Ellipse Series

Use in automotive applications

Operating handbook

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This operating handbook aims to guide Ellipse users during sensor installation and configuration in automotive environments.

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

Mechanical installation

When used in automotive application, Ekinox performs some velocity assumptions: No lateral velocity is allowed and therefore, a good sensor installation is a key point to follow.

For an optimal installation, please make sure these few **critical** points are respected:

- Unit is **rigidly fixed** to the vehicle and GNSS antennas
- Unit is not exposed to high vibrations. In some applications such as motor-sport, mechanical dampers may be used to mitigate vibration effects.

Vehicle reference frame

The vehicle coordinate frame is defined as follows:

- X axis points to the front of the car
- Y axis points Rightward.
- Z axis points downward.

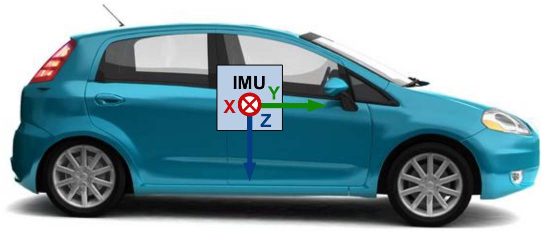
Sensor Orientation in the vehicle

The sensor can be placed in any orientation in the vehicle. When IMU axes do not match exactly with the vehicle coordinate frame, a two step software alignment method can be performed, as explained below.

> **Note:** Once the unit is aligned (mechanically or by software), the vehicle reference frame is used for all lever-arms in the Inertial Unit configuration.

Step 1: Axis Misalignment

In the first step, you basically need to check in which direction each IMU axes point. Next example shows IMU X axis is turned left, IMU Y axis is turned in vehicle Front direction and Z is turned down.



Step 2: Fine Misalignment (optional)

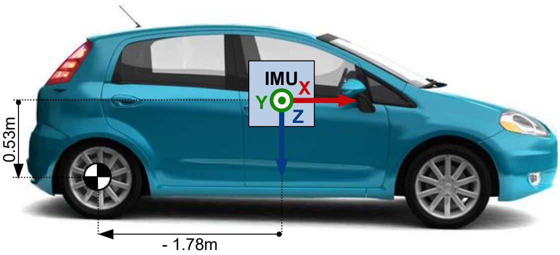
This step can be used to compensate for small angles in case the sensor is not aligned within 1 degree with the vehicle coordinate frame. The angles are expressed in terms of Euler Roll, Pitch and Yaw residuals.

An easy way to measure roll and pitch misalignment is to park the car and read roll and pitch angles. Then park the car again at the same location but reverse direction, and read again the roll and pitch angles. By averaging the two measurements, you will remove any effect of the road inclination and just have IMU to car misalignment residuals.

> **Note:** The alignment precision in the vehicle should be less than 2°. The Extended Kalman Filter is able to take into account the residual angle errors if the user configuration is not perfect.

Centre of Rotation Lever Arm (Primary Lever Arm)

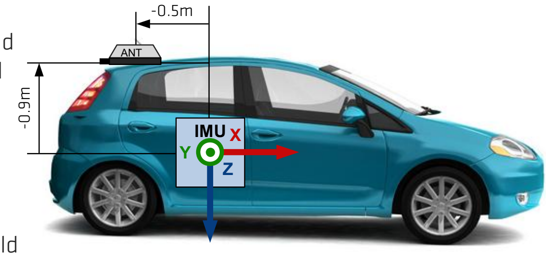
Once the sensor is installed in the car, the Centre of Rotation should be identified. This is most often located at the rear Axle. The Primary Lever Arm which is the signed distance **FROM** the IMU, **TO** the Centre of Rotation should be measured within a 5cm accuracy.



GNSS Antenna installation

For single antenna systems, the main installation requirement is to have a rigid installation between GNSS antenna and the IMU.

The antenna should be installed somewhere with a clear view of sky (typically on the roof of the car).



Once installed, the GPS lever arm should be measured. It is the signed distance, expressed in the vehicle coordinate frame, **FROM** the IMU center of measurements, **TO** the GNSS antenna. It must be measured within **5cm accuracy**.

Precise lever arms can be estimated in Post processing using **Qinertia**

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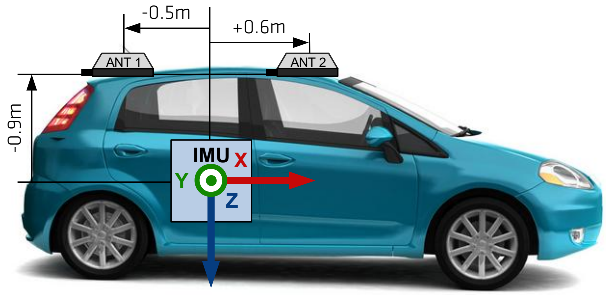
Dual GNSS antenna placement

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

- Both antennas must be **fixed** with respect to the to the inertial unit
- Both antennas must be **turned the same way** (connectors oriented in same direction)
- Both antennas must have the **same optimal view of sky** (avoiding signal masks due to the vehicle structure)
- **Same cables** with same length must be used for both antennas. Prefer no splitter, or make sure they are adapted.
- Baseline of **at least 1 meter between both antennas** is recommended for optimal performance

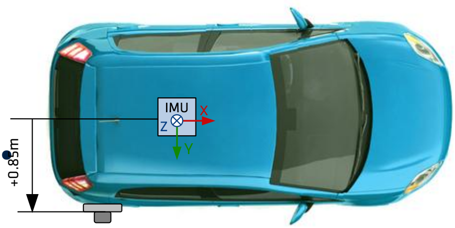
Once installed, the two GNSS antenna lever arms must be measured. These are the signed distances, expressed in the vehicle coordinate frame, **FROM** the IMU, **TO** the GNSS antenna. It must be measured within **5cm accuracy**. A calibration can be performed to estimate these lever arms within 1 cm of accuracy.

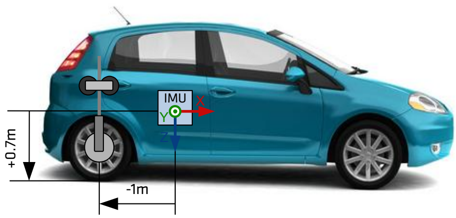


Odometer placement

Odometer has to be placed on a **non steering wheel** (rear wheel in most applications).

The Odometer lever arm has to be measured. It is the signed distance, expressed in the vehicle coordinate frame, **FROM** the IMU **TO** the Odometer. It has to be measured with 5cm accuracy, and should be lower than 10m for best performance.





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Software configuration

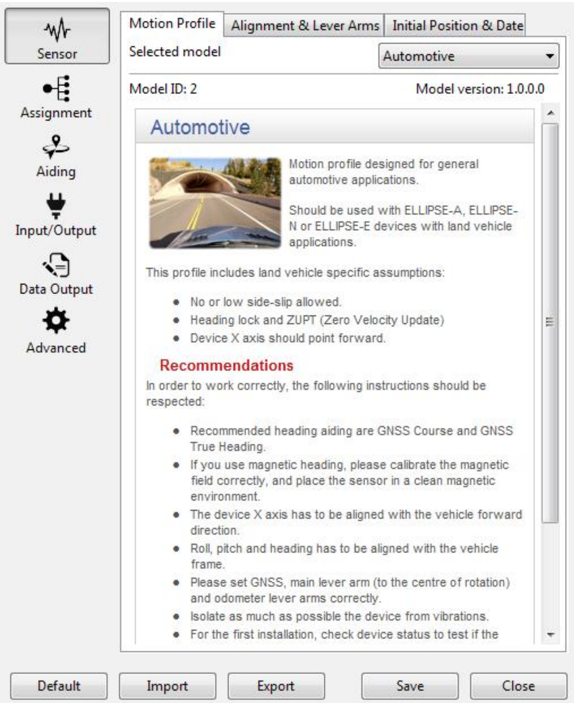
All Ellipse configuration is done through the sbgCenter.

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

Conventional vehicles should use the "Automotive" motion profile.

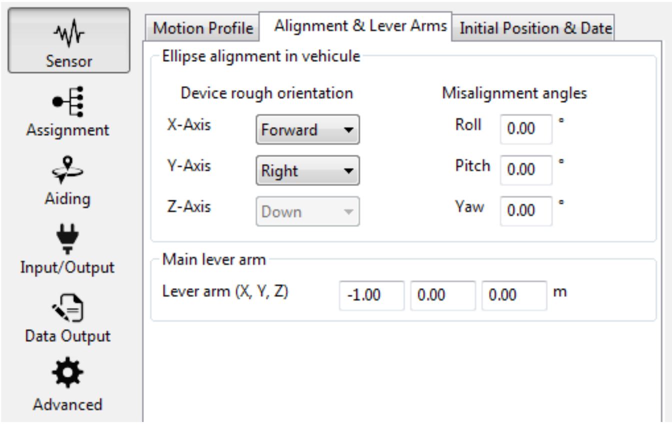


In case the vehicle will have movement on the Y-Axis (drift on a side), the Motion Profile "General Purpose" should be preferred.

Alignment and lever arm

Here you have to configure the device alignment in the vehicle and its lever arm in regard to the center of rotation of the car (rear axle).

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



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 an RTCM corrections input on any available serial port.

Other Aiding inputs

You can also enable or disable the odometer, if you have the opportunity to use one it may significantly improve the dead reckoning performance.

If the Odometer has only one channel for the distance, select Odometer A.

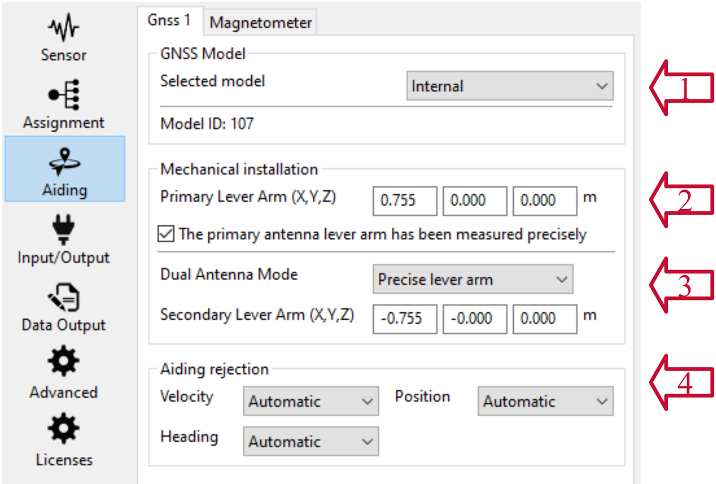
If the Odometer also has the direction on a second channel, select Odometer AB.

For the B2 version of the Ellipse, we can also use a CAN Odometer.

Please note that DVL is for marine application and Air Data for Airborne applications, so won't be used here.

Aiding

GNSS Configuration

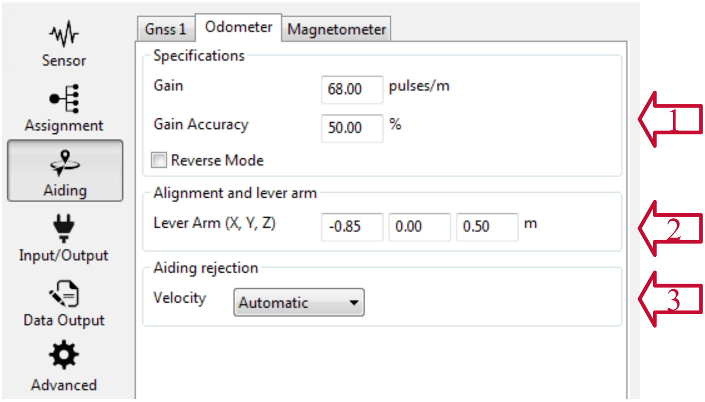


Please check following point at the GPS configuration level:

1. Choose this parameter depending on the GPS you are using (NMEA, Ublox or Novatel, Septentrio)
2. Set up the lever arm of the GPS depending on its position on the car (GNSS Antenna installation). 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, it automatically detects the confidence so the Kalman filter knows it can rely more on a parameter or less on an other.

Pulse Odometer configuration

If you are using an odometer and activated it in Aiding Assignments, you will see a thumbnail called “Odometer” in the Aiding panel.



1. Define here the initial Odometer gain in pulses per meter. This parameter will be then automatically tuned by the Kalman filter to optimize the dead reckoning performance.

   Initial gain error in percent should also be entered in this section: this defines how much the Kalman filter needs to estimate the Odometer's gain. Put 100% if you want it to be completely estimated, or 20% if you find your odometer is very accurate. If you are not sure, 50% is a good default value

   Depending on your hardware configuration, the receive mode can be used to reverse the velocity value in order to fit with an actual velocity direction.

2. Set up here the Odometer lever arm depending on its position (Odometer placement).

3. Auto-rejection is advised so the Kalman filter determines the confidence of this parameter by itself.

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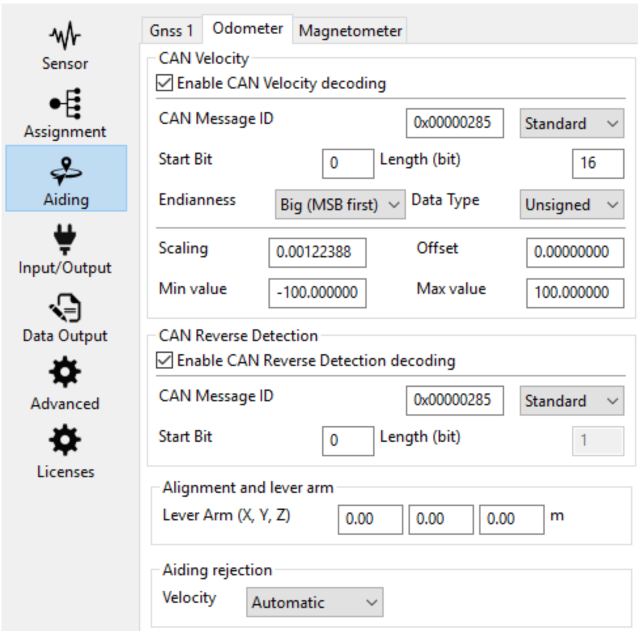
CAN Odometer configuration

In case a CAN odometer has been selected, the velocity and direction can be read from the CAN bus of the car, connected to the unit by the ODB connector.

You need to open first the can bus with the right bitrate. If you are using the can bus just to receive odometer information set it in "Listen only mode"
You need to know the ID of the velocity and select it in the configuration, then also enter the messages details such as the Start bit and the length of the relevant information from the CAN message. These data are usually available in a DBC file that can be provided by the car manufacturer.

If available you may also select one bit from a message that states the direction. It is recommended to configure it, especially if the car will have backward moves.



Magnetometer configuration

In automotive applications, conventional vehicles should avoid using magnetometers since there is usually a lot of disturbances.

Operation

Initialization

For applications with single antenna GPS receivers, the unit will be able to provide full navigation data once the platform has been moved at higher speed than 15 km/h.

Applications that use a dual antenna GPS system will start providing navigation data as soon as the GPS true heading data is available. For such systems, the unit should be started up in a clear view of sky environment to prevent bad initialization of the GPS true heading.

Bias Estimation

Once the navigation data is initialized, the system will be functional, but will require about 5 minutes to provide full navigation performance. This is required to let the sensors warm up, and to let the Kalman filter self calibrate some parameters, such as GPS lever arm, or sensors bias.

During this phase, some motion is recommended to ensure proper calibration. A good way to do it is driving with left and right turns, accelerations, decelerations, full stops, and so on. The following picture shows a typical successful calibration path: