Ekinox AHRS & INS

Use in marine applications

Operating handbook

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Support support@sbg-systems.com
+33 1 80 88 45 00

SBG SYSTEMS

This operating handbook aims to guide Ekinox users during sensor installation and configuration in marine environments.

You don't need to use the sbgCenter to configure the products.

Mechanical installation

When used in marine application, Ekinox performs some velocity assumptions: No high dynamics are involved, but you still need a good sensor installation to get best results.

Vibrations

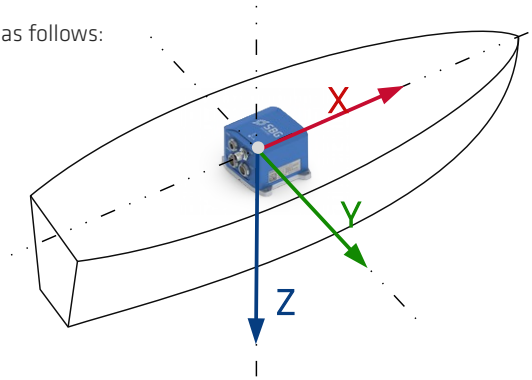
Ekinox is designed to handle vibrations. Nevertheless in case of highly vibrating environment, or vibrations above 1kHz, an efficient mechanical vibration isolation is required for proper operation. Silicon dampers can be used for that purpose.

Ekinox placement in the vessel

The vessel coordinate frame is defined as follows:

- X points to the front (bow)
- Y points to the right (starboard)
- Z points the bottom (keel)

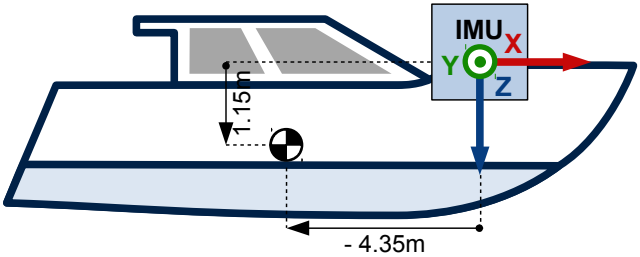
The Ekinox MUST be mechanically aligned with the vessel coordinate frame, as explained in the following diagram. **Alignment accuracy should be better than 1°.**



Note: If a correct mechanical alignment is not possible, then a software alignment can be used. Please refer to the Ekinox User Manual for such operation.

If the Ekinox is GPS aided, it can be placed anywhere in the ship. If you are using the Ekinox as an AHRS only (without any GPS aiding), you should place the device close to the center or rotation to ensure the best accuracy.

Once installed, you can enter a primary lever arm to deport velocity, position and main heave outputs. It must be measured in the vessel coordinate frame **FROM** the Ekinox **TO** the center of rotations.



Magnetic environment

If magnetometers are used for heading observation, user should also consider the magnetic environment.

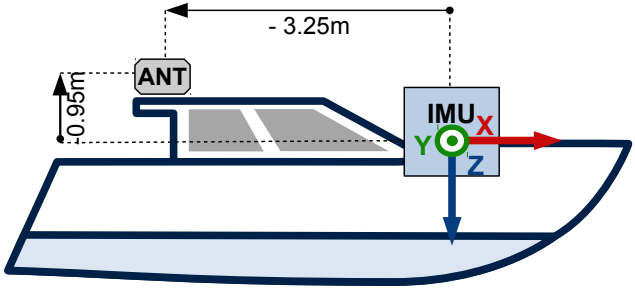
The Ekinox **magnetometers require**, for good operation, a **clean magnetic field**. The sensor should be placed away from any magnetic interference such as: DC motors, radios, strobe lights, power supplies etc.

Single GPS Antenna placement

GPS antenna must be fixed with respect to the Ekinox. It should have a clear view of sky.

The GPS lever arm is the signed distance, expressed in the vehicle coordinate frame, from the Ekinox center of measurements, to the GPS antenna. It must be measured within 5cm accuracy.

In addition, this lever arm should be lower than 10m for best performance.



Dual GPS Antenna placement

Dual antenna systems installation will require special care in order to obtain optimal performance:

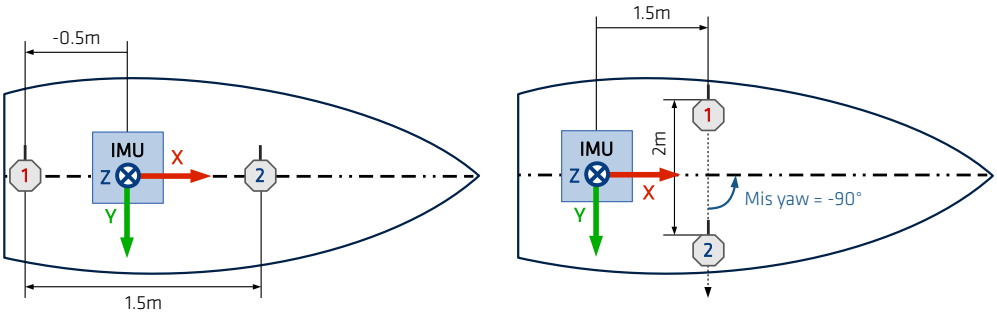
- Maximum separation between two antennas should not exceed 3 meters on Ekinox D. For external GPS receivers, please conform to Manufacturer guidelines
- Same antenna type, same cables with identical lengths must be used for both antennas. No signal splitter should be used.
- Both antennas must be mounted in the same orientation with respect to the vessel.
- Both antennas must have the same view of sky when mounted on the vessel.

Once installed, the GPS lever arm must be measured. It is the signed distance, expressed in the vehicle coordinate frame, from the Ekinox center of measurements, to the main GPS antenna. It must be measured within 5cm accuracy.

Then, the absolute distance between main and secondary antennas should be measured.

Finally, the alignment angle between the antennas and the vessel coordinate frame must be **accurately measured within 0.5°**.

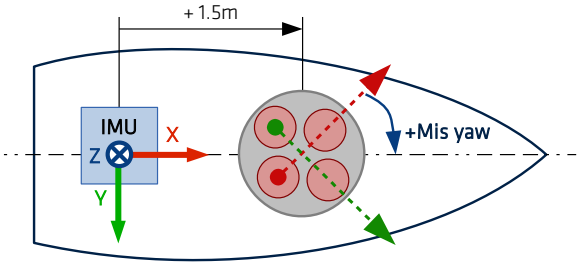
The following diagrams show two typical installations. The first one with the GPS antennas installed with a zero angle offset, and the second one, with a -90° installation:



DVL installation

DVL installation requires to be precisely performed, like the GPS dual antenna system.

The DVL lever arm, which is the signed distance, in the vessel coordinate frame, **FROM** the Ekinox, **TO** the DVL should be measured.

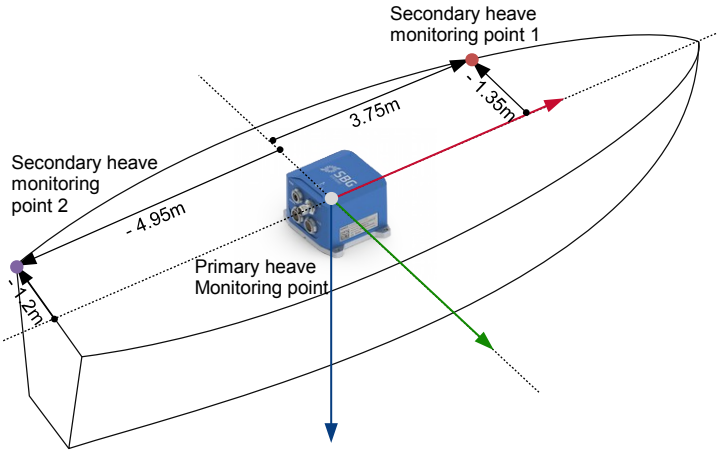


In addition, the DVL alignment should also be measured. The diagram above shows a recommended installation of the DVL, with a +45° alignment angle.

Heave

You can measure heave, surge and sway on 4 different locations with one Ekinox device: the main heave monitoring point, located on the device main lever arm, and three secondary monitoring points, placed where you wish without any limitation in range. You can configure the lever arm of each of the wanted points.

Heave lever arms are expressed in the vessel coordinate frame, from the Ekinox center of measurements, to the monitoring point.



Note: Deported heave accuracy is decreased as the lever arm becomes longer, due to orientation accuracy. Accuracy decreases of roughly 0.1 cm each meter. A 10 meters lever arm will therefore lead to 1 cm additional error on deported heave output.

Software configuration

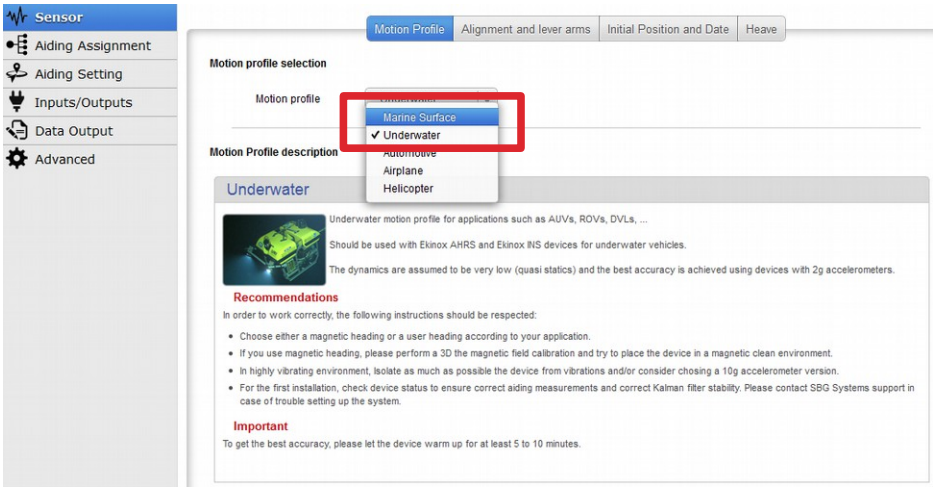
All Ekinox configuration is done through the web interface.

Note: At the first access or if the device firmware has been updated, the Ekinox will cache the entire embedded website to optimize the responsiveness. This preload operation may take up to two minutes depending on your system configuration.

Sensors

Motion profile

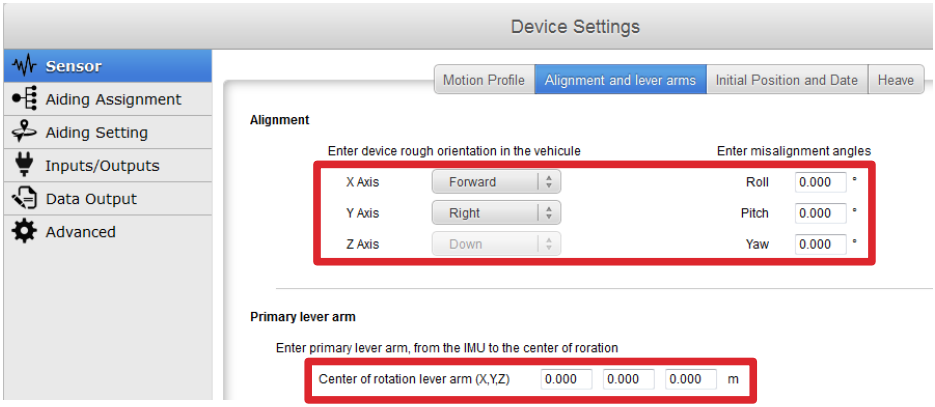
Conventional vessels should use the "Marine Surface" motion profile, for sub-sea applications you should use the "Underwater" motion profile.



Alignment and lever arm

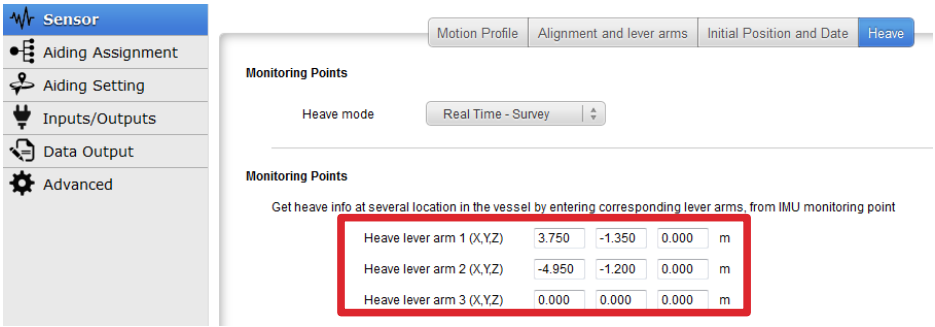
Here you can configure the alignment of the device and its lever arm in regard to the rotation center of the ship.

On the alignment settings you only need to set up the first two axis, then the third one will be automatically computed.



Heave

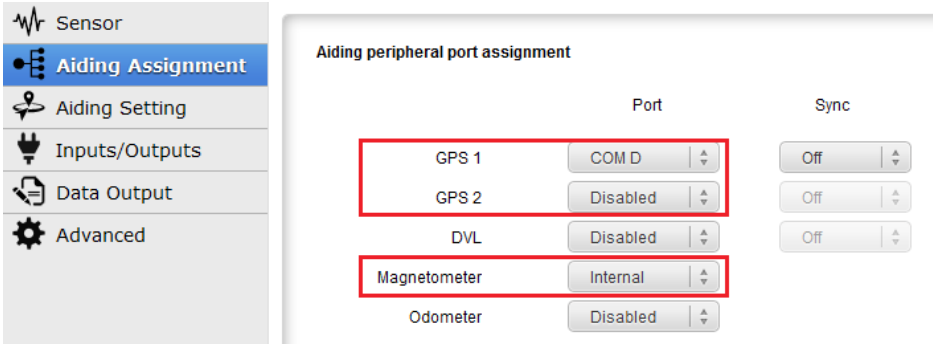
You can configure in the Heave panel the lever arm for the three deported heave. If you don't want to use it, you can leave it on default settings (as zero).



Aiding Assignment

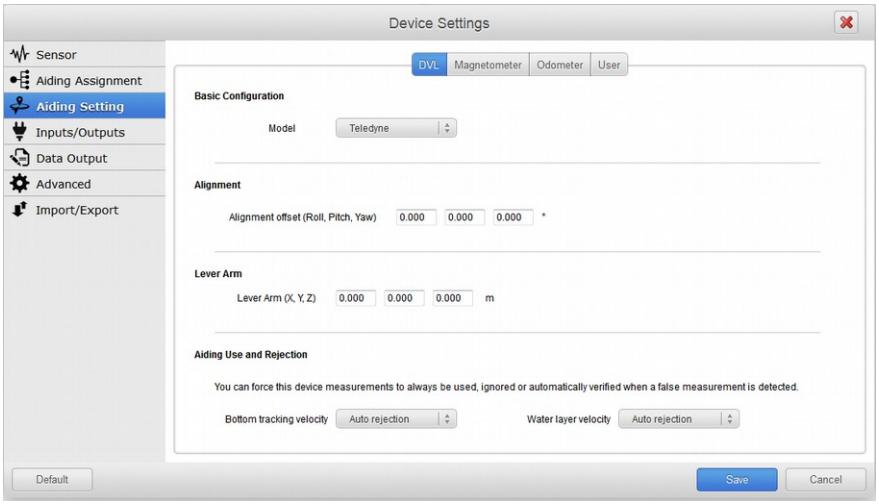
You can enable one or two GPS on this panel and in case of Ekinox N and D, you can chose whether you want to use the internal GPS or not.

In case of a clean magnetic environment and if you can run a calibration procedure, you should be able to use the internal magnetometers. Please check the calibration section for more details (Magnetic calibration in marine applications).



DVL configuration

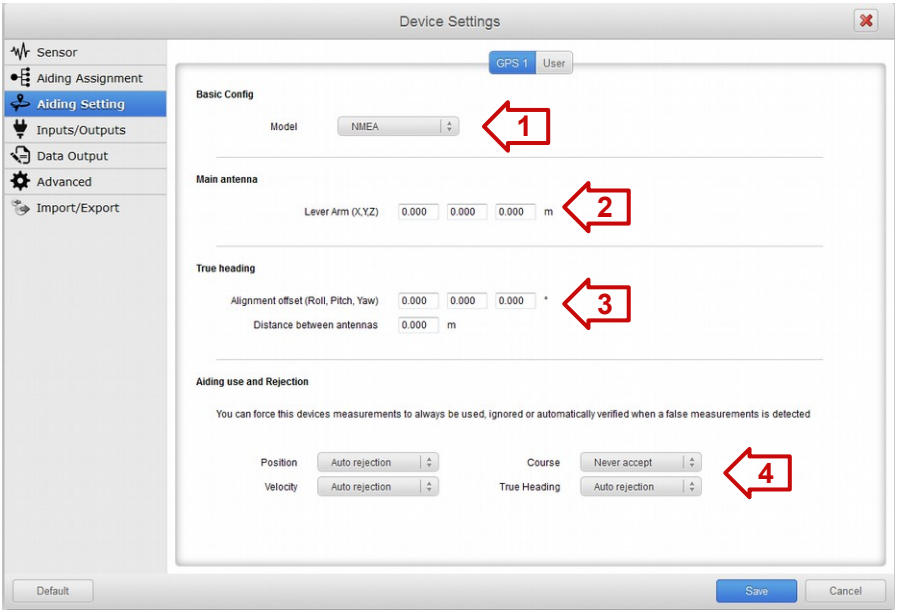
Please check the following points to ensure a correct DVL configuration:



1. Select the right DVL model. Up to now, only Teledyne PD0 compatible DVLs are supported.
2. Setup the DVL lever arm depending on its position on the ship (DVL installation).
3. Then DVL misalignment with respect to the vessel coordinate frame should be entered in terms of roll, pitch and yaw angles. Most users will only enter +/- 45° on yaw angle.
4. Auto-rejection is advised for both bottom tracking and water layer velocity, but it is possible to disable an item if required.

GPS Configuration

Please check the following points to ensure a correct GPS configuration:



1. Choose this parameter depending on the GPS you are using (NMEA or Novatel), you can refer to the corresponding manual to know how to configure the GPS.
2. Set up the lever arm of the GPS depending on its position on the ship (Single GPS Antenna placement).
3. If two antennas are used you have to define here the distance between antennas and the antennas misalignment with respect to the vessel coordinate frame.
4. Auto-rejection is advised for velocity and position. Course should be set to "Never Accept" and True Heading should be set to Auto Rejection if available. "Auto Rejection" mode automatically detects if a measurement can be trusted or not.

Note: It is not recommended to use GPS Course since we can expect side drift in most marine applications.

Magnetic calibration in marine applications

When magnetometers are used as heading, a **magnetic calibration is mandatory for normal sensor operation.** Different calibration methods are provided, depending on accuracy or ease of use requirement.

Large ship calibration

In case the boat is a heavy ship and it is not possible to move it by hand, it will be necessary to calibrate the magnetometers while cruising. The goal will be to collect data in every direction, so you will have to make a 360° with the ship (the turn radius and speed does not matter).

You should perform a 3D calibration in most cases as your boat as a good chance to heel (except heaviest ones).

The following procedure should be followed for good performance:

1. Install the sensor as described in previous sections, and place the whole system **away from external magnetic disturbances** (buildings, other vessels, etc).
2. Press “Start acquisition” button on sbgCenter calibration window
3. Navigate in an 8 shaped path, so you will be able to capture points in the Y-axis while heeling slightly on both sides. It doesn't need to be a critical angle, 20° would be enough for instance, it has to be representative of the usual behavior of the ship.
4. Check that the 3d method is used (In case of very large ship, or when the roll/pitch angles could not be changed significantly during calibration, a 2D method can be used), press “**Calibrate**” and check calibration results. Press “**OK**” to finalize calibration procedure.
5. Power cycle the sensor if you need immediate operation after calibration.

Light boat calibration (USV/ROV/AUV)

As long as a boat is light enough to be held by a few persons (especially unmanned vehicles), a 3D calibration, made on the ground is to be preferred. The basic procedure remain the same, and you should just rotate the system in as much orientations as possible.

Operation

For all applications, full performance is reached after a warm-up time of 15 minutes. The system is operational before that time, but performance parameters cannot be guaranteed.

DVL applications

For applications involving a DVL, the beginning of a mission should include some motion patterns with both GPS and DVL available that will be used to calibrate the DVL during the first minutes of operation. This calibration is fully automated and performed in real time.

A typical initialization pattern is shown in the next picture:

A few “eight” figures are performed in a first step, to help correct alignments to be estimated. Then a few straight lines should be performed to improve DVL gain accuracy.

Support

If you have any trouble or question with the use of the Ekinox, feel free to contact our support team by email, at support@sbg-systems.com.