Ellipse AHRS & INS

Use in marine applications

Operating handbook

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SBG SYSTEMS

This operating handbook explains how to install and setup an Ellipse in marine applications such as ship, ASV, ROV, or AUV. Mechanical installation is explained as well as software configuration and magnetic calibration.

We recommend using the sbgCenter to configure the products, but this is also possible by using our sbgECom C library.

Mechanical installation

Inertial Systems are very sensitive to their environment and the location of the inertial system into the vessel is a key point to get accurate and reliable measurements.

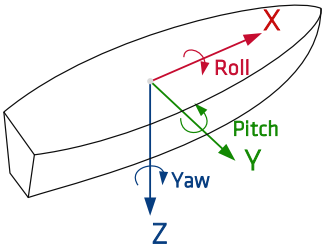
Vibrations

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

Ellipse placement in the vessel

The vehicle coordinate frame is defined as follows:

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

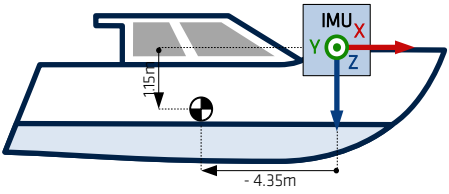


The Ellipse MUST be mechanically aligned with the vehicle coordinate frame, as explained in the following diagram. **Alignment accuracy should be better than 1°.**

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

The main lever arm is the signed distance, expressed in the vehicle coordinate frame, **FROM** the Ellipse center of measurements **TO** the vehicle desired measurement point. It can be used to deport the velocity and position outputs to this specified location.

Only velocity and position outputs are affected by this main lever arm measurement.



Magnetic environment

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

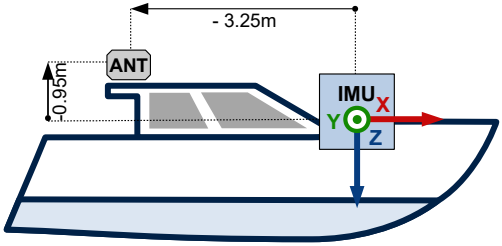
The Ellipse **magnetometers require** for good operation a **clean magnetic field**. The sensor should be placed away from any magnetic interference such as: DC motors, radios, strobe lights, power supplies etc.

GNSS Antenna placement

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

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

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



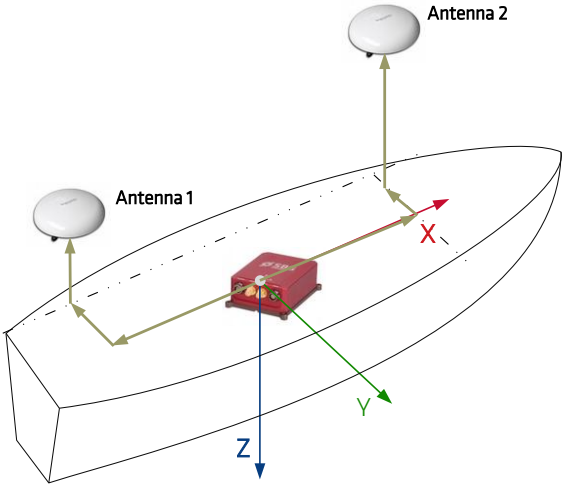
Dual GPS Antenna Placement

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

- Same antenna type, same cables with identical lengths must be used for both antennas.
- Both antennas must be turned the same way (connectors oriented in same direction)
- Both antennas must have the same view of sky when mounted on the vehicle.
- Both antennas must be placed on a suitable location to avoid masks and reflections.

Once installed, the main GPS antenna lever arm must be measured. It is the signed distance, expressed in the vehicle coordinate frame, from the Ellipse center of measurements, to the main GPS antenna. It must be measured within 5cm accuracy. Then, the same should be done for the second antenna.

Precise lever arms can also be estimated in post processing using **Qinertia**.



Note: If the Ellipse is not physically aligned with the ship, lever arms are still taken to the X, Y, Z reference frame of the ship. This is also the X, Y, Z reference frame of the Ellipse considering the re-alignment has already been applied.

Software configuration

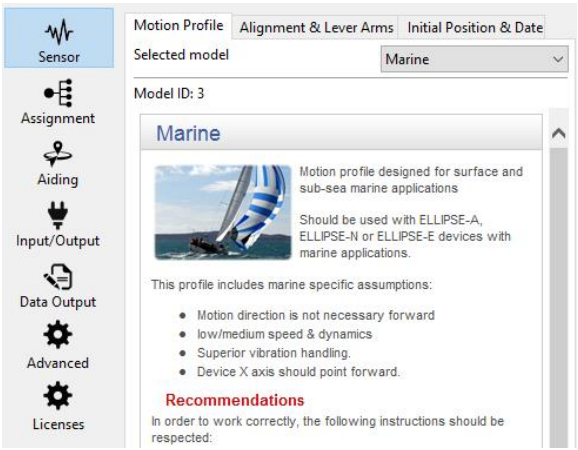
All Ellipse configuration is done through the sbgCenter interface, or using low level communication protocol.

Note: At the first access, the Ellipse will have its default configuration. This data output configuration should be used it you want to send logs to Support. Don't hesitate to contact the Support Team for help.

Sensor

Motion Profile

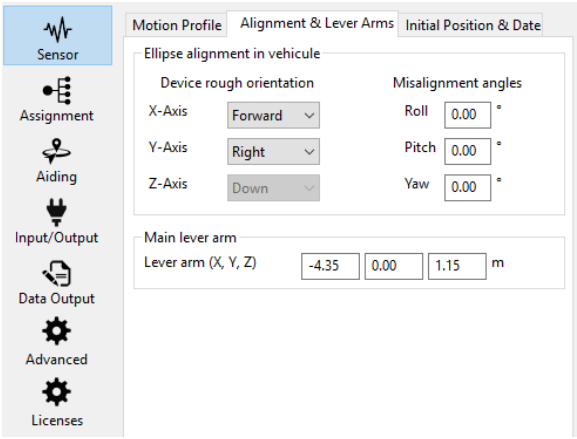
For marine application, you can choose the relevant motion profiles



Alignment and lever arms

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



Initial Position and Date

This parameter will matter if you are using magnetometers: the initial position and date will be used to compute the magnetic declination.

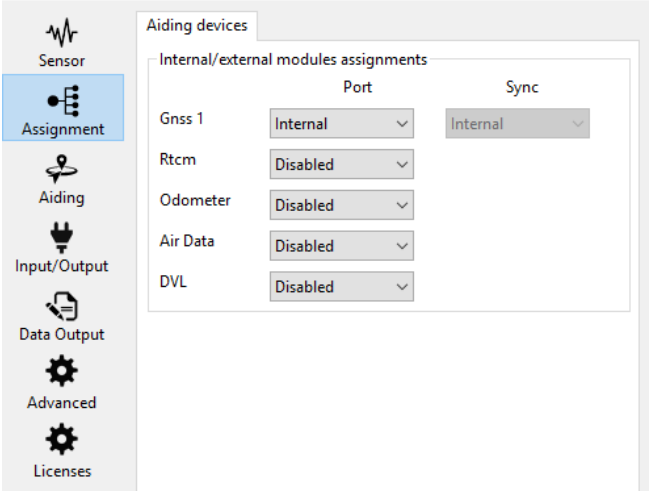
In case you use magnetometers as a heading source, then a magnetic calibration is mandatory. A 3D calibration should be preferred over a 2D one if possible. If a 2D magnetic calibration is performed, it will be only valid locally, and should be re-done if the ship is in a different geographic area.

Assignment

GNSS Receiver assignment

Here it is possible to select the serial port to receive the GNSS Receiver data, and select the input Synchronization as well.

The Ellipse N and D GNSS are automatically set to “Internal” by default to select the on-board GNSS Receiver. In addition, they accept In case the Internal GNSS Receiver is selected, the user can also set an RTCM corrections input on any available serial port.

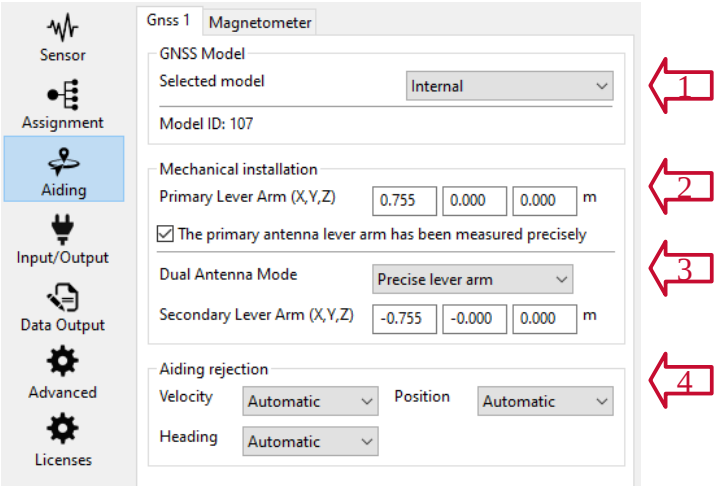


Other Aiding inputs

You can enable DVL aiding input for marine applications. Please note that Odometer is for automotive application and Air Data for Airborne applications, so won’t be used here.

Aiding

GNSS Configuration



Please check following point at the GPS configuration level:

1. Choose this parameter depending on the GPS you are using (NMEA, Ublox, Novatel, Septentrio)
2. Set up the lever arm of the GPS depending on its position on the ship (GNSS Antenna placement). If your lever arm has been precisely measured within 1-2 cm, or estimated by Qinertia, you can check the "Primary antenna Lever arm has been measured precisely" box. This will optimize Kalman filter warmup-time and overal performance..
3. Select Rough lever arm if you measured it within 5cm accuracy. If precisely measured or estimated by Qinertia, you can select "precise lever arm" to optimize filter warm-up time and performance
4. Automatic rejection mode is advised for each parameter. Automatic mode automatically detects the confidence so the Kalman filter knows it can rely more on a parameter or less on an other.

Magnetic calibration in marine applications

When magnetometers are used as heading reference, 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 prefer a 3D calibration if your boat can heel, if not then a 2D calibration should be done.

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 shape pattern, 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 the calibration procedure.
5. Power cycle the sensor if you need immediate operation after calibration.

Light boat calibration (ASV, 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 remains the same, and you should just rotate the system in as much orientations as possible.