# Magu Manual

Kanardia d.o.o.

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A lot of useful and recent information can be also found on the Internet. See `http://www.kanardia.eu` for more details.

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## Revision History

The following table shows the revision history of this document.

| Revision | Date | Description |
|---|---|---|
| 1.0 | June 2013 | Initial release |
| 1.1 | January 2017 | Emsis and Horis support |
| | | |

The document can be downloaded from
http://www.kanardia.eu/downloads/magu

# Contents

# 1 Introduction

First of all, we would like to thank you for purchasing our product. MAGU is electronic magnetic compass, designed especially for use in avionics.

We strongly recommend you to carefully read this manual, before you start connecting MAGU unit with your Nesis or Emsis system. The manual provides information about the installation of the MAGU unit and calibrating it for best results.

The introduction chapter contains some general information, later chapters reveal the details.

## 1.1 General Description

MAGU is an electronic device used to detect a magnetic field vector. It is especially suited for the Earth magnetic field detection and processing.

MAGU is particularly well suited for the use in the avionics, where it can serve as a simple compass, as a bank (roll) corrected compass and as a World Magnetic Model[1]. Namely, MAGU has built-in the complete World Magnetic Model (hereinafter referred to as WMM).

Two options are available, for nose or tail installation in your aircraft.

### Features

Below is the list of MAGU's main features. All features are explained in detail throughout the rest of this manual.

- Calculation of current magnetic heading.
- Calculation of bank corrected magnetic heading, when pitch and roll Euler angles are available.
- Calculation of true heading when current geographic position and time are available.
- Built-in World Magnetic Model (WMM) can be queried for declination, inclination and magnetic field values for any location on Earth.

[1] The World Magnetic Model is maintained by the National Geophysical Data Center, where we obtained the magnetic data. Please visit `www.ngdc.noaa.gov` for more details.

- Advanced calibration algorithm provides self calibration ability for removing soft and hard iron errors.
- Each unit is carefully calibrated in the factory. The results of this calibration can always be restored.
- Small size, weight and power consumption.

Please note that the output of the MAGU is effected by the input information it receives. For example, when MAGU receives the geographic location and correct time, it will output magnetic declination, inclination, true heading, etc. besides the standard magnetic heading output.

## 1.2 Technical Specification

Table 1 shows some basic technical specification of MAGU unit.

| Description | Value |
|---|---|
| Weight | 50 g |
| Electronic circut size | 65 x 75 x 25 mm |
| Processor | Cortex M3, 60 MHz |
| Sensors | Magneto-inductive, 3 separate sensors. |
| Operational voltage | 7-19 V DC |
| Power consumption | 0.25 W |
| Current | 20 mA at 12 V |
| Time from power up to first packet | $<$ 250 ms |
| Operating temperature | -30 °C to +90 °C |
| Humidity | 30 – 90 %, non condensing. |
| 3D Calibration | The calibration is done in factory. |
| 2D Calibration | Must be done by user. |
| Connector | Binder 99 0414 00 05 (cable side) |
| Communication | CAN bus, Kanardia protocol |

Table 1: Basic Technical Specifications.

# 2 Installation

Here we would like to emphasize the importance of good compass positioning.

An imprecise compass will yield to bad results, no matter how well Nesis or Emsis and MAGU devices were aligned to the reference pitch.

## 2.1 Position in Aircraft

Finding a good position for compass in aircraft is difficult.

Each aircraft has a lot of magnetic disturbances inside the aircraft and sometimes it is difficult to find a good place for the compass installation. Since compass is quickly interfered with electromagnetic fields, it is worth to put some effort in finding such spot. A simple hand-held compass can be used in search for such spot.

Search away from any parts that may contain iron or any other magnetic material (Cobalt, Nickel or ferromagnetic compounds) and, for God's sake, away from any device which contain permanent magnets (all electro-motors, servos, pumps . . . ) and away from electronic devices, which consume strong electrical current or produce electromagnetic fields.

Turn your avionics on (radios, transponders, etc.), allow electronics to warm up and start searching for a spot. When you find a candidate for such spot, check it with a hand-held compass first. Here you need to observe two things. The compass needle should not deviate, if the compass is moved around the spot and the needle should point to a direction, which is close to magnetic North direction measured outside of the aircraft. The needle should also not react (too much) to the radio transmission. So, press "push to talk" to transmit a couple of times and observe the needle. Also turn transponer transmitting on and off and the needle must not change. If you have large current consumers (like strong landing lights, stobes, etc.) turn them on and off and observe change on the needle.

## 2.2 Alignment

1. Make sure the AHRS unit in Nesis or Emsis is currently adjusted for the cruse flight position. This defines reference axes of your aircraft.

2. Make sure that compass axes are aligned with the reference axes described above.

This will ensure best pitch and roll corrections and provide good compass heading even in steep turns, climbs and descends.

# 3 Calibration

The MAGU unit (magnetic compass) is carefully calibrated in our lab. However, like any magnetic device, MAGU is affected by nearby ferrous materials as well as by local electromagnetic fields produced by other electronic devices. Earth magnetic field (which is what we want to detect) is combined with the unwanted magnetic fields produced by ferrous materials and electromagnetic devices.

The calibration process can efficiently remove a large part of the error caused by the unwanted magnetic fields, but only if such fields are not too strong. Therefore, it is of ultimate importance to install MAGU away from ferrous materials (like engine or steel rods) and away from electromagnetic devices (like speakers, radio transmitter, transponder, etc.)

Since electromagnetic devices emit their magnetic field only when they are turned on, you must turn on all electric devices before you start the compass calibration and keep them activated for the time of calibration. You should also make your aircraft as level as possible.

The calibration is done in two steps. Both steps are briefly explained first. Later, more detailed step by step procedure is given.

- The first step requires turning the aircraft for a little bit more than one full circle, about 400°. This step efficiently removes a large portion of the nonlinear error. However, some error, which is more or less constant in all directions, remains. This is called the offset error.
- In the second step, this remaining offset error is entered manually. In order to obtain the offset error, aircraft shall be directed into two or three known reference magnetic headings. Write down the differences between the reference magnetic heading and Nesis heading shown on the dialogue on figure 1. Average value of the differences, gives the final offset, which should be entered into Nesis. Note that the second step can be done much later (a few days or weeks) than the first step.

## 3.1 Calibration with Nesis

### 3.1.1 The First Step

Here are the instructions needed to perform the first step of the calibration. Please, be sure that you will be able to turn the aircraft for more than one full circle in a position, which is as close to the level flight as possible.

 

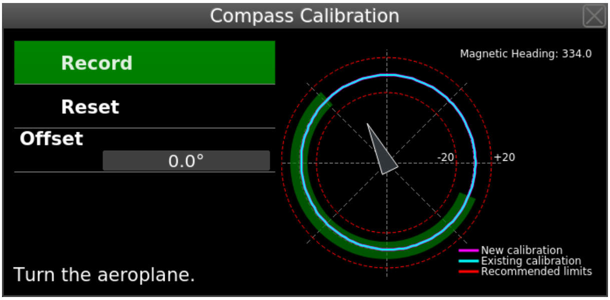


Figure 1: Compass calibration dialog - first step is in the progress.

Figure 1 shows compass calibration dialog.

1. Select the `User Options` page in Nesis.
2. Select the `Compass` icon and enter the password `314` if required.
3. Press the `Record` button and turn the aircraft for more than one full circle. Try to keep constant angular rate when turning. The recording stops automatically, when thick green line makes full circle on the Nesis screen.
4. Observe the *new calibration line*. In most situations, this line should be within the red dotted line interval. The calibration line shows magnetic compass correction calculated at given heading. These corrections can reach up to +/- 20°and in rare cases even more.
5. If you are happy with the results, close the window and Nesis will keep new calibration. Otherwise, press `Reset` button and go back to the turning step.

You must close the compass window before you continue with the second step. Closing will assure that calibration from first step becomes active and you are able to take the difference measurements needed in the second step.

### 3.1.2 The Second Step

Here we assume that the first step was completed successfully. Now, a constant offset error remains. You need to obtain this error by observing difference between known reference magnetic headings and by the headings shown on the dialogue on figure 1. This error is more or less constant regardless to the direction.

Write down this difference for a few different directions and calculate the average. Set this average into Nesis.

1. Open the Compass window and enter the password.
2. Press the `Offset` button and enter the offset.
3. Close the windows.

This completes the magnetic compass calibration.

## 3.2 Calibration with Emsis

Emsis calibration follows the same logic as Nesis calibration. It is a two step process. In order to start the procedure,

1. select the `Emsis Setup` page and then
2. select the Service item from the menu. Enter password `314` to proceed. This will open up service menu.
3. From this menu, select `Compass calibration` for the first step and `Compass offset` for the second step.

### 3.2.1 The First Step

When ready, you need to rotate the aircraft for cca 400 degrees. Direction of rotation and start azimuth are not important. When rotating, try to keep a steady pace for the best results – this will result in a constant angular velocity. When turning aircraft, the progress bar grows and the procedure is complete when it reaches full and turns to green. You have to make more than a full circle because the initial readings are not used in computation.

At this point a blue ellipse is drawn on the chart. Corrections up to 15 degrees are generally accepted as appropriate. If you constantly get correction curve larger than 15-20 degrees, then you probably need to find a better location for Magu. The correction on figure 2 reaches cca 8 degrees.

Important: If you are happy with the results, you must close the window using the check button. This will also save the results. Closing with the cross button does not save the results.

 

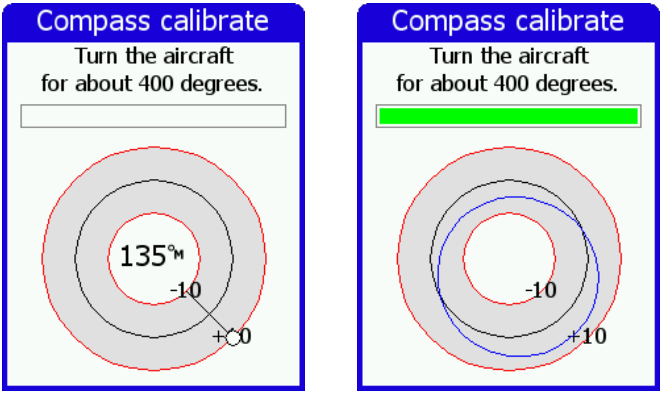


Figure 2: Emsis Magu calibration example. Left figure shows situation before and right figure shows situation when calibration is complete.

### 3.2.2 The Second Step

The procedure mentioned above removes most of the compass error and in most cases this is more than enough. However, some constant error in all direction remains. You need to obtain this error by observing difference between known reference magnetic headings and by the headings shown on the window. This error is more or less constant regardless to the direction. Write down this difference for at least a few different directions and calculate the average. Enter this final correction using the `Compass Offset` option. See figure 3.

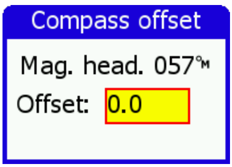


Figure 3: Compass offset window – final adjustment of compass.

When the compass readings were too large, enter negative value and vice versa.

## 3.3 Calibration with Horis

Important: Your Horis must have software version 2.15 or later. If this is not the case, Magu calibration is not possible. Please contact Kanardia for possible software update in your Horis.

Horis calibration follows the same logic, too. In fact, it is almost identical to the Emsis above.

1. Push the button and hold it to bring up the main menu.
2. Select the `Settings` item from it. This opens a new `Settings` menu.
3. Select `Compass cal.` item for the first step and `Compass off.` item for the second step.

### 3.3.1 The First Step

The window and the procedure is almost identical to the Emsis procedure. Please read the Emsis section first.

If you push the knob, while the calibration is not complete, Horis will simply close the window and reject the measurements.

However, if the procedure was complete and you got a green progress bar and blue circular diagram and you push the knob, Horis will ask you whether to save the new calibration or to reject it.

### 3.3.2 The Second Step

Again, this is practically identical to Emsis. Please refer to Emsis section for details.