Nesis III/IV User Manual

Revision 4.1

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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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Some open source code is used in the Nesis software:

- https://angusj.com/clipper2/
- https://flatbuffers.dev/

- https://www.oberhumer.com/opensource/lzo/
- https://rapidxml.sourceforge.net/
- https://www.sqlite.org/index.html
- https://www.nayuki.io/page/free-small-fft-in-multiple-languages
- https://rapidjson.org/
- https://design.ubuntu.com/font

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Revision History

The following table shows the revision history of this document.

Rev.	Date	Description
4.1	Jun 2025	Revision number is now matching the SW revision.
4.0	Jun 2025	SW 4.x: Complete review, most of figures were changed. Nesis IV introduction and its specifics were added.
2.3	Jan 2024	Metal debris (particles) detection added to the engine screen.
2.2	Feb 2023	SW 3.11: Chapters introduced, MWFly engine support, minor gauge configuration improvements, Modern screen PFD and Map full screen view, partial parameter synchronisation with Indu and Emsis.
2.1	Dec 2022	SW 3.10: Alarm signal line in service connector is now supported.
2.0	Oct 2022	SW 3.10: Screen editor, parameter storage and transfer, synchronization, new average fuel flow model, many minor fixes.
1.4	Apr 2022	SW 3.9: Approach chart capability, many minor fixes and improvements.
1.3	Oct 2020	SW 3.7: New route planning page, wired GDL90 support, trim positions on all screens, METAR reports interpretation, bug fixes.
1.2	Mar 2020	SW 3.6: New traffic message, various counters in info, removing unnamed waypoints, engine only logs, improved Rotax iS support, CAS support, WiFi GDL90 support, bug fixes.
1.1	Jan 2019	SW 3.4: GNSS Constellation window added, CTR is shown filled, UL Power, MWFly engine, Trig radio, Eagle Flarm, AIR Traffic support, GSA added to standard NMEA output, parameter editor enhancements, bug fixes.
1.0	Sep 2018	Complete manual rework to match software version 3.3

Contents

Chapter 1

Introduction

1.1 Introduction

First of all we would like to thank you for purchasing our product. Nesis is a complex instrument and we strongly recommend reading the manual before using Nesis. The introduction chapter contains some general information about the instrument and principles of the operation. Later chapters describe Nesis use and reveal the details. You may be also interested in reading:

- Nesis Installation Manual,
- Daqu or MiniDaqu Installation Manual,
- Magu Manual,
- Approacher User and Installation Manual,
- Autopilot Installation Manual
- Sven Manual
- Checklist Manual
- our web page www.kanardia.eu, in particular the `SUPPORT | Documentation` section, where all published material can be located.

1.1.1 Icons Used Through the Manual

A few icons appear on the side of the manual, which have special meanings:

This icon denotes information that needs to be taken with special attention.

This icon denotes background information about the subject.

This icon denotes a tip.

This icon denotes a touchscreen action.

1.1.2 Warnings

The following warnings and limitations apply, when you use this instrument. Failing to do so, may result in significant injuries or even death.

- Before using the instrument, you shall carefully review and understand the Nesis system and Operating Handbook of the aircraft.
- Information from the Aircraft Operating Handbook always supersedes Nesis information.
- Use of any navigational data contained by Nesis is entirely at the pilot's risk.
- Carefully compare Nesis navigational information with other available navigational sources. In the case of any discrepancies, resolve them before proceeding with the navigation.
- The navigational data used in Nesis comes from various public domain and open data sources. Although the data was carefully crosschecked (where this was possible), the data may contain serious errors. The pilot is obliged to verify any navigational information provided by Nesis, with the relevant official sources, AIPs, Notams, etc.
- Databases in Nesis must be updated regularly in order to stay current. Such databases are freely available from our web site.
- Terrain elevation data shall not be used for terrain separation. Its use is informative only. The pilot must always fly in VFR conditions and he must maintain visual separation.

- Do not rely on the traffic information and traffic warnings shown by the device. It is solely the pilot responsibility to look out, to see and avoid other aircraft. The other aircraft position depicted on the screen may be wrong due to lack of proper equipment, poor reception and inaccurate or old information.
- Do not use weather information for maneuvering in, near, or around areas of hazardous weather. Weather information may not accurately depict current weather conditions.
- Never use Nesis to attempt to penetrate a thunderstorm. Always avoid any thunderstorm at least 30 km.
- The Global Positioning System is operated by the United States government, which solely responsible for its accuracy and maintenance. In a similar way, Russian government is responsible for the GLONASS system. The GNSS systems are subject to changes which could affect the accuracy and performance of all GNSS equipment. Therefore, the navigation information can be misused or misinterpreted and become unsafe.

1.1.3 Cautions

- The Nesis display uses special coating, which is sensitive to abrasive cleaners or cleaners which are using strong chemicals like ammonia or alike. Always use a lint-free soft cloth and mild cleaning solution or just pure water.
- Nesis does not have any serviceable parts. Repairs must be done only by authorized service centers. An unauthorized repair could void warranty.
- Due to high complexity of the system, the pilot must accept that providing self-test capability for all possible system failures is not practical. This means that an erroneous operation may occur without a fault indication or warning. This makes the pilot responsible to detect such an occurrence by means of cross-checking with all redundant or correlated information available.

1.1.4 USB Memory Stick

Many Nesis operations require a USB memory stick. One such stick is provided together with the instrument. You can also use any other USB memory stick as long as:

1. The stick capacity is 32 GB or less.
2. The stick is formatted to FAT32 format.
3. Hint: avoid using top notch high speed sticks. Nesis may have problems detecting them due to the age of underlying Linux operating system.

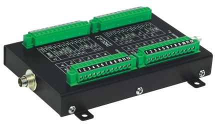
1.2 System Overview

The Nesis System consists of several electronic components, which work closely together to bring flight, engine, traffic, fuel,…information onto graphical display. Some of these are required and some are optional.

1.2.1 Required CAN Bus Components

Majority of these components communicate through CAN bus. This section lists components and explains their interaction. Please note that photos are not in scale.

`Nesis` master display is the major part of the system. It acts as a primary multi-functional display. Internally it hosts an embedded computer and an AD-AHRS-GNSS module called `Airu`. The embedded computer reads information from the CAN bus and translates it into graphics you see on the screen. The Airu module consists of multiple sensors: absolute pressure sensor for altitude and vertical speed, differential pressure sensor for airspeed, 3 axis angular rate and 3 axis accelerometer sensors for artificial horizon, GNSS sensor for position and OAT probe for true airspeed. Sensor readings are passed through various mathematical models which in turn put the information on the CAN bus. Airu is actually an independent device mounted inside Nesis for convenience.



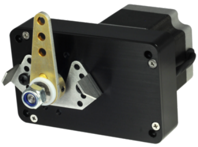
Engine monitoring (called `Daqu`) is required to read the engine, fuel and aircraft related sensors and to put the obtained information on the CAN bus. It has three digital channels (Z1, Y1 and Y2), twenty analog channels (A, B, C, D) and a special manifold pressure connector (A13). Daqu also hosts +5/+12 V *power output* and ground (GND). Digital channels are typically used to read engine or rotor RPM and fuel flow sensors. Analog channels are typically used to measure CHTs, EGTs, coolant temperature, oil temperature, carburetor temperature, airbox/gearbox temperature, fuel levels, system voltage, electrical current, oil pressure, fuel pressure, hydraulics pressure, pitch trim, flap position and many others.
Daqu comes in three forms:

- `Standard Daqu` is typically used with carbureted engines like Rotax 912 UL, ULS, Rotax 914, Jabiru, Lycoming, Continental, etc.
- `Mini Daqu` is typically used with an engine that has its own ECU. Rotax iS, D-motor, MW, various electrical motors, etc. Mini Daqu allows for a few additional sensors like Rotor RPM, fuel level, fuel pressure, etc.
- In some cases there is not enough channels on Mini Daqu. In this case, standard Daqu modified for an ECU engine can be also used. This in fact works like Mini Daqu, but with much more channels. Often used with ULPower engines, for example.

1.2.2 Optional CAN Bus Components or Accessories

Components listed below are all optional. This means they are not required for normal Nesis operation.

Electronic Compass (called `Magu`) is a stand alone unit which measures magnetic field vector. It serves as a gyro stabilized compass and provides true and magnetic heading with high accuracy. It features an intelligent calibration algorithm, where only one known magnetic direction is needed to calibrate it.
Magu provides heading information on the CAN bus. With this information available, wind direction and wind speed is also derived by the Airu unit.
Tail install and nose install versions of Magu exist.



When two servo units (called `Seru`) are added to the CAN bus, the system also performs the autopilot function. Seru II has a integrated clutch. Seru I has no clutch and it comes into two variants: stronger and heavier has 6 Nm (53 in lb) torque, while the lighter and weaker has 3 Nm (27 in lb) torque. Since 2025 we supply only Seru II.

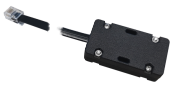
Remote autopilot panel (called `Amigo`) brings further enhancements to the autopilot functionality. It allows very simple and straightforward autopilot operation.

One or two remote control handles (called `Joyu`) can be added to the system. The handle allows almost complete control of the Nesis display with the buttons on the top. Buttons are fully configurable by Nesis. When Boxi unit is also present, it can also drive roll and pitch trim, radio transmission button (push-to-talk).

Trim and radio controller (called `Boxi`) must be used together with a Joyu handle. You can connect two trim motors to Boxi and then use Joyu handle to drive them. In addition, radio push-to-talk wiring can be made directly to Boxi.

`Dimu` is a dimming device. Its only job is to adjust LCD brightness of all devices connected to the CAN bus with a simple rotation of the knob. It also provides analogue output for third-party devices.

Small WiFi plug is used to connect Nesis to the WiFi network. This can be done with the help of a network access point created on a mobile phone. Nesis is connected to the Internet as long as the mobile phone is also connected. Alternatively, some public WiFi hot-spot can be also used, while aircraft is on the ground. Such connection can be used to make software updates, map and airspace updates and to access weather information. Note: Not all WiFi devices are compatible. See the Nesis Installation Manual for more details.



Sven is a Bluetooth - RS232 converter used to connect Nesis to a third party app communicating using low energy bluetooth (BLE) serial protocol. One such app is SkyDemon, but others exist as well. The requirement is that an app transmits standard NMEA positional sentences and `$GPRMB` sentence as a minimum. Please note that a it also exist a Sven-Amigo variant, which does the same, but connects to Amigo instead.

An external carbon monoxide (CO) sensor can be connected directly to Nesis. In the case of elevated CO concentration buildup, a visual and acoustic alarm will appear.

1.2.3 Optional CAN Bus Displays

The system can be extended with several displays. All these displays are optional. They have no internal sensors. They get the information from the CAN bus.

Slave Nesis Display can be added to the system. It has the same functionality as the master Nesis. The only difference is that it does not host the Airu unit and that some system tuning options are not accessible.

Slave Aetos display with diagonal size 7 inches is very similar to slave Nesis display. The Aetos display does not have touch screen and there are no maps available, however it includes 3D synthetic vision.

A rectangular, very slim and very light LCD display (called `Digi`) is typically used to show engine values. The values can be shown in the form of arcs, bars, boxes and values. Start of display is very fast. You can read oil pressure almost immediately, while Nesis primary display is still booting.
One or more slave round instruments (called `Indu`) can be added to the bus. They can show almost any value, which is available on the bus. The most typical are: airspeed indicator, altimeter, vertical speed indicator, engine RPM, rotor RPM, G-meter, etc. All indicators consists of a needle pointing to a scale and a LCD display. Pointer is driven by a stepper motor. Needle shows one value, but LCD display may show up to three different parameters.

`Horis` slave display can complement the Nesis system, too. Horis can show PDF screen, DI screen or G-meter screen.

Chapter 2

Screen Operation

This chapter will familiarize you with Nesis screen capabilities.

2.1 Overview

The Nesis command panel is organized according to Figures 2.1 and 2.2, depending on the model. It uses three push buttons and one push knob for manipulation. It has an USB port for software, map and data updates. Most actions can be also activated using the touch screen.

Figure 2.1: Nesis IV 10" display organization. A separate command panel named `Kliky` is connected to Nesis. Klicky is mounted separetely from Nesis in any orientation.

Figure 2.2: Nesis III display organization. Buttons and knob are integrated into the bezel.

Here is a brief description of individual items:

① The touch screen. It works just as touch on tablets and telephones do. It detects single touch, long single touch, multi touch, touch and drag, swipe, pinch.

② The Selector knob detects knob rotation, short push and long push. It is mostly used to select things, confirm selection, change values, change zoom levels, etc. Rotate the knob to select things and push the knob to confirm. Long push action opens the *options* screen.

③ A short push on the button will perform Close/Back/Cancel commands. It is mostly used to close windows, to go back or to cancel some action. Long push action is user configurable.

④ The User button. Both, short and long push are user configurable. By default it shows the list of nearest airports. However, when autopilot is detected, the default action opens the autopilot menu.

⑤ A short push on the Screen switching button is used to switch to the next screen. Long push action is user configurable.

⑥ The USB port is used for software, map and data updates, to copy the flights and logbook, etc.

In most cases you only use the selector knob and the close button.

Short push is defined as a momentarily press and release of the button. An associated action is activated on the release.

Long push is defined as a press-and-hold of the button. Button must be pressed and keep pressed for about two seconds. An associated action will be activated after two second period even if the button was not released yet. Nothing happens on release.

2.1.1 Touch Screen

The touch screen significantly simplifies handling and proves to be very helpful. It behaves in a similar way as most smart telephones and tablets do. Additionally it supports some swipes (gestures) listed below:

- Standard touch and long-touch actions are availble on many screen items.
- A swipe across the screen to the left switches to the next screen.
- A swipe across the screen to the right switches to the previous screen.

- A swipe upwards opens the main menu.
- On a map, place two fingers on the screen and pinch in or stretch out. This will zoom the map.

The list above is illustrative. More touch actions are revealed throughout the manual.

2.1.2 Turning ON/OFF

Nesis is usually connected to an avionics power bus which has a mechanical switch between the bus and the battery. Thus it is automatically turned ON and therefore it does not have an ON/OFF button.

Nesis has a pretty low power consumption. So, you may try to activate Nesis before cranking the engine. This works well in vast majority of cases assuming the battery is in good condition and power lines are are not too thin. If Nesis resets during engine start, this may indicate that the battery is becomming weak or some installation problem (long thin power lines or similar).

2.1.3 Start-up Sequence

On start, Nesis executes a start-up sequence illustrated in Figure 2.3:

1. Use the knob to confirm the warning (push the knob),
2. select the pilot,
3. select the copilot or passanger,
4. select the baro correction (rotate until correct value is shown and then push the knob),
5. Set the fuel level (for virtual software tanks only – not shown on the figure).

You are asked for the pilot and copilot only if more than one crew members are entered into the crew list. Please see Section 9.4 on page 131 to see how to define crew list.

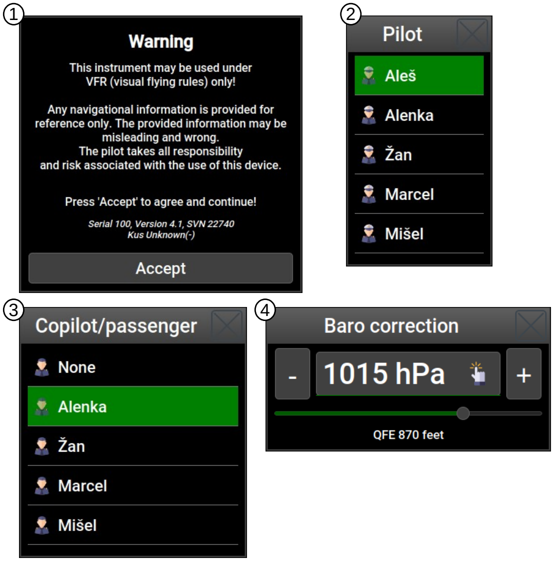


Figure 2.3: Typical start-up sequence: warning, pilot, copilot and baro correction.

2.1.4 Status Bar

All screens show status bar on the top with the engine screen being an exception. The status bar holds some valuable information. It is illustrated in Figure 2.4.

Figure 2.4: Illustration of the Status bar.

Status bar has the following elements:

① Outside air temperature.

② Flight time - time elapsed after takeoff was detected. In the case of traffic patterns, time since the last takeoff (touch-and-go) is shown.

(3) Bearing and distance to the next navigation point. (Only when navigation is active.)

(4) Estimated time of arrival to the next navigation point. Below is name of the navigation point.

(5) Steering indicator on the top and current course on the bottom. A yellow line left of the center means that you should steer left and a yellow line right of the center means you should steer right. Steering indicator is pretty sensitive. A flashing yellow line indicates that course deviation is too large to fit on the scale.

(6) Estimated time of arrival to the destination. Below is the name of the destination. (Only when route navigation is active.)

(7) Ground speed derived from GNSS.

(8) Actual time and sunset time alternate periodically. The actual time is shown most of the time, while the sunset time appears briefly.

(9) Various status symbols. More details are given next.

GNSS Symbols

These symbols show health of the GNSS receiver and reception of the GNSS satellites.


A flashing red satellite symbol indicates an error. It means that communication with GNSS receiver was lost.

A grey symbol indicates that GNSS is working, but position is not available.


A cyan/gray color symbol indicates that only 2D fix is available – position is known, but its precision is limited.


A cyan color symbol indicates that full 3D fix is available.


This cyan color symbol indicates that precision of position is further enhanced with some augmentation system (WAAS, EGNOS, etc.)


A flashing warning symbol appears over the GNSS symbol when the primary GNSS source[1] has been lost and Nesis has switched to the backup GNSS source, when such source is available.

[1] Internal Airu module is considered as the primary source.

Flarm Symbols

These symbols appear only when a Flarm® device is connected to the Nesis. If none of the symbols is shown, it means that communication was not established successfully.


A gray Flarm symbol indicates that communication with Flarm device was established, but Flarm is still not ready.


A gray symbol with cyan triangle indicates that Flarm received its own GNSS signal, but Flarm internal radio module is not active/not working.


A gray triangle with cyan arcs indicates that Flarm radio is working, but Flarm GNSS signal is not yet available or Flarm GNSS is not working.


A full cyan symbol indicates that Flarm is working properly.


A flashing red symbol indicates that Flarm has experienced an internal error and it may not be working properly or it does not work at all.

If connection between Nesis and a Flarm device was not established, no symbol apears. This means that either device is not present or it is not working or Nesis does not communicate properly with the device (wrong baud rate, parity, wrong connection, etc.)

GDL90 Devices

When an ADS-B device is connected with Nesis either over WiFi or directly with a cable and GDL90 communication protocol is used, the the following symbols appear.

A gray symbol indicates that communication with device was established, but the device is still not ready.

A cyan symbol indicates that communication with device was established and the device is ready to be used – it is working properly.

A red symbol indicates that device is in errorneous state and it should not be trusted.

If connection between Nesis and a GDL90 device was not established, no symbol apears. This means that either device is not present or it is not working or Nesis does not communicate properly with the device (wrong baud rate, parity, wrong connection, etc.)

Radio, Transponder and WiFi Symbols

Nesis can connect to some external devices like radio, transponder and traffic monitor using either RS232 ports or WiFi.

A communication with COM radio device was established.

T A communication with transponder device with the intention to set transponder squawk was established.[2]

A WiFi module was detected and communication was established. Note that this does not automatically mean that Nesis is also connected to the Internet. Nesis is connected to the Internet only when the host device (say mobile phone) is connected to the Internet.

External Navigation

Nesis can be connected with some external navigation device. This device may then act as the main navigation source. One of the following two symbols appear on the status line:

E A communication with some external navigation device was establied, the device is transmitting navigational information (active waypoint or route) however, the device is not used as the navigation source.

E A communication with some external navigation device was established, the device is transmitting and is also active as the navigaion source.

2.1.5 Screens

Nesis allows you to switch between different screens. Screens content depend on the Nesis model. Nesis III has more screens than Nesis IV, which seems like a contradiction.[3]

[2] The transponder symbol does not appear when NMEA information is being sent from Nesis to transponder.

[3] We are trying to simplify the use of Nesis, hence we decide to reduce number of screens in Nesis IV comparing to Nesis III. For example, Nesis III kept the `Classic` and `Engine` screens for backward compability, but this will change in the future versions, where these screens will be removed.

Nesis IV can show up to four different screens, Figure 2.5.

Nesis III can show up to six different screens, Figure 2.6.

Use short press on the *Screen switch button* to switch between the screens. Or use left or right swipe touch action to switch between the screens.

More details about each screen are given in next sections.

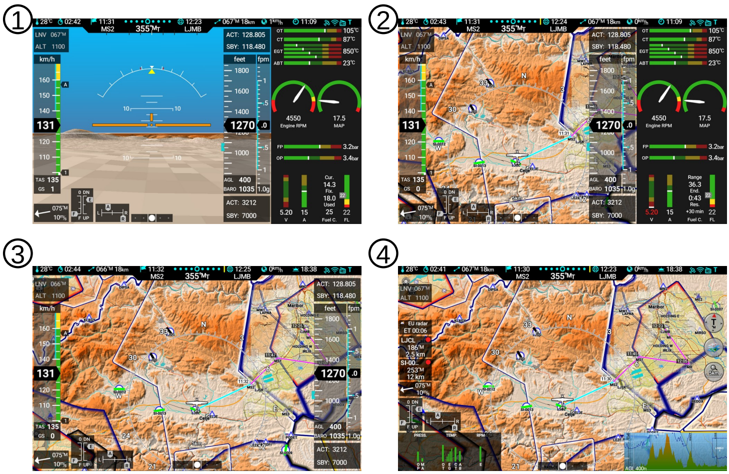


Figure 2.5: Typical screens on 10" Nesis: 1 - Modern Screen (AHRS) with engine section, 2 - Modern Screen (map) with engine section, 3 - Modern (map), full screen version, 4 - Navigation Screen.

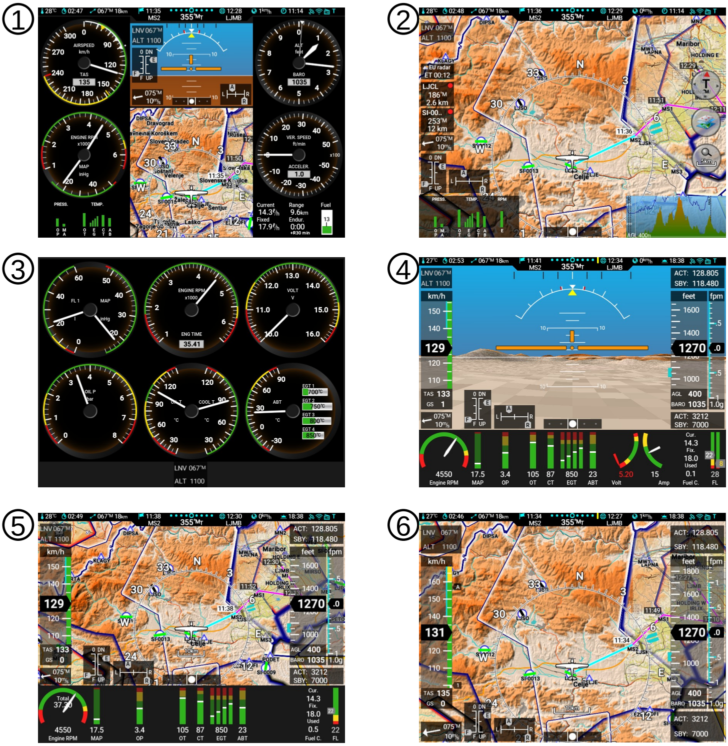


Figure 2.6: Typical screens on 8.4" Nesis: 1 - Classic Screen, 2 - Navigation Screen, 3 - Engine Screen, 4 - Modern Screen (AHRS) with engine section, 5 - Modern Screen (map) with engine section, 6 - Modern (map), full screen version.

2.2 Classic Screen

This option is limited to Nesis III only for compatibility reasons. We anticipate to remove this screen starting with software version 4.5.

The classic flight information screen shows information, which is the pilot's primary concern. The default screen organization follows the recommended IFR T layout (classic six-pack). Figure 2.7 on page 33 shows an example of this screen. Please note that your screen can be significantly different.

Figure 2.7: Illustration of the classic flight information screen.

This screen has the following typical elements:

1. Status bar. This bar is shown on the top of most screens. Please refer to Section 2.1.4 on page 27 for more details.

2. The airspeed indicator displays IAS (indicated airspeed) and TAS (true airspeed). The indicator background can display white, green, yellow arcs, V_{NE} limit, recommended approach speed and other important speed limits. See also Section 2.2.1 on page 34.

3. The artificial horizon indicator provides current attitude and side-slip information. Roll and pitch angle can be read from the top and middle scale respectively. The ball indicates the side-slip. Trim indicators (roll, pitch, yaw) and flap position are shown when corresponding position sensors are connected. If autopilot servos are connected an autopilot indication is shown in top left corner. A touch on the horizon will toggle between 3D view and standard view. See also Section 2.2.2 on page 36.

(4) The altitude indicator shows current baro-corrected altitude. It is available in feet or meters. When scale is given in feet, the third needle is shown as well. It also displays current QNH reference pressure (aka baro-correction). Pressure altitude and other details are accessible when touching the indicator. See also Section 2.2.3 on page 37.

(5) The RPM indicator is combined with the manifold pressure gauge. This combination allows optimal setting of power level. Gyroplanes and helicopters have rotors and in this case engine RPM is usually combined with rotor RPM. See also Section 2.2.4 on page 38.

(6) The moving map provides basic navigation information. It is located below the artificial horizon. The moving map can be configured to follow aircraft true heading, tracking or magnetic heading. This map can be also replaced with a direction indicator (see page 43). A touch on the moving map switches to the navigation screen.

(7) The vertical speed indicator. The indicator can be combined with g-meter (acceleration) located below the center.

(8) The mini engine window organizes important engine parameters into simple colored bars. Each bar corresponds to one parameter and the color of the bar to its current status. See also Section 2.2.7 on page 41.

(9) The fuel computer window provides the fuel and economy information. Level of the fuel in tank, current and average fuel consumption, approximate range and endurance. This monitor can be also replaced with some other windows. See also Section 2.2.8 on page 41.

Please note that most of the items in the classic screen are customizable. Refer to the `Installation` manual for more details.

Classic Screen Elements

Nesis classic screen have several different elements that are combined into one screen. Each of these elements have some specific features.

2.2.1 Airspeed Indicator

The airspeed indicator is used to display indicated and true airspeed. Indicated airspeed (IAS) is obtained from differential pressure sensor. The measured differential pressure (the difference between the total pressure and the static pressure) is converted into velocity assuming ISA conditions[4]. When outside temperature is known, true airspeed (TAS) is given as well. The scale has several markings as you can see in Figure 2.8.

Figure 2.8: An airspeed indicator example optimized for an aeroplane using two step landing flaps.

The markings in the figure have the following meanings:

(1) IAS (indicated airspeed) is presented by a needle, which starts at centre and ends at scale markings.

(2) TAS (true airspeed) is shown as a number inside the window.

(3) The white range is the normal range of operating speeds for the aircraft with flaps extended as for landing or take off. Depending on the aircraft, the white range may have additional upper speed limits, which are based on flap extension step. See also V_{FE1} and V_{FE2}.

(4) The green range is the normal range of operating speeds for the aircraft without extended flaps. The lower limit of the green range is also referred to as V_S – stall speed or minimum steady flight speed at which the aircraft is still controllable. The upper limit is also referred to as V_{NO} – maximum structural cruising speed.

(5) The 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.

[4] ISA – International Standard Atmosphere

⑥ V_{NE} (velocity never exceeded) – red-line mark indicates the maximum demonstrated safe airspeed that the aircraft must not exceed under any circumstances.

⑦ Units used for the indicated and true airspeed.

⑧ Optional V_{Ref} (yellow triangle) – landing reference speed, which is the recommended speed used on landings.

⑨ Optional V_Y speed (blue mark) – speed which results in the best rate of climb.

⑩ Optional V_{FE1} and V_{FE2}. When both are used, a white dot indicates a speed where first degree of flap can be used. The full flap extension speed limit is represented by V_{FE2} and it should in principle match end of white arc.

2.2.2 Attitude Indicator

The attitude indicator, also known as artificial horizon (AHRS), is used to inform the pilot on the orientation of the aircraft relative to earth. It indicates pitch and roll[5]. Figure 2.9 illustrates the attitude indicator combined with the inclinometer (ball).

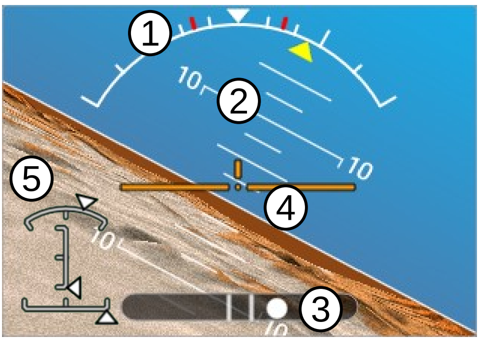


Figure 2.9: Attitude indicator combined with the slip – skid indicator.

The following markings are found on the indicator:

[5] Roll is also known as bank. The term bank is often found in literature but we prefer the term roll.

① The roll scale is used to give a rough estimate about the roll value. The roll arrow in the form of yellow triangle is used to mark current roll value on the scale. The white triangle on the scale identifies zero roll. Two short dashes identify 10° and 20° roll. Larger dash is used for 30° roll, next short dash for 45° and final longer dash for 60°.

During flight, two orange markers identify the roll required to keep standard turn rate. Please note that turn rate marker position depend on the airspeed and they move as speed is changed.

② The pitch scale gives a rough estimate about current pitch angle. The scale should be read at the middle point of the yellow wing reference line.

③ The slip-skid indicator, also known as the ball or inclinometer, indicates the coordination of aileron and rudder.

④ The orange wing reference line is fixed and represents the horizontal reference line of the aircraft.

⑤ Trim position indicators.

⑥ Flight director guide lines (blue) are shown when autopilot is operating. Note: This is not shown in the Figure.

A touch on the background toggles between standard view and 3D view.

2.2.3 Altitude Indicator

The altitude indicator also known as altimeter is used to measure the atmospheric pressure from a static port outside the aircraft. This measurement is then converted into an altitude above sea level in accordance with a mathematical model defined by the ISA. The altitude is always calculated according to some reference pressure (baro-correction – QNH value). This pressure must be set by a pilot and can be changed during flight. The baro correction value is typically obtained from air traffic control.

Figure 2.10: The altitude indicator with the scale given in feet. Three needles are shown in this case.

The indicator shown in Figure 2.10 is used to display altitude and reference baro-correction (QNH). The altitude is shown by two needles, where the short needle points to 1000 feet (or meters) and the long needle points to 100 feet (meters). When feet are in use, a 10.000 feet needle is also shown.

A touch on the bottom part of the indicator opens the baro correction window, see Section 3.1.1. A touch on the top part opens window with altitude details, Section 2.5.1.4.

2.2.4 Tachometer (RPM) and Manifold Pressure Indicator

A tachometer is an instrument that measures the rotation speed of a motor shaft. It displays engine revolutions per minute (RPM), hence its alternative name the *RPM indicator*. A manifold pressure is an effect of choked flow through a throttle in the intake manifold of an engine. It is a measure of the amount of airflow through the engine. Hence it is also a measure of the power capacity in the engine.

Both values are related to the power settings. Therefore we combined them into one single indicator, see Figure 2.11. This allows the pilot to optimally set the throttle and the propeller pitch. Note that some engines do not specify green and yellow range. Hence, such range is optional.

The optional green range defines the recommended range of RPM. The optional yellow range defines the range of RPM, which should not be used for longer period and should be generally avoided. The red mark limits the engine RPM.

Figure 2.11: The combination of RPM and manifold pressure indicator.

2.2.5 Gyroplane Engine RPM, Rotor RPM, Manifold and Prerotation Indicator

Gyroplanes require indication of rotor RPM. Figure 2.12 illustrates a special combination of parameters combined into one gauge.

Figure 2.12: Four in one: the combination of engine RPM, rotor RPM, manifold pressure and prerotation helper lamp.

① Engine RPM scale with color arcs.

② Rotor RPM scale with color arcs.

3. Manifold pressure scale with color arcs.
4. Prerotation lamp.

Prerotation lamp is used during rotor prerotation process as a part of takeoff procedure. The prerotation limiting values are set as rotor attributes. See the Nesis Installation Manual for more detais.

`Red` lamp is shown as long as rotor RPMs are has not reached the minimal safe value. This value is typically around 180 RPMs.

`Yellow` lamp is shown when minimal RPMs has been reached.

`Green` lamp is shown when recommended RPMs has been reached – typically around 200 RPMs.

The lamp symbol turns off once gyroplane is airborne.

2.2.6 Helicopter Rotor and Engine RPM Indicator

Piston engine powered helicopters have engines directly connected to the rotor (using some transmission, of course). So rotor RPM is directly related to engine RPM. The instrument in Figure 2.13 gives rotor and engine RPM expressed in percentages. The scales are set in such way that needles under normal operation have the symmetric indication. Any misalignment of needles can be easily spotted giving a hint that something is wrong with the transmission.

Figure 2.13: The combination of rotor RPM and engine RPM. Both scales are in percentages.

Like in the gyroplane case, the bottom window can be configured to show the manifold pressure.

2.2.7 Mini Engine Monitor

The mini engine monitor window shows the most relevant engine information in one place in the form of color bars, see Figure 2.14. Each bar corresponds to one engine parameter. Green, yellow and red colors represent normal, caution and dangerous range, respectively.

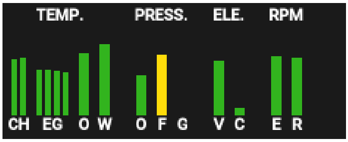


Figure 2.14: Illustration of the mini engine monitor.

The monitor bars are grouped into temperatures, pressures, electrics and RPMs. The temperature group includes CHT, EGT, oil and water (coolant) temperature. The pressure group contains oil and fuel pressures. Electrical section contains voltage and current. When monitor is shown on the navigation screen, engine RPM and rotor RPM bars are shown as well.

2.2.8 Fuel Computer Monitor

The fuel computer monitor provides the fuel related information like fuel quantity, economy, range and endurance. Figure 2.15 shows an example of such information.

The fuel computer monitor provides the following information:

- The current fuel consumption displays momentary fuel burning rate. It is given in l/h (liter per hour) or gal/h (gallons per hour) units.
- The average fuel consumption displays a value depending on the Fuel compute mode. See also Section 9.3.3 on page 123.
  - In the *Fixed* mode the fixed prescribed value is used for the average fuel consumption.

(a) Normal situation with endurance of 4 hours and 22 minutes with a 30 min reserve.

(b) Endurance without any reserve and range of 0 km. Both are shown in red.

Figure 2.15: Fuel computer displays fuel economy, fuel level, endurance and range.

  - In the *Integral* mode, the fixed prescribed value is shown while not flying (on the ground). After take-off, the integral fuel consumption is calculated from the fuel flow. The complete flight after take-off is taken into account in this calculation.
  - In the *Moving average* mode, average is calculated for some given period of time.

- The *endurance* is a derived value based on the available fuel quantity, average fuel consumption (depends on the fuel computer mode) and endurance reserve. It represents the engine time left assuming average fuel consumption. At the bottom, specified endurance reserve is shown. Once the reserve is reached, the range and endurance text are shown in red and the reserved endurance remaining is shown.

- *Range* is a derived value, which is based on the available fuel quantity, average fuel consumption, current ground speed and the specified endurance reserve. Once endurance reserve is reached, range is zero and it is shown in red.

When no fuel level probes are connected to Daqu, Nesis provides a simulated fuel tank where Nesis calculates the fuel remaining based on the information entered before the flight or updated during the flight. The fuel remaining is reduced by subtracting the fuel flow integrated in time. Both, the initial information and the fuel flow integration, may be source of significant error, which can quickly lead to a completely wrong fuel level indication. An indication higher than actual represents a dangerous situation, where the fuel computer displays more fuel than it actually is. This gives wrong and unsafe information to the pilot. Therefore, the pilot must frequently compare the fuel level indicated by the fuel computer with some independent external fuel gauges and update the Nesis fuel level accordingly.

2.2.9 OAT, Flight Time, Fuel

The fuel computer window can be replaced by OAT, flight time, time and fuel quantity information. Illustration of this window is given in Figure 2.16.

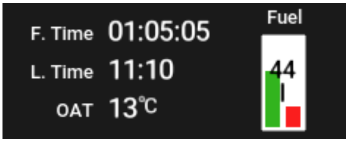


Figure 2.16: OAT, flight time, local time and fuel window.

2.2.10 Direction Indicator

A direction indicator may be shown instead the small moving map on the classic screen. The source of direction may either be a GNSS track or a magnetic compass. Figure 2.17 shows an example.

Figure 2.17: Illustration of the direction indicator.

The indicator also shows the target direction bug.

A long touch on the compass rose will set the target direction bug. If the autopilot is active it will also set the autopilot direction.

2.3 Engine Screen

This option is limited to Nesis III only for compatibility reasons. We anticipate to remove this screen starting with software version 4.5.

The engine monitoring screen displays classic round indicators of various engine and fuel related parameters. Round indicators are highly configurable and they may be adjusted to individual needs.

Figure 2.18: Example of the engine screen, your case may be different.

Figure 2.18 shows some of possibilities.

① Combination of MAP arc, two fuel level bars and a frame for total fuel level.

② The arc shows engine RPM and engine total time is visible in a frame.

③ Three arcs with single center used for ampere-meter, voltmeter and CO level.

4. Two arc used to show oil and fuel pressure.
5. Two arcs used to oil temperature and coolant temperature.
6. Single arc airbox temperature and four horizontal bars for EGT.
7. Roll, pitch and yaw trim indicators together with the flap indicator.
8. Metal debris (metal particles) and switch indicators.
9. OAT – outside air temperature indication and local time.

Note that the engine screen does not show the status bar on the top on the Nesis III 8.4 model.

Please note that all six gauges on the engine screen are customizable. Refer to the Nesis Installation Manual for more details.

2.3.1 Special Markings on Engine Parameters

Special markings may appear on some engine parameters. These marking are as follows:

`Lo` stands for low sensor condition – the sensor has reached the low measuring point. Example: Real CHT temperature is 5 degrees, but sensor is able to measure only values above 25 degrees. In this case you will see the Lo mark.

`Hi` stands for high sensor condition. The maximum of the sensor has been exceeded.

`NC` stands for not connected. Such detection is possible only for certain channel - sensor combinations.

Figure 2.19: Round pressure indicator, with special markings shown on needles.

Figure 2.19 shows a pressure indicator, with oil pressure value as sensor not connected and fuel pressure value as below measuring limit.

Please note that availability of these special markings strongly depends on a sensor type, Daqu channel type and on channel function type. Usually only a sub-set of above mentioned conditions can be detected.

2.3.2 Engines with ECU

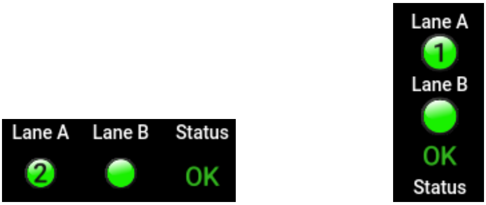
Some engines are equipped with an ECU. If such ECU is compatible with Daqu, then Daqu is receiving status and diagnostic messages. The status information item must be enabled. It will not appear automatically. Please refer to the Installation Manual for the details.

2.3.2.1 Rotax iS

Figure 2.20 shows examples of the horizontal and vertical engine status information. It consists of two lanes named `A` and `B` and general status. Each lane can be green (active) or red (inactive). You should see the light change during the test procedure, when lanes are being checked by switching them off.

Generator Control

A number `1` or `2` appear inside of one of the lane lights. This tells which lane is in control of the generator. The number tells which generator is in use.



(a) Horizontal orientation. (b) Vertical orientation.

Figure 2.20: Rotax iS engine status information.

① means that the primary generator is in use and all is working normally.

② means that secondary generator is in use. This should only appear during the engine start until the engine RPM exceed 2800 RPM for about six seconds. Afterwards the ECU switches to the primary generator. If this appears during the flight it shall be considered as a warning. In this case the aircraft electric system runs only on the battery. Please refer to the official Rotax documentation for more details.

Status Details

The status details are accessible with a touch on the status area. A status window opens as shown in Figure 2.21.

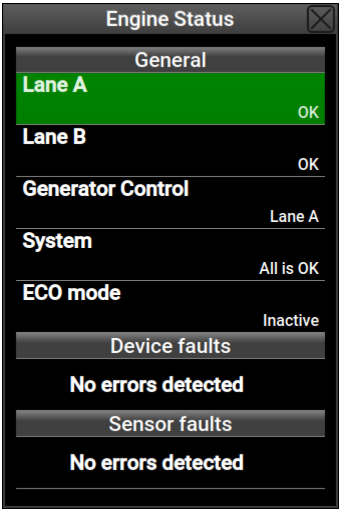


Figure 2.21: Detailed status information for Rotax iS engines.

The window has the following items:

`Lane A, Lane B` can have the following values: OK – normal operation, Inactive – lane is turned off, CAUTION and WARNING.

`Generator Control` tells which lane is in command for the generator control. It can be Lane A or Lane B.

`System` states general status of the ECU system. It can be one of the following messages:

- All is OK.
- No communication.
- Service is required.
- Land aircraft!

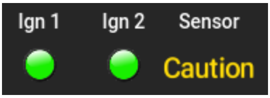
`ECO mode` has only two states: inactive and active. The active state means that the engine operates in the ECO mode.

`Device faults` Normaly `No errors detected` message is shown. In the case of ECU/engine failure, one or more messages can appear here.

`Sensor faults` Normaly `No errors detected` message is shown. In the case of sensor failure, one or more messages can appear here.

2.3.2.2 ULPower Engines

Figure 2.22 shows examples of the horizontal and vertical engine status information. It consists of two ignitions and general status.



(a) Horizontal orientation.

(b) Vertical orientation.

Figure 2.22: ULPower engine status information.

A touch on the status part of the screen opens a window with more details. Figure 2.23 shows an example.

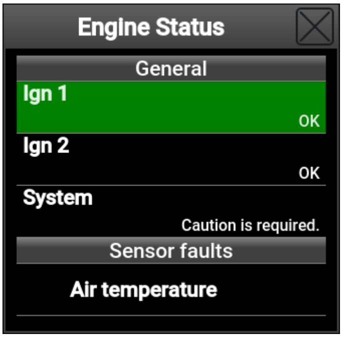


Figure 2.23: A more detailed status information for ULPower engines.

2.4 Navigation Screen

The navigation screen is a large moving map combined with some additional information. Large compass scale and vertical airspace situation are painted over the map.

Figure 2.24 illustrates an example and defines the main elements of the screen.

Figure 2.24: Illustration of the navigation screen.

(1) Status bar. This bar is shown on the top of most screens. Please refer to Section 2.1.4 on page 27 for more details.

(2) Several infromation boxes are shown. Actual box appearance depends on content and connected equipment. From top to bottom:

- Autopilot status – autopilot servos are required. A touch on the status area, opens the autopilot menu.
- Traffic information – either Flarm or some GDL90 traffic information system must be active. A long touch toggles the screen contrast to increase the visibility of the traffic items.
- Weather radar information – either ADS-B in system must be present (US only) or WiFi module is active and connected to the Internet (EU). A touch on the box allows for transparency adjustment.
- Two nearest airfields are shown: name of the airfield, distance and bearing. Green dot tells that airfield can be safely reached in the glide mode above minimum safe altitude, yellow dot tells it may be reached, but not above minimum altitude and red dot tells it can't be safely reached in the glide mode. See also Section 9.3.9 for glide settings.

The glide calculation does not take terrain and wind into account. This means that you can see green dot, but the airfield is not reachable, due to high terrain or strong headwind.

A short touch activates direct-to navigation. A long touch opens the nearest airfield window. Here you can see more then just two nearest airfields.

- Wind indication. This indication is available only when Magu (electronic magnetic compass) is also present on the CAN bus. Depending on the settings, the wind indication may be hidden when calculated windspeed is below some threshold. See also Section 9.3.4.

③ A large compass rose over the map gives directional awareness. A tracking projection line with time arcs defines future position of the aircraft in minutes. This tells predicted position assuming that current ground speed and tracking remain the same. A long touch on the compass rose will set the heading bug. If autopilot was engaged, this also sets new target heading for the autopilot.

④ The map orientation button. It shows the orientation of the map – red arrow points to the North. A touch on the button changes orientation in sequence: Tracking up, Heading up (only when Magu is present), North up.

⑤ Map layers button. A touch on this button opens a window, where map layers and other map details are manipulated.

⑥ Zoom scale button. The horizontal bar on the button defines a reference distance on the map. A touch on the button returns zoom to a default level.

⑦ Flap position and trim indicators. They are shown only if corresponding sensors are connected.

⑧ Side slip indicator.

⑨ The mini engine window organizes all most important engine parameters into one simple colored bar based map. Each bar corresponds to one parameter and the color of the bar to its current status. You can hide this window, see Section 9.3.5. A touch on this window opens the `engine` panel (Nesis III only).

(10) Terrain and airspace vertical profile window. The profile is always shown in the tracking direction – in the direction of the blue prediction line. A touch on the window makes it larger/smaller. You can hide this window, see Section 9.3.5.

2.4.1 Moving the Map Around

A long-touch action on the map puts the map into pan mode. It also adds a home button symbol on the map and remove all unnecessary elements. Once the map is in the pan mode, it can be easily moved around. Figure 2.25 shows an example.

We recommend that you do not start the *long-touch* near the compass rose or near information boxes as you may trigger some different action instead.

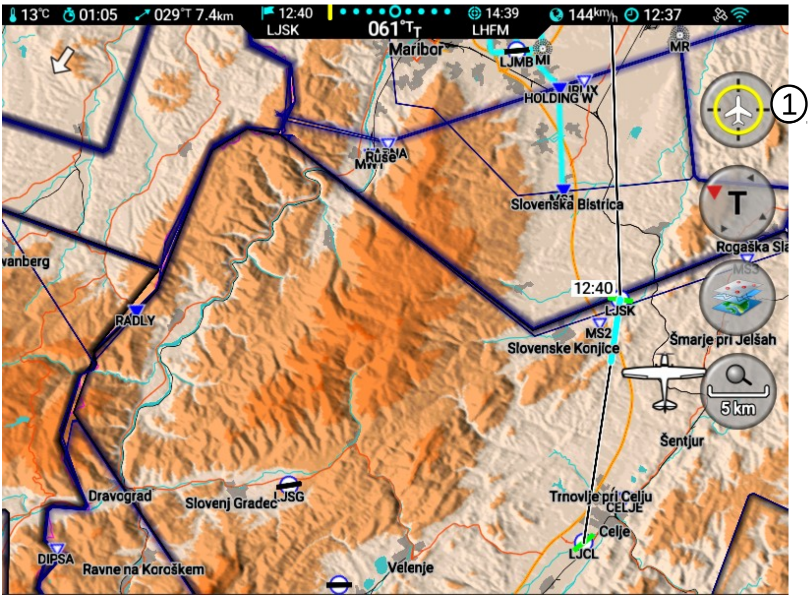


Figure 2.25: Illustration of the navigation screen in the pan mode.

A touch on the home button, marked as (1) on the Figure 2.25, brings back the standard navigation map.

2.4.2 Open Flightmap Association and Map Details

A large part of aeronautical information is obtained from the Open Flightmaps Association or OFM in short. Please visit `openflightmaps.org` home page for more details. The page also list the countries for which information is available.

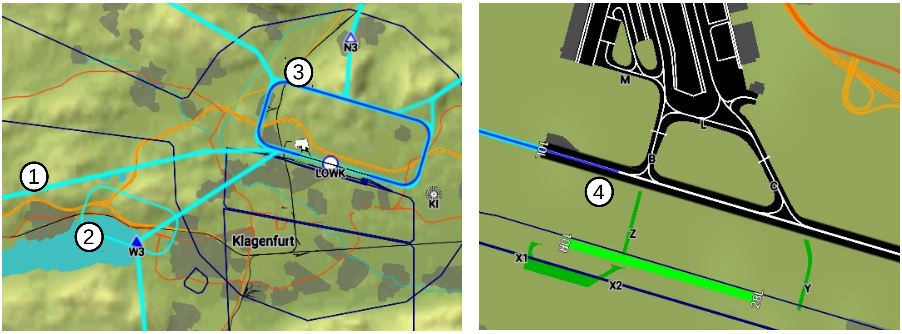


Figure 2.26: Example of OFM details.

OFM provides quality information for airspace structure (airspace zones), navigation points, airfield information, frequencies, transit, arrival and departure routes, holding zones, traffic circuits. Some of these countries have a very good coverage with a lot of details. Wherever such details are available, they are included in the Nesis. Figure 2.26 illustrates two examples.

1. Transit lines to holding and traffic circuit.
2. Holding.
3. Traffic circuit.
4. Runway and airfield details with taxiways and platforms.

2.4.3 Weather Overlay

When Nesis is equipped with a WiFi module and it has a live access to the Internet (EU only) or when it is equipped with an ADS-B receiver supporting GDL90 protocol (US only) a weather overlay is shown over the base map. The transparency of the weather can be adjusted.

The weather overlay can be turned off by setting transparency to 0%.

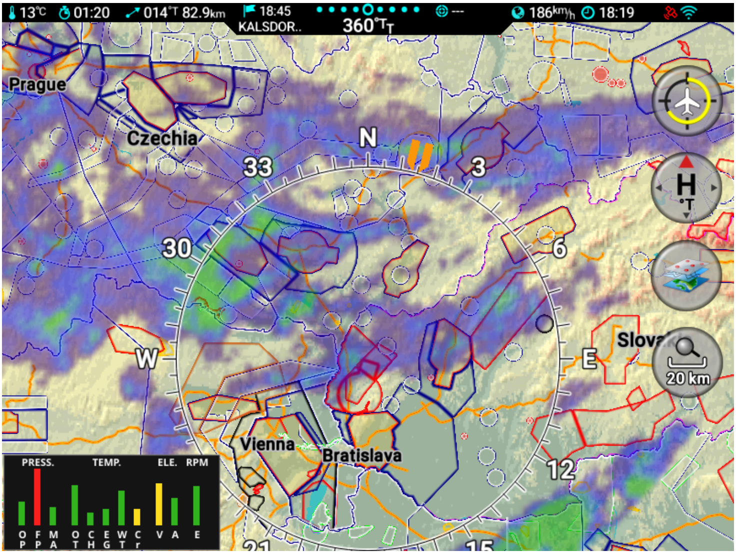


Figure 2.27: A weather overlay example.

2.4.4 Approach Maps

Nesis automatically shows approach maps as an overlay over the base map. A special desktop application called `Approacher` is used to prepare approach maps from various sources. Anyone can prepare his own set of approach maps. Figure 2.28 shows one such example for the LJPZ airfield.

The app is accessible from our web page: `https://www.kanardia.eu`, then search for `APPS | Approacher`.

Figure 2.28: Approach map overlay example for the LJPZ airfield.

There is a separate manual dedicated to the Approacher app, which provides step by step instructions of the map creation process. Select `www.kanardia.eu` and search for `SUPPORT|Documentation` on our web page.

See also sections 9.10, 11.5 for more details on how to copy maps, toggle their appearance or how to remove them.

Approach maps can be turned off by setting their transparency to 0%.

2.4.5 Map Layers and Details

The map shown on Nesis consists of several layers and details which are drawn on top of each other. Please refer to Section 2.4.5 for more details.

Certain map layers can be enabled or disabled and some of them can be tuned. Touching the map layers button (Figure 2.24, option (5)) opens a window shown in Figure 2.29.

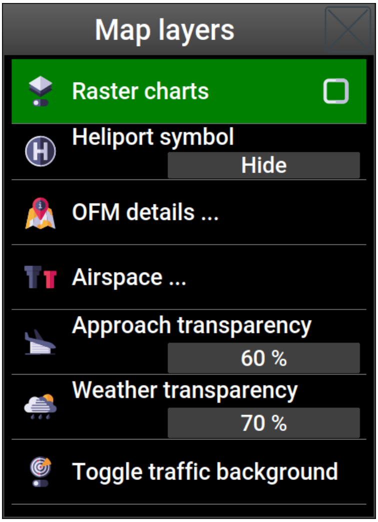


Figure 2.29: The Map layers window.

This window allows for quick access to various map options.

`Raster charts` This option toggles the visibility of the raster chart layer. When raster charts are not present, the command is ignored.

`Heliport symbol` allows to show, adjust or hide various heliport symbols that appear on the map.

`OFM details ...` opens a new window, where various OFM specific details are tuned. See Section 2.4.6.

`Airspace ...` Opens a new window, where visibility of airspace zones can be defined. See Section 2.4.7 for more details.

`Approach tranparency` is used to adjust the transparency of approach map overlay. A 0% means fully transparent (invisible) and 100% means opaque.

`Weather tranparency` is used to adjust the transparency of weather overlay. A 0% means fully transparent (invisible) and 100% means opaque.

`Toggle traffic background` is used to toggle dark map background in order to increase visibilty of traffic symbols. It has no effect when traffic devices (ADS-B in or Flarm or similar) are not connected or not active.

2.4.6 OFM Details

This window mostly holds toggle options, which turn certain layer on or off. Colored lines left of the text show how these item appear on the map, Figure 2.30.

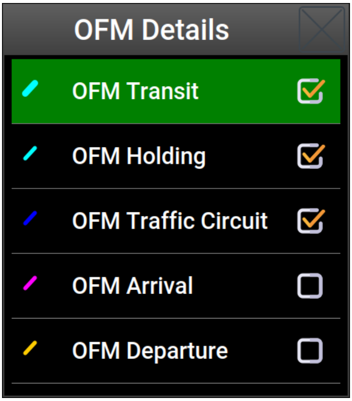


Figure 2.30: The Map layers window.

`OFM Transit` This option toggles transit routes defined in the OFM database. The transit routes are typically used to define a way through TMA into CTR or into CTR holding.

`OFM Holding` This option toggles the holding patterns.

`OFM Traffic Circuit` This option toggles the traffic circuits.

`OFM Arrival` This option toggles the arrival route. They typically define a route into traffic pattern.

`OFM Departure` This option toggle the departure route.

2.4.7 Airspace Filter

Airspace zones appearance can also be tuned. Airspace structure can be quite complex and it can be difficult to understand in a top down view. In order to improve readability, some airspace zones can be filtered out. Figure 2.31 illustrates an example of airspace filter.

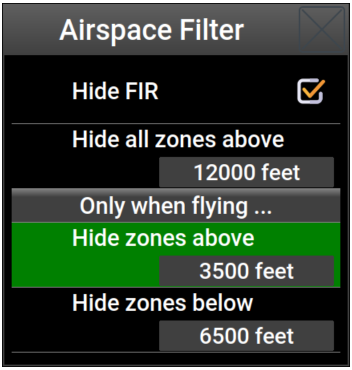


Figure 2.31: Dialog showing settings for the Airspace Filter window.

The following options are available:

`Hide FIR` When enabled, this option hides all airspace zones with the FIR attribute.

`Hide all zones above` unconditionally hides all zones, which bottom starts above specified value. Use this to hide some (typically A and B class) airspace zones, which are mostly used by the IFR only traffic. For example, if you never fly above 8000 feet, you can set this value at 10000 feet.

`Hide zones above` During flight, all zones whose bottom is more then specified distance above current flight altitude, will be hidden. This changes dynamically with the current aircraft altitude and with time. For example, when you fly at 4000 feet and this value is set to 2000 feet, all zones with the bottom above 6000 feet will be hidden. If you then descend to 1000 feet, all zones starting above 3000 feet will be hidden.

`Hide zones below` During flight, all zones whose top is more then specified distance below current flight altitude will be hidden. Again this changes dynamically with your current altitude.

2.5 Modern Screens

Modern screens combine flight data information with various background and engine options. They appear in several forms:

- Screen with the AHRS combined with the engine section on the bottom (8.4" version) or at the right side (7" or 10" version).
- Screen with the moving map combined with the engine section on the bottom (8.4" version) or at the right side (7" or 10" version).
- Screen with the moving map only (without engine section).

Please note that individual screens can be disabled. Use `Options | Service | Layout | Hide screens` command to access the screen enable/disable window.

Illustration in Figures 2.32 and 2.33 show a typical situation for a 8.4" screen. Yours may be significantly different. The engine part of the screen is completely configurable. Please refer to the Nesis Installation Manual for more details about how to configure the engine part.

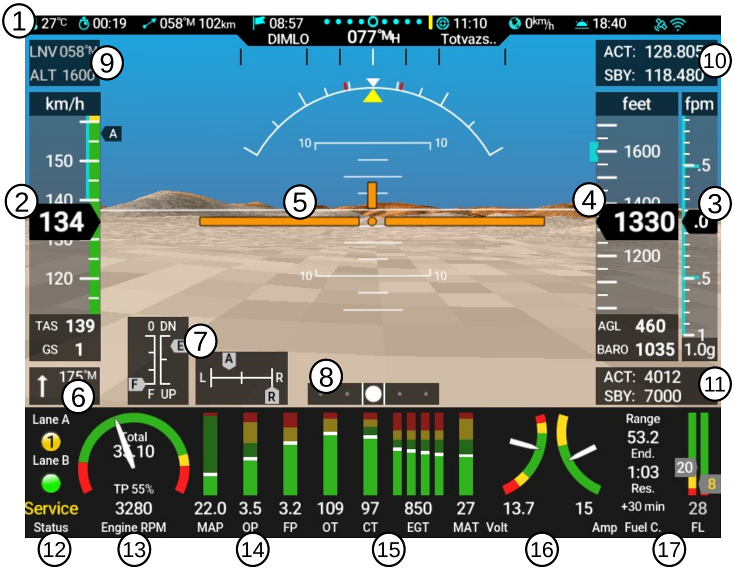


Figure 2.32: Illustration of the modern screen as shown on Nesis III, 8.4".

Figure 2.33: Illustration of the modern screen as shown on Nesis IV, 10".

1. Status bar. Please refer to Section 2.1.4 for more details.
2. Indicated airspeed with markings, true airspeed and ground speed. See Section 2.5.1.1.
3. Vertical speed, Section 2.5.1.2.
4. Altitude tape. A height above ground level (AGL) and current baro-correction value are shown at the bottom. See also Section 2.5.1.3.
5. Attitude indication of pitch and roll. Roll scale has dash markings at 10, 20, 30 (long), 45, 60 (long) degrees. Long pitch scale line has number at side, medium line refers to a 5 degree step and short line is 2.5 degree step. Red dashes represent target roll at given speed in order to maintain the standard turn.
6. Relative wind indication, Section 2.5.1.5.
7. Flap and trim indications, Section 2.5.1.6.
8. Slip indication.
9. Autopilot status indication, Section 2.5.1.7.
10. Radio frequencies, Section 2.5.1.8.

(11) Transponder squawks, Section 2.5.1.9.

(12) Engine status information for Rotax iS and ULPower engines. Number in the status light tells which generator is in use (Rotax iS). See also Section 2.3.2.

(13) Engine power section, RPM arc with totalizer and manifold pressure. During flight, the totalizer is not shown. A touch on the RPM arc will show totalizer for a couple of seconds. Throttle position is also shown when available.

(14) Engine pressure bars. This is typical example, you can use different organizaiton.

(15) Temprature bars. When multiple sensors are used for the same parameter (EGT, for example) all bars are shown and the highest value is given below. If there is enough space, then the lowest value is also shown.

(16) Combination of two arcs. Here it is used for voltage and current, but any other parameter can be also used instead.

(17) Fuel computer values and fuel tank (left, right tank and sum of both below). The indication changes every few seconds between two sets. The first set shows fuel consumption and fuel used, the second set shows range and endurance. A touch on this toggles between sets.

Please note that all items in the engine section (12 –17) are higly configurable. Please refer to the `Installation` manual for more details.

2.5.1 Modern Screen Elements

Next sub sections reveal some further details about individual elements and user actions of modern screens.

2.5.1.1 Airspeed

The airspeed element combines several airspeeds and its attributes, Figure 2.34 illustrates and example.

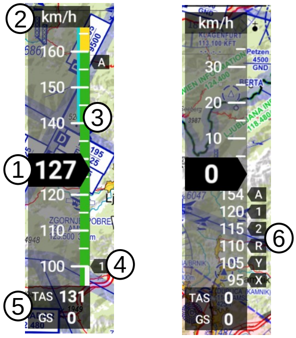


Figure 2.34: Illustration of airspeed as shown in flight (left) and on ground (right).

(1) Indicated airspeed current value. Scale at the background is adjusted accordingly.

(2) User selected units for the airspeeds.

(3) Indicated airspeed tape with scale and color codings. Standard green, yellow and red areas are used. White part is used for flaps speeds. Cyan line is defines limiting speed for the autopilot operation. It is shown only when AP is detected.

(4) Special tags for V-speeds.

(5) TAS (true airspeed) and GS (GNSS based ground speed).

(6) While on ground (no airspeed is detected) tags are displayed at the bottom, sorted according to speed for a quick reminder/reference. Once aispeed is detected, tags are distributed according to the speed scale.

2.5.1.2 Vertical Speed

When `ft/min` is used for vertical speed, the indicated value is shown in tousands with only one decimal place. For example, 500 ft/min is displayed as `.5`.

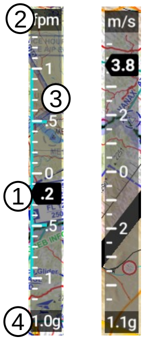


Figure 2.35: Illustration of vertical speed indication. Left is scale in `ft/min` right is scale in `m/s`.

① Indicated vertical speed. Scale is fixed and the pointer moves up and down according to the actual vertical speed. If the speed goes out of the scale range, pointer stops at the scale edge with actual vertical speed flashing inside the pointer.

② User selected units for the vertical speed.

③ Scale is fixed and does not move. Cyan line defines valid autopilot limits. It is shown only when autopilot is detected. Cyan horizontal dashes define target autopilot speeds.

④ Current `g` load (vertical acceleration) is displayed at the bottom.

2.5.1.3 Altitude Tape

The altitude tape has several features as shown on the Figure 2.36.

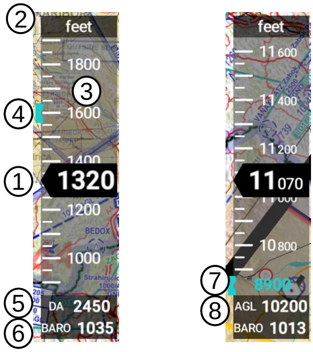


Figure 2.36: An altitude tape indication example: situation on the ground (left) and during flight (right).

① Baro corrected altitude pointer.

② User selected units for the altitude.

③ Scale moves in the background.

④ The target altitude bug. It is usually assosiated with the autopilot and defines target autopilot altitude.

⑤ Density altitude (DA) is shown on the ground.

⑥ Current baro correction value.

⑦ When the altitude bug is outside the scale limits, its value is displayed at the top or bottom of the scale edge.

⑧ Altitude above ground level (AGL) is displayed during the flight.

The altitude tape is touch sensitive:

- A short touch on the upper part opens altitude details window, Section 2.5.1.4.
- A short touch on the lower part opens baro correction window. See Section 3.1.1 and Figure 3.2.
- A long touch allows you to set the target altitude, typically used for the autopilot.

2.5.1.4 Altitude Details

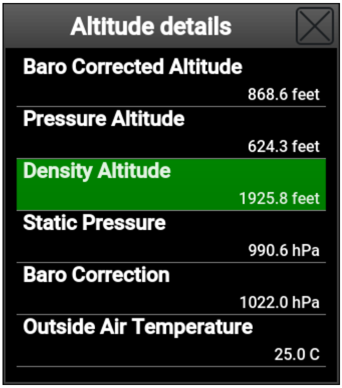


Figure 2.37: Altitude related detailed information.

The `Altitude details` window shows values for:

`Baro Corrected Altitude` this is the same altitude as shown on the altimeter. This altitude is corrected for the baro correction value (QNH value).

`Pressure Altitude` is altitude without baro correction – or baro correction set to 1013 hPa (29.92 inHg).

`Density Altitude` is altitude corrected for variations from standard temperature. It is the air density expressed as an altitude. This altitude is a measure of aircraft's performance.

`Static Pressure` is uncorrected pressure reading from the static port. It serves as a base for all before mentioned altitudes.

`Baro Correction` is a setting given by air traffic control (QNH value) and defines current air pressure at MSL.

`Outside Air Temperature` is actual air temperature and is used in density altitude and TAS calculation.

2.5.1.5 Wind

When `Magu` electronic compass is present on the CAN bus, the wind indication is shown on the screen. When map is used as a background, the wind arrow is oriented relative to the active map orientation. When AHRS used as a background, the arrow is oriented relative to current track.

When windspeed is below some threshold value, the indication is omitted. See also Section 9.3.4.

Figure 2.38: A windspeed example.

2.5.1.6 Flap and Trims

Depending on the connected position sensors, flap position and trim positions are shown. An example is given in Figure 2.39a. Is some sensor is not present, the indication is omitted.

(a) Indications only. (b) Trim recommendation.

Figure 2.39: Flap and trim indication options

Flap and elevator trim are grouped verticaly, while ailerons and rudder are grouped horizontaly. If sensor is omitted the corresponding indication is not shown. Positions are defined with tags. Each tag is designated with a letter:

- `F` – flaps. Position `0` means retracted and `F` fully deployed.
- `E` – elevator trim. `DN` means nose down and `UP` means nose up.
- `A` – ailerons trim. `L` means left and `R` means right.
- `R` – rudder trim. `L` means left and `R` means right.

When autopilot is active and equipped with servo hardware version 2 (these servos have a clutch and are capable of torque measuring), a special arrow symbol may appear over the elevator or aileron trim, Figure 2.39b. This arrow indicates the direction of trim request from servos. A yellow arrow indicates moderate load on servo, while red arrow indicates significant load on servo.

2.5.1.7 Autopilot

When autopilot servo motors are detected on the CAN bus, the status window similar to one shown in Figure 2.40 is displayed.

Figure 2.40: Autopilot status example.

A text in green color means that corresponding servo is active. A text in gray color means servo is present, but not active.

The top line is related to the direction. `TRK` is shown when autopilot is working in a bug tracking mode and `LNV` (short for LNAV) is shown when autopilot is following currently active navigation. Number next to it is the direction it wants to maintain.

The bottom line is related with the altitude. Here ALT is the only option. Number next to it is the target altitude.

Just like in the elevator and ailerons trim case, a yellow or red trim direction recommendation arrow advises you how to trim. See also Section 2.5.1.6. The arrow is shown over the center of the autopilot status area.

A touch on the autopilot status area opens the autopilot menu, while a long touch deactivates the autopilot.

2.5.1.8 Radio

When a radio is connected to Nesis, then currently active and standby frequencies are shown above the altimeter tape. Figure 2.41 shows an example. Active frequency is shown on the top and standby frequency is shown on the bottom.

Figure 2.41: Example of radio area.

A touch on the radio area opens the radio frequency selection options. Details depend on radio capabilities. See also Section 3.1.5.

2.5.1.9 Transponder

When a transponder is connected and configured to receive squawks from Nesis, then currently active and standby squawks are shown below the altimeter tape. Figure 2.42 shows an example. Active squawk is shown on the top and standby squawk is shown on the bottom.

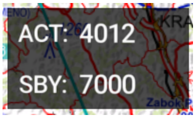


Figure 2.42: Example of transponder area.

A touch on the transponder area opens the squawk selection options. Details depend on transponder capabilities. See also Section 3.1.6.

2.5.2 Video

At the time of the writing, the video input for software version 4.x is not supported yet.

When Nesis is equipped with video source, then the modern screen with AHRS background also shows video image in the corner. This video image can be enlarged (over most of the screen, as shown in Figure 2.43) or reduced to the corner with a simple touch on the video image. Video can be also disabled.

Figure 2.43: Video example over most of the screen.

Chapter 3

Flight Time Activities

This chapter describes procedures that are mainly used during flight. Most of the flight-time activities are accessible from the main menu.

3.1 Main Menu

A push on the knob brings up the main menu. This happens on all screens. Figure 3.1 shows the a main menu example. Some screens may have less options. A swipe in upward direction on the touch screen will also open the main menu.

`Baro correction` opens the baro correction window. See Section 3.1.1 for more details.

`Navigation` gives access to various navigation related actions. Section 3.1.2 gives more details.

`Pitch` allows you to set in-fligh pitch correction. See also 3.1.3.

`Layers` allows you to edit various map layers and other map options. See 2.4.5 for more details.

`Fuel` is only shown when a virtual fuel level (tank) is used. It allows to adjust virtual fuel level, Section 3.1.4.

`Checklist` brings up a checklist window. See Section 7.

`Radio` opens a window, which allows setting a new radio frequency. See Section 3.1.5 for more details.

`Squawk` opens a window, which allows setting transponder squawk values. See Section 3.1.6 for more details.

`Options` Opens options screen used to tune the system settings. See Section 9 starting on page 119 for more details.

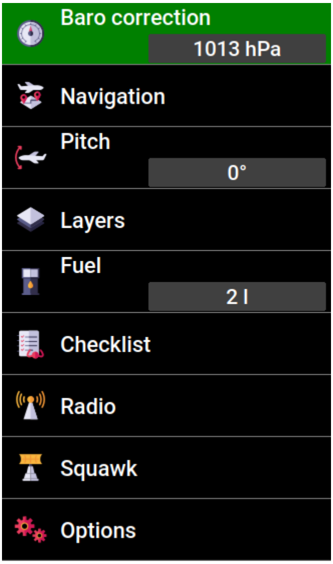


Figure 3.1: A typical main menu. Certain items may not show in your case as they depend on third party devices.

3.1.1 Baro Correction – QNH

`Main menu | Baro correction`

Rotate the knob to change the baro correction or press on the ⊕ or ⊖ buttons with the touch. Push the selector knob to close and confirm the selectionor touch the check or ⓧ on the title bar. The window closes itself after some time-out period.

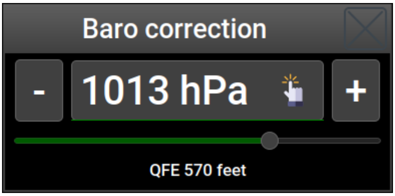


Figure 3.2: Setting the baro correction value.

3.1.1.1 QFE Setting

When aircraft is operated locally, the QFE altitude rather than QNH may be set. In order to set the altimeter to the zero altitude (the QFE altitude), turn the knob until the altimeter is close to zero [1].

3.1.1.2 Initial Baro Correction Setting

When baro correction is not known but the airfield elevation is known, the baro correction can be approximated by setting the altimeter to the airfield elevation.

3.1.2 Navigation

`Main menu | Navigation`

Figure 3.3 illustrates navigation menu options. The menu actual content depends on circumstances.

`Deactivate` option appears only when some navigation is active: either direct-to is active or route is active. This command will deactivate current navigation.

`Direct to / waypoint ...` opens a new window, which allows a waypoint selection. The selected waypoint becomes new navigation target. Alternatively, it also gives access to waypoint information. See Section 3.2 for more details.

`Route ...` opens a new window, which allows for route selection or route manipulation. If any route is selected, it becomes new navigation target.

[1] Normally, exact zero can't be obtained as baro-correcting pressure change is made in discrete steps. One hPa at the sea level corresponds to approximately 8 meters of altitude.

`Follow external direct to` appears only if some external navigation source is connected to Nesis and this source is providing some navigation target. The command activates Nesis in the *follow* mode. If target on the external device changes, then Nesis will adjust to the change automatically.[2]

`Import external route` appears only if some external navigation source is connected to Nesis and the source provides a complete route information. When command is executed, the route from external device is copied into Nesis and activated. Any later route change on the external device is NOT automatically synchronized.[3]

`Set marker` creates a user defined navigation point called *marker* at current location. The marker name is automatic (Mark 1, Mark 2, . . .). Markers are intended to be set during flight. After landing, you can edit the marker to change its name, description, or coordinates.

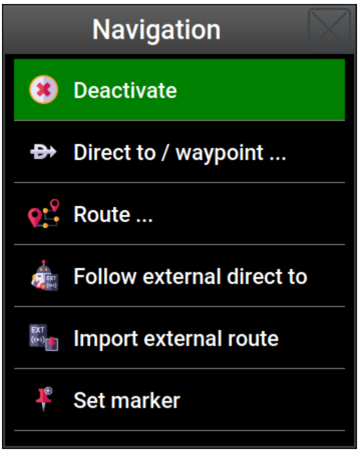


Figure 3.3: Navigation menu with all available options.

[2] Nesis monitors `$GPRMB` NMEA sentences. This sentence describes active navigation point on some external device. When a change in this sentence is detected, Nesis adjusts its target automatically.

[3] Nesis monitors `$GPRTE` and `$GPWPL` sentences and tries to assemble a route. A route may consists of many such sentences. Depending on the device communication speed and its internal logic, it may take quite some time before external device tranmists the complete combination. For example, on AERA it may take over a minute.

3.1.3 Pitch Correction

`Main menu | Pitch`

A change in the cruising speed results in a different pitch angle. In order to correct the pitch, a correction value can be entered. Figure 3.4 shows a pitch correction window.

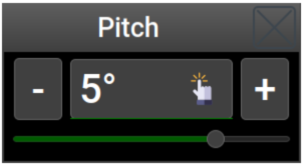


Figure 3.4: An example of the pitch correction window.

Note that this value is not permanently stored and Nesis always starts with the zero pitch correction. If you want to adjust the pitch correction permanently, please refer to the `Installation manual`.

3.1.4 Fuel

`Main menu | Fuel`

This option is available only when no fuel level sensors are connected to the EMS unit `Daqu` and Nesis calculates the virtual fuel level from the fuel flow information.

Virtual fuel level is initially set during the Nesis start-up procedure. This command allows for in-flight adjustmenst in order to be aligned with some other fuel level indication.

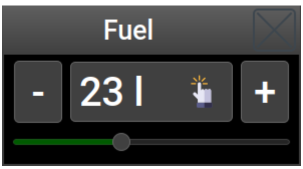


Figure 3.5: An example of virtual fuel level adjustment.

Note that such way of fuel level indication is highly speculative and may lead to very inaccurate results. Never fully trust the fuel level indication.

3.1.5 Radio

`Main menu | Radio`

This option is available only when Nesis is connected with a compatible radio. Please refer to the Installation Manual for more details.

The frequency is set in a window as shown in Figure 3.6.

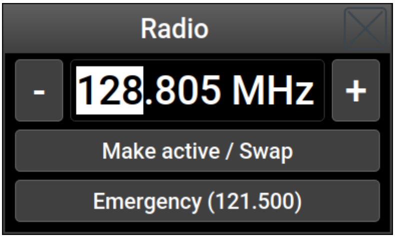


Figure 3.6: Setting the radio frequency value.

3.1.5.1 Frequency Standby

The frequency is set in three steps. First, value left of decimal point is set, then first digit after the decimal and finally the last two digits. If you press pushbutton in the last step, the frequency is sent to the radio as a standby frequency.

3.1.5.2 Make Active/Spap

If push button is not pressed in the last step (when last two digits are set) and you touch the `Make active/Swap` option instead, then the frequency will be set as the active frequency.

Please note that not all radios support this feature. In this case the `Make active/Swap` option will be hidden.

3.1.5.3 Emergency (121.500)

A touch on this options will try to set this frequency on the radio as active frequency. If radio does not allow to set active frequency, a standby frequency will be set instead.

Note: Always check on the radio, if proper frequency was selected and activated. Some radios do not support remotly activated *swap* option.

3.1.6 Squawk

`Main menu | Squawk`

This option is available only when Nesis is connected with a compatible transponder. Please refer to the Installation Manual for more details.

The squawk is set in a window as shown in Figure 3.7.

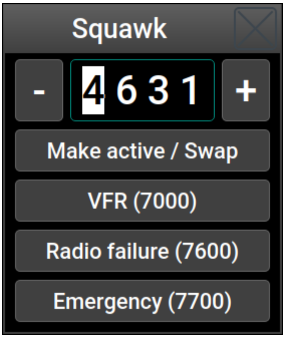


Figure 3.7: Setting the tranponder squawk value.

3.1.6.1 Squawk Standby

Squawk has four digits in the range between 0 and 7. If you push knob after the fourth digit was set, the squawk is sent to the transponder as a standby squawk.

3.1.6.2 Make Active/Spap

If push button is not pressed after last digit is set and you touch the `Make active/Swap` option instead, then the squawk will be set as the active squawk.

Please note that not all transponders support this feature. In this case the `Make active/Swap` option will be hidden.

3.1.6.3 VFR (7000)

This is a shortcut used to quickly set squawk to 7000 as an active squawk. Squawk 7000 is frequently used as a VFR flight designator.

3.1.6.4 Radio failure (7600)

This is a shortcut used to quickly set squawk to 7600 as an active squawk. Squawk 7600 is a code used to indicate a radio communication failure. It alerts air traffic control that the aircraft is experiencing a loss of two-way radio communication.

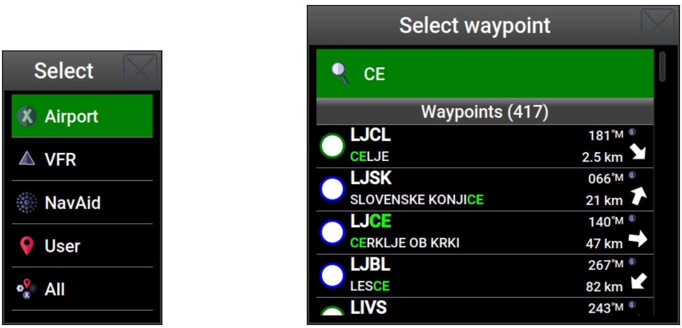
3.1.6.5 Emergency (7700)

This is a shortcut used to quickly set squawk to 7700 as an active squawk. Squawk 7700 is the transponder code used by aircraft to indicate a general emergency to air traffic control.

3.2 Direct To – Selecting a Waypoint

`Main menu | Navigation | Direct to / Waypoint...`

Nesis maintains separate lists of airfields, navigation aids[4], VFR reporting points[5] and user points. Thus selection of a waypoint is a two step process. In the first waypoint type is selected – Figure 3.8a. In the second step actual waypoint is searched for and selected, Figure 3.8b.



(a) Selecting a waypoint type. (b) Searching for a waypoint.

Figure 3.8: Two step waypoint search/selection.

[4] By the navigation aid we mean VORs, NDBs, ILSes, TACANs and other similar radio navigation aids, which locations are often used in VFR flight for the navigation.

[5] In Europe, VFR reporting points are more and more used in VFR flights to define the flying routes and entry/exit points in airspace zones.

3.2.1 Waypoint Type – Step One

The following waypoint types are listed:

`Airport` Displays only airports and those user waypoints that were classified as airports.

`VFR` Displays only VFR reporting points from the database.

`NavAid` Displays only VORs, NDBs, TACANs, etc. from the database.

`User` Displays only user specified waypoints and markers.

`All` Displays all items from all databases together. This option useful when the type of the waypoint is not known. All types will be searched.

3.2.2 Waypoint Search – Step Two

In the second step the list of points is displayed. The list is sorted according to the distance from the aircraft position at the time when the list was created. Select one waypoint from the list and Nesis will navigate to that point in the direct-to mode.

When too many points are listed, they can always be filtered by name. Select the name option on the top and enter a few letters of the waypoint. Number of listed waypoints will rapidly decrease. Nesis searches both the name and the waypoint description. Matching part of the name is marked in green, see Figure 3.8b right.

3.2.3 Waypoint Details

Some waypoints, airfields for example, have more attributes than coordinates. Hence, before actual selection, Nesis offers the *Details* option. This option opens a details window. An example is shown in Figure 3.9.

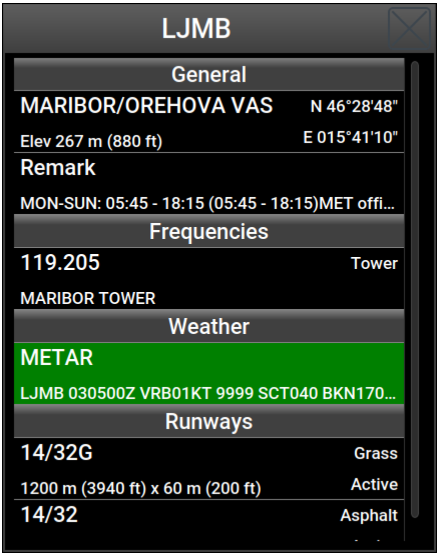


Figure 3.9: An example of the details window for LJMB airfield.

The window has several sections:

`General` The top part shows the coordinates and elevation.

`Frequencies` section lists frequencies associated with the waypoint. When radio is connected with Nesis, a selection of frequency will transfer it into the radio as a standby frequency.

`Runways` section lists runways available on this airfield.

`Weather` section is available when Nesis is connected to the Internet. METAR reports are shown. In addition, when the METAR report is selected, a new window is opened, where the METAR report is interpreted in a more friendly form. For an example, see Figure 3.10. Full METAR report is shown on the top and the interpreted part below. Note that we try to interpret as much as possible, but some parts may be too difficult to handle.

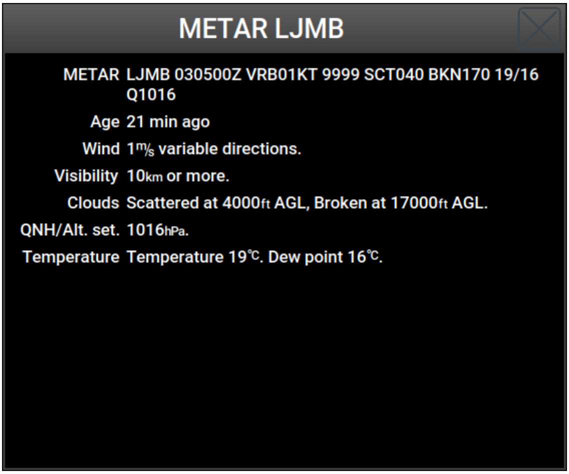


Figure 3.10: An example of interpreted METAR report.

3.3 Route

`Main Menu | Navigation | Route...`

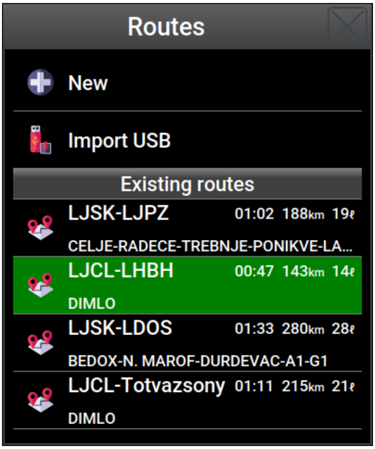
This section describes how to activate and manipulate a route. Depending on the current situation one of two different windows are opened:

- When there is no active route, Nesis opens the route selection/activation window. See Figure 3.11a. The window allows creation of a route, importing a route from USB stick or selection of one of existing routes.
- However, if some route is already active, Nesis opens a route manipulation window. See Figure 3.11b.

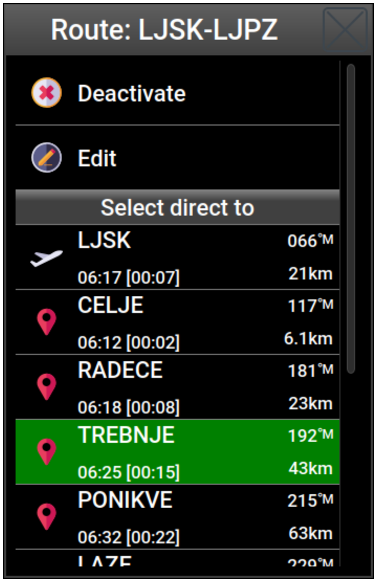
3.3.1 Route Selection

When no route is active a window opens like shown in Figure 3.11a. Routes are sorted according to the usage – recently used routes come first. Route name is typically defined by a takeoff - landing airfield pair unless a specific name was assigned to the route.

To select a route, rotate the knob and push it or simply touch the route name. A window appears asking for further actions. Select *Activate* in order to make



(a) Route selection.



(b) Active route manipulation.

Figure 3.11: Route window depends on active route status.

the route active. When window is closed, correct route leg will be selected automatically. This depends on current aircraft position regarding to the route.

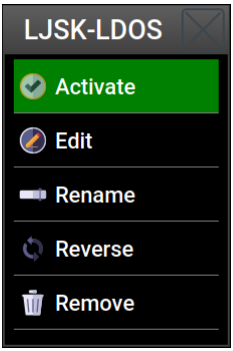


Figure 3.12: List of possible actions on the Route selection.

3.3.2 Actions on an Active Route

When the *Route* command is issued and some route is already active, a different window appears. See Figure 3.11b.

The following options are possible here:

- The *Deactivate* item will make the route inactive.
- Edit the route.
- Select one of the remaining route waypoints in *direct to* mode. Nesis will navigate directly to this waypoint and once the waypoint is reached, it will resume with the route navigation.

3.3.3 Make a New Route

Nesis will create a new route and switch into the edit mode. Please see Section 4 for more details.

3.3.4 Importing a Route

Nesis can also import a route, which was previously prepared with some route planner. The route file must be saved in the Garmin `GPX` format. This means that any route planner, which can save/export route in the `GPX` format can be used.

- Prepare a route, save it in the `GPX` format and copy it to some USB stick.
- Insert the stick into Nesis and select the `Import` command. See Figure 3.11a.
- Select the route file from the USB stick. This will only copy the route into Nesis but it will not make it active.

3.3.5 Deleting a Route

Select a route from the list of routes and then select the `Delete` command. The selected route will be deleted from the list. The command can not be reverted.

3.3.6 Renaming a Route

In most cases routes have an automatic name, which consists of takeoff and landing airfield. In order to put a special name to a route, select the *Route* from the main menu and then select the *Rename* command. Use the on-screen keyboard or the knob to enter a new name.

If you want to go back to *automatic name*, make a route name empty.

3.3.7 Edit a Route

This command allows editing an existing route. New waypoints can be added or modified. See Section 4 for more details.

3.3.8 Reversing a Route

This is a very convenient command. It reverses order of items in selected route. Route name is also automatically adjusted, unless route was previously renamed.

3.4 External Navigation

Nesis enables connection of third party devices, which can contribute to navigation control. Two such devices are:

- **Garmin® AERA®** is a portable GPS navigation device designed for aviation use. AERA can be connected to one of RS-232 ports.
- **SkyDemon ®** app, which runs on Android and iOS devices. It can be connected to one of RS232 ports using our `SVEN` dongle.
- Any device which transmits NMEA `$GPRMB` and/or `$GPRTE, $GPWPL` sentences over RS-232 connection.

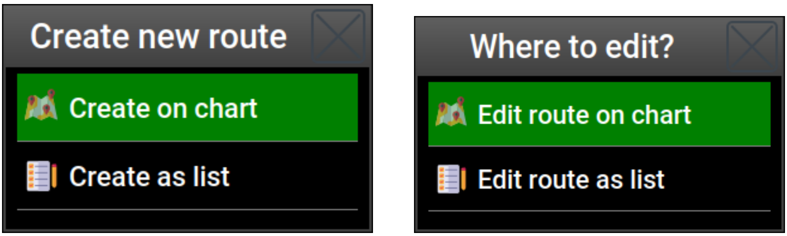
Please also note, that such devices may be also connected to `AMIGO`. In such case Nesis receives external navigation indirectly via CAN bus resulting in a very similar functionality.

Chapter 4

Flight Plan – Route Edit

This section explains the procedures used to create a new route or edit an existing one.

When a new route is about to be created or an existing one edited, Nesis asks to select from one of two variants, also shown in Figure 4.1.



(a) New route question. (b) Route edit question.

Figure 4.1: Route editing variant selection.

`On chart` variant opens a special route editing window and allows chart oriented route editig. This is useful if you are not 100% sure about exact routing. See Section 4.1.

`As list` variant is useful if you already know the exact routing and you only wish to quickly add waypoints. In this case no chart is shown. See Section 4.2.

4.1 Edit on Chart

Route editing/planning is performed in a special *Route Planning* screen. Here touch functions are used extensively. Figure 4.2 illustrates an example. The screen has the following main elements.

1. The chart area – used to edit the route using touch screen.
2. Airspace cross section for given route.
3. A list of waypoints.
4. Route summary.
5. Metar tab.
6. Some shortcuts.

The route creation process will be shown on an example on a route from LJCL (Celje) to LHBH (Besceshely). This route has the following intermediate VFR reporting waypoints: MS3, ME1 and DIMLO on border between Slovenia and Hungary.

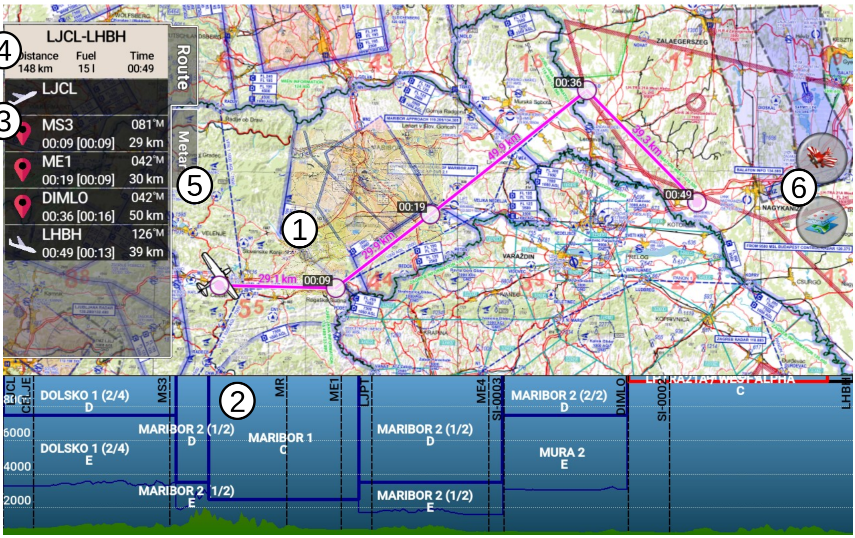


Figure 4.2: Example of route planning with touch screen.

The route shown on the example was created using the following steps:

- Touch and drag the map around so that the destination waypoint (LJCL) is visible. Use knob to zoom in or zoom out if necessary. Once you see the departing airfield, touch it. This defines the departing airfield.
- Drag the map so that you can see the destination airfield LHBH. Touch the destination airfield and confirm the selection. Figure 4.3 illustrates the waypoint list you should see on the screen.

Figure 4.3: A list of waypoints after the departure and destination points were set.

- Use the two finger touch (pinch) to zoom and to show Slovenian-Hungarian border in more detail. Touch the purple route line near the border and drag it over the `DIMLO` border point. This inserts new waypoint and recalculate the route automatically.

  Alternatively, touch the destination point on the list `LHBH`. This opens a window with the `Insert`, `Delete` and `Edit` options. Select `Insert`, then select `VFR` as this is a VFR border point and enter `DIMLO` into the search field.
- Inspect the route for any potential airspace crossing. Move the map if necessary. The route path crosses Maribor CTR area. Touch the route section near by and drag it over the `MS3` reporting point.

  Alternatively, you select the `DIMLO` on the list and insert the `MS3` VFR point.

  You may also include the `ME1` VFR reporting point, if you wish.
- At the bottom is the terrain profile with the airspace zones that route is crossing.

- Once you are happy with the route, select the `Airplane` icon. This saves the route and activates it at the same time.

  Alternatively, touch the `Summary` on the top of the route list. This opens a window and select the `Save & fly` option.

- If the `Close` or `Pager` button is pressed, Nesis ask wheather to save the route you have prepared so far, Figure 4.4.

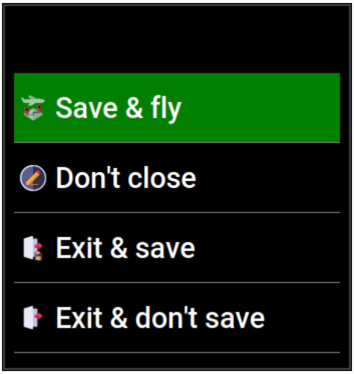


Figure 4.4: Closing the page or switching to a next page ask wheather to save, to ignore, to continue editing or to activate the route.

The route planning system is highly flexible and provides additional features. We recommend creating a few routes and checking them out.

- A touch on a circle representing a route waypoint allows you to remove the waypoint from the route.
- A list of route waypoints is displayed on the left. A touch on a waypoint name allows you to select a different waypoint instead the existing one, to remove the waypoint from the route or to insert a new waypoint.
- A swipe over a waypoint name to the left or to the right removes the waypoint from the route.
- A touch on the route summary opens the actions window. The following actions are displayed:
  - `Save & Fly` saves the route and activates it.

   - `Rename` opens a window where a different name can be assigned to the route. Default name consist from the departure and destination airfield designations. See also Section 3.3.6.
   - `Reverse` reverses all the waypoints in the route. See also Section 3.3.8.
   - `Clear` removes all waypoints from the route.

- A touch on the `Metar` tab collects current METAR information from airfields close to the route path and displays this in a list form. Either an Internet access or an active FIS-B link connection is required for this command. Figure 4.5 shows an example.

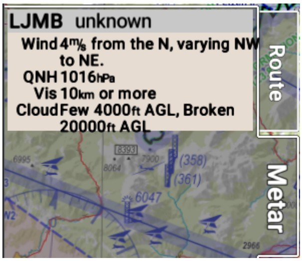


Figure 4.5: Example of METAR information along the route.

Estimated elapsed time (EET) is shown next to each waypoint on the route. EET is calculated based on the cruising speed, which is defined in Section 9.3.3 on page 123. The route title also shows total route distance and estimated fuel consumption.

Remember, these values are just a rough estimates. No extra climb time, descend time and traffic pattern times were added. The same is true for the fuel consumption estimate – no extra fuel for climb or any reserves are taken into account. The calculation is based on the typical consumption, see Section 9.3.3 on page 123 for more details.

4.2 Edit as List

`Main Menu | Navigation | Route... | New | Create as List`

When all waypoints are known in advance, creating or editing a route in a simple list form may be more efficient.

The route creation process is shown on a route from LJCL (Celje) to LHFM (Fertőszentmiklós). This route may have the following intermediate VFR reporting waypoints: MW1, to avoid Maribor CTR, MUREG on border between Slovenia and Austria, SASAL on border between Austria and Hungary.

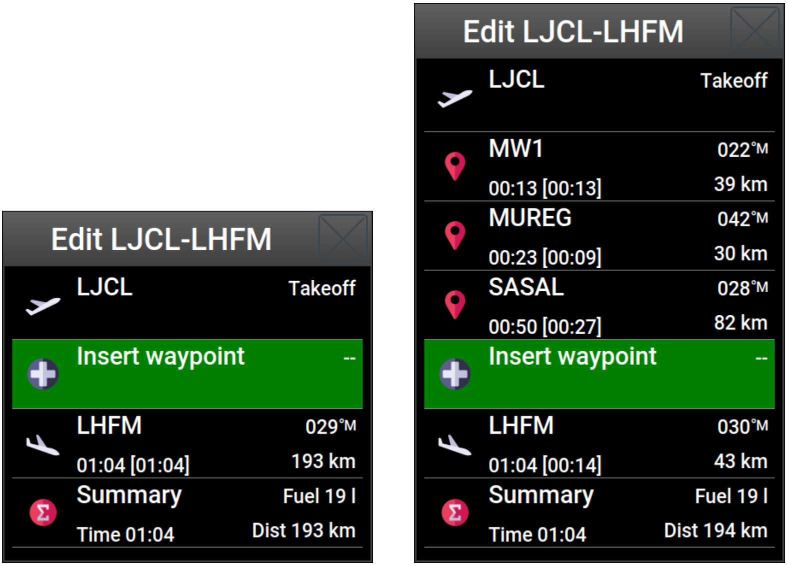
In order to create the above mentioned route, follow the steps:

- Nesis asks you for the departing (takeoff) airfield. Search for LJCL and select it.
- Next, Nesis asks for arrival (landing) airfield. Search for LHFM and select it.
- A window shown in Figure 4.6a appears. The window shows both airfields and an item labeled as *New* in-between.
- Select the *Insert waypoint* item to add MW1, MUREG and SASAL waypoints in sequence. All these are VFR waypoints, so select *VFR* or *All* when asked for a waypoint type.
- The final situation is shown in Figure 4.6b. The item labeled as *Insert waypoint* will be removed from the final route automatically.
- Close all windows. Note that a new route is not activated automatically. It must be activated manually.

Notice the *Summary* item. The total distance, estimated time needed for the route and estimated fuel consumption are shown. The time estimate is based on the typical aircraft cruising speed. See Section 9.3.3 on page 123.

Note, this is a rough estimate. No extra climb time, descend time and traffic pattern times are added. The same is true for fuel consumption estimate – no extra fuel for climb or any reserves are taken into account. The calculation is based on the typical fuel consumption. See Section 9.3.3 on page 123 for more details.

Each item in the route can be changed. Any intermediate waypoints can be changed or removed. A new waypoint can be inserted before the selected item. Please feel free to experiment.



(a) A situation after takeoff and landing waypoints were entered.

(b) Final situation when all waypoints were included.

Figure 4.6: Edit route as a list.

Chapter 5

Traffic

Nesis can show traffic on the screen, when connected with some Flarm or ADS-B-In receivers. In general, any device compatible with the Flarm or GDL90 protocol can be connected, however it was tested only with:

- Power Flarm Core, Power Flarm Fusion – produced by Flarm Technology Ltd.
- AT-1 - AIR Traffic, TRX 1500 – produced by Air avionics.
- Foxtral – produced by Foxtral sp z o.o.
- TM350 – produced by f.u.n.k.e. Avionics GmbH
- Stratux ADS-B receiver – various producers
- SkyEcho – produced by uAvionix for the UK market.

In this section, we will use term *device* for any of above mentioned products.

This section does not explain any Flarm or ADS-B working principles. There are several documents and information sources available various web sites. We strongly recommend that you read them before you connect your device to our system:

- Please study the Nesis installation manual and any other manuals that you received with your device. The device manual information supersedes any conflicting information in this manual.

- Please, make sure that you understand the working principle of the device.
- Visit `https://flarm.com/` and study documents found on this site. Specifically check the `Support` section, where you can find manuals and firmware updates. Also read the *FAQ* sub-section on the Flarm site. It can be found under `Support` section.
- ADS-B is a complex topic. Roughly speaking it is split into two parts:
  - ADS-B *Out*: it transmits your aircraft's position, altitude, speed and identity to ground stations and other aircraft using a Mode-S transponder at 1090 MHz (standard worldwide) or 978 MHz UAT in the US for lower altitude general aviation. Nesis is not involved in this process.
  - ADS-B *In*: This is a device, which receives ADS-B broadcasts, traffic info (TIS-B), and weather/fly info (FIS-B). This is optional but useful for traffic alerts and weather data without subscription. Nesis can receive a datastream from such a device and displays traffic on the screen.

  From Nesis perspective, it is the ADS-B *In*, which is important. Nesis can not participate in the ADS-B *Out*. Consult local avionics expert for more details.
- For TRX and AT-1 devices, visit `https://www.air-avionics.com` and check the *Support* section for manuals and firmware updates.
- Devices are sometimes shipped with obsolete firmware. Update device with the latest firmware (software) before installation.
- When a mode S transponder is installed in an aircraft, it does not necessary mean that it also transmits ADS-B out signal.
- Intruding traffic with C-mode or even S-mode transponder without ADS-B out signal are all non-directional targets. In addition, distance to the target is *estimated* from the signal strength. All this means that values shown in the traffic warning window are not very reliable for non-directional targets.

Please note that web pages are often reorganized and that manuals, firmware and FAQ can be moved to some other place.

5.1 Directional and Non-Directional Traffic

Power Flarm and other compatible devices consist of two independent subsystems merged into one device. The first is Flarm subsystem and the second one is ADS-B *In* subsystem.

5.1.1 Flarm Subsystem

The Flarm subsystem is only capable to *see* other aircraft that are also equipped with Flarm devices. The range of visibility varies significantly and depends on the antenna position, antenna shadowing, device strength, aircraft material ... The range is about 10 km at best but may be significantly less in reality. It can be as low as a few hundred meters and blind spots are also possible. When the device detects a target – an airplane which also has a Flarm on-board, it gets a full set of target data: type, position, speed, etc. This is a directional traffic (or directional target).

larms are mostly installed in gliders, but recently thay are also finding its way into light aircrafts as well.

5.1.2 ADS-B *In* Subsystem

The ADS-B in subsystem listens to transponder replies of other aircraft – targets. Here are two possibilities:

- The transponder reply comes from an aircraft, which is equipped with ADS-B *Out*. In this case, the transponder reply also holds information about aircraft position, speed, direction, etc. Not many small airplanes are equipped with this. This kind of equipment is mostly found in airliners and in "more serious" aircraft. Most small GA aircraft and ULMs do not have such equipment.
- The transponder reply comes from an aircraft, which is NOT equipped with ADS-B *Out*. These are majority of small aircraft. This reply does not include position, speed, direction. It has only altitude (C-mode) and squawk. The device tries to *estimate* distance of the target based on the transponder signal strength. A distance can be estimated (not very reliably) but the direction can not be estimated at all. Such targets are called *non-directional traffic* or non-directional targets.

During flying device detects transponder responses from non-directional targets mostly. As direction is not known and distance is only a rough estimate, their position can not be drawn on the map, but their presence is announced to the pilot. This means that there may be frequent traffic advisories from the system, but the actual position of the target is not known. Such behavior can be turned off, see Section 5.4.

5.2 Traffic on the Moving Map

Flarm device sends traffic information that it detects in regular intervals. A vertical or horizontal filter can be applied by the device to hide traffic that is out of specified limits.

Such traffic is shown on the main navigation map only. The following symbols are used.

	Approximate position of the intruding aircraft that poses as non-threat.
	A Proximity Advisory indicates that the intruding aircraft is within ±1200 feet and is within a 5 nm range, but is still not considered a threat.
	A Traffic Advisory is shown as a solid yellow circle. This indicates an aircraft in vicinity, which shall be considered as a threat.
	A serious threat is shown as a solid red circle. In most cases an additional warning window will appear on the screen in this case.

Figure 5.1 shows an example of such map. Three aircraft are shown, non of them as a threat.

Figure 5.1: Traffic symbols on a map. Vertical difference is in hundreds of feet, as three digits are used.

On top of each symbol a relative vertical difference is shown and arrow on the right side shows a climbing or descending aircraft.

When Nesis is set to show altitude in feet, then the vertical difference is shown in hundreds of feet. It is always shown as three digits. For example, *-008* means that aircraft is about 800 feet below. *000* means about the same height.

When Nesis is set to show altitude in meters, then the vertical difference is shown in hundred of meters. It is always shown as two digits. For example, *+03* means that aircraft is 300 meters above. *00* means about the same height.

When intruding aircraft is climbing or descending faster than 500 feet/min (2.5 m/s) a vertical arrow is shown.

Once device stops sending traffic data for some aircraft for more than 5 seconds, the symbol for this aircraft disappears.

5.3 Warning

When device calculates that certain aircraft (or ground obstacle, or protected zone) poses a serious threat, it sends special warning message. Nesis intercepts this message and it shows a large warning window on any screen as long as such messages persist.

We would like to emphasize that relative position calculation and warning level logic are done by the device and not by Nesis.

Figure 5.2 illustrates an example.

(1) Relative position of the threat regarding aircraft's track. The marking field will be yellow in the case of a warning and red in the case of an alert.

(2) Horizontal distance to the threat.

(3) Visual level of the threat. Circle is colored when threat is 10° on horizon. Inner arrow is colored when threat is 10° - 30° above or below the horizon and outer arrow is colored when threat is more than 30° above or below the horizon.

(4) Vertical relative distance to the threat.

(5) Threat symbol. Important: the symbol can be misleading. Always expect any kind of aircraft. The symbol depends on the value programmed into the intruding aircraft device.

Figure 5.2: Threat classified as warning comes from left, distance is 1.5 km, about at the same visual level, 450 feet below.

Figure 5.3 shows two more examples of traffic warning. Both these are classified as alerts. The right one is non-directional warning. A non-directional warning means that the device was not able to determine direction of the threat.

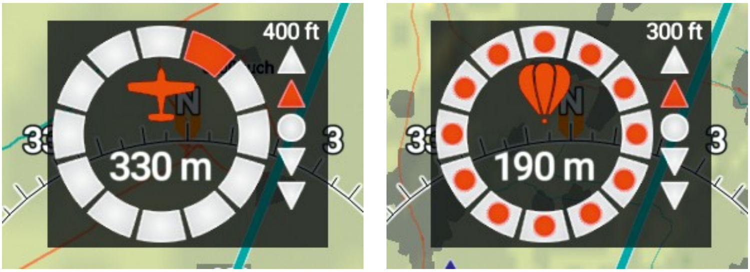


Figure 5.3: Left: Alert for an airplane, 330 meters away, slightly from right, 400 feet above and 10° - 30 degree above the horizon. Right: Alert for a balloon, 190 meters away, direction is not known, 300 feet above and 10° - 30° above the horizon.

5.4 Settings

`Main menu | Options | ADS-B/Flarm`

There are some Nesis specifc traffic options, which are accessed via the *Options* screen. These options are shown in Figure 5.4.

You can not use Nesis to change your device settings. If you need to adjust your device, please refer to the device manual. Each device model requires some special setup/settings procedure. Most of them use WiFi for the setup.

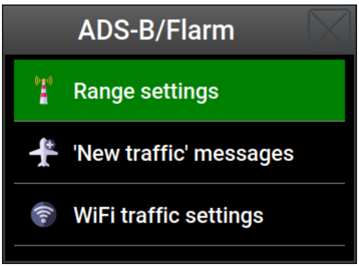


Figure 5.4: Traffic main menu window.

The following options are given:

`Range settings` allows configuration of some range based variables. Please note that these range restrictions are applied on top of the device specific settings, Section 5.4.1.

`'New traffic' messages` allows tunning the on-screen messages, which appear when new traffic has been detected, Section 5.4.2.

`WiFi traffic settings` define which port/protocol shall be used, Section 5.4.3.

`Errors & Warnings` option appears only when the device detects an internal error or warning. It opens a window with the details, Section 5.4.4.

5.4.1 Range Settings

The range related settings define range filters of the device *on top of* filters that may be already applied in the device. Set these filters to maximum if you want to see all traffic transmited by the device.

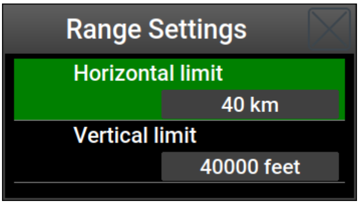


Figure 5.5: Example of traffic range options.

Please note that actual detection capabilities of the device may be significantly lower then specified by these values.

`Horizontal limit` defines the horizontal distance cut-off limit. Targets beyond this limit will not be shown.

`Vertical limit` defines the vertical distance cuf-off limits for targets.

5.4.2 'New traffic' Messages

When a new traffic is detected by the device and the traffic is close enough, Nesis may indicate it visualy or audibly. These specific settings are done in a window as shown in Figure 5.6.

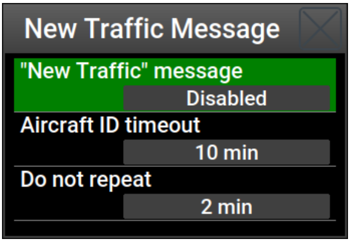


Figure 5.6: An example of setting for the new traffic message.

`"New Traffic" message` gives four options: `Disable`, `Text & Voice` gives a textual and audial indication of new traffic, `Text only` shows only text and `Voice only` plays only audial message.

`Aircraft ID timeout` defines how long does it take for an aircraft to be forgotten. When aircraft ID is not being received for this amount of time, it will be marked as forgotten and if later appears again later, a new warning will be given.

`Do not repeat` defines the time period, which starts when the last "New traffic" message is shown. Within this period this message will not be repeated for any new aircraft that may appear afterwards. This was introduced to reduce number of warnings. Please note that aircraft symbol will still appear on the map and that all collision warnings are still in effect regardless of this setting.

5.4.3 WiFi Traffic Settings

Some devices transmit traffic information over WiFi in several formats in parallel. This option allows selection of one such format.

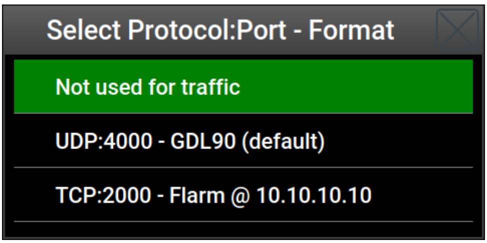


Figure 5.7: WiFi traffic settings.

`Not used for traffic` will ignore any WiFi data stream related to traffic. This option is useful if you receive traffic information via RS232 cable and over the WiFi at the same time. Using this option will prevent double reception.

`UDP:4000 - GDL90` will listen on port 4000 for traffic UDP packets carryig GDL90 data stream.

`TCP:2000 - Flarm@10.10.10.10` options is not currently in use. It will be used in future to receive traffic over WiFi in Flarm format using TCP packets.

5.4.4 Errors

Device may send error and warning messages, which indicate device's internal problems. When Nesis intercepts them, a red symbol is flashing in the status bar. In addition, number of error messages appear in the traffic status rectangle. See Figure 5.8 left.

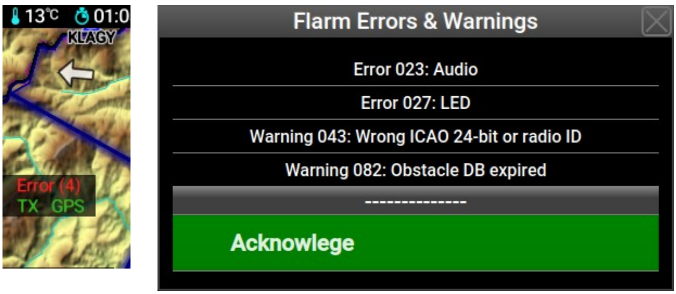


Figure 5.8: Left: a part of the main map screen, which shows the Flarm device status rectangle. Right: Flarm Error and Warning window. On top errors and warnings are displayed and the *Acknowledge* command at the bottom.

- In the main map window, touch the small Flarm status window. This opens the acknowledge window.
- Open the *Options* page with the icons, select the *ADSB/Flarm* icon and select the *Errors & Warnings* item. Note this item is shown only when an error or a warning is detected.

Please refer to the device documentation for the complete list of errors and warnings.

Chapter 6

Logbook

`Main menu | Options | Logbook`

Nesis automatically keeps a log of flights and stores them in a logbook. It keeps recording as long as Nesis is powered on. When logs are requested, it extracts takeoff and landing events and combines them in flights. An example is given in Figure 6.1.

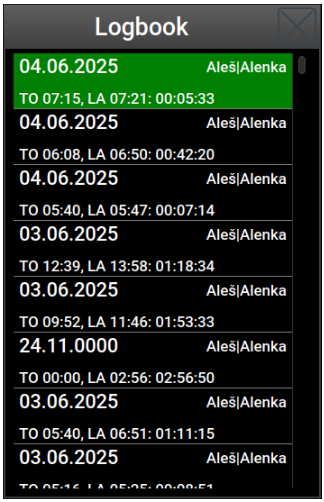


Figure 6.1: A logbook example.

Logbook can be accessed from the *Options* page by selecting the *Logbook* icon. See Figure 9.1 on page 119. Alternatively, a long-press on the pager button also opens the Logbook window by default.

The logbook shows only basic information about each flight, like date, name of the pilot, time of takeoff and time of landing.

The landing and takeoff detection strongly depend of the logger options. This is also true for touch-and-go, hovering, etc. Please see Section 9.3.6 for more details.

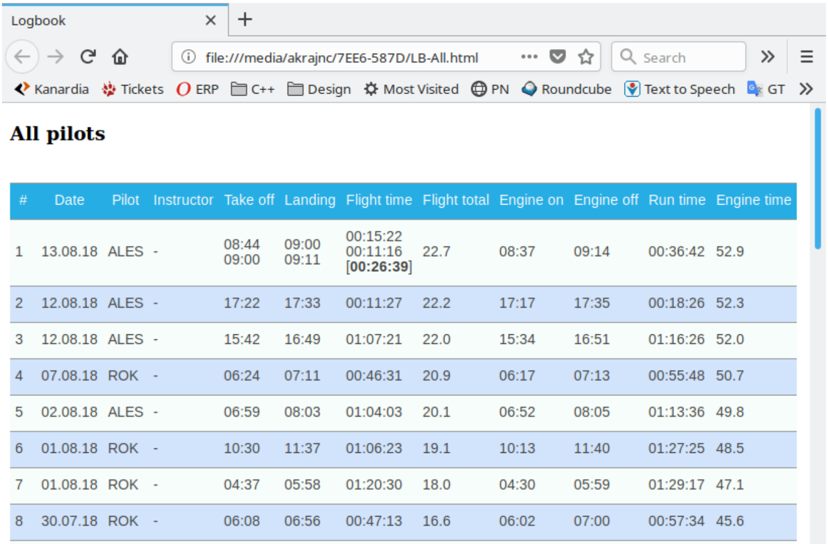
Note that the logbook has a limited capacity of about 270 hours. When the limit is reached, the oldest log entries will be overwritten. Since Nesis is logging all the time and not only when flying, some invisible internal logs are created. This means that actual logged flying time will be about 25% less – you can expect to see about 200 flight hours.

When an item from the logbook is selected, more options are available. See Figure 6.2.

Figure 6.2: A logbook options example.

6.1 Export Logbook to USB

This command creates a logbook file in *html* format and copies it to USB stick. Any web browser can be used to view it or print it. The last flights come first. When touch-and-goes are detected, flight time for each such event is also shown. Figure 6.3 shows an example.



All pilots

#	Date	Pilot	Instructor	Take off	Landing	Flight time	Flight total	Engine on	Engine off	Run time	Engine time
1	13.08.18	ALES	-	08:44 09:00	09:00 09:11	00:15:22 00:11:16 **[00:26:39]**	22.7	08:37	09:14	00:36:42	52.9
2	12.08.18	ALES	-	17:22	17:33	00:11:27	22.2	17:17	17:35	00:18:26	52.3
3	12.08.18	ALES	-	15:42	16:49	01:07:21	22.0	15:34	16:51	01:16:26	52.0
4	07.08.18	ROK	-	06:24	07:11	00:46:31	20.9	06:17	07:13	00:55:48	50.7
5	02.08.18	ALES	-	06:59	08:03	01:04:03	20.1	06:52	08:05	01:13:36	49.8
6	01.08.18	ROK	-	10:30	11:37	01:06:23	19.1	10:13	11:40	01:27:25	48.5
7	01.08.18	ROK	-	04:37	05:58	01:20:30	18.0	04:30	05:59	01:29:17	47.1
8	30.07.18	ROK	-	06:08	06:56	00:47:13	16.6	06:02	07:00	00:57:34	45.6

Figure 6.3: An example of logbook opened in Firefox browser. A touch-and-go event is shown in row 1.

6.2 Export Flight to USB

The *Export flight to USB* option creates two files on the USB stick for the selected flight. One file has .kml extension and the other has .tab extension. The file name is a combination of pilot name, date and flight made on this date. For example a file name *ALES13-08-18-B* means: pilot name is ALES, flight was taken on 13-th of August 2018 and letter *B* means that this was the second flight of the day.

6.2.1 The KML File

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 6.4 and 6.5 show two examples. First is the top view of a flight and the second one is a detail with visible vertical profile.

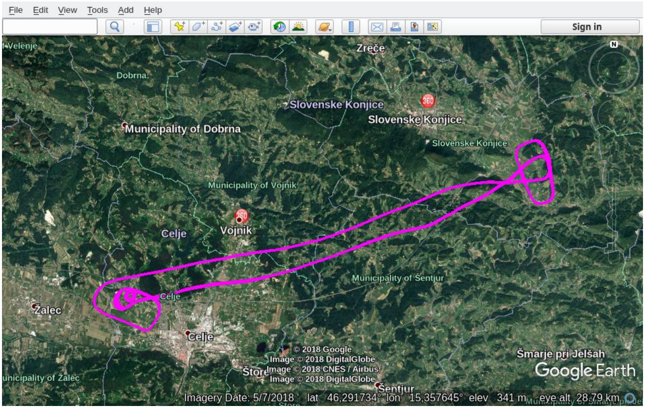


Figure 6.4: A flight file with kml extenstion opened in Google Earth.

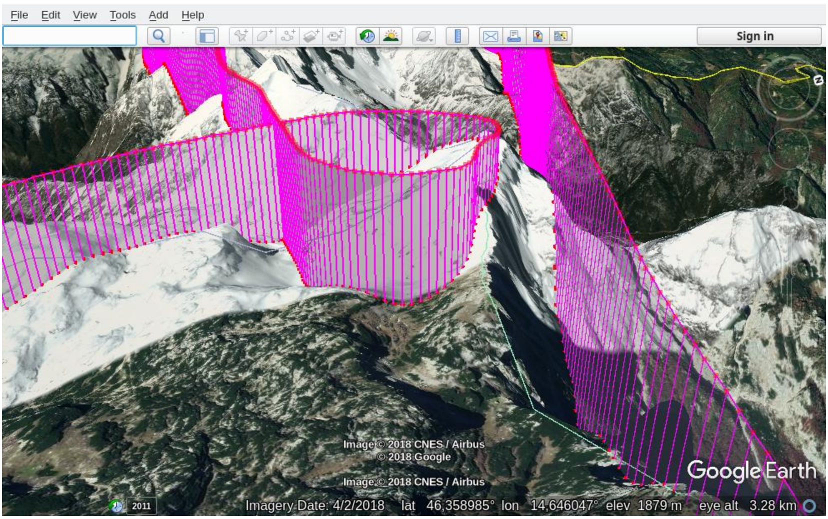


Figure 6.5: A detail of flight opened in Google Earth. Vertical profile is visible here.

6.2.2 The TAB File

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.

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. 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 *ALES12-08-18-B.tab*
5. Calc detects that a text file is being imported and it opens a window as shown in Figure 6.6. 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 in Figure 6.7. Some column widths were adjusted and some cells were hidden.

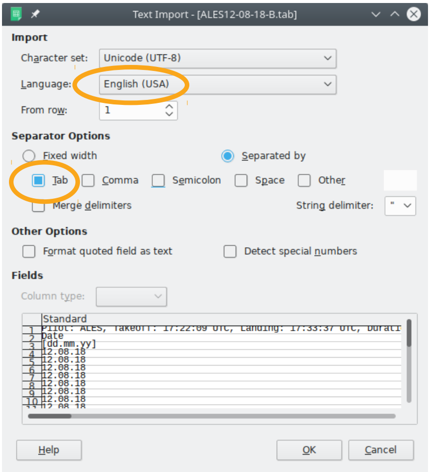
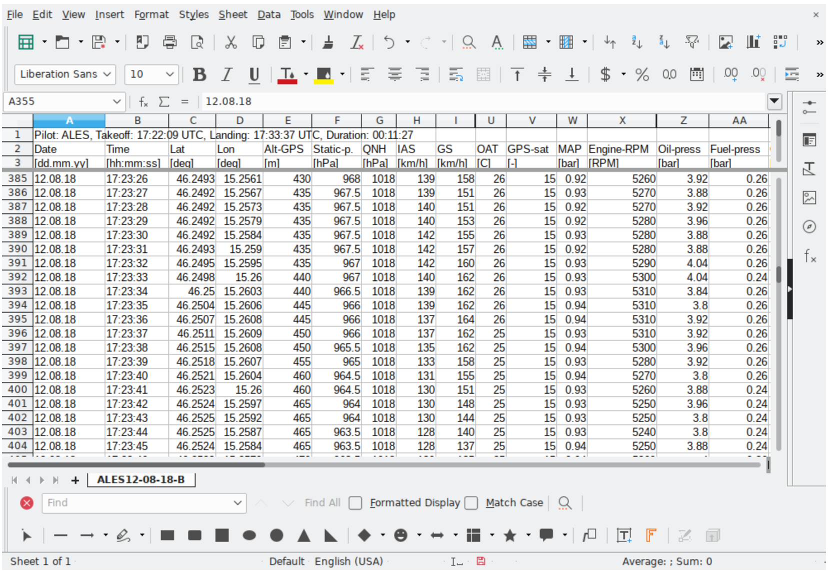


Figure 6.6: An example of Calc Text Import window.



	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 6.7: An example of flight details upon successful import.

6.3 Show Statistics

The *Show statistics* option, opens a window with more details about selected flight. Figure 6.8 gives an example.

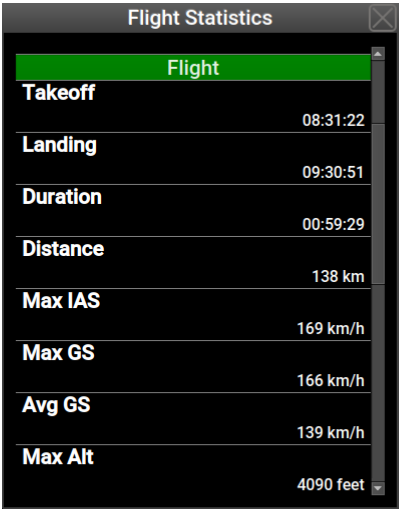


Figure 6.8: An example of flight details.

These details have three groups: general, flight and engine. The general group shows:

`Date` of the flight.

`Pilot` name – as it was defined at the time of the takeoff.

`Copilot/passanger` name – as it was defined at the time of the takeoff.

Flight section gives details and some statistics about a flight.

`Takeoff` time when takeoff conditions were detected.

`Landing` time when landing conditions were detected.

`Duration` total flight duration.

`Distance` distance traveled. This is not point-to-point distance. This is a distance of the path projected to the ground traveled during the flight.

`Max IAS` maximal indicated airspeed detected during flight.

`Max GS` maximal ground speed detected during flight.

`Avg GS` average ground speed detected during flight.

`Max Alt` maximal baro-corrected altitude reached during flight.

`Min Alt` minimal baro-corrected altitude reached during flight.

`Max Acc` maximal normal acceleration reached during flight.

`Min Acc` minimal normal acceleration reached during flight.

The engine group shows similar statistics for the engine.

`Start` time of engine start.

`Stop` time of engine stop.

`Duration` engine run time.

`Max engine RPM` maximal RPM reached during engine run.

`Max rotor RPM` maximal rotor RPM reached.

`Max CHT` maximal CHT reached during engine run.

`Max coolant temp.` maximal coolant temperature reached during engine run.

`Max oil temp.` maximal coolant temperature reached during engine run.

`Fuel used` during engine run.

`Avg fuel flow` average fuel consumption during engine run.

If a parameter is not active/provided by the system, then correcponding information is omited. For example, rotor RPMs are not used on airplanes and hence they will not be shown.

Please note that the fuel used and average fuel consumption strongly depend on the fuel flow measurement/estimation. If fuel flow is wrong, these two items will be wrong, too.

Chapter 7

Checklist

Nesis has ability to show checklists on the screen and also to speak its content to headset. In order to use this functionality, you have to perform next steps:

- Make your own checklists with our `Checklist Editor` online app.
- Copy checklists into Nesis.
- Activate a specific checklist to show on the screen.

7.1 Make Your Checklists

Checklist are prepared in our online app called `Checklist Editor`. We prepared a special manual which covers this particular topic and we encourage you to study the manual. Figure 7.1 shows an example.

`https://www.kanardia.eu/apps/checklist/CheckListEditor.html` is a direct link to the app.

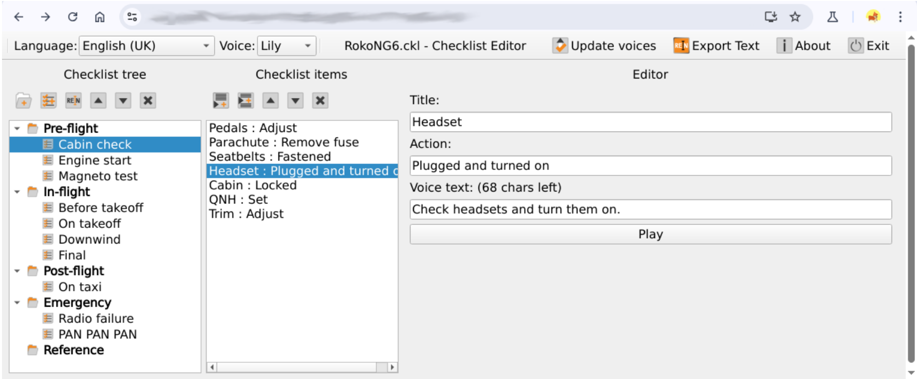


Figure 7.1: Here is an example of Checklist Editor usage.

7.2 Copy Checklists

`Main menu | User Options | Checklist`

Once the checklists have been prepared and copied to a USB memory stick, switch to the `Options` screen, select the `Checklist` item, and then choose `Import from USB`. Search for your checklist file.

Please note that any previously installed checklist will be overwritten by the selected one. Once the file has been copied, the checklists are ready to use.

7.3 Usage

`Main menu | Checklist`

First, select the `Chekclist` option from the main menu and then search for the proper checklist. Chekclists are organized in a tree like structure. Figure 7.2 shows an example.

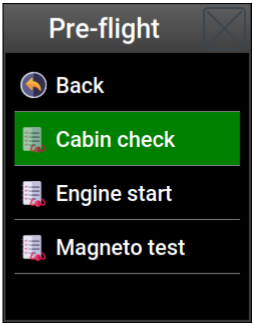


Figure 7.2: Checklist selection.

After selection, the first checklist item is displayed on the screen in a semi-transparent window as illustrated in Figure 7.3. Simultaneously, a voice is played through the headset.

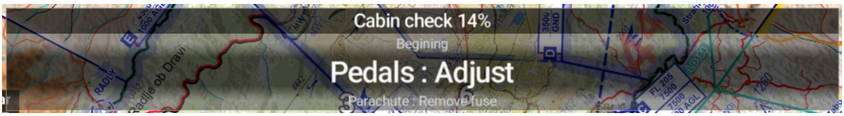


Figure 7.3: Checklist item displayed on the screen.

After a checklist item is displayed, use any of the following actions:

- A touch on the window advances to the next item. If this is the last item, the window will close automatically.
- A long touch closes the window.
- Rotate the knob to move to the next or previous item. This is handy if you want to replay a certain item or skip one.

Chapter 8

Autopilot

8.1 Introduction

When Nesis system is extended with one or two servo motors, than Nesis can be also used as an autopilot controlling device. In general, no other electronics, but servos is needed. This section describes basic operations with autopilot system.

8.1.1 Intended Use

The autopilot is designed to help a pilot in stable, controllable flight conditions during cruising. If such conditions are met, the autopilot can be engaged to take some relief from the pilot, who can perhaps focus a bit more on ATC communication or to do some navigation task. Nevertheless, it is still pilot's responsibility to monitor the autopilot and airplane behavior all the time.

8.1.2 Operation Limitations

Always respect the following limitations.

- Always expect that autopilot can disengage at any time – you must be able to take over the commands at any time.
- Make sure that aircraft is trimmed properly to prevent abrupt change of pitch/roll in the case of sudden autopilot disconnect.
- The autopilot shall be only used in VFR (Visual Flying Rules) conditions.

- Information from the Aircraft Operating Handbook always supersedes information given in this manual.
- The autopilot is designed to be used in cruising conditions only. It will not work at low and high speeds. It can't fly approaches and departures and it can't do takeoffs and landings.
- The autopilot shall not be used in turbulence.
- Do not use the autopilot with flaps extended.
- In any case of abnormal activity, the autopilot must be deactivated and the pilot must take over the commands immediately. Never wait for autopilot to deactivate itself automatically.
- Autopilot does not use any information from Magu (magnetic compass).

8.2 System Description

Autopilot system shown in Figure 8.1 consists of Nesis, power supply switch and two or more servo motors units called *Seru*. All these units are connected via CAN data bus which enables the communication between them. The Nesis is used for autopilot control and configuration. The Seru units are servo-motors which are moving the aircraft control surfaces. Power switch is used to cut the power to the servo motors – this quickly disables servo motors and frees the aircraft commands. In addition, it is also possible to install a quick autopilot disable switch which can be placed on the command stick.

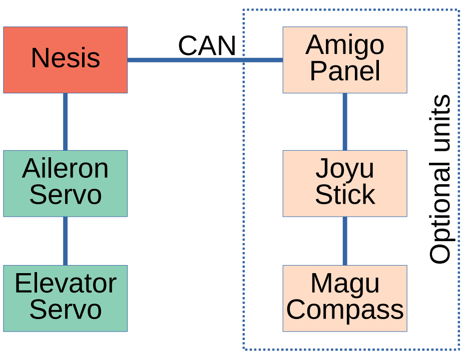


Figure 8.1: Main units of the autopilot system. Some units are optional.

Each Seru unit is controlling one aircraft control surface. In two axis autopilot system, one Seru unit is linked to the aircraft aileron which is controlling the roll angle and therefore controlling the heading of the aircraft. The second Seru unit is linked to the aircraft elevator and is controlling aircraft pitch and therefore altitude or vertical speed.

8.3 Autopilot Status Window

Autopilot status box as shown in Figure 8.2 can be found on most Nesis screens . The status box shows state of autopilot axes. A green text next to the axis indicates that it is active. A gray text means that an axis is disabled. In addition, selected autopilot parameters are also shown in the status box.

Figure 8.2: An example of the autopilot status box.

A short touch on the autopilot status opens the autopilot menu. A long touch on the autopilot status disables the autopilot.

8.4 Autopilot Setup

For autopilot installation and setup please check separate document: *Autopilot Installation Manual.* In addition to this you must configure a quick access to the autopilot menu.

The `User/Direct to` button should be configured to provide a quick access to autopilot functions. It is advised to configure button as:

- *Short Press* set to the `Autopilot Menu` function,
- *Long press* set to the `Autopilot Disable` function.

Please check Section 9.3.1 on page 120 for more details.

8.5 Safety

> Autopilot system is not terrain aware and it will not make any avoidance action or issue any terrain warning!

Please refer to the Autopilot Installation Manual for more details about the safety measures.

8.6 Operation

Short press on the *User* button shows the autopilot menu, Figure 8.3. All autopilot actions are accessed through this menu.

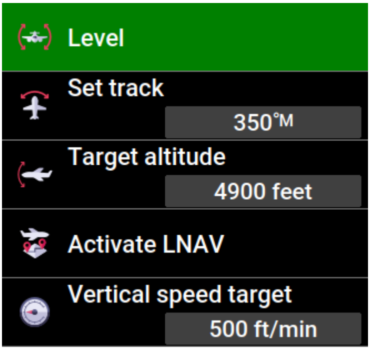


Figure 8.3: An example of the autopilot menu.

The description of the actions is presented below. Some actions enable only pitch and some only roll servo. The level action is the only one, which enables both autopilot servos simultaneously.

Autopilot menu remembers the previous selection. When the menu is opened, previously accessed action is already selected. This saves time when you change one parameter often.

8.6.1 Level

The `Level` command is the only autopilot command which activates aileron and elevator servos at the same time. It will activate `TRK` – track hold mode for aileron and set current altitude for elevator.

8.6.2 Set Track

In order to fly some desired track course the *Track* action is selected from the menu. A window with track direction input is shown in Figure 8.4. If active screen also shows the heading bug, the bug is adjusted as well.

Figure 8.4: Illustration of the track input window.

If the autopilot was not active before selecting new track the roll servo motor will be automatically enabled after the track is confirmed. Otherwise, the autopilot will follow desired track once the window is closed.

The autopilot will always turn the airplane in the direction which is closer to the current track. When a change for more than 180° is made in one direction, the autopilot will turn the aircraft in opposite direction. The maximum roll angle of the turn is selected in autopilot setup menu. See *Autopilot Installation Manual* for reference.

A long touch on the compass rose sets the heading bug.

8.6.3 Target Altitude

In order to hold or change desired flying altitude, select the *Target altitude* item. A window with altitude input is shown in Figure 8.5. The new target altitude activates when the window is closed. The altitude is specified in 100 feet steps.

A long touch on the altitude area is a shortcut to target altitude command.

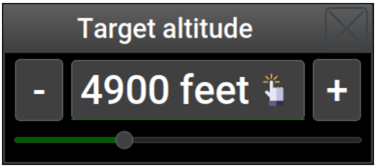


Figure 8.5: Illustration of the target altitude input window.

Make sure to adjust throttle position during autopilot climb or descend in order to stay withing the safe autopilot operation envelope limits.

8.6.4 Activate LNAV

In order to follow a pre-planned route or fly to some selected waypoint using the autopilot, select the `Activate LNAV` from the autopilot menu. Nesis then becomes primary navigation source for the autopilot. The autopilot will follow any active navigation. Roll servo motor is automatically activated. Please refer to Section 3.3 starting on page 79 for more information about route planing.

LNAV is controlling only direction of flight. To change altitude use the `Target altitude` command.

The navigation can be changed dynamically. When LNAV is active the aircraft will start to turn immediately after selecting new waypoint or activating a different route leg.

Once aircraft reaches the last point of the route or a direct-to waypoint it starts to circle around that point. During turns, the aircraft is maintaining the roll angle configured in settings.

When autopilot is active a touch on a map navigation point will activate the touched point as a direct-to and put the autopilot into LNAV mode.

8.6.5 Vertical Speed Target

This command is used to set target vertical speed for climb and descend. Autopilot will try to maintain this vertical speed during altitude change.

It is important to set this value well withing operational limits of the airplane.

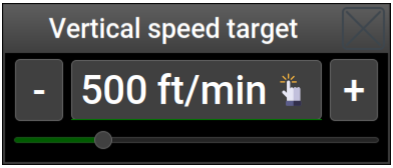


Figure 8.6: Illustration of the target vertical speed window.

8.6.6 Disable

The *Disable* command disengages all servomotors connected to the system. This action is immediate and the user is not asked for any confirmation. The route or direct-to waypoint selection remains unchanged.

Chapter 9

User Options

Nesis options are split into two parts: user options and service options. User options are always accessible, while service options require special unique password. Next section explains user options. See Section 9.15 on page 142 for service options.

The user options screen can be accessed from the main menu. See Figure 3.1 on page 70 – the last item. Alternatively, a long-press on the knob also opens the user options screen by default.

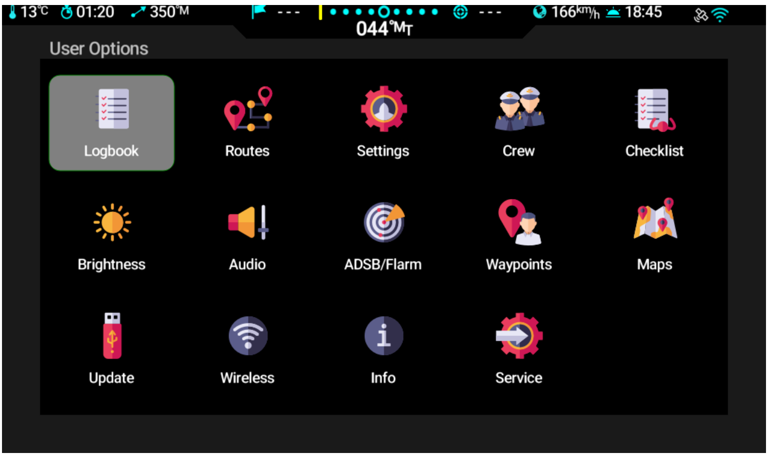


Figure 9.1: Illustration of the user options icon screen.

9.1 Logbook

Select the *Logbook* icon in order to access the logbook. Logbook activities are covered in Section 6 starting on page 101.

9.2 Routes

Select *Routes* icon to work with routes. A new route will be opened in the map editing mode. Route activities are covered in Section 3.3 starting on page 79.

9.3 Settings

Figure 9.2 shows the window of main user settings items. Each of these items leads to another window with several options. They are explained in next subsections.

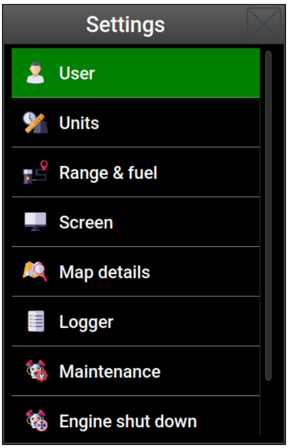


Figure 9.2: Main settings options.

9.3.1 User

The user item leads to some user specific options and it is also used to assign actions to buttons and knobs, Figure 9.3.

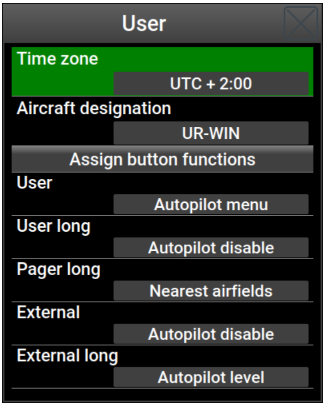


Figure 9.3: User options.

`Time zone` Specify the difference between local time and UTC time. Specify zero in order to show the UTC time everywhere. In majority of cases the difference is given in whole hours. However, some time zones also require the minute part. For example, Eucla in Australia is using UTC+8:45. In this case, set hours to 8 and minutes to 45.

`Aircraft designation` Enter aircraft registration number.

Depending on the Nesis model, some short-cut actions can be assigned to individual buttons:

`User` default action opens list of nearest airfields.

`User long` default action issues the *Waypoint* command.

`Pager long` default action opens the *Logbook* window.

`External` is not used by default. In fact, the external button is usually not connected to Nesis. When it is connected, it is typically set to deactivate autopilot.

`External long` When connected, it is typically used to re-activate autopilot.

The following actions can be assigned to each of the buttons mentioned before. Note that some actions require additional equipment to be connected to the CAN bus to be operational.

- `Not used` means that this shortcut is not in use. `Autopilot menu` is a shortcut to the Nesis autopilot menu. See Section 8.6 on page 115.
- `Autopilot level` is a shortcut to the autopilot level command.
- `Autopilot disable` is a shortcut to the autopilot disable command.
- `Logbook` is a shortcut to the logbook window.
- `Settings` is a shortcut to the user options page.
- `Near airfields` is a shortcut to the list of the nearest airfields.
- `Waypoints` is a shortcut to the waypoint selection window.
- `User Wayppoints` is a shortcut to user waypoint selection window.
- `Set marker` is a shortcut to the marker setting command.
- `Home screen` is a shortcut to the default (home) screen.
- `Video resize` enlarges or shrinks the video subwindow.
- `Next page` switches to the next page – same as pager button.

9.3.2 Units

Nesis uses several units for different physical quantities like distance, velocity, mass, volume, etc. Table 9.1 shows available units. The quantities are grouped according to their function.

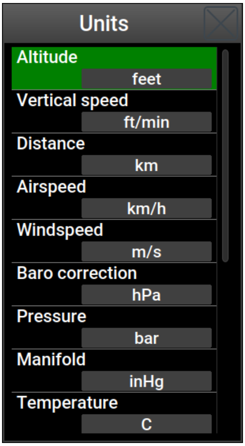


Figure 9.4: Unit selection window example.

Physical quantity	Available units
Altitude	feet, meters
Climb rate	ft/min, m/s
Distance	NM, km, mi(les)
Airspeed	kts, km/h, mph
Windspeed	kts, km/h, m/s
Baro correction (QNH)	hPa, inHg
Pressure	bar, psi
Temperature	°C, °F
Fuel	liters, US gallons, kWh (electric)
Flow	l/h, gal/h, kW (electric)
Engine RPM	RPM, %
Rotor RPM	RPM, %

Table 9.1: Available units for the individual physical quantity.

9.3.3 Range & Fuel

Parameters needed for range and fuel calculations are defined here. Figure 9.5 shows these parameters. Please refer also to Section 2.2.8 for more details on fuel computer monitor.

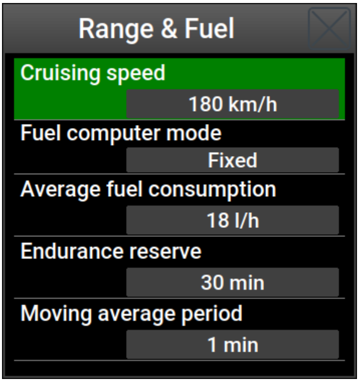


Figure 9.5: Parameters related to the range in fuel calculations.

`Cruising speed` This speed is used in *route* calculations. Fuel computer uses this value when aircraft is on the ground. Once aircraft is airborne, actual ground speed will be used by the fuel and range computer.

`Fuel computer mode` Fuel computer works in one of three modes, which define how average fuel consuption is calculated.

- The *Fixed* mode always uses the fuel consumption defined here in range and endurance calculations. It ignores actual values received from the fuel flow sensor.
- The *Integral* mode uses fixed estimated consumption while the aircraft is not flying – while on the ground or taxing. As soon as aircraft is airborne, it starts calculating integral consumption from the fuel flow and then it uses it for the range and endurance. The average is true integral average and takes all data after take-off into account -– it is not a moving average.
- The *Moving average* mode uses the fixed estimated consumption while the aircraft is not flying – while on the ground or taxing. As soon as aircraft is airborne, it starts calculating moving average consumption for the defined period of time. This value is then used for the range and endurance calculations.

`Average fuel consumption` represents fixed estimated average cruise fuel consumption of the aircraft. This value will be used by the fuel computer for the endurance and range calculation, depending on the selected mode.

`Endurance reserve` is the time reserve used in the endurance and range calculation.

`Moving average period` is the period of time used to monitor fuel consumption as required by moving average method. Shorter periods respond swifter to change in fuel consumption, while longer periods give slower response in range and endurance.

9.3.4 Screen

Figure 9.6 shows some options that affect how Nesis screens are shown.

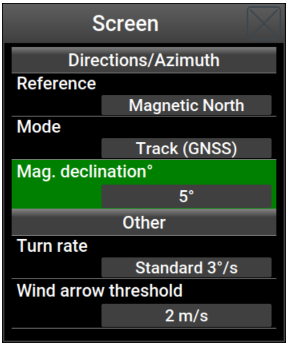


Figure 9.6: Parameters related to the Nesis screens.

`Reference` This options affects all directions shown in Nesis (bearings, tracking, flight planning etc.). These directions can be:

- true directions – as they are taken from standard paper map – they are related to true geographic North.
- magnetic directions – all directions are related to magnetic North.

`Mode` This option tells which value is shown on the top of each screen.

- Track received from the GNSS receiver or
- Heading received from the magnetic compass (Magu), when it is present on the CAN bus. If Magu is not present, GNSS track will be used instead even if this option is selected.

`Mag. declination` is the default declination value used in calculations in a case when GNSS coordiantes are not availale.

`Turn rate` defines visual aids for turn rate markers:

- Off – turn rate markers are not shown.
- Standard $3\,^{\circ}\,\mathrm{s}^{-1}$ – this is what most GA uses.
- Double $6\,^{\circ}\,\mathrm{s}^{-1}$ – double turn speed is slightly more dynamic.
- Glider option $12\,^{\circ}\,\mathrm{s}^{-1}$ – pretty fast rate.

`Wind arrow threshold` defines the windspeed above which the wind direction arrow is shown on the screen. `Magu` magnetic compass must be also present on the CAN bus in order to show the wind arrow.

9.3.5 Map Details

Maps (charts) can be also a bit customized. Figure 9.7 shows the options.

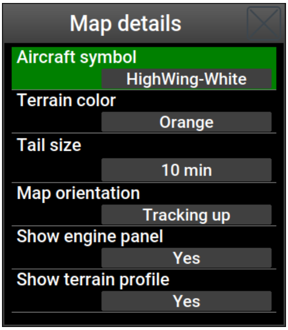


Figure 9.7: Map parameter that can be customized.

`Aircraft symbol` defines the aircraft symbol icon to be shown on the map.

`Terrain color` defines the terrain elevation color ramp used in terrain rendering.

`Tail size` is used to show your past flight path in real time on the map. The option defines how long this tail shall be in terms of time.

`Map orientation` defines the way the map is oriented on the screen.

- Heading up -– the map is oriented in the direction of the aircraft main axis.

- Tracking up – the map is oriented in the direction of the flight path – track (GNSS track).
- North up – the map is always oriented to the true North.

`Show engine panel` tells if the engine panel is shown on the main map screen.

`Show terrain profile` tells if the terrain profile is shown on the main map screen.

9.3.6 Logger

Logbook and logger use several parameters needed for correct takeoff and landing detection. Figure 9.8 shows these parameters.

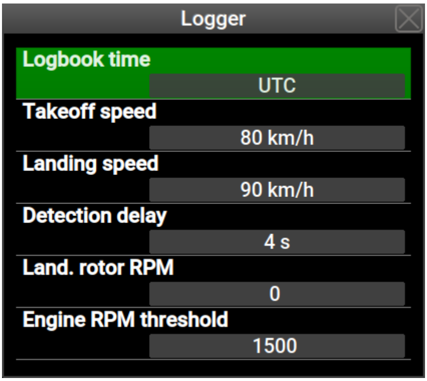


Figure 9.8: Logger and logbook specific parameters.

`Logbook time` defines the time used in logbook reports. It can be either local time or UTC.

`Takeoff speed` is the threshold speed, which must be exceeded. As soon it is exceeded (with a small delay) Nesis treats the aircraft as airborne. This speed shall be larger than wind gusts to prevent false logs.

`Landing speed` This is similar to takeoff speed, but it is used to detect landings. As soon as airspeed drops below this threshold, Nesis considers that the aircraft has landed and marks this in logger. It also stops counting flight time.

`Detection delay` is valid both for takeoff and landing. It defines the time for which takeoff or landing condition must be met. This is used to prevent false takeoff/landing detection.

`Takeoff rotor RPM` shall be used for helicopters only. All other aircraft shall set this to 0 (not used). This value is used to detect takeoff-and-hover condition. When rotor RPMs exceed this value for certain the detection delay amount of time, it considers helicopter as airborne. This works in conjunction with the takeoff speed.

`Landing rotor RPM` Set this to zero for all aeroplanes. Rotorcraft shall set this to a value, where they can't fly anymore (say 200 RPMs). When landing rotor RPM is set, Nesis does not relay completely on the landing speed alone, but it also demands that rotor RPMs are lower than given threshold. Only when both, speed and rotor RPMs are below their thresholds, it will detect landing.

9.3.7 Maintenance

This option is used to set a maintenance warning. Figure 9.9 shows the maintenance options on the left and a warning window on the right. There are two different maintanences that can be set: engine hour based and annual based.

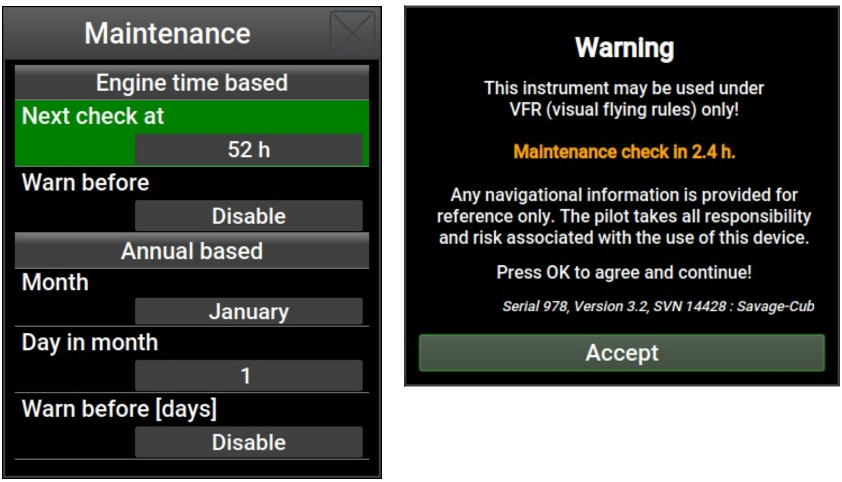


Figure 9.9: Left: Maintenance options. Right: Maintenance warning.

For warning related to the engine time, set next two items:

`Next check at` specifies engine hours when maintenance check shall be performed.

`Warn before` is used to define how many hours before the check the warning starts to appear on the startup window.

For annual check based warning, set:

`Month` set the month of aircraft annual service.

`Day in month` set the day in the month of aircraft annual service.

`Warn before` set number of days before annual service, when worning starts to appear.

9.3.8 Engine Shut Down

This is special option for the cases where the engine shall be cooled down by running on idle before shutting down. When aircraft is below some speed threshold and the engine RPMs are on idle a large countdown window starts on the Nesis screen. Once the countdown disappears, it is safe to shut down the engine.

A long touch on the countdown window closes the window prematurely.

Figure 9.10a shows the parameters and Figure 9.10b shows the countdown.

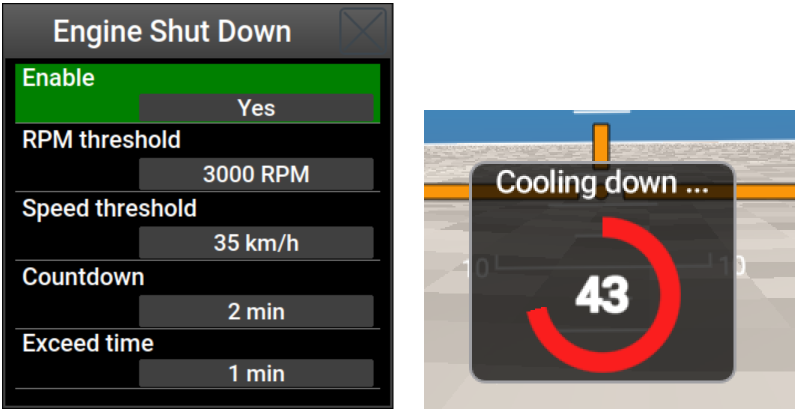
`Enable` toggles this function on and off. It is off by default.

`RPM threshold` When engine RPMs are above this threshold for a certain amount of time (exceed time), it is considered that the engine is hot. When aircraft indicated airspeed is below the speed threshold and engine RPM is below this threshold, the countdown starts (only when engine is in hot mode).

`Speed threshold` This threshold shall be set below the flying airspeed and above high speed taxi. It is used together with the RPM threshold to determine when to start the countdown.

`Countdown` The countdown time - waiting time. When this time elapses, it is considered that engine is cool enough.

`Exceed time` It works together with the RPM threshold. When RPMs are higher than the threshold for more than *Exceed time*, it is considered that the engine is hot.



(a) Parameters (b) Countdown.

Figure 9.10: Engine shut down example.

9.3.9 Glide

Glide is used to calculate the distance that can be reached by aircraft with engine not working – in a glide mode. The following parameters have to be defined:

`Glide ratio (finesse)` Define the glide ratio of the aircraft. Act conservatively. Smaller values yield to shorter glide distances.

`Reserve altitude` Define the reserve altitude. If some airfield can be reached in a glide mode above this altitude, then Nesis marks this in green. If an airfield can be reached, but below this altitude, it is marked yellow. All others are marked red.

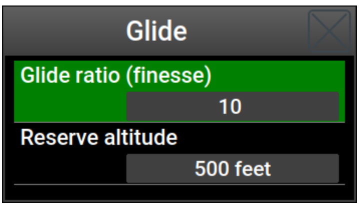


Figure 9.11: Glide parameters.

This feature is impractical for some aircraft types: gyro-planes and helicopters. In this cases set the glide ratio to zero.

See also Section 2.4 on page 49.

9.4 Crew

When several people are flying an aircraft, pilots and copilots/passangers can specified. When more that one pilot is given, Nesis ask for its name on the startup. Pilot and copilot names are automatically recorded, when takeoff conditions are detected and they will show in the logbook.

Figure 9.4 shown an example. A check over an icon means that this pilot/copilot is currently active.

Only one pilot can be active at the time. In addition, one copilot may be also active.

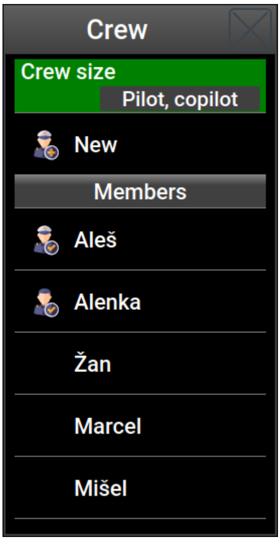


Figure 9.12: An example of window used to edit crew list.

`Crew size` – you can select between two options: `Pilot only` means that Nesis will ask only for a pilot at the startup. `Pilot, copilot` means that Nesis will ask for both crew members at the startup.

`New` – asks for a name and then adds a new crew member to the list.

`Members` shows the list of names that may be used for the crew selection. If you select a member, you can activate it as a pilot, as a copilot or delete it from the list.

9.5 Checklist

This command is used to transfer a checklist from USB memory stick into Nesis. A checlist is a file with `ckl` extension, which was prepared with our Checklist Editor online app.

9.6 Brightness

The brightness icon is used to change the display brightness. Nesis always starts with 100% brightness. Brightness is selected in 10% steps.

When Nesis runs on a backup battery (when such option is installed) it is highly recommended to reduce brightness to 80% or less. This will significantly increase the run time available on the backup battery.

9.7 Audio

The *Audio* icon is used to change the audio level output for Nesis warnings. Figure 9.13 illustrates an example. The *Test* option is used to play a test file and the *Volume* sets the volume level in 10% steps.

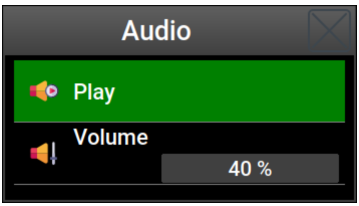


Figure 9.13: The audio level window.

9.8 ADSB/Flarm

The *ADSB/Flarm* icon is used to set various Flarm/ADSB settings. The details are covered in Section 5.4 starting on page 96.

9.9 Waypoints

The *Waypoints* icon is used to add and edit user specific waypoints. Figure 9.14 shows a window that appears. The top part list commands and the bottom part list all user defined waypoints.

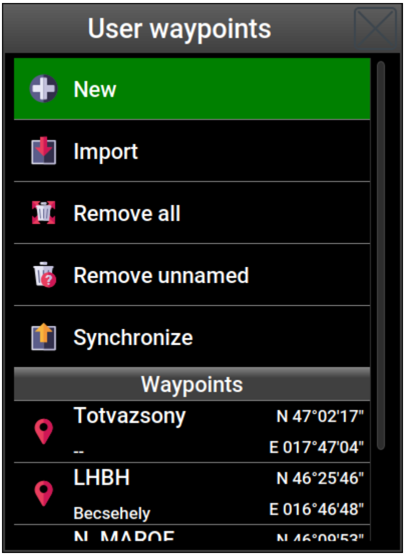


Figure 9.14: An example of user waypoint window.

9.9.1 New Waypoint

The *New* command is used to create a new user waypoint. Nesis asks for a waypoint name first and once the name was given, it asks for the details. Figure 9.15 shows an example.

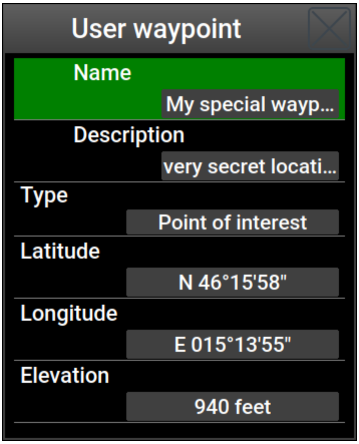


Figure 9.15: An example of user waypoint details window.

`Name` Name of the waypoint.

`Description` Longer description of the waypoint.

`Type` Type of the waypoint. When one of the airfield types is specified, this waypoint will also appear in the airfield list.

`Latitude` Waypoint latitude in degree, minutes, seconds format.

`Longitude` Waypoint longitude in degree, minutes, seconds format.

`Elevation` Waypoint mean sea level elevation.

9.9.2 Import

The *Import* command is used to import waypoints from a file on USB stick. Three different formats are recognised:

- Garmin GPX format,
- Google KML format,
- Glider CUP format.

During import, all importing waypoints that are closer than 0.5 NM to any existing waypoint are ignored.

Also, the total limit for user waypoint is set to 700. Any waypoint inserted after the limit has been reached, is ignored.

9.9.3 Remove All

The *Remove all* command deletes all user waypoints in one step. A confirmation is required.

9.9.4 Remove Unnamed

This command deletes all user waypoints that have no name assigned. These are typically markers, which name has not been changed to something meaningful.

9.9.5 Synchronize

This option is shown only, if the second Nesis is detected on the bus. This command will transfer all user waypoints from this Nesis to the other. Any existing user waypoint on the other Nesis will be overwritten.

9.9.6 Waypoint Edit/Delete

When a waypoint from the list is selected it can be either deleted or edited. No confirmation is required in the delete case. When `Edit` option is selected, a window shown in Figure 9.15 is opened. See Section 9.9.1 for details.

9.10 Maps

The *Maps* icon is used to copy map files from the USB memory stick into the system. Such files are various maps, airspace database, license files, etc. Figure 9.16 shows available options.

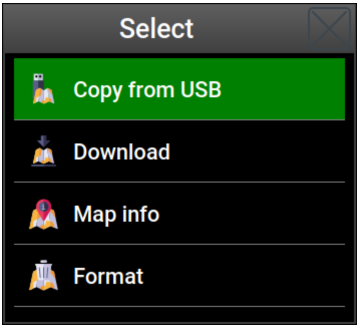


Figure 9.16: Map options window. Note that some options are available only when Nesis is connected to the Internet.

`Copy` copies a file with `kus`, `ras`, `nam` or `lic` extension from an USB memory stick. All these files are in Kanardia specific format. A new window appears asking for intended copy action, Figure 9.17. Vector maps have `kus` extension, raster maps use `ras` for the maps and `lic` for licenses and approach maps expect `nam` extension.

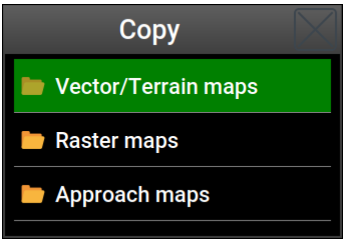


Figure 9.17: Type of file to search for.

Each copy is a two part process. First, Nesis checks the integrity of the file and if the check has passed, the file is copied next. Usually, a restart is required afterwards.

Please note that you can't use the copy command for the system update, although the update file has the correct extension. Use the *Update* icon instead.

`Download` is used to copy a file form the Internet and it is only shown when WiFi connection is available. In principle, this command is very similar to the `Copy`, just that it requires an active Internet connection.

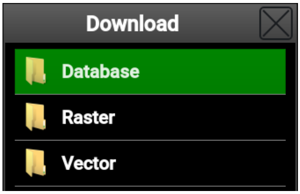


Figure 9.18: Type of file to search for download.

Selecting `Database` allows downloading the latest airspace, airfield and other navigational data, while `Raster` and `Vector` work the same as in the `Copy` case.

The download is limited in file size, though. Some very large files like `USA.kus` can't be downloaded and a USB memory stick must be used instead. Please also note these files are quite large and transfer fees from your GSM provider may occur.

`Map info` lists *map files* loaded into Nesis, Figure 9.19. It does not list any system map files. The raster files list shows map name, date of map creation, map file name, map type and size.

`Vector` maps can't be deleted. Nesis only lists the country names that were loaded into the system.

`Raster` displays raster maps in the system. A selected raster map can be removed with the `Delete` command. After removal, Nesis will restart.

`Approach` displays approach maps in the system. A selected map can be deleted from the system using the `Delete` command or simply turned off/on using the `Disable/Enable` command.

`Format` is a very powerful command and normally it should never be used. It will reformat internal disk section. This section stores maps. This effectively deletes all maps – system maps and raster maps. The command can't be revoked. If there were license files installed, they will be lost too.

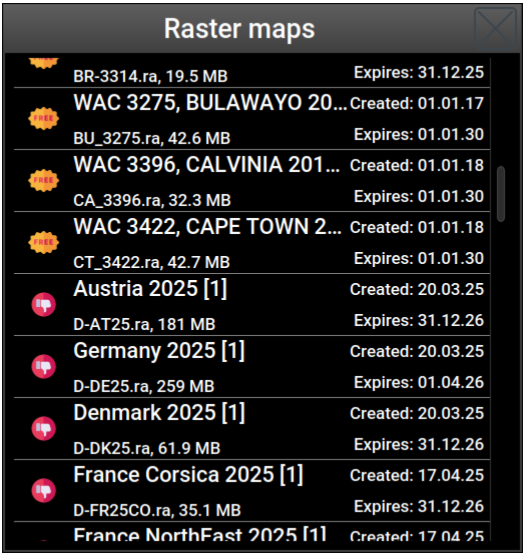


Figure 9.19: An example of raster file list. A thumb down icon means that file is correctly copied but valid licence file is missing. A thumb up icon means that correct license file is also present.

9.10.1 When Copy Fails

Copying may fail. When it happens, an error message is displayed after the verification process has been completed. The most probable cause is a corrupted file on the USB memory stick. Download the file again and make sure to use the *Safe remove* command before removing USB memory stick from PC. Then try again.

9.11 Update

The *Update* icon starts system software update. It asks for a confirmation and when confirmed, Nesis restarts in a special update mode. More details are given in Section 10.1 starting on page 144.

9.12 Wireless

The *Wireless* icon opens a window where parameters for wireless connection are given. Standard Nesis does not have wireless capabilities. You need a compatible wireless USB plug in adapter. It is typically connected to the USB port on the Nesis back side. Please refer to the Nesis Installation Manual for more details.

9.13 Info

The *Info* icon tells some technical information about the Nesis and connected CAN bus devices. Figure 9.20 shows an example.

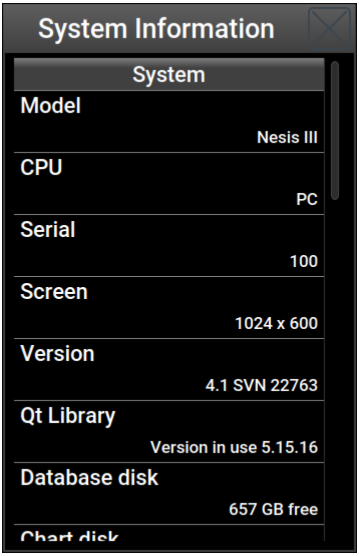


Figure 9.20: An example of info window with the system details.

`Qt Library` tells the Qt library version in use. When selected it opens further options. Please refer to Section 12.1 on page 161 for more details.

`Model` tells Nesis model.

`CPU` tells the model of the main CPU used in Nesis.

`Serial` tells serial number of Nesis.

`Screen` defines the screen pixels resolution.

`Config` defines the configuration file used to define the number and look of Nesis screens.

`Version` is the version number of software in Nesis. First number is version in standard format and the second number is a build number. The later is useful in troubleshooting.

`Sys disk` tells free space on the Nesis system disk.

`SD disk` tells free space on the internal SD card, where map files are stored.

`Service pass` holds a numeric password, which is needed to access the *Service Options*.

`GNSS details` opens a window with GNSS satellite positions and status. The following status are shown:

- *Error* is shown if there is no GNSS reception or some internal error is detected.
- *2D fix* is shown when a position is known, but precision is limited.
- *3D fix* is shown when a position is known and enough satellites are visible for a good fix.
- *3D+SBAS* is shown when a position is also augmented with SBAS system – highest precision.

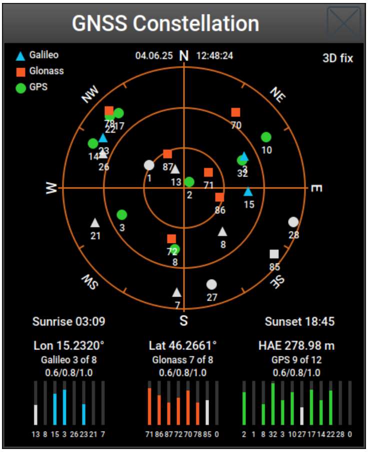


Figure 9.21: An example of GNSS details. The example shows bad satellite distribution and relatively weak signals.

`Counters` section lists three internal counters:

- Engine total time – total time of engine running.
- Flight total time – total time of aircraft being airborne.
- Power-on total time – total time of Nesis being powered on.

`CAN devices` section lists all devices detected on the CAN bus, together with their hardware and software versions, production data, etc.

9.14 Service

The *Service* icon is entry point to protected *Service Options* section. It requires a special password. This password is unique for each Nesis. It can be found under *Service pass* item on the info window. See Section 9.13.

Additionally, this password is also written on the warranty card, that comes with each Nesis.

Service option icons are briefly explained in separate Section 9.15, while the detailed explanation is given in the `Installation manual`.

9.15 Service Options

Most of *Service options* are covered in depth by other manuals, particularly in the *Nesis Installation Manual*. Here, only a brief information will be presented. Figure 9.22 shows the service options screen. Note that slave Nesis has only a subset of these icons.

9.15.1 Password

In order to access the service options page, a four digit device specific password is required. This password is written on the warranty statement, which should be delivered with the instrument. The same password can be also found by selecting the `Info` icon from user options (Section 9.13). Search for the `Service pass` and number next to it is the service password.

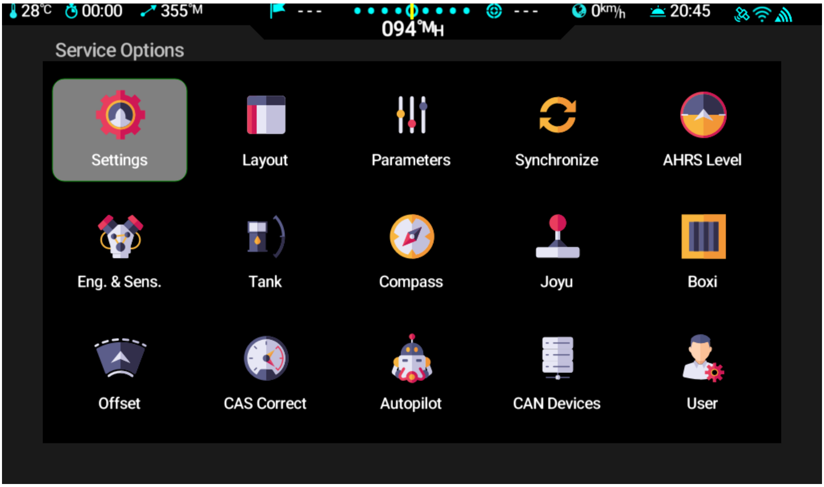


Figure 9.22: The service options window and corresponding icons.

9.15.2 Icons

The following icons are available on the service options page:

`Settings` opens a window, where access to further settings like flap positions, trim sensitivity, properller pitch, special recorders, video input, serial ports, backup and restore, etc..

`Layout` is used to start screen editing (limited to engine part on Modern screens) and to define various screen options.

`Parameters` is used to define engine, flight and other parameter details like their names, green, yellow and red limits, responce times and other parameter specific attributes.

`AHRS Level` is used to set the level position of the AD-AHRS-GNSS module.

`Eng. & Sens.` opens window for the EMS device. Channels and sensors are configured here.

`Compass` opens a window for the calibration of optional electronic compass device called MAGU. The window is opened only when Magu was detected on the CAN bus. Due to complexity the details are explained in the *MAGU Manual*.

`Tank` is used for tank calibration.

`Offset` allows various sensor and counter adjustments.

`Autopilot` is access point to several autopilot configuration windows. A separate document was prepared for autopilot installation and settings. Please see the *Autopilot Installation Manual*.

`CAN devices` lists devices found on CAN bus and allows to perform some special operations on them.

`Joyu` is used to assign commands to the `Joyu` command stick.

`Boxi` is used to configure `Boxi` box used to drive trims, radio or some other external motor or relay. Boxi often works together with Joyu.

`Engine Log` is similar to the logbook, but it shows logs based on the engine time. It also detects shorter test engine runs on the ground, which are normally ignored by the logbook. This is useful for service and testing purposes. When an item is selected, it is copied to an USB memory stick in the *tab* format. See Section 6.2.2 for more details.

`CAS Correct` is used to enter the calibration airspeed corrections. Please refer to the Installation manual for more details.

`User` brings back the *User Options* screen.

Chapter 10

Updates

10.1 Software Update

This section describes actions required to update the software.

The Nesis software is under continuous development, where we are adding new features and sometimes we also remove some old ones. Updating to the latest version is not completely without risk, especially if you are updating from a very old version. If your system works fine, think about updating and its associated risk first. If you can wait with an update, try to update at the end of flying season. Please, avoid updating just before a long flying trip which you were long wating for.

10.1.1 Versioning

Kanardia is using semantic versioning MAJOR.MINOR.PATCH. A version labeled as 3.2.5 means major version 3, minor revision 2 and patch (fix) 5.

A MAJOR version increase means that it may break compatibility with existing version. Furthermore it may also mean that old hardware is not supported anymore or that some old features will be dropped. Think twice before updating to a higher version as significant side effects may occur.

A MINOR revision increase should keep compatibility with previous revision of the same version. Though sometimes side effects may kick in. If they do, they should be small enough.

A PATCH with higher number and same version and revision is usually issued to correct some corner cases which were not properly addressed. In most cases the changes are insignificant and side effects shall be minor or nil.

10.1.2 Downgrading

In general, downgrading to previous version or even to previous revision *IS NOT SAFE*. Significant negative side effects may occur.

10.1.3 Updating with USB Memory Stick

In most cases, Nesis is updated using USB memory stick. Here the following steps are required:

1. downloading an update file,
2. copying the update file to the USB stick,
3. updating Nesis with the USB stick.

In the case of two or more Nesis units, they must be updated one by one. Start with master first.

Once Nesis is updated to a new version, old version can not be put back without causing system instability.

10.1.3.1 Downloading Updates

The latest (actual) software can be found on the Kanardia web page `www.kanardia.eu`. Follow these steps:

(1) Open the home page and select *Nesis* icon on the top. This leads to Nesis specific page.

(2) Select *Software* next. This opens a page with Nesis specific software. An example is shown in Figure 10.1.

(3) Click on the link to start download process of selected software file.

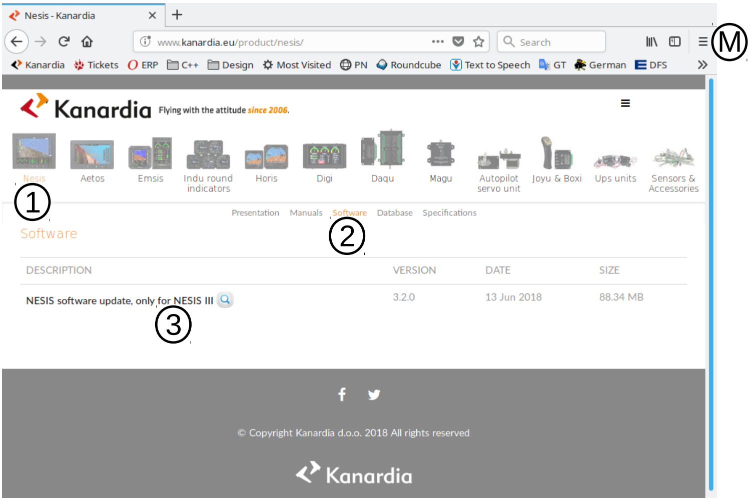


Figure 10.1: Illustration of the Nesis software download page. Usually only the latest update is available.

Problems with Download

Some people complain that after click on the link nothing happens. This is most probably because their browser blocks pop-up windows. Solution for this depends on the browser.

`Mozzila Firefox` solution is given in next steps:

1. Click on the ≡ menu symbol. See label Ⓜ in Figure 10.1.
2. Select *Preferences* option. This opens a window in Firefox.
3. Select *Privacy & Security*.
4. Scroll down to the *Permissions* section.
5. Click on the *Exceptions* button next to the *Block pop-up windows*.
6. The *Allowed Websites – Pop-ups* window appears. Enter url address *www.kanardia.eu*.
7. Click on the *Allow* button.
8. Click on the *Save Changes* button.

`Chrome` solution:

1. Click on the ⋮ menu symbol.
2. Select the *Settings* option.
3. Scroll completely down and click on the *Advanced*. This opens *Privacy and security* options.
4. Click on the *Content settings* to open them in a new window.
5. Click on the *Pop-ups and redirects*.
6. Under *Allow* section, click on the *Add* button.
7. Enter *www.kanardia.eu* and press *Save*.

`Safari` solution:

1. Click on the *Safari* menu and select *Preferences*.
2. A window appears. Select the *Security* icon.
3. Uncheck the *Block pop-up windows* checkbox.

Note that Safari does not allow exceptions for individual web sites.

10.1.3.2 Copying Update File to the USB Memory Stick

The downloaded file must be copied to a USB memory stick. We recommend copying it to the root folder.

Important: Once file was copied, please make sure that the USB stick is safely removed from PC. This makes sure that all files are properly copied and closed before the stick is actually removed from PC.

10.1.3.3 Performing the Update

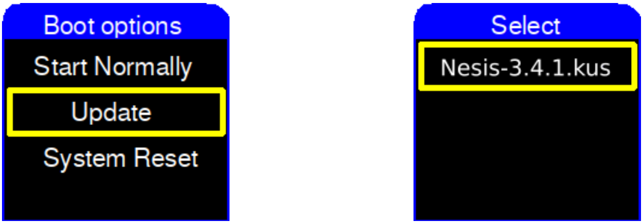
Once the update file is on the USB stick follow the steps below: Please note that touch screen is not working in the Nesis update mode.

1. Insert the USB stick with the update file into USB port.

2. Select *Options* from the main menu and then select the *Update* icon and confirm the decision. If option *User Password* is enabled the user must provide standard password **314**. Nesis will restart in special update mode.

3. Upon restart a window similar to Figure 10.2a opens. Select the *Update* option.

4. A window similar to Figure 10.2b opens with kus files listed. Normally, only one file is listed. Select the update file (kus file) and push the knob. The update process is now started.



(a) Nesis update mode options. (b) Update file selection.

Figure 10.2: Special update mode example.

Once update process has been started, do not cancel or terminate it. Make sure that battery is sufficiently full. The update process may take a few minutes.

The update process will automatically perform the following steps:

- The update file integrity is verified. In the case of *Update file checksum ERROR* message, it usually means that the file was corrupted and it must be downloaded again. In most cases, forgetting to *safely remove* the USB stick from PC is to blame.
- Files stored inside the update file are copied into Nesis. Once this is completed, Nesis restarts.
- A few moments after the restart, firmware update begins. Nesis will update firmware in all devices found on the CAN bus automatically. The firmware update process may take a few minutes[1]. Secondary Nesis does not perform firmware update[2].

10.1.4 Direct Update Mode (Emergency Mode)

In the case of software failure, where Nesis does not start-up properly anymore and the *Update* icon from the *Options* screen can't be reached, the following approach may help:

[1] In rare cases, the firmware update may fail. In this case, simply turn Nesis off and then on again. On the second try, it will update the remaining devices.

[2] Secondary Nesis with IGEP CPU is an exception, as it will only update its own MABU device.

1. Power Nesis off,
2. power it back on and
3. keep pressed the *Screen switching button*, see label (5) in Figures 2.1 and 2.2. Wait until the window similar to window shown in Figure 10.2a appears.

   This brings Nesis to the point where software can be updated.

10.2 Database Update

Nesis is using several aviation databases. These databases are regularly maintained and their latest versions are available on our web site.

The databases include: airfield information, frequency information, navigation points, airspace zones, recommended VFR routes, etc. All these databases are packed into one bundle and published on our web site. The name of the bundle is `Avio-YYMM.DD.kus`, where `YY` stands for year, `MM` stands for month and `DD` for day in the month.

10.2.1 Updating with USB Stick

In most cases the databases are updated using USB stick in three steps.

1. downloading the latest database file,
2. copying the file to the USB stick,
3. updating databases from the USB stick.

10.2.1.1 Downloading Updates

The latest (actual) database version can be found on the Kanardia web page `www.kanardia.eu`. Follow these steps:

1. Open the home page and select `Support` menu from the top and then select the `Database` option. A list of available files appears.
2. Select the `Avio-YYMM.DD.kus` file. Check the published date.
3. Click on the link to start the download process.

If you have problems with the download, please refer to Section 10.1 starting on page 144.

10.2.1.2 Copying Update File to the USB Stick

The downloaded file must be copied to the USB stick. We recommend copying it to the root folder.

Important: Once file was copied, please make sure that the USB stick is safely removed from PC. This makes sure that all files are properly copied and closed before the stick is actually removed from PC.

10.2.1.3 Performing the Update

Once the file is on the USB stick follow the steps below:

1. Insert the USB stick with the update file into Nesis USB port.
2. Select `Options` from the main menu and then select the `Map` icon
3. Select the `Copy from USB` option.
4. Select the `Vectors` option.
5. Search for the `Avio-YYMM.DD.kus` file and select it. Nesis will copy the databases.
6. Wait for copy to finish and then close all windows.

Nesis will restart with new databases being active.

10.2.2 Update with WiFi

When Nesis is equipped with WiFi dongle and Internet access is available, the database can be updated online.

1. Select `Options` from the main menu and then select the `Map` icon
2. Select the `Download` option,
3. Select `Database`.
4. Search for the `Avio-YYMM.DD.kus` file and select it. Nesis will copy the databases.
5. Wait for copy to finish and then close all windows.

Chapter 11

Maps

11.1 Introduction

Nesis uses several different map principles that are combined into one system using layers technique:

- Vector map with elevation data. This map principle is using vector information to draw a map. Most entities like road, railroads, rivers, etc. are drawn as lines and filled areas at run time on top of a elevated terrain image.
- Raster map. This map comes already fully prepared - it is like a very big photo, with all possible details included in the photo.
- Approach maps. These are similar to raster map. They are usually refering to smaller areas around airfields. Please see the Approacher Manual for more details.

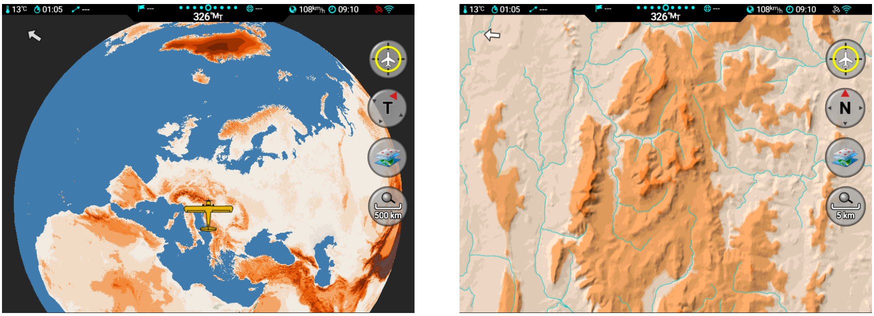
These map principles, which seems to be exclusive, are combined together using layers technique.

All map information is always drawn as a part of globe. No fixed projection is used. The projection is dynamic and automatically adapts according to the zoom level and current position. This was achieved by using the high performance graphics OpenGL system.

11.2 Layers

The map shown on Nesis consists of several layers, which are drawn on top of each other.

- Low resolution worldwide terrain presented as a globe is the most bottom layer. This layer is hidden most of the time by the high resolution terrain layers. Figure 11.1a shows example of this layer.
- High resolution terrain is drawn next. Some examples are shown as background in Figures 11.1b, 2.24 and 2.25.

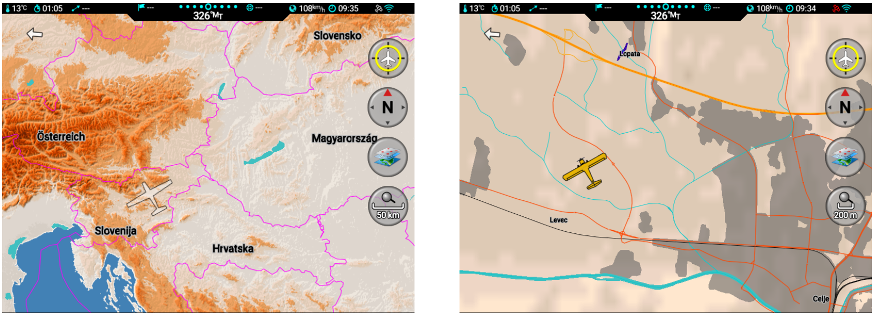


(a) Low resolution map – distant view seen as a globe.

(b) High resolution map – this one is made on globe as well.

Figure 11.1: All map operations are made on globe.

- Rivers, roads, railways, country borders, country names, cities are drawn next. The detail of this layer strongly depends on the zoom level. Figure 11.2 illustrates an example.
- On top of this layer come airspace zones. Their visibility also depends on the zoom level.
- Next, airfields, airfield details, navigation points are drawn. Some airfields have traffic patterns, holding zones, arrival and departure routes. They are drawn in a separate layer. See Figure 11.3a.
- When raster maps are used, they are drawn next. It is important to note, that they hide (overwrite) all layers below, in the part, where raster maps are visible. Figure 11.3b shows an example, where left part of the screen



(a) Low vector detail. (b) High vector detail.

Figure 11.2: The details of vector map depend on zoom level.

is covered with raster map and the rest is vector map. The figure shows how raster map overwrites all previous layers. It also shows that both maps blend together pretty good.

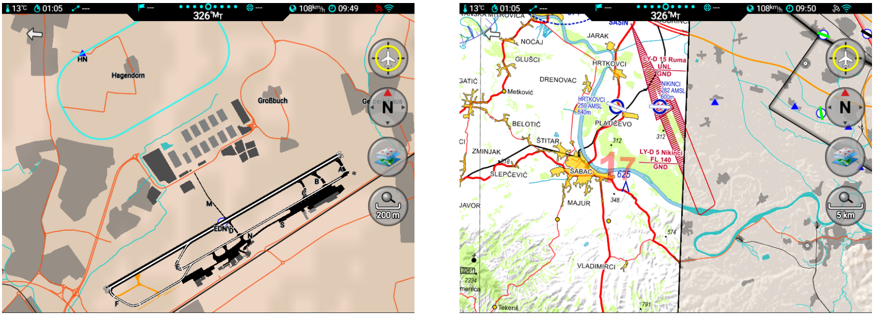
- When weather information is available, it is drawn next in a semitransparent way.
- Approach maps are drawn next. They are also drawn in a semitransparent way where the transparency can be adjusted.
- Active navigation details, airplane symbol and other navigational and operational items are drawn the last.

11.3 Vector Maps

Vector maps are based on several map sources.

- Elevation data is based on 3 arc-second DEM data, which is originaly provided by SRTM[1].
- Roads, rivers, lakes, railways, populated areas, state borders, etc. are obtained from the OSM[2] project. Only a tiny subset of this always growing project is used. We update this data once per year.

[1] Shuttle Radar Topography Mission, digital elevation data, produced by NASA.
[2] Open Street Map – `www.openstreetmap.org`.



(a) Airfield and traffic circuit detail.

(b) Raster and vector side by side.

Figure 11.3: More details of vector map and blending with raster map.

- The source for aeronautical information, airfields, airspace zones, navigation aids, etc. represents the OFM[3] project and OpenAIP[4] project. Partily, we also take data from Our airports[5] web page.

These maps are packed into several files, which can be downloaded from our server. These maps do not include any aviation information. They include terrain and basic topography.

11.3.1 Installing a Vector Map

The instrument is delivered with the vector maps partially installed. The low resolution maps are installed for complete world, but high resolution maps only for some specified area.

Low resolution world wide layer can be installed as follows:

1. Download the `WorldBase.kus` file.
2. Copy the file to a USB memory stick. Make sure to use *safe remove* option before removing the stick from your PC.
3. Insert the stick into Nesis, switch to `Options` page and select the `Map` icon.
4. Select the `Copy from USB|Vector` item and search for the `WorldBase.kus` on the stick. Select it to start the copy.

[3] Open flight-maps – `www.openflightmaps.org`.
[4] OpenAIP - Free Worldwide Aviation Database – `www.openaip.net`.
[5] Our Airports – `ourairports.com`.

The `WorldBase.kus` is already installed in Nesis by default, so the procedure mentioned above can be skipped in most cases.

High resolution layers are provided per country.

1. Visit our web page and use interactive map to select counties of your interest. Download them one by one.
2. Copy the downloaded files to the USB memory stick. Do not forget to use *safe remove* option before removing the stick form PC.
3. Start Nesis and insert the USB stick. Switch to the `Options` page and select the `Map` icon.
4. Select the `Copy from USB|Vector` item and then select a country with the `ras` extension from the stick. This start the copy process. Repeat this until all high resolution country files are copied.
5. Close all windows. Nesis will restart with new maps being active.

11.4 Raster Maps

Raster maps are complete maps in a form of an image usually prepared by professional organizations. The advantage of raster map is in the fact that final map optimization is done by human beings, which makes maps much more alike the paper map. In many cases, raster maps are nothing but electronic versions of paper maps.

Some of these maps may be obtained only under license and some of them are freely available.

Typically, these maps are provided as a file with `tiff`, `jpg`, `png`, `bmp pdf` or similar raster image extension. The most suitable format is tiff with integrated geo-referenced information – so called geotiff.

We use special software to convert one of these formats into a format optimized for Nesis and Emsis. Typical extension of our format is `ras`.

Some of our `ras` files are copy protected and they will be visible only when proper license file is also installed. This license file has `lic` extension.

11.4.1 DFS

We obtain DFS – Deutsche Flugsicherung maps from R. Eisenschmidt GmbH – `www.eisenschmidt.aero`. We convert these maps into `ras` format that is optimized for Nesis and also Emsis. The maps can be downloaded from our web site. Figure 11.4 shows coverage of DFS maps.

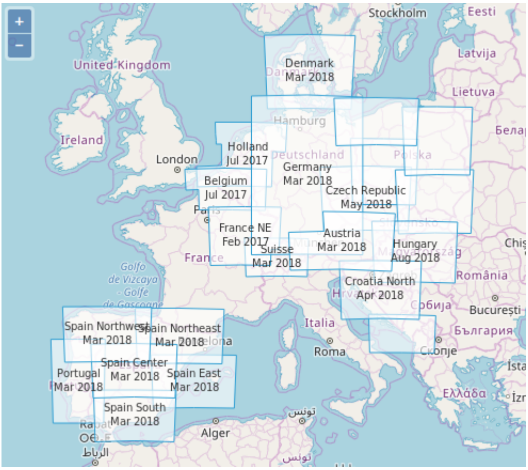


Figure 11.4: Availability of the DFS maps.

All DFS are licensed maps. You can download the `ras` files from our web page and install them on Nesis, but they will not be displayed on Nesis screen unless proper license file is purchased from us and copied.

Installing License

The license file is bound to a Nesis serial number. In order to obtain the license file, please contact `support@kanardia.eu` and tell us your Nesis serial number. We will charge you a license fee and once this is paid, an email with the license file will be send back to you. If you have two screens, you have to tell us serial numbers of both screens. There are no additional license fees for the second screen.

The license file has the `lic` extension. It is copied to Nesis in the same way as the maps with `ras` extension are copied. Please see Section 11.4.5. If you have two screens, you have to copy this to both.

You can copy any DFS ras file before you get the license file. The files will be installed, but ignored by Nesis until the proper license file is also present.

11.4.2 US Sectionals

FAA publishes and regularly updates several raster charts which are covering complete US territory. We take these charts and convert them into `ras` format suitable for Nesis.

All these charts are free – no license is needed. Figure 11.5 illustrates them for the main part of US.

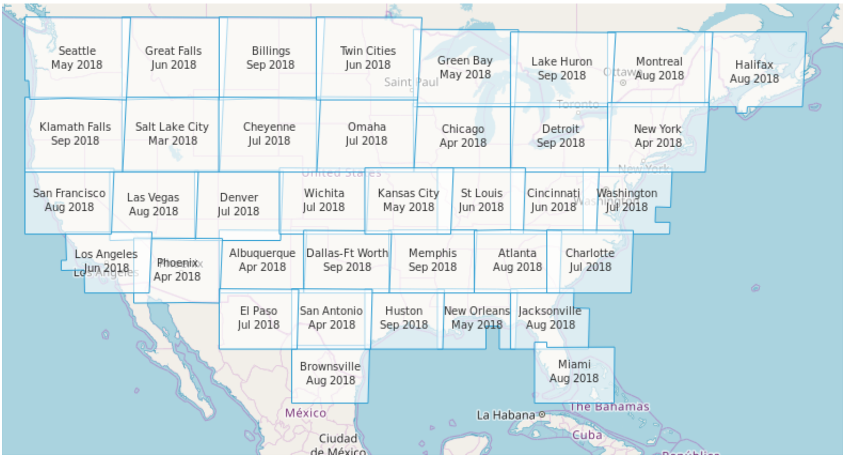


Figure 11.5: Availability of the US maps.

11.4.3 France – CartaBossy

CartaBossy is a popular choice for raster map of France. In order to respect the copyright of the author, please follow next steps:

1. Buy the paper map directly from CartaBossy web site `https://www.cartabossy.com/`.

2. For all buyers of the paper map, the author provides also access to the electronic version of the map. Download the electronic version to your PC. Use geo-referenced TIFF or TIF format.

3. Use "We transfer" web service (it is free) to send us the copy of the file you have downloaded. Use `support@kanardia.eu` address. Here is the link `https://wetransfer.com/`.

4. We will convert the file into a format, which is understood by Nesis. This will take a day or two. The file with `ras` extension will be send back to you using the same service.

5. Copy the file to Nesis with the help of the USB stick. See Section 9.10 for more details.

11.4.4 User Maps

Any image file which is available in proper format can be converted into a `ras` format and then displayed on Nesis. It is also possible to scan a paper map and then convert the resulting file into `ras` format. Please contact `support@kanardia.eu` and we will discus options.

In order to display a copy of a paper map on the screen, the following steps need to be taken:

1. Try to get a map on a roll, which is printed on a non-glossy paper. This yields best results during scanning.

2. Scan the map on a large format scanner at 250 dpi resolution. Nowadays, such scanners are available in almost any town. Save the result in a tiff or png format.

3. This file requires some manual processing – usually one hour work. So, we will ask for a minor fee.

4. Send the resulting file to us for georeferencing. Use "We transfer" web service (it is free). Use `support@kanardia.eu` address. Here is the link `https://wetransfer.com/`.

5. We will convert the file into a format, which is understood by Nesis. This will take a day or two. The file with `ras` extension will be send back to you using the same service.

11.4.5 Installing a Raster Map

Raster maps have `ras` extension. In most cases they are downloaded from our server. Sometimes they are also obtained via *WeTransfer* or a similar service.

In order to copy a raster map to Nesis, follow next steps:

1. Download the raster map from our web page. In this case, the map will have the right extension. Alternatively, you may also receive a map via some file transfer service. Such file is usually ziped and the map is hidden inside the zip file. Extract the `ras` file from the zip file.
2. Copy the `ras` file to a USB memory stick. Make sure that you use the *safe remove* option before removing the USB stick from your PC.
3. Start Nesis, insert the USB stick and switch to the `Options` page and select the `Map` icon.
4. Select the `Copy from USB|Raster` items and search for the raster file to copy from the USB memory stick.
5. The copy process starts. Fist the file's signature (integrity) is checked and if all is well, the file is copied.
6. Close all windows. Nesis will reboot and system will use raster file automatically.

Some raster files are protected with a special license file, which binds the raster file with a serial number of the instrument. In this case, you have to install the license file as well. License files have `lic` extension. A license file is copied in the same way as the raster file.

If integrity check fails, the file is not copied. The cause of the failure is usually linked to coping from PC to USB-stick. The stick was removed from PC too quickly. Repeat the whole procedure once again starting with downloading from the server.

11.5 Installing Approach Maps

Nesis can also show approach maps as an transparent overlay. These maps are not downloadable from our web site due to copyright restrictions. However we prepared a desktop app, which allows users to create their own approach maps. The app and manual can be obtained from our web site. See also Section 2.4.4.

The approach maps have the `nam` extension.

1. Once an approach map is prepared with the `Approacher` app, copy the `nam` file to an USB memory stick.
2. Insert the stick into Nesis, switch to the `Options` page and select the `Maps|Approach` items.
3. Select the file. This will copy the file into Nesis.
4. Close all windows. After restart maps will be used automatically.

Chapter 12

Licenses

This section has nothing to do with the usage of the Nesis. You can skip it completely if you are not interested in software development and licensing issues.

12.1 The Qt Library

The Nesis software was developed with the help of the *Qt library*, which is a product of *Qt Group Plc*. The library offers several licenses. One of them is the LGPLv3 license, which we have chosen for the Nesis.

Choosing this license gives us some obligations. They are partly fulfilled by Nesis, partly by this manual and partly by our web server. The following subsections give insight into the details.

12.1.1 Modules and Linking

Nesis is using dynamic linking (.so) with the following libraries from the Qt library bundle: libQt5Core.so, libQt5Gui.so, libQt5Widgets.so, libQt5Xml.so, libQt5Concurrent.so, libQt5Network.so, libQt5DBus.so, libQt5OpenGL.so and libQt5EglDeviceIntegration.so.

12.1.2 Source Code and Toolchain

The source code of the Qt library used with Nesis and the toolchain used to build the binary image of library modules can be obtained following next steps:

1. Use your browser and open `https://www.kanardia.eu` web page.
2. Select `SUPPORT|Software` from the menu on the top right side. A list of various software bundles will appear.
3. Select `QtLibrarySource` to download the Qt library source code.
4. Select `Toolchain` to download the suite of programs that were used to build the library binaries.

12.1.3 Compiling The Library

Once both the library and the toolchain were downloaded, use the following steps to build the library binaries on your computer. We are using Kubuntu flavor of Linux operating system and instructions will be given for such system (or similar).

1. Extract `Toolchain.tar.bz2`.
2. Extract `QtLibrarySource.tar.bz2`.
3. Enter folder `qt5base-5.6.0/`.
4. Configure Qt5 with the following command and replace `{DIR}` with the folder, where the toolchain was extracted:

```
# ./configure -opensource -shared -no-static -no-sql-mysql -no-sql-psql \
   -widgets  -gui -opengl es2 -eglfs -no-openssl -no-gstreamer \
   -prefix {DIR}/QT -no-rpath -nomake tests -device buildroot -no-xcb \
   -no-cups -no-nis -no-gtkstyle -no-pulseaudio -no-xcb-xlib -no-harfbuzz \
   -no-libproxy -no-icu -no-xcb -device-option \
   CROSS_COMPILE={DIR}/host.a20/usr/bin/arm-buildroot-linux-gnueabihf- \
   -sysroot {DIR}/host.a20/usr/arm-buildroot-linux-gnueabihf/sysroot
```

5. Compile library with:

```
# make
```

6. Install library with:

```
# make install
```

Library files are installed into folder:

`{DIR}/host.a20/usr/arm-buildroot-linux-gnueabihf/sysroot/QT`

12.1.4 Installing Modified Qt Library

The LGPLv3 license allows you to freely adapt and change the source code according to your needs.

1. Use your favorite source code editor to edit and modify the Qt library source code.
2. Compile the changes using the toolchain (see Section 12.1.3) and produce the binaries.
3. Copy the binaries to a USB memory stick. Put them into the USB stick root folder.
4. Insert the USB stick into Nesis.
5. Switch to the `Options` page and then select the `Info` icon.
6. Select the `Qt Library` from the list.
7. Select the `Install Qt Library` option.
8. Confirm the decision – select `Yes`.
9. Nesis will copy the libraries found on the USB stick to the internal flash drive by overwriting any existing libraries.
10. Close all windows and turn Nesis off.
11. Power Nesis on. Now, it should start with new version of Qt libraries.

If something goes wrong and Nesis does not start anymore, start it in emergency mode. See Section 10.1.4 . Then perform software update with the official version of Nesis software. This should restore Nesis back to working state.

12.1.5 Copy of Qt License Document

A copy of the Qt license document is stored in Nesis. It can be viewed using the procedure below:

1. Switch to the `Options` page.
2. Select the `Info` icon.
3. A list of items appears. Choose the `Qt Library` option.
4. Another list appears. Choose the `View Qt license` item.
5. A window with original Qt license document appears. Scroll down to read the complete text.

Chapter 13

Restrictions

13.1 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.

13.1.1 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.

Software distributed by Kanardia (with or without the Kanardia's brand name including, but not limited to system software) is not covered under this Limited Warranty. Refer to the licensing agreement accompanying such software for details of your rights with respect to its use.

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 Kanardia 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 merchantability, fitness for a particular purpose, non-infringement, and any warranties against hidden or latent defects. If Kanardia cannot lawfully disclaim statutory or implied warranties then to the extent permitted by law, all such warranties shall be limited in duration to the duration of this express warranty and to repair or replacement service as determined by

Kanardia in its sole discretion. Kanardia does not warrant that the operation of the product will be uninterrupted or error-free. Kanardia is not responsible for damage arising from failure to follow instructions relating to the product's use. No Kanardia reseller, agent, or employee is authorized to make any modification, extension, or addition to this warranty, and if any of the foregoing are made, they are void with respect to Kanardia.

Limitation of Liability

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 injury, or of incidental or consequential damages, so this limitation may not apply to you.

13.1.2 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.

