

# EMSIS

## Installation and User Manual

© Kanardia d.o.o.

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Manual Revision 3.1



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## Revision History

The following table shows the revision history of this document.

Rev.	Date	Description
1.0	November 2012	Initial release
2.0	February 2013	Added Installation
2.6	May 2013	Added Maps
2.12	June 2015	Added description of functions accumulated in since v2.6
2.13, 2.14	July 2016	Bug fixes, red crosses on interactive parameters, heading indicator, Lo-Hi-NC messages
3.0	May 2020	Latex rewrite
3.1	November 2021	Figures and text updated to the latest version



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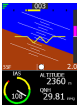
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# 1 Introduction

First of all, we would like to thank you for purchasing our product. The Emsis system is a set of complex electronics devices and we strongly recommend to carefully read this manual before installing and using the system.

Emsis is a name for a line of flight instruments which can be used as:



*primary flight display (PFD),*

*engine monitoring system (EMS).*

or both.

The introduction chapter contains some general information about the instrument and its operation. Later chapters describe Emsis use and reveal the details.

CAUTION: Emsis is not TSO approved as a flight instrument.

## 2 General Information

This chapter describes the organization of the Emsis instrument. It teaches you about the individual buttons and their meaning. After reading it, you will be familiar with basic operations.

## 2.1 Command Panel

Emsis instruments come in two physical sizes. The first one is a standard aviation size, which is 80 mm diagonal, while the second one is non-standard and is characterized with a 3.5" screen diagonal. The Emsis command panel is organized according to Figure 1. It uses six (80 mm version) or five (3.5" screen version) small push buttons to manipulate the user interface. Additionally, it has SD card slot for software, maps and data updates.

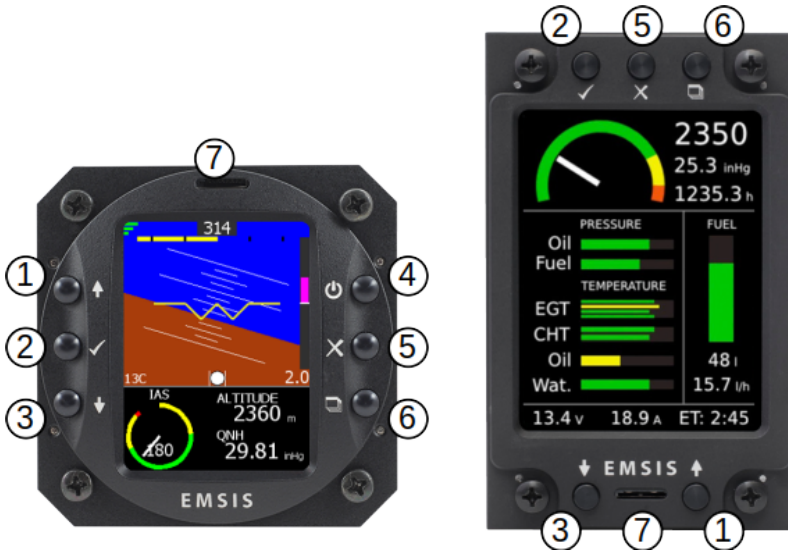


Figure 1: Organization of Emsis front panel. Emsis 80 mm version (left), Emsis 3.5" screen version (right)

Here is a brief description of individual items:

- ① The up **arrow** button is used to move the menu selection, to change a value or a letter within active control or some other screen-specific function.

- ② The **OK** button confirms selection.
- ③ The **down arrow** button does the same as the up arrow button, just in a reverse direction.
- ④ The **power ON/OFF** button is normally not used. However on some Emsis instruments, it is used to turn the instrument on/off. Note that 3.5" screen Emsis does not have the power ON/OFF button.
- ⑤ The **close** button serves as the close or cancel command.
- ⑥ The **screen selector** button is used to switch between screens.
- ⑦ **SD card slot** is used for software, maps and data updates.

## 2.2 Turning ON/OFF

Emsis is connected to the avionics power bus, therefore the instrument normally turns on as soon as the avionics is switched on and a couple of seconds later, it is ready for the operation. This is the default behaviour.

However, in some situations, the behaviour mentioned above is not suitable. In this case you can order a special version<sup>1</sup>, which can be switched on or off using the **power** button. Please note that a minor hardware modification is required. This must be done in factory.

## 2.3 Updating Emsis Software

The Emsis software is under constant development and if you want to keep the instrument up to date, you should update it regularly. This section describes actions required to update the software. The update is performed in several steps:

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<sup>1</sup> Typical use of this option is in a glider.

- Downloading new software.
- Copying new software to Emsis.
- Updating devices connected to Emsis (firmware update).

### 2.3.1 Downloading Software

The software updates are located in the **Emsis/Software** section of our web site <http://www.kanardia.eu/product/emsis>.

Download the update file and save it to a hard drive of your PC. The update file name is **Update.kus**. Never change the name of the file. The file must be copied onto the micro SD card, more precisely into the base (root) folder of the card. Once the file was copied, please make sure to use *safely remove* option on the PC, before you remove the card from PC.

Emsis software versions 2.4 and earlier support only micro SD cards with the capacity of 2GB or less. Later versions also recognise HDSD cards with a higher capacity (up to 32 GB).

Please make sure that SD card is formatted as *FAT 32* or *FAT 16* file system. Other file systems will not be recognised by Emsis.

### 2.3.2 Copying New Software to Emsis

To copy the software from the SD card to Emsis follow these steps:

1. Insert SD card with the new software (**Update.kus**) into Emsis SD card slot. The contacts on the card must face upward.
2. On Emsis 80, push and hold the **down** arrow (on Emsis 3.5", push and hold the **up** arrow) and turn Emsis ON. A window similar to Figure 2 appears.

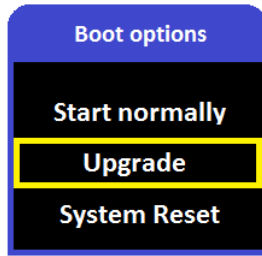


Figure 2: Boot options window

3. Use the **up** and **down** button to select the *Upgrade* option and press the **OK** button. Update process begins. Emsis tries to detect the *Update.kus* file on the SD card and if it is found, the update progress window will be displayed. In the first step, the file integrity is verified and in the second step the file is copied into Emsis.
4. Once finished, Emsis will start with the new software. The very first start after the update takes slightly longer.

The *Start normally* option is used if you changed your mind and you do not want to update the instrument, while the *System Reset* option is used only in emergency and should never be used in normal operation. This option asks for special password in order to protect it from accidental use.

### 2.3.3 Firmware Update

The procedure from previous section copied new software to Emsis and it has also made a partial update, but it did not change firmware in AD-AHRS-GPS module, Daqu or any other devices that may be connected to Emsis.

In order to sync firmware with Emsis software, follow the next steps:

1. Use **screen selector** to switch to the Emsis *Setup screen*.
2. Select the **Service** option. Enter *314* for the password.
3. Select the **Firmware update** option from the list. This will start the automatic firmware update procedure. It will update firmware in detected devices one by one. The procedure may take a few minutes.
4. Once finished, close all windows.

## 2.4 Installing New Layout

Emsis screen can be configured in many different ways, depending on the engine, other connected devices, specific sensors, etc. The engine limits and screen organization are stored in a layout file. Layouts are prepared by Kanardia and sent to users when requested.

Follow the steps below in order to copy a new layout to Emsis.

1. A layout file is usually sent by e-mail to the user. Copy the file to the micro SD card. Do not open or change the file on the PC.
2. Make sure to use the **Safe remove** option on PC before removing the card from PC.
3. Insert the card into Emsis and change to the **Emsis Setup** screen.
4. Select **Service** and enter *314* password.
5. From the list of items, select the **Import layout**.
6. This will list layouts/configurations found on the card. Select the one you need, then press the **OK** button. This will copy the layout from SD card and activate it.

7. Close all windows. Emsis will reboot with the new layout active.

## 2.5 Technical Specifications

Tables 1 and 2 illustrate some general instrument specifications for each instrument size.

## 2.6 CAN Bus

The Emsis system can be easily extended into a much more complex form, shown in Figure 3. We achieved this by introducing CAN bus for the communication between the units. The CAN bus does the magic of the all possible known and unknown future extensions.

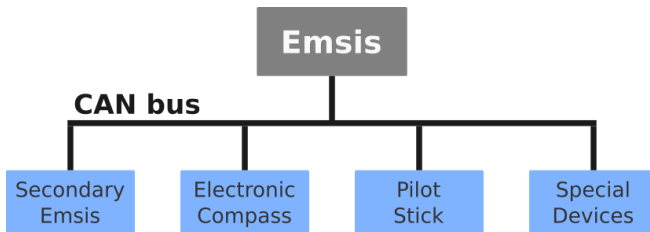


Figure 3: Illustration of Emsis configuration using CAN bus

Imagine the CAN bus as a kind of computer network. Just like new computers can be easily connected to the network, we connect all new devices to CAN. This allows introduction of secondary Emsis unit, electronic compass (Magu), pilot command stick, etc.

Description	Value
Weight	80 PFD: 298 g 80 EMS: 230 g
Size	80 PFD: 82 x 82 x 65 mm 80 EMS: 82 x 82 x 45 mm
Operational voltage	6 V to 32 V
Current	150 mA (PFD) or 140 mA (EMS) at 12 V 85 mA at 24 V
Operating temperature	-30 ~ +85 °C
Humidity	30 ~ 90 %, non condensing
Panel hole	80 mm (3.15 inch) diameter, standard fit
Altitude range	-500 m to 16000 m (-1600 to 52000 feet)
Acceleration	16 bit, 3D, dynamic range 0 to 16 g, typical resolution 0.12 mg
Angular rate	16 bit, 3D, 250°/s, resolution 0.009°/s
Barometric sensor	24 bit, 10 to 1200 hPa, 20 cm resolution
Airspeed sensor	12 bit, 0 to 69 hPa, 381 km/h, 205 kt resolution < 0.1 km/h
(units before Oct 19)	0 to 50 hPa, 325 km/h, 175 kt
GPS	10 Hz, 66 channel, hot start 1 s, cold 35 s, sensitivity -165 dBm
OAT	12 bit, range -55°C to 125°C, 0.5°C accuracy
QNH range	590 hPa to 1080 hPa (17.42 to 31.89 inHg)
Communication	CAN bus, 29 bit header, 500 kbit, Kanardia protocol
Display	240 x 320 pix, 2.7", 24 bit, full colour, super bright

Table 1: Basic technical specifications for the 80 mm Emsis.

Description	Value
Weight	3.5 PFD: 312 g 3.5 EMS: 235 g
Size	3.5 PFD: 112 x 69 x 65 mm 3.5 EMS: 112 x 69 x 45 mm
Operational voltage	6 V to 32 V
Current	170 mA (PFD) or 130 mA (EMS) at 12 V 85 mA at 24 V
Operating temperature	-30 ~ +85 °C
Humidity	30 ~ 90 %, non condensing
Panel hole	3.5 PFD: custom fit; see 3.5 cutout scheme
Altitude range	-500 m to 16000 m (-1600 to 52000 feet)
Acceleration	16 bit, 3D, dynamic range 0 to 16 g, typical resolution 0.12 mg
Angular rate	16 bit, 3D, 250°/s, resolution 0.009°/s
Barometric sensor	24 bit, 10 to 1200 hPa, 20 cm resolution
Airspeed sensor	12 bit, 0 to 69 hPa, 381 km/h, 205 kt resolution < 0.1 km/h
(units before Oct 19)	0 to 50 hPa, 325 km/h, 175 kt
GPS	10 Hz, 66 channel, hot start 1 s, cold 35 s, sensitivity -165 dBm
OAT	12 bit, range -55°C to 125°C, 0.5°C accuracy
QNH range	590 to 1080 hPa (17.42 to 31.89 inHg)
Communication	CAN bus, 29 bit header, 500 kbit, Kanardia protocol
Display	240 x 320 pix, 3.5", 24 bit, full colour, super bright

Table 2: Basic technical specifications for the 3.5" Emsis.

### 3 Emsis PFD

Emsis PFD (Primary flight display) consists of electronic units which work closely together to bring flight information onto graphical display. The system consists of the following electronic components:



- Airu (AD-AHRS and GPS unit) – hereinafter referred to as AHRS unit – is an inertial navigation unit aided by the GPS and pressure sensors. AHRS provides attitude, position and velocities. AHRS unit is hidden inside Emsis PFD unit.
- Emsis unit – presents all relevant information that appears on the CAN bus in a pilot friendly form on LCD screen. Most of this manual describes how to access, read and interact with the Emsis display.

Emsis PFD unit uses state of the art MEMS<sup>2</sup> sensors to read various physical quantities. Since all sensors are solid state, it has no moving parts. This means it has fewer problems with fatigue and ageing. The following MEMS sensors are used in the Emsis PFD system:

- The angular rate sensors, also known as gyros, are used in the attitude calculation. The angular rates are integrated in time in order to predict new attitude from the old one. We could say that they give short-time attitude prediction. They are also used in gravity vector calculation.
- The acceleration sensors are measuring apparent gravity vector. The true gravity vector is calculated assuming coordinated flight and readings from the other sensors (velocity and angular rate sensors). The ball slip indicator is directly obtained from the acceleration sensors.

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<sup>2</sup> MEMS - micro-electromechanical systems, a.k.a micro machines, a.k.a micro systems technology.

- The absolute pressure sensor is used to calculate altitude and vertical velocity (vario).
- The differential pressure sensor provides indicated airspeed - IAS. When it is coupled with the outside air temperature - OAT sensor, it also calculates true air speed - TAS.

Assuming coordinated flight, we calculate the referencing attitude from the gravity vector and heading. These values are then compared with the short-term prediction of the attitude. Non-linear Kalman filters are used to combine the short-term prediction and referencing attitude solution into one most probable solution. This is what you see on the attitude indicator.

In a very similar way, short-term inertial position prediction is compared with the GPS position. Again, Kalman filtering is used to obtain the final solution.



When engine monitoring unit (Daqu) is present on CAN bus, Emsis PFD can also show relevant engine and fuel information.



When maps are enabled and licensed, Emsis PFD can also show raster maps on graphical display. Further chapters reveal the details.

## 4 Emsis EMS



Emsis EMS (Engine monitoring system) consists of electronic units which work closely together to bring engine and fuel information onto graphical display. The system is presented in Figure 4. The system consists of the following electronic components:

- Engine monitoring unit (Daqu) is used to connect the engine, fuel and electric sensors.

- Emsis EMS unit presents all relevant information that appears on the CAN bus in a pilot friendly form on LCD screen. Most of this manual describes how to access, read and interact with the Emsis display.

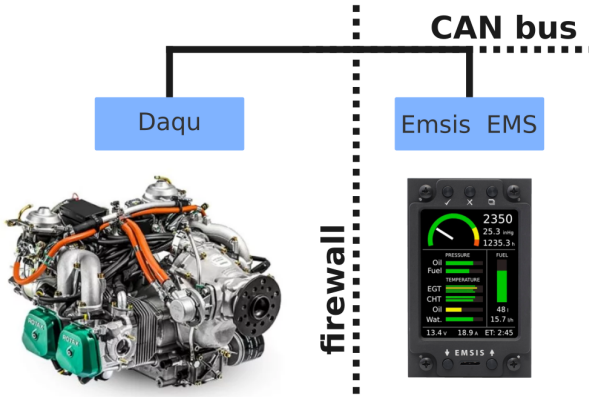


Figure 4: Illustration of Emsis EMS configuration

When AHRS unit is present on CAN bus, Emsis EMS can also show flight information on graphical display, too.

When maps are enabled and licensed and AHRS unit is present on CAN bus, Emsis EMS can also show raster maps on graphical display. Further chapters reveal the details.



## 4.1 Engine Sensors

Engine related sensors are connected to the engine monitoring unit Daqu. Daqu is designed to be installed on the engine side of the firewall. This has two advantages:

- Since the unit is close to the engine all cables are short and no extensions are needed. This means less weight and makes installation simpler.
- We need only one tiny hole through the firewall for the CAN bus cable. The cable transfers all the information and provides the power supply for Daqu unit.

Daqu unit is designed to monitor engine sensors for various engines such as Rotax, Rotax iS, D-motor, Jabiru, UL-Power, Lycoming, Continental, Simonini, Hirth etc.

When an engine is equipped with proper sensors, it can measure engine RPM, cylinder head temperature (CHT), exhaust gas temperature (EGT), oil pressure, oil temperature, fuel pressure, fuel flow, fuel level, manifold pressure, carburettor air temperature, voltage, battery current, alternator current, coolant temperature and more. We often add new functions on request of our customers (E.g. lambda, oil flow, etc.). In the case of gyroplane or helicopter installation, it also reads the rotor RPM sensor and sometimes pneumatic pressures.

The results of all these measurements are then transmitted on the CAN bus, where all other units are able to access them.

More about Daqu unit and engine sensors is written in *Daqu Installation Manual*.

## 5 Screens

The Emsis unit can toggle between several main screens depending on your Emsis type:

- *Primary flight display (PFD) screen* – artificial horizon with air data.

- *Engine monitoring (EMS) screen* – relevant engine and fuel information, more than one screen is also possible.
- *Maps screen* – graphical display of raster maps.
- *Emsis setup* – used to configure settings and options.

Toggle between screens by pressing the **screen selector** button.

## In Flight Interaction

During flight, the following interactions are accessible from the main screens (excluding *Setup* screen):

- Pushing and holding the **up** (on 80mm) or **down** (on 3.5") button sets current pitch, see Figure 5. It will take the current pitch and set it as zero pitch. The change is not immediate and it takes ca. 5 seconds for AHRS unit to accept it. Once Emsis is switched off, this setting is forgotten.

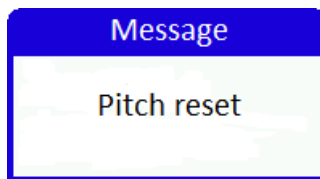


Figure 5: Setting pitch

- **Up** and **down** buttons modify either brightness or QNH, depending on system settings (see 5.4.10).
- Long pressing the **screen selector** button (see Figure 1, button 6) opens the *fuel quantity* window. This window is accessible only when no fuel level sensors are connected and thus a software fuel tank is provided.

## 5.1 Primary Flight Display Screen



The Primary flight display (PFD) screen is illustrated in Figure 6. It displays artificial horizon with flight data information.

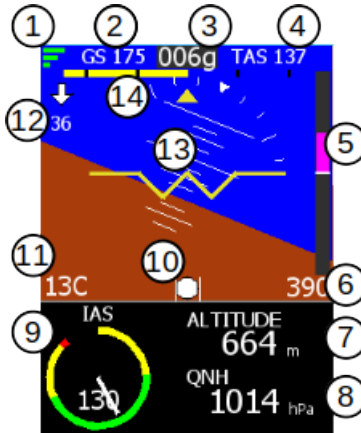


Figure 6: Emsis primary flight display screen

PFD screen consists of the following items:

- ① Quality of the GPS fix. Three green bars mean 3D fix, two yellow bars are 2D fix and cross means no signal from GPS.
- ② Ground speed from GPS.
- ③ Direction. It can be GPS track (active only when ground speed is over 20 km/h). In this case you will see “g” extension. When Magu (magnetic compass) is present, then it will show true heading with the “t” extension.
- ④ True air speed.
- ⑤ Vertical speed indicator (vario) scale.

- ⑥ Vario label displays current value of the vertical speed.
- ⑦ Baro corrected altitude value.
- ⑧ Current QNH setting (baro-correction).
- ⑨ Indicated airspeed (IAS).
- ⑩ The inclinometer (slip-skid) indicator.
- ⑪ Outside air temperature (OAT).
- ⑫ Wind indication. Arrow shows relative direction regarding to the flight line. Below it you see windspeed. Magnetic compass (Magu) is required to see these values.
- ⑬ Artificial horizon with roll and pitch indications.
- ⑭ Turning rate scale. Inner points indicate one minute turn (6 degrees per second) while outer points indicate 30 seconds turn (12 degrees per second).

## 5.2 Engine Monitoring Screen

An example of engine monitoring screen is illustrated in Figure 7. It can be designed differently for each Emsis unit regarding to the wishes of the customer. Additionally, more than one EMS screen can be configured.

EMS screen from Figure 7 shows the following items:

- ① Engine RPM indicator.
- ② Airbox temperature.
- ③ Manifold pressure.



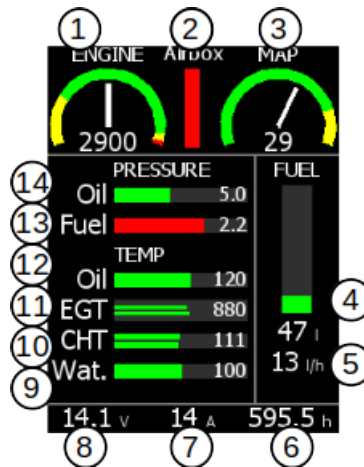


Figure 7: Emsis engine monitoring screen

- ④ Fuel level with the numeric indication.
- ⑤ Fuel consumption (fuel flow).
- ⑥ Engine total time.
- ⑦ Ampere meter (electrical current meter).
- ⑧ System voltage.
- ⑨ Water temperature.
- ⑩ CHT with two sensors and the largest value of both.
- ⑪ EGT with several sensors and the largest value of them all.
- ⑫ Oil temperature.
- ⑬ Fuel pressure.
- ⑭ Oil pressure.

This is just a subset of options. Emsis can also display: rotor RPM, pneumatic pressure, trim positions, gearbox temperature, carburetor temperature and much more. Additionally, the engine parameters can be mixed with flight parameters. So, you can see the altitude, airspeed, QNH, etc. as well.

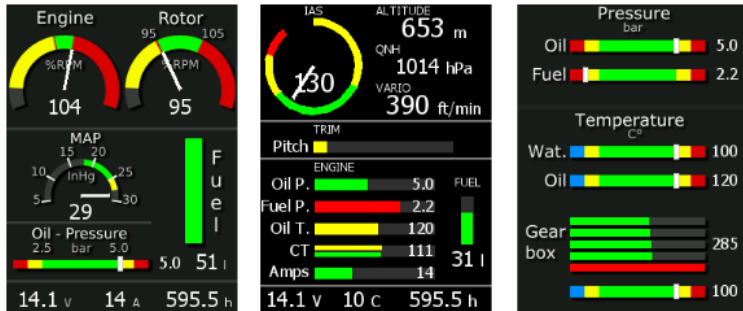


Figure 8: Examples of Emsis engine monitoring screens

Special values:

- If you see red cross over some parameter, it means that this parameter does not receive data from the CAN bus. This usually means that parameter is not configured properly.
- Text “LO” means that sensor has reached its low measuring point.
- Text “HI” means that sensor has reached its high measuring point.
- Text “N/C” stands for “not connected” - the system gets no reading from the sensor.

### 5.3 Maps Screen



The Maps screen is illustrated in Figure 9. Maps can be shown on Emsis only if GPS information is present on the CAN bus. Emsis PFD supports this by default, while other versions depend on units that are connected to the CAN bus (Nesis, some other Emsis PFD, Horis, etc.).

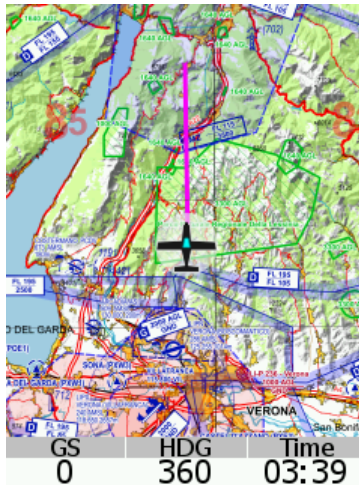


Figure 9: Emsis maps screen

Maps are not enabled by default. This option must be purchased, preferably at the time of the order. However, this can be done later as well.

Emsis can show raster maps, which must be copied to its internal memory first. Currently we have limited raster maps support. In future more countries will be supported. Please visit our web site for more details.

### 5.3.1 Zoom Level

Emsis unit keeps updating several different moving map zoom levels. These levels are seamlessly computed in the background and are immediately available. The only exception is at the start-up, when Emsis unit needs some time to prepare the initial maps. Zoom levels are changed with **up** and **down** buttons.

### 5.3.2 Activation

If you purchased the map option after the instrument was delivered, you need to activate this option manually. In this case you need to obtain the activation password from Kanardia. The procedure is as follows:

- Write down the serial number of your Emsis. The serial number is displayed in the *Setup | About* window.
- Email this serial number to Kanardia or to our representative.
- We will calculate the activation password and email it back to you either directly or over the representative.
- Enter the password using the *Setup* screen, *Maps | Enable Maps* window. The password usually consists of digits and letters. Emsis does not distinguish between uppercase or lowercase.
- Emsis restarts and the *Map* screen appears. The activation is stored on the chip and is valid for the lifetime of the instrument.

### 5.3.3 Copying

In order to copy a new map to Emsis, you need to obtain this map from our web site. Copy this map to the micro SD card that you

received with the instrument. (You may use other micro SD cards as well.) Do not put the maps into any folders. It is very important that you use *safely remove* option on your PC before you remove the card from it. Once you have a map on the micro SD card, do the following:

- Insert the SD card into Emsis with the contacts facing up.
- Select the *Setup* screen, *Maps | Copy Maps* option.
- If asked, enter standard password 314.
- A list of the maps on the SD card appears. Select a map you want to copy and press the OK button.
- Copy procedure commences. Copying is very slow in Emsis. A large file may take a few hours to copy. Please make sure the batteries are full before you begin. Copying is finished when the red progress bar turns into green. Please note that it may take some time before the progress bar appears.

Some proprietary maps require a special license file for the final activation. The same copy principle is used for them, too. Figure 10 shows an example of map copying.

#### 5.3.4 Deleting

It is wise to remove unused maps from the system. This speeds up initial map loading procedure.

- Select the *Setup* screen and choose *Maps | Delete Maps* option.
- A list of maps appears. Select the map you want to delete and press the OK button.

This removes the map from internal memory.

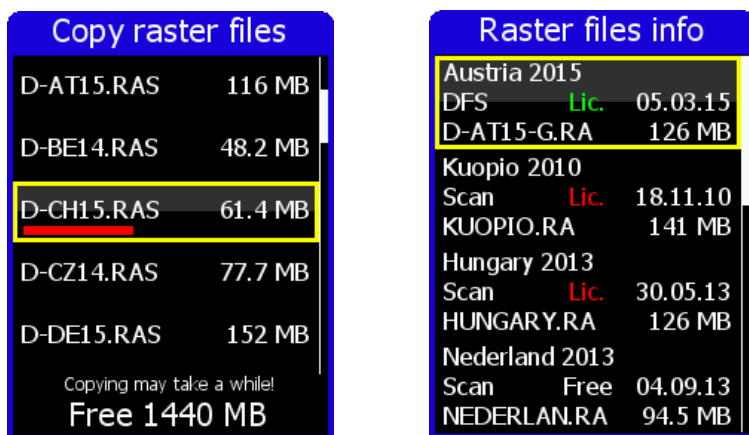


Figure 10: Copying maps (left) and maps info window (right)

### 5.3.5 Information

In order to see which maps are loaded into Emsis internal memory, select the *Setup* screen, *Maps | Maps Info* option. A list of maps appears. If you have a lot of maps loaded, there may be a delay.

The list also shows if map is accessible or not. Maps with a red “*Lic.*” text, are loaded, but not accessible – they are missing a valid license file. Figure 10 shows a valid DFS map of Austria and a loaded but invalid map of Hungary, for example.

### 5.3.6 Settings

The *Maps* screen can be additionally configured to show some navigational information at the top and/or the bottom of the screen. One top line and two bottom lines can be configured with the following items: IAS, TAS, GS, altitude, tracking, time, UTC, RPM, Rotor RPM.

## 5.4 Emsis Setup Screen

The *Emsis Setup screen* allows you to access or set several options. It is accessed by pushing the **screen selector** button. Figure 11 illustrates the screen. The displayed options depend on the hardware detected on the CAN bus. Thus, Emsis EMS version does not show the same options as Emsis PFD version.

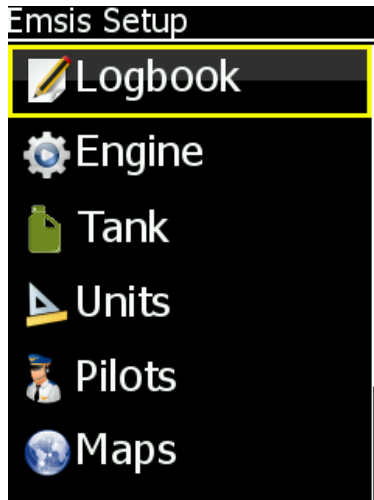


Figure 11: The Emsis setup screen. Not all options are visible.

The following options are available:

- *Logbook* – is used to access the logbook entries.
- *Engine* – configures the engine related settings and sensors connected to the engine monitoring unit (Daqu).<sup>3</sup> EMS unit only.
- *Tank* – opens menu for the fuel level measuring hardware and for the fuel tank shape calibration<sup>3</sup> or shows the software tank quantity, if the sensors are not present. EMS unit only.

---

<sup>3</sup> Engine monitoring unit (Daqu) is required.

- *Airspeed* – is used to define IAS speed limits. PFD unit only. When airspeeds were explicatively defined in a configuration file, this option is not shown even in PFD case.
- *Units* – is used to change the units of individual parameter groups.
- *Pilots* – is used to enter pilots. The pilot names are used in logbook. PFD unit only.
- *Maps* – is used to perform various activities with the maps. PFD unit only.
- *Service* – is a gateway to the service specific settings.
- *About* – displays information about software and hardware version.

Some user options are not shown on secondary Emsis, some options require password entry before proceeding and some options are available only when correct hardware is detected.

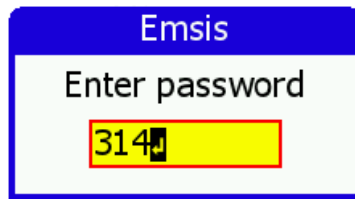


Figure 12: Emsis password is required in order to access certain options

The factory password is 314, first three most significant digits of number  $\pi$  as seen in Figure 12. The password was introduced in order to prevent unwanted accidental alterations of important settings. The password cannot be changed.

### 5.4.1 Logbook

The logbook window allows you to get some information about your flights. The logbook view differs between PFD and EMS mode.



**PFD Mode** The logbook window lists recent flights in reverse order (last flight is listed first). Date, pilot, takeoff time, landing time and duration are shown on each item. Selecting an item and pressing the OK button, gives further options:

- *More info* – open a new window with even more details about the selected flight. Use **up** & **down** buttons to scroll the details window.
- *Copy flight* – creates a file on the external SD card in the KML format. This format can be viewed in Google Earth, for example. It will show you the flight path with the altitude.
- *Copy details* – creates a special log file, where entries are separated by tabulator character. Each row in a such file represents one second of flight. Almost all flight and engine parameters are included in the file. This file can be then imported to Excel or Calc or some other spreadsheet application for further analysis.



**EMS Mode** The EMS mode also provides some limited logbook functions. In this case most recent engine runs (engine start, engine stop pairs) are listed. All are based on the engine total time. Selecting one of the listed items and pressing the OK button, performs the *Copy TAB action* – a special log file is created on the external SD card.

### 5.4.2 Engine

The Engine menu from the *Setup* screen gives three options: engine type selection, switch function and sensor configuration.

**Engine Type** Depending on specifications of your aircraft, select the correct engine. Figure 13 shows the engine selection window. Setting the engine type allows Emsis to calculate fuel consumption and has no other effect on the instrument.

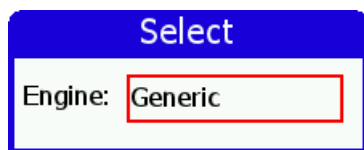


Figure 13: Engine type selection window

Available engines are:

- Generic
- Rotax 912 80 – four stroke 80 HP Rotax engine.
- Rotax 912 100 – four stroke 100 HP Rotax engine.
- Rotax 912 iS – iS or iS Sport.
- Rotax 915 iS
- Rotax 914 – 115 HP turbocharged version of Rotax engine.
- Rotax 912 80A – an alternative model for four stroke 80 HP Rotax engine.
- Rotax 912 100A – an alternative model for four stroke 100 HP Rotax engine.

- Rotax 582 65 – two stroke 65 HP Rotax engine.
- Jabiru 2200 – four cylinder Jabiru engine.
- Jabiru 3300 – six cylinder Jabiru engine.
- Geiger Wankel
- MW Fly + CC-m
- ULPower RS-232
- ULPower CAN 125kb
- ULPower CAN 500kb

**Switch Function** Switch function settings are used when configuring `miniDaqu` unit. Read more about this option in our MiniDaqu Manual.

**Sensors** The sensor menu is used to configure channels on Daqu. For each channel we define its function, sensor type and some specific parameters. Sensor channels are illustrated in Figure 14.

- Through function we define what this channel is meant for: e.g: Engine RPM, Fuel flow, Oil pressure, EGT, etc.
- By sensor type we tell which sensor is connected to that channel. Close to 100 different sensors are supported by Daqu and this number is still growing.
- By “specific parameters” we mean some general or some sensor/channel specific arguments that must also be provided.

Sensors		
Z01	Engine RPM	
	Rotax	F=600ms
Z02	Not used	
	None	F=500ms
Z03	Rotor RPM	
	Linear 5V	F=600ms
A01	CHT 1	
	VDO 150C	F=1000ms
A02	CHT 2	
	VDO 150C	F=1000ms

Figure 14: List of sensors connected to Daqu unit

Each row in the table corresponds to one Daqu channel. Channels are labelled as combination of one capital letter and one number. Letters define the channel type, while numbers enumerate channels of each type.

The following channel types are used in Daqu:

- A: analog channels with  $-2.5\text{ V}$  to  $+2.5\text{ V}$  input, which are typically used to connect resistive sensors and thermocouples.
- B: analog channels with  $0$  to  $+5\text{ V}$  input, used to read active sensors. Active sensors require power in order to operate properly.
- C: analog channel with  $0$  to  $+30\text{ V}$  input, used to read higher voltage levels.

- D: Same as B, but it also allow you to connect sensors that generate 4-20 mA current loop (one typical sensor is Rotax oil pressure sensor).
- E: Same as B, but it also allows measuring resistance with stronger current generator. It is typically used for fuel level probes.).
- Z: digital channel for engine RPM. It measures time between pulses. Z channel has special “normalizing” electronics, which is capable to measure signals from a wide voltage range. (Rotax 100-200 V range and Jabuiru 0.5V range.
- Y: digital channels, used to measure time between pulses. Pulses are expected to have a proper shape.

Please refer to Daqu Manual for more details.

After sensors are connected to the Daqu unit, each sensor needs to be configured. Select each channel from the list by using **up** and **down** buttons and confirm selection by pushing the **OK** button. Window illustrated in Figure 15 opens.

To change the specifications, follow the next procedure:

1. with **up** and **down** buttons select item you want to change and press the **OK** button,
2. select the value using **up** and **down** buttons and press the **OK** button to confirm,
3. press the **close** button to close the window, changes are saved automatically.

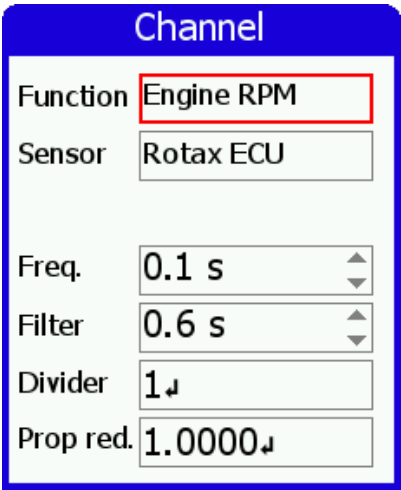


Figure 15: Window for setting a sensor on Daqu channel

5.4.3 Min/Max Values

Certain sensors require min/max values (trim sensors, position indication sensors, flap sensors). In this case you have to tell Emsis the sensor reading at minimum position and the reading at maximum position.

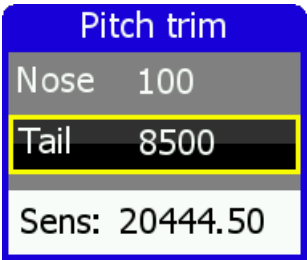


Figure 16: Position sensor min/max window

In order to show the Min/Max dialog on the screen, select the channel

and press and hold the **OK** button (long press). Figure 16 shows an example for pitch trim position sensor.

#### 5.4.4 Tank

Please refer to section 7 starting on page 59 for more details.

#### 5.4.5 Brightness

The brightness option is visible only when default action for **up** & **down** buttons is set to QNH. This is typical for Emsis PFD. Select the option and use **up** & **down** buttons to adjust the brightness. Note that Emsis always starts with maximal brightness.

#### 5.4.6 Airspeed



The Airspeed configuration is accessible by selecting the Airspeed option<sup>4</sup> from the *Setup* screen. A window illustrated in Figure 17 opens.

Changes can be made for five scale limits as seen in Figure 18:

1. *Low* – is the beginning of the scale. The scale shows nothing until the aircraft exceeds this speed limit – only numerical value is seen.
2. *Yellow 1* – to this limit the range is yellow. Yellow1 range is optional.
3. *Green* – the maximum value for the green range. Green range is the normal range of the operating speeds for the aircraft.

---

<sup>4</sup> Not available for all layouts. Some layouts have predetermined speed ranges.

Airspeed	
Low	0
Yellow 1	40
Green	40
Yellow 2	50
Red	100

Figure 17: Airspeed configuration window

4. *Yellow 2* – to this limit the range is yellow. The second yellow range is the range, in which the aircraft may be operated in smooth air, and then only with caution to avoid abrupt control movement.
5. *Red* – to this limit the range is red – also the end of the scale. Beginning of the red range indicates the maximum demonstrated safe airspeed that aircraft must not exceed under any circumstances (VNE).

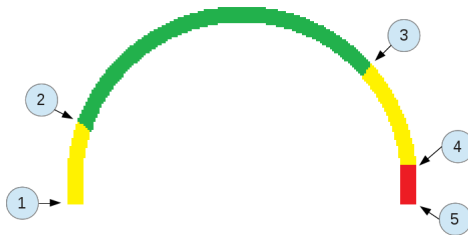


Figure 18: Example of an airspeed scale

### 5.4.7 Units

Units configuration is accessible by selecting the Units option from the *Setup* screen. A window illustrated in Figure 19 opens.



Units	
Distance	sm
Speed	kts
Vario	ft/min
Altitude	meter
QNH	inHg
Mass	kg

Figure 19: List of configurable units in Emsis unit

Emsis uses several units for different physical quantities like distance, velocity, mass, volume, etc. Table 3 shows available units.

### 5.4.8 Pilots



The Emsis PFD version allows you to enter several pilots who typically fly the aircraft. You can create a new pilot, edit an existing one or remove one.

Each pilot has a name and optional instructor rating. A pilot, who is also an instructor can have two roles. It can be either a normal pilot, when flying as PIC or an instructor, when flying in this role.

On startup, you will be asked to select the pilot and instructor for the flight, if for each role, at least one person is found from previous pilot entries.)

Physical quantity	Available units
Latitude/Longitude format	D° MM' SS", D° MM.MM
Directions	True, Magnetic
UTC Difference	Difference between local time and UTC
Distance (length)	nm, sm, km
Speed (velocity)	km/h, kts, mph
Vario (vertical velocity)	m/s, ft/min, kts
Wind speed	km/h, kts, mph
Altitude (length)	meter, feet
QNH (pressure)	hPa, inHg
Mass	kg, lbs
Temperature	C, F
Pressure (used in engine)	bar, psi
Volume	l, US gal
Flow	l/h, gal/h
RPM	RPM, percentage

Table 3: Available units for individual physical quantity

This information is then used in logbook.

### 5.4.9 Maps

Please refer to section 5.3.

### 5.4.10 Service

The Service menu opens a window illustrated in Figure 20. It always asks for password. You have to enter standard password 314.

There are many options displayed here. Some of them depend on the hardware, which is present on the CAN bus:

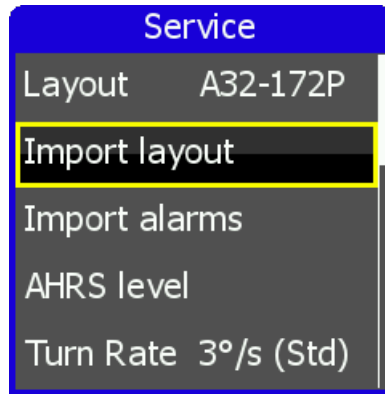


Figure 20: Emsis Service menu

- *Layout* - Allows you to change the configuration layout. Normally, you do not need to change this.
- *Import layout* - This option lists all layouts available on the SD card. By selecting a layout, it will be copied from the SD to Emsis. To activate this layout, select it in the *Layout* menu option.
- *Import alarms* - This option lists all alarms available on the SD card. By selecting an alarm, it will be copied from the SD to Emsis and activated by default.
- *AHRS level* - Used to define the “zero” for the AHRS.
- *Turn Rate* - Sets turn rate sensitivity.
- *Compass calibration* - Used to calibrate the Magu (magnetic compass).
- *Compass offset* - Used to make fine adjustment of Magu.
- *Dir. source* - Sets the source for the direction indicator.

- *Firmware update* - Used to update the software in Daqu, Airu, Magu.
- *RamBoot update* - Used to update the initial boot software.
- *Logger settings* - Used to define some logger settings.
- *Prop. pitch settings* - Defines minimum and maximum angles for propeller pitch.
- *Up/Down* - Used to define default behaviour of up/down buttons.
- *Set alt & IAS offset* - Used to adjust the zero for the altitude and airspeed sensors.
- *Set FF factor* - Defines fuel flow factor for software tank configurations.
- *Reset DAQU channels* - Resets the current Daqu configuration. All channel settings will be deleted immediately (without any confirmation prompt), so use this option carefully.
- *Ask for fuel* - Toggles fuel level prompt on startup for software tank configurations.

Some of the service options are described in further detail below:

**Layout** In most cases the correct layout is set in the factory and you do not need to change it unless we advise you to do so. Figure 21 shows a window for selecting a layout.

When dialogue is opened:

- use **up** and **down** buttons to change layout and confirm with the OK button,

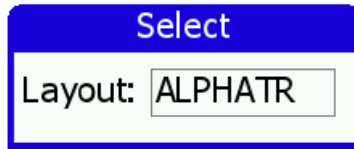


Figure 21: Window for setting Emsis layout

- push the `close` button to save and exit the window. Emsis will restart.



**AHRS Level** During the assembly of the AHRS unit into the Emsis unit and during the installation of the Emsis unit into the instrument panel, a small misalignment may appear. This means that internal axes of the AHRS unit are not parallel to the airplane axes – the AHRS unit is slightly rotated. Such misalignment can be perfectly adjusted without loss of precision using the procedure described next.

Please make sure that airplane is level for both, roll and pitch. Make also sure that Emsis unit is turned ON for at least five minutes – this warms up the internal electronics and stabilizes numerical filters.

Once the airplane is level and steady, select the AHRS level option to start the automatic calibration procedure. Window illustrated in Figure 22 opens.

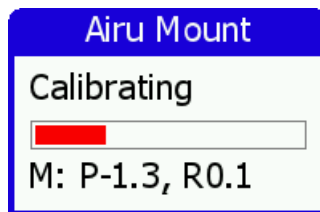


Figure 22: Calibrating the AHRS level

Wait for the progress bar to finish and observe the roll and pitch numerical values. At the end they should be close to zero. Close the window. This also stores new values.

**Compass Calibration** This option is available only when Magu (electronic magnetic compass) is also present on the CAN bus. Before you do the calibration, you need to finish the AHRS calibration. Compass and AHRS work in pair and information from AHRS greatly increases the precision of compass. Please, also make sure that the system is running at least for 15 minutes. This time is required to warm up the electronic and stabilize the numerical filters.

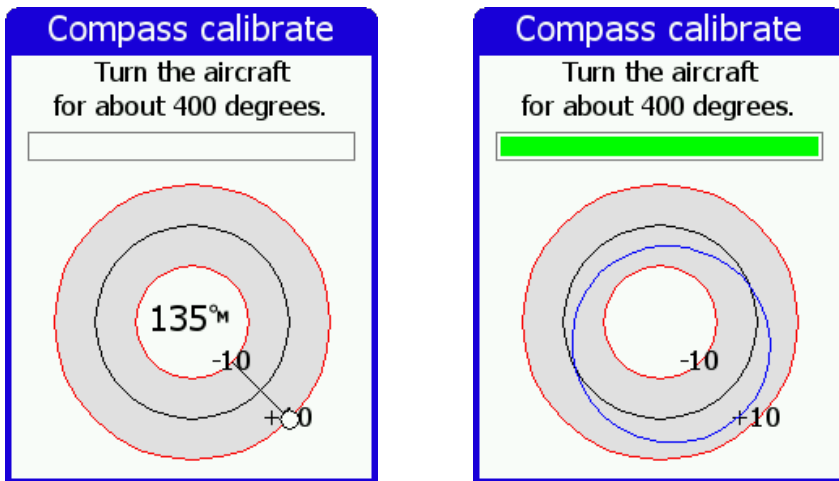


Figure 23: Calibrating Magu, situation before rotating (left) and after full rotation (right)

When ready, you need to rotate the aircraft for ca. 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. 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 in Figure 23 reaches ca. 8 degrees.

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



**Compass Offset** 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 a few different directions and calculate the average. Enter this final correction using the *Compass Offset* option. When the compass readings were too large, enter negative value and vice versa.

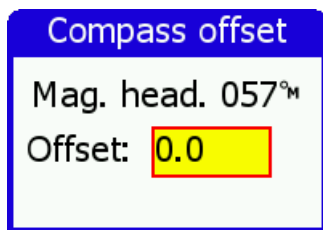


Figure 24: Compass offset window - final adjustment of compass

**Firmware Update** This command updates the software of devices present on the CAN bus: AD-AHRS module (Airu), EMS module (Daqu), compass module (Magu), etc. Do not use this function unless we advise you to do so.

**RamBoot Update** This command updates the startup software, which takes care for the instrument start. Do not use this function unless we advise you to do so.

**Logger Settings** Here we can tune some logger specific parameters. These parameters are used to identify conditions for the take-off, landing and engine start/stop.

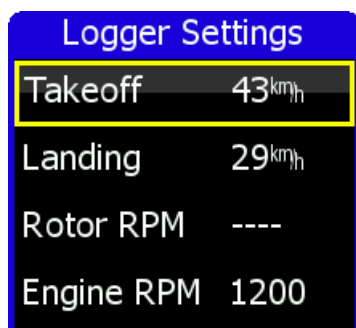


Figure 25: Logger settings window

- Take-off threshold specifies IAS, which must be exceeded for a few seconds for a logger to detect and record a take-off event.
- Landing threshold specifies IAS, which must be kept below for a few seconds in order to detect the landing event. This also works in conjunction with Rotor RPM.

- Rotor RPM threshold shall be defined for helicopters and gyroplanes only. In order to detect the landing situation, the logger monitors two things: IAS and rotor RPMs. They both must be below the specified thresholds in order to detect the landing. This prevents false landing detections, which happen if Rotor RPM threshold is not used.
- Engine RPM threshold is used to detect the engine start or stop event.

**Up/Down** The function of **up** and **down** buttons can be configured. Two options are available:

- setting brightness,
- setting QNH. In this case, a *Brightness* menu item becomes available from the *Setup* screen.



**Set Alt & IAS Offset** Modern digital sensors that are used for the IAS and altitude measurements may drift a little bit over time, especially after being exposed to a prolonged period of severe cold. The window illustrated in Figure 26 allows appropriate adjustment.

- Altitude: Change the offset until the altitude below the offset frame matches the reference altitude (Alt) or static pressure (SP). The reference values are obtained using a reference altimeter set to 1013 hPa.
- Airspeed: Change the offset until the differential pressure shows zero.

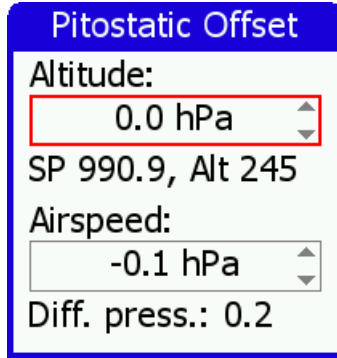


Figure 26: Altitude and IAS offset window

**Set FF factor** Fuel flow factor is used to correct the software fuel flow correction model. Setting value more than 1 increases indicated fuel consumption and vice versa. If fuel flow sensor is installed this factor has no effect.

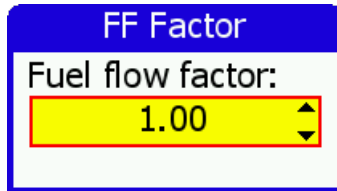


Figure 27: Fuel flow factor window

#### 5.4.11 About

The About window shows some relevant information about Emsis:

- selected layout
- program version,

- bootloader version,
- serial number,
- hobbs time,
- flight time,
- other units connected to CAN bus.

## 6 Installation

This section provides information about the installation of Emsis unit to the aircraft instrument panel. Here we assume that you are familiar with the Emsis user interface system. Therefore we recommend reading Emsis User's Manual from the beginning before proceeding with the installation. The following system components are covered in next sections:

- installation of Emsis unit (all versions),
- GPS antenna installation and
- outside air temperature (OAT) sensor installation.

### 6.1 Installation to the Instrument Panel

This section covers the installation of the Emsis unit. Emsis 80 mm version is presented (standard avionics unit dimension), while the same principles apply for the Emsis 3.5" screen version.

Cut your instrument panel according to your Emsis version using cut-out dimensions and cut-out template posted on our website <http://www.kanardia.eu/downloads/emsis>. Print the corresponding page

on a thick piece of paper. After printing take precise ruler or measuring tape and make sure that printed sizes are correct. Drill the mounting holes in the panel using 4.5 mm drill.

If you do not want to cut the panel yourself, you may consider to machine cut the opening in a local workshop using CNC equipment (a laser cutting machine is typically used). After cutting make sure, that Emsis fits into the new opening. You can powder paint the panel using non-reflective dark paint. This makes excellent results in practice.

The Emsis unit is mounted from the back. Position Emsis unit in the instrument panel and use the screws to fix it in place.

### 6.1.1 Emsis Back Panel Connectors and Cable Clearance

Emsis units are divided into two main groups (according to the back panel), Emsis with AHRS unit built-in and all the others. Here is a brief description of individual connectors from Figure 28:

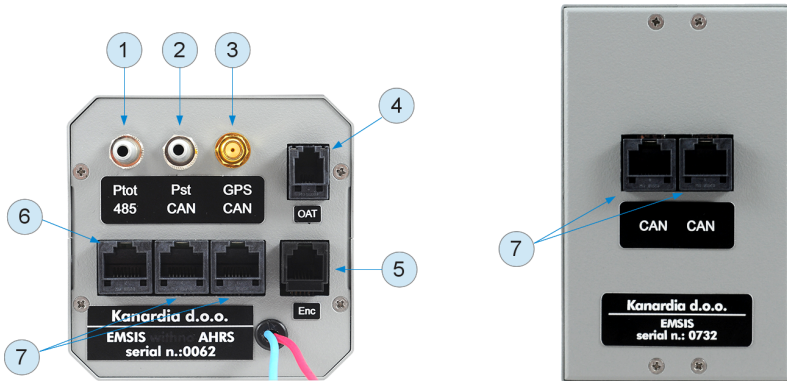


Figure 28: Emsis unit with AHRS built-in (left), Emsis slave unit (right). Both versions are available in 80 mm and 3.5" screens

- ① Total pressure port – must be connected to the total pressure tube.
- ② Static pressure port – must be connected to the static pressure tube.
- ③ Standard GPS antenna port – is used for external GPS antenna needed by the GPS receiver integrated on AHRS unit.
- ④ Outside air temperature port – connects to the Kanardia OAT digital probe.
- ⑤ Encoder port – connects with external encoder for regulating QNH (optional).
- ⑥ RS-485 port – used to connect with devices via 485 protocol such as indicators or LX Cluster.
- ⑦ Two CAN ports<sup>5</sup> – they are used to connect other CAN devices. Connectors are equivalent so either one can be used to connect a CAN device.

Emsis unit requires about 6 cm additional clearance behind. This clearance is needed for the connectors and cables. Figure 29 shows the photo of Emsis 80 mm version taken from side together with all cables and connectors. Emsis 3.5” screen version requires similar clearance space.

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<sup>5</sup> Emsis PFD is shipped with a connector inserted into one CAN port. It is a 120  $\Omega$  network terminator resistor to start and terminate the network. When Daqu unit is connected, terminator can be disconnected.

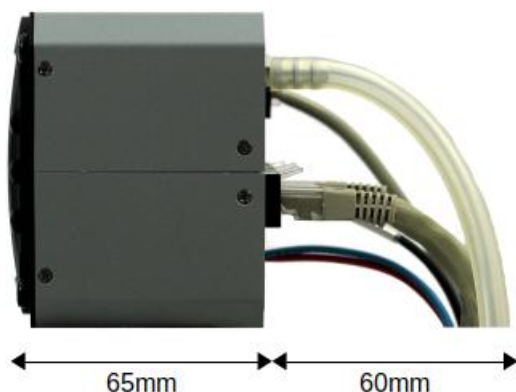


Figure 29: Side photo of Emsis 80mm version with all cables connected

## 6.2 Connection to the Electrical System

The Emsis unit must be connected to a 12 V DC standard aircraft power source. Additionally it can be connected to the backup battery – UPSU unit.

Do not connect it to a 24 V system. If you do, you will probably not damage the equipment, but the screen will be black. If you have a 24 V system in your aircraft, then you need a voltage adapter from 24 to 12 V.

The Emsis display consumes very little power (less than 2 W), which means about 0.15 A at 12 V. We recommend connecting Emsis using appropriately rated breaker or replaceable fuse on the power input. A 1 – 2.5 ampere fuse is appropriate.

Make sure that all units share the same common ground. There should be none or minimal voltage (up to 10 mA) between common ground and each unit ground, when all units are turned on. Otherwise your aircraft electrical system needs a good inspection.

Emsis with AHRS unit built-in is shipped with 1 m power cable with

2 pin female connector on one side and unterminated solid lines on the other. Red line connects to the 12 V DC avionics power bus and blue line connects to the aircraft common ground. If you find power cable too long, you can shorten it to any length, saving some precious weight.

When you use more than one Emsis unit in the cockpit, other Emsis units get power via CAN cable.

On our website you will find connection schema for Emsis unit with or without UPSU unit.

## 6.3 Pitot-Static Connection



In most avionics installations there are several instruments that need to be connected to the pitot-static system. A typical instrument panel has at least a mechanical airspeed indicator and altimeter. Emsis PFD unit shares the same pitot-static source with them.

Pitot-static consists of static pressure tubing and total pressure tubing.

In order to connect to the static source, cut the static tube on an appropriate place and insert plastic T junction. Cut some new tube to length and connect T junction with the Emsis PFD static port. We recommend use of hose clamps on all junctions and connections to secure against slippage and to reduce chance of static pressure leak.

Use the procedure above for the total pressure tube as well: cut the total pressure tube, insert T junction, connect T junction and Emsis total port and secure connections using hose clamps.

We strongly recommend labelling each tube before connecting to the Emsis PFD or any other instrument. If you ever have to remove Emsis PFD from the instrument panel, this will help a lot when you will reinstall it.

## 6.4 Outside Air Temperature Probe Installation

Although the OAT probe is a simple element in the Emsis PFD system, its installation requires some attention.



Outside air temperature (OAT) probe is shipped with the Emsis PFD unit. This is a digital temperature sensor inserted into a threaded aluminium tube. The default OAT cable length is 1.5 meters but other lengths are available on request.

OAT information is required to calculate true airspeed from indicated airspeed and altitude, as well as to provide you with the outside temperature information.

In order to provide accurate measurements, the OAT probe must be installed on a proper place where the probe is not exposed to the disturbing sources of heat:

- engine heat and exhaust heat,
- direct sunlight,
- heated air exited from cabin.

We also do not recommend installing the probe in the cabin area, since the elevated temperature in the cabin may influence the back side of the probe, though such influence is usually small.

Please follow these steps to install the OAT probe:

1. Locate a spot in the aircraft taking into account the considerations from above and drill a fi 8 mm hole.
2. Remove the external nut from the probe but keep the washer, internal nut and plastic insulation tube on the probe.
3. Install the probe into the hole from the interior. Guide the cable through the aircraft to the Emsis PFD back panel.

4. Apply some lock-tight and thread the external nut to the probe. The lock-tight is necessary to avoid losing the cap due to vibrations.
5. Tighten the internal nut so that the probe sits firmly and apply lock-tight on the nut. Do not over tight it.
6. Slide the plastic insulation tube over the exposed threads of the probe and cover as much threads as possible. Shrink the tube using hot air blower. Do not use open flame. Plastic insulation (shrink) tube also serves as internal isolation of the sensor located in the tip.



Figure 30: Inserting the OAT probe (left), cap is in place, tighten the internal nut, slide the insulation tube (right)

## 6.5 Connection to the CAN Network

Both CAN ports at the back of the Emsis unit are equivalent.

In most standard configurations with Emsis EMS, one CAN port is used to connect with Daqu (engine monitoring unit), while the other is unused or connected to other Emsis unit.

In standard configurations with Emsis PFD, one CAN port is connected to terminator, while the other is unused or connected to other Emsis unit. One CAN port may be used to connect with Daqu (engine monitoring unit), in this case terminator can be disconnected.

Just to remind you, Daqu unit has a 120  $\Omega$  CAN network terminator resistor built-in to start and terminate the network.

## 6.6 Connection to the 485 Network

The RS-485 connector is obsolete. It was used to connect devices via 485 protocol. It will be replaced by RS-232 connector in forthcoming versions.

## 6.7 GPS Antenna Installation

Please, consider mounting the GPS antenna using the following recommendations:



- Find a good spot in a cabin where the antenna is able to see blue sky during most of the aircraft movement. Such a good spot can be usually found on the top of the instrument panel cover, just below the canopy.
- Mounting surface should be flat, clean and rigid.
- Avoid close proximity to any transmitting antennas like radio stations, transponders or any other active GPS antennas (GPS antennas may interfere each other).
- Antenna must not be covered or obstructed by metals (metals sheets, rods) or any other conductive material (like carbon fibers).
- The triangle/GPS text must point upwards – to the sky. For the installation use self-adhesive tape and fix the antenna on a rigid and clean surface.
- The supplied antenna is not intended to be installed on the aircraft exterior. If you need to install the antenna on the external surface, search a suitable antenna in your local avionics shop. Any 3.3 V active antenna with SMA male connector can be used.

## 7 Tank



Depending on Daqu channel configuration and Emsis layout, tank can work in one of two modes:

- software tank — tank simulation,
- hardware tank — based on real measurements from sensors.

### 7.1 Software Tank

The software tank is active when no fuel level channel is configured in Daqu. Emsis allows you to enter the current amount of fuel and this amount is then reduced in time based on fuel consumption. The fuel consumption is either calculated or measured. Measured fuel consumption usually gives better results assuming that a high quality fuel flow sensor is applied. If fuel flow sensor is not applied, then the fuel flow is approximately calculated based on the engine type.

As you can see, the fuel level of software tank is highly subjective and depends on:

- initial estimate of fuel quantity,
- precision of the fuel flow sensor or precision of the fuel flow mathematical model.

Furthermore, any error in fuel flow will sum up in time resulting in a *significant error* in fuel level indication. This means that software tank level indication must be accepted with scepticism and the pilot should not rely only on this indication.

When software tank is active, selecting the *Tank* item from the *Emsis Setup* screen displays the *Set fuel* window, figure 31. Use the **up** and **down** buttons to adjust the fuel level.

Alternatively, you can long press on the **screen selection** button. This opens the same window.

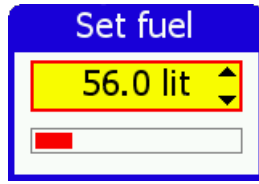


Figure 31: Software (simulated) fuel tank level adjustment

## 7.2 Hardware Tank

*Hardware* tank is based on fuel level sensors. First you need to connect sensors to Daqu and activate/configure appropriate channels. Once this is completed, you can continue with tank calibration.

When selecting the Tank option a window illustrated in Figure 32 opens. *T2* options are shown only when the second fuel level channel is also active.

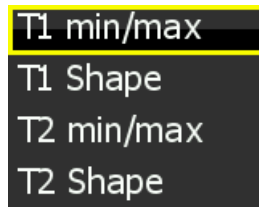


Figure 32: Tank options.

There are two ways to calibrate the tank:

- Tank calibration in steps. This involves pouring known quantity of fuel and taking sensor readings in several steps.
- Min/max calibration. This involves selecting some known tank shape and then defining sensor values at empty (min) and full (max) sensor position.

### 7.2.1 Units

Fuel level volume value on the CAN bus is always represented in *liters*. Hence the complete tank calibration process must be done in liters. Emsis will ignore the volume unit setting and always consider the numbers you are entering as liters.

However, when the calibration is complete and tanks (fuel level) are set, the fuel level values on the main pilot screens will be converted in units selected by user (US gal or liters).

### 7.2.2 Setting up the Channel

Please refer to *Daqu 2.3* or *miniDaqu* manual for more details on connections and channel settings. The manuals are accessible from our web page.

First we will show a most typical channel configuration for a resistive type fuel level sensor, which is connected to one of the E channels.

1. Switch to the *Emsis Setup* screen.
2. Select the *Engine* menu item and then *Sensors* subitem.
3. Enter *314* password, if necessary.
4. Search for the *E01* channel and open it.
5. Change the values to match the figure 33a.

Sometimes an active sensor is used. (Note: Capacitive sensors are just a special case of active sensors.) These sensors usually output voltage in 0-5V range. Let's assume that sensor is connected to E02 channel. Such a sensor shall be then configured as it is shown in Figure 33b.

Once channels have been configured you shall proceed to the tank calibration.

**Channel E01**

Function

Sensor

Freq.

Filter

Ref. val.

**Channel E02**

Function

Sensor

Freq.

Filter

Ref. val.

- (a) Channel E01 set for a tank with a resistive fuel level sensor for a measuring range between 0 and 400  $\Omega$ .
- (b) Channel E02 set for a tank with an active sensor (e.g. a capacitive sensor) with voltage output in 0-5V range.

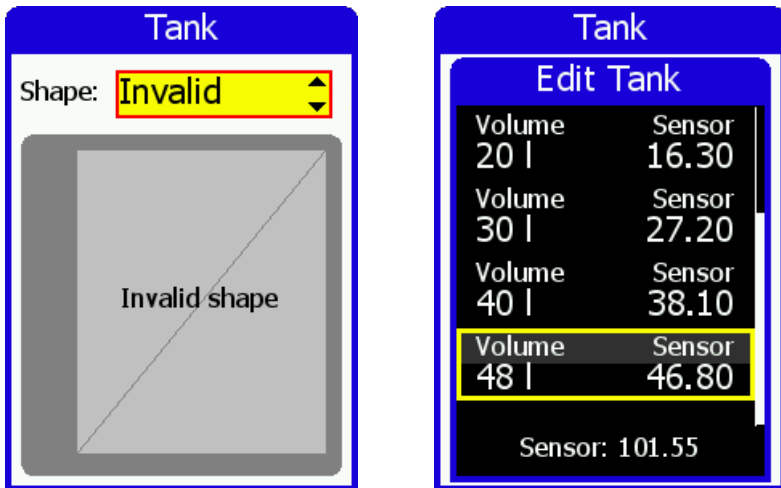
Figure 33: Two most typical examples of fuel level channel configurations.

### 7.2.3 Tank Calibration in Steps

This approach usually gives the best results as it takes into account tank shape, sensor installation and sensor specific response at the same time. Procedure given next shows principle for the tank 1. If you have two tanks, the procedure must be repeated for the tank 2.

1. Have a notebook and pencil at hand.
2. Make sure you have enough fuel and enough cans ready.
3. Make sure you have your cans calibrated and marked. 10 liter marks are sufficient. Do not try to be super precise. Fuel sensors are not very precise. The maximal number of measuring points is 18. In practice, 5 points are usually enough.

4. Make sure the tank is empty and make sure the aircraft is level as it will be in the flight.
5. Select *T1 Shape* from the *Tank* option in order to open the tank calibration window. A window similar to Figure 34a is displayed. Please read the *IMPORTANT* box on the page 65.
6. Press and hold the OK button – this opens *Edit Tank* window, Figure 34b.



- (a) A *Tank* window example. Yours will be a bit different.
- (b) An *Edit Tank* window example. Yours will differ.

Figure 34: Tank main window and tank edit window examples.

7. The window may show a few measuring points (volume – sensor pairs). Delete all of them. Select a point, press the OK button and then select *Delete*. Repeat this until all points are deleted.
8. Drain the tank completely.

9. Add the first point, which represents empty tank situation. Press the **OK** and select *Add*. Change volume to 0 and press **close** button. This will add the first point. Sensor value is recorded automatically. Write this point down (volume and sensor pair) to the notebook.
10. Pour some known quantity of fuel into the tank. Say 10 liters. Observe the *Sensor* value at the bottom of the window. This value must be alive – it must change. This value shows the raw sensor reading in Ohms for the resistance based sensors or voltage for active fuel level sensors (capacitive, or pressure based). Note: Usually, you have to put some amount of fuel before the fuel reaches the bottom of the sensor and the sensor starts reacting. This amount varies from case to case and it may be as small as 0 or as large as 15 liters (or even more). If sensor has reacted (its value is different from the empty case) and later on the value has stopped changing, write down the total amount of fuel and sensor value to the notebook and then press **OK** and *Add*. Adjust the volume to the amount of the fuel now in tank (10 l in our case) and close it with the **close** button.
11. Pour some more fuel into the tank. Say another 10 liters. Once the sensor stopped moving, write down the total amount of fuel (now 20 l) and sensor value into the notebook. Press **OK** and select *Add*. Adjust the volume to the amount of the fuel now in tank (20 l in our case) and close it with the **close** button. The volume numbers must always increase, while the sensor number may either always increase or always decrease. This depends on the sensor type.
12. Repeat this procedure until the tank is full. Be careful here. You may have a case where sensor stops reacting (has reached

its max point) way before the tank is completely full. Stop at the point where sensor do not react anymore.

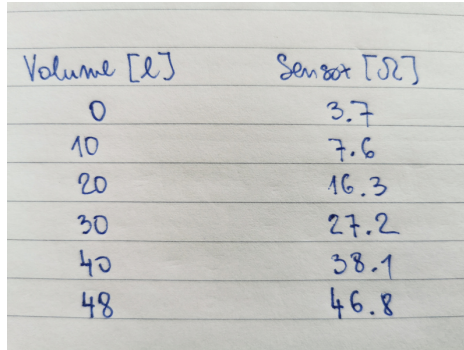
13. Close the *Edit tank* window pressing the **close** button. Now you are back to the *Tank* window. This window shows your tank curve. Name of the curve will be *Custom*. Press **close** again to close the *Tank* window and save the new shape – only now the new shape is really saved.

Hint: While editing a number, you can use the **screen selector** button to delete the highlighted character.

IMPORTANT: Once you have your shape defined and you see *Custom* next to the shape label in the *Tank* window, *do not play and change the shape to anything else. If you do, you will lose your calibration without a warning and you will have to enter it once again.*

It is important to take notes for each measuring point. Figure 35 shows an example. In the case that something went wrong and the tank calibration is not stored correctly, you can restore it from the notes – there is no need to drain the tank again and mess with the fuel.

1. Select *T1 Shape* from the *Tank* option in order to open the tank calibration window.
2. Press and hold the **OK** button – this opens *Edit Tank* window.
3. The window may show a few measuring points (volume – sensor pairs). Check if they match with the notes (some minor difference is OK).



Volume [L]	Sensor [Ω]
0	3.7
10	7.6
20	16.3
30	27.2
40	38.1
48	46.8

Figure 35: Example of notes made during a tank calibration.

4. If there is a point, where either volume or sensor values is incorrect, press **OK** then select *Edit* to open the *Edit point* window. Select volume or sensor item and press **OK** to start editing it. Change the value to match your notes.
5. In the case that some points were missing at the end, press **OK** then select *Add*. This creates a new point and puts it at the end of the list. Select volume and sensor and change their value to match the values from the notes.
6. Use the **close** button to exit the *Edit Tank* window and to show the *Tank* window underneath. You should see a valid tank shape curve.
7. Use **close** again to exit the *Tank* window.

### 7.2.4 Tank Calibration Using Known Shape

Emsis has several build in tank shapes and new ones are being added into new versions all the time. If your tank matches one of them, you can use it and save some time. In theory, this approach is as good as the previous one. However it does not take into account sensor

position differences. It gives good results, when sensor behaviour is predictable (read relay based sensors, for example) or in serial production, when sensor are installed with high precision.

This procedure requires two steps. In the first step, the tank shape is selected and in the second step, sensor value for empty (min) and full (max) condition is given.

1. Select the *Tank* option from the main menu. This offers further selection according to the Figure 32.
2. Select *T1 Shape*. This opens a tank shape window, Figure 36. Use **up** or **down** button to select the correct shape for your aircraft tank. The graphics below shows the non-linearity of the tank. Straight diagonal line indicates that the tank is linear. Please note that changing the shape deletes any existing tank calibration. See the *IMPORTANT* box on the page 65.

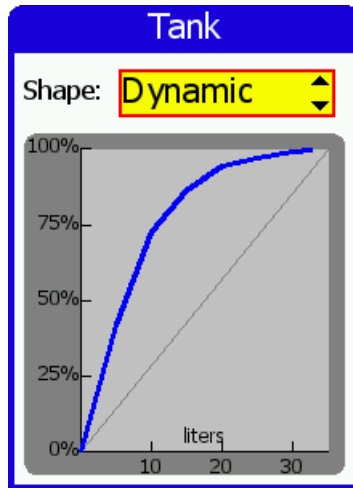
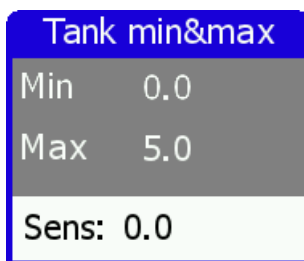


Figure 36: Tank shape selection window. The figure shows that the curve for the Dynamic WT9 tank is very non-linear

3. Once the correct shape is selected, press **close** to save the selection.
4. Select the *Tank:T1 min/max* from the menu. Figure 37 shows an example.



The image shows a window titled "Tank min&max" with a blue header. The window has a grey background and a white border. It contains three rows of text: "Min 0.0", "Max 5.0", and "Sens: 0.0". The "Sens: 0.0" row is highlighted with a white background.

Tank min&max	
Min	0.0
Max	5.0
Sens:	0.0

Figure 37: Window for setting the tank minimum and maximum values. Your values will be different.

Here you have two options. The first option is to drain the tank, set the sensor minimum value. Then fill up the value and set sensor maximal value. The second option is to manually enter some known min and max values from previous calibrations.

- *Working with fuel:* Make sure that the tank of the aircraft is empty and the fuel level sensor is connected to Daqu unit. In the *Sens* row you can observe the sensor value. When tank is empty, select the *Min* item and press and hold the OK button to copy the sensor value into min. Fill the tank, select the *Max* item and press and hold the OK button to copy the sensor value into max. Then close all the windows. This completes the tank calibration.
- *Entering values:* Select the *Min* item and press the OK button. Enter the known value that sensor shows when tank is empty. Then select the *Max* item and press OK. Enter the known value that sensor shows when tank is full. Close all the windows. This completes the tank calibration.

## 8 Limited Conditions

Although a great care was taken during the design, production, storage and handling, it may happen that the Product will be defective in some way. Please read the following sections about the warranty and the limited operation to get more information about the subject.

### 8.1 Warranty

Kanardia d.o.o. warrants the Product manufactured by it against defects in material and workmanship for a period of twenty-four (24) months from retail purchase.

#### Warranty Coverage

Kanardia's warranty obligations are limited to the terms set forth below:

Kanardia d.o.o. warrants the Kanardia-branded hardware product will conform to the published specification when under normal use for a period of twenty-four months (24) from the date of retail purchase by the original end-user purchaser ("Warranty Period"). If a hardware defect arises and a valid claim is received within the Warranty Period, at its option and as the sole and exclusive remedy available to Purchaser, Kanardia will either (1) repair the hardware defect at no charge, using new or refurbished replacement parts, or (2) exchange the product with a product that is new or which has been manufactured from new or serviceable used parts and is at least functionally equivalent to the original product, or, at its option, if (1) or (2) is not possible (as determined by Kanardia in its sole discretion), (3) refund the purchase price of the product. When a refund is given, the product for which the refund is provided must be returned to Kanardia and becomes Kanardia's property.

## Exclusions and Limitations

This Limited Warranty applies only to hardware products manufactured by or for Kanardia that have the "Kanardia" trademark, trade name, or logo affixed to them at the time of manufacture by Kanardia. The Limited Warranty does not apply to any non-Kanardia hardware products or any software, even if packaged or sold with Kanardia hardware. Manufacturers, suppliers, or publishers, other than Kanardia, may provide their own warranties to the Purchaser, but Kanardia and its distributors provide their products *AS IS*, without warranty of any kind.

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This warranty does not apply: (a) to damage caused by use with non-Kanardia products; (b) to damage caused by accident, abuse, misuse, flood, fire, earthquake or other external causes; (c) to damage caused by operating the product outside the permitted or intended uses described by Kanardia; (d) to damage caused by service (including upgrades and expansions) performed by anyone who is not a representative of Kanardia or an Kanarida Authorized Reseller; (e) to a product or part that has been modified to significantly alter functionality or capability without the written permission of Kanardia; (f) to consumable parts, such as batteries, unless damage has occurred due to a defect in materials or workmanship; or (g) if any Kanardia serial number has been removed, altered or defaced.

To the extent permitted by applicable law, this warranty and remedies set forth above are exclusive and in lieu of all other warranties, remedies and conditions, whether oral or written, statutory, express or implied, including, without limitation, warranties of merchantabil-

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To the extent permitted by applicable law, Kanardia is not responsible for indirect, special, incidental or consequential damages resulting from any breach of warranty or condition, or under any other legal theory, including but not limited to loss of use; loss of revenue; loss of actual or anticipated profits (including loss of profits on contracts); loss of the use of money; loss of anticipated savings; loss of business; loss of opportunity; loss of goodwill; loss of reputation; loss of, damage to or corruption of data; or any other loss or damage howsoever caused including the replacement of equipment and property, any costs of recovering, programming, or reproducing any program or data stored or used with Kanardia products and any failure to maintain the confidentiality of data stored on the product. Under no circumstances will Kanardia be liable for the provision of substitute goods or services. Kanardia disclaims any representation that it will be able to repair any product under this warranty or make a product exchange without risk to or loss of the programs or data. Some jurisdictions do not allow for the limitation of liability for personal

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## **8.2 TSO Information — Limited Operation**

This product is not TSO approved as a flight instrument. Therefore, the manufacturer will not be held responsible for any damage caused by its use. The Kanardia is not responsible for any possible damage or destruction of any part on the airplane caused by default operation of instrument.