IG Devices - Magnetic calibration in airborne applications

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SBG Systems
3bis, chemin de la Jonchère
92500 Rueil Malmaison
FRANCE

Email : support@sbg-systems.com
Phone : +33 (0)1 80 88 45 00

Revision history

Rev.	Date	Author	Information
3	19. Apr. 2012	Alexis GUINAMARD	Updated 2D horizontal calibration procedure.
2	11. May 2010	Alexis GUINAMARD	Updated address information
1	23. February 2010	Alexis GUINAMARD	First version of this document

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1. Overview

This document covers the magnetometers calibration procedures needed to get optimal magnetic field measurements in airborne applications.

User is advised to read also the IG Devices Magnetic Calibration Tools to have a complete overview of the magnetic calibration.

When the IG device is operated in airborne applications, the magnetic field measured by magnetometers is likely to be distorted by the ferromagnetic materials of the aircraft and rotating metal parts of the engines.

Therefore some considerations have to be taken into account in order to get optimal results with an IG-500 device. This document will explain how to get the best of the IG-500 sensors.

2. Device placement considerations

Ideally, the IG-500 should be placed at the center of rotations of the aircraft in order to get the best results. However in airborne applications, another consideration has to be taken: Device placement with respect to the engines as well as high current electrical wires/systems.

Where piston engines should not be a problem most of the time, it has been seen that turbojet and turboprop engines may cause magnetic distortions in their vicinity.

This is why user should verify before doing any flight that the engines will not disturb the magnetic field measurements. With the use of the sbgCenter software user can easily check that: If the device is not moving, the magnetic field read by magnetometers should remain constant in each axis (X, Y and Z), when the engine is turned ON and OFF.

Note: *It is not a problem if a magnetic distortion is observed only during engine starting or stopping.*

If oscillations of the magnetic field are observed, or the magnetic field level has changed as the engines are ON, the device should be moved away from the engines to work properly.

3. Magnetic calibration procedure

When the device is mounted in the aircraft, a magnetic field calibration procedure has to be performed.

Tow calibration methods are provided, depending on accuracy or ease of use requirement.

3.1. 2D Horizontal calibration

Although this method is not the most accurate, it's possible to calibrate the magnetometer on the ground, using the “2D horizontal” calibration method.

The procedure is really simple and only requires a few steps on the ground to be performed:

1. Install the IG-500 in the aircraft with the X axis turned into the aircraft nose direction.
2. Place the aircraft on an horizontal platform. The aircraft must be kept horizontal (in its line of flight level). This is the case with most tricycle landing gears airplanes, but this should be a concern with conventional landing gears.
3. Prior to the calibration, align the IG-500 to the aircraft coordinate frame, using the “pre-rotation XY reset”, or using a known transformation matrix.
4. Start the sbgCenter calibration tool and perform a 360° circle with the aircraft. The calibration mode has to be set on “2D Horizontal”. The aircraft should be at least 10m away from any metal building or other aircraft.

When using the 2D Horizontal calibration, the aircraft will only rely on magnetometer in steady level flight. During turns and maneuvers, the IG-500 heading will only rely on gyroscopes.

Therefore, compared to a full 3D calibration, a small heading drift may be observable when the aircraft has a significant inclination over extended periods.

Note: *For highest performance, please consider the 3D calibration.*

3.2. In flight 3D calibration

This calibration will give the best results as it allows to map the magnetic field in real 3D so that magnetometers readings are kept consistent even during turns and pitching.

In order to perform the calibration procedure, user can use the integrated sbgCenter calibration tool, or a data-logger to store the “magnetic calibration data” outputted by the IG-500 during calibration procedure.

Note: *Check the IG Devices Magnetometers Calibration Tools documentation to get more information about the use of log files for magnetometers calibration.*

3.2.1. Procedure

Once the aircraft is in steady flight at a reasonable altitude, the goal is to cover different orientations which are representative of the flight domain of the aircraft.

The calibration accuracy does not depend on any precise orientation (facing true North for example) and rather depends on how many significantly different orientations have been covered. The calibration algorithms are able to map the 3D magnetic field in orientation that have not really been covered during calibration; however, it is good to cover the full flight domain to get the best results.

For example an Extra 300 aerobatic airplane should get the best results by performing several representative aerobatic maneuvers in different directions in order to get a good 3D coverage of the magnetic field. In the other hand, a Cessna 172 private airplane could only perform high inclination eights to get optimal results.

3.3. Procedure tested on a private airplane

The following procedure has been tested with success on a piston private airplane.

The calibration starts in a steady flight. Two 360° turns will be performed decomposed in the following steps:

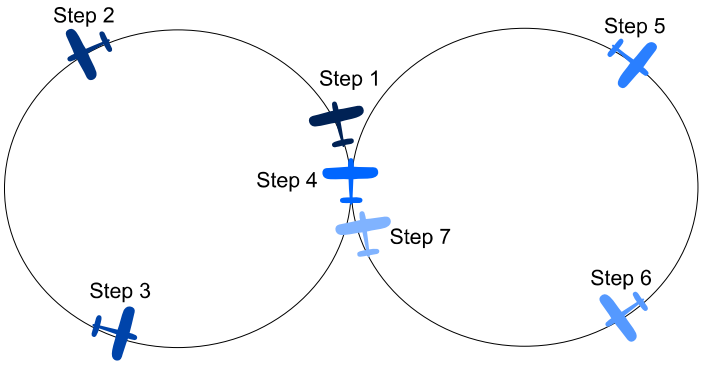

Figure 1: Trajectory performed during calibration

1. **Step 1: Calibration Start**
    1. High bank right rolling – without turning.
    2. High bank 120° left turn
2. **Step 2:**
    1. High bank right rolling – without turning.
    2. High bank 120° left turn
3. **Step 3:**
    1. High Pitching : + 20° then -20° then return to level flight
    2. High bank right rolling – without turning.
    3. High bank 120° left turn
4. **Step 4**
    1. High bank 120° right turn
5. **Step 5**
    1. High bank left rolling – without turning.
    2. High bank 120° right turn
6. **Step 6**
    1. High Pitching : + 20° then -20° then return to level flight
    2. High bank left rolling – without turning.
    3. High bank 120° right turn
7. **Step 7: Calibration end**

Once these tests are done the calibration can end. It is not crucial to perform exact 120° turns, but the procedure should perform rolling points at significantly different headings. In addition the pitching in the first should not be performed at the same heading as the one done in the second turn.

3.3.1. Calibration result examples

On the following screen-shots, it is possible to see that the calibration coverage is not a full 3D sphere but covers significantly different orientations. The first screen shows an example of the calibration procedure explained above. The second one shows a calibration only performed with a simple “8” performed.

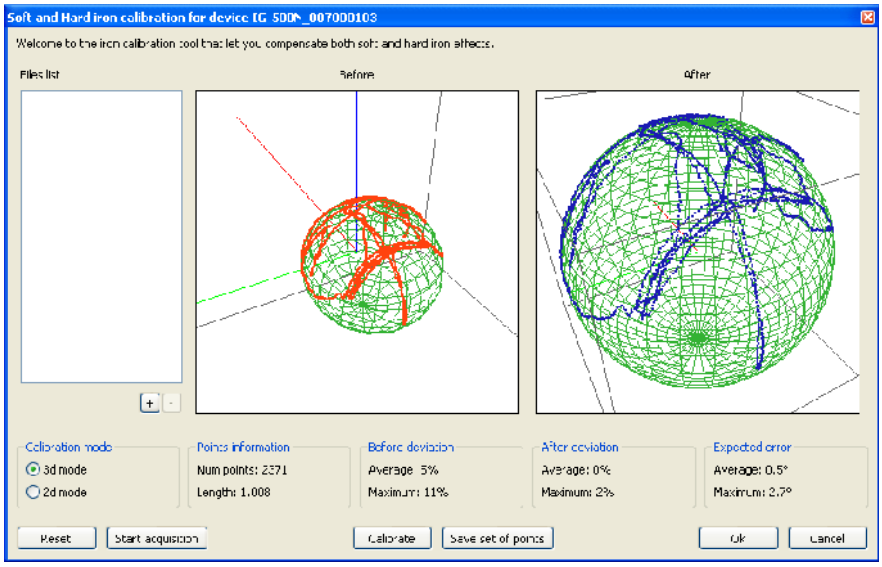

Figure 2: Calibration with the procedure described in paragraph 3.3.

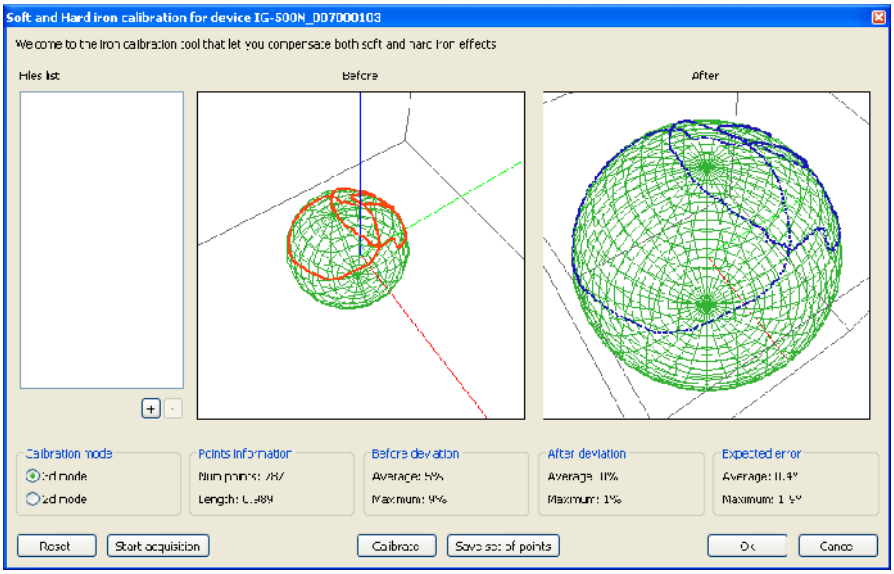

Figure 3: Calibration with only two 360° turns, describing a 8.

4. Support

If you still have some questions after reading this document, we would be glad to help you, so please feel free to contact us. Please do not forget to mention your Device ID of your IG-500 (written on your IG-500's label).

You can contact us by:

- Email : support@sbg-systems.com
- Phone : +33(0)1 80 88 45 00