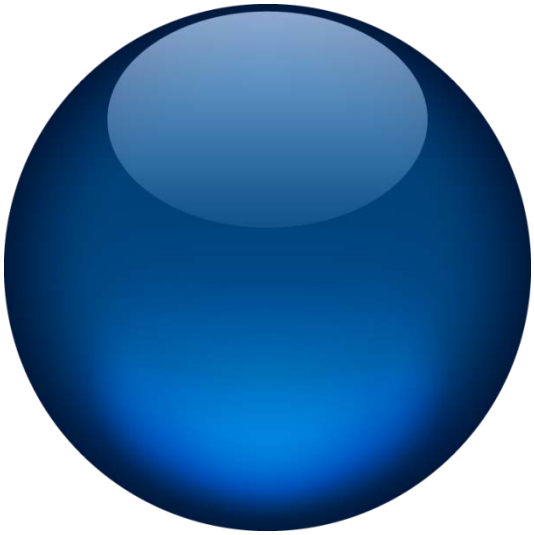

INS

Application note

Ins calibration

with rdi workhorse dvl

iXblue

DEEP INSIGHT. SHARPER SENSES.

Document Revision History

Edition	Date	Comments
A	12/2011	First Edition
B	05/2012	Calibration procedure updated
C	12/2013	Mechanical drawings updated
D	01/2014	Correction from claim for INS II
E	02/2014	Version without repeater
F	08/2014	Firmware restrictions chapter added Procedure chapter updated
G	11/2015	DVL2 calibration added. Navigation performance specification and performance pre-requisities chapters added. Operational specifications updated.

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Text Usage

Bold	Bold text is used for items you must select or click in the software. It is also used for the field names used into the dialog box.
`Courier`	Text in this font denotes text or characters that you should enter from the keyboard, the proper names of disk Drives, paths, directories, programs, functions, filenames and extensions.
Italic	Italic text is the result of an action in the procedures. It is also used for referencing to other document titles.

Icons

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

Important

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

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

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

Abbreviations and Acronyms

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

Table of Contents

1 OBJECT

This document is an addendum to the INS documentations referenced on next page.
This document points out the calibration procedure for an INS associated to a RDI Workhorse DVL. This procedure applies to a detached DVL or to a "DVL ready"[1] system.

This document describes the method to calibrate the misalignment between the INS and the RDI Workhorse DVL and speed scale factor residual error of the DVL[2].
It can be applied to PHINS Surface, MARINS, PHINS 6000 or ROVINS which all have Ethernet port.

Do not hesitate to contact iXBlue technical support for further information: support@ixblue.com

[1] INS unit mechanically coupled to DVL.

[2] Scale factor should be close to zero (within 0.2%) since it has been calibrated in factory at Teledyne.

2 REFERENCE DOCUMENTS

- RDI Documentation

Navigator Technical Manual_Nov06 (P/N 957-6172-00, November 2006)

Navigator ADCP/DVL user guide P/N 957-6173-00 (September 2002)

Application Note FSA018 (November 2004)

3 FIRMWARE RESTRICTIONS

This procedure is only applicable starting from following INS firmware version (included):

Designation	Version
Interface Board Firmware	FrmWCINT_INS_6_41
DSP Board Firmware	FrmWDSP4_INS_5_60
Web MMI	Web_xxxxxx_5.10-1.92.1 (*)

(*) xxxxxx is the product name

Firmware version can be retrieved on your unit from the maintenance page in the Web-based user interface.

4 REQUIRED TOOLS FOR INS/DVL CALIBRATION

The following equipment is required:

- INS test cable to power and configure the system.
- CTD or SVP probe to enter sound velocity into INS.
- CTD or SVP to INS cable
- DVL interface plate
- DVL to INS cable
- RDI DVL test cable to set DVL parameters directly
- INS power supply
- DVL power supply
- BBTALK 3.06 version to communicate with DVL and set parameters (other version can make it difficult to send the break command).

Caution

Use a separate power supply for INS and DVL.

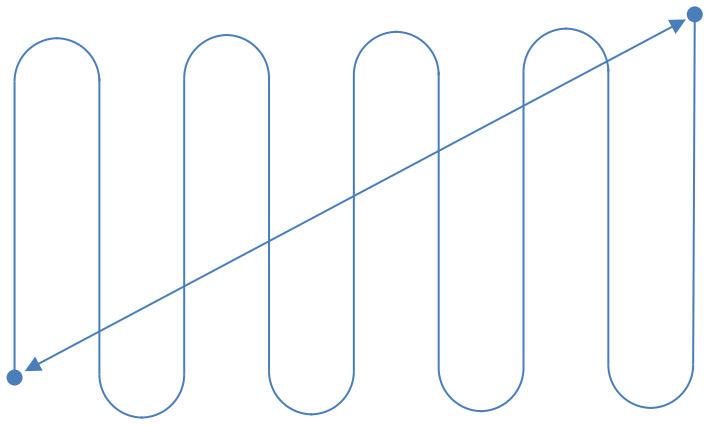
Do not use INS power supply to power both systems because power may not be sufficient to start both systems.

5 NAVIGATION PERFORMANCE SPECIFICATION

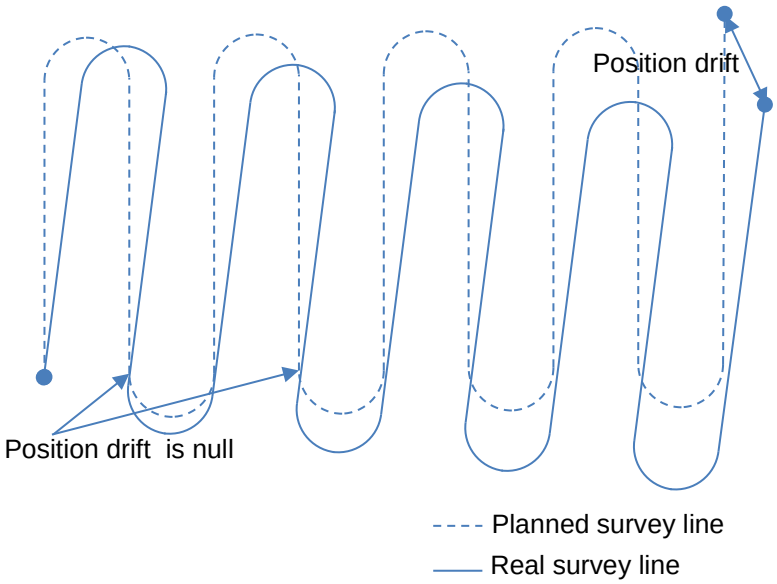
The navigation performance commercial specification is defined as 0.1% DT CEP50.

- CEP50: Circular Error Probability of 50 %
  This means that if you perform 100 verification lines more than 50 of them should have a position drift below 0.1% of distance travelled. This of course is not practical so we need to convert this value into an operational value. Making the assumption that position errors are Gaussian random errors, then CEP50 error converts into 3DRMS error as follow:
  3DRMS_Error= 2.5 CEP50_Error.
  3DRMS is the distance root mean square error and is commonly considered as the maximum error. In this case there is a 98.9% probability to have a position drift within this value.

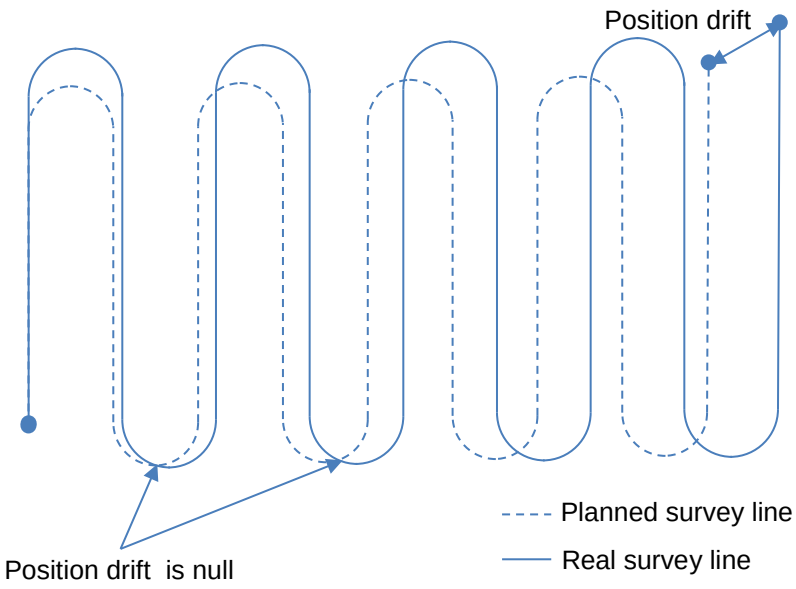
- DT is the distance travelled. It is the slant distance: straight line distance between start point and end point. This is depicted below:



Slant distance is relevant since misalignment error or scale factor error compensate when you perform a U turn as depicted below.



DVL calibration misalignment Error or INS heading error



Sound velocity error or DVL speed scale factor error

6 PERFORMANCE PRE-REQUISITES

To obtain the best performances we recommend the following:

Commercial specifications are guaranteed using RTK GPS for calibration.

- Use an SVP probe with a sound velocity accuracy better than ±0.1 m/s
- Adjust the DVL speed standard deviation in the “Advanced Position Filtering” page in the INS Web MMI (cf. Inertial Products - Web-based Interface User Guide, ref.: MU–INSIII-AN-021) to the following values:
  - Default value is set to 0.2 m/s in the INS system
  - For example for ROV or AUV navigation with an RDI WorkHorse DVL, bottom speed input standard deviation can be set to 0.05 m/s. Reducing the DVL SD, will improve navigation accuracy. You can reduce DVL SD ss long as INS is not rejecting the DVL.
  - For surface ship vessel the DVL standard deviation can be reduced to 0.1 m/s depending on sea state. You can reduce DVL SD ss long as INS is not rejecting the DVL.
- Use preferably RTK GPS which is more accurate. For ROV or AUV DGPS is highly recommended. USBL can also be used but calibration performance cannot be guaranteed since it depends on USBL accuracy as a position reference system.

7 DVL CONFIGURATION

7.1 Hardware Configuration

Since DVL data is not time-stamped, it should be linked directly to INS to avoid any latency due to intermediate devices (i.e.: Ethernet to serial converter, PC processing software on top side…).

To meet iXBlue rated specifications, you must send sound velocity data to one of the INS inputs to get an accurate DVL speed scale factor compensation (refer to the Appendix L. Influence of Temperature, Salinity and Depth on Sound Velocity).

7.2 Direct Configuration of the DVL

You can configure the DVL by connecting the DVL test cable to a PC and using RDI BBTALK configuration software.

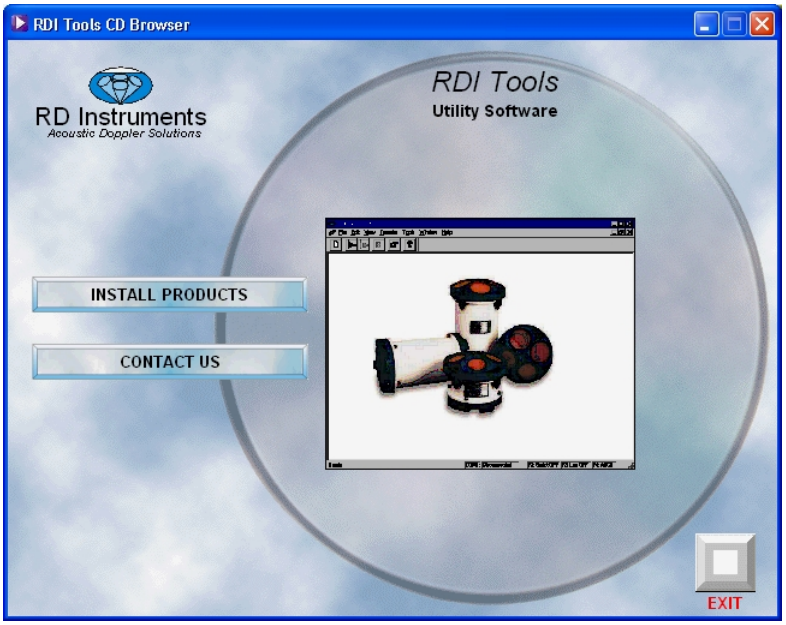
It is convenient to use **BBTALK 3.06** since there are dedicated functions to send a break or an auto-detect to the DVL.

Alternatively for INS generation III you can configure DVL through the Web-based interface using the DVL sensor control window (recommended). This avoids disconnecting the DVL cable specially on “DVL Ready” systems (i.e.: ROVINS+DVL, PHINS6000+DVL).

Refer to Appendix A and Appendix B.

Procedure to install BBTALK

Step	Action
1.	Insert the RDI Tools CD-ROM in the CD drive of the computer. The following window is displayed:



Step	Action
1.	Click on **Install Products** button. The following window is displayed: 
2.	End of procedure.

Tick **Echo Characters** if you want to see the characters while typing:

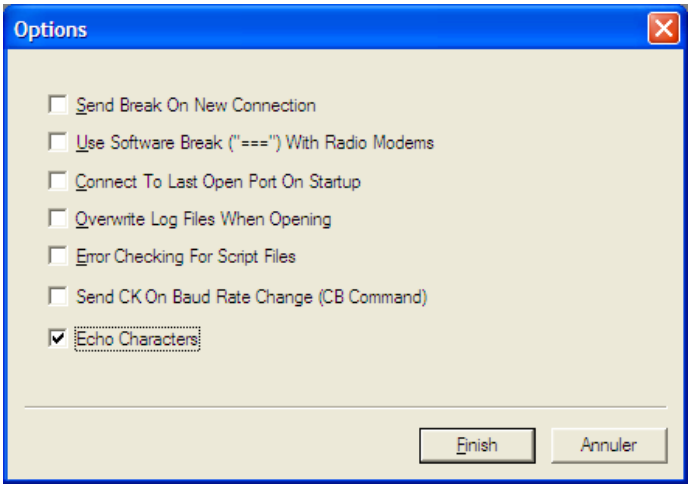


Figure 1 – BBTALK Options window

Notes

- The break command on BBTALK when talking to DVL using broadcast is “@” or “End” key or use break command from menu.
- If ADCP is pinging please disconnect serial cable. On some systems shutting down the program or computer can cause a break. This means that you will have to restart the DVL at every power-up.

- If you need to check DVL settings, you can send PD?, CB?, BK?,ES?, EZ?, EX?… for example.

7.3 DVL Setting

This is the best recommended configuration. It applies for all cases: setup with an SVP or CTD (compulsory to meet full INS+DVL position specification) or setup without SVP or CTD. It also deals with the case where DVL has a pressure probe option (EZ command).. Here are the settings that need to be changed from default factory values (refer to RDI, Navigator Technical Manual_Nov06 (P/N 957-6172-00, November 2006) for default factory values.
Settings in black are permanent. Settings in red should be updated prior to operation.

CR1 To load the default factory setting.

PD6 To select PD6 output protocol.

EX01010 EX01xxx : Instrument coordinates. X, Y, Z vectors relative to the ADCP. Heading/Pitch/Roll not applied.

EXxxx1x Allows 3-beam solutions if one beam is below the correlation threshold set by default WC setting.

EZ1000001 DVL calculates speed of sound using manually entered salinity, DVL internal temperature sensor and manually entered depth unless depth option is available EZ should be set to **EZ1100001** to use internal depth sensor.

EZxx000xx means that we do not use DVL internal heading and tilt sensors.

The INS will correct speed measurement using the SVP or CTD speed by applying a scale factor correction: (EC value/ SVP value). Although we could use a fixed EC=1500 m/s value it can useful, for quality control or trouble shooting, to compare consistency of DVL calculated sound velocity to SVP sound velocity.

Ez*cdhprst:*

Field	Value = 0	Value = 1	Value = 2	Value = 3
c Speed Of Sound	Manual EC	Calculate using ED, ES, and ET	N/A	Use SVSS Sensor
d Depth	Manual ED	Depth Sensor	N/A	N/A
h Heading	Manual EH	Internal Transducer Sensor	N/A	Use NMEA HDT
p Pitch (Tilt 1)	Manual EP	Internal Transducer Sensor	N/A	N/A
r Roll (Tilt 2)	Manual ER	Internal Transducer Sensor	N/A	N/A
s Salinity	Manual ES	N/A	N/A	N/A
t Temperature	Manual ET	Internal Transducer Sensor	N/A	N/A

ES35 Manual salinity is set to default salinity 35. If you want an accurate estimation of DVL sound velocity when no external SVP sensor is available

of for quality control, you must set salinity with an accuracy better than << +/- 1°/°°,before starting calibration or operation.

ED00000	Manual depth is set to default value 0. If you want an accurate estimation of DVL sound velocity in the situation where no external SVP sensor is available or for quality control, you must set depth with an accuracy better than of +/- 100 m, before calibration or operation.
TE00:00:00:20	To set ping recurrence to 200 ms (5 Hz).
BK0	Bottom track only.
CB811[3]	115200, None, 1 stop bit (this high speed is to limit latency of data due to length of ASCII PD6 protocol).
CK	To save settings. Send a break and verify that the settings were saved with the **PD?**, **EX?**, **EZ?**, **ES?**, **ED?**, **TE?**, **BK?**, **CB?** commands.
CS	To start pinging.

[3] If the baud rate was set to another value, in order to change it you must perform the following sequence if you are using the broadcast feature: send the CBnnn change the baud rate in INS settings, then CK command to save this setting and then CS command.

8 CALIBRATION PROCEDURE

8.1 Introduction

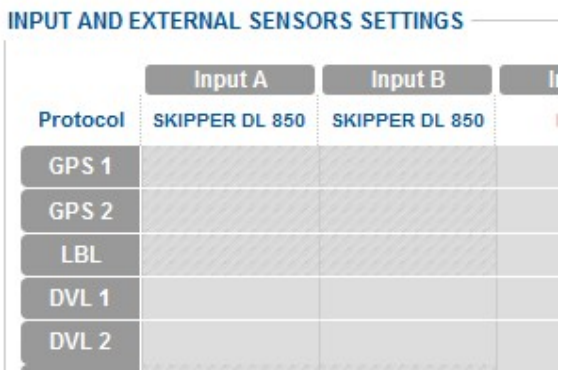
Calibration can be performed with a GPS at the surface (highly recommended) or using USBL positioning system if the calibration cannot be done at the surface.

8.2 Calibrating DVL1

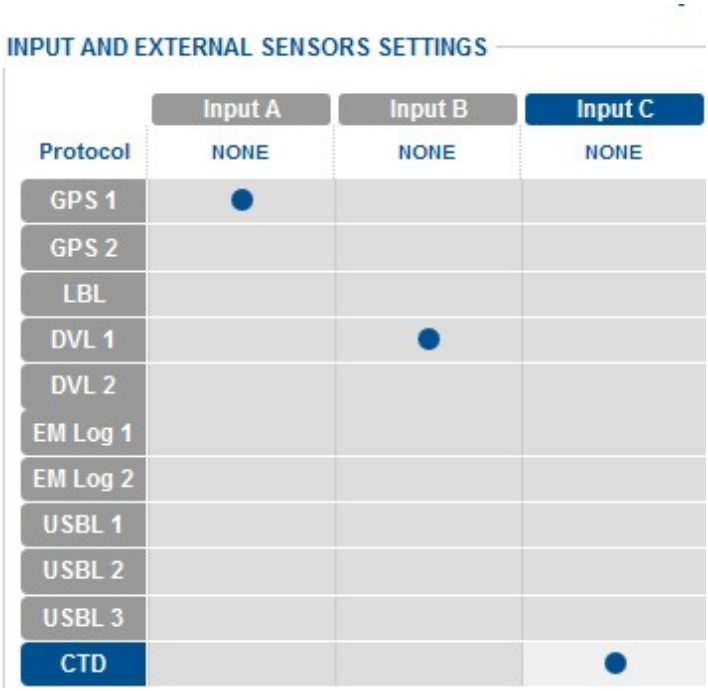
8.2.1 SYSTEM CONFIGURATION

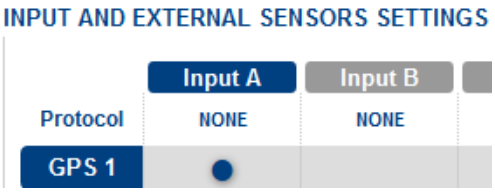
Step	Action
1.	Configure **DVL1** input

- Refer to §50 to configure DVL internal settings.
- DVL is set at 5 Hz, 115,2 KBaud, PD6 protocol. From the INS Web-Based User Interface, under **INSTALLATION** menu choose **INPUTS** option then select **DVL1** on the chosen port.



- Then set **INPUT X (X= A,B,...G) SETTINGS.**
- You can check data is valid on the main control page if “DVL valid” must appear on the main **CONTROL** page.
- Enter DVL lever arms with an accuracy of 5 cm.
  Refer to Appendix C for lever arm values of INS “DVL ready” systems.
  From the INS Web-Based User Interface, under **INSTALLATION** menu choose **INPUTS** option then click on **DVL1** label text to access the **DVL1 SETTINGS Lever Arms** parameters.
- For a coupled INS+DVL system, enter **DVL misalignment** in the **SETUP** and **DVL CALIBRATION** menu at -45° by default. Save setting by pressing on **Update Parameters**.

Step	Action
2.	Configure **SVP** input • SVP is set at 1 Hz. From the INS Web-Based User Interface, under **INSTALLATION** menu choose **INPUTS** option then select **CTD** on the chosen port.  • Then set **INPUT X (X= A,B,...G) SETTINGS** according to SVP output settings. • You can check data validity by observing the data telegram flow in the **EXTERNAL SENSOR DATA** window and data on the **navigation data** page.
3.	For subsea calibration configure **Depth** input Depth is set at maximum rate of 2 Hz (Max: 5 Hz). From the INS Web-Based User Interface, under **INSTALLATION** menu choose **INPUTS** option then select **Depth** on the chosen port. Then set **INPUT X (X= A,B,...G) SETTINGS** according to Depth output settings.

Step	Action
4.	Configure **GPS** (resp. USBL) input • GPS (resp. USBL) is set at 1 Hz (resp. max acoustic recurrence using any time stamped protocol) with “GPS” protocol (USBL protocol). From the INS Web-Based User Interface, under **INSTALLATION** menu choose **INPUTS** option then select **GPS** (resp. **USBL**) on the chosen port.  • Enter GPS (resp. USBL) lever arms with accuracy equal or better than 10% of GPS (resp. USBL) accuracy (i.e. 30 cm for DGPS with 3 m accuracy, 1 cm for RTK GPS with 10 cm accuracy). From the INS Web-Based User Interface, under **INSTALLATION** menu choose **INPUTS** option then click on **GPS** or **USBL** label text to access to the lever arm parameters.
5.	Configure **Time**[4] input • From the INS Web-Based User Interface, under **INSTALLATION** menu choose **INPUTS** option then select **UTC** on the chosen port. Select **GPS** protocol on the same port as described above. • Under **UTC SETTINGS** select the input pulse and the protocol (usually PPS rising + Time). **Note:** if GPS is rejected during acceleration of turns it could be that the PPS pulse protocol is not configured correctly (PPS Falling + Time instead of PPS rising + time). Verify in GPS user manual. 

[4] If GPS is input at 1 s at 3 knots this can lead to 1.5 m difference in position because GPS data is not accurately time stamped in the repeater logging file. If no ZDA time synchronization is used it is time stamped at reception on the PC. PPS pulse is also highly recommended.

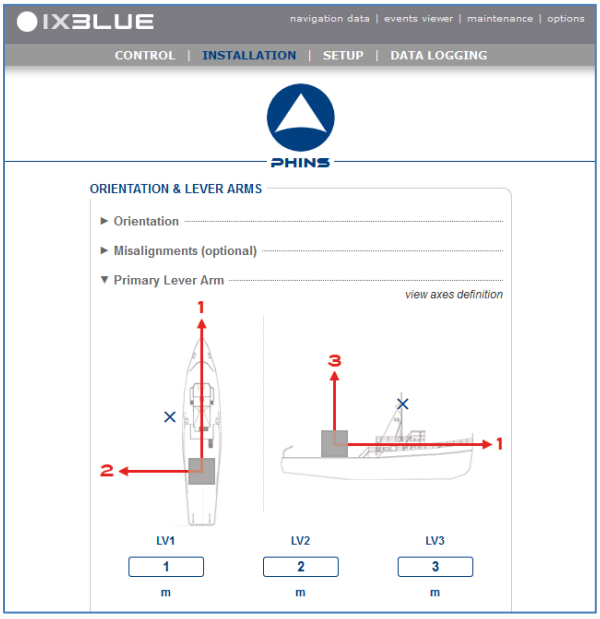
Step	Action

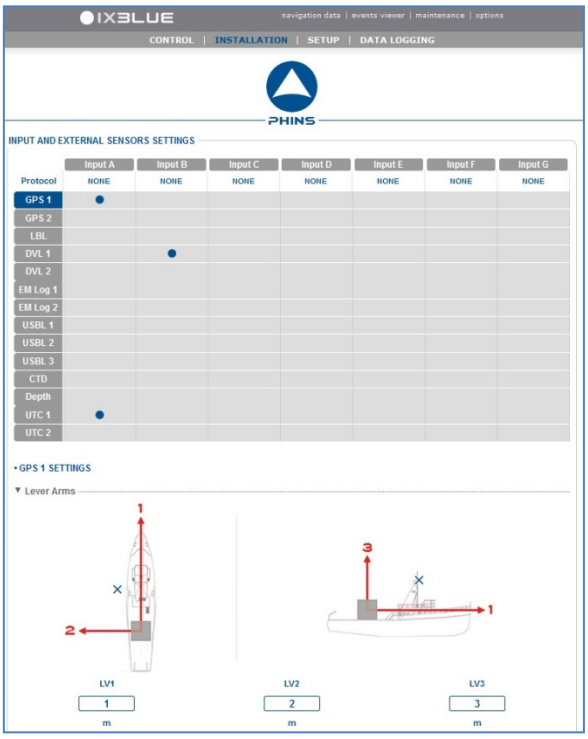
6. Configure Altitude mode

- From the INS Web-Based User Interface, under **SETUP** menu choose **NAVIGATION PARAMETERS** and set **Altitude Mode** to **GPS**.
  In Subsea calibration with USBL, **Altitude Mode** is set to **Depth**.

7. Set primary lever arms:

- Primary lever arms must be set with values identical to GPS (resp. USBL transponder) lever arms. This will enable position of INS+DVL and GPS (resp. USBL transponder) to be defined at the same location during the verification phase to verify the INS+DVL position drift on the data if necessary.
- From the INS Web-Based User Interface, under **INSTALLATION** menu choose **MECHANICAL PARAMETERS** and set **Primary Lever arms.** To see the GPS (USBL) lever arm: under **INSTALLATION** menu choose **INPUTS** option then display **GPS** (USBL) sensor settings by clicking on **GPS** (USBL) label and set the values. text.





Step	Action
8.	Prepare data logging: • Output “POSTPROCESSING” data is configured on an Ethernet port (highly recommended) or Serial port otherwise. This is only for quality control or debug if necessary after calibration. From the INS Web-Based User Interface, under **INSTALLATION** menu choose **OUTPUTS** and set “POSTPROCESSING” protocol at 100 Hz on a chosen output port (Preferably in **Ethernet / TPC Server**).
9.	End of procedure.

8.2.2 CALIBRATION

Two virtual points A and B are referenced on the maritime navigation. Slant range travelled distance must be at least 1,000 times and preferably 10,000 times the GPS or USBL accuracy so that error due to GPS or USBL in negligible compared to INS+DVL specification[5].

Depending on the GNSS receiver or USBL accuracy, the required calibration check distance may be longer (see table below).

Position sensor reference	Typical Error	Required slant range calibration distance	Error due to position sensor in % of travelled distance
GNSS Differential	0.5 m	5 km	0.01%
GNSS RTK	10 cm	1000 m	0.01%

Note: From table above it can be seen that RTK is highly recommended in practice to minimize calibration distances. Augmented Differential GNSS can be an option but standard Differential GNSS is not practical since calibration distance will be very long.

There is no constraint of navigation in a straight line as long as you navigate from point A to point B. Point A can be typically the harbor from which you are starting to sail. For example, distance between these points must be greater than 1 km for an RTK GPS with a maximum error better or close to 10 cm.

To enable DVL bottom track, the depth of water from A to B must be:

- < 200 m for a 300 kHz DVL
- < 90m for a 600 kHz DVL
- < 30 m for a 1200 kHz DVL

Power Supply Voltage (VDC)	Bottom-Track Range (meters)		
	1200 kHz	600 kHz	300 kHz
20	23	90	237
24	24	92	245
30	25	95	253
40	26	99	262
50	27	101	268

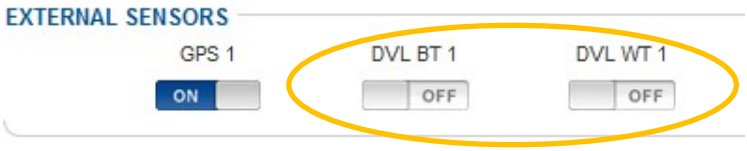
Figure 2 – Influence of DVL Power voltage on maximum range

[5] 0.1% (resp.0.2%) of travelling distance CEP50 for PHINS (resp. ROVINS) (50% probability that position error is within this interval of confidence). Max error = 2.5 CEP50 error. Cf. §5.

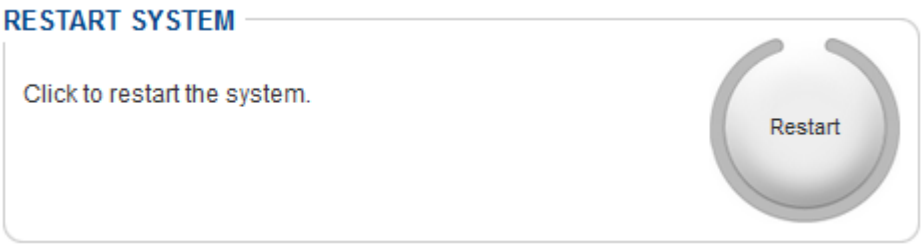
Step	Action

1. Check that GPS (resp. USBL) sensor is enabled from the **CONTROL** page, detailed status pop-up of the INS Web-based User Interface and that it is correctly accepted by the INS (i.e., the message 'GPS valid' must appear in the detailed status pop-up).

   Check that DVL bottom track and water track sensors are disabled from the **CONTROL** page, detailed status pop-up of the INS Web-based User Interface.



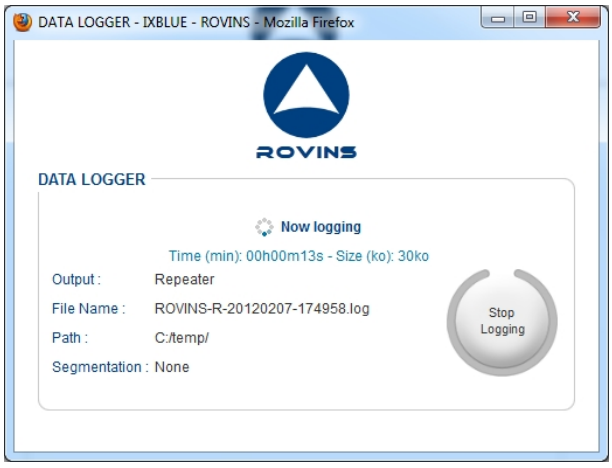
2. In the maintenance page, click the **Restart** button

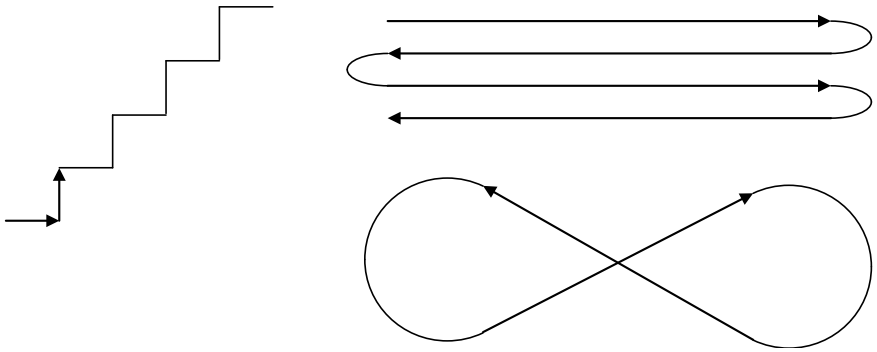


3. Start logging repeater data flow:

   - Click on **DATA LOGGING** menu.
   - In the **Output** drop-down list, select Repeater.
   - In the **File Explorer** select the logging directory.
   - Click on **Start Logging**.

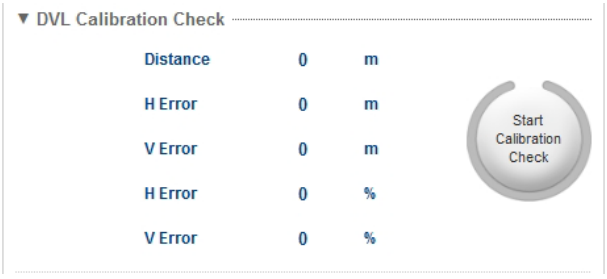
   The data logger window is displayed and the logging is starting:



Step	Action
4.	Start logging POSTPROCESSING data flow • Click on **DATA LOGGING** menu. • In the **Output** drop-down list, select the “POSPROCESSING” port. • In the **File Explorer** select the logging directory. • Click on **Start Logging**. **Important:** POSTPROCESSING protocol data should be logged as soon as system is powered up so that real time data can be compared to post-processed-data. If needed reboot the INS before start logging. Do not stop logging until the end of the calibration and verification process.
5.	Start Calibration process from the INS Web-Based User Interface: choose **DVL CALIBRATION** option under **SETUP** menu then press **Start Calibration** button. The **Start Calibration** button is replaced by a **Stop Calibration** button. The calibration parameters become orange and the current calibrated values are displayed. **Note:** If you start from harbor, the DVL calibration must be started before moving the vehicle to avoid false information while it is not calibrated (in the case DVL has not been disabled in main control page). The calibration computation only starts once the heading standard deviation is less than 2°.
6.	Keep the vehicle static (at harbor) or adrift or at constant speed and heading for at least 5 minutes to complete the initial coarse alignment phase.
7.	Navigate until the heading standard deviation is less than 0.1° for ROVINS and less than 0.05° for PHINS Surface, PHINS6000 or MARINS. Heading standard deviation will decrease faster if you follow typical patterns as shown below: 
8.	The ship or Subsea vehicle must sail now to point B. Sailing speed is not critical only travelled distance is important. Speed can be faster than 5 knots if system can withstand it. When speed is high the calibration will be less affected by DVL speed biases.

Step	Action
9.	During the calibration process, the **DVL Misalignments** parameters should become blue when computed heading and pitch misalignment values are stable enough (<0.01° standard deviation on DVL heading misalignment). In any case, one minute before arriving at point B, stop calibration by pressing **Stop Calibration** button.
10.	Save calibration parameters by pressing **Update parameters** button if the calibration completed is successful. Otherwise, click **Clear Values** to ignore the measured values and restart a new calibration.
11.	Note the values found for the calibration in your calibration form. If the DVL is mounted directly on the INS (DVL ready option) the heading misalignment should be approximately -45°± 1°. If you are using an SVP sensor, DVL speed scale factor should be within ± 0.2%.
12.	Calibration values found during first pass can be refined during a second pass from B to A. Perform calibration steps 1 to 12 starting from previous calibration values to get better misalignment estimation on second run. These values should hardly change during second pass. Save second pass calibration result and note the found values in your calibration form.
13.	End of procedure.

8.2.3 CHECKING THE CALIBRATION

Step	Action
1.	Start the calibration check. In the **DVL CALIBRATION** page, click on **Start Calibration Check** button.  *The Start Calibration Check button is replaced by a Stop Calibration Check button.* The INS will now calculate the difference between the INS+DVL trajectory and the position sensor each time the position sensor is received. The travelled distance will be also displayed.

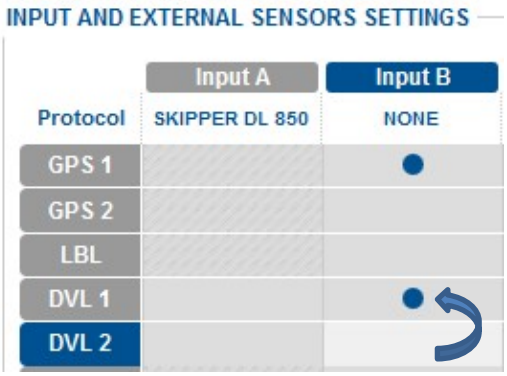
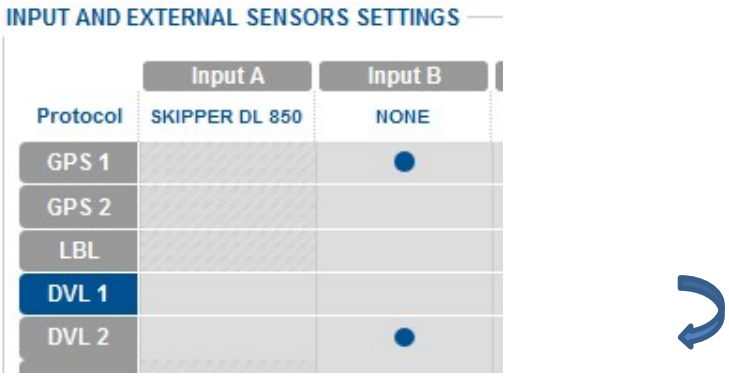
Step	Action
2.	Start sailing between point C and D. Sail a sufficiently long distance at least equal or greater than the calibration distance A to B. Speed can be faster than 5 knots if system can withstand it. When speed is high the calibration will be less affected by DVL speed biases.
3.	At the end of the line point D leave the ship drifting for a minute so that the position of GPS (resp. USBL) can be easily compared to the position of INS+DVL in the repeater or POSTPROCESSING data.
4.	**Stop Calibration Check** in the DVL Calibration page.
5.	Note the values found in your calibration Form.
6.	If you need to quality control the data, from the Repeater data, you can calculate the position error at the end of the navigation: Error = distance (INS-GPS or INS-USBL) at the end of the line. The errors (horizontal and vertical ones in m or %) and the travelled distance while checking are displayed in the DVL Calibration page. **Max error should be < 0.5% of travelled distance[6] for ROVINS** + GPS (resp. USBL) inaccuracy Max error should be < 0.25% of travelled distance[6] for PHINS+ GPS (resp. USBL) inaccuracy
7.	Calibration verification values found during first pass can be refined during a second pass from D to C. Perform calibration verification steps 1 to 7. These values should be consistent with the previous calibration verification. Note the found values in your calibration form.
8.	End of procedure.

[6] 0.1% for PHINS (resp. 0.2% for ROVINS) of travelled distance CEP50 equals to 0.25% for PHINS (resp. 0.5% for ROVINS) maximum position error over travelled distance.
This is obtained with correct sound velocity update from SVP or CTD probe. Incorrect update of sound velocity can lead to discrepancy on the navigation error.

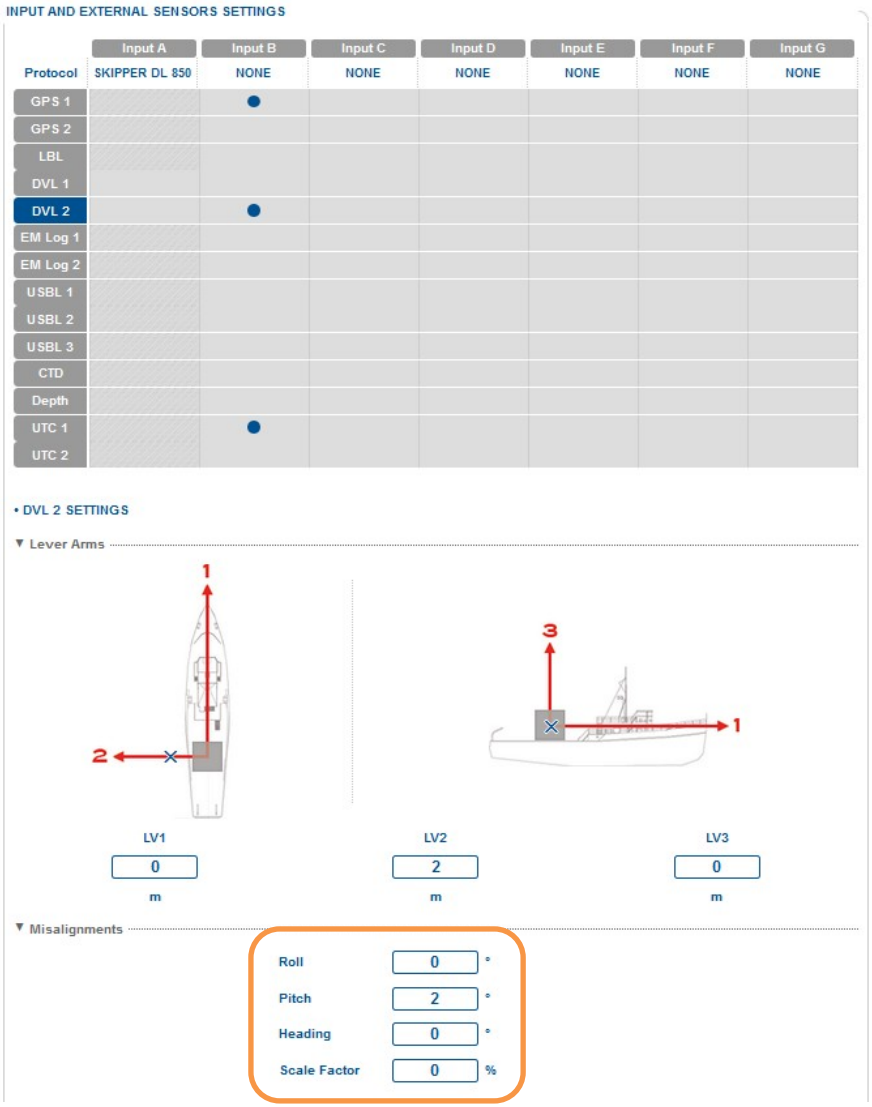
8.3 Calibrating DVL2

Caution

It is mandatory to calibrate DVL1 before calibrating DVL2.

Step	Action
1.	Under **INSTALLATION** menu choose **INPUTS** option then assign DVL2 to DVL1 input: 
2.	Follow the instructions of § 6.2.1 and § 6.2.2 to calibrate the DVL2.
3.	At the end of the step 9 of § 6.2.2, note the DVL misalignment values on the paper.
4.	Click on Clear Values button.
5.	Under **INSTALLATION** menu choose **INPUTS** option assign DVL1 to DVL2 input 

Step	Action
6.	Then enter the DVL misalignment values in the Misalignments area:



7.	Click on OK, DVL2 is calibrated.
8.	End of procedure

Appendices

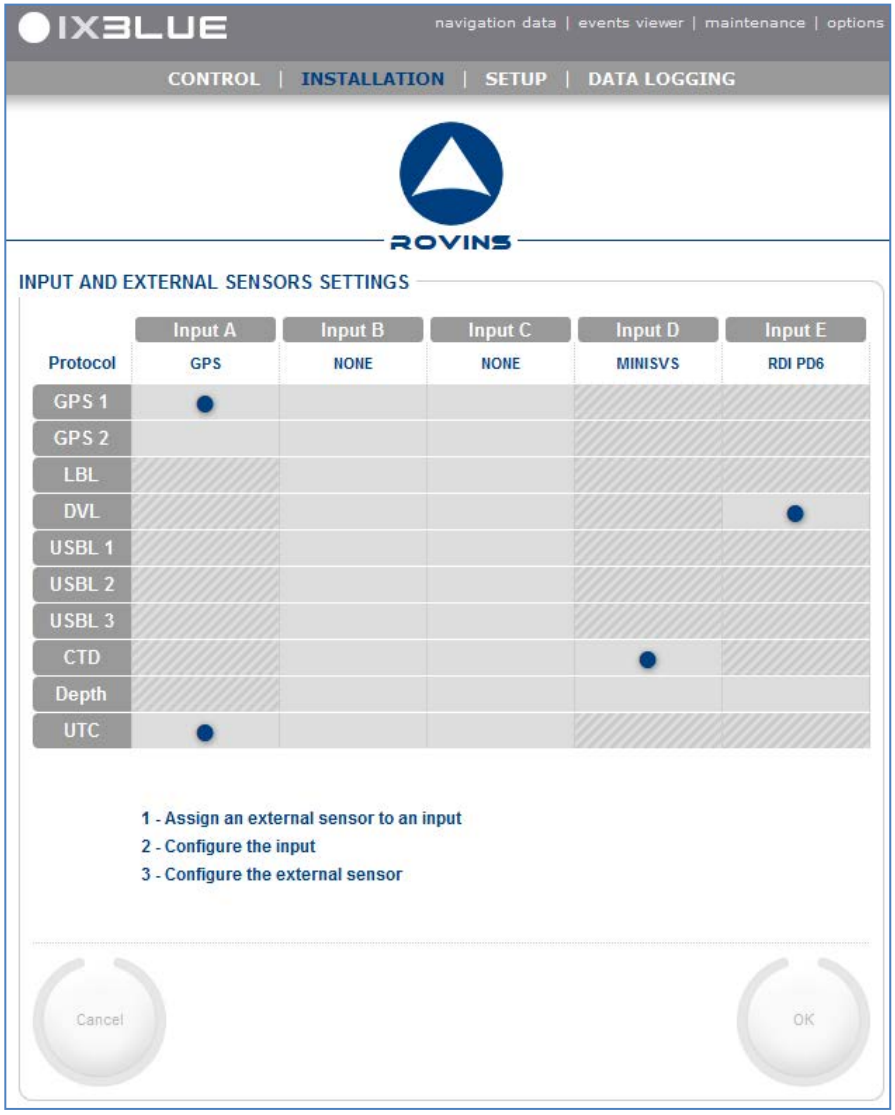
A COMMUNICATION WITH DVL THROUGH SENSOR CONTROL PANEL

The simplest way to send commands to the DVL is to use the external sensor data window from the Web-based user interface.

Step	Action

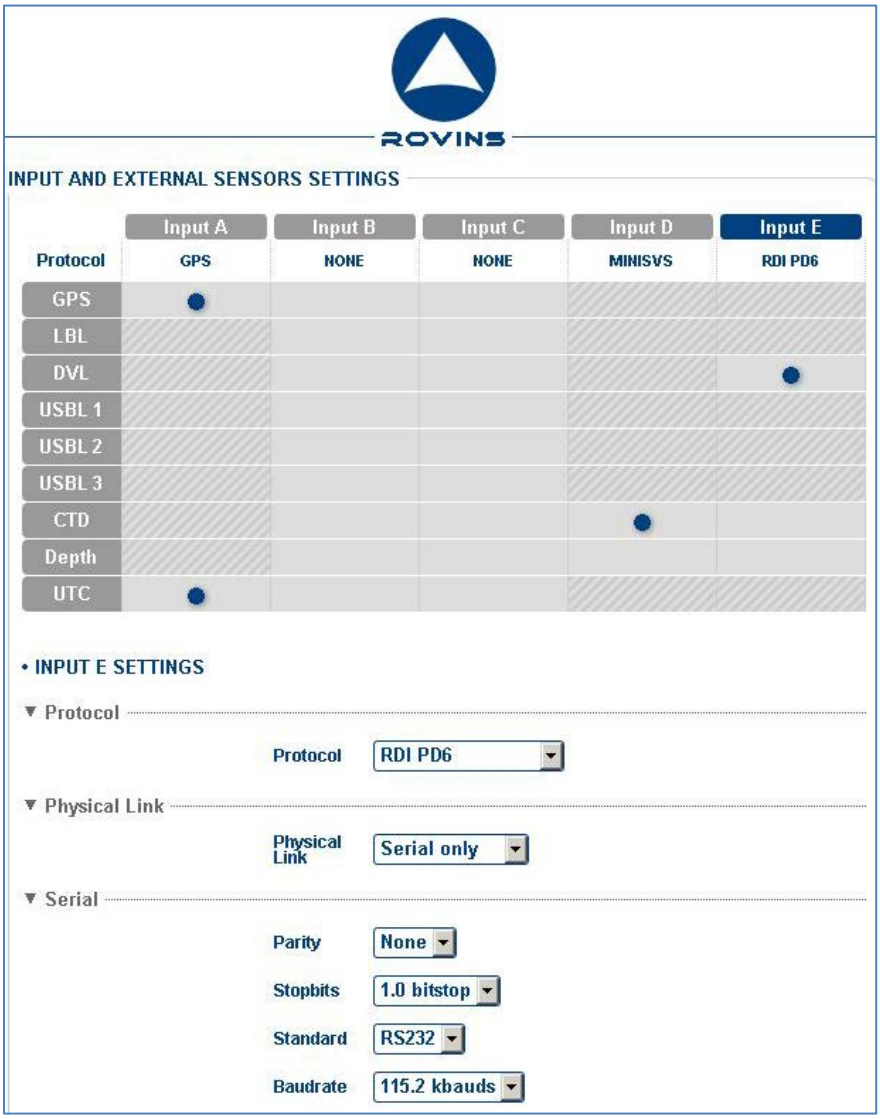
1. Select **INPUTS** option under **INSTALLATION** menu.

   The INPUTS page is displayed:



Step	Action

2. In the first row of the INPUTS table, click on the input (i.e., Input A, Input B, Input C, Input D, Input E) to which the external sensor to monitor is connected.
   The Input X (X being A, B, C, D or E according to your choice) area is displayed:



Example of the DVL connected to Input E.

Step	Action

3. Click on **Sensor Control Panel** label to display it.

   A separate window enabling to display the sensor data is displayed:

4. **Send Request to the external sensor:**

   - Use the dedicated area to type the command in
   - Select Send LF (Line Feed) after CR (Carrier Return) option if needed

   ❑ To break DVL data emission send “@” character then send any command to the DVL.

   ❑ To start pinging send “CS”.

   ❑ Type CR (Carriage Return) after each command line

   - Click **Send Request** Button to send the command typed in

   Find below an example:

5. End of procedure.

B COMMUNICATION WITH DVL THROUGH AN INS PORT (BROADCAST FEATURE)

In this example the DVL is set on port E and bi-directional communication with DVL is done through port C in Ethernet (you may also broadcast it in serial if required).
This procedure should not be necessary and used only if a problem occurs using the previous described method.

- To broadcast commands sent on port C to DVL on port E:
  - ❑ Select OUTPUTS option under INSTALLATION menu
  - ❑ Choose Output E tab then select Broadcast C for the output protocol.
- To broadcast DVL output from port E to port C
  - ❑ Select **OUTPUTS** option under **INSTALLATION** menu
  - ❑ Choose **Output C** tab then select **Broadcast E** for the output protocol.
  - ❑ Set the output physical link to **Ethernet only** and leave Ethernet settings to default values: TCP Server on port 8113.

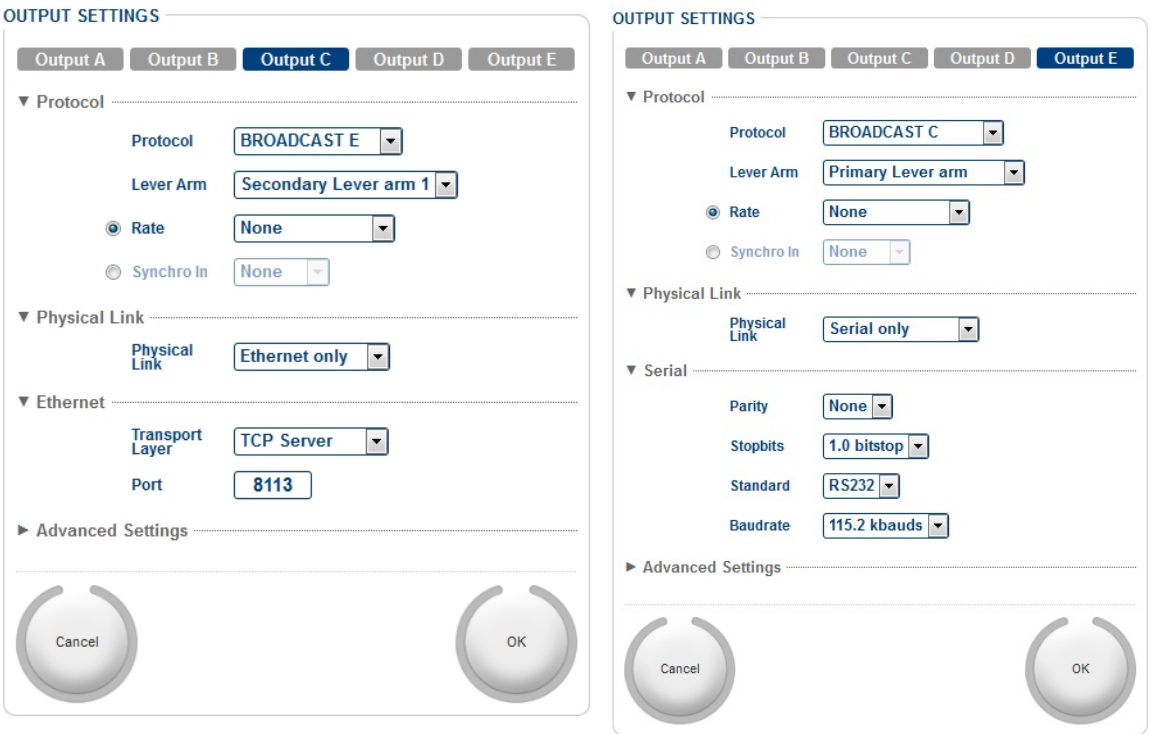


Figure 3 – Output settings on port C and E

- ❑ Select **INPUTS** option under **INSTALLATION** menu, set port C input physical link to **Ethernet only**. Leave Ethernet parameters to default values: TCP Server on port 8119.

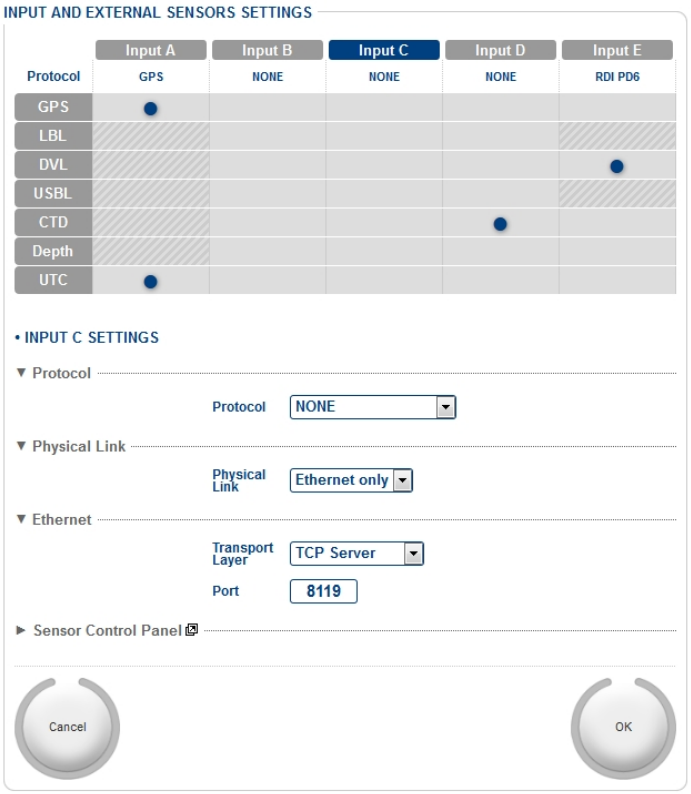


Figure 4 – Configuration of input port C

- Once port C is configured in both output and input in Ethernet, you can use any telnet client to connect to output and input port. For example, using Hyperterminal, select 'Connect using TCP/IP', and enter the INS IP address and port for input flow (8119). This window will then let you enter commands to the DVL. To send a break to the DVL, send '@' character in command window (port 8119).
- Open another Hyperterminal instance, select 'Connect using TCP/IP', and enter the INS IP address and port for output flow (8113). This window will receive output coming from the DVL. With these two windows, you will be able to configure your DVL through the ROVINS.

To send and receive commands to the DVL you need to open to BBTALK windows on 2 COM ports of your PC. One window will be used to send commands and the other to receive replies from the DVL.

C DVL LEVER ARMS FOR INS/DVL READY SYSTEMS

ROVINS Case

These values are given for a DVL close coupled to ROVINS with the interface plate.

For other DVL models refer to iXBlue for request.

Table 1 - DVL lever arms to be entered in ROVINS, when DVL ready option is chosen[7]

Teledyne DVL part number	X1 lever arm	X2 lever arm	X3 lever arm	Assembly iXBlue drawing
Actual models (common mechanical interface)				
967-1024-00 (300/600 kHz, 6000 m)	-0.00307 m	+0.00261 m	-0.182 m	PHI3TX_AS_009
967-1025-00 (300/600 kHz, 3000 m)	-0.00307 m	+0.00261 m	-0.182 m	PHI3TX_AS_009
967-1026-00 (1200 kHz, 3000 m)	-0.00307 m	+0.00261 m	-0.216 m	PHI3TX_AS_009
967-1027-00 (1200 kHz, 6000 m)	-0.00307 m	+0.00261 m	-0.216 m	PHI3TX_AS_009
Old models				
967-6003 (300/600 kHz,3000/6000 m)	-0.00307 m	+0.00261 m	-0.156 m	N/A
967-6004 (300/600 kHz, 1000/2000/6000 m)	-0.00307 m	+0.00261 m	-0.159 m	N/A
967-6006 (1200 kHz, 2000/4000/6000 m))	-0.00307 m	+0.00261 m	-0.193 m	N/A

[7] Calculated using ROVINS reference point P definition and RDI DVL drawings (refer to Appendix C DVL Reference Point).

These values are given for a DVL close coupled to PHINS 6000 with the interface plate. For other DVL models refer to iXBlue for request.

Table 2 - DVL lever arms to be entered in PHINS6000, when DVL ready option is chosen[8]

Teledyne DVL part number	X1 lever arm	X2 lever arm	X3 lever arm	Assembly iXBlue drawing
Actual models (common mechanical interface)				
967-1024-00 (300/600 kHz, 6000 m)	+0.0128 m	+0.006 m	-0.221 m	4569500 Rev B
967-1025-00 (300/600 kHz, 3000 m)	+0.0128 m	+0.006 m	-0.221 m	4569500 Rev B
967-1026-00 (1200 kHz, 3000 m)	+0.0128 m	+0.006 m	-0.255 m	4569500 Rev B
967-1027-00 (1200 kHz, 6000 m)	+0.0128 m	+0.006 m	-0.255 m	4569500 Rev B
Old models				
967-6003 (300/600 kHz,3000/6000 m)	+0.0128 m	+0.006 m	-0.195 m	N/A
967-6004 (300/600 kHz, 1000/2000/6000 m)	+0.0128 m	+0.006 m	-0.198 m	N/A
967-6006 (1200 kHz, 2000/4000/6000 m))	+0.0128 m	+0.006 m	-0.232 m	N/A

[8] Calculated using PHINS 6000 reference point P definition and RDI DVL drawings (refer to Appendix D DVL Reference Point).

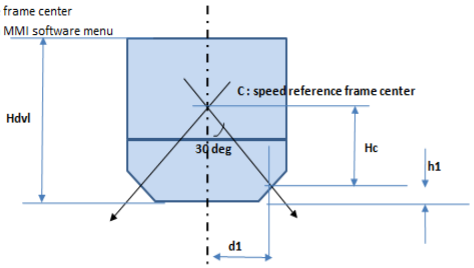
D DVL REFERENCE POINT

IXSEA	02/02/2010	M/NT/POP/011	Edition D

Applicable documents :
Navigator Velocity Log Technical Manual P/N 957-6172-00 (November 2006)
Navigator ADCP/DVL user guide P/N 957-6173-00 (September 2002)

DVL Part number	Rev		h1 (mm)	d1 (mm)	Hdvl (mm)	Hc (mm)	Hepoxy (mm)	Interface(1) (mm)	PHINS II 6000 Position P (2) (mm)	PHINS III 6000 Position P (2) (mm)	ROVINS Position P (2) (mm)	PHINS II 6000 X3(m) (3)	PHINS III 6000 X3(m) (3)	ROVINS X3(m) (3)
967-1024-00	XF	300/600 kHz 6000 m	22.4	73.7	241.2	127.6	3.3	11	113.7	115.8	76.46	-0.219	-0.221	-0.182
967-1025-00	XC	300/600 kHz 3000 m	22.4	73.7	241.3	127.6	3.3	11	113.7	115.8	76.46	-0.219	-0.221	-0.182
967-1026-00	XD	1200 kHz, 3000 m	19.6	54.9	239.8	95.2	3.3	11	113.7	115.8	76.46	-0.253	-0.255	-0.216
967-1027-00	XC	1200 kHz, 6000 m	19.6	54.9	239.7	95.2	3.3	11	113.7	115.8	76.46	-0.253	-0.255	-0.216
967-1020-00	XB	1200 kHz, 6000 m	22.5	60.5	190	104.7	0	11	113.7	115.8	76.46	-0.187	-0.190	-0.150
967-6003	F	300/600 kHz 3000/6000 m	21.9	73.62	214.8	127.5	3.3	11	113.7	115.8	76.46	-0.193	-0.195	-0.156
967-6004	G	300/600 kHz 1000/2000/6000	21.6	74.1	218	128.3	3.3	11	113.7	115.8	76.46	-0.196	-0.198	-0.159
967-6006	E	1200 kHz 2000/4000/6000 m	49.5	16.4	180	28.4	3.3	11	113.7	115.8	76.46	-0.230	-0.232	-0.193

(1) Interface plate thickness (cf. drawing PHI6XX_PI_009)
(2) PHINS/ROVINS vertical position of reference frame center
(3) DVL vertical lever arm value to be entered in MMI software menu



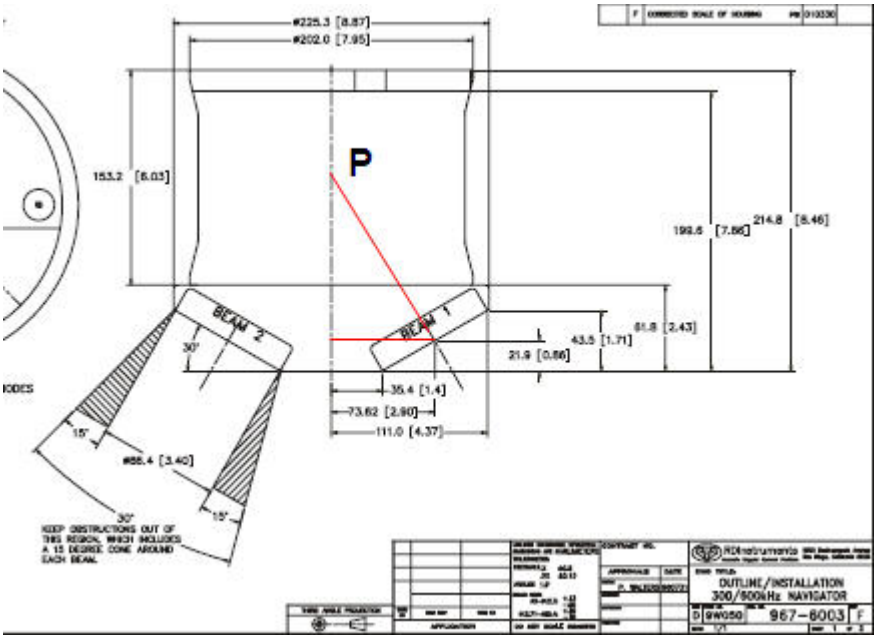


Figure 5 - DVL P/N 967-6003 (300-600 kHz, 3000/6000 m)

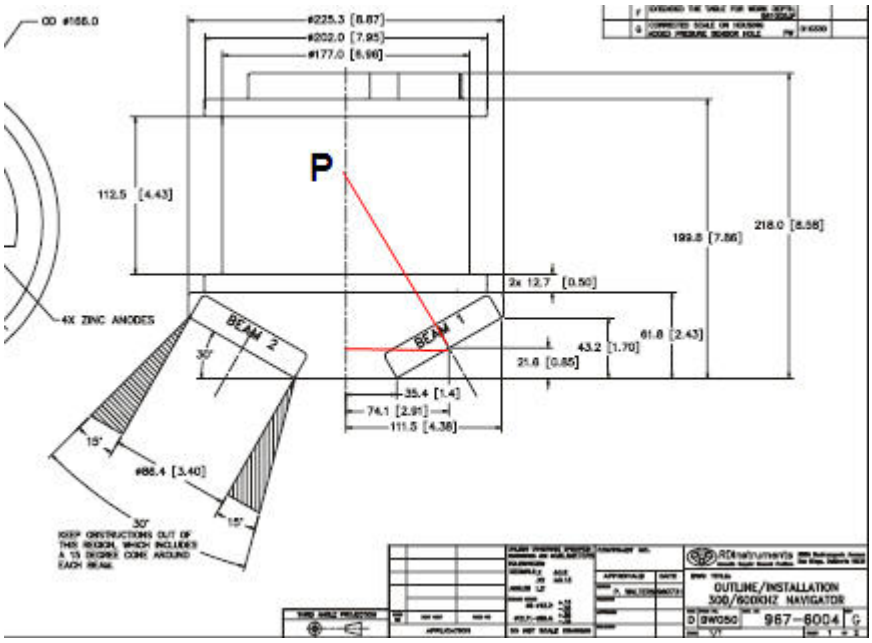


Figure 6 – DVL P/N 967-6004 (300-600 kHz)

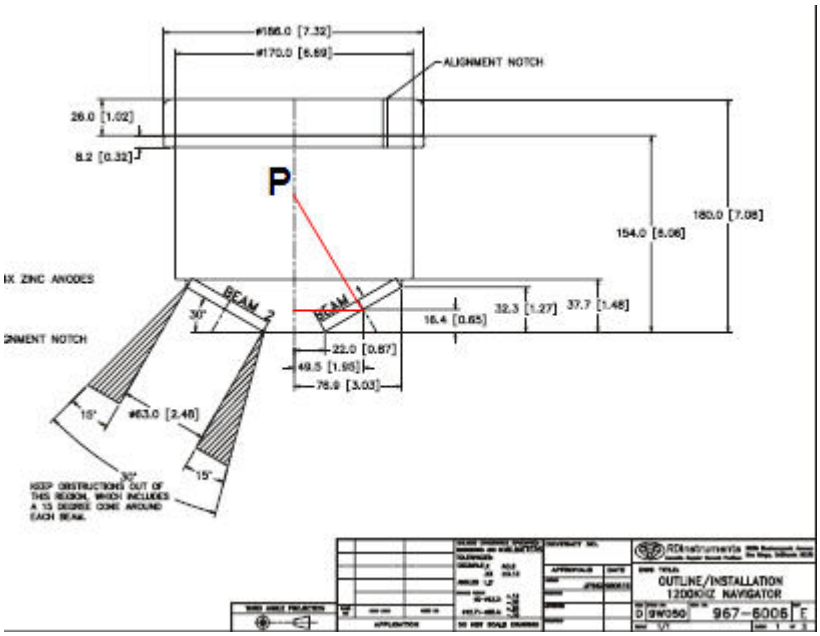


Figure 7 - DVL P/N 967-6006 (1200 kHz)

E ROVINS REFERENCE POINT

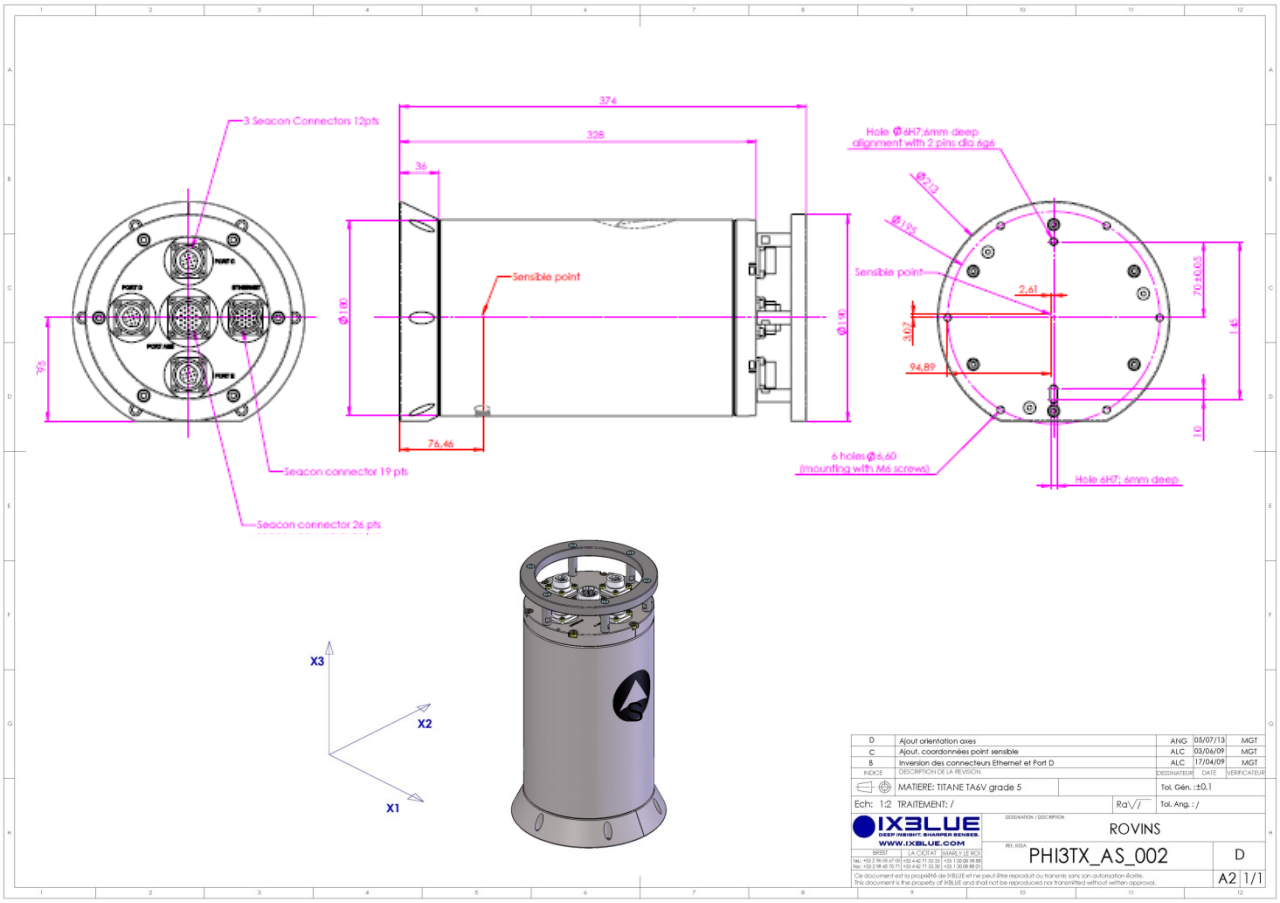


Figure 8 - ROVINS reference frame description

Distance from ROVINS center of measurement P to Reference points S	Along ROVINS Axis X1	Along ROVINS Axis X2	Along ROVINS Axis X3 (bottom to top)
	3.07 mm	-2.61 mm	-76.46 mm

F REFERENCE POINT OF PHINS 6000 GENERATION III

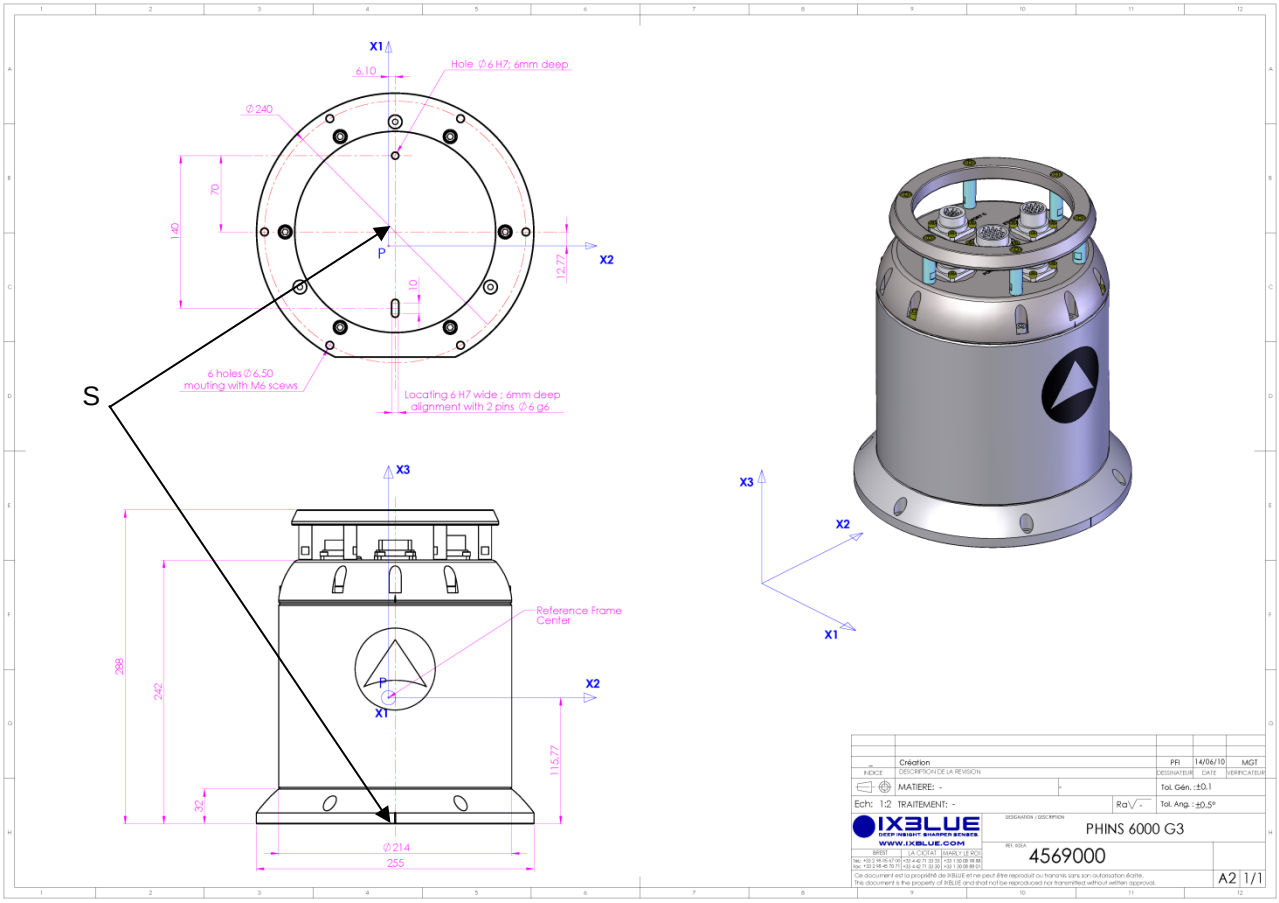


Figure 9 - PHINS III 6000 reference frame description

Distance from PHINS center of measurement P to Reference points S	Along PHINS Axis X1	Along PHINS Axis X2	Along PHINS Axis X3 (bottom to top)
	+0.0128 m	+0.006 m	-0.1158 m

G REFERENCE POINT OF PHINS SURFACE GENERATION III

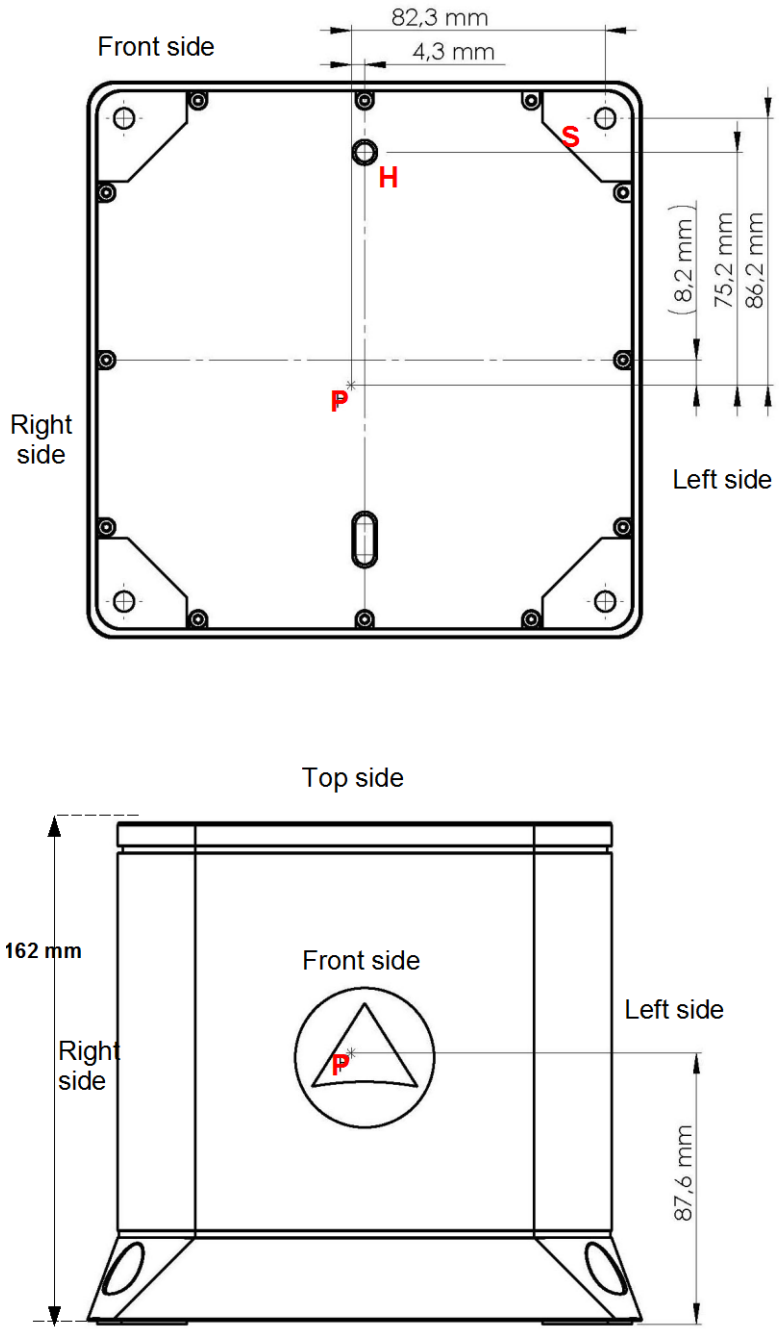


Figure 10 – PHINS generation III Surface center of measurement point description

Distances from PHINS center of measurements P to	Along PHINS X1 axis (connector to front)	along PHINS X2 axis (right to left)	Along PHINS X3 axis (bottom to top)
PHINS reference point S	86.2 mm	+82.3 mm	-8.76 cm
PHINS reference point H	75.2 mm	+4.3 mm	-8.76 cm

H REFERENCE POINT OF MARINS

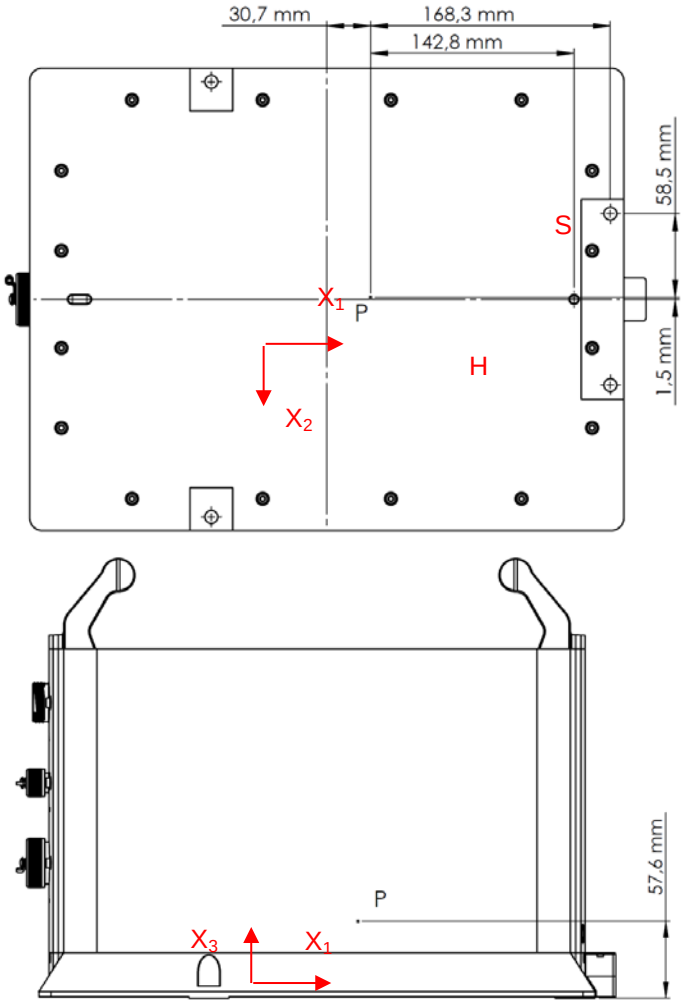


Figure 11 – MARINS alone center of measurement

Distances from MARINS center of measurements P to	Along MARINS X1 axis (connector to front)	Along MARINS X2 axis (right to left)	Along MARINS X3 axis (bottom to top)
MARINS reference point S	168.3 mm	-58.5 mm	- 57.6 mm
MARINS reference point H	142.8 mm	1.5 mm	- 57.6 mm

I RDI DVL-ROVINS OR PHINS SEACON RS232 CABLING TABLE

DVL Pin Assignment	DVL		ROVINS	ROVINS Port X Pin Assignment
Power +	3		1	Ext sensor 1 out (+V1)
Power -	7		2	Ext sensor 1 out GND (0V)
			3	Ext sensor 2 out (+V2)
			4	Ext sensor 2 out GND (0V)
IN RS232	1		5	**Port X :** RS422 TX(+) / RS232 TX(+)
			6	**Port X :** RS422 TX(-)
OUT RS232	2		7	**Port X :** RS422 RX(-) / RS232 RX(+)
			8	**Port X :** RS422 RX(+)
IN RS-422 A (optional)	5		9	Ext pulse IN +
IN RS-422 B (optional)	6		10	Ext pulse IN -
COMRETURN	4		11	**Port X** : GND
			12	Pulse C : IN TTL

Notes

- For long cables, iXBlue recommend the use of shielded pairs
- External pulse signal may be used to externally trigger the DVL to synchronize it with other acoustic instruments. Refer to RDI documentation for details on this topic.

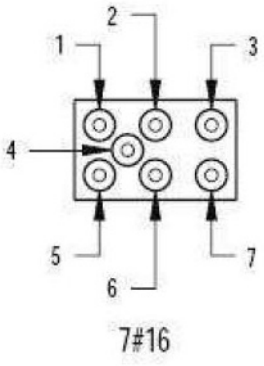


Figure 12 – 7-Pin IMULSE pin out (view: facing ROVINS)

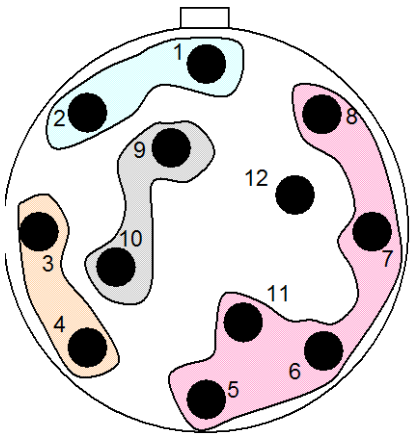


Figure 13 – ROVINS 12-pin SEACON connector

J RDI DVL-PHINS 6000 BURTON RS232 CABLING TABLE

DVL Pin Assignment	DVL		PHINS	PHINS Pin Assignment
Power -	7		1	Ext sensor Power Out GND (0 V)
Power +	3		2	Ext sensor Out (+ V)
COMRETURN	4		3	**Port X**: RS232 TX(-)GND
IN RS232	1		4	**Port X**: RS422 TX(+)/RS232 TX(+)
			5	**Port X**: RS422 TX(-)
			6	**Port X**: RS422 RX(+)/RS232 RX(-)
OUT RS232	2		7	**Port X**: RS422 RX(-)/RS232 RX(+)

Note

For long cable, iXBlue recommend the use of shielded pairs.

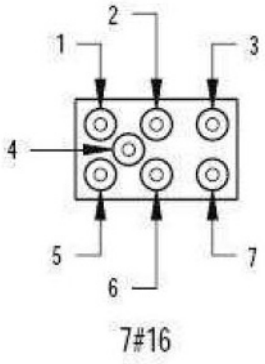


Figure 14 – 7-Pin IMULSE pin out (view: facing pins)

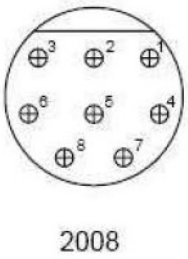


Figure 15 – 8-Pin BURTON pin out (male connector)

K HOW TO EXTERNALLY TRIGGER THE DVL

If you need to trigger the DVL due to synchronization with other acoustic equipment you need to refer to RDI application note (RDI, Application Note FSA018 (November 2004)).

L INFLUENCE OF TEMPERATURE, SALINITY AND DEPTH ON SOUND VELOCITY

DVL is a Doppler sensor and needs to know the sound velocity at the location of its sensor.

You may use the following equation to compute sound velocity (Urick, 1983):

$C = 1449.2 + 4.6T - 0.055T^2 + 0.00029T^3 + (1.34 - 0.01T)(S - 35) + 0.016D$ (8) where

T is the temperature in ºC

S is salinity in parts per thousand (‰)

D is the depth in meters

Velocity is very **sensitive to temperature (3.10^{-3}/°C),** three times **less sensitive to Salinity(10^{-3} /(°/°°))** and **not sensitive to depth (10^{-5}/m)**. Note that salinity does not usually vary very much over water column (< 1°/°°) so surface salinity can be entered as a constant value for a mission.

By letting DVL calculate velocity measuring temperature with its internal probe we should have the maximum accuracy.

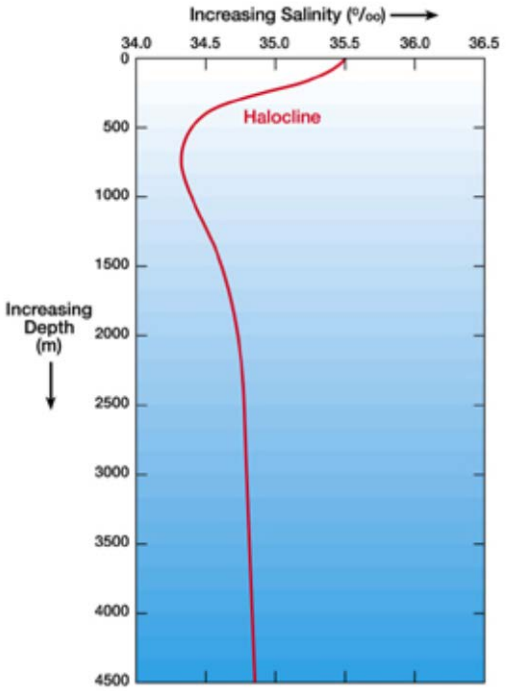


Figure 16 – Typical salinity profile for south Atlantic sea

Let's consider the case of setting DVL to calculate its own velocity.

If we want a navigation drift < 10^{-3} of travelled distance, sound velocity relative accuracy must also be better than 10^{-3}. This leads to the following constraints:

- Temperature measured (with internal probe) accuracy << 0.3°C
- Salinity accuracy << 1°/°°
- Depth accuracy << 100 m