EMSIS
Installation and User Manual

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Revision 3.3

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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 next table shows the revision history of this document.

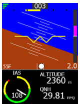
Rev.	Date	Description
3.3	Feb 2024	Clarification about logbook file exports.
3.2	Feb 2023	Rotax iS section, parameters editing, adjusted to SW 3.11.
3.1	Nov 2021	Figures and text updated to the latest version.
3.0	May 2020	Latex rewrite.
2.13	July 2016	Bug fixes, red crosses on interactive parameters, heading indicator, Lo-Hi-NC messages.
2.12	Jun 2015	Added description of functions accumulated in since v2.6.
2.6	May 2013	Added Maps.
2.0	Feb 2013	Added Installation.
1.0	Nov 2012	Initial release.

Contents

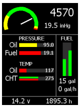
1 Introduction

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.

Here is a brief description of individual items:

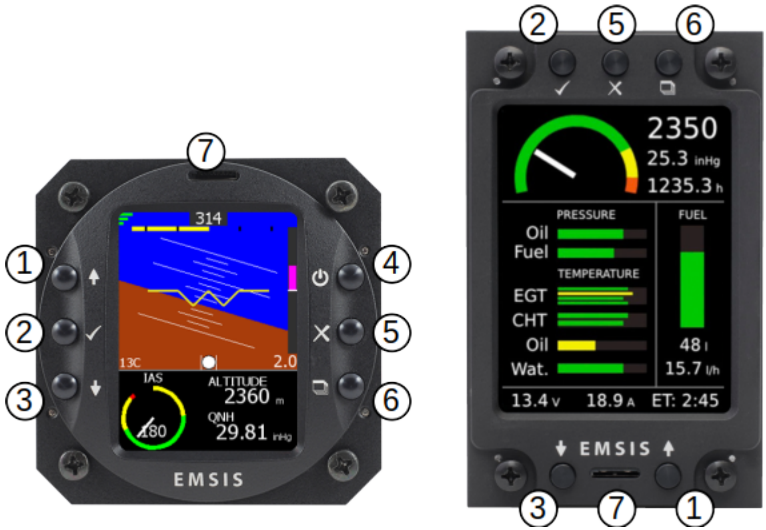


Figure 1: Organization of Emsis front panel. Emsis 80 mm version (left), Emsis 3.5" screen version (right)

(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[1], 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. This section describes actions required to update the software. The update is performed in several steps:

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

We recorded a video and published it on our YouTube channel. Please check out the link: Kanardia Emsis/HOW TO/Software 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 do not use the latest and greatest SD cards. Emsis may have troubles recognising them. Olderly SD cards usually work the best. 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.

[1] Typical use of this option is in a glider.

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.

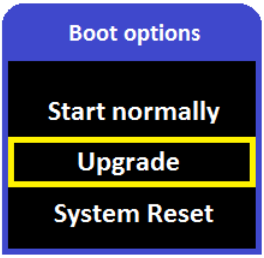


Figure 2: Boot options window

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.

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 (units before Oct 19)	12 bit, 0 to 69 hPa, 381 km/h, 205 kt resolution < 0.1 km/h 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.

2.6 The 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.

Imagine the CAN bus as a kind of computer network. Just like new computers

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 (units before Oct 19)	12 bit, 0 to 69 hPa, 381 km/h, 205 kt resolution < 0.1 km/h 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.

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.

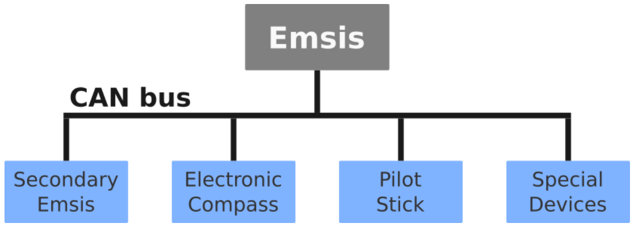
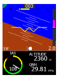


Figure 3: Illustration of Emsis configuration using `CAN bus`

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[2] 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:

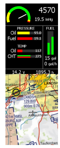
- The angular rate sensors, also known as gyros, are used in the attitude calculation. The angular rates are integrated in time in order to predict new attitude from the old one. We could say that they give short-time attitude prediction. They are also used in gravity vector calculation.
- The acceleration 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.

[2] 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.

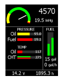
In a very similar way, short-term inertial position prediction is compared with the GPS position. Again, Kalman filtering is used to obtain the final solution.



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.

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.

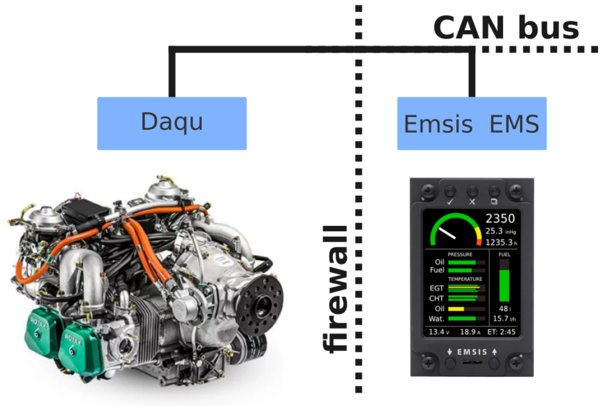


Figure 4: Illustration of Emsis EMS configuration

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/miniDaqu unit is designed to monitor engine sensors for various engines such as Rotax, Rotax iS, D-motor, Jabiru, UL-Power, Lycoming, Continetal, 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.
- Rotax iS status screen - it is functional for Rotax 912 iS and Rotax 915 iS engines only.
- 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.
- `Up` and `down` buttons modify either brightness or QNH, depending on system settings (see 7.7).

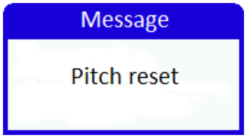
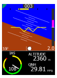


Figure 5: Setting pitch

- 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.

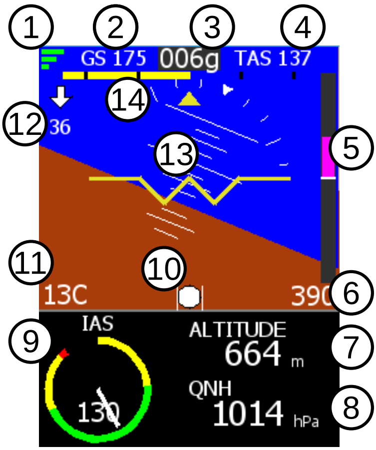


Figure 6: Emsis primary flight display screen

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.

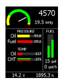
(11) Outside air temperature (OAT).

(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.

(4) Fuel level with the numeric indication.

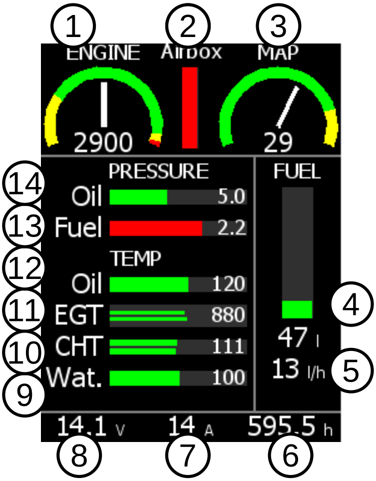


Figure 7: A typical Emsis engine monitoring screen.

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.

Special values:

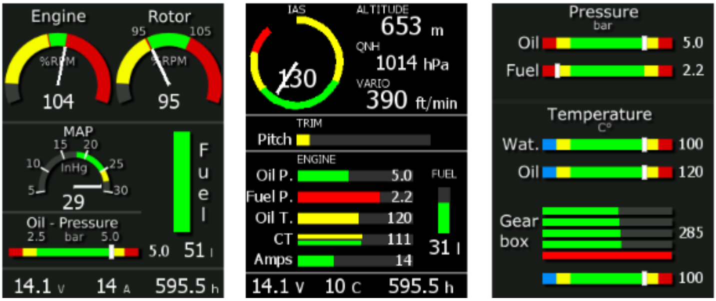


Figure 8: Examples of Emsis engine monitoring screens

- 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.).

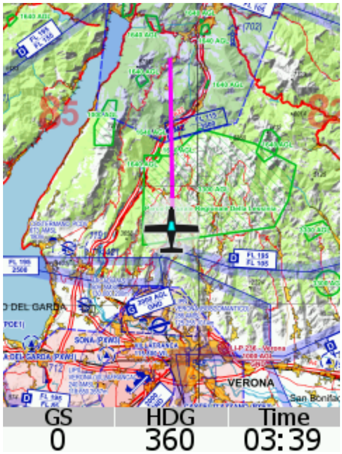


Figure 9: Emsis maps screen

Maps are not enabled by default. This option must be activated manually, preferably at the time of the order. However, this can be done later as well. Once this feature is activated, it cannot be deactivated.

Emsis can show raster maps, which must be copied to its internal memory first. The maps are limited to the raster format only. The system does not support our vector maps. Maps are available from our web site:

- DFS maps – these maps require a license in order to be displayed. The maps cover most of the continental Europe. Maps are issued once per year. Each country at different date.
- US Sectionals – maps provided by FAA. These maps are free. They are updated every two months.
- WAC Brazil – Brasil WAC maps. These maps are free. We update them once every year.

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.

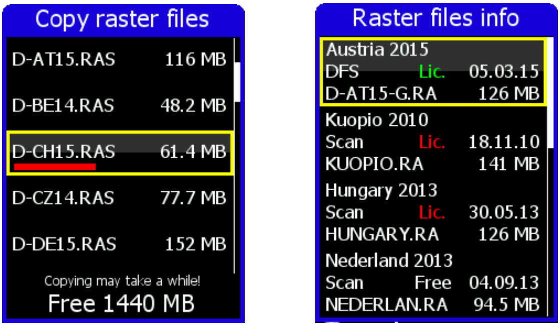


Figure 10: Copying maps (left) and maps info window (right)

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.

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 Rotax iS Status Screen

The official Rotax engine manual or aircraft operators manual always supersede the information given by this screen. If lane lamps information is not in sync with the lane status on this screen, lane lamps take precedence.

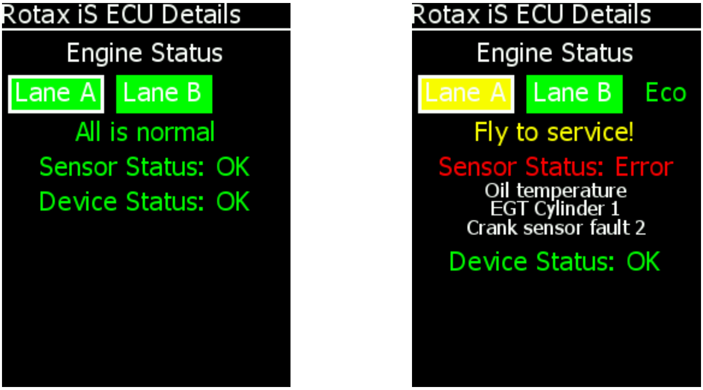
Rotax iS status screen is available for Rotax 912 iS and Rotax 915 iS engines only. These engine are equipped with an ECU, which transmits several engine status information. The most relevant part of this information is shown on this screen. It displays Lanes A and B status, sensor status and device status. Figure 11 show two examples. A typical situation is shown in Figure 11a, where all is working normally. An artificially made error situation is illustrated in Figure 11b. Here one lane has problems (control light should be flushing), and several sensor errors were detected.

5.4.1 Lane

Make sure to cross check this information with the lane lamps. In the case of any mismatch, lamps are taking precedence.

The lane frame background may have four different colors:

`Green` equals to the lane control lamp turned off. This is normal situation - the lane is operating as it should.



(a) A typical situation. (b) An error situation.

Figure 11: Rotax iS status screen examples.

`Yellow` equals to the lane control lamp flushing on and off. The lane is signaling some warning condition.

`Red` equals to the lane control lamp being permanently on. This indicates some error condition.

`Gray` indicates the lane being turned off – you should see this only during the engine check procedure.

In addition to this, one of the lane frames have a thicker frame. This frame tells which lane is used to control the engine generator. In vast majority of cases, this is the lane A. During the engine check, when lane A is switched of, the generator frame should move to the lane B.

5.4.2 Eco Label

The `Eco` label appears next to the lane frames when engine is operating in the ECO mode.

5.4.3 Status Summary

Make sure to cross check this information with the lane lamps. In the case of any mismatch, lamps are taking precedence.

An engine status summary is shown as a text below the lane line. This gives some instruction what to do if some error is detected. According to the Rotax Operators Manual for 912 iS and 915 iS engines, section 4.1 EMS Warning Lamps, the following advice is given:

`All is normal` both lanes are green – both lane warning lamps are off.

`Fly to service` at least one of lanes is yellow or green. Engine delivers normal power, but there is some error. Flight is possible to the destination at your own discretion. Maintenance is required afterwards.

`Land aircraft` both lanes are red – both lane warning lamps are lit. Loss of engine power is possible, flight is not permissible. Try to land safely as soon as possible.

5.4.4 Sensor Status

If no sensor errors are detected, this line is green with OK status displayed. However if there is some error reported, the line turns red and a list off faulty sensors are listed below.

5.4.5 Device Status

This works on similar principles as sensor status, green text is displayed on normal conditions but red in cases of error with a list of defects below.

5.4.6 Caution Message

It is possible to get a `Caution` message illustrated in Figure 12 without any report for defect in sensor or device status or even when both lane lamps are off. The warning message was sent by ECU, but it did not specify why it was sent. You must resolve this issue with a Rotax Service Center.

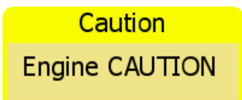


Figure 12: Engine Caution message example

If such message is shown, you acknowledge it with the `OK` button.

5.5 Emsis Setup Screen

The Emsis *Setup screen* allows you to access various options. Q quick overview is given here and more details are revealed in section 6. Figure 13 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.

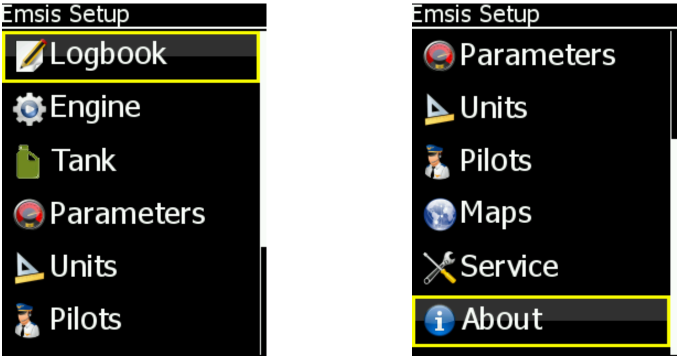


Figure 13: The Emsis setup screen.

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).[3] EMS unit only.

`Tank` opens menu for the fuel level measuring hardware and for the fuel tank shape calibration[3] or shows the software tank quantity, if the sensors are not present. EMS unit only.

`Parameters` is used to adjust flight and engine parameter details.

`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.

[3] Engine monitoring unit (Daqu) is required.

`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.

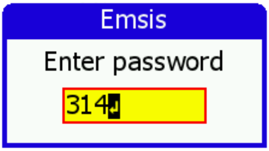


Figure 14: Emsis password is required in order to access certain options

The factory password is `314`, first three most significant digits of number π as seen in Figure 14. The password was introduced in order to prevent unwanted accidental alterations of important settings. The password cannot be changed.

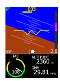
6 Emsis Setup Screen

This section list various details accessible from the Setup screen.

6.1 Logbook

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

6.1.1 PFD Mode



The logbook window lists recent flights in reverse order (last flight is listed first). The date and pilot (when known) are shown on the top line and takeoff time, landing time, number of flights and flight duration are shown on the bottom line for each flight. Flights shorter than two minutes are not shown.

Selecting an item and pressing the `OK` button, gives further options:

`More info` opens a new window with even more details about the selected flight. Use `up` & `down` buttons to scroll the details window. Use `close` to exit.

`Copy flight` creates a file on the external SD card in the KML format. The SD card must be inserted beforehand. Make sure the contacts on the card are facing upwards. The resulting KML file will have `kml` extension and it can be 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. The SD card must be inserted beforehand. Make sure the contacts on the card are facing upwards. The resulting file will have `tab` extension. Each row in a such file represents one second of flight. This file can be then imported to Excel or Calc or some other spreadsheet application for further analysis.

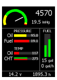
When a flight is copied to an SD card, it has the following filename structure:

- First two leters are used from the pilot name if name is available. `JD` is used when pilot name is not known.
- Next five digits define date of flight in the `ddmmy` format, where `dd` stands for day in month, `mm` month in year and `y` is the last digit of the year.
- The last letter before the dot is the flight in this day. Letter `A` is used for the first flight, `B` for the second, etc.
- The filename extension can be either `kml`, which is undestood by Google Earth and alike, or `tab`, which can be opened in Excel (or alike).

Example: `AT24082B.tab` represents a pilot whose name starts with `AT`, flight was taken on 24th of August 2022. This is the second flight of this day.

When file is viewed on a PC, the date/time attribute shown next to the filename is always invalid and should be ignored. This comes from the limitation of Emsis hardware.

6.1.2 EMS Mode



The EMS mode also provides some limited logbook functions. Here date and times are not known as GNSS information is not available. Hence engine start–stop pairs are shown insted. They are given in the reverse order (latest comes first). Engine total time is used to identify these pairs.

Example: `135.05 -> 136.47` defines an engine run pair, which started at 135.05 hours and ended at 136.47 hours of engine total time.

Selecting one of the listed pairs and pressing the `OK` button, performs the `Copy details` action. This exports records in `tab` format, where entries are separated by tabulator character. The SD card must be inserted beforehand. Make sure the contacts on the card are facing upwards. The resulting file has always the `tab` extension. Each row in a such file represents one second. This file can be then imported to Excel or Calc or some other spreadsheet application for further analysis.

The resulting filename has the following structure:

- Digits before the `dash` represent the whole part of the engine totalizer at the start.
- `Dash` is used instead of the decimal separator.
- Digits following the dash represent the decimal fraction if the engine totalizer at the start.
- The filename extension is always `tab`.

Example: `135-05.tab` represents the engine start-stop records, which started at engine total time 135.05 hours. Note that stop time is not included in the filename due to filename size limitation of the Emsis hardware.

When file is viewed on a PC, the date/time attribute shown next to the filename is always invalid and should be ignored. This comes from the limitation of Emsis hardware.

6.1.3 Working with KML

The kml file stores 3D points of the flight and can be viewed in any third party software, which accepts such format. One such software is Google Earth, but many others are supporting this format as well. Figures 15 and 16 show two examples. First is the top view of a flight and the second one is a detail with visible vertical profile.

Maybe the easiest way to open the `kml` file is to use the Web version of Google Earth:

- Open the link `https://earth.google.com/`.
- Select `File|Import` and search for the file.

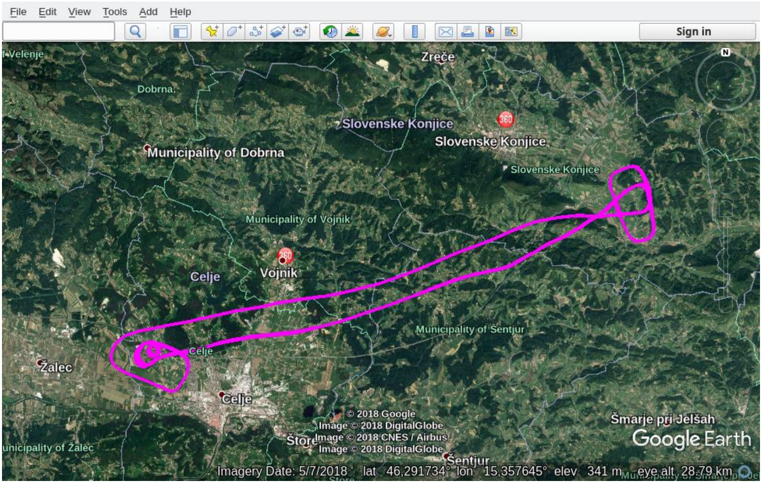


Figure 15: A flight file with kml extenstion opened in Google Earth.

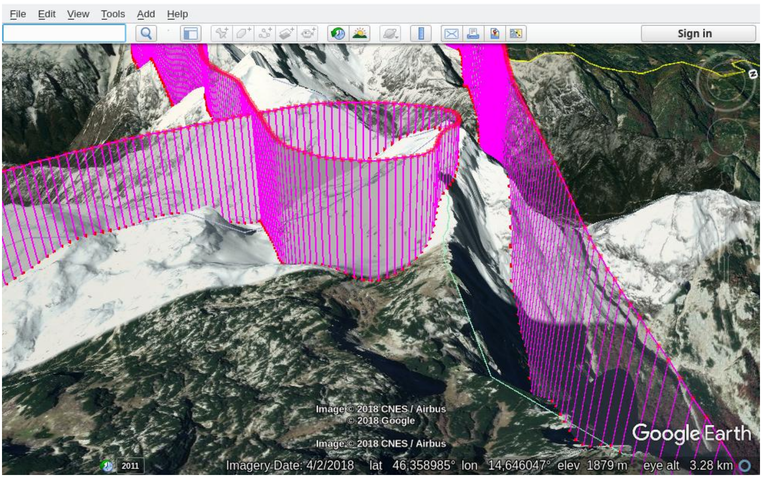


Figure 16: A detail of flight opened in Google Earth. Vertical profile is visible here.

6.1.4 Working with TAB

The tab file stores a detailed information for every recorded second. The recording typically starts when engine start is detected and ends when engine is stopped, but other scenarios are also possible.

The *Tab* file format is a plain text format, where each row represents one record and parameters in the record are separated by a tab character. Each record has several flight and engine parameters like: date, time, position, altitude, static pressure, velocities, wind speeds, engine temperatures, engine pressures, RPMs and many others.

Please note that content of the file is static (due legacy reasons) and it does not depend on actual sensors used in this particular case. This means that some information may be missing and quite some information will be redundant and filled with silly values (often zeros, but anything can be expected). This is especially true of the EMS case, where flight information is not available, but printed nevertheless.

Please also note that some stored information was compressed and precision is lost during the *decompression* phase. You will notice this as *jumps* in the data series.

Typically, the file is opened with Microsoft Excel or with LibreOffice Calc. Here are the steps needed to open the file in LibreOffice Calc. Steps in Microsoft Excel are similar.

1. Start the LibreOffice Calc.
2. Select the *File:Open* from the menu.
3. In the selection window, set *Filter* to *All Files.*
4. Search for file with the tab extension. An example is `AT12088B.tab`
5. Calc detects that a text file is being imported and it opens a window as shown on Figure 17. Please make sure that the *Tab* option is selected as the separator and *English (USA)* as the language. This makes sure that decimal values are properly imported.
6. The result of the import is then shown on Figure 18. Some column widths were adjusted and some cells were hidden.

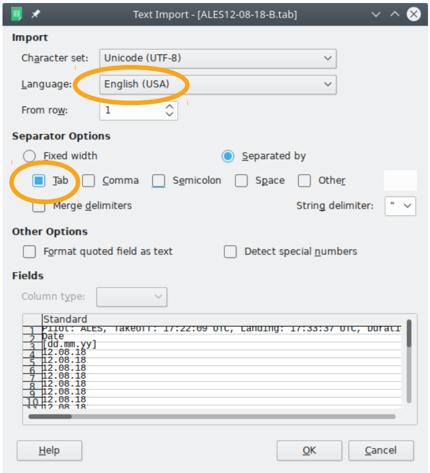
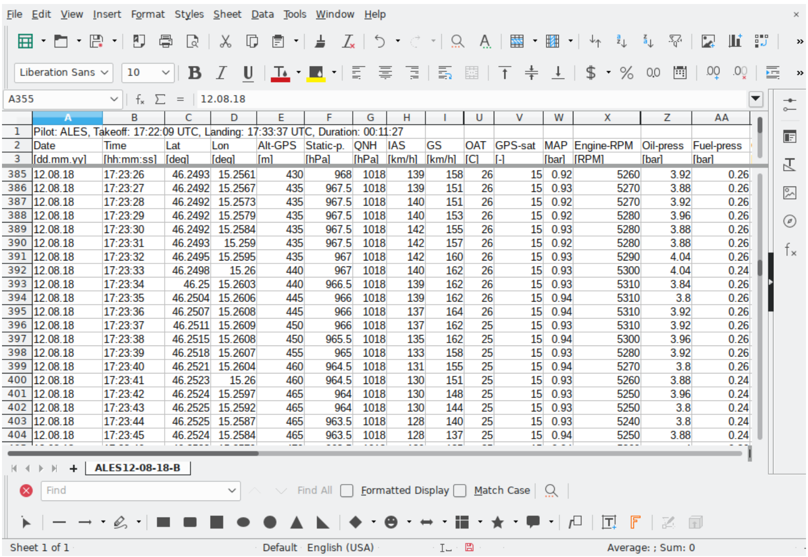


Figure 17: An example of Calc Text Import window.



	A	B	C	D	E	F	G	H	I	U	V	W	X	Z	AA
1	Pilot: ALES, Takeoff: 17:22:09 UTC, Landing: 17:33:37 UTC, Duration: 00:11:27														
2	Date	Time	Lat	Lon	Alt-GPS	Static-p.	QNH	IAS	GS	OAT	GPS-sat	MAP	Engine-RPM	Oil-press	Fuel-press
3	[dd.mm.yy]	[hh:mm:ss]	[deg]	[deg]	[m]	[hPa]	[hPa]	[km/h]	[km/h]	[C]	[-]	[bar]	[RPM]	[bar]	[bar]
385	12.08.18	17:23:26	46.2493	15.2561	430	968	1018	139	158	26	15	0.92	5260	3.92	0.26
386	12.08.18	17:23:27	46.2492	15.2567	435	967.5	1018	139	151	26	15	0.93	5270	3.88	0.26
387	12.08.18	17:23:28	46.2492	15.2573	435	967.5	1018	140	151	26	15	0.92	5270	3.92	0.26
388	12.08.18	17:23:29	46.2492	15.2579	435	967.5	1018	140	153	26	15	0.92	5280	3.96	0.26
389	12.08.18	17:23:30	46.2492	15.2584	435	967.5	1018	142	155	26	15	0.93	5280	3.88	0.26
390	12.08.18	17:23:31	46.2493	15.259	435	967.5	1018	142	157	26	15	0.92	5280	3.88	0.26
391	12.08.18	17:23:32	46.2495	15.2595	435	967	1018	142	160	26	15	0.93	5290	4.04	0.26
392	12.08.18	17:23:33	46.2498	15.26	440	967	1018	140	162	26	15	0.93	5300	4.04	0.24
393	12.08.18	17:23:34	46.25	15.2603	440	966.5	1018	139	162	26	15	0.93	5310	3.84	0.26
394	12.08.18	17:23:35	46.2504	15.2606	445	966	1018	139	162	26	15	0.94	5310	3.8	0.26
395	12.08.18	17:23:36	46.2507	15.2608	445	966	1018	137	164	26	15	0.94	5310	3.92	0.26
396	12.08.18	17:23:37	46.2511	15.2609	450	966	1018	137	162	25	15	0.93	5310	3.92	0.26
397	12.08.18	17:23:38	46.2515	15.2608	450	965.5	1018	135	162	25	15	0.94	5300	3.96	0.26
398	12.08.18	17:23:39	46.2518	15.2607	455	965	1018	133	158	25	15	0.93	5280	3.92	0.26
399	12.08.18	17:23:40	46.2521	15.2604	460	964.5	1018	131	155	25	15	0.94	5270	3.8	0.26
400	12.08.18	17:23:41	46.2523	15.26	460	964.5	1018	130	151	25	15	0.93	5260	3.88	0.24
401	12.08.18	17:23:42	46.2524	15.2597	465	964	1018	130	148	25	15	0.93	5250	3.96	0.24
402	12.08.18	17:23:43	46.2525	15.2592	465	964	1018	130	144	25	15	0.93	5250	3.8	0.24
403	12.08.18	17:23:44	46.2525	15.2587	465	963.5	1018	128	140	25	15	0.93	5240	3.8	0.24
404	12.08.18	17:23:45	46.2524	15.2584	465	963.5	1018	128	137	25	15	0.94	5250	3.88	0.24

Figure 18: An example of flight details upon successful import.

6.2 Engine

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

6.2.1 Engine Type

Depending on specifications of your aircraft, select the correct engine. Figure 19 shows the engine selection window. Setting the engine type allows Emsis to use some fuel consumption model and to activate correct mode in miniDaqu or modified standard Daqu in the case of ECU equipped engines.

Please note that fuel consumption models for carburetor engines are not reliable and it can be completely wrong. We highly recommend using fuel flow sensors instead.

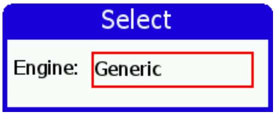


Figure 19: Engine type selection window

6.2.2 Switch Function

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

6.2.3 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 20.

- 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. Many 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.

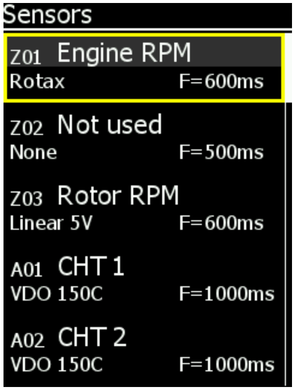


Figure 20: List of sensors connected to Daqu unit

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 V to +2.5 V input, which are typically used to connect resistive sensors and thermocouples.
- B: analog channels with 0 to +5 V input, used to read active sensors. Active sensors require power in order to operate properly.
- C: analog channel with 0 to +30 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 Jabiru 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 21 opens.

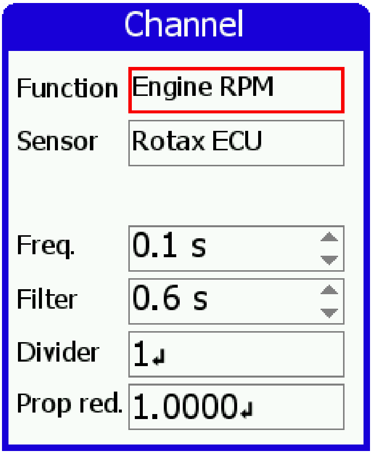
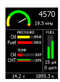


Figure 21: Window for setting a sensor on Daqu channel

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.

6.2.4 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.
In order to show the Min/Max dialog on the screen, select the channel and press and hold the `OK` button (long press). Figure 22 shows an example for pitch trim position sensor.

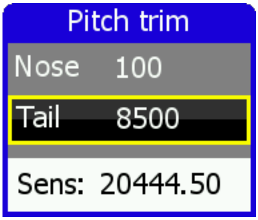


Figure 22: Position sensor min/max window

6.3 Tank

Please refer to section 9 starting on page 58 for more details.

6.4 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.

6.5 Parameters

Since software version 3.11 Emsis allows editing some parameter attributes that are used by the layout. In particular, filter time constant, number of cylinders (EGT and CHT only) and color bands limits can be fine tuned. Please note that some parameters are not suitable for color bands/arcs use (altitude for example). These do not allow color band editing.

Please note that changes made here only affect Emsis. If other instruments are connected to Emsis and if they present same parameters on their screens, these will not adapt to changes made here.

When Emsis is connected to Nesis or Aetos master instrument, then parameter changes done in Nesis/Aetos can be transferred into Emsis. Please refer to the Nesis/Aetos installation manual for more details.

Select the `Parameters` option from the list and enter the `314` password if necessary. This opens up a window with a list of parameters used by the layout. An example is shown in Figure 23.

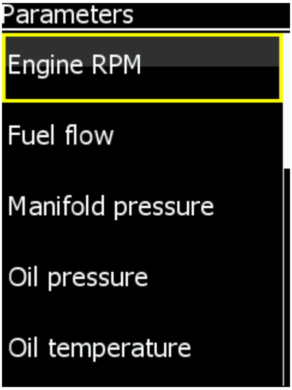


Figure 23: A part of a parameter list. The list depends on the layout in use.

Select a parameter and press the `OK` button. Depending on a parameter type, **`Filter`**, **`Index count`** and bands can be edited. Figure 24 shows an example for CHT.

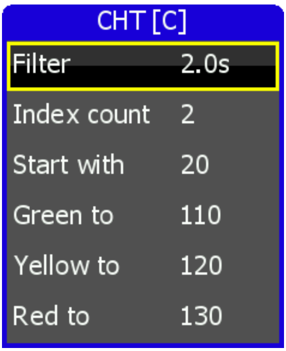


Figure 24: A part of a parameter list. The list depends on the layout in use.

6.5.1 Filter

The `Filter` is used to change the low pass filter time constant for this parameter. A large filter constant gives slower parameter response on a change. Opposite is true for a small value. A filter time constant tells how much time is needed to achieve about 65% change.

Please note that some engine parameters are already filtered by Daqu and you may want to address the response behavior there first. The larger number wins. So, if a large filter is set in Daqu and small value in Emsis, Daqu wins.

6.5.2 Index Count

This options is available to CHT and EGT parameters only. Here one defines how many *tiny sub-bars* are shown in the CHT or EGT compact bar. In most cases you do not want to increase this number as layout may not adapt well accordingly and most probably a layout change is also necessary.

However, you may give it a try, when needed.

6.5.3 Band Colors

Items from example shown in Figure 24 starting with `Start with` and ending with `Red to` define one example of color bands. This particular example tells that the bar starts at 20°C. Next there is a green part until 110°C, followed by the yellow part until 120°C and the bar ends with red part at 130°C.

By changing the `Start with` value, the start of color band is define. All values below this will translate to an empty bar. Correct parameter value will be still shown next to the bar placeholder, just the bar will be empty.

Each color can be increased or reduced next up/down to its neighbor value.

If you *long* press the `OK` button, a window appears which allows you to select some action. The long press is only available on *color to* items. Figure 25 illustrates an example.

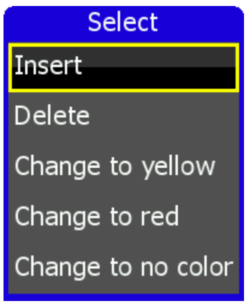


Figure 25: Action selection on `OK` long press. The long press only works on *color to* items.

The following actions are possible:

`Insert` will insert a new color part before the selected one. A newly inserted part is a placeholder. Its color will be set to `No color` and its corresponding value is set in the middle between previous part and this one. You have to change the color and its value afterwards.

`Append` works similar as Insert. It is not shown on the Figure. It appears only when the last color item is selected. It will create a placeholder after the last item.

`Delete` removed current color part from the band.

`Change to...` changes the color selected band part. Current color is omitted from the list.

6.6 Units

Units configuration is accessible by selecting the Units option from the *Setup* screen. A window illustrated in Figure 26 opens.

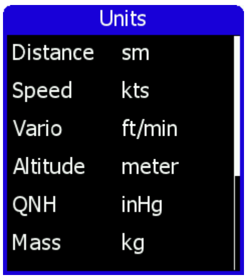
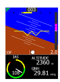


Figure 26: List of configurable units in Emsis unit

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

6.7 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.

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
Vertical speed	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

On startup, you will be asked to select the pilot and instructor for the flight. Emsis asks only if more than one pilot/instructor is provided.

The selected pilot/instructor information is also stored in logbook at the time of the takeoff.

6.8 Maps

Please refer to section 5.3.

6.9 Service

The Service menu opens a window illustrated in Figure 27. It always asks for password. You have to enter standard password `314`.

See section 7 for more details.

Figure 27: Emsis Service menu

6.10 About

The About window shows some relevant information about Emsis. An example is shown in Figure 28.

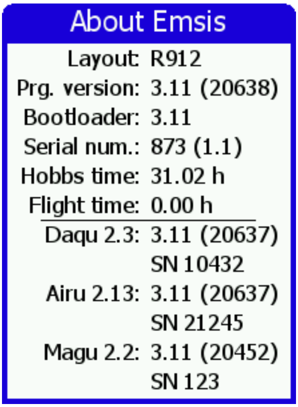


Figure 28: An example of the `About` window.

The information includes:

- Selected layout name.
- Emsis program version,
- Emsis boot-loader version,
- Serial number and hardware version,
- Total Hobbs time (power on time),

- Total flight time,
- List of other devices detected on the CAN bus. Each if this device tells:
  - Device name and its hardware version,
  - Software version and its SVN number,
  - Serial number.

When there are more devices to fit on the single screen, use up/down arrow to scroll screen up or down.

7 Service

The service menu window gives access to many different options listed below. The actual content shown on the screen also depends on devices detected on the CAN bus.

The service window is accessed from the `Emsis Setup` page by selecting the `Service` item and entering the `314` password, see Figure 27.

`Layout` allows you to select current layout from all layouts loaded into Emsis. Normally, you do not need to change this.

`Import layout` lists all layouts available on the external SD card. Select the layout to import. Once layout is imported, it will be automatically selected as the active layout.

`Import alarms` lists all alarms available on the SD card. By selecting an alarm, it will be imported from the SD to Emsis and activated by default.

`Restore parameters` loads parameter limits from the layout and overwrite changes you made on parameters.

`AHRS level` is used to define the *zero reference level* for the AHRS.

`Turn Rate` sets turn rate sensitivity – sensitivity of the heading rate bar on AHRS window.

`Compass calibration` is used to calibrate the Magu (electronic magnetic compass).

`Compass offset` is used to make fine adjustment of Magu.

`Dir. source` sets the source for the direction indicator.

`Firmware update` is used to update the software in Daqu, Airu, Magu.

`RamBoot update` is used to update the initial boot software.

`Logger settings` is used to define some logger settings.

`Prop. pitch settings` defines minimum and maximum angles for propeller pitch.

`Up/Down` is used to define default behaviour of `up/down` buttons.

`Set alt & IAS offset` is 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 channel 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:

7.1 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 29 shows a window for selecting a layout.

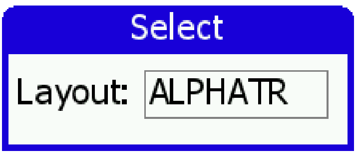
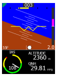


Figure 29: Window for setting Emsis layout

- press `Ok` to start (the frame gets yellow background).

- use **up** and **down** buttons to change layout and confirm with the OK button,
- push the Close button to save and exit the window. Emsis will restart.

7.2 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 30 opens.

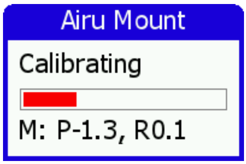
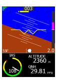


Figure 30: Calibrating the AHRS level

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.

7.3 Compass Calibration

This is just a brief description. Please refer to the Magu manual for more details.



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. Please, 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.

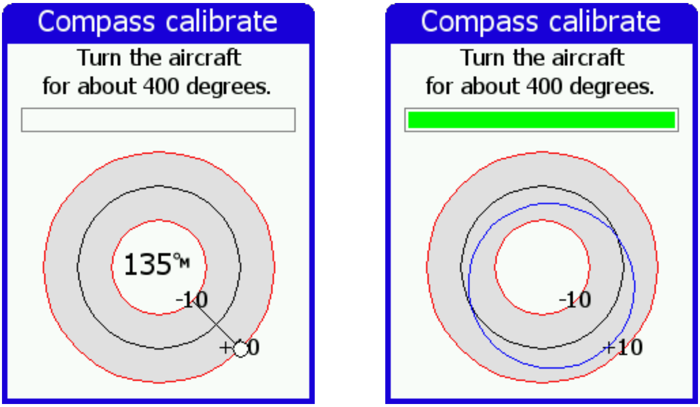


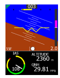
Figure 31: Calibrating Magu, situation before rotating (left) and after full rotation (right)

When ready, you need to rotate the aircraft for about 400°. Direction of rotation and start azimuth are not important. 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°are generally accepted as appropriate. If you constantly get correction curve larger than 15-20°, then you probably need to find a better location for Magu. The correction in Figure 31 reaches about 8°.

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.

7.4 Compass Offset



This is just a brief description. Please refer to the Magu manual for more details.

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. Write down the 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.

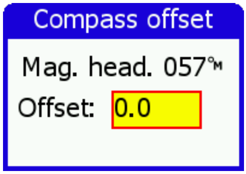


Figure 32: Compass offset window - final adjustment of compass

7.5 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.

7.5.1 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.

7.6 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.

`Takeoff` threshold specifies IAS, which must be exceeded for a few seconds for a logger to detect and record a take-off event. This also works in conjunction with `Takeoff rotor` RPM.

`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 `Landing rotor RPM`.

`Det. delay` defines number of second for takeoff/landing condition to be met. This prevents most false detections due to wind bursts.

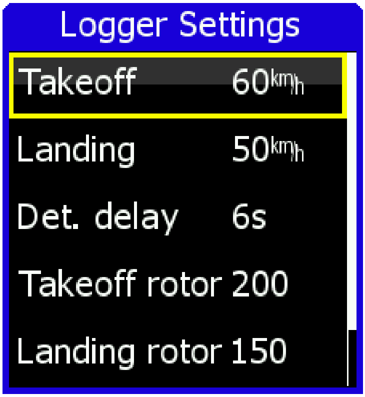


Figure 33: Logger settings window

`Takeoff rotor` RPM threshold shall be only set for helicopters. This is used to detect hovering takeoff, where IAS is low (below the IAS threshold). Takeoff is detected once rotor reaches this takeoff rotor limit even if IAS is zero.

`Landing rotor` RPM threshold shall be defined for helicopters and gyrocopters only. In order to detect the landing situation, the logger monitors two things: IAS and rotor RPM. They both must be below the specified thresholds in order to detect the landing. This prevents false landing detections.

`Engine RPM` threshold is used to detect the engine start or stop event.

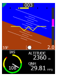
In principle landing IAS threshold shall be a bit smaller than takeoff IAS threshold. When these two are well defined, most touch-and-go events will be detected properly. Usually, some experimenting is needed.

7.7 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.

7.8 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 34 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.

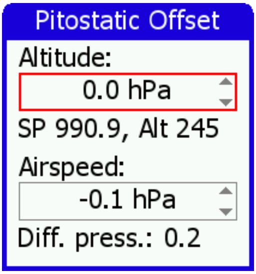


Figure 34: Altitude and IAS offset window

7.9 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.

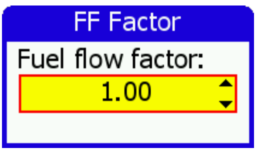


Figure 35: Fuel flow factor window

8 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.

8.1 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.

8.1.1 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 36:

① Total pressure port – must be connected to the total pressure tube.

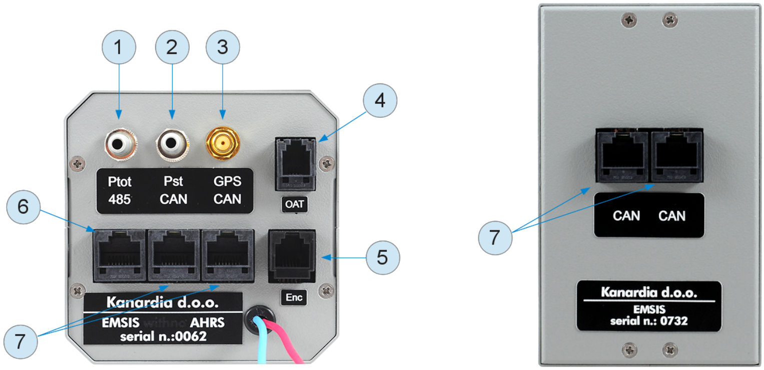


Figure 36: Emsis unit with AHRS built-in (left), Emsis slave unit (right). Both versions are available in 80 mm and 3.5” screens

- (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 asindicators or LX Cluster.
- (7) Two CAN ports[4] – 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 37 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.

[4] Emsis PFD is shipped with a connector inserted into one CAN port. It is a 120 Ω network terminator resistor to start and terminate the network. When Daqu unit is connected, terminator can be disconnected.

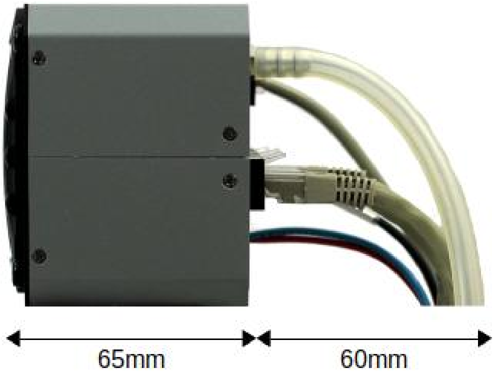


Figure 37: Side photo of Emsis 80mm version with all cables connected

8.2 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.

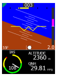
Make sure that all units share the same common ground. There should be none or minimal voltage (up to 10 mA) between common ground and each unit ground, when all units are turned on. Otherwise your aircraft electrical system needs a good inspection.

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.

8.3 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.

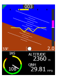
Pitot-static consists of static pressure tubing and total pressure tubing.

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.

8.4 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 38: Inserting the OAT probe (left), cap is in place, tighten the internal nut, slide the insulation tube (right)

8.5 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.

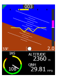
In standard configurations with Emsis PFD, one CAN port is connected to terminator, while the other is unused or connected to other Emsis unit. One CAN port may be used to connect with Daqu (engine monitoring unit), in this case terminator can be disconnected.

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

8.6 Connection to the 485 Network

The RS-485 connector is obsolete. It was used to connect devices via 485 protocol.

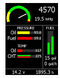
8.7 GPS Antenna Installation



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.

9 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.

9.1 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 39. 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.

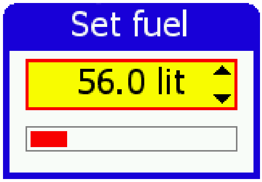


Figure 39: Software (simulated) fuel tank level adjustment

9.2 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 40 opens. *T2* options are shown only when the second fuel level channel is also active.

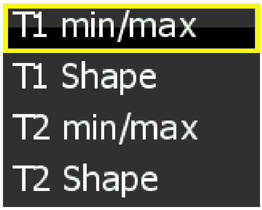


Figure 40: Tank options.

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.

9.2.1 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).

9.2.2 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 41a.

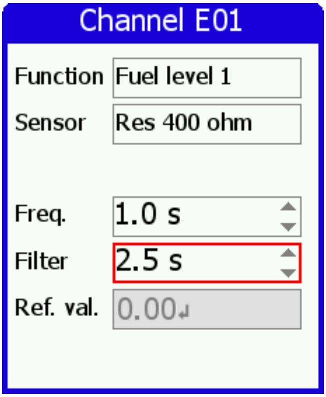
Sometimes an active sensor is used. (Note: Capacitive sensors are just a special case of active sensors.) These sensors usually output voltage in 0-5V range. Let's assume that sensor is connected to E02 channel. Such a sensor shall be then configured as it is shown in Figure 41b.

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

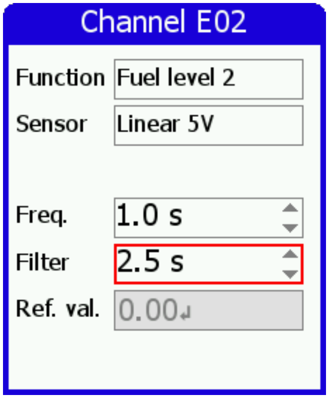
9.2.3 Tank Calibration in Steps

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.



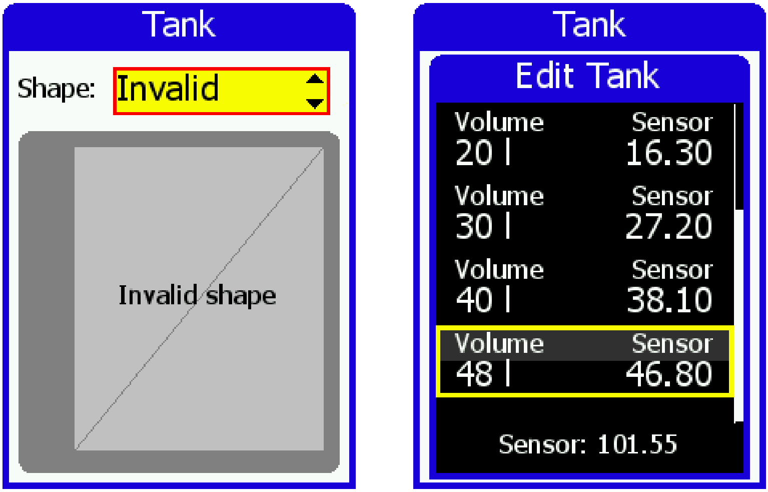
(a) Channel E01 set for a tank with a resistive fuel level sensor for a measuring range between 0 and 400 Ω.



(b) Channel E02 set for a tank with an active sensor (e.g. a capacitive sensor) with voltage output in 0-5V range.

Figure 41: Two most typical examples of fuel level channel configurations.

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 42a is displayed. Please read the *IMPORTANT* box on the page 63.
6. Press and hold the `OK` button – this opens *Edit Tank* window, Figure 42b. (On older SW versions you had to press and hold the `Down` button.)
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



(a) A *Tank* window example. Yours will be a bit different.

(b) An *Edit Tank* window example. Yours will differ.

Figure 42: Tank main window and tank edit window examples.

– 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.

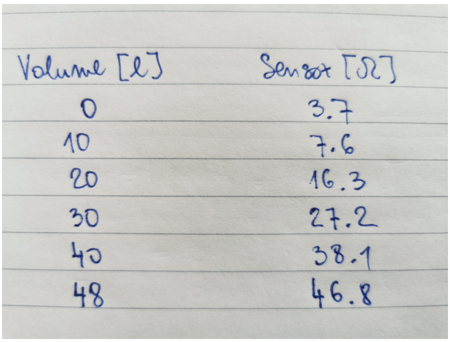
12. Repeat this procedure until the tank is full. Be careful here. You may have a case where sensor stops reacting (has reached its max point) way before the tank is completely full. Stop at the point where sensor do not react anymore.

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 43 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.



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

Figure 43: Example of notes made during a tank calibration.

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).

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.

9.2.4 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 40.

2. Select *T1 Shape*. This opens a tank shape window, Figure 44. 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 63.

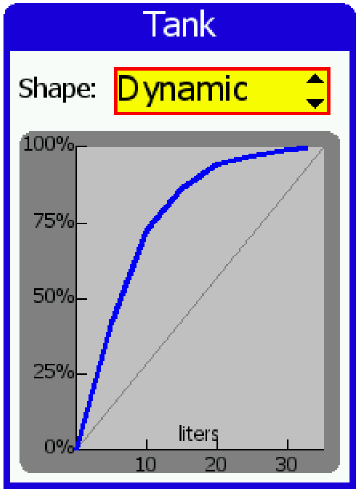


Figure 44: Tank shape selection window. The figure shows that the curve for the Dynamic WT9 tank is very non-linear

3. Once the correct shape is selected, press `close` to save the selection.
4. Select the *Tank:T1 min/max* from the menu. Figure 45 shows an example.

Figure 45: 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.

10 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.

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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:

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