(**) Hardware design limitation

(***) **WARNING:** CIEEMG-AEMG requirements supersedes limitations described in this document

To comply with French export regulations the inertial products delivered to some countries cannot output acceleration or rotation rate data and the post-processing protocol is not available. Hence DELPH INS is not provided in this case. Please contact IXBLUE for further details.

1.1.2 REFERENCE FRAME NOTATIONS

The following notations will be found in the protocol descriptions and are explained hereafter:

XV1, XV2, XV3: Vessel frame; XV1 (bow), XV2 (port), XV3 (up).

XVH1, XVH2, XVH3: Vessel Horizontal Frame; Vessel Frame compensated from roll and pitch.

X1, X2, X3: inertial product body frame; X1 (forward), X2 (left), X3 (up). Refer to the document *Inertial Products – Principle and Conventions (Ref.: MU-INS&AHRS-AN-003)* for convention description.

X1IMU, X2IMU, X3IMU: IMU reference frame or internal sensor bloc frame; X1IMU (forward), X2IMU (left), X3IMU (up).

XNorth, XWest, XUp: Local geographical frame.
In practice INS will output speed according to North, East and Up reference frame to be consistent with the fact that longitude is positive towards the East.

XS1, XS2, XS3: External Sensor Body Frame; (i.e., DVL, EM LOG), XS1 (forward), XS2 (left), XS3 (up). Sign convention is described in each protocol (i.e., XS1 longitudinal speed; '+' bow).

Rotation rates convention:
"XVI (I=1, 2, 3) rotation rate" is the rotation rate in inertial frame. The data is not compensated for earth rotation (15.04°/h) or craft rate. The rotation rate is positive when rotation vector is pointing in XVI (I=1, 2, 3) direction. Cork screw moving in this direction will give you the sign of rotation.

"Heading, Roll, Pitch rotation rate" is different from XVI (I=1,2,3) rotation rate. It is the derivative of Heading, Roll, and Pitch.

Acceleration convention:
"XVI (I=1, 2, 3) acceleration" is positive when acceleration vector is pointing in XVI (I=1, 2, 3) direction. Accelerations are compensated from gravity unless specified in the protocol (i.e.: CONTROL protocol).

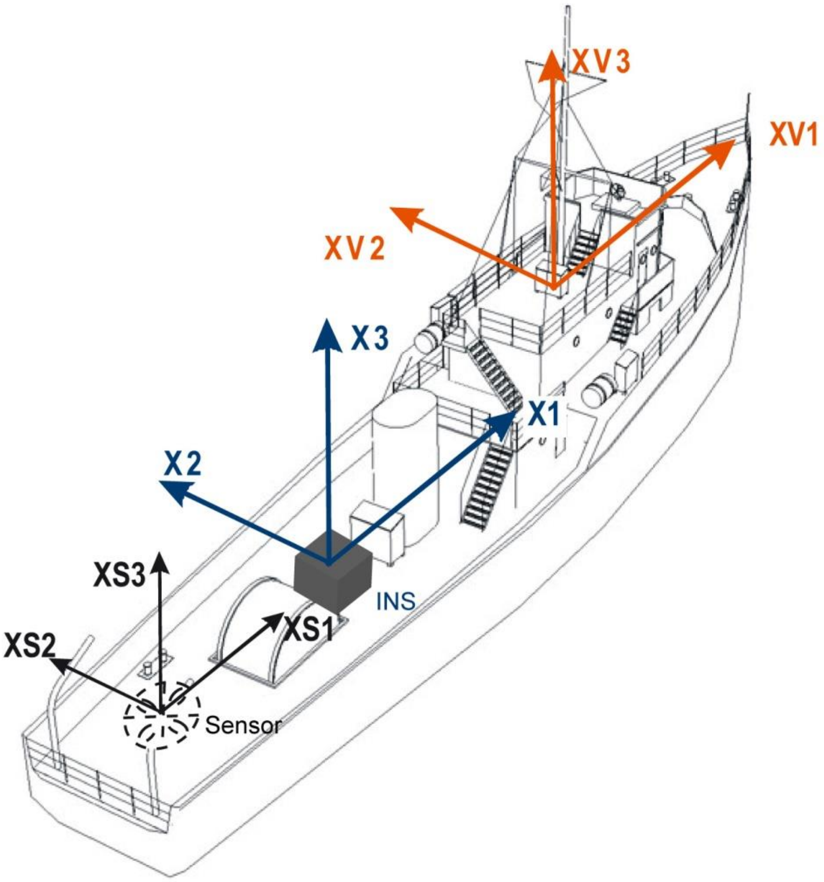

Figure 1 - Vessel, System and Sensor reference frame

1.1.3 TIME MANAGEMENT IN THE INERTIAL PRODUCTS

If the inertial product has never received the GPS time, the date starts on 1st January 2006. Otherwise the date is maintained on the GPS time as soon as the GPS time is received. If the GPS is lost, the inertial product will maintain time with its internal clock. If the inertial product is synchronized with the GPS time, the data time tags in the output telegrams are the UTC; otherwise they are the inertial product one (i.e., the time since power-up of the system).

To improve time synchronization accuracy it is recommended to input into INS a PPS pulse from the GPS. This is particularly critical for imagery applications (i.e.: mobile mapping, hydrography).

1.1.4 GNSS QUALITY FACTOR MANAGEMENT AT INPUT AND OUTPUT OF INS

For INPUT data:

When only GGA telegram is input to INS the following correspondence table is applied.

Q factor in GGA input telegram	Message in iXRepeater	INS corresponding SD attributed to GPS position fix (m)
4	RTK	= 0.1
5	Float RTK	= 0.3
2	Differential	= 3
3	Military	=10
1	Natural	= 10
0 or 6	N/A	0 or ≥ 6

For OUTPUT data:

When GPS like telegram is output from INS the following correspondence table is applied. The INS does not copy the quality indicator received on GGA input to GGA output.

INS calculated position SD (m)	Q factor in GPS like output protocol	Mode indicator
< 0.1	4	D
< 0.3	5	D
< 3	2	D
< 10	1	A
≥ 10	6	E

During initial alignment (at power up or after a system restart) the quality factor is fixed to 6.

The INS SD is the horizontal dilution of precision (HDOP) calculated from INS SDLat and SDLong on position:

$$SD = HDOP = \sqrt{SDLat^2 + SDLong^2}$$

The mode indicator provides status information about the operation of the source device (such as positioning systems, velocity sensors, etc.) generating the sentence, and the validity of data being provided. The possible indications are as follows:

A = Autonomous mode

D = Differential mode

E = Estimated (dead reckoning) mode

M = Manual input mode

S = Simulator mode

N = Data not valid

The mode indicator field should not be a null field.

1.1.5 PRESSURE TO DEPTH CONVERSION FORMULA

Depth is calculated by using the following formula from the Unesco Technical Papers in *Marine Science n°44, Algorithms for computation of fundamental properties in seawater*.

$$Depth = \frac{(((-1.82E-15*P+2.279E-10)*P-2.2512E-5)*P+9.72659)*P}{Gravity}$$

Where pressure P is pressure compensated from atmospheric pressure (10.1325 dbar). It is calculated in decibars as follows:

$$P(dB) = 0.6894757*x.x(PSI)-10.1325$$

and the gravity (in m/s²) is calculated as follows :

$$X = \left[\sin\left(\frac{Latitude}{57.29578}\right)\right]^2$$

$$Gravity = 9.780318*(1.0+(5.2788E-3+2.36E-5*X)*X)+1.092E-6*P$$

Where *P* is expressed in dbar and *Latitude* in degrees. PSI is the salinity unit.

Latitude used in the formula is the one computed by the INS.

1.1.6 SOUND VELOCITY CONVERSION FORMULA

When only conductivity, pressure and temperature are available, conductivity ratio R needs to be converted to salinity to compute sound velocity using salinity and temperature (this for the Chen and Millero equation which expects pressure, temperature and salinity as inputs).

Applied function are defined on pages 6, 7 and 8 of Unesco technical papers in marine science n° 44 - Algorithms for computation of fundamental properties in seawater, hereafter written :

$$S = a_0 + a_1 R_t^{1/2} + a_2 R_t + a_3 R_t^{3/2} + a_4 R_t^2 + a_5 R_t^{5/2} + \Delta S$$

Where :

$$\Delta S = \frac{(t-15)(b_0 + b_1 R_t^{1/2} + b_2 R_t + b_3 R_t^{3/2} + b_4 R_t^2 + b_5 R_t^{5/2})}{1 + 0.0162.(t-15)}$$

$$R_t = \frac{R}{R_p . r_t} \qquad r_t = c_0 + c_1 t + c_2 t^2 + c_3 t^3 + c_4 t^4 \qquad R_p = \frac{p(e_1 + e_2 p + e_3 p^2)}{1 + d_1 t + d_2 t^2 + (d_3 + d_4 t) R} + 1$$

$$R = \frac{C(S,t,p)}{C(35,15,0)}$$ with C(35,15,0)= 4.29140 S/m (see AD2)

S = salinity in Practical Salinity Units (psu)

t = temperature in degrees Celsius (°C)

p = pressure in decibars (assumption is made that a tare has been applied to compensate atmospheric pressure)

R = conductivity Ratio

Table of Coefficients

Coefficients	Numerical values	Coefficients	Numerical values
a_0	+ 0.0080	b_0	+0.0005
a_1	- 0.1692	b_1	-0.0056
a_2	+ 25.3851	b_2	-0.0066
a_3	+14.0941	b_3	-0.0375
a_4	- 7.0261	b_4	+0.0636
a_5	+2.7081	b_5	-0.0144
c_0	+0.6766097	d_1	+3.426E-2
c_1	+2.00564E-2	d_2	+4.464E-4
c_2	+1.104259E-4	d_3	+4.215E-1
c_3	-6.9698E-7	d_4	-3.107E-3
c_4	+1.0031E-9	e_1	+2.070E-5
e_2	-6.370E-10	e_3	+ 3.989E-15

The speed of sound in seawater is then computed respect to Chen and Millero equation.

The UNESCO equation Chen and Millero is hereafter written:

$$c(S,T,P) = Cw(T,P) + A(T,P)S + B(T,P)S^{3/2} + D(T,P)S^2$$

$$\begin{aligned} Cw(T,P) = {} & (C_{00} + C_{01}T + C_{02}T^2 + C_{03}T^3 + C_{04}T^4 + C_{05}T^5) + \\ & (C_{10} + C_{11}T + C_{12}T^2 + C_{13}T^3 + C_{14}T^4)P + \\ & (C_{20} + C_{21}T + C_{22}T^2 + C_{23}T^3 + C_{24}T^4)P^2 + \\ & (C_{30} + C_{31}T + C_{32}T^2)P^3 \end{aligned}$$

$$\begin{aligned} A(T,P) = {} & (A_{00} + A_{01}T + A_{02}T^2 + A_{03}T^3 + A_{04}T^4) + \\ & (A_{10} + A_{11}T + A_{12}T^2 + A_{13}T^3 + A_{14}T^4)P + \\ & (A_{20} + A_{21}T + A_{22}T^2 + A_{23}T^3)P^2 + \\ & (A_{30} + A_{31}T + A_{32}T^2)P^3 \end{aligned}$$

$$B(T,P) = B_{00} + B_{01}T + (B_{10} + B_{11}T)P$$

$$D(T,P) = D_{00} + D_{10}P$$

Table of Coefficients

Coefficients	Numerical values	Coefficients	Numerical values
C_{00}	+1402.388	A_{02}	7.164E-5
C_{01}	+5.03711	A_{03}	2.006E-6
C_{02}	-5.80852E-2	A_{04}	-3.21E-8
C_{03}	3.3420E-4	A_{10}	9.4742E-5
C_{04}	-1.47800E-6	A_{11}	-1.2580E-5
C_{05}	3.1464E-9	A_{12}	-6.4885E-8
C_{10}	0.153563	A_{13}	1.0507E-8
C_{11}	6.8982E-4	A_{14}	-2.0122E-10
C_{12}	-8.1788E-6	A_{20}	-3.9064E-7
C_{13}	1.3621E-7	A_{21}	9.1041E-9
C_{14}	-6.1185E-10	A_{22}	-1.6002E-10
C_{20}	3.1260E-5	A_{23}	7.988E-12
C_{21}	-1.7107E-6	A_{30}	1.100E-10
C_{22}	2.5974E-8	A_{31}	6.649E-12
$_{23}$	-2.5335E-10	A_{32}	-3.389E-13
C_{24}	1.0405E-12	B_{00}	-1.922E-2
C_{30}	-9.7729E-9	B_{01}	-4.42E-5
C_{31}	3.8504E-10	B_{10}	7.3637E-5
C_{32}	-2.3643E-12	B_{11}	1.7945E-7
A_{00}	1.389	D_{00}	1.727E-3
A_{01}	-1.262E-2	D_{10}	-7.9836E-6

Some values are provided for checking the correct use of above equations by the Inertial Product

P = 10000 dBars ; T = 40 °C; R = 1.888091 --> SVEL = 1731.9957 m/s
P = 0 dBars ; T = 15 °C; R = 1.000000 --> SVEL = 1506.6633 m/s
P = 2000 dBars ; T = 20 °C; R = 1.200000 --> SVEL = 1557.2327 m/s
P = 1500 dBars ; T = 5 °C; R = 0.650000 --> SVEL = 1486.4762 m/s

T : temperature value(input field ttt.tttt)
P : pressure value (input field pppp.ppp)
R : conductivity ratio value (input field cc.ccccc)
SVEL is the value of the Sound Velocity computed and used by PHINS

1.2 Firmware restrictions

The *Inertial Products - Interface Library* is part of the standard inertial product delivery and is stored into the inertial product interface board. The library is expanding with time and new interfaces may be added when an updated firmware release is issued.
Following the type of product, the firmware version is different as shown in the table below.

Table 3 – List of products and versions

Product	CINT Firmware version
ATLANS	Higher than FrmWCINT_INS_v6.30 version
AIRINS	Higher than FrmWCINT_INS_v5.39 version
QUADRANS	Higher than FrmWCINT_INS_v5.73 version
HYDRINS	Higher than FrmWCINT_INS_v6.48 version
MARINS	
PHINS	
PHINS 6000	
PHINS COMPACT C3	
PHINS COMPACT C7	
ROVINS	
ROVINS NANO	

To check the firmware version currently downloaded into your unit, refer to the document following your product:

- INS, Land & Air applications – Web-based interface user guide (ref.: MU-INSIII-AN-022) for ATLANS or AIRINS product.
- Inertial Products, Marine applications – Web-based interface user guide (ref.: MU-INSIII-AN-021).

Contact iXBlue customer support (support@ixblue.com) to check if your system is eligible to a firmware update.

2 NMEA FRAMES

Each NMEA frame described below is formatted as follows:

$CCCCCCCC*hh<CR><LF>		
$	'$' fix character	
CCCCC	is the frame content	
*****	'*' fix character	
hh	is the NMEA 0183 (hexadecimal encoded XOR of all bytes excluding the starting character '$' and the stop one '*')	

2.1 Input NMEA Frame Definition

This section described all NMEA 0183 frames being common in several inputs protocols. Refer to the chapter 3 to know exactly which frames are decoded by the NMEA compatible protocols.

2.1.1 NON STANDARD NMEA FRAME

2.1.1.1 UTC Frame

UTC yy.mm.dd hh:mm:ss ab <CR><LF>	
UTC	fixed text header
yy.mm.dd	year month and date (USED)
hh:mm:ss	UTC time not GPS time. (USED)
a	Integer number representing the position-fix type: (**Note 1**) (USED) 1 = time only 2 = 1D & time 3 = currently unused 4 = 2D & time 5 = 3D & time ? = no time
b	Number of GPS satellites being tracked. (NOT USED) Note – If the receiver is not tracking satellites, the time tag is based on the receiver clock. In this case, a and b are represented by "??". The time readings from the receiver clock are less accurate than time readings determined from the satellite signals.

Note 1: If a=?, telegram is invalid. if a=1, 2, 3, 4, or 5, telegram is valid.

2.1.2 STANDARD NMEA TELEGRAMS

2.1.2.1 $--ACN Frame

This frame is the new version of alert command received from the Integrated Navigation System to modify an alert state. It complies with IEC 61924-2: 2012-12.

$--ACN,HHMMSS.SS,AAA,BBB,C,D,E*hh<CR><LF>		
HHMMSS.SS	Time of command	(NOT USED)
AAA	Manufacturer mnemonic	Must be empty
BBB	Alert identifier	Must be 240 for standard gyrocompass system fault alert
C	Alert instance	Must be set to 1
D	Alert command	Must be: ‘A’ to acknowledge the alert ‘Q’ to request/repeat the alert ‘O’ to request a responsibility transfer ‘S’ to silence the alert
E	Sentence status flag	Must be set to ‘C’
hh	NMEA checksum	

2.1.2.2 $--ACK Frame

This frame is the old version of alert command received from the Integrated Navigation System to acknowledge an alert. It complies with standard IEC 61162-1 (2010-11).

$--ACK,AAA*hh<CR><LF>		
AAA	Alert identifier	Must be 240 for standard gyrocompass system fault alert
hh	NMEA checksum	

2.1.2.3 $--GGA Frame

$--GGA,hhmmss.ss,llmm.mm,a, LLLmm.mm,b,q,ss,y.y,x.x,M,g.g,M,a.a,zzzz*hh<CR><LF>	
hhmmss.ss	UTC of position (USED) (**Note 1**)
llmm.mm	Latitude in degrees (ll) and in minutes (mm.mm) (USED)
a	Hemisphere N: North S: South (USED)
LLLmm.mm	Longitude in degrees (LLL) and in minutes (mm.mm) (USED)
b	Longitude sign E: East W: West (USED)
q	GPS quality indicator (**Note 2**) 0 and ≥ 6 fix invalid 1=GPS SPS Mode, fix valid 2=Differential GPS, SPS Mode, fix valid 3= GPS PPS Mode, fix valid 4= RTK. Satellite system used in RTK mode with fixed integers 5= Float RTK. Satellite system used in RTK mode with floating integers (USED)
ss	Number of satellites. (**Note 3**) (USED)
y.y	Horizontal dilution of precision. (**Note 3**) (USED)
x.x	Antenna altitude (USED)
M	Units of antenna altitude (meters) (USED)
g.g	Geoidal separation. (USED)
M	Units of geoidal separation (meters)
a.a	Age of differential GPS data. (NOT USED)
zzzz	Differential reference station ID. (NOT USED)
hh	NMEA checksum

Note 1: Time is used by algorithm in “INS algorithm based” products.

Note 2: If no GST string is received, the quality factor in GGA telegram is interpreted by INS firmware as described:

Quality factor sent in telegram	Message in IXREPATER	INS corresponding SD attributed to GPS position fix
4	RTK	= 0.1
5	Float RTK	= 0.3
3	Military	= 10
2	Differential	= 3
1	Natural	= 10
0 or ≥ 6	N/A	invalid

Note 3: Data read and transmitted to certain output telegrams (i.e: GPS LIKE). The data is not used by the algorithm.

2.1.2.4 $--GLL Frame

$--GLL,llmm.mm,a,LLLmm.mm,b,hhmmss.ss,S,M*hh<CR><LF>		
llmm.mm	Latitude in degrees (ll) and in minutes (mm.mm)	(USED)
a	ASCII ‘N’ for North, ASCII ‘S’ for South	(USED)
LLLmm.mm	Longitude in degrees (LLL) and in minutes (mm.mm)	(USED)
b	ASCII ‘E’ for East, ASCII ‘W’ for West	(USED)
hhmmss.ss	UTC time of position (**Note 1**)	(USED)
S	Status (**Note 2**): ASCII ‘A’ = data valid ASCII ‘V’ = data invalid Warning : Shall not be blank field	(USED)
M	Positioning system Mode indicator (**Note 2**) : ASCII ‘A’ = Autonomous mode ASCII ‘D’ = Differential mode ASCII ‘E’ = Estimated (dead reckoning) mode ASCII ‘M’ = Manual input mode ASCII ‘S’ = Simulator N= Data not valid Warning : Shall not be blank field	(USED)
hh	NMEA checksum	

Note 1: Time is used by algorithm in “INS algorithm based” products.

Note 2: For GLL or RMC telegram, the Mode indicator field supplements the status field. The status field shall be set to ‘V’ (data invalid) for all values of operating mode except for ‘A’ and ‘D’ (Autonomous and Differential).

At input the quality factor is interpreted by INS firmware as described:

Positioning system Mode indicator	Message in IXREPATER	INS corresponding SD attributed to GPS position fix
A	Natural	= 10
D	Differential	= 3
E, M, S	N/A	invalid

2.1.2.5 $--GST Frame

$--GST,hhmmss.ss,x.x,. x.x,. x.x,. x.x,. x.x,. x.x,. x.x,*hh<CR><LF>		
hhmmss.ss	UTC time of the GGA fix associated with this sentence	(USED)
x.x	RMS value of the standard deviation on pseudo-ranges	(NOT USED)
x.x	Standard deviation of semi-major axis of error ellipse	(NOT USED)
x.x	Standard deviation of semi-minor axis of error ellipse	(NOT USED)
x.x	Orientation of semi-major axis of error ellipse	(NOT USED)
x.x	Standard deviation of latitude error, in meters	(USED)
x.x	Standard deviation of longitude error, in meters	(USED)
x.x	Standard deviation of altitude error, in meters	(USED)
hh	NMEA checksum	

2.1.2.6 $--RMC Frame

$--RMC,hhmmss.ss,S,llmm.mm,a,LLLmm.mm,b,x.x,x.x,ddmmyy,x.x,S,M*hh<CR><LF>		
S	Status : ASCII ‘A’ = data valid ASCII ‘V’ = data invalid Warning : Shall not be blank field	(USED)
llmm.mm	Latitude in degrees (ll) and in minutes (mm.mm)	(USED)
a	ASCII ‘N’ for North, ASCII ‘S’ for South	(USED)
LLLmm.mm	Longitude in degrees (LLL) and in minutes (mm.mm)	(USED)
b	ASCII ‘E’ for East, ASCII ‘W’ for West	(USED)
x.x	Speed over ground in knots (**Note 1**)	(USED)
x.x	Course over ground in degrees	(NOT USED)

$--RMC,hhmmss.ss,S,llmm.mm,a,LLLmm.mm,b,x.x,x.x,ddmmyy,x.x,S,M*hh<CR><LF>		
ddmmyy	Date	(NOT USED)
x.x	Magnetic variation	(NOT USED)
S	Mode indicator : ASCII 'E' = Easterly variation substracts from True course ASCII 'W' = Westerly variation adds to true course	(NOT USED)
M	Positioning system Mode indicator (**Note 2**) : ASCII 'A' = Autonomous mode ASCII 'D' = Differential mode ASCII 'E' = Estimated (dead reckoning) mode ASCII 'M' = Manual input mode ASCII 'S' = Simulator N= Data not valid Warning : Shall not be blank field	(USED)
hh	NMEA checksum	

Note 1: Speed in RMC telegram is only used in "INS algorithm based" products and input to algorithm as EM LOCH data. If position is valid, speed is not taken into account by algorithm. If position is invalid speed is taken into account by algorithm.. RMC telegram should be declared as position and speed input if both position and/or speed need to be used.

Note 2: For GLL or RMC telegram, the Mode indicator field supplements the status field. The status field shall be set to 'V' (data invalid) for all values of operating mode except for 'A' and 'D' (Autonomous and Differential).

At input the quality factor is interpreted by INS firmware as described:

Positioning system Mode indicator	Message in IXREPATER	INS corresponding SD attributed to GPS position fix
A	Natural	= 10
D	Differential	= 3
E, M, S	N/A	invalid

2.1.2.7 $--VHW Frame

$--VHW, x.x ,T, x.x ,M,x.x,N,x.x,K*hh<CR><LF>		
x.x	Heading, degrees true	(USED)
T	True	(USED)
x.x	Heading, degrees magnetic	(NOT USED)
M	Magnetic	(NOT USED)
x.x	Speed in knots	(USED)
N	Knots	(USED)
x.x	Speed in km/h	(NOT USED)
K	Kilometers/hour	(NOT USED)
hh	NMEA checksum	

2.1.2.8 $--VBW Frame

$--VBW,x.x,x.x,A,x.x,x.x,A,x.x,A,x.x,A*hh <CR><LF>		
x.x	Longitudinal DVL (XV1) water speed, in knots, ‘-‘ = astern.	(USED)
x.x	Transverse DVL (XV2) water speed, in knots, ‘-‘ = port.	(USED)
A	Status of DVL water speed, A=Data valid. V= data invalid	(USED)
x.x	Longitudinal DVL (XV1) ground speed, in knots, ‘-‘ = astern.	(USED)
x.x	Transverse DVL (XV2) ground speed, in knots, ‘-‘ = port.	(USED)
A	Status of DVL ground speed: A = data valid V = data invalid	(USED)
x.x	Stern transverse water speed in knots.	(NOT USED)
A	Status of stern water speed.	(NOT USED)
x.x	Stern transverse ground speed in knots.	(NOT USED)
A	Status of stern ground speed.	(NOT USED)
hh	NMEA checksum	

2.1.2.9 $--ZDA Frame

$--ZDA,hhmmss.ss,,,,, *hh <CR><LF>		
hhmmss.ss	UTC of the last PPS	(USED)
dd	UTC day	(USED)
mm	UTC month	(USED)
yyyy	UTC year	(USED)
hh	Local zone hour (**Note 1**)	(USED)
mm	Local zone minutes (**Note 1**)	(USED)
hh	NMEA checksum	

Note 1: Data read and transmitted to certain output telegrams (i.e: GPS LIKE). The data is not used by the algorithm.

2.2 Output NMEA Frame Definition

This section described all NMEA 0183 frames being common in several outputs protocols. Refer to the section 3 to know exactly which frames are output by the NMEA compatible protocols.

2.2.1 NON STANDARD NMEA TELEGRAMS

2.2.1.1 $GPGGA Frame

$GPGGA,hhmmss.ss,LLII.IIIIIII,a,LLLII.IIIIIII,a,x,xx,x.xxx,x.xxx,M,x.xxx,M,x.xxx,xxxx*hh<CR><LF>		
hhmmss.ss	UTC time of position	**Note 2**
LLII.IIIIIII	Latitude in degrees (LL) and in minutes (II.IIIIIII)	**Note 2**
a	'N' for Northern hemisphere, 'S' for Southern hemisphere	**Note 2**
LLLII.IIIIIII	Longitude in deg (LLL) and in minutes (II.IIIIIII)	**Note 2**
a	'E' for East, 'W' for West	**Note 2**
x	GPS quality indicator	**Note 3**
xx	Number of satellites in use	**Note 1**
x.xxx	Horizontal dilution of precision (HDOP)	**Note 2**
x.xxx	Antenna altitude above mean sea level (geoid) (meters)	**Note 2**
M	Unit of antenna altitude (fixed character = 'M' for meters)	
x.xxx	Geoidal separation	**Note 1**
M	Unit of Geoidal separation (fixed character = 'M' for meters)	
x.xxx	Age of the differential GPS data	**Note 1**
xxxx	Differential reference station ID	**Note 1**
hh	NMEA checksum	

Note 1: Copy of last GPS values received. When no GPS has been received since power up, these fields are null except for number of satellites in use set to 3 by default.

Note 2: INS calculated data. Magnetic course field is set to INS true course.

Note 3: The quality indicator is managed as follows: INS **does not copy** the quality indicator received on GGA input to GGA output. The quality factor is set with respect to an INS SD to quality factor correspondence table: refer to section 1.1.4.

2.2.1.2 $GPGLL Frame

$GPGLL,LLII.IIIIIII,a,LLLII.IIIIIII,a,hhmmss.ss,a,m*hh<CR><LF>		
LLII.IIIIIII	Latitude in degrees (LL) and in minutes (II.IIIIIII)	**Note 2**
a	‘N’ for Northern hemisphere, ‘S’ for Southern hemisphere	**Note 2**
LLLII.IIIIIII	Longitude in deg (LLL) and in minutes (II.IIIIIII)	**Note 2**
a	‘E’ for East, ‘W’ for West	**Note 2**
hhmmss.ss	UTC time of position	**Note 2**
a	Status ‘A’ for Data Valid, ‘V’ for Data Invalid	**Note 4**
m	Mode indicator ‘A’ , ‘D’ or ‘E'	**Note 3**
hh	NMEA checksum	**Note 2**

Note 2: INS calculated data. Magnetic course field is set to INS true course.

Note 3: The quality indicator is managed as follows: INS does not copy the quality indicator received on GGA input to GGA output. The quality factor is set with respect to an INS SD to quality factor correspondence table: refer to section 1.1.4.

Note 4: Data invalid for initial alignment **and** speed saturation (i.e INS User status ALIGNMENT **AND** INS User status SPEED_SATURATION bits set to 1)

2.2.1.3 $GPGST Frame

$GPGST,hhmmss.ss,x.x,x.x,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>		
hhmmss.ss	UTC Time	**Note 2**
x.x	RMS value of the standard deviation on pseudo-ranges	**Note 1**
x.x	Standard deviation of semi-major axis of error ellipse in meters	**Note 2**
x.x	Standard deviation of semi-minor axis of error ellipse in meters	**Note 2**
x.x	Orientation of semi-major axis of error ellipse	**Note 2**
x.x	Standard deviation of the error of Latitude in meters	**Note 2**
x.x	Standard deviation of the error of Longitude in meters	**Note 2**
x.x	Standard deviation of the error of Altitude	**Note 2**
hh	NMEA checksum	

Note 1: Copy of last GPS values received. When no GPS has been received since power up, these fields are null except for number of satellites in use set to 3 by default.

Note 2: INS calculated data. Magnetic course field is set to INS true course.

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2.2.1.4 $GPVTG Frame

$GPVTG,x.xxx,T,x.xxx,M,x.xxx,N,x.xxx,K,a*hh<CR><LF>		
x.xxx	True course (deg)	**Note 2**
T	Fixed character = 'T'	
x.xxx	Magnetic course (deg)	**Note 2**
M	Fixed character = 'M'	
x.xxx	Speed (knots)	**Note 2**
N	Fixed character = 'N'	
x.xxx	Speed (km/h)	**Note 2**
K	Fixed character='K'	
a	Positioning system mode indicator 'A', 'D' or 'E'	**Note 3**
hh	NMEA checksum	

Note 2: INS calculated data. Magnetic course field is set to INS true course.
Note 3: The quality indicator is managed as follows: INS does not copy the quality indicator received on GGA input to GGA output. The quality factor is set with respect to an INS SD to quality factor correspondence table: refer to section 1.1.4.

2.2.1.5 $GPZDA and $PHZDA Frame

"—" in the header is either GP or PH.

$--ZDA,hhmmss.ss,dd,mm,yyyy,hh,mm*hh<CR><LF>		
hhmmss.ss	UTC time of PHINS	**Note 2**
dd	UTC day	**Note 2**
mm	UTC month	**Note 2**
yyyy	UTC year	**Note 2**
hh	Local zone hours	**Note 1**
mm	Local zone minutes	**Note 1**
hh	NMEA checksum	

Note 1: Copy of last GPS values received. When no GPS has been received since power up, these fields are null except for number of satellites in use set to 3 by default.
Note 2: INS calculated data..

2.2.1.6 $PHCMP Frame

$PHCMP,llll.ll,a,x.xx,N*hh<CR><LF>		
llll.ll	Latitude in degrees (two first l) and in minutes (four last l)	
a	'N' for Northern hemisphere and 'S' for Southern hemisphere	
x.xx	Speed Norm in knots	
N	Fixed character = 'N'	
hh	NMEA checksum	

2.2.1.7 $PHHRP Frame

$PHHRP,sxx,d,hhhhhhhh*hh<CR><LF>		
s	+ for Clockwise - for Counter Clockwise	
xx	Number of heading turn since the last reset	
d	'd' fix character	
hhhhhhhh	User Status	Hexadecimal value
hh	NMEA checksum	

2.2.1.8 $PHINF Frame

$PHINF,hhhhhhhh*hh<CR><LF>		
hhhhhhhh	User Status	Hexadecimal value
hh	NMEA checksum	

2.2.1.9 $PHLIN Frame

$PHLIN,x.xxx,y.yyy,z.zzz*hh<CR><LF>		
x.xxx	surge in meters (signed)	
y.yyy	sway in meters (signed)	
z.zzz	Heave in meters (signed)	
hh	NMEA checksum	

2.2.1.10 $PHPOS Frame

$PHPOS,x.xxx,y.yyy,z.zzz,x.xxx,y.yyy,z.zzz *hh<CR><LF>		
x.xxx	Surge in m	With Selected Lever Arm
y.yyy	Sway in m	
z.zzz	Heave in m	
x.xxx	Surge in m	Without Lever Arm
y.yyy	Sway in m	
z.zzz	Heave in m	
hh	NMEA checksum	

2.2.1.11 $PHROT Frame

$PHROT,x.xxx,y.yyy,z.zzz*hh<CR><LF>		
x.xxx	Roll speed in °/s (signed)	
y.yyy	Pitch speed in °/s (signed)	
z.zzz	Heading speed in °/s (signed)	
hh	NMEA checksum	

2.2.1.12 $PHSPD Frame

$PHSPD,x.xxx,y.yyy,z.zzz*hh<CR><LF>		
x.xxx	Surge speed in m/s (signed)	
y.yyy	Sway speed in m/s (signed)	
z.zzz	Heave speed in m/s (signed	
hh	NMEA checksum	

2.2.1.13 $PHTRH Frame

$PHTRH,x.xx,a,y.yy,b,z.zz,c*hh<CR><LF>		
x.xx	Pitch in degrees	
a	'M' for bow up and 'P' for bow down	
y.yy	Roll in degrees	
b	'B' for port down and 'T' for port up	
z.zz	Heave absolute value in meters	
c	'O' if OCTANS goes up and 'U' if OCTANS goes down	
hh	NMEA checksum	

2.2.1.14 $PHTRO Frame

$PHTRO,x.xx,a,y.yy,b*hh<CR><LF>		
x.xx	Pitch in degrees	Pitch and Roll fields are empty if HRP_INVALID is set in user status
a	'M' for bow up and 'P' for bow down	
y.yy	Roll in degrees	
b	'B' for port down and 'T' for port up	
hh	NMEA checksum	

2.2.1.15 $PHVIT Frame

$PHVIT,x.xxx,y.yyy,z.zzz,x.xxx,y.yyy,z.zzz *hh<CR><LF>		
x.xxx	Surge speed in m/s	With Selected Lever Arm
y.yyy	Sway speed in m/s	
z.zzz	Heave speed in m/s	
x.xxx	Surge speed in m/s	Without Lever Arm
y.yyy	Sway speed in m/s	
z.zzz	Heave speed in m/s	
hh	NMEA checksum	

2.2.1.16 $ST_HL Frame

$ST_HL,aaaaaaaa *hh<CR><LF>		
aaaaaaaa	High level status	Internal use only
hh	NMEA checksum	

2.2.1.17 $STALG Frame

$STALG,aaaaaaaa,bbbbbbbb*hh<CR><LF>		
aaaaaaaa	Algorithm status 1	Hexadecimal value
bbbbbbbb	Algorithm status 2	
hh	NMEA checksum	

2.2.1.18 $STSOR Frame

$STSOR,aaaaaaaa,bbbbbbbb*hh<CR><LF>		
aaaaaaaa	Sensor status 1	Hexadecimal value
bbbbbbbb	Sensor status 2	
hh	NMEA checksum	

2.2.1.19 $STSYS Frame

$STSYS,aaaaaaaa,bbbbbbbb*hh<CR><LF>		
aaaaaaaa	System status 1	Hexadecimal value
bbbbbbbb	System status 2	
hh	NMEA checksum	

2.2.1.20 $TIME_ Frame

$TIME_,hhmmss.sss*hh<CR><LF>		
hh	Hours	System Time or UTC Time if time synchronized
mm	Minutes	
ss.sss	Seconds	
hh	NMEA checksum	

2.2.2 STANDARD NMEA TELEGRAMS

2.2.2.1 $HEALC Frame

This frame is sent to periodically report a list of active alerts.

Parameters GGG, HHH, J and K are not sent if no active alert (D=0).

It complies with standard IEC 61924-2 (Annex J and annex K).

$HEALC,A,B,C,D,GGG,HHH,J,K]*hh<CR><LF>		
A	Total number of ALF	Fixed to 1
B	Sentence number	Fixed to 1
C	Sequential message identifier	Fixed to 1
D	Number of alert entries	0 if no active alert, 1 if one active alert
GGG	Manufacturer mnemonic	Empty (standardized alert identifier used)
HHH	Alert identifier	Fixed to 240 for a gyrocompass (**Note 1**)
J	Alert instance	Fixed to 1
K	Revision counter	Starts at 1 and is incremented up to 99 after each alert status change in ALF message. Resets to 1 after 99 is used.
hh	NMEA checksum	

Note 1: See IEC 61924-2, Annex J, §J.5, Table J.3.

2.2.2.2 $HEALR Frame

This frame is used for compatibility with old NMEA standard to inform on alert state. It is transmitted each time the alert status changes, or each 30 seconds to update the upper system with active alert list, even if no alert is present. It complies with standard IEC 61924-2 (Annex L).

$HEALR,HHMMSS.SS,XXX,A,B,C*hh<CR><LF>		
HHMMSS.SS	Time	Current time (UTC time if the system is synchronized in UTC, or internal time otherwise) in hour, minute and seconds.
XXX	Unique Alert Identifier	Fixed to 240 for a gyrocompass
A	Alert condition	'A' if alert condition is raised 'V' if alert condition is cleared (**Note 1**)
B	Alert acknowledge state	'V' if not acknowledged 'A' if acknowledged
C	Description text	"System fault"
hh	NMEA checksum	

Note 1: The alert condition is raised on INS products when INS USER status bits 26, 30 or 31 are set (HRP_INVALID, DEGRADED_MODE, FAILURE_MODE). It is cleared otherwise.

2.2.2.3 $HEARC Frame

This frame is sent to refuse incoming bad formatted alert commands. It complies with standard It complies with standard IEC 61924-2 (Annex J and annex K).

$HEARC,HHMMSS.SS,AAA,BBB,C,D*hh<CR><LF>		
HHMMSS.SS	Time	Time of last alarm state change (UTC time if the system is synchronized in UTC, or internal time otherwise) in hour, minute and seconds.
AAA	Manufacturer mnemonic	Empty (standardized alert identifier used)
BBB	Alert identifier	Fixed to 240 for a gyrocompass (**Note 1**)
C	Alert instance	Repetition of received instance that was refused
D	Refused alert command	Repetition of received command character that was refused: ‘A’,’Q’, ‘O’, ‘S’ of ACN telegram.
hh	NMEA checksum	

Note 1: See IEC 61924-2, Annex J, §J.5, Table J.3.

2.2.2.4 $HEALF Frame

This frame is the new format for alert state reporting.

It is sent only when the alert status changes or on alert request from ACN telegram.

It complies with standard IEC 61924-2 (Annex J and annex K).

$HEALF,A,B,C,HHMMSS.SS,D,E,F,GGG,HHH,J,K,L,M--M*hh<CR><LF>		
A	Total number of ALF sentences	Fixed to 1
B	Sentence number	Fixed to 1
C	Sequential message identifier	Fixed to 1
HHMMSS.SS	Time	Time of last alert state change (UTC time if the system is synchronized in UTC, or internal time otherwise) in hour, minute and seconds.
D	Alert category	Fixed to ‘B’ for a gyrocompass
E	Alert priority	Fixed to ‘W’ for a gyrocompass
F	Alert state	‘V’ for active - unacknowledged ‘S’ for active – silenced ‘A’ for active – acknowledged ‘O’ for active – responsibility transferred ‘U’ for rectified – unacknowledged ‘N’ for normal – no alert active
GGG	Manufacturer mnemonic	Empty (standardized code)
HHH	Alert identifier	Fixed to 240 for a gyrocompass
J	Alert instance	Fixed to 1
K	Revision counter	Starts at 1 and is incremented up to 99 after each change of content of any field of the alert (i.e.: time, status). Resets to 1 after 99 is used.
L	Escalation counter	Starts at 0 and is incremented up to 9 each time the active-unacknowledged timer elapses. Resets to 1 after 9 is used.
M---M	Description text	Fixed to “System fault”
hh	NMEA checksum	

2.2.2.5 $HEHBT Frame

This frame is used to ensure that the link with other system is constant and not interrupted.
It also provides system status.
It complies with IEC 61162-1 (2010-11).

$HEHBT,xx,s,x*hh<CR><LF>		
xx,	Sentence's output period in seconds	Fixed 30 seconds (**Note 1**)
a,	Status 'A' for "Equipment in normal operation" 'V' for "Equipement not in normal operation"	Set to 'V' when alert condition is raised Set to 'A' when alert condition is cleared (**Note 2**)
x,	Output counter cycling from 0 to 9	
hh	NMEA checksum	

Note 1: 30 s is based on the that any alert modification status should be reported at a period not exceeding 60 s (cf. IEC 61924-2, Annex J) and that ALC telegram must be updated and sent at least every 30 s (cf. IEC 61924-2, Annex K, §K.3). We take the smallest value here which is 30 s.
Note 2: It is raised on INS products when INS USER status bits 26, 30 or 31 are set (HRP_INVALID, DEGRADED_MODE, FAILURE_MODE). It is cleared otherwise.

2.2.2.6 $HEHDT Frame

$HEHDT,x.x,T*hh<CR><LF>		
x.x	True heading in degrees. Empty if HRP INVALID is set in user status	**Note 1**
T	Fixed ASCII character 'T'	
hh	NMEA checksum	

Note 1: 2 digits after the decimal point in default mode.
5 digits after the decimal point in military mode.
Always 2 digits after the decimal point in case of udp library protocol

2.2.2.7 $HEROT Frame

$HEROT,x.x,S*hh<CR><LF>		
x.x	Heading rate of turn, in deg/mn Sign '–' when bow turns to port	**Note 1**
S	Status ASCII 'A' for data valid ASCII 'V' for data invalid	**Note 2**
hh	NMEA checksum	

Note 1: 2 digits after the decimal point in default mode. 5 digits after the decimal point in military mode. Always 2 digits after the decimal point in case of udp library protocol

Note 2: if Library protocol,
S = 'A' when OCTANS IV User status HRP_NOTVALID is set to 0
S = 'V' when OCTANS IV User status HRP_NOTVALID is set to 1

2.2.2.8 $HETHS Frame

$HETHS,x.x,a*hh<CR><LF>		
x.x	True heading in degrees	**Note 1**
a	Mode indicator character	**Note 2**
hh	NMEA checksum	

Note 1: 2 digits after the decimal point in default mode
5 digits after the decimal point in military mode
Always 2 digits after the decimal point in case of udp library protocol

Note 2:

Mode indicator	Set condition	Output priority level
A = Autonomous	Default value	Low
E = Estimated (dead-reckoning)	N/A	N/A
M = Manual input	N/A	N/A
S = Simulator Mode	System status 2: SIMULATION_MODE	Medium
V = Data not valid	User status : HRP_INVALID	High

$HETHS,,V*hh<CR><LF>

2.2.2.9 $PHTRH Frame

$PHTRH,x.xx,a,y.yy,b,z.zz,c*hh<CR><LF>		
x.xx	Pitch in degrees	
a	'M' for bow up and 'P' for bow down	
y.yy	Roll in degrees	
b	'B' for port down and 'T' for port up	
z.zz	Heave absolute value in meters	
c	'U' if OCTANS goes up and 'O' if OCTANS goes down	
hh	NMEA checksum	

2.3 NMEA Checksum Computation

NMEA sentences are formatted as $aaccc,c…v*hh<CR><LF>
hh is the NMEA checksum of the sentence, and allows checking for data transmission. It is calculated by exclusive-OR'ing (XOR) all characters in the sentence, starting just after the $ and ending just before the *. ASCII characters are converted into hexadecimal format prior to performing the calculation. The resulting checksum is 8 bits long and is coded as two hexadecimal characters. The most significant character, corresponding to the 4 most significant bits of the result, is transmitted first.

3 DIGITAL INTERFACES

3.1 General Overview

Input and output digital interfaces are user-configurable with different protocols (or formats) to be selected from the digital interface library, which is fully described in sections 3.5 (Digital Input protocols) and 3.6 (Digital Output protocols).

Digital protocols can handle input and output data with different format: binary, ASCII and NMEA compliant.

The System status, Algorithm status, Sensor status and User status are updated in real time as a built-in test tool. They are coded as bits, assembled into one or two 16 hexadecimal characters long words which are fully described in section 3.4.

The User status is a synthetic fusion of the System status and Algorithm status. It also incorporates information on the FOG gyrometers and accelerometers status. The whole status is available through some ASCII-NMEA compliant protocols (i.e., PHINS Standard). Some binary protocols also use specific status bits for alarm and error detection.

ASCII NMEA compliant protocols require a checksum to be sent at the end of each line. Detail on NMEA checksum is provided in section 2.3.

3.2 Heart beat management

The heart beat mechanism is used to monitor integrity of a connection between two systems over NMEA link.

The heart beat message is sent at fixed 30 second period. The status contained in the heartbeat message is set to “A” when the system is operating normally (Heading is valid), and to “V” when the system is not operating normally (i.e: Heading invalid due to initial coarse alignment or when a sensor error is present).

The heart beat output is:

- not available on the repeater output port in serial and Ethernet
- available on any output port configured to output NMEA or text protocols

The heart beat management can be enabled port by port from the web-based user interface, refer to the “Web-based interface user guide” document (Ref. MU-INSIII-AN-021).

3.3 Alerts Management

Following the standard IEC 61924-2 (Marine navigation and radio-communication equipment and systems – Integrated Navigation Systems – Part 2: Modular structure for INS – Operational and performance requirements, methods of testing and required test results) two types of alert mechanism are now available:

Old format: ALR/ACK alarm mechanism, see Figure 2 for the old alarm state diagram;

- The ALR message is sent each time the alarm status changes: activated, acknowledged or reset
- The system decodes ACK messages to acknowledge change in current alert state. These changes are then reported in ALR telegram.

- New format: ALF/ALC/ARC new alarm mechanism, see Figure 3 for the new alarm state diagram. The system sends an ALF sentence each time the alarm internal state changes.

Both alarm mechanism are:

- available on all input ports including the repeater input port in serial and Ethernet, as long as the "ALERT IN" protocol is selected.
- not available on the repeater output port in serial and Ethernet

Old and New format alert telegrams available on any output port configured to output NMEA or text protocols (ASCII).

The alarm and heart beat management telegrams can be configured port by port from the web-based user interface, refer to the "Web-Based Interface User Guide" document (Ref. MU-INSIII-AN-021).

The alarms are only triggered when the system is in alignment or when a sensor error is present that produces invalid heading information.

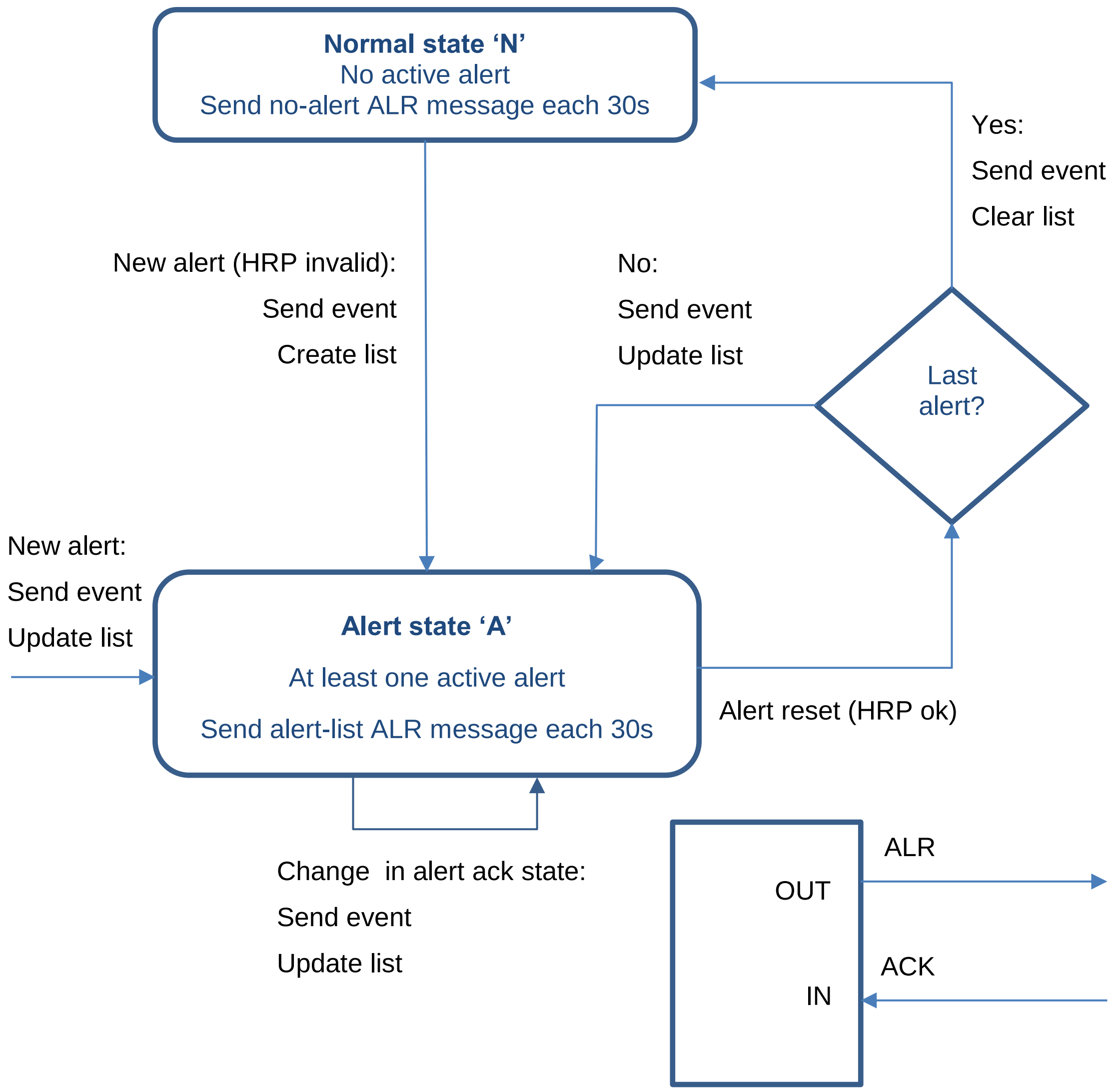


Figure 2 – Old alarm state diagram

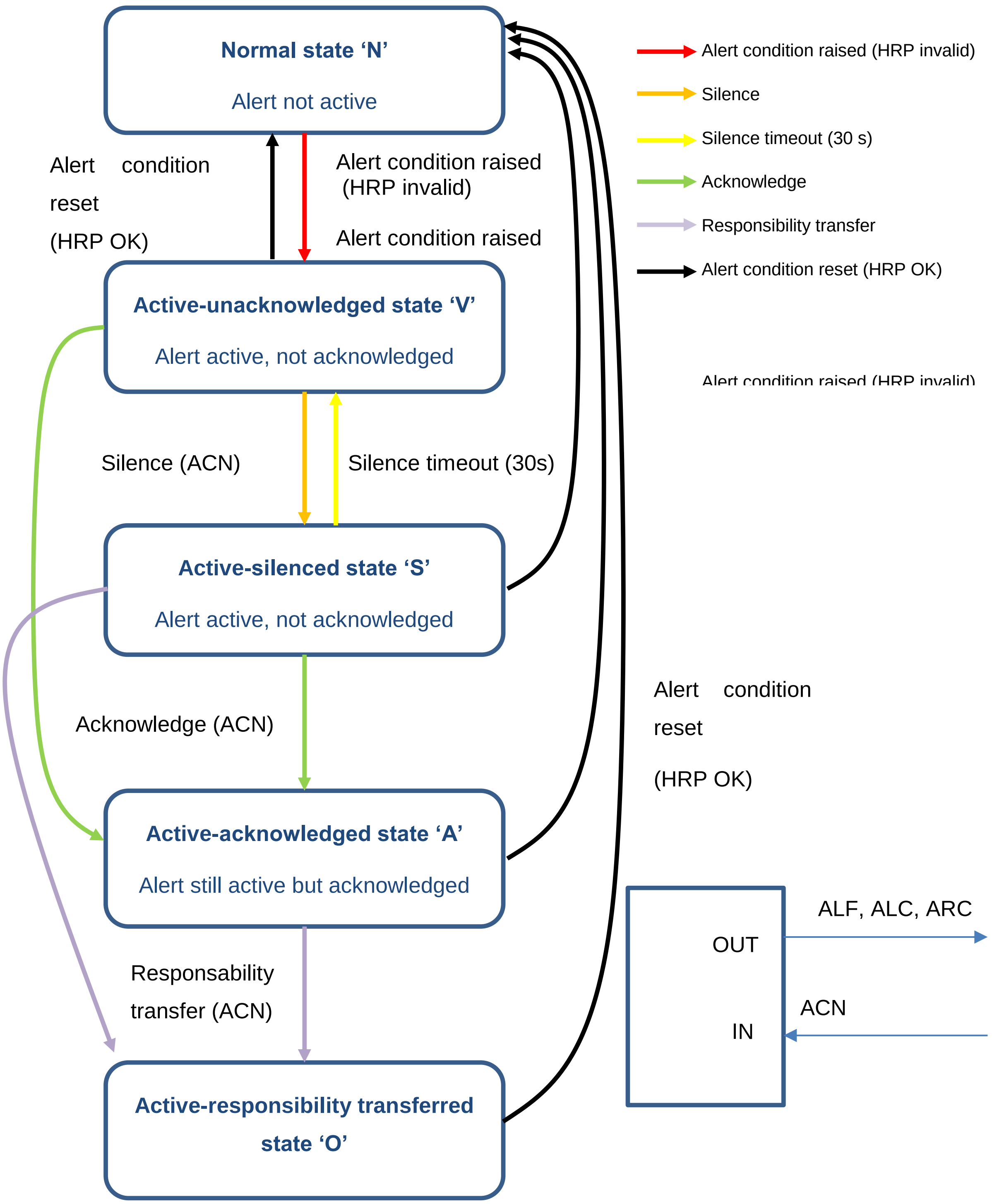


Figure 3 – New alarm state diagram

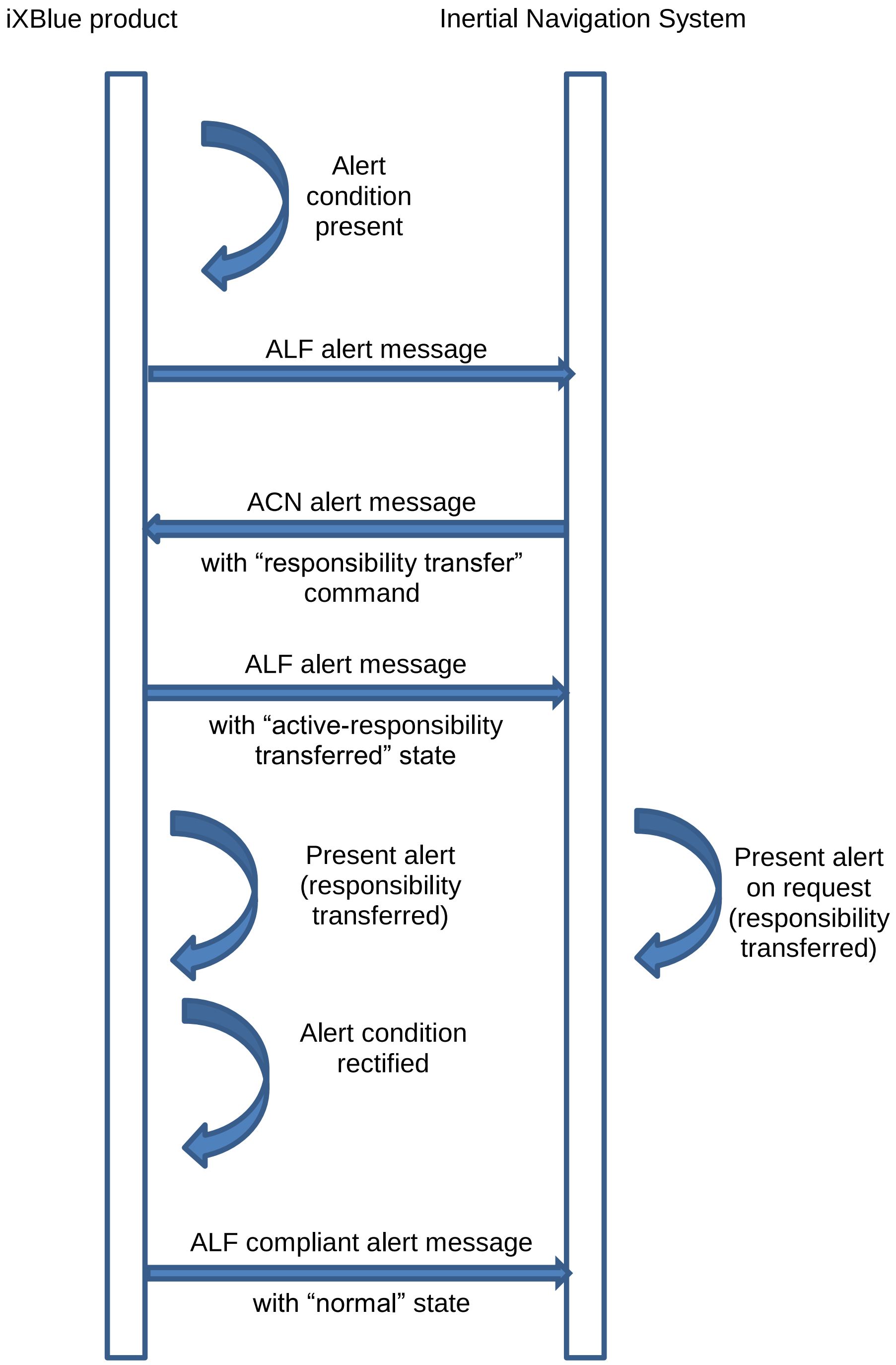


Figure 4 - Alert communication showing priority reduction (new alarm state)

3.4 Status description

3.4.1 STATUS OVERVIEW

The inertial product has built-in tests at a low level of the hardware. These tests convert information translated into status information. The status information will help user to automatically check, in real time, for any malfunctioning, failure or degradation of the system. In general the status display illumination persists for 3 seconds. In case of error, it is displayed for 10 seconds.

There is different status information:

- Sensor Status: (2 words of 32 bits)
  - Sensor Status 1: It corresponds to a low level sensor status word. Each flag is linked to sensors state (Optical source board, FOG sensors, accelerometers and temperature sensors).
  - Sensor Status 2: It corresponds to a high level sensor status. Each flag is a combination of specific sensor status flag.
- Algorithms Status: (4 words of 32 bits)
  - Each flag of the algorithm status is set/unset by navigation algorithm (algorithm state, external sensors, errors…).
- System Status: (3 words of 32 bits)
  - Each flag of the system status is linked to system state (input/output activity, sensor detection, system errors…)
- User Status: (1 word of 32 bits)
  - Each flag of the user status is a combination of flags from sensor, algorithm and/or system status.

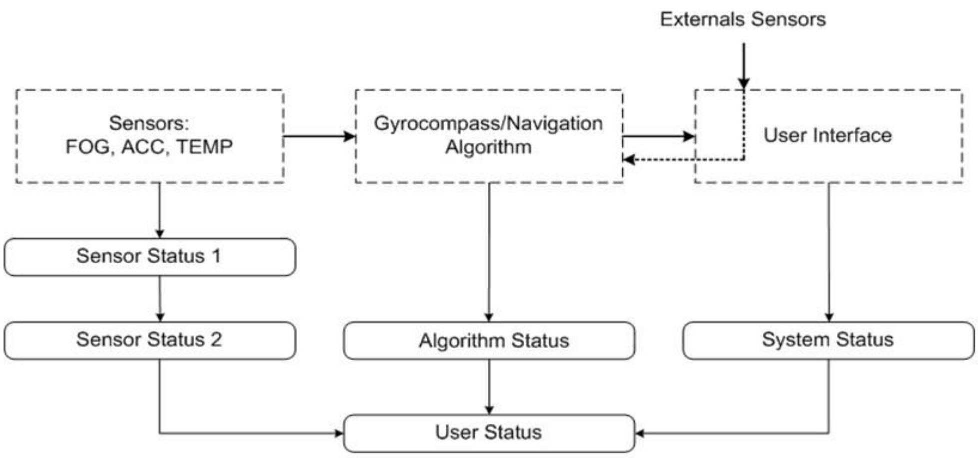


Figure 5 - Status tree arborescence

3.4.2 System Status 1, 2 and 3

$PIXSE,STATUS is a 64 bits word, which acts as a built-in test and control of the inertial product at the system level. This System status is updated in real time and monitored through dedicated flags. It is dedicated to get information on status of serial input and output lines together with Ethernet activity. It also controls the detection of external sensors and system malfunction. Each flag is a bit which is set to "1" when flag is ON and set to "0" when flag is OFF.

The inertial product status word is coded with 16 hexadecimal characters in the "$PIXSE,STATUS,hhhhhhhh,llllllll" NMEA sentence. hhhhhhhh is the hexadecimal value of the first 32 Less Significant Bits (System Status 1). llllllll is the hexadecimal value of the 32 Most Significant Bits (System Status 2). The hexadecimal coding hhhhhhhh of the 32 LSB of $PIXSE,STATUS is given in Table 4. Bits 0 to 3 correspond to the value of the weakest hexadecimal number, bits 4 to 7 correspond to the second weakest hexadecimal number and so on.

The hexadecimal coding llllllll of the 32 MSB of $PIXSE,STATUS is given in Table 6. Bits 32 to 35 correspond to the value of the weakest hexadecimal number, bits 36 to 39 correspond to the second weakest hexadecimal number and so on. When a status bit is set to 1, the corresponding message is displayed in the System Status area of the iXRepeater main window.

Status label are displayed on the web-based user interface with different colors:

- **Message in blue**: information message
- **Message in orange**: warning message
- **Message in red:** error message

Table 4 - list of 32 LSB of the 64 bits $PIXSE,STATUS word describing the inertial product System status 1 (except QUADRANS/ATLANS)

Bit	PHINS / ROVINS / PHINS6000 PHINS C3 / ROVINS NANO HYDRINS / MARINS Status / Web MMI status label	PHINS COMPACT C7 Status / Web MMI status label	LANDINS Status / Web MMI status label	Appearance conditions	Status value
0	SERIAL_IN_R_ERR / **Input R error**			/INPUT_X_ERR : Serial Port: Input port Framing Error (Baudrate, parity…). From repeater port R to port E. GPS_INPUT_ERR and UTC_INPUT_ERR: Only when using internal GPS	0x00000001
1	INPUT_A_ERR / **Input A error**	-	GPS_INPUT_ERR / **GPS Input error**		0x00000002
2	INPUT_B_ERR / **Input B error**	-	UTC_INPUT_ERR / **UTC Input B error**		0x00000004
3	INPUT_C_ERR / **Input C error**	-	-		0x00000008
4	INPUT_D_ERR / **Input D error**	INPUT_A_ERR / **Input A error**			0x00000010
5	INPUT_E_ERR / **Input E error**	INPUT_B_ERR / **Input B error**			0x00000020
6	INPUT_F_ERR / **Input F error**	INPUT_C_ERR / **Input C error**	-		0x00000040
7	INPUT_G_ERR / **Input G error**	INPUT_D_ERR / **Input D error**	-		0x00000080
8	INPUT_R_ACTIVITY / **Input R**			INPUT_X_ACTIVITY: Input port activity (set when received data, before input protocol decoding) ETHERNET_GPS_ACTIVITY and ETHERNET_UTC_ACTIVITY: Only when using internal GPS	0x00000100
9	INPUT_A_ACTIVITY / **Input A**	-	ETHERNET_GPS_ACTIVITY / **Input A**		0x00000200
10	INPUT_B_ACTIVITY / **Input B**	-	ETHERNET_UTC_ACTIVITY / **Input B**		0x00000400
11	INPUT_C_ACTIVITY / **Input C**	-	-		0x00000800
12	INPUT_D_ACTIVITY / **Input D**	INPUT_A_ACTIVITY / **Input A**			0x00001000
13	INPUT_E_ACTIVITY / **Input E**	INPUT_B_ACTIVITY / **Input B**			0x00002000
14	INPUT_F_ACTIVITY / **Input F**	INPUT_C_ACTIVITY / **Input C**	-		0x00004000
15	INPUT_G_ACTIVITY / **Input G**	INPUT_D_ACTIVITY / **Input D**			0x00008000
16	OUTPUT_R_FULL / **Output R full**			Output port full	0x00010000

Bit	PHINS / ROVINS / PHINS6000 PHINS C3 / ROVINS NANO HYDRINS / MARINS Status / Web MMI status label	PHINS COMPACT C7 Status / Web MMI status label	LANDINS Status / Web MMI status label	Appearance conditions	Status value
17	OUTPUT_A_FULL / **Output A full**			(too much data to transfer)	0x00020000
18	OUTPUT_B_FULL / **Output B full**				0x00040000
19	OUTPUT_C_FULL / **Output C full**		POSTPRO_OUT_FULL / **PostPro Output full**		0x00080000
20	OUTPUT_D_FULL / **Output D full**		OUTPUT_C_FULL / **Output C full**		0x00100000
21	OUTPUT_E_FULL / **Output E full**		OUTPUT_D_FULL / **Output D full**		0x00200000
22	ETHERNET_PORT_FULL / **Ethernet output full**			Ethernet output full (common for all Ethernet output ports)	0x00400000
23	*Reserved*			-	-
24	INTERNAL_TIME_USED / **Internal time**			Internal time used	0x01000000
25	*Reserved*		EVENT_MARKER_ERR / -	Event Marker process error (LANDINS) (input pulse frequency too high)	0x02000000
26	ETHERNET_PORT_ACTIVITY / -			Ethernet link reception (common for all Ethernet input ports)	0x04000000
27	PULSE_IN_A_ACTIVITY / **Pulse in A**		PPS_INPUT / **Pulse in A**	Input Pulse activity (*) PULSE B: not for ROVINS NANO (*) PULSE C: not for PHINS COMPACT C3 (*) PULSE D: not for ROVINS/PHINS 6000/ROVINS NANO/PHINS COMPACT C3	0x08000000
28	PULSE_IN_B_ACTIVITY / **Pulse in B**		EVENT_MARKER_A / **Pulse in B**		0x10000000
29	PULSE_IN_C_ACTIVITY / **Pulse in C**		EVENT_MARKER_B / **Pulse in C**		0x20000000
30	PULSE_IN_D_ACTIVITY(*) / **Pulse in D**		EVENT_MARKER_C / **Pulse in D**		0x40000000
31	*Reserved*			-	-

Note: This is System status 1 data in iXRepeater data file.

Example:

If system status= 04000002 this translates into: serial input stream A error and Ethernet device activity.

Table 5 - list of 32 LSB of the 64 bits $PIXSE,STATUS word describing QUADRANS/ATLANS System status 1

Bit	QUADRANS Status / Web MMI status label	ATLANS Status / Web MMI status label	Appearance conditions	Status value
0	SERIAL_IN_R_ERR / **Input R error**		INPUT_X_ERR : Serial Port: Input port Framing Error (Baudrate, parity…). From repeater port R to port E. INT_GPS_INPUT_ERR and INT_GPS_RAW_INPUT_ERR only when using internal GPS	0x00000001
1	-	INT_GPS_INPUT_ERR / **GNSS input error**		0x00000002
2	-	INT_GPS_RAW_INPUT_ERR / **GNSS PP input error**		0x00000004
3	-	-		0x00000008
4	INPUT_A_ERR / **Input A error**			0x00000010
5	INPUT_B_ERR / **Input B error**			0x00000020
6-7	*Reserved / -*		-	-
8	INPUT_R_ACTIVITY / **Input R**		INPUT_X_ACTIVITY: Input port activity (set when received data, before input protocol decoding) INT_GPS_ACTIVITY and INT_GPS_RAW_ACTIVITY only when using internal GPS	0x00000100
9	-	INT_GPS_ACTIVITY / **Internal GNSS**		0x00000200
10	-	INT_GPS_RAW_ACTIVITY / **Internal GNSS PP**		0x00000400
11	-	-		0x00000800
12	INPUT_A_ACTIVITY / **Input A**			0x00001000
13	INPUT_B_ACTIVITY / **Input B**			0x00002000
14-15	*Reserved / -*		-	-
16	OUTPUT_R_FULL / **Output R full**		Output port full (too much data to transfer)	0x00010000
17	OUTPUT_POSTPRO_FULL / **Output A full**			0x00020000
18	OUTPUT_GPS_RAW_FULL / **Output B full**			0x00040000
19	-			0x00080000
20	OUTPUT_A_FULL / **GNSS PP Output full**			0x00100000
21	OUTPUT_B_FULL / **PP Output full**			0x00200000
22	ETHERNET_PORT_FULL / **Ethernet output full**		Ethernet output full (common for all Ethernet output ports)	0x00400000
23	*Reserved / -*		-	-
24	INTERNAL_TIME_USED / **Internal time**		Internal time used	0x01000000
25	-	EVENT_MARKER_ERR / -	Event Marker process error (LANDINS) (input pulse frequency too high)	0x02000000
26	ETHERNET_PORT_ACTIVITY / -		Ethernet link reception (common for all Ethernet input ports)	0x04000000
27	PULSE_IN_A_ACTIVITY / **Pulse in A**	EVENT_MARKER_A / **Pulse in A**	Input Pulse activity	0x08000000
28	PULSE_IN_B_ACTIVITY / **Pulse in B**	EVENT_MARKER_B / **Pulse in B**		0x10000000
29	PULSE_IN_C_ACTIVITY / **Pulse in C**	EVENT_MARKER_C / **Pulse in C**		0x20000000
30	PPS _PULSE_ACTIVITY / **Pulse in D**			0x40000000
31	*Reserved / -*		-	-

Table 6 - list of 32 MSB of the 64 bits $PIXSE, STATUS word describing the inertial product System status 2 (except QUADRANS/ATLANS)

Bit	PHINS / PHINS C3 / C7	ROVINS / PHINS6000	HYDRINS / AIRINS	MARINS	LANDINS	Name	Status label displayed on the web-based user interface	Appearance conditions	Status value
0	✓	✓	-	✓	-	DVL_BT_DETECTED	**DVL BT reception**	DVL Bottom Track data detected	0x00000001
1						DVL_WT_DETECTED	**DVL WT reception**	DVL Water Track data detected	0x00000002
2	✓					GPS_DETECTED	**GPS reception**	GPS1 data detected	0x00000004
3	✓	-	-	✓	-	GPS2_DETECTED	**GPS 2 reception**	GPS2 data detected	0x00000008
4	✓	✓	-	-	-	USBL_DETECTED	**USBL reception**	USBL data detected	0x00000010
5	✓	✓	-	-	-	LBL_DETECTED	**LBL reception**	LBL data detected	0x00000020
6	✓	✓	-	✓	-	DEPTH_DETECTED	**Depth reception**	DEPTH data detected	0x00000040
7	✓	-	-	✓	-	EMLOG_DETECTED	**EMLog reception**	EMLOG data detected	0x00000080
8	-	-	-	-	✓	DMI_DETECTED	**DMI reception**	DMI data detected	0x00000100
9	✓					UTC_DETECTED	**UTC synchro**	UTC data detected (with synchronisation ZDA or ZDA+PPS)	0x00000200
10	✓					ALTITUDE_DETECTED	**Altitude reception**	Altitude data detected	0x00000400
11	✓					PPS_DETECTED	**Synchro PPS1**	PPS signal detected	0x00000800
12	✓					ZUP_MODE_ACTIVATED	**ZUP Mode enabled**	ZUP Mode activated	0x00001000
13	-					*Reserved*	-	-	-
14	✓					MANUAL_GPS_DETECTED	**Manual position reception**	Manual GPS data detected	0x00004000
15	✓	✓	-	✓	-	CTD_DETECTED	**Sound velocity reception**	CTD data detected	0x00008000
16	✓	✓	✓	✓	-	SIMULATION_MODE	**Simulation mode**	Simulation Mode active (MMI)	0x00010000
17	-					*Reserved*	-	-	-
18	✓					DSP_INCOMPATIBILITY	**Incompatible DSP firmware**	DSP firmware and CINT firmware not compatible	0x00040000
19	✓	✓	✓	✓	-	HEADING_ALERT	**Heading accuracy**	Heading standard deviation above user configurable value	0x00080000
20	✓	✓	✓	✓	-	POSITION_ALERT	**Position accuracy**	Position standard deviation above user configurable value	0x00100000
21	✓	✓	✓	✓	-	WAIT_FOR_POSITION	**Waiting for position**	Algorithm waiting for position to start	0x00200000
22	-					*Reserved*	-	-	-
23	✓	✓	✓	✓	-	POLAR_MODE	**Polar mode**	Polar Mode	0x00800000
24	✓	✓	✓	✓	✓	INTERNAL_LOG	**Internal logging**	Internal Log in progress	0x01000000
25	-					*Reserved*	-	-	-
26	✓					DOV_CORR_DETECTED	**Gravity corr. reception**	Vertical Deflection Correction Received	0x04000000
27	✓					MPC_OVERLOAD	**Latency warning**	Interface board CPU overload (too much output protocols with too high output rates)	0x08000000

Bit	PHINS / PHINS C3 / C7	ROVINS / PHINS6000	HYDRINS / AIRINS	MARINS	LANDINS	Name	Status label displayed on the web-based user interface	Appearance conditions	Status value
28	✓					POWER_SUPPLY_FAILURE	**Power failure**	Unit power failure	0x10000000
29	✓					RD_MODE	**Usine Mode**	Unit in R&D mode (Internal use only)	0x20000000
30	✓					CONFIGURATION_SAVED	**Configuration saved**	Configuration saved after having been changed	0x40000000
31	*Reserved*					-	-	-	-

Note: This is System status 2 data in iXRepeater data file. Example: If System status 2 = 00008E00 this translates into: PPS detected, Altitude detected, UTC detected and CTD detected.

Table 7 - list of 32 MSB of the 64 bits $PIXSE,STATUS word describing QUADRANS/ATLANS System status 2

Bit	QUADRANS	ATLANS	Name	Status label displayed on the web-based user interface	Appearance conditions	Status value
0	-		*Reserved*	-	-	-
1	-		*Reserved*	-	-	-
2	✓		GPS_DETECTED	**GPS reception**	GPS1 data detected	0x00000004
3	-		*Reserved*	-	-	-
4	-		*Reserved*	-	-	-
5	-		*Reserved*	-	-	-
6	-		*Reserved*	-	-	-
7	✓	-	EMLOG_DETECTED	**EMLog reception**	EMLOG data detected	0x00000080
8	-	✓	DMI_DETECTED	**DMI reception**	DMI data detected	0x00000100
9	✓		UTC_DETECTED	**UTC synchro**	UTC data detected (with synchronisation ZDA or ZDA+PPS)	0x00000200
10	✓		ALTITUDE_DETECTED	**Altitude reception**	Altitude data detected	0x00000400
11	✓		PPS_DETECTED	**Synchro PPS1**	PPS signal detected	0x00000800
12	✓		ZUP_MODE_ACTIVATED	**ZUP Mode enabled**	ZUP Mode activated / Manual speed input	0x00001000
13	-		*Reserved*	-	-	-
14	✓		MANUAL_GPS_DETECTED	**Manual position reception**	Manual GPS data detected	0x00004000
15	-		*Reserved*	-	-	0x00008000
16	-		SIMULATION_MODE	**Simulation mode**	Simulation Mode active (MMI)	0x00010000
17	-		*Reserved*	-	-	-
18	✓		DSP_INCOMPATIBILITY	**Incompatible DSP firmware**	DSP firmware and CINT firmware not compatible	0x00040000
19	✓		HEADING_ALERT	**Heading accuracy**	Heading standard deviation above user configurable value	0x00080000
20	✓		POSITION_ALERT	**Position accuracy**	Position standard deviation above user configurable value	0x00100000
21	-		WAIT_FOR_POSITION	**Waiting for position**	Algorithm waiting for position to start	0x00200000

Bit	QUADRANS	ATLANS	Name	Status label displayed on the web-based user interface	Appearance conditions	Status value
22	-		*Reserved*	-	-	-
23	-		*Reserved*	-	-	-
24	-	✓	INTERNAL_LOG	**Internal logging**	Internal Log in progress	0x01000000
25-26	-		*Reserved*	-	-	-
27	✓		MPC_OVERLOAD	**Latency warning**	Interface board CPU overload (too much output protocols with too high output rates)	0x08000000
28	-		POWER_SUPPLY_FAILURE	**Power failure**	Unit power failure	0x10000000
29	✓		RD_MODE	**Usine Mode**	Unit in R&D mode (Internal use only)	0x20000000
30	✓		CONFIGURATION_SAVED	**Configuration saved**	Configuration saved after having been changed	0x40000000
31	*Reserved*		-	-	-	-

Table 8 - list of $PIXSE,STATUS word describing the inertial product System status 3 (except QUADRANS/ATLANS)

Bit	PHINS PHINS C3 / C7 ROVINS NANO	ROVINS / PHINS6000	HYDRINS / AIRINS	MARINS	LANDINS	Name	Status label displayed on the web-based user interface	Appearance conditions	Status value
0	✓	-	-	✓	-	UTC2_DETECTED	**UTC2 synchro**	UTC data detected (with synchronisation ZDA or ZDA+PPS)	0x00000001
1	✓	-	-	✓	-	PPS2_DETECTED	**PPS2 synchro**	PPS signal detected	0x00000002
2	✓	-	-	-	-	ADVANCED_FILTERING	**Advanced filtering mode**	DP mode enabled	0x00000004
3	✓	-	-	-	-	NTP_SYNC_IN_PROGRESS	**-**	Appear between NTP activation and NTP synchronization	0x00000008
4	✓	-	-	-	-	NTP_RECEIVED	**-**	NTP is working but not used (only if UTC detected)	0x00000010
5	✓	-	-	-	-	NTP_SYNC	**-**	NTP synchronization successful	0x00000020
6	✓	-	-	-	-	NTP_FAILED	**NTP synchro failed**	NTP synchronization failed (DNS problem, name server unknown, Ethernet link broken...)	0x00000040
7	-	-	-	-	-	*Reserved*	-	*Reserved*	-
8	✓	✓	-	✓	-	DVL2_BT_DETECTED	**DVL2 BT reception**	DVL Bottom Track data detected	0x00000100
9						DVL2_WT_DETECTED	**DVL2 WT reception**	DVL Water Track data detected	0x00000200
10	✓	-	-	✓	-	EMLOG2_DETECTED	**EMLog2 reception**	EMLOG2 data detected	0x00000400
11	-	-	-	-	✓	ANGLES LOSS	**Turret/Angles Loss**	Loss of Angles Data	0x00000800
12	✓	✓	✓	✓	✓	GEOFRAME ERROR	**Geographic frame out of range**	Coordinates out of range	0x00001000
11 - 31	*Reserved*					-	-	-	-

3.4.3 ALGORITHM STATUS 1, 2, 3 AND 4

It is a 64 bits word, which acts as a built-in test and control of the inertial product Algorithm. This status is dedicated to inform the user on how the external sensor data is taken into account by the algorithm and describes the different functioning modes of the algorithm (i.e.: altitude mode, ZUPT mode). This Algorithm status is updated in real time and monitored through dedicated flags. Each flag is a bit which is set to “1” when flag is ON and set to “0” when flag is OFF.

The inertial product Algorithm status word is coded with 16 hexadecimal characters in the “$PIXSE,ALGSTS,hhhhhhhh,llllllll” NMEA sentence. hhhhhhhh is the hexadecimal value of the first 32 Less Significant Bits (Algorithm Status 1). llllllll is the hexadecimal value of the 32 Most Significant Bits (Algorithm Status 2).

The hexadecimal coding hhhhhhhh of the 32 LSB of $PIXSE,ALGSTS is given in Table 9. Bits 0 to 3 correspond to the value of the weakest hexadecimal number, bits 4 to 7 correspond to the second weakest hexadecimal number and so on. The hexadecimal coding llllllll of the 32 MSB of $PIXSE,ALGSTS is given in Table 10. Bits 32 to 35 correspond to the value of the weakest hexadecimal number, bits 36 to 39 correspond to the second weakest hexadecimal number and so on.

When an algo status bit is set to 1, the corresponding message is displayed in the System Status area of the iXRepeater main window.

Status label are displayed on the web-based user interface with different colors:

- **Message in blue**: information message
- **Message in orange**: warning message
- **Message in red:** error message

Table 9 - list of 32 LSB of the 64 bits $PIXSE,ALGSTS word describing the inertial product Algorithm status 1

<table>
<tr><th>Bit</th><th>QUADRANS</th><th>PHINS / ROVINS NANO PHINS C3/C7</th><th>ROVINS / PHINS 6000</th><th>HYDRINS / AIRINS</th><th>MARINS</th><th>LANDINS / ATLANS</th><th>Name</th><th>Status label displayed on the web-based user interface</th><th>Appearance conditions</th><th>Status value</th></tr>
<tr><td>0</td><td colspan="6">✓</td><td>NAVIGATION</td><td>Navigation mode</td><td>Navigation phase. Kalman filter enabled</td><td>0x00000001</td></tr>
<tr><td>1</td><td colspan="6">✓</td><td>ALIGNMENT</td><td>Alignment</td><td>Alignment phase (5 minutes from power on)</td><td>0x00000002</td></tr>
<tr><td>2</td><td colspan="6">✓</td><td>FINE_ALIGNMENT</td><td>-</td><td>Follows alignment phase.
Ends when heading standard deviation reaches 0.1°</td><td>0x00000004</td></tr>
<tr><td>3</td><td>-</td><td>✓</td><td>✓</td><td>-</td><td>✓</td><td>✓</td><td>DEAD_RECKONING</td><td>DVL1 Calibration
or DMI calibration (LANDINS & ATLANS)</td><td>Dead reckoning On.</td><td>0x00000008</td></tr>
<tr><td>4</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>GPS_ALTITUDE</td><td>GPS altitude</td><td>GPS altitude used.</td><td>0x00000010</td></tr>
<tr><td>5</td><td>-</td><td>✓</td><td>✓</td><td>-</td><td>✓</td><td>-</td><td>DEPTHSENSOR_ALTITUDE</td><td>Depth altitude</td><td>Altitude from depth sensor used.</td><td>0x00000020</td></tr>
<tr><td>6</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>ZERO_ALTITUDE</td><td>Stabilization</td><td>Altitude stabilized around zero.</td><td>0x00000040</td></tr>
<tr><td>7</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>-</td><td>HYDRO_ALTITUDE</td><td>Altitude hydro</td><td>Altitude = tide + heave</td><td>0x00000080</td></tr>
<tr><td>8</td><td rowspan="4">✓</td><td rowspan="4">✓</td><td rowspan="4">✓</td><td rowspan="4">-</td><td rowspan="4">✓</td><td rowspan="4">✓</td><td>LOG_RECEIVED / DMI_RECEIVED</td><td>DVL BT reception / DMI reception</td><td rowspan="4">PHINS, ROVINS, MARINS: LOG(DVL BottomTrack) Algorithm Status:
LANDINS, ADVANS: DMI Algorithm Status</td><td>0x00000100</td></tr>
<tr><td>9</td><td>LOG_VALID / DMI_VALID</td><td>DVL BT valid / DMI valid</td><td>0x00000200</td></tr>
<tr><td>10</td><td>LOG_WAITING / DMI_WAITING</td><td>DVL BT waiting / DMI waiting</td><td>0x00000400</td></tr>
<tr><td>11</td><td>LOG_REJECTED / DMI_REJECTED</td><td>DVL BT rejected / DMI rejected</td><td>0x00000800</td></tr>
<tr><td>12</td><td rowspan="2">✓</td><td rowspan="2">✓</td><td rowspan="2">✓</td><td rowspan="2">✓</td><td rowspan="2">✓</td><td rowspan="2">✓</td><td>GPS_RECEIVED</td><td>GPS reception</td><td rowspan="2">GPS Algorithm Status
Received = receiving LOG data</td><td>0x00001000</td></tr>
<tr><td>13</td><td>GPS_VALID</td><td>GPS valid</td><td>0x00002000</td></tr>
</table>

Bit	QUADRANS	PHINS / ROVINS NANO PHINS C3/C7	ROVINS / PHINNS 6000	HYDRINS / AIRINS	MARINS	LANDINS / ATLANS	Name	Status label displayed on the web-based user interface	Appearance conditions	Status value
14							GPS_WAITING	GPS waiting	Valid = used for navigation Waiting = LOG sensor configured but no data received Rejected = rejected by navigation algorithm	0x00004000
15							GPS_REJECTED	GPS rejected		0x00008000
16							USBL_RECEIVED	USBL reception		0x00010000
17	-	✓	✓	-	-	-	USBL_VALID	USBL valid	USBL Algorithm Status	0x00020000
18							USBL_WAITING	USBL waiting		0x00040000
19							USBL_REJECTED	USBL rejected		0x00080000
							DEPTH_RECEIVED	Depth reception		0x00100000
21	-	✓	✓	-	✓	-	DEPTH _VALID	Depth valid	DEPTH Algorithm Status	0x00200000
22							DEPTH_WAITING	Depth waiting		0x00400000
23							DEPTH_REJECTED	Depth rejected		0x00800000
24							LBL_RECEIVED	LBL reception		0x01000000
25	-	✓	✓	-	-	-	LBL_VALID	LBL valid	LBL Algorithm Status	0x02000000
26							LBL_WAITING	LBL waiting		0x04000000
27							LBL_REJECTED	LBL rejected		0x08000000
28	✓			✓			ALTITUDE_SATURATION	Altitude exceeded	Altitude greater than maximum accepted value: 4000 m for terrestrial mode 4000 m for maritime mode 50000 m for aerial mode	0x10000000
29	✓			✓			SPEED_SATURATION	Speed exceeded	Speed greater than maximum accepted value: 100 m/s for terrestrial mode 41.66 m/s for maritime mode 1000 m/s for aerial mode	0x20000000
30	✓			✓			INTERPOLATION_MISSED	-	Acceleration greater than maximal accepted value Rotation rate greater than maximal accepted value	0x40000000
31	-	✓	✓	✓	✓	-	HEAVE_INITIALISATION	Heave Init	Heave filters initialisation. Starts at power on and lasts less then 10 minutes.	0x80000000

Note: This is Algo status 1 data in iXRepeater data file.

If Algo status 1 = 00300321 this translates into: Navigation mode, Altitude calculated using depth sensor, Log received and valid, Depth received and valid.

Table 10 - list of 32 MSB of the 64 bits $PIXSE,ALGSTS word describing the inertial product Algorithm status 2

Bit	QUADRANS	PHINS / PHINS C3/C7 ROVINS NANO	ROVINS/ PHINNS6000	HYDRINS/AIRINS	MARINS	LANDINS, ATLANS	Name	Status label displayed on the web-based user interface	Appearance conditions	Status value
0	-	✓	✓	-	✓	-	WATERTRACK_RECEIVED	**DVL WT reception**	WaterTrack Algorithm Status	0x00000001
1							WATERTRACK_VALID	**DVL WT valid**		0x00000002
2							WATERTRACK_WAITING	**DVL WT waiting**		0x00000004
3							WATERTRACK_REJECTED	**DVL WT rejected**		0x00000008
4	-	✓	-	-	✓	-	GPS2_RECEIVED	**GPS 2 reception**	GPS2 Algorithm Status	0x00000010
5							GPS2_VALID	**GPS 2 valid**		0x00000020
6							GPS2_WAITING	**GPS 2 waiting**		0x00000040
7							GPS2_REJECTED	**GPS 2 rejected**		0x00000080
8-11							*Reserved*	-	-	-
12	✓	✓	✓	✓	✓	✓	ALTITUDE_RECEIVED	**Altitude reception**	Altitude Algorithm Status	0x00001000
13							ALTITUDE _VALID	**Altitude valid**		0x00002000
14							ALTITUDE _WAITING	**Altitude waiting**		0x00004000
15							ALTITUDE _REJECTED	**Altitude rejected**		0x00008000
16	✓	✓	✓	✓	✓	✓	ZUPT_MODE_ACTIVATED	**ZUPT mode enabled**	ZUPT mode activated / Manual speed on	0x00010000
17							ZUPT_MODE_VALID	**ZUPT mode valid**	ZUPT mode valid / Manual speed valid	0x00020000
18							AUTOSTATICBENCH_ZUPT_MODE	**Bench ZUPT Mode enabled**	AutoStatic Bench ZUPT mode activated	0x00040000
19							AUTOSTATICBENCH_ZUPT _VALID	**Bench ZUPT Mode valid**	AutoStatic Bench ZUPT mode valid	0x00080000
20	-	-	-	-	✓	-	STATIC_CONVERGENCE_ON	-	Special static convergence mode on: convergence in progress	0x00100000
21							STATIC_CONV_GO_TO_NAV	-	Special static convergence mode on: convergence ended, navigation ok.	0x00200000
22	-	✓	✓	✓	✓	-	FAST_ALIGNEMENT	**Fast alignment**	Fast alignment mode (Attitude restoration mode)	0x00400000
23	-	✓	✓	✓	✓	-	EMULATION_MODE	**Emulation mode**	Simulation of DSP input sensor data (FOG,ACC)	0x00800000
24	✓	✓	-	-	✓	-	EMLOG_RECEIVED	**EM LOG reception**	EMLOG Algorithm Status	0x01000000
25							EMLOG_VALID	**EM LOG valid**		0x02000000
26							EMLOG_WAITING	**EM LOG waiting**		0x04000000
27							EMLOG_REJECTED	**EM LOG rejected**		0x08000000
28	✓	✓	✓	✓	✓	✓	MANUALGPS_RECEIVED	**Manual position reception**	Manual GPS Algorithm Status	0x10000000
29							MANUALGPS _VALID	**Manual position valid**		0x20000000
30							MANUALGPS _WAITING	**Manual position waiting**		0x40000000
31							MANUALGPS _REJECTED	**Manual position rejected**		0x80000000

Note: This is Algo status 2 data in iXRepeater data file. If Algo status 2 = 00010000 this translates into: ZUPT mode activated.

Table 11 - list of 32 MSB of the 64 bits $PIXSE,ALGSTS word describing the inertial product Algorithm status 3

Bit	QUADRANS	PHINS / PHINS C3-C7/ ROVINS NANO	ROVINS/ PHINS6000	HYDRINS/ AIRINS	MARINS	LANDINS/ ATLANS	Name	Status label displayed on the web-based user interface	Appearance conditions	Status value
0	-	-	-	-	-	-	SVL_RECEIVED	-	SVL (Sonar Velocity Log) Algorithm Status	0x00000001
1							SVL_VALID	-		0x00000002
2							SVL_WAITING	-		0x00000004
3							SVL_REJECTED	-		0x00000008
4	-	✓	-	-	✓	-	EMLOG2_RECEIVED	**EM LOG 2 reception**	EMLOG2 Algorithm Status	0x00000010
5							EMLOG2_VALID	**EM LOG 2 valid**		0x00000020
6							EMLOG2_WAITING	**EM LOG 2 waiting**		0x00000040
7							EMLOG2_REJECTED	**EM LOG 2 rejected**		0x00000080
8	-	✓	✓	-	-	-	USBL2_RECEIVED	**USBL 2 reception**	USBL2 Algorithm Status	0x00000100
9							USBL2_VALID	**USBL 2 valid**		0x00000200
10							USBL2_WAITING	**USBL 2 waiting**		0x00000400
11							USBL2_REJECTED	**USBL 2 rejected**		0x00000800
12	-	✓	✓	-	-	-	USBL3_RECEIVED	**USBL 3 reception**	USBL3 Algorithm Status	0x00001000
13							USBL3_VALID	**USBL 3 valid**		0x00002000
14							USBL3_WAITING	**USBL 3 waiting**		0x00004000
15							USBL3_REJECTED	**USBL 3 rejected**		0x00008000
16	-	-	-	-	-	-	Reserved	-	-	0x00010000
17	-	✓	✓	-	✓	✓	CALCHK	**Calibration check**	DVL/Odometer calibration check On/Off (set when check is On)	0x00020000
18	✓	✓	✓	✓	✓	✓	RESTORE_ATTITUDE_FAILED.	**Fast alignment failed**	Restore Attitude Failed	0x00040000
19	✓	✓	✓	✓	✓	✓	REL_SPD_ZUP_ACTIVATED	**Relative ZUPT Mode enabled**	Relative Speed ZUP activated	0x00080000
20	✓	✓	✓	✓	✓	✓	REL_SPD_ZUP_VALID	**Relative ZUPT Mode valid**	Relative Speed ZUP valid	0x00100000
21	✓	✓	✓	✓	✓	✓	EXT_SENSOR_OUTDATED	**Timing issue**	One of the External Sensor received Is outdated	0x00200000
22	-	✓	✓	-	✓	✓	SENSOR_USED_BEFORE_CALIB	**Sensor used before calibration**	Sensor used before calibration	0x00400000
23	✓	✓	✓	✓	✓	✓	RESTORE_ATTITUDE_REJECTED	**Fast alignment rejected**	Restore Attitude Rejected (starting conditions not met)	0x00800000
24-26	-	-	-	-	-	-	Reserved	-	-	-
27	-	-	-	-	-	-	POLAR_VALIDITY	**Polar Heading not valid**	Output Polar Data validity	0x08000000
28	-	-	-	-	-	-	FIRM_INCOMPATIBLES	**Incompatible firmwares**	Firmwares incompatible with Hardware (FOG, ACC or Algo type unset)	0x10000000

Bit	QUADRANS	PHINS / PHINS C3-C7/ ROVINS NANO	ROVINS/ PHINNS6000	HYDRINS/ AIRINS	MARINS	LANDINS/ ATLANS	Name	Status label displayed on the web-based user interface	Appearance conditions	Status value
29	-	✓	✓	✓ (HYDRINS)	✓	-	IMO_ALIGNMENT	**IMO alignment**	IMO alignment flag is set when heading standard deviation is > 0.23° seclat (for marine products only) Flag persistence time: 1 second	0x20000000
30	-	✓ for PHINS, PHINS C7	✓	✓/- (HYDRINS)	✓	✓/- (LANDINS)	OPTIMAL_ALIGNMENT	**Optimal alignment**	Optimal alignment flag is set for F90 to F200 products only when heading standard deviation is: LANDINS/ROVINS: Heading std dev > 0.1° seclat AIRINS, HYDRINS, PHINS, PHINS C7, PHINS 6000, MARINS: Heading std dev > 0.05° seclat Flag persistence time: 1 second	0x40000000
31	-	-	-	-	✓	-	STRATEGIC_ALIGNMENT	**Strategic alignment**	Strategic alignment flag is set only for MARINS products when heading std dev > 0.05°seclat and FOG polar bias (FPB) is: MARINS M3/M5: FPB > 1.2m°/h MARINS M7: FPB > 0.4m°/h Flag persistence time: 1 second	0x80000000

Table 12 - list of 32 MSB of the 64 bits $PIXSE,ALGSTS word describing the inertial product Algorithm status 4

Bit	QUADRANS	PHINS / PHINS C3/C7 ROVINS NANO	ROVINS/ PHINNS6000	HYDRINS/AIRINS	MARINS	LANDINS, ATLANS	Name	Status label displayed on the web-based user interface	Appearance conditions	Status value
0	-	✓	✓	-	✓	-	LOG2_RECEIVED	**DVL2 BT reception**	DVL2 BottomTrack Algorithm Status	0x00000001
1							LOG2_VALID	**DVL2 BT valid**		0x00000002
2							LOG2_WAITING	**DVL2 BT waiting**		0x00000004
3							LOG2_REJECTED	**DVL2 BT rejected**		0x00000008
4	-	✓	✓	-	✓	-	WATERTRACK2_RECEIVED	**DVL2 WT reception**	DVL2 WaterTrack Algorithm Status	0x00000010
5							WATERTRACK2_VALID	**DVL2 WT valid**		0x00000020
6							WATERTRACK2_WAITING	**DVL2 WT waiting**		0x00000040
7							WATERTRACK2_REJECTED	**DVL2 WT rejected**		0x00000080
8	-	✓	✓	-	✓	-	DVL_DIST_TRAVELLED_VALID	-	Algorithm DVL calibration status	0x00000100
9							DVL_CALIBRATION_NONE	-		0x00000200
10							DVL_ROUGH_CALIBRATION	**Rough calibration**		0x00000400
11							DVL_FINE_CALIBRATION	**Fine calibration**		0x00000800
12							DVL_CHECK_CALIBRATION	**Verification in progress**		0x00001000
13-31	-	-	-	-	-	-	*Reserved*	-	*Reserved*	-

3.4.4 SENSOR STATUS 1 AND 2

It is an internal 64 bits word, which acts as a built-in test of Fog gyrometers, Accelerometers and optical source board. This status is dedicated to inform the user on any malfunction of the internal inertial sensors. This Sensor status is updated in real time and monitored through dedicated flags. Each flag is a bit which is set to “1” when flag is ON and set to “0” when flag is OFF.

The inertial product Sensor status word is coded with 16 hexadecimal characters in the “$PIXSE,SORSTS,hhhhhhhh,llllllll” NMEA sentence. hhhhhhhh is the hexadecimal value of the first 32 Less Significant Bits (Sensor Status 1). llllllll is the hexadecimal value of the 32 Most Significant Bits (Sensor Status 2).

The hexadecimal coding hhhhhhhh of the 32 LSB of $PIXSE,SORSTS is given in Table 13. Bits 0 to 3 correspond to the value of the weakest hexadecimal number, bits 4 to 7 correspond to the second weakest hexadecimal number and so on. The hexadecimal coding llllllll of the 32 MSB of $PIXSE,SORSTS is given in Table 14. Bits 32 to 35 correspond to the value of the weakest hexadecimal number, bits 36 to 39 correspond to the second weakest hexadecimal number and so on.

When a status bit is set to 1, the corresponding message is displayed in the System Status area of the iXRepeater main window.

Status label are displayed on the web-based user interface with different colors:

- **Message in blue**: information message
- **Message in orange**: warning message
- **Message in red:** error message

Table 13 - list of 32 LSB of the 64 bits Sensor status word describing the inertial product Sensor status 1

Bit	QUADRANS ATLANS	INS	Name	Appearance conditions	Status value	Sensor status 2 threshold	Degraded mode threshold	Failure mode threshold
0	✓	✓	DATA_READY_ERR	Loss of sensors raw data (FOG or ACC)	0x00000001	1	N/A	3
1	N/A	✓	SOURCE_POWER_CONTROL_ERR	FOG Optical source control power failure. Set when measured optical power <50% of set point (triggered by FOG Optical source board: bits 7 and 0 source status)	0x00000002	10	10	100
2	N/A	✓	SOURCE_DIODE_ERR	FOG Optical source diode off (bit 11 source status)	0x00000004	10	10	100
3	N/A	✓	SOURCE_MODE_ERR	FOG Optical source not in power control mode (bit 8 source status)	0x00000008	10	10	100
4	✓	✓	ACC_X_SATURATION_ERR	Accelerometer saturation (ADC saturation: OVF: bit 2 of ACC_n (n=X,Y,Z) status)	0x00000010	1	1	10
5			ACC_Y_SATURATION_ERR		0x00000020			
6			ACC_Z_SATURATION_ERR		0x00000040			
7	✓	✓	ACC_X_ACQ_ERR	Accelerometer acquisition error. (ADC incorrect frame: Ee: bit 3 ACC_n (n=X,Y,Z) status)	0x00000080	5	5	10
8			ACC_Y_ACQ_ERR		0x00000100			
9			ACC_Z_ACQ_ERR		0x00000200			
10	✓	✓	FOG_X_SATURATION_ERR	FOG saturation. (ADC saturation: OVF_CAN: bit 0 FOG_n (n=X,Y,Z) status)	0x00000400	100	100	1000
11			FOG_Y_SATURATION_ERR		0x00000800			
12			FOG_Z_SATURATION_ERR		0x00001000			
13	✓	✓	FOG_X_VPI_ERR	VPI voltage control error.	0x00002000	1	N/A	1
14			FOG_Y_VPI_ERR		0x00004000			

Bit	QUADRANS ATLANS	INS	Name	Appearance conditions	Status value	Sensor status 2 threshold	Degraded mode threshold	Failure mode threshold
15			FOG_Z_VPI_ERR	(VPI used to convert FOG phase shift to voltage and rotation: ERROR_VPI: bit 1 FOG_n (n=X,Y,Z) status)	0x00008000			
16	N/A	N/A	FOG_X_LOW_POWER	FOG low power. (LOW_POWER: bit 7 FOG_n (n=X,Y,Z) status)	0x00010000	10000	10000	N/A
17			FOG_Y_LOW_POWER		0x00020000			
18			FOG_Z_LOW_POWER		0x00040000			
19	✓	✓	FOG_X_ACQ_ERR	FOG frame acquisition error. (sensor board level: Framing FOG_n (n=X,Y,Z) byte)	0x00080000	1	1	10
20			FOG_Y_ACQ_ERR		0x00100000			
21			FOG_Z_ACQ_ERR		0x00200000			
22	✓	✓	FOG_X_CRC_ERR	FOG frame CRC error. (DSP board level: Check of CRC FOG_n (n=X,Y,Z) Data)	0x00400000	10	10	100
23			FOG_Y_CRC_ERR		0x00800000			
24			FOG_Z_CRC_ERR		0x01000000			
25	✓	✓	TEMP_ACQ_ERR	Temperature acquisition error (Optical source, ACC and FOG temperatures on sensor board)	0x02000000	1	1	N/A
26	✓	✓	TEMP_THRESHOLD_ERR	TEMP_THRESHOLD_ERR will be set to 1, if any of the measured temperature (TACCx,y,z; TFOGx,y,z, TSource board) is greater than 90° or Tsensor board is greater than 115°C. In practice the Tsensor board will trigger the alarm first since temperature sensor is on an electronic component	0x04000000	1	1	N/A
27	✓	✓	DTEMP_THRESHOLD_ERR	DTEMP_THRESHOLD_ERR will be set to 1 if any temperature variation is greater than 5°/minute.	0x08000000	1	1	N/A
28	✓	✓	SENSOR_DATA_FIFO_WARNING	Sensor raw data FIFO half full	0x10000000	N/A	N/A	N/A
29	✓	✓	SENSOR_DATA_FIFO_ERR	Sensor raw data FIFO full	0x20000000	1	N/A	1
30	N/A	✓	SOURCE_POWER_ERR	Difference between measured source power and requested source power greater than 10% (Computed by DSP board)	0x40000000	100	100	1000
31	N/A	✓	SOURCE_RECEPTION_ERR	Source data reception error (loss of source data, computed at DSP level)	0x80000000	100	N/A	100

Note: This is Sensor status 1 data in iXRepeater data file.

Example:

If Sensor status 1 = 00001C00 this translates into: FOG X Saturation Error, FOG Y Saturation Error, FOG Z Saturation Error.

Table 14 - list of 32 MSB of the 64 bits Sensor status word describing the inertial product Sensor status 2

Bit	QUADRANS ATLANS	INS (other)	Name	Status label displayed on the web-based user interface	Appearance conditions	Status value
0	✓	✓	FOG_X_ERR	**FOG X Error**	FOG_X_SATURATION_ERR (bit 10 Sensor Status 1) or FOG_X_ACQ_ERR (bit 19 Sensor Status 1) or FOG_X_CRC_ERR (bit 22 Sensor Status 1) or FOG_X_VPI_ERR (bit 13 Sensor Status 1) or FOG_X_LOW POWER (bit 16 Sensor Status 1)	0x00000001
1	✓	✓	FOG_Y_ERR	**FOG Y Error**	All Sensor Status 1 FOG_Y abnormalities (like FOG_X_ERR): (bits 11, 20, 23, 14, 17 and 5 of Sensor Status 1).	0x00000002
2	✓	✓	FOG_Z_ERR	**FOG Z Error**	All Sensor Status 1 FOG_Z abnormalities (like FOG_X_ERR): (bits 12, 21, 24, 15, 18 and 6 of Sensor Status 1).	0x00000004
3	N/A	✓	SOURCE_ERR	**Source error**	SOURCE_POWER_CONTROL_ERR (bit 1 Sensor Status 1) or SOURCE_DIODE_ERR (bit 2 Sensor Status 1) or SOURCE_MODE_ERR (bit 3 Sensor Status 1) or SOURCE_POWER__ERR (bit 30 Sensor Status 1) or SOURCE_RECEPTION _ERR (bit 31 Sensor Status 1)	0x00000008
4	✓	✓	ACC_X_ERR	**Acc X Error**	ACC_X_SATURATION_ERR (bit 4 Sensor Status 1) or ACC_X_ACQ_ERR (bit 7 Sensor Status 1)	0x00000010
5	✓	✓	ACC_Y_ERR	**Acc Y Error**	All Sensor Status 1 ACC_Y abnormalities (like ACC_X_ERR): (bits 5 and 8 of Sensor Status 1).	0x00000020
6	✓	✓	ACC_Z_ERR	**Acc Z Error**	All Sensor Status 1 ACC_Z abnormalities (like ACC_X_ERR): (bits 6 and 9 of Sensor Status 1).	0x00000040
7	✓	✓	TEMP_ERR	**Temperature Alarm**	TEMP_ACQ_ERR (bit 25 Sensor Status 1) or TEMP_THRESHOLD_ERR (bit 26 Sensor Status 1) or DTEMP_THRESHOLD_ERR (bit 27 Sensor Status 1)	0x00000080
8	✓	✓	DSP_OVERLOAD	**DSP overload**	DATA_READY_ERR (bit 0 Sensor Status 1) SENSOR_DATA_FIFO_WARNING (bit 28 Sensor Status 1) or SENSOR_DATA_FIFO_ERR (bit 29 Sensor Status 1)	0x00000100
9	N/A	✓	ERR_INIT_CAN_ACC_X	-	CAN_ACC_X Initialization Error	0x00000200
10	N/A	✓	ERR_INIT_CAN_ACC_Y	-	CAN_ACC_Y Initialization Error	0x00000400
11	N/A	✓	ERR_INIT_CAN_ACC_Z	-	CAN_ACC_Z Initialization Error	0x00000800
12	✓	✓	MODELISATION_ERROR	**Modelisation Error**	Modelisation version not managed	0x00001000
13-29	✓	✓	*Reserved*	-	-	-
30	✓	N/A	FAILURE_MODE	**Failure Mode**	See "*Low level Sensor Status 1 description*" table: Case numbers to trigger Degraded and Failure mode.	0x40000000
	N/A	✓	DEGRADED_MODE	**Degraded Mode**		
31	✓	N/A	DEGRADED_MODE	**Degraded Mode**		0x80000000
	N/A	✓	FAILURE_MODE	**Failure Mode**		

Note: This is Algo status 2 data in iXRepeater data file. Sensor status 2 corresponds to a high level sensor status. Each of the sensor status 2 flag is a combination ('or') of specific sensor status flag. *"Degraded_Mode"* or *"Failure_Mode"* flags are set if one of the sensor status 1 flag counts reaches respectively degraded mode or failure mode threshold. Example: if Algo status 2= 80000007 this translates into: Fog X Error, Fog Y Error, Fog Z Error, Failure Mode.

3.4.5 USER STATUS

User status is an internal 32 bits word, which acts as a built-in test and control of the inertial product. It is a synthetic fusion of System status, Algorithm Status and Sensor status.
It also incorporates additional information on FOG gyrometers and accelerometers status. This User status is updated in real time and monitored through dedicated flags.
Each flag is a bit which is set to "1" when flag is ON and set to "0" when flag is OFF. This status is used by several output protocols
The hexadecimal coding hhhhhhhh of the 32 bits of user status is given below. Bits 0 to 3 correspond to the value of the weakest hexadecimal number, bits 4 to 7 correspond to the second weakest hexadecimal number and so on.Status label are displayed on the web-based user interface with different colors:

- **Message in blue**: information message
- **Message in orange**: warning message
- **Message in red:** error message

Table 15 - list of 32 bits User status word describing the inertial product User status (except QUADRANS/ATLANS)

Bit	PHINS / PHINS COMPACT C7 ROVINS NANO	ROVINS/PHINS6000	HYDRINS/AIRINS	MARINS	LANDINS	Name	Set when following bits are set	Status value
0	✓	✓	-	✓	-	DVL_RECEIVED_VALID	LOG_RECEIVED (bit 8 Algo Status 1) when LOG Rejection mode = Always true or LOG_VALID (bit 9 Algo Status 1) or WATERTRACK_RECEIVED (bit 0 Algo Status 2) when WaterTrack Rejection mode = Always true or WATERTRACK_VALID(bit 1 Algo Status 2)	0x00000001
1	✓	✓	✓	✓	✓	GPS_RECEIVED_VALID	GPS_RECEIVED (bit 12 Algo Status 1) when GPS Rejection mode = Always true or GPS_VALID (bit 13 Algo Status 1)	0x00000002
2	✓	✓	-	✓	-	DEPTH_RECEIVED_VALID	DEPTH_RECEIVED (bit 20 Algo Status 1) when DEPTH Rejection mode = Always true or DEPTH_VALID (bit 21 Algo Status 1)	0x00000004
3	✓	✓	-	-	-	USBL_RECEIVED_VALID	USBL_RECEIVED (bit 16 Algo Status 1) when USBL Rejection mode = Always true or USBL_VALID (bit 17 Algo Status 1)	0x00000008
4	✓	✓	-	-	-	LBL_RECEIVED_VALID	LBL_RECEIVED (bit 24 Algo Status 1) when LBL Rejection mode = Always true or LBL_VALID (bit 25 Algo Status 1)	0x00000010
5	✓	-	-	✓	-	GPS2_ RECEIVED_VALID	GPS2_RECEIVED (bit 4 Algo Status 2) when GPS2 Rejection mode = Always true or GPS2_VALID (bit 5 Algo Status 2)	0x00000020
6	✓	-	-	✓	-	EMLOG_RECEIVED_VALID	EMLOG_RECEIVED (bit 24 Algo Status 2) when EMLOG Rejection mode = Always true or EMLOG_VALID (bit 25 Algo Status 2)	0x00000040
7	✓	✓	✓	✓	✓	MANUAL_GPS_ RECEIVED_VALID	MANUALGPS_RECEIVED (bit 28 Algo Status 2) when MANUALGPS Rejection mode = Always true or MANUALGPS_VALID (bit 29 Algo Status 2)	0x00000080
8	✓					TIME_RECEIVED_VALID	UTC_DETECTED (bit 9 System Status 2)	0x00000100
9	✓					FOG_ANOMALY	FOG_X_ERR (bit 0 Sensor Status 2)	0x00000200

Bit	PHINS / PHINS COMPACT C7 ROVINS NANO	ROVINS/PHINS6000	HYDRINS/AIRINS	MARINS	LANDINS	Name	Set when following bits are set	Status value
							or FOG_Y_ERR (bit 1 Sensor Status 2) or FOG_Z_ERR (bit 2 Sensor Status 2) or SOURCE_ERR (bit 3 Sensor Status 2)	
10	✓					ACC_ANOMALY	ACC_X_ERR (bit 4 Sensor Status 2) or ACC_Y_ERR (bit 5 Sensor Status 2) or ACC_Z_ERR (bit 6 Sensor Status 2)	0x00000400
11	✓					TEMPERATURE_ERR	TEMP_ERR (bit 7 Sensor Status 2)	0x00000800
12	✓					CPU_OVERLOAD	DSP_OVERLOAD (bit 8 Sensor Status 2) or MPC_OVERLOAD (bit 27 System Status 2)	0x00001000
13	✓					DYNAMIC_EXCEDEED	INTERPOLATION_MISSED (bit 30 Algo Status 1)	0x00002000
14	✓					SPEED_SATURATION	SPEED_SATURATION (bit 29 Algo Status 1)	0x00004000
15	✓					ALTITUDE_SATURATION	ALTITUDE_SATURATION (bit 28 Algo Status 1)	0x00008000
16	✓					INPUT_A_ERR / GPS_INPUT_ERR(*)	INPUT_A_ERR / GPS_INPUT_ERR(*) (bit 1 System Status 1)	0x00010000
17	✓					INPUT_B_ERR / UTC_INPUT_ERR(*)	INPUT_B_ERR / UTC_INPUT_ERR(*) (bit 2 System Status 1)	0x00020000
18	✓					INPUT_C_ERR	INPUT_C_ERR (bit 3 System Status 1)	0x00040000
19	✓					INPUT_D_ERR / INPUT_A_ERR (*)	INPUT_D_ERR / INPUT_A_ERR (*) (bit 4 System Status 1)	0x00080000
20	✓					INPUT_E_ERR / INPUT_B_ERR (*)	INPUT_E_ERR / INPUT_B_ERR (*) (bit 5 System Status 1)	0x00100000
21	✓					OUTPUT_A_ERR	OUTPUT_A_FULL (bit 17 System Status 1)	0x00200000
22	✓					OUTPUT_B_ERR	OUTPUT_B_FULL (bit 18 System Status 1)	0x00400000
23	✓					OUTPUT_C_ERR / POSTPRO_OUT_ERR(*)	OUTPUT_C_FULL / POST_PRO_OUT_FULL(*) (bit 19 System Status 1)	0x00800000
24	✓					OUTPUT_D_ERR / OUTPUT_C_ERR(*)	OUTPUT_D_FULL / OUTPUT_C_FULL(*) (bit 20 System Status 1)	0x01000000
25	✓					OUTPUT_E_ERR / OUTPUT_D_ERR(*)	OUTPUT_E_FULL / OUTPUT_D_FULL(*) (bit 21 System Status 1)	0x02000000
26	✓					HRP_INVALID	ALIGNEMENT (bit 1 Algo Status 1) or FOG_ANOMALY (bit 9 User Status) or ACC_ANOMALY (bit 10 User Status) or SPEED_SATURATION (bit 29 Algo Status 1)	0x04000000
27	✓					ALIGNEMENT	ALIGNEMENT (bit 1 Algo Status 1)	0x08000000
28	✓					FINE_ALIGNEMENT	FINE_ALIGNEMENT (bit 2 Algo Status 1)	0x10000000
29	✓					NAVIGATION	NAVIGATION (bit 0 Algo Status 1)	0x20000000
30	✓					DEGRADED_MODE	DEGRADED_MODE (bit 30 Sensor Status 2) or INTERPOLATION_MISSED (bit 30 Algo Status 1) or ALIGNEMENT (bit 1 Algo Status 1)	0x40000000
31	✓					FAILURE_MODE	FAILURE_MODE (bit 31 Sensor Status 2) or ALTITUDE_SATURATION (bit 28 Algo Status 1) or SPEED_SATURATION (bit 29 Algo Status 1)	0x80000000

Example:

If User status= 80000200 this translates into: Fog Anomaly, Failure mode.

Table 16 - list of 32 bits User status word describing QUADRANS/ATLANS User status

Bit	QUADRANS	ATLANS	Name	Set when following bits are set	Status value
0	-		Reserved	-	-
1	✓		GPS_RECEIVED_VALID	GPS_RECEIVED (bit 12 Algo Status 1) when GPS Rejection mode = Always true or GPS_VALID (bit 13 Algo Status 1)	0x00000002
2	-		*Reserved*	-	-
3	-		*Reserved*	-	-
4	-		*Reserved*	-	-
5	-		*Reserved*	-	-
6	✓	-	EMLOG_RECEIVED_VALID	EMLOG_RECEIVED (bit 24 Algo Status 2) when EMLOG Rejection mode = Always true or EMLOG_VALID (bit 25 Algo Status 2)	0x00000040
7	✓		MANUAL_GPS_ RECEIVED_VALID	MANUALGPS_RECEIVED (bit 28 Algo Status 2) when MANUALGPS Rejection mode = Always true or MANUALGPS_VALID (bit 29 Algo Status 2)	0x00000080
8	✓		TIME_RECEIVED_VALID	UTC_DETECTED (bit 9 System Status 2)	0x00000100
9	✓		FOG_ANOMALY	FOG_X_ERR (bit 0 Sensor Status 2) or FOG_Y_ERR (bit 1 Sensor Status 2) or FOG_Z_ERR (bit 2 Sensor Status 2)	0x00000200
10	✓		ACC_ANOMALY	ACC_X_ERR (bit 4 Sensor Status 2) or ACC_Y_ERR (bit 5 Sensor Status 2) or ACC_Z_ERR (bit 6 Sensor Status 2)	0x00000400
11	✓		TEMPERATURE_ERR	TEMP_ERR (bit 7 Sensor Status 2)	0x00000800
12	✓		CPU_OVERLOAD	DSP_OVERLOAD (bit 8 Sensor Status 2) or MPC_OVERLOAD (bit 27 System Status 2)	0x00001000
13	✓		DYNAMIC_EXCEDEED	INTERPOLATION_MISSED (bit 30 Algo Status 1)	0x00002000
14	✓		SPEED_SATURATION	SPEED_SATURATION (bit 29 Algo Status 1)	0x00004000
15	✓		ALTITUDE_SATURATION	ALTITUDE_SATURATION (bit 28 Algo Status 1)	0x00008000
16	-	✓	INT_GPS_INPUT_ERROR	INT_GPS_INPUT_ERR (bit 1 System Status 1)	0x00010000
17	-	✓	INT_GPS_RAW_ERR	INT_GPS_RAW_ERR (bit 2 System Status 1)	0x00020000
18	-		*Reserved*	-	-
19	✓		INPUT_A_ERR	INPUT_A_ERR (bit 4 System Status 1)	0x00080000
20	✓		INPUT_B_ERR	INPUT_B_ERR (bit 5 System Status 1)	0x00100000
21	-	✓	POSTPRO_OUTPUT_ERR	POSTPRO_OUTPUT_FULL (bit 16 System Status 2)	0x00200000
22	-	✓	GPS_RAW_OUTPUT_ERR	GPS_RAW_OUTPUT_FULL (bit 17 System Status 2)	0x00400000
23	-		*Reserved*	-	-
24	✓		OUTPUT_A_ERR	OUTPUT_A_FULL (bit 19 System Status 2)	0x01000000
25	✓		OUTPUT_B_ERR	OUTPUT_B_FULL (bit 20 System Status 2)	0x02000000

Bit	QUADRANS	ATLANS	Name	Set when following bits are set	Status value
26	✓		HRP_INVALID	ALIGNEMENT (bit 1 Algo Status 1) or FOG_ANOMALY (bit 9 User Status) or ACC_ANOMALY (bit 10 User Status) or SPEED_SATURATION (bit 29 Algo Status 1)	0x04000000
27	✓		ALIGNEMENT	ALIGNEMENT (bit 1 Algo Status 1)	0x08000000
28	✓		FINE_ALIGNEMENT	FINE_ALIGNEMENT (bit 2 Algo Status 1)	0x10000000
29	✓		NAVIGATION	NAVIGATION (bit 0 Algo Status 1)	0x20000000
30	✓		DEGRADED_MODE	DEGRADED_MODE (bit 30 Sensor Status 2) or INTERPOLATION_MISSED (bit 30 Algo Status 1) or ALIGNEMENT (bit 1 Algo Status 1)	0x40000000
31	✓		FAILURE_MODE	FAILURE_MODE (bit 31 Sensor Status 2) or ALTITUDE_SATURATION (bit 28 Algo Status 1) or SPEED_SATURATION (bit 29 Algo Status 1)	0x80000000

3.4.6 HIGH LEVEL REPEATER STATUS

$PIXSE, HT_STS is a 32 bits word, which is used by iXRepeater to format other status display on the screen.

This status word is coded with 8 hexadecimal characters in the "$PIXSE, HT_STS, hhhhhhhh" NMEA sentence. hhhhhhhh is the hexadecimal value of 32 bits.

Bit	PHINS / PHINS COMPACT C7	ROVINS/ PHINS6000	HYDRINS/ AIRINS	MARINS	ATLANS/ QUADRANS	Name	Set when following bits are set/unset	Status value
0	✓					SYSTEM OK	SYSTEM INIT (bit 1 HighLevel Status) NOT SET and SYSTEM ERROR (bit 2 HighLevel Status) NOT SET And SYSTEM WARNING (bit 3 HighLevel Status) NOT SET	0x00000001
1	✓					SYSTEM INIT	ALIGNMENT (bit 1 Algo Status 1) SET	0x00000002
2	✓					SYSTEM ERROR	ALTITUDE SATURATION (bit 28 Algo Status 1) SET or SPEED SATURATION (bit 29 Algo Status 1) SET or ELECTRONIC ERROR (bit 8 High Level Status) SET or SERIAL OUT ERROR (bit 7 High Level Status) SET or SERIAL IN ERROR (bit 5 High Level Status) SET or FAILURE MODE (bit 31 Sensor Status 2) SET or FOG ANOMALY (bit 9 User Status) or ACC ANOMALY (bit 10 User Status)	0x00000004
3	✓					SYSTEM WARNING	INTERPOLATION MISSED (bit 30 Algo Status 1) SET or DEGRADED MODE (bit 30 Sensor Status 2) SET	0x00000008
4	✓					SERIAL IN OK	SERIAL IN ERROR (bit 5 HighLevel Status) NOT SET	0x00000010
5	✓					SERIAL IN ERROR	INPUT R,A,B,C,D or E ERR (bits 0 to 5 System Status 1) SET	0x00000020
6	✓					SERIAL OUT OK	SERIAL OUT ERROR (bit 7 HighLevel Status) NOT SET	0x00000040
7	✓					SERIAL OUT ERROR	OUTPUT R,A,B,C,D or E FULL (bits 16 to 20 System Status 1) SET	0x00000080
8	✓					ELECTRONIC OK	ELECTRONIC ERROR (bit 9 HighLevel Status) NOT SET	0x00000100
9	✓					ELECTRONIC ERROR	TEMPERATUR ERROR (bit 16 HighLevel Status) SET or CPU ERROR (bit 15 HighLevel Status) SET or ACC ERROR (bit 13 HighLevel Status) SET or FOG ERROR (bit 11 HighLevel Status) SET	0x00000200
10	✓					FOG OK	FOG ERROR (bit 11 HighLevel Status) NOT SET	0x00000400
11	✓					FOG ERROR	FOG X,Y,or Z ERROR (bits 0,1,2 Sensor Status 2) SET	0x00000800
12	✓					ACC OK	ACC ERROR (bit 13 HighLevel Status) NOT SET	0x00001000
13	✓					ACC ERROR	ACC X,Y,Z ERROR (bit 4,5,6 Sensor Status 2) SET	0x00002000
14	✓					CPU OK	CPU ERROR (bit 15 HighLevel Status) NOT SET	0x00004000
15	✓					CPU ERROR	DSP OVERLOPAD (bit 8 Sensor Status 2) SET or CINT OVERLOAD (bit 27 System Status 2) SET	0x00008000
16	✓					TEMPERATURE OK	TEMP ERROR (bit 17 HighLevel Status) NOT SET	0x00010000
17	✓					TEMPERATURE ERROR	TEMP ERROR (bit 7 Sensor Status 2) SET	0x00020000
18	✓					GPS1	GPS1 DETECTED (bit 2 System Status 2) NOT SET	0x00040000
19	✓	-	-	✓	-	GPS2	GPS2 DETECTED (bit 3 System Status 2) NOT SET	0x00080000

<table>
<tr><th>Bit</th><th>PHINS / PHINS COMPACT C7</th><th>ROVINS/ PHINS6000</th><th>HYDRINS/ AIRINS</th><th>MARINS</th><th>ATLANS/ QUADRANS</th><th>Name</th><th>Set when following bits are set/unset</th><th>Status value</th></tr>
<tr><td>20</td><td colspan="5">✓</td><td>MANUAL GPS</td><td>MANUAL GPS DETECTED (bit 14 System Status 2) NOT SET</td><td>0x00100000</td></tr>
<tr><td rowspan="2">21</td><td>✓</td><td>✓</td><td>-</td><td>✓</td><td>-</td><td>DVL BOTTOM TRACK</td><td>DVL BT DETECTED (bit 0 System Status 2) NOT SET</td><td rowspan="2">0x00200000</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td>✓</td><td>DMI</td><td>DMI DETECTED (bit 8 System Status 2)</td></tr>
<tr><td>22</td><td>✓</td><td>✓</td><td>-</td><td>✓</td><td>-</td><td>DVL WATER TRACK</td><td>DVL WT DETECTED (bit 1 System Status 2) NOT SET</td><td>0x00400000</td></tr>
<tr><td>23</td><td>✓</td><td>-</td><td>-</td><td>✓</td><td>-</td><td>EM LOG</td><td>EM LOG DETECTED (bit 7 System Status 2) NOT SET</td><td>0x00800000</td></tr>
<tr><td>24</td><td>✓</td><td>✓</td><td>-</td><td>✓</td><td>-</td><td>DEPTH</td><td>DEPTH DETECTED (bit 6 System Status 2) NOT SET</td><td>0x01000000</td></tr>
<tr><td>25</td><td>✓</td><td>✓</td><td>-</td><td>-</td><td>-</td><td>USBL</td><td>USBL DETECTED (bit 4 System Status 2) NOT SET</td><td>0x02000000</td></tr>
<tr><td>26</td><td>✓</td><td>✓</td><td>-</td><td>-</td><td>-</td><td>LBL</td><td>LBL DETECTED (bit 5 System Status 2) NOT SET</td><td>0x04000000</td></tr>
<tr><td>27</td><td colspan="5">✓</td><td>ALTITUDE</td><td>ALTITUDE DETECTED (bit 10 System Status 2) NOT SET</td><td>0x08000000</td></tr>
<tr><td>28</td><td colspan="5">✓</td><td>UTC SYNC</td><td>UTC DETECTED (bit 9 System Status 2) NOT SET</td><td>0x10000000</td></tr>
<tr><td>29</td><td colspan="5">✓</td><td>PPS SYNC</td><td>PPS DETECTED (bit 11 System Status 2) NOT SET</td><td>0x20000000</td></tr>
<tr><td>30</td><td>✓</td><td>✓</td><td>-</td><td>✓</td><td>-</td><td>CTD</td><td>CTD DETECTED (bit 15 System Status 2) NOT SET</td><td>0x40000000</td></tr>
<tr><td>31</td><td colspan="5">✓</td><td>ZUPT</td><td>ZUPT MODE ACTIVATED (bit 16 Algo Ststus 2) NOT SET
and ZUPT MODE VALID (bit 17 Algo Ststus 2) NOT SET
and AUTOSTATICBENCH ZUPT MODE (bit 18 Algo Status 2) NOT SET
and AUTOSTATICBENCH ZUPT VALID (bit 19 Algo Status 2) NOT SET</td><td>0x80000000</td></tr>
</table>

3.5 Digital Input Protocols

3.5.1 Quick Guide to Input Protocols

Please use the tables below to quickly select the output protocol that best suits your application.

PROTOCOLS	APOS PSIMLBP	APOS PSIMSSB	EIVA	EM LOG VBW	EM LOG VHW	GAPS	GPS	GRAVI DOV CORR	GSM 3000	HALLIBURTON SAS	MICRO SVT_P	MINISVS	NMEA STANDARD	ODOMETER	PAROSCIENTIFIC	PDS	PRESSURE SENSOR	RDI PD6	SBE 37SI	SBE 49	SEAKING 700	SENIN	SKIPPER DL 850	SVP 70	SVX2	USBL LBL CTD	VBW	AUVG 3000	DCN STD LOCH	EXT SENSOR BIN	IXBLUE STD BIN V2	IXBLUE STD BIN V3	IXSEA AUV	IXEEA USBL INS 1	POSIDONIA	RAMSES POSTPRO	RDI PD0	RDI PD3	RDI PD3 RT	RDI PD4	SBF_SIX	SOC AUTOSUB	USBL BOX POSTPRO
	ASCII																											BINARY															
PRODUCTS	Check if the protocol is available for your product																																										
PHINS PHINS COMPACT C7 ROVINS / PHINS 6000	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ROVINS NANO / PHINS COMPACT C3	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		✓		✓	✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓
HYDRINS							✓						✓																		✓	✓											
MARINS BKA				✓	✓		✓	✓			✓	✓			✓	✓		✓	✓		✓	✓	✓	✓	✓		✓		✓	✓	✓	✓					✓			✓		✓	
MARINS BKB					✓		✓				✓	✓			✓				✓		✓	✓		✓	✓		✓		✓	✓	✓	✓										✓	
LANDINS							✓						✓	✓																													
AIRINS							✓		✓				✓																														
QUADRANS				✓	✓		✓						✓														✓		✓														
ATLANS							✓						✓	✓																											✓		
SENSORS																																											
ANGLES									✓																																		
GPS						✓	✓			✓			✓									✓						✓		✓	✓	✓	✓								✓	✓	
DMI														✓																	✓	✓											
DEPTH											✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓		✓	✓	✓	✓			✓	✓					✓	
EM LOG				✓	✓								✓									✓					✓		✓		✓	✓											
DVL																		✓					✓				✓	✓		✓	✓	✓	✓				✓	✓	✓	✓	□	✓	
CTD or SVP											✓	✓							✓	✓	✓			✓	✓	✓					✓	✓	✓			✓							
USBL	✓	✓	✓			✓				✓																✓		✓			✓	✓	✓	✓	✓								✓
LBL										✓																✓					✓	✓	✓			✓							
UTC						✓	✓			✓			✓									✓									✓	✓	✓								✓		
DOV								✓																																			
PARAMETERS																																											
UTC TIME						x	x			x			x					x													x	x	x								x		
POSITION UTC TIME STAMP		x	x			x	x			x			x									x									x	x		x							x		
POSITION AGE OF DATA		x	x							x																x		x		x			x		x							x	
POSITION QUALITY INDICATOR							x			x			x									x									x	x	x								x		
POSITION DATA VALIDITY		x								x																				x			x									x	
POSITION UTM X,Y			x																																								
POSITION LAT, LONG		x					x			x			x									x				x		x		x	x	x	x	x	x						x	x	
POSITION Z							x			x			x									x				x					x	x	x	x	x						x		
POSITION Z STD		x					x						x									x				x					x	x	x	x	x						x		
POSITION X,Y STD		x					x			x			x									x				x					x	x	x	x	x						x		
USBL TP CODE	x	x	x			x																									x	x	x	x	x								x
USBL LAT/LONG	x					x																									x	x	x										x
USBL LATENCY																																	x										x
USBL ALTITUDE	x					x																									x	x	x										x
USBL LAT/LONG STD	x																														x	x	x										x

Check if the protocol is available for your product

ASCII

PROTOCOLS	APOS PSIMLBP	APOS PSIMSSB	EIVA	EM LOG VBW	EM LOG VHW	GAPS	GPS	GRAVI DOV CORR	GSM 3000	HALLIBURTON SAS	MICRO SVT_P	MINISVS	NMEA STANDARD	ODOMETER	PAROSCIENTIFIC	PDS	PRESSURE SENSOR	RDI PD6	SBE 37SI	SBE 49	SEAKING 700	SENIN	SKIPPER DL 850	SVP 70	SVX2	USBL LBL CTD	VBW
PRODUCTS																											
PHINS PHINS COMPACT C7 ROVINS / PHINS 6000	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
ROVINS NANO / PHINS COMPACT C3	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		✓		✓	✓	✓		✓	✓		✓	✓	✓	✓
HYDRINS							✓						✓														
MARINS BKA				✓	✓		✓	✓			✓	✓			✓	✓		✓	✓		✓	✓	✓	✓	✓		✓
MARINS BKB					✓		✓				✓	✓			✓				✓		✓	✓		✓	✓		✓
LANDINS							✓						✓	✓													
AIRINS							✓		✓				✓														
QUADRANS				✓	✓		✓						✓														✓
ATLANS							✓						✓	✓													
SENSORS																											
ANGLES									✓																		
GPS						✓	✓			✓			✓									✓					
DMI														✓													
DEPTH											✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
EM LOG				✓	✓								✓									✓					✓
DVL																		✓					✓				✓
CTD or SVP											✓	✓							✓	✓	✓			✓	✓	✓	
USBL	✓	✓	✓			✓				✓																✓	
LBL										✓																✓	
UTC						✓	✓			✓			✓									✓					
DOV								✓																			
PARAMETERS																											
USBL ALTITUDE STD	x																										
USBL DATA VALIDITY	x																										
LBL TP CODE																										x	
LBL TP LAT/LONG										x																x	
LBL RANGE										x																x	
LBL RANGE STD										x																x	
LBL TP DEPTH																										x	
LBL AGE OF DATA										x																x	
LBL DATA VALIDITY																											
DEPTH or PRESSURE	x		x								x	x			x	x	x	x	x	x	x	x		x	x	x	
DEPTH STD																											
DEPTH LATENCY																											
DEPTH DATA VALIDITY																	x										
SOUND VELOCITY											x	x						x	x	x	x			x	x	x	
SOUND VELOCITY VALIDITY																								x			
RANGE TO BOTTOM																		x									
LONGITUDINAL WATER SPEED XS1																		x									
TRANSVERSE WATER SPEED XS2																		x									
VERTICAL WATER SPEED XS3																		x									
LONGITUDINAL WATER SPEED XS1 STD																											
TRANSVERSE WATER SPEED XS2 STD																											

BINARY

PROTOCOLS	AUVG 3000	DCN STD LOCH	EXT SENSOR BIN	IXBLUE STD BIN V2	IXBLUE STD BIN V3	IXSEA AUV	IXEEA USBL INS 1	POSIDONIA	RAMSES POSTPRO	RDI PD0	RDI PD3	RDI PD3 RT	RDI PD4	SBF_SIX	SOC AUTOSUB	USBL BOX POSTPRO
PRODUCTS																
PHINS PHINS COMPACT C7 ROVINS / PHINS 6000	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ROVINS NANO / PHINS COMPACT C3	✓		✓	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓
HYDRINS				✓	✓											
MARINS BKA		✓	✓	✓	✓					✓			✓		✓	
MARINS BKB		✓	✓	✓	✓										✓	
LANDINS																
AIRINS																
QUADRANS		✓														
ATLANS														✓		
SENSORS																
ANGLES																
GPS	✓		✓	✓	✓	✓								✓	✓	
DMI				✓	✓											
DEPTH	✓		✓	✓	✓	✓			✓	✓					✓	
EM LOG		✓		✓	✓											
DVL	✓		✓	✓	✓	✓				✓	✓	✓	✓	□	✓	
CTD or SVP				✓	✓	✓			✓							
USBL	✓			✓	✓	✓	✓	✓								✓
LBL				✓	✓	✓			✓							
UTC				✓	✓	✓								✓		
DOV																
PARAMETERS																
USBL ALTITUDE STD				x	x	x										x
USBL DATA VALIDITY						x										x
LBL TP CODE				x	x	x										
LBL TP LAT/LONG				x	x	x										
LBL RANGE				x	x	x										
LBL RANGE STD				x	x	x										
LBL TP DEPTH				x	x											
LBL AGE OF DATA						x										
LBL DATA VALIDITY						x										
DEPTH or PRESSURE	x		x	x	x	x			x	x					x	x
DEPTH STD				x	x	x										x
DEPTH LATENCY						x										
DEPTH DATA VALIDITY						x										
SOUND VELOCITY				x	x	x				x			x			
SOUND VELOCITY VALIDITY						x										
RANGE TO BOTTOM				x	x	x				x	x	x	x			
LONGITUDINAL WATER SPEED XS1	x			x	x	x				x	x	x	x			
TRANSVERSE WATER SPEED XS2	x			x	x	x				x	x	x	x			
VERTICAL WATER SPEED XS3	x			x	x	x				x	x	x	x			
LONGITUDINAL WATER SPEED XS1 STD				x	x	x										
TRANSVERSE WATER SPEED XS2 STD				x	x	x										

ASCII

PROTOCOLS	APOS PSIMLBP	APOS PSIMSSB	EIVA	EM LOG VBW	EM LOG VHW	GAPS	GPS	GRAVI DOV CORR	GSM 3000	HALLIBURTON SAS	MICRO SVT_P	MINISVS	NMEA STANDARD	ODOMETER	PAROSCIENTIFIC	PDS	PRESSURE SENSOR	RDI PD6	SBE 37SI	SBE 49	SEAKING 700	SENIN	SKIPPER DL 850	SVP 70	SVX2	USBL LBL CTD	VBW
PRODUCTS	Check if the protocol is available for your product																										
PHINS PHINS COMPACT C7 ROVINS / PHINS 6000	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
ROVINS NANO / PHINS COMPACT C3	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		✓		✓	✓	✓		✓	✓		✓	✓	✓	✓
HYDRINS							✓						✓														
MARINS BKA				✓	✓		✓	✓			✓	✓			✓	✓		✓	✓		✓	✓	✓	✓	✓		✓
MARINS BKB					✓		✓				✓	✓			✓				✓		✓	✓		✓	✓		✓
LANDINS							✓						✓	✓													
AIRINS							✓		✓				✓														
QUADRANS				✓	✓		✓						✓														✓
ATLANS							✓						✓	✓													
SENSORS																											
ANGLES									✓																		
GPS						✓	✓			✓			✓									✓					
DMI														✓													
DEPTH											✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
EM LOG				✓	✓								✓									✓					✓
DVL																		✓					✓				✓
CTD or SVP											✓	✓							✓	✓	✓			✓	✓	✓	
USBL	✓	✓	✓			✓				✓																✓	
LBL										✓																✓	
UTC						✓	✓			✓			✓									✓					
DOV								✓																			
PARAMETERS																											
VERTICAL WATER SPEED XS3 STD																											
LONGITUDINAL WATER SPEED XVH1																											
TRANSVERSE WATER SPEED XVH2																											
LONGITUDINAL WATER SPEED XV1				x	x								x									x	x				x
TRANSVERSE WATER SPEED XV2																							x				x
WATER SPEED DATA VALIDITY				x	x								x					x					x				x
WATER SPEED LATENCY																											
LONGITUDINAL GROUND SPEED XS1																		x									
TRANSVERSE GROUND SPEED XS2																		x									
VERTICAL GROUND SPEED XS3																		x									
TRANSVERSE GROUND SPEED XS1 STD																											
TRANSVERSE GROUND SPEED XS2 STD																											
VERTICAL GROUND SPEED XS3 STD																											
LONGITUDINAL GROUND SPEED XVH1																											
TRANSVERSE GROUND SPEED XVH2																											
LONGITUDINAL GROUND SPEED XV1																							x				x
TRANSVERSE GROUND SPEED XV2																							x				x
TRANSVERSE GROUND SPEED XV3																											
GROUND SPEED DATA VALIDITY																		x					x				x
GROUND SPEED LATENCY																											
DMI SPEED														x													

BINARY

PROTOCOLS	AUVG 3000	DCN STD LOCH	EXT SENSOR BIN	IXBLUE STD BIN V2	IXBLUE STD BIN V3	IXSEA AUV	IXEEA USBL INS 1	POSIDONIA	RAMSES POSTPRO	RDI PD0	RDI PD3	RDI PD3 RT	RDI PD4	SBF_SIX	SOC AUTOSUB	USBL BOX POSTPRO
PRODUCTS																
PHINS PHINS COMPACT C7 ROVINS / PHINS 6000	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ROVINS NANO / PHINS COMPACT C3	✓		✓	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓
HYDRINS				✓	✓											
MARINS BKA		✓	✓	✓	✓					✓			✓		✓	
MARINS BKB		✓	✓	✓	✓										✓	
LANDINS																
AIRINS																
QUADRANS		✓														
ATLANS														✓		
SENSORS																
ANGLES																
GPS	✓		✓	✓	✓	✓								✓	✓	
DMI				✓	✓											
DEPTH	✓		✓	✓	✓	✓			✓	✓					✓	
EM LOG		✓		✓	✓											
DVL	✓		✓	✓	✓	✓				✓	✓	✓	✓	□	✓	
CTD or SVP				✓	✓	✓			✓							
USBL	✓			✓	✓	✓	✓	✓								✓
LBL				✓	✓	✓			✓							
UTC				✓	✓	✓								✓		
DOV																
PARAMETERS																
VERTICAL WATER SPEED XS3 STD				x	x	x										
LONGITUDINAL WATER SPEED XVH1		x		x	x											
TRANSVERSE WATER SPEED XVH2				x	x											
LONGITUDINAL WATER SPEED XV1				x	x											
TRANSVERSE WATER SPEED XV2		x		x	x											
WATER SPEED DATA VALIDITY						x										
WATER SPEED LATENCY						x										
LONGITUDINAL GROUND SPEED XS1	x			x	x	x				x	x	x	x			
TRANSVERSE GROUND SPEED XS2	x			x	x	x				x	x	x	x			
VERTICAL GROUND SPEED XS3	x			x	x	x				x	x	x	x			
TRANSVERSE GROUND SPEED XS1 STD				x	x	x										
TRANSVERSE GROUND SPEED XS2 STD				x	x	x										
VERTICAL GROUND SPEED XS3 STD				x	x	x										
LONGITUDINAL GROUND SPEED XVH1						x										
TRANSVERSE GROUND SPEED XVH2																
LONGITUDINAL GROUND SPEED XV1			x	x	x										x	
TRANSVERSE GROUND SPEED XV2			x	x	x										x	
TRANSVERSE GROUND SPEED XV3			x	x	x											
GROUND SPEED DATA VALIDITY			x			x									x	
GROUND SPEED LATENCY						x										
DMI SPEED				x	x											

PROTOCOLS	ASCII																											BINARY															
	APOS PSIMLBP	APOS PSIMSSB	EIVA	EM LOG VBW	EM LOG VHW	GAPS	GPS	GRAVI DOV CORR	GSM 3000	HALLIBURTON SAS	MICRO SVT_P	MINISVS	NMEA STANDARD	ODOMETER	PAROSCIENTIFIC	PDS	PRESSURE SENSOR	RDI PD6	SBE 37SI	SBE 49	SEAKING 700	SENIN	SKIPPER DL 850	SVP 70	SVX2	USBL LBL CTD	VBW	AUVG 3000	DCN STD LOCH	EXT SENSOR BIN	IXBLUE STD BIN V2	IXBLUE STD BIN V3	IXSEA AUV	IXEEA USBL INS 1	POSIDONIA	RAMSES POSTPRO	RDI PD0	RDI PD3	RDI PD3 RT	RDI PD4	SBF_SIX	SOC AUTOSUB	USBL BOX POSTPRO
PRODUCTS	Check if the protocol is available for your product																																										
PHINS PHINS COMPACT C7 ROVINS / PHINS 6000	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ROVINS NANO / PHINS COMPACT C3	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓		✓		✓	✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓
HYDRINS							✓						✓																		✓	✓											
MARINS BKA				✓	✓		✓	✓			✓	✓			✓	✓		✓	✓		✓	✓	✓	✓	✓		✓		✓	✓	✓	✓					✓			✓		✓	
MARINS BKB					✓		✓				✓	✓			✓				✓		✓	✓		✓	✓		✓		✓	✓	✓	✓										✓	
LANDINS							✓						✓	✓																													
AIRINS							✓		✓				✓																														
QUADRANS				✓	✓		✓						✓														✓		✓														
ATLANS							✓						✓	✓																											✓		
SENSORS																																											
ANGLES									✓																																		
GPS						✓	✓			✓			✓									✓						✓		✓	✓	✓	✓								✓	✓	
DMI														✓																	✓	✓											
DEPTH											✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓		✓	✓	✓	✓			✓	✓					✓	
EM LOG				✓	✓								✓									✓					✓		✓		✓	✓											
DVL																		✓					✓				✓	✓		✓	✓	✓	✓				✓	✓	✓	✓	□	✓	
CTD or SVP											✓	✓							✓	✓	✓			✓	✓	✓					✓	✓	✓			✓							
USBL	✓	✓	✓			✓				✓																✓		✓			✓	✓	✓	✓	✓								✓
LBL										✓																✓					✓	✓	✓			✓							
UTC						✓	✓			✓			✓									✓									✓	✓	✓								✓		
DOV								✓																																			
PARAMETERS																																											
PLATFORM ATTITUDE									x																																		
EVENT MARKER TIME																															x	x											
DEFELCTION Xi								x																																			
DEFLECTION Eta								x																																			
GRAVITY NORM ERROR								x																																			
ALERT MANAGEMENT	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x																
CHECKSUM	x	x		x	x	x	x	x					x	x		x	x					x	x			x	x	x		x			x	x	x		x					x	x
NMEA 0183 STANDARD				x	x		x						x										x				x																

Note 1 : PHINS+DVL calibration

DVL data must be sent in body frame. A sea calibration must be performed to evaluate misalignment between PHINS reference frame and DVL reference frame. Please contact support@ixblue.com for assistance and procedure.

Note 2: Reference frame definition

X1,X2,X3: PHINS body reference frame. XV1,XV2,XV3: vehicle reference frame (i.e: for a vessel bow, port, up) XVH1, XVH2, XVH3: Vehicle horizontal frame. XV1,XV2,XV3 vehicle frame compensated from roll and pitch. Xnorth, Xeast, Xup: Local geographical frame. XS1, XS2, XS2: Input sensor body frame (i.e: DVL, EM LOG).

Note 3 :

STD: Standard deviation

3.5.2 DETAILED SPECIFICATIONS FOR INPUT PROTOCOLS

3.5.2.1 ASCII protocols

Protocol development is under completion and free firmware upgrade is provided.

APOS PSIMLBP

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: ASCII proprietary (compatible HIPAP APOS USBL/LBL data format).

Data received: Time, Position, depth, STD on position and depth.

Data frame: : ASCII frame contains a header, 12 fields, and a checksum.

This ASCII sentence contains the beacon absolute positions given by an LBL system. The operator can define various parameters. In order to be properly taken into account by INS algorithms some fields must be properly set otherwise data are rejected.

.

The format is:

$PSIMLBP,hhmmss.ss,Tpc,aa,S,C,x.x,y.y,d.d,M.M,m.m,e.e,t.t[,D,E,…]*hh<CR><LF>		
hhmmss.ss	real time of the measurement The INS only considers UTC time **Warning: Shall not be blank field.**	USED
TpC	Transponder code **Note 1** Up to three transponders can be taken into account **Warning: Shall not be blank field. At most, 3 characters expected.**	USED
aa	Type of the item positioned	NOT USED
S	Status **Note 2** **Warning: Shall not be blank field. Only 1 character expected.** ASCII 'A' = data valid ASCII 'V' = data invalid	USED
C	Coordinate system **Note 3** **Warning: Shall not be blank field. Only 1 character expected.** ASCII 'C' = Cartesian ASCII 'P' = Polar ASCII 'U' = UTM ASCII 'R' = Radians	USED
x.x	X_coordinate (latitude or UTM Northing) **Note 3**	USED
y.y	Y_coordinate (longitude or UTM Easting) **Note 3**	USED

$PSIMLBP,hhmmss.ss,Tpc,aa,S,C,x.x,y.y,d.d,M.M,m.m,e.e,t.t[,D,E,…]*hh<CR><LF>		
d.d	Depth of the position in meters	USED
M.M	Major axis of the error ellipse **Note 4**	USED
m.m	Minor axis of the error ellipse **Note 4**	USED
e.e	Direction of the major axis in the error ellipse (in degrees) **Note 4**	USED
t.t	r.m.s. value of the normalized residuals	NOT USED
D,E,…	Potential additional fields	NOT USED
*hh	is the NMEA checksum	USED

Note 1: The Tp code field contains a string characters code of the transponder for which the sentence contains a measurement. The characters are the same as the ones used on the HPR display and in the HPR operator manual. Up to three transponders can be taken into account by PHINS. The TP code and associated level arms shall be set with iXBlue Repeater software.

Note 2: The status field is 'A' when position is OK, and 'V' when the position is not OK or missing.

Note 3: INS uses either UTM or Radian coordinates of the transponder. Cartesian or Polar coordinates are not taken into account by PHINS.The Northing (X_coordinate) and the Eastings (Y_coordinate) are the UTM coordinates of the transponder.The Latitude (X_coordinate) and the Longitude (Y_coordinate) are the geographic position in Radians. Positive latitude is north. Positive longitude is east. The Latitude and Longitude are in radians with 9 digits after the decimal point, giving a resolution of 0.01m.

Note 4: The "major axis of the error ellipse", the "minor axis of the error ellipse" and "direction of the major axis in the error ellipse" are used to calculated the X,Y standard deviations set for INS algorithm.

$$\sigma_{lat} = \sqrt{M^2 \times (\cos e)^2 + m^2 \times (\sin e)^2}$$

$$\sigma_{long} = \sqrt{M^2 \times (\sin e)^2 + m^2 \times (\cos e)^2}$$

$$\mathrm{cov}_{LatLong} = -\cos e \times \sin e \times (m^2 - M^2)$$

M = major axis of the error ellipse

m = minor axis of the error ellipse

e = direction of the major axis in the error ellipse (in radians here)

The vertical depth standard deviation is fixed at 10 m.

Depending of sensor set-up, INS rejects the USBL data If USBL position is too far from the INS computed position: automatic rejection mode (recommended mode).

APOS PSIMSSB

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Input custom protocol.

Data received: Fix position, Time.

Data frame: NMEA ASCII frame.

This ASCII sentence contains the position of a USBL transponder. The operator may define various parameters. In order to be properly taken into account by INS algorithms, **some fields must be properly set otherwise the data are rejected.**

$PSIMSSB,hhmmss.ss,TpC,s,eee,C,O,F,x.x,y.y,d.d,a.a,I,A.A,B.B[,D,E,…]*hh<CR><LF>		
$PSIMSSB	NMEA message header	USED
hhmmss.ss	Real time of the measurement. The INS only considers UTC time **Warning: Shall not be blank field.**	USED
TpC	Transponder Tp code **Note 1** **Warning: Shall not be blank field. At most, 3 characters expected.**	USED
s	Status **Note 2** **Warning: Shall not be blank field. Only 1 character expected.** ASCII ‘A’ = data valid ASCII ‘V’ = data invalid	USED
eee	Error code **Note 3** PHINS will not reject the USBL frame if this field is empty **Warning: Blank field or 3 characters expected.**	USED
C	Coordinate system **Note 4Note 1** **Warning: Shall not be blank field. Only 1 character expected.** ASCII ‘C’ = Cartesian ASCII ‘P’ = Polar ASCII ‘U’ = UTM ASCII ‘R’ = Radians	USED
O	Orientation **Note 5** **Warning: Shall not be blank field. Only 1 character expected.** ASCII ‘H’ = vessel Head up ASCII ‘ E’ = East ASCII ‘N’ = North	USED

$PSIMSSB,hhmmss.ss,TpC,s,eee,C,O,F,x.x,y.y,d.d,a.a,I,A.A,B.B[,D,E,…]*hh<CR><LF>		
F	Filter **Note 6Note** 6ASCII 'M' = Measured data ASCII 'F' = Filt6red data ASCII 'P' = Predicted data	NOT USED
x.x	X_coordinate (latitude or UTM Northing) **Note 4**	USED
y.y	Y_coordinate (longitude or UTM Easting) **Note 4**	USED
d.d	Depth in meters	USED
a.a	Expected accuracy of the position **Note 7**	USED
I	Additional information **Note 8** **Warning: Shall not be blank field. Only 1 character expected.** ASCII 'N' = None ASCII 'C' = Compass ASCII 'I' = Inclinometer ASCII 'D' = Depth ASCII 'T' = Time from transponder to transducer ASCII 'V' = Velocity	USED
A.A	First additional value depending on additional info **Note 8** **Warning: Blank field or first additional value**	USED
B.B	Second additional value depending on additional info	NOT USED
D,E, …	Potential additional fields ignored	NOT USED
hh	NMEA checksum **Warning: Shall not be blank field**	USED

Note 1

The Tp code field contains a string characters code of the transponder for which the sentence contains a measurement. The characters are the same as the ones used on the HPR display and in the HPR operator manual. Up to three transponders can be taken into account by INS.

The TP code and associated level arms shall be set with iXBlue Repeater software.

Note 2

The status field is 'A' when position is OK, and 'V' when the position is not OK or missing.

The Error code field contains in both case further description. INS rejects all data flagged 'V'.

Note 3

INS will not reject the USBL frame if this field is empty. If it is not the case, the error codes that make USBL frame rejected by INS are :

'NRy' : No reply received

'AmX': Error in X direction

'AmY' : Error in Y direction

'VRU': VRU error

'GYR': Gyro error

'ATT': Attitude sensor error

'ExM': External depth wanted but not received.

'???': System Unknown error

Note 4

INS uses either UTM or Radian coordinates of the transponder. Cartesian or Polar coordinates are not taken into account by PHINS.

The Northing (X_coordinate) and the Eastings (Y_coordinate) are the UTM coordinates of the transponder.

The Latitude (X_coordinate) and the Longitude (Y_coordinate) are the geographic position in Radians. Positive latitude is north. Positive longitude is east. The Latitude and Longitude are in radians with 9 digits after the decimal point, giving a resolution of 0.01m.

Note 5

INS takes into account only North Orientation.

Note 6

INS doesn't check this field. It is recommended to use only measured data.

Note 7

Depending of sensor set-up, INS rejects the USBL data If USBL position is too far from the INS computed position: automatic rejection mode (recommended mode). The horizontal (X,Y) "expected accuracy of position" in the protocol is set for INS X,Y position standard deviation. The vertical depth standard deviation and the correlated latlong standard deviation is fixed at 10 m for INS.

Note 8

INS uses only Time delay "Time from transponder to transducer" when available and if INS is not UTC synchronized with GPS time. Unit in seconds. If INS is UTC synchronized it will use the time stamp in the telegram (first field).

EIVA

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: ASCII format.

Data received: position age of data, position, depth, heading of the vessel.

Data frame: This protocol is meant to interface INS with a SONARDYNE FUSION USBL/LBL. This protocol is compatible with EIVA navigation package.

Example:

FXTNP;000

ROV,14:45:16.69,00.92,E00416654.76,N05579616.11,D00099.05,S002.38,M001.92,T16 1.04

,P000.59,H000.0

FXTNP;ddd_nnnnnnnnnnnnnnnnnn,HH:MM:SS.ss,LL.LL,Eeeeeeeee.ee,Nnnnnnnnn.nn,Dddddd.dd,Saaa .aa,Maaa.aa,Taaa.aa,Paaa.aa,Hhhh.h<CR><LF>				
FXTNP;	Header with semi-colon separator		string	(USED)
ddd_nn…nn	The ID of the vehicle. Max. 20 characters.	(1)	string	(USED)
HH:MM:SS.ss	UTC time at which the position was valid		date	(USED)
LL.LL	Delay (in seconds) between which the position was valid and the time at which the sentence was sent.	(2)	float	(USED)
Eeeeeeeee.ee	"E" plus grid Easting (in meters)	(3) (4)	double	(USED)
Nnnnnnnnn.nn	"N" plus grid Northing (in meters)	(3) (4)	double	(USED)
Dddddd.dd	"D" plus depth (in meters)	(3)	float	(USED)
Saaa.aa	“S” plus semi-major axis error (in meters)	(3)	float	(USED)
Maaa.aa	“M” plus semi-minor axis error (in meters)	(3)	float	(USED)

FXTNP;ddd_nnnnnnnnnnnnnnnnnn,HH:MM:SS.ss,LL.LL,Eeeeeeeee.ee,Nnnnnnnnn.nn,Dddddd.dd,Saaa.aa,Maaa.aa,Taaa.aa,Paaa.aa,Hhhh.h<CR><LF>				
Taaa.aa	"T" plus error angle (theta) (in degree). Orientation of the major axis of the error ellipse.	(3)	float	(USED)
Paaa.aa	"P" plus depth error (1 sigma) (in meters)	(3)	float	(USED)
Hhhh.h	"H" plus grid heading (in degree). Heading of the vessel at the time the telegram is valid.	(3)	float	(NOT USED)
<CR><LF>	Termination characters, carriage return plus linefeed			(USED)

(1) ID : The field is made up of a 3 character integer ID followed by a space then by a string ID of up to 16 characters.

(2) If INS is time synchronized with GPS time (ZDA telegram) then the time stamp is used. If not latency is used.

(3) This sentence has a fixed length. To achieve this leading zeroes are always included before each value.

(4) INS takes the GPS (GGA telegram) input position to determine the UTM zone or the manual set position in INS if no GPS input.

EM LOG VBW

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Input NMEA 0183.

Data received: EM LOG: Water referenced longitudinal speed. DVL: Water track or Bottom track speeds.

Data frame:

$--VBW,x.x,x.x,S,x.x,x.x,s*hh <CR><LF>		
x.x	XV1 longitudinal water speed, in knots, '-' for astern.	USED (*) (**) (****)
x.x	XV2 transverse water speed, in knots, '-' for port.	USED (*) (**)
S	is the status of the water speed 'A' = data valid 'V' = data invalid	USED
x.x	XV1 longitudinal ground speed, in knots, '-' for astern.	USED (*) (***)
x.x	XV2 transverse ground speed, in knots, '-' for port.	USED (*) (***)
s	is the status of the ground speed A' = data valid 'V' = data invalid	USED
hh	Checksum	

Note: the default standard deviation on speed taken into account by INS is 0.5 m/s.

(*): Shall not be blank field if data valid (Status='A').

(**): Used as DVL Water track speed if DVL is configured.

(***): Used as DVL Bottom track speed is DVL is configured.

(****): Used as Emlog speed is Emlog is configured.

EM LOG VHW

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Input NMEA 0183.

Data received: EM LOG, water referenced longitudinal speed.

Data frame:

$--VHW,x.x,T,x.x,M,x.x,N,x.x,K*hh <CR><LF>		
x.x	is the true heading in degrees.	NOT USED
T	T = True	NOT USED
x.x	is the magnetic heading in degrees.	NOT USED
M	M = magnetic.	NOT USED
x.x	is the XV1 longitudinal water speed, in knot. **Warning : Shall not be blank field**	USED
N	N = knots.	NOT USED
x.x	is the speed, in km/h.	NOT USED
K	K = km/h	NOT USED
hh	Is the hexadecimal checksum.	USED

Note: the default standard deviation on speed taken into account by INS is 0.5 m/s.

GAPS

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: ASCII format.

Data received: USBL beacon position.

Data frame: This protocol is meant to interface GAPS output to INS input.

$PTSAG,#NNNNN,hhmss.s,jj,mm,aaaa,BBB,DDMM.M,H,DDDMM.M,D,A, M.M,A,M.M*hh<CR><LF>		
#NNNNN	Accoustic recurrence n°	NOT USED
hhmss.s	Time validity of the data	USED
jj	Day= 0 to 31	NOT USED
mm	Month= 1 to 12	NOT USED
aaaa	Year	NOT USED
BBB	Is the beacon or ship ID 0: Ship 1 to 128: beacon	USED
DDMM.M	Latitude in degree (DD) minutes (MM.MMMM)	USED
H	'N' for Northern hemisphere, 'S' for Southern hemisphere	USED
DDDMM.M	Longitude in degree (DDD) minutes (MM.MMMM)	USED
D	'E' for East, 'W' for West	USED
A	Lat/Long Beacon position validity. If A=0xF position is valid else position is false.	USED
M.M	Calculated beacon depth in meters (*)	USED
A	Beacon depth validity. A= 0 : no depth A= 1: Calculated A= 2: Sensor	NOT USED
M.M	Sensor depth in meters If Beacon is not equipped with depth sensor this field is 9999.	NOT USED
hh	Checksum	USED

(*) Beacon can be equipped with a depth sensor. Calculated beacon depth is the fusion between sensor depth and calculated USBL depth. If Ship position is sent, the last 3 fields are set to 0.

(**) The USBL fix SD on position is calculated taking into account the GAPS SD on position and internal INS SD on position. Hence we use, X,Y,Depth of $PTSAX telegram to calculate slant range SD and SDlat, SDlong, SDaltitude of the INS $PIXSE,STDPOS telegram as follow:

$$SD_{range} = 2\% \cdot \sqrt{X^2 + Y^2 + Depth^2}$$

$$SD_{latitude} = \sqrt{SD_{lat}^{\ 2} + SD_{range}^{\ 2}} \; ; SD_{longitude} = \sqrt{SD_{lat}^{\ 2} + SD_{range}^{\ 2}} \; ;$$

$$SD_{altitude} = \sqrt{SD_{altitude}^{\ 2} + SD_{range}^{\ 2}}$$

$PIXSE,STDPOS,x.x,y.y,z.z*hh<CR><LF> (*)		
x.x	Latitude standard deviation in meters	USED
y.y	Longitude standard deviation in meters	USED
z.z	Altitude standard deviation in meters	USED
hh	Checksum	USED

(*) This telegram is INS SD on position output by INS.

$PTSAX,#NNNNN,hhmss.s,jj,mm,aaaa,BBB,X.X,Y.Y,A,P.P,A,C.C*hh<CR><LF>		
#NNNNN	Accoustic recurrence n°	NOT USED
hhmss.s	Time validity of the data	USED
jj	Day= 0 to 31	NOT USED
mm	Month= 1 to 12	NOT USED
aaaa	Year	NOT USED
BBB	Is the beacon ID 1 to 128: beacon	USED
X.X	X forward position in meters (*)	USED
Y.Y	Y starboard position in meters (*)	USED
A	XY position validity If A=0xF position is valid else position is false.	USED
P.P	Calculated beacon depth in meters (**)	USED
A	Beacon depth validity. A= 0 : no depth A= 1: Calculated A= 2: Sensor	NOT USED
C.C	Sensor depth in meters If Beacon is not equipped with depth sensor this field is 9999.	NOT USED
hh	Checksum	USED

(*) This is relative position in GAPS reference frame.

(**) Beacon can be equipped with a depth sensor. Calculated beacon depth is the fusion between sensor depth and calculated USBL depth.

(***) PTSAX is only used to calculate the standard deviation on GAPS position given by the PTSAG telegram.

$PIXSE,GPSIN,x.x,y.y,z.z,hhmmss.s*hh<CR><LF> (*)		
x.x	Latitude in degrees	USED
y.y	Longitude in degrees	USED
z.z	Altitude in meters	USED
hhmss.s	Time validity of the data	USED
Q	Quality factor (**)	USED
hh	Checksum	USED

(*) Last valid GPS fix received by GAPS

(**) Table below is applied:

Quality factor sent by GPS	Message in IXREPATER	Converted SD in INS
0 or ≥ 6	N/A	Data rejected
1	Natural	10 m
2	Differential	3 m
3	Military	10 m
4	RTK	0.3 m
5	Float RTK	1 m

$PIXSE,UTCIN_, hhmss.sss*hh<CR><LF> (*)		
hhmss.sss	Time validity of the data	USED
hh	Checksum	USED

(*) This is a GAPS time. We recommend to use time and PPS pulse from GPS when available to get the best time synchronization accuracy.

GPS

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard:	Input ASCII.
Data received:	Time, latitude, longitude, altitude, hemisphere, quality factor, number of satellites, HDOP, depth, Geoïdal separation, Checksum NMEA
Data frame	is composed of:

- NMEA **$--GGA** Frame — see section 2.1.2.3
- NMEA **$--GLL** Frame — see section 2.1.2.4
- NMEA **$--GST** Frame — see section 2.1.2.5
- NMEA **$--RMC** Frame — see section 2.1.2.6
- **UTC** Frame — see section 2.1.1.1
- NMEA **$--ZDA** Frame — see section 2.1.2.9

GRAVI DOV CORR

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

External gravimetry data input

Data received: Data validity status, North/East deviation, Standard deviation.

Data frame: The data field delimiter is the comma character (HEX 2C). This input NMEA sentence must contain 6 commas delimiters, even if some fields are set to blank. The sentence is rejected if some fields are not set properly.

$NPDOV,s,n.nnn,e.eee,d.dd,x.xxxxxx,y.yyyyyy*hh<CR><LF>		
$	Start of sentence : HEX 24	
NPDOV	HEX 4E 50 44 4F 56	TALKER identifier = 'NP' for NetANS Processing Unit (external ISD box or external PC) Sentence formatter = 'DOV' for Deviation Of Vertical data
s	Data status : 1 when data valid 0 when data not valid	**Warning: Shall not be a blank field**
n.nnn	Xi angle value defining the south/north vertical deflection in arc seconds	3 digits after the decimal point **Warning: Shall not be a blank field if data valid**
e.eee	Eta angle value defining the east/west vertical deflection in arc seconds	3 digits after the decimal point **Warning: Shall not be a blank field if data valid**
d.dd	Error norm of the gravity error in the model used in milliGals	2 digits after the decimal point **Warning: Shall not be a blank field if data valid**
x.xxxxxx	Latitude in degrees	6 digits after the decimal point **Warning: Shall not be a blank field**
y.yyyyyy	Longitude in degrees	6 digits after the decimal point **Warning: Shall not be a blank field**
*	Checksum field delimiter : HEX 2A	
hh	Checksum field (hexadecimal value of the XOR of each character in the sentence, between, but excluding "$" and "*")	
<CR><LF>	End of sentence : HEX 0D 0A	

GSM 3000

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Input NMEA 0183.

Data received: Platform attitude (roll, pitch and drift/heading).

Data frame: GSM 3000 sends current platform angles either automatically, or after receiving a 'I' or 'J' command. Received data will be time stamped by the INS and sent in POSTPROCESSING protocol frames.

A ±RRRR ±PPPP ±DDDD C<CR><LF>			
where:	RRRR	is the roll angle of the platform in steps of 0.01°	(USED)
	PPPP	is the pitch angle of the platform in steps of 0.01° (USED)	(USED)
	DDDD	is the drift (heading) angle of the platform in steps of 0.01° (USED)	(USED)
	C	is the request command that generated this frame transmission. This field is not supported by all GSM 3000 versions and will not be parsed by the INS. (NOT USED)	(NOTUSED)

HALLIBURTON SAS

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard Input : NMEA 0183.

Data received: Time stamp, USBL Beacon position in Lat/Long, USBL position standard deviations, age of data, Beacon depth, Delta latitude, Delta longitude, Standard deviations, GPS Latitude, Longitude, GPS quality, GPS time.

Data frame:

$PUSBA,hhmmss.s,llmm.m,a,LLLmm.m,b,±c.c,±c.c,±c.c,±c.c,r.r,t.t,s.s,a.a, llmm.m,a,LLLmm.m,b,d.d,c<CR><LF>		
hhmmss.s	UTC time stamp of position in hours (hh) minutes (mm) and Second(ss.ss) (taken into account if INS is UTC time synchronized otherwise age of data is taken into account)[1]	ss.s : 40 bit float (*)
llmm.m	is the latitude in degrees (ll) and in minutes (mm.m)	mm.m : 40 bit float
a	is the hemisphere N: North S: South	char
LLLmm.m	is the longitude in degrees (LLL) and in minutes (mm.m)	mm.m : 40 bit float
b	is longitude sign E: East W: West	char
±c.c	is estimated errors in latitude, covar(Lat), in meters²	40 bit float
±c.c	is estimated error in longitude, covar(Long), in meters²	40 bit float
±c.c	is estimated correlated lat/long error, covar(LatLong), in meters²	40 bit float
±c.c	is estimated error in depth, covar(depth) in meters²	40 bit float
r.r	range standard deviation error in meters (NOT USED)	40 bit float
t.t	angular observation standard deviation in degrees (NOT USED)	40 bit float
s.s	is the slant range in meters (NOT USED)	40 bit float
a.a	is the age of the data in seconds (taken into account if INS is not UTC time synchronized)	40 bit float
llmm.m	is the vessel latitude in degrees (ll) and in minutes (mm.m) (NOT USED)	mm.m : 40 bit float
a	is the hemisphere N: North	char

[1] Available from Firmware V3.113.96.159

$PUSBA,hhmmss.s,llmm.m,a,LLLmm.m,b,±c.c,±c.c,±c.c,±c.c,r.r,t.t,s.s,a.a, llmm.m,a,LLLmm.m,b,d.d,c<CR><LF>		
LLLmm.m b d.d c	S: South is the vessel longitude in degrees (LLL) and in minutes (mm.m) (NOT USED) is longitude sign E: East W: West is the beacon depth is the computed mode (NOT USED)	mm.m : 40 bit float char 40 bit float

(*) xx.x : 2 characters before “.”

$PUSBR,hhmmss.ss,l.l,y.y,±ccc.c,±ccc.c,±ccc.c,±ccc.c,r.r,t.tt,ssss.s,aa.a,<CR><LF>		
where:	hhmmss.ss	UTC time stamp of position (taken into account if INS is UTC time synchronized otherwise age of data is taken into account)[2] (NOT USED)
	l.l	is the correction of latitude in meters (NOT USED)
	y.y	is the correction of longitude in meters (NOT USED)
	±ccc.c	are estimated errors in position, covar(Lat), covar(Long), covar(LatLong), covar(deltaT) in meters (NOT USED)
	r.r	is the standard error of range observation in meters (NOT USED)
	t.tt	is the standard error of angular observation in degrees (NOT USED)
	s.s	is the slant range in meters (NOT USED)
	a.a	is the age of the data in seconds (NOT USED)

$PLBL,hhmmss.ss,r.r,d.d,e.e,llm.m,a,LLLm.m,b,a.a,<CR><LF>		
where:	hhmmss.ss	UTC time stamp of position (taken into account if INS is UTC time synchronized otherwise delay of data is taken into account)[3]
	r.r	is the range in meters
	d.d	is the delay in seconds
	e.e	is the range standard error in meters
	llm.m	is the seabed beacon latitude in deg (ll) and in min (m.m)
	a	is the hemisphere N: North S: South
		is the seabed beacon longitude in deg (LLL) and in min (m.m)

[2] Available from Firmware V3.113.96.159
[3] Available from Firmware V3.113.96.159

$PLBL,hhmmss.ss,r.r,d.d,e.e,llm.m,a,LLLm.m,b,a.a,<CR><LF>		
	LLLm.m	is longitude sign
	b	E: East
		W: West
	a.a	is the seabed beacon depth in meters

$--GGA,hhmmss.ss,llmm.mm,a, LLLmm.mm,b,q,ss,y.y,x.x,M,g.g,M,a.a,zzzz*hh<CR><LF>		
where:	hhmmss.ss	is the UTC of position
	llmm.mm	is the latitude in degrees (ll) and in minutes (mm.mm)
	a	is the hemisphere
		N: North
		S: South
	LLLmm.mm	is the longitude in degrees (LLL) and in minutes (mm.mm)
	b	is longitude sign
		E: East
		W: West
	q	is the GPS quality indicator (*)
		0 and ≥ 6 fix invalid
		1=GPS SPS Mode, fix valid
		2=Differential GPS, SPS Mode, fix valid
		3= GPS PPS Mode, fix valid
		4= RTK. Satellite system used in RTK mode with fixed integers
		5= Float RTK. Satellite sysem used in RTK mode with floating integers
	ss	is the number of satellites
	y.y	is the horizontal dilution of precision. (NOT USED)
	x.x	is the antenna altitude
	M	is the units of antenna altitude (meters)
	g.g	is the geoidal separation. (NOT USED)
	M	is the units of geoidal separation (meters) (NOT USED)
	a.a	is the age of differential GPS data. (NOT USED)
	zzzz	Is the differential reference station ID. (NOT USED)
	*hh	is the checksum

$GPZDA,hhmmss.ss,,,,, *hh <CR><LF>		
where :	hhmmss.ss	is the UTC of the last PPS received
	hh	is the checksum

(*) For quality factor 0 and ≥ 6 GPS data is considered invalid by INS.

The quality factor is interpreted by INS as described in section 1.1.4.

MICRO SVT_P

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Input CTD.

Data received: Time Stamp, Sound velocity, Pressure, Temperature.

Data frame:

yy/mm/dd<SP>hh:mm:s.s<SP>p.p<SP>s.s<SP>t.t<CR><LF>		
yy	Year (Unsigned decimal integer – 2 digits)	
/	‘ / ’ character	
mm	Month (Unsigned decimal integer – 2 digits)	NOT USED
/	‘ / ’ character	
dd	Day (Unsigned decimal integer – 2 digits)	
<SP>	Space character	
hh	Hour (Unsigned decimal integer – 2 digits)	
:	‘ : ’ character	
mm	Minutes (Unsigned decimal integer – 2 digits)	NOT USED
:	‘ : ’ character	
s.s	Seconds (Unsigned decimal floating point)	
<SP>	Space character	
p.p	Pressure in dBar (Decimal floating point)	USED
<SP>	Space character	
s.s	Speed of sound in m/s (Decimal floating point)	USED
<SP>	Space character	
t.t	Temperature in °C (Decimal floating point)	NOT USED
<CR>	Carriage Return character	
<LF>	Line Feed character	

Depth is calculated by using the formula described in section 1.1.5. For this protocol, we expect that a Tare has been applied to the pressure sensor. Hence, we do not compensate atmospheric pressure Pa (10.1325 dBar) before pressure to depth conversion.

MINISVS

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Input CTD.

Data received: These protocols apply to SVP sensors:

Format 1 and 2 are compatible with the Valeport miniSVS.

Format 2 is compatible with Applied Micro systems Micro SV-X

Format 3 is compatible with the Valeport miniSVS with optional pressure sensor.

Both pressure sensor input and sound velocity can be used by INS.

Data frame:

Format 1: <F1><F2><CR><LF>				
<F1>	<space>	Header		
<F2>	SSSSSSS	Speed of sound in mm/sec (i.e : 1234567 mm/sec)	Integer	USED

Format 2: <F1><F2><F3><CR><LF>				
<F1>	<space>	Header		
<F2>	SSSS.SSS	Speed of sound in m/sec (i.e : 1234.567 m/sec)	Float	USED

Format 3: <space><F1><space><F2><CR><LF>				
<F1>	PPPP.P (i.e 1234.5 dBar) (**) PPP.PP (i.e 123.45 dBar) PP.PPP (i.e 12.345 dBar)	Pressure value is a fixed length string depending on the range of pressure sensor.	Float	USED
<F2>	SSSSSSS	Speed of sound in mm/sec (i.e : 1234567 mm/sec)	Integer	USED

(*) Depth is output from Valeport SVX-2 in meters only if a Tare has been applied and the latitude has been supplied to the instrument. We are expecting pressure in dbar.

(**) Depth is calculated by using the formula described in section 1.1.5. For this protocol, we expect that a Tare has been applied to the pressure sensor. Hence, we do not compensate atmospheric pressure Pa (10.1325 dBar) before pressure to depth conversion.

ODOMETER

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Input NMEA 0183.

Data received: Number of pulses per second.

Data frame:

$YDXDR,ODO,1,Cxxxxx*hh<CR><LF>	
C	=0 for a non signed number (USED)
	='+' or '-' for a signed number (USED
xxxxx	Number of pulses per second (USED)
hh	Is the checksum

Note : the default standard deviation on speed taken into account is 0.2 pulse/s.

PAROSCIENTIFIC

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: ParoScientific pressure sensor.

Data received: Depth calculated using sensor pressure.

Data frame:

*0001x.x<CR><LF>		
where:	x.x	is the pressure measured in PSI unit (i.e : *000114.5 is 14.5 PSI)

(*) Depth is calculated by using the formula described in section 1.1.5.

PDS

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Data received: Pressure depth.

Data frame:

$PBAE,PDS,a.a,b.b,c.c*hh<CR><LF>		
where:	a.a	is the pressure depth relative to transducer; meters
	b.b	is the offset from transducer; meters (NOT USED)
	c.c	is the maximum range scale; meters (NOT USED)
	hh	is the NMEA calculated checksum

PRESSURE SENSOR

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard:	Comma separated ASCII input protocol with NMEA compliant checksum.
Data received:	Pressure, pressure status.
Data frame:	This input frame must contain 3 commas delimiters and if some fields are not set properly, the frame is rejected (i.e.: If the pressure field or the status field is a blank field).

$PS,p.p,ss,t.t*hh<CR><LF>		
$PS	Start of sentence : HEX 24 50 53	
,	Data field delimiter : HEX 2C	
p.p	Absolute pressure in bar. This field is parsed as a floating point with at least 1 digit after the comma	USED **Warning: Shall not be a blank field**
,	Data field delimiter : HEX 2C	
ss	Status of the pressure sensor 11 or 10 when pressure valid 01 or 01 when pressure invalid	USED **Warning: Shall not be a blank field**
,	Data field delimiter : HEX 2C	
t.t	Is the temperature in °C	NOT USED **Warning: Blank field allowed**
*	Checksum field delimiter : HEX 2A	
hh	Checksum field (hexadecimal value of the XOR of each character in the sentence, between, but excluding “$” and “*”)	
<CR><LF>	End of sentence : HEX 0D 0A	

RDI PD6

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Data received:	DVL bottom track and water track speeds, DVL sound velocity, DVL altitude, DVL range to bottom, DVL depth (when pressure sensor. option). An additional time stamp telegram can be received (:UT) and decoded. This latter "UT" telegram is not in RDI PD6 telegram but can be supplied by client application.

Data frame:

Time Stamping Of Bottom Track Speed

:UT,hhmmss.sss<CR><LF>		
where:	hhmmss.sss	UTC of the DVL bottom track measurement (:BI telegram)

System Attitude Data (Not Used)

:SA,±PP.PP,±RR.RR,HH.HH<CR><LF>		
where:	PP.PP	is the pitch in degrees. (NOT USED)
	RR.RR	is the roll in degrees. (NOT USED)
	HH.HH	is the heading in degrees. (NOT USED)

Note: this frame is used to set the date of BI and WI frame info.

Timing And Scaling Data

:TS,YYMMDDHHmmsshh,ss.s,+TT.T,DDDD.D,CCCC.C,BBB<CR><LF>		
where:	YYMMDDHHmmsshh	Is the date: year, month, day, hour, minute, second, hundredths of seconds. (NOT USED)
	ss.s	Is the salinity in parts per thousand [ppt]. (NOT USED)
	+TT.T	Is the temperature in °C. (NOT USED)
	DDDD.D	Is the depth of transducer face in meters.
	CCCC.C	Is the DVL manual or calculated sound velocity. (NOT USED)
	BBB	Is the Built-In test (BIT) result code. (NOT USED)

Water-Mass, Instrument-Referenced Velocity Data

:WI,±TTTTT,±LLLLL,±NNNNN,±MMMMM,S<CR><LF>		
where:	TTTTT	is the X transverse velocity relative to current, data in mm/s (*)
	LLLLL	is the Y longitudinal velocity relative to current, data in mm/s (*)
	NNNNN	is the Z normal velocity relative to current, data in mm/s (*)
	MMMMM	Error velocity data in mm/s (NOT USED)

:WI,±TTTTT,±LLLLL,±NNNNN,±MMMMM,S<CR><LF>		
	S	is the status 'A': Valid (**)

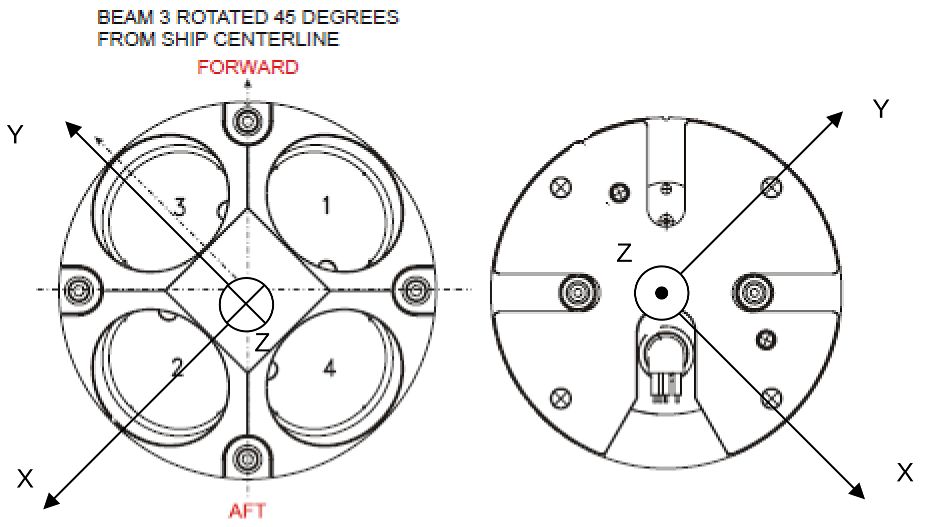
Bottom-Track, Instrument-Referenced Velocity Data

:BI,±TTTTT,±LLLLL,±NNNNN,±MMMMM,S<CR><LF>		
where:	TTTTT	is the X transverse velocity data in mm/s (*)
	LLLLL	is the Y longitudinal velocity data in mm/s (*)
	NNNNN	is the Z normal velocity data in mm/s (*)
	MMMMM	Error velocity data in mm/s (NOT USED)
	S	is the status, 'A': Valid. (**)

Bottom-Track, Earth-Referenced Distance Data

: BD,±EEEEEEEE.EE,±NNNNNNNN.NN,±UUUUUUUU.UU,DDDD.DD,TTT.TT <CR><LF>		
where:	EEEEEEEE.EE	is the East distance data in meters. (NOT USED)
	NNNNNNNN.NN	is the North distance data in meters. (NOT USED)
	UUUUUUUU.UU	is the upward distance data in meters. (NOT USED)
	DDDD.DD	Range to bottom in meters
	TTT.TT	is the time since the last good-velocity estimate in seconds. (NOT USED)

(*)



DVL reference frame in instruments coordinate before INS coordinate transformation (X=Y; Y=-X, Z=Z):

±XXXXX = X-axis velocity data in mm/s (+ = Bm1 Bm2 xdcr movement relative to bottom)

±YYYYY = Y-axis velocity data in mm/s (+ = Bm4 Bm3 xdcr movement relative to bottom)

±ZZZZZ = Z-axis velocity data in mm/s (+ = transducer movement away from bottom)

(**) A value different than 'A' indicates an invalid data transmitted by sensor. In such case, the data is considered as invalid by PHINS. (***) DVL must be set to send data in instrument body frame. Misalignment calibration between INS and DVL body frames must be performed for optimal results.

Contact **support@ixblue.com** to retrieve the proper calibration procedure.

SBE 37SI

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard:	ASCII protocol.
Data received:	Only pressure converted to depth in INS and Sound Velocity is taken into account.
Data frame:	The following describes both protocol formats chosen to interface to a Seabird SBE 37-SI MicroCAT CTD probe.

Note: psu= salinity unit. 1 g of Na+Cl- per 1 kg of sea water.

Format 1 : ttt.tttt,cc.ccccc,(pppp.ppp,)dddd.ddd,sss.ssss,vvvv.vvv,rrr.rrrr,dd mmm yyyy,hh:mm:ss			
where:	ttt.tttt	Temperature (°C, UTS-90)	(NOT USED)
	cc.ccccc	Conductivity (S/m)	(NOT USED)
	pppp.ppp	Pressure (dBars)	See **Note 1** above
	dddd.ddd	Depth (m)	CTD setting must be OutputDepth=Y (NOT USED)
	sss.ssss	Salinity (psu)	CTD setting must be OutputSal=Y (NOT USED)
	vvvv.vvv	Sound Velocity (m/s)	CTD Setting must be OutputSV=Y
	rrr.rrrr	Density sigma (kg/m^3)	CTD setting must be OutputDensity=Y (NOT USED)
	dd mmm yyyy	Date	CTD setting must be OutputDate=Y (NOT USED)
	hh:mm:ss	Time	CTD setting must be OutputTime =Y (NOT USED)

Format 2 : ttt.tttt,cc.ccccc, (pppp.ppp,) dddd.ddd, sss.ssss,vvvv.vvv, rrr.rrrr, mm-dd-yyyy, hh:mm:ss			
where:	ttt.tttt	Temperature (°C, UTS-90)	(NOT USED)
	cc.ccccc	Conductivity (S/m)	(NOT USED)
	pppp.ppp	Pressure (dBars)	See **Note 1** above
	dddd.ddd	Depth (m)	CTD setting must be OutputDepth=Y (NOT USED)
	sss.ssss	Salinity (psu)	CTD setting must be OutputSal=Y (NOT USED)
	vvvv.vvv	Sound Velocity (m/s)	CTD Setting must be OutputSV=Y
	rrr.rrrr	Density sigma (kg/m^3)	CTD setting must be OutputDensity=Y (NOT USED)
	mm-dd-yyyy	Date	CTD setting must be OutputDate=Y (NOT USED)
	hh:mm:ss	Time	CTD setting must be OutputTime =Y (NOT USED)

<u>Alternate supported formats:</u>

Format 3 : ttt.tttt,cc.ccccc, (pppp.ppp,) dddd.ddd, sss.ssss,vvvv.vvv,N,N,N			
where:	ttt.tttt	Temperature (°C, UTS-90)	(NOT USED)
	cc.ccccc	Conductivity (S/m)	(NOT USED)
	pppp.ppp	Pressure (dBars)	See **Note 1**
	dddd.ddd	Depth (m)	CTD setting must be OutputDepth=Y (NOT USED)
	sss.ssss	Salinity (psu)	CTD setting must be OutputSal=Y (NOT USED)
	vvvv.vvv	Sound Velocity (m/s)	CTD Setting must be OutputSV=Y
	N	Density sigma (kg/m^3)	CTD setting must be OutputDensity=N (NOT USED)
	N	Date	CTD setting must be OutputDate=N (NOT USED)
	N	Time	CTD setting must be OutputTime =N (NOT USED)

Format 4 : ttt.tttt,cc.ccccc,pppp.ppp			
where:	ttt.tttt cc.ccccc pppp.ppp	Temperature (°C, UTS-90) Conductivity (S/m) Pressure (dBars)	See **Note 2**

<u>Note 1 :</u> When there is no pressure sensor installed, the pressure field may be not a part of the input sentence or may be a blank field. When valid, the pressure is used to compute the depth, and INS can take it into account if configured to use it. Depth is calculated by using the formula described in section 1.1.5.

<u>Note 2 :</u> When only conductivity, pressure and temperature are available, conductivity ratio R needs to be converted to salinity to compute sound velocity using salinity and temperature (this for the Chen and Millero equation which expects pressure, temperature and salinity as inputs).
Sound velocity is calculated by using the formula described in 1.1.6.

SBE 49

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: ASCII protocol.

Data frame: The following describes format to interface to a CTD Sensor SBE49.

Format : ttt.tttt,<space>cc.ccccc,<space>pppp.ppp,<space>sss.ssss,<space>vvvv.vvv<CR><LF>			
where:	ttt.tttt	Temperature (°C, ITS-90)	NOT USED
	cc.ccccc	Conductivity (S/m)	NOT USED
	pppp.ppp	Pressure (dBars)	USED. See **NOTE 1**
	sss.ssss	Salinity (psu)	NOT USED. CTD setting must be **OutputSal=Y**
	vvvv.vvv	Sound Velocity (m/s)	See **NOTE 2**. CTD Setting must be **OutputSV=Y**

Data is expected in the order listed, with a comma followed by a space between each parameter. Shown with each parameter are the number of digits and the placement of the decimal point. Leading zeros are suppressed, except for one zero to the left of the decimal point.

Example of FastCAT output with OutputSal=Y, OutputSV=Y:

23.7658, 0.00019, 0.062, 0.0125, 0.456

- Temperature = 23.7658 (NOT USED by the INS)
- Conductivity = 0.00019 (NOT USED by the INS)
- Pressure = 0.062
- Salinity = 0.0125 (NOT USED by the INS)
- Sound velocity = 0.456

NOTE 1: Depth is calculated by using the formula described in section 1.1.5.

NOTE 2: Sound velocity is calculated by using the formula described in 1.1.6.

SEAKING 700

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard:	Tritech seaking700 Free Run specific protocol.
Data received:	Sound velocity, Depth.
Data frame:	See Tritech system documentation for full details on this frame.

The INS will decode a message in the following format:

%D<SlotReplyHdr><Bathymetric System Reply Data><CR><LF>

where *SlotReplyHdr* describes the data format of the *Bathymetric System Reply Data*. The data protocol is *Winson raw* or *Winson processed* data format.

SEAKING 700 message:

%D<SlotReplyHdr><Bathymetric System Reply Data><CR><LF>

<SlotReplyHdr> item:

<F0><F1><F2><F3><F4>			
Field	ASCII Hex Format	Data Description	
0	0000 to FFFF	Total Number of Bytes in Message (including header and terminators) (not used)	NOT USED
1	01 to 0C	Slot Number (not used)	NOT USED
2	00 to 63	Generic Device Type (not used)	NOT USED
3	0	Data Reply Mode is ASCII (0=ASCII Decimal, 1=ASCII Hex, 2=Binary, 3=CSV*) Only ASCII Decimal or CSV mode are processed by the INS.	USED
4	1	Data sent in Raw or processed data format (Seaking Long=3, Seaking Short=2, Raw data=1, Processed Data=0) Only Raw and processed data format are processed by the INS.	USED

***** Comma Separated ASCII Values (at most 14 commas) :

Data from SCU can be sent in ASCII mode with each field separated by comma delimiters. Numeric data is represented in Decimal ASCII format although not following the exact number of characters as defined by the DATA TYPE for ASCIIText mode.

For example, in ASCIIText mode, the Integer value –128 will be represented as '–00128', as defined by the DATA TYPE. In CSV mode this field would read as 'xx,-128,xx' (shown as part of comma delimited string). Only the required number of characters that will represent the ASCII value are used in each case.

<Bathymetric System Reply Data> item (identical structure for Raw or Processed mode, only Altimeter data differs)

when field 3 in <SlotReplyHdr> item is set to ASCII Decimal mode : ±aaaaabbbbbbbbbb±ccccddddddddddeeeeeeeeee±fffffggggg±hhhhhiiiiijjjjj±kkkkkkkkkklll±mmmmmmmmmmnnnnnnnn when field 3 in <SlotReplyHdr> item is set to CSV mode : ,±aaaaa,bbbbbbbbbb,±ccccc,dddddddddd,eeeeeeeeee,±fffff,ggggg,±hhhhh,iiiii,jjjjj,±kkkkkkkkkk,lll,±mmmmmmmmmm,nnnnnnnn			
Field	Data Description	Data Range	
±aaaaa	Internal temperature in tenths of a degree centigrade	-00200 to +00500	NOT USED
bbbbbbbbbb	Digiquartz pressure in 100,000ths of a PSIa	0000000000 to 100000000	NOT USED
±ccccc	Digiquartz temperature in 1/100ths of a degree centigrade	-05400 to +10700	NOT USED
dddddddddd	Raw digiquartz pressure reading is the number of 8MHz counts for 10,000 digiquartz pulses	000000000 to 0010000000	NOT USED
eeeeeeeeee	Raw digiquartz temperature reading is the number of 8MHz counts for 40,000 digiquartz pulses	000000000 to 0010000000	NOT USED
±fffff	Local oscillator calibration coefficient in Hz	-00500 to +00500	NOT USED
ggggg	Conductivity in µSiemens per centimetre	00000 to 65000	NOT USED
±hhhhh	Conductivity probe temperature in hundredths of a degree centigrade	-01000 to +05000	NOT USED
iiiii	Salinity in parts per 1,000,000 calculated from Conductivity readings	00000 to 65535	NOT USED
jjjjj	Velocity of Sound in metres per second * 10 calculated from Conductivity readings (or 'Manual' VOS if no CT probe)	14000 to 15500	USED

when field 3 in <SlotReplyHdr> item is set to ASCII Decimal mode : ±aaaaabbbbbbbbbb±cccccddddddddddeeeeeeeeee±fffffggggg±hhhhhiiiijjjjj±kkkkkkkkkklll±mm mmmmmmmmnnnnnnnn when field 3 in <SlotReplyHdr> item is set to CSV mode : ,±aaaaa,bbbbbbbbbb,±ccccc,dddddddddd,eeeeeeeeee,±fffff,ggggg,±hhhhh,iiii,jjjjj,±kkkkkkkkkk ,lll,±mmmmmmmmmm,nnnnnnnn			
±kkkkkkkkkk	Altimeter (return path) reading in clicks of 200nsecs (This value does not include 'Altimeter Position offset'. For **raw mode** and includes 'Altimeter Position offset' for **processed mode**)	+0000000000 to +0000203390	NOT USED
lll	Bathymetric system devices Bit 0 = 1 = Digiquartz valid Bit 1 = 1 = Conductivity valid Bit 2 = 1 = Altimeter valid Bit 3 = 1 = Internal temperature valid (only installed in SK701 Bathy) Bit 4 = 1 = Velocity of sound calculation valid Bit 5 = 1 = Salinity calculation valid Ex. : Digiquartz valid lll = 001 Digiquartz & Conductivity valid lll = 003 Digiquartz & Altimeter valid lll = 005 Digiquartz, Conductivity & Altimeter valid lll = 007	000 to 063 INS takes into account: the sound velocity when bit 4 is set to 1 the depth when bit 0 is set to 1	USED
±mmmmmmm mmm	Depth in millimetres (This value does not include 'Bathy Position Offset' and 'Bathy Zero Offset' for raw mode and include these corrections for processed mode)	+0000000000 to +0000700000	USED
nnnnnnnn	Time at Start of Scan	00000000 to 23595999	USED

Example:		
Internal temperature	= 5 degrees	= 50
Digiquartz pressure	= 200 PSIa	= 20000000
Digiquartz temperature	= 5 degrees	= 500
Raw digiquartz pressure reading	= 2135648	= 2135648
Raw digiquartz temperature reading	= 1986497	= 1986497
Local oscillator calibration	= -10 Hz	= -10
Conductivity	= 40 mS/cm	= 40000
Conductivity temperature	= 5 degrees	= 500
Conductivity Salinity	= 3.4 pts/1000	= 3400
Velocity of Sound	= 1475 metres per second	= 14750
Altimeter reading	= 24 metres	= 162710 (return path)
Bathymetric system devices	= SK704 (CTDA)	= 55
Depth in millimetres	= 136.921 metres	= 136921
Time in HHMMSSCC	= 09:45:33:74	= 09453374
ASCIIText = "+000500020000000+0050000021356480001986497-0001040000		
+005000340014750+0000162710055+000013692109453374"		

(*) Depth is calculated by using the formula described in section 1.1.5.

SENIN

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Input ASCII.

Data received: Depth, altitude, position, EM LOG speed, time validity of data.

Data frame: This protocol was specified for submarine application.

$NAGGA,hhmmss.ss,LLII.I,a,LLLII.I,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh<CR><LF> (Note 3)		
hhmmss.s	UTC time	USED
LLII.I	Latitude in degrees (LL) and in minutes (II.IIIIIII)	NOT USED
a	'N' for Northern hemisphere, 'S' for Southern hemisphere	NOT USED
LLLII.I	Longitude in deg (LLL) and in minutes (II.IIIIIII)	NOT USED
a	'E' for East, 'W' for West	NOT USED
x	GPS quality indicator	NOT USED
xx	Number of satellites in use	NOT USED
x.x	Horizontal dilution of precision (HDOP)	NOT USED
x.x	Antenna altitude above mean sea level (geoid) (meters)	USED
M	Unit of antenna altitude (fixed character = 'M' for meters)	NOT USED
x.x	Geoidal separation	NOT USED
M	Unit of Geoidal separation (fixed character = 'M' for meters)	NOT USED
x.x	Age of the differential GPS data	NOT USED
xxxx	Differential reference station ID	NOT USED
hh	Checksum	USED

$GPGGA,hhmmss.s,LLII.I,a,LLLII.I,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh<CR><LF> (Note 2)		
hhmmss.s	UTC time of position	USED
LLII.I	Latitude in degrees (LL) and in minutes (II.IIIIIII)	USED
a	'N' for Northern hemisphere, 'S' for Southern hemisphere	USED
LLLII.I	Longitude in deg (LLL) and in minutes (II.IIIIIII)	USED
a	'E' for East, 'W' for West	USED
x	GPS quality indicator	USED
xx	Number of satellites in use	NOT USED
x.x	Horizontal dilution of precision (HDOP)	NOT USED
x.x	Antenna altitude above mean sea level (geoid) (meters)	USED
M	Unit of antenna altitude (fixed character = 'M' for meters)	USED

$GPGGA,hhmmss.s,LLII.I,a,LLLII.I,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh<CR><LF> (Note 2)		
x.x	Geoidal separation	USED
M	Unit of Geoidal separation (fixed character = ‘M’ for meters)	USED
x.x	Age of the differential GPS data	NOT USED
xxxx	Differential reference station ID	NOT USED
hh	Checksum	USED

$NAVHW,x.x,T,x.x,M,x.x,N,x.x,K*hh <CR><LF> (Note 4)		
x.x	is the true heading in degrees.	NOT USED
T	T = True	NOT USED
x.x	is the magnetic heading in degrees.	NOT USED
M	M = magnetic.	NOT USED
x.x	is the XV1 longitudinal water speed, in knot.	USED
N	N = knots.	NOT USED
x.x	is the speed, in km/h.	NOT USED
K	K = km/h	NOT USED
hh	Is the hexadecimal checksum.	USED

Note 1: NAGGA is used as a ZDA telegram to synchronize INS time and retrieve depth from the altitude field (depth=-altitude). GPGGA is valid at the surface and sends position to INS. NAVHW is the EM LOG data sent at all times.

Note 2 : For quality factor 0 and ≥ 6 GPS data is considered invalid by INS. If no GST string is received, the correspondence table is applied, refer to section 1.1.4.

Note 3 : Standard deviation on depth is set to 1 m by default in INS firmware.

Note 4 : Standard deviation on EM LOG speed is set to 0.5 m/s by default.

SKIPPER DL 850

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Input NMEA 0183.

Data received: DVL, water referenced and ground referenced speed data in the vessel frame. This telegram is identical to “VBW” telegram but SD= 1 m/s whereas SD=0.5 m/s for “VBW” input data.

Data frame:

$VDVBW,x.x,x.x,A,x.x,x.x,A,x.x,A,x.x,A*hh <CR><LF>		
where:	x.x	is the longitudinal DVL (XV1) water speed, in knots, ‘-‘ = astern.
	x.x	is the transverse DVL (XV2) water speed, in knots, ‘-‘ = port.
	A	is the status of DVL water speed, A=Data valid. V= data invalid
	x.x	is the longitudinal DVL (XV1) ground speed, in knots, ‘-‘ = astern.
	x.x	is the transverse DVL (XV2) ground speed, in knots, ‘-‘ = port.
	A	is the status of DVL ground speed: A = data valid V = data invalid
	x.x	is the stern transverse water speed in knots. (NOT USED)
	A	is the status of stern water speed. (NOT USED)
	x.x	is the stern transverse ground speed in knots. (NOT USED)
	A	is the status of stern ground speed. (NOT USED)
	hh	Is the checksum

Note: the default SD set to 1 m/s is chosen to be compatible with the quality of the observed speed data produced by the SKIPPER DL 850 Doppler speed log.

SVP 70

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Protocol output by the SVP 70 Reson sensor, ASCII format.

Data received: Only Sound velocity, Pressure will be used by INS.

Data frame:

$SVP70,MMMMMM,SSSS.SSS,tt.t,PPP.P,aaa,n,f,v<CR><LF>		
where:	MMMMMM	Time in milliseconds since the switch on (NOT USED)
	SSSS.SSS	Speed of sound in m/s
	tt.t	Temperature in Celsius degree (NOT USED)
	PPP.P	Pressure in tenth of bar
	aaa	Signal strength (NOT USED)
	n	Approximate signal noise (NOT USED)
	f	Filter type (NOT USED)
	v	Last sample validity, 1 is OK , 0 is NOK

(*) Depth is calculated by using the formula described in section 1.1.5. For this protocol, we expect that a Tare has been applied to the pressure sensor. Hence, we do not compensate atmospheric pressure Pa (10.1325 dBar) before pressure to depth conversion.

SVX2

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Protocol output by Valeport MIDAS SVX2 SVP sensor, ASCII format.

Data received: Sound velocity and Pressure will be used by INS.

Data frame: Format 1 and 2 are compatible with Valeport MIDAS SVX2. Both pressure sensor input and sound velocity can be used by INS.

Format 1: <F1><TAB><F2><TAB><<F3><TAB><F4><TAB><F5><TAB> <F6><TAB><F7><TAB><F8><TAB><CR><LF>			
<F1>	Sound velocity	Float	(USED)
<F2>	Units = “M/SEC” or “F/S”	String	(USED)
<F3>	Depth	Float	(USED)
<F4>	Units= “M” or “DBAR” or “F” (*) (**)	String	(USED)
<F5>	Temperature	Float	(NOTUSED)
<F6>	Units=”C”	Sting	(NOT USED)
<F7>	Conductivity	Float	(NOT USED)
<F8>	Units=”MS/CM”	String	(NOT USED)

Format 1 string sample :

1483.576 M/SEC 0010.225 DBAR 0020.215 C -000.002 MS/CM

Format 2: <F1><TAB><F2><TAB><<F3><TAB><F4><TAB><F5><TAB> <F6><TAB><F7><TAB><F8><TAB>><F9><TAB>><F10><TAB><CR><LF>			
<F1>	Sound velocity	Float	(USED)
<F2>	Units = “M/SEC” or “F/S”	String	(USED)
<F3>	Depth	Float	(USED)
<F4>	Units= “M” or “DBAR” or “F” (*) (**)	String	(USED)
<F5>	Temperature	Float	(NOTUSED)
<F6>	Units=”C”	Sting	(NOT USED)
<F7>	Conductivity	Float	(NOT USED)
<F8>	Units=”MS/CM”	String	(NOT USED)
<F9>	Salinity	Float	(NOT USED)
<F10>	Units=”PSU”	String	(NOT USED)

Format 2 string sample :

1483.576 M/SEC 0010.225 DBAR 0020.200 C 0000.000 MS/CM 0000.000 PSU

(*) Deph is output from Valeport SVX2 in meters only if a Tare has been applied and the latitude has been supplied to the instrument. If depth is sent in “DBAR” we expect that a Tare has been applied.

(**) Depth is calculated by using the formula described in section 1.1.5. For this protocol, we expect that a Tare has been applied to the pressure sensor. Hence, we do not compensate atmospheric pressure Pa (10.1325 dBar) before pressure to depth conversion.

USBL LBL CTD

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard:	BLUEFIN proprietary protocol, ASCII format.
Data received:	SBL Fix Latitude, Longitude, Depth, Standard deviations LBL Latitude, Longitude, Depth, Beacon ID, Range, Range standard deviation, CTD Conductivity, Temperature, Pressure, Time and date, Salinity.
Data frame:	

Remark:

- x.x data format specification means that INS expects a float value (no matter the number of digits before or after the decimal point) .
- ±x.x data format specification means that INS expects the sign character before the float value (here again, no matter the number of digits before or after the decimal point).

$BFUSBL,LLmm.mmmm,a,LLLmm.mmmm,b,±x.x,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>			
where:	**LLmm.mmmm**	is the latitude in degrees (LL) and in minutes (mm.mmmm)	USED
	a	is 'N' for Northern hemisphere, 'S' for Southern hemisphere	USED
	LLLmm.mmmmmm	is the longitude in degrees (LLL) and in minutes(mm.mmm)	USED
	b	is 'E' for East, 'W' for West	USED
	±x.x	is the depth in meters	USED
	x.x	is the latitude standard deviation in meters	USED
	x.x	is the longitude standard deviation in meters	USED
	x.x	is the latitude-longitude covariance in meters^2	USED
	x.x	is the depth standard deviation in meters	USED
	x.x	is the age of the data in seconds	USED
	hh	is the checksum	USED

$BFLBL,llmm.mmmm,a,LLLmm.mmmm,b,x.x,i,x.x,x.x,x.x*hh<CR><LF>			
where:	**LLmm.mmmm**	is the latitude in degrees (LL) and in minutes (mm.mmmm)	USED
	a	is ‘N’ for Northern hemisphere, ‘S’ for Southern hemisphere	USED
	LLLmm.mmmmmm	is the longitude in degrees (LLL) and in minutes(mm.mmm)	USED
	b	is ‘E’ for East, ‘W’ for West	USED
	x.x	is the beacon depth in meters	USED
	i	is the beacon identifier	* USED
	x.x	is the range	USED
	x.x	is the range standard deviation	USED
	x.x	is the age of the data in seconds	USED
	hh	is the checksum	USED

$BFCTD,±x.x,±x.x,±x.x,hh:mm:ss mm-dd-yy,±x.x,±x.x*hh<CR><LF>			
where:	**±x.x**	is the conductivity in mS:cm	**
	±x.x	is the temperature in °C	**
	±x.x	is the pressure in decibar (1)	** USED
	hh:mm:ss mm-dd-yy	is the time and the date	NOT USED
	±x.x	is salinity in PSU	NOT USED
	±x.x	is sound velocity in m/s	** USED
	hh	is the checksum	USED

(1) Depth is calculated by using the formula described in section 1.1.5.

VBW

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Input NMEA 0183.

Data received: EM LOG: Water referenced longitudinal speed.

DVL: Water track or Bottom track speeds.

Data frame:

$--VBW,x.x,x.x,S,x.x,x.x,s*hh <CR><LF>		
x.x	XV1 longitudinal water speed, in knots, '-' for astern.	USED (*) (**)(****)
x.x	XV2 transverse water speed, in knots, '-' for port.	USED (*) (**)
S	is the status of the water speed	USED
	'A' = data valid 'V' = data invalid	
	XV1 longitudinal ground speed, in knots, '-' for astern.	
x.x	XV2 transverse ground speed, in knots, '-' for port.	USED (*) (***)
x.x	is the status of the ground speed	USED (*) (***)
s	A' = data valid 'V' = data invalid	USED
x.x	Stern transverse water speed in knots.	NOT USED
s	is the status of stern water speed.	NOT USED
x.x	Stern transverse ground speed in knots.	NOT USED
s	is the status of stern ground speed	NOT USED
hh	Checksum	

Note: the default standard deviation on speed taken into account by INS is 0.5 m/s.

(*): Shall not be blank field if data valid (Status='A').

(**): Used as DVL Water track speed if DVL is configured.

(***): Used as DVL Bottom track speed is DVL is configured.

(****): Used as Emlog speed is Emlog is configured.

3.5.2.2 Binary protocols

AUVG 3000

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Binary.

Data received: DVL bottom track and water track speeds , GPS latitude and longitude, USBL latitude and longitude, Depth, GPS fix position age, USBL fix position age, data validity status.

Data frame: 16 fields – 64 bytes MSB are sent first.

Message <F0><F1>…< F15>			
Field 0	Bytes 0 to 3	Synchronization bytes *	'$$$$'
Field 1	Bytes 4 to 7	DVL XS1 speed with respect to the bottom	IEEE floating point format, m/s
Field 2	Bytes 8 to 11	DVL XS2 speed with respect to the bottom	IEEE floating point format, m/s
Field 3	Bytes 12 to 15	DVL XS3 speed with respect to the bottom	IEEE floating point format, m/s
Field 4	Bytes 16 to 19	DVL XS1 speed with respect to the water	IEEE floating point format, m/s
Field 5	Bytes 20 to 23	DVL XS2 speed with respect to the water	IEEE floating point format, m/s
Field 6	Bytes 24 to 27	DVL XS3 speed with respect to the water	IEEE floating point format, m/s
Field 7	Bytes 28 to 31	GPS latitude '+': North of equator	IEEE floating point format, deg
Field 8	Bytes 32 to 35	GPS longitude '+': East of Greenwich	IEEE floating point format, deg
Field 9	Bytes 36 to 39	USBL latitude '+': North of equator	IEEE floating point format, deg
Field 10	Bytes 40 to 43	USBL longitude '+': East of Greenwich	IEEE floating point format, deg
Field 11	Bytes 44 to 47	Depth***	IEEE floating point format, meters
Field 12	Bytes 48 to 51	GPS Fix position Age	IEEE floating point format, seconds
Field 13	Bytes 52 to 55	USBL Fix position Age	IEEE floating point format, seconds
Field 14	Bytes 56 to 59	Data validity status **	See status specification Table 2
Field 15	Bytes 60 to 63	Checksum	Sum of all the bytes from 0 to 59

* INS will reject all the inputs for unexpected synchronisation bytes or bad checksum. If age of data or data validity is 0 INS will reject the corresponding data.

**** Status specification table 2**

Function	Bit	Value
DVL bottom track validity	0	1 if data is valid 0 otherwise
DVL water track validity	1	1 if data is valid 0 otherwise
GPS data validity	2	1 if data is valid 0 otherwise
USBL data validity	3	1 if data is valid 0 otherwise
Depth data validity	4	1 if data is valid 0 otherwise
GPS fix position age validity	5	1 if data is valid 0 otherwise
USBL fix position age validity	6	1 if data is valid 0 otherwise
Not used	7 to 31	N/A

*** The AUVG3000 input protocol sentence has not the USBL altitude and the GPS altitude fields. If the depth data is valid, INS will use the depth as the USBL altitude. If the depth data is not valid, the USBL altitude is set to 0.
The GPS altitude is always set to 0.

**** The AUVG3000 input protocol sentence does not send the standard deviations on sensor data so the following standard INS default values will be used.

- STD= 1 m for Depth
- STD= 5 m for GPS (lat/long)
- STD= 10 m for USBL (lat/long)

DCN STD LOCH

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Binary protocol (Spec DCN n° 19188 LSM/NAV March 90).

Data received: EM LOG data.

Data frame: The frame contains 3 bytes in binary format without header and “end of frame” fields. It is advisable to use the Timeout to synchronize the frames.

<u>Warning:</u> Protocol is received at 600 bps, which may not be standard in all systems.

Note 1: The Data is not two complemented; Bit 7 of Byte 1 is the sign and (Byte 1, Bit 6) to (Byte 0, Bit 0) is the absolute value of the log data.

Note 2: The input data is declared valid by INS algorithm only if all Bits 4 to 7 equal 0.

Note 3: Each byte is sent LSBit first. For data coded on several bytes, the bytes are sent MSByte first.

Message <F0><F1><F2>				
Field 0	Byte 0	Status byte	Bit 7: Operational (0:Yes, 1: No) Bit 6: Damage (0:No, 1: Yes) Bit 5: Simulation mode (0:No, 1: Yes) Bit 4: Test (0:No, 1: Yes) Bit 3: Reserved Bit 2: Reserved Bit 1: Reserved Bit 0: Reserved	(USED) (USED) (USED) (USED) (NOT USED) (NOT USED) (NOT USED) (NOT USED)
Field 1	Byte 1	Loch speed MSB	Bit 7: Sign (0:Positive, 1: Negative) Bit 6: MSB = 30 knots ……. Bit 0	(USED)
Field 2	Byte 2	Loch speed LSB	Bit 7 ……. Bit 0	(USED)

EXT SENSOR BIN

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Input custom protocol.

Data received: DVL speeds, Fix position, Depth.

Data frame: The frame contains 11 fields – 32 bytes – MSB are sent first.

Message <F0><F1>…< F10>			
Field 0	Byte 0	Synchronization byte	'$'
Field 1	Bytes 1 to 4	DVL Longitudinal ground speed (XV1 speed)	IEEE floating point format, m/s (positive towards the bow)
Field 2	Bytes 5 to 8	DVL Transverse ground speed (XV2 speed)	IEEE floating point format, m/s (positive towards starboard) **Warning:** Opposite sign of INS usual convention
Field 3	Bytes 9 to12	DVL Vertical ground speed (XV3 speed)	IEEE floating point format, m/s (positive towards up side)
Field 4	Byte 13	DVL Status*	1 when valid, 0 when not valid
Field 5	Byte 14	Fix position Status*	1 when valid, 0 when not valid
Field 6	Bytes 15 to18	Latitude	Signed 32 bits +/-2^{31} = +/-Pi
Field 7	Bytes 19 to 22	Longitude	Signed 32 bits +/-2^{31} = +/-Pi
Field 8	Bytes 23 to 26	Fix position Age	IEEE floating point format, seconds
Field 9	Bytes 27 to 30	Depth	IEEE floating point format, meters (minimum = 3m)**
Field 10	Byte 31	Checksum	Addition of all the bytes from 0 to 30

*INS will take account input DVL speeds and Fix Position if DVL and Fix position status are valid.

IXBLUE STD BIN V2, V3

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

For the description of this protocol, refer to IXBLUE STD BIN V2, V3 section in the Digital Output protocols chapter.

IXSEA AUV

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Input iXBlue protocol, dedicated to the interface with GAPS.

Conventions

Telegram format

The telegram is a combination of sensor blocks. Each block contains header, telegram identification and checksum. Any combination of sensor blocks can be sent at input of INS. Multiple sensor blocks of a kind can be sent (i.e: multiple USBL or LBL beacon positions). The checksum is the sum of signed bytes of the telegram (telegram length – 2 checksum bytes). All identification values (telegram identification, system type, rejection mode…) are expressed in decimal value otherwise specified.

Time

INS time can be synchronized with GPS UTC time when UTC time block is sent to INS at regular intervals (i.e: every second). To improve accuracy it is recommended to input a 1 PPS pulse at pulse input of INS. If INS is not time synchronized INS will use the data latency information in sensor data blocks to evaluate age of data. Time in sensor data blocks is reset to 0 every 24 hour.

Data types

Each telegram description uses following convention:

Type name	Description
Byte	Unsigned 8 bit integer
Character	Signed 8 bit integer
Word	Unsigned 16 bit integer
Short	Signed 16 bit integer
DWord	Unsigned 32 bit integer
Long	Signed 32 bit integer
Float	IEEE Float 32 bits
Double	IEEE Float 64 bits

All 16 and 32 bits integers are represented in Big endian convention (MSB sent first)

Frames

Different frames are used to express FOG and accelerometer data:

- INS frame (X1, X2, X3)
- Vessel (or user) frame (XV1, XV2, XV3). INS frame (X1, X2, X3) will coincide with vessel frame after rough and fine misalignment are stored in INS MMI.
- Sensor (i.e: DLV, EM LOG) reference frame (XS1, XS2, XS3). This frame will coincide with vessel frame after misalignments are stored in INS MMI (i.e: after INS+DVL calibration).

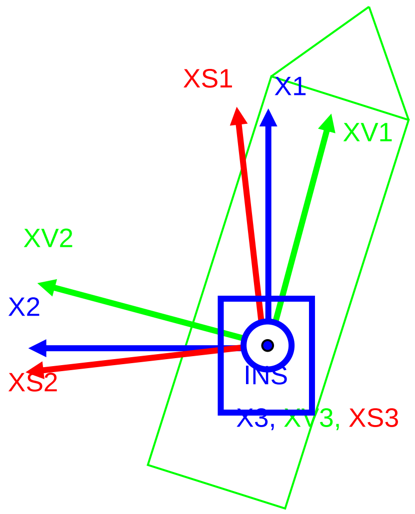


Figure 6 : Vessel, System and Sensor reference frame

Altitude convention

Altitude is referenced to Geoïdal model (mean sea level) if managed by the GPS. In this case, geoïdal separation field is a valid IEEE float that contains distance between geoid and ellipsoid at current position. Otherwise if GPS does not manage mean sea level altitude, the altitude field if referenced from ellipsoid and geoidal separation field contains NaN value 0x7FC00000.

DVL speed compensation in INS using sound speed

The speed of sound sent in the telegram is the value that was used internally by the DVL to compute velocity. INS will use both the speed of sound internally used by the DVL (calculated using temperature, depth, salinity or fixed set value) expressed as C_{DVL} and the speed of sound measured by an external sensor (CTD, SVP) expressed as C_{EXT}.

The corrected DVL speed will be calculated using the following formula:

$$V_{corrected} = \frac{C_{EXT}}{C_{DVL}} \cdot V_{DVL}$$

If water track or bottom track data is sent from another sensor (i.e: EM LOG, Speed correlation sensor) that does not use sound velocity, this field should be sent as NaN value 0x7FC00000. In this case no compensation is made on speed.

Protocol description

GPS input telegram (Id=1,2,3; version 0x01):

Data	Format	Units
Header	Byte	Value : '$'
Telegram size	Byte	48 Bytes
Telegram identification	Byte	1 for GPS1 2 for GPS2 3 for Manual GPS
Data bloc version	Byte	0x01
Data validity time	Dword	GPS time tag in steps of 100us
GPS quality	Byte	Refer to Table 1
Latitude	Long	+/- 2^{31}= +/-Pi radian
Longitude	Long	+/- 2^{31}= +/-Pi radian
Altitude	Float	meters
Latitude standard deviation	Float	Meters
Longitude standard deviation	Float	Meters
Altitude standard deviation	Float	meters
Validity flag	Byte	1= Valid; 0= Invalid
Latitude/Longitude covariance	Float	meters^2
Real time latency of data	Float	seconds (see § Time)
Geoidal separation	Float	meters (See §0)
Checksum	Word	unsigned sum of all fields except checksum

Quality indicator	Standard Deviation	Positioning system mode indicator
0	Data invalid	N/A
1	10 m	Natural
2	3 m	Differential
3	10 m	Military
4	0.3 m	RTK
5	10 m	Float RTK
6 - 255	10m	Other mode

Table 17: INS interpretation of GPS quality

UTC time (Id= 4; version 0x01)

Data	Format	Units
Header	Byte	Valeur : '$'
Telegram size	Byte	14 Bytes
Telegram identification	Byte	4
Data bloc version	Byte	0x01
UTC Time	Dword	UTC time in steps of 100us
Day	Byte	Day (1-31), 0 if unavailable
Month	Byte	Month (1-12), 0 if unavailable
Year	Word	Year (>2008), 0 if unavailable
Checksum	Word	Unsigned sum of all fields except checksum

USBL telegram (Id=5; version 0x01)

Data	Format	Units
Header	Byte	Value : '$'
Telegram size	Byte	49 Bytes
Telegram identification	Byte	5
Data bloc version	Byte	0x01
Data validity time	Dword	USBL time tag in steps of 100us
Beacon ID	6 Byte	6 ASCII characters (1)
Latitude	Long	+/- 2^{31}= +/-Pi Radian
Longitude	Long	+/- 2^{31}= +/-Pi Radian
Real time latency of data	Float	Seconds (see § Time)
Altitude	Float	Meters
Latitude standard deviation	Float	Meters
Longitude standard deviation	Float	Meters
Latitude/Longitude covariance	Float	$Meters^2$
Altitude standard deviation	Float	Meters
Validity flag	Byte	1=Valid; 0=Invalid
Checksum	Word	Unsigned sum of all fields except checksum

(1) If beacon ID length is less than 6 bytes, it must be padded with null (\0) ASCII characters at the end.

Depth telegram (Id= 6; version 0x01)

Data	Format	Units
Header	Byte	Value : '$'
Telegram size	Byte	23 Bytes
Telegram identification	Byte	6
Data bloc version	Byte	0x01
Data validity time	Dword	Depth time tag in steps of 100us
Depth	Float	Meters
Depth standard deviation	Float	Meters
Validity flag	Byte	1=Valid; 0=Invalid
Real time latency of data	Float	Seconds (see § Time)
Checksum	Word	Unsigned sum of all fields except checksum

LBL telegram (Id= 7; version 0x01)

Data	Format	Units
Header	Byte	Value : '$'
Telegram size	Byte	41 Bytes
Telegram identification	Byte	7
Data bloc version	Byte	0x01
Data validity time	Dword	LBL Time tag by steps of 100us
Beacon ID	6 Byte	6 ASCII characters (1)
Beacon latitude	Long	+/- 2^{31}= +/-Pi Radian
Beacon longitude	Long	+/- 2^{31}= +/-Pi Radian
Beacon altitude	Float	meters
Range	Float	meters
Real time latency of data	Float	seconds (see § Time)
Range standard deviation	Float	meters
Validity flag	Byte	1=Valid; 0=Invalid
Checksum	Word	unsigned sum of all fields except checksum

(1) If beacon ID length is less than 6 bytes, it must be padded with null (\0) ASCII characters at the end.

Ground speed (Id= 8; version 0x01)

Data	Format	Units
Header	Byte	Value : '$'
Telegram size	Byte	51 Bytes
Telegram identification	Byte	8
Data bloc version	Byte	0x01
Data validity time	Dword	Ground speed time tag in steps of 100us
XS1 speed	Float	meters/second (see § Frames)
XS2 speed	Float	meters/second
XS3 speed	Float	meters/second
DVL speed of sound or Nan	Float	meters/second (see § DVL speed compensation)
External sensor speed of sound	Float	meters/second (see § DVL speed compensation)
DVL altitude (bottom range)	Float	Meter
XS1 speed standard deviation	Float	meters/second
XS2 speed standard deviation	Float	meters/second
XS3 speed standard deviation	Float	meters/second
Validity flag	Byte	1=Valid; 0=Invalid
Real time latency of data	Float	Seconds (see § Time)
Checksum	Word	Unsigned sum of all fields except checksum

Water speed (Id= 9; version 0x01)

Data	Format	Units
Header	Byte	Valeur : '$'
Telegram size	Byte	51 Bytes
Telegram identification	Byte	9
Data bloc version	Byte	0x01
Data validity time	Dword	Water speed time tag by steps of 100us
XS1 speed	Float	meters/second (see § Frames)
XS2 speed	Float	meters/second
XS3 speed	Float	meters/second
DVL speed of sound or Nan	Float	meters/second (see § DVL speed compensation)
External sensor speed of sound	Float	meters/second (see § DVL speed compensation)

Data	Format	Units
DVL altitude (bottom range)	Float	meter
XS1 standard deviation	Float	meters/second
XS2 standard deviation	Float	meters/second
XS3 standard deviation	Float	meters/second
Validity flag	Byte	1=Valid; 0=Invalid
Real time latency of data	Float	seconds (see § Time)
Checksum	Word	unsigned sum of all fields except checksum

IXSEA USBL INS 1

This protocol is not available for all products.
Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Input iXBlue protocol, dedicated to the interface with GAPS

Data received: Latitude, Longitude, Immersion, time stamp, STD on position

Data frame: 21 bytes expected. Dedicated to receive USBL data from GAPS USBL system

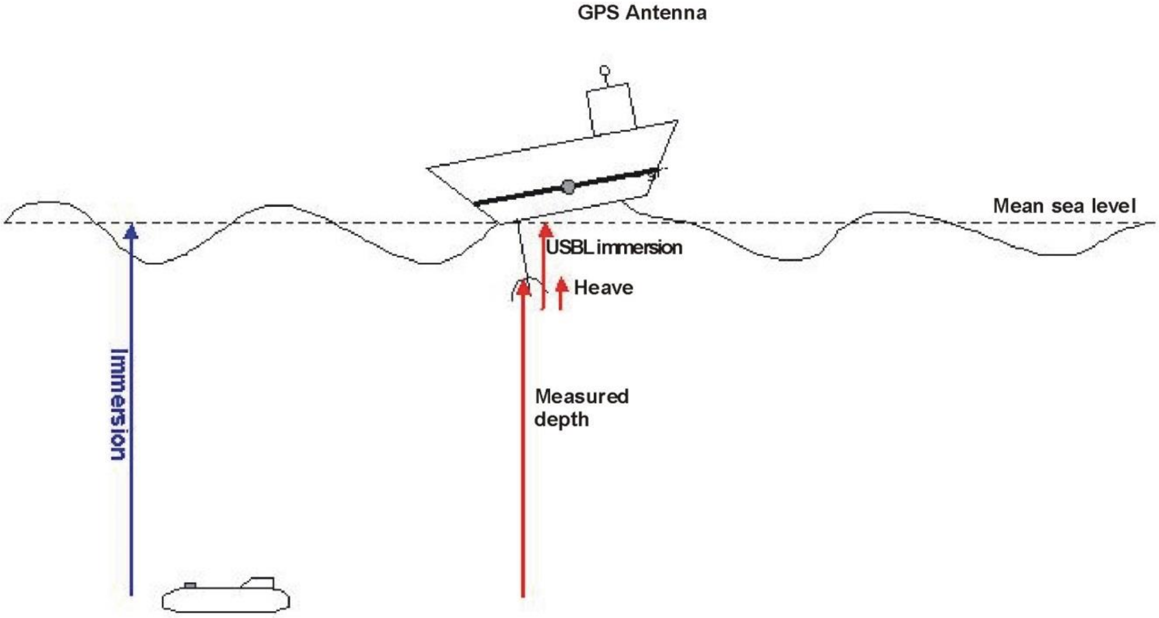
<table>
<tr><th rowspan="2">Byte Nb</th><th rowspan="2">Field</th><th rowspan="2">Nb of bits</th><th rowspan="2">definition</th><th colspan="3">Value</th></tr>
<tr><th>LSB</th><th>Min Value</th><th>Max Value</th></tr>
<tr><td>1</td><td>GG_{hex}</td><td>8</td><td>header</td><td colspan="3">55_{hex}</td></tr>
<tr><td rowspan="2">2</td><td>Bits 2 to 0</td><td>3</td><td>Message number</td><td colspan="3">001_{bin}</td></tr>
<tr><td>Bits 7 to 3</td><td>5</td><td>Transponder ID</td><td>NA</td><td>0</td><td>31</td></tr>
<tr><td>3, 4, 5, 6</td><td>$LLLLLLLL_{hex}$</td><td>32</td><td>Latitude (deg)
(Two-complement coded)</td><td>$180/2^{32}$</td><td>- 90 °</td><td>$90x(1-2^{32})$ °</td></tr>
<tr><td>7, 8, 9, 10</td><td>$NNNNNNNN_{hex}$</td><td>32</td><td>Longitude (deg)</td><td>$360/2^{32}$</td><td>0 °</td><td>$360.(1-2^{32})$ °</td></tr>
<tr><td>11 to12 and bit 0 to 3 of byte 13</td><td>$ZZZZZ_{hex}$</td><td>20</td><td>Z (m), immersion</td><td>0,01 m</td><td>0 m
(00000_{hex})</td><td>+10485,75 m
($FFFFF_{hex}$)</td></tr>
<tr><td rowspan="2">13</td><td>Bit 4</td><td>1</td><td colspan="4">Reserved</td></tr>
<tr><td>Bits 7 to 5</td><td>3</td><td colspan="4">Major axe XY: long axe (in m) of the error ellipse representing the standard deviation on the position in the XY plane
000 : 0 m < position STD < 0,5 m
001 : 0,5 m < position STD < 1,5 m
010 : 1,5 m < position STD < 3 m
011 : 3 m < position STD < 6 m
100 : 6 m < position STD < 12 m
101 : 12 m < position STD < 25 m
110 : 25 m < position STD < 50 m
111 : standard deviation > 50 m
000 to 110 : STD1 is set to max value (i.e : 50 m for 110)
111 : STD1 is set to 500 m</td></tr>
</table>

Byte Nb	Field	Nb of bits	definition	Value LSB	Min Value	Max Value
14	Bit 0	1	Reserved			
	Bits 3 to 1	3	Minor axe XY: small axe (in m) of the error ellipse representing the standard deviation of the position in the XY plane 000 : 0 m < standard deviation < 0,5 m 001 : 0,5 m < standard deviation < 1,5 m 010 : 1,5 m < standard deviation < 3 m 011 : 3 m < standard deviation < 6 m 100 : 6 m < standard deviation < 12 m 101 : 12 m < standard deviation < 25 m 110 : 25 m < standard deviation < 50 m 111 : standard deviation > 50 m 000 to 110 : STD1 is set to max value (i.e : 50 m for 110) 111 : STD1 is set to 500 m			
	Bits 7 to 4	4	Angle between the North and the major axe of the XY error ellipse l	$180/2^4$	0 °	15/16 x180 °
15	Bit 0	1	Reserved			
	Bits 3 to 1	3	Standard deviation of the Z(m) position 000 : 0 m < standard deviation < 0,5 m 001 : 0,5 m < standard deviation < 1,5 m 010 : 1,5 m < standard deviation < 3 m 011 : 3 m < standard deviation < 6 m 100 : 6 m < standard deviation < 12 m 101 : 12 m < standard deviation < 25 m 110 : 25 m < standard deviation < 50 m 111 : standard deviation > 50 m 000 to 110 : STD1 is set to max value (i.e : 50 m for 110) 111 : STD1 is set to 500 m			
	Bits 7 to 4	4	Reserved			
16	PP_{hex}	8	Reserved			
17, 18	$rrrrrrrrrrrrrrrrrrrrrr_{bin}$	22		1 ms	0 ms	

Byte Nb	Field	Nb of bits	definition	Value		
				LSB	Min Value	Max Value
19	(8+8+6 bits of: - byte 17, - byte 18, - bits 5 to 0 of byte 19)		UTC time stamp of position in ms.			(3 599 999 ms, i.e. 1h - 1ms The largest values of this field do not have any meaning
	Bits 7 and 6 of byte19	2	Reserved			
20	KK_{hex}	8	Status byte Bits 0 to 8 - Reserved			
21	SS_{hex}	8	Checksum exclusive OR by byte for the whole 20 first bytes thus header included.			

Immersion definition

The immersion corresponds to the mobile depth with respect to the mean sea level (heave corrected). This data is coherent with the one that would be given by a depth sensor on the underwater mobile. But it does not allow to deduce the absolute height as there is no compensation for tide.



ROV immersion calculated by GAPS = transponder depth (by the GAPS USBL acoustic array) +

+ USBL antenna immersion

- USBL antenna heave

POSIDONIA

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: POSIDONIA

Data received: Transponder number, Vessel Latitude, Vessel Longitude, Vessel Altitude, Latitude standard deviation, Longitude standard deviation, Altitude standard deviation, Delay

Data frame: The frame contains 10 fields – 32 bytes – MSB are received first

Message <F0><F1>…			
Field 0	Byte 0	First synchronization byte	Fixed value = 0x24
Field 1	Byte 1	Transponder number	Is a number in the range [0, 255] The firs received transponder number is NOT USED as a second synchronization byte.
Field 2	Bytes 2 to 5	USBL Latitude	Signed 32 bits $+/-2^{31}$ = +/-Pi
Field 3	Bytes 6 to 9	USBL longitude	Signed 32 bits $+/-2^{31}$ = +/-Pi
Field 4	Bytes 10 to 13	USBL Depth	IEEE floating point format, meters
Field 5	Bytes 14 to 17	USBL Latitude std. deviation	IEEE floating point format, meters
Field 6	Bytes 18 to 21	USBL Longitude std. deviation	IEEE floating point format, meters
Field 7	Bytes 22 to 25	USBL Depth std. deviation	IEEE floating point format, meters
Field 8	Bytes 26 to 29	USBL Position delay	IEEE floating point format, seconds
Field 9	Bytes 30 to 31	Checksum	2 characters Addition of all the bytes from 1 to 29.

RAMSES POSTPRO

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: RAMSES POSTPRO

Data received: LBL, Pressure, Speed of sound, LBL postprocessing

Data frame:

Conventions

Telegram format

The telegram is a combination of sensor blocks. Each block contains header, telegram identification and checksum. Any combination of sensor blocks can be sent at input of INS. Multiple sensor blocks of a kind can be sent (i.e: multiple USBL or LBL beacon positions). The checksum is the sum of signed bytes of the telegram (telegram length – 2 checksum bytes).All identification values (telegram identification, system type, rejection mode…) are expressed in decimal value otherwise specified.

Time

INS time can be synchronized with GPS UTC time when UTC time block is sent to INS at regular intervals (i.e: every second). To improve accuracy it is recommended to input a 1 PPS pulse at pulse input of INS. If INS is not time synchronized INS will use the data latency information in sensor data blocks to evaluate age of data. Time in sensor data blocks is reset to 0 every 24 hour.

Data types

Each telegram description uses following convention:

Type name	Description
byte	Unsigned 8 bit integer
character	Signed 8 bit integer
word / ushort	Unsigned 16 bit integer
short	Signed 16 bit integer
dword / ulong	Unsigned 32 bit integer
long	Signed 32 bit integer
float	IEEE Float 32 bits
double	IEEE Float 64 bits

All 16 and 32 bits integers are represented in Big endian convention (MSB sent first). NaN is defined by the following value 0x7FC00000.

Data blocs used by INS

Beacon slam position

Message <F0><F1>…….<F15>				
Field 0	Byte 0	byte	Synchronisation	0x24
Field 1	Byte 1	byte	Telegram size	44
Field 2	Byte 2	byte	Telegram identification	52
Field 3	Byte 3	byte	Data bloc version	0x01
Field 4	Bytes 4 to 7	dword	Data validity time	Time since 01/01/1970 in seconds
Field 5	Bytes 8 to 11	dword	Data validity time	μs
Field 6	Byte 12	byte	Beacon ID **Note 1**	0 to N (0 for Ramses)
Field 7	Bytes 13 to 16	long	Latitude	+/- 2^{31}= +/-180°
Field 8	Bytes 17 to 20	long	Longitude	+/- 2^{31}= +/-180°
Field 9	Bytes 21 to 24	float	Immersion	m
Field 10	Byte 25	byte	Position validity **Note 2**	0 : invalid 1 : in calibration process 2: valid for SLAM but not for INS aiding 3 : valid for SLAM and INS aiding
Field 11	Bytes 26 to 29	float	Latitude std dev.	m
Field 12	Bytes 30 to 33	float	Longitude std dev.	m
Field 13	Bytes 34 to 37	float	Altitude std dev.	m
Field 14	Bytes 38 to 41	float	North/East covariance	m - NOT USED
Field 15	Bytes 42 to 43	word	CRC	unsigned sum of all fields except checksum

Note 1 : Only RAMSES position is used by INS.

Note 2 : INS should only use position when position validity is 3

Beacon slant range

Message <F0><F1>…….<F15>				
Field 0	Byte 0	byte	Synchronisation	0x24
Field 1	Byte 1	byte	Telegram size	42
Field 2	Byte 2	byte	Telegram identification	53
Field 3	Byte 3	byte	Data bloc version	0x01
Field 4	Bytes 4 to 7	dword	Data validity time	Time since 01/01/1970 in seconds
Field 5	Bytes 8 to 11	dword	Data validity time	µs
Field 6	Byte 12	byte	Beacon ID	1 to N
Field 7	Bytes 13 to 14	word	Acoustique code	NOT USED
Field 8	Bytes 15 to 18	long	Latitude	+/- 2^{31}= +/-180°
Field 9	Bytes 19 to 22	long	Longitude	+/- 2^{31}= +/-180°
Field 10	Bytes 23 to 26	float	Immersion	m
Field 11	Bytes 27 to 30	float	Slant range	m
Field 12	Bytes 31 to 34	float	Range std dev	m
Field 13	Bytes 35 to 38	float	Measure age	s
Field 14	Byte 39	byte	Measurement validity according to Ramses algorithms **Note 3**	0 : invalid Slam and invalid rough filter 1 : invalid Slam 2 : invalid rough filter 3 : valid distance but invalid for INS 4 : valid distance and valid for INS
Field 15	Bytes 40 to 41	word	CRC	unsigned sum of all fields except checksum

Note 3 : INS should only use beacon ranges when position validity is 4

Sound velocity and pressure

Message <F0><F1>.......<F11>				
Field 0	Byte 0	byte	Synchronisation	0x24
Field 1	Byte 1	byte	Telegram size	31
Field 2	Byte 2	byte	Telegram identification	55
Field 3	Byte 3	byte	Data bloc version	0x01
Field 4	Bytes 4 to 7	dword	Data validity time	Time since 01/01/1970 in seconds
Field 5	Bytes 8 to 11	dword	Data validity time	µs
Field 6	Byte 12	byte	Device number	(0-5) - NOT USED
Field 7	Bytes 13 to 16	float	Conductivity	mS/cm - NOT USED
Field 8	Bytes 17 to 20	float	Pressure **Note 5**	dBar (NaN if data not available)
Field 9	Bytes 21 to 24	float	Salinity	PSU - NOT USED
Field 10	Bytes 25 to 28	float	Sound velocity **Note 5**	Range]1300 m/s, 1700 m/s[(NaN if data not available)
Field 11	Bytes 29 to 30	word	CRC	unsigned sum of all fields except checksum

Note 5 : If a parameter is not available the field is defined by default to NaN (i.e : only depth sensor connected to RAMSES).
When valid, the pressure is used to compute the depth, and the INS can take it into account if configured to use it.
For pressure to depth conversion refer to section 1.1.5.

Data blocs broadcasted for post-processing

The blocs which ID decimal value are in the range [50,79] are all broadcasted into the post-processing output protocol.
Only the ones which ID are 52, 53 and 55, are taken into account by the INS.

RDI PD0

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Binary.

Data received: Bottom Track velocities (Transverse velocity, Longitudinal velocity, Vertical velocity), Water Track velocities (Transverse velocity, Longitudinal velocity, Vertical velocity), Range to Bottom (given for each of 4 beams), Speed of Sound, Depth (calculated with Pressure).

Data frame:

PD0 Standard Output Data Buffer Format

Always Output	**HEADER** (6 bytes +[2bytes * Nb of DATA TYPES])
	FIXED LEADER DATA (53 or 59 bytes)
	VARIABLE LEADER DATA (65 bytes)
WD-command WP-command	**VELOCITY** (2 bytes + 8 bytes per Depth cell)
	CORRELATION MAGNITUDE (2 bytes + 4 bytes per Depth cell)
	ECHO INTENSITY (2 bytes + 4 bytes per Depth cell)
	PERCENT GOOD (2 bytes + 4 bytes per Depth cell)
BP-command	**BOTTOM TRACK DATA** (85 bytes)
Always Output	**RESERVED** (2 bytes)
	CHEKSUM (2 bytes)

Header

Message <F0><F1>….<F10><F11>			
Field 0	Byte 0	Header ID	Fixed value = 0x7F
Field 1	Byte 1	Data Source ID	Fixed value = 0x7F
Field 2	Bytes 2 to 3	No. of Bytes in ensemble excluding 2 bytes checksum (N)	(NOT USED)
Field 3	Byte 4	Spare	(NOT USED)
Field 4	Byte 5	Number of Data Type	8 bits unsigned
Field 4+1	Bytes 6 to 7	Offset For Data Type #1	16 bits unsigned Offset of each Data Type in Global Frame
Field 4+2	Bytes 8 to 9	Offset For Data Type #2	
…	…	…	
Field 4+N	Bytes 4+2*N to 5+2*N	Offset For Data Type #N	

Data Type corresponds to Fixed Leader, Variable Leader, Velocity, Correlation Magnitude, Echo Intensity, Percent Good and Bottom Track Data.

Fixed Leader Data

Message <F0><F1>….<F10><F11>			
Field 0	Bytes 0 to 1	Fixed Leader ID	Fixed value = 0x00 0x00
Field 1	Bytes 2 to 24	(NOT USED)	(NOT USED)
Field 2	Byte 25	Coordinate Transform	xxx00xxx = Beam coordinates xxx01xxx = Instrument Coordinate xxx10xxx = Ship coordinate (*)
Field 2	Bytes 26 to 52/58	(NOT USED)	(NOT USED)

(*) DVL must be set in beam, instrument or ship coordinates when used with PHINS.

Variable Leader Data

Message <F0><F1>….<F10><F11>			
Field 0	Bytes 0 to 1	Variable Leader ID	Fixed value = 0x80 0x00
Field 1	Bytes 2 to 13	**Note 1**	(NOT USED)
Field 2	Bytes 14 to 15	Sound of Speed	LSB = 1m/s, range 1400 to 1600 m/s
Field 3	Bytes 16 to 17	Depth of Transducer	(NOT USED)
Field 4	Bytes 18 to 47	**Note 1**	(NOT USED)
Field 5	Bytes 48 to 51	Pressure: Water pressure relative to one atmosphere. See section 1.1.5	LSB = 1 deca-pascal, range 0 to 4294967295 deca-pascal
Field 6	Bytes 52 to 55	Pressure variance	LSB = 1 deca-pascal, range 0 to 4294967295 deca-pascal
Field 7	Bytes 56 to 64	**Note 1**	(NOT USED)

Note 1: Data may be added to an existing data type only by adding the bytes to the end of the data format. As an example, the variable leader data contains information on ensemble number, time, heading, pitch, roll, temperature, pressure, etc.
The format for the bytes 0-52 are now specified by changes added in support to the Navigator DVL. If additional sensor data is to be added to the variable leader data then it must be added to the end of the data string (bytes 53-x as an example).

Velocity Data Format

Message <F0><F1>….<F10><F11>			
Field 0	Bytes 0 to 1	Velocity ID	Fixed value = 0x00 0x01
Field 1	Bytes 2 to 1+8*DepthCellNb	See section 1.1.5	(NOT USED)

Correlation Magnitude, Echo Intensity and Percent Good Data

Message <F0><F1>….<F10><F11>			
Field 0	Bytes 0 to 1	Correlation Magnitude ID OR Echo Intensity ID OR Percent-Good ID	Fixed value = 0x00 0x02 OR 0x00 0x03 OR 0x00 0x04
Field 1	Bytes 2 to 1+4*DepthCellNb	See section 1.1.5	(NOT USED)

Bottom Track Data

Message <F0><F1>….<F10><F11>			
Field 0	Bytes 0 to 1	Bottom Track ID	Fixed value = 0x00 0x06
Field 1	Bytes 2 to 15	See section 1.1.5	(NOT USED)
Field 2	Bytes 16 to 17	BEAM#1 Range To Bottom.	Unsigned integer LSB = 1cm, range 0 to 65535cm (0 when bottom detection is bad) (**)
Field 3	Bytes 18 to 19	BEAM#2 Range To Bottom.	
Field 4	Bytes 20 to 21	BEAM#3 Range To Bottom.	
Field 5	Bytes 22 to 23	BEAM#4 Range To Bottom.	
Field 6	Bytes 24 to 25	BEAM#1 Bottom Track Velocity	Instrument or ship coordinates: X,Y and Z-axis BT velocities Beam coordinates: Beams 1 to 4 BT velocities (***) Signed integer: LSB = 1mm/s, Range -32766 to 32767 mm/s 0x8000 when not received
Field 7	Bytes 26 to 27	BEAM#2 Bottom Track Velocity	
Field 8	Bytes 28 to 29	BEAM#3 Bottom Track Velocity	
Field 9	Bytes 30 to 31	BEAM#4 Bottom Track Velocity	
Field 10	Bytes 32 to 49	(****)	(NOT USED)
Field 11	Bytes 50 to 51	BEAM#1 Water Track Velocity	Instrument or ship coordinates: X,Y and Z-axis WT velocities Beam coordinates: Beams 1 to 4 WT velocities (***) Signed integer: LSB = 1mm/s, Range -32766 to 32767 mm/s 0x8000 when not received
Field 12	Bytes 52 to 53	BEAM#2 Water Track Velocity	
Field 13	Bytes 54 to 55	BEAM#3 Water Track Velocity	
Field 14	Bytes 56 to 57	BEAM#4 Water Track Velocity	
Field 15	Bytes 58 to 84	See section 1.1.5	(NOT USED)

(**) Range to bottom used is an average of the 4 ranges to bottom given for each beams, excluding zero fields meaning bad detection.

(***) The meaning of the velocity depends on the EX (coordinate system) command setting. The four velocities are as follows:

a) Instrument Coordinates: 1->2, 4->3, toward face, error

b) Ship Coordinates: Starboard, Fwd, Upward, Error

c) Beam Coordinates: Beam1, Beam2, Beam3, Beam4

The PD0 speed sign are opposite to PD6 protocol so sign is inversed before sending data to INS algorithm. So sign convention of speed described by above figure applies.

(****) Depth is calculated by using the formula described in section 1.1.5. For this protocol, we expect that a Tare has been applied to the pressure sensor. Hence, we do not compensate atmospheric pressure Pa (10.1325 dBar) before pressure to depth conversion.

Checksum

Message <F0><F1>….<F10><F11>			
Field 0	Bytes 0 to 1	Checksum Data	Sum of all frame bytes excluding checksum (modulo 65535)

RDI PD3 and RDI PD3 RT

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: DVL Input Data.

Data received: Bottom Track velocities (Transverse , longitudinal and vertical velocity), Water Track velocities (Transverse , longitudinal and vertical velocity), Range to Bottom.

Data frame: The frame contains at most 22 fields – 57 bytes LSB First.

<table>
<tr><th colspan="4">Message <F0><F1><F2>… <F21></th></tr>
<tr><td>Field 0</td><td>Byte 0</td><td>DVL Data ID</td><td>Fixed value = 0x7E</td></tr>
<tr><td>Field 1</td><td>Byte 1</td><td>Data to Follow status
<table><tr><td>Bit #0</td><td>System Coordinates</td></tr><tr><td>Bit #1</td><td>Vertical velocities</td></tr><tr><td>Bit #2</td><td>Water Reference velocities</td></tr><tr><td>Bit #3</td><td>Range To Bottom (4 beams)</td></tr><tr><td>Bit #4</td><td>Range To Bottom (average)</td></tr><tr><td>Bit #5</td><td>Not used</td></tr><tr><td>Bit #6</td><td>Not used</td></tr><tr><td>Bit #7</td><td>Sensor/Other Data</td></tr></table></td><td>If Bit #0 of “Data to Follow” status is set to 1, then Earth coordinates are used.
If Bit #0 of “Data to Follow” status is set to 0, then Ship coordinates are used.

<u>The INS will reject the message if Earth coordinates are used i.e Bit#0 set to 1. The DVL must be set to send data in the Ship coordinates</u>.

For the RDI_PD3 input, the DVL Roll and Pitch compensations must be disabled (EX100xx DVL command)
For the RDI_PD3_RT input, the DVL Roll and Pitch compensations must be enabled (EX101xx DVL command)</td></tr>
<tr><td>Field 2</td><td>Bytes 2-3</td><td>X Bottom Track transverse velocity Erreur ! ource du renvoi introuvable.Note 1</td><td>This field is always received
16 bits signed integer
LSB = 1mm/s. + for ship motion to Starboard.
USED</td></tr>
<tr><td>Field 3</td><td>Bytes 4-5</td><td>Y Bottom Track longitudinal velocity
Note 1</td><td>This field is always received
16 bits signed integer
LSB = 1mm/s. + for ship motion to Forward.
USED</td></tr>
<tr><td>Field 4</td><td>Bytes 6-7</td><td>Z Bottom Track vertical velocity</td><td>This field is received if Bit #1 of “Data to Follow” status is set. If this field is not received, the INS will</td></tr>
</table>

Message <F0><F1><F2>… <F21>			
		Note 1	take into account the value of 0 m/s on the vertical velocity. 16 bits signed integer LSB = 1 mm/s. **USED**
Field 5	Bytes 8-9	X Water Track transverse velocity **Note 1**	This field is received if Bit #2 of “Data to Follow” status is set. 16 bits signed integer LSB = 1 mm/s. **USED**
Field 6	Bytes 10-11	Y Water Track longitudinal velocity **Note 1**	This field is received if Bit #2 of “Data to Follow” status is set. 16 bits signed integer LSB = 1 mm/s. **USED**
Field 7	Bytes 12-13	Z WaterTrack vertical velocity **Note 1**	This field is received if Bit #1 and Bit#2 of “Data to Follow” status are set If this field is not received, the INS will take into account the value of 0 m/s on the vertical velocity. 16 bits signed integer LSB = 1 mm/s. **USED**

Note 1. Positive values indicate vessel motion to (X) Starboard/East, (Y) Forward/North, (Z) Upward.

If the value is –32768 (0x8000), the value is not valid :

i.e : When X,Y or Z Bottom Track velocity value = 0x8000, the INS will ignore X,Y and Z Bottom Track input velocities.

When X,Y or Z Water Track velocity value = 0x8000, the INS will ignore X,Y and Z Water Track input velocities.

Message <F0><F1><F2>… <F21>			
Field 8	Bytes 14-15	Beam 1 Range to Bottom	These fields are received if Bit #3 of “Data to Follow” status is set.
Field 9	Bytes 16-17	Beam 2 Range to Bottom	
Field 10	Bytes 18-19	Beam 3 Range to Bottom	

Message <F0><F1><F2>… <F21>			
Field 11	Bytes 20-21	Beam 4 Range to Bottom	16 bits unsigned integer LSB = 1 cm; Range = 0 to 65535 cm When a bottom detection is bad, the field is set 0. **USED** only if Average Range to Bottom (next field) is not received
Field 12	Bytes 22-23	Average Range to Bottom	This field is received if Bit #4 of “Data to Follow” status is set. It contains the average vertical range to bottom as determined by each beam. 16 bits unsigned integer LSB = 1 cm; Range = 0 to 65535 cm When a bottom detection is bad, the field is set 0. **USED**
Field 13	Bytes 24-39	16 bytes spare	**NOT USED**
Field 14	Byte 40	Sensor/Other Data status Bit #0 – Time Bit #1 – Heading Bit #2 – Pitch Bit #3 – Roll Bit #4 – Temperature Bit #5 – Active Built-In-Test Bit #6 – Not used Bit #7 – Not used	This field is received if Bit #7 of “Data to Follow” status is set **NOT USED**
Field 15	Byte 41	Hours	PING Time. These fields are received if Bit #0 of “Sensor/Other Data” status is set. **NOT USED**
	Byte 42	Minutes	
	Byte 43	Seconds	
	Byte 44	Hundredth of seconds	
Field 16	Bytes 45-46	Heading	These fields are received if Bit #1 of “Sensor/Other Data” status is set. **NOT USED**
Field 17	Bytes 47-48	Pitch	These fields are received if Bit #2 of “Sensor/Other Data” status is set. **NOT USED**
Field 18	Bytes 49-50	Roll	These fields are received if Bit #3 of “Sensor/Other Data” status is set. **NOT USED**
Field 19	Bytes 51-52	Temperature	These fields are received if Bit #4 of “Sensor/Other Data” status is set. **NOT USED**

Message <F0><F1><F2>… <F21>			
Field 20	Bytes 53-54	Built-In-Test result	These fields are received if Bit #5 of "Sensor/Other Data" status is set. **NOT USED**
Field 21	Bytes 55-56	Checksum	Sum of all the bytes excluding checksum (modulo 65535)

RDI PD4

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

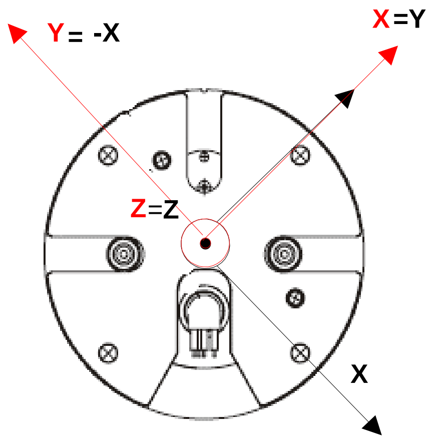
Data received: Bottom Track velocities (Transverse velocity, Longitudinal velocity, Vertical velocity), Water Track velocities (Transverse velocity, Longitudinal velocity, Vertical velocity), Range to Bottom (given for each of 4 beams), Speed of Sound.

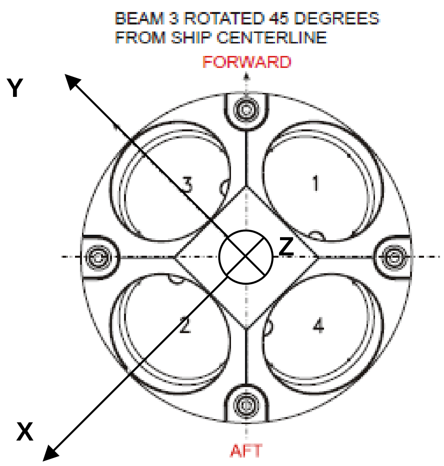
Data frame: The frame contains 12 fields – 47 bytes - LSB received first.

Message <F0><F1>….<F10><F11>			
Field 0	Byte 0	Input identification	Fixed value = 0x7D
Field 1	Byte 1	PD4 input frame	Fixed value = 0x00
Field 2	Bytes 2 to 3	No. of Bytes	(NOT USED)
Field 3	Byte 4	System configuration (should be set in instrument coordinate velocities).	01xxxxxx (instrument coordinate velocities) INS is expecting bit 7 = 1 and bit 8=0; Else input frame is rejected.
Field 4	Bytes 5 to 6	X Bottom track transverse velocity (*)	16 bits signed integer; LSB = 1mm/s
Field 5	Bytes 7 to 8	Y Bottom track longitudinal velocity (*)	16 bits signed integer; LSB = 1mm/s
Field 6	Bytes 9 to 10	Z Bottom track vertical velocity (*)	16 bits signed integer; LSB = 1mm/s
Field 7	Bytes 11 to 12	Not used	(NOT USED)
Field 8	Bytes 13 to 14	Beam1 range to bottom (**)	For each measure: 16 bits unsigned integer Range 0 to 65535 cm (LSB=1cm) (bad detection: field set to 0)
Field 9	Bytes 15 to 16	Beam2 range to bottom (**)	
Field 10	Bytes 17 to 18	Beam3 range to bottom (**)	
Field 11	Bytes 19 to 20	Beam4 range to bottom (**)	
Field 12	Byte 21	Not used	(NOT USED)
Field 13	Bytes 22 to 23	X Water track transverse velocity (*)	16 bits signed integer; LSB = 1mm/s
Field 14	Bytes 24 to 25	Y Water track longitudinal velocity (*)	16 bits signed integer; LSB = 1mm/s
Field 15	Bytes 26 to 27	Z Water track vertical velocity (*)	16 bits signed integer; LSB = 1mm/s
Field 16	Bytes 28 to 40	Not used	(NOT USED)

Message <F0><F1>….<F10><F11>			
Field 17	Bytes 41 to 42	Speed of Sound	Manual or calculated speed of sound 16 bits unsigned integer, LSB = 1m/s Range form 1300 to 1700m/s
Field 18	Bytes 43 to 46	Not used	(NOT USED)

(*) If one of those velocity value is –32768 (0x8000), the input frame is not valid and rejected by INS. DVL reference frame in instrument coordinate is described below :





DVL reference frame in instruments coordinate before INS coordinate transformation (X=Y; Y=-X, Z=Z):

±XXXXX = X-axis velocity data in mm/s (+ = Bm1 Bm2 xdcr movement relative to bottom)

±YYYYY = Y-axis velocity data in mm/s (+ = Bm4 Bm3 xdcr movement relative to bottom)

±ZZZZZ = Z-axis velocity data in mm/s (+ = transducer movement away from bottom)

(**) Range to bottom used is an average of the 4 ranges to bottom given for each beams, excluding zero fields meaning bad detection.

SBF SIGIL

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard

Data received: The SBF flow is generated by Septentrio GPS and contains both data used for real-time application and for post-processing. In real time, the firmware will use:

PVTGeodetic frame

PVTCovGeodetic frame

EndOfPVT frame

ReceiverTime frame

Data frame: All other frames will be ignored by the firmware.

All fields are used by the INS unless otherwise specified.

PVTGeodetic block <F0><F1><F2>…..<F27>			
Field 0	Byte	'$' (0x24)	Synchronization byte 1
Field 1	Byte	'@' (0x40)	Synchronization byte 2
Field 2	Word	CRC	CRC of all the subsequent bytes in the frame **(Note 1)**
Field 3	Word	Frame ID	Frame identifier (set to 4007 for PVTGeodetic block)
Field 4	Word	Length	Frame length in bytes including the header Should be set to 88 for PVTGeodetic block
Field 5	Dword	Time of Week	Time in the week in millisecond Ignored if set to 4294967295
Field 6	Word	Week number	Continouus week number Ignored if set to 65535
Field 7	Byte	Mode	Mode status flag **(Note 1)**
Field 8	Byte	Error	Error status flag **(NOT USED)**
Field 9	Double	Latitude	Latitude in radian based on specified Datum Ignored if set to -2E10.
Field 10	Double	Longitude	Longitude in radian based on specified Datum Ignored if set to -2E10.
Filed 11	Double	Altitude	Ellipsoidal altitude in meters based on specified Datum. Ignored if set to -2E10.

PVTGeodetic block <F0><F1><F2>…..<F27>			
Field 12	Float	Ondulation	Ellispoid/Geoid ondulation in meters Ignored if set to -2E10.
Field 11	Float	North speed	North speed in m/s **(NOT USED)**
Field 12	Float	East speed	East speed in m/s **(NOT USED)**
Field 13	Float	Vertical speed	Vertical speed in m/s (positive up) **(NOT USED)**
Filed 14	Float	COG	Course over ground **(NOT USED)**
Field 15	Double	RxClkBias	Receiver clock bias relative to system time reported in TimeSystem field in ms **(NOT USED)**
Field 16	Float	RxClkDrift	Receiver clock drift relative to the system time in ppm **(NOT USED)**
Field 17	Byte	TimeSystem	Time reference **(NOT USED)**: 0: GPS Time 1: Galileo Time
Field 18	Byte	Datum	Datum for coordinates: **0: WGS-84 (Must be in this mode for the INS)** 1: Galileo 2: PZ-90.02 250: UserDatum1 251: UserDatum2
Field 19	Byte	NrSV	Number of satellites used for the PVT solution **(NOT USED)**
Field 20	Byte	WACorrInfo	Specifies which wide area corrections were applied **(NOT USED)**
Field 21	Word	ReferenceID	Specifies which reference station ID was used **(NOT USED)**
Field 22	Word	MeanCorrAge	Mean age of differential corrections by steps of 0.01s **(NOT USED)**
Field 23	Dword	SignalInfo	Type of GPS signal used to generate the PVT **(NOT USED)**
Field 24	Byte	AlertFlag	Integrity related information **(NOT USED)**

PVTGeodetic block <F0><F1><F2>…..<F27>			
Field 25	Byte	NrBases	Number of base stations used to generate the PVT **(NOT USED)**
Field 26	Word	Reserved	**(NOT USED)**

PVTCovGeodetic block <F0><F1><F2>…..<F19>			
Field 0	Byte	'$' (0x24)	Synchronization byte 1
Field 1	Byte	'@' (0x40)	Synchronization byte 2
Field 2	Word	CRC	CRC of all the subsequent bytes in the frame (see Note 1)
Field 3	Word	Frame ID	Frame identifier Set to 5906 for PVTCovGeodetic block
Field 4	Word	Length	Frame length in bytes including the header Should be 56 for PVTCovGeodetic frame
Field 5	Dword	Time of Week	Time in the week in millisecond Ignored if set to 4294967295
Field 6	Word	Week number	Continouus week number Ignored if set to 65535
Field 7	Byte	Mode	Mode status flag (see Note 2)
Field 8	Byte	Error	Error status flag **(NOT USED)**
Field 9	Float	Latitude variance	Latitude variance in m^2 Ignored if set to -2E10.
Field 10	Float	Longitude variance	Longitude variance in m^2 Ignored if set to -2E10.
Filed 11	Float	Altitude variance	Altitude variance in m^2. Ignored if set to -2E10.
Field 12	Float	Clock variance	Clock bias variance **(NOT USED)** Ignored if set to -2E10.
Field 13	Float	Covariance lat/long	Covariance between latitude and longitude in m^2 Ignored if set to -2E10
Field 14	Float	Covariance lat/height	Covariance between latitude and height in m^2 Ignored if set to -2E10 **(NOT USED)**

PVTCovGeodetic block <F0><F1><F2>…..<F19>			
Field 15	Float	Covariance lat/clock	Covariance between latitude and clock bias in m^2 **(NOT USED)**
Field 16	Float	Covariance longitude/height	Covariance between longitude and height in m^2 **(NOT USED)**
Field 17	Float	Covariance longitude/clock	Covariance between longitude and height in m^2 **(NOT USED)**
Field 18	Float	Covariance height/clock	Covariance between latitude and height in m^2 **(NOT USED)**

ReceiverTime <F0><F1><F2>…..<F16>			
Field 0	Byte	'$' (0x24)	Synchronization byte 1
Field 1	Byte	'@' (0x40)	Synchronization byte 2
Field 2	Word	CRC	CRC of all the subsequent bytes in the frame (see Note 1)
Field 3	Word	Frame ID	Frame identifier Set to 5914 for ReceiverTime block
Field 4	Word	Length	Frame length in bytes including the header Should be 24 for ReceiverTime frame
Field 5	Dword	Time of Week	Time in the week in millisecond Ignored if set to 4294967295
Field 6	Word	Week number	Continouus week number Ignored if set to 65535
Field 7	Char	UTC Year	Current year in UTC time scale, from 0 to 99 -128 if not available
Field 8	Char	UTC Month	Current month in UTC time scale, from 1 to 12 -128 if not available
Field 9	Char	UTC Day	Current day in UTC time scale, from 1 to 31 -128 if not available
Field 10	Char	UTC Hour	Current hour in UTC time scale, from 0 to 23 -128 if not available
Field 11	Char	UTC Minute	Current day in UTC time scale, from 0 to 59 -128 if not available

ReceiverTime <F0><F1><F2>…..<F16>			
Field 12	Char	UTC Second	Current day in UTC time scale, from 0 to 59 -128 if not available
Field 13	Char	DeltaLS	Integer second difference between UTC time and GPS time. Positive if GPS time is ahead of UTC. -128 if not available. **(NOT USED)**
Field 14	Byte	Sync Level	Bit field indicating the synchronization level of the receiver time. If all bits are set, the synchronization is complete: Bit 0: WNSET: set if the week number is synchronized Bit 1: TOWSET: set if the Time of Week is synchronized Bit 2: FINETIME: set if the Time of Week is within limit specified by setClockThreshold command. **The INS will ignore synchronizations where all bits are not set.**
Field 15	Word	Reserved	**(NOT USED)**

EndOfPVT <F0><F1><F2>…..<F7>			
Field 0	Byte	'$' (0x24)	Synchronization byte 1
Field 1	Byte	'@' (0x40)	Synchronization byte 2
Field 2	Word	CRC	CRC of all the subsequent bytes in the frame (see Note 1)
Field 3	Word	Frame ID	Frame identifier Set to 5921 for EndOfPVT frame
Field 4	Word	Length	Frame length in bytes including the header Should be 16 for EndOfPVT block
Field 5	Dword	Time of Week	Time in the week in millisecond Ignored if set to 4294967295 **(NOT USED)**
Field 6	Word	Week number	Continouus week number Ignored if set to 65535 **(NOT USED)**

EndOfPVT <F0><F1><F2>…..<F7>			
Field 7	Word	Padding	**(NOT USED)**

Note 1: 16-bit CRC of all the bytes from Field 2 to Field X, using CRC-CCITT polynom x16+x12+x5+x0 in forward direction using a seed of 0, without final reverse and without XOR.

Note 2: The Mode flag is composed as follows:

- Bits 0-3: type of PVT solution:
  0: No PVT solution available (not sent to the algorithm)
  1: Stand-alone PVT (sent as GPS mode 1 - Natural)
  2: Differenctial PVT solution (sent as GPS mode 2 - Differential)
  3: Fixed location (sent as GPS mode 1 - Natural)
  4: RTK with fixed ambiguities (sent as GPS mode 4 – Fixed RTK)
  5: RTK with float ambiguities (sent as GPS mode 5 - Float RTK)
  6: SBAS Aided PVT (sent as GPS mode 2 - Differential)
  7: Moving RTK with fixed ambiguities (sent as GPS mode 4 – Fixed RTK)
  8: Moving RTK with float ambiguities (sent as GPS mode 5 - Float RTK)
  9: Precise point positioning (PPP) with fixed ambiguities (sent as GPS mode 4 – Fixed RTK)
  10: PPP with float ambiguities (sent as GPS mode 5 - Float RTK)
- Bits 4-5: reserved (set to 0)
- Bit 6: Set if the user has entered the command SetPVTMode,base,auto and the receiver is still determining its fixed position. Not used by the INS.
- Bit 7: 2D/3D flag (set in 2D mode, height constant assumed). Not used by the INS.

SOC AUTOSUB

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: Input SOC custom protocol.

Data received: DVL speeds, Fix position, Depth.

Data frame: The frame contains 10 fields – 28 bytes. MSB is received first.

Message <F0><F1>…< F9>			
Field 0	Byte 0	Synchronization byte	'$'
Field 1	Bytes 1 to 4	DVL (XV1) Longitudinal ground speed	IEEE floating point format, m/s (positive towards the bow)
Field 2	Bytes 5 to 8	DVL (XV2) Transverse ground speed	IEEE floating point format, m/s (positive towards starboard) **Warning:** Opposite sign of INS usual convention
Field 3	Byte 9	DVL Status*	1 when valid, 0 when not valid
Field 4	Byte 10	Fix position Status*	1 when valid, 0 when not valid
Field 5	Bytes 11 to14	Latitude	Signed 32 bits +/-2^{31} = +/-Pi
Field 6	Bytes 15 to 18	Longitude	Signed 32 bits +/-2^{31} = +/-Pi
Field 7	Bytes 19 to 22	Fix position Age	IEEE floating point format, seconds
Field 8	Bytes 23 to 26	Depth	IEEE floating point format, meters (minimum = 3m)**
Field 9	Byte 27	Checksum	Addition of all the bytes from 0 to 26

*INS will take account input DVL speeds and Fix Position if DVL and Fix position status are valid.

USBL BOX POSTPRO

This protocol is not available for all products.

Refer to the tables of the section 3.5.1 to know if this protocol is available for your product.

Standard: USBL BOX POSTPRO.

Data received: USBL, USBL postprocessing.

Data frame: Binary Frame, MSB received first.

Conventions

Telegram format

The telegram is a combination of sensor blocks. Each block contains header, telegram identification and checksum. Any combination of sensor blocks can be sent at input of INS. Multiple sensor blocks of a kind can be sent (i.e: multiple USBL or LBL beacon positions).

The checksum is the sum of signed bytes of the telegram (telegram length – 2 checksum bytes).

All identification values (telegram identification, system type, rejection mode…) are expressed in decimal value otherwise specified.

Time

INS time can be synchronized with GPS UTC time when UTC time block is sent to INS at regular intervals (i.e: every second). To improve accuracy it is recommended to input a 1 PPS pulse at pulse input of INS. If INS is not time synchronized INS will use the data latency information in sensor data blocks to evaluate age of data. Time in sensor data blocks is reset to 0 every 24 hour.

Data types

Each telegram description uses following convention:

Type name	Description
byte	Unsigned 8 bit integer
character	Signed 8 bit integer
word / ushort	Unsigned 16 bit integer
short	Signed 16 bit integer
dword / ulong	Unsigned 32 bit integer
long	Signed 32 bit integer
float	IEEE Float 32 bits
double	IEEE Float 64 bits

All 16 and 32 bits integers are represented in Big endian convention (MSB sent first). NaN is defined by the following value 0x7FC00000.

Data blocs used by INS

Beacon position telegram

Message <F0><F1>…				
Field 0	Byte 0	byte	Synchronisation	0x24
Field 1	Byte 1	byte	Telegram size	56
Field 2	Byte 2	byte	Telegram identification	0x87
Field 3	Byte 3	byte	Data bloc version	0x01
Field 4	Bytes 4 to 5	short	Beacon Identifier	Is a number in the range : [0, 65535]
Field 5	Bytes 6 to 9	dword	Position Age	µs
Field 6	Bytes 10 to 14	dword	Data validity time	Time since 01/01/1970 in seconds
Field 7	Bytes 14 to 17	dword	Data validity time	µs
Field 8	Bytes 18 to 21	long	Latitude	+/- 2^{31}= +/-180°
Field 9	Bytes 22 to 25	long	Longitude	+/- 2^{31}= +/-180°
Field 10	Bytes 26 to 29	float	Depth	meters
Field 11	Bytes 30 to 33	float	Covariance North/North	meters^2 (Latitude SD)^2
Field 12	Bytes 31 to 37	float	Covariance North/East	meters^2 (Latitude Longitude SD)^2
Field 13	Bytes 38 to 41	float	Covariance North/Depth	meters^2 (NOT USED)
Field 14	Bytes 42 to 45	float	Covariance East/East	meters^2 (Longitude SD)^2
Field 15	Bytes 46 to 49	float	Covariance East/Depth	meters^2 (NOT USED)
Field 16	Bytes 50 to 53	float	Covariance Depth/Depth	meters^2 (Altitude SD)^2
Field 17	Bytes 54 to 55	word	CRC	unsigned sum of all fields except checksum

Data blocs broadcasted for post-processing

The blocs which ID hexadecimal value are in the range [0x80, 0x8F] are all broad-casted into the post-processing output protocol.

Only the one which ID is 0x87 and specified above, is taken into account by the INS.

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3.6 Digital Output protocols

3.6.1 QUICK GUIDE TO OUTPUT PROTOCOLS

Please use the tables below to quickly select the output protocol that best suits your application.

PROTOCOLS	ASCII																																																		
	AIPOV	EVENT MARKER	DIST TRAVELLED	GEO3D	GPS LIKE	GPS LIKE SHORT	GPS LIKE SHORT ZZZ	GRAVI DOV CORR	GYROCOMPASS	GYROCOMPASS 2	HALLIBURTON SAS	HEHDT	HEHDT FIXED	HEHDT HEROT	HETHS HEROT	HYDROGRAPHY	IMU ASCII *	INDYN	INHDT	INSITU	IXSEA TAH	KVH EXTENDED	LANDINS STANDARD	MDL TRIM CUBE	NAV BHO	NAV BHO LONG	NAVIGATION	OCTANS STANDARD	PFEC	PHINS STANDARD	POSIDONIA 6000	PRDID	PRDID TSS	PRECISE ZDA	PTNL GGK	RDI PD11	RDI PING	RDI SYNC	RIEGL	SENIN	STOLT OFFSHORE	STOLT OFFSHORE 2	SUBMERGENCE A	SUBMERGENCE B	TECHSAS	TECHSAS TSS	TOKIMEC_PTVF	TSS335B	TSS1 DMS	VTG GGA	VTG GGU
PRODUCTS	Check if the protocol is available for your product																																																		
PHINS III surface HYDRINS PHINS 6000 ROVINS PHINS COMPACT C7	✓				✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PHINS COMPACT C3 ROVINS NANO	✓				✓				✓	✓	✓			✓	✓	✓					✓	✓			✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓					✓	✓	✓	✓	✓	✓	✓		
IMU version (additionnal protocols)																	✓																																		
MARINS BKA					✓			✓				✓		✓	✓		✓		✓								✓			✓					✓					✓			✓	✓						✓	✓
MARINS BKB					✓							✓		✓	✓				✓								✓			✓					✓					✓			✓	✓						✓	✓
LANDINS		✓	✓	✓	✓	✓	✓		✓		✓	✓	✓					✓					✓				✓	✓		✓		✓	✓						✓											✓	
AIRINS	✓	✓			✓		✓		✓		✓	✓	✓					✓			✓						✓	✓		✓		✓	✓	✓																✓	
QUADRANS									✓	✓		✓	✓	✓	✓	✓		✓		✓	✓	✓						✓	✓	✓		✓	✓	✓							✓	✓						✓	✓		
ATLANS	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓					✓			✓		✓				✓	✓		✓		✓	✓	✓					✓											✓	
PARAMETERS																																																			
UNFILTERED IMU DATA																	x																																		
HEADING	x							x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x			x			x	x	x	x	x		x	x	x				
POLAR HEADING																			x																																
ROLL	x							x	x	x	x					x		x		x	x	x	x	x	x		x	x	x	x	x	x	x			x			x	x	x	x	x		x	x	x	x	x		
PITCH	x							x	x	x	x					x		x		x	x	x	x	x	x		x	x	x	x	x	x	x			x			x	x	x	x	x		x	x	x	x	x		
HEADING SD								x			x												x		x	x				x														x	x	x					
ROLL SD								x			x												x		x	x				x														x	x	x					
PITCH SD								x			x												x		x	x				x														x	x	x					
HEADING RATE														x	x			x		x	x	x																			x	x		x			x				
ROLL RATE																		x		x																					x	x		x			x				
PITCH RATE																		x		x																					x	x		x			x				
POLAR HEADING RATE																																																			
ROTATION RATES XV1 (compensated from Earth rotation)	x										x																																								
ROTATION RATES XV2 (compensated from Earth rotation)	x										x																																								
ROTATION RATES XV3 (compensated from Earth rotation)	x										x																																								
ROTATION RATES XV1 (not compensated from Earth rotation)																	x																																		
ROTATION RATES XV2 (not compensated from Earth rotation)																	x																																		
ROTATION RATES XV3 (not compensated from Earth rotation)																	x																																		
HEAVE REAL TIME										x	x					x					x				x	x		x		x															x	x		x	x		
HEAVE REAL TIME without lever arm																					x							x		x																					
SURGE																					x							x		x																					
SWAY																					x							x		x																					

ASCII

PROTOCOLS	AIPOV	EVENT MARKER	DIST TRAVELLED	GEO3D	GPS LIKE	GPS LIKE SHORT	GPS LIKE SHORT ZZZ	GRAVI DOV CORR	GYROCOMPASS	GYROCOMPASS 2	HALLIBURTON SAS	HEHDT	HEHDT FIXED	HEHDT HEROT	HETHS HEROT	HYDROGRAPHY	IMU ASCII *
PRODUCTS	Check if the protocol is available for your product																
PHINS III surface HYDRINS PHINS 6000 ROVINS PHINS COMPACT C7	✓				✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	
PHINS COMPACT C3 ROVINS NANO	✓				✓				✓	✓	✓			✓	✓	✓	
IMU version (additionnal protocols)																	✓
MARINS BKA					✓			✓				✓		✓	✓		✓
MARINS BKB					✓							✓		✓	✓		
LANDINS		✓	✓	✓	✓	✓	✓		✓		✓	✓	✓				
AIRINS	✓	✓			✓		✓		✓		✓	✓	✓				
QUADRANS									✓	✓		✓	✓	✓	✓	✓	
ATLANS	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓				
PARAMETERS																	
SWAY without lever arm																	
HEAVE SPEED																	
SURGE SPEED																	
SWAY SPEED																	
ACCELERATION XV1 (compensated from G)	x																
ACCELERATION XV2 (compensated from G)	x																
ACCELERATION XV3 (compensated from G)	x																
ACCELERATION XV1 (not compensated from G & coriolis)																	x
ACCELERATION XV2 (not compensated from G & coriolis)																	x
ACCELERATION XV3 (not compensated from G & coriolis)																	x
DATE OF DATA				x	x												x
TIME STAMP OF DATA	x			x	x	x	x			x	x						
PULSE RECEPTION TIME		x															
LATITUDE	x			x	x	x	x	x			x					x	
POLAR LATITUDE																	
LONGITUDE	x			x	x	x	x	x			x					x	
POLAR LONGITUDE																	
ALTITUDE or DEPTH	x			x	x	x	x	x			x					x	
LATITUDE SD				x	x	x	x	x			x						
LONGITUDE SD				x	x	x	x	x			x						
LAT/ LONG COVARIANCE								x									
ALTITUDE or DEPTH SD				x	x	x	x	x			x						
SPEED XV1	x										x						
SPEED XV2	x										x						
SPEED XV3	x										x						
NORTH or SOUTH SPEED	x																
EAST or WEST SPEED	x																
VERTICAL SPEED	x																
NORTH SPEED SD											x						

PROTOCOLS	INDYN	INHDT	INSITU	IXSEA TAH	KVH EXTENDED	LANDINS STANDARD	MDL TRIM CUBE	NAV BHO	NAV BHO LONG	NAVIGATION	OCTANS STANDARD	PFEC	PHINS STANDARD	POSIDONIA 6000	PRDID	PRDID TSS	PRECISE ZDA
PRODUCTS																	
PHINS III surface HYDRINS PHINS 6000 ROVINS PHINS COMPACT C7	✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
PHINS COMPACT C3 ROVINS NANO				✓	✓			✓	✓	✓	✓		✓	✓	✓	✓	✓
IMU version (additionnal protocols)																	
MARINS BKA		✓								✓			✓				
MARINS BKB		✓								✓			✓				
LANDINS	✓					✓				✓	✓		✓		✓	✓	
AIRINS	✓			✓						✓	✓		✓		✓	✓	✓
QUADRANS	✓		✓	✓	✓						✓	✓	✓		✓	✓	✓
ATLANS	✓			✓		✓				✓	✓		✓		✓	✓	✓
PARAMETERS																	
SWAY without lever arm																	
HEAVE SPEED				x							x						
SURGE SPEED				x							x						
SWAY SPEED				x							x						
ACCELERATION XV1 (compensated from G)																	
ACCELERATION XV2 (compensated from G)																	
ACCELERATION XV3 (compensated from G)																	
ACCELERATION XV1 (not compensated from G & coriolis)																	
ACCELERATION XV2 (not compensated from G & coriolis)																	
ACCELERATION XV3 (not compensated from G & coriolis)																	
DATE OF DATA								x	x			x					
TIME STAMP OF DATA				x		x		x	x			x	x				
PULSE RECEPTION TIME																	
LATITUDE	x					x		x	x	x	x	x	x	x			
POLAR LATITUDE																	
LONGITUDE	x					x		x	x	x		x	x	x			
POLAR LONGITUDE																	
ALTITUDE or DEPTH	x					x		x	x	x		x	x				
LATITUDE SD						x			x			x	x				
LONGITUDE SD						x			x			x	x				
LAT/ LONG COVARIANCE																	
ALTITUDE or DEPTH SD						x			x			x	x				
SPEED XV1	x																
SPEED XV2																	
SPEED XV3																	
NORTH or SOUTH SPEED						x							x				
EAST or WEST SPEED						x							x				
VERTICAL SPEED						x							x				
NORTH SPEED SD						x							x				

PROTOCOLS	PTNL GGK	RDI PD11	RDI PING	RDI SYNC	RIEGL	SENIN	STOLT OFFSHORE	STOLT OFFSHORE 2	SUBMERGENCE A	SUBMERGENCE B	TECHSAS	TECHSAS TSS	TOKIMEC_PTVF	TSS335B	TSS1 DMS	VTG GGA	VTG GGU
PRODUCTS																	
PHINS III surface HYDRINS PHINS 6000 ROVINS PHINS COMPACT C7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PHINS COMPACT C3 ROVINS NANO		✓	✓	✓					✓	✓	✓	✓	✓	✓	✓		
IMU version (additionnal protocols)																	
MARINS BKA	✓					✓			✓	✓						✓	✓
MARINS BKB	✓					✓			✓	✓						✓	✓
LANDINS					✓											✓	
AIRINS																✓	
QUADRANS							✓	✓						✓	✓		
ATLANS					✓											✓	
PARAMETERS																	
SWAY without lever arm																	
HEAVE SPEED																	
SURGE SPEED																	
SWAY SPEED																	
ACCELERATION XV1 (compensated from G)										x				x	x		
ACCELERATION XV2 (compensated from G)										x				x	x		
ACCELERATION XV3 (compensated from G)										x				x	x		
ACCELERATION XV1 (not compensated from G & coriolis)																	
ACCELERATION XV2 (not compensated from G & coriolis)																	
ACCELERATION XV3 (not compensated from G & coriolis)																	
DATE OF DATA																	
TIME STAMP OF DATA	x				x	x			x	x	x	x				x	x
PULSE RECEPTION TIME																	
LATITUDE	x				x	x			x							x	x
POLAR LATITUDE																	
LONGITUDE	x				x	x			x							x	x
POLAR LONGITUDE																	
ALTITUDE or DEPTH	x	x			x	x			x				x			x	
LATITUDE SD	x					x				x							
LONGITUDE SD	x					x				x							
LAT/ LONG COVARIANCE																	
ALTITUDE or DEPTH SD						x				x							
SPEED XV1									x								
SPEED XV2									x								
SPEED XV3																	
NORTH or SOUTH SPEED									x								
EAST or WEST SPEED									x								
VERTICAL SPEED									x								
NORTH SPEED SD										x							

PROTOCOLS	ASCII																																																		
	AIPOV	EVENT MARKER	DIST TRAVELLED	GEO3D	GPS LIKE	GPS LIKE SHORT	GPS LIKE SHORT ZZZ	GRAVI DOV CORR	GYROCOMPASS	GYROCOMPASS 2	HALLIBURTON SAS	HEHDT	HEHDT FIXED	HEHDT HEROT	HETHS HEROT	HYDROGRAPHY	IMU ASCII *	INDYN	INHDT	INSITU	IXSEA TAH	KVH EXTENDED	LANDINS STANDARD	MDL TRIM CUBE	NAV BHO	NAV BHO LONG	NAVIGATION	OCTANS STANDARD	PFEC	PHINS STANDARD	POSIDONIA 6000	PRDID	PRDID TSS	PRECISE ZDA	PTNL GGK	RDI PD11	RDI PING	RDI SYNC	RIEGL	SENIN	STOLT OFFSHORE	STOLT OFFSHORE 2	SUBMERGENCE A	SUBMERGENCE B	TECHSAS	TECHSAS TSS	TOKIMEC_PTVF	TSS335B	TSS1 DMS	VTG GGA	VTG GGU
PRODUCTS	Check if the protocol is available for your product																																																		
PHINS III surface HYDRINS PHINS 6000 ROVINS PHINS COMPACT C7	✓				✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PHINS COMPACT C3 ROVINS NANO	✓				✓				✓	✓	✓			✓	✓	✓					✓	✓			✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓					✓	✓	✓	✓	✓	✓	✓		
IMU version (additionnal protocols)																	✓																																		
MARINS BKA					✓			✓				✓		✓	✓		✓		✓								✓			✓					✓					✓			✓	✓						✓	✓
MARINS BKB					✓							✓		✓	✓				✓								✓			✓					✓					✓			✓	✓						✓	✓
LANDINS		✓	✓	✓	✓	✓	✓		✓		✓	✓	✓					✓					✓				✓	✓		✓		✓	✓						✓											✓	
AIRINS	✓	✓			✓		✓		✓		✓	✓	✓					✓			✓						✓	✓		✓		✓	✓	✓																✓	
QUADRANS									✓	✓		✓	✓	✓	✓	✓		✓		✓	✓	✓						✓	✓	✓		✓	✓	✓							✓	✓						✓	✓		
ATLANS	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓					✓			✓		✓				✓	✓		✓		✓	✓	✓					✓											✓	
PARAMETERS																																																			
EAST SPEED SD											x												x							x														x							
VERTICAL SPEED SD											x												x							x														x							
INTEGRAL SPEED NORTH																																																			
INTEGRAL SPEED EAST																																																			
HORIZONTAL SPEED NORM				x	x						x														x	x			x		x					x				x										x	x
TRUE COURSE	x			x	x						x														x	x			x							x				x										x	x
TRAVELLED DISTANCE			x																				x																												
INS SYSTEM STATUS									x	x													x				x			x																					
INS ALGO STATUS																							x							x													x								
INS USER STATUS	x																											x		x																					
INS SENSOR STATUS																	x													x																					
OTHER STATUS											x			x	x					x	x		x		x	x				x															x	x	x	x	x		
CHECKSUM	x		x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x		x		x	x	x	x	x	x	x	x	x		x	x				x			x	x	x	x	x			x	x
LOG SPEED																														x																					
LOG HEADING MISALIGNMENT											x																			x																					
LOG PITCH MISALIGNMENT																														x																					
LOG SCALE FACTOR ERROR (%)											x																			x																					
SOUND VELOCITY											x																			x																					
DVL ALTITUDE											x																			x						x							x								
PRESSURE or DEPTH																														x																					
GPS LATITUDE																							x					x		x																					
GPS LONGITUDE																							x							x																					
GPS ALTITUDE																							x							x																					
USBL LATITUDE																														x																					
USBL LONGITUDE																														x																					
USBL ALTITUDE																														x																					
LBL LATITUDE																														x																					
LBL LONGITUDE																														x																					
LBL ALTITUDE																														x																					

PROTOCOLS	AIPOV	EVENT MARKER	DIST TRAVELLED	GEO3D	GPS LIKE	GPS LIKE SHORT	GPS LIKE SHORT ZZZ	GRAVI DOV CORR	GYROCOMPASS	GYROCOMPASS 2	HALLIBURTON SAS	HEHDT	HEHDT FIXED	HEHDT HEROT	HETHS HEROT	HYDROGRAPHY	IMU ASCII *	INDYN	INHDT	INSITU	IXSEA TAH	KVH EXTENDED	LANDINS STANDARD	MDL TRIM CUBE	NAV BHO	NAV BHO LONG	NAVIGATION	OCTANS STANDARD	PFEC	PHINS STANDARD	POSIDONIA 6000	PRDID	PRDID TSS	PRECISE ZDA	PTNL GGK	RDI PD11	RDI PING	RDI SYNC	RIEGL	SENIN	STOLT OFFSHORE	STOLT OFFSHORE 2	SUBMERGENCE A	SUBMERGENCE B	TECHSAS	TECHSAS TSS	TOKIMEC_PTVF	TSS335B	TSS1 DMS	VTG GGA	VTG GGU
	ASCII																																																		
PRODUCTS	Check if the protocol is available for your product																																																		
PHINS III surface HYDRINS PHINS 6000 ROVINS PHINS COMPACT C7	✓				✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PHINS COMPACT C3 ROVINS NANO	✓				✓				✓	✓	✓			✓	✓	✓					✓	✓			✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓					✓	✓	✓	✓	✓	✓	✓		
IMU version (additionnal protocols)																	✓																																		
MARINS BKA					✓			✓				✓		✓	✓		✓		✓								✓			✓					✓					✓			✓	✓						✓	✓
MARINS BKB					✓							✓		✓	✓				✓								✓			✓					✓					✓			✓	✓						✓	✓
LANDINS		✓	✓	✓	✓	✓	✓		✓		✓	✓	✓					✓					✓				✓	✓		✓		✓	✓						✓											✓	
AIRINS	✓	✓			✓		✓		✓		✓	✓	✓					✓			✓						✓	✓		✓		✓	✓	✓																✓	
QUADRANS									✓	✓		✓	✓	✓	✓	✓		✓		✓	✓	✓						✓	✓	✓		✓	✓	✓							✓	✓						✓	✓		
ATLANS	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓					✓			✓		✓				✓	✓		✓		✓	✓	✓					✓											✓	
PARAMETERS																																																			
LBL RANGE																														x																					
LOCH EM SPEED																														x																					
DEAD RECKONING DATA																							x							x																					
LOCAL ZONE																							x											x																	
ODOMETER PULSE NUMBER																							x																												
UTC DAY																																		x																	
UTC TIME																							x							x				x																	
DVL COMMANDS																																					x	x													
NMEA 0183 compatible			x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x		x		x	x	x	x	x	x	x	x	x		x	x				x	x	x	x	x	x	x				x	x

Binary protocols from A to N

PROTOCOLS	BINARY																																									
	ANSCHUTZ STD20	AUVG3000	BUC	CONTROL	CONTROL NO G	DCN FAA	DCN NAV1 FAA	DCN NAV1 FLF	DCN STD NAV1	DCN STD NAV10	DOLOG HRP	DORADO	DORADO 2	EMT SDV GCS	EXT SENSOR BIN	GAPS BIN	HDMS	HEAVE POSTPRO	IMU BIN *	IMU RAW DATA *	IXBLUE STD BIN V2	IXBLUE STD BIN V3	IXSEA ICCB1	KINETIC SCIENTIFIC	LM NAV	LONG BIN NAV HR	LONG BIN NAV HR 2	LONG BIN NAV SM	LONG BINARY NAV	LRS10 78 IC	LRS10 78 IIC	LRS100 32 IC	LRS100 32 IIC	LRS100 35 IC	LRS100 35 IIC	NAV AND CTD	NAV BINARY	NAV BINARY 1	NAV BINARY HR	NAVIGATION HDLC	NAVIGATION LONG	NAVIGATION SHORT
PRODUCTS	Check if the protocol is available for your product																																									
PHINS III surface HYDRINS PHINS 6000 ROVINS PHINS COMPACT C7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PHINS COMPACT C3		✓		✓	✓							✓	✓	✓	✓	✓					✓	✓		✓	✓			✓	✓							✓	✓	✓			✓	
ROVINS NANO		✓		✓	✓							✓	✓	✓	✓	✓					✓	✓		✓	✓			✓	✓							✓	✓	✓			✓	
IMU version (additionnal protocols)																			✓	✓																						
MARINS BKA	✓					✓	✓	✓	✓	✓								✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
MARINS BKB	✓					✓	✓	✓	✓	✓								✓			✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
LANDINS				✓	✓							✓	✓								✓	✓															✓				✓	✓
AIRINS				✓	✓							✓									✓	✓															✓				✓	✓
QUADRANS	✓		✓	✓	✓					✓	✓						✓	✓			✓		✓			✓																
ATLANS				✓	✓							✓	✓								✓	✓															✓				✓	✓
PARAMETERS																																										
UNFILTERED IMU DATA																			x	x																						
HEADING	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
POLAR HEADING																									x																	
ROLL		x	x			x	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PITCH		x	x			x	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
YAW																									x																	
VERTICAL REFERENCE																									x																	
HEADING SD		x					x	x	x							x					x	x			x	x	x	x	x												x	
POLAR HEADING SD																									x																	
ROLL SD		x																			x	x			x	x	x	x	x												x	
PITCH SD		x														x					x	x			x	x	x	x	x												x	
YAW SD																									x																	
VERTICAL REFERENCE SD																									x																	
HEADING RATE	x	x	x			x			x		x										x	x		x	x	x	x	x		x	x	x	x	x	x					x		
ROLL RATE		x	x			x			x		x										x	x		x	x	x	x	x		x	x	x	x	x	x					x		
PITCH RATE		x	x			x			x		x										x	x		x	x	x	x	x		x	x	x	x	x	x					x		
YAW RATE																									x																	
HEADING RATE SD																									x																	
ROLL RATE SD																									x																	
PITCH RATE SD																									x																	
YAW RATE SD																									x																	
ROTATION RATES XV1 (compensated from Earth rotation)				x	x							x	x		x						x	x							x								x	x	x			
ROTATION RATES XV2 (compensated from Earth rotation)				x	x							x	x		x						x	x							x								x	x	x			
ROTATION RATES XV3 (compensated from Earth rotation)				x	x							x	x		x						x	x							x								x	x	x			
ROTATION RATES XV1 (not compensated from Earth rotation)																			x	x		x																				
ROTATION RATES XV2 (not compensated from Earth rotation)																			x	x		x																				
ROTATION RATES XV3 (not compensated from Earth rotation)																			x	x		x																				
ROTATION RATES XV1 SD																						x																				

	BINARY																																								
PROTOCOLS	ANSCHUTZ STD20	AUVG3000	BUC	CONTROL	CONTROL NO G	DCN FAA	DCN NAV1 FAA	DCN NAV1 FLF	DCN STD NAV1	DCN STD NAV10	DOLOG HRP	DORADO	DORADO 2	EMT SDV GCS	EXT SENSOR BIN	GAPS BIN	HDMS	HEAVE POSTPRO	IMU BIN *	IMU RAW DATA *	IXBLUE STD BIN V2	IXBLUE STD BIN V3	IXSEA ICCB1	KINETIC SCIENTIFIC	LM NAV	LONG BIN NAV HR	LONG BIN NAV HR 2	LONG BIN NAV SM	LONG BINARY NAV	LRS10 78 IC	LRS10 78 IIC	LRS100 32 IC	LRS100 32 IIC	LRS100 35 IC	LRS100 35 IIC	NAV AND CTD	NAV BINARY	NAV BINARY 1	NAV BINARY HR	NAVIGATION HDLC	NAVIGATION LONG	NAVIGATION SHORT
PRODUCTS	Check if the protocol is available for your product																																								
PHINS III surface **HYDRINS** **PHINS 6000** **ROVINS** **PHINS COMPACT C7**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PHINS COMPACT C3		✓		✓	✓							✓	✓	✓	✓	✓					✓	✓		✓	✓			✓	✓							✓	✓	✓			✓	
ROVINS NANO		✓		✓	✓							✓	✓	✓	✓	✓					✓	✓		✓	✓			✓	✓							✓	✓	✓			✓	
IMU version (additionnal protocols)																			✓	✓																						
MARINS BKA	✓					✓	✓	✓	✓	✓								✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
MARINS BKB	✓					✓	✓	✓	✓	✓								✓			✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
LANDINS				✓	✓							✓	✓								✓	✓															✓				✓	✓
AIRINS				✓	✓							✓									✓	✓															✓				✓	✓
QUADRANS	✓		✓	✓	✓					✓	✓						✓	✓			✓		✓			✓																
ATLANS				✓	✓							✓	✓								✓	✓															✓				✓	✓
PARAMETERS																																										
ROTATION RATES XV2 SD																						x																				
ROTATION RATES XV3 SD																						x																				
SMART HEAVE (100 s delayed heave)																		x			x	x																				
HEAVE REAL TIME			x						x	x						x	x	x			x	x				x	x	x	x								x	x	x	x		
HEAVE REAL TIME without lever arm																					x	x																				
SURGE																		x			x	x																				
SWAY																		x			x	x																				
HEAVE SPEED																					x	x						x														
SURGE SPEED																					x	x																				
SWAY SPEED																					x	x																				
NORTH OR SOUTH ACCELERATION																					x	x										x	x	x	x							
EAST OR WEST ACCELERATION																					x	x										x	x	x	x							
VERTICAL ACCELERATION																					x	x			x							x	x	x	x							
SURGE ACCELERATION																									x																	
SWAY ACCELERATION																									x																	
VERTICAL ACCELERATION RATE																									x																	
SURGE ACCELERATION RATE																									x																	
SWAY ACCELERATION RATE																									x																	
ACCELERATION XV1 (compensated from G & coriolis)				x																	x	x		x																		
ACCELERATION XV2 (compensated from G & coriolis)				x																	x	x		x																		
ACCELERATION XV3 (compensated from G & coriolis)				x																	x	x		x																		
ACCELERATION XV1 (compensated from G)		x			x																																					
ACCELERATION XV2 (compensated from G)		x			x																																					
ACCELERATION XV3 (compensated from G)		x			x																																					
ACCELERATION XV1 (not compensated from G & coriolis)																			x	x		x																				
ACCELERATION XV2 (not compensated from G & coriolis)																			x	x		x																				
ACCELERATION XV3 (not compensated from G & coriolis)																			x	x		x																				
VERTICAL ACCELERATION SD																									x																	
SURGE ACCELERATION SD																									x																	

PROTOCOLS	BINARY																																									
	ANSCHUTZ STD20	AUVG3000	BUC	CONTROL	CONTROL NO G	DCN FAA	DCN NAV1 FAA	DCN NAV1 FLF	DCN STD NAV1	DCN STD NAV10	DOLOG HRP	DORADO	DORADO 2	EMT SDV GCS	EXT SENSOR BIN	GAPS BIN	HDMS	HEAVE POSTPRO	IMU BIN *	IMU RAW DATA *	IXBLUE STD BIN V2	IXBLUE STD BIN V3	IXSEA ICCB1	KINETIC SCIENTIFIC	LM NAV	LONG BIN NAV HR	LONG BIN NAV HR 2	LONG BIN NAV SM	LONG BINARY NAV	LRS10 78 IC	LRS10 78 IIC	LRS100 32 IC	LRS100 32 IIC	LRS100 35 IC	LRS100 35 IIC	NAV AND CTD	NAV BINARY	NAV BINARY 1	NAV BINARY HR	NAVIGATION HDLC	NAVIGATION LONG	NAVIGATION SHORT
PRODUCTS	Check if the protocol is available for your product																																									
PHINS III surface HYDRINS PHINS 6000 ROVINS PHINS COMPACT C7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PHINS COMPACT C3		✓		✓	✓							✓	✓	✓	✓	✓					✓	✓		✓	✓			✓	✓							✓	✓	✓			✓	
ROVINS NANO		✓		✓	✓							✓	✓	✓	✓	✓					✓	✓		✓	✓			✓	✓							✓	✓	✓			✓	
IMU version (additionnal protocols)																			✓	✓																						
MARINS BKA	✓					✓	✓	✓	✓	✓								✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
MARINS BKB	✓					✓	✓	✓	✓	✓								✓			✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
LANDINS				✓	✓							✓	✓								✓	✓															✓				✓	✓
AIRINS				✓	✓							✓									✓	✓															✓				✓	✓
QUADRANS	✓		✓	✓	✓					✓	✓						✓	✓			✓		✓			✓																
ATLANS				✓	✓							✓	✓								✓	✓															✓				✓	✓
PARAMETERS																																										
SWAY ACCELERATION SD																									x																	
ACCELERATION XV1 SD																						x																				
ACCELERATION XV2 SD																						x																				
ACCELERATION XV3 SD																						x																				
VERTICAL ACCELERATION RATE SD																									x																	
SURGE ACCELERATION RATE SD																									x																	
SWAY ACCELERATION RATE SD																									x																	
DATE OF DATA																			x		x	x								x	x											
TIME STAMP OF DATA		x				x	x	x	x							x					x	x			x	x	x	x	x	x	x					x	x	x	x	x	x	x
PULSE RECEPTION TIME																																										
LATITUDE		x				x	x	x	x			x	x		x	x					x	x			x	x	x	x	x	x	x					x	x	x	x	x	x	x
POLAR LATITUDE																									x																	
LONGITUDE		x				x	x	x	x			x	x		x	x					x	x			x	x	x	x	x	x	x					x	x	x	x	x	x	x
POLAR LONGITUDE																									x																	
ALTITUDE or DEPTH		x					x	x				x	x	x	x	x					x	x			x	x	x		x	x	x					x	x	x	x	x	x	x
LATITUDE SD		x					x	x	x							x					x	x			x	x	x	x	x	x	x										x	
LONGITUDE SD		x					x	x	x							x					x	x			x	x	x	x	x	x	x										x	
LAT/ LONG COVARIANCE																					x	x																				
ALTITUDE or DEPTH SD																x					x	x			x				x												x	
EXTENDED POSITION OUTPUTS (UTM, …)																					x	x			x																	
SPEED XV1																					x	x																				
SPEED XV2																					x	x																				
SPEED XV3																					x	x																				
NORTH or SOUTH SPEED		x				x	x	x	x			x	x		x	x					x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
EAST or WEST SPEED		x				x	x	x	x			x	x		x	x					x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
VERTICAL SPEED		x					x	x	x			x	x		x	x					x	x				x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x
NORTH SPEED SD																					x	x				x	x	x	x												x	
EAST SPEED SD																					x	x				x	x	x	x												x	
VERTICAL SPEED SD																					x	x				x	x	x	x												x	

PROTOCOLS	BINARY																																								
	ANSCHUTZ STD20	AUVG3000	BUC	CONTROL	CONTROL NO G	DCN FAA	DCN NAV1 FAA	DCN NAV1 FLF	DCN STD NAV1	DCN STD NAV10	DOLOG HRP	DORADO	DORADO 2	EMT SDV GCS	EXT SENSOR BIN	GAPS BIN	HDMS	HEAVE POSTPRO	IMU BIN *	IMU RAW DATA *	IXBLUE STD BIN V2	IXBLUE STD BIN V3	IXSEA ICCB1	KINETIC SCIENTIFIC	LM NAV	LONG BIN NAV HR	LONG BIN NAV HR 2	LONG BIN NAV SM	LONG BINARY NAV	LRS10 78 IC	LRS10 78 IIC	LRS100 32 IC	LRS100 32 IIC	LRS100 35 IC	LRS100 35 IIC	NAV AND CTD	NAV BINARY	NAV BINARY 1	NAV BINARY HR	NAVIGATION HDLC	NAVIGATION LONG	NAVIGATION SHORT
PRODUCTS	**Check if the protocol is available for your product**																																								
PHINS III surface HYDRINS PHINS 6000 ROVINS PHINS COMPACT C7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PHINS COMPACT C3		✓		✓	✓							✓	✓	✓	✓	✓					✓	✓		✓	✓			✓	✓							✓	✓	✓			✓	
ROVINS NANO		✓		✓	✓							✓	✓	✓	✓	✓					✓	✓		✓	✓			✓	✓							✓	✓	✓			✓	
IMU version (additionnal protocols)																			✓	✓																						
MARINS BKA	✓					✓	✓	✓	✓	✓								✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
MARINS BKB	✓					✓	✓	✓	✓	✓								✓			✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
LANDINS				✓	✓							✓	✓								✓	✓															✓				✓	✓
AIRINS				✓	✓							✓									✓	✓															✓				✓	✓
QUADRANS	✓		✓	✓	✓					✓	✓						✓	✓			✓		✓			✓																
ATLANS				✓	✓							✓	✓								✓	✓															✓				✓	✓
PARAMETERS																																										
HORIZONTAL SPEED NORM																					x	x	x							x	x											
TRUE COURSE																					x	x			x					x	x											
TRUE COURSE SD																									x																	
NORTH CURRENT SPEED																					x	x																				
EAST CURRENT SPEED SD																					x	x																				
NORTH CURRENT SPEED SD																					x	x																				
EAST CURRENT SPEED																					x	x																				
DIRECTION OF THE CURRENT																														x	x											
SPEED OF THE CURRENT																														x	x											
GROUND SPEED																									x																	
GROUND SPEED SD																									x																	
ATTITUDE QUATERNION																						x																				
ATTITUDE QUATERNION SD																						x																				
ROTATION ACCELERATION XV1																						x																				
ROTATION ACCELERATION XV2																						x																				
ROTATION ACCELERATION XV3																						x																				
ROTATION ACCELERATION XV1 SD																						x																				
ROTATION ACCELERATION XV2 SD																						x																				
ROTATION ACCELERATION XV3 SD																						x																				
Temperature FOG																			x	x	x	x																				
Temperature ACC																			x	x	x	x																				
Temperature Sensor board																			x	x	x	x																				
INS SYSTEM STATUS																					x	x					x									x						
INS ALGO STATUS																					x	x					x									x					x	x
INS USER STATUS		x																			x	x			x	x		x	x												x	x
INS SENSOR STATUS																			x		x	x					x															
OTHER STATUS	x						x	x	x	x	x	x	x	x	x	x				x			x	x						x	x	x	x	x	x		x	x	x			
CHECKSUM	x	x									x	x	x	x	x	x			x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		x	x	x	x		
LOG SPEED						x	x	x	x												x	x								x	x											

PROTOCOLS	BINARY																																									
	ANSCHUTZ STD20	AUVG3000	BUC	CONTROL	CONTROL NO G	DCN FAA	DCN NAV1 FAA	DCN NAV1 FLF	DCN STD NAV1	DCN STD NAV10	DOLOG HRP	DORADO	DORADO 2	EMT SDV GCS	EXT SENSOR BIN	GAPS BIN	HDMS	HEAVE POSTPRO	IMU BIN *	IMU RAW DATA *	IXBLUE STD BIN V2	IXBLUE STD BIN V3	IXSEA ICCB1	KINETIC SCIENTIFIC	LM NAV	LONG BIN NAV HR	LONG BIN NAV HR 2	LONG BIN NAV SM	LONG BINARY NAV	LRS10 78 IC	LRS10 78 IIC	LRS100 32 IC	LRS100 32 IIC	LRS100 35 IC	LRS100 35 IIC	NAV AND CTD	NAV BINARY	NAV BINARY 1	NAV BINARY HR	NAVIGATION HDLC	NAVIGATION LONG	NAVIGATION SHORT
PRODUCTS	**Check if the protocol is available for your product**																																									
PHINS III surface **HYDRINS** **PHINS 6000** **ROVINS** **PHINS COMPACT C7**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PHINS COMPACT C3		✓		✓	✓							✓	✓	✓	✓	✓					✓	✓		✓	✓			✓	✓							✓	✓	✓			✓	
ROVINS NANO		✓		✓	✓							✓	✓	✓	✓	✓					✓	✓		✓	✓			✓	✓							✓	✓	✓			✓	
IMU version (additionnal protocols)																			✓	✓																						
MARINS BKA	✓					✓	✓	✓	✓	✓								✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
MARINS BKB	✓					✓	✓	✓	✓	✓								✓			✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
LANDINS				✓	✓							✓	✓								✓	✓															✓				✓	✓
AIRINS				✓	✓							✓									✓	✓															✓				✓	✓
QUADRANS	✓		✓	✓	✓					✓	✓						✓	✓			✓		✓			✓																
ATLANS				✓	✓							✓	✓								✓	✓															✓				✓	✓
PARAMETERS																																										
LOG HEADING MISALIGNMENT												x			x																											
SOUND VELOCITY																					x	x														x						
DVL ALTITUDE																					x	x																				
CONDUCTIVITY																																				x						
TEMPERATURE																																				x						
PRESSURE or DEPTH																					x	x														x						
GPS LATITUDE																					x	x								x	x											
GPS LONGITUDE																					x	x								x	x											
GPS ALTITUDE																					x	x																				
USBL LATITUDE																					x	x																				
USBL LONGITUDE																					x	x																				
USBL ALTITUDE																					x	x																				
LBL LATITUDE																					x	x																				
LBL LONGITUDE																					x	x																				
LBL ALTITUDE																					x	x																				
LBL RANGE																					x	x																				
LOCH EM SPEED																					x	x																				
ODOMETER PULSE NUMBER																					x	x																				
UTC DAY																					x	x																				
UTC TIME																					x	x																				

Binary protocols from P to T

PRODUCTS	PEGASE CMS	PEGASE NAV	POLAR NAV	POS MV GRP111	POSTPROCESSING	SEANAV ID1	SEAPATH	SEATEX DHEAVE	SENSOR RD	SIMRAD EM	SIMRAD EM HEAVE2	SIMRAD EM TSS	SOC AUTOSUB	SPERRY ATT	SPERRY ATT STAN	S40 NAV10	S40 NAV100	TMS CCV IMBAT	TUS
PHINS III surface **HYDRINS** **PHINS 6000** **ROVINS** **PHINS COMPACT C7**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PHINS COMPACT C3 **ROVINS NANO**			✓		✓		✓	✓	✓	✓	✓	✓	✓					✓	✓
IMU version (additionnal protocols)																			
MARINS BKA			✓		✓									✓	✓	✓	✓		
MARINS BKB			✓											✓	✓	✓	✓		
LANDINS					✓		✓												
AIRINS					✓		✓												
QUADRANS					✓					✓		✓		✓	✓			✓	
ATLANS					✓		✓												
PARAMETERS																			
UNFILTERED IMU DATA					x														
HEADING	x	x	x		x	x	x			x	x	x	x	x	x	x	x	x	x
POLAR HEADING			x																
ROLL	x		x		x	x	x			x	x	x	x	x	x	x	x	x	x
PITCH	x		x		x	x	x			x	x	x	x	x	x	x	x	x	x
HEADING SD			x		x														
ROLL SD			x		x														
PITCH SD			x		x														
HEADING RATE						x	x							x	x	x	x		x
ROLL RATE						x	x							x	x	x	x		x
PITCH RATE						x	x							x	x	x	x		x
POLAR HEADING RATE			x																
ROTATION RATES XV1 (compensated from Earth rotation)	x												x					x	
ROTATION RATES XV2 (compensated from Earth rotation)	x												x					x	
ROTATION RATES XV3 (compensated from Earth rotation)	x												x					x	
SMART HEAVE				x				x											
HEAVE REAL TIME				x	x	x	x			x	x	x						x	
SURGE					x	x													
SWAY					x	x													
HEAVE SPEED																			x
SURGE SPEED																			x
SWAY SPEED																			x
NORTH OR SOUTH ACCELERATION																	x		
EAST OR WEST ACCELERATION																	x		
VERTICAL ACCELERATION																	x		
ACCELERATION XV1 (compensated from G & coriolis)																		x	x
ACCELERATION XV2 (compensated from G & coriolis)																		x	x
ACCELERATION XV3 (compensated from G & coriolis)																		x	x

PRODUCTS	PEGASE CMS	PEGASE NAV	POLAR NAV	POS MV GRP111	POSTPROCESSING	SEANAV ID1	SEAPATH	SEATEX DHEAVE	SENSOR RD	SIMRAD EM	SIMRAD EM HEAVE2	SIMRAD EM TSS	SOC AUTOSUB	SPERRY ATT	SPERRY ATT STAN	S40 NAV10	S40 NAV100	TMS CCV IMBAT	TUS
PHINS III surface HYDRINS PHINS 6000 ROVINS PHINS COMPACT C7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PHINS COMPACT C3 ROVINS NANO			✓		✓		✓	✓	✓	✓	✓	✓	✓					✓	✓
IMU version (additionnal protocols)																			
MARINS BKA			✓		✓									✓	✓	✓	✓		
MARINS BKB			✓											✓	✓	✓	✓		
LANDINS					✓		✓												
AIRINS					✓		✓												
QUADRANS					✓					✓		✓		✓	✓			✓	
ATLANS					✓		✓												
PARAMETERS																			
ACCELERATION XV1 (compensated from G)						x													
ACCELERATION XV2 (compensated from G)						x													
ACCELERATION XV3 (compensated from G)						x													
DATE OF DATA		x			x			x								x			
TIME STAMP OF DATA		x	x	x	x	x		x	x							x			
PULSE RECEPTION TIME					x														
LATITUDE	x	x	x		x	x							x			x			
POLAR LATITUDE			x																
LONGITUDE	x	x	x		x	x							x			x			
POLAR LONGITUDE			x																
ALTITUDE or DEPTH			x		x	x							x			x			
LATITUDE SD			x		x											x			
LONGITUDE SD			x		x											x			
ALTITUDE or DEPTH SD			x		x														
SPEED XV1	x	x				x			x										
SPEED XV2						x			x										
SPEED XV3						x			x										
NORTH or SOUTH SPEED			x		x		x						x			x	x		
EAST or WEST SPEED			x		x		x						x			x	x		
VERTICAL SPEED			x		x		x						x			x	x		
POLAR NORTH SPEED			x																
POLAR EAST SPEED			x																
NORTH SPEED SD			x																
EAST SPEED SD			x																
VERTICAL SPEED SD			x																
INTEGRAL SPEED NORTH			x																
INTEGRAL SPEED EAST			x																
HORIZONTAL SPEED NORM																x			
TRUE COURSE																x			
NORTH CURRENT SPEED			x																
EAST CURRENT SPEED SD			x																

PRODUCTS	PEGASE CMS	PEGASE NAV	POLAR NAV	POS MV GRP111	POSTPROCESSING	SEANAV ID1	SEAPATH	SEATEX DHEAVE	SENSOR RD	SIMRAD EM	SIMRAD EM HEAVE2	SIMRAD EM TSS	SOC AUTOSUB	SPERRY ATT	SPERRY ATT STAN	S40 NAV10	S40 NAV100	TMS CCV IMBAT	TUS
PHINS III surface HYDRINS PHINS 6000 ROVINS PHINS COMPACT C7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PHINS COMPACT C3 ROVINS NANO			✓		✓		✓	✓	✓	✓	✓	✓	✓					✓	✓
IMU version (additionnal protocols)																			
MARINS BKA			✓		✓									✓	✓	✓	✓		
MARINS BKB			✓											✓	✓	✓	✓		
LANDINS					✓		✓												
AIRINS					✓		✓												
QUADRANS					✓					✓		✓		✓	✓			✓	
ATLANS					✓		✓												
PARAMETERS																			
DIRECTION OF THE CURRENT																x			
SPEED OF THE CURRENT																x			
Temperature FOG					x														
Temperature ACC					x														
Temperature Sensor board					x														
INS ALGO STATUS					x														
INS USER STATUS			x																
INS SENSOR STATUS					x														
OTHER STATUS	x		x	x		x	x						x	x	x	x	x	x	x
CHECKSUM				x	x	x	x	x					x	x	x	x	x		x
LOG SPEED					x											x			
LOG HEADING MISALIGNMENT					x								x						
LOG PITCH MISALIGNMENT					x														
LOG SCALE FACTOR ERROR (%)					x														
SOUND VELOCITY					x														
DVL ALTITUDE					x				x										
PRESSURE or DEPTH	x	x	x		x														
GPS LATITUDE					x				x							x			
GPS LONGITUDE					x				x							x			
GPS ALTITUDE					x				x										
USBL LATITUDE					x				x										
USBL LONGITUDE					x				x										
USBL ALTITUDE					x				x										
LBL LATITUDE					x				x										
LBL LONGITUDE					x				x										
LBL ALTITUDE					x				x										
LBL RANGE					x				x										
LOCH EM SPEED	x	x	x		x														
UTC TIME					x														

3.6.2 Detailed Specifications for Output Protocols

3.6.2.1 ASCII protocols

Protocol development is under completion and free firmware upgrade is provided.

AIPOV

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183.

Data sent: UTC Time, Heading, Roll, Pitch, Rotation Rates, Linear Accelerations, Position, Speed, True course, User Status.

Data frame:

$AIPOV, hhmmss.ssss, h.hhh, r.rrr, p.ppp, x.xxx, y.yyy, z.zzz, e.ee,f.ff,g.gg, LL.LLLLLLLL, ll.lllllll, a.aaa, i.iii, j.jjj,k.kkk, m.mmm, n.nnn, o.ooo, c.ccc,hhhhhhhh*hh<CR><LF>

Parameter	ASCII model	Unit	Resolution	Range	Exact definition of parameter	Sign convention
Header	$AIPOV				ASCII header	
UTC time	hhmmss.ssss	second	10^{-4} s		UTC time in hour, minutes, seconds	
Heading	h.hhh	Decimal degree	10^{-3} deg	0-360	Heading of aircraft	0 : North 90 : East
Roll	+/-r.rrr	Decimal degree	10^{-3} deg	+/- 180	Roll of aircraft	>0 when left wing goes up
Pitch	+/-p.ppp	Decimal degree	10^{-3} deg	+/-90	Pitch of aircraft	>0 when nose up (*)
Rotation Rate XV1	+/-x.xxx	Degrees per second	10^{-3} deg/s	+/- 750	Angular rate around along-aircraft-axis	>0 when left wing goes up
Rotation Rate XV2	+/-y.yyy	Degrees per second	10^{-3} deg/s	+/- 750	Angular rate around across aircraft axis	>0 when nose up (*)
Rotation Rate XV3	+/-z.zzz	Degrees per second	10^{-3} deg/s	+/- 750	Angular rate around third aircraft axis	>0 when turning counter clockwise (*)
Linear Acceleration XV1	+/-e.ee	m/s^2	10^{-2} m/s^2	+/- 147.15 (15g)	Acceleration on along aircraft	>0 when acceleration

$AIPOV, hhmmss.ssss, h.hhh, r.rrr, p.ppp, x.xxx, y.yyy, z.zzz, e.ee,f.ff,g.gg, LL.LLLLLLLL, ll.lllllll, a.aaa, i.iii, j.jjj,k.kkk, m.mmm, n.nnn, o.ooo, c.ccc,hhhhhhhh*hh<CR><LF>						
Parameter	**ASCII model**	**Unit**	**Resolution**	**Range**	**Exact definition of parameter**	**Sign convention**
					axis. Gravity not included	towards front of vehicle
Linear acceleration XV2	+/-f.ff	m/s²	10^{-2} m/s²	+/- 147.15 (15g)	Acceleration on across aircraft axis Gravity not included	>0 when acceleration towards right wing (*)
Linear Acceleration XV3	+/-g.gg	m/s²	10^{-2} m/s²	+/- 147.15 (15g)	Acceleration on third aircraft axis Gravity not included	>0 when acceleration goes down (*)
Latitude	+/- LL.LLLLLLLL	Decimal degree	10^{-8} deg	+/-90	Latitude of aircraft position	>0 when North latitude
Longitude	+/-ll.lllllll	Decimal degree	10^{-8} deg	+/-180	Longitude of aircraft position	>0 when East
Altitude	a.aaa	meters	10^{-3} m	15000	Altitude of aircraft	
North Velocity	+/-I.iii	m/s	10^{-3} m/s	+/- 250	Velocity of aircraft along North axis	>0 when going North
East Velocity	+/-j.jjj	m/s	10^{-3} m/s	+/- 250	Velocity of aircraft along East axis	>0 when going East
Vertical Velocity	+/-k.kkk	m/s	10^{-3} m/s	+/- 250	Velocity of aircraft along vertical axis	>0 when going down
Along Velocity XV1	+/-m.mmm	m/s	10^{-3} m/s	+/- 250	Velocity on along aircraft axis.	>0 when velocity towards front of vehicle
Across Velocity XV2	+/-n.nnn	m/s	10^{-3} m/s	+/- 250	Velocity on across aircraft axis	>0 when velocity towards right wing (*)

$AIPOV, hhmmss.ssss, h.hhh, r.rrr, p.ppp, x.xxx, y.yyy, z.zzz, e.ee,f.ff,g.gg, LL.LLLLLLLL, ll.lllllll, a.aaa, i.iii, j.jjj,k.kkk, m.mmm, n.nnn, o.ooo, c.ccc,hhhhhhhh*hh<CR><LF>						
Parameter	**ASCII model**	**Unit**	**Resolution**	**Range**	**Exact definition of parameter**	**Sign convention**
Down Velocity XV3	+/-o.ooo	m/s	10^{-3} m/s	+/- 250	Velocity along third aircraft axis	>0 when velocity goes down (*)
True course	c.ccc	Decimal degrees	10^{-3} deg	0-360	Direction of the aircraft horizontal velocity	
User Status	hhhhhhhh	hexadecimal			AIRINS user status (32 bits), refer to 3.4.5.	
Checksum	hh	hexadecimal				

(*) Opposite of PHINS standard convention.

DIST TRAVELLED

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183.

Data sent: Travelled distance.

Data frame: ASCII frame.

$PIXSE,DSTTRV_,x.xxx*hh<CR><LF>	
x.xxx	Travelled distance in meters
hh	Checksum

EVENT MARKER

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Custom.

Data sent: Input pulse reception time (i.e., event time).

Data frame: ASCII frame.

x<TAB> y.yyyyyy<TAB>c<CR><LF>	
x	Input pulse: 0 for A 1 for B 2 for C 3 for D
y.yyyyyy	Pulse reception time (i.e: envent time) in seconds
c	Pulse counter (integer)

Example:

In this example the INS received two Event Markers, one on the Input Pulse A and the second on the Input Pulse D at the same frequency:

```
0	11354.374484	1
3	11354.374524	1
0	11354.379561	2
3	11354.379608	2
0	11354.384646	3
3	11354.384692	3
0	11354.389714	4
3	11354.389780	4
```

GEO3D

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Output NMEA 0183.
Data sent:	This protocol outputs INS computed position, speed, time, standard deviations values in an “GPS LIKE” format. Some characters of this output frame are set to fixed values. This telegram is similar to “GPS LIKE” but time stamp has 0.001 second resolution here whereas “GPS LIKE” has 0.01 second resolution.
Data frame:	ASCII frame.

$GPZDA,hhmmss.sss,dd,mm,yyyy,hh,mm*hh<CR><LF>		****
hhmmss.sss	UTC time of INS	**
dd	UTC day	*
mm	UTC month	*
yyyy	UTC year	*
hh	Local zone hours	*
mm	Local zone minutes	*
hh	Checksum	**

$GPGGA,hhmmss.sss,LLll.lllllll,a,LLLll.lllllll,a,x,xx,x.xxx,x.xxx,M,x.xxx,M,x.xxx,xxxx*hh<CR><LF>		
hhmmss.sss	UTC time of position	**
LLll.lllllll	Latitude in degrees (LL) and in minutes (ll.lllllll)	**
a	‘N’ for Northern hemisphere, ‘S’ for Southern hemisphere	**
LLLll.lllllll	Longitude in deg (LLL) and in minutes (ll.lllllll)	**
a	‘E’ for East, ‘W’ for West	**
x	GPS quality indicator	**
xx	Number of satellites in use	*
x.xxx	Horizontal dilution of precision (HDOP)	**
x.xxx	Antenna altitude above mean sea level (geoid) (meters)	**
M	Unit of antenna altitude (fixed character = ‘M’ for meters)	**
x.xxx	Geoidal separation	*
M	Unit of Geoidal separation (fixed character = ‘M’ for meters)	*
x.xxx	Age of the differential GPS data	*
xxxx	Differential reference station ID	*
hh	Checksum	**

$GPGST,hhmmss.sss,x.x,x.x,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>		
hhmmss.sss	UTC Time	**
x.x	RMS value of the standard deviation on pseudo-ranges	*
x.x	Standard deviation of semi-major axis of error ellipse in meters	**
x.x	Standard deviation of semi-minor axis of error ellipse in meters	**
x.x	Orientation of semi-major axis of error ellipse	**
x.x	Standard deviation of the error of Latitude in meters	**
x.x	Standard deviation of the error of Longitude in meters	**
x.x	Standard deviation of the error of Altitude	**
hh	Checksum	**

$GPVTG,x.xxx,T,x.xxx,M,x.xxx,N,x.xxx,K,a*hh<CR><LF>		
x.xxx	True course (deg)	**
T	Fixed character = 'T'	**
x.xxx	Magnetic course (deg)	** identical to true course
M	Fixed character = 'M'	**
x.xxx	Speed (knots)	**
N	Fixed character = 'N'	**
x.xxx	Speed (km/h)	**
K	Fixed character='K'	**
a	Positioning system mode indicator 'A', 'D' or 'E'	***
hh	Checksum	**

*Copy of last GPS values received. When no GPS has been received since power up, these fields are null.

** INS calculated data.

***The quality indicator is managed as follows:

INS does not copy the quality indicator received on GGA input to GGA output.

The quality factor is set with respect to a correspondence table between INS calculated SD and Quality indicator in GGA telegram (refer to section 1.1.4).

WARNING: Some empty fields are allowed in --GGA and –VTG data frames. See samples hereafter :

$--GGA,161229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M,,,,0000*18

$--GGA,064036.289,4836.5375,N,00740.9373,E,1,04,3.2,200.2,M,,,,0000*0E

$--VTG,309.62,T,,M,0.13,N,0,2,K*6E

**** The ZDA sentence is always sent at 1Hz whatever the chosen refresh rate.

GPS LIKE

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: This protocol outputs INS computed position, speed, time, standard deviations values in an “GPS like” format.

Time management: If INS has never received GPS, date starts on 1st January 2006. Otherwise date is maintained on GPS time as soon as GPS time is received. If GPS is lost, INS will maintain time with its internal clock. If INS is synchronized with GPS time, the time tags are UTC time, otherwise they are INS time (time since power-up of the system).

Data frame:

$GPZDA,hhmmss.ss,dd,mm,yyyy,hh,mm*hh<CR><LF>		****
hhmmss.ss	UTC time of PHINS	**
dd	UTC day	*
mm	UTC month	*
yyyy	UTC year	*
hh	Local zone hours	*
mm	Local zone minutes	*
hh	Checksum	**

$GPGGA,hhmmss.ss,LLll.lllllll,a,LLLll.lllllll,a,x,xx,x.xxx,x.xxx,M,x.xxx,M,x.xxx,xxxx*hh<CR><LF>		
hhmmss.ss	UTC time of position	**
LLll.lllllll	Latitude in degrees (LL) and in minutes (ll.lllllll)	**
a	‘N’ for Northern hemisphere, ‘S’ for Southern hemisphere	**
LLLll.lllllll	Longitude in deg (LLL) and in minutes (ll.lllllll)	**
a	‘E’ for East, ‘W’ for West	**
x	GPS quality indicator	**
xx	Number of satellites in use	*
x.xxx	Horizontal dilution of precision (HDOP)	**
x.xxx	Antenna altitude above mean sea level (geoid) (meters)	**
M	Unit of antenna altitude (fixed character = ‘M’ for meters)	**
x.xxx	Geoidal separation	*
M	Unit of Geoidal separation (fixed character = ‘M’ for meters)	*
x.xxx	Age of the differential GPS data	*
xxxx	Differential reference station ID	*
hh	Checksum	**

$GPGST,hhmmss.ss,x.x,x.x,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>		
hhmmss.ss	UTC Time	**
x.x	RMS value of the standard deviation on pseudo-ranges	*
x.x	Standard deviation of semi-major axis of error ellipse in meters	**
x.x	Standard deviation of semi-minor axis of error ellipse in meters	**
x.x	Orientation of semi-major axis of error ellipse	**
x.x	Standard deviation of the error of Latitude in meters	**
x.x	Standard deviation of the error of Longitude in meters	**
x.x	Standard deviation of the error of Altitude	**
hh	Checksum	**

$GPVTG,x.xxx,T,x.xxx,M,x.xxx,N,x.xxx,K,a*hh<CR><LF>		
x.xxx	True course (deg)	**
T	Fixed character = ‘T’	**
x.xxx	Magnetic course (deg)	** identical to true course
M	Fixed character = ‘M’	**
x.xxx	Speed (knots)	**
N	Fixed character = ‘N’	**
x.xxx	Speed (km/h)	**
K	Fixed character=’K’	**
a	Positioning system mode indicator ‘A’, ‘D’ or ‘E’	***
hh	Checksum	**

$GPGLL,LLll.lllllll,a,LLLll.lllllll,a,hhmmss.ss,a,m*hh<CR><LF>		
LLll.llllllll	Latitude in degrees (LL) and in minutes (ll.lllllll)	**
a	‘N’ for Northern hemisphere, ‘S’ for Southern hemisphere	**
LLLll.llllllll	Longitude in deg (LLL) and in minutes (ll.lllllll)	**
a	‘E’ for East, ‘W’ for West	**
hhmmss.ss	UTC time of position	**

$GPGLL,LLII.IIIIIII,a,LLLII.IIIIIII,a,hhmmss.ss,a,m*hh<CR><LF>		
a	Status 'A' for Data Valid, 'V' for Data Invalid	Data invalid for initial alignment **and** speed saturation (i.e INS User status ALIGNMENT **AND** INS User status SPEED_SATURATION bits set to 1)
m	Mode indicator 'A' , 'D' or 'E'	***
hh	Checksum	**

*Copy of last GPS values received. When no GPS has been received since power up, these fields are null.
** INS calculated data.

***The quality indicator is managed as follows:
INS does not copy the quality indicator received on GGA input to GGA output.
The quality factor is set with respect to a correspondence table between INS calculated SD and Quality indicator in GGA telegram (refer section 1.1.4).

WARNING

Some empty fields are allowed in --GGA and –VTG data frames. See samples hereafter :
$--GGA,161229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M,,,,0000*18$--GGA,064036.289,4836.5375,N,00740.9373,E,1,04,3.2,200.2,M,,,,0000*0E$--VTG,309.62,T,,M,0.13,N,0,2,K*6E

**** The ZDA sentence is always sent at 1Hz whatever the chosen refresh rate.

GPS LIKE SHORT

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: This protocol outputs INS computed position, speed, time, standard deviations values in an "GPS like" format.

Time management: If INS has never received GPS, date starts on 1st January 2006. Otherwise date is maintained on GPS time as soon as GPS time is received. If GPS is lost, INS will maintain time with its internal clock. If INS is synchronized with GPS time, the time tags are UTC time, otherwise they are INS time (time since power-up of the system).

Data frame:

$GPGGA,hhmmss.ss,LLII.IIIIIII,a,LLLII.IIIIIII,a,x,xx,x.xxx,x.xxx,M,x.xxx,M,x.xxx,xxxx*hh<CR><LF>		
hhmmss.ss	UTC time validity of position	**
LLII.IIIIIII	Latitude in degrees (LL) and in minutes (II.IIIIIII)	**
a	'N' for Northern hemisphere, 'S' for Southern hemisphere	**
LLLII.IIIIIII	Longitude in deg (LLL) and in minutes (II.IIIIIII)	**
a	'E' for East, 'W' for West	**
x	GPS quality indicator	***
xx	Number of satellites in use	*
x.xxx	Horizontal dilution of precision (HDOP)	*
x.xxx	Antenna altitude (meters) (here INS altitude)	**
M	Unit of antenna altitude (fixed character = 'M' for meters)	**
x.xxx	Geoidal separation	*
M	Unit of Geoidal separation (fixed character = 'M' for meters)	*
x.xxx	Age of the differential GPS data	*
xxxx	Differential reference station ID	*
hh	Checksum	

$GPGST,hhmmss.ss,x.x,x.x,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>		
hhmmss.ss	UTC Time validity of data	**
x.x	Standard deviation of the range inputs to the navigation process	*
x.x	Standard deviation of the half main roads of the ellipse of error in meters	**
x.x	Standard deviation of the small half centers ellipse of error in meters	**
x.x	Angle of orientation of the ellipse of error in meters	**
x.x	Standard deviation of the error of Latitude in meters	**
x.x	Standard deviation of the error of Longitude in meters	**
x.x	Standard deviation of the error of Altitude	**
hh	Checksum	

*Copy of last GPS values received. When no GPS has been received since power up, these fields are null.

** INS calculated data.

***The quality indicator is managed as follows:

INS does not copy the quality indicator received on GGA input to GGA output.

The quality factor is set with respect to a correspondence table between INS calculated SD and Quality indicator in GGA telegram (refer section 1.1.4).

WARNING: Some empty fields are allowed in --GGA and –VTG data frames. See samples hereafter :

$--GGA,161229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M,,,,0000*18

$--GGA,064036.289,4836.5375,N,00740.9373,E,1,04,3.2,200.2,M,,,,0000*0E

$--VTG,309.62,T,,M,0.13,N,0,2,K*6E

**** The ZDA sentence is always sent at 1 Hz whatever the chosen refresh rate.

GPS LIKE SHORT ZZZ

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: This protocol outputs INS computed position, standard deviations values in a “GPS like” format.
Some characters of this output frame are set to fixed values.
ZZZ means 000, UTC time is sent at the rounded second. Position data are interpolated.

Data frame:

WARNING

Some empty fields are allowed in --GGA data frame. See samples hereafter :
$--GGA,161229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M,,,,0000*18
$--GGA,064036.289,4836.5375,N,00740.9373,E,1,04,3.2,200.2,M,,,,0000*0E

$GPGGA,hhmmss.zzz,LLII.IIIIIII,a,LLLII.IIIIIII,a,x,xx,x.xxx,x.xxx,M,x.xxx,M,x.xxx,xxxx*hh<CR><LF>		
hhmmss.zzz	UTC time validity of position, ZZZ means 000 (round second)	**
LLII.IIIIIII	Latitude in degrees (LL) and in minutes (II.IIIIIII)	**
a	‘N’ for Northern hemisphere, ‘S’ for Southern hemisphere	**
LLLII.IIIIIII	Longitude in deg (LLL) and in minutes (II.IIIIIII)	**
a	‘E’ for East, ‘W’ for West	**
x	GPS quality indicator	***
xx	Number of satellites in use	*
x.xxx	Horizontal dilution of precision (HDOP)	*
x.xxx	Antenna altitude (meters) (here INS altitude)	**
M	Unit of antenna altitude (fixed character = ‘M’ for meters)	**
x.xxx	Geoidal separation	*
M	Unit of Geoidal separation (fixed character = ‘M’ for meters)	*
x.xxx	Age of the differential GPS data	*
xxxx	Differential reference station ID	*
hh	Checksum	

$GPGST,hhmmss.zzz,x.x,x.x,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>		
hhmmss.zzz	UTC Time validity of data, ZZZ means 000 (round second)	**
x.x	Standard deviation of the range inputs to the navigation process	*
x.x	Standard deviation of the half main roads of the ellipse of error in meters	**
x.x	Standard deviation of the small half centers ellipse of error in meters	**
x.x	Angle of orientation of the ellipse of error in meters	**
x.x	Standard deviation of the error of Latitude in meters	**
x.x	Standard deviation of the error of Longitude in meters	**
x.x	Standard deviation of the error of Altitude	**
hh	Checksum	

$--ZDA,hhmmss.zzz,dd,mm,yyyy,hh,mm*hh <CR><LF>	
hhmmss.zzz	UTC of the last PPS, ZZZ means 000 (round second) (USED)
dd	is the UTC day
mm	is the UTC month
yyyy	is the UTC year
hh	is the local zone hour
mm	is the local zone minutes
*hh	is the checksum

*Copy of last GPS values received. When no GPS has been received since power up, these fields are null.

** INS calculated data

***The quality indicator is managed as follows:

- Case 1:
  - ❑ If the GPS is received, INS **will copy** the quality indicator received on the GGA input to GGA and GGK output.
  - ❑ If GPS is not received or rejected for more than 3 s or during initial alignment of 5 minutes INS will output Q=6.
- Case 2:
  - ❑ If GPS is not received but other aiding sensors are received (USBL/LBL/DVL) then the following correspondence table is applied.
  - ❑ The quality factor is set with respect to the table with respect to INS HDOP: refer to section 1.1.4.

GRAVI DOV CORR

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

If you want to use the gravity deflection feature to further improve navigation performances, please contact your local sales representative or support contact.

GYROCOMPASS

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: Heading, Roll, Pitch, Status.

Data frame:

$HEHDT,x.xxx,T*hh<CR><LF>		
x.xxx	is the true heading in degrees	**3 digits after** the decimal point (*)
T	is a fixed character = ‘T’	
hh	is the checksum	

$PIXSE,ATITUD,x.xxx,y.yyy*hh<CR><LF>		
x.xxx	is the roll in degrees	**3 digits after** the decimal point (*)
y.yyy	is the pitch in degrees	**3 digits after** the decimal point (*)
hh	is the checksum	

$PIXSE,STATUS,hhhhhhhh,llllllll *hh<CR><LF>		
hhhhhhhh	is the hexadecimal value of the 32 LSB bits of the INS System status	Refer to section 3.4.2.
llllllll	is the hexadecimal value of the 32 MSB bits of the INS System status	
hh	is the checksum	

(*) 5 digits after the decimal point in Military mode.

GYROCOMPASS 2

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA compatible.

Data sent: Heading, Roll, Pitch, Heave, Status.

Data frame:

$HEHDT,x.xxx,T*hh<CR><LF>			
where:	**x.xxx**	is the true heading in degrees	**3 digits after** the decimal point (*)
	T	is a fixed character = 'T'	
	hh	is the checksum	

$PHTRH,x.xx,a,y.yy,b,z.zz,c*hh<CR><LF>			
where:	**x.xx**	is the pitch in degrees	**2 digits after** the decimal point
	a	is 'M' for bow up and 'P' for bow down	
	y.yy	is the roll in degrees	**2 digits after** the decimal point
	b	is 'B' for port down and 'T' for port up	
	z.zz	is the heave absolute value in meters	**2 digits after** the decimal point
	c	is 'U' if PHINS goes up and 'O' if PHINS goes down	
	hh	is the checksum	

$PIXSE,STATUS,hhhhhhhh,llllllll *hh<CR><LF>			
where:	**hhhhhhhh**	is the hexadecimal value of the 32 LSB bits of the INS System status	Refer to section 3.4.2.
	llllllll	is the hexadecimal value of the 32 MSB bits of the INS System status	
	hh	is the checksum	

HALLIBURTON SAS

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: Position time stamp, Lat/Long position, Depth, DVL range to bottom, Lat/Long standard deviation. Depth standard deviation, UTM position, DVL estimation of course misalignment and scale factor error. Speed of sound, heading, roll, pitch, heave, rotation rates, course over ground, horizontal speed, speed in mobile frame, heading, roll, pitch standard deviation. North, East, Vertical speed standard deviation. Sensor and system status.

Data frame:

$PIXSE,HSPOS_,hhmmss.ss, LLll.llllll,H,LLLmm.mmmmmm,D,d.dd,a.aa,x.xx,y.yy,z.zz,d.dd,nn,c,e.e ,n.n,m.mmmm,s.ssss,v.v*hh<CR><LF>		
hhmmss.ss	UTC time stamp if system is UTC synchronized, or in system time if not	2 digits after decimal point
LLll.llllll	Latitude in degress(LL), lminutes(ll) and decimals of minutes (llllll)	6 digits after decimal point
H	Hemisphere N or S	
LLLmm.mmmmmm	Longitude integer degrees(LLL), minutes(mm) and decimals of minutes (mmmmmm)	6 digits after decimal point
D	Hemisphere E or W	
d.dd	Depth in meters	Float, 2 digits after decimal point
a.aa	Altitude of the DVL in meters	Float, 2 digits after decimal point
x.xx	Latitude standard deviation error in meters	Float, 2 digits after decimal point
y.yy	Longitude standard deviation error in meters	Float, 2 digits after decimal point
z.zz	Latitude/Longitude Covariance error in meters	Float, 2 digits after decimal point
d.dd	Depth standard deviation error in meters	Float, 2 digits after decimal point
nn	UTM Zone Longitude integer	
c	UTM Zone Latitude character	
e.e	UTM Position East in meters	Float, 1 digit after decimal point
n.n	UTM Position North in meters	Float, 1 digit after decimal point
m.mmmm	Estimate of DVL course misalignment in degrees	Float, 4 digit after decimal point
s.ssss	Estimate of DVL scale factor correction in %	Float, 4 digit after decimal point
v.v	Speed of sound in meters/sec	Float, 1 digit after decimal point
hh	Checksum NMEA	

$PIXSE,HSATIT,h.hhh,r.rrr,p.ppp,h.hhh,a.aaa,b.bbb,c.ccc,d.ddd,e.eee,f.fff,g.ggg,h.hhh,i.ii,j.jj,k.kk,l.ll,m.mm,n.nn*hh<CR><LF>		
h.hhh*	Heading in degrees	Float, 3 digits after decimal point
r.rrr*	Roll in degrees (+ if port up)	Float, 3 digits after decimal point
p.ppp*	Pitch in degrees (+ bow down)	Float, 3 digits after decimal point
h.hhh	Heave in meters	Float, 3 digits after decimal point
a.aaa **	Rotation rate XV3 in degrees/sec	Float, 3 digits after decimal point
b.bbb **	Rotation rate XV1 in degrees/sec	Float, 3 digits after decimal point
c.ccc **	Rotation rate XV2 in degrees/sec	Float, 3 digits after decimal point
d.ddd	Horizontal speed course in degrees	Float, 3 digits after decimal point
e.eee	Horizontal speed in meters /sec	Float, 3 digits after decimal point
f.fff	Speed XV1 in Meters/sec	Float, 3 digits after decimal point
g.ggg	Speed XV2 in Meters/sec	Float, 3 digits after decimal point
h.hhh	Speed XV3 in Meters/sec	Float, 3 digits after decimal point
i.ii	Heading standard deviation error in degrees	Float, 2 digits after decimal point
j.jj	Roll standard deviation error in degrees	Float, 2 digits after decimal point
k.kk	Pitch standard deviation error in degrees	Float, 2 digits after decimal point
l.ll	North speed standard deviation error in meters/sec	Float, 2 digits after decimal point
m.mm	East speed standard deviation error in meters/sec	Float, 2 digits after decimal point
n.nn	Vertical speed standard deviation error in meters/sec	Float, 2 digits after decimal point
hh	Checksum NMEA	

$PIXSE,HSSTAT,FFAAVVQQ*hh<CR><LF>	
FF	Statut 1 : Bit 0 (0x01) : FOG or Source error Bit 1 (0x02) : Accelerometer error Bit 2 (0x04) : Serial input or Ethernet port A error Bit 3 (0x08) : Serial input or Ethernet port B error Bit 4 (0x10) : Serial input or Ethernet port C error Bit 5 (0x20) : Serial input or Ethernet port D error Bit 6 (0x40) : Serial input or Ethernet port E error
AA	Statut 2 : Bit 0 (0x01) GPS valid Bit 1 (0x02) : DVL Bottom track valid Bit 2 (0x04) : USBL valid Bit 3 (0x08) : Dead Reckoning

$PIXSE,HSSTAT,FFAAVVQQ*hh<CR><LF>	
VV	Statut 3 : Bit 0 (0x01) : GPS1 detected Bit 1 (0x02) : DVL Bottom or Water track detected Bit 2 (0x04) : USBL detected Bit 3 (0x08) : Depth detected Bit 4 (0x10) : Activity on serial input or Ethernet port A Bit 5 (0x20) : Activity on serial input or Ethernet port B Bit 6 (0x40) : Activity on serial input or Ethernet port C Bit 7 (0x80) : Activity on serial input or Ethernet port D
QQ	Statut 4 : Bit 0 (0x01) : Alignment Bit 1 (0x02) : Fine Alignement Bit 2 (0x04) : Navigation
hh	Checksum NMEA

* In Military mode 5 digits after decimal point.

** In non military mode: rotation rate quantification is 3.6°/h

HEHDT

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183.

Data sent: Heading.

Data frame:

NMEA **$HEHDT** Frame refer to section 2.2.2.6.

HEHDT FIXED

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output ASCII.

Data sent: Heading.

Data frame:

$HEHDT,xxx.x,T<CR><LF>			
where:	**xxx.x**	is the true heading in degrees	**3 digits before and 1 digit after** the decimal point
	T	is a fixed character = ‘T’	

HEHDT HEROT

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183.

Data sent: Heading and heading rotation rate.

Data frame:

This protocol is a standard NMEA protocol “$__HDT” and “$__ROT”. The output is respectively heading in degrees and heading rotation rate in °/min.

INS usual sign convention are used.

$HEHDT,x.x,T*hh<CR><LF>		
x.x T hh	is the true heading in degrees is a fixed character = ‘T’ is the checksum	3 digits after the decimal point (*)

$HEROT,x.x,A*hh<CR><LF>		
x.x A hh	Heading rate of turn , °/min ‘-‘= bow turns to port A= data valid , V = data invalid Is the checksum	2 digits after the decimal point in “Default” dual use mode(**)

(*) 5 digits after the decimal point in Military mode.

(**) 4 digits after the decimal point in Military mode.

The resolution of rotation rate data is limited to 3.6°/h to comply with export regulation.

HETHS HEROT

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183.

Data sent: Heading, Heading rate, Validity status.

Data frame:

NMEA **$HETHS** Frame	Refer to section 2.2.2.8.
NMEA **$HEROT** Frame	Refer to section 2.2.2.7.

HYDROGRAPHY

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: Heading, Roll, Pitch, Position, Heave.

Data frame:

$HYDRO,a.aaa,b.bbb,c.ccc,x.xxxxxxx,y.yyyyyyy,z.zzz,w.www*hh<CR><LF>			
where:	**a.aaa**	is the heading in degrees	3 digits after the decimal point
	b.bbb	is the roll in degrees	3 digits after the decimal point
	c.ccc	is the pitch in degrees	3 digits after the decimal point
	x.xxxxxxx	is the latitude in degrees	7 digits after the decimal pint
	y.yyyyyyy	is the longitude in degrees	7 digits after the decimal pint
	z.zzz	is the altitude in meters	3 digits after the decimal point
	w.www	is the heave in meters	3 digits after the decimal point
	hh	is the checksum	

IMU ASCII

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 (excepted 2 character header).

Data sent: Rotation rates, Linear Accelerations.

Data frame: ASCII frame.

$IMU,hhmmss.sss, p.pppppppp, q.qqqqqqqq, r.rrrrrrrr, x.xxxxxxxx, y.yyyyyyyy, z.zzzzzzzz*hh<CR><LF>	
hhmmss.sss	Time validity of the data (Note 1)
p.pppppp	XV1 delta rotation (rad) (Note 2)
q.qqqqqq	XV2 delta rotation (rad)
r.rrrrrr	XV3 delta rotation (rad)
x.xxxxx	XV1 delta velocity (m/s) (Note 2)
y.yyyyy	XV2 delta velocity(m/s)
z.zzzzzz	XV3 delta velocity(m/s)
hh	Checksum

Note 1: If INS is synchronized with GPS time then it is UTC time.

Note 2: Delta rotation is the integration of the gyro readings in the time interval of output data rate. We define t1 as the time validity of the delta rotation data, Δt the output data rate and t2 the instant of output of first bit of data telegram. Then (t2-t1) is the latency on data and delta rotation is the integration of rotation angle from t1-Δt to t1.
Delta velocity is the integration of accelerometer readings in the time interval of output data rate in the same manner as delta rotation. It is expressed in the vehicle frame before the delta rotation.

INDYN

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Output NMEA compatible.
Data sent:	Position, Heading, Heading, Roll, Pitch, Heading rate, Roll rate, Pitch rate, Longitudinal speed.
Data frame:	ASCII frame.

$INDYN,x.xxxxxxxx,y.yyyyyyyy,z.zzz,h.hhh,r.rrr,p.ppp,a.aaa,b.bbb,c.ccc,s.sss*hh<CR><LF>		
x.xxxxxxxx	is the latitude in degrees	Float, 8 digits after decimal point
y.yyyyyyyy	is the longitude in degrees	Float, 8 digits after decimal point
z.zzz	is the altitude in meters	Float, 3 digits after decimal point
h.hhh	is the heading in degrees	Float, 3 digits after decimal point
r.rrr	is the roll in degrees (positive for port up)	Float, 3 digits after decimal point
p.ppp	is the pitch in degrees (positive when bow down)	Float, 3 digits after decimal point
a.aaa	is the heading rate in °/s	Float, 3 digits after decimal point
b.bbb	is the roll rate in °/s (positive when roll increase)	Float, 3 digits after decimal point
c.ccc	is the pitch rate in °/s (positive when pitch increase)	Float, 3 digits after decimal point
s.sss	Speed XV1 in m/s (positive towards the bow)	Float, 3 digits after decimal point
hh	is the checksum	

INHDT

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA compliant.

Data sent: Heading in conventional or polar mode.

Data frame: ASCII frame.

$INHDT,x.x,T*hh<CR><LF>		
x.x	Heading in degrees relative to True North or Polar North, as selected by the operator (**Note 1**)	Fixed point decimal with a variable number of digits of degrees and 1 fixed digit for decimal fraction of degrees. Range [0.0°; 359.9°]; Granularity = 0.1°
T	/	Always set to ASCII “T”
hh	NMEA checksum	

Note 1: The Operator selects whether True or Polar North should be output using the Web-based user interface.

INSITU

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Output NMEA 0183 compliant.
Data sent:	HEHDT, TIROT, PPLAR, PPLAX.
Data frame:	ASCII frames.

All the frames are sent at the same rate.

The rate is configurable through the MMI and can be: 0.1Hz, 0.2Hz, 0.25Hz, 0.33Hz, 0.5Hz, 1Hz, 2Hz,
2.5Hz,3.33Hz, 5Hz, 10Hz, 20Hz, 25Hz, 33.3Hz, 50Hz, 100Hz, 200Hz

The serial parameters (except data bit fixed to 8) are also configurable through the MMI and can be :

- for the Parity : None, Even, Odd
- for the Stop bits : 0.5, 1, 1.5, 2
- for the Baud rate : 600 Bauds, 1.2 Kbauds, 4.8 Kbauds, 9.6 KBauds, 19.2 KBauds, 38.4 KBauds, 57.6 KBauds, 115.2 Kbauds

$HEHDT,xxx.xx,T*hh<CR><LF>			
where:	xxx.xx T hh	is the true heading in degrees, always positive is the fixed ASCII character ‘T’ is the checksum	2 digits after the decimal point and 3 digits before the decimal point. (examples : 024.00, 172.00)
$TIROT,xxxxx.x,S*hh<CR><LF>			
where:	xxxxx.x S hh	is the heading rate of turn, in deg/mn Sign ‘–‘ when bow turns to port is the status (**Note 2**) ASCII ‘A’ for data valid ASCII ‘V’ for data invalid is the checksum	1 digit after the decimal point and 5 digits before the decimal point, and only the sign ‘–‘ is added if needed. (examples : -00002.1 , 00005.0)

$PPLAR,xxx.xx,yyy.yy*hh<CR><LF>			
where:	xxx.xx	is the roll, in degrees Sign '–' for left-port side down	**Note 1**
	yyy.yy	is the pitch, in degrees Sign '–' for front side-bow down <u>Warning:</u> Opposite sign of INS convention	**Note 1**
	hh	is the checksum	

$PPLAX,xxx.xx,yyy.yy*hh<CR><LF>			
where:	xxx.xx	is the roll rate, in degrees/second Positive when the INS roll angle increases	**Note 1**
	yyy.yy	is the pitch rate, in degrees/second Positive when the INS pitch angle increases <u>Warning:</u> Opposite sign of INS convention	**Note 1**
	hh	is the checksum	

<u>Note 1</u> : 2 digits after the decimal point and **3 digits before** the decimal point, and only the sign '–' is added if needed. (examples : -046.12 , 056.24 , -002.00)

<u>Note 2</u> : S = 'V' when INS User status HRP_INVALID is set to 1, otherwise S = 'A'

IXSEA TAH

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Output NMEA 0183 compatible.
Data sent:	Time, Roll, Pitch, Heading, heading rotation rate, Attitude and heading angles, Heave, surge, sway movement.

Important

The value of the heave without lever arm is set to 0 when selecting Smart heave in the web-based user interface with this protocol for the output settings.

The smart heave is delayed by 100 s.

Data frame:

$PHOCT,01,hhmmss.sss,G,AA,HHH.HHH,N,eRRR.RRR,L,ePP.PPP,K,eFF.FFF, M,eHH.HHH,eSS.SSS,eWW.WWW,eZZ.ZZZ,eYY.YYY,eXX.XXX,eQQQ.QQ*hh	
$PHOCT	is the header
01	is the protocol version identifier
hhmmss.sss	is the UTC valid time of observations hh is the local zone hours (from 00 to 23 hours) mm is the local zone minutes (from 00 to +59) ss.sss is the local zone seconds (from 00.000 to +59.999)
G	is UTC Time status: T=Valid E=Invalid (*)
AA	is the latency for heading, roll, pitch AA= 03 (OCTANS IV & PHINSIII) AA= 25 (OCTANS III) (data latency in ms to be used if UTC time of observations is not used) (**)
HHH.HHH	is the true heading in degree (from 000.000 to 359.999)
N	is the True Heading status: T=Valid E=Invalid I=Initializing
eRRR.RRR	is the Roll in degree (e= +/-, positive if port side up) from -180.000 to +180.000
L	is the Roll status: T=Valid E=Invalid I=Initializing
ePP.PPP	is the Pitch degree (e= +/-, positive if bow down), from –90.000 to +90.000
K	is the Pitch status: T=Valid E=Invalid I=Initializing
eFF.FFF	is the Heave without Primary Lever arms applied in meters

$PHOCT,01,hhmmss.sss,G,AA,HHH.HHH,N,eRRR.RRR,L,ePP.PPP,K,eFF.FFF, M,eHH.HHH,eSS.SSS,eWW.WWW,eZZ.ZZZ,eYY.YYY,eXX.XXX,eQQQ.QQ*hh	
	(e= +/-, positive up) from -99.999 to +99.999
M	is the Heave status (also used for surge, sway & speed) : T=Valid E=Invalid I=Initializing
eHH.HHH	is the Heave with Chosen lever arms applied in meters (e= +/-, positive up) from –99.999 to +99.999
eSS.SSS	is the Surge with Lever arms applied in meters (e= +/-) from –99.999 to +99.999
eWW.WWW	is the Sway with Lever arms applied in meters (e= +/-) from –99.999 to +99.999
eZZ.ZZZ	is the Heave speed with Lever arms in meters/s (e= +/-) from –99.999 to +99.999
eYY.YYY	is the Surge speed with Lever arms in meters/s (e= +/-) from –99.999 to +99.999
eXX.XXX	is the Sway speed with Lever arms in meters/s (e= +/-) from –99.999 to +99.999
eQQQQ.QQ	is the heading rate of turns in degree/minute (e= +/-) from –9999.99 to +9999.99 (****)
hh	is the NMEA checksum: hexadecimal encoded XOR of all bytes excluding the starting character '$' and the stop one '*

(*) UTC time is valid (G=T) if both PPS pulse and &ZDA telegram are received and valid. If either PPS or ZDA telegram are not received or valid, UTC time flag is invalid : G=E.

(**) The attitude and heading latency for INS data is as follow :

		Output latency
Serial ports	All	2.35 ms
Ethernet ports (in priority order)	First	2.95 ms
	Second	3.45 ms
	Third	3.95 ms
	Fourth	4.45 ms
	Fifth	4.95 ms

Latency value in telegram is rounded to 03 ms.

Be aware that latency on Ethernet data is guaranteed only for point to point link.

If INS is time synchronized, time stamp is used and latency is then not relevant.

(***) For INS we output Heave with Primary lever arm and Heave with chosen lever arm (Primary, A, B, C).

(****) Rotation rate resolution is limited to 3.6°/h

KVH EXTENDED

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: ASCII telegram.

Data sent: Roll, Pitch, Heading and Heading Rate.

Data frame:

%P,R,H,Y**<CR><LF>**		
Where :	%	is the preamble character
	P (see **Note 1**)	is the pitch angle value X 10 in degrees Signed integer; range (-900° to 900°) Positive for front-side bow up **Warning:** Opposite sign of INS usual convention
	R (see **Note 1**)	is the roll angle value X 10 in degrees Signed integer; range (-1800° to 1800°) Positive for left-port side up
	H	is the heading angle value X 10 in degrees Signed integer; range (0°to 3600°)
	Y	is the heading rate value X 100 in degrees/s Signed integer; range (-9900 degrees/s ,9900 degrees/s) Positive when heading angle increases
	<CR><LF>	is the end of the frame : 0x0D 0x0A (NO CHECKSUM)

Note 1: The KVH EXTENDED sign convention is **ISO Convention**.

	ISO Convention	Inverse ISO Convention	INS Convention
Roll > 0	for left-port side up	for left-port side down	for left-port side up
Pitch > 0	for front-side bow up	for front side-bow down	for front side-bow down

LANDINS STANDARD

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: Heading, Attitude, Position, Speed, Standard deviations, Sensors input, Status.

Data frame:

$HEHDT,x.xxxxx,T*hh<CR><LF>		
x.xxx	is the true heading in degrees	3 digits after the decimal point. (*)
T	is a fixed character = 'T'	
hh	is the checksum	

(*) 5 digits after the decimal point in military mode

$PIXSE,ATITUD,x.xxx,y.yyy*hh<CR><LF>		
x.xxx	is the roll in degrees	3 digits after the decimal point. (*)
y.yyy	is the pitch in degrees	3 digits after the decimal point. (*)
hh	is the checksum	

(*) 5 digits after the decimal point in military mode

$PIXSE,POSITI,x.xxxxxxxx,y.yyyyyyyy,z.zzz*hh<CR><LF>		
x.xxxxxxxx	is the latitude in degrees	8 digits after decimal point
y.yyyyyyyy	is the longitude in degrees	8 digits after decimal point
z.zzz	is the altitude in meters	3 digits after decimal point
hh	is the checksum	

$PIXSE,SPEED_,x.xxx,y.yyy,z.zzz*hh<CR><LF>		
x.xxx	Speed X_{East} in m/s (East speed)	3 digits after decimal point
y.yyy	Speed X_{North} in m/s (North speed)	3 digits after decimal point
z.zzz	Speed X_{UP} in m/s (Sign "+" towards up side)	3 digits after decimal point
hh	is the checksum	

$PIXSE,UTMWGS,c,nn,x.xxx,y.yyy,z.zzz*hh<CR><LF>		
C	is the latitude UTM zone (character)	
nn	is the longitude UTM zone (integer)	
x.xxx	is the east UTM position in meter	3 digits after decimal point
y.yyy	is the north UTM position in meter	3 digits after decimal point
z.zzz	is the altitude in meters	3 digits after decimal point
hh	is the checksum	

$PIXSE,STDHRP,x.xxx,y.yyy,z.zzz*hh<CR><LF>		
x.xxx	is the heading std dev (degrees)	3 digits after the decimal point
y.yyy	is the roll std dev (degrees)	3 digits after the decimal point
z.zzz	is the pitch std dev (degrees)	3 digits after the decimal point
hh	is the checksum	

$PIXSE,STDPOS,x.xx,y.yy,z.zz*hh<CR><LF>		
x.xx	is the latitude std dev (meters)	2 digits after the decimal point
y.yy	is the longitude std dev (meters)	2 digits after the decimal point
z.zz	is the altitude std dev (meters)	2 digits after the decimal point
hh	is the checksum	

$PIXSE,STDSPD,x.xxx,y.yyy,z.zzz*hh<CR><LF>		
x.xxx	is the east speed std dev (m/s)	3 digits after the decimal point
y.yyy	is the north speed std dev (m/s)	3 digits after the decimal point
z.zzz	is the vertical speed std dev (m/s)	3 digits after the decimal point
hh	is the checksum	

$PIXSE,TIME__, hhmmss.ssssss*hh<CR><LF>	
hhmmss.ssssss	is the validity time of the computed data transmitted in the UTC time reference frame if available otherwise in the system time reference frame. 6 digits after the decimal point.
hh	is the checksum

$PIXSE,UTCIN_,hhmmss.ssssss*hh<CR><LF>		
Last UTC received		
hhmmss.ssssss **hh**	is the UTC time received is the checksum	6 digits after the decimal point

$PIXSE,GPSIN_,x.xxxxxxx,y.yyyyyyy,z.zzz,hhmmss.ssssss,q *hh<CR><LF>		
Last data received from the GPS 1 sensor		
x.xxxxxxx **y.yyyyyyy** **z.zzz** **hhmmss.ssssss** **q** **hh**	is the latitude in degrees is the longitude in degrees is the altitude in meters is the validity time of the GPS data received in the UTC time reference frame if available otherwise in the system time reference frame is the GPS quality indicator : 0 and ≥ 5: Fix not valid 1: GPS SPS Mode Fix not valid 2: Differential Mode, SPS Mode, Fix not valid 3: GPS PPS Mode, Fix not valid 4: GPS RTK Mode is the checksum	8 digits after the decimal point 8 digits after the decimal point 3 digits after the decimal point 6 digits after the decimal point

Data frames GPSIN_, are sent only when updated data is received from the external sensor (DDRECK if dead reckoning mode is turned on).

$PIXSE,GPMIN_,x.xxxxxxx,y.yyyyyyy,z.zzz,hhmmss.ssssss,q*hh<CR><LF>		
Last data received from the manual GPS sensor		
x.xxxxxxx **y.yyyyyyy** **z.zzz** **hhmmss.ssssss**	is the latitude in degrees is the longitude in degrees is the altitude in meters is the validity time of the Manual GPS data received in the UTC time reference frame if available otherwise in the system time reference frame	8 digits after the decimal point 8 digits after the decimal point 3 digits after the decimal point

$PIXSE,GPMIN_,x.xxxxxxx,y.yyyyyyy,z.zzz,hhmmss.ssssss,q*hh<CR><LF>		
q **hh**	is the GPS quality indicator : 0 and ≥ 5: Fix not valid 1: GPS SPS Mode fix valid 2: Differential Mode, SPS Mode, fix valid 3: GPS PPS Mode, fix valid 4: GPS RTK Mode is the checksum	6 digits after the decimal point

$PIXSE,ODRECK,x.xxxxxxxx,y.yyyyyyyy,z.zzz,m.mmm,f.ffffff,p.ppp*hh<CR><LF>		
x.xxxxxxxx **y.yyyyyyyy** **z.zzz** **m.mmm** **f.ffffff** **p.ppp** **hh**	is the dead reckoning latitude in degrees is the dead reckoning longitude in degrees is the dead reckoning altitude in meters is the heading misalignment dead reckoning estimation in degrees is the scale factor dead reckoning estimation (**) is the pitch dead reckoning estimation in degrees is the checksum	8 digits after the decimal point 8 digits after the decimal point 3 digits after the decimal point 3 digits after the decimal point 6 digits after the decimal point 3 digits after the decimal point

(**) 0.00123 means 0.123% scale factor correction.

$PIXSE,ODOIN_,x.xxx,x.xxx,x.xxx, 0.000,hhmmss.sss *hh<CR><LF>		
x.xxx **hhmmss.ssssss** **hh**	is the odometer pulse number is the validity time of odometer data is the checksum	3 digits after the decimal point 6 digits after the decimal point

$PIXSE,ALGSTS,hhhhhhhh,llllllll *hh<CR><LF>	
INS Algo status	
hhhhhhhh	is the hexadecimal value of the INS Algo status1 (LSB)
llllllll	is the hexadecimal value of the INS Algo status 2 (MSB)
hh	is the checksum

$PIXSE,STATUS,hhhhhhhh,llllllll *hh<CR><LF>	
INS System status	
hhhhhhhh	is the hexadecimal value of PHINS System status 1 (LSB)
llllllll	is the hexadecimal value of PHINS System status 2 (MSB)
hh	is the checksum

$PIXSE,HT_STS,hhhhhhhh *hh<CR><LF>	
hhhhhhhh	is the hexadecimal value of INS High Level status (***)
hh	is the checksum

(***) High Level Status is only used by iXRepeater MMI software to flag PHINS status.

$PIXSE,DSTTRV_,x.xxx*hh<CR><LF>		
x.xxx	Travelled distance in meters	3 digits after the decimal point
hh	Checksum	

$PIXSE,EVMIN_,a,b,c,d*hh<CR><LF>	
LANDINS	
a	0
b	event marker A number of events
c	event marker B number of events
d	event marker C number of events
hh	Checksum
Others (ATLANS…)	
a	event marker A number of events
b	event marker B number of events
c	event marker C number of events
d	event marker D number of events
hh	Checksum

MDL TRIM CUBE

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Custom protocol in ASCII.

Data sent: Heading, pitch and roll values.

Data frame:

HxxxxP±yyyyR±zzzz<CR><LF>		
H	'H' character	
xxxx	heading value in degrees multiplied by 10 (no sign character)	Four digits range [0000,3599]
P	'P' character	
±yyyy	pitch value in degrees multiplied by 100 with its sign character '+' or ' –'	Four digits after the sign character range [-8999,+8999]
R	'R' character	
±zzzz	roll value in degrees multiplied by 100 with its sign character '+' or ' –'	Four digits after the sign character range [-8999,+8999]

NAV BHO

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: This protocol outputs INS computed position values in an ASCII frame ; some characters of this output frame are set to fixed values.

Data frame:

$PHZDA,hhmmss.ss,dd,mm,yyyy,hh,mm*hh<CR><LF>		(****)
hhmmss.ss	is UTC time	synchronized with the last PPS frame received
dd	is the UTC day	(*)
mm	is the UTC month	(*)
yyyy	is the UTC year	(*)
hh	is the local zone hours	(*)
mm	is the local zone minutes	(*)
hh	is the checksum	

$PHGGA,hhmmss.ss,LLll.llllllll,a,LLLmm.mmmmmm,a,x,xx,x.xxx,x.xxx,M,x.xxx,M,x.xxx,xxxx*hh<CR><LF>		
hhmmss.ss	is the UTC of position	(**)
LLll.llllllll	is the latitude in degrees (LL) and in minutes (ll.llllllll)	(**) 8 digits after decimal point
a	is 'N' for Northern hemisphere, 'S' for Southern hemisphere	(**)
LLLll.llllllll	is the longitude in deg (LLL) and in minutes (ll.llllllll)	(**) 8 digits after decimal point
a	is 'E' for East, 'W' for West	(**)
x	is the GPS quality indicator	(***)
xx	is the number of satellites in use	(*)
x.xxx	is the horizontal dilution of precision (HDOP)	(**) 3 digits after decimal point
x.xxx	is the antenna altitude (meters) (here Phins altitude)	(**) 3 digits after decimal point
M	is the unit of antenna altitude (fixed character = 'M' for meters)	
x.xxx	is the Geoidal separation	(*) 3 digits after decimal point
M	is the unit of Geoidal separation (fixed character = 'M' for meters)	
x.xxx	is the age of the differential GPS data(seconds)	(*) 3 digits after decimal point
xxxx	is the differential reference station ID	(*)
hh	is the checksum	

$PHVTG,x.xxx,T,x.xxx,M,x.xxx,N,x.xxx,K,a*hh<CR><LF>		
x.xxx	iis the True course (deg)	(**) 3 digits after decimal point
T	is a fixed character = 'T'	
x.xxx	is the Magnetic course (deg) : same value as the True course	(**) 3 digits after decimal point
M	is a fixed character = 'M'	
x.xxx	is the Horizontal speed (knots)	(**) 3 digits after decimal point
N	is a fixed character = 'N'	
x.xxx	is the Horizontal speed (km/h)	(**) 3 digits after decimal point
K	is a fixed character	
a	is the positioning system mode indicator 'A', 'D' or 'E'	(**)
hh	is the checksum	

$HEHDT,x.xxxxx,T*hh<CR><LF>		
x.xxx	is the true heading in degrees	**3 digits after** the decimal point. (*****)
T	is a fixed character = 'T'	
hh	is the checksum	

$PASHR,hhmmss.sss,H.HH,T,aR.RR,bP.PP,cD.DD,r.rrr,p.ppp,h.hhh,x,y*hh<CR><LF>		
hhmmss.sss	is the UTC of the data	
H.HH	is the heading in degrees	2 digits after decimal point
T	is a fixed character = 'T'	
aR.RR	is the roll in degrees and a, its sign character '+' when port up, '–' when port down	2 digits after decimal point
bP.PP	is the pitch in degrees and b, its sign character '–' when bow down, '+' when bow up **<u>Warning:</u>** Opposite sign of PHINS usual convention	2 digits after decimal point
cD.DD	is the heave in meters and c, its sign character '–' when PHINS goes up, '+' when PHINS goes down **<u>Warning:</u>** Opposite sign of PHINS usual convention	2 digits after decimal point
r.rrr	is the roll standard deviation	3 digits after decimal point
p.ppp	is the pitch standard deviation	3 digits after decimal point
h.hhh	is the heading standard deviation	3 digits after decimal point
x	is the GPS aiding status flag 1 when GPS received, otherwise 0	
y	is the sensor error status flag 1 when FOG or ACC error, otherwise 0	
hh	is the checksum	

(*) Last GPS values received. When no GPS has been received since power up, these fields are null.

(**) INS calculated data

(***) The quality indicator is managed as follows:

INS **does not copy** the quality indicator received on GGA input to GGA output.

The quality factor is set with respect to a correspondence table between INS calculated SD and Quality indicator in GGA telegram (refer to section 1.1.4).

(****) The ZDA sentence is always sent at 1 Hz whatever the chosen refresh rate.

(*****) 5 digits after the decimal point in Military mode.

WARNING

Some empty fields are allowed in --GGA and –VTG data frames. See samples hereafter :

$--GGA,161229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M,,,,0000*18

$--GGA,064036.289,4836.5375,N,00740.9373,E,1,04,3.2,200.2,M,,,,0000*0E

$--VTG,309.62,T,,M,0.13,N,0,2,K*6

NAV BHO LONG

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Output NMEA 0183 compatible.
Data sent:	This protocol outputs INS computed position values in an ASCII frame. Some characters of this output frame are set to fixed values.
Data frame:	The ZDA sentence is always sent at 1hz whatever the chosen refresh rate.

$PHZDA,hhmmss.ss,dd,mm,yyyy,hh,mm*hh<CR><LF>		(****)
hhmmss.ss	is UTC time	synchronized with the last PPS frame received
dd	is the UTC day	(*)
mm	is the UTC month	(*)
yyyy	is the UTC year	(*)
hh	is the local zone hours	(*)
mm	is the local zone minutes	(*)
hh	is the checksum	

$PHGGA,hhmmss.ss,LLll.llllllll,a,LLLmm.mmmmmmm,a,x,xx,x.xxx,x.xxx,M,x.xxx,M,x.xxx,xxxx*hh<CR><LF>		
hhmmss.ss	is the UTC of position	(**)
LLll.llllllll	is the latitude in degrees (LL) and in minutes (ll.llllllll)	(**) 8 digits after decimal point
a	is ‘N’ for Northern hemisphere, ‘S’ for Southern hemisphere	(**)
LLLll.llllllll	is the longitude in deg (LLL) and in minutes (ll.llllllll)	(**) 8 digits after decimal point
a	is ‘E’ for East, ‘W’ for West	(**)
x	is the GPS quality indicator	(***)
xx	is the number of satellites in use	(*)
x.xxx	is the horizontal dilution of precision (HDOP)	(**) 3 digits after decimal point
x.xxx	is the antenna altitude (meters) (here Phins altitude)	(**) 3 digits after decimal point
M	is the unit of antenna altitude (fixed character = ‘M’ for meters)	
x.xxx	is the Geoidal separation	(*) 3 digits after decimal point
M	is the unit of Geoidal separation (fixed character = ‘M’ for meters)	
x.xxx	is the age of the differential GPS data(seconds)	(*) 3 digits after decimal point
xxxx	is the differential reference station ID	(*)
hh	is the checksum	

$PHGST,hhmmss.ss,x.xxx,y.yyy,z.zzz,a.aaa,x.xxx,y.yyy,z.zzz*hh<CR><LF>		
hhmmss.ss	is the UTC time of the GGA fix associated with this sentence	
x.xxx	is the RMS value of the standard deviation of the range inputs to the navigation process	(**) 3 digits after decimal point
y.yyy	is the standard deviation of semi-major axis of error ellipse (meters)	(**) 3 digits after decimal point
z.zzz	is the standard deviation of semi-minor axis of error ellipse (meters)	(**) 3 digits after decimal point
a.aaa	is the orientation of semi-major axis of error ellipse (degrees from true North)	(**) 3 digits after decimal point
x.xxx	is the standard deviation of latitude error, in meters	(**) 3 digits after decimal poin
y.yyy	is the standard deviation of longitude error, in meters	(**) 3 digits after decimal point
z.zzz	is the standard deviation of altitude error, in meters	(**) 3 digits after decimal point
hh	is the checksum	

$PHVTG,x.xxx,T,x.xxx,M,x.xxx,N,x.xxx,K,a*hh<CR><LF>		
x.xxx	iis the True course (deg)	(**) 3 digits after decimal point
T	is a fixed character = ‘T’	
x.xxx	is the Magnetic course (deg) : same value as the True course	(**) 3 digits after decimal point
M	is a fixed character = ‘M’	
x.xxx	is the Horizontal speed (knots)	(**) 3 digits after decimal point
N	is a fixed character = ‘N’	
x.xxx	is the Horizontal speed (km/h)	(**) 3 digits after decimal point
K	is a fixed character	
a	is the positioning system mode indicator ‘A’, ‘D’ or ‘E’	(**)
hh	is the checksum	

$HEHDT,x.xxxxx,T*hh<CR><LF>		
x.xxx	is the true heading in degrees	**3 digits after** the decimal point. (****)
T	is a fixed character = ‘T’	
hh	is the checksum	

(*) Last GPS values received. When no GPS has been received since power up, these fields are null.

(**) INS calculated data

(***)The quality indicator is managed as follows: INS does not copy the quality indicator received on GGA input to GGA output.

The quality factor is set with respect to the table with respect to STD = Max value of (Std lat, Std Lon) refer to section 1.1.4.

(****) 5 digits after the decimal point in Military mode.

WARNING

Some empty fields are allowed in --GGA and –VTG data frames. See samples hereafter :

$--GGA,161229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M,,,,0000*18

$--GGA,064036.289,4836.5375,N,00740.9373,E,1,04,3.2,200.2,M,,,,0000*0E

$--VTG,309.62,T,,M,0.13,N,0,2,K*6E

NAVIGATION

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: Heading, Attitude, Position, Status.

Data frame:

$HEHDT,x.xxxxx,T*hh<CR><LF>		
x.xxx	is the true heading in degrees	Float, 3 digits after the decimal point. (*)
T	is a fixed character = 'T'	
hh	is the checksum	

$PIXSE,ATITUD,x.xxx,y.yyy*hh<CR><LF>		
x.xxx	is the roll in degrees	Float, 3 digits after the decimal point. (*)
y.yyy	is the pitch in degrees	Float, 3 digits after the decimal point. (*)
hh	is the checksum	

$PIXSE,POSITI,x.xxxxxxxx,y.yyyyyyyy,z.zzz*hh<CR><LF>		
x.xxxxxxxx	is the latitude in degrees	Float, 8 digits after decimal point
y.yyyyyyyy	is the longitude in degrees	Float, 8 digits after decimal point
z.zzz	is the altitude in meters	Float, 3 digits after decimal point
hh	is the checksum	

$PIXSE,STATUS,hhhhhhhh,llllllll *hh<CR><LF>		
hhhhhhhh	is the hexadecimal value of the 32 LSB bits of the INS System status	Refer to section 3.4.2
llllllll	is the hexadecimal value of the 32 MSB bits of the INS System status	
hh	is the checksum	

(*) 5 digits after the decimal point in M Heading, Attitude, Position , Status military mode.

OCTANS STANDARD

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Output NMEA 0183 compatible.
Data sent:	Heading, Roll, Pitch, Position, Linear speed, Compensation values, Status, Date and time if ZDA option selected.
Data frame:	Heading, Roll, Pitch, Position, Linear Speeds, User Status.

NMEA **$HEHDT** Frame	refer to section 2.2.2.8
NMEA **$PHTRO** Frame	refer to section 2.2.1.14
NMEA **$PHLIN** Frame	refer to section 2.2.1.9
NMEA **$PHSPD** Frame	refer to section 2.2.1.12
NMEA **$PHCMP** Frame	refer to section 0
NMEA **$PHINF** Frame	refer to section 2.2.1.8

PFEC

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data frame:

Data Sent at 1Hz:

NMEA **$GPZDA** Frame refer to section 2.2.1.5

Data Sent at the selected refresh rate:

$PFEC,GPatt,H.H,±P.P,±R.R*hh<CR><LF>		
H.H	is the heading in degrees	1 digit after the decimal point.
P.P	is the pitch in degrees	
R.R	is the roll in degrees	

NMEA **$HEHDT** Frame refer to section 2.2.2.6

NMEA **$GPGGA** Frame refer to section 2.2.1.1

NMEA **$GPGLL** Frame refer to section 2.2.1.2

NMEA **$GPVTG** Frame refer to section 2.2.1.4

PHINS STANDARD

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: Heading, Attitude, Position, Speed, Standard deviations, Sensors input, Status.

The maximal refresh rate is 20 Hz.

Important

The value of the heave without lever arm is set to 0 when selecting Smart heave in the web-based user interface with this protocol for the output settings.

The smart heave is delayed by 100 s.

Data frame:

NMEA **$HEHDT** Frame refer to section 2.2.2.6

NMEA **$HETHS** Frame refer to section 2.2.2.8

$PIXSE,ATITUD,x.xxx,y.yyy*hh<CR><LF>		
x.xxx	is the roll in degrees	3 digits after the decimal point. (*)
y.yyy	is the pitch in degrees	3 digits after the decimal point. (*)
hh	is the checksum	

(*) 5 digits after the decimal point in military mode

$PIXSE,POSITI,x.xxxxxxxx,y.yyyyyyyy,z.zzz*hh<CR><LF>		
x.xxxxxxxx	is the latitude in degrees	8 digits after decimal point
y.yyyyyyyy	is the longitude in degrees	8 digits after decimal point
z.zzz	is the altitude in meters	3 digits after decimal point
hh	is the checksum	

$PIXSE,SPEED_,x.xxx,y.yyy,z.zzz*hh<CR><LF>		
x.xxx	Speed X_{East} in m/s (East speed)	3 digits after decimal point
y.yyy	Speed X_{North} in m/s (North speed)	3 digits after decimal point
z.zzz	Speed X_{UP} in m/s (Sign “+” towards up side)	3 digits after decimal point
hh	is the checksum	

$PIXSE,UTMWGS,c,nn,x.xxx,y.yyy,z.zzz*hh<CR><LF>		
C	is the latitude UTM zone (character)	
nn	is the longitude UTM zone (integer)	
x.xxx	is the east UTM position in meter	3 digits after decimal point
y.yyy	is the north UTM position in meter	3 digits after decimal point
z.zzz	is the altitude in meters	3 digits after decimal point
hh	is the checksum	

$PIXSE,HEAVE_,x.xxx,y.yyy,z.zzz*hh<CR><LF>		
x.xxx	is the surge in meters (signed)	3 digits after the decimal point
y.yyy	is the sway in meters (signed)	3 digits after the decimal point
z.zzz	is the heave in meters (signed)	3 digits after the decimal point
hh	is the checksum	

$PIXSE,STDHRP,x.xxx,y.yyy,z.zzz*hh<CR><LF>		
x.xxx	is the heading std dev (degrees)	3 digits after the decimal point
y.yyy	is the roll std dev (degrees)	3 digits after the decimal point
z.zzz	is the pitch std dev (degrees)	3 digits after the decimal point
hh	is the checksum	

$PIXSE,STDPOS,x.xx,y.yy,z.zz*hh<CR><LF>		
x.xx	is the latitude std dev (meters)	2 digits after the decimal point
y.yy	is the longitude std dev (meters)	2 digits after the decimal point
z.zz	is the altitude std dev (meters)	2 digits after the decimal point
hh	is the checksum	

$PIXSE,STDSPD,x.xxx,y.yyy,z.zzz*hh<CR><LF>		
x.xxx	north speed std dev (m/s)	3 digits after the decimal point
y.yyy	east speed std dev (m/s)	3 digits after the decimal point
z.zzz	vertical speed std dev (m/s)	3 digits after the decimal point
hh	is the checksum	

$PIXSE,TIME__, hhmmss.ssssss*hh<CR><LF>	
hhmmss.ssssss	is the validity time of the computed data transmitted in the UTC time reference frame if available otherwise in the system time reference frame. 6 digits after the decimal point.
hh	is the checksum

$PIXSE,LOGIN_,x.xxx,y.yyy,z.zzz,m.mmm,hhmmss.ssssss*hh<CR><LF>		
Last data received from the log bottom track sensor		
x.xxx	is the XS1 longitudinal DVL speed in m/s	3 digits after the decimal point
y.yyy	is the XS2 transverse DVL speed in m/s	3 digits after the decimal point
z.zzz	is the XS3 vertical DVL speed in m/s	3 digits after the decimal point
m.mmm	is the log heading misalignment Kalman estimation in degrees	3 digits after the decimal point
hhmmss.ssssss	is the validity time of the log data received in the UTC time reference frame if available otherwise in the system time reference frame	
hh	is the checksum	

$PIXSE,LOGDVL,x.xx,y.yy,z.zz*hh<CR><LF>		
Last raw data received from the log sensor		
x.xx	is the DVL set sound velocity in water in m/s	2 digits after the decimal point
y.yy	is the measured compensation sound velocity in m/s	2 digits after the decimal point
z.zz	is the DVL distance to bottom in meters	2 digits after the decimal point
hh	is the checksum	

$PIXSE,LOGWAT,x.xxx,y.yyy,z.zzz,n.nnn,e.eee,N.NNN,E.EEE,hhmmss.ssssss*hh<CR><LF>		
Last data received from the log water track sensor		
x.xxx	is the XS1 longitudinal DVL speed in m/s	3 digits after the decimal point
y.yyy	is the XS2 transverse DVL speed in m/s	3 digits after the decimal point
z.zzz	is the XS3 vertical DVL speed in m/s	3 digits after the decimal point
n.nnn	is the north current speed in in m/s	3 digits after the decimal point
e.eee	is the east current speed in m/s	3 digits after the decimal point
N.NNN	is the north current speed std dev in m/s	3 digits after the decimal point
E.EEE	is the east current speed std dev in m/s	3 digits after the decimal point
hhmmss.ssssss	is the validity time of the log WT data received in the UTC time reference frame if available otherwise in the system time reference frame	6 digits after decimal point
hh	is the checksum	

$PIXSE,GPSIN_,x.xxxxxxx,y.yyyyyyy,z.zzz,hhmmss.ssssss,q*hh<CR><LF>		
Last data received from the GPS 1 sensor		
x.xxxxxxx	is the latitude in degrees	8 digits after the decimal point
y.yyyyyyy	is the longitude in degrees	8 digits after the decimal point
z.zzz	is the altitude in meters	3 digits after the decimal point
hhmmss.ssssss	is the validity time of the GPS data received in the UTC time reference frame if available otherwise in the system time reference frame	6 digits after the decimal point
q	is the GPS quality indicator 0 and ≥ 5 Fix not valid 1 GPS SPS Mode Fix not valid 2 Differential Mode, SPS Mode, Fix not valid 3 GPS PPS Mode, Fix not valid 4 GPS RTK Mode	
hh	is the checksum	

$PIXSE,GP2IN_,x.xxxxxxx,y.yyyyyyy,z.zzz,hhmmss.ssssss,q*hh<CR><LF>		
Last data received from the GPS 2 sensor		
x.xxxxxxx	Is the latitude in degrees	8 digits after the decimal point
y.yyyyyyy	is the longitude in degrees	8 digits after the decimal point
z.zzz	is the altitude in meters	3 digits after the decimal point
hhmmss.ssssss	is the validity time of the GPS 2 data received in the UTC time reference frame if available otherwise in the system time reference frame	6 digits after the decimal point
q	is the GPS quality indicator 0 and ≥ 5 Fix not valid 1 GPS SPS Mode fix valid 2 Differential Mode, SPS Mode, fix valid 3 GPS PPS Mode, fix valid 4 GPS RTK Mode	
hh	is the checksum	

$PIXSE,GPMIN_,x.xxxxxxx,y.yyyyyyy,z.zzz,hhmmss.ssssss,q*hh<CR><LF>		
Last data received from the manual GPS sensor		
x.xxxxxxx	is the latitude in degrees	8 digits after the decimal point
y.yyyyyyy	is the longitude in degrees	8 digits after the decimal point
z.zzz	is the altitude in meters	3 digits after the decimal point
hhmmss.ssssss	is the validity time of the Manual GPS data received in the UTC time reference frame if available otherwise in the system time reference frame	6 digits after the decimal point
q	is the GPS quality indicator 0 and ≥ 5 Fix not valid 1 GPS SPS Mode fix valid 2 Differential Mode, SPS Mode, fix valid 3 GPS PPS Mode, fix valid 4 GPS RTK Mode	
hh	is the checksum	

$PIXSE,DEPIN_,x.xxx,hhmmss.ssssss*hh<CR><LF>		
Last data received from the depth sensor		
x.xxx	is the depth in meters	3 digits after the decimal point
hhmmss.ssssss	is the validity time of the depth sensor data received in the UTC time reference frame if available otherwise in the system time reference frame	6 digits after the decimal point
hh	is the checksum	

$PIXSE,USBIN_,x.xxxxxxxx,y.yyyyyyyy,z.zzz,d.dd,hhmmss.ssssss,n,ccccccc*hh<CR><LF>		
Last data received from the USBL sensor		
x.xxxxxxxx	is the latitude in degrees	8 digits after the decimal point
y.yyyyyyyy	is the longitude in degrees	8 digits after the decimal point
z.zzz	is the altitude in meters	3 digits after the decimal point
d.dd	is the delay (age of data) in seconds	2 digits after the decimal point
hhmmss.ssssss	is the validity time of the USBL data received in the UTC time reference frame if available otherwise in the system time reference frame	
n	number of configured beacon for display	
ccccccc	TP code of the beacon	7 ASCII characters
hh	is the checksum	

$PIXSE,LBLIN_,x.xxxxxxx,y.yyyyyyyy,z.zzz,n,r.rrr,hhmmss.ssssss*hh<CR><LF>		
Last data received from the LBL		
x.xxxxxxxx	is the latitude of the beacon in degrees	8 digits after the decimal point
y.yyyyyyyy	is the longitude of the beacon in degrees	8 digits after the decimal point
z.zzz	is the altitude of the beacon in meters	3 digits after the decimal point
n	is the beacon internal index (i.e : 0, 1, 2 or 3)	
r.rrr	is the range in meters	3 digits after the decimal point
hhmmss.ssssss	is the validity time of the LBL data received in the UTC time reference frame if available otherwise in the system time reference frame	6 digits after the decimal point
hh	is the checksum	

$PIXSE,UTCIN_,hhmmss.ssssss*hh<CR><LF>		
Last UTC received		
hhmmss.ssssss	is the UTC time received	6 digits after the decimal point
hh	is the checksum	

$PIXSE,LMNIN_,x.xxx,n.nnn,e.eee,N.NNN,E.EEE,hhmmss.ssssss*hh<CR><LF>		
Last data received from the log EM sensor		
x.xxx	is the XS1 speed in m/s	3 digits after the decimal point
n.nnn	is the speed of the north current in m/s	3 digits after the decimal point
e.eee	is the speed of the east current in m/s	3 digits after the decimal point
N.NNN	is the north current speed std dev in m/s	3 digits after the decimal point
E.EEE	is the east current speed std dev in m/s	3 digits after the decimal point
hhmmss.ssssss	is the validity time of the EM log data received in the UTC time reference frame if available otherwise in the system time reference frame	6 digits after the decimal point
hh	is the NMEA checksum	

$PIXSE,DDRECK,x.xxxxxxxx,y.yyyyyyyy,z.zzz,m.mmm,f.ffffff,p.ppp*hh<CR><LF>		
x.xxxxxxxx	is the dead reckoning latitude in degrees	8 digits after the decimal point
y.yyyyyyyy	is the dead reckoning longitude in degrees	8 digits after the decimal point
z.zzz	is the dead reckoning altitude in meters	3 digits after the decimal point
m.mmm	is the heading misalignment dead reckoning estimation in degrees	3 digits after the decimal point
f.ffffff	is the scale factor dead reckoning estimation (*)	3 digits after the decimal point
p.ppp	is the pitch dead reckoning estimation in degrees	3 digits after the decimal point
hh	is the checksum	

(*) 0.00123 means 0.123% scale factor correction.

$PIXSE,CALCHK,x.xx,y.yy,z.zz*hh<CR><LF>	
Calibration check frame. This frame is only transmitted when calibration verification is active	
x.xx	is the travelled distance from start of verification line in meters
y.yy	is the current vertical error in meters
z.zz	is the current horizontal error in meters
hh	is the checksum

$PIXSE,ALGSTS,hhhhhhhh,llllllll *hh<CR><LF>	
INS Algo status (refer to section 3.4.3)	
hhhhhhhh	is the hexadecimal value of INS Algo status1 (LSB)
llllllll	is the hexadecimal value of INS Algo status 2 (MSB)
hh	is the checksum

$PIXSE,STATUS,hhhhhhhh,llllllll *hh<CR><LF>	
INS System status (refer to section 3.4.2)	
hhhhhhhh	is the hexadecimal value of INS System status 1 (LSB)
llllllll	is the hexadecimal value of INS System status 2 (MSB)
hh	is the checksum

$PIXSE,SORSTS,hhhhhhhh,llllllll *hh<CR><LF> (*)	
INS Sensor status (refer to section 3.4.4)	
hhhhhhhh	is the hexadecimal value of INS Sensor status 1 (LSB)
llllllll	is the hexadecimal value of INS Sensor status 2 (MSB)
hh	is the checksum

(*) This telegram is only sent on the repeater link data flow.

$PIXSE,HT_STS,hhhhhhhh *hh<CR><LF>	
INS Sensor status (refer to section 3.4.4)	
hhhhhhhh	is the hexadecimal value of INS High Level repeater status (*)
hh	is the checksum

(*) High Level Repeater Status is only used by IXRepeater MMI software to flag INS status.

$PIXSE,FOGEST,x.xxxx,y,yyyy,z,zzzz*hh <CR><LF>	
x.xxxx	is the error FOG X estimation in 10^{-3} °/h
y.yyyy	is the error FOG Y estimation in 10^{-3} °/h
z .zzzz	is the error FOG Z estimation in 10^{-3} °/h
hh	is the checksum

$PIXSE,ACCEST,x.xxxx,y,yyyy,z,zzzz*hh <CR><LF>	
x.xxxx	is the error ACC X estimation in µg
y.yyyy	is the error ACC Y estimation in µg
z .zzzz	is the error ACC Z estimation in µg
hh	is the checksum

$PIXSE,LOGEST,x.xxxx*hh <CR><LF>	
x.xxxx	is the error log estimation in °
hh	is the checksum

(**) Data frames LOGIN_, LOGVDL, GPSIN_, DEPIN_, USBIN_, LBLIN_ … are sent only when updated data is received from the external sensor (DDRECK if dead reckoning mode is turned on).

POSIDONIA 6000

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	POSIDONIA 6000.
Data sent:	Latitude, Hemisphere, Longitude, Direction, GPS mode, Norm speed, Roll, Pitch, Heading.
Data frame:	ASCII format.

$CAPACK,LLll.lll,a,LLll.lll,b,m,SS.SS,sR.RR,sP.PP,sH.HH*hh<CR><LF>		
LLll.lll	is the latitude in degrees (LL) and in minutes (ll.lll)	3 digits after decimal point
a	is ‘N’ for Northern hemisphere, ‘S’ for Southern hemisphere	
LLll.lll	is the longitude in deg (LL) and in minutes (ll.lll)	3 digits after decimal point
b	is ‘E’ for East, ‘W’ for West	
m	is the GPS quality indicator*	
SS.SS	is the horizontal speed norm in knots	2 digits after decimal point
sR.RR	is the roll in degrees and s is the sign character ‘ + ’ for port up and ‘ - ’ for port down. -180° to +180°.	2 digits after decimal point
sP.PP	is the pitch in degrees and s is the sign character ‘ + ’ for bow down and ‘ - ’ for bow up. -90° to +90°.	2 digits after decimal point
sH.HH	is the heading in degrees and s is the sign character even if always ‘ + ’ for PHINS. +0 to +360°.	2 digits after decimal point
hh	is the checksum	

* The INS **does not copy** the quality indicator received on GGA input to GGA output. The quality factor is set with respect to a correspondence table between INS calculated SD and Quality indicator in GGA telegram (refer to section 1.1.4).

PRDID

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: Pitch, Roll, Heading.

Data frame:

$PRDID,aPPP.PP,bRRR.RR,HHH.HH*hh<CR><LF>		
aPPP.PP	is the pitch in degrees and a, its sign character '–' when bow down, '+' when bow up **Warning:** Opposite sign of PHINS usual convention	2 digits after decimal point
bRRR.RR	is the roll angle in degrees and a, its sign character '–' for port down, '+' for port up	2 digits after decimal point
HHH.HH	is the heading in degrees.	
hh	is the checksum	

PRDID TSS

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: Pitch, Roll, Heading.

Data frame:

$PRDID,aPPP.PP,bRRR.RR,HHH.HH*hh<CR><LF>		
aPPP.PP	is the pitch in degrees and a, its sign character '–' when bow down, '+' when bow up **Warning:** Opposite sign of INS usual convention	(*) 2 digits after the decimal point
bRRR.RR	is the roll angle in degrees and a, its sign character '–' for port down, '+' for port up	(*) 2 digits after the decimal point
HHH.HH	is the heading in degrees	
hh	is the checksum	

(*) The attitude angles are computed with respect to TSS convention.

Roll and Pitch are referenced to the local vertical acceleration.

The formula calculation with respect to INS standard convention (Euler Angle or Tate Bryant) is given hereafter:

$Roll_{TSS} = Sin^{-1}(Sin(Roll_{TB}) \times Cos(Pitch_{TB}))$ and $Pitch_{TSS} = Pitch_{TB}$

PRECISE ZDA

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183.

Data sent: UTC time, UTC day, UTC month, UTC year, Local zone hours, Local zone minutes.

Data frame: Following frame is sent at 1 Hz.

$GPZDA,hhmmss.ss,dd,mm,yyyy,hh,mm*hh<CR><LF>			
where:	**hhmmss.ssssss**	UTC time	**
	dd	UTC day	**
	mm	UTC month	**
	yyyy	UTC year	**
	hh	local zone hours	*
	mm	local zone minutes	*
	hh	checksum	**

* Copy of last GPS values received. When no GPS has been received since power up, these fields are null.

** INS calculated data.

The time in the message has 6 digits after the comma. It corresponds to the transmission of the PPS LIKE output pulse, if this pulse is enabled.

PTNL GGK

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: The $PTNLG, GGK is provided to simulate a Trimble GPS output. Some characters of this output frame are set to fixed values and some empty fields are allowed.

See samples hereafter when there is no ZDA input :

$PTNL,GGK,000527.01,,4852.2000122,N,00200.0000013,E,6,03,613.8,EHT0.000,M*7C

Time management in INS: If INS has never received GPS, date starts on 1st January 2006. Otherwise date is maintained on GPS time as soon as GPS time is received.

If GPS is lost, INS will maintain time with its internal clock.

If INS is synchronized with GPS time, the time tags are UTC time, otherwise they are INS time (time since power-up of the system).

$PTNL,GGK,hhmmss.ss,ddmmyy,LLII.IIIIIII,a, LLII.IIIIIII,a,x,y.z.z,EHTx.xxx,M*hh<CR><LF>		
GGK	Message ID	Fixed value
hhmmss.ss	UTC time of position fix.	**
ddmmyy	UTC date of position fix (empty field allowed).	**
LLII.IIIIIII	Latitude in degrees (LL) and in minutes (II.IIIIIII)	**
a	'N' for Northern hemisphere, 'S' for Southern hemisphere	**
LLII.IIIIIII	Longitude in deg (LLL) and in minutes (II.IIIIIII)	**
a	'E' for East, 'W' for West	**
x	GPS quality indicator***	**
y	Number of satellites in fix	*
z.z	DOP of fix (1 digit after coma)	**
EHTx.xxx	Height above ellipsoid (3 digits after coma)	**
M	Ellipsoid height measured in meters.	*
hh	Checksum	**

* Copy of last GPS values received. When no GPS has been received since power up, these fields are null.

** The INS calculated data.

*** The quality indicator is managed as follows:

- The INS **does not copy** the quality indicator received on GGA input to GGA output.
- The quality factor is set with respect to a correspondence table between INS calculated SD and Quality indicator in GGA telegram (refer to section 1.1.4).

Sample telegram:

$PTNL,GGK,180432.00,101300,4027.0279123,N,08704.8570697,W,4,07,1.7,EHT178.340,M*69

RDI PD11

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: There are 3 NMEA0183 sentences containing sensor and navigational data. All data are here INS computed output data. All data fields are variable width. Empty data fields will indicate missing or invalid data.

Note:

- Data is output in telegram $PRDIH:
- If GPS and/or DVL bottom track data is valid.
- Data is output in telegram $PRDII:
- If GPS or DVL water track data is valid.
- If no GPS, DVL water track and DVL bottom track are valid, no data is output in $PRDIH and $PRDII telegrams.
- In all cases data in the $PRDIG, $PRDIH and $PRDII telegram are PHINS data.

Data frame:

$PRDIG,H,x.xxx,P,x.xxx,R,x.xxx,D,x.xxx*hh<CR><LF>			
H	Heading ID	Fixed character	
x.xxx	Heading	0.000 to 360.000 deg	3 digits after decimal point
P	Pitch ID	Fixed character	
x.xxx	Pitch	-90.000 to 90.000 deg	3 digits after decimal point
R	Roll ID	Fixed character	
x.xxx	Roll	-180.000 to 180.000 deg	3 digits after decimal point
D	Depth ID	Fixed character	
x.xxx	Depth below surface	In meters	3 digits after decimal point
hh	Is the checksum		

$PRDIH,R,x.x,S,x.xxx,C,x.xxx*hh<CR><LF>			
R	Range to bottom ID	Fixed character	
x.x	Range to bottom	In meters	1 digit after decimal point
S	Speed over ground ID	Fixed character	
x.xxx	Speed over ground	In meters/second	3 digit after decimal point
C	Course over ground ID	Fixed character	
x.xxx	Course of speed over ground	0.000 to 360.000 deg	3 digit after decimal point
hh	Is the checksum		

$PRDII,S,x.xxx,C,x.xxx*hh<CR><LF>			
S	Speed relative to water ID	Fixed character	
x.xxx	Speed relative to water	In meters/second	3 digit after decimal point
C	Course of speed relative to water ID	Fixed character	
x.xxx	Course of speed relative to water	0.000 to 360.000 deg	3 digit after decimal point
hh	Is the checksum		

RDI PING

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: RDI Start Pinging command.

Data frame:

When this protocol is selected on the INS output port that is connected to the DVL input, the INS will send a CS command each time the INS is powered on. This can avoid issue of DVL stopping to ping when INS is powered on. At INS power on, the DVL can sometimes interprets initial flow sent on the output of INS as a break command.

CS<CR><LF>	
CS	Start Ping Command

RDI SYNC

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

This output protocol is used to trigger acoustic emission at the rate chosen by this output protocol.

DVL should be set with CF10110 instead of CF11110 (default value).

Sending the F1 character triggers the acoustic output at the chosen output frequency of this protocol.

F1<CR><LF>		
F1	Space + enter	Fixed character

RIEGL

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: ARINC 705 (aviation standard).

Data sent: Latitude, longitude, altitude, roll, pitch, yaw.

Data frame: Data is separated by space characters.

Example: 50759.013 48.33841614 15.93149532 471.005 -0.8156 7.1238 71.1383

t.ttt x.xxxxxxxx y.yyyyyyyy z.zzz r.rrrr p.pppp h.hhhh<CR><LF>		
t.ttt	UTC time stamp in seconds (0-24 h) (*)	Long double, 3 digits after the decimal point
x.xxxxxxxx	Latitude in degrees	Float, 8 digits after the decimal point
y.yyyyyyyy	Longitude in degrees	Float, 8 digits after the decimal point
z.zzz	Altitude in meters	Float, 3 digits after the decimal point
r.rrrr	Roll in degrees, positive port up, [-180° to +180°]	Float, 4 digits after the decimal point
p.pppp	Pitch in degrees, positive bow up, [-90° to +90°]	Float, 4 digits after the decimal point
h.hhh	Heading in degrees, [0° to 360°]	Float, 4 digits after the decimal point

(*) INS time or UTC time if INS is synchronized with GPS time.

SENIN

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: ASCII.

Data sent: This protocol outputs PHINS computed position, speed, time, standard deviations values in an “GPS like” format. It also output NMEA telegram for heading, roll and pitch.

Time management in INS:

If PHINS has never received GPS, date starts on 1st January 2006. Otherwise date is maintained on GPS time as soon as GPS time is received.

If GPS is lost, INS will maintain time with its internal clock.

If INS is synchronized with GPS time, the time tags are UTC time, otherwise they are INS time (time since power-up of the system).

$PHGGA,hhmmss.ss,LLII.IIIIIII,a,LLLII.IIIIIII,a,x,xx,x.xxx,x.xxx,M,x.xxx,M,x.xxx,xxxx*hh<CR><LF>		
hhmmss.ss	UTC time of position	**
LLII.IIIIIII	Latitude in degrees (LL) and in minutes (II.IIIIIII)	**
a	‘N’ for Northern hemisphere, ‘S’ for Southern hemisphere	**
LLLII.IIIIIII	Longitude in deg (LLL) and in minutes (II.IIIIIII)	**
a	‘E’ for East, ‘W’ for West	**
x	GPS quality indicator	**
xx	Number of satellites in use	*
x.xxx	Horizontal dilution of precision (HDOP)	**
x.xxx	Antenna altitude above mean sea level (geoid) (meters)	**
M	Unit of antenna altitude (fixed character = ‘M’ for meters)	**
x.xxx	Geoidal separation	*
M	Unit of Geoidal separation (fixed character = ‘M’ for meters)	*
x.xxx	Age of the differential GPS data	*
xxxx	Differential reference station ID	*
hh	Checksum	**

$PHGST,hhmmss.ss,x.x,x.x,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>		
hhmmss.ss	UTC Time	**
x.x	RMS value of the standard deviation on pseudo-ranges	*
x.x	Standard deviation of semi-major axis of error ellipse in meters	**
x.x	Standard deviation of semi-minor axis of error ellipse in meters	**
x.x	Orientation of semi-major axis of error ellipse	**
x.x	Standard deviation of the error of Latitude in meters	**
x.x	Standard deviation of the error of Longitude in meters	**
x.x	Standard deviation of the error of Altitude	**
hh	Checksum	**

$PHVTG,x.xxx,T,x.xxx,M,x.xxx,N,x.xxx,K,a*hh<CR><LF>		
x.xxx	True course (deg)	**
T	Fixed character = 'T'	**
x.xxx	Magnetic course (deg)	** identical to true course
M	Fixed character = 'M'	**
x.xxx	Speed (knots)	**
N	Fixed character = 'N'	**
x.xxx	Speed (km/h)	**
K	Fixed character='K'	**
a	Positioning system mode indicator 'A', 'D' or 'E'	***
hh	Checksum	**

$HEHDT,x.xxx,T*hh<CR><LF>		
x.xxx	is the true heading in degrees	**3 digits after** the decimal point (5 in Military mode)
T	is a fixed character = 'T'	
hh	is the checksum	

$PHTRO,x.xx,a,y.yy,b*hh<CR><LF>		
x.xx	is the pitch in degrees	**2 digits after** the decimal point
a	is 'M' for bow up and 'P' for bow down	
y.yy	is the roll in degrees	**2 digits after** the decimal point
b	is 'B' for port down and 'T' for port up	
hh	is the checksum	

Notes:

*Copy of last GPS values received. When no GPS has been received since power up, these fields are null.

** INS calculated data.

*** The quality indicator is managed as follows:

INS does not copy the quality indicator received on GGA input to GGA output.

The quality factor is set with respect to a correspondence table between INS calculated SD and Quality indicator in GGA telegram (refer to section 1.1.4).

WARNING

Some empty fields are allowed in --GGA and –VTG data frames.

See samples hereafter:

$--GGA,161229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M,,,,0000*18

$--GGA,064036.289,4836.5375,N,00740.9373,E,1,04,3.2,200.2,M,,,,0000*0E

$--VTG,309.62,T,,M,0.13,N,0,2,K*6E

STOLT OFFSHORE

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible with Seatex MRU system.

Data sent: Heading, Roll, Pitch, Roll speed, Pitch speed, Heading speed.

Data frame:

$PSXN,S,ddd,X1,X2,X3,X4,X5,X6,*hh<CR><LF>		**Note 3**
S	Status S = 10 for data valid S = 11 for data invalid	**Note 1**
ddd	User identification = 014	Three fixed Ascii characters
X1	Pitch in radian Warning: Opposite sign of INS/OCTANS usual convention	**Note 2**
X2	Roll in radian	**Note 2**
X3	Heading in radian	**Note 2**
X4	Pitch speed in radian/second, positive when PSXN pitch value increases Warning: Opposite sign of INS/OCTANS usual convention	**Note 2**
X5	Roll speed in radian/second, positive when roll increases	**Note 2**
X6	Heading speed in radian/second, positive when heading decreases	**Note 2**
hh	Checksum	**Note 2**

Note 1: S = 11 when one of those INS User status bit is set to 1

FOG_ANOMALY

ACC_ANOMALY

TEMPERATURE_ERR

CPU_OVERLOAD

DYNAMIC_EXCEEDED

SPEED_SATURATION

ALTITUDE_SATURATION

ALIGNMENT

DEGRADED_MODE

FAILURE_MODE

Note 2: x1, x2, x3, x4, x5, x6 are written as floats in scientific format (for example –2.5648e01)

Note 3: STOLT OFFSHORE Telegram sample :

$PSXN,11,014,-4.000e-03,-1.350e-02,1.254e-01,0.000e+00,0.000e+00,0.000e+00,*0B<CR><LF>

STOLT OFFSHORE 2

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible with Seatex MRU system.

Data sent: Heading, Roll, Pitch, Roll speed, Pitch speed, Heading speed.

Data frame:

$PSXN,S,dd,X1,X2,X3,X4,X5,X6*hh<CR><LF		
S	Status S = 10 when no error occurs S = 11 when one or more error occurs	**Note 1**
dd	User identification = 14	Two fixed Ascii characters
X1	Pitch in radian Warning: Opposite sign of PHINS usual convention	**Note 2**
X2	Roll in radian	**Note 2**
X3	Heading in radian	**Note 2**
X4	Pitch speed in radian/second, positive when PSXN pitch value increases Warning: Opposite sign of PHINS usual convention	**Note 2**
X5	Roll speed in radian/second, positive when roll increases	**Note 2**
X6	Heading speed in radian/second, positive when heading decreases	**Note 2**
hh	Checksum	

Note 1

S = 11 when one of those INS User status bit is set to 1.

FOG_ANOMALY

ACC_ANOMALY

TEMPERATURE_ERR

CPU_OVERLOAD

DYNAMIC_EXCEEDED

SPEED_SATURATION

ALTITUDE_SATURATION

ALIGNMENT

DEGRADED_MODE

FAILURE_MODE

Note 2: x1, x2, x3, x4, x5, x6 are written as floats in scientific format (for example –2.5648e01)

SUBMERGENCE A

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: Navigation data and algorithm status in a **SUBGP1** sentence. i.e only one **SUBGP** sentence : NMEA **$PIXSE,SUBGP1** Non standard Frame, here defined.

$PIXSE,SUBGP1,hhmmss.sss,x.xxxxxxx,y.yyyyyyy,z.zzz,d.ddd,e.eee,n.nnn,v.vvv,w.www,h.hhh,r.rrr,p.ppp ,l.lll,t.ttt,hhhhhhhh,llllllll *hh<CR><LF>			
hhmmss.sss	Time		UTC Time
x.xxxxxxx	Latitude	[degrees]	+/-90° ; + for North, - for South
y.yyyyyyy	Longitude	[degrees]	+/-180° ; + for East, - for West
z.zzz	Range to bottom*	[meters]	Unprocessed DVL data. Always +
d.ddd	Altitude (-Depth)	[meters]	Distance from actual sea surface. Always - for a submarine.
e.eee	East speed	[m/s]	+ when moving Eastwards
n.nnn	North speed	[m/s]	+ when moving Northwards
v.vvv	Vertical speed	[m/s]	+ when moving Upwards
w.www	Speed through water	[m/s]	Reserved. Set to 0.000
h.hhh	Heading - True	[degrees]	0-359, 0 is True North
r.rrr	Roll	[degrees]	+ when Port side is up
p.ppp	Pitch	[degrees]	+ when Bow is down
l.lll	XV1 Longitudinal velocity	[m/s]	+ when moving forward.
t.ttt	-XV2 Transverse velocity	[m/s]	+ when moving to Starboard. **Warning:** Opposite sign of INS usual convention
hhhhhhhh	INS algo status 1		Hex value of the first 32 LSB of INS algorithm status
llllllll	INS algo status 2		Hex value of the 32 MSB of INS algorithm status
hh	Checksum		NMEA checksum

*If DVL bottom track data is valid. Otherwise, value is 0.

SUBMERGENCE B

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: Navigation data and algorithm status in a **SUBGP1** sentence.
Navigation data standard deviation in a **SUBGP2** sentence.
Raw Data data in a **SUBGP3** sentence.
I.e three **SUBGP** sentences:
NMEA **$PIXSE,SUBGP1** Non standard Frame (see SUBMERGENCE A sentence).
NMEA **$PIXSE,SUBGP2** Non standard Frame.
NMEA **$PIXSE,SUBGP3** Non standard Frame.

Data frame:

$PIXSE,SUBGP2,x.xx,y.yy,z.zz,d.dd,e.ee,n.nn,v.vv,w.ww,h.hh,r.rr,p.pp,l.ll,t.tt*hh<CR><LF>			
x.xx	Latitude std dev	[meters]	
y.yy	Longitude std dev	[meters]	
z.zz	Range to bottom std dev	[meters]	Data not currently available. Always = 0.00
d.dd	Depth std dev (Altitude std dev)	[meters]	
e.ee	East speed std dev	[m/s]	
n.nn	North speed std dev	[m/s]	
v.vv	Vertical speed std dev	[m/s]	
w.ww	Speed through water std dev	[m/s]	Reserved. Always = 0.00
h.hh	Heading std dev	[degrees]	
r.rr	Roll std dev	[degrees]	
p.pp	Pitch std dev	[degrees]	
l.ll	XV1 longitudinal velocity std dev	[m/s]	See NOTE 1 Above
t.tt	XV2 transverse velocity std dev	[m/s]	See NOTE 1 Above
hh	Checksum		NMEA checksum

$PIXSE,SUBGP3,a.aaa,b.bbb,c.ccc,d.ddd,e.eee,f.fff*hh<CR><LF>			
a.aaa	Heading rate	[°/s]	Heading speed, + when heading increases.
b.bbb	Roll rate	[°/s]	+ when roll increases
c.ccc	Pitch rate	[°/s]	+ when pitch increases
d.ddd	XV1 longitudinal acceleration	[m/s²]	+ when accelerating forwards
e.eee	-XV2 transverse acceleration	[m/s²]	+ when accelerating to starboard Warning: Opposite sign of INS usual convention
f.fff	XV3 vertical acceleration	[m/s²]	+ when accelerating upwards
hh	Checksum		NMEA checksum

NOTE 1: Longitudinal and transverse velocity std dev are computed as follow :

$$\sigma(V_{XV1}) = \sqrt{(V_{UP}{}^2 \cdot \sigma(P)^2 + V_{east}{}^2 \cdot \sigma(H)^2}$$

$$\sigma(V_{XV2}) = \sqrt{(V_{UP}{}^2 \cdot \sigma(R)^2 + V_{North}{}^2 \cdot \sigma(H)^2}$$

Where

$\sigma(V_{XV1})$: XV1 longitudinal velocity std dev

$\sigma(V_{XV2})$:: XV2 transverse velocity std dev

V_{North}, V_{East}, V_{Up} : North, East and Vertical speeds.

H: Heading

R: Roll angle

P: Pitch angles

TECHSAS

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183.

Data sent: Heading, Roll, Pitch, Heave, standard deviations for Heading, Roll and Pitch, Status flags.

Data frame:

$PASHR,hhmmss.sss,H.HH,T,aR.RR,bP.PP,cD.DD,r.rrr,p.ppp,h.hhh,x,y*hh<CR><LF>		
hhmmss.sss	is the UTC of the data	
H.HH	is the heading in degrees, no sign character	2 digits after decimal point
T	is a fixed character = 'T'	
aR.RR	is the roll in degrees and a, its sign character '+' when port up, '–' when port down	2 digits after decimal point
bP.PP	is the pitch in degrees and b, its sign character '–' when bow down, '+' when bow up **Warning:** Opposite sign of INS usual convention	2 digits after decimal point
cD.DD	is the heave in meters and c, its sign character '–' when PHINS goes up, '+' when PHINS goes down **Warning:** Opposite sign of INS usual convention	
r.rrr	is the roll standard deviation	3 digits after decimal point
p.ppp	is the pitch standard deviation	3 digits after decimal point
h.hhh	is the heading standard deviation	3 digits after decimal point
x	is the GPS aiding status flag 1 when GPS received and valid, otherwise 0	x = 1 when the following INS User status bit is set to 1 GPS_RECEIVED_VALID otherwise x = 0
y	is the sensor error status flag 1 when ACC or FOG error, otherwise 0	y = 1 when one of those INS User status bit is set to 1 FOG_ANOMALY ACC_ANOMALY otherwise y = 0
hh	is the checksum	

TECHSAS TSS

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: Heading, Roll, Pitch, Heave, standard deviations for Heading, Roll and Pitch, Status flags.

Data frame:

$PASHR,hhmmss.sss,H.HH,T,aR.RR,bP.PP,cD.DD,r.rrr,p.ppp,h.hhh,x,y*hh<CR><LF>		
hhmmss.sss	is the UTC of the data	
H.HH	is the heading in degrees	Float, 2 digits after decimal point
T	is a fixed character = ‘T’	
aR.RR	is the roll in degrees and a, its sign character (*) ‘+’ when port up, ‘–‘ when port down	Float, 2 digits after decimal point
bP.PP	is the pitch in degrees and b, its sign character (*) ‘–‘ when bow down, ‘+’ when bow up **<u>Warning:</u>** Opposite sign of INS usual convention	Float, 2 digits after decimal point
cD.DD	is the heave in meters and c, its sign character ‘–’ when INS goes up, ‘+’ when INS goes down **<u>Warning:</u>** Opposite sign of INS usual convention	Float, 2 digits after decimal point
r.rrr	is the roll standard deviation	Float, 3 digits after decimal point
p.ppp	is the pitch standard deviation	Float, 3 digits after decimal point
h.hhh	is the heading standard deviation	Float, 3 digits after decimal point
x	is the GPS aiding status flag 1 when GPS received and valid, otherwise 0	
y	is the sensor error status flag 1 when ACC or FOG error, otherwise 0	
hh	is the checksum	

***** The attitude angles are computed with respect to TSS convention. Roll and Pitch are referenced to the local vertical acceleration. The formula calculation with respect to INS standard convention (Euler Angle or Tate Bryant) is given hereafter: $Roll_{TSS} = Sin^{-1}(Sin(Roll_{TB}) \times Cos(Pitch_{TB}))$ and $Pitch_{TSS} = Pitch_{TB}$

TOKIMEC_PTVF

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

The number of characters in the string (including carriage return line feed) is always 75.

$PTVF,abbbbP,cddddR,eee.eT,fgg.gPR,hii.iRR,jkk.kAR,lmm.mN,yyyMD,000sAL*nn<CR><LF>		
abbbb	is the Pitch in degrees bb(deg)bb(min) sign character a : [-] bow up / [space] bow down	
cdddd	is the Roll in degrees dd(deg)dd(min) sign character c : [-] port up / [space] port down	**Warning:** Opposite sign of INS usual convention
eee.e	is the Heading in degrees no sign character	[0 to 359.9] 0° at North and increasing when bow turns starboard.
fgg.g	is the Pitch Rate in degrees/sec sign character f : [-] bow up / [space] bow down **Note 1**	Sign of the INS pitch derivative.
hii.i	is the Roll Rate in degrees/sec sign character h : [-] port up / [space] port down **Note 1**	Sign of the INS roll derivative **Warning:** Opposite sign of INS usual convention
jkk.k	is the Heading Rate in degrees/sec sign character j : [-] CCW / [space] CW **Note 1**	Sign of the INS heading derivative
lmm.m	is the vessel speed in Knots sign character l : [-] is astern / [space] ahead	
yyy	NOT USED.	3 digits fixed to 000
s	Hexadecimal value of the Status flag (one digit) **Note 2**	
hh	checksum of all in string but $ and * characters	NMEA Checksum

Note 1: These data are attitude rates and are given in the INS reference frame (X1, X2, X3). See AD2.

Note 2 : Status flag

Meaning	Value	Links with INS status words
IDLE	= 0	INS System status 2 WAIT_FOR_POSITION
Coarse stationary alignment	= 1	INS User status & INS System status 2 ALIGNMENT **AND NOT** WAIT_FOR_POSITION **AND NOT** Alignment mode (**Note 3**)
Fine stationary alignment – Not complete	= 2	INS User status FINE_ALIGNMENT **AND NOT** Alignment mode (**Note 3**)
Fine stationary alignment – Complete	= 3	INS User status **NOT** (ALIGNMENT **OR** FINE_ALIGNEMENT) **AND NOT** Alignment mode (**Note 3**)
Coarse GPS alignment	= 4	INS User status & INS System status 2 ALIGNMENT **AND NOT** WAIT_FOR_POSITION **AND** Alignment mode (**Note 3**)
Fine GPS alignment – Not complete	= 5	INS User status FINE_ALIGNMENT **AND** Alignment mode (Note 3)
Fine GPS alignment – Complete	= 6	INS User status **NOT** (ALIGNMENT **OR** FINE_ALIGNEMENT) **AND** Alignment mode (**Note 3**)
Aided navigation	= 9 Not used	NA
System failure (This state has priority over all the other states)	= A	INS User status CPU_OVERLOAD **OR** TEMPERATURE_ERR **OR** INPUT_x_ERR **OR** OUTPUT_x_ERR **OR** FAILURE_MODE

Note 3: Logic of the Alignment mode flag

Meaning	Value	Links with INS status words
Alignment mode	= 0 without position = 1 with position	INS System status 2 GPS_DETECTED **OR** GPS2_DETECTED seen at least once during coarse alignment with a rejection mode set to Always True or to Automatic Reacquisition. When this alignment mode flag is set to one, it will remain set to one for GPS dropouts.

TSS335B

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output TSS proprietary protocol.

Data sent: Roll, Pitch, Heave, Linear accelerations, Status Accelerations are compensated from earth gravity. All values are saturated to maximum value.

Data frame: 27 bytes in ASCII format.

:XXAAAA<SP>MHHHHQMRRRR<SP>MPPPP<CR><LF>		
:	Header character	0x3A
XX	Horizontal acceleration (in plane X_{V1}, X_{V2})	Acc: 0 to 9.81 m.s^{-2} Unit: 3.83 cm.s^{-2} **(ASCII representation of a 8 bits unsigned integer hexadecimal value)**
AAAA	X_{V3} acceleration	Acc: ± 20.48 m.s^{-2} Unit: 0.0625 cm.s^{-2} Sign "+" when system goes up **(ASCII representation of a 16 bits signed 2 complement integer hexadecimal value)**
<SP>	Space character	0x20
MHHHH	Heave	Heave: ± 99 m Unit: 1 cm M is the space character when system goes up M is the minus character when system goes down
Q	Status character	'?' for alignment mode space character for nominal mode
MRRRR	Roll	Roll ± 90° Unit : 0.01° M is the space character when port up M is the minus character when port down
<SP>	Space character	0x20

:XXAAAA<SP>MHHHHQMRRRR<SP>MPPPP<CR><LF>		
MPPPP	Pitch	Pitch ± 90° Unit : 0.01° Sign “+” when bow up M is the space character when bow up M is the minus character when bow down **Warning:** Opposite sign of usual convention
<CR><LF>	End of frame	0x0D 0x0A

TSS1 DMS

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output TSS proprietary protocol.

Data sent: Roll, Pitch, Heave, Linear accelerations, Status Accelerations are compensated from earth gravity. All values are saturated to maximum value.

Data frame: 27 bytes in ASCII format.

:XXAAAA<SP>MHHHHQMRRRR<SP>MPPPP<CR><LF>		
:	Header character	0x3A
XX	Horizontal acceleration (in plane X_{V1}, X_{V2})	Acc: 0 to 9.81 m.s^{-2} Unit: 3.83 cm.s^{-2} **(ASCII representation of a 8 bits unsigned integer hexadecimal value)**
AAAA	X_{V3} acceleration	Acc: ± 20.48 m.s^{-2} Unit: 0.0625 cm.s^{-2} Sign “+” when system goes up **(ASCII representation of a 16 bits signed 2 complement integer hexadecimal value)**
<SP>	Space character	0x20
MHHHH	Heave	Heave: ± 99 m Unit: 1 cm M is the space character when system goes up M is the minus character when system goes down
Q	Status character	‘h’ for alignment mode ‘H’ for nominal mode
MRRRR	Roll	Roll ± 90° Unit : 0.01° M is the space character when port up M is the minus character when port down
<SP>	Space character	0x20

:XXAAAA<SP>MHHHHQMRRRR<SP>MPPPP<CR><LF>		
MPPPP	Pitch	Pitch ± 90° Unit : 0.01° Sign "+" when bow up M is the space character when bow up M is the minus character when bow down **Warning:** Opposite sign of usual convention
<CR><LF>	End of frame	0x0D 0x0A

VTG GGA

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: This protocol outputs INS computed position values in an ASCII frame. Some characters of this output frame are set to fixed values.

Data frame:

$PHGGA,hhmmss.ss,LLll.lllllll,a,LLLmm.mmmmmm,a,x,xx,x.xxx,x.xxx,M,x.xxx,M,x.xxx,xxxx*hh<CR><LF>		
hhmmss.ss	is the UTC of position	
LLll.llllllll	is the latitude in degrees (LL) and in minutes (ll.llllllll)	8 digits after decimal point
a	is ‘N’ for Northern hemisphere, ‘S’ for Southern hemisphere	
LLLll.llllllll	is the longitude in deg (LLL) and in minutes (ll.llllllll)	8 digits after decimal point
a	is ‘E’ for East, ‘W’ for West	
x	is the GPS quality indicator	
xx	is the number of satellites in use (**)	
x.xxx	is the horizontal dilution of precision (HDOP) (*)	3 digits after decimal point
x.xxx	is the antenna altitude (meters) (here Phins altitude)	3 digits after decimal point
M	is the unit of antenna altitude (fixed character = ‘M’ for meters)	
x.xxx	is the Geoidal separation	3 digits after decimal point
M	is the unit of Geoidal separation (fixed character = ‘M’ for meters)	
x.xxx	is the age of the differential GPS data(seconds) (*)	3 digits after decimal point
xxxx	is the differential reference station ID (*)	
hh	is the checksum	

$PHVTG,x.xxx,T,x.xxx,M,x.xxx,N,x.xxx,K,a*hh<CR><LF>		
x.xxx	iis the True course (deg)	3 digits after decimal point
T	is a fixed character = ‘T’	
x.xxx	is the Magnetic course (deg) : same value as the True course	3 digits after decimal point
M	is a fixed character = ‘M’	
x.xxx	is the Horizontal speed (knots)	3 digits after decimal point
N	is a fixed character = ‘N’	
x.xxx	is the Horizontal speed (km/h)	3 digits after decimal point
K	is a fixed character	
a	is the positioning system mode indicator ‘A’, ‘D’ or ‘E’ (**)	
hh	is the checksum	

(*) Last GPS values received. When no GPS has been received since power up, these fields are null.

(**) The quality indicator is managed as follows:

The INS **does not copy** the quality indicator received on GGA input to GGA output.

The quality factor is set with respect to a correspondence table between INS calculated SD and Quality indicator in GGA telegram (refer to section 1.1.4).

VTG GGU

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output NMEA 0183 compatible.

Data sent: This protocol outputs INS UTM WGS84 computed position and speed values in an ASCII frame.

Data frame:

$PHVTG,x.xxx,T,x.xxx,M,x.xxx,N,x.xxx,K,a*hh<CR><LF>		
x.xxx	iis the True course (deg)	3 digits after decimal point
T	is a fixed character = 'T'	
x.xxx	is the Magnetic course (deg) : same value as the True course	3 digits after decimal point
M	is a fixed character = 'M'	
x.xxx	is the Horizontal speed (knots)	3 digits after decimal point
N	is a fixed character = 'N'	
x.xxx	is the Horizontal speed (km/h)	3 digits after decimal point
K	is a fixed character	
a	is the positioning system mode indicator 'A', 'D' or 'E' (**)	
hh	is the checksum	

$PHGGU,xxxxxxxx.x,a,yyyyyyyy.y,b,hhmmss.ss,*hh<CR><LF>		
xxxxxxxx.x	is the UTM WGS84 easting coordinate	1 digit after decimal point
a	is a fixed character 'E'	
yyyyyyyy.y	is the UTM WGS84 northing coordinate	1 digit after decimal point
b	is a fixed character 'N'	
hhmmss.ss	is the UTC of the position	
hh	is the checksum	

3.6.2.2 Binary protocols

Protocol development is under completion and free firmware upgrade is provided.

ANSCHUTZ STD20

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary 18 Bytes.

Data sent: Heading and heading rate.

Data frame: 8 fields – 18 bytes. Big Endian (MSB sent first).

<F0><F1><F2><B3><B4><B5><B6><F7>			
Field 0	Byte 0	Header	set to 0x02
Field 1	Bytes 1 to 2	Heading	If binary heading value is $h_{15}h_{14}h_{13}h_{12}h_{11}h_{10}h_9h_8h_7h_6h_5h_4h_3h_2h_1h_0$, the heading is coded on 12 bits only, and $h_3h_2h_1h_0$ LSB bits are not provided. Heading Byte 1 = $01h_{15}h_{14}h_{13}h_{12}h_{11}h_{10}$ Heading Byte 2 = $01h_9h_8h_7h_6h_5h_4$ LSB $180/2^{15}$= 0.00549°
Field 2	Bytes 3 to 7	Fixed fields	All the bytes are set to 0x40
Field 3	Bytes 8 to 10	Heading rate	If binary heading rate value is $h_{15}h_{14}h_{13}h_{12}h_{11}h_{10}h_9h_8h_7h_6h_5h_4h_3h_2h_1h_0$, the heading rate is 2 complement binary coded on 3 bytes. Heading rate Byte 8 = 01**s**0$h_{15}h_{14}h_{13}h_{12}$, where **s** is the **sign bit** set to 0 if heading rate positive, otherwise set to 1. Heading rate Byte 9 = $01h_{11}h_{10}h_9h_8h_7h_6$ Heading rate Byte 10 = $01h_5h_4h_3h_2h_1h_0$ LSB = $2636.718/2^{15}$ = 0.08046 °/min Opposite sign of the ANSCHUTZ STD20 heading derivative **Warning:** Opposite sign of the INS usual convention
Field 4	Bytes 11 to 12	Status word	See **Note 1** below
Field 5	Bytes 13 to 15	Fixed fields	All the bytes are set to 0x40
Field 6	Byte 16	Checksum	Checksum is computed as follow ((0xFF **xor**[Bytes 1 to 15]) **and** 0x3F) **or** 0x40
Field 7	Byte 17	End of frame	set to 0x03

Note 1: Status word

MSB: 0|1|**a**|**b**|0|0|0|**f** **LSB:** 0|1|**g**|1|0|1|0|0	**Description**	**Involved INS status bits**
a=0 and b=0	System OK	N/A
a=1 and b=1	System Error	When one of those INS User status bit is set to 1: FOG_ANOMALY ACC_ANOMALY TEMPERATURE_ERR CPU_OVERLOAD DEGRADED_MODE DYNAMIC_EXCEEDED FAILURE_MODE FINE ALIGNMENT INPUT_x_ERR OUTPUT_x_ERR
f=1 and g=1	Default status	N/A
f=0 and g=1	Settling phase	When the INS User status bit ALIGNMENT is set to 1
f=0 and g=0	Heading not valid	When the INS User status bit HRP_INVALID is set to 1

AUVG3000

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Binary 98 Bytes.
Data sent:	Time, Latitude, Longitude, Latitude and Longitude standard deviations, Heading, Roll and Pitch standard deviations, Depth, Heading , Roll, Pitch, North, West and Depth velocities, Heading, Roll and Pitch rotation rates, Accelerations, Status.
Data frame:	25 fields – 98 bytes MSB First.

Message <F0><F1><F2>…..<F24>			
Field 0	Bytes 0 to 3	'qqqq'	Synchronisation bytes
Field 1	Bytes 4 to 7	Data validity time in seconds	32 bit unsigned integer representing data validity time in seconds (loops from 0 to 86400). This time is synchronized with UTC if the INS is UTC synchronized. Otherwise it starts from 0 at system boot time.
Field 2	Bytes 8 to 9	Data validity time residual in hundreds of microseconds	16 bits unsigned integer representing the fraction of seconds of the validity time. It cycles from 0 to 9999 (0 to 0.9999 second).
Field 3	Bytes 10 to 13	Latitude '+': North of equator	IEEE floating point format, deg
Field 4	Bytes 14 to 17	Longitude '+': East of Greenwich	IEEE floating point format, deg
Field 5	Bytes 18 to 21	Latitude standard deviation	IEEE floating point format, meters
Field 6	Bytes 22 to 25	Longitude standard deviation	IEEE floating point format, meters
Field 7	Bytes 26 to 29	Heading standard deviation	IEEE floating point format, deg
Field 8	Bytes 30 to 33	Roll standard deviation	IEEE floating point format, deg
Field 9	Bytes 34 to 37	Pitch standard deviation	IEEE floating point format, deg
Field 10	Bytes 38 to 41	Depth	IEEE floating point format, meters
Field 11	Bytes 42 to 45	Heading	IEEE floating point format, deg
Field 12	Bytes 46 to 49	Roll Sign "+" when port side up	IEEE floating point format, deg
Field 13	Bytes 50 to 53	Pitch Sign "+" when bow up	IEEE floating point format, deg **Warning:** Opposite sign of INS usual convention

Message <F0><F1><F2>…..<F24>			
Field 14	Bytes 54 to 57	North velocity	IEEE floating point format, m/s
Field 15	Bytes 58 to 61	West velocity	IEEE floating point format, m/s
Field 16	Bytes 62 to 65	Depth velocity	IEEE floating point format, m/s
Field 17	Bytes 66 to 69	Roll rate *	IEEE floating point format, deg/s
Field 18	Bytes 70 to 73	Pitch rate *	IEEE floating point format, deg/s
Field 19	Bytes 74 to 77	Heading rate *	IEEE floating point format, deg/s
Field 20	Bytes 78 to 81	XV1 acceleration *	IEEE floating point format, m/s^2
Field 21	Bytes 82 to 85	X V2 acceleration *	IEEE floating point format, m/s^2
Field 22	Bytes 86 to 89	X V3 acceleration *	IEEE floating point format, m/s^2
Field 23	Bytes 90 to 93	Status	Refer to section 3.2.5: User status specification
Field 24	Bytes 94 to 97	Checksum	Sum of all bytes 0 to 93

(*) To comply with export regulation, the resolution of rotation rate data is limited to 3.6°/h and the resolution of acceleration data is limited to 1 mg.

BUC

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output Simrad proprietary protocol.

Data sent: Roll, Pitch, Heave and Heading.

Data frame: 6 fields - 10 bytes. Except the heading, each data sent is two complemented coded. LSB are sent first.

Message <F0><F1><F2>…..<F5>			
Field 0	Byte 0	Sensor status	Fixed value = 0x9A
Field 1	Byte 1	Synchronization byte	0x90
Field 2	Bytes 2 to 3	Roll	+/-180° ; LSB = 0.01° Sign “+” when port up
Field 3	Bytes 4 to 5	Pitch	+/-180° ; LSB = 0.01° Sign “+” when bow up **Warning:** Opposite sign of INS usual convention.
Field 4	Bytes 6 to 7	Heave	LSB = 0.01 m Sign +” when INS goes up
Field 5	Bytes 8 to 9	Heading	0° to 360° ; LSB = 0.01°

CONTROL

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: CONTROL output.

Data sent: Rotation rates and accelerations. Acceleration are not compensated for g vector.

Data frame:

Message <$><F1><F2>…..<F6>			
Field 0	Byte 0	Header	'$' : integer 8 bits
Field 1	Bytes 1 to 4	Acceleration XV1 *	Signed 32 bits LSB = 30g / 2^{31} = 0.01397µg
Field 2	Bytes 5 to 8	Acceleration XV2 *	Signed 32 bits LSB = 30g / 2^{31} = 0.01397µg
Field 3	Bytes 9 to 12	Acceleration XV3 *	Signed 32 bits LSB = 30g / 2^{31} = 0.01397µg
Field 4	Bytes 13 to 16	Rotation rates XV1 **	Signed 32 bits LSB = 100°/s / 2^{31} = $46.566.10^{-9}$ °/s
Field 5	Bytes 17 to 20	Rotation rates XV2 **	Signed 32 bits LSB = 100°/s / 2^{31} = $46.566.10^{-9}$ °/s
Field 6	Bytes 21 to 24	Rotation rates XV3 **	Signed 32 bits LSB = 100°/s / 2^{31} = $46.566.10^{-9}$ °/s

* in non military mode: acceleration quantification is 1mg.

** in non military mode: rotation rate quantification with 3.6°/h.

CONTROL NO G

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: CONTROL output.

Data sent: Rotation rates and accelerations. Acceleration are compensated for g vector.

Data frame:

Message <$><F1><F2>…..<F6>			
Field 0	Byte 0	Header	'$' : integer 8 bits
Field 1	Bytes 1 to 4	Acceleration XV1 *	+/- 2^{31} = +/- 30g Signed 32 bits with saturation
Field 2	Bytes 5 to 8	Acceleration XV2 *	+/- 2^{31} = +/- 30g Signed 32 bits with saturation
Field 3	Bytes 9 to 12	Acceleration XV3 *	+/- 2^{31} = +/- 30g Signed 32 bits with saturation
Field 4	Bytes 13 to 16	Rotation rates XV1 **	+/- 2^{31} = +/- 100°/s Signed 32 bits with saturation
Field 5	Bytes 17 to 20	Rotation rates XV2 **	+/- 2^{31} = +/- 100°/s Signed 32 bits with saturation
Field 6	Bytes 21 to 24	Rotation rates XV3 **	+/- 2^{31} = +/- 100°/s Signed 32 bits with saturation

* in non military mode: acceleration quantification is 1mg.

** in non military mode: rotation rate quantification with 3.6°/h

DCN FAA

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	DCN protocol based on 110718 STB Interfaces Marins 2.0 (DCNS/DSE/DI/Syst Brest/2011/21 version 2.0 July 2011).
Data sent:	Heading, Roll, Pitch, Attitude rates, Loch speed, Latitude, Longitude, North and West speeds.
Data frame:	15 fields - 34 bytes. Standard Big Endian. **(**For data coded on several bytes, the bytes are sent MSB byte first. All signed integer are coded as two's complement).

Message <F0><F1>… … <F13><F14>			
Field 0	Bytes 0 to 1	Length of message	0x22 ; 34 bytes
Field 1	Bytes 2 to 3	INS number	1 or 2 See **Note 2**
Field 2	Bytes 4 to 5	Status	0x00ss See **Note 1**
Field 3	Bytes 6 to 8	Heading	Unsigned 24 bits; LSB = 180°/2^{23} range [0° to +360°[0 at north, then heading value increasing eastward from north axis.
Field 4	Byte 9	Heading rate	Signed 8 bits; LSB = 70.32°/s /2^{7} range [-70.32°/s to +70.32°/s[Positive when DCN FFA Heading angle increasing.
Field 5	Bytes 10 to 12	Roll	Signed 24 bits; LSB = 90°/2^{23} range [-90° to +90°[Positive for left-port side down. **Warning:** Opposite sign of INS usual convention.
Field 6	Byte 13	Roll rate	Signed 8 bits; LSB = 35.16°/s /2^{7} range [-35.16°/s to +35.16°/s[Positive when DCN FFA Roll angle increasing. **Warning:** Opposite sign of INS usual convention.
Field 7	Bytes 14 to 16	Pitch	Signed 24 bits; LSB = 90°/2^{23} range [-90° to +90°[Positive for front side-bow down.
Field 8	Byte 17	Pitch rate	Signed 8 bits; LSB = 35.16°/s /2^{7} range [-35.16°/s to +35.16°/s[Positive when DCN FFA Pitch angle increasing.

Message <F0><F1>… … <F13><F14>			
Field 9	Bytes 18 to 19	Loch speed	Unsigned 16 bits; LSB = 120 knots/2^{15} range [0 knots to +240 knots[
Field 10	Bytes 20 to 21	Attitude age	Unsigned 16 bits; LSB = 1.28 seconds/2^{15} Elapsed time between the data validity time and the data transmission time.
Field 11	Bytes 22 to 25	Latitude	Signed 32 bits; LSB = 90°/2^{31}, range [-90° to +90°[Positive in North hemisphere, Negative in South.
Field 12	Bytes 26 to 29	Longitude	Unsigned 32 bits; LSB = 180°/2^{31}, range [0° to 360°] Positive and increasing towards west from Greenwich meridian.
Field 13	Bytes 30 to 31	North speed	Signed 16 bits; LSB = 120 knots/2^{15} range [-120 knots to +120 knots[Positive in North direction.
Field 14	Bytes 32 to 33	West speed	Signed 16 bits; LSB = 120 knots/2^{15} range [-120 knots to +120 knots[Positive in West direction.

Note 1: Status word = 0x00ss where ss byte is detailed hereafter :

7|6|5|4|3|2|1|0	Description	Involved INS status bits
0 0 0 0 0 0 0 0	Not used	N/A
0 0 0 0 0 0 0 1	Failure, degraded mode or alignment	When one of those INS User status bit is set to 1 : ALTITUDE_SATURATION CPU_OVERLOAD TEMPERATURE_ERR INPUT_x_ERR (x from A to E) OUTPUT_x_ERR (x from A to E) DEGRADED_MODE HRP_INVALID DYNAMIC_EXCEEDED FAILURE_MODE
0 0 0 0 0 0 1 0	Mode maintenance	When the bit SIMULATION_MODE of the INS System status 2 is set to 1
0 0 0 0 0 0 1 1	INS operational	When the bit NAVIGATION of the INS User status is set to 1

Note 2: 1 for the INS which IP address is odd and 2 for the INS which IP address is even.

DCN NAV1 FAA

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Binary DCNS proprietary protocol (interface nav 1 LSM/NAV 19187 du 21/11/89 R4-juin 1996). It is designed to be sent at 100 ms data rate at 19200 bauds.
Data sent:	Status, Heading, Roll, Pitch, Latitude, Longitude, North speed, West speed, Vertical speed, EM Loch speed, Heave, Std deviations.
Data frame:	12 fields- 27 bytes at 100 ms. 20 fields- 40 bytes at 1 second.

Data frame sent every 9 times out of 10 (27 bytes) :

Message <F0><F1>…<F11> (See Note 1)			
Field 0	Byte 0	Header byte 0	Message size (fixed value = 27 decimal, 0x1B hex)
Field 1	Byte 1	Header byte 1	See **Note 3**
Field 2	Byte 2	Status byte	See **Note 4**
Field 3	Bytes 3 to 6	Hour	Unsigned 32 bits integer. MSB = 2^{31} = 12 h
Field 4	Byte 7	Ageing fixed to 3ms	Unsigned 8 bits integer. MSB = 2^{7}= 128 ms.
Field 5	Bytes 8 to 10	Heading	Unsigned 24 bits integer. MSB = 2^{23} = 180 degrees (Positive when rotating from North to East)
Field 6	Bytes 11 to 13	Roll	Signed 24 bits integer. MSB = 2^{23} = 90 degrees (Positive when port side down) Warning: Opposite sign of INS usual convention.
Field 7	Bytes 14 to 16	Pitch	Signed 24 bits integer. MSB = 2^{23} = 90 degrees (Positive when bow down)
Field 8	Bytes 17 to 19	Latitude	Signed 24 bits integer. MSB = 2^{23} = 90 degrees (Positive in north hemisphere and increasing to north pole).
Field 9	Bytes 20 to 22	Longitude	Signed 24 bits integer. MSB = 2^{23} = 180 degrees (Positive and increasing towards west from Greenwich)
Field 10	Bytes 23 to 24	North speed	Signed 16 bits integer. MSB = 2^{15} = 120 knots (Positive in North direction)
Field 11	Bytes 25 to 26	West speed	Signed 16 bits integer. MSB = 2^{15} = 120 knots (Positive in West direction)

Data frame sent 1 time out of 10 (40 bytes) :

Message <F0><F1>…<F19> (See Note 1)			
Field 0	Byte 0	Header byte 0	Message size (fixed value = 40 decimal / 0x28 hex)
Field 1	Byte 1	Header byte 1	See **Note 3**
Field 2	Byte 2	Status byte	See **Note 4**
Field 3	Bytes 3 to 6	Hour	Unsigned 32 bits integer. MSB= 2^{31} = 12 h
Field 4	Byte 7	Ageing	Unsigned 8 bits integer. MSB= 2^{7}= 128 ms
Field 5	Bytes 8 to 10	Heading	Unsigned 24 bits integer. MSB= 2^{23} = 180 degrees (Positive when rotating from North to East)
Field 6	Bytes 11 to 13	Roll	Signed 24 bits integer. MSB= 2^{23} = 90 degrees (Positive when port side down) Warning: Opposite sign of INS usual convention.
Field 7	Bytes 14 to 16	Pitch	Signed 24 bits integer. MSB= 2^{23} = 90 degrees (Positive when bow down)
Field 8	Bytes 17 to 19	Latitude	Signed 24 bits integer. MSB= 2^{23} = 90 degrees (Positive in north hemisphere and increasing to north pole).
Field 9	Bytes 20 to 22	Longitude	Signed 24 bits integer. MSB= 2^{23} = 180 degrees (Positive and increasing towards west from Greenwich)
Field 10	Bytes 23 to 24	North speed	Signed 16 bits integer. MSB= 2^{15} = 120 knots (Positive in North direction)
Field 11	Bytes 25 to 26	West speed	Signed 16 bits integer. MSB= 2^{15} = 120 knots (Positive in West direction)
Field 12	Bytes 27 to 28	Day of year	Unsigned 16 bits integer; MSB = 2^{15} = 256 days.
Field 13	Bytes 29 to 30	Heave	Unsigned 16 bits integer 2^{15} = 360 m (Positive below sea level)
Field 14	Bytes 31 to 32	EM Log speed	Signed 16 bits integer 2^{15} = 120 knots
Field 15	Bytes 33 to 34	Vertical speed	Signed 16 bits integer 2^{15} = 40 m/s (Positive when vessel goes down) Warning: Opposite sign of INS usual convention.
Field 16	Byte 35	Latitude std.deviation	Unsigned 7 bits integer (see **Note 2**)

Message <F0><F1>…<F19> (See Note 1)			
Field 17	Byte 36	Longitude std.deviation	Unsigned 7 bits integer(see **Note 2**)
Field 18	Bytes 37 to 38	Heading std.deviation	Unsigned 16 bits integer; 2^{15}= 1 degree
Field 19	Byte 39	Position error CEP 95%	Unsigned 7 bits integer (see **Note 2**Note)

Note 1:

1) Byte is transmitted with LSB first preceded by a start bit and followed by an even parity bit and a stop bit.

Byte Format:

Stop	Parity	MSBit							LSBit	Start
		7	6	5	4	3	2	1	0	

2) For data coded on several bytes, the bytes are sent MSB byte first. For data coded on a non multiple of 8 bits (for example Heading coded on 18 bits), the data is flush left (MSB side) and the unused bits are considered non significant.

Example of data code over 18 bits before left shift.

23	22	21	20	19	18	17	…	6	5	4	3	2	1	0
0	0	0	0	0	0	1	…	1	0	1	1	0	1	1

18 significant bits

Data after left shift

23	22	21	20	19	18	17	…	6	5	4	3	2	1	0
1	1	0	1	1	0	1	…	1	0	0	0	0	0	0

18 significant bits

6 non significant bits

3) All signed integer are coded as two's complement.

Note 2:

The latitude/longitude/position standard deviations and CEP values are calculated by INS algorithm. Standard deviations are expressed at 1 σ (66.66% probability).

Bit 0 indicates the scale factor conversion. The data is coded over Bit 1 to Bit 7.

Bit 0= 0, then LSB = 0.078125 NM and MSB = 5 NM

Bit 0= 1, then LSB = 0.00189 and MSB= 0.121 NM

If a latitude/longitude/position CEP value is > 10 NM, it will be coded as 0xFE (9.92 NM).

CEP95 will be computed as: $CEP95 = 1{,}2254.(\sigma_{LAT} + \sigma_{LONG})$

Note 3: Following table details content of header byte 1

Function	Bit	Value	Links with PHINS status words
HRP validity	0	0 valid data 1 invalid data	OR of bits 0 to 6 of the INS Sensor status 2 and bits 1, 28, 29 of the INS Algorithm status 1
Sensor anomaly	1	0 sensor OK 1 sensor anomaly	OR of bits 0 to 6 of the INS Sensor status 2
Alignment	2	0 operational 1 alignment	Bit 1 of the INS Algorithm status 1
Source n°2	3	= 0 when last digit of IP address is odd =1 when last digit of IP address is even	N/A
Source n°1	4	= 0 when last digit of IP address is odd =1 when last digit of IP address is even	N/A
Ponderated	5	= 0 This field is set to 1 by ICCB in nominal mode and 0 in other mode. The INS always sets this bit to 0	N/A
Filtered	6	= 1	N/A
Transmitted	7	= 0	N/A

Note 4: Following table details content of status byte

Function	Bit	Value	Links with PHINS status words
Reserved	0	= 0	N/A
GPS valid	1	= 0 GPS received and valid = 1 GPS invalid	NOT(Bit 12 & Bit 13) of the INS Algorithm status 1
Radio navigation valid	2	= 1	N/A
Position correction age	3	= 0 Position correction received in last 24h = 1 Position correction received more than 24 ago	N/A
Reserved	4	= 0	N/A
EM Log valid	5	= 0 EM Log received and valid = 1 EM Log invalid	NOT(Bit 8 & Bit 9) of the INS Algorithm status 2
Reserved	6	= 0	N/A
Reserved	7	= 0	N/A

DCN NAV1 FLF

This protocol is not available for all products.
Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary DCNS proprietary protocol (interface nav 1 LSM/NAV 19187 du 21/11/89 R4-juin 1996). It is designed to be sent at 100 ms data rate at 19200 bauds.

Data sent: Status, Heading, Roll, Pitch, Latitude, Longitude, North speed, West speed, Vertical speed, EM Loch speed, Heave, Std deviations.

Data frame: 12 fields- 27 bytes at 100 ms. 20 fields- 40 bytes at 1 second.

Data frame sent every 9 times out of 10 (27 bytes) :

Message <F0><F1>…<F11> (See Note 3)			
Field 0	Byte 0	Header byte 0	Message size (fixed value = 27 decimal, 0x1B hex)
Field 1	Byte 1	Header byte 1	See Note 1 for DCN NAV1 FLF
Field 2	Byte 2	Status byte	See Note **2** for DCN NAV1 FLF
Field 3	Bytes 3 to 6	Hour	Unsigned 32 bits integer. MSB = 2^{31} = 12 h
Field 4	Byte 7	Ageing fixed to 3ms	Unsigned 8 bits integer. MSB = 2^{7}= 128 ms.
Field 5	Bytes 8 to 10	Heading	Unsigned 24 bits integer. MSB = 2^{23} = 180 degrees (Positive when rotating from North to East)
Field 6	Bytes 11 to 13	Roll	Signed 24 bits integer. MSB = 2^{23} = 90 degrees (Positive when port side down) **Warning:** Opposite sign of INS usual convention.
Field 7	Bytes 14 to 16	Pitch	Signed 24 bits integer. MSB = 2^{23} = 90 degrees (Positive when bow down)
Field 8	Bytes 17 to 19	Latitude	Signed 24 bits integer. MSB = 2^{23} = 90 degrees (Positive in north hemisphere and increasing to north pole).
Field 9	Bytes 20 to 22	Longitude	Signed 24 bits integer. MSB = 2^{23} = 180 degrees (Positive and increasing towards west from Greenwich)
Field 10	Bytes 23 to 24	North speed	Signed 16 bits integer. MSB = 2^{15} = 120 knots (Positive in North direction)
Field 11	Bytes 25 to 26	West speed	Signed 16 bits integer. MSB = 2^{15} = 120 knots (Positive in West direction)

Data frame sent 1 time out of 10 (40 bytes) :

Message <F0><F1>…<F19> (See Note 3)			
Field 0	Byte 0	Header byte 0	Message size (fixed value = 40 decimal / 0x28 hex)
Field 1	Byte 1	Header byte 1	See Note 1 for DCN NAV1 FLF
Field 2	Byte 2	Status byte	See Note **2** for DCN NAV1 FLF
Field 3	Bytes 3 to 6	Hour	Unsigned 32 bits integer. MSB= 2^{31} = 12 h
Field 4	Byte 7	Ageing	Unsigned 8 bits integer. MSB= 2^{7}= 128 ms
Field 5	Bytes 8 to 10	Heading	Unsigned 24 bits integer. MSB= 2^{23} = 180 degrees (Positive when rotating from North to East)
Field 6	Bytes 11 to 13	Roll	Signed 24 bits integer. MSB= 2^{23} = 90 degrees (Positive when port side down) **Warning:** Opposite sign of INS usual convention.
Field 7	Bytes 14 to 16	Pitch	Signed 24 bits integer. MSB= 2^{23} = 90 degrees (Positive when bow down)
Field 8	Bytes 17 to 19	Latitude	Signed 24 bits integer. MSB= 2^{23} = 90 degrees (Positive in north hemisphere and increasing to north pole).
Field 9	Bytes 20 to 22	Longitude	Signed 24 bits integer. MSB= 2^{23} = 180 degrees (Positive and increasing towards west from Greenwich)
Field 10	Bytes 23 to 24	North speed	Signed 16 bits integer. MSB= 2^{15} = 120 knots (Positive in North direction)
Field 11	Bytes 25 to 26	West speed	Signed 16 bits integer. MSB= 2^{15} = 120 knots (Positive in West direction)
Field 12	Bytes 27 to 28	Day of year	Unsigned 16 bits integer; MSB = 2^{15} = 256 days.
Field 13	Bytes 29 to 30	Heave	Unsigned 16 bits integer 2^{15} = 360 m (Positive below sea level)
Field 14	Bytes 31 to 32	EM Log speed	Signed 16 bits integer 2^{15} = 120 knots
Field 15	Bytes 33 to 34	Vertical speed	Signed 16 bits integer 2^{15} = 40 m/s (Positive when vessel goes down) **Warning:** Opposite sign of INS usual convention.

Message <F0><F1>…<F19> (See Note 3)			
Field 16	Byte 35	Latitude std.deviation	Unsigned 7 bits integer (see Note 4)
Field 17	Byte 36	Longitude std.deviation	Unsigned 7 bits integer(see Note 4)
Field 18	Bytes 37 to 38	Heading std.deviation	Unsigned 16 bits integer; 2^{15}= 1 degree
Field 19	Byte 39	Position error CEP 95%	Unsigned 7 bits integer (see Note 4)

Note 1: Following table details content of header byte 1

Function	Bit	Value	Links with PHINS status words
HRP validity	0	= 0 valid data = 1 invalid data	OR of bits 0 to 6 of the INS Sensor status 2 and bits 1, 28, 29 of the INS Algorithm status 1
Sensor anomaly	1	= 0 sensor OK = 1 sensor anomaly	OR of bits 0 to 6 of the INS Sensor status 2
Alignment	2	= 0 operational = 1 alignment	Bit 1 of the INS Algorithm status 1
Source n°2	3	= 0 when last digit of IP address is odd =1 when last digit of IP address is even	N/A
Source n°1	4	= 0 when last digit of IP address is odd =1 when last digit of IP address is even	N/A
Simulation mode	5	= 0 if simulation mode is not activated in the MMI = 1 if simulation mode is activated in the MMI	N/A
Reserved	6	= 0	N/A
Reserved	7	= 0	N/A

Note 2: Following table details content of status byte

Function	Bit	Value	Links with PHINS status words
Reserved	0	= 0	N/A
GPS valid	1	= 0 GPS received and valid = 1 GPS invalid	NOT(Bit 12 & Bit 13) of the INS Algorithm status 1

Function	Bit	Value	Links with PHINS status words
Radio navigation valid	2	= 1	N/A
Navigation validity	3	= 0 Navigation valid = 1 Alignment or saturation of speed or altitude	OR of bits 1, 28, 29 of the INS Algorithm status 1
Time synchronization	4	= 0 UTC Time synchronized = 1 UTC Time not synchronized	
EM Log valid	5	= 0 EM Log received and valid = 1 EM Log invalid	NOT(Bit 8 & Bit 9) of the INS Algorithm status 2.
Reserved	6	= 0	N/A
Reserved	7	= 0	N/A

Note 3:

1) Byte is transmitted with LSB first preceded by a start bit and followed by an even parity bit and a stop bit.

Byte Format:

Stop	Parity	MSBit							LSBit	Start
		7	6	5	4	3	2	1	0	

2) For data coded on several bytes, the bytes are sent MSB byte first. For data coded on a non multiple of 8 bits (for example Heading coded on 18 bits), the data is flush left (MSB side) and the unused bits are considered non significant.

Example of data code over 18 bits before left shift.

23	22	21	20	19	18	17	…	6	5	4	3	2	1	0
0	0	0	0	0	0	1	…	1	0	1	1	0	1	1

18 significant bits

Data after left shift

23	22	21	20	19	18	17	…	6	5	4	3	2	1	0
1	1	0	1	1	0	1	…	1	0	0	0	0	0	0

18 significant bits

6 non significant bits

3) All signed integer are coded as two's complement.

Note 4:

The latitude/longitude/position standard deviations and CEP values are calculated by INS algorithm. Standard deviations are expressed at 1 σ (66.66% probability).

Bit 0 indicates the scale factor conversion. The data is coded over Bit 1 to Bit 7.

Bit 0= 0, then LSB = 0.078125 NM and MSB = 5 NM

Bit 0= 1, then LSB = 0.00189 and MSB= 0.121 NM

If a latitude/longitude/position CEP value is > 10 NM, it will be coded as 0xFE (9.92 NM).

CEP95 will be computed as: $CEP95 = 1{,}2254.(\sigma_{LAT} + \sigma_{LONG})$

DCN STD NAV1

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Protocol of the Nav DCN 100 ms network (Spec DCN n° 19187 LSM/NAV June 96).
Data sent:	Status, Heading, Roll, Pitch, Heave.
Data frame:	11 fields - 27 bytes and , once on ten, 20 fields - 40 bytes MSB are sent first.

Frame of 27 bytes sent 9 times out of 10

Message <F0><F1>…<F18>			
Field 0	Byte 0	Message size	Fixed value = 27
Field 1	Byte 1	Status 1*	See status specification table 1
Field 2	Byte 2	Status 2**	See status specification table 2
Field 3	Bytes 3 to 6	Hour	MSB = 12 h and LSB = 12 h/ 2^{31}
Field 4	Byte 7	Ageing	Fixed value = 4 ms
Field 5	Bytes 8 to 10	Heading	Unsigned 24 bits integer 2^{23} = 180°
Field 6	Bytes 11 to 13	Roll	Signed 24 bits integer +/-2^{23} = +/-90° (Positive when port side down) Warning: Opposite sign of INS usual convention.
Field 7	Bytes 14 to 16	Pitch	Signed 24 bits integer +/-2^{23} = +/-90°
Field 8	Bytes 17 to 19	Latitude	Signed 24 bits integer ; MSB = 90 degrees
Field 9	Bytes 20 to 22	Longitude	Signed 24 bits integer ; MSB = 180 degrees
Field 10	Bytes 23 to 24	North speed	Signed 16 bits integer ; MSB = 120 knots
Field 11	Bytes 25 to 26	West speed	Signed 16 bits integer ; MSB = 120 knots

Frame of 40 bytes sent 1 times out of 10

Message <F0><F1>…<F18>			
Field 0	Byte 0	Message size	Fixed value = 40
Field 1	Byte 1	Status 1*	See status specification table 1 below
Field 2	Byte 2	Status 2**	See status specification table 2 below
Field 3	Bytes 3 to 6	Hour	MSB = 12 h and LSB = 12 h/ 2^{31}
Field 4	Byte 7	Ageing	Fixed value = 4 ms
Field 5	Bytes 8 to 10	Heading	Unsigned 24 bits integer 2^{23} = 180°
Field 6	Bytes 11 to 13	Roll	Signed 24 bits integer +/-2^{23} = +/-90° (Positive when port side down) Warning: Opposite sign of PHINS usual convention.
Field 7	Bytes 14 to 16	Pitch	Signed 24 bits integer +/-2^{23} = +/-90°
Field 8	Bytes 17 to 19	Latitude	Signed 24 bits integer ; MSB = 90 degrees
Field 9	Bytes 20 to 22	Longitude	Signed 24 bits integer ; MSB = 180 degrees
Field 10	Bytes 23 to 24	North speed	Signed 16 bits integer ; MSB = 120 knots
Field 11	Bytes 25 to 26	West speed	Signed 16 bits integer ; MSB = 120 knots
Field 12	Bytes 27 to 28	Date	Fixed value = 0
Field 13	Bytes 29 to 30	Heave***	Signed 16 bits integer +/-2^{15} = +/-360m (Positive when INS goes down) **Warning:** Opposite sign of INS usual convention.
		Depth***	Signed 16 bits integer +/-2^{15} = +/-360m (Positive when INS goes down)
Field 14	Bytes 31 to 32	EM Log speed	Signed 16 bits integer +/-2^{15} = +/-120 knots
Field 15	Bytes 33 to 34	Vertical speed	Fixed value = 0
Field 16	Byte 35	Latitude std.deviation	MSB = 5 miles
Field 17	Byte 36	Longitude std.deviation	MSB = 5 miles
Field 18	Bytes 37 to 38	Heading std.deviation	MSB = 1 deg
Field 19	Byte 39	Error position	Maximum value of latitude standard deviation and longitude standard deviation. MSB= 5 miles

*** Status specification table 1**

Function	Bit	Value	Links with INS status words
HRP validity	0	0 valid data 1 invalid data	OR of bits 0 to 6 of the INS Sensor status 2: FOG,ACC,SRC ERR and bits 1, 28, 29 of the INS Algorithm status 1
Sensor anomaly	1	0 sensor OK 1 sensor anomaly	OR of bits 0 to 6 of the INS Sensor status 2
Alignment	2	0 operational 1 alignment	Bit 1 of the INS Algorithm status 1
Source n°2	3	= 0 or 1	0 (resp. 1) If last digit of IP address is odd (resp. even)
Source n°1	4	= 0 or 1	1 (resp. 0) If last digit of IP address is odd (resp. even)
Simulation mode	5	= 0 or 1	1 if simulation mode is activated in the MMI
Reserved	6	= 0	*Reserved field*
Reserved	7	= 0	*Reserved field*

**** Status specification table 2**

Function	Bit	Value	Links with INS status words
Heading, attitude validity	0	0 if Heading, roll and pitch valid 1if Heading, roll or pitch not valid	OR of bits 0 to 2 of the 32 MSB bits of the INS Sensor status and bits 1, 28, 29 of the 32 LSB bits of the INS Algorithm status
FOGs validity	1	0 if FOG X, Y and Z valid 1 if FOG X, Y or Z not valid	OR of bits 0 to 2 of the 32 MSB bits of the INS Sensor status
Accelerometers validity	2	0 if ACC X, Y and Z valid 1 if ACC X ,Y or Z not valid	OR of bits 4 to 6 of the 32 MSB bits of the INS Sensor status
Optical source and FOG transmission validities	3	0 if Optical source and FOG transmission valid 1 if Optical source or FOG transmission not valid	Bit 3 of the 32 MSB bits of the INS Sensor status
Validity of the serial inputs	4	0 if all the serial inputs valid 1 if one or more serial inputs not valid	OR of bits 1 to 5 of the 32 LSB bits of the INS System status
Validity of the serial outputs	5	0 if all the serial outputs are valid 1 if one or more serial outputs not valid	OR of bits 17 to 21 of the 32 LSB bits of the INS System status
Reserved	6	= 0	
Reserved	7	= 0	

*** Depth is given when a Depth sensor is configured. Otherwise, Heave is given.

DCN STD NAV10

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Binary DCSN proprietary protocol (interface nav 1 LSM/NAV 19187 21/11/89 R4-juin 1996).
Data sent:	Status, Heading, Roll, Pitch, Heave.
Data frame:	1 data blocs: 7 fields-15 bytes (sent at 10 ms in DCNS application).

Message <F0><F1>…<F6>			
Field 0	Byte 0	Header byte 0	Message size (fixed value = 15 decimal, 0x0F hex)
Field 1	Byte 1	Header byte 1	See **Note 1**
Field 2	Bytes 2 to 4	Heading	Unsigned 24 bits integer 2^{23} = 180° (Positive when rotating from North to East)
Field 3	Bytes 5 to 7	Roll	Signed 24 bits integer +/-2^{23}= +/-90° (Positive when port side down) **Warning:** Opposite sign of INS usual convention.
Field 4	Bytes 8 to 10	Pitch	Signed 24 bits integer +/-2^{23} = +/-90° (Positive when bow down)
Field 5	Bytes 11 to 12	Vertical speed	Signed 16 bits integer +/-2^{15} = +/-40 m/s (Positive going down)
Field 6	Bytes 13 to 14	Heave	Signed 16 bits integer +/-2^{15} = +/- 400 m (Positive going down) **Warning:** Opposite sign of INS usual convention.

Note 1: Following table details header byte 1 content:

Function	Bit	Value	Links with PHINS status words
HRP invalid	0	0 valid data 1 invalid data	OR of bits 0 to 2 of the INS Sensor status 2 and bits 1, 28, 29 of the INS Algorithm status 1
Sensor anomaly	1	0 sensor OK 1 sensor anomaly	OR of bits 0 to 6 of the INS Sensor status 2
Alignment	2	0 operational 1 alignment	Bit 1 of the INS Algorithm status 1
Source n°2	3	= 0 or 1	0 (resp. 1) If last digit of IP address is odd (resp. even)

Function	Bit	Value	Links with PHINS status words
Source n°1	4	= 0 or 1	1 (resp. 0) If last digit of IP address is even (resp. odd)
Simulation mode	5	= 0 or 1	1 if simulation mode is activated in the web-based user interface
Reserved	6	= 0	*Reserved field*
Reserved	7	= 0	*Reserved field*

DOLOG HRP

This protocol is not available for all products.
Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output Dolog custom protocol.
Data sent: Status, Heading, Roll, Pitch, Heading Rate, Roll Rate, Pitch Rate.
Data frame: The frame contains 10 fields - 16 bytes. MSB are sent first.

Message <F0><F1><F2>…..<F9>			
Field 0	Byte 0	0x02	Start of sentence
Field 1	Byte 1	Status	Bit 7, 6, 3, 2 and 1 not used Bit 5 : Alarm bit = 1 if ACC or FOG error Bit 4 : Alignment bit = 1 for Alignment Bit 0 : Data valid bit = 1 for HRP data valid
Field 2	Bytes 2 to 3	Heading	Unsigned 16 bits integer 2^{15} = 180° 0 to 359.99°
Field 3	Bytes 4 to 5	Roll	Signed 16 bits integer +/-2^{15} = +/-90° -90° to 89.99° (Positive when port side up)
Field 4	Bytes 6 to 7	Pitch	Signed 16 bits integer +/-2^{15} = +/-90° -90° to 89.99° (Positive when bow up) **Warning:** Opposite sign of the INS usual convention
Field 5	Bytes 8 to 9	Heading rate*	Signed 16 bits integer +/-2^{15} = +/-45°/s -45 to 44.99°/s (Positive when the INS heading angle decreases) **Warning:** Opposite sign of the INS usual convention
Field 6	Bytes 10 to 11	Roll rate*	Signed 16 bits integer +/-2^{15} = +/-45°/s -45 to 44.99°/s (Positive when the INS roll angle increases)
Field 7	Bytes 12 to 13	Pitch rate*	Signed 16 bits integer +/-2^{15} = +/-45°/s -45 to 44.99°/s (Positive when the INS pitch angle decreases) **Warning:** Opposite sign of the INS usual convention
Field 8	Byte 14	Checksum	Negative sum of all the bytes before checksum byte (ignoring overflow)
Field 9	Byte 15	0x03	End of sentence

***** The precision of rotation rate data is limited to 3,6 deg/h to comply with export regulation.

DORADO

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output Dorado custom protocol.

Data sent: Position, Heading, Heading, Roll, Pitch, Rotation rates, speed coordinates in geographical frame, PHINS lat/long position, Log misalignment.

Data frame:

<F0><F1>…F16><F17>			
Field 0	Byte 0	Header	integer 8 bits : '$'
Field 1	Byte 1	Status	Integer 8 bits :0x01 => Initial alignment 0x06 => Invalid attitude 0x08 => Invalid heading
Field 2	Bytes 2 to 5	Heading	Floating IEEE 32 bits *in Radians
Field 3	Bytes 6 to 9	Roll	Floating IEEE 32 bits * in Radians (+ if port up)
Field 4	Bytes 10 to 13	Pitch	Floating IEEE 32 bits * in Radians (+ if bow down)
Field 5	Bytes 14 to 17	Rotation rate XV3	Floating IEEE 32 bits ** in Radians /sec
Field 6	Bytes 18 to 21	Rotation rate XV1	Floating IEEE 32 bits ** in Radians /sec
Field 7	Bytes 22 to 25	Rotation rate -XV2	Flotting IEEE 32 bits ** in Radians /sec *Warning : sign opposite with the conventional sign*
Field 8	Bytes 26 to 29	Depth	Floating IEEE 32 bits in Meters
Field 9	Bytes 30 to 33	Down speed	Floating IEEE 32 bits in m/s (positive downwards)
Field 10	Bytes 34 to 37	East speed	Floating IEEE 32 bits in Meters/sec
Field 11	Bytes 38 to 41	South speed	Floating IEEE 32 bits in Meters/sec
Field 12	Bytes 42 to 45	Latitude	Integer 32 bits signed in Radians (+/- 2^{31}= +/- 180°)
Field 13	Bytes 46 to 49	Longitude	Integer 32 bits signed in Radians (+/- 2^{31}= +/- 180°)
Field 14	Bytes 50 to 53	Kalman log misalignment estimation	Floating IEEE 32 bits in Radians
Field 15	Bytes 54 to 57	Word reserved	Floating IEEE 32 bits : Value forced with 0.0
Field 16	Bytes 58 to 59	Counter of sequences	Integer 16 bits from 0 to 65535
Field 17	Byte 60	Checksum	Integer 8 bits : Summon of all the bytes of the frame, heading included

*In non military mode: Heading, roll, pitch quantification with 0.001°.

** In non military mode: rotation rate quantization is limited to 3.6°/h.

DORADO 2

This protocol is not available for all products.
Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Output Dorado custom protocol.
Data sent:	Position, Heading, Roll, Pitch, Rotation rates, speed coordinates in geographical frame, PHINS lat/long position, Log misalignment.
Data frame:	A header, 15 fields with 4 bytes in binary format and a checksum.

<F0><F1>…F16><F17>			
Field 0	Byte 0	Header	integer 8 bits : '$'
Field 1	Byte 1	Status	Integer 8 bits : 0x01 => Initial alignment 0x06 => Invalid attitude 0x08 => Invalid heading 0x10 => Fine alignment 0x20 => GPS position rejected 0x40 => GPS altitude rejected 0x80 => Altitude saturation
Field 2	Bytes 2 to 5	Heading	Floating IEEE 32 bits *in Radians
Field 3	Bytes 6 to 9	Roll	Floating IEEE 32 bits * in Radians (+ if port up)
Field 4	Bytes 10 to 13	Pitch	Floating IEEE 32 bits * in Radians (+ if bow down)
Field 5	Bytes 14 to 17	Rotation rate XV3	Floating IEEE 32 bits ** in Radians /sec
Field 6	Bytes 18 to 21	Rotation rate XV1	Floating IEEE 32 bits ** in Radians /sec
Field 7	Bytes 22 to 25	Rotation rate -XV2	Flotting IEEE 32 bits ** in Radians /sec *Warning : sign opposite with the conventional sign*
Field 8	Bytes 26 to 29	Depth	Floating IEEE 32 bits in Meters
Field 9	Bytes 30 to 33	Down speed	Floating IEEE 32 bits in m/s (positive downwards)
Field 10	Bytes 34 to 37	East speed	Floating IEEE 32 bits in Meters/sec
Field 11	Bytes 38 to 41	South speed	Floating IEEE 32 bits in Meters/sec
Field 12	Bytes 42 to 45	Latitude	Integer 32 bits signed in Radians (+/- 2^{31}= +/- 180°)
Field 13	Bytes 46 to 49	Longitude	Integer 32 bits signed in Radians (+/- 2^{31}= +/- 180°)
Field 14	Bytes 54 to 57	Epoch Time	Integer 64 bits Number of seconds since 00:00:00 01/01/1970

<F0><F1>…F16><F17>			
Field 15	Bytes 58 to 59	Counter of sequences	Integer 16 bits from 0 to 65535
Field 16	Byte 60	Checksum	Integer 8 bits : Summon of all the bytes of the frame, heading included

* In non military mode: heading, roll, pitch quantification with 0.001°

** In non military mode: rotation rate quantification with 3.6°/h

EMT SDV GCS

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output Simrad proprietary protocol.

Data sent: Status, Roll, Pitch, Depth, Heading.

Data frame: The frame contains 7 fields - 11 bytes. LSB are sent first.

Message <F0><F1><F2>…..<F6>			
Field 0	Byte 0	Sensor status	0x90 if ok 0x9A if alignment
Field 1	Byte 1	Synchronization byte	0x90
Field 2	Bytes 2 to 3	Roll*	+/-180° ; LSB = 0.01° Sign "+" when port up
Field 3	Bytes 4 to 5	Pitch*	+/-180° ; LSB = 0.01° Sign "+" when bow up **Warning:** Opposite sign of INS usual convention.
Field 4	Bytes 6 to 7	Depth	LSB = 1 mm
Field 5	Bytes 8 to 9	Heading	0° to 360° ; LSB = 0.01°
Field 6	Byte 10	Checksum	XOR on bytes 0 to 9

***** The attitude angles are computed with respect to TSS convention.

Roll and Pitch are referenced to the local vertical acceleration.

The formula calculation with respect to INS standard convention (Euler Angle or Tate Bryant) is given hereafter:

$Roll_{TSS} = Sin^{-1} (Sin (Roll_{TB}) \times Cos (Pitch_{TB}))$ and $Pitch_{TSS} = Pitch_{TB}$

EXT SENSOR BIN

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Output SOC custom protocol.
Data sent:	Status, Heading, Attitude, Rotation rates, Depth, Speeds, Position, Log misalignment.
Data frame:	The frame contains 18 fields - 61 byte. MSB are sent first.

Message <F0><F1><F2>…..<F17>			
Field 0	Byte 0	'$'	Synchronization byte
Field 1	Byte 1	Status	1 if Alignment
Field 2	Bytes 2 to 5	Heading	Radians IEEE floating point format
Field 3	Bytes 6 to 9	Roll	Radians IEEE floating point format Sign "+" when port up
Field 4	Bytes 10 to 13	Pitch	Radians IEEE floating point format Sign "+" when bow down
Field 5	Bytes 14 to 17	XV3 rotation rate*	Rad/s IEEE floating point format
Field 6	Bytes 18 to 21	Xv1 rotation rate*	Rad/s IEEE floating point format
Field 7	Bytes 22 to 25	-XV2 rotation rate*	Rad/s IEEE floating point format **Warning:** Opposite sign of INS usual convention
Field 8	Bytes 26 to 29	Depth	Meters IEEE floating point format
Field 9	Bytes 30 to 33	Down speed	M/s IEEE floating point format
Field 10	Bytes 34 to 37	East speed	M/s IEEE floating point format
Field 11	Bytes 38 to 41	South speed	M/s IEEE floating point format
Field 12	Bytes 42 to 45	Latitude	$+/-2^{31}$ = +/-Pi Signed 32 bits
Field 13	Bytes 46 to 49	Longitude	$+/-2^{31}$ = +/-Pi Signed 32 bits
Field 14	Bytes 50 to 53	Log misalignment	Radians IEEE floating point format
Field 15	Bytes 54 to 57	Spare fields	**4 bytes**
Field 16	Bytes 58 to 59	Counter	Incremented by 1 Unsigned 16 bits
Field 17	Byte 60	Checksum	Addition of all the bytes for 0 to 59

* The resolution of rotation rate data is limited to 3.6°/h to comply with export regulation.

GAPS BIN

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: This protocol is used by the INS II GAPS 3.

Data sent: Heading, Attitude, Position, speeds, heave, attitude, heading and position standard deviations, status.

Data frame: On INS III, interface status is mapped to INS II equivalent status. All fields are transmitted MSB first.

Data	Format	Units
Header	8 bit unsigned integer	Value : '$'
Time tag of data	64 bit unsigned integer	See Note 1
INS interface status 1	32 bit unsigned integer	See Note 3
INS algorithm status 2	32 bit unsigned integer	See Note 4
Heading	32 bit IEEE Float	Rad
Roll	32 bit IEEE Float	Rad
Pitch	32 bit IEEE Float	Rad
Latitude	32 bit signed integer +/- 2^{31}= +/- 90°	Degrees
Longitude	32 bit signed integer +/- 2^{31}= +/- 180°	Degrees
Altitude (positive up)	32 bit IEEE Float	m
North speed	32 bit IEEE Float	m/s
West speed	32 bit IEEE Float	m/s
Vertical speed (positive up)	32 bit IEEE Float	m/s
Heave on selected lever arm (positive up)	32 bit IEEE Float	m
Latitude standard deviation	32 bit IEEE Float	m
Longitude standard deviation	32 bit IEEE Float	m
Altitude standard deviation	32 bit IEEE Float	m
Heading standard deviation	32 bit IEEE Float	Rad
Roll standard deviation	32 bit IEEE Float	Rad
Pitch standard deviation	32 bit IEEE Float	Rad
CRC	16 bit unsigned integer	Note
Fin de trame	8 bit unsigned integer	Valeur : '#'

Note 1: The 64 bits time tag is described hereafter :

Bit [63..56] spare

Bit [55..52] x 10 days (0 à 3)	Bit [51..48] days (0 à 9)
Bit [47..44] x 10 hour (0 à 2)	Bit [43..40] hours (0 à 9)
Bit [39..35] x 10 minutes (0 à 5)	Bit [34..31] minutes (0 à 9)
Bit [31..28] x 10 seconds (0 à 5)	Bit [27..24] seconds (0 à 9)
Bit [23..20] x 1/10 seconds (0 à 9)	Bit [19..16] x 1/100 seconds (0 à 9)
Bit [15..12] x 1000 µseconds (0 à 9)	Bit [11..8] x 100 µseconds (0 à 9)
Bit [7..4] x 10 µseconds (0 à 9)	Bit [3..0] µseconds (0 à 9)

Note 2: Crc computation is performed using XOR with polynom = X15+X10+X3, initialized to 0xFFFF.

CRC code:

```
unsigned short blkcrc(unsigned char* bufptr, unsigned len)
{
    unsigned char i;
    unsigned short data;
    unsigned short crc = 0xffff;

    if (len == 0)
        return ~crc;

    do
    {
        for (i = 0, data = (unsigned short)(0xff & *bufptr++);
            i < 8;
            i++, data >>= 1)
        {
            if ((crc & 0x0001) ^ (data & 0x0001))
            {
                crc = (crc >> 1) ^ 0x8408;
            }
            else
            {
                crc >>= 1;
            }
        }
    } while (--len);

    crc = ~crc;
    data = crc;
    crc = (crc << 8) | ((data >> 8) & 0xff);

    return crc;
}
```

Note 3: INS interface status 1 (mapped from INS II System status 1)

Hexadecimal Value	Bit number	Description	Hexadecimal Value	Bit number	Description
hhhhhhh**H**	0	Log received	hhh**H**hhhh	16	Serial input A error
	1	GPS received		17	Serial input B error
	2	Depth received		18	Serial input C error
	3	USBL received		19	FIFO Full
hhhhhh**H**h	4	LBL received	hh**H**hhhhh	20	Serial output A full
	5	GPS2 received		21	Serial output B full
	6	Log EM received		22	Serial output C full
	7	Settings Saved		23	Serial output D full
hhhhh**H**hh	8	FOG X1 Error	h**H**hhhhhh	24	Serial IN A activity
	9	FOG X2 Error		25	Serial IN B activity
	10	FOG X3 Error		26	Serial IN C activity
	11	source error		27	CPU overload
hhhh**H**hhh	12	Acc. X1 error	**H**hhhhhhh	28	Heading not valid
	13	Acc. X2 error		29	Attitude not valid
	14	Acc. X3 error		30	Altitude received
	15	Temperature error		31	Reserved

Note 4: INS interface status 2 (mapped from INS Algorithm status 1)

Hexadecimal Value	Bit number	Description	Hexadecimal Value	Bit number	Description
hhhhhhh**H**	0	Navigation mode	hhh**H**hhhh	16	USBL received
	1	Alignment		17	USBL data valid
	2	Fine alignment		18	Waiting for USBL data
	3	Dead reckoning mode		19	USBL data rejected
hhhhhh**H**h	4	Altitude calculated using GPS	hh**H**hhhhh	20	Depth sensor received
	5	Altitude calculated using Depth sensor		21	Depth sensor data valid
	6	Altitude stabilized		22	Waiting for Depth sensor data
	7	Altitude Hydro		23	Depth sensor data rejected
hhhhh**H**hh	8	Log received	h**H**hhhhhh	24	LBL received
	9	Log data valid		25	LBL data valid
	10	Waiting for Log data		26	Waiting for LBL data
	11	Log data rejected		27	LBL data rejected
hhhh**H**hhh	12	GPS received	**H**hhhhhhh	28	Saturation of altitude
	13	GPS data valid		29	Saturation of speed
	14	Waiting for GPS data		30	Acc or Rotation speed dynamic exceeded
	15	GPS data rejected		31	Heave initialisation

HDMS

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Output Simrad proprietary protocol.
Data sent:	Roll, Pitch, Heave and Heading.
Data frame:	The frame contains 6 fields - 10 bytes. LSB are sent first.

Message <F0><F1><F2>…..<F5>			
Field 0	Byte 0	Sensor status	Fixed value = 0x90
Field 1	Byte 1	Synchronization byte	Fixed value = 0x90
Field 2	Bytes 2 to 3	Roll	+/-180° ; LSB = 0.01° Sign "+" when port up
Field 3	Bytes 4 to 5	Pitch	+/-180° ; LSB = 0.01° Sign "+" when bow up **Warning:** Opposite sign of INS usual convention.
Field 4	Bytes 6 to 7	Heave (*)	LSB = 0.01 m Sign +" when INS goes up
Field 5	Bytes 8 to 9	Heading	0° to 360° ; LSB = 0.01°

(*) The heave corresponds to the lever arm set on the output port.

HEAVE POSTPRO

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary.

Data sent: Heave.

Data frame:

Conventions

Time

INS clock gives time starting when system is turned on. Time is reset to 0 every 24 hour. Early block versions used IEEE 32 floats to store time, which lacks accuracy when hours increase. Thus this floating point representation was replaced by a fixed point datation of 100us granularity in new bloc versions.

Data types

Each telegram description uses following convention:

Type name	Description
Byte	Unsigned 8 bit integer
Character	Signed 8 bit integer
Word	Unsigned 16 bit integer
Short	Signed 16 bit integer
DWord	Unsigned 32 bit integer
Long	Signed 32 bit integer
Float	IEEE Float 32 bits
Double	IEEE Float 64 bits

All 16 and 32 bits integers are represented in Big endian convention (MSB sent first)

Encryption

Only the the data fields of the ACC are enciphered. A new encrypting key is sent every 6000 frame that enables the decoding of the 6000 previous frames (hence every 60 second at 100 Hz).

Every 32 bits field is encoded as follow: Byte1 XOR KeyH, Byte2 XOR KeyL, Byte3 XOR KeyH and Byte4 XOR KeyL.

Protocol description

Heave Telegram

Version 0x01

Data	Format	Units
Header	Byte	Value : ‘$’
Telegram size	Byte	NN bytes
Telegram identification	Byte	30
Data bloc version	Byte	0x10
Data validity time	Dword	INS time tag in steps of 100 μs
Telegram counter	Word	N/A
Decoding key	Word	KeyH then KeyL
ACC X on COG	Float	meters/second^2 in terrestrial frame (enciphered)
ACC Y on COG	Float	meters/second^2 in terrestrial frame (enciphered)
ACC Z on COG	Float	meters/second^2 in terrestrial frame (enciphered)
Real Time Surge	Float	meters (INS level)
Real Time Sway	Float	meters (INS level)
Real Time Heave	Float	meters (INS level)
Smart Heave Delay	Dword	in steps of 100us
Smart Heave*	Float	Delayed heave in meters (INS level)
Heave Status	Byte	0x01 if Heave Ok
Real Time Heave Mode	Byte	Real Time Heave Filter mode: 1-Slight, 2-Moderate, 3-Rough, 4-Automatic
Heave Period	Float	Estimated Heave Period
Heave Amplitude	Float	Estimated Heave Amplitude

* The smart heave is delayed by 100 s.

IMU BIN

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Binary.
Data sent:	Delta rotations and delta velocities.
Data frame:	The frame contains 10 fields – 37 bytes, MSB sent first.

Message <F0><F1><F2>…..<F10>			
Field 0	Byte 0	'$'	Synchronization byte
Field 1	Byte 1 to 4	Time stamp (0-24)	Unsigned 32 bit integer. LSB= 50 µs (**Note 1**)
Field 2	Byte 5 to 8	XV1 delta rotation	IEEE float 32 bits in radian (**Note 2**)
Field 3	Byte 9 to 12	XV2 delta rotation	IEEE float 32 bits in radian
Field 4	Byte 13 to 16	XV3 delta rotation	IEEE float 32 bits in radian
Field 5	Byte 17 to 20	XV1 delta velocity	IEEE float 32 bits in m/s (**Note 2**)
Field 6	Byte 21 to 24	XV2 delta velocity	IEEE float 32 bits in m/s
Field 7	Byte 25 to 28	XV3 delta velocity	IEEE float 32 bits in m/s
Field 8	Byte 29 to 32	Sensor status	Unsigned 32 bit integer. INS sensor status 2
Field 9	Byte 33 to 34	Sensor temperature	Signed 16 bit integer. x10 Kelvin (**Note 3**)
Field 10	Byte 35 to 36	Checksum	Unsigned 16 bit integer (**Note 4**)

Note 1: If INS is synchronized with GPS time then it is UTC time.

Note 2: Delta rotation is the integration of the gyro readings in the time interval of output data rate. We define t1 as the time validity of the delta rotation data, Δt the output data rate and t2 the instant of output of first bit of data telegram. Then (t2-t1) is the latency on data and delta rotation is the integration of rotation angle from t1-Δt to t1.

Delta velocity is the integration of accelerometer readings in the time interval of output data rate in the same manner as delta rotation. It is expressed in the vehicle frame before the delta rotation.

Note 3: to convert value to °C= (Temperature/10)-273.15. This is the mean value of T_{FOGX1}, T_{FOGX2}, T_{FOGX3}, T_{ACCX1}, T_{ACCX2}, T_{ACCX3}.

Note 4: Sum of all bytes from byte 0 to byte 34.

IMU RAW DATA

This protocol is not available for all products.
Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary.

Data sent: Rotation rates, Delta , Temperature, Status.

Data frame: The frame contains 12 fields – 32 bytes. Multiple byte data is sent most significant byte first except the checksum, which is coded in LSB first.

Message <F0><F1><F2>…..<F11>			
Field 0	Byte 0	0x55	Synchronization byte
Field 1	Byte 1	0..255	Counter (**Note 1**)
Field 2	Byte 2 to 3	See below	Status (**Note 2**)
Field 3	Byte 4 to 7	XV1 delta rotation	IEEE Float 32 bits in radian(**Note 5**)
Field 4	Byte 8 to 11	XV2 delta rotation	IEEE Float 32 bits in radian
Field 5	Byte 12 to 15	XV3 delta rotation	IEEE Float 32 bits in radian
Field 6	Byte 16 to 19	XV1 delta velocity	IEEE Float 32 bits in m/s(**Note 5**)
Field 7	Byte 20 to 23	XV2 delta velocity	IEEE Float 32 bits in m/s
Field 8	Byte 24 to 27	XV3 delta velocity	IEEE Float 32 bits in m/s
Field 9	Byte 28	Temperature	Signed 8 bit integer in °C(**Note 4**)
Field 10	Byte 29 to 30	See below	Checksum (**Note 3**)
Field 11	Byte 31	0xAA	Stop byte

Note 1: The counter starts from 0 and is incremented by 1 for each message transmitted. Counter wraps back to 0 when it reaches the maximum value of 255. The counter is used to detect lost messages at receiver.

Note 2: The status is described hereafter:

Bit 0	FOG X1 anomaly (bit 0 of sensor status 2)
Bit 1	FOG X2 anomaly (bit 1 of sensor status 2)
Bit 2	FOG X3 anomaly (bit 2 of sensor status 2)
Bit 3	FOG Acquisition error (OR of bit 19 to 24 of Sensor status 1)
Bit 4	Accelerometer X1 anomaly (bit 4 of sensor status 2)
Bit 5	Accelerometer X2 anomaly (bit 5 of sensor status 2)
Bit 6	Accelerometer X3 anomaly (bit 6 of sensor status 2)
Bit 7	Sensor error (OR of bit 0 to 6 of present status)
Bit 8	Optical source error (bit 3 of sensor status 2)
Bit 9	Temperature error (bit 7 of sensor status 2)
Bit 12-15	Reserved

Note 3: The CRC is defined as follows and is computed based on data fields 0 to 9.

Name: “CRC/CCITT”

Width: 16

Poly: 0x1021, (or X16+X12+X5+1)

Init: FFFF

Final XOR value: 0

Reflected input: True

Reflected output: True

Note 4: Temperatue is coded in 2’s complement signed integer format, ranging from -128°C to +127°C.

The temperature represents the mean temperature of T_{FOGX1}, T_{FOGX2}, T_{FOGX3}, T_{ACCX1}, T_{ACCX2}, T_{ACCX3}

Note 5: Delta rotation is the integration of the gyro readings in the time interval of output data rate. We define t1 as the time validity of the delta rotation data, Δt the output data rate and t2 the instant of output of first bit of data telegram. Then (t2-t1) is the latency on data and delta rotation is the integration of rotation angle from t1-Δt to t1.

Delta velocity is the integration of accelerometer readings in the time interval of output data rate in the same manner as delta rotation.

IXBLUE STD BIN V2, V3

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Important

The value of the heave without lever arm is set to 0 when selecting Smart heave in the web-based user interface with this protocol for the output settings.

The smart heave is delayed by 100 s.

Conventions

Validity time fields

Output mode

If the protocol is used as output, the validity time fields contain internal system time that can be synchronized with GPS UTC time when UTC time is sent to system at regular intervals (i.e: every second). To improve accuracy it is recommended to input a 1 PPS pulse at pulse input of system. If no UTC is received, the internal time starts at 0 at system boot time. The time fields are formatted in steps of 100 µs and cycle from 0 to 24h, thus covering [0:863999999] steps of 100 µs.

Input mode

If the protocol is used as input, the validity time field is used to provide external sensor validity time, formatted in steps of 100 µs. Three cases can be distinguished:

- Time stamp shall be positive or null to send timestamp ([0:863999999] steps of 100 µs). In this case, used timestamp corresponds to the transmitted timestamp.
- Time stamp shall be negative to indicate sensor delay. In this case, used timestamp correspond to reception time minus transmitted delay.
- Time stamp shall be 0x7FC0000 if no time information has to be sent. In this case, external sensor timestamp corresponds to reception timestamp
- Data types

Each telegram description uses following convention:

Type name	Description
Byte	Unsigned 8 bit integer
Character	Signed 8 bit integer
Word	Unsigned 16 bit integer
Short	Signed 16 bit integer
DWord	Unsigned 32 bit integer
Long	Signed 32 bit integer

Float	IEEE Float 32 bits
Double	IEEE Float 64 bits

All 16 and 32 bits integers are represented in Big Endian convention (MSB sent first).

Direction

Given that the protocol can used both as output or input, the following conventions is used to indicate if a data is used in output mode, input mode or both (mainly apply on bit masks):

Type name	Description
I	Filled/Used in input mode only
O	Filled/Used in output mode only
I/O	Filled/Used in both input and output mode

Frames

Different frames are used to express data:

- QUADRANS or INS body frame (X1, X2, X3)
- Vehicle frame (XV1, XV2, XV3) that coincide with vessel frame after rough and fine misalignment are stored into the system using MMI.
- Sensor (i.e: DLV, EM LOG) reference frame (XS1, XS2, XS3).
- Local geographical frame (XNorth, XWest ,XUp)
- Horizontal vehicle frame (XV1H, XV2H, XV3H) is vehicle frame compensated from roll an pitch. It lies in geographical horizontal plane.

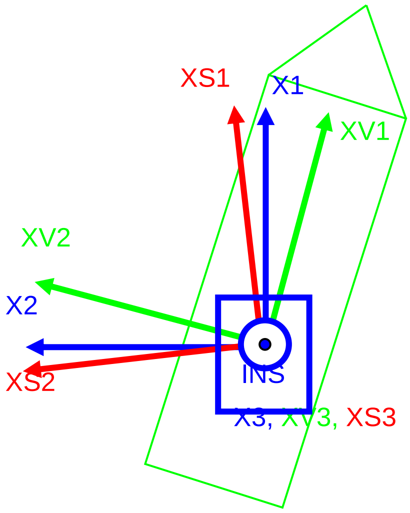


Figure 7 : Vehicle, Body and sensor reference frame

Altitude convention

Altitude can referenced to Geoïdal model (mean sea level) if managed by the GPS input. In this case, geoïdal separation field is a valid IEEE float that contains distance between geoid and ellipsoid at current position. Otherwise if GPS does not manage mean sea level altitude, the altitude field if referenced from ellipsoid and geoidal separation field contains NaN value 0x7FC00000.

DVL speed compensation in INS using sound speed

When available, INS will use both the sound speed calculated by the DVL (using temperature, depth, salinity) expressed as C_{DVL} and the speed of sound measured by an external sensor (CTD, SVP) expressed as C_{EXT}.
The corrected DVL speed will be calculated using the following formula:

$$V_{corrected} = \frac{C_{EXT}}{C_{DVL}} \cdot V_{DVL}$$

Protocol description

The iXBlue StdBin protocol can be used both as output or input protocol. The output telegram is used to get navigation data and received external sensors from the system. The input telegram is used to send external sensors data to the system.

Protocol structure

The structure of the protocol is the same whether it's used as input or output. Each protocol frame contains a header message, followed the message body that can contain a combination a different data blocks.
When used as output, the message body contains both navigation data blocks and external sensors data blocks (external sensors received by the system). When used as input, the message body only contains external sensors data blocks (to send to the system).
Additional command frames can be sent to the system, using specific command header, to send parameters to the product. The system will reply to these command frames with answer frames starting with answer header as detailed in next chapters.
Each message is terminated by a checksum to validate all the content of the telegram. This checksum is a DWord unsigned sum of all frame bytes, including the header and excluding the checksum itself.

Header	Body	Checksum

Protocol Use

As described in the following paragraphs, the protocol header is slightly different in input and output modes. However, the input mode manages both the input telegram coded as specified hereafter (including input header format) and the output telegram coming from another INS/QUADRANS (including output header format). This enables to loopback one system to another using iXBlue Std Bin protocol.

Message Headers

There are four types of headers in this protocol:

- Command header, used to send commands to the system
- Answer header, used to contain responses to a command sent to the system
- Output navigation data header, used to contains system navigation data and external sensor copies
- Input sensor data header, used to send external sensors to the system

The headers hold the protocol version, and for navigation messages, the bit masks that indicate which data block is present, the telegram size and other information depending on protocol direction.

Input message header for commands

Input messages that contain commands to be sent to the system are formatted using following header (available from version 3 only):

Data	Format	Units
Header 1	Byte	Value : ‘C’
Header 2	Byte	Value : ‘M’
Protocol version	Byte	0x03
Total telegram size	Word	Number of bytes of the message including 7 byte header

The body part of each command message contains a single command formatted as detailed in Advanced Configuration User Guide (ref.: MU-INSIII-004). They are used to send parameters to the system.

Output message header for answers to commands

Output messages that contain answers to commands that were sent to the system are formatted using following header (available from version 3 only):

Data	Format	Units
Header 1	Byte	Value : ‘A’
Header 2	Byte	Value : ‘N’
Protocol version	Byte	0x03
Total telegram size	Word	Number of bytes of the message including 7 byte header

Output message header for navigation data

Version 0x2 header

Data	Format	Units
Header 1	Byte	Value : 'I'
Header 2	Byte	Value : 'X'
Protocol version	Byte	0x02
Navigation data blocks bit mask	DWord	Bloc combination identification bit mask Bit is set to 1 when bloc is output, 0 otherwise.
External data bit mask	DWord	Bloc combination identification bit mask Bit is set to 1 when bloc is output, 0 otherwise.
Total telegram size	Word	Number of bytes of the message including 21 byte header
Navigation data validity time	Dword	Validity time in steps of 100 µs
Counter	DWord	Cycling counter inside [0:2^{32}-1]

Version 0x3 header

Navigation data output telegram header version 3 is formatted as follows:

Data	Format	Units
Header 1	Byte	Value : 'I'
Header 2	Byte	Value : 'X'
Protocol version	Byte	0x03
Navigation data blocks bit mask	DWord	Bloc combination identification bit mask Bit is set to 1 when bloc is output, 0 otherwise.
Extended Navigation data block bit mask	DWord	Bloc combination identification bit mask Bit is set to 1 when bloc is output, 0 otherwise.
External data bit mask	DWord	Bloc combination identification bit mask Bit is set to 1 when bloc is output, 0 otherwise.
Total telegram size	Word	Number of bytes of the message including 25 byte header
Navigation data validity time	Dword	Validity time in steps of 100us
Counter	DWord	Cycling counter inside [0:2^{32}-1]

Navigation data input message header

Navigation data input messages are used to send external sensor data to the system using the same structure as output messages.

Version 0x2 header

On protocol version 2, navigation data messages are formatted using following header:

Data	Format	Units
Header 1	Byte	Value : 'I'
Header 2	Byte	Value : 'X'
Protocol version	Byte	0x02
Navigation data blocks bit mask	DWord	Unused in input mode. Shall be set to 0x00000000
External data bit mask	DWord	Bloc combination identification bit mask Bit is set to 1 when bloc is output, 0 otherwise.
Total telegram size	Word	Number of bytes of the message including 21 byte header
External sensors time stamp reference	Byte	External sensors timestamp : 0x00: UTC time
RFU	7 Bytes	Shall be set to 0x00.

Version 0x3 header

On protocol version 3, navigation data messages are formatted using following header:

Data	Format	Units
Header 1	Byte	Value : 'I'
Header 2	Byte	Value : 'X'
Protocol version	Byte	0x03
Navigation data blocks bit mask	DWord	Unused in input mode. Shall be set to 0x00000000
Extended navigation data blocks bit mask	DWord	Unused in input mode. Shall be set to 0x00000000
External data bit mask	DWord	Bloc combination identification bit mask Bit is set to 1 when bloc is output, 0 otherwise.
Total telegram size	Word	Number of bytes of the message including 25 byte header
External sensors time stamp reference	Byte	External sensors timestamp : 0x00: UTC time
RFU	7 Bytes	Shall be set to 0x00.

Bit Masks description for navigation data messages

Navigation data blocks

Following table describes the navigation data blocks and their corresponding bit number:

Bit n°	Internal Block description	INS(*)	QUADRANS	Dir.
0	Attitude & Heading	X	X	O
1	Attitude & Heading standard deviation	X	N/A	O
2	Real time Heave/Surge/Sway	X	X	O
3	Smart Heave™(**)	X	X	O
4	Heading/Roll/Pitch Rate	X	X	O
5	Rotation rate in vessel frame, compensated from Earth rotation	X	X	O
6	Acceleration in vessel frame, compensated from gravity	X	X	O
7	Position	X	N/A	O
8	Position standard deviation	X	N/A	O
9	Speed in geographic frame	X	From V3	O
10	Speed std dev in geographic frame	X	N/A	O
11	Current in geographic frame	X	N/A	O
12	Current std dev in geographic frame	X	N/A	O
13	System date	X	X	O
14	INS/Quadrans sensor status	X	X	O
15	INS algorithm status	X	N/A	O
16	INS system status	X	N/A	O
17	INS user status	X	N/A	O
18	Quadrans algorithm status	N/A	X	O
19	Quadrans system status	N/A	X	O
20	Quadrans user status	N/A	X	O
21	Heave, surge and sway speeds	X	X	O
22	Speed in vessel frame	X	From V3	O
23	Acceleration in geographic frame not compensated from gravity	X	X	O
24	Course and speed over ground	X	From V3	O
25	Temperatures (ACC/FOG/ANA)	X	X	O
26	Attitude quaternion data	From V3	From V3	O
27	Attitude quaternion standard deviation	From V3	N/A	O

Bit n°	Internal Block description	INS(*)	QUADRANS	Dir.
28	Raw accelerations in vessel frame not compensated from gravity	From V3	From V3	O
29	Accelerations standard deviation vessel frame	From V3	N/A	O
30	Rotation rate standard deviation (vessel frame)	From V3	N/A	O
31	RFU	N/A	N/A	N/A

(*) INS stands for PHINS, AIRINS, ROVINS, PHINS6000, HYDRINS, MARINS, LANDINS, GAPS, ATLANS, ROVINS NANO, PHINS COMPACT product range
(**) The smart heave is 100 s delayed.

Extended navigation data blocks

Following table describes the extended navigation data blocks and their corresponding bit number. This section is only available from protocol version 3:

Bit n°	Internal Block description	INS(*)	QUADRANS	Dir.
0	Rotation accelerations in vessel frame	From V3	From V3	O
1	Rotation acceleration standard deviation	From V3	N/A	O
2	Raw rotation rate in vessel frame, not compensated from Earth rotation	From V3	From V3	O
2-31	Reserved	N/A	N/A	N/A

External sensor data blocks

Following table details the external sensor and status blocks and their corresponding bit number:

Bit n°	Block description	INS(*)	QUADRANS	Dir.
0	UTC data	X	X	I/O
1, 2, 3	GPS1, GPS2, manual GPS data	X	X	I/O
4, 5	EMLOG1, EMLOG 2 data	X	X	I/O
6, 7, 8	USBL1 - 3 data	X	N/A	I/O
9	Depth data	X	N/A	I/O
10	DVL Ground Speed	X	N/A	I/O
11	DVL Water Speed	X	N/A	I/O
12	Sound Velocity	X	N/A	I/O
13	DMI	X	N/A	I/O

Bit n°	Block description	INS(*)	QUADRANS	Dir.
14 - 17	LBL1 - 4 data	X	N/A	I/O
18 - 20	Event marker A, B, C	X	N/A	O
21	DVL2 Ground Speed	X	N/A	I/O
22	DVL2 Water Speed	X	N/A	I/O
24 to 31	*Reserved*	N/A	N/A	I/O

(*) INS stands for PHINS, AIRINS, ROVINS, PHINS6000, HYDRINS, MARINS, LANDINS, GAPS, ATLANS, ROVINS NANO, PHINS COMPACT product range.

Navigation data blocks

The navigation data blocks are used in output mode only.

Attitude & Heading data block (bit n°0)

Attitude and Heading relates to Vehicle reference frame.

Data	Format	Units
Heading	Float	In degrees, inside [0°:360°[
Roll	Float	In degrees, positive when port up, inside [-180°:180°[
Pitch	Float	In degrees, positive bow down, inside [-90°:90°]

Attitude & Heading standard deviation data block (bit n°1)

Data	Format	Units
Heading Standard deviation	Float	In degrees, inside [0°:360°[
Roll Standard deviation	Float	In degrees, inside [0°:360°[
Pitch Standard deviation	Float	In degrees, inside [0°:360°[

Heave/Surge/Sway data block (bit n°2)

Data	Format	Units
Real time heave without lever arm(*)	Float	In meters, positive up (XV3H direction)
Real time heave at selected lever arm	Float	In meters, positive up (XV3H direction)
Real time surge at selected lever arm	Float	In meters, positive forward in XV1H
Real time sway at selected lever arm	Float	In meters, positive port side in XV2H

(*) if the user specified the COG lever arm, this field corresponds to COG heave. Otherwise, if COG lever arm is not specified, this is the heave at the system position (i.e. center of body frame).

Smart Heave^{TM} data block (bit n°3)

This block contains Smart Heave^{TM} data and related time.

Data	Format	Units
Smart Heave Time(*)	Dword	Smart heave validity time (steps of 100 us)
Smart Heave^{TM} At primary lever arm (**)	Float	In meters, positive up (XV3H direction)

(*) The smart heave is delayed by 100 s. This field contains the time of validity for the Smart Heave.

(**) The smart heave is only available on primary lever arm.

Heading/Roll/Pitch rate data block (bit n°4)

This block contains attitude rates data (derivative of heading, roll and pitch):

Data	Format	Units
Heading rotation rate	Float	In °/s, positive when heading increases
Roll rotation rate	Float	In °/s, positive when port going up
Pitch rotation rate	Float	In °/s, positive when bow going down

Body rotation rates data block in vessel frame (bit n°5)

This block contains rotation rates in vessel frame XV1, XV2, XV3, compensated from earth rotation, gyros biases and scale factors:

Data	Format	Units
Rotation rate XV1	Float	In °/s, positive when port is going up
Rotation rate XV2	Float	In °/s, positive when bow is going down
Rotation rate XV3	Float	In °/s, positive counter clock wise around XV3

Accelerations data block in vessel frame (bit n°6)

This block contains accelerations **at primary lever arm** in vessel frame XV1, XV2, XV3, compensated from gravity:

Data	Format	Units
Acceleration XV1	Float	In m/s^2, positive forward
Acceleration XV2	Float	In m/s^2, positive toward port
Acceleration XV3	Float	In m/s^2, positive up

Linear acceleration expressed in vessel frame, noted:

$$\underline{a}_v = \frac{d}{dt}(\underline{v}_v)$$

It is computed by compensating gravity and Coriolis acceleration from raw measured accelerations as body frame is not Galilean.

Position data block (bit n°7)

This block contains position data in WGS84 frame at selected lever arm:

Data	Format	Units
Latitude	Double	In degree, positive North, inside [-90°:90°]
Longitude	Double	In degree, increasing toward East, inside [0°:360°[
Altitude reference	Byte	0: Geoid (Mean Sea Level), 1: Ellipsoid
Altitude	Float	In meters, positive up

Position standard deviation data block (bit n°8)

This block contains position standard deviation data:

Data	Format	Units
North standard deviation	Float	In meters
East standard deviation	Float	In meters
North/East correlation	Float	No unit
Altitude standard deviation	Float	In meters

Speed data block in geographic frame (bit n°9)

This block contains speed data **at primary lever arm** in geographical frame:

Data	Format	Units
North velocity	Float	In m/s, positive north
East velocity	Float	In m/s, positive east
Up velocity	Float	In m/s, positive up

Speed standard deviation data block in geographic frame (bit n°10)

This block contains speed standard deviation data:

Data	Format	Units
North velocity std. deviation	Float	In m/s
East velocity std. deviation	Float	In m/s
Up velocity std. deviation	Float	In m/s

Current data block in geographic frame (bit n°11)

This block contains estimated current data:

Data	Format	Units
North current	Float	In m/s, positive north
East current	Float	In m/s, positive east

Current standard deviation data block in geographic frame (bit n°12)

This block contains estimated current standard deviation data:

Data	Format	Units
North current std. deviation	Float	In m/s
East current std. deviation	Float	In m/s

System date data block (bit n°13)

This is INS or QUADRANS internal date if system is not date synchronized to GPS otherwise it is ZDA date.

Data	Format	Units
Day	Byte	Day inside [0:31], 0 if unavailable
Month	Byte	Month inside [0:12], 0 if unavailable
Year	Word	Year inside [0:65535], 0 if unavailable

QUADRANS or INS Sensor Status (bit n°14)

This block contains sensor statuses detailed in section 3.4.

Data	Format	Units
Sensor Status 1	DWord	N/A
Sensor Status 2	DWord	N/A

INS Algorithm Status (bit n°15)

This block contains INS algorithm statuses detailed in section 3.4.

Data	Format	Units
Algorithm Status 1	DWord	N/A
Algorithm Status 2	DWord	N/A
Algorithm Status 3	DWord	N/A
Algorithm Status 4	DWord	N/A

INS System Status (bit n°16)

This block contains INS system status detailed in section 3.4.

Data	Format	Units
System Status 1	DWord	N/A
System Status 2	DWord	N/A
System Status 3	DWord	N/A

INS User Status (bit n°17)

This block contains INS user status detailed in in section 3.4.

Data	Format	Units
User Status	DWord	N/A

QUADRANS Algorithm Status (bit n°18)

This block contains QUADRANS algorithm status detailed in section 3.4.

Data	Format	Units
Algorithm Status	DWord	N/A

QUADRANS System Status (bit n°19)

This block contains QUADRANS system status detailed in section 3.4.

Data	Format	Units
System Status 1	DWord	N/A
System Status 2	DWord	N/A
System Status 3	DWord	N/A

QUADRANS User Status (bit n°20)

This block contains QUADRANS user status detailed in section 3.4.

Data	Format	Units
User Status	DWord	N/A

Heave/Surge/Sway speed data block (bit n°21)

Data	Format	Units
Real time heave speed (at selected lever arm)	Float	In m/s, positive up in XV3H direction
Surge speed (at selected lever arm)	Float	In m/s, positive forward in XV1H
Sway speed (at selected lever arm)	Float	In m/s, positive port side in XV2H

Speed data block in vessel frame (bit n°22)

This block contains speed data **at primary lever arm** in vessel frame:

Data	Format	Units
XV1 velocity	Float	In m/s, positive along XV1
XV2 velocity	Float	In m/s, positive along XV2
XV3 velocity	Float	In m/s, positive along XV3

Acceleration data block in geographic frame (bit n°23)

This block contains accelerations **at primary lever arm** in geographical frame, not compensated from gravity:

Data	Format	Units
North acceleration	Float	In m/s^2, positive North
East acceleration	Float	In m/s^2, positive East
Vertical acceleration	Float	In m/s^2, positive up

Course and speed over ground (bit n°24)

This block contains course and speed over ground data, **at primary lever arm**:

Data	Format	Units
Course over ground	Float	In degrees, inside [0°:360°[
Speed over ground	Float	In m/s

Temperatures (bit n°25)

This block contains the average temperature data:

Data	Format	Units
Mean temperature FOG: Average(TEMP_FOG_X, TEMP_FOG_Y, TEMP_FOG_Z)	Float	In °Celsius
Mean temperature ACC: Average(TEMP_ACC_X, TEMP_ACC_Y, TEMP_ACC_Z)	Float	In °Celsius
Temperature [TEMP_ANA] (Sensor board temperature)	Float	In °Celsius

Attitude quaternion (bit n°26)

This block contains the attitude quaternion representation:

Data	Format	Units
Attitude quaternion component q0	Float	N/A
Attitude quaternion component q1	Float	N/A
Attitude quaternion component q2	Float	N/A
Attitude quaternion component q3	Float	N/A

See at the end of this protocol description for details on quaternions definitions, operations and relationship with Euler angles.

Attitude quaternion standard deviation (bit n°27)

This block contains the standard deviations of attitude quaternion:

Data	Format	Units
Attitude quaternion std dev component $\sigma\left(\underline{\xi}_1\right)$	Float	N/A
Attitude quaternion std dev component $\sigma\left(\underline{\xi}_2\right)$	Float	N/A
Attitude quaternion std dev component $\sigma\left(\underline{\xi}_3\right)$	Float	N/A

See at the end of this protocol description for details on quaternions definitions, operations and relationship with Euler angles.

Raw acceleration in vessel frame (bit 28)

This block contains the acceleration in vessel frame, at primary lever arm, not compensated from gravity:

Data	Format	Units
Acceleration XV1	Float	In m/s^2, positive forward
Acceleration XV2	Float	In m/s^2, positive toward port
Acceleration XV3	Float	In m/s^2, positive up

Acceleration standard deviation in vessel frame (bit 29)

This block contains the acceleration standard deviation in vessel frame:

Data	Format	Units
Acceleration XV1 std dev	Float	In m/s^2
Acceleration XV2 std dev	Float	In m/s^2
Acceleration XV3 std dev	Float	In m/s^2

Rotation rate standard deviation in vessel frame (bit 30)

This block contains the rotation rate standard deviation in vessel frame:

Data	Format	Units
Rotation rate XV1 std dev	Float	In °/s
Rotation rate XV2 std dev	Float	In °/s
Rotation rate XV3 std dev	Float	In °/s

Extended navigation data blocks

Rotation accelerations in vessel frame (bit 0)

This block contains the rotation accelerations (derivate of compensated rotation rates in vessel frame:

Data	Format	Units
Raw rotation acceleration XV1	Float	In $°/s^2$
Raw rotation acceleration XV2	Float	In $°/s^2$
Raw rotation acceleration XV3	Float	In $°/s^2$

Rotation acceleration standard deviation in vessel frame (bit 1)

This block contains the rotation acceleration standard deviation in vessel frame:

Data	Format	Units
Raw rotation acceleration std dev XV1	Float	In $°/s^2$
Raw rotation acceleration std dev XV2	Float	In $°/s^2$
Raw rotation acceleration std dev XV3	Float	In $°/s^2$

Raw rotation rate in vessel frame (bit 2)

This block contains raw rotation rates in vessel frame, not compensated from Earth rotation:

Data	Format	Units
Raw rotation rate XV1	Float	In °/s
Raw rotation rate XV2	Float	In °/s
Raw rotation rate XV3	Float	In °/s

External sensors data blocks

The external sensors data blocks are used in both output and input mode.

- When used as output, the sensor blocks are sent only when the corresponding data is received by the system. The data validity time corresponds to the internal time or the UTC time if the system is UTC synchronized.
- When used as input, the sensor blocks are sent only to send external sensor data to the system. The time tag data corresponds to the sensor validity time.

UTC data block (bit n°0)

Last UTC data block received or UTC data block to send:

Data	Format	Units
Data validity time	Dword	Time tag in steps of 100us (refer to §0)
UTC Source	Byte	0: UTC1, 1: UTC2

GPS1, GPS2 and Manual GPS data blocks (bits n°1,2,3)

Last GPS1, GPS2 or Manual GPS data received or GPS data to send:

Data	Format	Units
Data validity time	Long	Time tag in steps of 100 us
GPS identification	Byte	0: GPS1 1: GPS2 2: Manual GPS
GPS quality	Byte	Refer to Table 17 Fixed to 1 for manual GPS
Latitude	Double	In degrees, positive North, inside [-90° :90°]
Longitude	Double	In degrees, positive East, inside [0° :360°[
Altitude	Float	In meters, positive up, in geoid reference
Latitude standard deviation	Float	In meters
Longitude standard deviation	Float	In meters
Altitude standard deviation	Float	In meters
Latitude/Longitude covariance	Float	In meters^2 Fixed to 0 for manual GPS
Geoidal separation	Float	meters

Quality indicator	Corresponding SD attributed to GPS position fix if no GST is received	Positioning system mode indicator
0	Data invalid	N/A
1	10 m	Natural
2	3 m	Differential
3	10 m	Military
4	0.1 m	RTK
5	0.3 m	Float RTK
6 - 255	Data invalid	Other mode

Table 18: INS interpretation of GPS quality

EMLOG1 and EMLOG2 data blocks (bits n°4,5)

Last EMLOG1 or EMLOG2 data received or EMLOG data to send:

Data	Format	Units
Data validity time	Long	Time tag in steps of 100 µs
EMLOG ID	Byte	0: EMLOG1 1: EMLOG2
XV1 longitudinal water speed	Float	In m/s, positive forward
XV1 speed standard deviation	Float	In m/s

USBL1, USBL2 and USBL3 data blocks (bits n°6,7,8)

Last USBL1, USBL2 or USBL3 data received or USBL data to send:

Data	Format	Units
Data validity time	Long	Time tag in steps of 100 µs
USBL identifier	Byte	0: USBL1 1: USBL2 2: USBL3
Beacon ID	8 Bytes	8 ASCII characters (*)
Latitude	Double	In Degrees, positive North inside [-90° :90°]
Longitude	Double	In Degrees, positive East inside [0°:360°[
Altitude	Float	In Meters, as received from USBL system (could be MSL altitude or -beacon depth)
North standard deviation	Float	In Meters
East standard deviation	Float	In Meters
Latitude/Longitude covariance	Float	In Meters^2
Altitude standard deviation	Float	In Meters

(*) If beacon ID length is less than 8 bytes, it is padded with null (\0) ASCII characters at the end.

Depth data block (bit n°9)

Last DEPTH data received or DEPTH data to send:

Data	Format	Units
Data validity time	Long	Time tag in steps of 100us
Depth	Float	In Meters
Depth standard deviation	Float	In Meters

DVL1, DVL2 Ground speed data block (bits 10,21)

Last DVL1 or DVL2 data received or DVL data to send:

Data	Format	Units
Data validity time	Long	Time tag in steps of 100us (refer to §0)
DVL identification	Byte	0: DVL 1 1: DVL 2
XV1 longitudinal ground speed	Float	In m/s
XV2 transverse ground speed	Float	In m/s
XV3 vertical ground speed	Float	In m/s
DVL speed of sound	Float	In m/s
DVL altitude (bottom range)	Float	In Meter
XV1 speed standard deviation	Float	In m/s
XV2 speed standard deviation	Float	In m/s
XV3 speed standard deviation	Float	In m/s

DVL1, DVL2 Water speed data block (bits 11, 22)

Last DVL1 or DVL2 data received or DVL data to send:

Data	Format	Units
Data validity time	Long	Time tag in steps of 100us
DVL identification	Byte	0: DVL 1 1: DVL 2
XV1 longitudinal water speed	Float	In m/s
XV2 transverse water speed	Float	In m/s
XV3 vertical water speed	Float	In m/s
DVL speed of sound	Float	In m/s
XV1 speed standard deviation	Float	In m/s
XV2 speed standard deviation	Float	In m/s
XV3 speed standard deviation	Float	In m/s

External Sound velocity data block (bit n°12)

Last external sound velocity received from a sound velocity probe, or sound velocity to send:

Data	Format	Units
Data validity time	Long	Time tag in steps of 100us
External sensor speed of sound	Float	In m/s (see §0)

DMI data blocks (bit n°13)

Last received DMI data, or DMI data to send:

Data	Format	Units
Data validity time	Long	Time tag in steps of 100us
Pulse count	Long	Number of pulses received since last DMI event

LBL1 to LBL4 data blocks (bits n°14, 15, 16, 17)

Last received LBL data, or LBL data to send:

Data	Format	Units
Data validity time	Long	Time tag in steps of 100us
LBL identifier	Byte	0: LBL1 1: LBL2 2: LBL3 3: LBL4
Beacon ID	8 Bytes	8 ASCII characters (*)
Beacon latitude	Double	In Degrees, positive North, inside [-90° :90°]
Beacon longitude	Double	In Degrees, positive East, inside [0° :360°[
Beacon altitude	Float	In meters, positive up
Range	Float	In Meters, positive
Range standard deviation	Float	In meters

(*) If beacon ID length is less than 8 bytes, it must be padded with null (\0) ASCII characters at the end.

Event marker A to C data blocks (bits 18, 19, 20)

These blocks contain the number of events received since last protocol update:

Data	Format	Units
Data validity time	Dword	Time tag in steps of 100us
Event Identification	Byte	0: Event A 1: Event B 2: Event C
Event count	Long	Number of events received since last protocol update

Quaternions conventions

Quaternion definition and operations

General expression of a quaternion

If q is a real number and $\underline{V}=\begin{bmatrix} V_x \\ V_y \\ V_z \end{bmatrix}$ a vector of the three dimensional Euclidian space, then the quaternion $Q = q + \underline{V}$ can be defined as:

$$Q = q + \underline{V} = \begin{bmatrix} q \\ V_x \\ V_y \\ V_z \end{bmatrix}$$

Where q and $\underline{V}$ are respectively the scalar part and the vector part of the quaternion Q.

Conjugate of a quaternion:

If $Q = \begin{bmatrix} q0 \\ q1 \\ q2 \\ q3 \end{bmatrix}$ is a quaternion, the conjugate $\bar{Q}$ of Q is given by:

$$\bar{Q} = \begin{bmatrix} q0 \\ -q1 \\ -q2 \\ -q3 \end{bmatrix}$$

Product of two quaternions

If $P = \begin{bmatrix} p0 \\ p1 \\ p2 \\ p3 \end{bmatrix}$ and $Q = \begin{bmatrix} q0 \\ q1 \\ q2 \\ q3 \end{bmatrix}$ are two quaternions, the product of P by Q, written $P.Q$ is given by:

$$P.Q = \begin{bmatrix} p0 \\ p1 \\ p2 \\ p3 \end{bmatrix} \cdot \begin{bmatrix} q0 \\ q1 \\ q2 \\ q3 \end{bmatrix} = \begin{bmatrix} p0q0 - p1q1 - p2q2 - p3q3 \\ p0q1 + p1q0 + p2q3 - p3q2 \\ p0q2 - p1q3 + p2q0 + p3q1 \\ p0q3 + p1q2 - p2q1 + p3q0 \end{bmatrix}$$

Conjugation of a vector V by a quaternion Q

$$Q.\underline{V}.\overline{Q} = \begin{bmatrix} q0 \\ q1 \\ q2 \\ q3 \end{bmatrix} \cdot \begin{bmatrix} 0 \\ Vx \\ Vy \\ Vz \end{bmatrix} \cdot \begin{bmatrix} q0 \\ -q1 \\ -q2 \\ -q3 \end{bmatrix} = \begin{bmatrix} 0 \\ (q0^2 + q1^2 - q2^2 - q3^2)Vx + 2(q1q2 - q0q3)Vy + 2(q1q3 + q0q2)Vz \\ 2(q1q2 + q0q3)Vx + (q0^2 - q1^2 + q2^2 - q3^2)Vy + 2(q2q3 - q0q1)Vz \\ 2(q1q3 - q0q2)Vx + 2(q2q3 + q0q1)Vy + (q0^2 - q1^2 - q2^2 + q3^2)Vz \end{bmatrix}$$

Attitude quaternion definition

Definition

Quaternion Q_{Geob} represents the rotation required to get from geographical frame to body frame:

For a vector V, V_b being its expression in body frame and V_{geo} its expression in geographical frame, the transformation from geographical frame to body frame is done through V_{geo} conjugation by quaternion Q_{Geob} :

$$V_b = Q_{Geob}.V_{geo}.\overline{Q_{Geob}}$$

Here we note «.» the usual product in quaternion space and $\overline{Q_{Geob}}$ the conjugate of quaternion Q_{Geob}.

Relationship between attitude quaternion and Euler angles

- H is heading angle, positive from North to East (indirect)
- P is pitch angle, positive when bow gets down
- R is roll angle, positive when port side gets up

[A'] and [A''] are intermediate frames where:

- [A'] is the image of geographical frame by heading rotation (-H, X_{UP})
- [A''] is the image of [A'] by pitch rotation (P, $Y_{A'}$)
- [v] is the image of [A''] by roll rotation (R, $X_{A''}$)

To get from geographical frame to vessel frame, we successively apply:

- A heading rotation of -H degrees around X_{UP}, represented by quaternion:

$$Q_{A'Geo} = \left(\cos\left(\frac{H}{2}\right) - \sin\left(\frac{H}{2}\right)X_{UP}\right)$$

- A pitch rotation P, around axis $Y_{A'}$ represented by the quaternion

$$Q_{A''A'} = \left(\cos\left(\frac{P}{2}\right) + \sin\left(\frac{P}{2}\right)Y_{A'}\right)$$

- Roll rotation R around axis $X_{A''}$ represented by quaternion :

$$Q_{vA''} = \left(\cos\left(\frac{R}{2}\right) + \sin\left(\frac{R}{2}\right)X_{A''}\right)$$

The global transition quaternion from geographical frame to vessel frame is thus the product:

$$Q_{Geov} = \left(\cos\left(\frac{R}{2}\right) - \sin\left(\frac{R}{2}\right)\mathrm{X}_{A''}\right).\left(\cos\left(\frac{P}{2}\right) - \sin\left(\frac{P}{2}\right)\mathrm{Y}_{A'}\right).\left(\cos\left(\frac{H}{2}\right) + \sin\left(\frac{H}{2}\right)\mathrm{X}_{UP}\right)$$

Or:

$$Q_{Geov} = \begin{bmatrix} cos\left(\frac{R}{2}\right) \\ -sin\left(\frac{R}{2}\right) \\ 0 \\ 0 \end{bmatrix} \cdot \begin{bmatrix} cos\left(\frac{P}{2}\right) \\ 0 \\ -sin\left(\frac{P}{2}\right) \\ 0 \end{bmatrix} \cdot \begin{bmatrix} cos\left(\frac{H}{2}\right) \\ 0 \\ 0 \\ sin\left(\frac{H}{2}\right) \end{bmatrix}$$

That can be developed as:

$$Q_{Geov} = \begin{bmatrix} cos\left(\frac{R}{2}\right).cos\left(\frac{P}{2}\right)cos\left(\frac{H}{2}\right) - sin\left(\frac{R}{2}\right).sin\left(\frac{P}{2}\right).sin\left(\frac{H}{2}\right) \\ -sin\left(\frac{R}{2}\right).cos\left(\frac{P}{2}\right).cos\left(\frac{H}{2}\right) - cos\left(\frac{R}{2}\right).sin\left(\frac{P}{2}\right)sin\left(\frac{H}{2}\right) \\ sin\left(\frac{R}{2}\right).cos\left(\frac{P}{2}\right).sin\left(\frac{H}{2}\right) - cos\left(\frac{R}{2}\right).sin\left(\frac{P}{2}\right).cos\left(\frac{H}{2}\right) \\ cos\left(\frac{R}{2}\right).cos\left(\frac{P}{2}\right).sin\left(\frac{H}{2}\right) + sin\left(\frac{R}{2}\right).sin\left(\frac{P}{2}\right).cos\left(\frac{H}{2}\right) \end{bmatrix}$$

Standard deviation of attitude quaternion

Definition

Attitude quaternion Q_{Geov} can be written as follows :

$$Q_{Geov} = Q_{bv} Q_{nb} Q_{Geon}$$

Introducing the error quaternions for Q_{nb} and Q_{Geon}, the above can be rewritten as follows :

$$Q_{Geov} = Q_{bv} \hat{Q}_{nb} \left(1 - \frac{\eta}{2}\right) \hat{Q}_{Geon} \left(1 - \frac{\gamma}{2}\right) \quad (0.1)$$

Introducing the error quaternion for Q_{Geov}, we can write :

$$Q_{Geov} = \hat{Q}_{Geov} \left(1 - \frac{\xi}{2}\right)$$

$$Q_{Geov} = Q_{bv} \hat{Q}_{Geob} \left(1 - \frac{\xi}{2}\right) \quad (0.2)$$

with $\underline{\xi}$ defined as the (small) rotation vector to get from actual [Geo] frame to erroneous [Geo] frame.

Equating Eq. **Erreur ! Source du renvoi introuvable.** and Eq.(0.2) yields:

$$\hat{Q}_{Geob}\left(1-\frac{\underline{\xi}}{2}\right)=\hat{Q}_{nb}\left(1-\frac{\underline{\eta}}{2}\right)\hat{Q}_{Geon}\left(1-\frac{\underline{\gamma}}{2}\right)$$

$$\left(1-\frac{\underline{\xi}}{2}\right)=\hat{Q}_{nGeo}\left(1-\frac{\underline{\eta}}{2}\right)\hat{Q}_{Geon}\left(1-\frac{\underline{\gamma}}{2}\right)$$

Neglecting the second order terms, we can write:

$$\left(1-\frac{\underline{\xi}}{2}\right)=1-\frac{\underline{\gamma}}{2}-\hat{Q}_{nGeo}\frac{\underline{\eta}}{2}\hat{Q}_{Geon}$$

$$\underline{\xi}=\underline{\gamma}+\hat{Q}_{nGeo}\underline{\eta}\hat{Q}_{Geon}$$

Finally, we can write the covariance matrix on vector $\underline{\xi}$, i.e., the so-called "attitude quaternion covariance", as follows :

$$\boxed{\sigma^2\left(\underline{\xi}\right)=\sigma^2\left(\underline{\gamma}\right)+\hat{C}_n^{Geo}\sigma^2\left(\underline{\eta}\right)\left(\hat{C}_n^{Geo}\right)^T}$$

The standard deviations on vector $\underline{\xi}$ components are noted:

$$\sigma\left(\underline{\xi}_1\right)$$
$$\sigma\left(\underline{\xi}_2\right)$$
$$\sigma\left(\underline{\xi}_3\right)$$

N.B.: $\sigma^2\left(\underline{\gamma}\right)$, $\hat{C}_n^{Geo}$ and $\sigma^2\left(\underline{\eta}\right)$ are computed by the navigation algorithm.

Expression of Euler angles covariance from error vector covariance

The covariance of vector $\underline{\eta}$ is related to the covariance of the roll, pitch and yaw variances as follows :

$$\sigma^2\begin{pmatrix}\delta R\\ \delta T\\ -\delta A\end{pmatrix}=F\sigma^2\begin{pmatrix}v_x\\ v_y\\ v_z\end{pmatrix}F^t$$

where

$$F=\begin{pmatrix}-\dfrac{\cos\hat{A}}{\cos\hat{T}} & \dfrac{\sin\hat{A}}{\cos\hat{T}} & 0\\ -\sin\hat{A} & -\cos\hat{A} & 0\\ -\tan\hat{T}\cos\hat{A} & \tan\hat{T}\sin\hat{A} & -1\end{pmatrix}$$

IXSEA ICCB1

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Custom to interface to ICCB cabinet.
Data sent:	Status, Heading , Roll, Pitch, Horizontal speed over ground, Checksum.
Data frame:	The frame contains 7 fields - 15 bytes, MSB are sent first.

Message <F0><F1><F2>…..<F6>			
Field 0	Byte 0	0x02	Start of sentence
Field 1	Byte 1	Status	System status byte (see table below)
Field 2	Bytes 2 to 4	Heading	Unsigned 24 bits integer 2^{24} = 360°
Field 3	Bytes 5 to 7	Roll	Signed 24 bits integer +/-2^{23} = +/-180° Sign "+" when port side up
Field 4	Bytes 8 to 10	Pitch	Signed 24 bits integer +/-2^{23} = +/-180° **Warning:** Opposite sign of INS usual convention Sign "+" when bow up
Field 5	Bytes 11 to 12	Horizontal speed norm over ground	Unsigned 16 bits integer LSB= 1 cm/s
Field 6	Bytes 13 to 14	Checksum CRC16-Modbus	Computed on bytes 1 to 12

The table below details status byte bit definition according to user status byte table:

Status byte bit index	Description	Corresponding user status bits
0	'1' = Data is invalid '0' = Data is valid	27 or 9 or 10 or 11 or 13 or 14 or 15 or 30 or 31
1	'1' = Initial alignment '0' = End of initial alignment	27
2	'1' = Fine alignment in progress '0' = End of fine alignment	28
3	'1' = Internal sensor error '0' = Internal sensor OK	9 or 10 or 11

Status byte bit index	Description	Corresponding user status bits
4	‘1’ = Algorithm error ‘0’ = Algorithm OK	13 or 14 or 15
5	‘1’ = Input stream error ‘0’ = Input stream OK	16 or 17 or 18 or 19 or 20
6	‘1’ = Output stream error ‘0’ = Output stream OK	21 or 22 or 23 or 24 or 25
7	‘1’ = External sensor valid ‘0’ = External sensor lost	0 or 1 or 3 or 4 or 5 or 6 or 7

KINETIC SCIENTIFIC

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary.

Data frame: 12 fields, 24 bytes. For data coded on several bytes, the bytes are sent MSB first.

Message <F0><F1><F2>…..<F16>

Field	Byte(s)	Data	Description	Note(s)
0	0	Header	Fixed value = 0xA5	
1	1	Status	0x00: Full Accuracy 0x01: Fine Alignment (bit 2 of Algorithm status 1) 0x02: Alignment (bit 1 of Algorithm status 1) 0x03: ACC/FOG anomaly (bit 9 or 10 of User status) 0x04: Failure Mode (bit 31 of User status)	
2	2-3	Sequence	Incremental 16 bits integer Counter: 0 to 65535	
3	4-5	Heading	Unsigned 16 bits integer Range = [0,360°], LSB=0.01°	
4	6-7	Roll	Signed 16 bits integer Range = [-180°,+180°], LSB=0.01° Positive for left-port side up.	Note 1
5	8-9	Pitch	Signed 16 bits integer Range = [-90°,+90°], LSB=0.01° Positive for front side-bow down.	Note 1
6	10-11	Heading rate	Signed 16 bits integer Range = [-256°/s,+256°/s], LSB=2^{-7}°/s	Note 1
7	12-13	Roll rate		
8	14-15	Pitch rate		
9	16-17	XV1 Acceleration	Not compensated from g Signed 16 bits integer Range = [-16g,16g], LSB=2^{-11}g	Note 1
10	18-19	XV2 Acceleration		
11	20-21	XV3 Acceleration		
12	22-23	Checksum	Fletcher Checksum	Note 2

Note 1: Saturation values. When maximum or minimum value is reached, the output is set to maximum or minimum value.

Note 1: Fletcher Checksum Algorithm

Following pseudo-code implementation is of a modified Fletcher Checksum.

Compute performs the computation of the Fletcher Sum over a vector of bytes and returns a 16-bit value.

Append is passed a vector of bytes and a packet length. It presumes that the last two bytes of the packet are to hold the 16-bit checksum. It calls compute on the first Length-2 bytes of the packet and then fills in the last two bytes with the value returned by Compute.

Check is passed a vector of bytes, the last two of which are presumed to be the Fletcher Sum of the preceeding bytes. It uses Compute to determine the correctness of the packet and returns a Boolean with this result.

```
type Packet is array of byte;

function Check (The_Packet : Packet;
                The_Length : Integer) return Boolean is
begin
   return Compute (The_Packet, The_Length) = 0;
end Check;


procedure Append (The_Packet : Packet;
                  The_Length : Integer) is
   Sum : Integer;
begin
   Sum := Compute (The_Packet, The_Length – 2;
   The_Packet [The_Length – 2] := Sum and 255;
   The_Packet [The_Length – 1] := Sum >> 8;
end Append;


function Compute (The_Packet : Packet;
                  The_Length : Integer) return Integer is
   N : Integer;
   Sum1 : Integer;
   Sum2 : Integer;
   R_Upper : Integer
   R_Lower : Integer

begin
   Sum1 := 255;
   Sum2 := 255;
   for N in 0 .. The_Length - 1 loop
      Sum1 := Sum1 + The_Packet [N];
      if Sum1 > 255 then
         Sum1 := Sum1 – 255;
      end if;
      Sum2 := Sum2 + Sum1;
      if Sum2 > 255 then
         Sum2 := Sum2 – 255;
      end if;
   end loop;
   R_Lower := Sum1 + Sum2;
   R_Lower := 255 – (R_Lower and 255) + (R_Lower >> 8);
   R_Upper := Sum1 + R_Lower;
   R_Upper := 255 – (R_Upper and 255) + (R_Upper >> 8);
   return (R_Upper << 8) + R_Lower;
end Compute;
```

An alternate version of the loop in Compute is:

```
for N in 0 .. The_Length - 1 loop
   Sum1 := (Sum1 + The_Packet [N]) mod 255;
   Sum2 := (Sum2 + Sum1) mod 255;
end loop;
```

Note that the Fletcher Checksum computed over the 24 ordered bytes (Values followed by the Checksum) has a value of (0x0000).

Hereafter are some Fletcher Checksum Examples:

```
Example 1
Buffer 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Checksum 00 00

Example 2
Buffer 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F 10 11 12 13 14 15
Checksum 26 F1

Example 3
Buffer 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F 10 11 12 13 14 15 16
Checksum 12 EF

Example 4
Buffer FF FE FD FC FB FA F9 F8 F7 F6 F5 F4 F3 F2 F1 F0 EF EE ED EC EB EA
Checksum D9 0E

Example 5
Buffer 11 1C 14 1A 10 1D 15 DB 0D 08 0E CA 11 1C 14 4A 19 12 1E D7 04 07
Checksum 87 59
```

LM NAV

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary.

Data types conventions: each telegram description uses following convention:

Type name	Description
Byte	Unsigned 8 bit integer
Character	Signed 8 bit integer
Word	Unsigned 16 bit integer
Short	Signed 16 bit integer
DWord	Unsigned 32 bit integer
Long	Signed 32 bit integer
Float	IEEE Float 32 bits
Double	IEEE Float 64 bits

All 16 and 32 bits integers are represented in Big Endian convention (MSB sent first).

Data	Format	Units	Comments
Header 1	Byte	Value : ‘L’	Used as a delimiter to identify the start of the protocol
Header 2	Byte	Value : ‘M’	
Protocol version	Byte	0x01	Used to discriminate frame content in case of protocol change
Timestamp	Dword	Steps of 100µ in range [0:863999999] (Note 1)	Time of validity of all data contained in the frame
User status	Dword	Refer to user status section	INS user status for health monitoring capability
Heading	Float	In degrees, range in [0°:360°[	True heading of the INS with appropriate resolution and range
Heading std dev	Float	In degree, range [0°:360°]	True Heading confidence estimation (1σ)
Polar heading	Float	In degrees, range in [0°:360°[(Note 7)	Polar heading of the INS with appropriate resolution and range
Polar heading std dev	Float	In degree, range [0°:360°] (Note 7)	Polar heading confidence estimation (1σ)

Data	Format	Units	Comments
Yaw	Float	In degrees, range in [0°:360°[(Note 6)	Rotation around ship vertical axis with appropriate resolution and range.
Yaw std dev	Float	In degree, range [0°:360°]	Yaw confidence estimation (1σ)
Roll	Float	In degrees, positive when port up, range in [-180°:180°[	Ship roll output with appropriate resolution and range
Roll std dev	Float	in degree, range [0:180°]	Roll confidence estimation (1σ)
Pitch	Float	in degrees, positive bow down, inside [-90°:90°]	Ship pitch output with appropriate resolution and range
Pitch std dev	Float	in degree, range [0:90°]	Pitch confidence estimation (1σ)
Heading rate	Float	In degrees/s, range in [-3000°/s : 3000°/s]	Ship heading rate output with appropriate resolution and range
Heading rate std dev	Float	in degrees/s, range in [0°/s : 3000°/s]	Heading rate confidence estimation (1σ)
Roll rate	Float	In degrees/s, range in [-3000°/s : 3000°/s]	Ship roll rate output with appropriate resolution and range
Roll rate std dev	Float	in degrees/s, range in [0°/s : 3000°/s]	Roll rate confidence estimation (1σ)
Pitch rate	Float	In degrees/s, range in [-3000°/s : 3000°/s]	Ship pitch rate output with appropriate resolution and range
Pitch rate std dev	Float	in degrees/s, range in [0°/s : 3000°/s]	Pitch rate confidence estimation (1σ)
Yaw rate	Float	In degrees/s, range in [-3000°/s : 3000°/s]	Ship yaw rate output with appropriate resolution and range
Yaw rate std dev	Float	in degrees/s, range in [0°/s : 3000°/s]	Yaw rate confidence estimation (1σ)
Vertical reference	Float	in degrees, range in [0°:180°] (Note 5)	Ship vertical reference with appropriate resolution and range
Vertical reference std dev	Float	in degrees, range in [0°:180°]	Vertical reference confidence estimation (1σ)
Latitude	Float	In degrees, positive North, in range [-90° : 90°] (Note 3)	Cartesian position output – Latitude field with appropriate resolution and range.
Latitude std dev	Float	In meters (Note 3)	Latitude confidence estimation (1σ)

Data	Format	Units	Comments
Longitude	Float	In degrees, positive East, in range [-180° : 180°] (Note 3)	Cartesian position output – Longitude field with appropriate resolution and range.
Longitude std dev	Float	In meters (Note 3)	Longitude confidence estimation (1σ)
Altitude	Float	In meters, positive up (Note 3)	Cartesian position output – Altitude field with appropriate resolution and range.
Altitude std dev	Float	In meters (Note 3)	Altitude confidence estimation (1σ)
Ext position convention	Byte	Extended Position convention mode index (Note 3 and Note 8)	Current system coordinate mode indication
Ext position validity flag	Byte	Set to 1 when extended position coordinates are valid and set to 0 when out of range/invalid	UPS, UTM and British National Grid are defined in specific areas and not valid on the whole earth. This flag is used to indicate whether the coordinates are within acceptable range for current position convention mode
Ext position coordinate A	Double	Position coordinate field A (Note 3 and Note 8)	Field content depends on selected geospatial parameters
Ext position coordinate B	Double	Position coordinate field B (Note 3 and Note 8)	
Ext position coordinate C	Float	Position coordinate field C (Note 3 and Note 8)	
Ext position coordinate D	Byte	Position coordinate field D (Note 3 and Note 8)	
Ext position coordinate E	Byte	Position coordinate field E (Note 3 and Note 8)	
Ext position coordinate F	Byte	Position coordinate field F (Note 3 and Note 8)	
Ext position coordinate G	Byte	Position coordinate field G (Note 3 and Note 8)	
Speed over ground	Float	In meter/s (Note 2)	Speed over ground output with appropriate resolution and range.

Data	Format	Units	Comments
Speed over ground std dev	Float	In meter/s (Note 2)	Speed over ground confidence estimation (1σ)
Future course	Float	In degrees, in range [0:360°[(Note 2)	Future course over ground with appropriate resolution and range.
Future course std dev	Float	In degrees, in range [0:360°[(Note 2)	Future course confidence estimation (1σ)
Heave acceleration	Float	In m/s², positive up (Note 3 and Note 4)	Heave output with appropriate resolution and range.
Heave acceleration std dev	Float	In m/s² (Note 3 and Note 4)	Heave confidence estimation (1σ)
Surge acceleration	Float	In m/s², positive forward (Note 3 and Note 4)	Surge output with appropriate resolution and range.
Surge acceleration std dev	Float	In m/s² (Note 3 and Note 4)	Surge confidence estimation (1σ)
Sway acceleration	Float	In m/s², positive port side (Note 3 and Note 4)	Sway output with appropriate resolution and range.
Sway acceleration std dev	Float	In m/s² (Note 3 and Note 4)	Sway confidence estimation (1σ)
Heave acc rate	Float	In m/s³, positive up (Note 3 and Note 4)	Heave rate output with appropriate resolution and range.
Heave acc rate std dev	Float	In m/s³(Note 3)	Heave rate confidence estimation (1σ)
Surge acc rate	Float	In m/s³, positive forward (Note 3)	Surge rate output with appropriate resolution and range.
Surge acc rate std dev	Float	In m/s³ (Note 3)	Surge rate confidence estimation (1σ)
Sway acc rate	Float	In m/s³, positive port side (Note 3)	Sway rate output with appropriate resolution and range.
Sway acc rate std dev	Float	In m/s³ (Note 3)	Sway rate confidence estimation (1σ)
Checksum	Word	Unsigned sum of all frame bytes excepted Checksum field	Used to verify the complete frame integrity : the checksum computed with received data must be equal to the checksum contained in this last field to guarantee no byte was lost or corrupted during transmission

Note 1: The timestamp reference cycles from 0 to 24 h by steps of 100 µs. It starts at 0 when the INS is powered up will be referenced to UTC as soon as the INS received a UTC synchronization from external time sensor.

Note 2: These values are computed for primary lever arm only, independently of selected lever arm for this protocol output.

Note 3: These values are computed on selected lever arm (primary or secondary), depending on selected lever arm for this protocol output.

Note 4: These values are computed in vessel horizontal frame (vessel frame projected on the local horizontal plane).

Note 5: Vertical reference is the angle of displacement of the vessels normal axis to the Earth-referenced vertical datum and computed as arccos(cos(roll)*cos(pitch)).

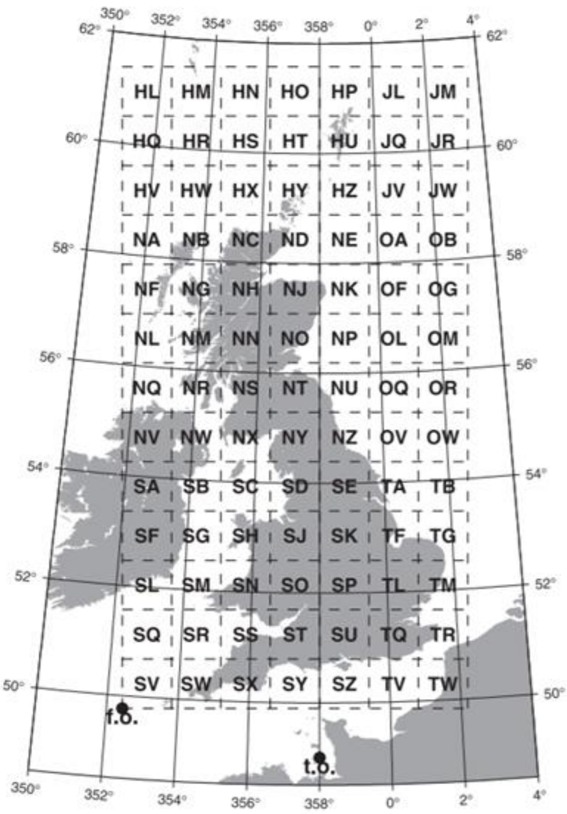
Note 6: Yaw is initialized at 0 at boot time and computed as the integration of the yaw velocity which is rotation rate around the ship vertical axis.

Note 7: Polar heading is used at high latitude where conventional heading become less significant. Both polar heading and conventional heading are always computed and output by the INS. Polar position will be output when position mode is set to polar mode.

Note 8: Position can be sent in different conventions, depending on selected mode in the Web-based User Interface. Fields A to G will have different meaning depending on selected mode, as detailed below:

Mode	Mode name	Validity area	A field	B field	C field	D field	E field	F field	G field
0	UTM	Latitude <80°S or <84°N	Northing (m)	Easting (m)	Altitude (m)	UTM zone number 0 if invalid	UTM zone letter 0 if invalid	N/A Set to 0	N/A Set to 0
1	Universal Polar Stereographic	Latitude >80°S or >84°N	Northing (m)	Easting (m)	Altitude (m)	Zone letter 0 if invalid	N/A Set to 0	N/A Set to 0	N/A Set to 0
2	Universal Polar Transverse	Global	Polar latitude (°)	Polar longitude (°)	Altitude (m)	N/A Set to 0	N/A Set to 0	N/A Set to 0	N/A Set to 0
3	British National Grid	National grid limits (Note 9)	Northing (m)	Easting (m)	Altitude (m)	500km grid letter 0 if invalid	100km grid letter	N/A Set to 0	N/A Set to 0
4	MGRS	Global	Northing (m)	Easting (m)	Altitude (m)	Grid zone number	Grid zone letter	Square column	Square row
5	GEOREF	Global	Northing (min)	Easting (min)	Altitude (m)	15° longitude letter	15° latitude letter	1° longitude letter	1° latitude letter
6	ECEF	Global	X (m)	Y (m)	Z (m)	N/A Set to 0	N/A Set to 0	N/A Set to 0	N/A Set to 0

Note 9: The British grid defines a true origin at 49°N, 2°W and a false origin 400 km west and 100 km north from the true origin (t.o.). The Brithsh grid coordinates are defined when longitude is inside [f.o. : f.o. + 700km] and the latitude is inside [f.o. ; f.o. + 1300km].



LONG BIN NAV HR

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Derived from the LONG BINARY NAV protocol with 3 supplementary bytes to increase resolution on HRP and on time.

Data sent: Time, Latitude, Longitude, Altitude, Heave, North Velocity , East Velocity, Down Velocity, Roll, Pitch, Heading, Heading rate, Roll rate, Pitch rate, Status and standard deviations for Latitude, Longitude, North Velocity, East Velocity, Down Velocity, Roll, Pitch and Heading data.

Data frame: The frame contains 26 fields - 61 bytes.

Message <F0><F1><F2>…..<F25> (**Note 1**)			
Field 0	Byte 0	'q' (0x71)	Synchronization byte
Field 1	Bytes 1 to 4	Data time tag	32 bits integer (seconds). Time of day (0-24 h)
Field 2	Bytes 5 to 6	Data time tag	Unsigned 16 bits integer (fraction of seconds). LSB = 15.26 µs.
Field 3	Bytes 7 to 10	Latitude (WGS84) '+': North of equator	Signed 32 bits integer +/-2^{31} = +/- 180°
Field 4	Bytes 11 to 14	Longitude (WGS84) '+': East of Greenwich	Signed 32 bits integer +/-2^{31} = +/- 180°
Field 5	Bytes 15 to 18	Altitude** (WGS84) "+" Up	Signed 32 bits integer. LSB=1 mm
Field 6	Bytes 19 to 20	Heave "+" when down	Signed 16 bits integer. LSB= 1 mm **Warning:** Opposite sign of INS usual convention
Field 7	Bytes 21 to 22	North velocity	Signed 16 bits integer. LSB= 1 mm/s
Field 8	Bytes 23 to 24	East velocity	Signed 16 bits integer LSB= 1 mm/s
Field 9	Bytes 25 to 26	Down velocity	Signed 16 bits integer LSB= 1 mm/s
Field 10	Bytes 27 to 29	Roll Sign "+" when port side up	Signed 24 bits integer +/-2^{23} = +/- 180°
Field 11	Bytes 30 to 32	Pitch Sign "+" when bow up	Signed 24 bits integer +/-2^{23} = +/- 180° **Warning:** Opposite sign of INS usual convention
Field 12	Bytes 33 to 35	Heading	Unsigned 24 bits integer 2^{23} = 180°

Message <F0><F1><F2>…..<F25> (**Note 1**)			
Field 13	Bytes 36 to 38	Heading rotation rate****	Signed 24 bits integer $+/-2^{23}$ = +/- 180°/s
Field 14	Bytes 39 to 41	Roll rotation rate****	Signed 24 bits integer $+/-2^{23}$ = +/- 180°/s
Field 15	Bytes 42 to 44	Pitch rotation rate****	Signed 24 bits integer $+/-2^{23}$ = +/- 180°/s
Field 16	Bytes 45 to 48	User Status	4 Bytes INS User status
Field 17	Bytes 49 to 50	Latitude std. deviation	Unsigned 16 bits integer. LSB= 1 cm
Field 18	Bytes 51 to 52	Longitude std. deviation	Unsigned 16 bits integer. LSB= 1 cm
Field 19	Bytes 53 to 54	North velocity std. deviation	Unsigned 16 bits integer. LSB= 1 mm/s
Field 20	Bytes 55 to 56	East velocity std. deviation	Unsigned 16 bits integer. LSB= 1 mm/s
Field 21	Bytes 57 to 58	Down velocity std. deviation	Unsigned 16 bits integer. LSB= 1 mm/s
Field 22	Bytes 59 to 60	Roll std. deviation	Unsigned 16 bits integer 2^{15} = 90°
Field 23	Bytes 61 to 62	Pitch std. deviation	Unsigned 16 bits integer 2^{15} = 90°
Field 24	Bytes 63 to 64	Heading std. deviation	Unsigned 16 bits integer 2^{15} = 90°
Field 25	Bytes 65 to 66	Checksum (CRC)***	Computed on bytes 1 to 64

Note 1: MSB is sent first then LSB (big-endian convention).

***** The precision of rotation rate data is limited to 3.6 deg/h to comply with export regulation.

****** Altitude value depends on the Altitude Computation Mode :

If Altitude Computation Mode = GPS then Altitude = Altitude with respect of the mean sea level

If Altitude Computation Mode = Altitude Hydro then Altitude = Altitude with respect of the mean sea level + Heave

If Altitude Computation Mode = Depth Sensor then Altitude = Depth

If Altitude Computation Mode = Stabilization then Altitude = manually entered altitude

***CRC computation is given hereafter:

```
unsigned short blkcrc(unsigned char* bufptr, unsigned len)
{
unsigned char i;
unsigned short data;
unsigned short crc = 0xffff;

    if (len == 0)
            return ~crc;
    do
    {
            for (i = 0, data = (unsigned short)(0xff & *bufptr++); i < 8; i++, data >>= 1)
            {
                    if ((crc & 0x0001) ^ (data & 0x0001))
                    {
                            crc = (crc >> 1) ^ 0x8408;
                    }
                    else
                    {
                            crc >>= 1;
                    }
            }
    } while (--len);

    crc = ~crc;
    data = crc;
    crc = (crc << 8) | ((data >> 8) & 0xff);

    return crc;
}
```

**** HRP rate values are averaged over the last sampling period for output rates from 0.1 to 50Hz; for output rates faster than 50Hz, instantaneous values are used.

LONG BIN NAV HR 2

This protocol is not available for all products.
Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Derived from the LONG BINARY NAV HR protocol with higher resolution on position data and User status replaced by Sensor, Algorithm and System Status.
Data sent:	Time, Latitude, Longitude, Altitude, Heave, North Velocity , East Velocity, Down Velocity, Roll, Pitch, Heading, Heading rate, Roll rate, Pitch rate, Sensor/Algorithm and System Status, standard deviations for Latitude, Longitude, North Velocity, East Velocity, Down Velocity, Roll, Pitch and Heading data.
Data frame:	31 fields – 95 bytes.

Message <F0><F1><F2>…..<F25> **(Note 1)**			
Field 0	Byte 0	'q' (0x71)	Synchronization byte
Field 1	Bytes 1 to 4	Data time tag	32 bits integer (seconds). Time of day (0-24 h)
Field 2	Bytes 5 to 6	Data time tag	Unsigned 16 bits integer (fraction of seconds). LSB = 15.26 µs.
Field 3	Bytes 7 to 14	Latitude (WGS84) '+': North of equator	Signed 64 bits integer +/-2^{63} = +/- 180°
Field 4	Bytes 15 to 22	Longitude (WGS84) '+': East of Greenwich	Signed 64 bits integer +/-2^{63} = +/- 180°
Field 5	Bytes 23 to 26	Altitude** (WGS84) "+" Up	Signed 32 bits integer. LSB=1 mm
Field 6	Bytes 27 to 28	Heave "+" when down	Signed 16 bits integer. LSB= 1 mm **Warning:** Opposite sign of INS usual convention
Field 7	Bytes 29 to 30	North velocity	Signed 16 bits integer. LSB= 1 mm/s
Field 8	Bytes 31 to 32	East velocity	Signed 16 bits integer LSB= 1 mm/s
Field 9	Bytes 33 to 34	Down velocity	Signed 16 bits integer LSB= 1 mm/s
Field 10	Bytes 35 to 37	Roll Sign "+" when port side up	Signed 24 bits integer +/-2^{23} = +/- 180°

Message <F0><F1><F2>…..<F25> **(Note 1)**			
Field 11	Bytes 38 to 40	Pitch Sign “+” when bow up	Signed 24 bits integer +/-2^{23} = +/- 180° **Warning:** Opposite sign of INS usual convention
Field 12	Bytes 41 to 43	Heading	Unsigned 24 bits integer 2^{23} = 180°
Field 13	Bytes 44 to 46	Heading rotation rate****	Signed 24 bits integer +/-2^{23} = +/- 180°/s
Field 14	Bytes 47 to 49	Roll rotation rate****	Signed 24 bits integer +/-2^{23} = +/- 180°/s
Field 15	Bytes 50 to 52	Pitch rotation rate****	Signed 24 bits integer +/-2^{23} = +/- 180°/s
Field 16	Bytes 53 to 56	System Status 1	4 Bytes INS System Status 1
Field 17	Bytes 57 to 60	System Status 2	4 Bytes INS System Status 2
Field 18	Bytes 61 to 64	Algorithm Status 1	4 Bytes INS Algo Status 1
Field 19	Bytes 65 to 68	Algorithm Status 2	4 Bytes INS Algo Status 2
Field 20	Bytes 69 to 72	Sensor Status 1	4 Bytes INS Sensor Status 1
Field 21	Bytes 73 to 76	Sensor Status 2	4 Bytes INS Sensor Status 2
Field 22	Bytes 77 to 78	Latitude std. deviation	Unsigned 16 bits integer. LSB= 1 cm
Field 23	Bytes 79 to 80	Longitude std. deviation	Unsigned 16 bits integer. LSB= 1 cm
Field 24	Bytes 81 to 82	North velocity std. deviation	Unsigned 16 bits integer. LSB= 1 mm/s
Field 25	Bytes 83 to 84	East velocity std. deviation	Unsigned 16 bits integer. LSB= 1 mm/s
Field 26	Bytes 85 to 86	Down velocity std. deviation	Unsigned 16 bits integer. LSB= 1 mm/s
Field 27	Bytes 87 to 88	Roll std. deviation	Unsigned 16 bits integer 2^{15} = 90°
Field 28	Bytes 89 to 90	Pitch std. deviation	Unsigned 16 bits integer 2^{15} = 90°
Field 29	Bytes 91 to 92	Heading std. deviation	Unsigned 16 bits integer 2^{15} = 90°
Field 30	Bytes 93 to 94	Checksum (CRC)***	Computed on bytes 1 to 92

Note 1 : MSB is sent first then LSB (big-endian convention).

*****The precision of rotation rate data is limited to 3.6 deg/h to comply with export regulation.

******Altitude value depends on the Altitude Computation Mode :

If Altitude Computation Mode = GPS then Altitude = Altitude with respect of the mean sea level. If Altitude Computation Mode = Altitude Hydro then Altitude = Altitude with respect of the mean sea level + Heave. If Altitude Computation Mode = Depth Sensor then Altitude = Depth. If Altitude Computation Mode = Stabilization then Altitude = manually entered altitude

***CRC computation is given hereafter:

```
unsigned short blkcrc(unsigned char* bufptr, unsigned len)
{
unsigned char i;
unsigned short data;
unsigned short crc = 0xffff;
    if (len == 0)
        return ~crc;
    do
    {
        for (i = 0, data = (unsigned short)(0xff & *bufptr++); i < 8; i++, data >>= 1)
        {
            if ((crc & 0x0001) ^ (data & 0x0001))
            {
                crc = (crc >> 1) ^ 0x8408;
            }
            else
            {
                crc >>= 1;
            }
        }
    } while (--len);

    crc = ~crc;
    data = crc;
    crc = (crc << 8) | ((data >> 8) & 0xff);
    return crc;
}
```

**** HRP rate values are averaged over the last sampling period for output rates from 0.1 to 50Hz; for output rates faster than 50Hz, instantaneous values are used.

LONG BIN NAV SM

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:

Data sent: Time, Latitude, Longitude, Heave, North Velocity , East Velocity, Heave speed, Roll, Pitch, Heading, Heading rate, Roll rate, Pitch rate, Status and standard deviations for Latitude, Longitude, North Velocity, East Velocity, Heave speed, Roll, Pitch and Heading data.

Data frame: 25 fields – 63 bytes. For multi-byte fields, the MSB is sent first (big-endian convention). The resolution of rotation rate data is limited to 3.6 deg/h to comply with export regulation.

Message <F0><F1><F2>…..<F24>			
Field 0	Byte 0	Synchronization byte	Fixed character ‘s’ (0x73)
Field 1	Bytes 1 to 4	Data validity time	Unsigned 32 bits integer. Epoch time in second (number of second since 1st January 1970)
Field 2	Bytes 5 to 6	Residual data validity time	Unsigned 16 bits integer (fraction of seconds from 0 to 65535). LSB = 1/65536 (about 15.26us).
Field 3	Bytes 7 to 10	Latitude (WGS84)	Signed 32 bits integer +/-2^{31} = +/- 180° Positive toward North
Field 4	Bytes 11 to 14	Longitude (WGS84)	Signed 32 bits integer +/-2^{31} = +/- 180° Positive toward East of Greenwich meridian
Field 5	Bytes 15 to 16	Heave	Signed 16 bits integer. LSB= 1 mm Positive upwards
Field 6	Bytes 17 to 18	North velocity	Signed 16 bits integer. LSB= 1 mm/s Positive toward North
Field 7	Bytes 19 to 20	East velocity	Signed 16 bits integer LSB= 1 mm/s Positive toward East
Field 8	Bytes 21 to 22	Heave speed	Signed 16 bits integer LSB= 1 mm/s Positive upwards
Field 9	Bytes 23 to 25	Roll	Signed 24 bits integer +/-2^{23} = +/- 180° Positive when port side up

Message <F0><F1><F2>…..<F24>			
Field 10	Bytes 26 to 28	Pitch	Signed 24 bits integer +/-2^{23} = +/- 180° Positive when bow up **(warning: inverse of INS standard convention)**
Field 11	Bytes 29 to 31	Heading	Unsigned 24 bits integer 2^{23} = 180° Increases clockwise.
Field 12	Bytes 32 to 34	Heading rotation rate	Signed 24 bits integer +/-2^{23} = +/- 180°/s Positive clockwise (**Note 1**)
Field 13	Bytes 35 to 37	Roll rotation rate	Signed 24 bits integer +/-2^{23} = +/- 180°/s Positive when port moves upwards (**Note 1**)
Field 14	Bytes 38 to 40	Pitch rotation rate	Signed 24 bits integer +/-2^{23} = +/- 180°/s Positive when bow moves upwards (**Note 1**) **(warning: inverse of INS standard convention)**
Field 15	Bytes 41 to 44	User Status	4 Bytes INS User status
Field 16	Bytes 45 to 46	Latitude std. deviation	Unsigned 16 bits integer. LSB= 1cm
Field 17	Bytes 47 to 48	Longitude std. deviation	Unsigned 16 bits integer. LSB= 1cm
Field 18	Bytes 49 to 50	North velocity std. deviation	Unsigned 16 bits integer. LSB= 1mm/s
Field 19	Bytes 51 to 52	East velocity std. deviation	Unsigned 16 bits integer. LSB= 1mm/s
Field 20	Bytes 53 to 54	Down velocity std. deviation	Unsigned 16 bits integer. LSB= 1mm/s
Field 21	Bytes 55 to 56	Roll std. deviation	Unsigned 16 bits integer 2^{15} = 90°
Field 22	Bytes 57 to 58	Pitch std. deviation	Unsigned 16 bits integer 2^{15} = 90°
Field 23	Bytes 59 to 60	Heading std. deviation	Unsigned 16 bits integer 2^{15} = 90°
Field 24	Bytes 61 to 62	CRC	Computed on bytes 1 to 60 (**Note 2**)

Note 1: Heading, Roll and Pitch rates are averaged over the last sampling period for output rates from 0.1 to 50Hz; for output rates faster than 50Hz, instantaneous values are used.

Note 2: CRC computation is described below:

```
unsigned short blkcrc(unsigned char* bufptr, unsigned len)
{
unsigned char i;
unsigned short data;
unsigned short crc = 0xffff;
    if (len == 0)
        return ~crc;
    do
    {
        for (i = 0, data = (unsigned short)(0xff & *bufptr++); i < 8; i++, data >>= 1)
        {
            if ((crc & 0x0001) ^ (data & 0x0001))
            {
                crc = (crc >> 1) ^ 0x8408;
            }
            else
            {
                crc >>= 1;
            }
        }
    } while (--len);
    crc = ~crc;
    data = crc;
    crc = (crc << 8) | ((data >> 8) & 0xff);
    return crc;
}
```

LONG BINARY NAV

This protocol is not available for all products.
Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Custom protocol.

Data sent: Time, Latitude, Longitude, Altitude, Heave, North Velocity , East Velocity, Down Velocity, Roll, Pitch, Heading, X1 Rotation Rate, X2 Rotation Rate, X3 Rotation Rate, Status and standard, deviations for Latitude, Longitude, North Velocity, East Velocity, Down Velocity, Roll, Pitch and Heading datas.

Data frame: 26 fields - 61 bytes.

Message <F0><F1><F2>…..<F25> (**Note 1**)			
Field 0	Byte 0	'q'	Synchronization byte
Field 1	Bytes 1 to 4	Data time tag	32 bits integer (seconds)
Field 2	Bytes 5 to 6	Data time tag	Unsigned 16 bits integer 0.0001 seconds (0 to 10000)
Field 3	Bytes 7 to 10	Latitude '+': North of equator	Signed 32 bits integer +/-2^{31} = +/- 180° (+/- 180 degrees)
Field 4	Bytes 11 to 14	Longitude '+': East of Greenwich	Signed 32 bits integer +/-2^{31} = +/- 180° (+/- 180 degrees)
Field 5	Bytes 15 to 18	Altitude**	Signed 32 bits integer (centimeters)
Field 6	Bytes 19 to 20	Heave "+" when down	Signed 16 bits integer (centimeters) **Warning:** Opposite sign of INS usual convention
Field 7	Bytes 21 to 22	North velocity	Signed 16 bits integer (centimeters/second)
Field 8	Bytes 23 to 24	East velocity	Signed 16 bits integer (centimeters/second)
Field 9	Bytes 25 to 26	Down velocity	Signed 16 bits integer (centimeters/second)
Field 10	Bytes 27 to 28	Roll Sign "+" when port side up	Signed 16 bits integer +/-2^{15} = +/- 180° (+/- 180 degrees)
Field 11	Bytes 29 to 30	Pitch Sign "+" when bow up	Signed 16 bits integer +/-2^{15} = +/- 180° (+/- 180 degrees) **Warning:** Opposite sign of INS usual convention
Field 12	Bytes 31 to 32	Heading	Unsigned 16 bits integer 2^{15} = 180° (0 to 360 degrees)
Field 13	Bytes 33 to 34	XV1 rotation rate*	Signed 16 bits integer +/-2^{15} = +/- 180°/s

Message <F0><F1><F2>…..<F25> (**Note 1**)			
			(+/- 180 degrees/second)
Field 14	Bytes 35 to 36	XV2 rotation rate*	Signed 16 bits integer $+/-2^{15}$ = +/- 180°/s (+/- 180 degrees/second)
Field 15	Bytes 37 to 38	XV3 rotation rate*	Signed 16 bits integer $+/-2^{15}$ = +/- 180°/s (+/- 180 degrees/second)
Field 16	Bytes 39 to 42	User Status	INS User status
Field 17	Bytes 43 to 44	Latitude std. deviation	Unsigned 16 bits integer (centimeters)
Field 18	Bytes 45 to 46	Longitude std. deviation	Unsigned 16 bits integer (centimeters)
Field 19	Bytes 47 to 48	North velocity std. deviation	Unsigned 16 bits integer (centimeters/second)
Field 20	Bytes 49 to 50	East velocity std. deviation	Unsigned 16 bits integer (centimeters/second)
Field 21	Bytes 51 to 52	Down velocity std. deviation	Unsigned 16 bits integer (centimeters/second)
Field 22	Bytes 53 to 54	Roll std. deviation	Unsigned 16 bits integer 2^{15} = 90° (0 to 180 degrees)
Field 23	Bytes 55 to 56	Pitch std. deviation	Unsigned 16 bits integer 2^{15} = 90° (0 to 180 degrees)
Field 24	Bytes 57 to 58	Heading std. deviation	Unsigned 16 bits integer 2^{15} = 90° (0 to 180 degrees)
Field 25	Bytes 59 to 60	Checksum (CRC)***	Computed on bytes 1 to 58

Note 2 : MSB is sent first then LSB (big-endian convention).

***The precision of rotation rate data is limited to 36 deg/h to comply with export regulation.

****Altitude value depends on the Altitude Computation Mode :

If Altitude Computation Mode = GPS then Altitude = Altitude with respect of the mean sea level

If Altitude Computation Mode = Altitude Hydro then Altitude = Altitude with respect of the mean sea level + Heave

If Altitude Computation Mode = Depth Sensor then Altitude = Depth

If Altitude Computation Mode = Stabilization then Altitude = manually entered altitude

***CRC computation is given hereafter:

```
unsigned short blkcrc(unsigned char* bufptr, unsigned len)
{
unsigned char i;
unsigned short data;
unsigned short crc = 0xffff;

    if (len == 0)
        return ~crc;
    do
    {
        for (i = 0, data = (unsigned short)(0xff & *bufptr++); i < 8; i++, data >>= 1)
        {
            if ((crc & 0x0001) ^ (data & 0x0001))
            {
                crc = (crc >> 1) ^ 0x8408;
            }
            else
            {
                crc >>= 1;
            }
        }
    } while (--len);

    crc = ~crc;
    data = crc;
    crc = (crc << 8) | ((data >> 8) & 0xff);

    return crc;
}
```

LRS10 78 IC

LRS10 78 IIC

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: IC=ISO Convention, IIC= Inverse ISO Convention.

Data sent: Status, date, time ref GPS, heading, roll, pitch, heading rate, roll rate, pitch rate, latitude, longitude, depth, latitude accuracy, longitude accuracy, position correlation, GPS latitude, GPS longitude, North velocity, East velocity, down velocity, Log speed, course made good, speed over ground, direction of the current, speed of the current.

Data frame: 78 bytes – For data coded on several bytes, the bytes are sent MSB byte first. All signed integer are coded as two’s complement. This protocol telegram is assumed to be sent at the rate of 10 Hz.

Message <F0><F1><F2>…..<F33>			
Field 0	Byte 0 Byte 1	Header	0x5A 0xA5
Field 1	Byte 2	NUMDATA	0x48
Field 2	Byte 3	IDENT	0x02
Field 3	Byte 4	Status 1	**Table 1**
Field 4	Byte 5	Status 2	**Table 2**
Field 5	Byte 6	BITE Status	**Table 3**
Field 6	Bytes 7-8	Date **Note 1**	Unsigned 16 bits; LSB= 1 day, [1 to 366 days]
Field 7	Bytes 9-11	Time Ref GPS	Unsigned 24 bits; LSB= 0.01 s, [0 to 86400 s]
Field 8	Bytes 12-13	Spare	Set to 0
Field 9	Bytes 14-15	Heading	Unsigned 16 bits; LSB= $180/2^{15}$ deg, [0 to 360 deg] Positive and increasing when bow turns starboard.
Field 10	Bytes 16-17	Roll	Signed 16 bits; LSB= $90/2^{15}$ deg, ±90 deg
		For **LRS10_78_IIC**	Positive for left-port side down. **Warning:** Opposite sign of INS usual convention Inverse ISO Convention **Note 9**
		For **LRS10_78_IC**	Positive for left-port side up. ISO Convention **Note 9**

Message <F0><F1><F2>…..<F33>			
Field 11	Bytes 18-19	Pitch	Signed 16 bits; LSB= $90/2^{15}$ deg, ±90 deg
		For **LRS10_78_IIC**	Positive for front side-bow down. Inverse ISO Convention **Note 9**
		For **LRS10_78_IC**	Positive for front side-bow up. **Warning:** Opposite sign of INS usual convention ISO Convention **Note 9**
Field 12	Bytes 20-21	Heading rate **Note 2**	Signed 16 bits; LSB= $1/2^{15}$ rd/s, ±1 rd/s Positive when heading angle increases
Field 13	Bytes 22-23	Roll rate **Note 2**	Signed 16 bits; LSB= $1/2^{15}$ rd/s, ±1 rd/s Positive when roll angle increases
Field 14	Bytes 24-25	Pitch rate **Note 2**	Signed 16 bits; LSB= $1/2^{15}$ rd/s, ±1 rd/s Positive when pitch angle increases
Field 15	Bytes 26-29	Latitude	Signed 32 bits; LSB= $90/2^{31}$ deg, ±90 deg Positive in North hemisphere.
Field 16	Bytes 30-33	Longitude	Signed 32 bits; LSB= $180/2^{31}$ deg, ±180 deg Positive East of Greenwich meridian, up to 180 deg.
Field 17	Bytes 34-35	Depth **Note 3**	Signed 16 bits; LSB= $655.36/2^{15}$, ±655.36 m
Field 18	Bytes 36-39	Latitude accuracy **Note 4**	Unsigned 32 bits; LSB= $10800/2^{31}$ Nm, [0 to 10800 Nm]
Field 19	Bytes 40-43	Longitude accuracy **Note 4**	Unsigned 32 bits; LSB= $10800/2^{31}$ Nm, [0 to 10800 Nm]
Field 20	Bytes 44-45	Position correlation **Note 4**	Signed 16 bits; LSB= $1/2^{15}$, ±1 V^2
Field 21	Bytes 46-49	GPS Latitude	Signed 32 bits; LSB= $90/2^{31}$ deg, ±90 deg Positive in North hemisphere.
Field 22	Bytes 50-53	GPS Longitude	Signed 32 bits; LSB= $180/2^{31}$ deg, ±180 deg Positive East of Greenwich meridian, up to 180 deg.
Field 23	Bytes 54-55	North Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 24	Bytes 56-57	East Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 25	Bytes 58-59	Down Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 26	Bytes 60-61	Log Speed	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s

Message <F0><F1><F2>…..<F33>			
		Navigation Data	
Field 27	Bytes 62-63	Course made good **Note 5**	Unsigned 16 bits; LSB= $180/2^{15}$ deg, [0 to 360 deg]
Field 28	Bytes 64-65	Speed over ground **Note 5**	Unsigned 16 bits; LSB= $65.536/2^{15}$, [0 to 65.536 m/s]
Field 29	Bytes 66-67	Direction of the current **Note 11**	Unsigned 16 bits; LSB= $180/2^{15}$ deg, [0 to 360 deg]
Field 30	Bytes 68-69	Speed of the current **Note 10**	Unsigned 16 bits; LSB= $65.536/2^{15}$, [0 to 65.536 m/s]
Field 31	Bytes 70-75	Spare	Set to 0
Field 32	Byte 76	Checksum	**Note 6**
Field 33	Byte 77	Terminator	0xAA

Table 1: Byte STATUS 1

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# # # # # 0 0 0	Built In Test Equipment **Note 7**	Level 0 – No failure	N/A
# # # # # 0 0 1		Level 1 – Anomaly	When one of those INS User status bit is set to 0: DVL_RECEIVED_VALID GPS_RECEIVED_VALID GPS2_RECEIVED_VALID EMLOG_RECEIVED_VALID DEPTH_RECEIVED_VALID TIME_RECEIVED_VALID **Note 8**
# # # # # 0 1 0		Level 2 – Warning	When one of those INS User status bit is set to 1: ALTITUDE_SATURATION CPU_OVERLOAD TEMPERATURE_ERR INPUT_x_ERR OUTPUT_x_ERR
# # # # # 0 1 1		Level 3 – Failure (Attitude data not valid)	When one of those INS User status bit is set to 1: DEGRADED_MODE HRP_INVALID DYNAMIC_EXCEEDED

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# # # # # 1 0 0		Level 4 – Failure (no data valid)	INS User status FAILURE_MODE set to 1
# # # 0 0 # # #	Mode	Navigation – Sea	INS User status NAVIGATION set to 1
# # # 0 1 # # #		Navigation – Quay	INS Algo 2 status ZUPT_MODE_VALID set to 1
# # # 1 0 # # #		Alignment	INS User status ALIGNMENT set to 1
# # # 1 1 # # #		Maintenance	INS System status 2 SIMULATION_MODE set to 1
# 0 0 # # # # #	Attitude and Heading Reference validity	Data valid	N/A
# 0 1 # # # # #		Data degraded	When one of those INS User status bit is set to 1: DEGRADED_MODE FINE_ALIGNMENT
# 1 0 # # # # #		Data not valid	INS User status HRP_INVALID set to 1
x # # # # # # #	/	Reserved	N/A

Table 2: Byte STATUS 2

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# # # # # # # 0	GPS time validity	Data valid	INS User status TIME_RECEIVED_VALID set to 1
# # # # # # # 1		Data not valid	INS User status TIME_RECEIVED_VALID set to 0
# # # # # # 0 #	GPS position Validity **Note 8**	Data valid	INS User status GPS_RECEIVED_VALID set to 1 or GPS2_RECEIVED_VALID set to 1
# # # # # # 1 #		Data not valid	When one of those INS User status bit is set to 0: GPS_RECEIVED_VALID GPS2_RECEIVED_VALID
# # # # # x # #	/	Reserved	N/A
# # # # 0 # # #	Log speed **Note 8**	Data valid	INS User status EMLOG_RECEIVED_VALID set to 1
# # # # 1 # # #		Data not valid	INS User status EMLOG_RECEIVED_VALID set to 0
# # # 0 # # # #	Navigation data	Data valid	**Note 5**
# # # 1 # # # #		Data not valid	
# # x # # # # #	/	Reserved	N/A
# 0 # # # # # #	Simulation	Operational	INS System status 2 SIMULATION_MODE set to 0
# 1 # # # # # #		Simulation mode	INS System status 2 SIMULATION_MODE set to 1

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
0 # # # # # # #	INS Identification	when last digit of IP address is even	No INS status is related to this bit.
1 # # # # # # #		when last digit of IP address is odd	

Table 3: BITE status

Bit N°	7	6	5	4	3	2	1	0
User status bits	N/A	9	10	11	12	13	14	15
Message description	Reserved as spare	FOG_ANOMALY	ACC_ANOMALY	TEMPERATURE_ERR	CPU_OVERLOAD	DYNAMIC_EXCEEDED	SPEED_SATURATION	ALTITUDE_SATURATION

Note 1:

The date corresponds to the number of the day in the year. If the date is not included in the messages received from the GPS, bytes 7 and 8 of the field 6 are set to 1. The time corresponds to the GPS time in seconds since the beginning of the GPS day. When the INS is powered on, time is reset to 0 and until reception of a valid GPS message including a valid time, the time emitted in messages will be the INS internal system time (number of seconds since the start).

When a GPS time is received, the time is set at this value, and then it is updated by INS internal clock until the next time received in a GPS message.

The date and UTC synchronization time can de received in ZDA, RMC or UTC messages, if sent by GPS.

Note 2:

The attitude rate data corresponds to the time derivation of the attitude data, respect to the LRS telegram attitude data sign convention (ISO Convention or Inverse ISO Convention).

Note3:

The depth is positive under sea level . When depth sensor altitude mode is selected, the depth corresponds to the INS altitude. For a surface ship (for Stabilization, GPS or Hydro altitude mode), the depth corresponds to the heave (the mean value is then 0).

Note 4:

The position accuracy corresponds to the maximum error estimation (3σ value = 99% probability). The position correlation corresponds to: σLat.Lon/(σLat. σLon) where σLat.Lon is the cross-covariance of latitude and Longitude.

Note 5:

The Navigation data bit (bit 4 of the status 2) is set to 1 when one of the following condition is met:

- The speed over ground (field 28) < 1 knot (then course made good (field 27) is set to 0).
- The Built In Test Equipement status (see status 1) is on level 3 or 4:
  i.e: When one of those INS User status bit is set to 1: DEGRADED_MODE, HRP_INVALID DYNAMIC_EXCEEDED, FAILURE_MODE.
- The INS is not in navigation mode at sea situation: i.e: INS User status NAVIGATION is set to 0.
- The current standard deviation > 95% of the current standard deviation set in the MMI.

Note 6:

One byte is used and it represents the checksum of the message. It is an 8-bit word. Checksum is a binary addition without carry modulo 256 of all data bytes, NUMDATA and IDENTincluded. Therefore, Header, Checksum and Terminator are excluded from this addition.

Note 7:

For the parameter *Built in Test Equipment*, the level 4 is checked first, than level 3, then level 2 and finally level 1.

Note 8:

Only input sensors that are configured through the MMI are taken into account. In Simulation mode, sensors flags are not managed and the operator should not take them into account.

Note 9:

Sign convention of roll and pitch :

	ISO Convention	Inverse ISO Convention	INS Convention
Roll > 0	for left-port side up	for left-port side down	for left-port side up
Pitch > 0	for front-side bow up	for front side-bow down	for front side-bow down

Note 10: The speed of current is computed as follow : $\sqrt{(Vc_{north})^2 + (Vc_{east})^2}$

Note 11: The direction of current is issued from the angle $\alpha = \arctan\left(\frac{Vc_{east}}{Vc_{north}}\right)$

Direction of current	$Vc_{east} > 0$	$Vc_{east} < 0$
$Vc_{north} > 0$	abs(α)	2*PI – abs(α)
$Vc_{north} < 0$	PI – abs(α)	PI + abs(α)

If Vc_{North} is 0, the direction of current is not calculated and set to 0.

LRS100 32 IC

LRS100 32 IiC

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	IC=ISO Convention, IIC= Inverse ISO Convention.
Data sent:	Status, heading, roll, pitch, heading rate, roll rate, pitch rate, North velocity, East velocity, down velocity, North acceleration, East acceleration, down acceleration.
Data frame:	32 bytes – For data coded on several bytes, the bytes are sent MSB Byte first. All signed integer are coded as two's complement. Telegram assumed to be sent at the rate of 100 Hz.

Message <F0><F1><F2>…..<F18>			
Field 0	Byte 0 Byte 1	Header	0x5A 0xA5
Field 1	Byte 2	NUMDATA	0x1A
Field 2	Byte 3	IDENT	0x01
Field 3	Byte 4	Status 1	**Table 1**
Field 4	Byte 5	Status 2	**Table 2**
Field 5	Bytes 6-7	Heading	Unsigned 16 bits; LSB= $180/2^{15}$ deg, [0 to 360 deg] Positive and increasing when bow turns starboard.
Field 6	Bytes 8-9	Roll	Signed 16 bits; LSB= $90/2^{15}$ deg, ±90 deg
		For **LRS100_32_IIC**	Positive for left-port side down. **<u>Warning:</u>** Opposite sign of INS usual convention Inverse ISO Convention **Note 9**
		For **LRS100_32_IC**	Positive for left-port side up. ISO Convention **Note 9**
Field 7	Bytes 10-11	Pitch	Signed 16 bits; LSB= $90/2^{15}$ deg, ±90 deg
		For **LRS100_32_IIC**	Positive for front side-bow down. Inverse ISO Convention **Note 9**
		For **LRS100_32_IC**	Positive for front side-bow up. **<u>Warning:</u>** Opposite sign of INS usual convention ISO Convention **Note 9**
Field 8	Bytes 12-13	Heading rate **Note 2**	Signed 16 bits; LSB= $1/2^{15}$ rd/s, ±1 rd/s Positive when heading angle increases

Message <F0><F1><F2>…..<F18>			
Field 9	Bytes 14-15	Roll rate **Note 2**	Signed 16 bits; LSB= $1/2^{15}$ rd/s, ±1 rd/s Positive when roll angle increases
Field 10	Bytes 16-17	Pitch rate **Note 2**	Signed 16 bits; LSB= $1/2^{15}$ rd/s, ±1 rd/s Positive when pitch angle increases
Field 11	Bytes 18-19	North Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 12	Bytes 20-21	East Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 13	Bytes 22-23	Down Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 14	Bytes 24-25	North acceleration	Signed 16 bits; LSB= $327.68/2^{15}$, ±327.68 m/s²
Field 15	Bytes 26-27	East acceleration	Signed 16 bits; LSB= $327.68/2^{15}$, ±327.68 m/s²
Field 16	Bytes 28-29	Down acceleration **Note 12**	Signed 16 bits; LSB= $327.68/2^{15}$, ±327.68 m/s²
Field 17	Byte 30	Checksum	**Note 6**
Field 18	Byte 31	Terminator	0xAA

Table 1: Byte STATUS 1

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# # # # # 0 0 0	Built In Test Equipment **Note 7**	Level 0 – No failure	N/A
# # # # # 0 0 1		Level 1 – Anomaly	When one of those INS User status bit is set to 0: DVL_RECEIVED_VALID GPS_RECEIVED_VALID GPS2_RECEIVED_VALID EMLOG_RECEIVED_VALID DEPTH_RECEIVED_VALID TIME_RECEIVED_VALID **Note 8**
# # # # # 0 1 0		Level 2 – Warning	When one of those INS User status bit is set to 1: ALTITUDE_SATURATION CPU_OVERLOAD TEMPERATURE_ERR INPUT_x_ERR OUTPUT_x_ERR
# # # # # 0 1 1		Level 3 – Failure (Attitude data not valid)	When one of those INS User status bit is set to 1: DEGRADED_MODE

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
			HRP_INVALID DYNAMIC_EXCEEDED
# # # # # 1 0 0		Level 4 – Failure (no data valid)	INS User status FAILURE_MODE set to 1
# # # 0 0 # # #	Mode	Navigation – Sea	INS User status NAVIGATION set to 1
# # # 0 1 # # #		Navigation – Quay	INS Algo 2 status ZUPT_MODE_VALID set to 1
# # # 1 0 # # #		Alignment	INS User status ALIGNMENT set to 1
# # # 1 1 # # #		Maintenance	INS System status 2 SIMULATION_MODE set to 1
# 0 0 # # # # #	Attitude and Heading Reference validity	Data valid	N/A
# 0 1 # # # # #		Data degraded	When one of those INS User status bit is set to 1: DEGRADED_MODE FINE_ALIGNMENT
# 1 0 # # # # #		Data not valid	INS User status HRP_INVALID set to 1
x # # # # # # #	/	Reserved	N/A

Table 2: Byte STATUS 2

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# # # # # # # 0	GPS time validity	Data valid	INS User status TIME_RECEIVED_VALID set to 1
# # # # # # # 1		Data not valid	INS User status TIME_RECEIVED_VALID set to 0
# # # # # # 0 #	GPS position Validity **Note 8**	Data valid	INS User status GPS_RECEIVED_VALID set to 1 or GPS2_RECEIVED_VALID set to 1
# # # # # # 1 #		Data not valid	When one of those INS User status bit is set to 0: GPS_RECEIVED_VALID GPS2_RECEIVED_VALID
# # # # # x # #	/	Reserved	N/A
# # # # 0 # # #	Log speed **Note 8**	Data valid	INS User status EMLOG_RECEIVED_VALID set to 1
# # # # 1 # # #		Data not valid	INS User status EMLOG_RECEIVED_VALID set to 0
# # # 0 # # # #	Navigation data	Data valid	**Note 5**
# # # 1 # # # #		Data not valid	
# # x # # # # #	/	Reserved	N/A

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# 0 # # # # # #	Simulation	Operational	INS System status 2 SIMULATION_MODE set to 0
# 1 # # # # # #		Simulation mode	INS System status 2 SIMULATION_MODE set to 1
0 # # # # # # #	INS Identification	when last digit of IP address is even	No INS status is related to this bit.
1 # # # # # # #		when last digit of IP address is odd	

Note 1:

The date corresponds to the number of the day in the year. If the date is not included in the messages received from the GPS, bytes 7 and 8 of the field 6 are set to 1. The time corresponds to the GPS time in seconds since the beginning of the GPS day. When the INS is powered on, time is reset to 0 and until reception of a valid GPS message including a valid time, the time emitted in messages will be the INS internal system time (number of seconds since the start).

When a GPS time is received, the time is set at this value, and then it is updated by INS internal clock until the next time received in a GPS message.

The date and UTC synchronization time can de received in ZDA, RMC or UTC messages, if sent by GPS.

Note 2:

The attitude rate data corresponds to the time derivation of the attitude data, respect to the LRS telegram attitude data sign convention (ISO Convention or Inverse ISO Convention).

Note3:

The depth is positive under sea level. When depth sensor altitude mode is selected, the depth corresponds to the INS altitude. For a surface ship (for Stabilization, GPS or Hydro altitude mode), the depth corresponds to the heave (the mean value is then 0).

Note 4:

The position accuracy corresponds to the maximum error estimation (3σ value = 99% probability). The position correlation corresponds to: σLat.Lon/(σLat. σLon) where σLat.Lon is the cross-covariance of latitude and Longitude.

Note 5:

The Navigation data bit (bit 4 of the status 2) is set to 1 when one of the following condition is met:

- The speed over ground (field 28) < 1 knot (then course made good (field 27) is set to 0).
- The Built In Test Equipement status (see status 1) is on level 3 or 4:
  i.e: When one of those INS User status bit is set to 1: DEGRADED_MODE, HRP_INVALID DYNAMIC_EXCEEDED, FAILURE_MODE.
- The INS is not in navigation mode at sea situation: i.e: INS User status NAVIGATION is set to 0.
- The current standard deviation > 95% of the current standard deviation set in the MMI.

Note 6:

One byte is used and it represents the checksum of the message. It is an 8-bit word. Checksum is a binary addition without carry modulo 256 of all data bytes, NUMDATA and IDENTincluded. Therefore, Header, Checksum and Terminator are excluded from this addition.

Note 7:

For the parameter *Built in Test Equipment*, the level 4 is checked first, than level 3, then level 2 and finally level 1.

Note 8:

Only input sensors that are configured through the MMI are taken into account. In Simulation mode, sensors flags are not managed and the operator should not take them into account.

Note 9:

Sign convention of roll and pitch :

	ISO Convention	Inverse ISO Convention	INS Convention
Roll > 0	for left-port side up	for left-port side down	for left-port side up
Pitch > 0	for front-side bow up	for front side-bow down	for front side-bow down

Note 10: The speed of current is computed as follow : $\sqrt{(Vc_{north})^2 + (Vc_{east})^2}$

Note 11: The direction of current is issued from the angle $\alpha = \arctan\left(\frac{Vc_{east}}{Vc_{north}}\right)$

Direction of current	$Vc_{east} > 0$	$Vc_{east} < 0$
$Vc_{north} > 0$	abs(α)	2*PI – abs(α)
$Vc_{north} < 0$	PI – abs(α)	PI + abs(α)

If Vc_{North} is 0, the direction of current is not calculated and set to 0.

Note 12: The down acceleration is compensated from the g measurement.

LRS100 35 IC

LRS100 35 IIC

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: IC=ISO Convention, IIC= Inverse ISO Convention.

Data sent: Status, heading, roll, pitch, heading rate, roll rate, pitch rate, North velocity, East velocity, down velocity, North acceleration, East acceleration, down acceleration.

Data frame: 35 bytes – For data coded on several bytes, the bytes are sent MSB byte first. All signed integer are coded as two's complement.
Telegram assumed to be sent at the rate of 100 Hz.

Message <F0><F1><F2>…..<F18>			
Field 0	Byte 0 Byte 1	Header	0x5A 0xA5
Field 1	Byte 2	NUMDATA	0x1D
Field 2	Byte 3	IDENT	0x03
Field 3	Byte 4	Status 1	**Table 1**
Field 4	Byte 5	Status 2	**Table 2**
Field 5	Bytes 6-8	Heading	Unsigned 24 bits; LSB= 180/2^{23} deg, [0 to 360 deg] Positive and increasing when bow turns starboard.
Field 6	Bytes 9-11	Roll	Signed 24 bits; LSB= 90/2^{23} deg, ±90 deg
		For **LRS100_35_IIC**	Positive for left-port side down. **<u>Warning:</u>** Opposite sign of INS usual convention Inverse ISO Convention **Note 9**
		For **LRS100_35_IC**	Positive for left-port side up. ISO Convention **Note 9**
Field 7	Bytes 12-14	Pitch	Signed 24 bits; LSB= 90/2^{23} deg, ±90 deg
		For **LRS100_35_IIC**	Positive for front side-bow down. Inverse ISO Convention **Note 9**
		For **LRS100_35_IC**	Positive for front side-bow up. **<u>Warning:</u>** Opposite sign of INS usual convention ISO Convention **Note 9**
Field 8	Bytes 15-16	Heading rate **Note 1**	Signed 16 bits; LSB= 1/2^{15} rd/s, ±1 rd/s Positive when heading angle increases

Message <F0><F1><F2>…..<F18>			
Field 9	Bytes 17-18	Roll rate **Note 1**	Signed 16 bits; LSB= $1/2^{15}$ rd/s, ±1 rd/s Positive when roll angle increases
Field 10	Bytes 19-20	Pitch rate **Note 1**	Signed 16 bits; LSB= $1/2^{15}$ rd/s, ±1 rd/s Positive when pitch angle increases
Field 11	Bytes 21-22	North Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 12	Bytes 23-24	East Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 13	Bytes 25-26	Down Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 14	Bytes 27-28	North acceleration	Signed 16 bits; LSB= $327.68/2^{15}$, ±327.68 m/s^2
Field 15	Bytes 29-30	East acceleration	Signed 16 bits; LSB= $327.68/2^{15}$, ±327.68 m/s^2
Field 16	Bytes 31-32	Down acceleration **Note 12**	Signed 16 bits; LSB= $327.68/2^{15}$, ±327.68 m/s^2
Field 17	Byte 33	Checksum	**Note 6**
Field 18	Byte 34	Terminator	0xAA

Table 1: Byte STATUS 1

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# # # # # 0 0 0	Built In Test Equipment **Note 7**	Level 0 – No failure	N/A
# # # # # 0 0 1		Level 1 – Anomaly	When one of those INS User status bit is set to 0: DVL_RECEIVED_VALID GPS_RECEIVED_VALID GPS2_RECEIVED_VALID EMLOG_RECEIVED_VALID DEPTH_RECEIVED_VALID TIME_RECEIVED_VALID **Note 8**
# # # # # 0 1 0		Level 2 – Warning	When one of those INS User status bit is set to 1: ALTITUDE_SATURATION CPU_OVERLOAD TEMPERATURE_ERR INPUT_x_ERR OUTPUT_x_ERR
# # # # # 0 1 1		Level 3 – Failure (Attitude data not valid)	When one of those INS User status bit is set to 1: DEGRADED_MODE

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
			HRP_INVALID DYNAMIC_EXCEEDED
# # # # # 1 0 0		Level 4 – Failure (no data valid)	INS User status FAILURE_MODE set to 1
# # # 0 0 # # #	Mode	Navigation – Sea	INS User status NAVIGATION set to 1
# # # 0 1 # # #		Navigation – Quay	INS Algo 2 status ZUPT_MODE_VALID set to 1
# # # 1 0 # # #		Alignment	INS User status ALIGNMENT set to 1
# # # 1 1 # # #		Maintenance	INS System status 2 SIMULATION_MODE set to 1
# 0 0 # # # # #	Attitude and Heading Reference validity	Data valid	N/A
# 0 1 # # # # #		Data degraded	When one of those INS User status bit is set to 1: DEGRADED_MODE FINE_ALIGNMENT
# 1 0 # # # # #		Data not valid	INS User status HRP_INVALID set to 1
x # # # # # # #	/	Reserved	N/A

Table 2: Byte STATUS 2

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# # # # # # # 0	GPS time validity	Data valid	INS User status TIME_RECEIVED_VALID set to 1
# # # # # # # 1		Data not valid	INS User status TIME_RECEIVED_VALID set to 0
# # # # # # 0 #	GPS position Validity **Note 8**	Data valid	INS User status GPS_RECEIVED_VALID set to 1 or GPS2_RECEIVED_VALID set to 1
# # # # # # 1 #		Data not valid	When one of those INS User status bit is set to 0: GPS_RECEIVED_VALID GPS2_RECEIVED_VALID
# # # # # x # #	/	Reserved	N/A
# # # # 0 # # #	Log speed **Note 8**	Data valid	INS User status EMLOG_RECEIVED_VALID set to 1
# # # # 1 # # #		Data not valid	INS User status EMLOG_RECEIVED_VALID set to 0
# # # 0 # # # #	Navigation data	Data valid	**Note 5**
# # # 1 # # # #		Data not valid	
# # x # # # # #	/	Reserved	N/A

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# 0 # # # # # #	Simulation	Operational	INS System status 2 SIMULATION_MODE set to 0
# 1 # # # # # #		Simulation mode	INS System status 2 SIMULATION_MODE set to 1
0 # # # # # # #	INS Identification	when last digit of IP address is even	No INS status is related to this bit.
1 # # # # # # #		when last digit of IP address is odd	

Note 1:

The date corresponds to the number of the day in the year. If the date is not included in the messages received from the GPS, bytes 7 and 8 of the field 6 are set to 1. The time corresponds to the GPS time in seconds since the beginning of the GPS day. When the INS is powered on, time is reset to 0 and until reception of a valid GPS message including a valid time, the time emitted in messages will be the INS internal system time (number of seconds since the start).

When a GPS time is received, the time is set at this value, and then it is updated by INS internal clock until the next time received in a GPS message.

The date and UTC synchronization time can de received in ZDA, RMC or UTC messages, if sent by GPS.

Note 2:

The attitude rate data corresponds to the time derivation of the attitude data, respect to the LRS telegram attitude data sign convention (ISO Convention or Inverse ISO Convention).

Note3:

The depth is positive under sea level. When depth sensor altitude mode is selected, the depth corresponds to the INS altitude. For a surface ship (for Stabilization, GPS or Hydro altitude mode), the depth corresponds to the heave (the mean value is then 0).

Note 4:

The position accuracy corresponds to the maximum error estimation (3σ value = 99% probability). The position correlation corresponds to: σLat.Lon/(σLat. σLon) where σLat.Lon is the cross-covariance of latitude and Longitude.

Note 5:

The Navigation data bit (bit 4 of the status 2) is set to 1 when one of the following condition is met:

- The speed over ground (field 28) < 1 knot (then course made good (field 27) is set to 0).
- The Built In Test Equipement status (see status 1) is on level 3 or 4:
  i.e: When one of those INS User status bit is set to 1: DEGRADED_MODE, HRP_INVALID DYNAMIC_EXCEEDED, FAILURE_MODE.
- The INS is not in navigation mode at sea situation: i.e: INS User status NAVIGATION is set to 0.
- The current standard deviation > 95% of the current standard deviation set in the MMI.

Note 6:

One byte is used and it represents the checksum of the message. It is an 8-bit word. Checksum is a binary addition without carry modulo 256 of all data bytes, NUMDATA and IDENTincluded. Therefore, Header, Checksum and Terminator are excluded from this addition.

Note 7:

For the parameter *Built in Test Equipment*, the level 4 is checked first, than level 3, then level 2 and finally level 1.

Note 8:

Only input sensors that are configured through the MMI are taken into account. In Simulation mode, sensors flags are not managed and the operator should not take them into account.

Note 9:

Sign convention of roll and pitch :

	ISO Convention	Inverse ISO Convention	INS Convention
Roll > 0	for left-port side up	for left-port side down	for left-port side up
Pitch > 0	for front-side bow up	for front side-bow down	for front side-bow down

Note 10: The speed of current is computed as follow : $\sqrt{(Vc_{north})^2 + (Vc_{east})^2}$

Note 11: The direction of current is issued from the angle $\alpha = \arctan\left(\frac{Vc_{east}}{Vc_{north}}\right)$

Direction of current	$Vc_{east} > 0$	$Vc_{east} < 0$
$Vc_{north} > 0$	abs(α)	2*PI – abs(α)
$Vc_{north} < 0$	PI – abs(α)	PI + abs(α)

If Vc_{North} is 0, the direction of current is not calculated and set to 0.

Note 12: The down acceleration is compensated from the g measurement.

NAV AND CTD

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	BLUEFIN proprietary protocol.
Data sent:	Transverse velocity, Longitudinal velocity, DVL Altitude, Vertical velocity, GPS Latitude, GPS Longitude, GPS Altitude, USBL Latitude, USBL Longitude, USBL Altitude, LBL Latitude, LBL Longitude, LBL Altitude, LBL Beacon ID, LBL Range, Time.
Data frame:	The frame contains 19 fields – 74 bytes.

Message <F0><F1><F2>…..<F19>			
Field 0	Byte 0	0x24	Synchronization byte
Field 1	Byte 1	0xAA	Synchronization byte
Field 2	Bytes 2 to 5	System Status	**32 LSB bits of the INS System status** **32 bits integer ; MSB are sent first**
Field 3	Bytes 6 to 9	Algorithm Status	32 LSB bits of the INS Algorithm status 32 bits integer ; MSB are sent first
Field 4	Bytes 10 to 13	Algorithm Status	32 MSB bits of the INS Algorithm status 32 bits integer ; MSB are sent first
Field 5	Bytes 14 to 17	Heading	IEEE floating point format, radians (0 to 2Pi)
Field 6	Bytes 18 to 21	Roll	IEEE floating point format, radians (+/-Pi)
Field 7	Bytes 22 to 25	Pitch	IEEE floating point format, radians (+/-Pi/2)
Field 8	Bytes 26 to 29	North speed	IEEE floating point format, m/s
Field 9	Bytes 30 to 33	East speed	IEEE floating point format, m/s
Field 10	Bytes 34 to 37	Vertical speed	IEEE floating point format, m/s
Field 11	Bytes 38 to 41	Latitude	Signed 32 bits $+/-2^{31}$ = +/- 180° ; MSB are sent first
Field 12	Bytes 42 to 45	Longitude	Signed 32 bits $+/-2^{31}$ = +/- 180° ; MSB are sent first
Field 13	Bytes 46 to 49	Altitude '+' Up	IEEE floating point format, meters
Field 14	Bytes 50 to 53	Depth sensor	IEEE floating point format, meters
Field 15	Bytes 54 to 57	Conductivity*	IEEE floating point format, mS.cm

Message <F0><F1><F2>…..<F19>			
Field 16	Bytes 58 to 61	Temperature*	IEEE floating point format, °C
Field 17	Bytes 62 to 65	Pressure*	IEEE floating point format, decibar
Field 18	Bytes 66 to 69	Sound Velocity*	IEEE floating point format, m/s
Field 19	Bytes 70 to 73	Time	Bit 0 to bit 4 : 00000 Bit 5 to bit 14 : Milliseconds Bit 15 to bit 20 : Seconds Bit 21 to bit 26 : Minutes Bit 27 to bit 31 : Hours

* Conductivity, Temperature, Pressure and Sound Velocity are the values received with the $BFCTD data frame from the USBL LBL CTD input protocol.
Otherwise, the values are 0.

NAV BINARY

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Standard output binary.
Data sent:	Status, Heading, Roll, Pitch, Heading Rate, Roll Rate, Pitch Rate, Latitude, Longitude, Altitude, Heave, North speed, East speed, Vertical speed, Status, Time.
Data frame:	16 bytes.

Message <71><F1><F2>…..<F16><CRC>			
Field 0	Byte 0	0x71	Synchronization byte
Field 1	Byte 1 to 4	UTC data timestamp	32 bits integer in s
Field 2	Bytes 5	UTC data timestamp	**8 bits integer in hundredths of seconds**
Field 3	Bytes 6 to 9	Latitude	Signed 32 bits in radians (+/-2^{31} = +/- 180°) Sign "+" North of equator
Field 4	Bytes 10 to 13	Longitude	Signed 32 bits in radians (+/-2^{31} = +/- 180°)) Sign "+" East of Greenwich
Field 5	Bytes 14 to 17	Altitude	Signed 32 bits in centimeters
Field 6	Bytes 18 to 19	Heave	Signed 16 bits in centimeters Sign "+" in down direction
Field 7	Bytes 20 to 21	North speed	Signed 16 bits in centimeters/sec
Field 8	Bytes 22 to 23	East speed	Signed 16 bits in centimeters/sec
Field 9	Bytes 24 to 25	Down speed	Signed 16 bits in centimeters/sec
Field 10	Bytes 26 to 27	Roll*	Signed 16 bits in radians (+/- 2^{15}= +/- 180°)) Sign "+" when port side up
Field 11	Bytes 28 to 29	Pitch*	Signed 16 bits in radians (+/- 2^{15}= +/- 180°)) Sign "+" when bow up. **Warning:** Opposite sign of INS usual convention
Field 12	Bytes 30 to 31	Heading*	Unsigned 16 bits in radians (2^{16}= 360°)
Field 13	Bytes 32 to 33	X_{V1} rotation rate **	Signed 16 bits in Radians /sec (+/- 2^{15}= +/- 180°/sec)
Field 14	Bytes 34 to 35	X_{V2} rotation rate **	Signed 16 bits in Radians /sec (+/- 2^{15}= +/-Pi 180°/sec) **Warning:** Opposite sign of INS usual convention
Message <71><F1><F2>…..<F16><CRC>			
Field 15	Bytes 36 to 37	X_{V3} rotation rate **	Signed 16 bits in Radians /sec (+/- 2^{15}= + 180°/sec) **Warning:** Opposite sign of INS usual convention
Field 16	Bytes 38 to 39	Status	Unsigned 16 bits : 0x0000 (data valid) 0x00AA (data invalid)
Field 17	Bytes 40 to 41	Checksum (CRC)***	Unsigned 16 bits computed on bytes 1 to 39

*In non military mode , the precision of heading, roll and pitch data are limited to 0.001° to comply with export regulation.

****** In non military mode, the precision of rotation rate data is limited to 3.6 deg/h to comply with export regulation.

*******CRC computation is given hereafter:

```
unsigned short blkcrc(unsigned char* bufptr, unsigned len)
{
unsigned char i;
unsigned short data;
unsigned short crc = 0xffff;
	if (len == 0)
		return ~crc;
	do
	{
		for (i = 0, data = (unsigned short)(0xff & *bufptr++); i < 8; i++, data >>= 1)
		{
			if ((crc & 0x0001) ^ (data & 0x0001))
			{
				crc = (crc >> 1) ^ 0x8408;
			}
			else
			{
				crc >>= 1;
			}
		}
	} while (--len);

	crc = ~crc;
	data = crc;
	crc = (crc << 8) | ((data >> 8) & 0xff);
	return crc;
}
```

NAV BINARY 1

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Standard output binary.
Data sent:	Status, Heading, Roll, Pitch, Heading Rate, Roll Rate, Pitch Rate, Latitude, Longitude, Altitude, Heave, North speed, East speed, Vertical speed, Status, Time.
Data frame:	17 fields - 50 bytes. Endian (MSB sent first).

Message <F0><F1><F2>…..<F16><F17>			
Field 0	Byte 0	0x71	Synchronization byte
Field 1	Bytes 1 to 4	UTC data timestamp	32 bits integer in s
Field 2	Byte 5	UTC data timestamp	**8 bits integer in hundredths of seconds**
Field 3	Bytes 6 to 13	Latitude	Signed 64 bits in degrees (+/-2^{63} = +/- 180°) Sign "+" North of equator
Field 4	Bytes 14 to 21	Longitude	Signed 64 bits in degrees (+/-2^{63} = +/- 180°) Sign "+" East of Greenwich
Field 5	Bytes 22 to 25	Altitude	Signed 32 bits in centimeters Sign "+" Up direction
Field 6	Bytes 26 to 27	Heave	Signed 16 bits in centimeters Sign "+" in down direction
Field 7	Bytes 28 to 29	North speed	Signed 16 bits in centimeters/sec
Field 8	Bytes 30 to 31	East speed	Signed 16 bits in centimeters/sec
Field 9	Bytes 32 to 33	Down speed	Signed 16 bits in centimeters/sec
Field 10	Bytes 34 to 35	Roll*	Signed 16 bits in degrees (+/- 2^{15}= +/- 180°)) Sign "+" when port side up
Field 11	Bytes 36 to 37	Pitch*	Signed 16 bits in degrees (+/- 2^{15}= +/- 180°)) Sign "+" when bow up. **Warning:** Opposite sign of INS usual convention
Field 12	Bytes 38 to 39	Heading*	Unsigned 16 bits in degrees (2^{16}= 360°)
Field 13	Bytes 40 to 41	X_{V1} rotation rate **	Signed 16 bits in degrees /sec (+/- 2^{15}= +/- 180°/sec)
Field 14	Bytes 42 to 43	X_{V2} rotation rate **	Signed 16 bits in degrees /sec (+/- 2^{15}= +/- 180°/sec) **Warning:** Opposite sign of INS usual convention
Message <F0><F1><F2>…..<F16><F17>			
Field 15	Bytes 44 to 45	X_{V3} rotation rate **	Signed 16 bits in degrees /sec (+/- 2^{15}= + /- 180°/sec) **Warning:** Opposite sign of INS usual convention
Field 16	Bytes 46 to 47	Status	Unsigned 16 bits : 0x0000 (data valid) 0x00AA (data invalid)
Field 17	Bytes 48 to 49	Checksum (CRC)***	Unsigned 16 bits computed on bytes 1 to 47

*In non military mode, the precision of heading, roll and pitch data are limited to 0.001° to comply with export regulation.

******In non military mode, the precision of rotation rate data is limited to 3.6 deg/h to comply with export regulation.

This protocol is derived from NAV_BINARY. Latitude and Longitude resolution have been extended from 32 bits to 64 bits.

*******CRC computation is given hereafter:

```
unsigned short blkcrc(unsigned char* bufptr, unsigned len)
{
unsigned char i;
unsigned short data;
unsigned short crc = 0xffff;
	if (len == 0)
		return ~crc;
	do
	{
		for (i = 0, data = (unsigned short)(0xff & *bufptr++); i < 8; i++, data >>= 1)
		{
			if ((crc & 0x0001) ^ (data & 0x0001))
			{
				crc = (crc >> 1) ^ 0x8408;
			}
			else
			{
				crc >>= 1;
			}
		}
	} while (--len);
	crc = ~crc;
	data = crc;
	crc = (crc << 8) | ((data >> 8) & 0xff);
	return crc;
}
```

NAV BINARY HR

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Standard output binary.
Data sent:	Status, Heading, Roll, Pitch, XV1, XV2 and XV3 rotation rates, Latitude, Longitude, Altitude, Heave, North speed, East speed, Vertical speed, Status, Time.
Data frame:	This protocol is derived from BINARY NAV protocol with higher resolution on roll and pitch.

Message <71><F1><F2>…..<F16><CRC>			
Field 0	Byte 0	0x71	Synchronization byte
Field 1	Byte 1 to 4	UTC data timestamp	32 bits integer in s
Field 2	Bytes 5	UTC data timestamp	**8 bits integer in hundredths of seconds**
Field 3	Bytes 6 to 9	Latitude	Signed 32 bits in radians (+/-2^{31} = +/-180°) Sign “+” North of equator
Field 4	Bytes 10 to 13	Longitude	Signed 32 bits in radians (+/-2^{31} = +/-180°)) Sign “+” East of Greenwich
Field 5	Bytes 14 to 17	Altitude	Signed 32 bits in centimeters
Field 6	Bytes 18 to 19	Heave	Signed 16 bits in centimeters Sign “+” in down direction
Field 7	Bytes 20 to 21	North speed	Signed 16 bits in centimeters/sec
Field 8	Bytes 22 to 23	East speed	Signed 16 bits in centimeters/sec
Field 9	Bytes 24 to 25	Down speed	Signed 16 bits in centimeters/sec
Field 10	Bytes 26 to 27	Roll*	Signed 16 bits in radians (+/- 2^{15}= +/- 45°) Sign “+” when port side up
Field 11	Bytes 28 to 29	Pitch*	Signed 16 bits in radians (+/- 2^{15}= +/- 45°)) Sign “+” when bow up. **Warning:** Opposite sign of INS usual convention
Field 12	Bytes 30 to 31	Heading*	Unsigned 16 bits in radians (2^{16}= 360°)
Field 13	Bytes 32 to 33	XV1 rotation rate **	Signed 16 bits in Radians /sec (+/- 2^{15}= +/- 180°/sec)

Message <71><F1><F2>…..<F16><CRC>			
Field 14	Bytes 34 to 35	XV2 rotation rate **	Signed 16 bits in Radians /sec (+/- 2^{15}= +/-180°/sec) **Warning:** Opposite sign of INS usual convention
Field 15	Bytes 36 to 37	XV3 rotation rate **	Signed 16 bits in Radians /sec (+/- 2^{15}= +/-180°/sec) **Warning:** Opposite sign of INS usual convention
Field 16	Bytes 38 to 39	Status	Unsigned 16 bits : 0x0000 (data valid) 0x00AA (data invalid)
Field 17	Bytes 40 to 41	Checksum (CRC)***	Unsigned 16 bits CRC16 computed on bytes 1 to 39

*In non military mode, the precision of heading, roll and pitch data are limited to 0.001° to comply with export regulation.

**In non military mode, the precision of rotation rate data is limited to 3.6 deg/h to comply with export regulation.

***CRC computation is given hereafter:

```
unsigned short blkcrc(unsigned char* bufptr, unsigned len)
{
unsigned char i;
unsigned short data;
unsigned short crc = 0xffff;
    if (len == 0)
            return ~crc;
    do
    {
            for (i = 0, data = (unsigned short)(0xff & *bufptr++); i < 8; i++, data >>= 1)
            {
                    if ((crc & 0x0001) ^ (data & 0x0001))
                    {
                            crc = (crc >> 1) ^ 0x8408;
                    }
                    else
                    {
                            crc >>= 1;
                    }
            }
    } while (--len);
    crc = ~crc;
    data = crc;
    crc = (crc << 8) | ((data >> 8) & 0xff);
    return crc;
}
```

NAVIGATION HDLC

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: THALES proprietary binary protocol.

Data sent: Time, Latitude, Longitude, Altitude, Heave, North Velocity , East Velocity, Down Velocity, Heading, Roll, Pitch, Heading rate, Roll rate, Pitch rate, Data validity, Checksum.

Data frame: 22 fields - 47 bytes.

Message <F1><F1><F2>…..<F22>			
Field 1	Byte 0	Start marker	Fixed 0x02 value
Field 2	Byte 1 to 3	Data time tag	Unsigned integer. LSB= 2^{-10} ms= 0.9765625 µs
Field 3	Byte 4	reserved	Set to 0 by default
Field 4	Byte 5 to 8	Latitude	Signed integer. '+': North of equator. LSB=90°*2^{-30}.
Field 5	Byte 9 to 12	Longitude	Signed integer. '+': East of Greenwich. LSB=90°*2^{-30}.
Field 6	Byte 13 to 16	Altitude	Signed integer. '+' above sea level. LSB= 1 cm.
Field 7	Byte 17 to 18	Heave	Signed integer. '+' when down. LSB= 1 cm
Field 8	Byte 19 to 20	North Velocity	Signed integer. LSB= 1 cm/s
Field 9	Byte 21 to 22	East Velocity	Signed integer. LSB= 1 cm/s
Field 10	Byte 23 to 24	Down Velocity	Signed integer. LSB= 1 cm/s
Field 11	Byte 25 to 27	Heading	Unsigned integer. MSB= 180°
Field 12	Byte 28	Reserved	Set to 0 by default
Field 13	Byte 29 to 31	Roll	Signed integer. '+' Starboard down. LSB=90°*2^{-22}
Field 14	Byte 32	Reserved	Set to 0 by default
Field 15	Byte 33 to 35	Pitch	Signed integer.'+' Bow down. LSB=90°*2^{-22}
Field 16	Byte 36	Reserved	Set to 0 by default
Field 17	Byte 37 to 38	Heading rate	Signed integer.LSB=45°/s*2^{-14}.
Field 18	Byte 39 to 40	Roll rate	Signed integer.LSB=45°/s*2^{-14}.
Field 19	Byte 41 to 42	Pitch rate	Signed integer.LSB=45°/s*2^{-14}.
Field 20	Byte 43	INS source	Bit 0 to 1: =0 (by default) Bit 2: =0 : Data fields invalid; 1: Data fields valid
Field 21	Byte 44	Reserved	Set to 0 by default
Field 22	Byte 45 to 46	Checksum	CRC16-Modbus. Computed on bytes 1 to 44.

Note 1: MSB is sent first then LSB (big-endian convention). Least significant bit (lsb) sent first

Note 2: Two’s complement notation is used for signed integers

Note 3: The resolution of rotation rate data is limited to 3.6 deg/h to comply with export regulation.

Note 4: Time is UTC time if INS is time synchronized with GPS time. Otherwise it is INS internal clock time. Time is code over 0-24 h.

Note 5: Altitude value depends on the Altitude Computation Mode (refer to user manual)

Note 6: Validity Bit 2 of Field 20 description
Bit 2= OR (Bit 9 to 15, Bit 28, Bit 30, Bit 31)of INS User status.

NAVIGATION LONG

This protocol is not available for all products.
Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output navigation.

Data sent: Status, Heading, Roll, Pitch, North speed, East speed, Vertical speed in the terrestrial reference mark, Latitude, Longitude, Altitude, Standard deviation of speeds , HRP and position, Status, Time.

Data frame: 24 Fields – 90 Bytes; All multi-byte integers and floating point fields are sent MSB first. Signed integers are two's complement coded.

Message <F0><F1>…<F23>			
Field 0	Byte 0	Header byte 1	Fixed value = 0x24
Field 1	Byte 1	Header byte 2	Fixed value = 0xAA
Field 2	Bytes 2 to 5	INS User Status	32 bits of the INS User status
Field 3	Bytes 6 to 9	INS Algorithm Status 1	32 LSB bits of the INS Algorithm status
Field 4	Bytes 10 to 13	INS Algorithm Status 2	32 MSB bits of the INS Algorithm status
Field 5	Bytes 14 to 17	Heading	IEEE Float 32 bits ; radians ; range = [0 ; 2π[Increasing when bow turns to east
Field 6	Bytes 18 to 21	Roll	IEEE Float 32 bits ; radians ; range = [-π ; π[Positive when port side rises
Field 7	Bytes 22 to 25	Pitch	IEEE Float 32 bits ; radians ; range = [-π/2 ; π/2[Positive when bow down
Field 8	Bytes 26 to 29	North speed	IEEE Float 32 bits ; meters/second
Field 9	Bytes 30 to 33	East speed	IEEE Float 32 bits ; meters/second
Field 10	Bytes 34 to 37	Vertical speed	IEEE Float 32 bits ; meters/second Positive up
Field 11	Bytes 38 to 41	Latitude	Signed 32 bit integer; range = [-180°:+180°[LSB = 180° / 2^{31} = 83.82.10^{-9} °
Field 12	Bytes 42 to 45	Longitude	Signed 32 bit integer; range = [-180°:+180°[LSB = 180° / 2^{31} = 83.82.10^{-9} °
Field 13	Bytes 46 to 49	Altitude	IEEE Float 32 bits; meters Positive up

Message <F0><F1>…<F23>			
Field 14	Bytes 50 to 53	Validity time of the data	Bits 27 to 31 : hours Bits 21 to 26 : minutes Bits 15 to 20 : seconds Bits 0 to 14 : microseconds (LSB = 50µs)
Field 15	Bytes 54 to 57	Heading error standard deviation	IEEE Float 32 bits ; radians
Field 16	Bytes 58 to 61	Roll error standard deviation	IEEE Float 32 bits ; radians
Field 17	Bytes 62 to 65	Pitch error standard deviation	IEEE Float 32 bits ; radians
Field 18	Bytes 66 to 69	North speed error standard deviation	IEEE Float 32 bits ; meters/second
Field 19	Bytes 70 to 73	East speed error standard deviation	IEEE Float 32 bits ; meters/second
Field 20	Bytes 74 to 77	Vertical speed error standard deviation	IEEE Float 32 bits ; meters/second
Field 21	Bytes 78 to 81	Latitude speed error standard deviation	IEEE Float 32 bits ; meters
Field 22	Bytes 82 to 85	Longitude error standard deviation	IEEE Float 32 bits ; meters
Field 23	Bytes 86 to 89	Altitude error standard deviation	IEEE Float 32 bits ; meters

NAVIGATION SHORT

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output Navigation.

Data sent: Status, Heading , Roll, Pitch, North speed, East speed, Vertical speed in the terrestrial reference mark, Latitude, Longitude, Altitude, Time.

Data frame: The frame contains 22 fields – 54 bytes.

In mode not military, the precision of heading, roll and pitch data are limited to 0.001° to comply with export regulation.

Message <24><AA><F2>…..<F13><CRC>			
Field 0	Byte 0	Header 1	Integer 8 bits Value : 0x24
Field 1	Byte 1	Header 2	Valeur : 0xAA
Field 2	Bytes 2 to 5	User Status	32 bits of the INS User status 32 bits integer ; MSB are sent first
Field 3	Bytes 6 to 13	Algorithm Status	64 bits of the INS Algorithm status 32 bits integer ; MSB are sent first
Field 4	Bytes 14 to 17	Heading	Floating IEEE in Radians
Field 5	Bytes 18 to 21	Roll	Floating IEEE in Radians (+ if port side rises)
Field 6	Bytes 22 to 25	Pitch	Floating IEEE in Radians (+ if the prow is inserted)
Field 7	Bytes 26 to 29	North speed in the terrestrial reference frame	Floating IEEE in Meters/second
Field 8	Bytes 30 to 33	East speed in the terrestrial reference frame	Floating IEEE in Meters/second
Field 9	Bytes 34 to 37	Vertical speed in the terrestrial reference frame	Floating IEEE in Meters/second
Field 10	Bytes 38 to 41	Latitude	Integer (+/- 2^{31}= +/- 180°)
Field 11	Bytes 42 to 45	Longitude	Integer (+/- 2^{31}= +/- 180°)
Field 12	Bytes 46 to 49	Altitude	Floating IEEE in Meters
Field 13	Bytes 50 to 53	Time	5 Bits interger : Hour 6 Bits interger : Min 6 Bits integer: Sec 10 Bits integer: msec 5 Bits: 00000

PEGASE CMS

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Binary protocol.
Data sent:	Status, heading, EMLOG speed, roll, pitch, latitude, longitude, depth, body rotation rates, ground speed.
Data frame:	Fixed 56 byte message length. Each multi-byte field is sent in big endian (MSB first). Signed fields are encoded in 2-complement.

Field	Size (bytes)	Field type	Field content	Comment
1	4	Unsigned 32 bit integer	Block validity	Block valid: 1; Block invalid: 0 **(Note 2)**
2	4	Signed 32 bit integer	Heading	LSB: 0.01°; Range: [0°..360°[Positive clockwise from North to East -100° if not available **(Note 2)**
3	4	Signed 32 bit integer	EMLOG speed	LSB: 0.01m/s; Range: [-62m/s..+62m/s] Positive forward -100m/s if not available **(Notes 2 & 3)**
4	4	Signed 32 bit integer	Roll	LSB: 0.01°; Range: [-90°..90°] Positive when port down ! Opposite to INS Std. convention ! -100° if not available **(Note 2)**
5	4	Signed 32 bit integer	Pitch	LSB: 0.01°; Range: [-90°..90°] Positive when bow down -100° if not available **(Note 2)**
6	4	Signed 32 bit integer	Latitude	LSB: 0.01 arc second; Range: [-90°..90°] Positive toward north -100° if not available **(Note 2)**
7	4	Signed 32 bit integer	Longitude	LSB: 0.01 arc second; Range: [-180°..180°] Positive toward west -200° if not available **(Note 2)**
8	4	Unsigned 32 bit integer	Depth	LSB: 0.01m ; Range: [0..2000m] Positive down **0xFFFFFF9C** if not available (**Note 2**)
Field	Size (bytes)	Field type	Field content	Comment
9	8	NA	Reserved	All the bytes set to the fixed value = 0x00
10	4	Signed 32 bit integer	XV1 rotation rate	LSB: 0.5°/s; Range: [-30°/s..30°/s] Positive when port down **Opposite to INS Std. convention** -100°/s if not available (**Note 2**)

11	4	Signed 32 bit integer	XV2 rotation rate	LSB: 0.5°/s; Range: [-30°/s..30°/s] Positive when bow down (when pitch increases) -100°/s if not available (**Note 2**)
12	4	Signed 32 bit integer	XV3 rotation rate	LSB: 0.5°/s; Range: [-30°/s..30°/s] Positive clockwise (when heading increases) **Opposite to INS Std. convention** -100°/s if not available (**Note 2**)
13	4	Signed 32 bit integer	XV1 speed	LSB: 0.01m/s; Range: [-62m/s..62m/s] Positive forward -100m/s if not available (**Note 2**)

Note 1: Required conversion formulas:

Null and positive latitude and longitude binary fields are encoded as follows:

Longitude binary field = *Longitude* / Longitude LSB

Latitude binary field = *Latitude* / Latitude LSB

Negative latitude and longitude binary fields are encoded as follows:

Longitude binary field = (*Longitude* + 360) / Longitude LSB

Latitude binary field = (*Latitude* + 180) / Latitude LSB

Where:

Latitude is positive in North Hemisphere and increasing toward North, negative in South Hemisphere and increasing in absolute value towards South.

Longitude is 0 at Greenwich meridian, positive and increasing toward West, negative towards East and increasing in absolute value towards East.

Note 2: The block is flagged invalid during alignment or when the INS is in failure mode : when the bit 26 or bit 27 are set in the INS User Status. In this case, all the fields values are set to their respective 'not available' value.

Note 3: The EMLOG speed field is also set to its 'not available' value when the bit 6 of the INS User Status is set to 0.

PEGASE NAV

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary protocol.

Data sent: Message ID, message length, day and time, heading, speed, EMLOG speed, depth, latitude and longitude.

Data frame: Fixed 40 byte message length. Each multi-byte field is sent in big endian (MSB first). Signed fields are encoded in 2-complement.

Field	Size (bytes)	Field type	Field content	Comment
1	4	Unsigned 32 bit integer	Message ID	Fixed value = 101
2	4	Unsigned 32 bit integer	Message length	Fixed value = 40
3	4	Unsigned 32 bit integer	Day in year	LSB: 1 day; Range: [1..366] 0xFFFFFFFF if not available (**Note 2**)
4	4	Unsigned 32 bit integer	Data validity time in tenth of seconds of a day	LSB: 0.1s; Range: [0..863999] 0xFFFFFFFF if not available (**Note 2**)
5	4	Unsigned 32 bit integer	Heading	LSB: 180°/2^{15} ; Range: [0..360°[0xFFFFFFFF if not available (**Note 2**)
6	4	Signed 32 bit integer	XV1 speed	LSB: 0.01 knot; Range: [-327.68..327.68] 0xFFFFFFFF if not available (Note 2)
7	4	Signed 32 bit integer	EMLOG speed	LSB: 0.01 knot; Range: [-327.68..327.68] 0x00000000 if not available (**Note 2 & 3**)
8	4	Unsigned 32 bit integer	Depth	LSB: 1m; Range: [0..2000] 0xFFFFFFFF if not available (**Note 2**)
9	4	Unsigned 32 bit integer	Latitude	LSB: 360°/2^{32}; (Note 1) 0xFFFFFFFF if not available (**Note 2**)
10	4	Unsigned 32 bit integer	Longitude	LSB: 360°/2^{32}; (Note 1) 0xFFFFFFFF if not available (**Note 2**)

Note 1: Required conversion formulas:

Null and positive latitude and longitude binary fields are encoded as follows:

Longitude binary field = _Longitude_ / Longitude LSB

Latitude binary field = _Latitude_ / Latitude LSB

Negative latitude and longitude binary fields are encoded as follows:

Longitude binary field = (*Longitude* + 360) / Longitude LSB

Latitude binary field = (*Latitude* + 180) / Latitude LSB

Where:

Latitude is positive in North Hemisphere and increasing toward North, negative in South Hemisphere and increasing in absolute value towards South.

Longitude is 0 at Greenwich meridian, positive and increasing toward West, negative towards East and increasing in absolute value towards East.

Note 2: The block is flagged invalid during alignment or when the INS is in failure mode : when the bit 26 or bit 27 are set in the INS User Status. In this case, all the fields values are set to their respective 'not available' value.

Note 3: The EMLOG speed field is also set to its 'not available' value when the bit 6 of the INS User Status is set to 0.

POLAR NAV

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Standard output binary.
Data sent:	Attitude and Navigation data, INS algorithm status …
Data frame:	Header message: 9 fields - 28 bytes.
	Attitude and Navigation message : 59 fields – 260 bytes.
	Big Endian (MSB sent first) in the Header message.
	Little Endian (LSB sent first) in the Attitude and Navigation message.

Header message <F0><F1>… <F8>			
Field 0	Byte 0	Type	Fixed value = 0 (Data)
Field 1	Byte 1	Byte Order	Fixed value = 1 (Little Endian)
Field 2	Byte 2	Header version	Fixed value = 3 (UDP Multicast)
Field 3	Byte 3	Header length	Fixed value = 20
Field 4	Bytes 4 to 7	Transmission counter	Unsigned 32 bit integer Initialized to 0, than incremented by one for every message sent.
Field 5	Bytes 8 to 11	Attitude and Navigation message length	Unsigned 32 bit integer; Fixed value = 260
Field 6	Bytes 12 to 15	Header signature	Unsigned 32 bit integer Fixed value = 0x7CC5D474
Field 7	Bytes 16 to 19	UNUSED	Fixed value = 0
Field 8	Bytes 20 to 27	Message Name	8 ASCII fixed characters: “ANDxxxxx”
Attitude and Navigation message <F0><F1>… <F52>			
Field 0	Bytes 28 to 43	Service name **Note 1**	16 ASCII characters: “a.sna.privgroup.” for SINS_A “b.sna.privgroup.” for SINS_B
Field 1	Bytes 44 to 51	Time of Validity	IEEE Float 64 bits; GMT time of validity of data in seconds, based on UNIX epoch time.
Field 2	Bytes 52 to 55	Context	Unsigned 32 bit integer 1: Live/Real context 3: Synthetic (Simulation Mode for the INS)

Attitude and Navigation message <F0><F1>… <F52>			
Field 3	Bytes 56 to 59	INS Source ID **Note 1**	Unsigned 32 bit integer 1 for SINS_A 2 for SINS_B
Field 4	Bytes 60 to 63	Time of Transmission	32 bit integer containing GMT time of transmission of this message. LSB = 50µs.
Field 5	Bytes 64 to 67	Time of Sampling	32 bit integer containing GMT time of sensor sampling used to compute data contained in this message. LSB = 50µs.
Field 6	Bytes 68 to 71	INS Alignment status	Unsigned 32 bit integer containing INS alignment status: 1 for coarse alignment (bit 27 of INS user status) 2 for fine alignment (bit 28 of INS user status) 3 for navigation (bit 29 of INS user status)
Field 7	Bytes 72 to 75	Time of last fix	Unsigned 32 bit integer representing the GMT time in seconds of last INS position fix accepted by the Kalman filter. This time is also updated when the system receives first position initialization at boot time. Range: [0-86400).
Field 8	Bytes 76 to 79	Last fix source	Unsigned 32 bit integer indication of whether last fix was input from GPS or not: 0 no fix received 1 if last fix comes from GPS (bit 13 of INS Algo1 status, bits 5 of INS Algo2 status) 2 if last fix does not come from GPS (bits 29 of INS Algo2 status)
		Position conventional	Conventional latitude and longitude as calculated by the INS in WGS 84 Earth Model.
Field 9	Bytes 80 to 83	Latitude	32 bit fixed point two's complement. MSB = Pi or Full Circle / 2 Positive North, Negative South
Field 10	Bytes 84 to 87	Longitude	32 bit fixed point two's complement. MSB = Pi or Full Circle / 2 Positive East, Negative West
Field 11	Bytes 88 to 91	Position validity	Unsigned 32 bit integer that defines data validity 1 if valid 2 if invalid (bit 26 of user status set to 1)

Attitude and Navigation message <F0><F1>… <F52>			
		Velocity components	Velocity components in the local navigation reference frame as calculated by the INS.
Field 12	Bytes 92 to 95	Velocity East	IEEE Float 32 bits ; meters/second + when moving Eastwards
Field 13	Bytes 96 to 99	Velocity North	IEEE Float 32 bits ; meters/second + when moving Northwards
Field 14	Bytes 100 to 103	Velocity Vertical	IEEE Float 32 bits ; meters/second + when moving Upwards
Field 15	Bytes 104 to 107	Velocity Validity	Unsigned 32 bit integer that defines data validity: 1 if valid 2 if invalid (bit 26 of user status set to 1)
		Speed through water	Speed through water as measured by the EM LOG.
Field 16	Bytes 108 to 111	Speed through water	IEEE Float 32 bits ; meters/second
Field 17	Bytes 112 to 115	Speed through water validity	Unsigned 32 bit integer that defines data validity: 1 if valid (bit 25 of algo2 status or bit 5 of algo3 status) 2 if invalid
		Ocean current	North and East component of ocean current calculated by the INS.
Field 18	Bytes 116 to 119	North ocean current	IEEE Float 32 bits ; meters/second
Field 19	Bytes 120 to 123	East ocean current	IEEE Float 32 bits ; meters/second
		Integral velocity	The integral of North and East velocity since the reset of the INS
Field 20	Bytes 124 to 131	Integral velocity North	IEEE Float 64 bits in meters/second. Positive or North Velocity
Field 21	Bytes 132 to 139	Integral velocity East	IEEE Float 64 bits in meters/second. Positive or East Velocity

Attitude and Navigation message <F0><F1>… <F52>			
		Attitude	The ships attitude as calculated by the INS
Field 22	Bytes 140 to 143	Heading	IEEE Float 32 bits ; Full Circle, range [-0.5,+0.5) 0 at north, heading value positive eastwards from north axis and heading value negative westward from north axis.
Field 23	Bytes 144 to 147	Pitch	IEEE Float 32 bits ; Full Circle, range [0,+0.5) Pitch value greater than 0.25 FC when vessel's bow is up, and pitch value less than 0.25 FC when vessel's bow is down.
Field 24	Bytes 148 to 151	Roll	IEEE Float 32 bits ; Full Circle, range [-0.5,+0.5) Positive Port up
Field 25	Bytes 152 to 155	Heading rate	IEEE Float 32 bits ; Full Circle/second, range [-1000,+1000]
Field 26	Bytes 156 to 159	Pitch rate	IEEE Float 32 bits ; Full Circle/second, range [-1000,+1000]
Field 27	Bytes 160 to 163	Roll rate	IEEE Float 32 bits ; Full Circle/second, range [-1000,+1000]
Field 28	Bytes 164 to 167	Attitude validity	Unsigned 32 bit integer that defines data validity: 1 if valid 2 if invalid (bit 26 of user status set to 1)
		Sensor pressure depth	Pressure depth as calculated by depth sensor.
Field 29	Bytes 168 to 171	Sensor pressure depth	IEEE Float 32 bits ; meters – range [0,+12000]
Field 30	Bytes 172 to 175	Sensor pressure depth validity	Unsigned 32 bit integer that defines data validity: 1 if valid (bit 21 of algo1 status) 2 if invalid
		Inertial depth	Estimate of depth as calculated by INS. Distance from actual sea surface
Field 31	Bytes 176 to 179	Inertial depth	IEEE Float 32 bits ; meter
Field 32	Bytes 180 to 183	Inertial depth validity	Unsigned 32 bit integer that defines data validity: 1 if valid 2 if invalid (bit 26 of user status set to 1)

Attitude and Navigation message <F0><F1>… <F52>			
		Attitude error estimate	The estimated error deviations in heading, roll and pitch.
Field 33	Bytes 184 to 187	Heading deviation	IEEE Float 32 bits ; Full Circle
Field 34	Bytes 188 to 191	Pitch deviation	IEEE Float 32 bits ; Full Circle
Field 35	Bytes 192 to 195	Roll deviation	IEEE Float 32 bits ; Full Circle
Field 36	Bytes 196 to 199	Error estimate validity	Unsigned 32 bit integer that defines data validity: 1 if valid 2 if invalid (bit 26 of user status set to 1)
		Velocity error estimate	Error standard deviation estimate for reported velocity components.
Field 37	Bytes 200 to 203	Velocity East deviation	IEEE Float 32 bits ; meters/second
Field 38	Bytes 204 to 207	Velocity North deviation	IEEE Float 32 bits ; meters/second
Field 39	Bytes 208 to 211	Velocity Vertical deviation	IEEE Float 32 bits ; meters/second
Field 40	Bytes 212 to 215	Error estimate validity	Unsigned 32 bit integer that defines data validity: 1 if valid 2 if invalid (bit 26 of user status set to 1)
		Position error estimate	Error standard deviation estimates for reported position.
Field 41	Bytes 216 to 219	Latitude deviation	IEEE Float 32 bits ; meters
Field 42	Bytes 220 to 223	Longitude deviation	IEEE Float 32 bits ; meters
Field 43	Bytes 224 to 227	Error estimate validity	Unsigned 32 bit integer that defines data validity: 1 if valid 2 if invalid (bit 26 of user status set to 1)
		Inertial depth error estimate	Error standard deviation estimates for reported inertial depth.
Field 44	Bytes 228 to 231	Inertial depth deviation	IEEE Float 32 bits ; meters
Field 45	Bytes 232 to 235	Error estimate validity	Unsigned 32 bit integer that defines data validity: 1 if valid 2 if invalid (bit 26 of user status set to 1)

Attitude and Navigation message <F0><F1>… <F52>			
		Polar transverse fields	
Field 46	Bytes 236 to 239	Polar Latitude	32 bit fixed point two's complement. MSB = Pi or Full Circle / 2 Positive Polar North, Negative Polar South
Field 47	Bytes 240 to 243	Polar Longitude	32 bit fixed point two's complement. MSB = Pi or Full Circle / 2 Positive Polar East, Negative Polar West
Field 48	Bytes 244 to 247	Polar Position validity	Unsigned 32 bit integer that defines data validity: 1 if valid 2 if invalid (bit 26 of user status set to 1)
Field 49	Bytes 248 to 251	Polar Heading	IEEE Float 32 bits ; Full Circle, range [-0.5,+0.5)
Field 50	Bytes 252 to 255	Polar Heading validity	Unsigned 32 bit integer that defines data validity: 1 if valid 2 if invalid (bit 26 of user status set to 1)
		INS status	
Field 51	Bytes 256 to 259	INS user status word Lower Status Word	32 bits of the INS user status
Field 52	Bytes 260 to 263	Upper Status Word	Reserved for future use and set to 0 today.
		Polar Heading Rate	
Field 53	Bytes 264 to 267	Polar Heading Rate	IEEE Float 32 bits ; Full Circle/second, range [-1000,+1000]
Field 54	Bytes 268 to 271	Polar Heading Rate validity	Unsigned 32 bit integer that defines data validity: 1 if valid 2 if invalid (bit 26 of user status set to 1)
		Polar Velocities	
Field 55	Bytes 272 to 275	Polar Velocity East	IEEE Float 32 bits ; meters/second + when moving Eastwards
Field 56	Bytes 276 to 279	Polar Velocity North	IEEE Float 32 bits ; meters/second + when moving Northwards
Field 57	Bytes 280 to 283	Polar Velocity Validity	Unsigned 32 bit integer that defines data validity: 1 if valid 2 if invalid (bit 26 of user status set to 1)

Attitude and Navigation message <F0><F1>… <F52>			
		<u>Padding</u>	
Field 58	Bytes 284 to 287	Upper Status Word	Reserved for future use and set to 0 today.

Note 1:

SINS_A is assumed to be the INS which IP address is odd and SINS_B is assumed to be the INS which IP address is even.

POS MV GRP111

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary POS MV Group 111 Aplanix proprietary protocol.

Data sent: Smart Heave, Real time heave.

Data frame: The frame contains a header, 15 fields with 84 bytes in binary format. Reference document: POSMV 320 V3 Ethernet SCSI ICD 30 January 2003.

Message <F0><F1><F2>…..<F15>				
Field 0	Byte 0 to 3	$GRP	char	Group start
Field 1	Bytes 4 to 5	111	ushort	Group ID
Field 2	Bytes 6 to 7	76	ushort	Bytes count
Field 3	Bytes 8 to 15	Time 1	double	Seconds (NOT USED)
Field 4	Bytes 16 to 23	Time 2	double	Seconds (NOT USED)
Field 5	Bytes 24 to 31	Distance tag	double	meters (NOT USED)
Field 6	Bytes 32	Time types	byte	Value: bits 0-3 (*) 0: Time 1: INS time 1: Time 1: GPS time (NOT USED) 2: Time 1: UTC time Value: bits 4-7 (*) 0: Time 2: INS time (NOT USED) 1: Time 2: GPS time (NOT USED) 2: Time 2: UTC time (NOT USED) 3: Time 2: User time (NOT USED)
Field 7	Byte 33	Distance type		Value: bits 0-3 0: N/A 1: INS distance (NOT USED) 2: DMI distance (NOT USED)
Field 4	Bytes 34 to 37	Smart Heave	float	Delayed heave in meters, positive down
Field 5	Bytes 38 to 41	Smart Heave RMS	float	Delayed heave standard deviation in meters (NOT USED)

Message <F0><F1><F2>…..<F15>				
Field 6	Bytes 42 to 45	Status	ulong	Bit 0=1 : Smart heave Valid Bit1=1 : Real-Time heave Valid Bit 2 to 31 : Reserved
Field 7	Bytes 46 to 49	Real Time Heave	float	in meters, positive down
Field 8	Bytes 50 to 53	Real Time Heave RMS	float	standard deviation in meters (NOT USED)
Field 9	Bytes 54 to 61	Heave Time 1	double	Delayed heave time (**) seconds
Field 10	Bytes 62 to 69	Heave Time 2	double	(NOT USED)
Field 11	Bytes 70 to 73	Rejected IMU data count	ulong	(NOT USED)
Field 12	Bytes 74 to 77	Out of range IMU data count	ulong	(NOT USED)
Field 13	Bytes 78 to 79	Pad	byte	Set to 0
Field 14	Bytes 80 to 81	Checksum	ushort	16 bit sum of all data in the data group: byte 34 to 79
Field 15	Bytes 82 to 83	$#	char	Group end

(*) Only INS time or UTC time will be flagged. UTC time is flagged when INS time synchronization with GPS is valid (ZDA or ZDA+PPS valid). By default INS should be time synchronized with GPS time. It is highly recommended to use PPS pulse for accurate timing.

(**) If INS is time synchronized with GPS (ZDA+PPS) Time is UTC seconds in the week (0-604800= 7 x 86400sec per day). Otherwise it is time since power on of the INS.

Both Smart Heave (100 s delayed heave) and real time heave are time-matched to “Heave Time 1”.

LSB are sent first and MSB in last position (Little Endian)

All data not output by INS, labeled “NOT USED”, will be set to 0 default value.

POSTPROCESSING

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Please note that this protocol is not detailed in this documentation.

To get more information about this protocol, contact ixblue.

SEANAV ID1

This protocol is not available for all products.
Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary standard.

Data sent: Status, Latitude, Longitude, Altitude, Date, Roll, Pitch, Heading, Vehicle frame velocities, Vehicle frame accelerations, Heading rate, Roll rate, Pitch rate, Time, Heave, Surge, Sway.

Data frame: 56 bytes - For data coded on several bytes, the bytes are sent LSB byte first. All signed integer are coded as two's complement.

Message <F0><F1>…<F11>			
Field 0	Byte 0	Header byte	0xAA
Field 1	Byte 1	ID	0x01
Field 2	Byte 2	Message length	0x34
Field 3	Bytes 3-4	Transmission counter	Unsigned 16 bits integer. Cycling from 0 to 65535.
Field 4	Byte 5	Alignment status	**Note 2**
Field 5	Byte 6	Navigation aid status	**Note 3**
Field 6	Bytes 7-10	Latitude	Signed 32 bits integer. +/-90 deg. LSB = $180/2^{31}$ deg Positive in north hemisphere and increasing to north pole
Field 7	Bytes 11-14	Longitude	Signed 32 bits integer. +/-180 deg. LSB = $180/2^{31}$ deg Positive and increasing towards east from Greenwich, negative west from Greenwich
Field 8	Bytes 15-18	INS Depth (-INS Altitude)	Signed 32 bits integer. LSB = 1 cm, positive down
Field 9	Bytes 19-20	Date	Unsigned 16 bits integer. $b_{15}\,b_{14}\,b_{13}\,b_{12}\,b_{11}\,b_{10}\,b_9$: year since 1970 $b_8\,b_7\,b_6\,b_5$: month [1,12] $b_4\,b_3\,b_2\,b_1\,b_0$: day [1,31]
Field 10	Bytes 21-22	Roll	Signed 16 bits integer. +/-180 deg. LSB = $180/2^{15}$ deg Positive when port side up
Field 11	Bytes 23-24	Pitch	Signed 16 bits integer. +/-90deg. LSB =$180/2^{15}$ deg Positive when bow up **Warning:** Opposite sign of INS usual convention.

Message <F0><F1>…<F11>			
Field 12	Bytes 25-26	Heading	Unsigned 16 bits integer. [0,360°[. LSB =180/2^{15} deg 0° at North and increasing from North to East
Field 13	Bytes 27-28	XV1 Velocity	Signed 16 bits integer. +/-32 m/s. LSB = 32/2^{15} m/s Positive when moving forward
Field 14	Bytes 29-30	XV2 Velocity	Signed 16 bits integer. +/-32 m/s. LSB = 32/2^{15} m/s Positive when moving toward port side
Field 15	Bytes 31-32	XV3 Velocity	Signed 16 bits integer. +/-32 m/s. LSB = 32/2^{15} m/s Positive when moving upwards
Field 16	Bytes 33-34	XV1 longitudinal acceleration	Signed 16 bits integer. +/-32 m/s^2. LSB = 32/2^{15} m/s^2 Positive when accelerating forward
Field 17	Bytes 35-36	XV2 transverse acceleration	Signed 16 bits integer. +/-32 m/s^2. LSB = 32/2^{15} m/s^2 Positive when accelerating to port
Field 18	Bytes 37-38	XV3 vertical acceleration	Signed 16 bits integer. +/-32 m/s^2. LSB = 32/2^{15} m/s^2 Positive when accelerating upwards, compensated from gravity
Field 19	Bytes 39-40	Roll rate Note 1	Signed 16 bits integer. +/-4 rad/s. LSB = 4/2^{15} rad/s Sign of the SEANAV_ID1 roll derivative
Field 20	Bytes 41-42	Pitch rate **Note 1**	Signed 16 bits integer. +/-4 rad/s. LSB = 4/2^{15} rad/s Sign of the SEANAV_ID1 pitch derivative **Warning:** Opposite sign of INS usual convention
Field 21	Bytes 43-44	Heading rate **Note 1**	Signed 16 bits integer. +/-4 rad/s. LSB = 4/2^{15} rad/s Sign of the SEANAV_ID1 heading derivative
Field 22	Bytes 45-48	INS Time	b_{31} : **Note 6** $b_{30}\, b_{29} \ldots b_4\, b_3\, b_2\, b_1\, b_0$: Time in day since 00:00:00 [0, 86400 s[LSB = 1/2^{14} sec
Field 23	Bytes 49-50	Surge	Signed 16 bits integer. +/-64 m. LSB = 64/2^{15} m Positive forward
Field 24	Bytes 51-52	Sway	Signed 16 bits integer. +/-64 m. LSB = 64/2^{15} m Positive port
Field 25	Bytes 53-54	Heave	Signed 16 bits integer. +/-64 m. LSB = 64/2^{15} m Positive upwards

Message <F0><F1>…<F11>			
Field 26	Byte 55	Checksum	XOR of all the bytes from 1 to 54 Initial value = 0x00

Note 1: These fields are attitude rates and are given in the INS reference frame (X1, X2, X3). They are not XV1, XV2, XV3 rotations rates.

Note 2: Alignment status byte

Function	Value	Links with INS status words
IDLE **Note 4**	= 0x00	INS System status 2 WAIT_FOR_POSITION
Coarse stationary alignment **Note 5**	= 0x01	INS User status & INS System status 2 ALIGNMENT **AND NOT** WAIT_FOR_POSITION **AND NOT** Alignment mode (**Note 3**)
Fine stationary alignment – Not complete	= 0x02	INS User status FINE_ALIGNMENT **AND NOT** Alignment mode (**Note 3**)
Fine stationary alignment – Complete	= 0x03	INS User status **NOT** (ALIGNMENT **OR** FINE_ALIGNEMENT) **AND NOT** Alignment mode (**Note 3)**
Coarse GPS alignment **Note 5**	= 0x04	INS User status & INS System status 2 ALIGNMENT **AND NOT** WAIT_FOR_POSITION **AND** Alignment mode (**Note 3**)
Fine GPS alignment – Not complete	= 0x05	INS User status FINE_ALIGNMENT **AND** Alignment mode (**Note 3**)
Fine GPS alignment – Complete	= 0x06	INS User status **NOT** (ALIGNMENT **OR** FINE_ALIGNEMENT) **AND** Alignment mode (**Note 3**)
Doppler/EM Log alignment – Not complete	= 0x07 Not used	NA
Spare	= 0x08 Not used	NA
Aided navigation	= 0x09 Not used	NA
NO GO (System fault) **Note 5**	= 0x0A	INS User status CPU_OVERLOAD **OR** TEMPERATURE_ERR **OR** INPUT_x_ERR

Function	Value	Links with INS status words
		OR OUTPUT_x_ERR **OR** FAILURE_MODE

Note 3: Navigation aid status byte

Function	Bit #	Value	Links with INS status words
Spare	0	= 0	NA
Alignment mode	1	= 0 without position = 1 with position	INS System status 2 GPS_DETECTED **OR** GPS2_DETECTED seen at least once during coarse alignment with a rejection mode set to Always True or to Automatic Reacquisition. When the SEANAV_ID1 alignment mode flag is set to one, it will remain set to one for GPS dropouts.
ZUPT mode	2	= 0 ZUPT processing off = 1 ZUPT processing on	INS Algorithm status 2 ZUPT_MODE_VALID **OR** AUTOSTATICBENCH_ZUPT_MODE_VALID
Spare	3	= 0	NA
Spare	4	= 0	NA
GPS data	5,6	= 0,1 GPS data accepted	INS Algorithm status 1 & 2 GPS_VALID **OR** GPS2_VALID
		= 1,0 GPS data rejected	INS Algorithm status 1 GPS_REJECTED **AND** GPS2_REJECTED
Spare	7	= 0	NA

Note 4: When the system is in IDLE or NO GO state, all the bytes from 7 to 54 are set to 0x00. The NO GO state has priority over all the other states.

Note 5: During Coarse stationary alignment or Coarse GPS alignment state, all the bytes from 49 to 54 are set to 0x00. Other fields are available, but with degraded accuracy. Full performance is only reached after fine alignment is completed.

Note 6: Logic of the MSB b_{31} of the INS Time field

MSB b_{31}	= 1 GPS time not yet received In this case the time in this field is internal time = 0 GPS time available In this case the time in this field is UTC time	INS System status 2 SYS2_UTC_DETECTED seen at least once. When b_{31} is set to 0, it will remain set to 0 even for GPS dropouts.

SEAPATH

This protocol is not available for all products.
Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary standard.
Data sent: Time, Latitude, Longitude, Altitude, Heave, North Velocity, East Velocity, Down Velocity, Roll, Pitch, Heading, Roll Rate, Pitch Rate, Yaw Rate, Status.
Data frame: 18 fields - 42 bytes. All multi-byte data is sent MSB first.

Message <F0><F1><F2>…..<F17>			
Field 0	Byte 0	'q'	Synchronization byte
Field 1	Bytes 1 to 4	PHINS time (Synchro with GPS time)	32 bits integer (seconds)
Field 2	Byte 5	PHINS time (Synchro with GPS time) Fraction of seconds	Unsigned 8 bits integer 0.01 seconds (0 to 99)
Field 3	Bytes 6 to 9	Latitude '+': North of equator	Signed 32 bits integer +/-2^{31} = +/- 180°
Field 4	Bytes 10 to 13	Longitude '+': East of Greenwich	Signed 32 bits integer +/-2^{31} = +/- 180°
Field 5	Bytes 14 to 17	Altitude**	Signed 32 bits integer (centimeters)
Field 6	Bytes 18 to 19	Heave "+" when down	Signed 16 bits integer (centimeters) **Warning:** Opposite sign of INS usual convention
Field 7	Bytes 20 to 21	North Velocity	Signed 16 bits integer (centimeters/second)
Field 8	Bytes 22 to 23	East Velocity	Signed 16 bits integer (centimeters/second)
Field 9	Bytes 24 to 25	Down Velocity	Signed 16 bits integer (centimeters/second)
Field 10	Bytes 26 to 27	Roll Sign "+" when port side up	Signed 16 bits integer +/-2^{15} = +/- 180°
Field 11	Bytes 28 to 29	Pitch Sign "+" when bow up	Signed 16 bits integer +/-2^{15} = +/- 180° **Warning:** Opposite sign of INS usual convention
Field 12	Bytes 30 to 31	Heading	Unsigned 16 bits integer 2^{15} = 180°
Field 13	Bytes 32 to 33	Roll rate*	Signed 16 bits integer +/-2^{15} = +/-180°/s
Field 14	Bytes 34 to 35	Pitch rate*	Signed 16 bits integer +/-2^{15} = +/-180°/s **Warning:** Opposite sign of INS usual convention

Message <F0><F1><F2>…..<F17>			
Field 15	Bytes 36 to 37	Heading rate*	Signed 16 bits integer +/-2^{15} = +/-180°/s **Warning:** Opposite sign of INS usual convention
Field 16	Bytes 38 to 39	Status	0x00AA : Invalid data 0x0000 : Data valid
Field 17	Bytes 40 to 41	Checksum (CRC)***	Computed on bytes 1 to 39

*The precision of rotation rate data is limited to 36 deg/h to comply with export regulation.

**Altitude value depends on the Altitude Computation Mode :

If Altitude Computation Mode = GPS then Altitude = Altitude with respect of the mean sea level.

If Altitude Computation Mode = Altitude Hydro then Altitude = Altitude with respect of the mean sea level + Heave.

If Altitude Computation Mode = Depth Sensor then Altitude = Depth.

If Altitude Computation Mode = Stabilization then Altitude = manually entered altitude.

***CRC computation is given hereafter:

```
unsigned short blkcrc(unsigned char* bufptr, unsigned len)
{
unsigned char i;
unsigned short data;
unsigned short crc = 0xffff;
    if (len == 0)
            return ~crc;
    do
    {
            for (i = 0, data = (unsigned short)(0xff & *bufptr++); i < 8; i++, data >>= 1)
            {
                    if ((crc & 0x0001) ^ (data & 0x0001))
                    {
                            crc = (crc >> 1) ^ 0x8408;
                    }
                    else
                    {
                            crc >>= 1;
                    }
            }
    } while (--len);
    crc = ~crc;
    data = crc;
    crc = (crc << 8) | ((data >> 8) & 0xff);
    return crc;
}
```

SEATEX DHEAVE

This protocol is not available for all products.
Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary PFreeHeave® Kongsberg Seatex proprietary protocol.

Data sent: Smart Heave™ and Time validity of data.

Data frame: The frame contains a header, 6 fields with 13 bytes in binary format. The signed integers are represented as two-complement numbers. For multi-byte elements, the MSB (Most Significant Byte) is transmitted first. The PFreeHeave® output is delayed by a few minutes due to the processing.

Message <F0><F1><F2>…..<F6>				
Field 0	Byte 0	0xAA	Unsigned	Header
Field 1	Byte 1	0x52	Unsigned	Header
Field 2	Bytes 2 to 5	Time (*)	Integer	In seconds
Field 3	Bytes 6 to 7	0 to 9999	Unsigned	Time, fraction of second: 0.0001 s
Field 4	Bytes 8 to 9	Smart Heave™	Integer	Delayed heave, in centimeters, positive down
Field 5	Byte 10	Status word	Bit-fields	0 : Heave is valid 1 : Heave is invalid
Field 6	Bytes 11 to 12	Checksum (**)	Unsigned	See **Note 1**

(*) The time fields contain time of validity of the data. The integer seconds part of time is counted from 1970-01-01 UTC time, ignoring leap seconds.

(**) Checksum is calculated as a 16-bit Block Cyclic Redundancy Check of all bites between, but not including the Header and Checksum fields. The CRC algorithm is describes in Note 1.

Note 1: Cyclic redundancy check algorithm

The 16-bit Block Cyclic Redundancy Check algorithm used to calculate the checksum in some formats is described in C and Fortran source code next page.

C code:

```
#define POLY 0x8408
unsigned short blkcrc(
unsigned char *bufptr, /* message buffer */
unsigned long len /* number of bytes */
)
{
unsigned char i;
unsigned short data;
unsigned short crc = 0xffff;
if (len == 0L) {
return ~crc;
}
do {
for (i=0, data = (unsigned short) (0xff & *bufptr++);
i < 8;
i++, data >>= 1) {
if ((crc & 0x0001) ^ (data & 0x0001)) {
crc = (crc >> 1) ^ POLY;
} else {
crc >>= 1;
}
}
} while (--len);
crc = ~crc;
data = crc;
crc = (crc << 8) | ((data >> 8) & 0xff);
return crc;
}
```

SENSOR RD

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: BLUEFIN proprietary protocol. It is linked to the input USBL-LBL-CTD protocol.

Data sent: Transverse velocity, Longitudinal velocity, DVL Altitude, Vertical velocity, GPS Latitude, GPS Longitude, GPS Altitude, USBL Latitude, USBL Longitude, USBL Altitude, LBL Latitude, LBL Longitude, LBL Altitude, LBL Beacon ID, LBL Range, Time.

Data frame: 24 fields – 88 bytes.

Message <F0><F1><F2>…..<F23>			
Field 0	Byte 0	0x24	Synchronization byte
Field 1	Byte 1	0xF0	Synchronization byte
Field 2	Bytes 2 to 5	Reserved	**Set to 0**
Field 3	Bytes 6 to 9	Reserved	Set to 0
Field 4	Bytes 10 to 13	Reserved	Set to 0
Field 5	Bytes 14 to 17	Reserved	Set to 0
Field 6	Bytes 18 to 21	Reserved	Set to 0
Field 7	Bytes 22 to 25	Reserved	Set to 0
Field 8	Bytes 26 to 29	Speed XV2	IEEE floating point format, m/s (positive towards port side)
Field 9	Bytes 30 to 33	Speed XV1	IEEE floating point format, m/s (positive towards the bow)
Field 10	Bytes 34 to 37	DVL Altitude	IEEE floating point format, meters
Field 11	Bytes 38 to 41	Speed XV3	IEEE floating point format, m/s (positive towards up side)
Field 12	Bytes 42 to 45	GPS Latitude	Signed 32 bits $+/-2^{31}$ = +/-180° ; MSB are sent first
Field 13	Bytes 46 to 49	GPS Longitude	Signed 32 bits $+/-2^{31}$ = +/-180° ; MSB are sent first
Field 14	Bytes 50 to 53	GPS Altitude	IEEE floating point format, meters
Field 15	Bytes 54 to 57	USBL Latitude	Signed 32 bits $+/-2^{31}$ = +/-180° ; MSB are sent first

Message <F0><F1><F2>…..<F23>			
Field 16	Bytes 58 to 61	USBL Longitude	Signed 32 bits +/-2^{31} = +/-180° ; MSB are sent first
Field 17	Bytes 62 to 65	USBL Altitude	IEEE floating point format, meters
Field 18	Bytes 66 to 69	LBL Latitude	Signed 32 bits +/-2^{31} = +/-180° ; MSB are sent first
Field 19	Bytes 70 to 73	LBL Longitude	Signed 32 bits +/-2^{31} = +/-180° ; MSB are sent first
Field 20	Bytes 74 to 77	LBL Altitude	IEEE floating point format, meters
Field 21	Bytes 78 to 79	LBL Beacon ID*	2 ASCII bytes
Field 22	Bytes 80 to 83	LBL Range	IEEE floating point format, meters
Field 23	Bytes 84 to 87	Time	Bit 0 to bit 4 : 00000 Bit 5 to bit 14 : Milliseconds Bit 15 to bit 20 : Seconds Bit 21 to bit 26 : Minutes Bit 27 to bit 31 : Hours

*The Beacon ID is the beacon ID value received with the $BFLBL data frame from the USBL-LBL-CTD input protocol. Otherwise, the value is 0.

SIMRAD EM

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output Simrad proprietary protocol.

Data sent: Status, Roll, Pitch, Heave and Heading.

Data frame: The frame contains 6 fields - 10 bytes. Except the heading, each sent data is two complemented coded. LSB are sent first.

Message <F0><F1><F2>…..<F5>			
Field 0	Byte 0	Sensor Status	0x90 if ok 0x9A if alignment
Field 1	Byte 1	Synchronization byte	0x90
Field 2	Bytes 2 to 3	Roll	+/-180° ; LSB = 0.01° Sign "+" when port up
Field 3	Bytes 4 to 5	Pitch	+/-180° ; LSB = 0.01° Sign "+" when bow up **Warning:** Opposite sign of INS usual convention.
Field 4	Bytes 6 to 7	Heave (*)	+/-10 m ; LSB = 0.01 m Sign +" when PHINS goes up
Field 5	Bytes 8 to 9	Heading	0° to 360° ; LSB = 0.01°

(*) The heave corresponds to the lever arm set on the output port.

SIMRAD EM HEAVE2

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Output Simrad proprietary protocol.
Data sent:	Status, Roll, Pitch, Heave 2 and Heading.
Data frame:	6 fields - 10 bytes. Except the heading, each sent data is two complemented coded. LSB are sent first.

Message <F0><F1><F2>…..<F5>			
Field 0	Byte 0	Sensor Status	0x90 if ok 0x9A if alignment
Field 1	Byte 1	Synchronization byte	0x90
Field 2	Bytes 2 to 3	Roll (*)	+/-180° ; LSB = 0.01° Sign "+" when port up
Field 3	Bytes 4 to 5	Pitch (*)	+/-180° ; LSB = 0.01° Sign "+" when bow up **Warning:** Opposite sign of INS usual convention
Field 4	Bytes 6 to 7	Heave 2 (**)	+/-10 m ; LSB = 0.01 m Sign +" when INS goes up
Field 5	Bytes 8 to 9	Heading	0° to 360° ; LSB = 0.01°

(*) The attitude angles are computed with respect to TSS convention.
Roll and Pitch are referenced to the local vertical acceleration.
The formula calculation with respect to PHINS standard convention (Euler Angle or Tate Bryant) is given hereafter:

$$Roll_{TSS} = Sin^{-1} (Sin (Roll_{TB}) \times Cos (Pitch_{TB})) \text{ and } Pitch_{TSS} = Pitch_{TB}$$

(**) This outputs the "specific heave" and corresponds to the lever arm set on the output port.

SIMRAD EM TSS

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard:	Output Simrad proprietary protocol TSS convention.
Data sent:	Status, Roll, Pitch, Heave and Heading.
Data frame:	The frame contains 6 fields - 10 bytes. LSB are sent first.

Message <F0><F1><F2>…..<F5>			
Field 0	Byte 0	Sensor Status	0x90 if ok 0x9A if alignment
Field 1	Byte 1	Synchronization byte	0x90
Field 2	Bytes 2 to 3	Roll*****	+/-180° ; LSB = 0.01° Sign "+" when port up
Field 3	Bytes 4 to 5	Pitch (*****)	+/-180° ; LSB = 0.01° Sign "+" when bow up **Warning:** Opposite sign of INS usual convention
Field 4	Bytes 6 to 7	Heave (******)	+/-10 m ; LSB = 0.01 m Sign +" when INS goes up
Field 5	Bytes 8 to 9	Heading	0° to 360° ; LSB = 0.01°

(*) The attitude angles are computed with respect to TSS convention.

Roll and Pitch are referenced to the local vertical acceleration.

The formula calculation with respect to INS standard convention (Euler Angle or Tate Bryant) is given hereafter:

$Roll_{TSS} = Sin^{-1} (Sin (Roll_{TB}) \times Cos (Pitch_{TB}))$ and $Pitch_{TSS} = Pitch_{TB}$

(**) The heave corresponds to the lever arm set on the output port

SOC AUTOSUB

This protocol is not available for all products.
Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output SOC custom protocol.
Data sent: Status, Heading, Attitude, Rotation rates, Depth, Speeds, Position, Log misalignment.
Data frame: The frame contains 18 fields - 61 bytes - MSB are sent first.

Message <F0><F1><F2>…..<F17>			
Field 0	Byte 0	'$'	Synchronization byte
Field 1	Byte 1	Status	1 if Alignment
Field 2	Bytes 2 to 5	Heading	Radians IEEE floating point format
Field 3	Bytes 6 to 9	Roll	Radians IEEE floating point format Sign "+" when port up
Field 4	Bytes 10 to 13	Pitch	Radians IEEE floating point format Sign "+" when bow down
Field 5	Bytes 14 to 17	XV3 rotation rate*	Rad/s IEEE floating point format
Field 6	Bytes 18 to 21	XV1 rotation rate*	Rad/s IEEE floating point format
Field 7	Bytes 22 to 25	-XV2 rotation rate*	Rad/s IEEE floating point format **Warning:** Opposite sign of INS usual convention
Field 8	Bytes 26 to 29	Depth	Meters IEEE floating point format
Field 9	Bytes 30 to 33	Down speed	M/s IEEE floating point format
Field 10	Bytes 34 to 37	East speed	M/s IEEE floating point format
Field 11	Bytes 38 to 41	South speed	M/s IEEE floating point format
Field 12	Bytes 42 to 45	Latitude	+/-2^{31} = +/-Pi Signed 32 bits
Field 13	Bytes 46 to 49	Longitude	+/-2^{31} = +/-Pi Signed 32 bits
Field 14	Bytes 50 to 53	Log misalignment	Radians IEEE floating point format
Field 15	Bytes 54 to 57	Spare fields	**4 bytes**
Field 16	Bytes 58 to 59	Counter	Incremented by 1 Unsigned 16 bits
Field 17	Byte 60	Checksum	Addition of all the bytes for 0 to 59

* The precision of rotation rate data is limited to 36 deg/h to comply with export regulation.

SPERRY ATT

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary.

Data sent: Status, Heading, Attitude, Rotation rates.

Data frame: 11 fields - 18 bytes - MSB first.

Message <F0><F1><F2>…..<F10>			
Field 0	Byte 0	0xAA	Header TP1
Field 1	Byte 1	0x55	Header TP2
Field 2	Byte 2 to 3	Status**	See status specification table 1
Field 3	Bytes 4 to 5	Heading	0° to 360° ; LSB = 180°/ 2^{15}
Field 4	Bytes 6 to 7	Roll	± 90° ; LSB = 90°/ 2^{15} Sign "+" for port down **Warning:** Opposite sign of INS usual convention
Field 5	Bytes 8 to 9	Pitch	± 90° ; LSB = 90°/ 2^{15} Sign "+" when bow down
Field 6	Bytes 10 to 11	Heading rotation rate*	± 45°/s ; LSB = 45°/ 2^{15}
Field 7	Bytes 12 to 13	Roll rotation rate*	± 45°/s ; LSB = 45°/ 2^{15} **Warning:** Opposite sign of INS usual convention
Field 8	Bytes 14 to 15	Pitch rotation rate*	± 45°/s ; LSB = 45°/ 2^{15}
Field 9	Byte 16	CSUM checksum	Negative sum of all the bytes from 0 to 15
Field 10	Byte 17	CSUMN checksum	CSUM checksum 1's complement

* The precision of rotation rate data is limited to 36 deg/h to comply with export regulation.

** Status specification table 1

Function	Bits	Value	Links with PHINS status words
Time Tag	0 to 9	Fractions of seconds: Unsigned 10 bits integer ~0.00125 seconds (0 to 799)	None
Not used	10	set to 0	None
Alignment	11	0 if alignment , otherwise 01	NOT(Bit 1) of the 32 LSB bits of the INS Algorithm status 1. Warning: Opposite of INS convention.
System error	12 to 15	0000 : no error XXX1 : system warning XX1X : system alarm X1XX : system malfunction 1XXX : system fail or not ready	XXX1 : OR of bits 11, 15, 19, 23, 27 of the INS Algorithm status 1 and bits 3,7, 27 of INS Algorithm status 2 and bits 7,11,15 of the INS Algorithm status 3. XX1X : OR of bits 1 to 5 and 17 to 21 of the INS System status 1 bit 27 of the INS System status 2 bits 0,1,2,4,5,6, 8 of the INS Sensor status 2 X1XX : OR of bits 28, 29 of the INS Algorithm status 1 1XXX : bit 26 of INS User status

SPERRY ATT STAN

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary.

Data sent: Status, Heading, Attitude, Rotation rates.

Data frame: 11 fields - 18 bytes - MSB first.

Message <F0><F1><F2>…..<F10>			
Field 0	Byte 0	0xAA	Header TP1
Field 1	Byte 1	0x55	Header TP2
Field 2	Byte 2 to 3	Status**	See status specification table 1
Field 3	Bytes 4 to 5	Heading	0° to 360° ; LSB = 180°/ 2^{15}
Field 4	Bytes 6 to 7	Roll	± 90° ; LSB = 90°/ 2^{15} Sign “+” for port up (STANAG 4222 convention)
Field 5	Bytes 8 to 9	Pitch	± 90° ; LSB = 90°/ 2^{15} Sign “+” when bow up (STANAG 4222 convention) **Warning:** Opposite sign of INS usual convention
Field 6	Bytes 10 to 11	Heading rotation rate*	± 45°/s ; LSB = 45°/ 2^{15}
Field 7	Bytes 12 to 13	Roll rotation rate*	± 45°/s ; LSB = 45°/ 2^{15} **Warning:** Opposite sign of INS usual convention
Field 8	Bytes 14 to 15	Pitch rotation rate*	± 45°/s ; LSB = 45°/ 2^{15}
Field 9	Byte 16	CSUM checksum	Negative sum of all the bytes from 0 to 15
Field 10	Byte 17	CSUMN checksum	CSUM checksum 1's complement

* The resolution of rotation rate data is limited to 36 deg/h to comply with export regulation.

** Status specification table 1

Function	Bits	Value	Links with PHINS status words
Time Tag	0 to 9	Fractions of seconds: Unsigned 10 bits integer ~0.00125 seconds (0 to 799)	None
Not used	10	set to 0	None
Alignment	11	0 if alignment , otherwise 1	NOT(Bit 1) of the 32 LSB bits of the INS Algorithm status 1. Warning: Opposite of INS convention.
System error	12 to 15	0000 : no error XXX1 : system warning XX1X : system alarm X1XX : system malfunction 1XXX : system fail or not ready	XXX1 : OR of bits 11, 15, 19, 23, 27 of the INS Algorithm status 1 and bits 3,7, 27 of the INS Algorithm status 2 and bits 7, 11, 15 of the INS Algorithm status 3 XX1X : OR of bits 1 to 5 and 17 to 21 of the INS System status 1 bit 27 of the INS System status 2 bits 0,1,2,4,5,6, 8 of the INS Sensor status 2 X1XX : OR of bits 28, 29 of the INS Algorithm status 1 1XXX : bit 26 of INS User status

S40 NAV10

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary standard.

Data sent: Status, Date, GPS Time, Heading, Roll, Pitch, Heading rate, Roll rate, Pitch rate, Latitude, Longitude, Depth, Latitude accuracy, Longitude accuracy, position correlation, GPS latitude, GPS longitude, North Velocity, East Velocity, Down Velocity, Log speed, Course made good, Speed over ground, Direction of the current, Speed of the current.

Data frame: The frame contains 78 bytes. For data coded on several bytes, the bytes are sent MSB byte first. All signed integer are coded as two's complement.

This protocol telegram is assumed to be sent at the rate of 10 Hz.

Message <F0><F1><F2>…..<F33>			
Field 0	Byte 0 Byte 1	Header	0x5A 0xA5
Field 1	Byte 2	NUMDATA	0x48
Field 2	Byte 3	IDENT	0x02
Field 3	Byte 4	Status 1	**Table 1**
Field 4	Byte 5	Status 2	**Table 2**
Field 5	Byte 6	BITE Status	**Table 3**
Field 6	Bytes 7-8	Date **Note 1**	Unsigned 16 bits; LSB= 1 day, [1 to 366 days]
Field 7	Bytes 9-11	Time Ref GPS	Unsigned 24 bits; LSB= 0.01 s, [0 to 86400 s]
Field 8	Bytes 12-13	Spare	Set to 0
Field 9	Bytes 14-15	Heading	Unsigned 16 bits; LSB= $180/2^{15}$ deg, [0 to 360 deg] Positive and increasing when bow turns starboard.
Field 10	Bytes 16-17	Roll	Signed 16 bits; LSB= $90/2^{15}$ deg, ±90 deg Positive for left-port side down. **Warning:** Opposite sign of INS usual convention Inverse ISO Convention **Note 9**

Message <F0><F1><F2>…..<F33>			
Field 11	Bytes 18-19	Pitch	Signed 16 bits; LSB= $90/2^{15}$ deg, ±90 deg Positive for front side-bow down. Inverse ISO Convention **Note 9**
Field 12	Bytes 20-21	Heading rate **Note 2**	Signed 16 bits; LSB= $45/2^{15}$ deg/s, ±45 deg/s Positive when heading angle increasing
Field 13	Bytes 22-23	Roll rate **Note 2**	Signed 16 bits; LSB= $45/2^{15}$ deg/s, ±45 deg/s Positive when roll angle increasing
Field 14	Bytes 24-25	Pitch rate **Note 2**	Signed 16 bits; LSB= $45/2^{15}$ deg/s, ±45 deg/s Positive when pitch angle increasing
Field 15	Bytes 26-29	Latitude	Signed 32 bits; LSB= $90/2^{31}$ deg, ±90 deg Positive in North hemisphere.
Field 16	Bytes 30-33	Longitude	Signed 32 bits; LSB= $180/2^{31}$ deg, ±180 deg Positive East of Greenwich meridian, up to 180 deg.
Field 17	Bytes 34-35	Depth **Note 3**	Signed 16 bits; LSB= $655.36/2^{15}$, ±655.36 m
Field 18	Bytes 36-39	Latitude accuracy **Note 4**	Unsigned 32 bits; LSB= $10800/2^{31}$ Nm, [0 to 10800 Nm]
Field 19	Bytes 40-43	Longitude accuracy **Note 4**	Unsigned 32 bits; LSB= $10800/2^{31}$ Nm, [0 to 10800 Nm]
Field 20	Bytes 44-45	Position correlation **Note 4**	Signed 16 bits; LSB= $1/2^{15}$, ±1
Field 21	Bytes 46-49	GPS Latitude	Signed 32 bits; LSB= $90/2^{31}$ deg, ±90 deg Positive in North hemisphere.
Field 22	Bytes 50-53	GPS Longitude	Signed 32 bits; LSB= $180/2^{31}$ deg, ±180 deg Positive East of Greenwich meridian, up to 180 deg.
Field 23	Bytes 54-55	North Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 24	Bytes 56-57	East Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 25	Bytes 58-59	Down Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 26	Bytes 60-61	Log Speed	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s

Message <F0><F1><F2>…..<F33>			
		<u>Navigation Data</u>	
Field 27	Bytes 62-63	Course made good **Note 5**	Unsigned 16 bits; LSB= $180/2^{15}$ deg, [0 to 360 deg]
Field 28	Bytes 64-65	Speed over ground **Note 5**	Unsigned 16 bits; LSB= $65.536/2^{15}$, [0 to 65.536 m/s]
Field 29	Bytes 66-67	Direction of the current **Note 11**	Unsigned 16 bits; LSB= $180/2^{15}$ deg, [0 to 360 deg]
Field 30	Bytes 68-69	Speed of the current **Note 11**	Unsigned 16 bits; LSB= $65.536/2^{15}$, [0 to 65.536 m/s]
Field 31	Bytes 70-75	Spare	Set to 0
Field 32	Byte 76	Checksum	**Note 6**
Field 33	Byte 77	Terminator0	0xAA

Table 1: Byte STATUS 1

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# # # # # 0 0 0	Built In Test Equipment **Note 7**	Level 0 – No failure	N/A
# # # # # 0 0 1		Level 1 – Anomaly	When one of those INS User status bit is set to 0: DVL_RECEIVED_VALID GPS_RECEIVED_VALID GPS2_RECEIVED_VALID EMLOG_RECEIVED_VALID DEPTH_RECEIVED_VALID TIME_RECEIVED_VALID **Note 8**
# # # # # 0 1 0		Level 2 – Warning	When one of those INS User status bit is set to 1: ALTITUDE_SATURATION CPU_OVERLOAD TEMPERATURE_ERR INPUT_x_ERR OUTPUT_x_ERR
# # # # # 0 1 1		Level 3 – Failure (Attitude data not valid)	When one of those INS User status bit is set to 1: DEGRADED_MODE HRP_INVALID DYNAMIC_EXCEEDED

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# # # # # 1 0 0		Level 4 – Failure (no data valid)	INS User status FAILURE_MODE set to 1
# # # 0 0 # # #	Mode	Navigation – Sea	INS User status NAVIGATION set to 1
# # # 0 1 # # #		Navigation – Quay	INS Algo 2 status ZUPT_MODE_VALID set to 1
# # # 1 0 # # #		Alignment	INS User status ALIGNMENT set to 1
# # # 1 1 # # #		Maintenance	INS System status 2 SIMULATION_MODE set to 1
# 0 0 # # # # #	Attitude and Heading Reference validity	Data valid	N/A
# 0 1 # # # # #		Data degraded	When one of those INS User status bit is set to 1: DEGRADED_MODE FINE_ALIGNMENT
# 1 0 # # # # #		Data not valid	INS User status HRP_INVALID set to 1
x # # # # # # #	/	Reserved	N/A

Table 2: Byte STATUS 2

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# # # # # # # 0	GPS time validity	Data valid	INS User status TIME_RECEIVED_VALID set to 1
# # # # # # # 1		Data not valid	INS User status TIME_RECEIVED_VALID set to 0
# # # # # # 0 #	GPS position Validity **Note 8**	Data valid	INS User status GPS_RECEIVED_VALID set to 1 or GPS2_RECEIVED_VALID set to 1
# # # # # # 1 #		Data not valid	When one of those INS User status bit is set to 0: GPS_RECEIVED_VALID GPS2_RECEIVED_VALID
# # # # # x # #	/	Reserved	N/A
# # # # 0 # # #	Log speed **Note 8**	Data valid	INS User status EMLOG_RECEIVED_VALID set to 1
# # # # 1 # # #		Data not valid	INS User status EMLOG_RECEIVED_VALID set to 0
# # # 0 # # # #	Navigation data	Data valid	**Note 5**
# # # 1 # # # #		Data not valid	
# # x # # # # #	/	Reserved	N/A
# 0 # # # # # #	Simulation	Operational	INS System status 2 SIMULATION_MODE set to 0
# 1 # # # # # #		Simulation mode	INS System status 2 SIMULATION_MODE set to 1

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
0 # # # # # # #	INS Identification	when last digit of IP address is even	No INS status is related to this bit.
1 # # # # # # #		when last digit of IP address is odd	

Table 3: BIT status

This BITE Status is not defined in RD documents. Hence iXBlue has defined the following table.

Bit N°	7	6	5	4	3	2	1	0
User status bits	N/A	9	10	11	12	13	14	15
Message description	Reserved as spare	FOG_ANOMALY	ACC_ANOMALY	TEMPERATURE_ERR	CPU_OVERLOAD	DYNAMIC_EXCEEDED	SPEED_SATURATION	ALTITUDE_SATURATION

Note 3:

The date corresponds to the number of the day in the year. If the date is not included in the messages received from the GPS, bytes 7 and 8 of the field 6 are set to 1. The time corresponds to the GPS time in seconds since the beginning of the GPS day. When the INS is powered on, time is reset to 0 and until reception of a valid GPS message including a valid time, the time emitted in messages will be the INS internal system time (number of seconds since the start).

When a GPS time is received, the time is set at this value, and then it is updated by INS internal clock until the next time received in a GPS message.

The date and UTC synchronization time can de received in ZDA, RMC or UTC messages, if sent by GPS.

Note 2:

The attitude rate data corresponds to the time derivation of the attitude data, respect to the S40 telegram attitude data sign convention (ISO Convention or Inverse ISO Convention).

Note 3:

The depth is positive under sea level . When depth sensor altitude mode is selected, the depth corresponds to the INS altitude. For a surface ship (for Stabilization, GPS or Hydro altitude mode), the depth corresponds to the heave (the mean value is then 0).

Note 4:

The position accuracy corresponds to the maximum error estimation (3σ value = 99% probability). The position correlation corresponds to: σLat.Lon/(σLat. σLon) where σLat.Lon is the cross-covariance of latitude and Longitude.

Note 5:

The Navigation data bit (bit 4 of the status 2) is set to 1 when one of the following condition is met:

- The speed over ground (field 28) < 1 knot (then course made good (field 27) is set to 0).
- The Built In Test Equipement status (see status 1) is on level 3 or 4: i.e: When one of those INS User status bit is set to 1: DEGRADED_MODE, HRP_INVALID DYNAMIC_EXCEEDED, FAILURE_MODE.
- The INS is not in navigation mode at sea situation: i.e: INS User status NAVIGATION is set to 0.
- The current standard deviation > 95% of the current standard deviation set in the Web-based user interface.

Note 6:

One byte is used and it represents the checksum of the message. It is an 8-bit word. Checksum is a binary addition without carry modulo 256 of all data bytes, NUMDATA and IDENT. Therefore, Header, Checksum and Terminator are excluded from this addition.

Note 7:

For the parameter *Built in Test Equipment*, the level 4 is checked first, than level 3, then level 2 and finally level 1.

Note 8:

Only input sensors that are configured through the MMI are taken into account. In Simulation mode, sensors flags are not managed and the operator should not take them into account.

Note 9:

Sign convention of roll and pitch :

	ISO Convention	Inverse ISO Convention	INS Convention
Roll > 0	for left-port side up	for left-port side down	for left-port side up
Pitch > 0	for front-side bow up	for front side-bow down	for front side-bow down

Note 10: The speed of current is computed as follow : $\sqrt{(Vc_{north})^2 + (Vc_{east})^2}$

Note 11: The direction of current is issued from the angle $\alpha = \arctan\left(\frac{Vc_{east}}{Vc_{north}}\right)$

Direction of current	$Vc_{east} > 0$	$Vc_{east} < 0$
$Vc_{north} > 0$	abs(α)	2*PI – abs(α)
$Vc_{north} < 0$	PI – abs(α)	PI + abs(α)

If Vc_{North} is 0, the direction of current is not calculated and set to 0.

S40 NAV100

This protocol is not available for all products.
Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary standard.

Data sent: Status, Heading, Roll, Pitch, Heading rate, Roll rate, Pitch rate, North Velocity, East Velocity, Down Velocity, North acceleration, East acceleration, Down acceleration.

Data frame: The frame contains 32 bytes. For data coded on several bytes, the bytes are sent MSB byte first. All signed integer are coded as two's complement. This protocol telegram is assumed to be sent at the rate of 100 Hz.

Message <F0><F1><F2>…..<F18>			
Field 0	Byte 0 Byte 1	Header	0x5A 0xA5
Field 1	Byte 2	NUMDATA	0x1A
Field 2	Byte 3	IDENT	0x01
Field 3	Byte 4	Status 1	**Table 1**
Field 4	Byte 5	Status 2	**Table 2**
Field 5	Bytes 6-7	Heading	Unsigned 16 bits; LSB= $180/2^{15}$ deg, [0 to 360 deg] Positive and increasing when bow turns starboard.
Field 6	Bytes 8-9	Roll	Signed 16 bits; LSB= $90/2^{15}$ deg, ±90 deg Positive for left-port side down. **Warning:** Opposite sign of INS usual convention Inverse ISO Convention **Note 9**
Field 7	Bytes 10-11	Pitch	Signed 16 bits; LSB= $90/2^{15}$ deg, ±90 deg Positive for front side-bow down. Inverse ISO Convention **Note 9**
Field 8	Bytes 12-13	Heading rate **Note 2**	Signed 16 bits; LSB= $45/2^{15}$ deg/s, ±45 deg/s Positive when heading angle increasing
Field 9	Bytes 14-15	Roll rate **Note 2**	Signed 16 bits; LSB= $45/2^{15}$ deg/s, ±45 deg/s Positive when roll angle increasing
Field 10	Bytes 16-17	Pitch rate **Note 2**	Signed 16 bits; LSB= $45/2^{15}$ deg/s, ±45 deg/s Positive when pitch angle increasing

Message <F0><F1><F2>…..<F18>			
Field 11	Bytes 18-19	North Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 12	Bytes 20-21	East Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 13	Bytes 22-23	Down Velocity	Signed 16 bits; LSB= $65.536/2^{15}$, ±65.536 m/s
Field 14	Bytes 24-25	North acceleration	Signed 16 bits; LSB= $327.68/2^{15}$, ±327.68 m/s^2
Field 15	Bytes 26-27	East acceleration	Signed 16 bits; LSB= $327.68/2^{15}$, ±327.68 m/s^2
Field 16	Bytes 28-29	Down acceleration **Note 12**	Signed 16 bits; LSB= $327.68/2^{15}$, ±327.68 m/s^2
Field 17	Byte 30	Checksum	**Note 6**
Field 18	Byte 31	Terminator	0xAA

Table 1: Byte STATUS 1

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# # # # # 0 0 0	Built In Test Equipment **Note 7**	Level 0 – No failure	N/A
# # # # # 0 0 1		Level 1 – Anomaly	When one of those INS User status bit is set to 0: DVL_RECEIVED_VALID GPS_RECEIVED_VALID GPS2_RECEIVED_VALID EMLOG_RECEIVED_VALID DEPTH_RECEIVED_VALID TIME_RECEIVED_VALID **Note 8**
# # # # # 0 1 0		Level 2 – Warning	When one of those INS User status bit is set to 1: ALTITUDE_SATURATION CPU_OVERLOAD TEMPERATURE_ERR INPUT_x_ERR OUTPUT_x_ERR
# # # # # 0 1 1		Level 3 – Failure (Attitude data not valid)	When one of those INS User status bit is set to 1: DEGRADED_MODE HRP_INVALID DYNAMIC_EXCEEDED
# # # # # 1 0 0		Level 4 – Failure (no data valid)	INS User status FAILURE_MODE set to 1
# # # 0 0 # # #	Mode	Navigation – Sea	INS User status NAVIGATION set to 1

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# # # 0 1 # # #		Navigation – Quay	INS Algo 2 status ZUPT_MODE_VALID set to 1
# # # 1 0 # # #		Alignment	INS User status ALIGNMENT set to 1
# # # 1 1 # # #		Maintenance	INS System status 2 SIMULATION_MODE set to 1
# 0 0 # # # # #	Attitude and Heading Reference validity	Data valid	N/A
# 0 1 # # # # #		Data degraded	When one of those INS User status bit is set to 1: DEGRADED_MODE FINE_ALIGNMENT
# 1 0 # # # # #		Data not valid	INS User status HRP_INVALID set to 1
x # # # # # # #	/	Reserved	N/A

Table 2: Byte STATUS 2

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
# # # # # # # 0	GPS time validity	Data valid	INS User status TIME_RECEIVED_VALID set to 1
# # # # # # # 1		Data not valid	INS User status TIME_RECEIVED_VALID set to 0
# # # # # # 0 #	GPS position Validity **Note 8**	Data valid	INS User status GPS_RECEIVED_VALID set to 1 or GPS2_RECEIVED_VALID set to 1
# # # # # # 1 #		Data not valid	When one of those INS User status bit is set to 0: GPS_RECEIVED_VALID GPS2_RECEIVED_VALID
# # # # # x # #	/	Reserved	N/A
# # # # 0 # # #	Log speed **Note 8**	Data valid	INS User status EMLOG_RECEIVED_VALID set to 1
# # # # 1 # # #		Data not valid	INS User status EMLOG_RECEIVED_VALID set to 0
# # # 0 # # # #	Navigation data	Data valid	**Note 5**
# # # 1 # # # #		Data not valid	
# # x # # # # #	/	Reserved	N/A
# 0 # # # # # #	Simulation	Operational	INS System status 2 SIMULATION_MODE set to 0
# 1 # # # # # #		Simulation mode	INS System status 2 SIMULATION_MODE set to 1

7|6|5|4|3|2|1|0	Parameter	Description	Attached INS status bits
0 # # # # # # #	INS Identification	when last digit of IP address is even	No INS status is related to this bit.
1 # # # # # # #		when last digit of IP address is odd	

Table 3: BIT status

This BITE Status is not defined in RD documents. Hence iXBlue has defined the following table.

Bit N°	7	6	5	4	3	2	1	0
User status bits	N/A	9	10	11	12	13	14	15
Message description	Reserved as spare	FOG_ANOMALY	ACC _ANOMALY	TEMPERATURE_ERR	CPU_OVERLOAD	DYNAMIC_EXCEEDED	SPEED_SATURATION	ALTITUDE_SATURATION

Note 4:

The date corresponds to the number of the day in the year. If the date is not included in the messages received from the GPS, bytes 7 and 8 of the field 6 are set to 1. The time corresponds to the GPS time in seconds since the beginning of the GPS day. When the INS is powered on, time is reset to 0 and until reception of a valid GPS message including a valid time, the time emitted in messages will be the INS internal system time (number of seconds since the start).

When a GPS time is received, the time is set at this value, and then it is updated by INS internal clock until the next time received in a GPS message.

The date and UTC synchronization time can de received in ZDA, RMC or UTC messages, if sent by GPS.

Note 2:

The attitude rate data corresponds to the time derivation of the attitude data, respect to the S40 telegram attitude data sign convention (ISO Convention or Inverse ISO Convention).

Note 3:

The depth is positive under sea level . When depth sensor altitude mode is selected, the depth corresponds to the INS altitude. For a surface ship (for Stabilization, GPS or Hydro altitude mode), the depth corresponds to the heave (the mean value is then 0).

Note 4:

The position accuracy corresponds to the maximum error estimation (3σ value = 99% probability). The position correlation corresponds to: σLat.Lon/(σLat. σLon) where σLat.Lon is the cross-covariance of latitude and Longitude.

Note 5:

The Navigation data bit (bit 4 of the status 2) is set to 1 when one of the following condition is met:

- The speed over ground (field 28) < 1 knot (then course made good (field 27) is set to 0).
- The Built In Test Equipement status (see status 1) is on level 3 or 4: i.e: When one of those INS User status bit is set to 1: DEGRADED_MODE, HRP_INVALID DYNAMIC_EXCEEDED, FAILURE_MODE.
- The INS is not in navigation mode at sea situation: i.e: INS User status NAVIGATION is set to 0.
- The current standard deviation > 95% of the current standard deviation set in the Web-based user interface.

Note 6:

One byte is used and it represents the checksum of the message. It is an 8-bit word. Checksum is a binary addition without carry modulo 256 of all data bytes, NUMDATA and IDENT. Therefore, Header, Checksum and Terminator are excluded from this addition.

Note 7:

For the parameter *Built in Test Equipment*, the level 4 is checked first, than level 3, then level 2 and finally level 1.

Note 8:

Only input sensors that are configured through the MMI are taken into account. In Simulation mode, sensors flags are not managed and the operator should not take them into account.

Note 9:

Sign convention of roll and pitch :

	ISO Convention	Inverse ISO Convention	INS Convention
Roll > 0	for left-port side up	for left-port side down	for left-port side up
Pitch > 0	for front-side bow up	for front side-bow down	for front side-bow down

Note 10: The speed of current is computed as follow : $\sqrt{(Vc_{north})^2 + (Vc_{east})^2}$

Note 11: The direction of current is issued from the angle $\alpha = \arctan\left(\frac{Vc_{east}}{Vc_{north}}\right)$

Direction of current	$Vc_{east} > 0$	$Vc_{east} < 0$
$Vc_{north} > 0$	abs(α)	2*PI – abs(α)
$Vc_{north} < 0$	PI – abs(α)	PI + abs(α)

If Vc_{North} is 0, the direction of current is not calculated and set to 0.

Note 12: The down acceleration is compensated from the g measurement.

TMS CCV IMBAT

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Output Thomson Marconi Sonar proprietary protocol.

Data sent: Roll, Pitch, Heave, Heading, Linear accelerations, Rotations rates, Status.

Data frame: The frame contains 13 fields - 24 bytes. LSB are sent first.

Message <F0><F1>…<F12>			
Field 0	Bytes 0 to 1	Header	Fixed value = 0x0090
Field 1	Bytes 2 to 3	Roll	+/-180° ; LSB = 180° / 2^{15} Sign "+" when port up
Field 2	Bytes 4 to 5	Pitch	+/-180° ; LSB = 180° / 2^{15} Sign "+" when bow up **Warning:** Opposite sign of INS usual convention.
Field 3	Bytes 6 to 7	Heave	+/-327 m ; LSB = 327m / 2^{15} Sign "+" when PHINS goes down **Warning:** Opposite sign of INS usual convention.
Field 4	Bytes 8 to 9	Heading	0° to 360° ; LSB = 360° / 2^{16}
Field 5	Bytes 10 to 11	XV1 acceleration*	+/-0.5 g; LSB = 0.5g / 2^{15}
Field 6	Bytes 12 to 13	XV2 acceleration*	+/-0.5 g; LSB = 0.5g / 2^{15}
Field 7	Bytes 14 to 15	XV3 acceleration*	+/-0.5 g; LSB = 0.5g / 2^{15}
Field 8	Bytes 16 to 17	XV1 rotation rate*	+/-20°/s; LSB = 20°/s / 2^{15}
Field 9	Bytes 18 to 19	-XV2 rotation rate*	+/-20°/s; LSB = 20°/s / 2^{15} **Warning:** Opposite sign of INS usual convention.
Field 10	Bytes 20 to 21	-XV3 rotation rate*	+/-20°/s; LSB = 20°/s / 2^{15} **Warning:** Opposite sign of INS usual convention.
Field 11	Byte 22	Status	0xFF if Ok 0xAA if Alignment 0x00 if Error
Field 12	Byte 23	End of sentence	Fixed value = 0x91

***To comply with export regulation, the precision of rotation rate data is limited to 3.6 deg/h and the precision of acceleration data is limited to 1mg. Accelerations are compensated from g.

TUS

This protocol is not available for all products.

Refer to the tables of the section 3.6.1 to know if this protocol is available for your product.

Standard: Binary protocol.

Data sent: Heading, Roll, Pitch, Heave speed, Surge speed, Sway speed, Linear accelerations, Rotation rates, Status.

Data frame: The frame contains 16 fields - 29 bytes. LSB are sent first. Except Heading, each data is “two complemented” coded.

Message <F0><F1>…<F12>			
Field 0	Bytes 0 to 1	Header	Header LSB = 0x00 ; Header MSB = 0x90
Field 1	Bytes 2 to 3	Roll	+/-180° ; LSB = $180/2^{15}$= 0.00549° Sign “+” when port up
Field 2	Bytes 4 to 5	Pitch	+/-180° ; LSB = $180/2^{15}$= 0.00549° Sign “+” when bow up
Field 3	Bytes 6 to 7	Heave speed	+/-327 m/s ; LSB = $327/2^{15}$=0.00997 m/s Sign “+” in down direction
Field 4	Bytes 8 to 9	Surge speed	+/-327 m/s ; LSB = $327/ 2^{15}$=0.00997 m/s Sign “+” in forward direction
Field 5	Bytes 10 to 11	Sway speed	+/-327 m/s ; LSB = $327/ 2^{15}$=0.00997 m/s Sign “+” in left direction
Field 6	Bytes 12 to 13	Heading	0° to 360° ; LSB = $360/2^{16}$= 0.00549°
Field 7	Bytes 14 to 15	XV1 acceleration*	+/-0.5 g; LSB = $0.5/ 2^{15}$. Positive in XV1 direction (forward)
Field 8	Bytes 16 to 17	-XV2 acceleration*	+/-0.5 g; LSB = $0.5/2^{15}$= 15.2 µg Sign “+” in opposite direction of XV2 (right)
Field 9	Bytes 18 to 19	-XV3 acceleration*	+/-0.5 g; LSB = $0.5/2^{15}$ =15.2 µg Sign “+” in opposite direction of XV3 (down)
Field 10	Bytes 20 to 21	Roll rate*	+/-20°/s; LSB = $20/2^{15}$=0.00061 °/s Sign “+” when rotating port up
Field 11	Bytes 22 to 23	Pitch rate*	+/-20°/s; LSB = $20/2^{15}$=0.00061 °/s Sign “+” when rotating bow up
Field 12	Bytes 24 to 25	Heading rate*	+/-20°/s; LSB = $20/2^{15}$=0.00061 °/s Sign “+” when heading decreases

Message <F0><F1>…<F12>			
Field 13	Byte 26	Status**	0xFF if Ok 0xAA if Initial alignment (5 first minutes) 0x00 if Error
Field 14	Byte 27	Checksum	Addition of all the bytes from 0 to 26 discarding overflow
Field 15	Byte 28	End of sentence	Fixed value = 0x91

* To comply with export regulation, the resolution of rotation rate data is limited to 3.6 deg/h and the resolution of acceleration data is limited to 1 mg. Accelerations are compensated from g.

** Status specification table

Function	Value	Links with INS status word
Alignment	0xAA	Bit 1 of the INS LSB Algorithm status word
Error	0x00	Bit 26 and 30 of the INS MSB User status word
Ok	0xFF (Status default value)	None

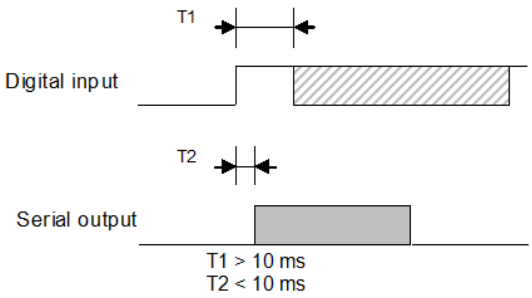
4 PULSES SPECIFICATION

4.1 Input Pulses Specification

4.1.1 INPUT PULSES FUNCTIONAL SPECIFICATION

Four input pulses are available in the system, but in some products, only part of them may be present on external connectors. Depending on the product type, the following protocols can be configured:

- **PPS rising/falling + Time:** In this configuration, the system waits for an input PPS pulse and associated UTC time should be provided in following time frame. UTC time validity corresponds to rising/falling edge of PPS pulse.
- **Time + PPS rising/falling:** In this configuration, the system waits for a time frame, stores UTC time contained in the frame and associate it with following PPS pulse. UTC time validity corresponds to rising/falling edge of PPS pulse.
- **Synchro out X**: In this configuration, input pulse is used to trigger protocol output on associated port X during next available output slot (a slot is available each 5 ms).



- **Event marker rising/falling:** In this configuration, the input pulse will be used to time stamp external event. Associated counts will be sent in LANDINS STANDARD protocol EVMIN_ frame and logged in POST PROCESSING protocol (see protocol description for details).
- **Log:** In this configuration, the input pulse is used to indicate a log speed. The scale factor parameter is used to convert number of pulses per second into speed in knots:

  Speed in knots = number of pulses per seconds / scale factor
- **Odometer:** In this configuration, the input pulse is used to indicate a mean speed. The scale factor parameter is used to convert number of pulses accumulated per hour into speed in knots (the accumulation is performed over 10 seconds and extrapolated to one hour):

  Speed in knots = number of pulses per hour / scale factor
- **DVL Trigger by Pulse Out:** In this configuration, a signal trigger input pulse could be redirected to a chosen output pulse (with a minimum of delay and jitter max known).

The table below details the pulses and the protocols available on the products:

Table 19 – Pulses and protocols available on the products

	Pulse A	Pulse B	Pulse C	Pulse D
PHINS **HYDRINS** **MARINS** **QUADRANS**	PPS rising/falling + Time Time + PPS rising/falling Synchro out X	Idem pulse A	Idem pulse A	Idem pulse A
ROVINS NANO	PPS rising/falling + Time Time + PPS rising/falling Synchro out X	N/A	Idem pulse A	N/A
PHINS **COMPACT C3**	PPS rising/falling + Time Time + PPS rising/falling Synchro out X Event marker rising/falling Trigger broadcast	Idem pulse A	N/A	N/A
ATLANS	PPS rising/falling + Time Time + PPS rising/falling Synchro out X Event marker rising/falling	Idem pulse A	Idem pulse A	PPS rising/falling + Time Time + PPS rising/falling Synchro out X
LANDINS **AIRINS**	PPS rising/falling + Time Time + PPS rising/falling Synchro out X Event marker rising/falling	Idem pulse A	Idem pulse A	Idem pulse A
ROVINS **PHINS COMPACT C7** **PHINS 6000**	PPS rising/falling + Time Time + PPS rising/falling Synchro out X	Idem pulse A	Idem pulse A	N/A

4.1.2 Input Pulses Electrical Characteristics

The following table details the input pulse characteristics.

Table 20 – Input Pulse Electrical Characteristics

	Symbol	Min	Max	Unit
Input pulse width	T_W	1	-	µs
Low to High transition voltage	V_{LH}	2	-	V
High to Low transition voltage	V_{HL}	-	0.8	V
Input voltage	V_{IN}	-0.5	5.5	V
Input current	I_{IN}	-10	10	µA
Input impedance	Z_{IN}	550		kΩ
Pulse internal latency	T_L	-	10	µs

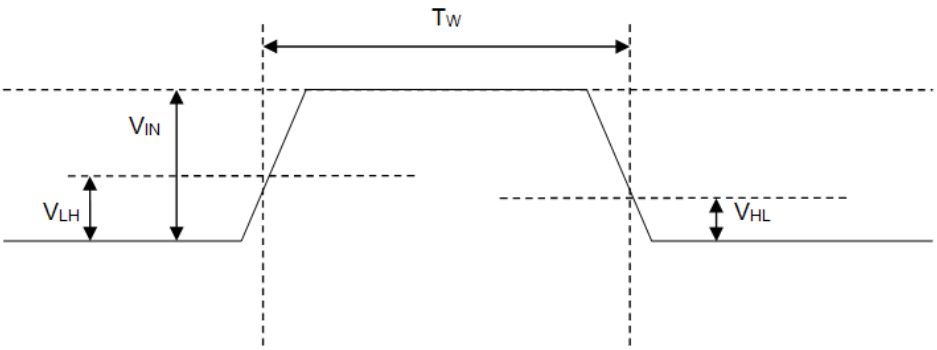
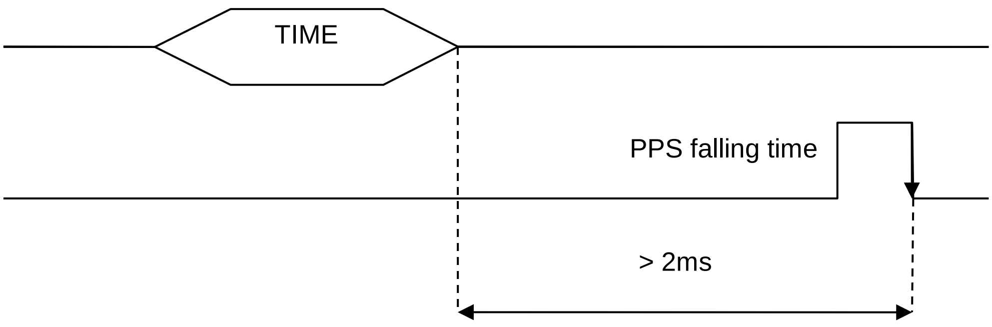


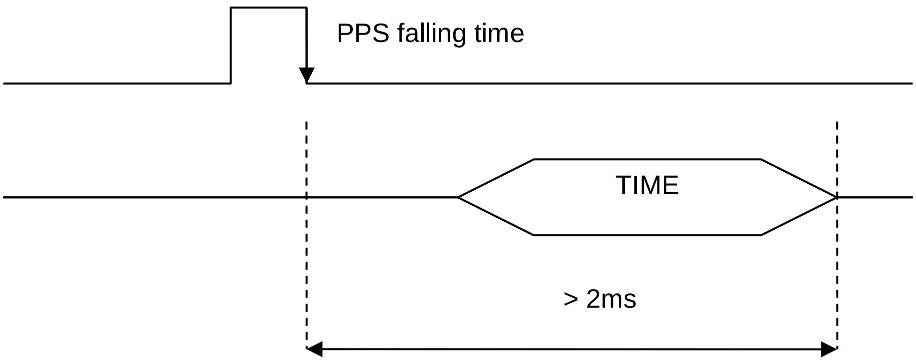
Figure 8 – Input Pulse Diagram

4.1.3 TIME / PPS INPUT CONSTRAINTS

When configured in Time + PPS, the Time frame content must be fully received at least 2ms before the PPS signal to be correctly taken into account:



When configured in PPS + Time, the PPS must be sent at least 2ms before the Time frame is entirely received to be correctly taken into account:



4.2 Output pulses specification

4.2.1 OUTPUT PULSES FUNCTIONAL SPECIFICATIONS

Two output pulses are available in the system. In some products, only part of them may be present on external connectors.
For each output pulse, the following protocols can be configured:

- **Serial out X RTC:** In this configuration, the output pulse will be active during selected port output (the pulse will reflect the envelope of selected serial output). Pulse width thus depends on serial port baudrate and frame length.

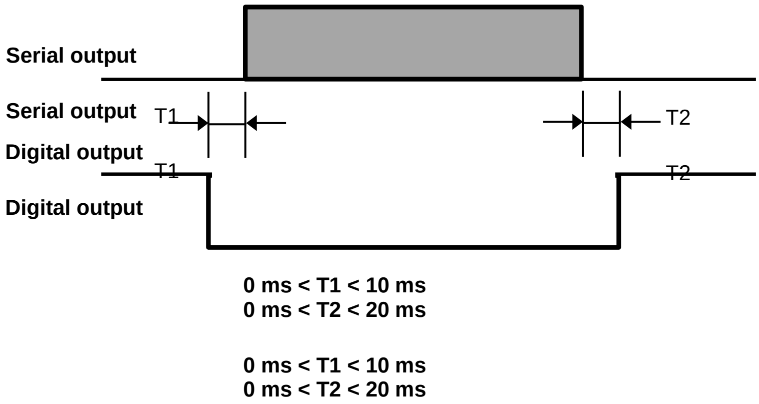


Figure 9 – Serial out X RTC

- **Distance travelled rising/falling**: In this configuration, the pulse will be output each time the travelled distance increases by specified step set in pulse out scale factor. For example, if step is 1, the pulse will be output each meter.
  Pulse width is 5 ms in this mode.

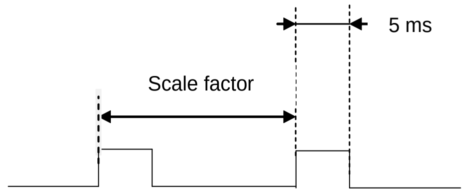


Figure 10 – Distance travelled rising

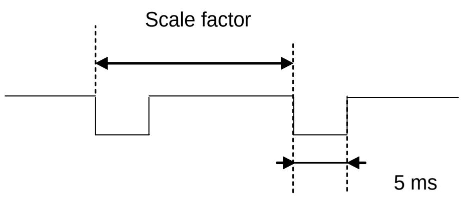


Figure 11 – Distance travelled falling

- **Timer rising/falling**: in this configuration, the pulse will be output at specified period in seconds. The time resolution for the output period is derived from the 200 Hz base is 5ms, so the output period must be a multiple of 5ms.
- **PPS Like**: in this configuration, the pulse will be triggered once per second, at the moment when the ZDA frame is sent by the system in the GPS LIKE protocol. This pulse can be used to synchronize the system with equipment in case no PPS is available from an external UTC reference.
- **System failure**: In this configuration associated pulse will be set to Failure State when at least one of the following user status bit is set:
  - Bit 27: ALIGNMENT
  - Bit 14: SPEED SATURATION
  - Bit 15: ALTITUDE SATURATION
  - Bit 11: TEMPERATURE ERROR
  - Bit 13: DYNAMIC EXCEEDED
  - Bit 26: HRP INVALID
  - Bit 31: FAILURE MODE

  In all other cases, the pulse is set to Idle State.

  When this pulse is set, the system outputs should not be trusted and must be considered invalid for the external equipment.
- **Broadcast pulse X:** In this configuration, a signal input pulse could be redirected to a chosen output pulse (with a minimum of delay and jitter max known). In case of DVL trigger, this redirection shall be memorised by INS in order to calculate the offset time between the trigger sent to external sensor and his response.
- **System warning**: In this configuration, the associated pulse will be set to Warning State when at least one of the following user status bit is set:
  - Bit 28: FINE ALIGNMENT
  - Bit 30: DEGRADED MODE
  - Bit 12: CPU OVERLOAD
  - Bit 21, 22, 23, 24, 25: OUTPUT A, B, C, D or E FULL

  In all other cases, the pulse is set to Idle State.

The table next page details the pulses and protocols available on the products.

Table 21 – Pulses and protocols available on the products

	Pulse A	Pulse B	Failure pulse	Warning pulse
PHINS **HYDRINS** **LANDINS** **AIRINS** **ROVINS** **PHINS COMPACT C7**	Serial out X RTC PPS Like Distance travelled Timer	Serial out X RTC PPS Like Distance travelled Timer	System failure	N/A
MARINS	Serial out X RTC	Serial out X RTC	System failure	System warning
LANDINS	Serial out X RTC Distance travelled	Serial out X RTC Distance travelled	System failure	N/A
QUADRANS	Serial out X RTC	Serial out X RTC	N/A	N/A
ATLANS	Serial out X RTC PPS Like Distance travelled Timer	Serial out X RTC PPS Like Distance travelled Timer	N/A	N/A
PHINS COMPACT C3	Serial out X RTC PPS Like Trigger broadcast	N/A	N/A	N/A
ROVINS NANO	N/A	N/A	N/A	N/A

4.2.2 OUTPUT PULSES ELECTRICAL CHARACTERISTICS

The following table details the output pulse characteristics.

Table 22 – Output Pulse Electrical Characteristics

	Symbol	Min	Max	Unit
Output voltage at logic low	V_L	0	0.4	V
Output voltage at logic high	V_H	4.8	5	V
Output current	I_{OUT}	-	4	mA

4.2.3 INS SYSTEM FAILURE PULSE

On INS systems, the failure signal corresponds to failure output pulse. This signal is available on pin D of the 10-pins Repeater connector. This is an open collector output. The maximum current is limited by an internal 330Ohm resistor. Eg: When connected to Vcc=5V, the maximum current is around 15mA.

4.2.4 MARINS SYSTEM WARNING PULSE

The warning output pulse detailed in 4.2.1 is available on MARINS digital connector pin n°35. The state of this pin is inverted and is set only when no warning is present. Following table details pin level of this signal:

Table 23 – Pin level of the warning output pulse

	System Off	Warning State	Idle State
Warning pulse	0V	0V	5V

The output characteristics of this signal are the same as the output pulses detailed in 0.

4.2.5 MARINS SYSTEM FAILURE RELAY

On MARINS systems only, the failure signal is connected to a relay. The connector offers normally on and normally off outputs instead of TTL output level. On other systems, the failure signal corresponds to the failure output pulse.

Following table details system warning output pulse states and MARINS relay states:

Table 24 – System Failure Output Pulse and MARINS Relay States

	System Off	Failure state	Iddle state
MARINS (relay)	NC connected to COM	NC connected to COM	NO connected to COM

Where:

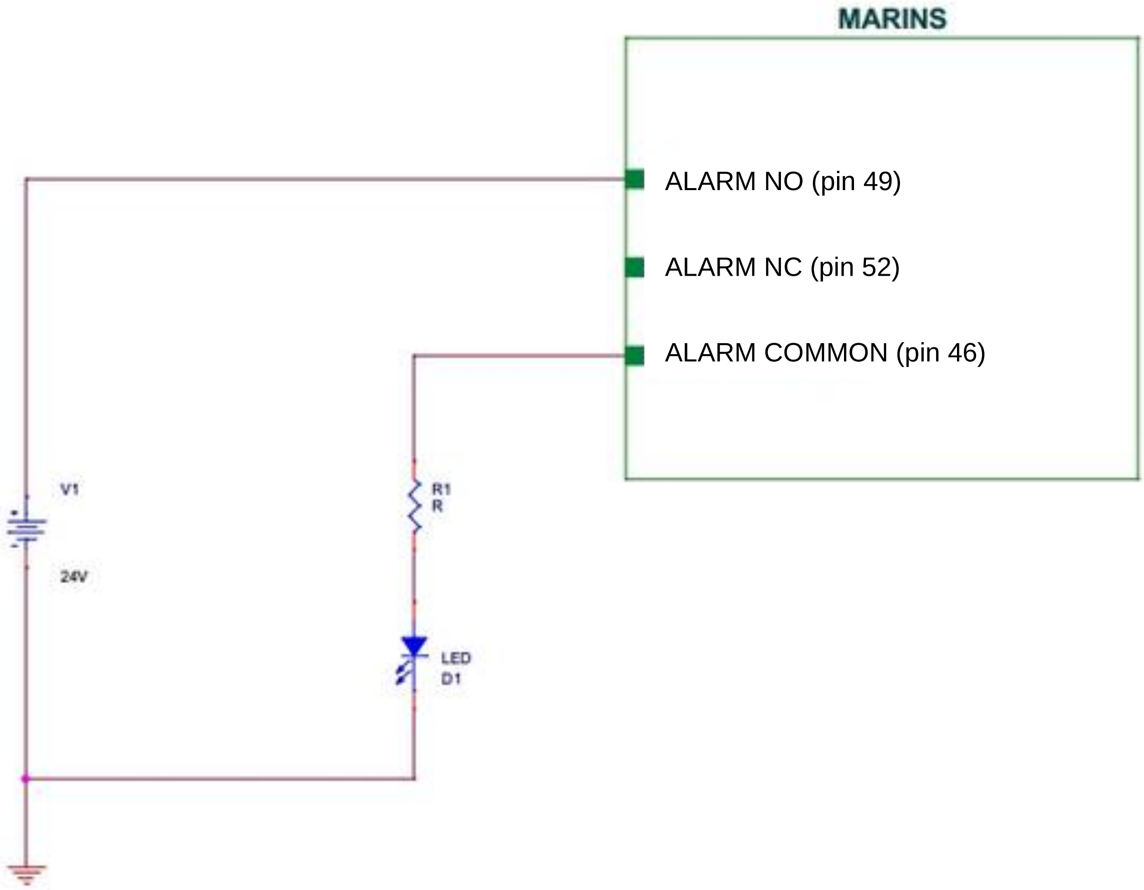
- NC: Normally ON relay signal (if no failure is detected, circuit will be closed)
- NO: Normally OFF relay signal (if no failure is detected, circuit will be open)
- COM: Common relay signal

Following table details relay characteristics:

Table 25 – Relay Characteristics

Maximum switching voltage	220 V_{DC} / 250 V_{AC}
Maximum switching current	2 A
Maximum switching capacity	60 W / 62.5 VA
Endurance	> 10^5 operations

Typical setup for external LED indicator with pins references:



By default Relay is OFF and LED is OFF. LED can be replaced by a light indicator.

External Power Supply V1: 24V DC.

Vf voltage drop @ LED, If LED current.

R1 is determined as follows:

R1= (V1-Vf) / If

Power dissipated by R1:

PR1= (V1-Vf) x If

Refer to MARINS Interface Control Document to get the pinout details.

5 LIST OF THE DATA PROVIDED BY THE INS

According to your product, the following data may be provided:

Table 26 - Navigation data provided by the INS

NAVIGATION DATA				
Position Data	**Unit**	**Min value**	**Max value**	**Convention**
Latitude	Degree	-90	90	positive in northern hemisphere
Longitude	Degree	0	360	increasing eastwards
Altitude	Meter	NA	PHINS, PHINS 6000, ROVINS, QUADRANS, HYDRINS, MARINS, LANDINS, ROVINS NANO, PHINS COMPACT C3, PHINS COMPACT C7: 4,000 AIRINS, ATLANS: 15,000	Altitude above sea level(Geoïd) or Ellipsoid WGS84
UTM North	Meter	0	10,000,000	WGS 84
UTM East	Meter	0	1,000,000	
UTM zone	Integer	1	60	
UTM band	Letter	C	X	
Speed data	**Unit**	**Min value**	**Max value**	**Convention used**
Speed north	Meter/second	NA	PHINS, PHINS 6000, ROVINS,QUADRANS, HYDRINS, MARINS, LANDINS, ROVINS NANO, PHINS COMPACT C3, PHINS COMPACT C7: 41.667 AIRINS, ATLANS: 250	Note: 41.667 m/s ~150 km/h~81 knot 250 m/s = 900 km/h~486 knot
Speed west				
Speed up				
Heading and attitude data	**Unit**	**Min value**	**Max value**	**Convention used**
Heading	**Degree**	**0**	**360**	**To switch from vehicle to navigation frame, the order of rotations is roll then pitch then heading**
Roll		-180	180	
Pitch		-90	90	

NAVIGATION DATA				
Rotation and acceleration data	**Unit**	**Min value**	**Max value**	**Convention used**
X1 rotation rate X2 rotation rate X3 rotation rate	Degree/second	PHINS, HYDRINS, MARINS: -750 ROVINS NANO, PHINS COMPACT C3 : -250 ROVINS, PHINS 6000, LANDINS: -180 AIRINS, ATLANS: -500	PHINS, HYDRINS, MARINS: 750 ROVINS NANO, PHINS COMPACT C3 : 250 ROVINS, PHINS COMPACT C7, QUADRANS, PHINS 6000, LANDINS: 180 AIRINS, ATLANS: 500	Resolution is limited to 0.001°/s (3.6°/h) to comply with export regulations. For MARINS: no limitation.
X1 linear acceleration X2 linear acceleration X3 linear acceleration	m/s²	ATLANS, QUADRANS, ROVINS NANO, PHINS COMPACT C3 : -50 PHINS, HYDRINS, MARINS: -150 ROVINS, PHINS 6000, LANDINS:-180 AIRINS:-150	ATLANS, QUADRANS, ROVINS NANO, PHINS COMPACT C3: 50 PHINS, HYDRINS, MARINS: 150 ROVINS, PHINS 6000, PHINS COMPACT C7, LANDINS: 180 AIRINS: 150	Resolution is limited to 9.81 10^{-3} m/s² (1mg) to comply with export regulations. For MARINS: no limitation.
Motion sensing data **(Not output by QUADRANS, PHINS COMPACT C3, ROVINS NANO, AIRINS, ATLANS & LANDINS)**	**Unit**	**Min value**	**Max value**	**Convention**
Heave Surge Sway	Meter	NA	NA	Heave measured along local vertical
Heave speed Surge speed Sway speed	Meter/second	NA	NA	Refer to *Inertial Products - Principle and Conventions* document *(Ref.: MU-INS&AHRS-AN-003)*
Time	**Unit**	**Min value**	**Max value**	**Convention**
Time	hh/mm/ss	0	23/59/59.99	

Table 27 - Standard deviation data provided by the INS

Standard deviation data	
Position standard deviation	**Unit**
Latitude standard deviation	meter
Longitude standard deviation	
Altitude standard deviation	
Speed standard deviation	**Unit**
North speed standard deviation	meter/second
West speed standard deviation	
Up speed standard deviation	
Heading and attitude standard deviation	**Unit**
Heading standard deviation	degree
Roll standard deviation	
Pitch standard deviation	

Table 28 - External sensor data provided by the INS

EXTERNAL SENSOR DATA		
GPS Data	**Unit**	**Convention**
Latitude	degree	positive in northern hemisphere
Longitude	degree	positive eastwards
Altitude	meter	Altitude above sea level
Last update	hour/minute/second	
GPS1 Data	**Unit**	**Convention**
Latitude	degree	positive in northern hemisphere
Longitude	degree	positive eastwards
Altitude	meter	Altitude above sea level
Last update	hour/minute/second	
GPS2 Data	**Unit**	**Convention**
Latitude	degree	positive in northern hemisphere
Longitude	degree	positive eastwards
Altitude	meter	Altitude above sea level
Last update	hour/minute/second	
DMI Data	**Unit**	**Convention**
Speed X	Pulses	
Last update	hour/minute/second	
Speed bottom track data	**Unit**	**Convention used**
Speed X	meter/second	Speed in Log Sensor frame X, Y, Z (body or beam)
Speed Y		
Speed Z		
Altitude	meter	
Sound velocity	meter/second	Sound velocity calculated by the DVL
Last update	hour/minute/second	
Speed water track data	**Unit**	**Convention used**
Speed X	meter/second	Speed with respect to water layer in Log Sensor frame X, Y, Z (body or beam)
Speed Y		
Speed Z		
Sound velocity sensor data	**Unit**	**Convention used**
Sound velocity	Meter/second	From external CTD or SVP sensor
Depth sensor data	**Unit**	**Convention used**
Depth	Meter	Depth from local sea level

EXTERNAL SENSOR DATA		
USBL data	**Unit**	**Convention**
Latitude	degree	
Longitude	degree	
Altitude	meter	
Latency	second	Latency of USBL data (>0)
Last update	hour/minute/second	
LBL data	**Unit**	**Convention**
Beacon latitude	degree	
Beacon longitude	degree	
Beacon altitude	meter	
range	Meter	
Last update	hour/minute/second	
EM Log data	**Unit**	**Convention**
Speed module	Meters/second	
Speed of North current	Meters/second	
Speed of East current	Meters/second	
Last update	hour/minute/second	
EM Log 1 data	**Unit**	**Convention**
Speed module	Meters/second	
Speed of North current	Meters/second	
Speed of East current	Meters/second	
Last update	hour/minute/second	
EM Log 2 data	**Unit**	**Convention**
Speed module	Meters/second	
Speed of North current	Meters/second	
Speed of East current	Meters/second	
Last update	hour/minute/second	
CTD data	**Unit**	**Convention**
Sound speed	Meters/second	