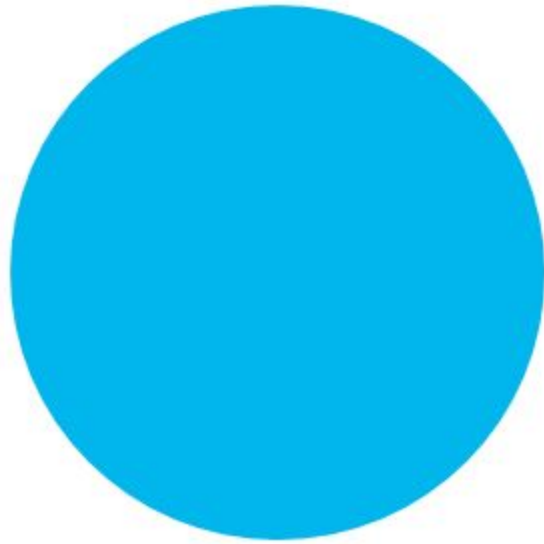




# **Phins Compact C7**

Interface Library



## Revision History

| Edition | Date    | Comments                                                                                |
|---------|---------|-----------------------------------------------------------------------------------------|
| A       | 07/2019 | Creation                                                                                |
| B       | 02/2020 | Broadcast protocol added, protocol name updated, status updated, control commands added |
| C       | 01/2023 | Status description, Digital protocols & Control commands chapters updated               |

## Copyright

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

## Disclaimer

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

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

## Trademarks

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

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

## Export Control

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

# Phins Compact C7 Documentation

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

- **Phins Compact C7 Technical Description** (*ref.: MU-PHINC7TD-AN-001*)
  - > Phins Compact C7 and iXblue technology presentation
  - > Technical specifications
  - > Certification and qualification, life cycle
  - > Mechanical, electrical and communication interface description
- **Phins Compact C7 Installation & Setup Guide** (*ref.: MU-PHINC7ISG-AN-001*)
  - > Conventions
  - > Physical and electrical installation
  - > Connecting to the Web-Based Graphical User Interface
  - > Setup the Phins Compact C7
  - > Contacting iXblue support
- **Phins Compact C7 Operation Guide** (*ref.: MU-PHINC7OG-AN-001*)
  - > Introduction to the Inertial Navigation System
  - > Start-up Phases
  - > Web-Based Graphical User Interface description
  - > Configuring the navigation parameters & managing the external information
  - > Viewing the system information
  - > Recording data
- **Phins Compact C7 Interface Library** (*ref.: MU-PHINC7IL-AN-001*)
  - > NMEA frames
  - > Digital input and output protocols
  - > Pulses interfaces specification
  - > Control commands
- **Subsea Inertial Products - Maintenance Manual** (*ref.: MU-SUBSEAMM-AN-001*)
  - > Troubleshooting
  - > Corrective maintenance
- **Subsea Inertial Products - Illustrated Part Catalog** (*ref.: MU-SUBSEADP-AN-001*)
  - > Detailed part list
  - > Alphanumerical Index
- **Application Note - INS+DVL Calibration** (*ref.: MU-DVLINS-AN-001*)
  - > Configuring the calibration
  - > Calibrating the DVL+INS
- **Application Note - Installation and Configuration of AHRS and INS for Seabed Mapping Measurements** (*ref.: MU-HEAVAPN-AN-001*)
  - > Using heave compensation on seabed mapping
  - > Effect of vehicle transient movements

# Manual Overview

This document is the Interface Library for Phins Compact C7. It must be read and understood prior to using the product.

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

The Phins Compact C7 Interface Library is divided into several parts:

- **Part 1: Conventions**  
This part gives details of conventions used in this document.
- **Part 2: List of the Data provided by Phins Compact C7**  
This part lists the data provided by Phins Compact C7: navigation data, their standard deviations and external sensor data.
- **Part 3: Input NMEA Frame Definition**  
This part gives the definition of the different input NMEA frames.
- **Part 4: Output NMEA Frame Definition**  
This part gives the definition of the different output NMEA frames.
- **Part 5: Status Description**  
This part gives a detailed description of Phins Compact C7 algorithm and user status words. These status words act as built-in test and control tools to check for Phins Compact C7 operation.
- **Part 6: Digital Protocols**  
This part gives definition of the different input and output protocols.
- **Part 7: Pulses Interfaces Specification**  
This part gives a detailed description of the different pulse inputs and output protocols available.
- **Part 8: Control Command**  
This part details all the configuration and monitoring commands which can be used during operation.
- **Appendix A: Quaternion definitions**  
This part gives details on quaternions definitions, operations and relationship with Euler angles.

## Abbreviations and Acronyms

|         |                                                                                                                       |
|---------|-----------------------------------------------------------------------------------------------------------------------|
| ACC     | Accelerometer                                                                                                         |
| CTD     | Conductivity, Temperature, Depth sensor                                                                               |
| DVL     | Doppler Velocity Log                                                                                                  |
| EEPROM  | Electrically-erasable programmable read-only memory                                                                   |
| EGNOS   | European Geo-stationary Navigation Overlay Service                                                                    |
| GALILEO | European Satellite Navigation System                                                                                  |
| GGA     | Essential fix data which provide 3D location and accuracy data                                                        |
| GLONASS | Global Navigation Satellite System (operated by the Russian Space Forces)                                             |
| GNSS    | Global Navigation Satellite System                                                                                    |
| GPS     | Global Positioning System (operated by the United States Department of Defense)                                       |
| GST     | GPS Pseudo-range Noise (PRN) statistics (The GST message is used to support Receiver Autonomous Integrity Monitoring) |
| GUI     | Graphical User Interface                                                                                              |
| HRP     | Heading, Roll, Pitch                                                                                                  |
| IMU     | Inertial Measurement Unit                                                                                             |
| IP      | Internet Protocol                                                                                                     |
| LVA     | Lever Arms                                                                                                            |
| PPS     | Pulse Per Second                                                                                                      |
| PROM    | Programmable read-only memory                                                                                         |
| RTK     | Real Time Kinematic                                                                                                   |
| SD      | Standard Deviation                                                                                                    |
| SecLat  | Secant latitude= $1/\cosine\ latitude$                                                                                |
| UTC     | International acronym for Coordinated Universal Time (CUT)                                                            |
| UTM     | Universal Transverse Mercator                                                                                         |
| VTG     | Vector Track and speed over Ground                                                                                    |
| ZDA     | Time and Date (The ZDA message identifies UTC time, day, month, and year, local zone number, and local zone minutes)  |
| ZUPT    | Zero velocity UPdaTe                                                                                                  |

# Table of Contents

|          |                                                                           |           |
|----------|---------------------------------------------------------------------------|-----------|
| <b>1</b> | <b>CONVENTIONS</b>                                                        | <b>14</b> |
| 1.1      | TIME MANAGEMENT                                                           | 14        |
| 1.2      | ALTITUDE MANAGEMENT                                                       | 14        |
| 1.3      | REFERENCE FRAME NOTATIONS                                                 | 16        |
| 1.4      | GNSS QUALITY INDICATOR MANAGEMENT AT INPUT AND OUTPUT OF PHINS COMPACT C7 | 17        |
| 1.5      | PRESSURE TO DEPTH CONVERSION FORMULA                                      | 18        |
| 1.6      | SOUND VELOCITY CONVERSION FORMULA                                         | 19        |
| <b>2</b> | <b>LIST OF THE DATA PROVIDED BY PHINS COMPACT C7</b>                      | <b>22</b> |
| <b>3</b> | <b>INPUT NMEA FRAME DEFINITION</b>                                        | <b>26</b> |
| 3.1      | INPUT TELEGRAM CONVENTIONS                                                | 26        |
| 3.2      | STANDARD NMEA TELEGRAMS                                                   | 27        |
| 3.2.1    | \$--GGA Frame                                                             | 27        |
| 3.2.2    | \$--GLL Frame                                                             | 28        |
| 3.2.3    | \$--GST Frame                                                             | 28        |
| 3.2.4    | \$--RMC Frame                                                             | 29        |
| 3.2.5    | \$--VBW Frame                                                             | 30        |
| 3.2.6    | \$--VHW Frame                                                             | 30        |
| 3.2.7    | \$--ZDA Frame                                                             | 31        |
| 3.3      | NON-STANDARD NMEA OR ASCII TELEGRAMS                                      | 31        |
| 3.3.1    | UTC Frame                                                                 | 31        |
| <b>4</b> | <b>OUTPUT NMEA FRAME DEFINITION</b>                                       | <b>32</b> |
| 4.1      | STANDARD OUTPUT NMEA TELEGRAMS                                            | 32        |
| 4.1.1    | \$GPGGA Frame                                                             | 32        |
| 4.1.2    | \$GPGLL Frame                                                             | 33        |
| 4.1.3    | \$GPGST Frame                                                             | 33        |
| 4.1.4    | \$GPVTG Frame                                                             | 34        |
| 4.1.5    | \$GPZDA and \$PHZDA Frame                                                 | 34        |
| 4.1.6    | \$HEALF Frame                                                             | 35        |
| 4.1.7    | \$HEHDT Frame                                                             | 36        |
| 4.1.8    | \$HETHS Frame                                                             | 36        |
| 4.2      | NON-STANDARD NMEA OR ASCII TELEGRAMS                                      | 37        |
| 4.2.1    | \$PHCMP Frame                                                             | 37        |
| 4.2.2    | \$PHGGA Frame                                                             | 37        |
| 4.2.3    | \$PHHRP Frame                                                             | 38        |
| 4.2.4    | \$PHINF Frame                                                             | 38        |
| 4.2.5    | \$PHLIN Frame                                                             | 38        |
| 4.2.6    | \$PHPOS Frame                                                             | 39        |
| 4.2.7    | \$PHROT Frame                                                             | 39        |
| 4.2.8    | \$PHSPD Frame                                                             | 39        |
| 4.2.9    | \$PHTRO Frame                                                             | 39        |
| 4.2.10   | \$PHVIT Frame                                                             | 40        |
| 4.2.11   | \$PHVTG Frame                                                             | 40        |
| 4.2.12   | \$STALG Frame                                                             | 40        |
| 4.2.13   | \$STSOR Frame                                                             | 41        |
| 4.2.14   | \$STSYS Frame                                                             | 41        |
| 4.2.15   | \$TIME_ Frame                                                             | 41        |

|            |                                                    |            |
|------------|----------------------------------------------------|------------|
| <b>5</b>   | <b>STATUS DESCRIPTION</b>                          | <b>42</b>  |
| <b>5.1</b> | <b>STATUS OVERVIEW</b>                             | <b>43</b>  |
| <b>5.2</b> | <b>SENSOR STATUS</b>                               | <b>44</b>  |
| 5.2.1      | Low-level Sensor Status 1 Description              | 44         |
| 5.2.2      | High-level Sensor Status 2 Description             | 45         |
| <b>5.3</b> | <b>ALGORITHM STATUS</b>                            | <b>47</b>  |
| 5.3.1      | Algorithm Status 1 Description                     | 47         |
| 5.3.2      | Algorithm Status 2 Description                     | 48         |
| 5.3.3      | Algorithm Status 3 Description                     | 49         |
| 5.3.4      | Algorithm Status 4 Description                     | 51         |
| 5.3.5      | Algorithm Status 5 Description                     | 52         |
| 5.3.6      | Algorithm Status 6 Description                     | 53         |
| <b>5.4</b> | <b>SYSTEM STATUS</b>                               | <b>54</b>  |
| 5.4.1      | System Status 1 Description                        | 54         |
| 5.4.2      | System Status 2                                    | 55         |
| 5.4.3      | System Status 3                                    | 56         |
| 5.4.4      | System Status 4                                    | 58         |
| <b>5.5</b> | <b>USER STATUS</b>                                 | <b>59</b>  |
| <b>5.6</b> | <b>HIGH-LEVEL STATUS</b>                           | <b>61</b>  |
| <b>6</b>   | <b>DIGITAL PROTOCOLS</b>                           | <b>63</b>  |
| <b>6.1</b> | <b>DETAILED SPECIFICATION OF INPUT PROTOCOLS</b>   | <b>64</b>  |
|            | APOS PSIMLBP                                       | 64         |
|            | APOS PSIMSSB                                       | 66         |
|            | AUVG3000                                           | 69         |
|            | GAPS                                               | 71         |
|            | GPS (GNSS)                                         | 74         |
|            | HALLIBURTON SAS                                    | 75         |
|            | IXBLUE STD BIN V2, V3                              | 77         |
|            | IXSEA USBL INS1                                    | 78         |
|            | MICRO SVT_P                                        | 81         |
|            | MINISVS                                            | 82         |
|            | NORTEK DF21/DF22                                   | 83         |
|            | PAROSCIENTIFIC                                     | 87         |
|            | POSIDONIA                                          | 88         |
|            | PRESSURE SENSOR                                    | 89         |
|            | RAMSES POSTPRO                                     | 90         |
|            | RDI PD0                                            | 94         |
|            | RDI PD3 and RDI PD3 RT                             | 102        |
|            | RDI PD4                                            | 105        |
|            | RDI PD6                                            | 108        |
|            | SBE 49                                             | 111        |
|            | SVX2                                               | 112        |
|            | TERPS8000                                          | 114        |
|            | USBL BOX POSTPRO                                   | 115        |
|            | USBL LBL CTD                                       | 117        |
| <b>6.2</b> | <b>DETAILED SPECIFICATIONS OF OUTPUT PROTOCOLS</b> | <b>119</b> |
|            | AIPOV                                              | 119        |
|            | AUVG3000                                           | 122        |

|                                                                |            |
|----------------------------------------------------------------|------------|
| BROADCAST FROM PORT X .....                                    | 124        |
| CONTROL .....                                                  | 125        |
| CONTROL NO G .....                                             | 126        |
| DORADO .....                                                   | 127        |
| DORADO 2 .....                                                 | 129        |
| EVENT MARKER .....                                             | 130        |
| GAPS BIN .....                                                 | 131        |
| GPS LIKE .....                                                 | 135        |
| GYROCOMPASS .....                                              | 138        |
| GYROCOMPASS 2 .....                                            | 139        |
| HALLIBURTON SAS .....                                          | 140        |
| HEHDT HEROT .....                                              | 143        |
| HETHS HEROT .....                                              | 144        |
| IMU ASCII .....                                                | 145        |
| IMU BINARY .....                                               | 146        |
| IMU RAW DATA .....                                             | 147        |
| IXBLUE STD BIN V2, V3 .....                                    | 149        |
| IXSEA TAH .....                                                | 170        |
| LONG BINARY NAV .....                                          | 172        |
| MDL2 .....                                                     | 174        |
| NAV BHO .....                                                  | 175        |
| NAV BHO LONG .....                                             | 177        |
| NAV BINARY .....                                               | 179        |
| NAV BINARY 1 .....                                             | 181        |
| NAVIGATION .....                                               | 184        |
| OCTANS STANDARD .....                                          | 185        |
| PHINS STANDARD .....                                           | 186        |
| POSTPROCESSING .....                                           | 194        |
| PRDID .....                                                    | 195        |
| PRDID TSS .....                                                | 196        |
| PRECISE ZDA .....                                              | 197        |
| <b>7 PULSES INTERFACES .....</b>                               | <b>198</b> |
| 7.1 TIME/PPS INPUT CONSTRAINTS .....                           | 199        |
| 7.2 INPUT PULSES FUNCTIONAL SPECIFICATION .....                | 199        |
| <b>8 CONTROL COMMAND DESCRIPTION .....</b>                     | <b>201</b> |
| 8.1 GENERAL CONVENTIONS .....                                  | 201        |
| 8.1.1 Command Syntax .....                                     | 201        |
| 8.1.2 How to Send and Receive Commands .....                   | 202        |
| 8.1.3 NMEA Checksum Web Page .....                             | 202        |
| 8.2 GENERAL SYSTEM CONFIGURATION .....                         | 204        |
| 8.2.1 User Mode .....                                          | 204        |
| 8.2.2 Save to EEPROM .....                                     | 204        |
| 8.2.3 Software System Reboot .....                             | 204        |
| 8.2.4 Reset to factory MPC parameters .....                    | 205        |
| 8.2.5 Web-Based Graphical User Interface Passwords Reset ..... | 205        |
| 8.2.6 System Errors Log Reset .....                            | 205        |
| 8.2.7 Internal Datalogger Management .....                     | 205        |
| 8.2.8 Initial Position .....                                   | 207        |

|            |                                                                        |            |
|------------|------------------------------------------------------------------------|------------|
| 8.2.9      | Manual UTM Position .....                                              | 207        |
| 8.2.10     | Manual Attitude .....                                                  | 208        |
| 8.2.11     | Heading, roll and pitch fine misalignments .....                       | 208        |
| 8.2.12     | Axis Orientation .....                                                 | 209        |
| 8.2.13     | Main Lever Arms .....                                                  | 211        |
| 8.2.14     | Secondary Lever Arms .....                                             | 211        |
| 8.2.15     | Center of Gravity Position .....                                       | 212        |
| 8.2.16     | Zero Velocity Update .....                                             | 212        |
| 8.2.17     | Turn on/off DVL Calibration Mode .....                                 | 214        |
| 8.2.18     | Turn ON/OFF DVL Calibration Check Mode .....                           | 215        |
| 8.2.19     | Starting Mode .....                                                    | 215        |
| 8.2.20     | Altitude Calculation Mode .....                                        | 215        |
| 8.2.21     | Heave Parameters .....                                                 | 216        |
| 8.2.22     | UTM Zone Mode .....                                                    | 216        |
| 8.2.23     | Geoidal Separation .....                                               | 217        |
| 8.2.24     | Advanced Filtering Setup .....                                         | 217        |
| 8.2.24.1   | <i>Setup Activation</i> .....                                          | 217        |
| 8.2.24.2   | <i>GNSS and USBL min/max input standard deviation thresholds</i> ..... | 218        |
| 8.2.24.3   | <i>Input Standard Deviation</i> .....                                  | 220        |
| 8.2.24.4   | <i>Advanced Position Priority</i> .....                                | 221        |
| 8.2.24.5   | <i>Advanced GNSS Input/Output Mode</i> .....                           | 221        |
| <b>8.3</b> | <b>EXTERNAL SENSOR CONFIGURATION .....</b>                             | <b>223</b> |
| 8.3.1      | DVL Configuration .....                                                | 223        |
| 8.3.1.1    | <i>Lever Arm</i> .....                                                 | 223        |
| 8.3.1.2    | <i>DVL calibration (misalignments and scale factor)</i> .....          | 223        |
| 8.3.1.3    | <i>DVL Interface</i> .....                                             | 225        |
| 8.3.1.4    | <i>Sound velocity compensation</i> .....                               | 225        |
| 8.3.1.5    | <i>Rejection Filter configuration for Bottom Track</i> .....           | 226        |
| 8.3.1.6    | <i>Rejection Filter configuration for Water Track</i> .....            | 226        |
| 8.3.1.7    | <i>Coupling Mode</i> .....                                             | 226        |
| 8.3.1.8    | <i>DVL Type</i> .....                                                  | 227        |
| 8.3.2      | DVL2 Configuration .....                                               | 227        |
| 8.3.2.1    | <i>Lever Arm</i> .....                                                 | 227        |
| 8.3.2.2    | <i>DVL2 calibration (misalignments and scale factor)</i> .....         | 227        |
| 8.3.2.3    | <i>DVL2 Interface</i> .....                                            | 229        |
| 8.3.2.4    | <i>Rejection Filter configuration for Bottom Track</i> .....           | 229        |
| 8.3.2.5    | <i>Rejection Filter configuration for Water Track</i> .....            | 230        |
| 8.3.2.6    | <i>Coupling Mode</i> .....                                             | 230        |
| 8.3.2.7    | <i>DVL Type</i> .....                                                  | 230        |
| 8.3.3      | DVL Command .....                                                      | 231        |
| 8.3.4      | EM Log Configuration .....                                             | 232        |
| 8.3.4.1    | <i>EM Log Lever Arm</i> .....                                          | 232        |
| 8.3.4.2    | <i>EM Log Interface</i> .....                                          | 232        |
| 8.3.4.3    | <i>EM Log Rejection Filter</i> .....                                   | 233        |
| 8.3.5      | GNSS Configuration .....                                               | 234        |
| 8.3.5.1    | <i>GNSS Lever Arm</i> .....                                            | 234        |
| 8.3.5.2    | <i>GNSS Interface</i> .....                                            | 234        |
| 8.3.5.3    | <i>GNSS Rejection Filter</i> .....                                     | 235        |
| 8.3.6      | GNSS2 Configuration .....                                              | 235        |

|            |                                                           |            |
|------------|-----------------------------------------------------------|------------|
| 8.3.6.1    | GNSS2 Lever Arm .....                                     | 235        |
| 8.3.6.2    | GNSS2 Interface .....                                     | 236        |
| 8.3.6.3    | GNSS2 Rejection Filter .....                              | 236        |
| 8.3.7      | Manual GNSS Configuration .....                           | 237        |
| 8.3.7.1    | Manual GNSS Lever Arm .....                               | 237        |
| 8.3.7.2    | Manual GNSS Rejection Filter .....                        | 237        |
| 8.3.7.3    | Manual GNSS Position Fix .....                            | 238        |
| 8.3.8      | Depth Sensor Configuration .....                          | 239        |
| 8.3.8.1    | Depth Lever Arm .....                                     | 239        |
| 8.3.8.2    | Depth Sensor Offset .....                                 | 239        |
| 8.3.8.3    | Zero Depth Sensor .....                                   | 239        |
| 8.3.8.4    | Depth Sensor Interface .....                              | 240        |
| 8.3.8.5    | Rejection Filter Mode for Depth Sensor .....              | 240        |
| 8.3.9      | USBL Configuration .....                                  | 241        |
| 8.3.9.1    | USBL Lever Arm .....                                      | 241        |
| 8.3.9.2    | USBL Interface .....                                      | 241        |
| 8.3.9.3    | USBL Rejection Filter Mode .....                          | 242        |
| 8.3.9.4    | USBL Beacon Watch Selection .....                         | 242        |
| 8.3.9.5    | Maximum Number of USBL Beacon .....                       | 242        |
| 8.3.10     | LBL Configuration .....                                   | 243        |
| 8.3.10.1   | LBL Lever Arm .....                                       | 243        |
| 8.3.10.2   | LBL Interface .....                                       | 243        |
| 8.3.10.3   | LBL Rejection Filter Mode .....                           | 244        |
| 8.3.11     | UTC (time synchronization) interface .....                | 244        |
| 8.3.12     | UTC2 (time synchronization) interface .....               | 245        |
| <b>8.4</b> | <b>INTERFACES CONFIGURATION .....</b>                     | <b>246</b> |
| 8.4.1      | Port Mapping .....                                        | 246        |
| 8.4.2      | Serial and Ethernet Commands .....                        | 246        |
| 8.4.2.1    | Serial I/O general parameters (parity and stop bit) ..... | 246        |
| 8.4.2.2    | Serial/Ethernet input port configuration .....            | 247        |
| 8.4.2.3    | Serial/Ethernet output port configuration .....           | 250        |
| 8.4.2.4    | Output port protocol datablock configuration .....        | 256        |
| 8.4.2.5    | Output Data Convention .....                              | 257        |
| 8.4.2.6    | Output Device Selection .....                             | 258        |
| 8.4.2.7    | Input Device Selection .....                              | 258        |
| 8.4.2.8    | Port Forwarding Command .....                             | 259        |
| 8.4.3      | Ethernet Configuration .....                              | 260        |
| 8.4.3.1    | Network Setup Command .....                               | 260        |
| 8.4.3.2    | Ethernet Output Configuration .....                       | 260        |
| 8.4.3.3    | IP Input Configuration .....                              | 261        |
| 8.4.4      | NTP Configuration .....                                   | 261        |
| 8.4.5      | SSDP Management .....                                     | 262        |
| 8.4.6      | Pulses Interface .....                                    | 262        |
| 8.4.6.1    | Pulses Input Configuration .....                          | 262        |
| 8.4.6.2    | Pulses Input Association .....                            | 263        |
| <b>8.5</b> | <b>DYNAMIC STRING RETRIEVE COMMANDS .....</b>             | <b>264</b> |
| 8.5.1      | Generic text retrieve command .....                       | 264        |
| 8.5.2      | Specific text retrieve command .....                      | 267        |

|          |                                                 |            |
|----------|-------------------------------------------------|------------|
| <b>A</b> | <b>APPENDIX A: QUATERNION DEFINITIONS .....</b> | <b>269</b> |
|----------|-------------------------------------------------|------------|

# 1 Conventions

---

For position data conventions, refer to Phins Compact C7 Installation & Setup Guide.

## 1.1 Time Management

Phins Compact C7 typical time management is to synchronize with the GNSS time.

If GNSS is not at all available or UTC not configured, Phins Compact C7 starts per default on the 1st January 2006 and relies on its internal clock to maintain time.

Otherwise the date is maintained on the GNSS time as soon as the GNSS time is received. If GNSS is received and then lost for a period of time, Phins Compact C7 will maintain time based on its internal clock and will jump to the GNSS time as soon as this one is recovered.

If Phins Compact C7 is synchronized with the GNSS time, the data time tags in the output telegrams are the UTC; otherwise they are Phins Compact C7 one (i.e., the time since power-up of the system).

To achieve this, you need to associate the UTC input to the GNSS input (refer to the Phins Compact C7 Installation & Setup Guide).

**Note:** To improve time synchronization accuracy it is recommended to input into Phins Compact C7 a PPS pulse from the GNSS.

## 1.2 Altitude Management

A dedicated mechanism is used to manage the altitude in the navigation algorithm:

- An altitude loop is in charge of estimating the current altitude based on measured accelerations, current attitude and external altitude control value
- This altitude estimation is provided to the Kalman filter together with altitude sensor input to estimate internal sensor biases and validate / reject the external altitude sensor input to determine altitude control value

The altitude loop computation is done by projecting accelerometers to local vertical axis using gyros, to determine the vertical acceleration which is used to compute vertical speed and altitude by first and double integration with respect to sampling time. This altitude is merged with altitude control value to provide best estimation of current altitude.

When no external altitude sensor is present for some time, the altitude loop switches to a “degraded mode” where the altitude output is stabilized using last altitude control value and associated standard deviation. After 600s without any altitude sensor, the loop switches into “safe mode” where the altitude output is set to last altitude output when the sensor was lost. In this mode, the altitude will jump to the external sensor value when recovered.

Depending on selected mode, the algorithm will use the appropriate sensor to stabilize the altitude loop:

- In **Depth** mode, the altitude loop and Kalman filter will use depth sensor when available and USBL Z information otherwise.
- In **GNSS** mode, the altitude loop will use the most precise information coming from GNSS1, GNSS2 or manual GNSS altitude input. If a vertical speed is present, it will also be used in the Kalman filter.

- In **Hydro** mode, the altitude loop and the Kalman filter will use the most precise altitude information coming from GNSS1 or GNSS2 only in RTK mode. If no RTK is available, the altitude loop switches to “degraded mode”.
- In **Stabilization** mode, the altitude loop will maintain the altitude around the initial altitude entered in initial position at boot time, or current altitude when this mode is selected during the mission.

The altitude will be referenced either to Mean Sea Level (Geoïd), or to WGS84 Ellipsoid, depending on what was selected in the output protocol altitude reference parameter. The offset between Geoïd and Ellipsoid is set to 0 at boot time and is then updated with information coming from the GNSS. If no GNSS is ever received, this will stay to 0 (no Geoïd map embedded in the Phins Compact C7).

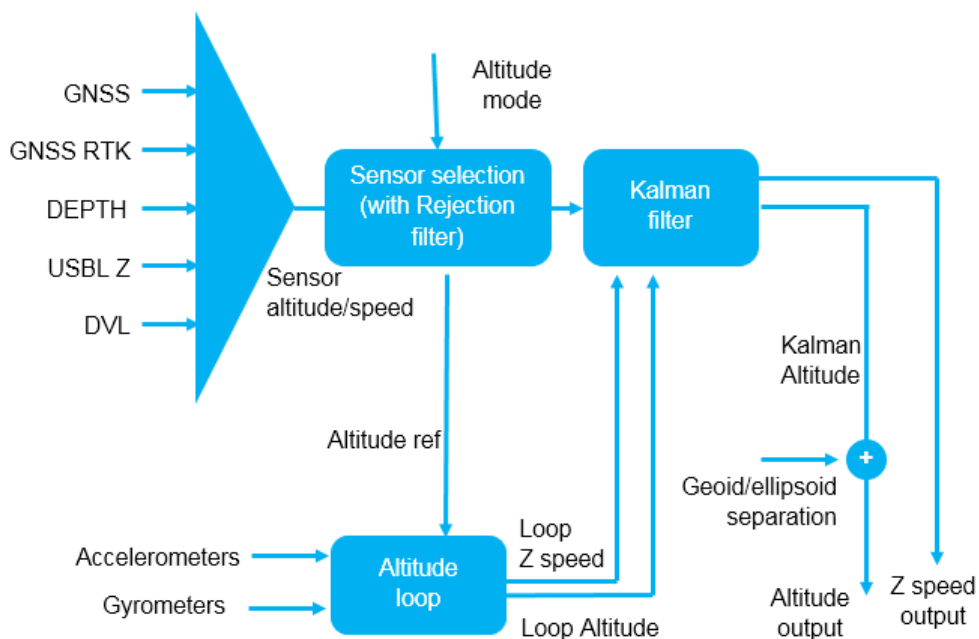


Figure 1 - Altitude loop diagram

## 1.3 Reference Frame Notations

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

- $\underline{X}_{V1}$ ,  $\underline{X}_{V2}$ ,  $\underline{X}_{V3}$ : Subsea vehicle frame:  $\underline{X}_{V1}$  (forward),  $\underline{X}_{V2}$  (left),  $\underline{X}_{V3}$  (up).
- $\underline{X}_{VH1}$ ,  $\underline{X}_{VH2}$ ,  $\underline{X}_{VH3}$ : Subsea vehicle horizontal frame; Subsea vehicle frame compensated from roll and pitch.
- $\underline{X}_1$ ,  $\underline{X}_2$ ,  $\underline{X}_3$ : Phins Compact C7 body frame;  $\underline{X}_1$  (forward),  $\underline{X}_2$  (left),  $\underline{X}_3$  (up). Refer to the Phins Compact C7 Installation & Setup Guide for convention description.
- $\underline{X}_{1IMU}$ ,  $\underline{X}_{2IMU}$ ,  $\underline{X}_{3IMU}$ : IMU reference frame or internal sensor bloc frame;  $\underline{X}_{1IMU}$  (forward),  $\underline{X}_{2IMU}$  (left),  $\underline{X}_{3IMU}$  (up).
- $\underline{X}_{North}$ ,  $\underline{X}_{East}$ ,  $\underline{X}_{Down}$ : local geographical frame.
- $\underline{X}_{S1}$ ,  $\underline{X}_{S2}$ ,  $\underline{X}_{S3}$ : external sensor body frame:  $\underline{X}_{S1}$  (forward),  $\underline{X}_{S2}$  (left),  $\underline{X}_{S3}$  (up). Sign convention is described in each protocol.
- **Rotation rates convention:** " $\underline{X}_{Vi}$  ( $i=1, 2, 3$ ) rotation rate" is the rotation rate in the inertial frame. The data is not compensated for earth rotation ( $15.04^\circ/h$ ) or craft rate. The rotation rate is positive when the rotation vector is pointing in  $\underline{X}_{Vi}$  ( $i=1, 2, 3$ ) direction. Assuming that a right-handed corkscrew is oriented along the considered axis and that the screw is rotated to move in the positive direction, the positive direction of rotation is the same as the direction of rotation of the screw.. "
- **Acceleration convention:** " $\underline{X}_{Vi}$  ( $i=1, 2, 3$ ) acceleration" is positive when the acceleration vector is pointing in  $\underline{X}_{Vi}$  ( $i=1, 2, 3$ ) direction. Accelerations are compensated from gravity unless specified in the protocol (i.e.: CONTROL protocol).

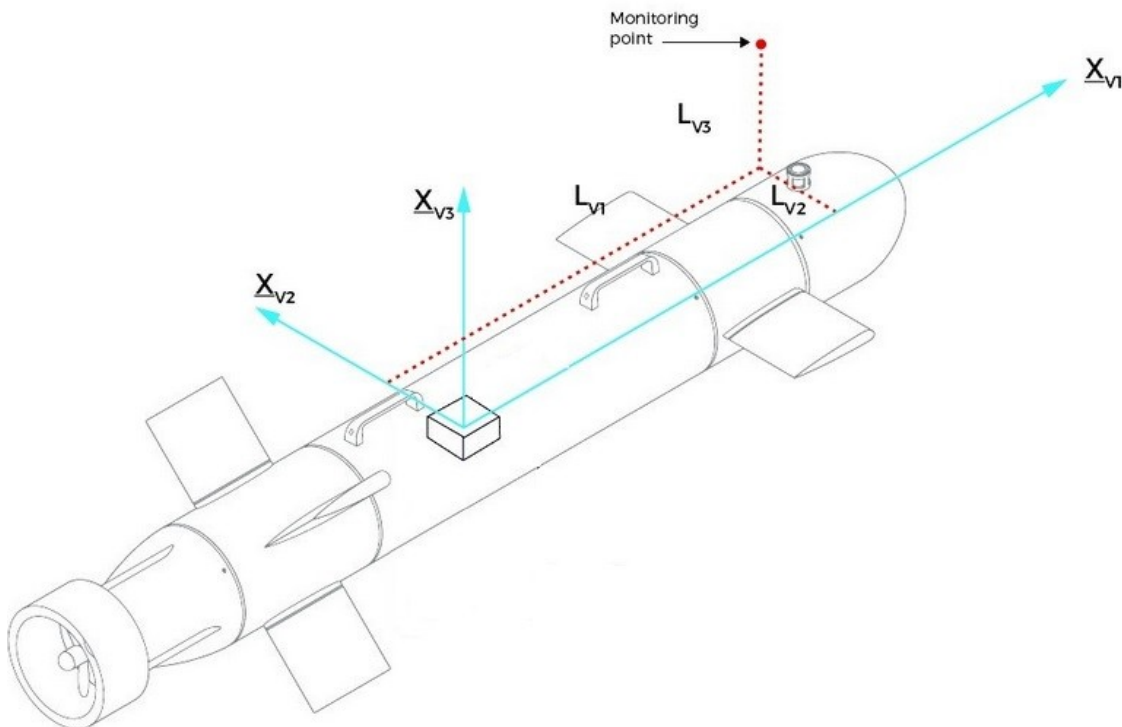


Figure 2 - Vehicle, System and Sensor reference frame

## 1.4 GNSS Quality Indicator Management at Input and Output of Phins Compact C7

### For INPUT data:

When Phins Compact C7 receives GGA only (no GST), Phins Compact C7 will associate the standard deviation to the GNSS position according to each Q factor as per the following table. If GST is available, GST standard deviation will be used instead.

| Q factor in \$--GGA | Quality      | Associated SD to GNSS 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:

Phins Compact C7 does not copy the quality indicator received on GGA input to GGA output. It estimates the quality factor corresponding to the standard deviation associated with the Phins Compact C7 position data.

When GPS LIKE telegram is output from Phins Compact C7 the following correspondence table is applied.

| 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 Phins Compact C7 SD is the horizontal dilution of precision (HDOP) calculated from Phins Compact C7 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.

## 1.5 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/s<sup>2</sup>) is calculated as follows:

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

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 Phins Compact C7.

## 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 :

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

$$R_t = \frac{R}{R_p \cdot r_t}$$

$$r_t = c_0 + c_1 t + c_2 t^2 + c_3 t^3 + c_4 t^4$$

$$R_p = \frac{p(e_1 + e_2 p + e_3 p^2)}{1 + d_1 t + d_2 t^2 + (d_3 + d_4 t)R} + 1$$

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

$S$  = salinity in Practical Salinity Units (psu)

**Table 1 - Table of Coefficients**

| Coefficients | Numerical values | Coefficients | Numerical values |
|--------------|------------------|--------------|------------------|
| a0           | + 0.0080         | b0           | +0.0005          |
| a1           | - 0.1692         | b1           | -0.0056          |
| a2           | + 25.3851        | b2           | -0.0066          |
| a3           | +14.0941         | b3           | -0.0375          |
| a4           | - 7.0261         | b4           | +0.0636          |
| a5           | +2.7081          | b5           | -0.0144          |
| c0           | +0.6766097       | d1           | +3.426E-2        |
| c1           | +2.00564E-2      | d2           | +4.464E-4        |
| c2           | +1.104259E-4     | d3           | +4.215E-1        |
| c3           | -6.9698E-7       | d4           | -3.107E-3        |
| c4           | +1.0031E-9       | e1           | +2.070E-5        |
| e2           | -6.370E-10       | e3           | + 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:

|              |                                                                        |
|--------------|------------------------------------------------------------------------|
| $c(S,T,P) =$ | $C_w(T,P) + A(T,P)S + B(T,P)S^{3/2} + D(T,P)S^2$                       |
| $C_w(T,P) =$ | $(C_{00} + C_{01}T + C_{02}T^2 + C_{03}T^3 + C_{04}T^4 + C_{05}T^5) +$ |
|              | $(C_{10} + C_{11}T + C_{12}T^2 + C_{13}T^3 + C_{14}T^4)P +$            |
|              | $(C_{20} + C_{21}T + C_{22}T^2 + C_{23}T^3 + C_{24}T^4)P^2 +$          |
|              | $(C_{30} + C_{31}T + C_{32}T^2)P^3$                                    |
| $A(T,P) =$   | $(A_{00} + A_{01}T + A_{02}T^2 + A_{03}T^3 + A_{04}T^4) +$             |
|              | $(A_{10} + A_{11}T + A_{12}T^2 + A_{13}T^3 + A_{14}T^4)P +$            |
|              | $(A_{20} + A_{21}T + A_{22}T^2 + A_{23}T^3)P^2 +$                      |
|              | $(A_{30} + A_{31}T + A_{32}T^2)P^3$                                    |
| $B(T,P) =$   | $B_{00} + B_{01}T + (B_{10} + B_{11}T)P$                               |
| $D(T,P) =$   | $D_{00} + D_{10}P$                                                     |

**Table 2 - Table of coefficients**

| Coefficients | Numerical values | Coefficients | Numerical values |
|--------------|------------------|--------------|------------------|
| C00          | +1402.388        | A02          | 7.164E-5         |
| C01          | +5.03711         | A03          | 2.006E-6         |
| C02          | -5.80852E-2      | A04          | -3.21E-8         |
| C03          | 3.3420E-4        | A10          | 9.4742E-5        |
| C04          | -1.47800E-6      | A11          | -1.2580E-5       |
| C05          | 3.1464E-9        | A12          | -6.4885E-8       |
| C10          | 0.153563         | A13          | 1.0507E-8        |
| C11          | 6.8982E-4        | A14          | -2.0122E-10      |
| C12          | -8.1788E-6       | A20          | -3.9064E-7       |
| C13          | 1.3621E-7        | A21          | 9.1041E-9        |
| C14          | -6.1185E-10      | A22          | -1.6002E-10      |
| C20          | 3.1260E-5        | A23          | 7.988E-12        |
| C21          | -1.7107E-6       | A30          | 1.100E-10        |
| C22          | 2.5974E-8        | A31          | 6.649E-12        |
| 23           | -2.5335E-10      | A32          | -3.389E-13       |

| Coefficients | Numerical values | Coefficients | Numerical values |
|--------------|------------------|--------------|------------------|
| C24          | 1.0405E-12       | B00          | -1.922E-2        |
| C30          | -9.7729E-9       | B01          | -4.42E-5         |
| C31          | 3.8504E-10       | B10          | 7.3637E-5        |
| C32          | -2.3643E-12      | B11          | 1.7945E-7        |
| A00          | 1.389            | D00          | 1.727E-3         |
| A01          | -1.262E-2        | D10          | -7.9836E-6       |

Some values are provided for checking the correct use of above equations by Phins Compact C7.

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.cccc)

SVEL is the value of the Sound Velocity computed and used by Phins Compact C7.

## 2 List of the Data Provided by Phins Compact C7

Table 3 - Navigation data provided by Phins Compact C7

| NAVIGATION DATA                |                  |           |             |                                                                                                           |
|--------------------------------|------------------|-----------|-------------|-----------------------------------------------------------------------------------------------------------|
| Position Data                  | Unit             | Min value | Max value   | Convention                                                                                                |
| Latitude                       | Degree           | -90       | 90          | positive in northern hemisphere                                                                           |
| Longitude                      |                  | 0         | 360         | increasing eastwards                                                                                      |
| Altitude                       | Meter            | NA        | 4,000       | Altitude above sea level (Geoïd) or Ellipsoid WGS84                                                       |
| UTM North                      |                  | 0         | 10,000,000  | WGS84                                                                                                     |
| UTM East                       |                  | 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        | 41.667      | Note:<br>41.667 m/s ~150 km/h~81 knot                                                                     |
| Speed west                     |                  |           |             |                                                                                                           |
| Speed up                       |                  |           |             |                                                                                                           |
| Heading and attitude data      | Unit             | Min value | Max value   | Convention used                                                                                           |
| Heading                        | Degree           | 0         | 360         | To switch from Subsea vehicle to navigation frame, the order of rotations is roll then pitch then heading |
| Roll                           |                  | -180      | 180         |                                                                                                           |
| Pitch                          |                  | -90       | 90          |                                                                                                           |
| Rotation and acceleration data | Unit             | Min value | Max value   | Convention used                                                                                           |
| X1 rotation rate               | Degree/second    | -180      | 180         | Resolution is limited to 0.001°/s (3.6°/h) to comply with export regulations.                             |
| X2 rotation rate               |                  |           |             |                                                                                                           |
| X3 rotation rate               |                  |           |             |                                                                                                           |
| X1 linear acceleration         | m/s <sup>2</sup> | -180      | 180         | Resolution is limited to 9.81 10 <sup>-3</sup> m/s <sup>2</sup> (1mg) to comply with export regulations.  |
| X2 linear acceleration         |                  |           |             |                                                                                                           |
| X3 linear acceleration         |                  |           |             |                                                                                                           |
| Motion sensing data            | Unit             | Min value | Max value   | Convention                                                                                                |
| Heave                          | Meter            | NA        | NA          | Heave measured along local vertical                                                                       |
| Surge                          |                  |           |             |                                                                                                           |
| Sway                           |                  |           |             |                                                                                                           |
| Time                           | Unit             | Min value | Max value   | Convention                                                                                                |
| Time                           | hh/mm/ss         | 0         | 23/59/59.99 |                                                                                                           |

Table 4 - Standard deviation data provided by Phins Compact C7

| 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 5 - External sensor data provided by Phins Compact C7

| EXTERNAL SENSOR DATA    |                    |                                 |
|-------------------------|--------------------|---------------------------------|
| 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 |                                 |
| 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 |                                                                              |
| <b>Speed water track data</b>     | <b>Unit</b>        | <b>Convention used</b>                                                       |
| Speed X                           | meter/second       | Speed with respect to water layer in Log Sensor frame X, Y, Z (body or beam) |
| Speed Y                           |                    |                                                                              |
| Speed Z                           |                    |                                                                              |
| <b>Sound velocity sensor data</b> | <b>Unit</b>        | <b>Convention used</b>                                                       |
| Sound velocity                    | Meter/second       | From external CTD or SVP sensor                                              |
| Depth sensor data                 | Unit               | Convention used                                                              |
| Depth                             | Meter              | Depth from local sea level                                                   |
| <b>USBL data</b>                  | <b>Unit</b>        | <b>Convention</b>                                                            |
| Latitude                          | degree             |                                                                              |
| Longitude                         | degree             |                                                                              |
| Altitude                          | meter              |                                                                              |
| Latency                           | second             | Latency of USBL data (>0)                                                    |
| Last update                       | hour/minute/second |                                                                              |
| <b>LBL data</b>                   | <b>Unit</b>        | <b>Convention</b>                                                            |
| Beacon latitude                   | degree             |                                                                              |
| Beacon longitude                  | degree             |                                                                              |
| Beacon altitude                   | meter              |                                                                              |
| range                             | Meter              |                                                                              |
| Last update                       | hour/minute/second |                                                                              |
| <b>EM Log data</b>                | <b>Unit</b>        | <b>Convention</b>                                                            |
| Speed module                      | Meters/second      |                                                                              |
| Speed of North current            | Meters/second      |                                                                              |
| Speed of East current             | Meters/second      |                                                                              |
| Last update                       | hour/minute/second |                                                                              |
| <b>CTD data</b>                   | <b>Unit</b>        | <b>Convention</b>                                                            |

|             |               |  |
|-------------|---------------|--|
| Sound speed | Meters/second |  |
|-------------|---------------|--|

## 3 Input NMEA Frame Definition

---

This section described all NMEA 0183 frames being common in several inputs protocols. Refer to the chapter 6 to know exactly which frames are decoded by the NMEA compatible protocols.

### 3.1 Input telegram conventions

- Following chapters detail the NMEA input frames managed by Phins Compact C7 systems. Each described field can be either:
  - > Mandatory, used: the Phins Compact C7 expects the field to be present in the frame and will reject the frame if this is not the case. Associated field is used by the Phins Compact C7 algorithm.
  - > Optional, used: the Phins Compact C7 check whether the field is present or not. If not present it is ignored without generating an error. If it is present, it will be used by the algorithm
  - > Optional, verified: the Phins Compact C7 check whether the field is present or not. If not present it is ignored without generating an error. If it is present, it will be checked to match specified value or checksum computation
  - > Optional, repeated: the Phins Compact C7 check whether the field is present or not. If not present it is ignored without generating an error. If it is present, it will be repeated as is to some output protocols (GPS LIKE for example) but it will not affect the internal algorithms.
  - > Not used: the field is ignored and not used / repeated to output protocols
- Position is taken into account in this priority sequence: \$--GGA, \$--GLL and \$--RMC telegrams. For example, if \$--GGA frames are received, \$--GLL and \$--RMC frames will be ignored until next reboot or until the input protocol is de-configured / reconfigured to GPS / NMEA input protocol.

## 3.2 Standard NMEA Telegrams

### 3.2.1 \$--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 (Note 1)                                                                                                                                                                                                                                                                                | Mandatory, used                         |
| llmm.mm                                                                         | Latitude in degrees (ll) and in minutes (mm.mm)                                                                                                                                                                                                                                                         | Mandatory, used                         |
| a                                                                               | Hemisphere<br>N: North<br>S: South                                                                                                                                                                                                                                                                      | Mandatory, used                         |
| LLLmm.mm                                                                        | Longitude in degrees (LLL) and in minutes (mm.mm)                                                                                                                                                                                                                                                       | Mandatory, used                         |
| b                                                                               | Longitude sign<br>E: East<br>W: West                                                                                                                                                                                                                                                                    | Mandatory, used                         |
| q                                                                               | GPS quality indicator (Note 2)<br>0 and ≥6 fix invalid<br>1=GPS SPS Mode, fix valid<br>2=Differential GPS, SPS Mode, fix valid<br>3= GPS PPS Mode, fix valid<br>4= RTK. Satellite system used in RTK mode with fixed integers<br>5= Float RTK. Satellite system used in RTK mode with floating integers | Mandatory, used                         |
| ss                                                                              | Number of satellites. (Note 3)                                                                                                                                                                                                                                                                          | Optional, Repeated                      |
| y.y                                                                             | Horizontal dilution of precision. (Note 3 )                                                                                                                                                                                                                                                             | Optional, Repeated                      |
| x.x                                                                             | Antenna altitude                                                                                                                                                                                                                                                                                        | Mandatory, used                         |
| M                                                                               | Units of antenna altitude (meters)                                                                                                                                                                                                                                                                      | Mandatory, verified                     |
| g.g                                                                             | Geoidal separation.                                                                                                                                                                                                                                                                                     | Optional, used                          |
| M                                                                               | Units of geoidal separation (meters)                                                                                                                                                                                                                                                                    | Optional, verified                      |
| a.a                                                                             | Age of differential GPS data.                                                                                                                                                                                                                                                                           | Not used                                |
| zzzz                                                                            | Differential reference station ID.                                                                                                                                                                                                                                                                      | Not used                                |
| hh                                                                              | NMEA checksum                                                                                                                                                                                                                                                                                           | Mandatory, used<br>(following NMEA0183) |

**Note 1 :**

Time is used by algorithm in Phins Compact C7 products.

**Note 2:** If no GST string is received, the quality factor in GGA telegram is interpreted by the firmware. Refer to section 1.

**Note 3:** Data read and transmitted to certain output telegrams. The data is not used by the algorithm.

### 3.2.2 \$--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)                                                                                                                                                                                                             | Mandatory, used                         |
| a                                                     | ASCII 'N' for North, ASCII 'S' for South                                                                                                                                                                                                                    | Mandatory, used                         |
| LLLmm.mm                                              | Longitude in degrees (LLL) and in minutes (mm.mm)                                                                                                                                                                                                           | Mandatory, used                         |
| b                                                     | ASCII 'E' for East, ASCII 'W' for West                                                                                                                                                                                                                      | Mandatory, used                         |
| hhmmss.ss                                             | UTC time of position ( <b>see chapter 1.1</b> )<br>(hh: hour on 2 digits, mm: minutes on 2 digits, ss.ss: seconds as float)                                                                                                                                 | Mandatory, used                         |
| S                                                     | Status ( <b>see chapter 1.4</b> ):<br>ASCII 'A' = data valid<br>ASCII 'V' = data invalid                                                                                                                                                                    | Mandatory, used                         |
| M                                                     | Positioning system Mode indicator ( <b>see chapter 1.4</b> ):<br>ASCII 'A' = Autonomous mode<br>ASCII 'D' = Differential mode<br>ASCII 'E' = Estimated (dead reckoning) mode<br>ASCII 'M' = Manual input mode<br>ASCII 'S' = Simulator<br>N= Data not valid | Optional, used                          |
| hh                                                    | NMEA checksum                                                                                                                                                                                                                                               | Mandatory, used<br>(following NMEA0183) |

### 3.2.3 \$--GST FRAME

| \$--GST,hhmmss.ss,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<br>(hh: hour on 2 digits, mm: minutes on 2 digits, ss.ss: seconds as float) | Mandatory, 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                                                                                   | Mandatory, used                         |
| x.x                                                             | Standard deviation of longitude error, in meters                                                                                  | Mandatory, used                         |
| x.x                                                             | Standard deviation of altitude error, in meters                                                                                   | Mandatory, used                         |
| hh                                                              | NMEA checksum                                                                                                                     | Mandatory, used<br>(following NMEA0183) |

## 3.2.4 \$--RMC FRAME

| \$--RMC,hhmmss.ss,S,llmm.mm,a,LLLmm.mm,b,x.x,x.x,ddmmyy,x.x,S,M*hh<CR><LF> |                                                                                                                                                                                                                                                                             |                                      |
|----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| hhmmss.ss                                                                  | UTC time of the RMC fix associated with this sentence.<br>(hh: hour on 2 digits, mm: minutes on 2 digits, ss.ss: seconds as float)                                                                                                                                          | Mandatory, used                      |
| S                                                                          | Status :<br>ASCII 'A' = data valid<br>ASCII 'V' = data invalid                                                                                                                                                                                                              | Mandatory, used                      |
| llmm.mm                                                                    | Latitude in degrees (ll) and in minutes (mm.mm)                                                                                                                                                                                                                             | Mandatory, used                      |
| a                                                                          | ASCII 'N' for North, ASCII 'S' for South                                                                                                                                                                                                                                    | Mandatory, used                      |
| LLLmm.mm                                                                   | Longitude in degrees (LLL) and in minutes (mm.mm)                                                                                                                                                                                                                           | Mandatory, used                      |
| b                                                                          | ASCII 'E' for East, ASCII 'W' for West                                                                                                                                                                                                                                      | Mandatory, used                      |
| x.x                                                                        | Speed over ground in knots ( <b>Note 1</b> )                                                                                                                                                                                                                                | Optional, used                       |
| x.x                                                                        | Course over ground in degrees                                                                                                                                                                                                                                               | Not used                             |
| ddmmyy                                                                     | Date                                                                                                                                                                                                                                                                        | Not used                             |
| x.x                                                                        | Magnetic variation                                                                                                                                                                                                                                                          | Not used                             |
| S                                                                          | Mode indicator :<br>ASCII 'E' = Easterly variation subtracts from True course<br>ASCII 'W' = Westerly variation adds to true course                                                                                                                                         | Not used                             |
| M                                                                          | Positioning system Mode indicator, used if present ( <b>see chapter 1.4</b> )<br>ASCII 'A' = Autonomous mode<br>ASCII 'D' = Differential mode<br>ASCII 'E' = Estimated (dead reckoning) mode<br>ASCII 'M' = Manual input mode<br>ASCII 'S' = Simulator<br>N= Data not valid | Optional, used                       |
| hh                                                                         | NMEA checksum                                                                                                                                                                                                                                                               | Mandatory, used (following NMEA0183) |

**Note 1:** Speed in RMC telegram is only used in INS algorithm.

### 3.2.5 \$--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 (XV1) water speed, in knots, '-' = astern.  | Mandatory, used                      |
| x.x                                                 | Transverse (XV2) water speed, in knots, '-' = port.      | Mandatory, used                      |
| A                                                   | Status of water speed, A=Data valid. V= data invalid     | Mandatory, used                      |
| x.x                                                 | Longitudinal (XV1) ground speed, in knots, '-' = astern. | Mandatory, used                      |
| x.x                                                 | Transverse (XV2) ground speed, in knots, '-' = port.     | Mandatory, used                      |
| A                                                   | Status of ground speed: A = data valid V = data invalid  | Mandatory, 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                                            | Mandatory, used (following NMEA0183) |

### 3.2.6 \$--VHW FRAME

| \$--VHW, x.x ,T, x.x ,M,x.x,N,x.x,K*hh<CR><LF> |                           |                                      |
|------------------------------------------------|---------------------------|--------------------------------------|
| x.x                                            | Heading, degrees true     | Not used                             |
| T                                              | True                      | Not used                             |
| x.x                                            | Heading, degrees magnetic | Not used                             |
| M                                              | Magnetic                  | Not used                             |
| x.x                                            | Speed in knots            | Mandatory, used                      |
| N                                              | Knots                     | Mandatory, verified                  |
| x.x                                            | Speed in km/h             | Not used                             |
| K                                              | Kilometers/hour           | Not used                             |
| hh                                             | NMEA checksum             | Mandatory, used (following NMEA0183) |

### 3.2.7 \$--ZDA FRAME

| \$--ZDA,hhmmss.ss,dd,mm,yyyy,hh,mm *hh <CR><LF> |                                                                                              |                                         |
|-------------------------------------------------|----------------------------------------------------------------------------------------------|-----------------------------------------|
| hhmmss.ss                                       | UTC of the last PPS (hh: hour on 2 digits, mm: minutes on 2 digits, ss.ss: seconds as float) | Mandatory, used                         |
| dd                                              | UTC day, ranging between 01 and 31                                                           | Mandatory, used                         |
| mm                                              | UTC month, ranging between 01 and 12                                                         | Mandatory, used                         |
| yyyy                                            | UTC year                                                                                     | Mandatory, used                         |
| hh                                              | Local zone hour offset from GMT, ranging from 00 through +/-13 (Note 1)                      | Optional, Repeated                      |
| mm                                              | Local zone minutes offset from GMT, ranging from 00 through 59 (Note 1)                      | Optional, Repeated                      |
| hh                                              | NMEA checksum                                                                                | Mandatory, used<br>(following NMEA0183) |

Note 1: Speed in RMC telegram is only used in “INS algorithm based” products (cf. §2) and input to algorithm as EM LOCH data.

## 3.3 Non-Standard NMEA or ASCII Telegrams

### 3.3.1 UTC FRAME

| UTC yy.mm.dd hh:mm:ss ab <CR><LF> |          |                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Where                             | UTC      | fixed text header                                                                                                                                                                                                                                                                                                         |
|                                   | yy.mm.dd | year month and day (USED)                                                                                                                                                                                                                                                                                                 |
|                                   | hh:mm:ss | UTC time not GPS time. (USED)                                                                                                                                                                                                                                                                                             |
|                                   | a        | Integer number representing the position-fix type: (cf. Note 1) (USED)<br>1 = time only<br>2 = 1D & time<br>3 = currently unused<br>4 = 2D & time<br>5 = 3D & time<br>? = no time                                                                                                                                         |
|                                   | b        | Number of GPS satellites being tracked. (NOT USED)<br>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.

## 4 Output NMEA Frame Definition

### 4.1 Standard Output NMEA Telegrams

#### 4.1.1 \$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 (hh: hour on 2 digits, mm: minutes on 2 digits, ss.ss: seconds as float) | <b>Note 2</b>          |
| LLII.IIIIIII                                                                                      | Latitude in degrees (LL) and in minutes (II.IIIIIII)                                          | <b>Note 2</b>          |
| a                                                                                                 | 'N' for Northern hemisphere, 'S' for Southern hemisphere                                      | <b>Note 2</b>          |
| LLLII.IIIIIII                                                                                     | Longitude in deg (LLL) and in minutes (II.IIIIIII)                                            | <b>Note 2</b>          |
| a                                                                                                 | 'E' for East, 'W' for West                                                                    | <b>Note 2</b>          |
| x                                                                                                 | GNSS quality indicator                                                                        | <b>see chapter 1.4</b> |
| xx                                                                                                | Number of satellites in use                                                                   | <b>Note 1</b>          |
| x.xxx                                                                                             | Horizontal dilution of precision (HDOP)                                                       | <b>Note 2</b>          |
| x.xxx                                                                                             | Antenna altitude above mean sea level (geoid) (meters)                                        | <b>Note 2</b>          |
| M                                                                                                 | Unit of antenna altitude (fixed character = 'M' for meters)                                   |                        |
| x.xxx                                                                                             | Geoidal separation                                                                            | <b>Note 1</b>          |
| M                                                                                                 | Unit of Geoidal separation (fixed character = 'M' for meters)                                 |                        |
| x.xxx                                                                                             | Age of the differential GNSS data                                                             | <b>Note 1</b>          |
| xxxx                                                                                              | Differential reference station ID                                                             | <b>Note 1</b>          |
| hh                                                                                                | NMEA checksum                                                                                 | Mandatory hex value    |

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

**Note 2:** Phins Compact C7 calculated data. Magnetic course field is set to Phins Compact C7 true course.

### 4.1.2 \$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)                                          | <b>Note 1</b>          |
| a                                                               | 'N' for Northern hemisphere, 'S' for Southern hemisphere                                      | <b>Note 1</b>          |
| LLLII.IIIIIII                                                   | Longitude in deg (LLL) and in minutes (II.IIIIIII)                                            | <b>Note 1</b>          |
| a                                                               | 'E' for East, 'W' for West                                                                    | <b>Note 1</b>          |
| hhmmss.ss                                                       | UTC time of position (hh: hour on 2 digits, mm: minutes on 2 digits, ss.ss: seconds as float) | <b>Note 1</b>          |
| a                                                               | Status 'A' for Data Valid, 'V' for Data Invalid                                               | <b>Note 2</b>          |
| m                                                               | Mode indicator 'A' or 'D' or 'E'                                                              | <b>see chapter 1.4</b> |
| hh                                                              | NMEA checksum                                                                                 | Mandatory hex value    |

**Note 1:** Phins Compact C7 calculated data. Magnetic course field is set to Phins Compact C7 true course.

**Note 2:** Data invalid for initial alignment or speed saturation (i.e. User status ALIGNMENT OR User status SPEED\_SATURATION bits set to 1).

### 4.1.3 \$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 (hh: hour on 2 digits, mm: minutes on 2 digits, ss.ss: seconds as float) | <b>Note 2</b>       |
| x.x                                                      | RMS value of the standard deviation on pseudo-ranges                              | <b>Note 1</b>       |
| x.x                                                      | Standard deviation of semi-major axis of error ellipse in meters                  | <b>Note 2</b>       |
| x.x                                                      | Standard deviation of semi-minor axis of error ellipse in meters                  | <b>Note 2</b>       |
| x.x                                                      | Orientation of semi-major axis of error ellipse                                   | <b>Note 2</b>       |
| x.x                                                      | Standard deviation of the error of Latitude in meters                             | <b>Note 2</b>       |
| x.x                                                      | Standard deviation of the error of Longitude in meters                            | <b>Note 2</b>       |
| x.x                                                      | Standard deviation of the error of Altitude                                       | <b>Note 2</b>       |
| hh                                                       | NMEA checksum                                                                     | Mandatory hex value |

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

**Note 2:** Phins Compact C7 calculated data. Magnetic course field is set to Phins Compact C7 true course.

#### 4.1.4 \$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 1              |
| T                                                    | Fixed character = 'T'                             |                     |
| x.xxx                                                | Magnetic course (deg)                             | Note 1              |
| M                                                    | Fixed character = 'M'                             |                     |
| x.xxx                                                | Speed (knots)                                     | Note 1              |
| N                                                    | Fixed character = 'N'                             |                     |
| x.xxx                                                | Speed (km/h)                                      | Note 1              |
| K                                                    | Fixed character='K'                               |                     |
| a                                                    | Positioning system mode indicator 'A', 'D' or 'E' | see chapter 1.4     |
| hh                                                   | NMEA checksum                                     | Mandatory hex value |

**Note 1:** Phins Compact C7 calculated data. Magnetic course field is set to Phins Compact C7 true course.

#### 4.1.5 \$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 Compact C7 (hh: hour on 2 digits, mm: minutes on 2 digits, ss.ss: seconds as float) | 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                                                                                         | Mandatory hex value |

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

**Note 2:** Phins Compact C7 calculated data. Magnetic course field is set to Phins Compact C7 true course.

### 4.1.6 \$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 (2012).

| \$HEALF,A,B,C,HHMMSS.SS,D,E,F,GGG,HHHHHHH,J,K,L,M--M*hh<CR><LF> |                                                                               |                                                                                                                                                                                                         |
|-----------------------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>A</b>                                                        | Total number of ALF sentences                                                 | Fixed to 1                                                                                                                                                                                              |
| <b>B</b>                                                        | Sentence number                                                               | Fixed to 1                                                                                                                                                                                              |
| <b>C</b>                                                        | Sequential message identifier                                                 | Fixed to 1                                                                                                                                                                                              |
| <b>HHMMSS.SS</b>                                                | Time (hh: hour on 2 digits, mm: minutes on 2 digits, ss.ss: seconds as float) | Time of last alert state change (UTC time if the system is synchronized in UTC, or empty otherwise) in hour, minute and seconds.[1]                                                                     |
| <b>D</b>                                                        | Alert category                                                                | Fixed to 'B' for a gyrocompass[2]                                                                                                                                                                       |
| <b>E</b>                                                        | Alert priority                                                                | Fixed to 'W' for a gyrocompass[3]                                                                                                                                                                       |
| <b>F</b>                                                        | 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 |
| <b>GGG</b>                                                      | Manufacturer mnemonic                                                         | Empty (standardized code)                                                                                                                                                                               |
| <b>HHHHHHH</b>                                                  | Alert identifier (integer, variable length)                                   | Fixed to 3062 for a gyrocompass ( <b>Note 1</b> )                                                                                                                                                       |
| <b>J</b>                                                        | Alert instance                                                                | Fixed to 1                                                                                                                                                                                              |
| <b>K</b>                                                        | 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.                                                       |
| <b>L</b>                                                        | 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.                                                                                  |
| <b>M---M</b>                                                    | Description text                                                              | Fixed to "System fault"                                                                                                                                                                                 |
| <b>hh</b>                                                       | NMEA checksum                                                                 | Mandatory hex value                                                                                                                                                                                     |

[1] See IEC 62923-1 §8.1.3.2

[2] Only category B for gyro : see 61923-1 2018 §3.1.20

[3] Only warning for gyro : see 62923-2 Table A.3

**Note 1**

Active alerts See IEC 62923-2, Annex A, Table A.3. For gyrocompass, only <System fault>, '3062' is mandatory.

**Note 2 : Alert rise conditions**

### 4.1.7 \$HEHDT FRAME

| \$HEHDT,x.x,t*hh<CR><LF> |                           |                     |
|--------------------------|---------------------------|---------------------|
| x.x                      | True heading in degrees.  | <b>Note 1</b>       |
| t                        | Fixed ASCII character 'T' |                     |
| hh                       | NMEA checksum             | Mandatory hex value |

**Note 1:**

- 2 digits after the decimal point in default mode
- 5 digits after the decimal point in full resolution
- Always 2 digits after the decimal point in case of UDP library protocol

### 4.1.8 \$HETHS FRAME

| \$HETHS,x.x,a*hh<CR><LF> |                          |                        |
|--------------------------|--------------------------|------------------------|
| x.x                      | True heading in degrees  | <b>Note 1</b>          |
| a                        | Mode indicator character | <b>see chapter 1.4</b> |
| hh                       | NMEA checksum            | Mandatory hex value    |

**Note 1:**

- 2 digits after the decimal point in default mode
- 5 digits after the decimal point in full resolution
- Always 2 digits after the decimal point if Library protocol

**Note 2:**

| Indicator mode                 | 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:<br>SIMULATION_MODE              | Medium                |
| V = Data not valid             | User status :<br>HRP_INVALID or<br>USR_ALIGNMENT | High                  |

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

## 4.2 Non-Standard NMEA or ASCII Telegrams

### 4.2.1 \$PHCMP FRAME

| \$PHCMP,IIII.II,a,x.xx,N*hh<CR><LF> |                                                                |                     |
|-------------------------------------|----------------------------------------------------------------|---------------------|
| IIII.II                             | Latitude in degrees (two first I) and in minutes (four last I) |                     |
| a                                   | 'N' for Northern hemisphere and 'S' for Southern hemisphere    |                     |
| x.xx                                | Speed Norm in knots                                            |                     |
| N                                   | Fixed character = 'N'                                          |                     |
| hh                                  | NMEA checksum                                                  | Mandatory hex value |

### 4.2.2 \$PHGGA FRAME

| \$PHGGA,hhmmss.ss,LLII.IIIIIII,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                                               |                              |
| LLII.IIIIIII                                                                                     | is the latitude in degrees (LL) and in minutes (II.IIIIIII)          | 8 digits after decimal point |
| a                                                                                                | is 'N' for Northern hemisphere, 'S' for Southern hemisphere          | 8 digits after decimal point |
| LLLII.IIIIIII                                                                                    | is the longitude in deg (LLL) and in minutes (II.IIIIIII)            |                              |
| a                                                                                                | is 'E' for East, 'W' for West                                        | 3 digits after decimal point |
| x                                                                                                | is the GNSS quality indicator                                        | 3 digits after decimal point |
| 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 product altitude)             | 3 digits after decimal point |
| M                                                                                                | is the unit of antenna altitude (fixed character = 'M' for meters)   |                              |
| x.xxx                                                                                            | is the Geoidal separation                                            |                              |
| M                                                                                                | is the unit of Geoidal separation (fixed character = 'M' for meters) |                              |
| x.xxx                                                                                            | is the age of the differential GNSS data(seconds) (*)                |                              |
| xxxx                                                                                             | is the differential reference station ID (*)                         |                              |
| hh                                                                                               | is the checksum                                                      |                              |

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

### 4.2.3 \$PHHRP FRAME

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

### 4.2.4 \$PHINF FRAME

| \$PHINF,hhhhhhhh*hh<CR><LF> |               |                     |
|-----------------------------|---------------|---------------------|
| <b>hhhhhhhh</b>             | User Status   | Hexadecimal value   |
| <b>hh</b>                   | NMEA checksum | Mandatory hex value |

### 4.2.5 \$PHLIN FRAME

| \$PHLIN,x.xxx,y.yyy,z.zzz*hh<CR><LF> |                          |                     |
|--------------------------------------|--------------------------|---------------------|
| <b>x.xxx</b>                         | surge in meters (signed) |                     |
| <b>y.yyy</b>                         | sway in meters (signed)  |                     |
| <b>z.zzz</b>                         | Heave in meters (signed) |                     |
| <b>hh</b>                            | NMEA checksum            | Mandatory hex value |

#### 4.2.6 \$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 | Mandatory hex value     |

#### 4.2.7 \$PHROT FRAME

| \$PHROT,x.xxx,y.yyy,z.zzz*hh<CR><LF> |                                                         |                     |
|--------------------------------------|---------------------------------------------------------|---------------------|
| x.xxx                                | Roll speed in °/s (signed) – quantification : 3.6°/h    |                     |
| y.yyy                                | Pitch speed in °/s (signed) – quantification : 3.6°/h   |                     |
| z.zzz                                | Heading speed in °/s (signed) – quantification : 3.6°/h |                     |
| hh                                   | NMEA checksum                                           | Mandatory hex value |

#### 4.2.8 \$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               | Mandatory hex value |

#### 4.2.9 \$PHTRO FRAME

| \$PHTRO,x.xx,a,y.yy,b*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 |                     |
| hh                               | NMEA checksum                         | Mandatory hex value |

#### 4.2.10 \$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      | Mandatory hex value     |

#### 4.2.11 \$PHVTG FRAME

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

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

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

The Phins Compact C7 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 Phins Compact C7 calculated SD and Quality indicator in GGA telegram (refer to section 1.4).

#### 4.2.12 \$STALG FRAME

| \$STALG,aaaaaaaa,bbbbbbbb*hh<CR><LF> |                    |                     |
|--------------------------------------|--------------------|---------------------|
| aaaaaaaa                             | Algorithm status 1 | Hexadecimal value   |
| bbbbbbbb                             | Algorithm status 2 |                     |
| hh                                   | NMEA checksum      | Mandatory hex value |

#### 4.2.13 \$STSOR FRAME

| \$STSOR,aaaaaaa,bbbbbbb*hh<CR><LF> |                 |                     |
|------------------------------------|-----------------|---------------------|
| aaaaaaa                            | Sensor status 1 | Hexadecimal value   |
| bbbbbbb                            | Sensor status 2 |                     |
| hh                                 | NMEA checksum   | Mandatory hex value |

#### 4.2.14 \$STSYS FRAME

| \$STSYS,aaaaaaa,bbbbbbb*hh<CR><LF> |                 |                     |
|------------------------------------|-----------------|---------------------|
| aaaaaaa                            | System status 1 | Hexadecimal value   |
| bbbbbbb                            | System status 2 |                     |
| hh                                 | NMEA checksum   | Mandatory hex value |

#### 4.2.15 \$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 | Mandatory hex value                          |

## 5 Status Description

---

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.

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. 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.

When a status bit is set to 1, the corresponding message is displayed in the System Status area of the Web-Based Graphical User Interface with different colors:

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

## 5.1 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. A warning status persists for 3 seconds. An error status persists for 10 seconds. This remains true regardless of the protocol frequency.

The Web-Based Graphical User Interface display associated with the status follows in real-time the status.

There are different status information:

- **Sensor Status:**
  - > Sensor Status 1: It corresponds to a low-level sensor status word. Each flag is linked to sensors state (optical source board, 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
- **Algorithm Status:**
  - > Each flag of the algorithm status is set/unset by navigation algorithm (algorithm state, external sensors, errors...).
- **System Status:**
  - > Each flag of the system status is linked to system state (input/output activity, sensor detection, system errors...)
- **User Status:**
  - > Each flag of the user status is a combination of flags from sensor, algorithm and/or system status.

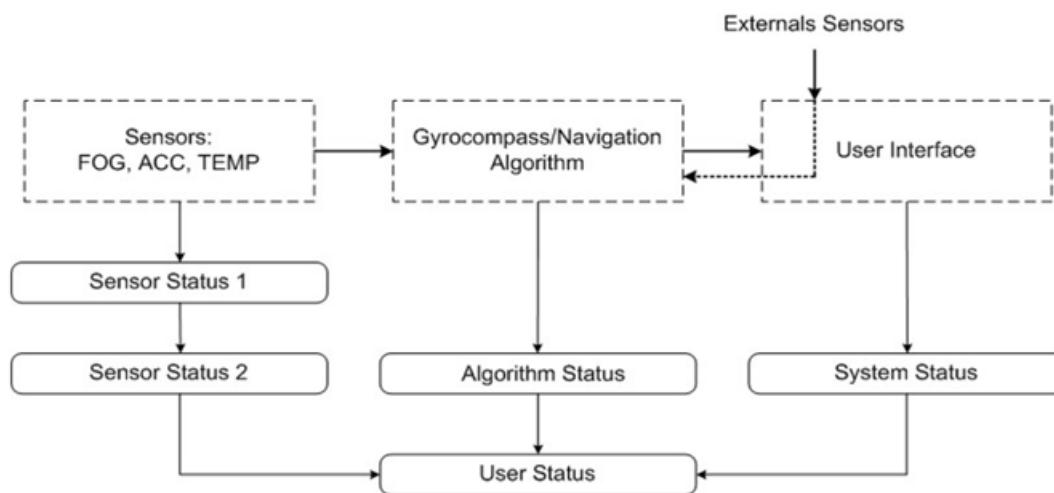


Figure 3 - Status tree description

## 5.2 Sensor Status

**Sensor status 1 corresponds to a low-level sensor status.**

Each of sensor status 1 flag can trigger "Degraded\_Mode" or "Failure\_Mode" flags, visible in sensor status 2.

Triggering thresholds corresponds to a number of successive occurrences (counted at sensor raw data frequency of  $f_e=1/T_e=400\text{Hz}$ ). If an error occurs the total error count is incremented and if an error does not occur total error count is decremented as depicted below. If threshold is 100 and error is permanent it will take  $100 * T_e = 0.25\text{ s}$  to declare the error as "degraded mode" or "failure mode" in sensor status 2. This also means that we can tolerate 99 consecutive errors without declaring "degraded mode" or "failure mode" in sensor status 2. Each of sensor status 1 flag will be taken into account in sensor status 2 if "sensor status 2 threshold" is equal or greater to the specified value. For example, you need above the threshold count of 100 "FOG\_n\_SATURATION" errors, in sensor status 1 to flag "FOG\_n\_ERROR" in sensor status 2.

### 5.2.1 LOW-LEVEL SENSOR STATUS 1 DESCRIPTION

| Bit | Name                     | Appearance conditions                                                                                                                                               | Status value | Log inside Event Viewer | Log inside Error Viewer* |
|-----|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------------------|--------------------------|
| 0   | DATA_READY_ERR           | Loss of sensors raw data (FOG or ACC)                                                                                                                               | 0x00000001   | No                      | No                       |
| 1   | SOURCE_POWER_CONTROL_ERR | FOG Optical source control power failure.<br>Set when measured optical power < 50% of set point (triggered by FOG Optical source board: bits 7 and 0 source status) | 0x00000002   | No                      | No                       |
| 2   | SOURCE_DIODE_ERR         | FOG Optical source diode off (bit 11 source status)                                                                                                                 | 0x00000004   | No                      | No                       |
| 3   | SOURCE_MODE_ERR          | FOG Optical source not in power control mode (bit 8 source status)                                                                                                  | 0x00000008   | No                      | No                       |
| 4   | ACC_X_SATURATION_ERR     | Accelerometer saturation (ADC saturation: OVF: bit 2 of ACC_n (n=X,Y,Z) status)                                                                                     | 0x00000010   | No                      | No                       |
| 5   | ACC_Y_SATURATION_ERR     |                                                                                                                                                                     | 0x00000020   | No                      | No                       |
| 6   | ACC_Z_SATURATION_ERR     |                                                                                                                                                                     | 0x00000040   | No                      | No                       |
| 7   | ACC_X_ACQ_ERR            | Accelerometer acquisition error. (ADC incorrect frame: I.e.: bit 3 ACC_n (n=X,Y,Z) status)                                                                          | 0x00000080   | No                      | No                       |
| 8   | ACC_Y_ACQ_ERR            |                                                                                                                                                                     | 0x00000100   | No                      | No                       |
| 9   | ACC_Z_ACQ_ERR            |                                                                                                                                                                     | 0x00000200   | No                      | No                       |
| 10  | FOG_X_SATURATION_ERR     | FOG saturation. (ADC saturation: OVF_CAN: bit 0 FOG_n (n=X,Y,Z) status)                                                                                             | 0x00000400   | No                      | No                       |
| 11  | FOG_Y_SATURATION_ERR     |                                                                                                                                                                     | 0x00000800   | No                      | No                       |
| 12  | FOG_Z_SATURATION_ERR     |                                                                                                                                                                     | 0x00001000   | No                      | No                       |
| 13  | FOG_X_VPI_ERR            | VPI voltage control error. (VPI used to convert FOG phase shift to voltage and rotation: ERROR_VPI: bit 1 FOG_n (n=X,Y,Z) status)                                   | 0x00002000   | No                      | No                       |
| 14  | FOG_Y_VPI_ERR            |                                                                                                                                                                     | 0x00004000   | No                      | No                       |
| 15  | FOG_Z_VPI_ERR            |                                                                                                                                                                     | 0x00008000   | No                      | No                       |
| 16  | reserved                 | -                                                                                                                                                                   | 0x00010000   | No                      | No                       |
| 17  | reserved                 | -                                                                                                                                                                   | 0x00020000   | No                      | No                       |
| 18  | reserved                 | -                                                                                                                                                                   | 0x00040000   | No                      | No                       |
| 19  | FOG_X_ACQ_ERR            | FOG frame acquisition error. (sensor board level: Framing FOG_n (n=X,Y,Z) byte)                                                                                     | 0x00080000   | No                      | No                       |
| 20  | FOG_Y_ACQ_ERR            |                                                                                                                                                                     | 0x00100000   | No                      | No                       |
| 21  | FOG_Z_ACQ_ERR            |                                                                                                                                                                     | 0x00200000   | No                      | No                       |

| Bit | Name                     | Appearance conditions                                                                                                                                                                                                                                                                      | Status value | Log inside Event Viewer | Log inside Error Viewer* |
|-----|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------------------|--------------------------|
| 22  | FOG_X_CRC_ERR            | FOG frame CRC error. (DSP board level: Check of CRC FOG_n (n=X,Y,Z) Data)                                                                                                                                                                                                                  | 0x00400000   | No                      | No                       |
| 23  | FOG_Y_CRC_ERR            |                                                                                                                                                                                                                                                                                            | 0x00800000   | No                      | No                       |
| 24  | FOG_Z_CRC_ERR            |                                                                                                                                                                                                                                                                                            | 0x01000000   | No                      | No                       |
| 25  | TEMP_ACQ_ERR             | Temperature acquisition error (Optical source, ACC and FOG temperatures on sensor board)                                                                                                                                                                                                   | 0x02000000   | No                      | No                       |
| 26  | TEMP_THRESHOLD_ERR       | Set to 1, if any of the measured temperature (TACC <sub>x,y,z</sub> ; TFOG <sub>x,y,z</sub> ; 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   | No                      | No                       |
| 27  | DTEMP_THRESHOLD_ERR      | DTEMP_THRESHOLD_ERR will be set to 1 if any temperature variation is greater than 5°/minute.                                                                                                                                                                                               | 0x08000000   | No                      | No                       |
| 28  | SENSOR_DATA_FIFO_WARNING | Sensor raw data FIFO half full                                                                                                                                                                                                                                                             | 0x10000000   | No                      | No                       |
| 29  | SENSOR_DATA_FIFO_ERR     | Sensor raw data FIFO full                                                                                                                                                                                                                                                                  | 0x20000000   | No                      | No                       |
| 30  | SOURCE_POWER_ERR         | Difference between measured source power and requested source power greater than 10%                                                                                                                                                                                                       | 0x40000000   | No                      | No                       |
| 31  | SOURCE_RECEPTION_ERR     | Source data reception error (loss of source data, computed at DSP level)                                                                                                                                                                                                                   | 0x80000000   | No                      | No                       |

\* Error viewer corresponds to the Statistics in the Maintenance page of the Web-Based Graphical User Interface.

## 5.2.2 HIGH-LEVEL SENSOR STATUS 2 DESCRIPTION

**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 the sensor status 1 flag count respectively reaches degraded mode or failure mode threshold.

| Bit | Name       | Status label displayed on the GUI | Appearance conditions                                                                                                                                                                                                                         | Status value | Log inside Event Viewer | Log inside Error Viewer* |
|-----|------------|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------------------|--------------------------|
| 0   | FOG_X_ERR  | <b>FOG X Error</b>                | FOG_X_SATURATION_ERR (bit 10 Sensor Status 1)<br>or FOG_X_ACQ_ERR (bit 19 Sensor Status 1)<br>or FOG_X_CRC_ERR (bit 22 Sensor Status 1)<br>or FOG_X_VPI_ERR (bit 13 Sensor Status 1)<br>or FOG_X_LOW POWER (bit 16 Sensor Status 1)           | 0x00000001   | Yes                     | Yes                      |
| 1   | FOG_Y_ERR  | <b>FOG Y Error</b>                | All Sensor Status 1 FOG_Y abnormalities (like FOG_X_ERR):<br>(bits 11, 20, 23, 14, 17 and 5 of Sensor Status 1).                                                                                                                              | 0x00000002   | Yes                     | Yes                      |
| 2   | FOG_Z_ERR  | <b>FOG Z Error</b>                | All Sensor Status 1 FOG_Z abnormalities (like FOG_X_ERR):<br>(bits 12, 21, 24, 15, 18 and 6 of Sensor Status 1).                                                                                                                              | 0x00000004   | Yes                     | Yes                      |
| 3   | SOURCE_ERR | <b>Source error</b>               | SOURCE_POWER_CONTROL_ERR (bit 1 Sensor Status 1) or SOURCE_DIODE_ERR (bit 2 Sensor Status 1) or<br>SOURCE_MODE_ERR (bit 3 Sensor Status 1) or SOURCE_POWER__ERR (bit 30 Sensor Status 1) or<br>SOURCE_RECEPTION__ERR (bit 31 Sensor Status 1) | 0x00000008   | Yes                     | Yes                      |
| 4   | ACC_X_ERR  | <b>Acc X Error</b>                | ACC_X_SATURATION_ERR (bit 4 Sensor Status 1)<br>or ACC_X_ACQ_ERR (bit 7 Sensor Status 1)                                                                                                                                                      | 0x00000010   | Yes                     | Yes                      |
| 5   | ACC_Y_ERR  | <b>Acc Y Error</b>                | All Sensor Status 1 ACC_Y abnormalities (like ACC_X_ERR):                                                                                                                                                                                     | 0x00000020   | Yes                     | Yes                      |

| Bit     | Name                | Status label displayed on the GUI   | Appearance conditions                                                                                                                                      | Status value | Log inside Event Viewer | Log inside Error Viewer* |
|---------|---------------------|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------------------|--------------------------|
|         |                     |                                     | (bits 5 and 8 of Sensor Status 1).                                                                                                                         |              |                         |                          |
| 6       | ACC_Z_ERR           | <b>Acc Z Error</b>                  | All Sensor Status 1 ACC_Z abnormalities (like ACC_X_ERR):<br>(bits 6 and 9 of Sensor Status 1).                                                            | 0x00000040   | Yes                     | Yes                      |
| 7       | TEMP_ERR            | <b>Temperature Alarm</b>            | TEMP_ACQ_ERR (bit 25 Sensor Status 1)<br>or TEMP_THRESHOLD_ERR (bit 26 Sensor Status 1)<br>or DTEMP_THRESHOLD_ERR (bit 27 Sensor Status 1)                 | 0x00000080   | Yes                     | Yes                      |
| 8       | DSP_OVERLOAD        | <b>DSP overload</b>                 | DATA_READY_ERR (bit 0 Sensor Status 1)<br>SENSOR_DATA_FIFO_WARNING (bit 28 Sensor Status 1)<br>or SENSOR_DATA_FIFO_ERR (bit 29 Sensor Status 1)            | 0x00000100   | Yes                     | No                       |
| 9       | ERR_INIT_CAN_ACC_X  | -                                   | CAN_ACC_X Initialization Error                                                                                                                             | 0x00000200   | No                      | Yes                      |
| 10      | ERR_INIT_CAN_ACC_Y  | -                                   | CAN_ACC_Y Initialization Error                                                                                                                             | 0x00000400   | No                      | Yes                      |
| 11      | ERR_INIT_CAN_ACC_Z  | -                                   | CAN_ACC_Z Initialization Error                                                                                                                             | 0x00000800   | No                      | Yes                      |
| 12      | MODELISATION_ERROR  | <b>Modelisation Error</b>           | Modelization version not managed                                                                                                                           | 0x00001000   | No                      | Yes                      |
| 13      | CONFIGURATION_ERROR | <b>Configuration issue</b>          | Invalid critical factory configuration (bad asynchronism value, incompatible accelerometer type with detected sensor board, unknown mechanical type, etc.) | 0x00002000   | Yes                     | Yes                      |
| 14      | SB_DETECTION_ERROR  | <b>Sensor board detection issue</b> | Cannot detect the sensor board type after 10 tries                                                                                                         | 0x00004000   | Yes                     | Yes                      |
| 15 - 27 | <i>reserved</i>     | -                                   | -                                                                                                                                                          | -            | No                      | Yes                      |
| 28      | IMU_SATURATION      | <b>IMU Saturation</b>               | IMU dynamic has been surpassed                                                                                                                             | 0x10000000   | Yes                     | Yes                      |
| 29      | BAD_IMU_MODEL       | <b>Bad IMU Model</b>                | IMU model is not supported                                                                                                                                 | 0x20000000   | Yes                     | Yes                      |
| 30      | DEGRADED_MODE       | <b>Degraded Mode</b>                | Fixed numbers trigger the Degraded Mode.                                                                                                                   | 0x40000000   | Yes                     | Yes                      |
| 31      | <i>reserved</i>     | -                                   | reserved                                                                                                                                                   | 0x80000000   | Yes                     | Yes                      |

\* Error viewer corresponds to the Statistics in the Maintenance page of the Web-Based Graphical User Interface.

## 5.3 Algorithm Status

### 5.3.1 ALGORITHM STATUS 1 DESCRIPTION

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.

| Bit | Name                 | Status label displayed on the GUI | Conditions                                        | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-----|----------------------|-----------------------------------|---------------------------------------------------|------------|-------------------------|-------------------------|
| 0   | NAVIGATION           | Navigation mode                   | Navigation phase<br>Kalman filter enable          | 0x00000001 | Yes                     | No                      |
| 1   | ALIGNMENT            | Alignment                         | Alignment phase (5 minutes from power)            | 0x00000002 | Yes                     | No                      |
| 2   | FINE ALIGNMENT       | Fine alignment                    | Fine alignment is set after the coarse alignment. | 0x00000004 | Yes                     | No                      |
| 3   | DEAD_RECKONING       | DVL calibration                   | Dead reckoning ON                                 | 0x00000008 | Yes                     | No                      |
| 4   | GPS_ALTITUDE         | GNSS altitude                     | GNSS altitude used                                | 0x00000010 | Yes                     | No                      |
| 5   | DEPTHSensor_ALTITUDE | Depth altitude                    | Altitude from depth sensor used                   | 0x00000020 | Yes                     | No                      |
| 6   | ZERO_ALTITUDE        | Stabilization                     | Altitude stabilized around zero                   | 0x00000040 | Yes                     | No                      |
| 7   | HYDRO_ALTITUDE       | Altitude Hydro                    | Altitude = tide + heave                           | 0x00000080 | Yes                     | No                      |
| 8   | LOG_RECEIVED         | DVL BT reception                  | Receiving sensor data                             | 0x00000100 | No                      | No                      |
| 9   | LOG_VALID            | DVL BT valid                      | Information used for navigation                   | 0x00000200 | Yes                     | No                      |
| 10  | LOG_WAITING          | DVL BT waiting                    | Sensor configured but no data received            | 0x00000400 | No                      | No                      |
| 11  | LOG_REJECTED         | DVL BT rejected                   | Information rejected by navigation algorithm      | 0x00000800 | Yes                     | No                      |
| 12  | GPS_RECEIVED         | GNSS reception                    | Receiving sensor data                             | 0x00001000 | No                      | No                      |
| 13  | GPS_VALID            | GNSS valid                        | Information used for navigation                   | 0x00002000 | Yes                     | No                      |
| 14  | GPS_WAITING          | GNSS waiting                      | Sensor configured but no data received            | 0x00004000 | No                      | No                      |
| 15  | GPS_REJECTED         | GNSS rejected                     | Information rejected by navigation algorithm      | 0x00008000 | Yes                     | No                      |
| 16  | USBL_RECEIVED        | USBL reception                    | Receiving sensor data                             | 0x00010000 | No                      | No                      |
| 17  | USBL_VALID           | USBL valid                        | Information used for navigation                   | 0x00020000 | Yes                     | No                      |
| 18  | USBL_WAITING         | USBL waiting                      | Sensor configured but no data received            | 0x00040000 | No                      | No                      |
| 19  | USBL_REJECTED        | USBL rejected                     | Information rejected by navigation algorithm      | 0x00080000 | Yes                     | No                      |
| 20  | DEPTH_RECEIVED       | Depth reception                   | Receiving sensor data                             | 0x00100000 | No                      | No                      |
| 21  | DEPTH_VALID          | Depth valid                       | Information used for navigation                   | 0x00200000 | Yes                     | No                      |
| 22  | DEPTH_WAITING        | Depth waiting                     | Sensor configured but no data received            | 0x00400000 | No                      | No                      |
| 23  | DEPTH_REJECTED       | Depth rejected                    | Information rejected by navigation algorithm      | 0x00800000 | Yes                     | No                      |

| Bit | Name                 | Status label displayed on the GUI | Conditions                                                                                          | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-----|----------------------|-----------------------------------|-----------------------------------------------------------------------------------------------------|------------|-------------------------|-------------------------|
| 24  | LBL_RECEIVED         | <b>LBL reception</b>              | Receiving sensor data                                                                               | 0x01000000 | No                      | No                      |
| 25  | LBL_VALID            | <b>LBL valid</b>                  | Information used for navigation                                                                     | 0x02000000 | Yes                     | No                      |
| 26  | LBL_WAITING          | <b>LBL waiting</b>                | Sensor configured but no data received                                                              | 0x04000000 | No                      | No                      |
| 27  | LBL_REJECTED         | <b>LBL rejected</b>               | Information rejected by navigation algorithm                                                        | 0x08000000 | Yes                     | No                      |
| 28  | ALTITUDE_SATURATION  | <b>Altitude exceeded</b>          | Altitude greater than maximum accepted value: 4000 m                                                | 0x10000000 | Yes                     | No                      |
| 29  | SPEED_SATURATION     | <b>Speed exceeded</b>             | Speed greater than maximum accepted value: 41.66 m/s                                                | 0x20000000 | Yes                     | No                      |
| 30  | INTERPOLATION_MISSED | -                                 | Acceleration greater than maximal accepted value. Rotation rate greater than maximal accepted value | 0x40000000 | Yes                     | No                      |
| 31  | HEAVE_INITIALIZATION | <b>Heave init</b>                 | Heave filter initialization. Starts at power on and lasts in 6 minutes after power on               | 0x80000000 | Yes                     | No                      |

### 5.3.2 ALGORITHM STATUS 2 DESCRIPTION

| Bit | Name                | Status label displayed on the GUI | Conditions                                   | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-----|---------------------|-----------------------------------|----------------------------------------------|------------|-------------------------|-------------------------|
| 0   | WATERTRACK_RECEIVED | <b>DVL WT reception</b>           | Receiving sensor data                        | 0x00000001 | No                      | No                      |
| 1   | WATERTRACK_VALID    | <b>DVL WT valid</b>               | Information used for navigation              | 0x00000002 | Yes                     | No                      |
| 2   | WATERTRACK_WAITING  | <b>DVL WT waiting</b>             | Sensor configured but no data received       | 0x00000004 | No                      | No                      |
| 3   | WATERTRACK_REJECTED | <b>DVL WT rejected</b>            | Information rejected by navigation algorithm | 0x00000008 | Yes                     | No                      |
| 4   | GPS2_RECEIVED       | <b>GNSS2 reception</b>            | Receiving sensor data                        | 0x00000010 | No                      | No                      |
| 5   | GPS2_VALID          | <b>GNSS2 valid</b>                | Information used for navigation              | 0x00000020 | Yes                     | No                      |
| 6   | GPS2_WAITING        | <b>GNSS2 waiting</b>              | Sensor configured but no data received       | 0x00000040 | No                      | No                      |
| 7   | GPS2_REJECTED       | <b>GNSS2 rejected</b>             | Information rejected by navigation algorithm | 0x00000080 | Yes                     | No                      |
| 8   | <i>reserved</i>     | -                                 | <i>reserved</i>                              | 0x00000100 | No                      | No                      |
| 9   | <i>reserved</i>     | -                                 | <i>reserved</i>                              | 0x00000200 | No                      | No                      |
| 10  | <i>reserved</i>     | -                                 | <i>reserved</i>                              | 0x00000400 | No                      | No                      |
| 11  | <i>reserved</i>     | -                                 | <i>reserved</i>                              | 0x00000800 | No                      | No                      |
| 12  | ALTITUDE_RECEIVED   | <b>Altitude reception</b>         | Receiving sensor data                        | 0x00001000 | No                      | No                      |
| 13  | ALTITUDE_VALID      | <b>Altitude valid</b>             | Information used for navigation              | 0x00002000 | Yes                     | No                      |
| 14  | ALTITUDE_WAITING    | <b>Altitude waiting</b>           | Sensor configured but no data received       | 0x00004000 | No                      | No                      |
| 15  | ALTITUDE_REJECTED   | <b>Altitude rejected</b>          | Information rejected by navigation algorithm | 0x00008000 | Yes                     | No                      |
| 16  | ZUPT_MODE_ACTIVATED | <b>ZUPT enabled</b>               | ZUPT mode activated                          | 0x00010000 | Yes                     | No                      |
| 17  | ZUPT_MODE_VALID     | <b>ZUPT valid</b>                 | ZUPT mode valid                              | 0x00020000 | Yes                     | No                      |

| Bit | Name               | Status label displayed on the GUI | Conditions                                    | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-----|--------------------|-----------------------------------|-----------------------------------------------|------------|-------------------------|-------------------------|
| 18  | RO_ZUPT_MODE       | Rot ZUPT enabled                  | AutoStatic Bench ZUPT mode activated          | 0x00040000 | Yes                     | No                      |
| 19  | RO_ZUPT_VALID      | Rot ZUPT valid                    | AutoStatic Bench ZUPT mode valid              | 0x00080000 | Yes                     | No                      |
| 20  | Reserved           | -                                 | Reserved                                      | 0x00100000 | No                      | No                      |
| 21  | Reserved           | -                                 | Reserved                                      | 0x00200000 | No                      | No                      |
| 22  | Reserved           | -                                 | Reserved                                      | 0x00400000 | Yes                     | No                      |
| 23  | EMULATION_MODE     | Emulation mode                    | Simulation of DSP input sensor data (FOG,ACC) | 0x00800000 | Yes                     | No                      |
| 24  | EMLOG_RECEIVED     | EM LOG reception                  | Receiving information                         | 0x01000000 | No                      | No                      |
| 25  | EMLOG_VALID        | EM LOG valid                      | Information used for navigation               | 0x02000000 | Yes                     | No                      |
| 26  | EMLOG_WAITING      | EM LOG waiting                    | Sensor configured but no data received        | 0x04000000 | No                      | No                      |
| 27  | EMLOG_REJECTED     | EM LOG rejected                   | Information rejected by navigation algorithm  | 0x08000000 | Yes                     | No                      |
| 28  | MANUALGPS_RECEIVED | Manual position reception         | Receiving information                         | 0x10000000 | No                      | No                      |
| 29  | MANUALGPS_VALID    | Manual position valid             | Information used for navigation               | 0x20000000 | Yes                     | No                      |
| 30  | MANUALGPS_WAITING  | Manual position waiting           | Sensor configured but no data received        | 0x40000000 | No                      | No                      |
| 31  | MANUALGPS_REJECTED | Manual position rejected          | Information rejected by navigation algorithm  | 0x80000000 | Yes                     | No                      |

5.3.3 ALGORITHM STATUS 3 DESCRIPTION

| Bit | Name           | Status label displayed on the GUI | Conditions                             | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-----|----------------|-----------------------------------|----------------------------------------|------------|-------------------------|-------------------------|
| 0   | reserved       | -                                 | reserved                               | 0x00000001 | No                      | No                      |
| 1   | reserved       | -                                 | reserved                               | 0x00000002 | No                      | No                      |
| 2   | reserved       | -                                 | reserved                               | 0x00000004 | No                      | No                      |
| 3   | reserved       | -                                 | reserved                               | 0x00000008 | No                      | No                      |
| 4   | reserved       | -                                 | reserved                               | 0x00000010 | No                      | No                      |
| 5   | reserved       | -                                 | reserved                               | 0x00000020 | Np                      | No                      |
| 6   | reserved       | -                                 | reserved                               | 0x00000040 | No                      | No                      |
| 7   | reserved       | -                                 | reserved                               | 0x00000080 | No                      | No                      |
| 8   | USBL2_RECEIVED | USBL 2 reception                  | Receiving information                  | 0x00000100 | No                      | No                      |
| 9   | USBL2_VALID    | USBL 2 valid                      | Information used for navigation        | 0x00000200 | Yes                     | No                      |
| 10  | USBL2_WAITING  | USBL 2 waiting                    | Sensor configured but no data received | 0x00000400 | No                      | No                      |

| Bit | Name                     | Status label displayed on the GUI     | Conditions                                                                                                      | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-----|--------------------------|---------------------------------------|-----------------------------------------------------------------------------------------------------------------|------------|-------------------------|-------------------------|
| 11  | USBL2_REJECTED           | <b>USBL 2 rejected</b>                | Information rejected by navigation algorithm                                                                    | 0x00000800 | Yes                     | No                      |
| 12  | USBL3_RECEIVED           | <b>USBL 3 reception</b>               | Receiving information                                                                                           | 0x00001000 | No                      | No                      |
| 13  | USBL3_VALID              | <b>USBL 3 valid</b>                   | Information used for navigation                                                                                 | 0x00002000 | Yes                     | No                      |
| 14  | USBL3_WAITING            | <b>USBL 3 waiting</b>                 | Sensor configured but no data received                                                                          | 0x00004000 | No                      | No                      |
| 15  | USBL3_REJECTED           | <b>USBL 3 rejected</b>                | Information rejected by navigation algorithm                                                                    | 0x00008000 | Yes                     | No                      |
| 16  | <i>reserved</i>          | -                                     | -                                                                                                               | 0x00010000 | No                      | No                      |
| 17  | CALCHK                   | <b>Calibration check</b>              | DVL calibration check On/Off                                                                                    | 0x00020000 | Yes                     | No                      |
| 18- | <i>reserved</i>          | -                                     | -                                                                                                               | 0x00040000 | Yes                     | No                      |
| 19  | REL_SPD_ZUP_ACTIVATED    | <b>Rel. Spd ZUPT Mode enabled</b>     | Relative Speed ZUP activated                                                                                    | 0x00080000 | Yes                     | No                      |
| 20  | REL_SPD_ZUP_VALID        | <b>Rel. Spd ZUPT Mode valid</b>       | Relative Speed ZUP valid                                                                                        | 0x00100000 | Yes                     | No                      |
| 21  | EXT_SENSOR_OUTDATED      | <b>Timing issue</b>                   | One of the External Sensor received is outdated                                                                 | 0x00200000 | Yes                     | No                      |
| 22  | SENSOR_USED_BEFORE_CALIB | <b>Sensor used before calibration</b> | Sensor used before calibration                                                                                  | 0x00400000 | No                      | No                      |
| 23  | <i>reserved</i>          | -                                     | -                                                                                                               | 0x00800000 | Yes                     | No                      |
| 24  | <i>reserved</i>          | -                                     | <i>reserved</i>                                                                                                 | 0x01000000 | No                      | No                      |
| 25  | <i>reserved</i>          | -                                     | <i>reserved</i>                                                                                                 | 0x02000000 | No                      | No                      |
| 26  | <i>reserved</i>          | -                                     | <i>reserved</i>                                                                                                 | 0x04000000 | No                      | No                      |
| 27  | <i>reserved</i>          | -                                     | <i>reserved</i>                                                                                                 | 0x08000000 | No                      | No                      |
| 28  | FIRM_INCOMPATIBLES       | <b>Incompatible firmwares</b>         | Firmwares incompatible with hardware                                                                            | 0x10000000 | Yes                     | No                      |
| 29  | <i>reserved</i>          | -                                     | <i>reserved</i>                                                                                                 | 0x20000000 | No                      | No                      |
| 30  | OPTIMAL_ALIGNMENT        | <b>Optimal Alignment</b>              | Optimal alignment flag is set only when heading standard deviation < 0.02° seclat<br>Flag persistence time: 1 s | 0x40000000 | Yes                     | No                      |
| 31  | <i>reserved</i>          | -                                     | <i>reserved</i>                                                                                                 | 0x80000000 | No                      | No                      |

## 5.3.4 ALGORITHM STATUS 4 DESCRIPTION

| Bit | Name                    | Status label displayed on the GUI | Conditions                                   | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-----|-------------------------|-----------------------------------|----------------------------------------------|------------|-------------------------|-------------------------|
| 0   | LOG2_RECEIVED           | DVL2 BT reception                 | Receiving sensor data                        | 0x00000001 | No                      | No                      |
| 1   | LOG2_VALID              | DVL2 BT valid                     | Information used for navigation              | 0x00000002 | Yes                     | No                      |
| 2   | LOG2_WAITING            | DVL2 BT waiting                   | Sensor configured but no data received       | 0x00000004 | No                      | No                      |
| 3   | LOG2_REJECTED           | DVL2 BT rejected                  | Information rejected by navigation algorithm | 0x00000008 | Yes                     | No                      |
| 4   | WATERTRACK2_RECEIVED    | DVL2 WT reception                 | Receiving sensor data                        | 0x00000010 | No                      | No                      |
| 5   | WATERTRACK2_VALID       | DVL2 WT valid                     | Information used for navigation              | 0x00000020 | Yes                     | No                      |
| 6   | WATERTRACK2_WAITING     | DVL2 WT waiting                   | Sensor configured but no data received       | 0x00000040 | No                      | No                      |
| 7   | WATERTRACK2_REJECTED    | DVL2 WT rejected                  | Information rejected by navigation algorithm | 0x00000080 | Yes                     | No                      |
| 8   | DVL_DIST_TRAVELED_VALID | -                                 | Algorithm DVL calibration status             | 0x00000100 | Yes                     | No                      |
| 9   | DVL_CALIBRATION_NONE    | -                                 |                                              | 0x00000200 | Yes                     | No                      |
| 10  | DVL_ROUGH_CALIBRATION   | Rough Calibration                 |                                              | 0x00000400 | Yes                     | No                      |
| 11  | DVL_FINE_CALIBRATION    | Fine Calibration                  |                                              | 0x00000800 | Yes                     | No                      |
| 12  | DVL_CHECK_CALIBRATION   | Verification in progress          |                                              | 0x00001000 | Yes                     | No                      |
| 13  | reserved                | -                                 | reserved                                     | 0x00002000 | No                      | No                      |
| 14  | reserved                | -                                 | reserved                                     | 0x00004000 | No                      | No                      |
| 15  | reserved                | -                                 | reserved                                     | 0x00008000 | No                      | No                      |
| 16  | reserved                | -                                 | reserved                                     | 0x00010000 | No                      | No                      |
| 17  | reserved                | -                                 | reserved                                     | 0x00020000 | No                      | No                      |
| 18  | reserved                | -                                 | reserved                                     | 0x00040000 | No                      | No                      |
| 19  | reserved                | -                                 | reserved                                     | 0x00080000 | No                      | No                      |
| 20  | reserved                | -                                 | reserved                                     | 0x00100000 | No                      | No                      |
| 21  | reserved                | -                                 | reserved                                     | 0x00200000 | No                      | No                      |
| 22  | reserved                | -                                 | reserved                                     | 0x00400000 | No                      | No                      |
| 23  | reserved                | -                                 | reserved                                     | 0x00800000 | No                      | No                      |
| 24  | reserved                | -                                 | reserved                                     | 0x01000000 | No                      | No                      |
| 25  | reserved                | -                                 | reserved                                     | 0x02000000 | No                      | No                      |
| 26  | reserved                | -                                 | reserved                                     | 0x04000000 | No                      | No                      |
| 27  | reserved                | -                                 | reserved                                     | 0x08000000 | No                      | No                      |
| 28  | CINT_FLASH_MEMORY_WRERR | CINT Write Error                  | Memory writing error after 3 retries         | 0x10000000 | Yes                     | Yes                     |

| Bit | Name                                    | Status label displayed on the GUI | Conditions                             | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-----|-----------------------------------------|-----------------------------------|----------------------------------------|------------|-------------------------|-------------------------|
| 29  | CINT_FLASH_MEMORY_ERERR                 | <b>CINT Erase Error</b>           | Memory erasing error after 3 retries   | 0x20000000 | Yes                     | Yes                     |
| 30  | CALIBRATION_COMPLETED                   | -                                 | Calibration criteria has been reached  | 0x40000000 | No                      | No                      |
| 31  | INCONSISTENT_SENSOR_DATA <sup>(1)</sup> | -                                 | A forced sensor data has been rejected | 0x80000000 | Yes                     | No                      |

<sup>(1)</sup> If the flag is raised, this means that the REJECTED flag of the concerned sensor has been raised also.

### 5.3.5 ALGORITHM STATUS 5 DESCRIPTION

| Bit   | Name                     | Status label displayed on the GUI | Conditions                                                                            | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-------|--------------------------|-----------------------------------|---------------------------------------------------------------------------------------|------------|-------------------------|-------------------------|
| 0-4   | reserved                 | -                                 | reserved                                                                              | 0x00000001 | No                      | No                      |
| 5-18  | <i>reserved</i>          | -                                 | reserved for future use                                                               | 0x00000020 | Yes                     | No                      |
| 19-21 | <i>reserved</i>          | -                                 | <i>reserved</i>                                                                       | 0x00080000 | No                      | No                      |
| 22    | PO_ZUPT_ACTIVATED        | <b>Pos. ZUPT enabled</b>          | <i>Position ZUPT activated</i>                                                        | 0x00400000 | Yes                     | No                      |
| 23    | PO_ZUPT_VALID            | <b>Pos. ZUPT valid</b>            | Position ZUPT valid                                                                   | 0x00800000 | Yes                     | No                      |
| 24    | <i>reserved</i>          | -                                 | <i>reserved</i>                                                                       | 0x01000000 | Yes                     | No                      |
| 25    | <i>reserved</i>          | -                                 | <i>reserved</i>                                                                       | 0x02000000 | Yes                     | No                      |
| 26    | CDSP_FLASH_MEMORY_WRERR  | <b>CDSP Write Error</b>           | Memory writing error after 3 retries                                                  | 0x04000000 | Yes                     | No                      |
| 27    | CDSP_FLASH_MEMORY_ERERR  | <b>CDSP Erase Error</b>           | Memory erasing error after 3 retries                                                  | 0x08000000 | Yes                     | No                      |
| 28    | CINT_FLASH_MEMORY_VIRGIN | <b>CINT Memory Virgin</b>         | Memory is virgin on both configuration sectors (CRC and validity counter =0xffffffff) | 0x10000000 | Yes                     | Yes                     |
| 29    | CDSP_FLASH_MEMORY_ERROR  | <b>CINT Memory Error</b>          | Both sectors used to save configuration are corrupted                                 | 0x20000000 | Yes                     | Yes                     |
| 30    | CINT_FLASH_MEMORY_Backup | <b>Backup Memory Used</b>         | Previous configuration not been saved correctly                                       | 0x40000000 | Yes                     | No                      |
| 31    | reserved                 | -                                 | reserved                                                                              | 0x80000000 | No                      | No                      |

5.3.6 ALGORITHM STATUS 6 DESCRIPTION

| Bit  | Name            | Status label<br>displayed on the GUI | Conditions      | Value      | Log inside Event<br>Viewer | Log inside Error<br>Viewer |
|------|-----------------|--------------------------------------|-----------------|------------|----------------------------|----------------------------|
| 0    | <i>reserved</i> | -                                    | <i>reserved</i> | 0x00000001 | Yes                        | No                         |
| 1    | <i>reserved</i> | -                                    | <i>reserved</i> | 0x00000002 | Yes                        | No                         |
| 2    | <i>reserved</i> | -                                    | <i>reserved</i> | 0x00000004 | Yes                        | No                         |
| 3    | <i>reserved</i> | -                                    | <i>reserved</i> | 0x00000008 | Yes                        | No                         |
| 4    | <i>reserved</i> | -                                    | <i>reserved</i> | 0x00000010 | Yes                        | No                         |
| 5    | <i>reserved</i> | -                                    | <i>reserved</i> | 0x00000020 | Yes                        | No                         |
| 6-31 | <i>reserved</i> | -                                    | <i>reserved</i> | 0x00002000 | No                         | No                         |

## 5.4 System Status

This System status is updated in real time and monitored through dedicated flags. It is dedicated to getting information on the 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.

### 5.4.1 SYSTEM STATUS 1 DESCRIPTION

| Bit | Name               | Status label displayed on the Web-Based Graphical User Interface | Conditions                                                  | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-----|--------------------|------------------------------------------------------------------|-------------------------------------------------------------|------------|-------------------------|-------------------------|
| 0   | SERIAL_IN_R_ERR    | <b>Input R error</b>                                             | Serial input framing error                                  | 0x00000001 | Yes                     | No                      |
| 1   | <i>Reserved</i>    | -                                                                | Input port framing error                                    | 0x00000002 | No                      | No                      |
| 2   | <i>Reserved</i>    | -                                                                | Input port framing error                                    | 0x00000004 | No                      | No                      |
| 3   | <i>Reserved</i>    | -                                                                | Input port framing error                                    | 0x00000008 | No                      | No                      |
| 4   | INPUT_A_ERR        | <b>Input A error</b>                                             | Input port framing error                                    | 0x00000010 | Yes                     | No                      |
| 5   | INPUT_B_ERR        | <b>Input B error</b>                                             | Input port framing error                                    | 0x00000020 | Yes                     | No                      |
| 6   | INPUT_C_ERR        | <b>Input C error</b>                                             | Input port framing error                                    | 0x00000040 | Yes                     | No                      |
| 7   | INPUT_D_ERR        | <b>Input D error</b>                                             | Input port framing error                                    | 0x00000080 | Yes                     | No                      |
| 8   | INPUT_R_ACTIVITY   | <b>Input R</b>                                                   | Input port activity                                         | 0x00000100 | No                      | No                      |
| 9   | <i>Reserved</i>    | -                                                                | -                                                           | 0x00000200 | No                      | No                      |
| 10  | <i>Reserved</i>    | -                                                                | -                                                           | 0x00000400 | No                      | No                      |
| 11  | <i>Reserved</i>    | -                                                                | -                                                           | 0x00000800 | No                      | No                      |
| 12  | INPUT_A_ACTIVITY   | <b>Input A</b>                                                   | Input port activity                                         | 0x00001000 | No                      | No                      |
| 13  | INPUT_B_ACTIVITY   | <b>Input B</b>                                                   | Input port activity                                         | 0x00002000 | No                      | No                      |
| 14  | INPUT_C_ACTIVITY   | <b>Input C</b>                                                   | Input port activity                                         | 0x00004000 | No                      | No                      |
| 15  | INPUT_D_ACTIVITY   | <b>Input D</b>                                                   | Input port activity                                         | 0x00008000 | No                      | No                      |
| 16  | OUTPUT_R_FULL      | <b>Output R full</b>                                             | Output port full                                            | 0x00010000 | Yes                     | No                      |
| 17  | OUTPUT_A_FULL      | <b>Output A full</b>                                             | Output port full                                            | 0x00020000 | Yes                     | No                      |
| 18  | OUTPUT_B_FULL      | <b>Output B full</b>                                             | Output port full                                            | 0x00040000 | Yes                     | No                      |
| 19  | OUTPUT_C_FULL      | <b>Output C full</b>                                             | Output port full                                            | 0x00080000 | Yes                     | No                      |
| 20  | OUTPUT_D_FULL      | <b>Output D full</b>                                             | Output port full                                            | 0x00100000 | Yes                     | No                      |
| 21  | OUTPUT_E_FULL      | <b>Output E full</b>                                             | Output port full                                            | 0x00200000 | Yes                     | No                      |
| 22  | ETHERNET_PORT_FULL | <b>Ethernet output full</b>                                      | Ethernet output full (common for all Ethernet output ports) | 0x00400000 | Yes                     | No                      |
| 23  | <i>reserved</i>    | -                                                                | <i>reserved</i>                                             | 0x00800000 | No                      | No                      |

| Bit | Name                   | Status label displayed on the Web-Based Graphical User Interface | Conditions                                                    | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-----|------------------------|------------------------------------------------------------------|---------------------------------------------------------------|------------|-------------------------|-------------------------|
| 24  | INTERNAL_TIME_USED     | Internal time                                                    | Internal time used                                            | 0x01000000 | No                      | No                      |
| 25  | <i>reserved</i>        | -                                                                | <i>reserved</i>                                               | 0x02000000 | No                      | No                      |
| 26  | ETHERNET_PORT_ACTIVITY | -                                                                | Ethernet link reception (common for all Ethernet input ports) | 0x04000000 | No                      | No                      |
| 27  | PULSE_IN_A_ACTIVITY    | Pulse in A                                                       | Input Pulse activity                                          | 0x08000000 | No                      | No                      |
| 28  | PULSE_IN_B_ACTIVITY    | Pulse in B                                                       | Input Pulse activity                                          | 0x10000000 | No                      | No                      |
| 29  | PULSE_IN_C_ACTIVITY    | Pulse in C                                                       | Input Pulse activity                                          | 0x20000000 | No                      | No                      |
| 30  | <i>reserved</i>        | -                                                                | <i>reserved</i>                                               | 0x40000000 | No                      | No                      |
| 31  | <i>reserved</i>        | -                                                                | <i>reserved</i>                                               | 0x80000000 | No                      | No                      |

#### 5.4.2 SYSTEM STATUS 2

| Bit | Name                | Status label displayed on the GUI | Conditions                                              | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-----|---------------------|-----------------------------------|---------------------------------------------------------|------------|-------------------------|-------------------------|
| 0   | DVL_BT_DETECTED     | DVL BT reception                  | DVL Bottom Track data detected                          | 0x00000001 | No                      | No                      |
| 1   | DVL_WT_DETECTED     | DVL WT reception                  | DVL Water Track data detected                           | 0x00000002 | No                      | No                      |
| 2   | GPS_DETECTED        | GNSS reception                    | GPS data detected                                       | 0x00000004 | No                      | No                      |
| 3   | GPS2_DETECTED       | GNSS2 reception                   | GPS2 data detected                                      | 0x00000008 | No                      | No                      |
| 4   | USBL_DETECTED       | USBL reception                    | USBL data detected                                      | 0x00000010 | No                      | No                      |
| 5   | LBL_DETECTED        | LBL reception                     | LBL data detected                                       | 0x00000020 | No                      | No                      |
| 6   | DEPTH_DETECTED      | DEPT reception                    | GPS data detected                                       | 0x00000040 | No                      | No                      |
| 7   | EMLOG_DETECTED      | EM LOG reception                  | GPS data detected                                       | 0x00000080 | No                      | No                      |
| 8   | <i>reserved</i>     | -                                 | <i>reserved</i>                                         | 0x00000100 | No                      | No                      |
| 9   | UTC_DETECTED        | UTC synchro                       | UTC data detected (with synchronization ZDA or ZDA+PPS) | 0x00000200 | No                      | No                      |
| 10  | ALTITUDE_DETECTED   | Altitude reception                | Altitude data detected                                  | 0x00000400 | No                      | No                      |
| 11  | PPS_DETECTED        | Synchro PPS1                      | PPS signal detected                                     | 0x00000800 | No                      | No                      |
| 12  | ZUP_MODE_ACTIVATED  | ZUPT Mode enabled                 | ZUPT Mode activated                                     | 0x00001000 | No                      | No                      |
| 13  | <i>reserved</i>     | -                                 | <i>reserved</i>                                         | 0x00002000 | No                      | No                      |
| 14  | MANUAL_GPS_DETECTED | Manual position reception         | Manual GPS data detected                                | 0x00004000 | No                      | No                      |

| Bit | Name                 | Status label displayed on the GUI | Conditions                                                                          | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-----|----------------------|-----------------------------------|-------------------------------------------------------------------------------------|------------|-------------------------|-------------------------|
| 15  | CTD_DETECTED         | Sound velocity reception          | CTD data detected                                                                   | 0x00008000 | No                      | No                      |
| 16  | SIMULATION_MODE      | Simulation mode                   | Simulation mode active                                                              | 0x00010000 | Yes                     | No                      |
| 17  | reserved             | -                                 | reserved                                                                            | 0x00020000 | No                      | No                      |
| 18  | DSP_INCOMPATIBILITY  | Incompatible DSP firmware         | DSP firmware and CINT firmware not compatible                                       | 0x00040000 | Yes                     | No                      |
| 19  | HEADING_ALERT        | Heading accuracy                  | Heading standard deviation above user configurable value                            | 0x00080000 | Yes                     | No                      |
| 20  | POSITION_ALERT       | Position accuracy                 | Position standard deviation above user configurable value                           | 0x00100000 | Yes                     | No                      |
| 21  | WAIT_FOR_POSITION    | Waiting for position              | Algorithm waiting for position to start                                             | 0x00200000 | Yes                     | No                      |
| 22  | reserved             | -                                 | reserved                                                                            | 0x00400000 | No                      | No                      |
| 23  | POLAR_MODE           | Polar Mode                        | Polar mode                                                                          | 0x00800000 | No                      | No                      |
| 24  | INTERNAL_LOG         | Internal logging                  | Internal Log in progress                                                            | 0x01000000 | No                      | No                      |
| 25  | reserved             | -                                 | reserved                                                                            | 0x02000000 | No                      | No                      |
| 26  | DOV_CORR_DETECTED    | Gravity corr. reception           | Vertical Deflection Correction Received                                             | 0x04000000 | No                      | No                      |
| 27  | MPC_OVERLOAD         | Latency Warning                   | Interface board CPU overload (too much output protocols with too high output rates) | 0x08000000 | Yes                     | No                      |
| 28  | POWER_SUPPLY_FAILURE | Power failure                     | Unit power failure                                                                  | 0x10000000 | Yes                     | No                      |
| 29  | reserved             | -                                 | reserved                                                                            | 0x20000000 | No                      | No                      |
| 30  | CONFIGURATION_SAVED  | Configuration saved               | Configuration saved after having been changed                                       | 0x40000000 | Yes                     | No                      |
| 31  | reserved             | -                                 | reserved                                                                            | 0x80000000 | No                      | No                      |

### 5.4.3 SYSTEM STATUS 3

| Bit | Name                 | Status label displayed on the GUI | Conditions                                              | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-----|----------------------|-----------------------------------|---------------------------------------------------------|------------|-------------------------|-------------------------|
| 0   | UTC2_DETECTED        | UTC2 synchro                      | UTC data detected (with synchronization ZDA or ZDA+PPS) | 0x00000001 | No                      | No                      |
| 1   | PPS2_DETECTED        | PPS2 Synchro                      | PPS signal detected                                     | 0x00000002 | No                      | No                      |
| 2   | ADVANCED_FILTERING   | Advanced filtering mode           | DP mode enabled                                         | 0x00000004 | No                      | No                      |
| 3   | NTP_SYNC_IN_PROGRESS | NTP Synchro in progress           | Appear between NTP activation and NTP synchronization   | 0x00000008 | No                      | No                      |

| Bit   | Name             | Status label<br>displayed on the GUI | Conditions                                                                             | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-------|------------------|--------------------------------------|----------------------------------------------------------------------------------------|------------|-------------------------|-------------------------|
| 4     | NTP_RECEIVED     | NTP received                         | NTP is working but not used (only if UTC detected)                                     | 0x00000010 | No                      | No                      |
| 5     | NTP_SYNCHRO      | NTP synchro                          | NTP synchronization successful                                                         | 0x00000020 | Yes                     | No                      |
| 6     | NTP_FAILED       | NTP synchro failed                   | NTP synchronization failed (DNS problem, name server unknown, Ethernet link broken...) | 0x00000040 | Yes                     | No                      |
| 7     | reserved         | -                                    | reserved                                                                               | 0x00000080 | No                      | No                      |
| 8     | DVL2_BT_DETECTED | DVL2 BT reception                    | DVL Bottom Track data detected                                                         | 0x00000100 | No                      | No                      |
| 9     | DVL2_WT_DETECTED | DVL2 WT reception                    | DVL Water Track data detected                                                          | 0x00000200 | No                      | No                      |
| 10    | reserved         | -                                    | reserved                                                                               | 0x00000400 | No                      | No                      |
| 11    | reserved         | -                                    | reserved                                                                               | 0x00000800 | No                      | No                      |
| 12    | reserved         | -                                    | reserved                                                                               | 0x00001000 | yes                     | No                      |
| 13    | reserved         | -                                    | reserved                                                                               | 0x00002000 | No                      | No                      |
| 14    | reserved         | -                                    | reserved                                                                               | 0x00004000 | No                      | No                      |
| 15    | reserved         | -                                    | reserved                                                                               | 0x00008000 | No                      | No                      |
| 16    | reserved         | -                                    | reserved                                                                               | 0x00010000 | No                      | No                      |
| 17    | reserved         | -                                    | reserved                                                                               | 0x00020000 | No                      | No                      |
| 18    | SYSTEM_READY     | System Ready                         | All alignments are done, no saturation, no FOG error and no source error               | 0x00040000 | No                      | No                      |
| 19-25 | reserved         | -                                    | reserved                                                                               | -          | No                      | No                      |
| 26    | SYSTEM_FULL_PERF | System full performance              | Optimal alignment completed                                                            | 0x04000000 | No                      | No                      |
| 27    | reserved         | -                                    | reserved                                                                               | -          | No                      | No                      |
| 28    | USBL2_DETECTED   | USBL2 reception                      | USBL2 data detected                                                                    | 0x10000000 | No                      | No                      |
| 29    | USBL3_DETECTED   | USBL3 reception                      | USBL3 data detected                                                                    | 0x20000000 | No                      | No                      |
| 30-31 | reserved         | -                                    | reserved                                                                               | -          | No                      | No                      |

## 5.4.4 SYSTEM STATUS 4

| Bit   | Name                  | Status label displayed on the GUI | Conditions                                                                             | Value      | Log inside Event Viewer | Log inside Error Viewer |
|-------|-----------------------|-----------------------------------|----------------------------------------------------------------------------------------|------------|-------------------------|-------------------------|
| 0     | <i>reserved</i>       | -                                 | <i>reserved</i>                                                                        | 0x00000001 | -                       | -                       |
| 1     | <i>reserved</i>       | -                                 | <i>reserved</i>                                                                        | 0x00000002 | -                       | -                       |
| 2     | <i>reserved</i>       | -                                 | <i>reserved</i>                                                                        | 0x00000004 | -                       | -                       |
| 3     | NTP2_SYNC_IN_PROGRESS | <b>NTP2 synchro in progress</b>   | Appear between NTP activation and NTP synchronization                                  | 0x00000008 | Yes                     | No                      |
| 4     | NTP2_RECEIVED         | <b>NTP2 received</b>              | NTP is working but not used (only if UTC detected)                                     | 0x00000010 | Yes                     | No                      |
| 5     | NTP2_SYNC             | <b>NTP2 synchro</b>               | NTP synchronization successful                                                         | 0x00000020 | Yes                     | No                      |
| 6     | NTP2_FAILED           | <b>NTP2 synchro failed</b>        | NTP synchronization failed (DNS problem, name server unknown, Ethernet link broken...) | 0x00000040 | Yes                     | No                      |
| 7     | NTP3_SYNC_IN_PROGRESS | <b>NTP3 synchro in progress</b>   | Appear between NTP activation and NTP synchronization                                  | 0x00000080 | Yes                     | No                      |
| 8     | NTP3_RECEIVED         | <b>NTP3 received</b>              | NTP is working but not used (only if UTC detected)                                     | 0x00000100 | Yes                     | No                      |
| 9     | NTP3_SYNC             | <b>NTP3 synchro</b>               | NTP synchronization successful                                                         | 0x00000200 | Yes                     | No                      |
| 10    | NTP3_FAILED           | <b>NTP3 synchro failed</b>        | NTP synchronization failed (DNS problem, name server unknown, Ethernet link broken...) | 0x00000400 | Yes                     | No                      |
| 11-31 | <i>reserved</i>       | -                                 | <i>reserved</i>                                                                        | 0x00000800 | -                       | -                       |

## 5.5 User Status

User status is a synthetic fusion of System status, Algorithm Status and Sensor 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.

| Bit | Name                      | Conditions                                                                                                                                                                                                                                               | Value      |
|-----|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 0   | DVL_RECEIVED_VALID        | LOG_RECEIVED (bit 8 Algo Status 1) when LOG Rejection mode = Always true<br>or LOG_VALID (bit 9 Algo Status 1)<br>or WATERTRACK_RECEIVED (bit 0 Algo Status 2) when WaterTrack Rejection mode = Always true<br>or WATERTRACK_VALID (bit 1 Algo Status 2) | 0x00000001 |
| 1   | GPS_RECEIVED_VALID        | OR function on GPS status                                                                                                                                                                                                                                | 0x00000002 |
| 2   | DEPTH_RECEIVED_VALID      | DEPTH_RECEIVED (bit 20 Algo Status 1) when DEPTH Rejection mode = Always true<br>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<br>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<br>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 | OR function on manual fix status                                                                                                                                                                                                                         | 0x00000080 |
| 8   | TIME_RECEIVED_VALID       | UTC detected                                                                                                                                                                                                                                             | 0x00000100 |
| 9   | FOG_ANOMALY               | FOG_X_ERR (bit 0 Sensor Status 2)<br>or FOG_Y_ERR (bit 1 Sensor Status 2)<br>or FOG_Z_ERR (bit 2 Sensor Status 2)<br>or SOURCE_ERR (bit 3 Sensor Status 2)                                                                                               | 0x00000200 |
| 10  | ACC_ANOMALY               | ACC_X_ERR (bit 4 Sensor Status 2)<br>or ACC_Y_ERR (bit 5 Sensor Status 2)<br>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)<br>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               | INPUT_A_ERR (bit 1 System Status 1)                                                                                                                                                                                                                      | 0x00010000 |
| 17  | INPUT_B_ERR               | INPUT_B_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_D_ERR (bit 4 System Status 1)                                                                                                                                                                                                                      | 0x00080000 |
| 20  | INPUT_E_ERR               | INPUT_E_ERR (bit 5 System Status 1)                                                                                                                                                                                                                      | 0x00100000 |
| 21  | OUTPUT_A_ERR              | OUTPUT_A_FULL (bit 16 System Status 2)                                                                                                                                                                                                                   | 0x00200000 |

| Bit | Name           | Conditions                                                                                                                                                                             | Value      |
|-----|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 22  | OUTPUT_B_ERR   | OUTPUT_B_FULL (bit 17 System Status 2)                                                                                                                                                 | 0x00400000 |
| 23  | OUTPUT_C_ERR   | OUTPUT_C_FULL (bit 18 System Status 2)                                                                                                                                                 | 0x00800000 |
| 24  | OUTPUT_D_ERR   | OUTPUT_D_FULL (bit 19 System Status 2)                                                                                                                                                 | 0x01000000 |
| 25  | OUTPUT_E_ERR   | OUTPUT_E_FULL (bit 20 System Status 2)                                                                                                                                                 | 0x02000000 |
| 26  | HRP_INVALID    | ALIGNEMENT (bit 1 Algo Status 1)<br>or FOG_ANOMALY (bit 9 User Status )<br>or ACC_ANOMALY (bit 10 User Status )<br>or SPEED_SATURATION (bit 29 Algo Status 1)                          | 0x04000000 |
| 27  | ALIGNEMENT     | ALIGNEMENT (bit 1 Algo Status 1)                                                                                                                                                       | 0x08000000 |
| 28  | FINE_ALIGNMENT | 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)<br>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)<br>or ALTITUDE_SATURATION (bit 28 Algo Status 1) or SPEED_SATURATION (bit 29 Algo Status 1)<br>or RESTORE_ATTITUDE_FAILED (bit 23 Algo Status 3) | 0x80000000 |

## 5.6 High-level Status

Each flag of the high-level Status is a combination of flags from sensor, algorithm and/or system status. Unlike other status, some status bits are set when others are not set.

| Bit | Name             | Set when following bits are returned                                                                                                                                                                                                                                                                                                                                                        | Value      |
|-----|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 0   | SYSTEM OK        | SYSTEM INIT (bit 1 HighLevel Status) NOT SET<br>and SYSTEM ERROR (bit 2 HighLevel Status) NOT SET<br>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<br>or SPEED SATURATION (bit 29 Algo Status 1) SET<br>or ELECTRONIC ERROR (bit 8 high-level Status) SET<br>or SERIAL OUT ERROR (bit 7 high-level Status) SET<br>or SERIAL IN ERROR (bit 5 high-level Status) SET<br>or FAILURE MODE (bit 31 Sensor Status 2) SET<br>or FOG ANOMALY (bit 9 User Status)<br>or ACC ANOMALY (bit 10 User Status) | 0x00000004 |
| 3   | SYSTEM WARNING   | INTERPOLATION MISSED (bit 30 Algo Status 1) SET<br>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 | TEMPERATURE ERROR (bit 16 HighLevel Status) SET<br>or CPU ERROR (bit 15 HighLevel Status) SET<br>or ACC ERROR (bit 13 HighLevel Status) SET<br>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        | OR function on accelerometer error                                                                                                                                                                                                                                                                                                                                                          | 0x00002000 |
| 14  | CPU OK           | CPU ERROR (bit 15 HighLevel Status) NOT SET                                                                                                                                                                                                                                                                                                                                                 | 0x00004000 |
| 15  | CPU ERROR        | DSP OVERLOPAD (bit 8 Sensor Status 2) SET<br>or CINT OVERLOAD (bit 27 System Status 2) SET                                                                                                                                                                                                                                                                                                  | 0x00008000 |
| 16  | TEMPERATURE OK   | TEMP ERROR (bit 17 HighLevel Status) NOT SET                                                                                                                                                                                                                                                                                                                                                | 0x00010000 |

| Bit | Name              | Set when following bits are returned                                                                                                                                                                                                      | Value      |
|-----|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 17  | TEMPERATURE ERROR | TEMP ERROR (bit 7 Sensor Status 2) SET                                                                                                                                                                                                    | 0x00020000 |
| 18  | GPS1              | GPS DETECTED (bit 2 System Status 2) NOT SET                                                                                                                                                                                              | 0x00040000 |
| 20  | MANUAL GPS        | MANUAL GPS DETECTED (bit 14 System Status 2) NOT SET                                                                                                                                                                                      | 0x00100000 |
| 21  | DVL BOTTOM TRACK  | DVL BT DETECTED (bit 0 System Status 2) NOT SET                                                                                                                                                                                           | 0x00200000 |
| 22  | DVL WATER TRACK   | DVL WT DETECTED (bit 1 System Status 2) NOT SET                                                                                                                                                                                           | 0x00400000 |
| 23  | EM LOG            | EM LOG DETECTED (bit 7 System Status 2) NOT SET                                                                                                                                                                                           | 0x00800000 |
| 24  | DEPTH             | DEPTH DETECTED (bit 6 System Status 2) NOT SET                                                                                                                                                                                            | 0x01000000 |
| 25  | USBL              | USBL DETECTED (bit 4 System Status 2) NOT SET                                                                                                                                                                                             | 0x02000000 |
| 26  | LBL               | LBL DETECTED (bit 5 System Status 2) NOT SET                                                                                                                                                                                              | 0x04000000 |
| 27  | ALTITUDE          | ALTITUDE DETECTED (bit 10 System Status 2) NOT SET                                                                                                                                                                                        | 0x08000000 |
| 28  | UTC SYNC          | UTC DETECTED (bit 9 System Status 2) NOT SET                                                                                                                                                                                              | 0x10000000 |
| 29  | PPS SYNC          | PPS DETECTED (bit 11 System Status 2) NOT SET                                                                                                                                                                                             | 0x20000000 |
| 30  | CTD               | CTD DETECTED (bit 15 System Status 2) NOT SET                                                                                                                                                                                             | 0x40000000 |
| 31  | ZUPT              | ZUPT MODE ACTIVATED (bit 16 Algo Status 2) NOT SET<br>and ZUPT MODE VALID (bit 17 Algo Status 2) NOT SET<br>and AUTOSTATICBENCH ZUPT MODE (bit 18 Algo Status 2) NOT SET<br>and AUTOSTATICBENCH ZUPT VALID (bit 19 Algo Status 2) NOT SET | 0x80000000 |

## 6 Digital Protocols

---

Input digital interfaces are user-configurable with different protocols (or formats) to be selected from the digital interface library. Digital protocols can handle input data with different format: binary, ASCII and NMEA compliant.



An excel file is provided into the Phins Compact C7 flash drive with the input and output protocols in order to choose the protocol depending on the parameters.

## 6.1 Detailed Specification of Input Protocols

### APOS PSIMLBP

**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 Phins Compact C7 algorithm 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. Phins Compact C7 only considers UTC time<br>Warning: Shall not be blank field.                                                                                                              | USED     |
| TpC                                                                             | Transponder code <b>Note 1</b><br>Up to three transponders can be taken into account<br>Warning: Shall not be blank field. At most, 3 characters expected.<br><br>Type of the item positioned                             | USED     |
| aa                                                                              | Status <b>Note 2</b><br>Warning: Shall not be blank field.                                                                                                                                                                | NOT USED |
| S                                                                               | Only 1 character expected.<br>ASCII 'A' = data valid<br>ASCII 'V' = data invalid                                                                                                                                          | USED     |
| C                                                                               | Coordinate system <b>Note 3</b><br>Warning: Shall not be blank field. Only 1 character expected.<br>ASCII 'C' = Cartesian ASCII 'P' = Polar ASCII 'U' = UTM ASCII 'R' = Radians                                           | USED     |
| x.x                                                                             | X_coordinate (latitude or UTM Northing) <b>Note 3</b><br>Y_coordinate (longitude or UTM Easting) <b>Note 3</b><br>Depth of the position in meters                                                                         | USED     |
| y.y                                                                             | Major axis of the error ellipse <b>Note 4</b><br>Minor axis of the error ellipse <b>Note 4</b><br>Direction of the major axis in the error ellipse (in degrees) <b>Note 4</b><br>r.m.s. value of the normalized residuals | USED     |
| d.d                                                                             | Potential additional fields                                                                                                                                                                                               | USED     |
| M.M                                                                             | is the NMEA checksum                                                                                                                                                                                                      | USED     |
| m.m                                                                             |                                                                                                                                                                                                                           | USED     |
| e.e                                                                             |                                                                                                                                                                                                                           | USED     |
| t.t                                                                             |                                                                                                                                                                                                                           | NOT 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,E,...                                                                         |  | NOT USED |
| *hh                                                                             |  | 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 Compact C7. 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:** Phins Compact C7 uses either UTM or Radian coordinates of the transponder. Cartesian or Polar coordinates are not taken into account by Phins Compact C7. 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 calculate the X,Y standard deviations set for Phins Compact C7 algorithm.

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

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

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

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, Phins Compact C7 rejects the USBL data if USBL position is too far from the Phins Compact C7 computed position: automatic rejection mode (recommended mode).

**APOS PSIMSSB**

**Standard:** ASCII proprietary. 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.

The format is:

| \$PSIMSSB,hhmmss.ss,TpC,s,eee,C,O,F,x.x,y.y,d.d,a.a,l,A.A,B.B[,D,E,...]*hh<CR><LF> |                                                                                                                                                                                            |          |
|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| \$PSIMSSB                                                                          | NMEA message header                                                                                                                                                                        | USED     |
| hhmmss.ss                                                                          | Real time of the measurement.<br>The INS only considers UTC time<br>Warning: Shall not be blank field.                                                                                     | USED     |
| TpC                                                                                | Transponder Tp code <b>Note 1</b><br>Warning: Shall not be blank field.<br>At most, 3 characters expected.                                                                                 | USED     |
| s                                                                                  | Status <b>Note 2</b><br>Warning: Shall not be blank field.<br>Only 1 character expected. ASCII 'A' = data valid ASCII 'V' = data invalid                                                   | USED     |
| eee                                                                                | Error code <b>Note 3</b><br>INS will not reject the USBL frame if this field is empty<br>Warning: Blank field or 3 characters expected.                                                    | USED     |
| C                                                                                  | Coordinate system <b>Note 4</b> <b>Note 1</b> Warning: Shall not be blank field. Only 1 character expected.<br>ASCII 'C' = Cartesian ASCII 'P' = Polar ASCII 'U' = UTM ASCII 'R' = Radians | USED     |
| O                                                                                  | Orientation <b>Note 5</b><br>Warning: Shall not be blank field. Only 1 character expected.<br>ASCII 'H' = vehicle Head up ASCII 'E' = East ASCII 'N' = North                               | USED     |
| F                                                                                  | Filter <b>Note 6</b><br>ASCII 'M' = Measured data ASCII 'F' = Filtered data ASCII 'P' = Predicted data                                                                                     | NOT USED |
| x.x                                                                                | X_coordinate (latitude or UTM Northing)<br><b>Note 4</b>                                                                                                                                   | USED     |
| y.y                                                                                | Y_coordinate (longitude or UTM Easting)<br><b>Note 4</b>                                                                                                                                   | USED     |
| d.d                                                                                | Depth in meters                                                                                                                                                                            | USED     |
| a.a                                                                                | Expected accuracy of the position <b>Note 7</b>                                                                                                                                            | USED     |
| l                                                                                  | Additional information <b>Note 8</b>                                                                                                                                                       | 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> |                                                                                                                                                                                                                             |          |
|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|                                                                                    | Warning: Shall not be blank field. Only 1 character expected.<br>ASCII 'N' = None ASCII 'C' = Compass ASCII 'I' =<br>Inclinometer ASCII 'D' = Depth ASCII 'T' = Time from<br>transponder to transducer ASCII 'V' = Velocity |          |
| A.A                                                                                | First additional value depending on additional info <b>Note 8</b><br>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<br>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.

**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 Compact C7.

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 GNSS time. Unit in seconds. If INS is UTC synchronized it will use the time stamp in the telegram (first field).

**AUVG3000****Standard:**

**Data received:** DVL bottom track and water track speeds, GNSS latitude and longitude, USBL latitude and longitude, Depth, GNSS fix position age, USBL fix position age, data validity status  
16 fields – 64 bytes MSB first

**Data frame:**

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

\* Phins Compact C7 will reject all the inputs for unexpected synchronisation bytes or bad checksum. If age of data or data validity is 0 PHINS will reject the corresponding data.

**\*\* Status specification**

| 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 GNSS altitude fields. If the depth data is valid, Phins Compact C7 will use the depth as the USBL altitude. If the depth data is not valid, the USBL altitude is set to 0. The GNSS altitude is always set to 0.

\*\*\*\* The AUVG3000 input protocol sentence does not send the standard deviations on sensor data so the following standard Phins Compact C7 default values will be used.

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

**GAPS****Standard:** Input ASCII.**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                                                                          | Acoustic 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<br>0: Ship<br>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.<br>If A=0xF position is valid else position is false.  | USED     |
| M.M                                                                             | Calculated beacon depth in meters (*)                                                     | USED     |
| A                                                                               | Beacon depth validity.<br>A= 0 : no depth<br>A= 1: Calculated<br>A= 2: Sensor             | NOT USED |
| M.M                                                                             | Sensor depth in meters<br>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,hmss.s,jj,mm,aaaa,BBB,X.X,Y.Y,A,P.P,A,C.C*hh<CR><LF> |                                                                                           |          |
|---------------------------------------------------------------------|-------------------------------------------------------------------------------------------|----------|
| #NNNNN                                                              | Acoustic recurrence n°                                                                    | NOT USED |
| hmss.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<br>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<br>If A=0xF position is valid else position is false.                | USED     |
| P.P                                                                 | Calculated beacon depth in meters (**)                                                    | USED     |
| A                                                                   | Beacon depth validity.<br>A= 0 : no depth<br>A= 1: Calculated<br>A= 2: Sensor             | NOT USED |
| C.C                                                                 | Sensor depth in meters<br>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 |
| hhmmss.s                                           | Time validity of the data | USED |
| Q                                                  | Quality factor (**)       | USED |
| hh                                                 | Checksum                  | USED |

(\*) Last valid GNSS fix received by GAPS

(\*\*) Refer to section 1.4.

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

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

## GPS (GNSS)

**Standard:** Input ASCII.

**Data received:** Time, latitude, longitude, altitude, hemisphere, quality factor, number of satellites, HDOP, depth, geoidal separation, checksum NMEA

**Data frame is composed of:**

- NMEA \$--GGA Frame see section 3.2.1
- NMEA \$--GLL Frame see section 3.2.2
- NMEA \$--GST Frame see section 3.2.3
- NMEA \$--RMC Frame see section 3.2.4
- UTC Frame see section 3.3.1
- NMEA \$--ZDA Frame see section 3.2.7

**HALLIBURTON SAS**

**Standard:** ASCII, 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, GNSS Latitude, Longitude, GNSS quality, GNSS 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>

|                 |                                                                                                                                                                           |                         |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| <b>hhmmss.s</b> | 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) | ss.s : 32 bit float (*) |
| <b>llmm.m</b>   | is the latitude in degrees (ll) and in minutes (mm.m)                                                                                                                     | mm.m : 32 bit float     |
| <b>a</b>        | is the hemisphere<br>N: North<br>S: South                                                                                                                                 | char                    |
| <b>LLLmm.m</b>  | is the longitude in degrees (LLL) and in minutes (mm.m)                                                                                                                   | mm.m : 32 bit float     |
| <b>b</b>        | is longitude sign<br>E: East<br>W: West                                                                                                                                   | char                    |
| <b>±c.c</b>     | is estimated errors in latitude, covar(Lat), in meters <sup>2</sup>                                                                                                       | 32 bit float            |
| <b>±c.c</b>     | is estimated error in longitude, covar(Long), in meters <sup>2</sup>                                                                                                      | 32 bit float            |
| <b>±c.c</b>     | is estimated correlated lat/long error, covar(LatLong), in meters <sup>2</sup>                                                                                            | 32 bit float            |
| <b>±c.c</b>     | is estimated error in depth, covar(depth) in meters <sup>2</sup>                                                                                                          | 32 bit float            |
| <b>r.r</b>      | range standard deviation error in meters (NOT USED)                                                                                                                       | 32 bit float            |
| <b>t.t</b>      | angular observation standard deviation in degrees (NOT USED)                                                                                                              | 32 bit float            |
| <b>s.s</b>      | is the slant range in meters (NOT USED)                                                                                                                                   | 32 bit float            |
| <b>a.a</b>      | is the age of the data in seconds (taken into account if INS is not UTC time synchronized)                                                                                | 32 bit float            |
| <b>llmm.m</b>   | is the vehicle latitude in degrees (ll) and in minutes (mm.m) (NOT USED)                                                                                                  | mm.m: 32 bit float      |
| <b>a</b>        | is the hemisphere<br>N: North<br>S: South                                                                                                                                 | char (NOT USED)         |
| <b>LLLmm.m</b>  | is the vehicle longitude in degrees (LLL) and in minutes (mm.m)                                                                                                           | mm.m : 32 bit float     |
| <b>b</b>        | is longitude sign<br>E: East<br>W: West                                                                                                                                   | char                    |
| <b>d.d</b>      | is the beacon depth                                                                                                                                                       | 32 bit float            |
| <b>c</b>        | is the computed mode (NOT USED)                                                                                                                                           |                         |

(\*) 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>

|               |           |                                                                                                                                           |
|---------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>where:</b> | hhmmss.ss | UTC time stamp of position (taken into account if INS is UTC time synchronized otherwise age of data is taken into account)[1] (NOT USED) |
|               | l.l       | is the correction of latitude in meters                                                                                                   |
|               | y.y       | is the correction of longitude in meters                                                                                                  |
|               | ±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>**

|               |           |                                                                                                                                  |
|---------------|-----------|----------------------------------------------------------------------------------------------------------------------------------|
| <b>where:</b> | hhmmss.ss | UTC time stamp of position (taken into account if INS is UTC time synchronized otherwise delay of data is taken into account)[1] |
|               | 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<br>N: North<br>S: South                                                                                        |
|               | LLLm.m    | is the seabed beacon longitude in deg (LLL) and in min (m.m)                                                                     |
|               | b         | is longitude sign<br>E: East<br>W: West                                                                                          |
|               | a.a       | is the seabed beacon depth in meters                                                                                             |

\$--GGA Frame, see chapter 3.2.1

**\$GPZDA, hhmmss.ss, , , , , \*hh <CR><LF>**

|                |           |                                     |
|----------------|-----------|-------------------------------------|
| <b>where :</b> | hhmmss.ss | is the UTC of the last PPS received |
|                | hh        | is the checksum                     |

## **IXBLUE STD BIN V2, V3**

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

**IXSEA USBL INS1****Standard:** Input ASCII.**Data received:** Latitude, Longitude, Immersion, time stamp, STD on position.

21 bytes expected. LSB first. Dedicated to receive USBL data from GAPS USBL system

**Data frame:**

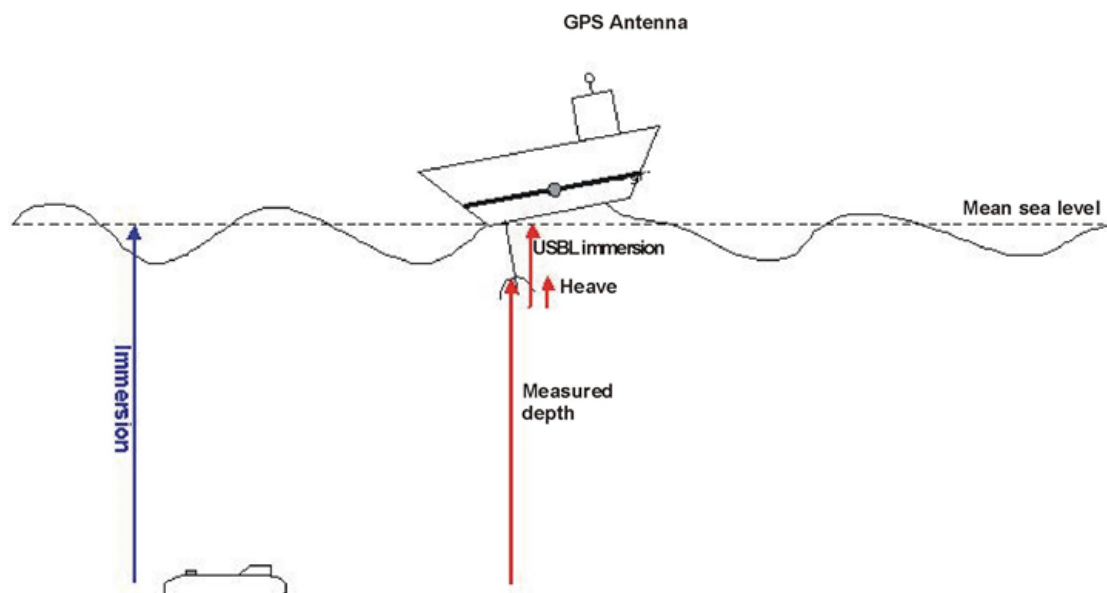
| Byte Nb                           | Field       | Nb of bits | definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Value LSB | Min Value         | Max Value                 |
|-----------------------------------|-------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------------|---------------------------|
| 1                                 | GGhex       | 8          | header                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 55hex     |                   |                           |
| 2                                 | Bits 2 to 0 | 3          | Message number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 001bin    |                   |                           |
|                                   | Bits 7 to 3 | 5          | Transponder ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | NA        | 0                 | 31                        |
| 3, 4, 5, 6                        | LLLLLLLLhex | 32         | Latitude (deg)<br>(Two-complement coded)                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 180/232   | - 90 °            | 90x(1-232) °              |
| 7, 8, 9, 10                       | NNNNNNNNhex | 32         | Longitude (deg)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 360/232   | 0 °               | 360.(1-232) °             |
| 11 to12 and bit 0 to 3 of byte 13 | ZZZZZhex    | 20         | Z (m), immersion                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 0,01 m    | 0 m<br>(00000hex) | +10485,75 m<br>(FFFFFhex) |
| 13                                | Bit 4       | 1          | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                   |                           |
|                                   | Bits 7 to 5 | 3          | Standard deviation of semi-major axis of error ellipse in meters:<br>000 : 0 m < standard deviation < 0,5 m<br>001 : 0,5 m < standard deviation < 1,5 m<br>010 : 1,5 m < standard deviation < 3 m<br>011 : 3 m < standard deviation < 6 m<br>100 : 6 m < standard deviation < 12 m<br>101 : 12 m < standard deviation < 25 m<br>110 : 25 m < standard deviation < 50 m<br>111 : standard deviation > 50 m<br>000 to 110 : STD1 is set to max value (i.e : 50 m for 110)<br>111 : STD1 is set to 500 m |           |                   |                           |
|                                   |             |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |                   |                           |

| Byte Nb | Field                                                                                                 | Nb of bits | definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Value LSB | Min Value | Max Value                                                                                |
|---------|-------------------------------------------------------------------------------------------------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|------------------------------------------------------------------------------------------|
| 14      | Bit 0                                                                                                 | 1          | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |           |                                                                                          |
|         | Bits 3 to 1                                                                                           | 3          | Standard deviation of semi-minor axis of error ellipse in meters:<br>000 : 0 m < standard deviation < 0,5 m<br>001 : 0,5 m < standard deviation < 1,5 m<br>010 : 1,5 m < standard deviation < 3 m<br>011 : 3 m < standard deviation < 6 m<br>100 : 6 m < standard deviation < 12 m<br>101 : 12 m < standard deviation < 25 m<br>110 : 25 m < standard deviation < 50 m<br>111 : standard deviation > 50 m<br>000 to 110 : STD1 is set to max value (i.e : 50 m for 110)<br>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                                                                                                                                                                                                                                                                                                                                                                                                                                   | 180/24    | 0 °       | 15/16 x180 °                                                                             |
| 15      | Bit 0                                                                                                 | 1          | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |           |                                                                                          |
|         | Bits 3 to 1                                                                                           | 3          | Standard deviation of the Z(m) position<br>000 : 0 m < standard deviation < 0,5 m<br>001 : 0,5 m < standard deviation < 1,5 m<br>010 : 1,5 m < standard deviation < 3 m<br>011 : 3 m < standard deviation < 6 m<br>100 : 6 m < standard deviation < 12 m<br>101 : 12 m < standard deviation < 25 m<br>110 : 25 m < standard deviation < 50 m<br>111 : standard deviation > 50 m<br>000 to 110 : STD1 is set to max value (i.e : 50 m for 110)<br>111 : STD1 is set to 500 m                           |           |           |                                                                                          |
|         | Bits 7 to 4                                                                                           | 4          | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |           |                                                                                          |
| 16      | PPhex                                                                                                 | 8          | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |           |                                                                                          |
| 17, 18  | rrrrrrrrrrrrrrrrrrrrrrbin<br>(8+8+6 bits of:<br>- byte 17,<br>- byte 18,<br>- bits 5 to 0 of byte 19) | 22         | UTC time stamp of position in ms.                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1 ms      | 0 ms      | (3 599 999 ms, i.e. 1h - 1ms<br>The largest values of this field do not have any meaning |

| Byte Nb | Field                  | Nb of bits | definition                                                                          | Value LSB | Min Value | Max Value |
|---------|------------------------|------------|-------------------------------------------------------------------------------------|-----------|-----------|-----------|
|         | Bits 7 and 6 of byte19 | 2          | Reserved                                                                            |           |           |           |
| 20      | KKhex                  | 8          | Status byte<br>Bits 0 to 8 - Reserved                                               |           |           |           |
| 21      | SShex                  | 8          | Checksum<br>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

**MICRO SVT\_P****Standard:** ASCII, Input CTD.**Data received:** Time Stamps, 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)     | NOT USED |
| /                                                  | '/' character                                  |          |
| mm                                                 | Month (Unsigned decimal integer – 2 digits)    |          |
| /                                                  | '/' character                                  |          |
| dd                                                 | Day (Unsigned decimal integer – 2 digits)      |          |
| <SP>                                               | Space character                                |          |
| hh                                                 | Hour (Unsigned decimal integer – 2 digits)     | NOT USED |
| :                                                  | ':' character                                  |          |
| mm                                                 | Minutes (Unsigned decimal integer – 2 digits)  |          |
| :                                                  | ':' 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 1.5. 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

**Standard:** ASCII, Input CTD.

**Data frame:** This protocol applies 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 Phins Compact C7.

Applicable document :

- Valeport miniSVS Operating manual 0650808i.doc page 7 and 8 for format 1, 2 and 3.
- Applied Microsystems Micro SV-X Micro SV User Manual V1.21 page 11 for format 2

### 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><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) (*)<br>PPP.PP (i.e. 123.45 dbar)<br>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 1.5. 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.

**NORTEK DF21/DF22**

**Standard:** ASCII. NORTEK proprietary protocol.

**Data received:** Pressure, Temperature, Internal Speed of Sound, Range to Bottom, Figure of Merit, SpeedX, SpeedY, SpeedZ, Delay X, Delay Y, Delay Z.

**Data frame:**

Unique definition message used for two types of DVL data (ID message) :

- 0x1B: Speed data in Bottom track
- 0x1D: Speed data in Water track

Little Indian (LSB sent first)

**Header**

| Field | Index  | Type    | Designation                   | Comment                                             |
|-------|--------|---------|-------------------------------|-----------------------------------------------------|
| 0     | 0      | UINT 8  | Header ID                     | Fixed value = 0xA5                                  |
| 1     | 1      | UINT 8  | Header Size                   | (NOT USED)                                          |
| 2     | 2      | UINT 8  | ID Message. See (1)           | 0x1B: DVL Bottom Track OR<br>0x1D: DVL Water Track. |
| 3     | 3      | UINT 8  | Family                        | (NOT USED)                                          |
| 4     | 4 to 5 | UINT 16 | Data Size of following record | (NOT USED)                                          |
| 5     | 6 to 7 | UINT 16 | Data Checksum                 | (NOT USED)                                          |
| 6     | 8 to 9 | UINT 16 | Header Checksum               | (NOT USED)                                          |

Ref: Nortek Doc - 8.1 Header definition - Page 39.

**Errata:** Nortek documentation tag a lot of things as 'signed' on array (8.1) but samples code (8.1.1 & 8.1.2) on the same doc declare it as 'unsigned', use 'unsigned' on our implementation.

UINT 8: Integer 8 bits unsigned / UINT 16: Integer 16 bits unsigned.

**DF21 / DF22****Record Data**

| Field | Index    | Type    | Designation      | Comment                                               |
|-------|----------|---------|------------------|-------------------------------------------------------|
| 0     | 10       | UINT 8  | Version          | Fixed value = 1                                       |
| 1     | 11       | UINT 8  | Offset of Data   | Number of bytes from start of record to start of data |
| 2     | 12 to 15 | UINT 32 | Serial number    | (NOT USED)                                            |
| 3a    | 16       | UINT 8  | Year             | (NOT USED)                                            |
| 3b    | 17       | UINT 8  | Month            | (NOT USED)                                            |
| 4     | 18       | UINT 8  | Day. See (2)     | (NOT USED)                                            |
| 5     | 19       | UINT 8  | Hour. See (2)    | LSB = 1 Hour (For NTP mechanism)                      |
| 6     | 20       | UINT 8  | Minute. See (2)  | LSB = 1 Minute (For NTP mechanism)                    |
| 7     | 21       | UINT 8  | Seconds. See (2) | LSB = 1 Second (For NTP mechanism)                    |

| Field | Index      | Type     | Designation             | Comment                                                                                                                  |
|-------|------------|----------|-------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 8     | 22 to 23   | UINT 16  | Microsec100             | LSB = 100 $\mu$ sec                                                                                                      |
| 9     | 24 to 25   | UINT 16  | #Beams. See (3)         | Number of Beams 4: All Beams used                                                                                        |
| 10    | 26 to 29   | UINT 32  | Error                   | (NOT USED)                                                                                                               |
| 11    | 30 to 33   | UINT 32  | Status                  | (NOT USED)                                                                                                               |
| 12    | 34 to 37   | UINT 32  | Sound of Speed          | Speed of Sound in [m/s]<br>Float 32 bits (IEE754)                                                                        |
| 13    | 38 to 41   | UINT 32  | Temperature             | (NOT USED)                                                                                                               |
| 14    | 42 to 45   | UINT 32  | Pressure                | Pressure in [Bar]<br>Float 32 bits (IEE754)                                                                              |
| 15    | 46 to 61   | FLOAT 32 | Velocity Beam [0,1,2,3] | (NOT USED)                                                                                                               |
| 16    | 62 to 65   | FLOAT 32 | Distance Beam 0.        | See (4)                                                                                                                  |
| 17    | 66 to 69   | FLOAT 32 | Distance Beam 1.        | Range to bottom altitude in [m] Float 32 bits (IEE754) used only on BT mode<br>Range 0 to 65535m Invalid data set to 0.0 |
| 18    | 70 to 73   | FLOAT 32 | Distance Beam 2.        |                                                                                                                          |
| 19    | 74 to 77   | FLOAT 32 | Distance Beam 3.        |                                                                                                                          |
| 20    | 78 to 81   | FLOAT 32 | FOM Beam 0              | (NOT USED)                                                                                                               |
|       | 82 to 85   | FLOAT 32 | FOM Beam 1              | (NOT USED)                                                                                                               |
|       | 86 to 89   | FLOAT 32 | FOM Beam 2              | (NOT USED)                                                                                                               |
|       | 90 to 93   | FLOAT 32 | FOM Beam 3              | (NOT USED)                                                                                                               |
| 21    | 94 to 97   | FLOAT 32 | DT1 Beam 0              | (NOT USED)                                                                                                               |
|       | 98 to 101  | FLOAT 32 | DT1 Beam 1              | (NOT USED)                                                                                                               |
|       | 102 to 105 | FLOAT 32 | DT1 Beam 2              | (NOT USED)                                                                                                               |
|       | 106 to 109 | FLOAT 32 | DT1 Beam 3              | (NOT USED)                                                                                                               |
| 22    | 110 to 113 | FLOAT 32 | DT2 Beam 0              | (NOT USED)                                                                                                               |
|       | 114 to 117 | FLOAT 32 | DT2 Beam 1              | (NOT USED)                                                                                                               |
|       | 118 to 121 | FLOAT 32 | DT2 Beam 2              | (NOT USED)                                                                                                               |
|       | 122 to 125 | FLOAT 32 | DT2 Beam 3              | (NOT USED)                                                                                                               |
| 23    | 126 to 129 | FLOAT 32 | Time Vel Est Beam 0     | (NOT USED)                                                                                                               |
|       | 130 to 133 | FLOAT 32 | Time Vel Est Beam 1     | (NOT USED)                                                                                                               |
|       | 134 to 137 | FLOAT 32 | Time Vel Est Beam 2     | (NOT USED)                                                                                                               |
|       | 128 to 141 | FLOAT 32 | Time Vel Est Beam 3     | (NOT USED)                                                                                                               |
| 24    | 142 to 145 | FLOAT 32 | Velocity X. See (5)     | Data velocity in Ship coordinate in [m/s] Float 32 bits (IEE754) used on BT & WT mode Invalid data set to -32.768 m/s    |
| 25    | 146 to 149 | FLOAT 32 | Velocity Y. See (5)     |                                                                                                                          |
| 26    | 150 to 153 | FLOAT 32 | Velocity Z1. See (5)    |                                                                                                                          |
| 27    | 154 to 157 | FLOAT 32 | Velocity Z2. See (5)    |                                                                                                                          |

| Field | Index      | Type     | Designation       | Comment                                                                                                        |
|-------|------------|----------|-------------------|----------------------------------------------------------------------------------------------------------------|
| 28    | 158 to 161 | FLOAT 32 | FOM X             | Figure of Merit in [m/s]                                                                                       |
| 29    | 162 to 165 | FLOAT 32 | FOM Y             | Float 32 bits (IEE754) used on BT & WT mode Range 0 to 10m/s Invalid data set to 10.0                          |
| 30    | 166 to 169 | FLOAT 32 | FOM Z1            |                                                                                                                |
| 31    | 170 to 173 | FLOAT 32 | FOM Z2            | (NOT USED)                                                                                                     |
| 32    | 174 to 177 | FLOAT 32 | DT1 X. See (6)    | Beam data latency in Ship coordinate in [s] Float 32 bits (IEE754) used only in BT mode Range 0.0 to 5.0s      |
| 33    | 178 to 181 | FLOAT 32 | DT1 Y. See (6)    |                                                                                                                |
| 34    | 182 to 185 | FLOAT 32 | DT1 Z1. See (6)   |                                                                                                                |
| 35    | 186 to 189 | FLOAT 32 | DT1 Z2. See (6)   | Invalid data set to 0.0                                                                                        |
| 36    | 190 to 193 | FLOAT 32 | DT2 X. See (6)    | Computing data latency in Ship coordinate in [s] Float 32 bits (IEE754) used only in BT mode Range 0.0 to 5.0s |
| 37    | 194 to 197 | FLOAT 32 | DT2 Y. See (6)    |                                                                                                                |
| 38    | 198 to 201 | FLOAT 32 | DT2 Z1. See (6)   |                                                                                                                |
| 39    | 202 to 205 | FLOAT 32 | DT2 Z2. See (6)   | Invalid data set to 0.0                                                                                        |
| 40    | 206 to 221 | FLOAT 32 | Time Vel Est Axis | (NOT USED)                                                                                                     |

Ref: Nortek Doc - 8.3 DF21/DF22 - DVL Bottom Track & Water Track Data Record Definitions  
- Page 49 to 51.

UINT8: Integer 8 bits unsigned / UINT 16: Integer 16 bits unsigned

UINT32: Integer 32 bits unsigned / FLOAT 32: Float 32 bits using IEEE754 format.

| Bit # | Description                                                                                                                                |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 0     | Beam 1 Velocity Valid                                                                                                                      |
| 1     | Beam 2 Velocity Valid                                                                                                                      |
| 2     | Beam 3 Velocity Valid                                                                                                                      |
| 3     | Beam 4 Velocity Valid                                                                                                                      |
| 4     | Beam 1 Distance Valid                                                                                                                      |
| 5     | Beam 2 Distance Valid                                                                                                                      |
| 6     | Beam 3 Distance Valid                                                                                                                      |
| 7     | Beam 4 Distance Valid                                                                                                                      |
| 8     | Beam 1 Figure of Merit Valid                                                                                                               |
| 9     | Beam 2 Figure of Merit Valid                                                                                                               |
| 10    | Beam 3 Figure of Merit Valid                                                                                                               |
| 11    | Beam 4 Figure of Merit Valid                                                                                                               |
| 12    | X Velocity Valid - Warning this flag can be set with an out of range value [-32;+32]                                                       |
| 13    | Y Velocity Valid - Warning there a bug on the vendor documentation.<br>- Warning this flag can be set with an out of range value [-32;+32] |
| 14    | Z1 Velocity Valid - Warning this flag can be set with an out of range value [-32;+32]                                                      |
| 15    | Z2 Velocity Valid - Warning this flag can be set with an out of range value [-32;+32]                                                      |

| Bit #    | Description                                                                                                                                 |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 16       | X Figure of Merit Valid                                                                                                                     |
| 17       | Y Figure of Merit Valid                                                                                                                     |
| 18       | Z1 Figure of Merit Valid                                                                                                                    |
| 19       | Z2 Figure of Merit Valid                                                                                                                    |
| 20       | Less than 3% processing capacity left – Do not monitor reserved for vendors debug.                                                          |
| 21       | Less than 6% processing capacity left – Do not monitor reserved for vendors debug.                                                          |
| 22       | Less than 12% processing capacity left – Do not monitor reserved for vendors debug.                                                         |
| 28 to 31 | Wakeup State:<br>0010 = break<br>0011 = RTC alarm<br>0000 = bad power<br>0001 = power applied<br>Do not monitor reserved for vendors debug. |

- (1) The ID value is used to define if the data is in the Bottom track or Water track mode.
- (2) The Absolute time is applied when the NTP synchronization is set to ON into IHM DVL parameters.
- (3) The DVL shall be configured to ALL beam used. By default: #Beams is set to 4.
- (4) Range to bottom is computed as an average of 4 ranges to bottom given (excluding zero field meaning bad detection).
- (5) iXblue/Nortek Ship Coordinates convention:
  - >  $INS\ Forward = XDVL * 0.7071068 + YDVL * 0.7071068$
  - >  $INS\ Left = XDVL * 0.7071068 - YDVL * 0.7071068$
  - >  $INS\ Up = -ZDVL$ .

#### Checksum computation

- Header  
The checksum computation includes all header's data including 'Sync' and excluding 'Header Checksum'.
- Data  
The checksum computation includes all headers' extra data, 'Header Checksum is not included, all data after header must be included.
- Code  
Nortek original code was modified to avoid memory alignment issues on Arm platform during 16-bit data mapping on 8-bit buffers.

```

CRC = 0xB58C;
for (All 16-bit data)
  CRC += 16-bit data
if the last data is 8 bits size,
  CRC += "8-bit data" << 8
return CRC

```

Implementation detail: keep in mind that 16-bit pointers need to be aligned correctly on ARM devices.

PAROSCIENTIFIC

**Standard:** ASCII, Paroscientific pressure sensor.  
**Data received:** Depth calculated using sensor pressure.  
**Data frame:**

|                  |                                                                    |
|------------------|--------------------------------------------------------------------|
| *0001x.x<CR><LF> |                                                                    |
| 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 1.5.

**POSIDONIA**

**Standard:** Binary. 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>... |                |                               |                                                                                                                          |
|---------------------|----------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| <b>Field 0</b>      | Byte 0         | First synchronization byte    | Fixed value = 0x24                                                                                                       |
| <b>Field 1</b>      | Byte 1         | Transponder number            | Is a number in the range [0, 255]<br>The first received transponder number is NOT USED as a second synchronization byte. |
| <b>Field 2</b>      | Bytes 2 to 5   | USBL Latitude                 | Signed 32 bits +/-231 = +/-Pi                                                                                            |
| <b>Field 3</b>      | Bytes 6 to 9   | USBL longitude                | Signed 32 bits +/-231 = +/-Pi                                                                                            |
| <b>Field 4</b>      | Bytes 10 to 13 | USBL Depth                    | IEEE floating point format, meters                                                                                       |
| <b>Field 5</b>      | Bytes 14 to 17 | USBL Latitude std. deviation  | IEEE floating point format, meters                                                                                       |
| <b>Field 6</b>      | Bytes 18 to 21 | USBL Longitude std. deviation | IEEE floating point format, meters                                                                                       |
| <b>Field 7</b>      | Bytes 22 to 25 | USBL Depth std. deviation     | IEEE floating point format, meters                                                                                       |
| <b>Field 8</b>      | Bytes 26 to 29 | USBL Position delay           | IEEE floating point format, seconds                                                                                      |
| <b>Field 9</b>      | Bytes 30 to 31 | Checksum                      | 2 characters<br>Addition of all the bytes from 1 to 29.                                                                  |

## PRESSURE SENSOR

**Standard:** ASCII, 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).

For depth formula, refer to the section "Pressure to Depth Conversion Formula"

| \$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<br><b>Warning: Shall not be a blank field</b> |
| ,                          | Data field delimiter : HEX 2C                                                                                         |                                                    |
| ss                         | Status of the pressure sensor 11 or 10 when pressure valid 01 or 01 when pressure invalid                             | USED<br><b>Warning: Shall not be a blank field</b> |
| ,                          | Data field delimiter : HEX 2C                                                                                         |                                                    |
| t.t                        | Is the temperature in °C                                                                                              | NOT USED<br><b>Warning: Blank field allowed</b>    |
| *                          | 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                                                                                           |                                                    |

## RAMSES POSTPRO

**Standard:** Binary. 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 GNSS 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                 | +/- 231= +/-180°                                                                                                           |
| Field 8                    | Bytes 17 to 20 | long  | Longitude                | +/- 231= +/-180°                                                                                                           |
| Field 9                    | Bytes 21 to 24 | float | Immersion                | m                                                                                                                          |
| Field 10                   | Byte 25        | byte  | Position validity Note 2 | 0 : invalid<br>1 : in calibration process<br>2: valid for SLAM but not for INS aiding<br>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  | Synchronization         | 0x24                             |
| Field 1                    | Byte 1         | byte  | Telegram size           | 42                               |
| Field 2                    | Byte 2         | byte  | Telegram identification | 53                               |
| Field 3                    | Byte 3         | byte  | Data block 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  | Acoustic mode           | NOT USED                         |
| Field 8                    | Bytes 15 to 18 | long  | Latitude                | +/- 231= +/-180°                 |

| Message <F0><F1>.....<F15> |                |       |                                                                   |                                                                                                                                                                             |
|----------------------------|----------------|-------|-------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Field 9</b>             | Bytes 19 to 22 | long  | Longitude                                                         | +/- 231= +/-180°                                                                                                                                                            |
| <b>Field 10</b>            | Bytes 23 to 26 | float | Immersion                                                         | m                                                                                                                                                                           |
| <b>Field 11</b>            | Bytes 27 to 30 | float | Slant range                                                       | m                                                                                                                                                                           |
| <b>Field 12</b>            | Bytes 31 to 34 | float | Range std dev                                                     | m                                                                                                                                                                           |
| <b>Field 13</b>            | Bytes 35 to 38 | float | Measure age                                                       | s                                                                                                                                                                           |
| <b>Field 14</b>            | Byte 39        | byte  | Measurement validity according to Ramses algorithms <b>Note 3</b> | 0 : invalid Slam and invalid rough filter<br>1 : invalid Slam<br>2 : invalid rough filter<br>3 : valid distance but invalid for INS<br>4 : valid distance and valid for INS |
| <b>Field 15</b>            | 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> |                |       |                              |                                                         |
|----------------------------|----------------|-------|------------------------------|---------------------------------------------------------|
| <b>Field 0</b>             | Byte 0         | byte  | Synchronisation              | 0x24                                                    |
| <b>Field 1</b>             | Byte 1         | byte  | Telegram size                | 31                                                      |
| <b>Field 2</b>             | Byte 2         | byte  | Telegram identification      | 55                                                      |
| <b>Field 3</b>             | Byte 3         | byte  | Data bloc version            | 0x01                                                    |
| <b>Field 4</b>             | Bytes 4 to 7   | dword | Data validity time           | Time since 01/01/1970 in seconds                        |
| <b>Field 5</b>             | Bytes 8 to 11  | dword | Data validity time           | µs                                                      |
| <b>Field 6</b>             | Byte 12        | byte  | Device number                | (0-5) - NOT USED                                        |
| <b>Field 7</b>             | Bytes 13 to 16 | float | Conductivity                 | mS/cm - NOT USED                                        |
| <b>Field 8</b>             | Bytes 17 to 20 | float | Pressure <b>Note 5</b>       | dbar (NaN if data not available)                        |
| <b>Field 9</b>             | Bytes 21 to 24 | float | Salinity                     | PSU - NOT USED                                          |
| <b>Field 10</b>            | Bytes 25 to 28 | float | Sound velocity <b>Note 5</b> | Range ]1300 m/s, 1700 m/s [ (NaN if data not available) |
| <b>Field 11</b>            | 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 1.5.

**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 PDO**

**Standard:** Binary.

**Data received:**

Bottom Track velocities (Transverse velocity, Longitudinal velocity, Vertical velocity).

Water Track velocities (Transverse velocity, Longitudinal velocity, Vertical velocity)

High resolution Bottom Track velocities (Transverse velocity, Longitudinal velocity, Vertical velocity). High resolution Water Track velocities (Transverse velocity, Longitudinal velocity, Vertical velocity). Latency Track velocities.

Range to Bottom (given for each of 4 beams).

Speed of Sound

Depth (calculated with Pressure)

**Data frame:** LSB sent first, Signed integers are sent as 2-complemented values.

**Beam to Instrument Transformation:**

When velocities are given in Beam coordinates mode, INS has to apply beam to instrument transformation.

The beam to instrument transformation matrix is given by:

|   | Beam 1 | Beam 2 | Beam 3 | Beam 4 |
|---|--------|--------|--------|--------|
| X | $c*a$  | $-c*a$ | 0      | 0      |
| Y | 0      | 0      | $-c*a$ | $c*a$  |
| Z | b      | b      | b      | b      |

Where:

$c = 1$  for a convex transducer head

$a = 1/(2*\sin(30^\circ))$

$b = 1/(4*\cos(30^\circ))$

However, this transformation matrix has to be compensated from small beams misalignment. User has to retrieve this transformation matrix using PS3 command and enter the matrix values in the Web-Based Graphical User Interface (DVL parameters). Here is an example of PS3 command result (given with 20° beam angle instead of 30°)

**PS3 – Instrument Transformation Matrix**

PS3 sends information about the transducer beams. The WorkHorse uses this information in its coordinate-transformation calculations; for example, the output may look like this:

```
ps3
Beam Width: 3.7 degrees

Beam   Elevation   Azimuth
1      -70.14      269.72
2      -70.10      89.72
3      -69.99      0.28
4      -70.01      180.28

Beam Directional Matrix (Down):
0.3399  0.0017  0.9405  0.2414
-0.3405 -0.0017  0.9403  0.2410
-0.0017 -0.3424  0.9396 -0.2411
0.0017  0.3420  0.9398 -0.2415

Instrument Transformation Matrix (Down):
1.4691 -1.4705  0.0078 -0.0067
-0.0068  0.0078 -1.4618  1.4606
0.2663  0.2657  0.2657  0.2661
1.0367  1.0350  1.0359  1.0374
Beam Angle Corrections Are Loaded.
>
```

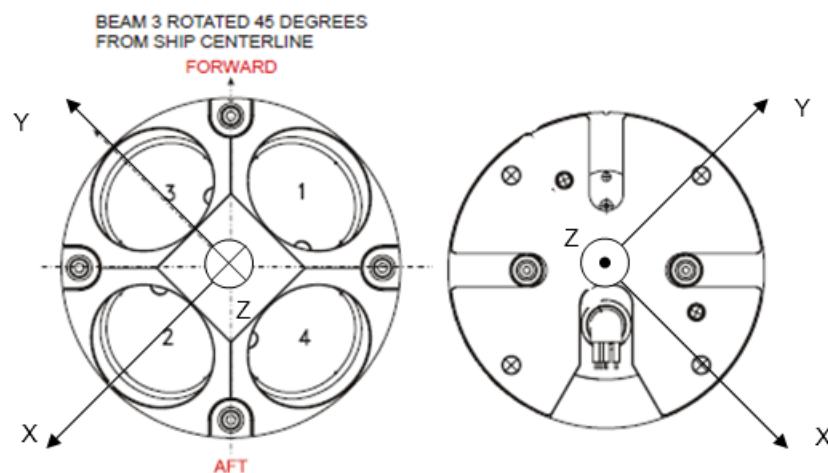
Q14:

|       |        |        |        |
|-------|--------|--------|--------|
| 24069 | -24092 | 127    | -109   |
| -111  | 127    | -23950 | 23930  |
| 4363  | 4354   | 4353   | 4359   |
| 16985 | 16957  | -16972 | -16996 |

If the WorkHorse has beam angle errors, they are reflected in the instrument transformation matrix and the Beam Directional matrix. This matrix, when multiplied by the raw beam data gives currents in the x, y, z, and e directions.

**Instrument reference frame (X, Y, Z):**

DVL body reference frame is defined by X, Y, Z on figure below. Before Phins Compact C7 coordinate transformation ( $X=Y$ ;  $Y=-X$ ,  $Z=Z$ ):



DVL reference frame before PHINS transformation ( $X=Y$ ;  $Y=-X$ ,  $Z=Z$ ):

±XXXX = X-axis velocity data in mm/s (+ = Bm1 Bm2 xdcr movement relative to bottom)  
 ±YYYY = Y-axis velocity data in mm/s (+ = Bm4 Bm3 xdcr movement relative to bottom)  
 ±ZZZZ = Z-axis velocity data in mm/s (+ = transducer movement away from bottom)

**Ship reference frame (X) Starboard/East, (Y) Forward/North, (Z) Upward.:**

DVL ship reference frame is defined by (X) Starboard/East, (Y) Forward/North, (Z) Upward on figure above. This frame can be aligned to ship center line by using EA command. For example, Beam 3 has been rotated 45 clockwise (+45) from the ship's center line. Use the EA command to tell the ADCP where beam 3 is in relation to the ship's centerline. To convert +45 to an EA command value, multiply the desired alignment angle in degrees by 100:

$$EA = +45.00 \times 100 = +4500 = EA+04500.$$

(1) 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. For depth calculation refer to chapter 1.5.

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

#### PD0 Standard Output Data Buffer Format

|                          |                                                             |
|--------------------------|-------------------------------------------------------------|
| Always Output            | HEADER<br>(6 bytes + [2bytes * Nb of DATA TYPES])           |
|                          | FIXED LEADER DATA<br>(53 or 59 bytes)                       |
|                          | VARIABLE LEADER DATA<br>(65 bytes)                          |
| WD-command<br>WP-command | VELOCITY<br>(2 bytes + 8 bytes per Depth cell)              |
|                          | CORRELATION MAGNITUDE<br>(2 bytes + 4 bytes per Depth cell) |
|                          | ECHO INTENSITY<br>(2 bytes + 4 bytes per Depth cell)        |
|                          | PERCENT GOOD<br>(2 bytes + 4 bytes per Depth cell)          |
| BP-command               | TRACK VELOCITY DATA<br>(85 bytes)                           |
| BP-command               | HIGH RES TRACK VELOCITY DATA<br>(52 bytes)                  |
| BP-command               | TRACK TIME OF VALIDITY<br>(69 bytes)                        |
| Always Output            | RESERVED<br>(2 bytes)                                       |
|                          | CHEKSUM<br>(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 2bytes 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                         |
| Field 4+2                     | Bytes 8 to 9         | Offset For Data Type #2                                | Offset of each Data Type in Global Frame |
| ...                           | ...                  | ...                                                    |                                          |
| 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) refer to (3) | (NOT USED)                                                                                        |
| Field 2                       | Byte 25           | Coordinate Transform    | xxx00xxx = Beam coordinates<br>xxx01xxx = Instrument Coordinate<br>xxx10xxx = Ship coordinate (*) |
| Field 2                       | Bytes 26 to 52/58 | (NOT USED) refer to (3) | (NOT USED)                                                                                        |

(\*) DVL must be set in beam, instrument or ship coordinates when used with Phins Compact C7.

(3) Applicable documents:

- Workhorse commands and output data format (ref : Navigator Technical Manual Nov06)
- Adcp coordinate transformation Jan10

## 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  | <b>Note 1</b>                                                         | (NOT USED)                                             |
| Field 2                        | Bytes 14 to 15 | Sound of Speed                                                        | LSB = 1m/s<br>range 1400 to 1600 m/s                   |
| Field 3                        | Bytes 16 to 17 | Depth of Transducer                                                   | (NOT USED)                                             |
| Field 4                        | Bytes 18 to 47 | <b>Note 1</b>                                                         | (NOT USED)                                             |
| Field 5                        | Bytes 48 to 51 | Pressure: Water pressure relative to one atmosphere. See section 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 | <b>Note 1</b>                                                         | (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 is 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 (1)     | (NOT USED)              |

## Correlation Magnitude, Echo Intensity and Percent Good Data

| Message <F0><F1>....<F10><F11> |                            |                                                                        |                                                         |
|--------------------------------|----------------------------|------------------------------------------------------------------------|---------------------------------------------------------|
| Field 0                        | Bytes 0 to 1               | Correlation Magnitude ID<br>OR Echo Intensity ID<br>OR Percent-Good ID | Fixed value = 0x00 0x02<br>OR 0x00 0x03<br>OR 0x00 0x04 |
| Field 1                        | Bytes 2 to 1+4*DepthCellNb | See section 1.5                                                        | (NOT USED)                                              |

## Track Velocity 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 (1)                         | (NOT USED)                                                                                                                                                                                                         |
| Field 2                        | Bytes 16 to 17 | BEAM#1 Range To Bottom. See (2) | Unsigned integer<br>LSB = 1cm, range 0 to 65535 cm<br>(0 when bottom detection is bad)<br>(**)                                                                                                                     |
| Field 3                        | Bytes 18 to 19 | BEAM#2 Range To Bottom. See (2) |                                                                                                                                                                                                                    |
| Field 4                        | Bytes 20 to 21 | BEAM#3 Range To Bottom. See (2) |                                                                                                                                                                                                                    |
| Field 5                        | Bytes 22 to 23 | BEAM#4 Range To Bottom. See (2) |                                                                                                                                                                                                                    |
| Field 6                        | Bytes 24 to 25 | BEAM#1 Bottom Track Velocity    | Instrument or ship coordinates: X,Y<br>and Z-axis BT velocities<br>Beam coordinates: Beams 1 to 4<br>BT velocities (***)<br>Signed integer: LSB = 1mm/s,<br>Range -32766 to 32767 mm/s<br>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 | See (1)                         | (NOT USED)                                                                                                                                                                                                         |
| Field 11                       | Bytes 50 to 51 | BEAM#1 Water Track Velocity     | Instrument or ship coordinates: X,Y<br>and Z-axis WT velocities<br>Beam coordinates: Beams 1 to 4<br>WT velocities (***)<br>Signed integer: LSB = 1mm/s,<br>Range -32766 to 32767 mm/s<br>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 (1)                         | (NOT USED)                                                                                                                                                                                                         |

(\*\*) Range to bottom used is an average of the 4 ranges to bottom given for each beam, 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 is opposite to PD6 protocol so the sign is inverted before sending data to the INS algorithm. So the sign convention of speed described by the above figure applies.

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

## High resolution track Velocity Data

| Message <F0><F1>...<F10><F11> |                |                              |                                                                                                                                                                                                                             |
|-------------------------------|----------------|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Field 0                       | Bytes 1 to 2   | ID                           | Fixed value = 0x5803                                                                                                                                                                                                        |
| Field 1                       | Bytes 3 to 6   | BEAM#1 Bottom Track Velocity | Instrument or ship coordinates:<br>X,Y and Z- axis BT velocities<br>Beam coordinates: Beams 1 to 4<br>BT velocities (*) Signed integer:<br>LSB = 0.01mm/s, Range -21474<br>m/s to +21474 m/s 0x8000000<br>when not received |
| Field 2                       | Bytes 7 to 10  | BEAM#2 Bottom Track Velocity |                                                                                                                                                                                                                             |
| Field 3                       | Bytes 11 to 14 | BEAM#3 Bottom Track Velocity |                                                                                                                                                                                                                             |
| Field 4                       | Bytes 15 to 18 | BEAM#4 Bottom Track Velocity |                                                                                                                                                                                                                             |
| Field 5                       | Bytes 19 to 22 | BEAM#1 Range To Bottom       | (NOT USED)                                                                                                                                                                                                                  |
| Field 6                       | Bytes 23 to 26 | BEAM#2 Range To Bottom       |                                                                                                                                                                                                                             |
| Field 7                       | Bytes 27 to 30 | BEAM#3 Range To Bottom       |                                                                                                                                                                                                                             |
| Field 8                       | Bytes 31 to 34 | BEAM#4 Range To Bottom       |                                                                                                                                                                                                                             |
| Field 9                       | Bytes 35 to 38 | BEAM#1 Water Track Velocity  | Instrument or ship coordinates:<br>X,Y and Z- axis BT velocities<br>Beam coordinates: Beams 1 to 4<br>BT velocities (*) Signed integer:<br>LSB = 0.01mm/s, Range -21474<br>m/s to +21474 m/s 0x8000000<br>when not received |
| Field 10                      | Bytes 39 to 42 | BEAM#2 Water Track Velocity  |                                                                                                                                                                                                                             |
| Field 11                      | Bytes 43 to 46 | BEAM#3 Water Track Velocity  |                                                                                                                                                                                                                             |
| Field 12                      | Bytes 47 to 50 | BEAM#4 Water Track Velocity  |                                                                                                                                                                                                                             |
| Field 13                      | Bytes 51 to 70 | (NOT USED)                   | (NOT USED)                                                                                                                                                                                                                  |

(\*) The priority is given on High data resolution track velocity if this message is available. Nonetheless, if the standard track velocity is not configured (through EX command) or invalid, speed data will interpreted as not received by the INS.

Source: *TRDI PD0 High Resolution BT Velocity Format.docx*.

## Time of Validity Data

| Message <F0><F1>...<F10><F11> |                |                                    |                                                                                                                                |
|-------------------------------|----------------|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Field 0                       | Bytes 1 to 2   | ID Message                         | Fixed value = 0x2013                                                                                                           |
| Field 1                       | Bytes 3 to 18  | Time-To-Bottom Beams 1-4           | (NOT USED)                                                                                                                     |
| Field 2                       | Bytes 19 to 20 | Bottom Std Deviation Beam 1        | (NOT USED)                                                                                                                     |
| Field 3                       | Bytes 21 to 22 | Bottom Std Deviation Beam 2        |                                                                                                                                |
| Field 4                       | Bytes 23 to 24 | Bottom Std Deviation Beam 3        |                                                                                                                                |
| Field 5                       | Bytes 25 to 26 | Bottom Std Deviation Beam 4        |                                                                                                                                |
| Field 3                       | Byte 27        | Shallow Operation Flag             | (NOT USED)                                                                                                                     |
| Field 4                       | Bytes 28 to 43 | Time-To-Water Beams 1-4            | (NOT USED)                                                                                                                     |
| Field 5                       | Bytes 44 to 45 | Range to Water                     | (NOT USED)                                                                                                                     |
| Field 6                       | Bytes 46 to 47 | Water Std Deviation Beam 1         | (NOT USED)                                                                                                                     |
| Field 7                       | Bytes 48 to 49 | Water Std Deviation Beam 2         |                                                                                                                                |
| Field 8                       | Bytes 50 to 51 | Water Std Deviation Beam 3         |                                                                                                                                |
| Field 9                       | Bytes 52 to 53 | Water Std Deviation Beam 4         |                                                                                                                                |
| Field 10                      | Bytes 54 to 57 | BT Time Of Validity Beam 1. See(1) | Relative time of validity in Bottom track Unsigned integer: LSB = 1μs, Range 0 μs to 65535μs. See (3) 0x0000 when not received |
| Field 11                      | Bytes 58 to 61 | BT Time Of Validity Beam 2. See(1) |                                                                                                                                |
| Field 12                      | Bytes 62 to 65 | BT Time Of Validity Beam 3. See(1) |                                                                                                                                |
| Field 13                      | Bytes 66 to 69 | BT Time Of Validity Beam 4. See(1) |                                                                                                                                |
| Field 14                      | Bytes 70 to 73 | WT Time Of Validity Beam 1. See(2) | Relative time of validity in Water track Unsigned integer: LSB = 1μs, Range 0 μs to 65535μs. See (3) 0x0000 when not received  |
| Field 15                      | Bytes 74 to 77 | WT Time Of Validity Beam 2. See(2) |                                                                                                                                |
| Field 19                      | Bytes 78 to 81 | WT Time Of Validity Beam 3. See(2) |                                                                                                                                |
| Field 20                      | Bytes 82 to 85 | WT Time Of Validity Beam 4. See(2) |                                                                                                                                |

(1) The DVL shall be configured with Cx=0 which correspond to the time elapsed between the center and the first character send in the PD0 sentence (DVL side).

(2) The priority is given on Bottom track time of validity if valid.

(3) *Time of validity used is an average of the 4 Time of validity given for each beams, excluding zero fields meaning bad detection.*

Source : TRDI DVL Bottom & Water Track Time of Validity.docx

## 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**

**Standard:** Binary. 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.

| Message <F0><F1><F2>... <F21> |             |                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Field 0</b>                | Byte 0      | DVL Data ID                                                                                                                                                                                                                                                  | Fixed value = 0x7E                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Field 1</b>                | Byte 1      | Data to Follow status<br>Bit #0 System Coordinates<br>Bit #1 Vertical velocities Bit #2 Water Reference velocities<br>Bit #3 Range To Bottom (4 beams)<br>Bit #4 Range To Bottom (average)<br>Bit #5 Not used<br>Bit #6 Not used<br>Bit #7 Sensor/Other Data | If Bit #0 of “Data to Follow” status is set to 1, then Earth coordinates are used.<br>If Bit #0 of “Data to Follow” status is set to 0, then Ship coordinates are used.<br>The INS will reject the message if Earth coordinates are used i.e. Bit#0 set to 1.<br>The DVL must be set to send data in the Ship coordinates.<br>For the RDI_PD3 input, the DVL Roll and Pitch compensations must be disabled (EX100xx DVL command)<br>For the RDI_PD3_RT input, the DVL Roll and Pitch compensations must be enabled (EX101xx DVL command) |
| <b>Field 2</b>                | Bytes 2-3   | X Bottom Track transverse <b>Note 1</b>                                                                                                                                                                                                                      | This field is always received<br>16 bits signed integer LSB = 1mm/s. + for ship motion to Starboard.<br>USED                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Field 3</b>                | Bytes 4-5   | Y Bottom Track longitudinal velocity <b>Note 1</b>                                                                                                                                                                                                           | This field is always received<br>16 bits signed integer LSB = 1mm/s. + for ship motion to Forward.<br>USED                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Field 4</b>                | Bytes 6-7   | Z Bottom Track vertical velocity <b>Note 1</b>                                                                                                                                                                                                               | This field is received if Bit #1 of “Data to Follow” status is set. If this field is not received, the INS will take into account the value of 0 m/s on the vertical velocity.<br>16 bits signed integer LSB = 1 mm/s.<br>USED                                                                                                                                                                                                                                                                                                           |
| <b>Field 5</b>                | Bytes 8-9   | X Water Track transverse velocity <b>Note 1</b>                                                                                                                                                                                                              | This field is received if Bit #2 of “Data to Follow” status is set. 16 bits signed integer<br>LSB = 1 mm/s.<br>USED                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Field 6</b>                | Bytes 10-11 | Y Water Track longitudinal velocity <b>Note 1</b>                                                                                                                                                                                                            | This field is received if Bit #2 of “Data to Follow” status is set. 16 bits signed integer<br>LSB = 1 mm/s.<br>USED                                                                                                                                                                                                                                                                                                                                                                                                                      |

| Message <F0><F1><F2>... <F21> |             |                                                 |                                                                                                                                                                                                                                           |
|-------------------------------|-------------|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Field 7</b>                | Bytes 12-13 | Z WaterTrack vertical velocity<br><b>Note 1</b> | 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.<br>16 bits signed integer LSB = 1 mm/s.<br>USED |

**Note 1:** Positive values indicate vehicle 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> |             |                                                                                                                                                                                     |                                                                                                                                                                                                                                                                            |
|-------------------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Field 8</b>                | Bytes 14-15 | Beam 1 Range to Bottom                                                                                                                                                              | These fields are received if Bit #3 of "Data to Follow" status is set.<br>16 bits unsigned integer LSB = 1 cm; Range = 0 to 65535 cm When a bottom detection is bad, the field is set 0.<br>USED only if Average Range to Bottom (next field) is not received              |
| <b>Field 9</b>                | Bytes 16-17 | Beam 2 Range to Bottom                                                                                                                                                              |                                                                                                                                                                                                                                                                            |
| <b>Field 10</b>               | Bytes 18-19 | Beam 3 Range to Bottom                                                                                                                                                              |                                                                                                                                                                                                                                                                            |
| <b>Field 11</b>               | Bytes 20-21 | Beam 4 Range to Bottom                                                                                                                                                              |                                                                                                                                                                                                                                                                            |
| <b>Field 12</b>               | 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.<br>16 bits unsigned integer LSB = 1 cm; Range = 0 to 65535 cm When a bottom detection is bad, the field is set 0.<br>USED |
| <b>Field 13</b>               | Bytes 24-39 | 16 bytes spare                                                                                                                                                                      | NOT USED                                                                                                                                                                                                                                                                   |
| <b>Field 14</b>               | Byte 40     | Sensor/Other Data status<br>Bit #0 Time<br>Bit #1 Heading<br>Bit #2 Pitch<br>Bit #3 Roll<br>Bit #4 Temperature<br>Bit #5 Active Built-In-Test<br>Bit #6 Not used<br>Bit #7 Not used | This field is received if Bit #7 of "Data to Follow" status is set<br>NOT USED                                                                                                                                                                                             |

| Message <F0><F1><F2>... <F21> |             |                      |                                                                                               |
|-------------------------------|-------------|----------------------|-----------------------------------------------------------------------------------------------|
| <b>Field 15</b>               | 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 |                                                                                               |
| <b>Field 16</b>               | Bytes 45-46 | Heading              | These fields are received if Bit #1 of "Sensor/Other Data" status is set. NOT USED            |
| <b>Field 17</b>               | Bytes 47-48 | Pitch                | These fields are received if Bit #2 of "Sensor/Other Data" status is set. NOT USED            |
| <b>Field 18</b>               | Bytes 49-50 | Roll                 | These fields are received if Bit #3 of "Sensor/Other Data" status is set. NOT USED            |
| <b>Field 19</b>               | Bytes 51-52 | Temperature          | These fields are received if Bit #4 of "Sensor/Other Data" status is set. NOT USED            |
| <b>Field 20</b>               | Bytes 53-54 | Built-In-Test result | These fields are received if Bit #5 of "Sensor/Other Data" status is set. NOT USED            |
| <b>Field 21</b>               | Bytes 55-56 | Checksum             | Sum of all the bytes excluding checksum (modulo 65535)                                        |

## RDI PD4

**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.

**Data frame:** 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 (***)                  | 010xxxxx (instrument coordinate velocities)<br>Or<br>100xxxxx (ship coordinate velocities)<br>The INS is expecting bit 6 = 0 (no tilt sensor used) and any frame excepted earth coordinates mode.<br>Otherwise, DVL frame is rejected. |
| Field 4                        | Bytes 5 to 6   | XDVL Bottom track transverse velocity (*)   | 16 bits signed integer; LSB = 1mm/s                                                                                                                                                                                                    |
| Field 5                        | Bytes 7 to 8   | YDVL Bottom track longitudinal velocity (*) | 16 bits signed integer; LSB = 1mm/s                                                                                                                                                                                                    |
| Field 6                        | Bytes 9 to 10  | ZDVL 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:<br>16 bits unsigned integer<br>Range 0 to 65535 cm (LSB=1cm)<br>(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 | XDVL Water track transverse velocity (*)    | 16 bits signed integer; LSB = 1mm/s                                                                                                                                                                                                    |
| Field 14                       | Bytes 24 to 25 | YDVL Water track longitudinal velocity (*)  | 16 bits signed integer; LSB = 1mm/s                                                                                                                                                                                                    |
| Field 15                       | Bytes 26 to 27 | ZDVL 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> |                |                |                                                                                                           |
|--------------------------------|----------------|----------------|-----------------------------------------------------------------------------------------------------------|
| <b>Field 17</b>                | Bytes 41 to 42 | Speed of Sound | Manual or calculated speed of sound<br>16 bits unsigned integer, LSB = 1m/s<br>Range from 1300 to 1700m/s |
| <b>Field 18</b>                | 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 the Phins Compact C7.

Depending on DVL settings, XDVL, YDVL and ZDVL may be output in instrument frame or ship frame.

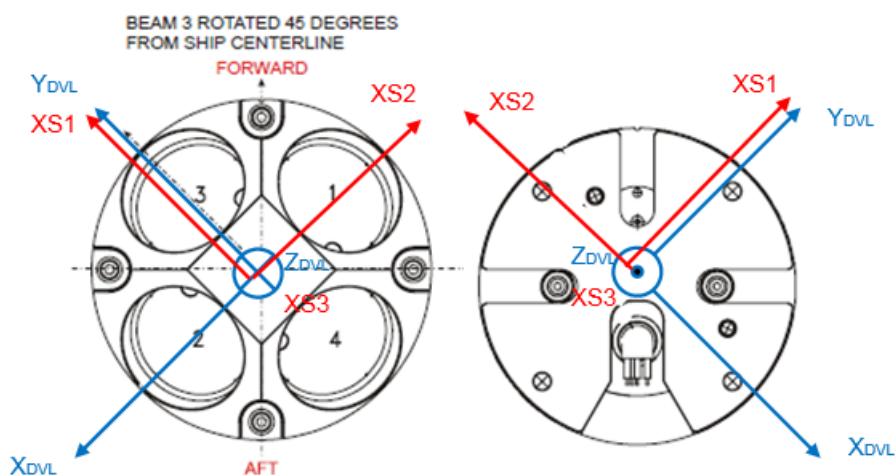
In both cases, Phins Compact C7 will rotate the DVL input by  $90^\circ$ , applying following rule:

$XS1 = YDVL$

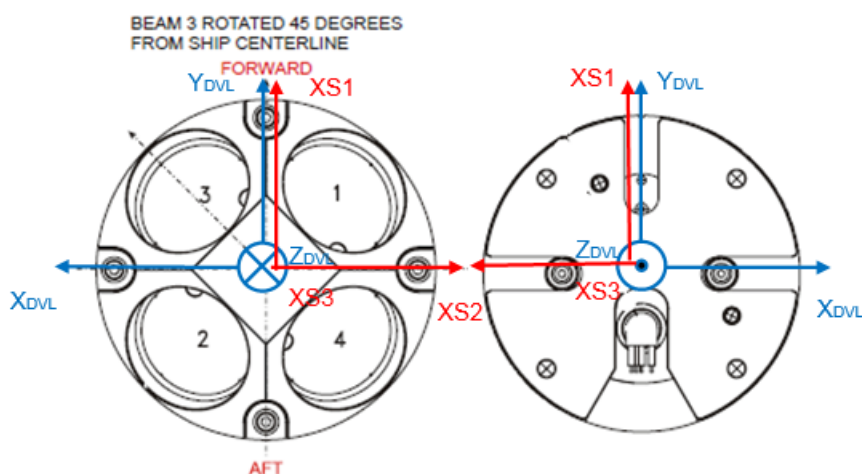
$XS2 = -XDVL$

$XS3 = ZDVL$

The diagram below illustrates DVL raw speed and Phins Compact C7 rotated speed when DVL is set in instrument frame, before Phins Compact C7 transformation (blue) and after Phins Compact C7 rotation (red):



The diagram below illustrates DVL raw speed and Phins Compact C7 rotated speed when DVL is set in ship frame in case the DVL EA field is set to  $45^\circ$  to get aligned with the Subsea vehicle, before Phins Compact C7 transformation (blue) and after Phins Compact C7 rotation (red):



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

(\*\*\*) DVL must be set to send data in instrument body frame or ship frame. Misalignment calibration between Subsea vehicle and DVL body frames must be performed for optimal results. DVL Tilt sensor must not be used to compensate from attitude: this will be performed by Subsea vehicle.



The default standard deviation is set to 0.2 m/s and can be customized through the advanced filtering page from the Web-Based Graphical User Interface. Refer to the Phins Compact C7 Installation & Setup Guide to get information about the advanced filtering page.

**RDI PD6**

**Standard:** ASCII.

**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>

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>

|       |                                       |
|-------|---------------------------------------|
| 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) |

**Timing And Scaling Data**

This frame is used to set the date of BI and WI frame info.

:TS,YYMMDDHHmmsshh,ss.s,+TT.T,DDDD.D,CCCC.C,BBB<CR><LF>

|                |                                                                                        |
|----------------|----------------------------------------------------------------------------------------|
| 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

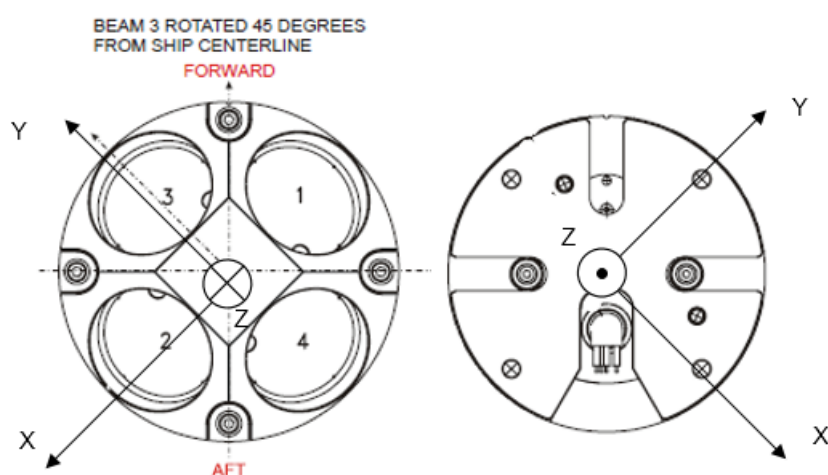
| :WI,±TTTTT,±LLLLL,±NNNNN,±MMMMM,S<CR><LF> |                                                                      |
|-------------------------------------------|----------------------------------------------------------------------|
| TTTTT                                     | is the X transverse velocity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

## Bottom-Track, Instrument-Referenced Velocity Data

| :BI,±TTTTT,±LLLLL,±NNNNN,±MMMMM,S<CR><LF> |                                                 |
|-------------------------------------------|-------------------------------------------------|
| 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> |                                                                          |
|---------------------------------------------------------------------|--------------------------------------------------------------------------|
| 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 Phins Compact C7 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 being invalid by Phins Compact C7.

(\*\*) DVL must be set to send data in instrument body frame. Misalignment calibration between Phins Compact C7 and DVL body frames must be performed for optimal results. Contact [support@ixblue.com](mailto:support@ixblue.com) to retrieve the proper calibration procedure.

**SBE 49****Standard:** ASCII.**Data frame:** The following describes format to interface to a CTD Sensor SBE49.

```
tth.tttt,<space>cc.ccccc,<space>pppp.ppp,<space>sss.ssss,<space>vvvv.vvv<CR><LF>
```

|               |          |                          |                                            |
|---------------|----------|--------------------------|--------------------------------------------|
| <b>where:</b> | tth.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 1.5.

**NOTE 2:** Sound velocity is calculated by using the formula described in section 1.6.

**SVX2**

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

**Data received:** Sound velocity and Pressure will be used by Phins Compact C7.

**Data frame:** Format 1 and 2 are compatible with Valeport MIDAS SVX2. Both pressure sensor input and sound velocity can be used by Phins Compact C7.

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"                            | String | (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>  | (*) (**)                    | Float  | (NOTUSED)  |
| <F6>  | Temperature                 | String | (NOT USED) |
| <F7>  | Units="C"                   | Float  | (NOT USED) |
| <F8>  | Conductivity                | String | (NOT USED) |
| <F9>  | Units="MS/CM"               | Float  | (NOT USED) |
| <F10> | Salinity<br>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

(\*) Depth 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 1.5. 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.

**TERPS8000**

**Standard:** ASCII, DPS8xxB pressure sensor (see TERPS User Manual, GE Druck)

**Data received:** Depth.

**Data frame:**

| <F1><space><F2><CR><LF> |               |                                                               |           |      |
|-------------------------|---------------|---------------------------------------------------------------|-----------|------|
| <F1>                    | PPPP.PP       | Varying string size and decimal point.                        | Float     | USED |
|                         | (i.e 1234.56) | The unit is determined by the following field in bar or mBar, |           |      |
|                         | P.PPPPP       | from 0 to 1500 bar max.                                       |           |      |
|                         | (i.e 1.23456) |                                                               |           |      |
| <F2>                    | CCC           | Unity: Bar or mBar                                            | Character | USED |
|                         | CCCC          |                                                               |           |      |

Depth is calculated by using a formula, refer to section 1.5.

## USBL BOX POSTPRO

**Standard:** Binary. USBL BOX POSTPRO.

**Data received:** USBL, USBL 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 GNSS 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                | +/- 231= +/-180°                                         |
| Field 9             | Bytes 22 to 25 | long  | Longitude               | +/- 231= +/-180°                                         |
| Field 10            | Bytes 26 to 29 | float | Depth                   | meters                                                   |
| Field 11            | Bytes 30 to 33 | float | Covariance North/North  | meters <sup>2</sup> (Latitude SD) <sup>2</sup>           |
| Field 12            | Bytes 31 to 37 | float | Covariance North/East   | meters <sup>2</sup> (Latitude Longitude SD) <sup>2</sup> |
| Field 13            | Bytes 38 to 41 | float | Covariance North/Depth  | meters <sup>2</sup> (NOT USED)                           |
| Field 14            | Bytes 42 to 45 | float | Covariance East/East    | meters <sup>2</sup> (Longitude SD) <sup>2</sup>          |
| Field 15            | Bytes 46 to 49 | float | Covariance East/Depth   | meters <sup>2</sup> (NOT USED)                           |
| Field 16            | Bytes 50 to 53 | float | Covariance Depth/Depth  | meters <sup>2</sup> (Altitude SD) <sup>2</sup>           |
| 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.

**USBL LBL CTD**

**Standard:** ASCII. BLUEFIN proprietary protocol.

**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\*hh<CR><LF>**

|              |                                                             |      |
|--------------|-------------------------------------------------------------|------|
| 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 <sup>2</sup> | USED |
| x.x          | is the depth standard deviation in meters                   |      |
| x.x          | is the age of the data in seconds                           |      |
| hh           | is the checksum                                             |      |

**\$BFLBL,llmm.mmmm,a,LLLmm.mmmm,b,x.x,i,x.x,x.x,x.x\*hh<CR><LF>**

|              |                                                             |      |
|--------------|-------------------------------------------------------------|------|
| 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                             |      |

| \$BFLBL, lmm.mmmm, a, LLLmm.mmmm, b, x.x, i, x.x, x.x, x.x*hh<CR><LF> |                                   |  |
|-----------------------------------------------------------------------|-----------------------------------|--|
| x.x                                                                   | is the age of the data in seconds |  |
| hh                                                                    | is the checksum                   |  |

| \$BFCTD, ±x.x, ±x.x, ±x.x, hh:mm:ss mm-dd-yy, ±x.x, ±x.x*hh<CR><LF> |                                |          |
|---------------------------------------------------------------------|--------------------------------|----------|
| ±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     |

\* The beacon identifier value received in the \$BFLBL data frame will be issued in the output Sensor RD.

\*\* Conductivity, temperature, pressure and sound velocity values received in the \$BFCTD data frame will be issued in the output Navigation & CTD.

(1) Depth is calculated by using the formula described in section 1.5.

## 6.2 Detailed Specifications of Output Protocols

### AIPOV

**Standard:** output NMEA 0183.

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

**Data frame:** ASCII 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.IIIIIII, 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 vehicle                                       | 0 : North<br>90 : East                         |
| Roll                    | +/-r.rrr    | Decimal degree     | 10-3 deg              | +/- 180          | Roll of vehicle                                          | > 0 when left wing goes up                     |
| Pitch                   | +/-p.ppp    | Decimal degree     | 10-3 deg              | +/-90            | Pitch of vehicle                                         | > 0 when nose up (*)                           |
| Rotation Rate XV1       | +/-x.xxx    | Degrees per second | 10-3 deg/s            | +/- 750          | Angular rate around along vehicle axis                   | > 0 when left wing goes up                     |
| Rotation Rate XV2       | +/-y.yyy    | Degrees per second | 10-3 deg/s            | +/- 750          | Angular rate around across vehicle axis                  | > 0 when nose up (*)                           |
| Rotation Rate XV3       | +/-z.zzz    | Degrees per second | 10-3 deg/s            | +/- 750          | Angular rate around third vehicle axis                   | > 0 when turning counter clockwise (*)         |
| Linear Acceleration XV1 | +/-e.ee     | m/s <sup>2</sup>   | 10-2 m/s <sup>2</sup> | +/- 147.15 (15g) | Acceleration on along vehicle axis. Gravity not included | > 0 when acceleration towards front of vehicle |

| Parameter               | ASCII model     | Unit             | Resolution            | Range            | Exact definition of parameter                            | Sign convention                              |
|-------------------------|-----------------|------------------|-----------------------|------------------|----------------------------------------------------------|----------------------------------------------|
| Linear acceleration XV2 | +/-f.ff         | m/s <sup>2</sup> | 10-2 m/s <sup>2</sup> | +/- 147.15 (15g) | Acceleration on across vehicle axis Gravity not included | > 0 when acceleration towards right wing (*) |
| Linear Acceleration XV3 | +/-g.gg         | m/s <sup>2</sup> | 10-2 m/s <sup>2</sup> | +/- 147.15 (15g) | Acceleration on third vehicle axis Gravity not included  | > 0 when acceleration goes down (*)          |
| Latitude                | +/- LL.LLLLLLLL | Decimal degree   | 10-8 deg              | +/-90            | Latitude                                                 | > 0 when North latitude                      |
| Longitude               | +/-ll.IIIIIII   | Decimal degree   | 10-8 deg              | +/-180           | Longitude                                                | >0 when East                                 |
| Altitude                | a.aaa           | meters           | 10-3 m                | 15000            | Altitude                                                 |                                              |
| North Velocity          | +/-l.iii        | m/s              | 10-3 m/s              | +/- 250          | Velocity of vehicle along North axis                     | > 0 when going North                         |
| East Velocity           | +/-j.jjj        | m/s              | 10-3 m/s              | +/- 250          | Velocity of vehicle along East axis                      | > 0 when going East (*)                      |
| Vertical Velocity       | +/-k.kkk        | m/s              | 10-3 m/s              | +/- 250          | Velocity of vehicle along vertical axis                  | > 0 when going down                          |
| Along Velocity (XV1)    | +/-m.mmm        | m/s              | 10-3 m/s              | +/- 250          | Velocity on along vehicle axis.                          | > 0 when velocity towards front of vehicle   |
| Across Velocity XV2     | +/-n.nnn        | m/s              | 10-3 m/s              | +/- 250          | Velocity on across vehicle axis                          | > 0 when velocity towards right wing (*)     |
| Down Velocity XV3       | +/-o.ooo        | m/s              | 10-3 m/s              | +/- 250          | Velocity along vertical vehicle axis                     | > 0 when velocity goes down (*)              |

| Parameter   | ASCII model | Unit            | Resolution | Range | Exact definition of parameter                | Sign convention |
|-------------|-------------|-----------------|------------|-------|----------------------------------------------|-----------------|
| True course | c.ccc       | Decimal degrees | 10-3 deg   | 0-360 | Direction of the vehicle horizontal velocity |                 |
| User Status | hhhhhhhh    | hexadecimal     |            |       | User status (32 bits)                        |                 |
| Checksum    | hh          | hexadecimal     |            |       |                                              |                 |

(\*) Opposite of Phins Compact C7 standard convention

**AUVG3000****Standard:**

**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

25 fields – 98 bytes MSB First

**Data frame:**

| Message <F0><F1><F2>.....<F24> |                |                                                         |                                                                                                                                                                                                                |
|--------------------------------|----------------|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Field 0</b>                 | Bytes 0 to 3   | 'qqqq'                                                  | Synchronisation bytes                                                                                                                                                                                          |
| <b>Field 1</b>                 | 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. |
| <b>Field 2</b>                 | 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).                                                                             |
| <b>Field 3</b>                 | Bytes 10 to 13 | Latitude<br>'+' : North of equator                      | IEEE floating point format, deg                                                                                                                                                                                |
| <b>Field 4</b>                 | Bytes 14 to 17 | Longitude<br>'+' : East of                              | IEEE floating point format, deg                                                                                                                                                                                |
| <b>Field 5</b>                 | Bytes 18 to 21 | Latitude standard deviation                             | IEEE floating point format, meters                                                                                                                                                                             |
| <b>Field 6</b>                 | Bytes 22 to 25 | Longitude standard deviation                            | IEEE floating point format, meters                                                                                                                                                                             |
| <b>Field 7</b>                 | Bytes 26 to 29 | Heading standard deviation                              | IEEE floating point format, deg                                                                                                                                                                                |
| <b>Field 8</b>                 | Bytes 30 to 33 | Roll standard deviation                                 | IEEE floating point format, deg                                                                                                                                                                                |
| <b>Field 9</b>                 | Bytes 34 to 37 | Pitch standard deviation                                | IEEE floating point format, deg                                                                                                                                                                                |
| <b>Field 10</b>                | Bytes 38 to 41 | Depth                                                   | IEEE floating point format, meters                                                                                                                                                                             |
| <b>Field 11</b>                | Bytes 42 to 45 | Heading                                                 | IEEE floating point format, deg                                                                                                                                                                                |
| <b>Field 12</b>                | Bytes 46 to 49 | Roll<br>Sign "+" when port side up                      | IEEE floating point format, deg                                                                                                                                                                                |
| <b>Field 13</b>                | Bytes 50 to 53 | Pitch<br>Sign "+" when bow up                           | IEEE floating point format, deg<br>Warning: Opposite sign of PHINS usual convention                                                                                                                            |
| <b>Field 14</b>                | Bytes 54 to 57 | North velocity                                          | IEEE floating point format, m/s                                                                                                                                                                                |
| <b>Field 15</b>                | Bytes 58 to 61 | West velocity                                           | IEEE floating point format, m/s                                                                                                                                                                                |
| <b>Field 16</b>                | Bytes 62 to 65 | Depth velocity                                          | IEEE floating point format, m/s                                                                                                                                                                                |
| <b>Field 17</b>                | Bytes 66 to 69 | Roll rate *                                             | IEEE floating point format, deg/s                                                                                                                                                                              |
| <b>Field 18</b>                | Bytes 70 to 73 | Pitch rate *                                            | IEEE floating point format, deg/s                                                                                                                                                                              |
| <b>Field 19</b>                | Bytes 74 to 77 | Heading rate *                                          | IEEE floating point format, deg/s                                                                                                                                                                              |

| Message <F0><F1><F2>.....<F24> |                |                     |                                              |
|--------------------------------|----------------|---------------------|----------------------------------------------|
| <b>Field 20</b>                | Bytes 78 to 81 | XV1 acceleration *  | IEEE floating point format, m/s <sup>2</sup> |
| <b>Field 21</b>                | Bytes 82 to 85 | X V2 acceleration * | IEEE floating point format, m/s <sup>2</sup> |
| <b>Field 22</b>                | Bytes 86 to 89 | X V3 acceleration * | IEEE floating point format, m/s <sup>2</sup> |
| <b>Field 23</b>                | Bytes 90 to 93 | Status **           | See PHINS user specification table 1         |
| <b>Field 24</b>                | Bytes 94 to 97 | Checksum            | Sum of all bytes 0 to 93                     |

\*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 1 mg.

\*\* Phins Compact C7 User status specification, refer to chapter User Status.

## **BROADCAST FROM PORT X**

**Standard:** That of the input port X

**Data sent:** Used to broadcast all the data coming from an input port\* (port X) to the selected output port.

## CONTROL

**Standard:** Binary protocol. 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<br>LSB = 30g / 231 = 0.01397μg          |
| Field 2                       | Bytes 5 to 8   | Acceleration XV2 *    | Signed 32 bits<br>LSB = 30g / 231 = 0.01397μg          |
| Field 3                       | Bytes 9 to 12  | Acceleration XV3 *    | Signed 32 bits<br>LSB = 30g / 231 = 0.01397μg          |
| Field 4                       | Bytes 13 to 16 | Rotation rates XV1 ** | Signed 32 bits<br>LSB = 100°/s / 231 = 46.566.10-9 °/s |
| Field 5                       | Bytes 17 to 20 | Rotation rates XV2 ** | Signed 32 bits<br>LSB = 100°/s / 231 = 46.566.10-9 °/s |
| Field 6                       | Bytes 21 to 24 | Rotation rates XV3 ** | Signed 32 bits<br>LSB = 100°/s / 231 = 46.566.10-9 °/s |

\* in standard mode: acceleration quantification is 1mg.

\*\* in standard mode: rotation rate quantification with 3.6°/h.

**CONTROL NO G**

**Standard:** Binary protocol. 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 *    | +/- 231 = +/- 30g Signed 32 bits with saturation    |
| Field 2                       | Bytes 5 to 8   | Acceleration XV2 *    | +/- 231 = +/- 30g Signed 32 bits with saturation    |
| Field 3                       | Bytes 9 to 12  | Acceleration XV3 *    | +/- 231 = +/- 30g Signed 32 bits with saturation    |
| Field 4                       | Bytes 13 to 16 | Rotation rates XV1 ** | +/- 231 = +/- 100°/s Signed 32 bits with saturation |
| Field 5                       | Bytes 17 to 20 | Rotation rates XV2 ** | +/- 231 = +/- 100°/s Signed 32 bits with saturation |
| Field 6                       | Bytes 21 to 24 | Rotation rates XV3 ** | +/- 231 = +/- 100°/s Signed 32 bits with saturation |

\* in standard mode: acceleration quantification is 1mg.

\*\* in standard mode: rotation rate quantification with 3.6°/h

**DORADO**

**Standard:** Binary protocol. Output Dorado custom protocol.

**Data sent:** Position, Heading, Heading, Roll, Pitch, Rotation rates, speed coordinates in geographical frame, INS 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<br>0x06 => Invalid attitude<br>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<br>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<br>(+/- 231= +/- 180°)                                          |
| Field 13             | Bytes 46 to 49 | Longitude                          | Integer 32 bits signed in Radians<br>(+/- 231= +/- 180°)                                          |
| Field 14             | Bytes 50 to 53 | Kalman log misalignment estimation | Floating IEEE 32 bits in Radians                                                                  |

| <F0><F1>...F16><F17> |                |                      |                                                                         |
|----------------------|----------------|----------------------|-------------------------------------------------------------------------|
| 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 standard mode: Heading, roll, pitch quantification with 0.001°.

\*\* In standard mode: rotation rate quantization is limited to 3.6°/h.

**DORADO 2**

**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> |                |                      |                                                                                                                                                                                                                                 |
|----------------------|----------------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Field 0</b>       | Byte 0         | Header               | integer 8 bits : '\$'                                                                                                                                                                                                           |
| <b>Field 1</b>       | Byte 1         | Status               | Integer 8 bits :<br>0x01 => Initial alignment<br>0x06 => Invalid attitude<br>0x08 => Invalid heading<br>0x10 => Fine alignment<br>0x20 => GPS position rejected<br>0x40 => GPS altitude rejected<br>0x80 => Altitude saturation |
| <b>Field 2</b>       | Bytes 2 to 5   | Heading              | Floating IEEE 32 bits *in Radians                                                                                                                                                                                               |
| <b>Field 3</b>       | Bytes 6 to 9   | Roll                 | Floating IEEE 32 bits * in Radians (+ if port up)                                                                                                                                                                               |
| <b>Field 4</b>       | Bytes 10 to 13 | Pitch                | Floating IEEE 32 bits * in Radians (+ if bow down)                                                                                                                                                                              |
| <b>Field 5</b>       | Bytes 14 to 17 | Rotation rate XV3    | Floating IEEE 32 bits ** in Radians /sec                                                                                                                                                                                        |
| <b>Field 6</b>       | Bytes 18 to 21 | Rotation rate XV1    | Floating IEEE 32 bits ** in Radians /sec                                                                                                                                                                                        |
| <b>Field 7</b>       | Bytes 22 to 25 | Rotation rate -XV2   | Flotting IEEE 32 bits ** in Radians /sec<br>Warning : sign opposite with the conventional sign                                                                                                                                  |
| <b>Field 8</b>       | Bytes 26 to 29 | Depth                | Floating IEEE 32 bits in Meters                                                                                                                                                                                                 |
| <b>Field 9</b>       | Bytes 30 to 33 | Down speed           | Floating IEEE 32 bits in m/s (positive downwards)                                                                                                                                                                               |
| <b>Field 10</b>      | Bytes 34 to 37 | East speed           | Floating IEEE 32 bits in Meters/sec                                                                                                                                                                                             |
| <b>Field 11</b>      | Bytes 38 to 41 | South speed          | Floating IEEE 32 bits in Meters/sec                                                                                                                                                                                             |
| <b>Field 12</b>      | Bytes 42 to 45 | Latitude             | Integer 32 bits signed in Radians (+/- 231= +/- 180°)                                                                                                                                                                           |
| <b>Field 13</b>      | Bytes 46 to 49 | Longitude            | Integer 32 bits signed in Radians (+/- 231= +/- 180°)                                                                                                                                                                           |
| <b>Field 14</b>      | Bytes 54 to 57 | Epoch Time           | Integer 64 bits Number of seconds since 00:00:00 01/01/1970                                                                                                                                                                     |
| <b>Field 15</b>      | Bytes 58 to 59 | Counter of sequences | Integer 16 bits from 0 to 65535                                                                                                                                                                                                 |
| <b>Field 16</b>      | Byte 60        | Checksum             | Integer 8 bits : Summon of all the bytes of the frame, heading included                                                                                                                                                         |

\* In standard mode: heading, roll, pitch quantification with 0.001°

\*\* In standard mode: rotation rate quantification with 3.6°/h

EVENT MARKER

**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:<br>0 for A<br>1 for B<br>2 for C<br>3 for D |
| y.yyyyyy                      | Pulse reception time (i.e: event time) in seconds        |
| c                             | Pulse counter (integer)                                  |

Example:  
In this example Phins Compact C7 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
```

## GAPS BIN

**Standard:** Binary protocol. 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<br>+/- 231= +/- 90°  | Degrees      |
| Longitude                                    | 32 bit signed integer<br>+/- 231= +/- 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<br>(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         |
| End of frame                                 | 8 bit unsigned integer                     | Value: '#'   |

**Note 1:**

The 64 bits time tag is described hereafter :

Bit [63..56] spare

Bit [55..52] x 10 days (0 to 3)

Bit [47..44] x 10 hour (0 to 2)

Bit [39..35] x 10 minutes (0 to 5)

Bit [31..28] x 10 seconds (0 to 5)

Bit [23..20] x 1/10 seconds (0 to 9)

Bit [15..12] x 1000  $\mu$  seconds (0 to 9)

Bit [7..4] x 10  $\mu$  seconds (0 to 9)

Bit [51..48] days (0 to 9)

Bit [43..40] hours (0 to 9)

Bit [34..31] minutes (0 to 9)

Bit [27..24] seconds (0 to 9)

Bit [19..16] x 1/100 seconds (0 to 9)

Bit [11..8] x 100  $\mu$  seconds (0 to 9)

Bit [3..0]  $\mu$  seconds (0 to 9)

**Note 2:** Crc computation is performed using XOR with polynom =  $X^{15}+X^{10}+X^3$ , 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          |
|-------------------|------------|-------------------|-------------------|------------|----------------------|
| hhhhhhhH          | 0          | Log received      | hhhHhhh           | 16         | Serial input A error |
|                   | 1          | GNSS received     |                   | 17         | Serial input B error |
|                   | 2          | Depth received    |                   | 18         | Serial input C error |
|                   | 3          | USBL received     |                   | 19         | FIFO Full            |
| hhhhhhHh          | 4          | LBL received      | hhHhhhhh          | 20         | Serial output A full |
|                   | 5          | GNSS2 received    |                   | 21         | Serial output B full |
|                   | 6          | Log EM received   |                   | 22         | Serial output C full |
|                   | 7          | Settings Saved    |                   | 23         | Serial output D full |
| hhhhhHhh          | 8          | FOG X1 Error      | hHhhhhh           | 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         |
| hhhhHhhh          | 12         | Acc. X1 error     | Hhhhhhhh          | 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                            |
|-------------------|------------|----------------------------------------|-------------------|------------|----------------------------------------|
| hhhhhhhH          | 0          | Navigation mode                        | hhhHhhh           | 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                     |
| hhhhhhHh          | 4          | Altitude calculated using GNSS         | hhHhhhhh          | 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             |
| hhhhhHhh          | 8          | Log received                           | hHhhhhhh          | 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                      |
| hhhhHhhh          | 12         | GNSS received                          | Hhhhhhhh          | 28         | Saturation of altitude                 |
|                   | 13         | GNSS data valid                        |                   | 29         | Saturation of speed                    |
|                   | 14         | Waiting for GNSS data                  |                   | 30         | Acc or Rotation speed dynamic exceeded |
|                   | 15         | GNSS data rejected                     |                   | 31         | Heave initialization                   |

**GPS LIKE**

**Standard:** Output NMEA 0183 compatible.

**Data sent:** This protocol outputs Phins Compact C7 computed position, speed, time, standard deviations values in a “GPS like” format.

**Time management:** see chapter 1.1.

**Data frame:**

**\$GPZDA,hhmmss.ss,dd,mm,yyyy,hh,mm\*hh<CR><LF> \*\*\*\***

|           |                              |    |
|-----------|------------------------------|----|
| hhmmss.ss | UTC time of Phins Compact C7 | ** |
| dd        | UTC day                      | *  |
| mm        | UTC month                    | *  |
| yyyy      | UTC year                     | *  |
| hh        | Local zone hours             | *  |
| mm        | Local zone minutes           | *  |
| hh        | Checksum                     | ** |

**\$GPGGA,hhmmss.ss,LLII.IIIIII,a,LLLII.IIIIII,a,x,xx,x.xxx,x.xxx,M,x.xxx,M,x.xxx,xxxx\*hh<CR><LF>**

|              |                                                               |    |
|--------------|---------------------------------------------------------------|----|
| hhmmss.ss    | UTC time of position                                          | ** |
| LLII.IIIIII  | Latitude in degrees (LL) and in minutes (II.IIIIII)           | ** |
| a            | 'N' for Northern hemisphere, 'S' for Southern hemisphere      | ** |
| LLLII.IIIIII | Longitude in deg (LLL) and in minutes (II.IIIIII)             | ** |
| a            | 'E' for East, 'W' for West                                    | ** |
| x            | GNSS 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 GNSS data                             | *  |
| xxxx         | Differential reference station ID                             | *  |
| hh           | Checksum                                                      | ** |

**\$GPGST,hhmmss.ss,x.x,x.x,x.x,x.x,x.x,x.x\*hh<CR><LF>**

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

**\$GPVTG,x.xxx,T,x.xxx,M,x.xxx,N,x.xxx,K,a\*hh<CR><LF>**

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

**\$GPGLL,LLII.IIIIII,a,LLLII.IIIIII,a,hhmmss.ss,a,m\*hh<CR><LF>**

|                     |                                                          |                                                                                                                                     |
|---------------------|----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| <b>LLII.IIIIII</b>  | Latitude in degrees (LL) and in minutes (II.IIIIII)      | **                                                                                                                                  |
| <b>a</b>            | 'N' for Northern hemisphere, 'S' for Southern hemisphere | **                                                                                                                                  |
| <b>LLLII.IIIIII</b> | Longitude in deg (LLL) and in minutes (II.IIIIII)        | **                                                                                                                                  |
| <b>a</b>            | 'E' for East, 'W' for West                               | **                                                                                                                                  |
| <b>hhmmss.ss</b>    | UTC time of position                                     | **                                                                                                                                  |
| <b>a</b>            | Status 'A' for Data Valid, 'V' for Data Invalid          | Data invalid for initial alignment and speed saturation (i.e User status ALIGNMENT AND User status SPEED_ SATURATION bits set to 1) |
| <b>m</b>            | Mode indicator 'A', 'D' or 'E'                           | ***                                                                                                                                 |
| <b>hh</b>           | Checksum                                                 | **                                                                                                                                  |

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

\*\* Phins Compact C7 calculated data.

\*\*\* see chapter 1.4



---

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.

**GYROCOMPASS**

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,IIIIII,zzzzzz*hh<CR><LF> |                                                                            |
|--------------------------------------------------|----------------------------------------------------------------------------|
| hhhhhhh                                          | is the hexadecimal value of the 32 bits of Phins Compact C7 System status1 |
| IIIIII                                           | is the hexadecimal value of the 32 bits of Phins Compact C7 System status2 |
| zzzzzz                                           | is the hexadecimal value of the 32 bits of Phins Compact C7 System status3 |
| hh                                               | is the checksum                                                            |

(\*) 5 digits after the decimal point in full resolution.

**GYROCOMPASS 2**

Standard: ASCII. Output NMEA 0183 compatible.

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

Data frame:

| \$HEHDT,x.x,T*hh<CR><LF> |                                                                             |               |
|--------------------------|-----------------------------------------------------------------------------|---------------|
| <b>x.x</b>               | True heading in degrees. Must be empty if HRP INVALID is set in user status | <b>Note 1</b> |
| <b>T</b>                 | Fixed ASCII character 'T'                                                   |               |
| <b>hh</b>                | NMEA checksum                                                               |               |

| \$PHTRH,x.xx,a,y.yy,b,z.zz,c*hh<CR><LF> |                                                                       |  |
|-----------------------------------------|-----------------------------------------------------------------------|--|
| <b>x.xx</b>                             | Pitch in degrees                                                      |  |
| <b>a</b>                                | 'M' for bow up and 'P' for bow down                                   |  |
| <b>y.yy</b>                             | Roll in degrees                                                       |  |
| <b>b</b>                                | 'B' for port down and 'T' for port up                                 |  |
| <b>z.zz</b>                             | Heave absolute value in meters                                        |  |
| <b>c</b>                                | 'U' if Phins Compact C7 goes up and 'O' if Phins Compact C7 goes down |  |
| <b>hh</b>                               | NMEA checksum                                                         |  |

| \$PIXSE,STATUS,hhhhhhhh,IIIIIII *hh<CR><LF> |                                                                      |                     |
|---------------------------------------------|----------------------------------------------------------------------|---------------------|
| <b>hhhhhhhh</b>                             | is the hexadecimal value of the 32 LSB bits of the INS System status | Refer to section 5. |
| <b>IIIIIII</b>                              | is the hexadecimal value of the 32 MSB bits of the INS System status |                     |
| <b>hh</b>                                   | is the checksum                                                      |                     |

## HALLIBURTON SAS

**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,LLII.IIIII,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        |
| LLII.IIIII   | Latitude in degrees (LL), Iminutes (II) and decimals of minutes (IIIIII)       | 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>

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

\* In full resolution 5 digits after decimal point.

\*\* In standard mode: rotation rate quantification is 3.6°/h

\$PIXSE,HSSTAT,FFAAVVQQ\*hh<CR><LF>

|           |                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>FF</b> | Statut 1 : Bit 0 (0x01) : FOG or Source error<br>Bit 1 (0x02) : Accelerometer error<br>Bit 2 (0x04) : Serial input or Ethernet port A error<br>Bit 3 (0x08) : Serial input or Ethernet port B error<br>Bit 4 (0x10) : Serial input or Ethernet port C error<br>Bit 5 (0x20) : Serial input or Ethernet port D error<br>Bit 6 (0x40) : Serial input or Ethernet port E error                                            |
| <b>AA</b> | Statut 2 : Bit 0 (0x01) GNSS valid<br>Bit 1 (0x02) : DVL Bottom track valid<br>Bit 2 (0x04) : USBL valid<br>Bit 3 (0x08) : Dead Reckoning                                                                                                                                                                                                                                                                              |
| <b>VV</b> | Statut 3 : Bit 0 (0x01) : GNSS1 detected<br>Bit 1 (0x02) : DVL Bottom or Water track detected<br>Bit 2 (0x04) : USBL detected<br>Bit 3 (0x08) : Depth detected<br>Bit 4 (0x10) : Activity on serial input or Ethernet port A<br>Bit 5 (0x20) : Activity on serial input or Ethernet port B<br>Bit 6 (0x40) : Activity on serial input or Ethernet port C<br>Bit 7 (0x80) : Activity on serial input or Ethernet port D |
| <b>QQ</b> | Statut 4 : Bit 0 (0x01) : Alignment<br>Bit 1 (0x02) : Fine Alignement<br>Bit 2 (0x04) : Navigation                                                                                                                                                                                                                                                                                                                     |
| <b>hh</b> | Checksum NMEA                                                                                                                                                                                                                                                                                                                                                                                                          |

HEHDT HEROT

**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.  
Phins Compact C7 usual sign convention is used.

NMEA \$HEHDT Frame refer to section 4.1.7.

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

(\*) 5 digits after the decimal point in full resolution.  
(\*\*) 4 digits after the decimal point in full resolution.  
Refer to export regulation for the resolution of rotation rate.

HETHS HEROT

**Standard:** Output NMEA 0183.  
**Data sent:** Heading and heading rotation rate.  
**Data frame:**

NMEA \$HETHS Frame, refer to section 4.1.8.

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

(\*) 5 digits after the decimal point in full resolution.  
(\*\*) 4 digits after the decimal point in full resolution.  
The resolution of rotation rate data is limited to 3.6°/h to comply with export regulation.

## IMU ASCII

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

**Data sent:** Rotation rates, Linear Accelerations.

**Data frame:** ASCII frame.

Data are compensated from:

- Residual mechanical misalignment
- Bias and scale factor from sensor thermal sensibility
- Coning/sculling effects

Data are output in the [s] (soleplate) frame, oriented as forward (X1), left (X2), up (X3)

|                                                                                                                       |                                                               |
|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| <b>\$IMU,hhmmss.sss, p.pppppppp, q.qqqqqqqq, r.rrrrrrr, x.xxxxxxxx, y.yyyyyyyy, z.zzzzzzzz*hh&lt;CR&gt;&lt;LF&gt;</b> |                                                               |
| <b>hhmmss.sss</b>                                                                                                     | Time validity of the data (Note 1)                            |
| <b>p.pppppppp</b>                                                                                                     | XV1 delta rotation (rad) (Note 2) positive when port up       |
| <b>q.qqqqqqqq</b>                                                                                                     | XV2 delta rotation (rad) positive bow down                    |
| <b>r.rrrrrrrr</b>                                                                                                     | XV3 delta rotation (rad) positive counter-clockwise around X3 |
| <b>x.xxxxxxxx</b>                                                                                                     | XV1 delta velocity (m/s) (Note 2) positive forward            |
| <b>y.yyyyyyyy</b>                                                                                                     | XV2 delta velocity(m/s) positive toward port                  |
| <b>z.zzzzzzzz</b>                                                                                                     | XV3 delta velocity(m/s) positive up                           |
| <b>hh</b>                                                                                                             | Checksum                                                      |

**Note 1:** see chapter 1.1.

**Note 2:** Delta rotation is the integration of the gyro readings in the time interval of output data rate. We define  $t_1$  as the time validity of the delta rotation data,  $\Delta t$  the output data rate and  $t_2$  the instant of output of first bit of data telegram. Then  $(t_2 - t_1)$  is the latency on data and delta rotation is the integration of rotation angle from  $t_1 - \Delta t$  to  $t_1$ .

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. The value of the data will change with data rate (i.e: if output frequency is doubled the delta rotation and delta velocity value will be divided by 2).

## IMU BINARY

**Standard:** Binary.

**Data sent:** Delta rotations and delta velocities.

**Data frame:** The frame contains 10 fields – 37 bytes, MSB sent first.

Data are compensated from:

- Residual mechanical misalignment
- Bias and scale factor from sensor thermal sensibility
- Coning/sculling effects
- Compensated for user defined vehicle misalignment

Data are output in the vehicle frame, oriented as forward (XV1), left (XV2), up (XV3)

| Message <F0><F1><F2>.....<F10> |               |                    |                                                            |
|--------------------------------|---------------|--------------------|------------------------------------------------------------|
| <b>Field 0</b>                 | Byte 0        | '\$'               | Synchronization byte                                       |
| <b>Field 1</b>                 | Byte 1 to 4   | Time stamp (0-24 ) | Unsigned 32 bit integer. LSB= 50 $\mu$ s ( <b>Note 1</b> ) |
| <b>Field 2</b>                 | Byte 5 to 8   | XV1 delta rotation | IEEE float 32 bits in radian ( <b>Note 2</b> )             |
| <b>Field 3</b>                 | Byte 9 to 12  | XV2 delta rotation | IEEE float 32 bits in radian                               |
| <b>Field 4</b>                 | Byte 13 to 16 | XV3 delta rotation | IEEE float 32 bits in radian                               |
| <b>Field 5</b>                 | Byte 17 to 20 | XV1 delta velocity | IEEE float 32 bits in m/s ( <b>Note 2</b> )                |
| <b>Field 6</b>                 | Byte 21 to 24 | XV2 delta velocity | IEEE float 32 bits in m/s                                  |
| <b>Field 7</b>                 | Byte 25 to 28 | XV3 delta velocity | IEEE float 32 bits in m/s                                  |
| <b>Field 8</b>                 | Byte 29 to 32 | Sensor status      | Unsigned 32 bit integer. INS sensor status 2               |
| <b>Field 9</b>                 | Byte 33 to 34 | Sensor temperature | Unsigned 16 bit integer in increments ( <b>Note 3</b> )    |
| <b>Field 10</b>                | Byte 35 to 36 | Checksum           | Unsigned 16 bit integer ( <b>Note 4</b> )                  |

**Note 1:** If Phins Compact C7 is synchronized with GNSS 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  $t_1$  as the time validity of the delta rotation data,  $\Delta t$  the output data rate and  $t_2$  the instant of output of first bit of data telegram. Then  $(t_2 - t_1)$  is the latency on data and delta rotation is the integration of rotation angle from  $t_1 - \Delta t$  to  $t_1$ .

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.

The value of the data will change with data rate (i.e.: if output frequency is doubled the delta rotation and delta velocity value will be divided by 2).

**Note 3:** To get the sensor temperature in  $^{\circ}\text{C}$  from temperature increments, the following formula must be used.

$$T(^{\circ}\text{C}) = T_{\text{inc}} / 10 - 273.00$$

with temperature range (software)  $-273$  to  $+136^{\circ}\text{C}$

This is the mean value of  $T_{\text{FOGX1}}$ ,  $T_{\text{FOGX2}}$ ,  $T_{\text{FOGX3}}$ ,  $T_{\text{ACCX1}}$ ,  $T_{\text{ACCX2}}$ ,  $T_{\text{ACCX3}}$ .

**Note 4:** Sum of all bytes from byte 0 to byte 34.

## IMU RAW DATA

**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.

Data are compensated from:

- Residual mechanical misalignment
- Bias and scale factor from sensor thermal sensibility
- Coning/sculling effects
- Compensated for user defined vehicle misalignment

Data are output in the vehicle frame, oriented as forward (XV1), left (XV2), up (XV3)

| Message <F0><F1><F2>.....<F11> |               |                    |                                      |
|--------------------------------|---------------|--------------------|--------------------------------------|
| <b>Field 0</b>                 | Byte 0        | 0x55               | Synchronization byte                 |
| <b>Field 1</b>                 | Byte 1        | 0..255             | Counter (Note 1)                     |
| <b>Field 2</b>                 | Byte 2 to 3   | See below          | Status (Note 2)                      |
| <b>Field 3</b>                 | Byte 4 to 7   | XV1 delta rotation | IEEE Float 32 bits in radian(Note 5) |
| <b>Field 4</b>                 | Byte 8 to 11  | XV2 delta rotation | IEEE Float 32 bits in radian         |
| <b>Field 5</b>                 | Byte 12 to 15 | XV3 delta rotation | IEEE Float 32 bits in radian         |
| <b>Field 6</b>                 | Byte 16 to 19 | XV1 delta velocity | IEEE Float 32 bits in m/s(Note 5)    |
| <b>Field 7</b>                 | Byte 20 to 23 | XV2 delta velocity | IEEE Float 32 bits in m/s            |
| <b>Field 8</b>                 | Byte 24 to 27 | XV3 delta velocity | IEEE Float 32 bits in m/s            |
| <b>Field 9</b>                 | Byte 28       | Temperature        | Signed 8 bit integer in °C(Note 4)   |
| <b>Field 10</b>                | Byte 29 to 30 | See below          | Checksum (Note 3)                    |
| <b>Field 11</b>                | 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  $X^{16}+X^{12}+X^5+1$ )

Init: FFFF

Final XOR value: 0

Reflected input: True

Reflected output: True

**Note 4:** Temperature is coded in 2's complement signed integer format, ranging from -128°C to +127°C.

The temperature represents the mean temperature of TFOGX1, TFOGX2, TFOGX3, TACCX1, TACCX2, TACCX3.

**Note 5:** Delta rotation is the integration of the gyro readings in the time interval of output data rate. We define  $t_1$  as the time validity of the delta rotation data,  $\Delta t$  the output data rate and  $t_2$  the instant of output of first bit of data telegram. Then  $(t_2-t_1)$  is the latency on data and delta rotation is the integration of rotation angle from  $t_1-\Delta t$  to  $t_1$ .

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

**Standard:** Binary protocol.



This protocol description details all the blocks for the iXblue products. Refer to the Phins Compact C7 Technical Description to get the features and sensors available for your product.

### 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  $\mu$ s and cycle from 0 to 24h, thus covering [0:863999999] steps of 100  $\mu$ s.

#### 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  $\mu$ s. Three cases can be distinguished:

- Timestamp shall be positive or null to send timestamp ([0:863999999] steps of 100  $\mu$ s). In this case, used timestamp corresponds to the transmitted timestamp.
- Timestamp shall be negative to indicate sensor delay. In this case, used timestamp correspond to reception time minus transmitted delay.
- Timestamp 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 the 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 be 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, see chapter 1.3

**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 CDVL and the speed of sound measured by an external sensor (CTD, SVP) expressed as CEXT.

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 Std Bin 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 of 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 a 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 the 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 Phins Compact C7 (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   | Total telegram bytes number: 5 bytes header + X bytes message + 4 bytes checksum |

The body part of each command message contains a single command formatted as detailed in section 8. 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   | Total telegram bytes number: 5 bytes header + X bytes message + 4 bytes checksum |

## Output message header for navigation data

### Version 0x2 header

Navigation data output telegram header is formatted as follows:

| 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<br>Bit is set to 1 when the bloc is output, 0 otherwise. |
| External data bit mask          | DWord  | Bloc combination identification bit mask<br>Bit is set to 1 when the 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 $\mu$ s                                                             |
| Counter                         | DWord  | Cycling counter inside $[0:2^{32}-1]$                                                             |

### Version 0x3 header

Navigation data output telegram header 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<br>Bit is set to 1 when the bloc is output, 0 otherwise. |
| Extended Navigation data block bit mask | DWord  | Bloc combination identification bit mask<br>Bit is set to 1 when the bloc is output, 0 otherwise. |
| External data bit mask                  | DWord  | Bloc combination identification bit mask<br>Bit is set to 1 when the bloc is output, 0 otherwise. |
| Total telegram size                     | Word   | Total telegram bytes number: 25 bytes header + X bytes message + 4 bytes checksum                 |
| Navigation data validity time           | Dword  | Validity time in steps of 100 $\mu$ s                                                             |
| 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.<br>Shall be set to 0x00000000                                               |
| External data bit mask                | DWord   | Bloc combination identification bit mask<br>Bit is set to 1 when the bloc is output, 0 otherwise. |
| Total telegram size                   | Word    | Total telegram bytes number: 21 bytes header + X bytes message + 4 bytes checksum                 |
| External sensors time stamp reference | Byte    | External sensors timestamp:<br>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 for version 0x03                                                                             |
| Navigation data blocks bit mask          | DWord   | Unused in input mode.<br>Shall be set to 0x00000000                                               |
| Extended navigation data blocks bit mask | DWord   | Unused in input mode.<br>Shall be set to 0x00000000                                               |
| External data bit mask                   | DWord   | Bloc combination identification bit mask<br>Bit is set to 1 when the bloc is output, 0 otherwise. |
| Total telegram size                      | Word    | Total telegram bytes number: 25 bytes header + X bytes message + 4 bytes checksum                 |
| External sensors time stamp reference    | Byte    | External sensors timestamp:<br>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                                             | Size in bytes | INS         | AHRS                          | Dir. |
|--------|------------------------------------------------------------------------|---------------|-------------|-------------------------------|------|
| 0      | Attitude & Heading                                                     | 12            | X           | X                             | I/O  |
| 1      | Attitude & Heading standard deviation                                  | 12            | X           | N/A                           | O    |
| 2      | Real time Heave/Surge/Sway                                             | 16            | X           | X                             | O    |
| 3      | Smart Heave™                                                           | 8             | X           | X                             | O    |
| 4      | Heading/Roll/Pitch Rate                                                | 12            | X           | X <sup>(1)</sup>              | O    |
| 5      | Rotation rate in Subsea vehicle frame, compensated from Earth rotation | 12            | X           | X <sup>(1)</sup>              | I/O  |
| 6      | Acceleration in Subsea vehicle frame, compensated from gravity         | 12            | X           | X <sup>(1)</sup>              | O    |
| 7      | Position                                                               | 21            | X           | X <sup>(1)</sup>              | I/O  |
| 8      | Position standard deviation                                            | 16            | X           | N/A                           | O    |
| 9      | Speed in geographic frame                                              | 12            | X           | X (from V3)                   | I/O  |
| 10     | Speed std dev. in geographic frame                                     | 12            | X           | N/A                           | O    |
| 11     | Current in geographic frame                                            | 8             | X           | N/A                           | O    |
| 12     | Current std dev in geographic frame                                    | 8             | X           | N/A                           | O    |
| 13     | System date                                                            | 4             | X           | X                             | O    |
| 14     | INS/AHRS sensor status                                                 | 8             | X           | X                             | O    |
| 15     | INS algorithm status                                                   | 16            | X           | N/A                           | O    |
| 16     | INS system status                                                      | 12            | X           | N/A                           | O    |
| 17     | INS user status                                                        | 4             | X           | N/A                           | O    |
| 18     | AHRS algorithm status                                                  | 4             | N/A         | X                             | O    |
| 19     | AHRS system status                                                     | 12            | N/A         | X                             | O    |
| 20     | AHRS user status                                                       | 4             | N/A         | X                             | O    |
| 21     | Heave, surge and sway speeds                                           | 12            | X           | X                             | O    |
| 22     | Speed in Subsea vehicle frame                                          | 12            | X           | X (from V3)                   | O    |
| 23     | Acceleration in geographic frame not compensated from gravity          | 12            | X           | X <sup>(1)</sup>              | I/O  |
| 24     | Course and speed over ground                                           | 8             | X           | X (from V3)                   | O    |
| 25     | Temperatures (ACC/FOG/ANA)                                             | 12            | X           | X <sup>(*)</sup>              | O    |
| 26     | Attitude quaternion data                                               | 16            | X (from V3) | X (from V3)                   | O    |
| 27     | Attitude quaternion standard deviation                                 | 12            | X (from V3) | N/A                           | O    |
| 28     | Raw accelerations in Subsea vehicle frame not compensated from gravity | 12            | X (from V3) | X <sup>(1)</sup><br>(from V3) | O    |
| 29     | Accelerations standard deviation Sub-sea vehicle frame                 | 12            | X (from V3) | N/A                           | O    |

| Bit n° | Internal Block description                               | Size in bytes | INS         | AHRS | Dir. |
|--------|----------------------------------------------------------|---------------|-------------|------|------|
| 30     | Rotation rate standard deviation (Sub-sea vehicle frame) | 12            | X (from V3) | N/A  | O    |
| 31     | RFU                                                      |               | N/A         | N/A  | N/A  |

(1) Mean value over the sampling period.

#### Extended navigation data blocks

Following table describes the extended navigation data blocks and their corresponding bit number.

| Bit n° | Internal Block description                                                     | Size in bytes | INS         | AHRS                          | Dir. |
|--------|--------------------------------------------------------------------------------|---------------|-------------|-------------------------------|------|
| 0      | Rotation accelerations in vessel frame                                         | 12            | X (from V3) | X <sup>(1)</sup><br>(from V3) | O    |
| 1      | Rotation acceleration standard deviation                                       | 12            | X (from V3) | N/A                           | O    |
| 2      | Raw rotation rate in Subsea vehicle frame, not compensated from Earth rotation | 12            | X (from V3) | X <sup>(1)</sup><br>(from V3) | I/O  |
| 3      | Reserved                                                                       | 12            | N/A         | N/A                           | O    |
| 4      | Reserved                                                                       | 12            | N/A         | N/A                           | O    |
| 5      | Reserved                                                                       | 21            | N/A         | N/A                           | O    |
| 6      | Reserved                                                                       | 16            | N/A         | N/A                           | O    |
| 7-31   | Reserved                                                                       |               | N/A         | N/A                           | N/A  |

(1) Mean value over the sampling period.

#### External sensor data blocks

Following table details the external sensor and status blocks and their corresponding bit number:

| Bit n°  | Block description           | Size in bytes | INS | AHRS | Dir. |
|---------|-----------------------------|---------------|-----|------|------|
| 0       | UTC data                    | 5             | X   | X    | I/O  |
| 1, 2, 3 | GPS1, GPS2, manual GPS data | 46 / 46 / 46  | X   | X    | I/O  |
| 4, 5    | EMLOG1, EMLOG 2 data        | 13 / 13       | X   | X    | I/O  |
| 6, 7, 8 | USBL1 - 3 data              | 49 / 49 / 49  | X   | N/A  | I/O  |
| 9       | Depth data                  | 12            | X   | N/A  | I/O  |

| Bit n°   | Block description          | Size in bytes     | INS | AHRS | Dir. |
|----------|----------------------------|-------------------|-----|------|------|
| 10       | DVL Ground Speed           | 37                | X   | N/A  | I/O  |
| 11       | DVL Water Speed            | 33                | X   | N/A  | I/O  |
| 12       | Sound Velocity             | 8                 | X   | N/A  | I/O  |
| 13       | DMI                        | 8                 | X   | N/A  | I/O  |
| 14 - 17  | LBL data<br>(LBL1 to LBL4) | 41 / 41 / 41 / 41 | X   | N/A  | I/O  |
| 18 - 20  | Event marker A, B, C       | 9 / 9 / 9         | X   | N/A  | O    |
| 21       | DVL2 Ground Speed          | 37                | X   | N/A  | I/O  |
| 22       | DVL2 Water Speed           | 33                | X   | N/A  | I/O  |
| 23       | Reserved                   | 28                | N/A | N/A  | I    |
| 24       | Angles                     | 16                | N/A | N/A  | I/O  |
| 25-26    | VTG1-2                     | 17 / 17           | N/A | N/A  | I/O  |
| 27       | Log Book                   | 40                | N/A | N/A  | O    |
| 28 to 31 | Reserved                   |                   | N/A | N/A  | I/O  |

### Navigation data blocks

The navigation data blocks are used in output mode only, except for Attitude and Heading data block (bit n°0), body rotation rates data block (bit n°5), position data block (bit n°7), speed in geographical frame data block (bit n°9) and acceleration in geographical frame data block (bit N°23).

#### Attitude & Heading data block (bit n°0)

Attitude and Heading relate to Subsea 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™ data block (bit n°3)**

This block contains Smart Heave™ data and related time.

| Data                                      | Format | Units                                       |
|-------------------------------------------|--------|---------------------------------------------|
| Smart Heave Time(*)                       | Dword  | Smart heave validity time (steps of 100 µs) |
| Smart Heave™<br>At primary lever arm (**) | Float  | In meters, positive up (XV3H direction)     |

(\*) The smart heave is delayed by 100s. 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 Subsea vehicle frame (bit n°5)**

This block contains rotation rates in vehicle 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 Subsea vehicle frame (bit n°6)**

This block contains accelerations at primary lever arm in vehicle frame XV1, XV2, XV3, compensated from gravity:

| Data             | Format | Units                                      |
|------------------|--------|--------------------------------------------|
| Acceleration XV1 | Float  | In m/s <sup>2</sup> , positive forward     |
| Acceleration XV2 | Float  | In m/s <sup>2</sup> , positive toward port |
| Acceleration XV3 | Float  | In m/s <sup>2</sup> , positive up          |

Linear acceleration expressed in Subsea vehicle 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),<br>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 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 Phins Compact C7 internal date if system is not date synchronized to GNSS 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 |

**AHRS or INS Sensor Status (bit n°14)**

This block contains sensor statuses detailed in section 5:

| 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 5:

| 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 5:

| 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 section 5:

| Data        | Format | Units |
|-------------|--------|-------|
| User Status | DWord  | N/A   |

**AHRS Algorithm Status (bit n°18)**

This block contains Phins Compact C7 algorithm statuses detailed in section 5:

| Data             | Format | Units |
|------------------|--------|-------|
| Algorithm Status | DWord  | N/A   |

**AHRS System Status (bit n°19)**

This block contains Phins Compact C7 system status detailed in section 5:

| Data            | Format | Units |
|-----------------|--------|-------|
| System Status 1 | DWord  | N/A   |
| System Status 2 | DWord  | N/A   |
| System Status 3 | DWord  | N/A   |

**AHRS User Status (bit n°20)**

This block contains Phins Compact C7 user status detailed in section 5:

| Data        | Format | Units |
|-------------|--------|-------|
| User Status | DWord  | N/A   |

**Heave/Surge/Sway speed data block (bit n°21)**

| Data | Format | Units |
|------|--------|-------|
|------|--------|-------|

|                                                  |       |                                       |
|--------------------------------------------------|-------|---------------------------------------|
| Real time heave speed<br>(at selected lever arm) | Float | In m/s, positive up in XV3H direction |
| Surge speed<br>(at selected lever arm)           | Float | In m/s, positive forward in XV1H      |
| Sway speed<br>(at selected lever arm)            | Float | In m/s, positive port side in XV2H    |

**Speed data block in Subsea vehicle frame (bit n°22)**

This block contains speed data at primary lever arm in Subsea vehicle frame:

| Data                | Format | Units                      |
|---------------------|--------|----------------------------|
| <b>XV1 velocity</b> | Float  | In m/s, positive along XV1 |
| <b>XV2 velocity</b> | Float  | In m/s, positive along XV2 |
| <b>XV3 velocity</b> | 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 $\text{m/s}^2$ , positive North |
| East acceleration     | Float  | In $\text{m/s}^2$ , positive East  |
| Vertical acceleration | Float  | In $\text{m/s}^2$ , 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                                    |
|---------------------------|--------|------------------------------------------|
| <b>Course over ground</b> | Float  | In degrees, inside $[0^\circ:360^\circ[$ |
| <b>Speed over ground</b>  | 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)**

| 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   |

Refer to Appendix A: Quaternion Definitions 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 $\sigma(\xi_1)$ | Float  | N/A   |
| Attitude quaternion std dev component $\sigma(\xi_2)$ | Float  | N/A   |
| Attitude quaternion std dev component $\sigma(\xi_3)$ | Float  | N/A   |

Refer to the end of this chapter for details on quaternions definitions, operations and relationship with Euler angles.

**Raw acceleration in Subsea vehicle frame (bit 28)**

This block contains the acceleration in Subsea vehicle frame, at primary lever arm, not compensated from gravity:

| Data             | Format | Units                                    |
|------------------|--------|------------------------------------------|
| Acceleration XV1 | Float  | In $\text{m/s}^2$ , positive forward     |
| Acceleration XV2 | Float  | In $\text{m/s}^2$ , positive toward port |
| Acceleration XV3 | Float  | In $\text{m/s}^2$ , positive up          |

**Acceleration standard deviation in Subsea vehicle frame (bit 29)**

This block contains the acceleration standard deviation in Subsea vehicle frame:

| Data                     | Format | Units             |
|--------------------------|--------|-------------------|
| Acceleration XV1 std dev | Float  | In $\text{m/s}^2$ |
| Acceleration XV2 std dev | Float  | In $\text{m/s}^2$ |
| Acceleration XV3 std dev | Float  | In $\text{m/s}^2$ |

**Rotation rate standard deviation in Subsea vehicle frame (bit 30)**

This block contains the rotation rate standard deviation in Subsea vehicle frame:

| Data                      | Format | Units                |
|---------------------------|--------|----------------------|
| Rotation rate XV1 std dev | Float  | In $^\circ/\text{s}$ |
| Rotation rate XV2 std dev | Float  | In $^\circ/\text{s}$ |
| Rotation rate XV3 std dev | Float  | In $^\circ/\text{s}$ |

**Extended navigation data blocks****Rotation accelerations in Subsea vehicle frame (bit 0)**

This block contains the rotation accelerations (derivative of compensated rotation rates) in Subsea vehicle frame:

| Data                          | Format | Units               |
|-------------------------------|--------|---------------------|
| Raw rotation acceleration XV1 | Float  | In °/s <sup>2</sup> |
| Raw rotation acceleration XV2 | Float  | In °/s <sup>2</sup> |
| Raw rotation acceleration XV3 | Float  | In °/s <sup>2</sup> |

**Rotation acceleration standard deviation in Subsea vehicle frame (bit 1)**

This block contains the rotation acceleration standard deviation in Subsea vehicle frame:

| Data                                  | Format | Units               |
|---------------------------------------|--------|---------------------|
| Raw rotation acceleration std dev XV1 | Float  | In °/s <sup>2</sup> |
| Raw rotation acceleration std dev XV2 | Float  | In °/s <sup>2</sup> |
| Raw rotation acceleration std dev XV3 | Float  | In °/s <sup>2</sup> |

**Raw rotation rate in Subsea vehicle frame (bit 2)**

This block contains raw rotation rates in Subsea vehicle 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 an 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 100µs |
| UTC Source         | Byte   | 0: UTC1, 1: UTC2           |

### GNSS1, GNSS2 and Manual GNSS data blocks (bits n°1,2,3)

Last GNSS1, GNSS2 or Manual GNSS data received or GNSS data to send:

| Data                          | Format | Units                                               |
|-------------------------------|--------|-----------------------------------------------------|
| Data validity time            | Long   | Time tag in steps of 100 µs                         |
| GNSS identification           | Byte   | 0: GNSS1<br>1: GNSS2<br>2: Manual GNSS              |
| GNSS quality                  | Byte   | Refer to Table 1<br>Fixed to 1 for manual GNSS      |
| Latitude                      | Double | In degrees, positive North,<br>inside [-90° :90°]   |
| Longitude                     | Double | In degrees, positive East,<br>inside [0° :360°[     |
| Altitude                      | Float  | In meters, positive up, in geoid<br>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 <sup>2</sup><br>Fixed to 0 for manual GPS |
| Geoidal separation            | Float  | In meters                                           |

Table 6 - Phins Compact C7 interpretation of GNSS quality

| Quality indicator | Corresponding SD attributed to GNSS 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                        |

**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<br>1: EMLOG2      |
| XV1 longitudinal water speed | Float  | In m/s,<br>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<br>1: USBL2<br>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                                                                         |

| Data                          | Format | Units                  |
|-------------------------------|--------|------------------------|
| East standard deviation       | Float  | In meters              |
| Latitude/Longitude covariance | Float  | In meters <sup>2</sup> |
| 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 100 $\mu$ s |
| 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 100 $\mu$ s |
| DVL identification             | Byte   | 0: DVL 1<br>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                           |

XV1, XV2 XV3 speeds are corrected with external Sound velocity sensor measurement.

#### 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 100 $\mu$ s |
| DVL identification | Byte   | 0: DVL 1                         |

| Data                         | Format | Units    |
|------------------------------|--------|----------|
|                              |        | 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 100 $\mu$ s |
| External sensor speed of sound | Float  | In m/s                           |

**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 100 $\mu$ s               |
| Pulse count        | Long   | Number of pulses received since last DMI event |

**LBL data blocks (bit n°14)**

Last received LBL data (up to 10 LBL data blocks in STD BIN frame), or LBL data to send:

| Data                     | Format  | Units                                           |
|--------------------------|---------|-------------------------------------------------|
| Data validity time       | Long    | Time tag in steps of 100 $\mu$ s                |
| RFU                      | Byte    | RFU                                             |
| 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                                       |

**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   | Long   | Time tag in steps of 100 $\mu$ s                     |
| Event Identification | Byte   | 0: Event A<br>1: Event B<br>2: Event C               |
| Event count          | Long   | Number of events received since last protocol update |

**IXSEA TAH**

**Standard:** Output NMEA 0183 compatible.

**Data sent:** Heave, Surge, Sway, Heave speed, Surge speed, Sway speed, Heading, Roll, Pitch, data validity status.

**Data frame:**

| <b>\$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</b> |                                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>\$PHOCT</b>                                                                                                                        | is the header                                                                                                                                                                                           |
| <b>01</b>                                                                                                                             | is the protocol version identifier                                                                                                                                                                      |
| <b>hhmmss.sss</b>                                                                                                                     | is the UTC valid time of observations<br>hh is the local zone hours (from 00 to 23 hours)<br>mm is the local zone minutes (from 00 to +59)<br>ss.sss is the local zone seconds (from 00.000 to +59.999) |
| <b>G</b>                                                                                                                              | is UTC Time status:<br>T=Valid E=Invalid (note 1)                                                                                                                                                       |
| <b>AA</b>                                                                                                                             | is the Phins Compact C7 latency for heading, roll, pitch (note 2)                                                                                                                                       |
| <b>HHH.HHH</b>                                                                                                                        | is the true heading in degree<br>(from 000.000 to 359.999)                                                                                                                                              |
| <b>N</b>                                                                                                                              | is the True Heading status: (note 7)<br>T=Valid E=Invalid I=Initializing                                                                                                                                |
| <b>eRRR.RRR</b>                                                                                                                       | is the Roll in degree<br>(e= +/-, positive if port side up) (from -180.000 to +180.000)                                                                                                                 |
| <b>L</b>                                                                                                                              | is the Roll status: (note 7)<br>T=Valid E=Invalid I=Initializing                                                                                                                                        |
| <b>ePP.PPP</b>                                                                                                                        | is the Pitch degree<br>(e= +/-, positive if bow down), (from -90.000 to +90.000)                                                                                                                        |
| <b>K</b>                                                                                                                              | is the Pitch status: (note 7)<br>T=Valid E=Invalid I=Initializing                                                                                                                                       |
| <b>eFF.FFF</b>                                                                                                                        | is the Heave without Lever arms applied in meters (note 3)<br>(e= +/-, positive up) from -99.999 to +99.999                                                                                             |
| <b>M</b>                                                                                                                              | is the Heave status (also used for surge, sway & speed) : (note 8)<br>T=Valid E=Invalid I=Initializing                                                                                                  |
| <b>eHH.HHH</b>                                                                                                                        | is the Heave with chosen lever arms applied in meters (note 4)<br>(e= +/-, positive up) from -99.999 to +99.999                                                                                         |
| <b>eSS.SSS</b>                                                                                                                        | is the Surge with Lever arms applied in meters (note 5)<br>(e= +/-) from -99.999 to +99.999                                                                                                             |
| <b>eWW.WWW</b>                                                                                                                        | is the Sway with Lever arms applied in meters (note 5)<br>(e= +/-) from -99.999 to +99.999                                                                                                              |
| <b>eZZ.ZZZ</b>                                                                                                                        | is the Heave speed with Lever arms in meters/s (note 5)<br>(e= +/-) from -99.999 to +99.999                                                                                                             |
| <b>eYY.YYY</b>                                                                                                                        | is the Surge speed with Lever arms in meters/s (note 5)<br>(e= +/-) from -99.999 to +99.999                                                                                                             |
| <b>eXX.XXX</b>                                                                                                                        | is the Sway speed with Lever arms in meters/s(note 5)                                                                                                                                                   |

|                                                                                                                               |                                                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| \$PHOCT,01,hmmss.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= +/-) from -99.999 to +99.999                                                                                      |
| eQQQQ.QQ                                                                                                                      | is the heading rate of turns in degree/minute (note 6)<br>(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 '*' |

Note 1: 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.  
 G='T' when (bits 9 and 11 of system 2 status are set) or (bits 0 and 1 of system 3 status are set)  
 Otherwise G='E'

Note 2: The attitude and heading latency for Phins Compact C7 data is 2.26 ms  
 If Phins Compact C7 is time synchronized, time stamp is used and latency is then not relevant.

Note 3: The field eFF.FFF will stay at zero when "smart heave" is selected

Note 4: The field eHH.HHH will output 100 sdelayed heave when "smart heave" is selected.  
 This is only in combination with the primary lever arm.

Note 5: Surge, Sway and Heave Speed, Surge Speed, Sway Speed are real-time values at chosen lever arm (Primary,A,B,C)

Note 6: Rotation rate resolution is limited to 3.6°/h

Note 7: True Heading, Roll and Pitch status : N = L = K  
 N = 'I' when bit 27 of user status is set  
 N = 'E' when bit 31 of user status is set  
 Otherwise N = 'T'

Note 8: Heave Status  
 M = 'I' when bit 27 of user status is set  
 M = 'E' (never)  
 Otherwise M = 'T'

## LONG BINARY NAV

**Standard:** Binary protocol. 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 data.

**Data frame:** The frame contains 26 fields – 61 bytes.

| Message <F0><F1><F2>.....<F25> (Note 1) |                |                                      |                                                                                                                               |
|-----------------------------------------|----------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| <b>Field 0</b>                          | Byte 0         | 'q'                                  | Synchronization byte                                                                                                          |
| <b>Field 1</b>                          | Bytes 1 to 4   | Data time tag                        | UTC_TIME ; 32 bits integer (seconds)<br>Note 2                                                                                |
| <b>Field 2</b>                          | Bytes 5 to 6   | Data time tag                        | Unsigned 16 bits integer<br>0.0001 seconds (0 to 10000)                                                                       |
| <b>Field 3</b>                          | Bytes 7 to 10  | Latitude<br>'+' : North of equator   | Signed 32 bits integer $\pm 2^{31} = \pm 180^\circ$<br>( $\pm 180$ degrees)                                                   |
| <b>Field 4</b>                          | Bytes 11 to 14 | Longitude<br>'+' : East of Greenwich | Signed 32 bits integer $\pm 2^{31} = \pm 180^\circ$<br>( $\pm 180$ degrees)                                                   |
| <b>Field 5</b>                          | Bytes 15 to 18 | Altitude**                           | Signed 32 bits integer (centimeters)                                                                                          |
| <b>Field 6</b>                          | Bytes 19 to 20 | Heave<br>" + " when down             | Signed 16 bits integer (centimeters)<br>Warning: Opposite sign of PHINS usual convention                                      |
| <b>Field 7</b>                          | Bytes 21 to 22 | North velocity                       | Signed 16 bits integer (centimeters/second)                                                                                   |
| <b>Field 8</b>                          | Bytes 23 to 24 | East velocity                        | Signed 16 bits integer (centimeters/second)                                                                                   |
| <b>Field 9</b>                          | Bytes 25 to 26 | Vertical velocity<br>" + " when down | Signed 16 bits integer (centimeters/second)<br>Warning: Opposite sign of INS usual convention                                 |
| <b>Field 10</b>                         | Bytes 27 to 28 | Roll<br>Sign " + " when port side up | Signed 16 bits integer $\pm 2^{15} = \pm 180^\circ$<br>( $\pm 180$ degrees)                                                   |
| <b>Field 11</b>                         | Bytes 29 to 30 | Pitch<br>Sign " + " when bow up      | Signed 16 bits integer $\pm 2^{15} = \pm 180^\circ$<br>( $\pm 180$ degrees)<br>Warning: Opposite sign of INS usual convention |
| <b>Field 12</b>                         | Bytes 31 to 32 | Heading                              | Unsigned 16 bits integer $2^{15} = 180^\circ$<br>(0 to 360 degrees)                                                           |

**Note 1:** MSB is sent first then LSB (big-endian convention).

Note 2 : UTC time if product is UTC synchronized, system time otherwise.

\*The precision of rotation rate data is limited to 3.6 deg/h to comply with export regulation.

\*\* refer to section 1.2 for altitude management.

\*\*\*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;
    }
```

## MDL2

**Standard:** Output MDL ASCII standard.

**Data sent:** Heading, Roll, Pitch, Gyro status.

**Data frame:** HhhhhP±xxxxR±yyyyQ<CR><LF>

where:

hhhh is the heading in degrees multiplied by 10 range [0.0°, 359.9°]

xxxx is the pitch in degrees multiplied by 100, range [+89.99°, -89.99°]

yyyy is the roll in degrees multiplied by 100, range [+89.99°, -89.99°]

**Q** is the gyro status as follows:

**M** Gyro alignment mode <sup>(1)</sup>

**E** Gyro reports good data <sup>(2)</sup>

**N** reports invalid data <sup>(3)</sup>

<sup>(1)</sup> Q=M when flag USR\_INS\_ALIGNMENT is raised

<sup>(2)</sup> Q=E when M and N condition are false

<sup>(3)</sup> Q=N whenever any of the following flags are raised :

USR\_INS\_CPU\_OVERLOAD | USR\_INS\_DEGRADED\_MODE | USR\_INS\_FAILURE\_MODE | USR\_INS\_HRP\_UNVALID

## NAV BHO

**Standard:** ASCII NMEA 0183.

**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:** is composed of:

- \$PHZDA, refer to section 4.1.5
- \$PHGGA, refer to section 4.2.2
- \$PHVTG, refer to section 4.2.11
- \$HEHDT, refer to section 4.1.7

| \$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<br>'+' when port up, '-' when port down                                                                                                             | 2 digits after decimal point                                                                                                 |
| bP.PP                                                                        | is the pitch in degrees and b, its sign character.<br>'-' when bow down, '+' when bow up                                                                                                             | 2 digits after decimal point                                                                                                 |
| cD.DD                                                                        | Warning: Opposite sign of INS usual convention<br>is the heave in meters and c, its sign character<br>'-' when INS goes up, '+' when INS goes down<br>Warning: Opposite sign of INS usual convention | 2 digits after decimal point<br>3 digits after decimal point<br>3 digits after decimal point<br>3 digits after decimal point |
| r.rrr                                                                        | is the roll standard deviation                                                                                                                                                                       |                                                                                                                              |
| p.ppp                                                                        | is the pitch standard deviation                                                                                                                                                                      |                                                                                                                              |
| h.hhh                                                                        | is the heading standard deviation                                                                                                                                                                    |                                                                                                                              |
| x                                                                            | is the GNSS aiding status flag<br>1 when GNSS received, otherwise 0                                                                                                                                  |                                                                                                                              |
| y                                                                            | is the sensor error status flag<br>1 when FOG or ACC error, otherwise 0                                                                                                                              |                                                                                                                              |
| hh                                                                           | is the checksum                                                                                                                                                                                      |                                                                                                                              |

(\*) Last GNSS values received. When no GNSS 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 1.4).

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

(\*\*\*\*\*) 5 digits after the decimal point in full resolution.

**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

**Standard:** ASCII NMEA 0183.

**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:** is composed of:

\$PHZDA, refer to section 4.1.5

\$PHGGA, refer to section 4.2.2

**\$PHGST,hhmmss.ss,x.xxx,y.yyy,z.zzz,a.aaa,x.xxx,y.yyy,z.zzz\*hh<CR><LF>**

|                  |                                                                                          |                                   |
|------------------|------------------------------------------------------------------------------------------|-----------------------------------|
| <b>hhmmss.ss</b> | is the UTC time of the GGA fix associated with this sentence                             | (**) 3 digits after decimal point |
| <b>x.xxx</b>     | is the RMS value of the standard deviation of the range inputs to the navigation process |                                   |
| <b>y.yyy</b>     | is the standard deviation of semi-major axis of error ellipse (meters)                   | (**) 3 digits after decimal point |
| <b>z.zzz</b>     | is the standard deviation of semi-minor axis of error ellipse (meters)                   | (**) 3 digits after decimal point |
| <b>a.aaa</b>     | is the orientation of semi-major axis of error ellipse (degrees from true North)         | (**) 3 digits after decimal point |
| <b>x.xxx</b>     | is the standard deviation of latitude error, in meters                                   | (**) 3 digits after decimal point |
| <b>y.yyy</b>     | is the standard deviation of longitude error, in meters                                  | (**) 3 digits after decimal point |
| <b>z.zzz</b>     | is the standard deviation of altitude error, in meters                                   | (**) 3 digits after decimal point |
| <b>hh</b>        | is the checksum                                                                          | (**) 3 digits after decimal point |

\$PHVTG, refer to section 4.2.11

\$HEHDT, refer to section 4.1.7

\$PASHR,hhmmss.sss,H.HH,T,aR.RR,bP.PP,cD.DD,r.rrr,p.ppp,h.hhh,x,y\*hh<CR><LF>

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

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

(\*\*) Phins Compact C7 calculated data

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

Phins Compact C7 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 Phins Compact C7 calculated SD and Quality indicator in GGA telegram (refer to section 1.4).

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

(\*\*\*\*\*) 5 digits after the decimal point in full resolution.

### 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 BINARY

**Standard:** Binary protocol.

**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   | Unsigned 32 bits integer in s                                                                                                             |
| Field 2                             | Bytes 5        | UTC data timestamp   | Unsigned 8 bits integer in hundredths of seconds                                                                                          |
| Field 3                             | Bytes 6 to 9   | Latitude             | Signed 32 bits in radians ( $\pm 2^{31} = \pm 180^\circ$ )<br>Sign "+" North of the equator                                               |
| Field 4                             | Bytes 10 to 13 | Longitude            | Signed 32 bits in radians ( $\pm 2^{31} = \pm 180^\circ$ )<br>Sign "+" East of                                                            |
| Field 5                             | Bytes 14 to 17 | Altitude             | Signed 32 bits in centimeters                                                                                                             |
| Field 6                             | Bytes 18 to 19 | Heave                | Signed 16 bits in centimeters<br>Sign "+" in down direction<br>Warning: Opposite sign of product usual convention                         |
| 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<br>Warning: Opposite sign of product usual convention                                                   |
| Field 10                            | Bytes 26 to 27 | Roll*                | Signed 16 bits in radians ( $\pm 2^{15} = \pm 180^\circ$ )<br>Sign "+" when port side up                                                  |
| Field 11                            | Bytes 28 to 29 | Pitch*               | Signed 16 bits in radians ( $\pm 2^{15} = \pm 180^\circ$ )<br>Sign "+" when bow up.<br>Warning: Opposite sign of product usual convention |
| Field 12                            | Bytes 30 to 31 | Heading*             | Unsigned 16 bits in radians ( $2^{16} = 360^\circ$ )                                                                                      |
| Field 13                            | Bytes 32 to 33 | XV1 rotation rate ** | Signed 16 bits in Radians /sec ( $\pm 2^{15} = \pm 180^\circ/\text{sec}$ )                                                                |
| Field 14                            | Bytes 34 to 35 | XV2 rotation rate ** | Signed 16 bits in Radians /sec ( $\pm 2^{15} = \pm 180^\circ/\text{sec}$ )<br>Warning: Opposite sign of product usual convention          |
| Field 15                            | Bytes 36 to 37 | XV3 rotation rate ** | Signed 16 bits in Radians /sec ( $\pm 2^{15} = \pm 180^\circ/\text{sec}$ )<br>Warning: Opposite sign of product usual convention          |

\* In standard mode, the precision of heading, roll and pitch data are limited to  $0.001^\circ$  to comply with export regulation.

\*\* In standard mode, the precision of rotation rate data is limited to  $3.6 \text{ deg/h}$  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

**Standard:** Binary protocol.

**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. Big 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 ( $\pm 2^{63} = \pm 180^\circ$ )<br>Sign "+" North of equator                                                                                                                             |
| Field 4                             | Bytes 14 to 21 | Longitude                 | Signed 64 bits in degrees ( $\pm 2^{63} = \pm 180^\circ$ )<br>Sign "+" East of Greenwich                                                                                                                            |
| Field 5                             | Bytes 22 to 25 | Altitude                  | Signed 32 bits in centimeters<br>Sign "+" Up direction                                                                                                                                                              |
| Field 6                             | Bytes 26 to 27 | Heave                     | Signed 16 bits in centimeters<br>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 ( $\pm 2^{15} = \pm 180^\circ$ )<br>Sign "+" when port side up                                                                                                                            |
| Field 11                            | Bytes 36 to 37 | Pitch*                    | Signed 16 bits in degrees ( $\pm 2^{15} = \pm 180^\circ$ )<br>Sign "+" when bow up.<br>Warning: Opposite sign of INS usual convention                                                                               |
| Field 12                            | Bytes 38 to 39 | Heading*                  | Unsigned 16 bits in degrees ( $2^{16} = 360^\circ$ )                                                                                                                                                                |
| Field 13                            | Bytes 40 to 41 | $X_{V1}$ rotation rate ** | Signed 16 bits in degrees /sec<br>( $\pm 2^{15} = \pm 180^\circ/\text{sec}$ )                                                                                                                                       |
| Field 14                            | Bytes 42 to 43 | $X_{V2}$ rotation rate ** | Signed 16 bits in degrees /sec<br>( $\pm 2^{15} = \pm 180^\circ/\text{sec}$ )<br>Warning: Opposite sign of INS usual convention                                                                                     |
| Field 15                            | Bytes 44 to 45 | $X_{V3}$ rotation rate ** | Signed 16 bits in degrees /sec<br>( $\pm 2^{15} = \pm 180^\circ/\text{sec}$ )<br>Warning: Opposite sign of INS usual convention                                                                                     |
| Field 16                            | Bytes 46 to 47 | Status                    | Unsigned 16 bits :<br>0x0000 when data valid<br>0x00AA when data invalid<br>Data are not valid if one of the following User Status bit is set to 1:<br>USR_INS_FOG_ERROR<br>USR_INS_ACC_ERROR<br>USR_INS_TEMP_ERROR |

| Message <F0><F1><F2>.....<F16><F17> |                |                   |                                                                                                                                                   |
|-------------------------------------|----------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
|                                     |                |                   | USR_INS_DYNAMIC_EXCEEDED<br>USR_INS_SPEED_SATURATION USR_INS_ALTI_<br>SATURATION USR_INS_ALIGNMENT USR_INS_<br>DEGRADED_MODE USR_INS_FAILURE_MODE |
| <b>Field 17</b>                     | Bytes 48 to 49 | Checksum (CRC)*** | Unsigned 16 bits computed on bytes 1 to 47                                                                                                        |

\* In standard mode, the precision of heading, roll and pitch data are limited to 0.001° to comply with export regulation.

\*\* In standard 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;
    }
}
}
} while (--len);
crc = ~crc;
data = crc;

```

```
crc = (crc << 8) | ((data >> 8) & 0xff);  
return crc;  
}
```

## NAVIGATION

**Standard:** Output NMEA 0183 compatible.

**Data sent:** Heading, Attitude, Position, Status.

**Data frame:**

**\$HEHDT,x.xxxxx,T\*hh<CR><LF>**

|              |                                |                                              |
|--------------|--------------------------------|----------------------------------------------|
| <b>x.xxx</b> | is the true heading in degrees | Float, 3 digits after the decimal point. (*) |
| <b>T</b>     | is a fixed character = 'T'     |                                              |
| <b>hh</b>    | is the checksum                |                                              |

**\$PIXSE,ATITUD,x.xxx,y.yyy\*hh<CR><LF>**

|              |                         |                                              |
|--------------|-------------------------|----------------------------------------------|
| <b>x.xxx</b> | is the roll in degrees  | Float, 3 digits after the decimal point. (*) |
| <b>y.yyy</b> | is the pitch in degrees | Float, 3 digits after the decimal point. (*) |
| <b>hh</b>    | is the checksum         |                                              |

**\$PIXSE,POSITI,x.xxxxxxxx,y.yyyyyyyy,z.zzz\*hh<CR><LF>**

|                   |                              |                                     |
|-------------------|------------------------------|-------------------------------------|
| <b>x.xxxxxxxx</b> | is the latitude in degrees   | Float, 8 digits after decimal point |
| <b>y.yyyyyyyy</b> | is the longitude in degrees* | Float, 8 digits after decimal point |
| <b>z.zzz</b>      | is the altitude in meters    | Float, 3 digits after decimal point |
| <b>hh</b>         | is the checksum              |                                     |

\*Longitude negative is from Greenwich meridian to east and positive to west.

**\$PIXSE,STATUS,hhhhhhhh,IIIIIII,jjjjjjjj\*hh<CR><LF>**

|                 |                                                                    |
|-----------------|--------------------------------------------------------------------|
| <b>hhhhhhhh</b> | is the hexadecimal value of the 32 bits of the INS System status 1 |
| <b>IIIIIII</b>  | is the hexadecimal value of the 32 bits of the INS System status 2 |
| <b>jjjjjjjj</b> | is the hexadecimal value of the 32 bits of the INS System status 3 |
| <b>hh</b>       | is the checksum                                                    |

(\*) 5 digits after the decimal point in full resolution.

## OCTANS STANDARD

**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 4.1.7

NMEA \$HETHS Frame refer to section 4.1.8

NMEA \$PHTRO Frame refer to section 4.2.9

NMEA \$PHLIN Frame refer to section 4.2.5

NMEA \$PHSPD Frame refer to section 4.2.8

NMEA \$PHCMP Frame refer to section 4.2.1

NMEA \$PHINF Frame refer to section 4.2.4.

## PHINS STANDARD

**Standard:** Output NMEA 0183 compatible.

**Data sent:** Heading, Attitude, Position, Speed, Standard deviations, Sensors input, Status.  
The maximal refresh rate is 20 Hz.

**Data frame:**

NMEA \$HEHDT Frame refer to section 4.1.7.

NMEA \$HETHS Frame refer to section 4.1.8.

**\$PIXSE,ATITUD,x.xxx,y.yyy\*hh<CR><LF>**

|              |                         |                                       |
|--------------|-------------------------|---------------------------------------|
| <b>x.xxx</b> | is the roll in degrees  | 3 digits after the decimal point. (*) |
| <b>y.yyy</b> | is the pitch in degrees | 3 digits after the decimal point. (*) |
| <b>hh</b>    | is the checksum         |                                       |

(\*) 5 digits after the decimal point in full resolution

**\$PIXSE,POSITI,x.xxxxxxxx,y.yyyyyyyy,z.zzz\*hh<CR><LF>**

|                   |                              |                              |
|-------------------|------------------------------|------------------------------|
| <b>x.xxxxxxxx</b> | is the latitude in degrees   | 8 digits after decimal point |
| <b>y.yyyyyyyy</b> | is the longitude in degrees* | 8 digits after decimal point |
| <b>z.zzz</b>      | is the altitude in meters    | 3 digits after decimal point |
| <b>hh</b>         | is the checksum              |                              |

\*Longitude negative is from Greenwich meridian to east and positive to west.

**\$PIXSE,SPEED\_,x.xxx,y.yyy,z.zzz\*hh<CR><LF>**

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

**\$PIXSE,UTMWGS,c,nn,x.xxx,y.yyy,z.zzz\*hh<CR><LF>**

|              |                                      |                              |
|--------------|--------------------------------------|------------------------------|
| <b>C</b>     | is the latitude UTM zone (character) |                              |
| <b>nn</b>    | is the longitude UTM zone (integer)  |                              |
| <b>x.xxx</b> | is the east UTM position in meter    | 3 digits after decimal point |
| <b>y.yyy</b> | is the north UTM position in meter   | 3 digits after decimal point |
| <b>z.zzz</b> | is the altitude in meters            | 3 digits after decimal point |
| <b>hh</b>    | is the checksum                      |                              |

**\$PIXSE,HEAVE\_,x.xxx,y.yyy,z.zzz\*hh<CR><LF>**

|              |                                 |                                  |
|--------------|---------------------------------|----------------------------------|
| <b>x.xxx</b> | is the surge in meters (signed) | 3 digits after the decimal point |
| <b>y.yyy</b> | is the sway in meters (signed)  | 3 digits after the decimal point |
| <b>z.zzz</b> | is the heave in meters (signed) | 3 digits after the decimal point |
| <b>hh</b>    | is the checksum                 |                                  |

**\$PIXSE,STDHRP,x.xxx,y.yyy,z.zzz\*hh<CR><LF>**

|              |                                             |                                  |
|--------------|---------------------------------------------|----------------------------------|
| <b>x.xxx</b> | is the heading standard deviation (degrees) | 3 digits after the decimal point |
| <b>y.yyy</b> | is the roll standard deviation (degrees)    | 3 digits after the decimal point |
| <b>z.zzz</b> | is the pitch standard deviation (degrees)   | 3 digits after the decimal point |
| <b>hh</b>    | is the checksum                             |                                  |

**\$PIXSE,STDPOS,x.xx,y.yy,z.zz\*hh<CR><LF>**

|             |                                              |                                  |
|-------------|----------------------------------------------|----------------------------------|
| <b>x.xx</b> | is the latitude standard deviation (meters)  | 2 digits after the decimal point |
| <b>y.yy</b> | is the longitude standard deviation (meters) | 2 digits after the decimal point |
| <b>z.zz</b> | is the altitude standard deviation (meters)  | 2 digits after the decimal point |
| <b>hh</b>   | is the checksum                              |                                  |

**\$PIXSE,STDSPD,x.xxx,y.yyy,z.zzz\*hh<CR><LF>**

|              |                                         |                                  |
|--------------|-----------------------------------------|----------------------------------|
| <b>x.xxx</b> | north speed standard deviation (m/s)    | 3 digits after the decimal point |
| <b>y.yyy</b> | east speed standard deviation (m/s)     | 3 digits after the decimal point |
| <b>z.zzz</b> | vertical speed standard deviation (m/s) | 3 digits after the decimal point |
| <b>hh</b>    | is the checksum                         |                                  |

**\$PIXSE,TIME\_\_,hhmmss.ssssss\*hh<CR><LF>**

|                      |                                                                                                                                                                                    |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>hhmmss.ssssss</b> | 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. |
| <b>hh</b>            | 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**

|                      |                                                                                                                                         |                                  |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| <b>x.xxx</b>         | is the XS1 longitudinal DVL speed in m/s                                                                                                | 3 digits after the decimal point |
| <b>y.yyy</b>         | is the XS2 transverse DVL speed in m/s                                                                                                  | 3 digits after the decimal point |
| <b>z.zzz</b>         | is the XS3 vertical DVL speed in m/s                                                                                                    | 3 digits after the decimal point |
| <b>m.mmm</b>         | is the log heading misalignment Kalman estimation in degrees                                                                            | 3 digits after the decimal point |
| <b>hhmmss.ssssss</b> | is the validity time of the log data received in the UTC time reference frame if available otherwise in the system time reference frame |                                  |
| <b>hh</b>            | is the checksum                                                                                                                         |                                  |

**\$PIXSE,LOGDVL,x.xx,y.yy,z.zz\*hh<CR><LF>****Last raw data received from the log sensor**

|             |                                                    |                                  |
|-------------|----------------------------------------------------|----------------------------------|
| <b>x.xx</b> | is the DVL set sound velocity in water in m/s      | 2 digits after the decimal point |
| <b>y.yy</b> | is the measured compensation sound velocity in m/s | 2 digits after the decimal point |
| <b>z.zz</b> | is the DVL distance to bottom in meters            | 2 digits after the decimal point |
| <b>hh</b>   | 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

|                      |                                                                                                                |                                  |
|----------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------|
| <b>x.xxx</b>         | is the XS1 longitudinal DVL speed in m/s                                                                       | 3 digits after the decimal point |
| <b>y.yyy</b>         | is the XS2 transverse DVL speed in m/s                                                                         | 3 digits after the decimal point |
| <b>z.zzz</b>         | is the XS3 vertical DVL speed in m/s                                                                           | 3 digits after the decimal point |
| <b>n.nnn</b>         | is the north current speed in m/s                                                                              | 3 digits after the decimal point |
| <b>e.eee</b>         | is the east current speed in m/s                                                                               | 3 digits after the decimal point |
| <b>N.NNN</b>         | is the north current speed std dev in m/s                                                                      | 3 digits after the decimal point |
| <b>E.EEE</b>         | is the east current speed std dev in m/s                                                                       | 3 digits after the decimal point |
| <b>hhmmss.ssssss</b> | is the validity time of the log WT data received in the UTC time reference frame if available otherwise in the | 6 digits after decimal point     |
| <b>hh</b>            | system time reference frame<br>is the checksum                                                                 |                                  |

\$PIXSE,GPSIN\_,x.xxxxxxx,y.yyyyyyy,z.zzz,hhmmss.ssssss,q\*hh<CR><LF>

#### Last data received from the GNSS1 sensor

|                      |                                                                                                                                                                                             |                                  |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| <b>x.xxxxxxx</b>     | is the latitude in degrees                                                                                                                                                                  | 8 digits after the decimal point |
| <b>y.yyyyyyy</b>     | is the longitude in degrees                                                                                                                                                                 | 8 digits after the decimal point |
| <b>z.zzz</b>         | is the altitude in meters                                                                                                                                                                   | 3 digits after the decimal point |
| <b>hhmmss.ssssss</b> | is the validity time of the GNSS data received in the UTC time reference frame if available otherwise in the system time reference frame                                                    | 6 digits after the decimal point |
| <b>q</b>             | is the GNSS quality indicator<br>0 and ≥ 5 Fix not valid<br>1 GPS SPS Mode Fix not valid<br>2 Differential Mode, SPS Mode, Fix not valid<br>3 GPS PPS Mode, Fix not valid<br>4 GPS RTK Mode |                                  |
| <b>hh</b>            | is the checksum                                                                                                                                                                             |                                  |

**\$PIXSE,GP2IN\_,x.xxxxxxx,y.yyyyyyy,z.zzz,hhmmss.ssssss,q\*hh<CR><LF>**

**Last data received from the GNSS2 sensor**

|                      |                                                                                                                                                                                 |                                  |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| <b>x.xxxxxxx</b>     | Is the latitude in degrees                                                                                                                                                      | 8 digits after the decimal point |
| <b>y.yyyyyyy</b>     | is the longitude in degrees                                                                                                                                                     | 8 digits after the decimal point |
| <b>z.zzz</b>         | is the altitude in meters                                                                                                                                                       | 3 digits after the decimal point |
| <b>hhmmss.ssssss</b> | is the validity time of the GNSS2 data received in the UTC time reference frame if available otherwise in the system time reference frame                                       | 6 digits after the decimal point |
| <b>q</b>             | is the GNSS quality indicator<br>0 and ≥ 5 Fix not valid<br>1 GPS SPS Mode fix valid<br>2 Differential Mode, SPS Mode, fix valid<br>3 GPS PPS Mode, fix valid<br>4 GPS RTK Mode |                                  |
| <b>hh</b>            | is the checksum                                                                                                                                                                 |                                  |

**\$PIXSE,GPMIN\_,x.xxxxxxx,y.yyyyyyy,z.zzz,hhmmss.ssssss,q\*hh<CR><LF>**

**Last data received from the manual GNSS sensor**

|                      |                                                                                                                                                                                 |                                  |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| <b>x.xxxxxxx</b>     | is the latitude in degrees                                                                                                                                                      | 8 digits after the decimal point |
| <b>y.yyyyyyy</b>     | is the longitude in degrees                                                                                                                                                     | 8 digits after the decimal point |
| <b>z.zzz</b>         | is the altitude in meters                                                                                                                                                       | 3 digits after the decimal point |
| <b>hhmmss.ssssss</b> | is the validity time of the manual GNSS data received in the UTC time reference frame if available otherwise in the system time reference frame                                 | 6 digits after the decimal point |
| <b>q</b>             | is the GNSS quality indicator<br>0 and ≥ 5 Fix not valid<br>1 GPS SPS Mode fix valid<br>2 Differential Mode, SPS Mode, fix valid<br>3 GPS PPS Mode, fix valid<br>4 GPS RTK Mode |                                  |
| <b>hh</b>            | is the checksum                                                                                                                                                                 |                                  |

**\$PIXSE,DEPIN\_,x.xxx,hhmmss.ssssss\*hh<CR><LF>**

**Last data received from the depth sensor**

|                      |                                                                                                                                                  |                                  |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| <b>x.xxx</b>         | is the depth in meters                                                                                                                           | 3 digits after the decimal point |
| <b>hhmmss.ssssss</b> | 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 |
| <b>hh</b>            | is the checksum                                                                                                                                  |                                  |

\$PIXSE,USBIN\_,x.xxxxxxxx,y.yyyyyyyy,z.zzz,d.dd,hhmmss.ssssss,n,cccccc\*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                                                                                                  |                                  |
| cccccc                                  | TP code of the beacon                                                                                                                    | 7 ASCII characters               |
| hh                                      | is the checksum                                                                                                                          |                                  |

\$PIXSE,LBLIN\_,x.xxxxxxxx,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 EM Log 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.xxxxxxx,y.yyyyyyy,z.zzz,m.mmm,f.fffff,p.ppp,q.qqq,r.rrrrr,s.sss\*hh<CR><LF>**

|                  |                                                                                     |                                  |
|------------------|-------------------------------------------------------------------------------------|----------------------------------|
| <b>x.xxxxxxx</b> | is the dead reckoning latitude in degrees                                           | 8 digits after the decimal point |
| <b>y.yyyyyyy</b> | is the dead reckoning longitude in degrees                                          | 8 digits after the decimal point |
| <b>z.zzz</b>     | is the dead reckoning altitude in meters                                            | 3 digits after the decimal point |
| <b>m.mmm</b>     | is the heading misalignment dead reckoning estimation in degrees                    | 3 digits after the decimal point |
| <b>f.fffff</b>   | is the scale factor dead reckoning estimation (*)                                   | 6 digits after the decimal point |
| <b>p.ppp</b>     | is the pitch dead reckoning estimation in degrees                                   | 3 digits after the decimal point |
| <b>q.qqq</b>     | is the heading misalignment dead reckoning standard deviation estimation in degrees | 3 digits after the decimal point |
| <b>r.rrrrrr</b>  | is the scale factor dead reckoning standard deviation estimation (*)                | 6 digits after the decimal point |
| <b>s.sss</b>     | is the pitch dead reckoning standard deviation estimation in degrees                | 3 digits after the decimal point |
| <b>hh</b>        | 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**

|             |                                                                     |
|-------------|---------------------------------------------------------------------|
| <b>x.xx</b> | is the travelled distance from start of verification line in meters |
| <b>y.yy</b> | is the current vertical error in meters                             |
| <b>z.zz</b> | is the current horizontal error in meters                           |
| <b>hh</b>   | is the checksum                                                     |

**\$PIXSE,ALGSTS,hhhhhhh,IIIIII \*hh<CR><LF>**

**INS Algo status (refer to section 5.3)**

|                |                                                     |
|----------------|-----------------------------------------------------|
| <b>hhhhhhh</b> | is the hexadecimal value of INS Algo status1 (LSB)  |
| <b>IIIIII</b>  | is the hexadecimal value of INS Algo status 2 (MSB) |
| <b>hh</b>      | is the checksum                                     |

**\$PIXSE,STATUS,hhhhhhh,IIIIII \*hh<CR><LF>**

**INS System status (refer to section 5.4)**

|                |                                                       |
|----------------|-------------------------------------------------------|
| <b>hhhhhhh</b> | is the hexadecimal value of INS System status 1 (LSB) |
| <b>IIIIII</b>  | is the hexadecimal value of INS System status 2 (MSB) |
| <b>hh</b>      | is the checksum                                       |

**\$PIXSE,SORSTS,hhhhhhhh,IIIIIII \*hh<CR><LF> (\*)**

**INS Sensor status (refer to section 5.2)**

|          |                                                       |
|----------|-------------------------------------------------------|
| hhhhhhhh | is the hexadecimal value of INS Sensor status 1 (LSB) |
| IIIIIII  | 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,ALGSTX,hhhhhhhh,IIIIIII,jjjjjjj,kkkkkkkk\*hh<CR><LF>**

**Extended INS Algorithm status (refer to section 5.3)**

|          |                                              |
|----------|----------------------------------------------|
| hhhhhhhh | is the hexadecimal value of INS Algo status3 |
| IIIIIII  | is the hexadecimal value of INS Algo status4 |
| jjjjjjj  | is the hexadecimal value of INS Algo status5 |
| kkkkkkkk | is the hexadecimal value of INS Algo status6 |
| hh       | is the checksum                              |

(\*) For Subsea product, this field is filled with "0" value.

**\$PIXSE,SYSSTX,hhhhhhhh\*hh<CR><LF>**

**Extended System status (refer to section 5.4)**

|          |                                             |
|----------|---------------------------------------------|
| hhhhhhhh | is the hexadecimal value of System status 3 |
| hh       | is the checksum                             |

**\$PIXSE,USRSTS,hhhhhhhh\*hh<CR><LF>**

**Extended User status (refer to section 5)**

|          |                                             |
|----------|---------------------------------------------|
| hhhhhhhh | is the hexadecimal value of INS User status |
| hh       | is the checksum                             |

**\$PIXSE,HT\_STS,hhhhhhhh \*hh<CR><LF>**

**INS high-level repeater status (refer to section 5)**

|          |                                                                           |
|----------|---------------------------------------------------------------------------|
| hhhhhhhh | is the hexadecimal value of INS high-level repeater status <sup>(*)</sup> |
| hh       | is the checksum                                                           |

**\$PIXSE,FOGEST,x.xxxx,y,yyy,z,zzzz\*hh <CR><LF>**

|         |                                                |
|---------|------------------------------------------------|
| x.xxxx  | is the error FOG X estimation in $10^{-3}$ °/h |
| y.yyy   | 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>**

|                |                                                |
|----------------|------------------------------------------------|
| <b>x.xxxx</b>  | is the error ACC X estimation in $\mu\text{g}$ |
| <b>y.yyyy</b>  | is the error ACC Y estimation in $\mu\text{g}$ |
| <b>z .zzzz</b> | is the error ACC Z estimation in $\mu\text{g}$ |
| <b>hh</b>      | is the checksum                                |

**\$PIXSE,LOGEST,x.xxxx\*hh <CR><LF>**

|               |                                           |
|---------------|-------------------------------------------|
| <b>x.xxxx</b> | is the error log estimation in $^{\circ}$ |
| <b>hh</b>     | 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).

## POSTPROCESSING

**Standard:** Binary protocol.

---

Please note that this protocol is not detailed in this documentation.

To get more information about this protocol, contact iXblue.

---

PRDID

**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<br>‘-’ when bow down, ‘+’ when bow up<br>Warning: Opposite sign of product usual convention | 2 digits after decimal point |
| bRRR.RR                                   | is the roll angle in degrees and a, its sign character<br>‘-’ for port down, ‘+’ for port up                                                  | 2 digits after decimal point |
| HHH.HH                                    | is the heading in degrees.                                                                                                                    |                              |
| hh                                        | is the checksum                                                                                                                               |                              |

PRDID TSS

**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<br>'-' when bow down, '+' when bow up<br>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<br>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

**Standard:** ASCII 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> |                    |    |
|-----------------------------------------------|--------------------|----|
| hhmmss.ssssss                                 | UTC time           | ** |
| dd                                            | UTC day            | ** |
| mm                                            | UTC month          | ** |
| yyyy                                          | UTC year           | ** |
| hh                                            | local zone hours   | *  |
| mm                                            | local zone minutes | *  |
| hh                                            | checksum           | ** |

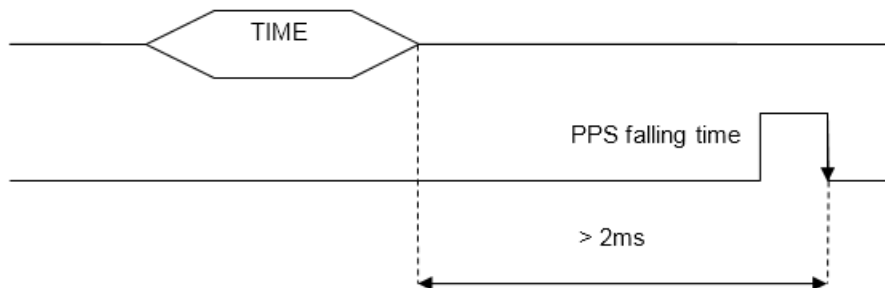
\* Copy of last GNSS values received. When no GNSS has been received since power-up, these fields are null.  
\*\* INS calculated data.  
The time in the message has 6 digits after the comma. It corresponds to the transmission of the PPS LIKE output pulse, if this pulse is enabled.

## **7     Pulses Interfaces**

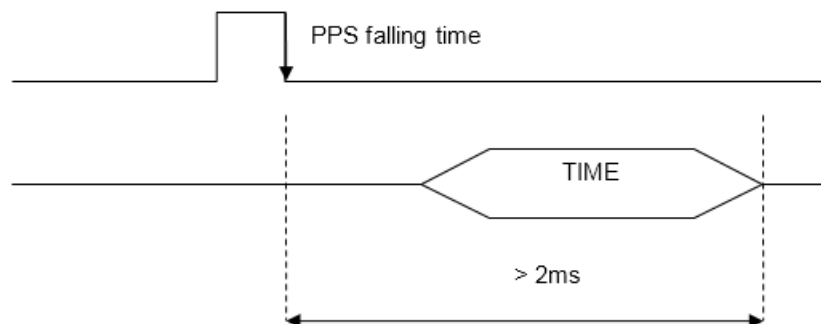
---

## 7.1 Time/PPS Input Constraints

When configured in Time + PPS, the Time frame content must be fully received at least 2 ms before the PPS signal to be correctly taken into account:



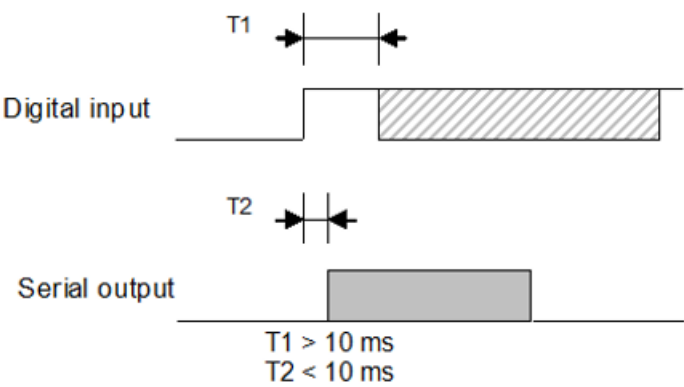
When configured in PPS + Time, the PPS must be sent at least 2ms before the Time frame is entirely received to be correctly taken into account:



## 7.2 Input Pulses Functional Specification

Four input pulses are available in the system, but only part of them may be present on external connectors. 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 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.
- **Event marker rising/falling:** In this configuration, the input pulse will be used to time stamp external event. Associated counts will be logged in EVENT MARKER protocol (see protocol description for details).
- **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).



The table below details pulses and protocols available:

Table 7 - Pulses and Protocols available

| Pulse A                                                                                                | Pulse B      | Pulse C |
|--------------------------------------------------------------------------------------------------------|--------------|---------|
| PPS rising/falling + Time<br>Time + PPS rising/falling<br>Synchro out X<br>Event marker rising/falling | Idem Pulse A | N/A     |

## 8 Control Command Description

This section describes the Phins Compact C7 configuration and monitoring commands which can be used during operation. These commands are sent directly through the repeater port to check settings and modify Phins Compact C7 or external sensors configuration, to reset the unit, and save the configuration to PROM. Refer refer to the section "How to Send and Receive Commands"

However, commands described below are exactly equivalent to the ones which are sent by the Web-Based Graphical User Interface. They may be useful when launching and using the Web-Based Graphical User Interface during operation is not possible.



When Phins Compact C7 is configured during initial installation, the Web-Based Graphical User Interface is not mandatory to operate the Phins Compact C7.

Customer can control/monitor Phins Compact C7 operation using control commands through the repeater port over serial or on Ethernet port 8110.

### 8.1 General Conventions

#### 8.1.1 COMMAND SYNTAX

All frames are compatible with NMEA 0183 standard and are formatted as follows:

**\$PIXSE,CONFIG,NAME[,xxx,...,y]\*hh<CR><LF>** for generic configuration commands

**\$PIXSE,TEXT\_\_,NAME[,xxx,...,y]\*hh<CR><LF>** for generic configuration text retrieve commands

**\$PHCNF,NAME[,xxx,...,y]\*hh<CR><LF>** for Phins Compact C7 specific configuration commands

**\$PHTXT,NAME[,xxx,...,y]\*hh<CR><LF>** for Phins Compact C7 specific configuration text retrieve commands

**\$** is a header and "NAME" depends on the command.

Brackets [ ] indicates optional parameters, depending on the command.

Most commands can be used either to send configuration parameters "xxx,...,y" to the system, or to ask for the current value for the parameter.

In such case, the "xxx,...,y" should be replaced by ".,.". "hh" is the checksum of the sentence, and allows for a control during the transmission.

It is calculated by exclusive-OR'ing (XOR) the 8 bits (no start bits or stop bits) of each character in the sentence, excluding "\$" and "\*".

The hexadecimal values of the most significant and least significant 4 bits of the result are converted to two ASCII (0-9, A-F) for transmission.

The most significant character is transmitted first.

The checksum field is required in all transmitted sentences.

All frames should be ended by the two characters <CR><LF> (0D 0A hexadecimal).

A web based NMEA calculator is provided next page to help computing checksums.

### 8.1.2 HOW TO SEND AND RECEIVE COMMANDS

The Phins Compact C7 will listen for COMMAND protocol on repeater flow, which is available on repeater connector, digital connector and Ethernet.

On repeater port:

- serial configuration is fixed and set to 57600 bauds, odd parity bit, 2 stop bits.
- Ethernet configuration via TCP/IP is available on port 8110 of the system IP address.

Repeater flow will also output PHINS STANDARD protocol.

Answers to commands sent to this port will thus be mixed in PHINS STANDARD output frames.

If a command is not correctly formatted, Phins Compact C7 will ignore it and no answer will be sent. If a parameter is out of allowed range, it will be ignored by Phins Compact C7 and set to default value (0 or none). Thus, to confirm that a command was correctly handled by Phins Compact C7, the control application should systematically send the command to change a parameter, and then send the read back command to check stored value. After all changes are made, the application can send a SAVE command to store parameters in non-volatile memory inside Phins Compact C7.

### 8.1.3 NMEA CHECKSUM WEB PAGE

To get a simple NMEA computation tool, copy following code into a new file (nmea.html) and save it, and open this file with your internet navigator:

```
<html><head><title>NMEA MTK checksum calculator</title>
<script><!--
function updateChecksum(cmd)
{
var checksum = 0;
for(var i = 0; i < cmd.length; i++) checksum = checksum ^
cmd.charCodeAt(i);
var hexsum = Number(checksum).toString(16).toUpperCase();
if (hexsum.length < 2) hexsum = ("00" + hexsum).slice(-2);
settext(document.getElementById("output"), "$" + cmd + "*" +
hexsum);
}
function settext(span, text)
{
if (!span.hasChildNodes()) {
span.appendChild(span.ownerDocument.createTextNode(text));
return;
} else span.firstChild.nodeValue = text;
}
--></script></head><body>
<h1>MTK NMEA checksum calculator</h1>
<p>This is a simple calculator to compute the checksum field of
NMEA frames.</p>
<p> The checksum is simple, just an XOR of all the bytes between
the <tt>$</tt> and the <tt>*</tt> (not including the delimiters
themselves), and written in hexadecimal.</p>
```

```
<p>For this to work you'll need to be using a browser that supports  
JavaScript and DHTML  
(most modern browsers do).</p>  
<div style="margin:1em; padding: 2em; background: #ddddff;">  
<form onsubmit="document.getElementById('commandfld').select();  
return false;">  
<table>  
<tr><th align=right>Command:</th><td><tt>${<input id="commandfld"  
size=80 type="text" onchange="updateChecksum(this.value);">  
value="PIXSE,CONFIG,WAKEUP">*</tt></td></tr>  
<tr><th align=right>With checksum:</th><td><span id="output"  
style="font-family: monospace;"></span></td></tr>  
</table></form></div>  
<script>updateChecksum(document.getElementById  
("commandfld").value);</script>  
<hr></body></html>
```

## 8.2 General System Configuration

### 8.2.1 USER MODE

To start the communication with Phins Compact C7 in User Mode:

|                |                                                               |
|----------------|---------------------------------------------------------------|
| <b>Message</b> | <b>\$PIXSE,CONFIG,WAKEUP*40&lt;CR&gt;&lt;LF&gt;</b>           |
| <b>Title</b>   | Starting Communication with the Phins Compact C7 in User Mode |

Commands can be sent directly without having to call WAKEUP before.

### 8.2.2 SAVE TO EEPROM

Save all parameters into EEPROM:

|                |                                                     |
|----------------|-----------------------------------------------------|
| <b>Message</b> | <b>\$PIXSE,CONFIG,SAVE__*5C&lt;CR&gt;&lt;LF&gt;</b> |
| <b>Title</b>   | Save Configuration to EEPROM                        |

Please note the 2 underscores (" \_ ") characters at the end of this frame.



Be careful do not send a SAVE command between or after to sent both RSTDSP/RSTMPC commands, the save command will cancel the reset request.

### 8.2.3 SOFTWARE SYSTEM REBOOT

#### Important

Please wait for 1s between each reset command to avoid any problem inside the system.

To reboot the system by software, following command can be used:

|                |                                                     |
|----------------|-----------------------------------------------------|
| <b>Message</b> | <b>\$PIXSE,CONFIG,RESET_*57&lt;CR&gt;&lt;LF&gt;</b> |
| <b>Title</b>   | Restart Phins Compact C7 algorithm                  |



Phins Compact C7 will restart with the configuration saved into PROM. It is recommended to perform a save to PROM command (see section 8.2.2) before resetting if you changed the settings and want to keep them.

### 8.2.4 RESET TO FACTORY MPC PARAMETERS

To reset MPC parameters to factory defaults, following command can be used:

|         |                                                     |
|---------|-----------------------------------------------------|
| Message | <b>\$PIXSE,CONFIG,RSTMPC*56&lt;CR&gt;&lt;LF&gt;</b> |
| Title   | Reset MPC parameters to factory defaults            |



This command resets only MPC parameters (input and output protocols, sensor interfaces, etc.). Default parameters will apply only after next reboot. To completely reset system settings, use RSTDSP command as well.

### 8.2.5 WEB-BASED GRAPHICAL USER INTERFACE PASSWORDS RESET

To reset Web-Based Graphical User Interface passwords, following command can be used:

|         |                                                     |
|---------|-----------------------------------------------------|
| Message | <b>\$PIXSE,CONFIG,PWDRST*4B&lt;CR&gt;&lt;LF&gt;</b> |
| Title   | Reset Web-Based Graphical User Interface Passwords  |

### 8.2.6 SYSTEM ERRORS LOG RESET

To reset System Error Log, following command can be used:

|         |                                                     |
|---------|-----------------------------------------------------|
| Message | <b>\$PIXSE,CONFIG,ERRRST*4D&lt;CR&gt;&lt;LF&gt;</b> |
| Title   | Reset System Errors log                             |

### 8.2.7 INTERNAL DATALOGGER MANAGEMENT

To manage the internal datalogger, use the following command:

| Message    | <b>\$PIXSE,CONFIG,FLASHM,i,j*hh&lt;CR&gt;&lt;LF&gt;</b> |      |         |
|------------|---------------------------------------------------------|------|---------|
| Title      | Internal datalogger management                          |      |         |
| Data Field | Semantics                                               | Unit | Type    |
| i          | Internal data logging :0:<br>Stop Logging               | None | Integer |
|            | 1: Start Logging                                        |      |         |
| j          | Auto start up logging :0:<br>OFF                        | None | Integer |
|            | 1: ON                                                   |      |         |

Note: Before using this command, the flow to be logged shall be properly configured through control/command and/or the Web-Based Graphical User Interface.

To retrieve the datalogging state, use following command:

**\$PIXSE,CONFIG,FLASHM,,\*40<CR><LF>**



## 8.2.8 INITIAL POSITION

Use this command to setup the default initial position used by the algorithm when firmware starts:

| Message    | \$PIXSE,CONFIG,MANPOS,x.x,y.y,z.z*hh<CR><LF> |        |       |
|------------|----------------------------------------------|--------|-------|
| Title      | Manual Position                              |        |       |
| Data Field | Semantics                                    | Unit   | Type  |
| x.x        | Latitude, positive north                     | Degree | float |
| y.y        | Longitude, positive east                     | Degree | float |
| z.z        | Altitude, positive up                        | m      | float |

To retrieve current initial position:

**\$PIXSE,CONFIG,MANPOS,,\*53<CR><LF>**

Note : this position is only used in "Immediate Run" starting mode. It is ignored otherwise.

## 8.2.9 MANUAL UTM POSITION

To enter initial UTM position used in static alignment process:

| Message    | \$PIXSE,CONFIG,UTMWGS,c,i,x.x,y.y,z.z*hh<CR><LF> |      |       |
|------------|--------------------------------------------------|------|-------|
| Title      | Manual UTM Position                              |      |       |
| Data Field | Semantics                                        | Unit | Type  |
| c          | Northing area letter                             | N/A  | char  |
| i          | Easting area index                               | N/A  | int   |
| x.x        | Easting offset in area                           | m    | float |
| y.y        | Northing offset in area                          | m    | float |
| z.z        | Altitude                                         | m    | float |

To retrieve current UTM initial position:

**\$PIXSE,CONFIG,UTMWGS,,\*52<CR><LF>**

## 8.2.10 MANUAL ATTITUDE

To enter manual attitude for used in denied GNSS:

| Message    | \$PIXSE,CONFIG,MANATT,a.a,b.b*hh<CR><LF> |        |       |
|------------|------------------------------------------|--------|-------|
| Title      | Manual Attitude                          |        |       |
| Data Field | Semantics                                | Unit   | Type  |
| a.a        | heading                                  | degree | float |
| b.b        | heading standard deviation               | degree | float |

To retrieve manual attitude:

**\$PIXSE,CONFIG,MANATT,,\*53<CR><LF>**

## 8.2.11 HEADING, ROLL AND PITCH FINE MISALIGNMENTS

To configure user attitude biases (fine misalignment with respect to Subsea vehicle frame XV1, XV2, XV3):

| Message    | \$PIXSE,CONFIG,BIAS__,x.x,y.y,z.z *hh<CR><LF> |        |       |
|------------|-----------------------------------------------|--------|-------|
| Title      | Bias Configuration                            |        |       |
| Data Field | Semantics                                     | Unit   | Type  |
| x.x        | Heading misalignment                          | Degree | float |
| y.y        | Roll misalignment                             | Degree | float |
| z.z        | Pitch misalignment                            | Degree | float |

To retrieve the biases:

**\$PIXSE,CONFIG,BIAS\_\_,\*44<CR><LF>**

## 8.2.12 AXIS ORIENTATION

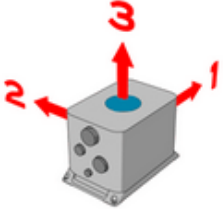
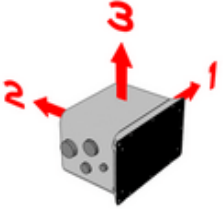
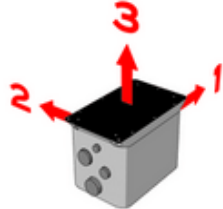
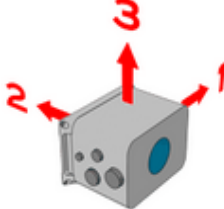
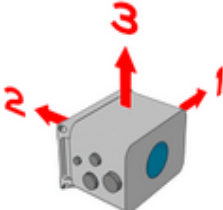
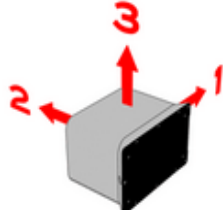
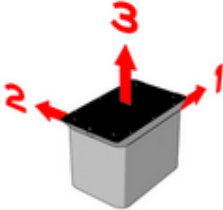
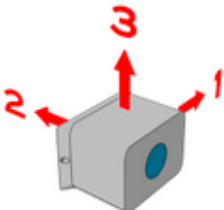
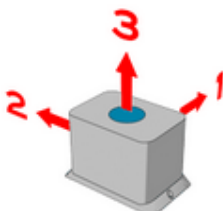
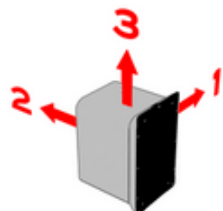
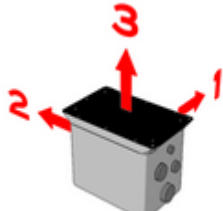
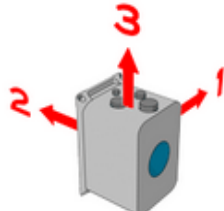
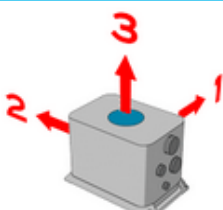
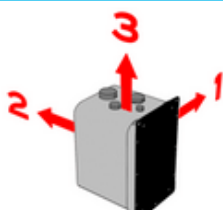
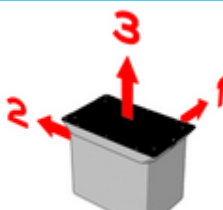
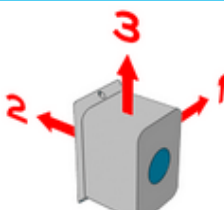
To enter an axis orientation (rough misalignment):

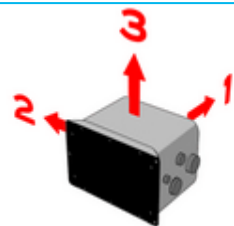
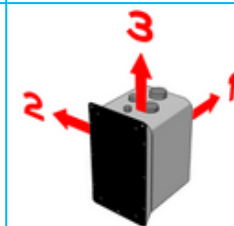
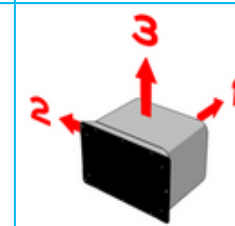
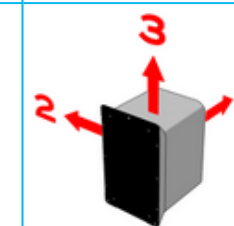
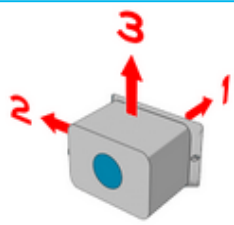
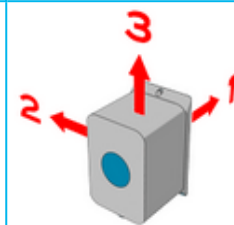
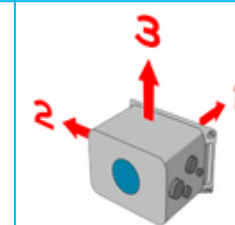
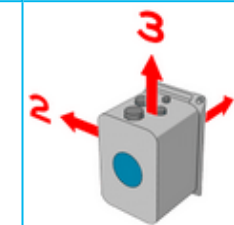
| Message    | \$PIXSE,CONFIG,AXISOR,i*hh<CR><LF> |                                                                         |      |
|------------|------------------------------------|-------------------------------------------------------------------------|------|
| Title      | Axis Orientation                   |                                                                         |      |
| Data Field | Semantics                          | Syntax                                                                  | Type |
| i          | Index of the rough misalignment    | See table next page for index / orientation correspondence and checksum | int  |

To retrieve the axis orientation, also called the rough misalignment:

**\$PIXSE,CONFIG,AXISOR,,\*43<CR><LF>**

**Table 8 - Matching between index i and Phins Compact C7 axis orientation with associated checksum (hh)**

| index      | orientation                                                                         | index      | orientation                                                                         | index      | orientation                                                                          | index      | orientation                                                                           |
|------------|-------------------------------------------------------------------------------------|------------|-------------------------------------------------------------------------------------|------------|--------------------------------------------------------------------------------------|------------|---------------------------------------------------------------------------------------|
| 0<br>(5F)  |   | 1<br>(5E)  |   | 2<br>(5D)  |   | 3<br>(5C)  |   |
| 4<br>(5B)  |  | 5<br>(5A)  |  | 6<br>(59)  |  | 7<br>(58)  |  |
| 8<br>(57)  |  | 9<br>(56)  |  | 10<br>(6E) |  | 11<br>(6F) |  |
| 12<br>(6C) |  | 13<br>(6D) |  | 14<br>(6A) |  | 15<br>(6B) |  |

| index      | orientation                                                                       | index      | orientation                                                                       | index      | orientation                                                                        | index      | orientation                                                                         |
|------------|-----------------------------------------------------------------------------------|------------|-----------------------------------------------------------------------------------|------------|------------------------------------------------------------------------------------|------------|-------------------------------------------------------------------------------------|
| 16<br>(68) |  | 17<br>(69) |  | 18<br>(66) |  | 19<br>(67) |  |
| 20<br>(6D) |  | 21<br>(6C) |  | 22<br>(6F) |  | 23<br>(6E) |  |

### 8.2.13 MAIN LEVER ARMS

To configure the main monitoring point lever arms from the Phins Compact C7:

| Message    | \$PIXSE,CONFIG,LEVARM,x.x,y.y,z.z*hh<CR><LF> |      |       |
|------------|----------------------------------------------|------|-------|
| Title      | Lever Arm Configuration                      |      |       |
| Data Field | Semantics                                    | Unit | Type  |
| x.x        | $X_{V1}$ lever arm                           | m    | Float |
| y.y        | $X_{V2}$ lever arm                           | m    | Float |
| z.z        | $X_{V3}$ lever arm                           | m    | Float |

To retrieve main monitoring point lever arms from the Phins Compact C7:

**\$PIXSE,CONFIG,LEVARM,,\*5C<CR><LF>**

### 8.2.14 SECONDARY LEVER ARMS

To configure secondary monitoring point lever arms from the Phins Compact C7:

| Message    | \$PIXSE,CONFIG,SECLVX,x.x,y.y,z.z*hh<CR><LF> |      |       |
|------------|----------------------------------------------|------|-------|
| Title      | Lever Arm Configuration                      |      |       |
| Data Field | Semantics                                    | Unit | Type  |
| X          | Lever arm ('A', 'B' or 'C')                  | N/A  | Char  |
| x.x        | $X_{V1}$ lever arm                           | m    | Float |
| y.y        | $X_{V2}$ lever arm                           | m    | Float |
| z.z        | $X_{V3}$ lever arm                           | m    | Float |

To retrieve secondary monitoring point lever arms from the Phins Compact C7:

**\$PIXSE,CONFIG,SECLVA,,\*53<CR><LF>**

**\$PIXSE,CONFIG,SECLVB,,\*50<CR><LF>**

**\$PIXSE,CONFIG,SECLVC,,\*51<CR><LF>**

### 8.2.15 CENTER OF GRAVITY POSITION

To configure center of gravity position relative to Phins Compact C7:

| Message    | \$PIXSE,CONFIG,COG____,x.x,y.y,z.z*hh<CR><LF> |      |       |
|------------|-----------------------------------------------|------|-------|
| Title      | Lever Arms Configuration                      |      |       |
| Data Field | Semantics                                     | Unit | Type  |
| x.x        | $X_{V1}$ cog                                  | m    | Float |
| y.y        | $X_{V2}$ cog                                  | m    | Float |
| z.z        | $X_{V3}$ cog                                  | m    | Float |

Please note the 3 underscore(" \_ ") characters after COG header.

To retrieve center of gravity from the INS:

**\$PIXSE,CONFIG,COG\_\_\_\_,\*49<CR><LF>**

### 8.2.16 ZERO VELOCITY UPDATE

Enabling a ZUPT mode is equivalent to sending a speed sensor forced to 0m/s in the INS.

Following modes are available:

- Static 10m/s : this mode sends a 0m/s speed input with 10 m/s standard deviation
- Static 0.1m/s: this mode sends a 0m/s speed input with 0.1 m/s standard deviation
- Autostatic 0.01m/s: this mode detects system movements and when no rotation larger than 10°/h is detected, it enables a null speed entry with 0.01 m/s standard deviation.
- Autostatic bench 0.01m/s: this mode detects movements and when no average rotation, over 3 s, larger than 25°/h (not included earth rotation) is detected, it enables a 0 m/s speed entry with 0.01 m/s standard deviation and a null rotation with 10°/h standard deviation.
- Position: in this mode, the Phins Compact C7 is considered static, and this information is used by the Kalman filter to estimate its parameters.

To configure the Zero Velocity Update Mode:

| Message    | \$PIXSE,CONFIG,ZUP____,i*hh<CR><LF> |                 |      |
|------------|-------------------------------------|-----------------|------|
| Title      | Zero Velocity Update Mode           |                 |      |
| Data Field | Semantics                           | Syntax          | Type |
| i          | Index of ZUPT mode                  | See table below | int  |

Please note the 3 underscore(" \_ ") characters after ZUP header.

|   |           |
|---|-----------|
| i | ZUPT mode |
| 0 | None      |

|   |                          |
|---|--------------------------|
| 1 | Static 10m/s             |
| 2 | Static 0.1m/s            |
| 3 | Auto static 0.01m/s      |
| 4 | Autostatic bench 0.01m/s |
| 6 | Fixed position           |

To retrieve the Zero Velocity Update Mode:

**\$PIXSE,CONFIG,ZUP\_\_\_\_,\*5D<CR><LF>**

### 8.2.17 TURN ON/OFF DVL CALIBRATION MODE

To control the DVL calibration process:

| Message    | \$PIXSE,CONFIG,DDRECK,i*hh<CR><LF> |                                                                                                                                                                                                 |      |
|------------|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Title      | Dead Reckoning Configuration       |                                                                                                                                                                                                 |      |
| Data Field | Semantics                          | Syntax                                                                                                                                                                                          | Type |
| i          | Index of Dead Reckoning Mode       | 0: Stop calibration and ignore estimated calibration values<br>1: Start calibration mode and reset estimations<br>2: Stop calibration and save estimated calibration values for DVL calibration | int  |

Comments:

- When calibration (Dead Reckoning) is started (index set to 1), the \$PIXSE,DDRECK frame is output from the PHINS Standard protocol, to provide for estimated misalignment (heading and pitch) and scale factor during calibration + associated standard deviation. For more details, refer to PHINS STANDARD protocol description.
- When calibration is stopped (index set to 0), the misalignments and scale factor estimations are not accounted for, and the misalignment parameters are kept unchanged.
- When calibration is stopped (index set to 2), current DVL misalignments and scale factor parameters are automatically corrected with new calibration estimation. A "Save to PROM" command is required afterward to permanently save these values.

To retrieve current calibration mode:

**\$PIXSE,CONFIG,DDRECK,,\*42<CR><LF>**

| Message    | \$PIXSE,CONFIG,DDRECK,i*hh<CR><LF> |      |  |
|------------|------------------------------------|------|--|
| Title      | Dead Reckoning Configuration       |      |  |
| Data Field | Syntax                             | Type |  |
| i          | 0: Calibration OFF                 | int  |  |
|            | 1: Calibration NONE                |      |  |
|            | 2: Calibration COARSE              |      |  |
|            | 3: Calibration FINE                |      |  |
|            | 4: Calibration COMPLETE            |      |  |

The DVL calibration process is not stopped automatically by the algorithm, but the Index value is set to 4 when all parameters estimated internally has been finished to converge. The frame associated to this estimation is also described on section 8.3.1.2 (LOGCAL command).

### 8.2.18 TURN ON/OFF DVL CALIBRATION CHECK MODE

To control the DVL calibration check process:

| Message    | \$PIXSE,CONFIG,CALCHK,i*hh<CR><LF> |                     |      |
|------------|------------------------------------|---------------------|------|
| Title      | Calibration Check                  |                     |      |
| Data Field | Semantics                          | Syntax              | Type |
| i          | Calibration Check State            | 0: STOP<br>1: START | int  |

To retrieve current calibration check mode:

**\$PIXSE,CONFIG,CALCHK,,\*53<CR><LF>**

### 8.2.19 STARTING MODE

The frame used to define the starting mode is:

| Message    | \$PIXSE,CONFIG,START_,i*hh<CR><LF> |                                                                                 |      |
|------------|------------------------------------|---------------------------------------------------------------------------------|------|
| Title      | Starting Mode                      |                                                                                 |      |
| Data Field | Semantics                          | Syntax                                                                          | Type |
| i          | Index for Starting Mode            | 0 : Immediate run after power on<br>1 : Wait for Position<br>4 : Emulation mode | int  |

To retrieve the starting mode:

**\$PIXSE,CONFIG,START\_,\*42<CR><LF>**

### 8.2.20 ALTITUDE CALCULATION MODE

The frame used to define the mode to compute the altitude is:

| Message    | \$PIXSE,CONFIG,ALTMDE,i*hh<CR><LF> |                 |      |
|------------|------------------------------------|-----------------|------|
| Title      | Altitude Calculation Mode          |                 |      |
| Data Field | Semantics                          | Syntax          | Type |
| i          | Index                              | See table below | int  |

To retrieve the altitude computation mode:

**\$PIXSE,CONFIG,ALTMDE,,\*48<CR><LF>**

**Table 9 - Altitude Mode for Phins Compact C7**

|   |               |
|---|---------------|
| i | Altitude mode |
| 0 | None          |

|   |       |
|---|-------|
| 1 | GNSS  |
| 2 | Depth |
| 3 | Hydro |

### 8.2.21 HEAVE PARAMETERS

The frame used to define the sea state is:

|                   |                              |                                                                                                           |             |
|-------------------|------------------------------|-----------------------------------------------------------------------------------------------------------|-------------|
| <b>Message</b>    | \$PIXSE,HVEC NF,i*hh<CR><LF> |                                                                                                           |             |
| <b>Title</b>      | Heave Parameters             |                                                                                                           |             |
| <b>Data Field</b> | <b>Semantics</b>             | <b>Syntax</b>                                                                                             | <b>Type</b> |
| I                 | Index                        | 0: Slight Sea (< 1.2 m)<br>1: Moderate Sea (< 2.5 m)<br>2: Rough Sea (> 2.5 m)<br>3: Harbors and Channels | int         |

To retrieve current sea state mode:

**\$PIXSE,CONFIG,HVEC NF,,\*4D<CR><LF>**

### 8.2.22 UTM ZONE MODE

The frame used to define the UTM Zone mode is:

|                   |                                     |                                        |             |
|-------------------|-------------------------------------|----------------------------------------|-------------|
| <b>Message</b>    | \$PIXSE,CONFIG,UTMEXT_,i*hh<CR><LF> |                                        |             |
| <b>Title</b>      | UTM Zone                            |                                        |             |
| <b>Data Field</b> | <b>Semantics</b>                    | <b>Syntax</b>                          | <b>Type</b> |
| i                 | UTM Zone Mode                       | 0 : Standard Mode<br>1 : Extended Mode | int         |

To retrieve the UTM Zone mode:

**\$PIXSE,CONFIG,UTMEXT\_,\*58<CR><LF>**

### 8.2.23 GEOIDAL SEPARATION

The frame used to configure the Geoïdal Separation:

| Message    | \$PIXSE,CONFIG,GEOSEP,s.s*hh<CR><LF> |      |       |
|------------|--------------------------------------|------|-------|
| Title      | Geoïdal Separation                   |      |       |
| Data Field | Semantics                            | Unit | Type  |
| s.s        | Separation                           | m    | float |

To retrieve the Geoïdal Separation:

**\$PIXSE,CONFIG,GEOSEP,,\*56<CR><LF>**

### 8.2.24 ADVANCED FILTERING SETUP

#### 8.2.24.1 Setup Activation

The frame used to enable/disable the “Advanced Filtering mode” is:

| Message    | \$PIXSE,CONFIG,ADVFIL,i*hh<CR><LF>                     |      |      |
|------------|--------------------------------------------------------|------|------|
| Title      | ADVanced FILtering mode                                |      |      |
| Data Field | Semantics                                              | Unit | Type |
| i          | Advanced filtering mode activation:<br>0: OFF<br>1: ON | -    | int  |

To retrieve the advanced filtering setup parameters is:

**\$PIXSE,CONFIG,ADVFIL,,\*4D<CR><LF>**

### 8.2.24.2 GNSS and USBL min/max input standard deviation thresholds

The frame used to set the minimum and maximum input standard deviation thresholds for GNSS and USBL is:

| Message    | \$PIXSE,CONFIG,ADVREJ,i,j,k.k[,m][,n.n]*hh<CR><LF>      |      |       |
|------------|---------------------------------------------------------|------|-------|
| Title      | Advanced filtering minimum and maximum thresholds setup |      |       |
| Data Field | Semantics                                               | Unit | Type  |
| i          | Sensors switch input<br>0: GNSS<br>1: USBL              | -    | int   |
| j          | Minimum mode rejection<br>0: OFF<br>1: ON               | -    | int   |
| k.k        | SD value to set                                         | m    | float |
| m          | Maximum mode rejection<br>0: OFF<br>1: ON               | -    | int   |
| n.n        | SD value to set                                         | m    | float |

This command is ignored if the Advanced Filtering mode is OFF.

Minimum and maximum thresholds are used as follows:

- GNSS/USBL input standard deviation will be set to the minimum specified value if below that threshold
- GNSS/USBL input will be rejected if input standard deviation is above specified maximum threshold

To retrieve the advanced filtering minimum and maximum input standard deviation thresholds is:

**\$PIXSE,CONFIG,ADVREJ,,\*53<CR><LF>**

| Message    | \$PIXSE,CONFIG,ADVREJ,i,j,k.k,m.m,n,o,p.p,q.q*hh<CR><LF>   |      |       |
|------------|------------------------------------------------------------|------|-------|
| Title      | Advanced filtering minimum and maximum thresholds retrieve |      |       |
| Data Field | Semantics                                                  | Unit | Type  |
| i          | Minimum mode rejection for GNSS<br>0 : OFF<br>1 : ON       | -    | int   |
| j          | Minimum mode rejection for USBL<br>0 : OFF<br>1 : ON       | -    | int   |
| k.k        | GNSS Minimum SD value                                      | m    | float |
| m.m        | USBL Minimum SD value                                      | m    | float |
| n          | Maximum mode rejection for GNSS<br>0 : OFF<br>1 : ON       | -    | int   |
| o          | Maximum mode rejection for USBL<br>0 : OFF<br>1 : ON       | -    | int   |
| p.p        | GNSS Maximum SD value                                      | m    | float |
| q.q        | USBL Maximum SD value                                      | m    | float |

### 8.2.24.3 Input Standard Deviation

The frame used to set the input standard deviation associated to input sensors is:

| Message    | \$PIXSE,CONFIG,ADVISED,i,j*hh<CR><LF>                                                                    |       |       |
|------------|----------------------------------------------------------------------------------------------------------|-------|-------|
| Title      | ADVanced filtering Input Standard Deviation                                                              |       |       |
| Data Field | Semantics                                                                                                | Unit  | Type  |
| i          | Sensors switch input SD<br>0: DVL Bottom Track<br>1: DVL Water Track<br>2: EMLOG<br>3: DEPTH             | -     | int   |
| j          | SD value to set in (-1 to ignore):<br>- Meters for DEPTH<br>- Meters per Second for DVL (BT/WT) or EMLOG | m m/s | float |

This command is ignored if the Advanced Filtering mode is OFF.

To retrieve the advanced filtering input standard deviation parameters is:

**\$PIXSE,CONFIG,ADVISED,,\*50<CR><LF>**

| Message    | \$PIXSE,CONFIG,ADVISED,i.i,j.j,k.k,l.l*hh<CR><LF> |      |       |
|------------|---------------------------------------------------|------|-------|
| Title      | ADVanced filtering Input Standard Deviation       |      |       |
| Data Field | Semantics                                         | Unit | Type  |
| i.i        | DVL Bottom Track SD value                         | m/s  | float |
| j.j        | DVL Water Track SD value                          | m/s  | float |
| k.k        | EMLOG SD value                                    | m/s  | float |
| l.l        | DEPTH SD value                                    | m    | float |

Note : some of these value may not be relevant if the sensor is not available on the product.

#### 8.2.24.4 Advanced Position Priority

The frame used to set advanced position input priority for input position is:

| Message    | \$PIXSE,CONFIG,ADVPRI,i*hh<CR><LF>                          |      |      |
|------------|-------------------------------------------------------------|------|------|
| Title      | Advanced position input priority                            |      |      |
| Data Field | Semantics                                                   | Unit | Type |
| i          | Position Input Priority<br>0 : None<br>1 : GNSS<br>2 : USBL | -    | int  |

This command is ignored if the Advanced Filtering mode is OFF.

The frame used to retrieve the advanced position input priority for input position parameter is:

**\$PIXSE,CONFIG,ADVPRI,,\*45<CR><LF>**

#### 8.2.24.5 Advanced GNSS Input/Output Mode

The frame used to set advanced GNSS input and output mode is:

| Message    | \$PIXSE,CONFIG,ADVGPS,i,j,k,m,n,o*hh<CR><LF>   |      |      |
|------------|------------------------------------------------|------|------|
| Title      | Advanced input and output gnss configuration   |      |      |
| Data Field | Semantics                                      | Unit | Type |
| i          | Accept Natural Input<br>0 : NO<br>1 : YES      | -    | int  |
| j          | Accept Differential Input<br>0 : NO<br>1 : YES | -    | int  |
| k          | Accept Military Input<br>0 : NO<br>1 : YES     | -    | int  |
| m          | Accept RTK Input<br>0 : NO<br>1 : YES          | -    | int  |
| n          | Accept Float RTK Input<br>0 : NO<br>1 : YES    | -    | int  |
| o          | GPS Output Mode<br>0 : None                    |      |      |

|  |                                                                                                                                                                                                                                        |  |  |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|
|  | 1: Limit GNSS Quality to<br>Differential or Natural<br>2: Force GNSS Quality Factor to<br>Natural<br>3: Force GNSS Quality Factor to<br>Differential<br>4: Force GNSS Quality Factor to<br>RTK<br>5: Copy input GNSS Quality<br>Factor |  |  |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|

This command is ignored if the Advanced Filtering mode is OFF.

To retrieve the advanced input and output GNSS configuration is:

**\$PIXSE,CONFIG,ADVGPS,,\*4A<CR><LF>**

## 8.3 External Sensor Configuration

### 8.3.1 DVL CONFIGURATION

#### 8.3.1.1 Lever Arm

To configure the lever arm from Phins Compact C7 to the DVL:

| Message    | \$PIXSE,CONFIG,LOGLV_,x.x,y.y,z.z*hh<CR><LF> |      |       |
|------------|----------------------------------------------|------|-------|
| Title      | DVL Lever Arm                                |      |       |
| Data Field | Semantics                                    | Unit | Type  |
| x.x        | X <sub>V1</sub> lever arm                    | m    | float |
| y.y        | X <sub>V2</sub> lever arm                    | m    | float |
| z.z        | X <sub>V3</sub> lever arm                    | m    | float |

To retrieve the lever arm from Phins Compact C7 to the DVL:

**\$PIXSE,CONFIG,LOGLV\_,\*5C<CR><LF>**

#### 8.3.1.2 DVL calibration (misalignments and scale factor)

To manually configure the DVL calibration:

| Message    | \$PIXSE,CONFIG,LOGCAL,x.x,y.y,z.z,s.s*hh<CR><LF>        |      |       |
|------------|---------------------------------------------------------|------|-------|
| Title      | DVL Calibration                                         |      |       |
| Data Field | Semantics                                               | Unit | Type  |
| x.x        | misalignment / unit around X <sub>V1</sub><br>(roll)    | Deg  | float |
| y.y        | misalignment / unit around X <sub>V2</sub><br>(pitch)   | Deg  | float |
| z.z        | misalignment / unit around X <sub>V3</sub><br>(heading) | Deg  | float |
| s.s        | Scale factor correction<br>percentage                   |      | float |

To retrieve the DVL calibration:

**\$PIXSE,CONFIG,LOGCAL,,\*57<CR><LF>**

| Message    | \$PIXSE,CONFIG,LOGCAL,o.o,p.p,q.q,r.r,x.x,y.y,z.z,s.s*hh<CR><LF> |      |       |
|------------|------------------------------------------------------------------|------|-------|
| Title      | DVL Calibration                                                  |      |       |
| Data Field | Semantics                                                        | Unit | Type  |
| o.o        | misalignment / unit around XV1 (roll) estimation                 | Deg  | float |
| p.p        | misalignment / unit around XV2 (pitch) estimation                | Deg  | float |
| q.q        | misalignment /unit around XV3 (heading) estimation               | Deg  | float |
| r.r        | Scale factor correction estimation (*)                           |      | float |
| x.x        | SD misalignment / unit around XV1 (roll) estimation (**)         | Deg  | float |
| y.y        | SD misalignment / unit around XV2 (pitch) estimation (**)        | Deg  | float |
| z.z        | SD misalignment /unit around XV3 (heading) estimation (**)       | Deg  | float |
| s.s        | SD Scale factor correction estimation (*)                        |      | float |

(\*) for example 0.00123 give 0.123%

(\*\*) only available when calibration process is running.

**Note:** These estimations are also available through the PHINS STANDARD output frame (refer to section 8.2.18).

### 8.3.1.3 DVL Interface

To configure the DVL interface (Phins Compact C7 interface to receive data from log):

| Message    | \$PIXSE,CONFIG,LOGINT,i*hh<CR><LF> |                                                                                                    |      |
|------------|------------------------------------|----------------------------------------------------------------------------------------------------|------|
| Title      | DVL Interface                      |                                                                                                    |      |
| Data Field | Semantics                          | Syntax                                                                                             | Type |
| i          | Interface                          | 0: None<br>1: Port A<br>2: Port B<br>3: Port C<br>4: Port D<br>5: Port E<br>6: Port F<br>7: Port G | int  |

The interface should be configured in accordance with the instrument.

To retrieve the Phins Compact C7 interface for DVL data reception:

**\$PIXSE,CONFIG,LOGINT,,\*4A<CR><LF>**

### 8.3.1.4 Sound velocity compensation

Phins Compact C7 can compensate the DVL measurement with the velocity of sound received from an external sensor.

To configure the interface to get the real time velocity of sound:

| Message    | \$PIXSE,CONFIG,LOGSND,i*hh<CR><LF> |                                                                                                    |      |
|------------|------------------------------------|----------------------------------------------------------------------------------------------------|------|
| Title      | Sound Velocity compensation        |                                                                                                    |      |
| Data Field | Semantics                          | Syntax                                                                                             | Type |
| i          | Interface                          | 0: None<br>1: Port A<br>2: Port B<br>3: Port C<br>4: Port D<br>5: Port E<br>6: Port F<br>7: Port G | int  |

The interface should be configured in accordance with the instrument.

To retrieve the Phins Compact C7 interface to which the sound velocity sensor is connected:

**\$PIXSE,CONFIG,LOGSND,,\*40<CR><LF>**

### 8.3.1.5 Rejection Filter configuration for Bottom Track

To configure the Rejection Filter mode for DVL data in Bottom Track mode:

| Message    | \$PIXSE,CONFIG,LOGKFM,i*hh<CR><LF>              |                                                                                              |      |
|------------|-------------------------------------------------|----------------------------------------------------------------------------------------------|------|
| Title      | Rejection Filter Configuration for Bottom Track |                                                                                              |      |
| Data Field | Semantics                                       | Syntax                                                                                       | Type |
| i          | Mode Index                                      | 0: Not Active Always True<br>1: Not Active Always False<br>2: Active Automatic reacquisition | int  |

To retrieve the Rejection Filter mode for DVL data in Bottom Track mode:

**\$PIXSE,CONFIG,LOGKFM,,\*59<CR><LF>**

### 8.3.1.6 Rejection Filter configuration for Water Track

To configure the Rejection Filter mode for DVL data in Water Track mode:

| Message    | \$PIXSE,CONFIG,LOGWTM,i*hh<CR><LF>             |                                                                                              |      |
|------------|------------------------------------------------|----------------------------------------------------------------------------------------------|------|
| Title      | Rejection Filter Configuration for Water Track |                                                                                              |      |
| Data Field | Semantics                                      | Syntax                                                                                       | Type |
| i          | Mode Index                                     | 0: Not Active Always True<br>1: Not Active Always False<br>2: Active Automatic reacquisition | int  |

To retrieve the Rejection Filter mode for DVL data in Water Track mode:

**\$PIXSE,CONFIG,LOGWTM,,\*57<CR><LF>**

### 8.3.1.7 Coupling Mode

To configure the DVL Coupling Mode:

| Message    | \$PIXSE,CONFIG,LOGCPL,i*hh<CR><LF> |                                                                  |      |
|------------|------------------------------------|------------------------------------------------------------------|------|
| Title      | DVL Coupling mode                  |                                                                  |      |
| Data Field | Semantics                          | Syntax                                                           | Type |
| i          | Coupling Mode                      | 0: DVL not coupled to the system<br>1: DVL coupled to the system | int  |

To retrieve the DVL coupling mode:

**\$PIXSE,CONFIG,LOGCPL,,\*46<CR><LF>**

### 8.3.1.8 DVL Type

To configure the DVL type:

| Message    | \$PIXSE,CONFIG,LOGTYP,i*hh<CR><LF> |                                      |      |
|------------|------------------------------------|--------------------------------------|------|
| Title      | DVL Type                           |                                      |      |
| Data Field | Semantics                          | Syntax                               | Type |
| i          | DVL type                           | 0: Piston DVL<br>1: Phased Array DVL | int  |

To retrieve the DVL type:

**\$PIXSE,CONFIG,LOGTYP,,\*44<CR><LF>**

## 8.3.2 DVL2 CONFIGURATION

### 8.3.2.1 Lever Arm

To configure the lever arm from Phins Compact C7 to the DVL2:

| Message    | \$PIXSE,CONFIG,LG2LV_,x.x,y.y,z.z*hh<CR><LF> |      |       |
|------------|----------------------------------------------|------|-------|
| Title      | DVL2 Lever Arm                               |      |       |
| Data Field | Semantics                                    | Unit | Type  |
| x.x        | $X_{V1}$ lever arm                           | m    | float |
| y.y        | $X_{V2}$ lever arm                           | m    | float |
| z.z        | $X_{V3}$ lever arm                           | m    | float |

To retrieve the lever arm from Phins Compact C7 to the DVL2:

**\$PIXSE,CONFIG,LG2LV\_,\*21<CR><LF>**

### 8.3.2.2 DVL2 calibration (misalignments and scale factor)

To manually configure the DVL2 calibration:

| Message    | \$PIXSE,CONFIG,LG2CAL,x.x,y.y,z.z,s.s*hh<CR><LF> |      |       |
|------------|--------------------------------------------------|------|-------|
| Title      | DVL2 Calibration                                 |      |       |
| Data Field | Semantics                                        | Unit | Type  |
| x.x        | misalignment / unit around $X_{V1}$ (roll)       | Deg  | float |
| y.y        | misalignment / unit around $X_{V2}$ (pitch)      | Deg  | float |
| z.z        | misalignment / unit around $X_{V3}$ (heading)    | Deg  | float |
| s.s        | Scale factor correction percentage               |      | float |

To retrieve the DVL2 calibration:

| Message    | \$PIXSE,CONFIG,LG2CAL,o.o,p.p,q.q,r.r,x.x,y.y,z.z,s.s*hh<CR><LF> |      |       |
|------------|------------------------------------------------------------------|------|-------|
| Title      | DVL2 Calibration                                                 |      |       |
| Data Field | Semantics                                                        | Unit | Type  |
| <b>o.o</b> | misalignment / unit around XV1 (roll) estimation                 | Deg  | float |
| <b>p.p</b> | misalignment / unit around XV2 (pitch) estimation                | Deg  | float |
| <b>q.q</b> | misalignment / unit around XV3 (heading) estimation              | Deg  | float |
| <b>r.r</b> | Scale factor correction estimation*                              |      | float |
| <b>x.x</b> | SD misalignment / unit around XV1 (roll) estimation (**)         | Deg  | float |
| <b>y.y</b> | SD misalignment / unit around XV2 (pitch) estimation (**)        | Deg  | float |
| <b>z.z</b> | SD misalignment / unit around XV3 (heading) estimation (**)      | Deg  | float |
| <b>s.s</b> | SD Scale factor correction estimation*                           |      | float |

\* for example 0.00123 give 0.123%

(\*\*) only available when calibration process is running.

Note: These estimations are also available through the PHINS STANDARD output frame.

### 8.3.2.3 DVL2 Interface

To configure the DVL2 interface (Phins Compact C7 interface to receive data from log):

| Message    | \$PIXSE,CONFIG,LG2INT,i*hh<CR><LF> |                                                                                                    |      |
|------------|------------------------------------|----------------------------------------------------------------------------------------------------|------|
| Title      | DVL2 Interface                     |                                                                                                    |      |
| Data Field | Semantics                          | Syntax                                                                                             | Type |
| i          | Interface                          | 0: None<br>1: Port A<br>2: Port B<br>3: Port C<br>4: Port D<br>5: Port E<br>6: Port F<br>7: Port G | int  |

The interface should be configured in accordance with the instrument.

To retrieve the Phins Compact C7 interface for DVL2 data reception:

**\$PIXSE,CONFIG,LG2INT,,\*37<CR><LF>**

### 8.3.2.4 Rejection Filter configuration for Bottom Track

To configure the Rejection Filter mode for DVL data in Bottom Track mode:

| Message    | \$PIXSE,CONFIG,LOGKFM,i*hh<CR><LF>              |                                                                                              |      |
|------------|-------------------------------------------------|----------------------------------------------------------------------------------------------|------|
| Title      | Rejection Filter Configuration for Bottom Track |                                                                                              |      |
| Data Field | Semantics                                       | Syntax                                                                                       | Type |
| i          | Mode Index                                      | 0: Not Active Always True<br>1: Not Active Always False<br>2: Active Automatic reacquisition | int  |

To retrieve the Rejection Filter mode for DVL data in Bottom Track mode:

**\$PIXSE,CONFIG,LOGKFM,,\*59<CR><LF>**

### 8.3.2.5 Rejection Filter configuration for Water Track

To configure the Rejection Filter mode for DVL data in Water Track mode:

| Message    | \$PIXSE,CONFIG,LOGWTM,i*hh<CR><LF>             |                                                                                              |      |
|------------|------------------------------------------------|----------------------------------------------------------------------------------------------|------|
| Title      | Rejection Filter Configuration for Water Track |                                                                                              |      |
| Data Field | Semantics                                      | Syntax                                                                                       | Type |
| i          | Mode Index                                     | 0: Not Active Always True<br>1: Not Active Always False<br>2: Active Automatic reacquisition | int  |

To retrieve the Rejection Filter mode for DVL data in Water Track mode:

**\$PIXSE,CONFIG,LOGWTM,,\*57<CR><LF>**

### 8.3.2.6 Coupling Mode

To configure the DVL2 Coupling Mode:

| Message    | \$PIXSE,CONFIG,LG2CPL,i*hh<CR><LF> |                                                                  |      |
|------------|------------------------------------|------------------------------------------------------------------|------|
| Title      | DVL2 Coupling mode                 |                                                                  |      |
| Data Field | Semantics                          | Syntax                                                           | Type |
| i          | Coupling Mode                      | 0: DVL not coupled to the system<br>1: DVL coupled to the system | int  |

To retrieve the DVL coupling mode:

**\$PIXSE,CONFIG,LG2CPL,,\*3B<CR><LF>**

### 8.3.2.7 DVL Type

To configure the DVL type:

| Message    | \$PIXSE,CONFIG,LG2TYP,i*hh<CR><LF> |                                      |      |
|------------|------------------------------------|--------------------------------------|------|
| Title      | DVL Type                           |                                      |      |
| Data Field | Semantics                          | Syntax                               | Type |
| i          | DVL type                           | 0: Piston DVL<br>1: Phased Array DVL | int  |

To retrieve the DVL type:

**\$ PIXSE,CONFIG,LG2TYP,,\*39<CR><LF>**

### 8.3.3 DVL COMMAND

To send command to DVL:

| Message    | \$PIXSE,CONFIG,DVLCMD,x,y*hh<CR><LF> |                                                                                                                                                      |                     |
|------------|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| Title      | DVL command                          |                                                                                                                                                      |                     |
| Data Field | Semantics                            | Syntax                                                                                                                                               | Type                |
| x          | ID DVL                               | 1: DVL<br>2: DVL2                                                                                                                                    | int                 |
| y          | ID command<br>Or<br>Sub Command      | ID command:<br>0: DVL Stop ping<br>1: DVL Start Ping<br>2: DVL Single Ping (see note 1)<br>Sub Command:<br>string: sub ASCII command (256 chars max) | int<br>or<br>string |

**Frame examples:**

- DVL2 Stop ping:
 

**\$PIXSE,CONFIG,DVLCMD,2,0\*4B<CR><LF>**
- Sending a sub ASCII command to DVL1:
 

**\$PIXSE,CONFIG,DVLCMD,1,CS\*68<CR><LF>**

Note 1: Refer to Teledyne RDI user guide to configure your DVL into single ping or periodic ping mode.

Follow this procedure to use this function:

- Set flow control of RDI DVL to CFx0xxx (Single Ping), CFx1xxx being for periodic ping (default is CF11110)
- To engage the single ping mode, send a first command "1: DVL Start Ping"
- Send single ping command ("2: DVL Single Ping") periodically
- To disengage the single ping mode, send "0: DVL Stop ping" command

### 8.3.4 EM Log CONFIGURATION

#### 8.3.4.1 EM Log Lever Arm

To configure the lever arm from the Phins Compact C7 to the EM Log sensor:

| Message    | \$PIXSE,CONFIG,LMNLV_,x.x,y.y,z.z*hh<CR><LF> |      |       |
|------------|----------------------------------------------|------|-------|
| Title      | EM Log Lever Arm                             |      |       |
| Data Field | Semantics                                    | Unit | Type  |
| x.x        | X <sub>V1</sub> lever arm                    | m    | float |
| y.y        | X <sub>V2</sub> lever arm                    | m    | float |
| z.z        | X <sub>V3</sub> lever arm                    | m    | float |

To retrieve the lever arm from the Phins Compact C7 to the EM Log sensor:

**\$PIXSE,CONFIG,LMNLV\_,\*57<CR><LF>**

#### 8.3.4.2 EM Log Interface

To configure the EM Log interface (Phins Compact C7 interface to receive data from EM Log sensor):

| Message    | \$PIXSE,\$PIXSE,CONFIG,LMNINT,i*hh<CR><LF> |                                                                                                    |      |
|------------|--------------------------------------------|----------------------------------------------------------------------------------------------------|------|
| Title      | EM Log Interface                           |                                                                                                    |      |
| Data Field | Semantics                                  | Syntax                                                                                             | Type |
| i          | Interface                                  | 0: None<br>1: Port A<br>2: Port B<br>3: Port C<br>4: Port D<br>5: Port E<br>6: Port F<br>7: Port G | int  |

The interface should be configured in accordance with the instrument.

To retrieve the Phins Compact C7 interface to which EM Log should be connected:

**\$PIXSE,CONFIG,LMNINT,\*,\*41<CR><LF>**

### 8.3.4.3 EM Log Rejection Filter

To configure the EM Log Rejection Filter mode:

| Message    | \$PIXSE,CONFIG,LMNKFM,i*hh<CR><LF>        |                                                                                              |      |
|------------|-------------------------------------------|----------------------------------------------------------------------------------------------|------|
| Title      | Rejection Filter Configuration for EM Log |                                                                                              |      |
| Data Field | Semantics                                 | Syntax                                                                                       | Type |
| i          | Mode Index                                | 0: Not Active Always True<br>1: Not Active Always False<br>2: Active Automatic reacquisition | int  |

To retrieve the EM Log Rejection Filter mode :

**\$PIXSE,CONFIG,LMNKFM,,\*52<CR><LF>**

### 8.3.5 GNSS CONFIGURATION

#### 8.3.5.1 GNSS Lever Arm

To configure the lever arm from the Phins Compact C7 to the GNSS:

| Message    | \$PIXSE,CONFIG,GPSLV_,x.x,y.y,z.z*hh<CR><LF> |      |       |
|------------|----------------------------------------------|------|-------|
| Title      | GNSS Lever Arm                               |      |       |
| Data Field | Semantics                                    | Unit | Type  |
| x.x        | $X_{V1}$ lever arm                           | m    | float |
| y.y        | $X_{V2}$ lever arm                           | m    | float |
| z.z        | $X_{V3}$ lever arm                           | m    | float |

To retrieve the lever arm from the Phins Compact C7 to the GNSS:

**\$PIXSE,CONFIG,GPSLV\_,\*5C<CR><LF>**

#### 8.3.5.2 GNSS Interface

To configure the GNSS interface (Phins Compact C7 interface to receive data from GNSS):

| Message    | \$PIXSE,CONFIG,GPSINT,i*hh<CR><LF> |                                                                                                                     |      |
|------------|------------------------------------|---------------------------------------------------------------------------------------------------------------------|------|
| Title      | GNSS Interface                     |                                                                                                                     |      |
| Data Field | Semantics                          | Syntax                                                                                                              | Type |
| i          | Interface                          | 0: None<br>1: Port A<br>2: Port B<br>3: Port C<br>4: Port D<br>5: Port E<br>6: Port F<br>7: Port G<br>200: Repeater | int  |

The interface should be configured in accordance with the instrument.

To retrieve the Phins Compact C7 interface to which GNSS should be connected:

**\$PIXSE,CONFIG,GPSINT,\*,\*4A<CR><LF>**

### 8.3.5.3 GNSS Rejection Filter

To configure the GNSS Rejection Filter mode:

| Message    | \$PIXSE,CONFIG,GPSKFM,i*hh<CR><LF>      |                                                                                              |      |
|------------|-----------------------------------------|----------------------------------------------------------------------------------------------|------|
| Title      | Rejection Filter Configuration for GNSS |                                                                                              |      |
| Data Field | Semantics                               | Syntax                                                                                       | Type |
| i          | Mode Index                              | 0: Not Active Always True<br>1: Not Active Always False<br>2: Active Automatic reacquisition | int  |

To retrieve the GNSS Rejection Filter mode :

**\$PIXSE,CONFIG,GPSKFM,,\*59<CR><LF>**

## 8.3.6 GNSS2 CONFIGURATION

### 8.3.6.1 GNSS2 Lever Arm

To configure the lever arm from the Phins Compact C7 to the GNSS2:

| Message    | \$PIXSE,CONFIG,GP2LV_,x.x,y.y,z.z*hh<CR><LF> |      |       |
|------------|----------------------------------------------|------|-------|
| Title      | GNSS2 Lever Arm                              |      |       |
| Data Field | Semantics                                    | Unit | Type  |
| x.x        | $X_{V1}$ lever arm                           | m    | float |
| y.y        | $X_{V2}$ lever arm                           | m    | float |
| z.z        | $X_{V3}$ lever arm                           | m    | float |

To retrieve the lever arm from the Phins Compact C7 to the GNSS2:

**\$PIXSE,CONFIG,GP2LV\_,\*3D<CR><LF>**

### 8.3.6.2 GNSS2 Interface

To configure the GNSS2 interface (Phins Compact C7 interface to receive data from GNSS2):

| Message    | \$PIXSE,CONFIG,GP2INT,i*hh<CR><LF> |                                                                                                                     |      |
|------------|------------------------------------|---------------------------------------------------------------------------------------------------------------------|------|
| Title      | GNSS2 Interface                    |                                                                                                                     |      |
| Data Field | Semantics                          | Syntax                                                                                                              | Type |
| i          | Interface                          | 0: None<br>1: Port A<br>2: Port B<br>3: Port C<br>4: Port D<br>5: Port E<br>6: Port F<br>7: Port G<br>200: Repeater | int  |

The interface should be configured in accordance with the instrument.

To retrieve the Phins Compact C7 interface to which GNSS2 should be connected:

**\$PIXSE,CONFIG,GP2INT,,\*2B<CR><LF>**

### 8.3.6.3 GNSS2 Rejection Filter

To configure the GNSS2 Rejection Filter mode:

| Message    | \$PIXSE,CONFIG,GP2KFM,i*hh<CR><LF>       |                                                                                              |      |
|------------|------------------------------------------|----------------------------------------------------------------------------------------------|------|
| Title      | Rejection Filter Configuration for GNSS2 |                                                                                              |      |
| Data Field | Semantics                                | Syntax                                                                                       | Type |
| i          | Mode Index                               | 0: Not Active Always True<br>1: Not Active Always False<br>2: Active Automatic reacquisition | int  |

To retrieve the GNSS2 Rejection Filter mode :

**\$PIXSE,CONFIG,GP2KFM,,\*38<CR><LF>**

### 8.3.7 MANUAL GNSS CONFIGURATION

#### 8.3.7.1 Manual GNSS Lever Arm

To configure the lever arm from the Phins Compact C7 to the manual GNSS:

| Message    | \$PIXSE,CONFIG,GPMLV_,x.x,y.y,z.z*hh<CR><LF> |      |       |
|------------|----------------------------------------------|------|-------|
| Title      | Manual GNSS Lever Arm                        |      |       |
| Data Field | Semantics                                    | Unit | Type  |
| x.x        | $X_{V1}$ lever arm                           | m    | float |
| y.y        | $X_{V2}$ lever arm                           | m    | float |
| z.z        | $X_{V3}$ lever arm                           | m    | float |

To retrieve the lever arm from the Phins Compact C7 to the manual GNSS:

**\$PIXSE,CONFIG,GPMLV\_,\*42<CR><LF>**

#### 8.3.7.2 Manual GNSS Rejection Filter

To configure the manual GNSS Rejection Filter mode:

| Message    | \$PIXSE,CONFIG,GPMKFM,i*hh<CR><LF>             |                                                                                              |      |
|------------|------------------------------------------------|----------------------------------------------------------------------------------------------|------|
| Title      | Rejection Filter Configuration for manual GNSS |                                                                                              |      |
| Data Field | Semantics                                      | Syntax                                                                                       | Type |
| I          | Mode Index                                     | 0: Not Active Always True<br>1: Not Active Always False<br>2: Active Automatic reacquisition | int  |

To retrieve the manual GNSS Rejection Filter mode:

**\$PIXSE,CONFIG,GPMKFM,,\*47<CR><LF>**

### 8.3.7.3 Manual GNSS Position Fix

To send a manual position fix:

| Message    | \$PIXSE,CONFIG,MANGPS,a.a,b.b,c.c,d.d,e.e,f.f*hh<CR><LF> |        |       |
|------------|----------------------------------------------------------|--------|-------|
| Title      | Manual GNSS position fix                                 |        |       |
| Data Field | Semantics                                                | Unit   | Type  |
| a.a        | Latitude                                                 | degree | float |
| b.b        | Longitude                                                | degree | float |
| c.c        | Altitude                                                 | m      | float |
| d.d        | Latitude standard deviation                              | m      | float |
| e.e        | Longitude standard deviation                             | m      | float |
| f.f        | Altitude standard deviation                              | m      | float |

To retrieve last manual position fix:

**\$PIXSE,CONFIG,MANGPS,,\*5B<CR><LF>**

### 8.3.8 DEPTH SENSOR CONFIGURATION

#### 8.3.8.1 Depth Lever Arm

To configure the lever arm from the Phins Compact C7 to the depth sensor:

| Message    | \$PIXSE,CONFIG,DEPLV_,x.x,y.y,z.z*hh<CR><LF> |      |       |
|------------|----------------------------------------------|------|-------|
| Title      | Depth Lever Arm                              |      |       |
| Data Field | Semantics                                    | Unit | Type  |
| x.x        | X <sub>V1</sub> lever arm                    | m    | float |
| y.y        | X <sub>V2</sub> lever arm                    | m    | float |
| z.z        | X <sub>V3</sub> lever arm                    | m    | float |

To retrieve the lever arm from the Phins Compact C7 to the depth sensor:

**\$PIXSE,CONFIG,DEPLV\_,\*49<CR><LF>**

#### 8.3.8.2 Depth Sensor Offset

To configure the offset that will be subtracted from depth sensor input value:

| Message    | \$PIXSE,CONFIG,DEPOFS,x.x*hh<CR><LF> |      |       |
|------------|--------------------------------------|------|-------|
| Title      | Depth offset                         |      |       |
| Data Field | Semantics                            | Unit | Type  |
| x.x        | Offset                               | m    | float |

To retrieve current depth offset:

**\$PIXSE,CONFIG,DEPOFS,\*56<CR><LF>**

#### 8.3.8.3 Zero Depth Sensor

To use current raw depth input as depth offset (calibrate the depth sensor):

| Message | \$PIXSE,CONFIG,DEPZER,,*41<CR><LF> |
|---------|------------------------------------|
| Title   | Zero depth                         |

Note: this command is normally used to reset depth before diving, canceling possible offset from the depth sensor due to atmospheric pressure change of depth internal offset.

### 8.3.8.4 Depth Sensor Interface

To configure the depth sensor interface (Phins Compact C7 interface to receive data from depth sensor):

| Message    | \$PIXSE,CONFIG,DEPINT,i*hh<CR><LF> |                                                                                                    |      |
|------------|------------------------------------|----------------------------------------------------------------------------------------------------|------|
| Title      | Depth Sensor Interface             |                                                                                                    |      |
| Data Field | Semantics                          | Syntax                                                                                             | Type |
| i          | Interface                          | 0: None<br>1: Port A<br>2: Port B<br>3: Port C<br>4: Port D<br>5: Port E<br>6: Port F<br>7: Port G | int  |

The interface should be configured in accordance with the instrument.

To retrieve the depth sensor interface (Phins Compact C7 interface to receive data from depth sensor):

**\$PIXSE,CONFIG,DEPINT,,\*5F<CR><LF>**

### 8.3.8.5 Rejection Filter Mode for Depth Sensor

To configure the Rejection Filter mode for the depth sensor:

| Message    | \$PIXSE,CONFIG,DEPKFM,i*hh<CR><LF>              |                                                                                              |      |
|------------|-------------------------------------------------|----------------------------------------------------------------------------------------------|------|
| Title      | Rejection Filter Configuration for Depth Sensor |                                                                                              |      |
| Data Field | Semantics                                       | Syntax                                                                                       | Type |
| i          | Mode Index                                      | 0: Not Active Always True<br>1: Not Active Always False<br>2: Active Automatic reacquisition | int  |

To retrieve the Rejection Filter mode for Depth Sensor::

**\$PIXSE,CONFIG,DEPKFM,,\*4C<CR><LF>**

### 8.3.9 USBL CONFIGURATION

#### 8.3.9.1 USBL Lever Arm

To configure the lever arm from the Phins Compact C7 to the USBL beacon:

| Message    | \$PIXSE,CONFIG,USBLV_,x.x,y.y,z.z,i*hh<CR><LF> |      |       |
|------------|------------------------------------------------|------|-------|
| Title      | USBL Lever Arm                                 |      |       |
| Data Field | Semantics                                      | Unit | Type  |
| x.x        | $X_{V1}$ lever arm                             | m    | float |
| y.y        | $X_{V2}$ lever arm                             | m    | float |
| z.z        | $X_{V3}$ lever arm                             | m    | float |
| i          | USBL beacon index (0, 1 or 2)                  | n/a  | int   |

To retrieve the lever arm from the Phins Compact C7 to the specified USBL beacon (i is the beacon index):

**\$PIXSE,CONFIG,USBLV\_,i\*hh<CR><LF>**

#### 8.3.9.2 USBL Interface

To configure the USBL interface (Phins Compact C7 interface to receive data from specified USBL beacon):

| Message    | \$PIXSE,CONFIG,USBINT,i,ttt,j*hh<CR><LF> |                                                                                                    |        |
|------------|------------------------------------------|----------------------------------------------------------------------------------------------------|--------|
| Title      | USBL Interface                           |                                                                                                    |        |
| Data Field | Semantics                                | Syntax                                                                                             | Type   |
| i          | Interface                                | 0: None<br>1: Port A<br>2: Port B<br>3: Port C<br>4: Port D<br>5: Port E<br>6: Port F<br>7: Port G | int    |
| ttt        | Tp code                                  | 8 char max                                                                                         | string |
| j          | index                                    | USBL beacon index (0,1 or 2)                                                                       | int    |

To retrieve the specified USBL beacon interface (j is the beacon index):

**\$PIXSE,CONFIG,USBINT,,j\*hh<CR><LF>**

### 8.3.9.3 USBL Rejection Filter Mode

To configure the Rejection Filter mode for the specified USBL beacon:

| Message    | \$PIXSE,CONFIG,USBKFM,i,j*hh<CR><LF>    |                                                                                              |      |
|------------|-----------------------------------------|----------------------------------------------------------------------------------------------|------|
| Title      | Rejection Filter Configuration for USBL |                                                                                              |      |
| Data Field | Semantics                               | Syntax                                                                                       | Type |
| i          | Mode Index                              | 0: Not Active Always True<br>1: Not Active Always False<br>2: Active Automatic reacquisition | int  |

To retrieve the Rejection Filter mode for specified USBL beacon index j::

**\$PIXSE,CONFIG,USBKFM,,j\*hh<CR><LF>**

### 8.3.9.4 USBL Beacon Watch Selection

In PHINS STANDARD protocol, only one USBL beacon will be reported at a time.

To configure the USBL beacon to watch in PHINS STANDARD protocol:

| Message    | \$PIXSE,CONFIG,USBVIE,i*hh<CR><LF> |                               |      |
|------------|------------------------------------|-------------------------------|------|
| Title      | USBL beacon watch selection        |                               |      |
| Data Field | Semantics                          | Syntax                        | Type |
| I          | Beacon index                       | USBL beacon index (0, 1 or 2) | int  |

To retrieve currently selected beacon:

**\$PIXSE,CONFIG,USBVIE,,\*43<CR><LF>**

### 8.3.9.5 Maximum Number of USBL Beacon

To retrieve maximum number of beacon, the firmware can manage:

**\$PIXSE,CONFIG,USBNBB,,\*57<CR><LF>**

This will return:

**\$PIXSE,CONFIG,USBNBB,3\*48<CR><LF>**

### 8.3.10 LBL CONFIGURATION

#### 8.3.10.1 LBL Lever Arm

To configure the lever arm from the Phins Compact C7 to the LBL computing point:

| Message    | \$PIXSE,CONFIG,LBLLV_,x.x,y.y,z.z*hh<CR><LF> |      |       |
|------------|----------------------------------------------|------|-------|
| Title      | LBL Lever Arm                                |      |       |
| Data Field | Semantics                                    | Unit | Type  |
| x.x        | $X_{V1}$ lever arm                           | m    | float |
| y.y        | $X_{V2}$ lever arm                           | m    | float |
| z.z        | $X_{V3}$ lever arm                           | m    | float |

To retrieve the lever arm from the Phins Compact C7 to the LBL computing point:

**\$PIXSE,CONFIG,LBLLV\_,\*5A<CR><LF>**

#### 8.3.10.2 LBL Interface

To configure the LBL interface (Phins Compact C7 interface to receive data from LBL):

| Message    | \$PIXSE,CONFIG,LBLINT,i*hh<CR><LF> |                                                                                                    |      |
|------------|------------------------------------|----------------------------------------------------------------------------------------------------|------|
| Title      | LBL Interface                      |                                                                                                    |      |
| Data Field | Semantics                          | Syntax                                                                                             | Type |
| i          | Interface                          | 0: None<br>1: Port A<br>2: Port B<br>3: Port C<br>4: Port D<br>5: Port E<br>6: Port F<br>7: Port G | int  |

To retrieve the LBL interface Phins Compact C7 interface to receive data from LBL):

**\$PIXSE,CONFIG,LBLINT,,\*4C<CR><LF>**

### 8.3.10.3 LBL Rejection Filter Mode

To configure the LBL Rejection Filter mode:

| Message    | \$PIXSE,CONFIG,LBLKFM,i*hh<CR><LF>     |                                                                                                 |      |
|------------|----------------------------------------|-------------------------------------------------------------------------------------------------|------|
| Title      | Rejection Filter Configuration for LBL |                                                                                                 |      |
| Data Field | Semantics                              | Syntax                                                                                          | Type |
| i          | Mode Index                             | 0 : Not Active Always True<br>1 : Not Active Always False<br>2 : Active Automatic reacquisition | int  |

To retrieve the LBL Rejection Filter mode:

**\$PIXSE,CONFIG,LBLKFM,,\*5F<CR><LF>**

### 8.3.11 UTC (TIME SYNCHRONIZATION) INTERFACE

To configure the UTC interface (Phins Compact C7 interface to receive data from UTC):

| Message    | \$PIXSE,CONFIG,UTCINT,i*hh<CR><LF> |                                                                                           |      |
|------------|------------------------------------|-------------------------------------------------------------------------------------------|------|
| Title      | UTC Interface                      |                                                                                           |      |
| Data Field | Semantics                          | Syntax                                                                                    | Type |
| i          | Interface                          | 0: None<br>1: Port A<br>2: Port B<br>3: Port C<br>4: Port D<br>5: Port E<br>200: Repeater | int  |

To retrieve the UTC interface (Phins Compact C7 interface to receive data from UTC):

**\$PIXSE,CONFIG,UTCINT,,\*4C<CR><LF>**

### 8.3.12 UTC2 (TIME SYNCHRONIZATION) INTERFACE

To configure the UTC interface (Phins Compact C7 interface to receive data from UTC):

| Message    | \$PIXSE,CONFIG,UTC2INT,i*hh<CR><LF> |                                                                                           |      |
|------------|-------------------------------------|-------------------------------------------------------------------------------------------|------|
| Title      | UTC Interface                       |                                                                                           |      |
| Data Field | Semantics                           | Syntax                                                                                    | Type |
| i          | Interface                           | 0: None<br>1: Port A<br>2: Port B<br>3: Port C<br>4: Port D<br>5: Port E<br>200: Repeater | int  |

To retrieve the UTC interface (Phins Compact C7 interface to receive data from UTC2):

**\$PIXSE,CONFIG,UTC2INT,,\*4C<CR><LF>**

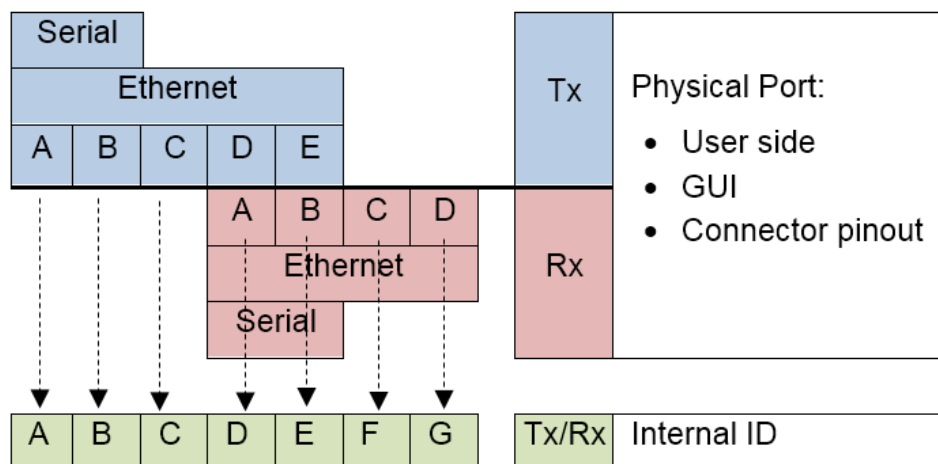
## 8.4 Interfaces Configuration

### 8.4.1 PORT MAPPING

To configure the physical serial input ports A and B use configuration commands with respectively ID D and E instead.

To configure the physical Ethernet input ports A to D use configuration commands with respectively ID D to G instead.

To configure output ports use the physical port ID.



### 8.4.2 SERIAL AND ETHERNET COMMANDS

#### 8.4.2.1 Serial I/O general parameters (parity and stop bit)

Used to configure the parity and stop bit for serial port X:

| Message    | \$PIXSE,CONFIG,RSCM_X,i,j[,k][,l]*hh<CR><LF> |                                                                                  |      |
|------------|----------------------------------------------|----------------------------------------------------------------------------------|------|
| Title      | Serial interface configuration               |                                                                                  |      |
| Data Field | Semantics                                    | Syntax                                                                           | Type |
| X          | Port                                         | D to E to configure input ports A to B<br>A to B to configure output port A to B | int  |
| I          | parity                                       | 0: None<br>1: Even<br>2: Odd                                                     | int  |
| J          | number of stop bits                          | 0: 0.5 stop bit<br>1: 1 stop bit<br>2: 1.5 stop bit<br>3: 2 stop bits            | int  |
| K          | RFU                                          | 0                                                                                | int  |
| L          | RFU                                          | 0                                                                                | int  |

To retrieve parity and stop bit for serial port X (checksum hh depends on port X, see below) :

**\$PIXSE,CONFIG,RSCM\_X,,\*hh<CR><LF>**

### 8.4.2.2 Serial/Ethernet input port configuration

To configure the input port X:

| Message    | \$PIXSE,CONFIG,RSIN_X,i,j[,k[,l]]*hh<CR><LF> |                                                                     |      |
|------------|----------------------------------------------|---------------------------------------------------------------------|------|
| Title      | Input port configuration                     |                                                                     |      |
| Data Field | Semantics                                    | Syntax                                                              | Type |
| X          | Port                                         | D to G                                                              | char |
| i          | Baud rate                                    | See table "Baud rate index" below                                   | int  |
| j          | Protocol                                     | See table "List and index of input protocols for input ports" below | int  |
| k          | RFU                                          | 0                                                                   | int  |
| l          | RFU                                          | 0                                                                   | int  |

The RSIN command must be used to select input protocol in Ethernet mode too.

Changing input port baud rate will affect corresponding output port baud rate as baud rate generator is common to both input and output serial transceiver.



To configure RS level, the output port configuration command RSOUTX shall be used.

To retrieve configuration of serial input port X (checksum hh depends on port X, see below):

**\$PIXSE,CONFIG,RSIN\_X,,\*hh<CR><LF>**

**Table 10 - Baud rate index**

| i  | Baud rate   |
|----|-------------|
| 0  | 600 bps     |
| 1  | 1200 bps    |
| 2  | 2400 bps    |
| 3  | 4800 bps    |
| 4  | 9600 bps    |
| 5  | 19200 bps   |
| 6  | 38400 bps   |
| 7  | 57600 bps   |
| 8  | 115200 bps  |
| 9  | 230400 bps  |
| 10 | 460800 bps  |
| 11 | 921600 bps  |
| 12 | 1000000 bps |

| i  | Baud rate   |
|----|-------------|
| 13 | 2000000 bps |
| 14 | 76800 bps   |
| 15 | 576000 bps  |

Table 11 - List and index of input protocols for input ports

| Id   | Protocol        |
|------|-----------------|
| 5000 | NONE            |
| 5001 | APOS_PSIM_LBP   |
| 5002 | APOS_PSIM_SSB   |
| 5003 | AUVG3000        |
| 5004 | Reserved        |
| 5005 | Reserved        |
| 5006 | Reserved        |
| 5007 | Reserved        |
| 5008 | Reserved        |
| 5009 | GAPS            |
| 5010 | GPS (GNSS)      |
| 5011 | Reserved        |
| 5012 | Reserved        |
| 5013 | HALLIBURTON     |
| 5014 | Reserved        |
| 5015 | Reserved        |
| 5016 | IXSEA_USBL_INS1 |
| 5017 | Reserved        |
| 5018 | Reserved        |
| 5019 | Reserved        |
| 5020 | MICRO_SVT-P     |
| 5021 | MINISVS         |
| 5022 | Reserved        |
| 5023 | PAROSCIENTIFIC  |
| 5024 | Reserved        |

| Id   | Protocol        |
|------|-----------------|
| 5025 | POSIDONIA       |
| 5026 | PRESSURE_SENSOR |
| 5027 | RAMSES_POSTPRO  |
| 5028 | RDI_PD0         |
| 5029 | RDI_PD3         |
| 5030 | RDI_PD3_RT      |
| 5031 | RDI_PD4         |
| 5032 | RDI_PD6         |
| 5033 | Reserved        |
| 5034 | Reserved        |
| 5035 | Reserved        |
| 5036 | Reserved        |
| 5037 | STD_BIN         |
| 5038 | Reserved        |
| 5039 | Reserved        |
| 5040 | SVX_2           |
| 5041 | Reserved        |
| 5042 | USBL_LBL_CTD    |
| 5043 | USBLBOX_POSTPRO |
| 5044 | Reserved        |
| 5045 | TERPS8000       |
| 5046 | Reserved        |
| 5047 | Reserved        |
| 5048 | NRK DF21        |
| 5049 | SBE49           |

### 8.4.2.3 Serial/Ethernet output port configuration

To configure the Serial/Ethernet output on port X:

| Message    | \$PIXSE,CONFIG,RSOUTX,i,j,k,l,m[,n][,o]*hh<CR><LF> |                                                                                                                                                                            |      |
|------------|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Title      | Output port configuration                          |                                                                                                                                                                            |      |
| Data Field | Semantics                                          | Syntax                                                                                                                                                                     | Type |
| X          | Port                                               | A to E                                                                                                                                                                     | char |
| i          | baud rate                                          | See "Baud rate index" table below                                                                                                                                          | int  |
| j          | protocol                                           | See "List and index of output protocols for output ports" table below                                                                                                      | int  |
| k          | rate                                               | Output rate in ms<br>(100 = 100 ms = 10 Hz)<br>Minimum value is 5 ms (200 Hz)                                                                                              | int  |
| l          | RS level                                           | 0: RS232<br>1: RS422                                                                                                                                                       | int  |
| m          | Lever arm                                          | 0: Main lever arm<br>1: Secondary lever arm 1, standard heave filter<br>2: Secondary lever arm 2, standard heave filter<br>3: Secondary lever arm 3, standard heave filter | int  |
| n          | Heave                                              | 0: Real Time Heave<br>1: Smart Heave (100s delayed)                                                                                                                        | int  |
| o          | Altitude reference                                 | 0: WGS84 Geoidal (default)<br>1: WGS84 Ellipsoidal                                                                                                                         | int  |

Changing the RS level with the RSOUTX command will also affect input port.

To retrieve configuration of serial output port X (checksum hh depends on port X):

**\$PIXSE,CONFIG,RSOUTX,,\*hh<CR><LF>**

**Table 12 - Baud rate index**

| i | Baud rate |
|---|-----------|
| 0 | 600 bps   |
| 1 | 1200 bps  |
| 2 | 2400 bps  |
| 3 | 4800 bps  |
| 4 | 9600 bps  |
| 5 | 19200 bps |

| i  | Baud rate  |
|----|------------|
| 6  | 38400 bps  |
| 7  | 57600 bps  |
| 8  | 115200 bps |
| 9  | 230400 bps |
| 10 | 460800 bps |
| 11 | 76800 bps  |
| 12 | 307200 bps |

**Table 13 - List and index of output protocols for output ports**

| Id   | Protocol     |
|------|--------------|
| 2000 | NONE         |
| 2001 | Reserved     |
| 2002 | AIPOV        |
| 2003 | Reserved     |
| 2004 | AUVG3000     |
| 2005 | BROADCAST R  |
| 2006 | BROADCAST A  |
| 2007 | BROADCAST B  |
| 2008 | BROADCAST C  |
| 2009 | BROADCAST D  |
| 2010 | BROADCAST E  |
| 2011 | Reserved     |
| 2012 | Reserved     |
| 2013 | CONTROL      |
| 2014 | CONTROL NO G |
| 2015 | Reserved     |
| 2016 | Reserved     |
| 2017 | Reserved     |
| 2018 | Reserved     |
| 2019 | Reserved     |
| 2020 | Reserved     |

| <b>Id</b> | <b>Protocol</b> |
|-----------|-----------------|
| 2021      | Reserved        |
| 2022      | DORODO          |
| 2023      | DORADO 2        |
| 2024      | Reserved        |
| 2025      | Reserved        |
| 2026      | Reserved        |
| 2027      | Reserved        |
| 2028      | EVENT MARKER    |
| 2029      | Reserved        |
| 2030      | GAPS BIN        |
| 2031      | Reserved        |
| 2032      | GPS LIKE        |
| 2033      | GYROCOMPASS     |
| 2034      | GYROCOMPASS 2   |
| 2035      | HALLIBURTON SAS |
| 2036      | Reserved        |
| 2037      | Reserved        |
| 2038      | Reserved        |
| 2039      | Reserved        |
| 2040      | HEHDT HEROT     |
| 2041      | HETHS HEROT     |
| 2042      | Reserved        |
| 2043      | IMU ASCII       |
| 2044      | IMU BINARY      |
| 2045      | IMU RAW         |
| 2046      | Reserved        |
| 2047      | Reserved        |
| 2048      | Reserved        |
| 2049      | POSTPROCESSING  |
| 2050      | Reserved        |
| 2051      | IXSEA TAH       |

| <b>Id</b> | <b>Protocol</b> |
|-----------|-----------------|
| 2052      | Reserved        |
| 2053      | Reserved        |
| 2054      | Reserved        |
| 2055      | LONG BINARY NAV |
| 2056      | Reserved        |
| 2057      | Reserved        |
| 2058      | Reserved        |
| 2059      | Reserved        |
| 2060      | Reserved        |
| 2061      | Reserved        |
| 2062      | Reserved        |
| 2063      | Reserved        |
| 2064      | Reserved        |
| 2065      | Reserved        |
| 2066      | Reserved        |
| 2067      | NAV BINARY      |
| 2068      | NAV BINARY 1    |
| 2069      | Reserved        |
| 2070      | Reserved        |
| 2071      | Reserved        |
| 2072      | NAV BHO         |
| 2073      | NAV BHO LONG    |
| 2074      | NAVIGATION      |
| 2075      | Reserved        |
| 2076      | PHINS STANDARD  |
| 2077      | OCTANS STANDARD |
| 2078      | Reserved        |
| 2079      | Reserved        |
| 2080      | Reserved        |
| 2081      | Reserved        |
| 2082      | Reserved        |

| <b>Id</b> | <b>Protocol</b> |
|-----------|-----------------|
| 2083      | PRDID           |
| 2084      | PRDID TSS       |
| 2085      | PRECISE ZDA     |
| 2086      | Reserved        |
| 2087      | Reserved        |
| 2088      | Reserved        |
| 2089      | Reserved        |
| 2090      | Reserved        |
| 2091      | Reserved        |
| 2092      | Reserved        |
| 2093      | Reserved        |
| 2094      | Reserved        |
| 2095      | Reserved        |
| 2096      | Reserved        |
| 2097      | Reserved        |
| 2098      | Reserved        |
| 2099      | Reserved        |
| 2100      | Reserved        |
| 2101      | Reserved        |
| 2102      | SEROUT A RTC    |
| 2103      | SEROUT B RTC    |
| 2104      | SEROUT C RTC    |
| 2105      | SEROUT D RTC    |
| 2106      | SEROUT E RTC    |
| 2107      | Reserved        |
| 2108      | Reserved        |
| 2109      | Reserved        |
| 2110      | Reserved        |
| 2111      | Reserved        |
| 2112      | Reserved        |
| 2113      | Reserved        |

| <b>Id</b> | <b>Protocol</b>   |
|-----------|-------------------|
| 2114      | Reserved          |
| 2115      | Reserved          |
| 2116      | IXBLUE STD BIN V2 |
| 2117      | IXBLUE STD BIN V3 |
| 2118      | Reserved          |
| 2119      | Reserved          |
| 2120      | Reserved          |
| 2121      | Reserved          |
| 2122      | Reserved          |
| 2123      | Reserved          |
| 2124      | Reserved          |
| 2125      | Reserved          |
| 2126      | Reserved          |
| 2127      | Reserved          |
| 2128      | Reserved          |
| 2129      | Reserved          |
| 2130      | Reserved          |
| 2131      | Reserved          |
| 2132      | Reserved          |
| 2133      | Reserved          |
| 2134      | Reserved          |
| 2135      | Reserved          |
| 2136      | Reserved          |
| 2137      | Reserved          |
| 2138      | Reserved          |
| 2139      | Reserved          |
| 2140      | Reserved          |
| 2141      | MDL_2             |
| 2142      | Reserved          |
| 2143      | Reserved          |

#### 8.4.2.4 Output port protocol datablock configuration

To configure the serial/Ethernet output on port X:

| Message    | \$PIXSE,CONFIG,DBLOCX,aaa...a,i[,bbb...b,j,...]*hh<CR><LF> |                                             |        |
|------------|------------------------------------------------------------|---------------------------------------------|--------|
| Title      | Output port configuration                                  |                                             |        |
| Data Field | Semantics                                                  | Syntax                                      | Type   |
| X          | Port                                                       | A to E                                      | char   |
| aaa...a    | Datablock name                                             | See list below                              | string |
| i          | Datablock state                                            | 0 to do not output datablock<br>1 to output | int    |
| bbb...b    | Datablock name                                             | See list below                              | string |
| j          | Datablock state                                            | 0 to do not output datablock<br>1 to output | int    |
| ...        | Datablock name                                             | See list below                              | string |
| ...        | Datablock state                                            | 0 to do not output datablock<br>1 to output | int    |
| ...        |                                                            |                                             |        |

To retrieve configuration of protocol to output port X (checksum hh depends on port X):

**\$PIXSE,CONFIG,DBLOCX,,\*hh<CR><LF>**

List of datablock name for IXBLUE STD BIN output protocols:

- Attitude and Heading
- Attitude and Heading Std. Dev.
- Real Time Heave/Surge/Sway
- Smart Heave
- Heading/Roll/Pitch Rate
- Rot. Rate in Vehicle Frame Compensated from Earth Rot.
- Accel. in Vehicle Frame Compensated from gravity
- Position
- Position Std. Dev.
- Speed in Geographic Frame
- Speed Std. Dev in Geographic Frame
- Current in Geographic Frame
- Current Std. Dev. in Geographic Frame
- System Date
- INS Sensor Status
- INS Algorithm Status
- INS System Status
- INS User Status
- Heave Surge and Sway Speed
- Speed in Vehicle Frame
- Accel. in Geographic Frame not Compensated from Gravity
- Course and Speed Over Ground

- Temperatures (ACC/FOG/ANA)
- Attitude Quaternion Data
- Attitude Quaternion Std. Dev.
- Raw Accel. in Vehicle Frame not Compensated from Gravity
- Accel. Std Dev. in Vehicle Frame
- Rot. Rate std. Dev. in Vehicle Frame
- Rotation accelerations in Vehicle frame
- Rotation acceleration Std. Dev.
- Raw rot. Rate in Vehicle Frame not Comp. from Earth Rot.
- UTC
- GNSS1
- GNSS2
- Manual GNSS
- EMLOG1
- USBL1
- USBL2
- USBL3
- LBL1
- LBL2
- LBL3
- LBL4
- Depth
- Sound Velocity
- DVL Ground Speed
- DVL Water Speed
- DVL2 Ground Speed
- DVL2 Water Speed

#### 8.4.2.5 Output Data Convention

To configure the Data Convention on port X:

| Message \$PIXSE,CONFIG,OUTCVX,c*hh<CR><LF> |           |                                                                    |      |
|--------------------------------------------|-----------|--------------------------------------------------------------------|------|
| Title                                      |           | Output Convention configuration                                    |      |
| Data Field                                 | Semantics | Syntax                                                             | Type |
| X                                          | Port      | R for repeater.<br>A to E for others                               | char |
| c                                          | parity    | 0: iXblue Convention<br>1: OTAN Convention<br>2: STANAG Convention | int  |

#### 8.4.2.6 Output Device Selection

To select the device that will be used for data output on selected port:

| Message    | \$PHCNF,EDIROX,i*hh<CR><LF> |                                                                                                                                                     |      |
|------------|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Title      | Output device selection     |                                                                                                                                                     |      |
| Data Field | Semantics                   | Syntax                                                                                                                                              | Type |
| X          | Port                        | A to E                                                                                                                                              | char |
| I          | Device                      | 0: No device selected<br>1: Serial output on selected port<br>2: Ethernet output on selected port<br>3: Ethernet and serial output on selected port | int  |

To retrieve network configuration (where X is the port letter):

**\$PHCNF,EDIROX,,\*hh<CR><LF>**

#### 8.4.2.7 Input Device Selection

To select the device that will be used for data input on selected port:

| Message    | \$PHCNF,EDIRIX,i*hh<CR><LF> |                                                                                                 |      |
|------------|-----------------------------|-------------------------------------------------------------------------------------------------|------|
| Title      | Input device selection      |                                                                                                 |      |
| Data Field | Semantics                   | Syntax                                                                                          | Type |
| X          | Port                        | D to G to configure A to D                                                                      | char |
| I          | Device                      | 0: No device selected<br>1: Serial input on selected port<br>2: Ethernet input on selected port | int  |

To retrieve network configuration (where X is the port letter):

**\$PHCNF,EDIRIX,,\*hh<CR><LF>**

### 8.4.2.8 Port Forwarding Command

Use this command to send frames from repeater port to another port. This can be useful to configure external sensors through the Phins Compact C7:

| Message    | \$PIXSE,CONFIG,TXx,D*hh<CR><LF> |                                                                                                                                                                            |        |
|------------|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| Title      | Port forwarding                 |                                                                                                                                                                            |        |
| Data Field | Semantics                       | Syntax                                                                                                                                                                     | Type   |
| x          | Port                            | A: Port A,<br>B: Port B,<br>...<br>E: Port E                                                                                                                               | char   |
| D          | Forwarded data                  | String to forward to selected port.<br>The system will add <CR><LF> to the string and forward it to port X.<br>End of string is detected by '*' character before checksum. | string |



To send a break on selected output port, use "BREAK,t" as D string. This will generate a break of t milliseconds to selected port.

Example: to send frame 'TEST' to port A:

**\$PIXSE,CONFIG, TXA,TEST\*0A<CR><LF>**

### 8.4.3 ETHERNET CONFIGURATION

#### 8.4.3.1 Network Setup Command

Use this command to configure Ethernet network settings. These settings will be effective after next reboot only.

| Message    | \$PHCNF,ETHI,D,I,N[,G][,H]*hh<CR><LF> |                                              |            |
|------------|---------------------------------------|----------------------------------------------|------------|
| Title      | Ethernet configuration                |                                              |            |
| Data Field | Semantics                             | Syntax                                       | Type       |
| D          | DHCP                                  | 0: disable DHCP at boot time, 1: enable DHCP | Int        |
| I          | IP address                            | System IP address (i.e.: 192.168.36.100)     | IP address |
| N          | Netmask                               | Network mask (i.e.: 255.255.255.0)           | IP address |
| G          | Gateway                               | Gateway (i.e.: 192.168.36.254)               | IP address |
| H          | DNS                                   | DNS (i.e.: 192.168.36.1)                     | IP address |

To retrieve network configuration:

**\$PHCNF,ETHI,,\*3F<CR><LF>**

#### 8.4.3.2 Ethernet Output Configuration

To configure the IP output settings on selected port:

| Message    | \$PHCNF,ELCFOX,m,i,p*hh<CR><LF> |                                                                                                                    |            |
|------------|---------------------------------|--------------------------------------------------------------------------------------------------------------------|------------|
| Title      | IP output settings              |                                                                                                                    |            |
| Data Field | Semantics                       | Syntax                                                                                                             | Type       |
| X          | Port                            | Use A to E to configure port A to E                                                                                | char       |
| m          | Mode                            | IP output mode:<br>0: TCP server<br>1: TCP client<br>2: UDP point to point<br>3: UDP broadcast<br>4: UDP multicast | int        |
| i          | Destination IP                  | IP address to connect to.<br>This field is ignored in TCP server and UDP broadcast modes.                          | IP address |
| p          | IP Port                         | Port to connect/listen to                                                                                          | int        |

To retrieve IP input settings on port X, use following command:

**\$PHCNF,ELCFOA,,\*7D<CR><LF>**

**\$PHCNF,ELCFOB,,\*7E<CR><LF>**

**\$PHCNF,ELCFOC,,\*7F<CR><LF>**

**\$PHCNF,ELCFOD,,\*78<CR><LF>**

**\$PHCNF,ELCFOE,,\*79<CR><LF>**

### 8.4.3.3 IP Input Configuration

To configure the Ethernet input settings on selected port:

| Message    | \$PHCNF,ELCFIX,m,i,p*hh<CR><LF> |                                                                                                                   |            |
|------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------|------------|
| Title      | Ethernet input settings         |                                                                                                                   |            |
| Data Field | Semantics                       | Syntax                                                                                                            | Type       |
| X          | Port                            | use D to G to configure ports A to D                                                                              | char       |
| m          | Mode                            | IP input mode:<br>0: TCP server<br>1: TCP client<br>2: UDP point to point<br>3: UDP broadcast<br>4: UDP multicast | int        |
| i          | Destination IP                  | IP address to connect to.<br>This field is ignored in TCP server and UDP broadcast modes.                         | IP address |
| p          | IP Port                         | Port to connect/listen to                                                                                         | int        |

To retrieve IP output settings on port X, use following command:

```
$PHCNF,ELCFID,,*7B<CR><LF>
$PHCNF,ELCFIE,,*78<CR><LF>
$PHCNF,ELCFIF,,*79<CR><LF>
$PHCNF,ELCFIG,,*7E<CR><LF>
```

For mode details on input configuration, see port mapping chapter 8.4.1.

### 8.4.4 NTP CONFIGURATION

Use this command to enable/disable NTP and configure NTP settings. These settings will be only effective after a 'SAVE' command.

| Message    | \$PIXSE,CONFIG,NTP,aa,ip1,ip2,ip3*hh<CR><LF> |      |            |
|------------|----------------------------------------------|------|------------|
| Title      | NTP                                          |      |            |
| Data field | Semantics                                    | Unit | Type       |
| aa         | 1: enabled NTP, 0:disable NTP                | -    | Boolean    |
| IP 1/2/3   | IP address                                   | -    | IP address |

A 'SAVE' command is needed after the NTP command to take the new parameters into account ( \$PIXSE,CONFIG,SAVE\_\_\*5C<CR><LF> )

To retrieve NTP configuration:

```
$PIXSE,CONFIG,NTP,,*17<CR><LF>
```

### 8.4.5 SSDP MANAGEMENT

Use this command to enable or disable the SSDP manager.

| Message    | \$PIXSE,CONFIG,SSDP,a,[p...p],[w...w]*hh<CR><LF> |                                         |         |
|------------|--------------------------------------------------|-----------------------------------------|---------|
| Title      | CAN External Sensors Configuration               |                                         |         |
| Data Field | Semantics                                        | Syntax                                  | Type    |
| a          | Start / stop                                     | 0,1}                                    | Boolean |
| [p...p]    | Product name                                     | Displayed product name (max 63 char)    | String  |
| [w...w]    | Web server name                                  | Displayed web server name (max 63 char) | string  |

To check if the SSDP manager is running or not:

**\$PIXSE,CONFIG,SSDP,,\*40<CR><LF>**

Note: No need to restart the unit.

### 8.4.6 PULSES INTERFACE

#### 8.4.6.1 Pulses Input Configuration

To configure pulse input X:

| Message    | \$PIXSE,CONFIG,IOIN_X,x.x,i*hh<CR><LF> |                          |       |
|------------|----------------------------------------|--------------------------|-------|
| Title      | Pulse Input                            |                          |       |
| Data Field | Semantics                              | Syntax                   | Type  |
| X          | Pulse index                            | A: Pulse A               | char  |
| x.x        | Parameter                              | Pulse protocol parameter | float |
| i          | protocol                               | See table below          | int   |



The protocol parameter is only used on factory protocols for now (heading, roll, pitch trigger). When not used, this parameter can be set to 0.0.

To retrieve configuration of input pulse port X (checksum hh depends on port X):

**\$PIXSE,CONFIG,IOIN\_X,,\*hh<CR><LF>**

**Table 14 - list and index of input protocols for pulse ports**

| Index | Input Pulse Type       |
|-------|------------------------|
| 0     | NONE                   |
| 1     | PPS RISING + ZDA EDGE  |
| 2     | PPS FALLING + ZDA EDGE |
| 3     | ZDA + PPS RISING EDGE  |
| 4     | ZDA + PPS FALLING EDGE |
| 5     | SERIAL OUT SYNC A      |

| Index | Input Pulse Type     |
|-------|----------------------|
| 6     | SERIAL OUT SYNC B    |
| 7     | SERIAL OUT SYNC C    |
| 8     | SERIAL OUT SYNC D    |
| 9     | SERIAL OUT SYNC E    |
| 10    | EVENT MARKER RISING  |
| 11    | EVENT MARKER FALLING |

#### 8.4.6.2 Pulses Input Association

To associate the pulse input X to an UTC interface with:

| Message    | \$PIXSE,CONFIG,IOINAX,y*hh<CR><LF> |                               |      |
|------------|------------------------------------|-------------------------------|------|
| Title      | Pulse Input                        |                               |      |
| Data Field | Semantics                          | Syntax                        | Type |
| X          | Pulse index                        | A : Pulse A                   | char |
| y          | port                               | 0: None<br>1: UTC1<br>2: UTC2 | int  |

The command will not be taken into account if the selected pulse has been already associated to another mechanism (UTC or Event Marker). There is no protection mechanism which avoids to configure a nonexistent pulse.

To retrieve the associated UTC interface on pulse selected:

**\$PIXSE,CONFIG,IOINAX,,\*hh<CR><LF>**

## 8.5 Dynamic string retrieve commands

### 8.5.1 GENERIC TEXT RETRIEVE COMMAND

To retrieve a specific text for a command:

| Message    | \$PIXSE,TEXT__,list,i,j,c*hh<CR><LF>> |                                            |        |
|------------|---------------------------------------|--------------------------------------------|--------|
| Title      | Text list retrieve                    |                                            |        |
| Data Field | Semantics                             | Syntax                                     | Type   |
| list       | List name                             | Name of command associated to the list     | string |
| i          | Section index                         | Index of list to retrieve for this command | int    |
| j          | String index                          | Index of string in the list                | int    |
| c          | Language                              | Only english 'E' is supported              | char   |

Example:

To retrieve the equipment type, you should send:

\$PIXSE,TEXT\_\_,EQP\_\_,\*,51

To retrieve first serial output protocol name, you should send:

\$PIXSE,TEXT\_\_,RSOUTX,1,0,E\*35<CR><LF>

The Phins Compact C7 will then answer:

\$PIXSE,TEXT\_\_,RSOUTX,1,0,NONE\*7A<CR><LF>

When no string is available, the Phins Compact C7 returns " " (16 x ' ' character). Thus, to retrieve all available output protocol names, you should send \$PIXSE,CONFTEXT,RSOUT command and increment string index until the firmware answers no string available.

For the SYSID\_ function, the Phins Compact C7 returns an acknowledgment and the system type in response to the following request:

\$PIXSE,TEXT\_\_,SYSID\_,0,0,E\*28<CR><LF>

In this case, Phins Compact C7 will then answer:

\$PIXSE,TEXT\_\_,SYSID\_,1,n\*hh<CR><LF>

where n is the system identifier, and hh the NMEA checksum.



Refer to the Phins Compact C7 Technical Description to get the features and sensors available for your product.

**Table 15 - List name table**

| List name | Section index | Retrieved list description                               |
|-----------|---------------|----------------------------------------------------------|
| RSOUTX    | 0             | Port output baud rate strings                            |
|           | 1             | Port output protocol names                               |
|           | 2             | Port output lever arm names                              |
|           | 3             | Port output level names                                  |
|           | 4             | Port output heave filter names                           |
| RSCM_X    | 0             | Port input/output parity strings                         |
|           | 1             | Port input/output stop bits strings                      |
| RSIN_X    | 0             | Port input/output baud rate strings                      |
|           | 1             | Port input protocol names                                |
| IOIN_X    | 0             | Input pulse protocol names                               |
| IOOUTX    | 0             | Output pulse protocol names                              |
| STATUS    | 0             | System status word bit names and attributes (Note 1)     |
| ALGSTS    | 0             | Algorithm status word bit names and attributes (Note 1)  |
| HT_STS    | 0             | High-level status word bit names and attributes (Note 1) |
| LOGINT    | 0             | DVL bottom track sensor interface names                  |
| LOGSND    | 0             | Sound velocity sensor interface names                    |
| LOGKFM    | 0             | DVL bottom track rejection filter mode names             |
| LOGWTM    | 0             | DVL water track sensor interface names                   |
| GPSINT    | 0             | GPS sensor interface names                               |
| GPSKFM    | 0             | GPS sensor rejection filter mode names                   |
| GP2INT    | 0             | GPS2 sensor interface names                              |
| GP2KFM    | 0             | GPS2 sensor rejection filter mode names                  |
| DEPINT    | 0             | Depth sensor interface names                             |
| DEPKFM    | 0             | Depth sensor rejection filter mode names                 |
| USBINT    | 0             | USBL sensor interface names                              |
| USBKFM    | 0             | USBL sensor rejection filter mode names                  |

| List name | Section index | Retrieved list description                               |
|-----------|---------------|----------------------------------------------------------|
| LBLINT    | 0             | LBL sensor interface names                               |
| LBLKFM    | 0             | LBL sensor rejection filter mode names                   |
| UTCINT    | 0             | UTC synchronization interface names                      |
| START_    | 0             | Starting mode selection strings                          |
| ZUP__     | 0             | ZUPT mode selection strings                              |
| ALTMDE    | 0             | Altitude stabilization mode selection strings            |
| SERNUM    | 0             | INS Serial number (i and j parameters not used)          |
| VERFRM    | 0             | INS firmware version (i and j parameters not used)       |
| VERLDR    | 0             | INS loader version (i and j parameters not used)         |
| EQP__     | 0             | Phins Compact C7 type name (i and j parameters not used) |
| GENPRO    | 0             | System configuration when using the protocol generator   |
| SYSID_    | 0             | System identifier                                        |

(Note 1) To a status retrieve command the Phins Compact C7 will answer:

**\$PIXSE,TEXT\_\_,list,attributes,string index,string value\*hh<CR><LF>**

- attributes: value in decimal. This field is used only by the iXRepeater tool to build its Web-Based Graphical User Interface in order to visualize the status data. First byte defines the size and the color of the status string, the third byte defines the event to trig, and the other bytes defines where the status is placed in the status root structure.
- string index: see above.
- string value: value in the status list at the string index.

## 8.5.2 SPECIFIC TEXT RETRIEVE COMMAND

To retrieve a specific text for a command:

| Message    | \$PHTXT,list,c,i,j*hh<CR><LF> |                                            |        |
|------------|-------------------------------|--------------------------------------------|--------|
| Title      | Text list retrieve            |                                            |        |
| Data Field | Semantics                     | Syntax                                     | Type   |
| list       | List name                     | Name of command associated with the list   | string |
| c          | Language                      | Only English 'E' is supported              | char   |
| i          | Section index                 | Index of list to retrieve for this command | int    |
| j          | String index                  | Index of string in the list                | int    |

Example:

To retrieve first input interface selection name, you should send:

**\$PHTXT,EDIRIX,0,0,E\*0E<CR><LF>**

Phins Compact C7 will then answer:

**\$PHTXT,EDIRIX,0,0,Serial\_only\_\_\_\_\*7F<CR><LF>**

When no string is available, Phins Compact C7 returns "\_\_\_\_\_" (16 x '\_' character).

Thus, to retrieve all available input interface names, you should send \$PHTXT,EDIRX command and increment string index until the firmware answers no string available. Following table details all string retrieve functions and their parameters:

**Table 16 - List name table**

| List name | Section index | Retrieved list description           |
|-----------|---------------|--------------------------------------|
| EDIRIX    | 0             | Port input interface selection name  |
| EDIROX    | 0             | Port output interface selection name |
| ELCFIX    | 0             | IP input mode selection name         |
| ELCFOX    | 0             | IP output mode selection name        |

## **iXblue CONTACT - SUPPORT**

### **For non-URGENT support:**

- by email: [support@ixblue.com](mailto:support@ixblue.com)
- using the form on the iXblue web site [www.ixblue.com](http://www.ixblue.com)

### **For 24/7 URGENT SUPPORT:**

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

## A Appendix A: Quaternion Definitions

### 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  $Q = \begin{bmatrix} q_0 \\ q_1 \\ q_2 \\ q_3 \end{bmatrix}$  is a quaternion, the conjugate  $\overline{Q}$  of  $Q$  is given by:

$$\overline{Q} = \begin{bmatrix} q_0 \\ -q_1 \\ -q_2 \\ -q_3 \end{bmatrix}$$

#### Product of two quaternions

If  $P = \begin{bmatrix} p_0 \\ p_1 \\ p_2 \\ p_3 \end{bmatrix}$  and  $Q = \begin{bmatrix} q_0 \\ q_1 \\ q_2 \\ q_3 \end{bmatrix}$  are two quaternions,

the product of  $P$  by  $Q$ , written  $P \cdot Q$  is given by:

$$P \cdot Q = \begin{bmatrix} p_0 \\ p_1 \\ p_2 \\ p_3 \end{bmatrix} \cdot \begin{bmatrix} q_0 \\ q_1 \\ q_2 \\ q_3 \end{bmatrix} = \begin{bmatrix} p_0q_0 - p_1q_1 - p_2q_2 - p_3q_3 \\ p_0q_1 + p_1q_0 + p_2q_3 - p_3q_2 \\ p_0q_2 - p_1q_3 + p_2q_0 + p_3q_1 \\ p_0q_3 + p_1q_2 - p_2q_1 + p_3q_0 \end{bmatrix}$$

Conjugation of a vector V by a quaternion Q

$$Q \cdot \underline{V} \cdot \overline{Q} = \begin{bmatrix} q0 \\ q1 \\ q2 \\ q3 \end{bmatrix} \cdot \begin{bmatrix} 0 \\ Vx \\ Vy \\ Vz \end{bmatrix} \cdot \begin{bmatrix} q0 \\ -q1 \\ -q2 \\ -q3 \end{bmatrix} = \begin{bmatrix} (q0^2 + q1^2 - q2^2 - q3^2)Vx + 2(q1q2 - q0q3)Vy + 2(q1q3 + q0q2)Vz \\ 2(q1q2 + q0q3)Vx + (q0^2 - q1^2 + q2^2 - q3^2)Vy + 2(q2q3 - q0q1)Vz \\ 2(q1q3 - q0q2)Vx + 2(q2q3 + q0q1)Vy + (q0^2 - q1^2 - q2^2 + q3^2)Vz \end{bmatrix}$$

**Attitude quaternion definition**Definition

Quaternion  $Q_{GeoB}$  represents the rotation required to get from geographical frame to body frame:

For a vector  $\underline{V}$ ,  $V_b$  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  $Q_{GeoB}$  :

$$V_b = Q_{GeoB} \cdot V_{geo} \cdot \overline{Q_{GeoB}}$$

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<sub>UP</sub>)
- [A''] is the image of [A'] by pitch rotation (P, Y<sub>A'</sub>)
- [v] is the image of [A''] by roll rotation (R, X<sub>A''</sub>)

To get from geographical frame to vehicle frame, we successively apply:

- A heading rotation of -H degrees around X<sub>UP</sub>, 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<sub>A'</sub>, 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<sub>A''</sub>, 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 vehicle frame is thus the product:

Or:

$$Q_{Geov} = \left( \cos\left(\frac{R}{2}\right) - \sin\left(\frac{R}{2}\right) X_{A''}, \left( \cos\left(\frac{P}{2}\right) - \sin\left(\frac{P}{2}\right) Y_{A'}, \left( \cos\left(\frac{H}{2}\right) + \sin\left(\frac{H}{2}\right) X_{UP} \right) \right.$$

$$Q_{Geov} = \begin{bmatrix} \cos\left(\frac{R}{2}\right) \\ -\sin\left(\frac{R}{2}\right) \\ 0 \\ 0 \end{bmatrix} \cdot \begin{bmatrix} \cos\left(\frac{P}{2}\right) \\ 0 \\ -\sin\left(\frac{P}{2}\right) \\ 0 \end{bmatrix} \cdot \begin{bmatrix} \cos\left(\frac{H}{2}\right) \\ 0 \\ 0 \\ \sin\left(\frac{H}{2}\right) \end{bmatrix}$$

That can be developed as:

$$Q_{Geov} = \begin{bmatrix} \cos\left(\frac{R}{2}\right) \cdot \cos\left(\frac{P}{2}\right) \cos\left(\frac{H}{2}\right) - \sin\left(\frac{R}{2}\right) \cdot \sin\left(\frac{P}{2}\right) \cdot \sin\left(\frac{H}{2}\right) \\ -\sin\left(\frac{R}{2}\right) \cdot \cos\left(\frac{P}{2}\right) \cdot \cos\left(\frac{H}{2}\right) - \cos\left(\frac{R}{2}\right) \cdot \sin\left(\frac{P}{2}\right) \sin\left(\frac{H}{2}\right) \\ \sin\left(\frac{R}{2}\right) \cdot \cos\left(\frac{P}{2}\right) \cdot \sin\left(\frac{H}{2}\right) - \cos\left(\frac{R}{2}\right) \cdot \sin\left(\frac{P}{2}\right) \cdot \cos\left(\frac{H}{2}\right) \\ \cos\left(\frac{R}{2}\right) \cdot \cos\left(\frac{P}{2}\right) \cdot \sin\left(\frac{H}{2}\right) + \sin\left(\frac{R}{2}\right) \cdot \sin\left(\frac{P}{2}\right) \cdot \cos\left(\frac{H}{2}\right) \end{bmatrix}$$

**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  $Q_{bv}$  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  $\xi$  defined as the (small) rotation vector to get from actual [Geo] frame to erroneous [Geo] frame.

Equating Eq. (1.3) and Eq.(1.6) yields:

$$\hat{Q}_{Geob} \left(1 - \frac{\xi}{2}\right) = \hat{Q}_{nb} \left(1 - \frac{\eta}{2}\right) \hat{Q}_{Geon} \left(1 - \frac{\gamma}{2}\right)$$

$$\left(1 - \frac{\xi}{2}\right) = \hat{Q}_{nGeo} \left(1 - \frac{\eta}{2}\right) \hat{Q}_{Geon} \left(1 - \frac{\gamma}{2}\right)$$

Neglecting the second order terms, we can write:

$$\left(1 - \frac{\underline{\xi}}{2}\right) = 1 - \frac{\underline{\gamma}}{2} - \hat{Q}_{nGeo} \frac{\underline{\eta}}{2} \hat{Q}_{Geo}$$

$$\underline{\xi} = \underline{\gamma} + \hat{Q}_{nGeo} \underline{\eta} \hat{Q}_{Geo}$$

Finally, we can write the covariance matrix on vector  $\underline{\xi}$ , i.e., the so-called "attitude quaternion covariance", as follows:

$$\sigma^2(\underline{\xi}) = \sigma^2(\underline{\gamma}) + \hat{C}_n^{Geo} \sigma^2(\underline{\eta}) (\hat{C}_n^{Geo})^T$$

The standard deviations on vector  $\underline{\xi}$  components are noted:

$$\sigma(\xi_1)$$

$$\sigma(\xi_2)$$

$$\sigma(\xi_3)$$

Nota:  $\sigma^2(\underline{\gamma})$ ,  $\hat{C}_n^{Geo}$  and  $\sigma^2(\underline{\eta})$  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

$$F = \begin{pmatrix} -\frac{\cos \hat{A}}{\cos \hat{T}} & \frac{\sin \hat{A}}{\cos \hat{T}} & 0 \\ -\sin \hat{A} & -\cos \hat{A} & 0 \\ -\tan \hat{T} \cos \hat{A} & \tan \hat{T} \sin \hat{A} & -1 \end{pmatrix}$$