A-EFIS
User's Guide

March 2020

Thank you for installing A-EFIS. We recommend that you spend some time looking through this manual in order to gain a good understanding of A-EFIS and its functionality. Get familiar with the manual and keep it handy for future reference. Although we have tried to make the interface of A-EFIS as simple and intuitive as possible, it is important that you go through this manual before you use A-EFIS in a flight.

If you have just installed A-EFIS, please start by following the quick setup guide in Section 17, which will guide you through the necessary initial setup and calibration steps.

You can download the latest version of this manual from:

http://www.a-efis.com/software/aefis/aefis_manual.pdf

ATTENTION: A-EFIS is not a certified aviation instrument. Do not rely on A-EFIS as your only navigation aid. Failure to comply with this warning may result in property damage, serious injury or death. You assume total responsibility and risk associated with using this application.

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1 Short description

A-EFIS is an Electronic Flight Information System (EFIS) that works on mobile (Android and IOS) devices, using their standard internal sensors.

A-EFIS makes use of state-of-the-art stochastic models and advanced digital filtering methods in order to estimate the airplane's attitude and other properties with exceptional accuracy and robustness.

A-EFIS can estimate and display the following quantities:

- Artificial Horizon (AHRS)
- Ground speed
- Altimeter (via barometric pressure sensor, if available, or via GPS)
- Vertical speed (via barometric pressure sensor, if available, or via GPS)
- Turn coordinator
- Slip ball
- Compass
- True course indicator (via GPS)
- Deviation from true track indication
- Flight-plan with nearby airports and airfields.

A-EFIS can also be used with X-Plane (https://www.x-plane.com), the well-known flight simulator by Laminar Research. Instructions on how to use A-EFIS with the X-Plane simulator are given in Section 18.

2 Versions and limitations

A-EFIS comes in two versions: the free (black and white) version and the paid (pro) version. Both versions are available for both Android and IOS operating systems.

The free version offers exactly the same functionality as the pro version with the exception that the main EFIS screen is displayed in black and white.

Both versions offer lifetime free upgrades. Moreover, a single paid license for one operating system (IOS or Android) permits installation in an infinite number of devices of the same operating system, in compliance with Google play store and Apple's app store policies.

That is, by buying A-EFIS pro from Apple's App store, one can install A-EFIS pro and use it in as many IOS devices as he/she wants without having to pay a second time, provided that all devices use the same Apple ID as the device used to buy the app originally.

Similarly, by buying A-EFIS pro from Google Play Store, one can install and use A-EFIS in as many Android devices as he/she likes, provided that they all use the same Google account.

Table 1 below summarizes the above-mentioned similarities and differences between A-EFIS versions.

Table 1: A-EFIS versions and limitations

Version	License	Limitations
A-EFIS Black and White for IOS	Free	Black & white EFIS screen
A-EFIS Pro for Android	Paid	none
A-EFIS Black and White for IOS	Free	Black & white EFIS screen
A-EFIS Pro for IOS	Paid	none

3 Sensor Input

A-EFIS algorithms rely on data from the following sensors:

- 3-axis Gyroscopes, mandatory
- 3-axis Accelerometers, mandatory
- GPS, mandatory
- 3-axis Magnetometers, optional
- Barometric pressure, optional

Gyroscopes, accelerometers and GPS are mandatory for the correct estimation of the plane's attitude (roll, pitch, yaw) of the airplane. **If any of the mandatory sensors is missing, the artificial horizon is frozen and relevant warning messages are shown on the screen.**

Optional sensors (magnetometers and barometric pressure sensor), only affect the relevant components of A-EFIS and can be substituted by the GPS.

A brief description of each type of sensor and how it is being used by A-EFIS is given in the following sections.

3.1 Three-axis accelerometers

Accelerometers are sensors that measure proper acceleration along an axis, including the acceleration due to earth's gravity. In order to compute and keep track of the attitude of the airplane, A-EFIS needs three accelerometers, one for each major axis. That is, a three-axis accelerometer.

A calibration procedure to null-out errors and inaccuracies of the internal accelerometers of the user's mobile device must be performed once, before using A-EFIS for the first time. See forward, Section 17 for a quick setup guide.

3.2 Three-axis gyroscopes

Gyroscopes are sensors used for measuring angular velocity around an axis. In order to compute and keep track of the attitude of the airplane, a three-axis gyroscope is absolutely necessary.

As with the accelerometers, a calibration procedure is also needed to null-out errors and inaccuracies of the internal gyroscopes of the user's mobile device. The calibration procedure must be performed once, before using A-EFIS for the first time and it is described in Section 17.

3.3 GPS receiver

A Global Positioning System (GPS) receiver is required in order to provide the coordinates of the airplane.

Besides geo-location, the GPS signal is also used in order to derive the direction of travel, the ground speed, the altitude, and the vertical speed.

3.4 Three-axis magnetometer

In the context of A-EFIS, magnetometers are sensors that measure the strength of the ambient magnetic field along a particular axis. In order to locate and measure the magnetic field of the earth, A-EFIS needs a three axis magnetometer.

Data from the three-axis magnetometer is used to compute the compass indication. The compass is used by A-EFIS in (a) the Compass Strip and (b) in the HSI rosette.

A compass calibration procedure to null-out noise and magnetic interference must be performed before using A-EFIS for the first time and/or before mounting your device in a new place. The compass calibration procedure is described in Section 17).

3.5 Barometric pressure sensor

Barometric pressure is used in order to compute the altitude of the airplane and the vertical speed. To compute the altitude, the pilot needs to configure the altimeter settings (the pressure at sea level) (see Section 7).

Unfortunately, not all mobile phones and tablets have internal barometric pressure sensors. If no barometric pressure is available, the GPS receiver is used instead in order to provide altitude and vertical speed. In this case a “GPS” indication is shown on the left side of the altitude box (Figure 1b).

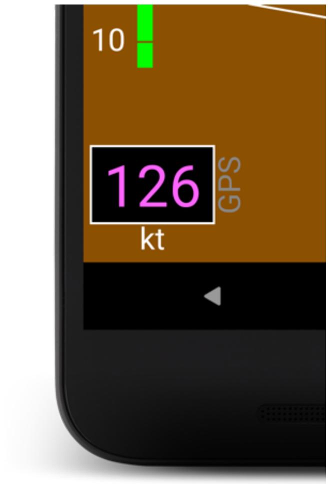
Similarly, if barometric pressure is available and if it is used to provide altitude and vertical speed, a “Baro” indication is shown on the left side of the altitude box (Figure 1d).

If both barometric and GPS altitude are available, the user can switch between the two of them by tapping on the “GPS” or “Baro” indications besides the altitude box on the main EFIS screen. The default altitude and vertical speed source (GPS or barometric) can also be configured on the “default data sources” screen (Section 10).

Please note that on pressurized cabins, the barometric pressure measured inside the cabin by a smartphone or tablet cannot be used to compute altitude or vertical speed. In this case, only the GPS altitude should be used.

(a)

(b)



(c)

(d)

Figure 1: (a) Indicated Air Speed: The "IAS" sign besides the speed box means that the displayed speed is the Indicated Air Speed provided by the Pitot-Static system (with the simulator only). (b) The "Baro" indication besides the altitude box means that altitude and vertical speed are provided by barometric pressure. (c) Ground speed: The "GPS" sign besides the speed box means that the displayed speed is obtained via GPS and, thus, it is the ground speed. (d) GPS altitude: The "GPS" sign besides the altitude box means that the displayed altitude and the vertical speed are derived form GPS data.

Please also note that even on non-pressurized cabins, the air pressure inside the flight deck, where the smartphone is located, might be different (usually slightly lower) than the static pressure outside the aircraft, which might cause the altitude computed by A-EFIS to be slightly off.

4 Application layout

The main application interface consists of 12 screens: flight plan settings, flight plan view, flight plan, main EFIS screen, main menu, altimeter settings, aircraft specifications, default units, default data sources, display settings, responsiveness, and sensor status.

The user can browse all screens by swiping left to right and right to left.

The initial startup screen is the main EFIS Screen. The three flight plan screens (flight plan settings, flight plan view and flight plan) are located on the left side of the main EFIS screen and can be reached by swiping right. The menu screen and the remaining seven settings screens are located on the right side of the main EFIS screen and can be reached by swiping left.

5 Main EFIS screen

The main EFIS screen is the initial startup screen. There are two different layouts for the main EFIS screen which can be alternated by long tapping (tapping for 2 seconds) anywhere on the screen: a) The artificial horizon (AHRS) only layout, and b) the artificial horizon plus the horizontal situation indicator (AHRS + HSI) layout. The display layout can also be selected in the "display layout" screen (Section 11).

Furthermore, the main EFIS screen can be displayed in either portrait or landscape mode. The screen orientation (portrait or landscape) is automatically determined during the program startup and cannot be changed during operation. If the user needs to change the orientation, he/she must exit A-EFIS, lock his/her device at the desired orientation, and start A-EFIS again.

Important notice: In order for the sensors to work correctly, at least in some smartphones, it maybe necessary for the user to lock the interface orientation of his/her device before starting A-EFIS, using the standard method provided by the device/OS manufacturer.

Figure 2 depicts the main EFIS screen with the available layouts in portrait orientation and Figure 3 depicts the same layouts in landscape orientation.

Figure 4 displays an overview of the interaction possibilities with the main EFIS Screen.

5.1 Switching units

The default units for all displayed quantities can be configured in the "Default units" configuration screen (see forward, Section 9). Units can also be changed units from the main EFIS screen simply by tapping on them. More specifically:

(a) (b)

Figure 2: Main EFIS screen in portrait mode. (a) AHRS only layout, (b) AHRS + HSI layout.

(a)

(b)

Figure 3: Main EFIS screen in landscape mode. (a) AHRS only layout, (b) AHRS + HSI layout.

Figure 4: Interacting with the main EFIS screen

- To change the displayed speed units, one needs to tap on the speed units label displayed just below the speed indicator (black rectangle at the bottom left corner of the artificial horizon window). Every time the user taps, units alternate between km/h, mph, and knots.
- To switch altitude units, the user needs to tap on the altitude units label, just below the altitude indicator (black rectangle at the bottom right corner of the artificial horizon window). Tapping switches units between meters and feet.
- To switch vertical speed units between feet/min or meters/sec, the user needs to tap on the vertical speed units label, located at the left of the altitude bar.

Tapping on any of the above unit labels can either change the relevant unit temporarily (switch for five seconds, then return to the default units) or change it permanently. This tap behavior (switch for five seconds or switch permanently) is configured in the "Default units" configuration screen (Section 9).

5.2 Switching data sources

- If a barometric pressure sensor is available (available in some smartphones and tablets), the altitude indicator, the altitude bar and the vertical speed bar can either display barometric altitude or GPS altitude. If barometric pressure is not available, altitude and vertical speed indications are based on GPS only information. To switch between GPS and barometric altitude, the user can tap on the altitude source sign which is located the left of the altitude box and shows either "Baro" or "GPS" (Figures 1b and 1d). Every time the user taps on the altitude source sign, the altitude source alternates between "Baro" and "GPS".
- To switch the heading source for the heading strip at the top of the main EFIS screen, the user needs to tap on the relevant sign located at the right side of the heading box. Tapping switches between GPS heading (true course) and magnetic (compass) heading. Depending on the selected source, the source sign displays either "MAG" or "GPS"
- Heading source for the HSI rosette can also be switched between GPS (true course) and compass (magnetic) by tapping on the relevant source sign, located right bellow the heading reading. Depending on the selected source, the source sign displays either "MAG" or "GPS"
- When A-EFIS is connected to the simulator, Indicated Air Speed (IAS) is also available. In this case, the speed box and the speed bar can either display IAS or ground speed. To switch between IAS and Ground Speed, the user needs to tap on the relevant ("IAS" or "GPS") sign located on the right of the speed box (Figures 1a and 1c). When A-EFIS is not connected tp the simulator, IAS is not available and the speed indicator will only displays ground (GPS) speed.

As with when switching units, tapping on a source indication on the main EFIS screen can either change the relevant source temporarily (switch the source for five seconds, then return to the default source) or switch the source permanently. This behavior (switching the source for five seconds or permanently) is configured in the "Default data sources" configuration screen (Section 10).

5.3 Turn coordinator

The turn coordinator (Figure 5) indicates the rate of turn or the rate of change in the aircraft's heading. The two marks at the end of the miniature airplane wings mark a "standard rate", or "rate one" turn. A standard rate turn corresponds to three degrees per second, or, equivalently, 2 minutes per 360 degrees.

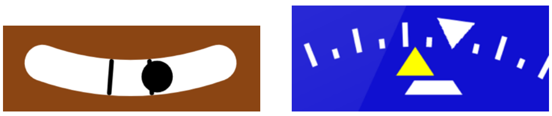
Figure 5: The turn coordinator

- To switch off the turn coordinator, tap on the turn coordinator.
- To switch on the turn coordinator, tap in the same area, above the slip ball, between the slip ball and the center of the screen.

5.4 Slip indicator

The slip indicator is an instrument that indicates whether the aircraft is in coordinated flight or not. In practice, it is an inclinometer that while at rest displays the angle of the aircraft's lateral axis with respect to horizontal plane, and while in motion displays this angle as modified by the various forces and accelerations of the aircraft.

A-EFIS provides a slip indicator in the form of a slip ball (Figure 6b), and also combines it with the triangular turn index at the top of the heading indicator in the form of a trapezoid parallel to the base of the triangle (the "sailboat" pattern) that slides away from the triangle to indicate lack of coordination (Figure 6a).



(a) (b)

Figure 6: Slip indicators (a) trapezoid indicator combined with the turn index, (b) slip ball.

5.5 Heading strip

The moving strip at the top of the EFIS screen can be selected to display either the magnetic heading of the aircraft (compass) or the direction of travel of the aircraft (GPS heading).

When the magnetic heading is selected, a "MAG" indication is shown at the right of the heading box at the center of the moving strip. When GPS heading is selected, a "GPS" indication is shown.

Magnetic heading is the heading of the aircraft's nose with respect to the magnetic north. GPS heading is the direction of travel with respect to the true north.

- To switch the contents of the strip between GPS heading (true track) and magnetic heading (compass), tap in the heading source indication at the right of the heading box at the center of the strip.

Please note that for correct indication of the compass, the device must be installed as far away as possible from any metallic objects or sources of electromagnetic interference. The compass should also be calibrated as close as possible to the installation point, according to the instructions given in Section **??**.

For GPS heading (direction of travel), GPS signal must be present and the aircraft has to be moving. When the aircraft is stationary, GPS heading is not correct.

5.6 HSI Display

The HSI display (Figure 7) can be switched on and off by long-tapping (tapping with one finger and holding down for 2 sec) anywhere within the screen. The HSI display is shown at the bottom of the artificial horizon when in portrait mode (Figure 2b), or on the right side of the artificial horizon when in landscape mode (Figure 3b).

Figure 7: The HSI screen

The circular compass (HSI Rose) displays the current course of the airplane. The small fixed triangle pointing upwards indicates the nose of the aircraft, while the indication below the fixed triangle, shows the current course.

- By taping on the course indication, below the fixed triangle, the user can switch between true track ()GPS direction of travel) and magnetic heading.

When the magnetic heading is selected, a "MAG" indication is shown bellow the heading indication. When the GPS heading is selected, a "GPS" indication is shown instead.

The large arrow passing through the center of the HSI Rose, shows the correct course from the current position to the next waypoint according to the current flight plan.

- Tapping on the “GPS” or “MAG” indication switches between true track (GPS heading) and compass (magnetic heading) on the HSI rose.
- Taping on the top right corner of the HSI screen (under the caption “Destination”) switches to the next destination waypoint, as defined in the flight plan.

To edit the flight plan see Section **??**.

The center part of the arrow is broken and moves sideways to the left or the right side of the arrow. This measures the distance between your current location and the straight line connecting the previous and the next waypoint (i.e. the deviation from your course). The deviation from the correct course is measured on the dotted line which is perpendicular to the current course arrow. Each dot of the line corresponds to a course deviation of two miles.

The upper left corner of the HSI display shows the current GPS data: coordinates, speed and altitude. Coordinates are displayed either in Decimal, DMS (degrees, minutes, seconds) or DMM (degrees, decimal minutes) format. The coordinates format is selected in the Options screen (Section 9).

The upper right corner of the HSI display shows (in cyan) information about the current destination waypoint: Name, location, course, and distance. Taping on this area, switches to the next waypoint.

The lower right corner of the HSI display shows local (according to timezone defined in the device settings) and UTC time, as well as the battery level of the device.

- Taping on the time indication (bottom right corner) switches between local and UTC time.

6 Main menu screen

Figure 8 depicts the main menu screen. The main menu screen includes three buttons for AHRS-leveling, for sensor calibration (accelerometers and gyroscopes) and for compass calibration as well as buttons with links to register this software, support, service commands and the about box.

The First three options are for AHRS leveling, for Sensor (accelerometers and gyroscopes) calibration and for compass calibration.

The “Support” button leads to a screen with contact and support information. Do not hesitate to contact as for any problem, difficulty or any other question you may have regarding A-EFIS.

The “User guide” button will download and display the latest version of this manual in pdf format from the A-EFIS website. In order to be able to download and view the manual you will need an active internet connection and your device must also have the ability to read and display pdf files. Alternatively you can manually download the manual from this link:

http://www.a-efis.com/software/aefis/aefis_manual.pdf

The “Register” button can be used to register the app.

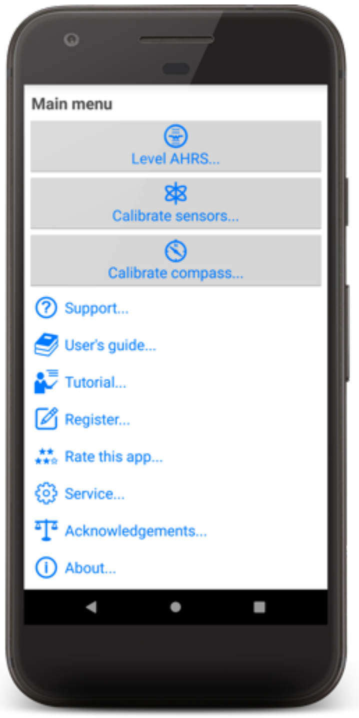


Figure 8: The main menu screen

Registration enables us to get to know a little more about you! Registration is done via email. We promise that we will not spam you and that we will NEVER share ANY of the information that you will kindly provide us with anyone else!

The "Service" button leads to a prompt where the user may enter "Service commands". Service commands are used to enable advanced debugging or beta features of A-EFIS and to fine-tune some parameters of A-EFIS. Normally, a user will never have to mess with "Service commands", except if instructed to do so by support.

The "About" button is used to provide information about the current version of A-EFIS.

Last but not least, the "Acknowledgements" button leads to a page where usage of a number of great software and data libraries in A-EFIS is acknowledged and their respective licenses are provided.

6.1 Level AHRS

For the correct operation of A-EFIS, the mobile device (smartphone or tablet) should be placed vertically, as close to the symmetry axis of the airplane as possible, with its respective axes as parallel to the axes of the airplane as possible. Unfortunately, the device cannot always be mounted as described above. AHRS leveling allows the user to adjust the placement of the device, compensating for any inaccuracies during placement.

The "Level AHRS" procedure described in this section needs only to be done once, after having performed sensor and compass calibration and after mounting the device on the cockpit (Sections **??** and **??**, respectively).

If, for any reason, there is a need to change the placement of your device, you must repeat the AHRS calibration procedure. Nevertheless, it is a good practice to repeat the calibration

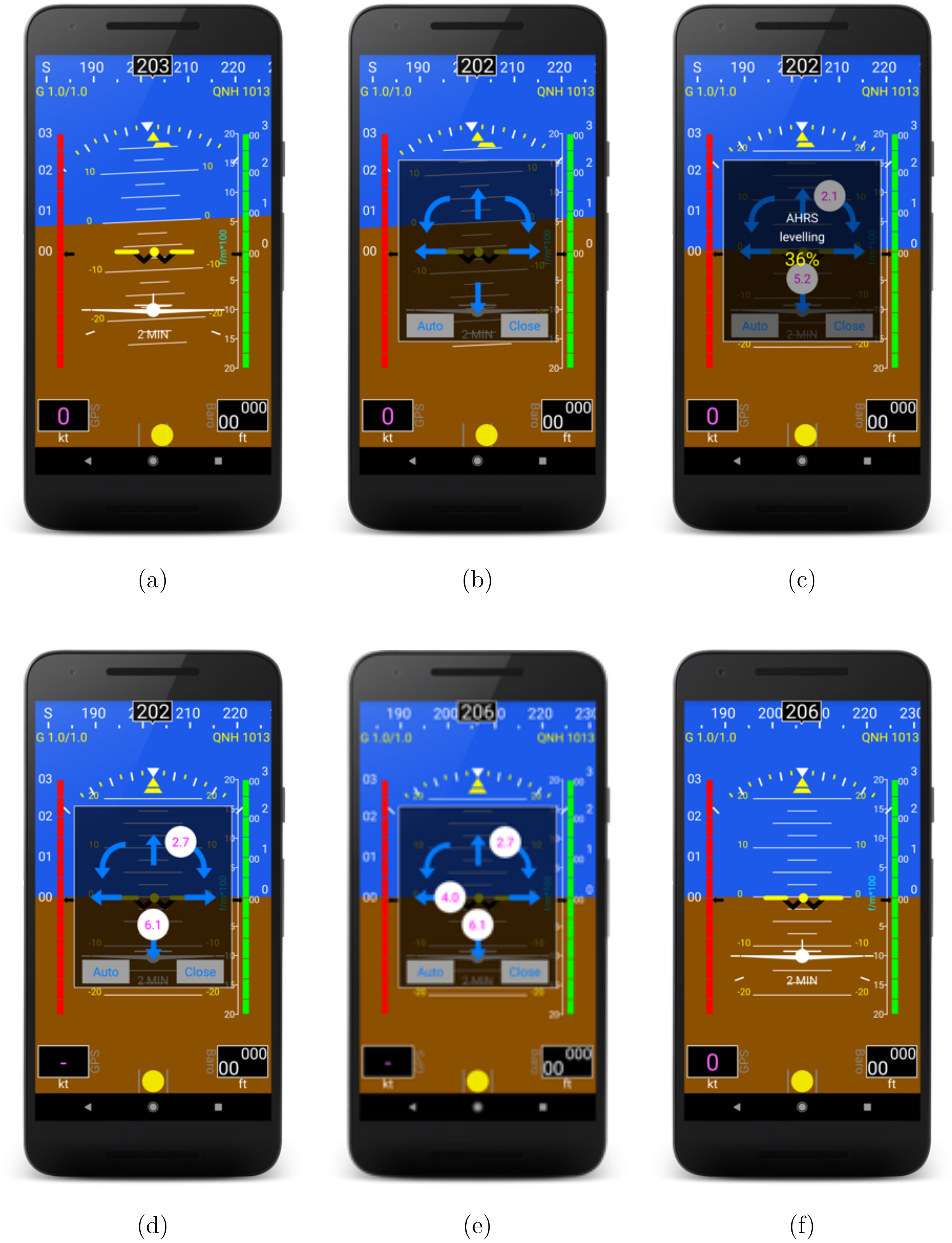


Figure 9: AHRS leveling. (a) Before leveling. (b) Press “Auto” for automatic leveling, and/or use the arrows to manually adjust the AHRS. (c) Auto-leveling in progress. (d) Artificial leveling finished. (d) Using the yaw arrow to add offset to compass. (f) Leveling is finished.

procedure (i.e. press the “AHRS leveling” button) every time you change position of your device or, maybe, whenever you are about to start a flight.

- Start the A-EFIS software on your mobile device.
- Mount device on cockpit.
- Swipe right to the menu screen and press “Level AHRS”.
- A-EFIS will return back to the main screen and the “Level AHRS” window (Figure 9) will appear.
- Press the “Auto” button to automatically level the artificial horizon (Figure 9b,c).
- Use the left and right (yaw) arrows to manually adjust the compass (Figure 9d), if necessary.
- When you are done adjusting, press “Close” to save the changes.

As an alternative to automatically adjusting the artificial horizon (by pressing the “Auto” button), you can also adjust it by pressing the roll and pitch arrows until the artificial horizon is leveled.

Manual adjustment is also necessary for aircrafts with a tail-wheel-type landing gear (taildraggers). In this case, the airplane is not leveled while on ground and the automatic calibration procedure will not adjust the artificial horizon correctly. The user can perform an automatic leveling of the artificial horizon by pressing the “Auto” button, and then manually add the appropriate pitch angle using the pitch arrows.

> ATTENTION: During automatic AHRS leveling the aircraft must be still, on the ground and the engine must be turned off. The attitude of the aircraft must be as when in a straight and leveled flight. Your device must be mounted on a solid, non-vibrating holder. Suction cup holders are not suitable, because they tend to vibrate too much when in turbulence.

If, for any reason, the user needs to re-level the AHRS during flight, he/she has to fly a leveled and straight flight with as little engine vibrations as possible. Automatic leveling during flight is not permitted (the relevant button is disabled), so the user has to adjust the artificial horizon manually using the arrows. Leveling during flight is not accurate and should be avoided.

6.2 Calibrate sensors

Before using A-EFIS for the first time, the user should calibrate the gyroscopes and the accelerometers. The “Calibrate sensors” procedure described below needs only to be done once, when you run A-EFIS for the first time.

- Start the A-EFIS.
- Hold your device vertically against a flat vertical surface (e.g. a wall). If necessary use a spirit level tool.

(a) (b) (c)

Figure 10: Sensor calibration. (a) Press “Start” to begin sensor calibration. (b) Sensor calibration in progress. (c) Sensor calibration finished.

- Swipe right to the menu screen and press “Calibrate sensors”.
- A-EFIS will return back to the main screen and the “Sensor calibration” window (Fig. 10) will appear.
- Don’t move your device while the sensors are being calibrated.
- The calibration window will automatically close when the calibration procedure is over.

6.3 Calibrate compass

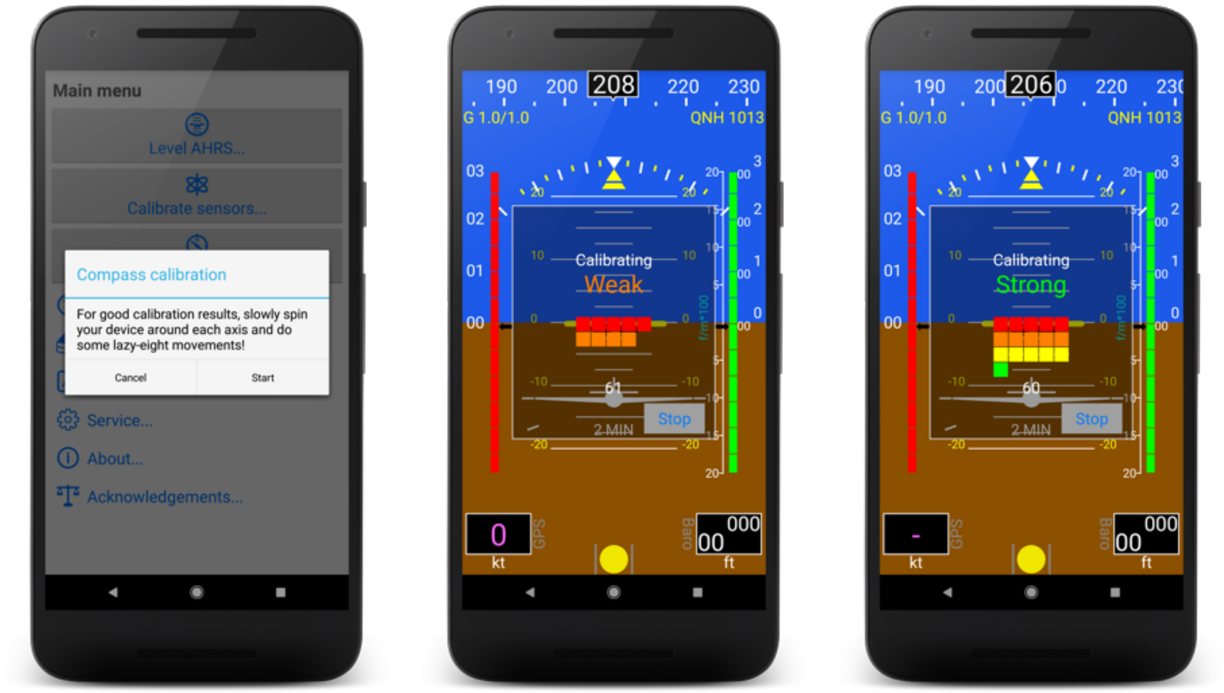
Before you can start using your device you should calibrate the compass.

Compass calibration is necessary in order for A-EFIS to be able to compensate for the effect of roll and pitch rotations, as well as to cancel out all hard- and soft-iron magnetic interference.

To calibrate the compass, you the user must rotate the device in all possible orientations.

The procedure is as follows:

- Start A-EFIS.
- Swipe right to the main menu screen and press “Calibrate compass”.
- A notification window will pop up, informing you that the calibration procedure is about to start. Press “OK” to continue.



(a) (b) (c)

Figure 11: (a) Press OK to start compass calibration. (b) Calibration in progress. The calibration results are indicated as "Weak". You should continue rotating your device until the indication becomes "Strong". (c) A "Strong" calibration has been reached.

- A-EFIS will return back to the main EFIS screen and the compass calibration window, indicating the calibration progress will appear (Fig. 11). Start rotating your device slowly, until the indication on the screen becomes "Good" or, preferably, "Strong". To easily achieve the desired calibration result, start be rotating your device three times around each axis and then perform a sequence of "lazy eight" maneuvers (Fig. 12).
- Press "Close" or wait a few seconds until the calibration window closes itself.

The compass calibration procedure is necessary to be done once, the first time you run A-EFIS. However, it is recommended to repeat the compass calibration procedure whenever you install the device in a new location so that it will be able to take into account the magnetic interference at the exact installation point. For this reason, it is very important to perform the compass calibration procedure while the device remains as close as possible to the final mounting location.

It is also recommended to repeat the calibration procedure above procedure one more time after some flights.

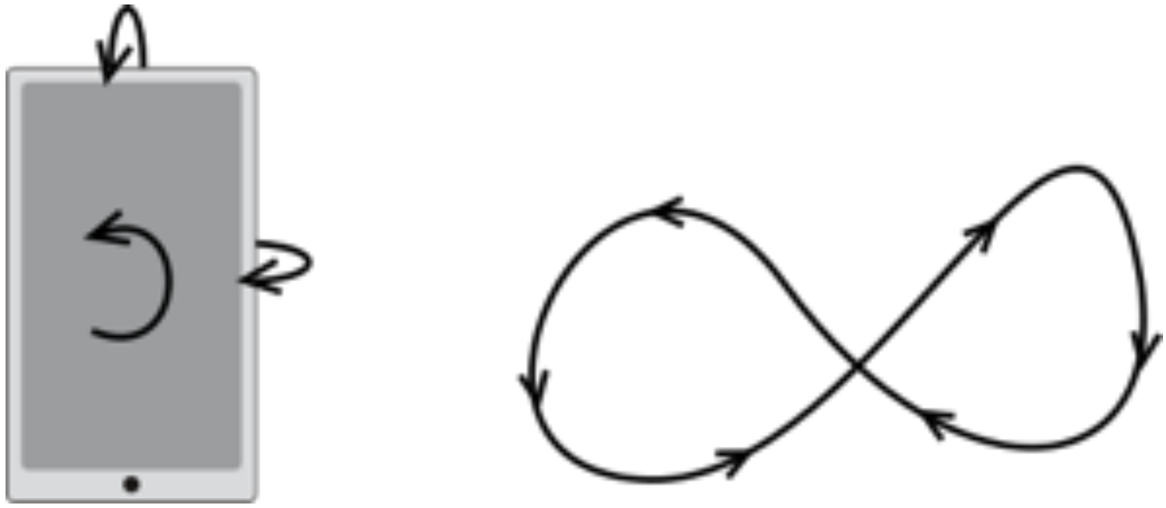


Figure 12: To easily calibrate the compass start by slowly rotating your device tree times around each axis and then perform a sequence of "lazy eight" maneuvers until you have a "Good" or a "Strong" indication on the screen.

7 Altimeter settings screen

The Altimeter settings screen (Figure 13) allows the user to configure the altimeter with the current pressure adjusted to mean sea level (QNH).

If there is no barometric pressure sensor present the altimeter settings are completely irrelevant and they have no effect at all. In this case, the displayed altitude and vertical speed are based on GPS data only and a GPS sign appears besides the altitude box (Figure 1d).

If your smart-phone/tablet is equipped with a barometric pressure sensor, the altimeter settings screen provides the necessary means to configure QNH.

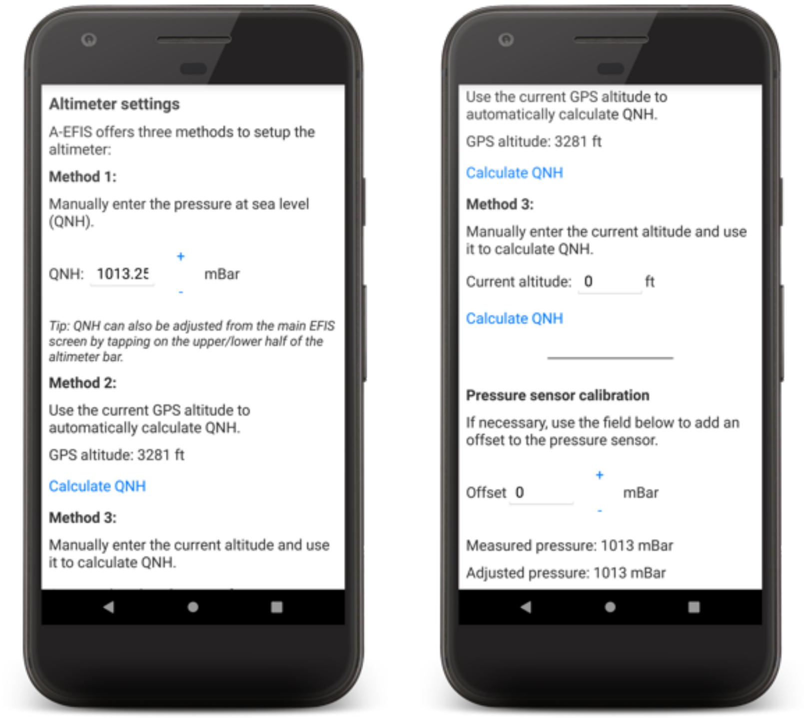
The Altimeter settings screen provides three methods to configure QNH:

Method 1. Manually enter the pressure at mean sea level. The user must use this method if he/she knows the current pressure at mean sea level (e.g. by ATC or ATIS). QNH can be entered either in mBar or inches Hg. The default units can be configured in the "Default units" screen (see forward, Section 9).

Method 2. Use the current altitude provided by GPS to calculate QNH. In this case the current altitude and current pressure are used to compute QNH. Affectively by choosing this method, the user synchronizes the barometric altitude with the GPS altitude.

Method 3. Manually enter the current altitude and use it to calculate QNH. The user may chose this method if he/she knows the current altitude (e.g. the altitude at his/her home airfield). The altitude units can be configured in the "Default units" screen (see forward, Section 9).

The current QNH setting is displayed with yellow color at the top of the altimeter bar, if "Baro' is selected as a source for altitude.



(a) (b)

Figure 13: The altimeter settings screen.

Please also note that, when "Baro' is selected as a source for altitude, the pilot can adjust the current QNH value from the main EFIS screen by tapping on the upper (to slightly increase QNH) or the lower half (to slightly decrease QNH) of the altimeter bar. This is very useful during a flight for the pilot to update the QNH value e.g. if instructed so by the ATC.

Pressure sensor calibration. The user can add an offset to his/her pressure sensor, if he/she knows that there is an offset.

GPS altitude reference (v3.56). This option allows the user to define the reference level for the displayed GPS altitude. This can be set to either the height above the surface of the theoritical ellipsoid that models the shape of the earth, or the height above the approximate Mean Sea Level.

The first option, usually used by GPS receivers, is known as the "geodetic" altitude, and it is formally defined as the height above the ellipsoid surface, normal to the ellipsoid, of the elipsoid defined by the World Geodetic System-84 (WGS84).

The second option is the height above the approximate Mean Sea Level. Formally, it is the height above the equipotential surface of the Earth's gravity field that coincides with average sea level (Geoid).

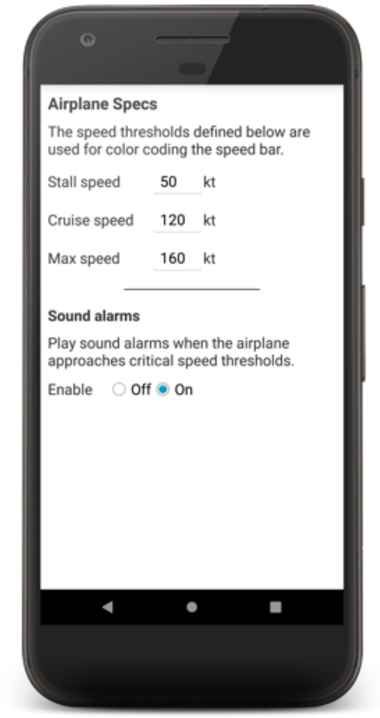


Figure 14: The airplane specifications screen

8 Airplane specifications screen

Here the user can enter the Stall, Cruise, and Maximum speeds of his/her airplane. The above speeds are used to setup the colors of the speed bar and also to play the sound alarms for the speed, if enabled.

The speed units can be configured in the "Default units" screen (see forward, Section 9).

Sounds alarms

Use this checkbox to enable sound warnings for low speed, stall and high speed.

9 Default units screen

The Default units screen (Figure 17i) allows the user to define all units of measurement used throughout the application. More specifically:

- Distance can be either in km or miles.
- Speed (IAS or ground speed) can be displayed either in km/h, mph, or knots.
- Vertical speed can be displayed either in m/sec of ft/min.
- Altitude can be displayed either in meters or in feet.

- Coordinates can be entered/displayed in Decimal, DMS (Degrees, Minutes, Seconds) or DMM (Degrees, decimal Minutes) format.

- Pressure can be displayed either in mBar or in inches Hg.

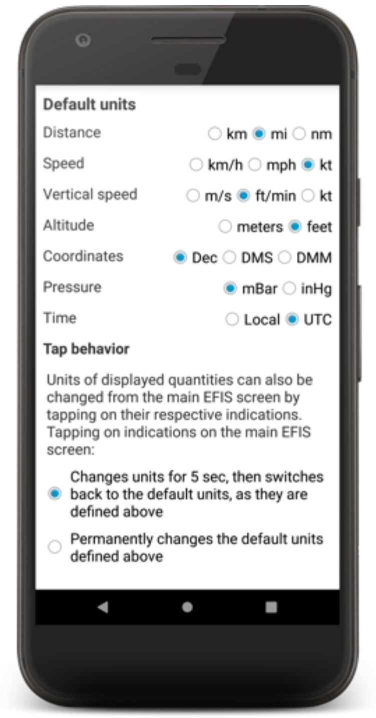


Figure 15: The default units screen

Tap behaviour

The measurement units defined above can also be changed from the main EFIS screen simply by tapping on any unit indication.

When taping on measurement units on the main EFIS screen, there are two options:

a) The units change for 5 seconds (so that the pilot has a quick glance to some other unit of measurement) and then, after 5 seconds, they automatically return back to default. This eliminates the need for the pilot to tap again in order to have the units return back to its default setting. Also, having defined the default units once in this screen, the pilot is always certain that he/she has not accidentally changed them by an accidental tap.

b) The measurement units change permanently. This is equivalent to changing the default units from this screen.

10 Default sources screen

The Default sources screen (Figure 16) allows the user to define the sensor sources used for speed, altitude, vertical speed indicators and the heading. More specifically:

- The displayed speed in the speed bar and the speed box can be either IAS or Ground Speed. When not connected with a simulator this setting is ignored and the displayed speed is always GPS (ground) speed.
- Altitude and Vertical speed can either be provided via barometric pressure of via GPS. If no barometric pressure is available, this setting is ignored and the displayed altitude and vertical speed are always computed via GPS.
- The heading displayed on the heading strip (top of the EFIS screen) can either be the GPS heading (direction of travel) or the magnetic heading of the nose of the aircraft (compass).
- The heading displayed ot the HSI display can either be GPS heading (direction of travel) or magnetic heading (compass).

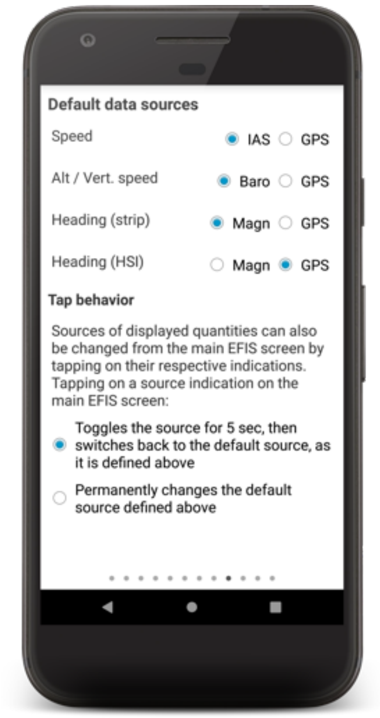


Figure 16: The default sources screen

Please note the convention that GPS information is always displayed in the same color (or shade of gray) throughout the EFIS screen. Magnetic, Barometric and Pitot-static information are displayed in a different color (or shade of gray). The exact colors depend on the selected color theme.

Tap behaviour

The sources defined above can also be changed from the main EFIS screen simply by tapping on the relevant indication.

When taping on the main EFIS screen, there are two options:

a) The source changes for 5 seconds (so that the pilot has a quick glance to some other source) and then, after 5 seconds, EFIS automatically returns back to the default source, as it is defined in this screen. This eliminates the need for the pilot to tap again in order to have the source return back to its default setting. Also, having defined the default data sources in the settings screen, the pilot is always certain that he/she has not accidentally changed them by an accidental tap.

b) The source changes permanently. This is equivalent to changing the source from this screen.

11 Display layout screen

The display layout screen (Fig. 17) allows the customization of the layout of the main EFIS screen and the color theme.

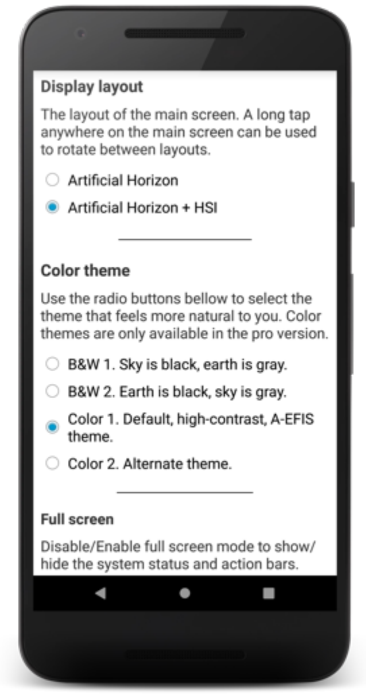


Figure 17: The display layout screen

The display layout of the main EFIS screen can be switched between:

- Artificial horizon only (Figures 2a and 3a)
- Artificial horizon with HSI (Figures 2b and 3b)

The display layout can be also switched from the main EFIS screen by long-tapping anywhere on the screen.

Color theme

A set of radio buttons that can be used to define the color theme of the main EFIS screen. For the free, black and white, version only black and white themes are available.

Full screen

Use the radio buttons under this section to enable/disable full screen mode. While in full screen mode, the operating system's status and action bars are hidden to increase the available display size.

User's with devices with a notch might should disable the full screen mode in order to enforce the status bar to expand to the area around notch, preventing this way A-EFIS components (e.g. the compass indication) to get hidden behind the notch.

12 Responsiveness screen

The responsiveness screen (Fig. 18j) can be used to fine-tune the responsiveness of various components (artificial horizon, airspeed, vertical speed, compass, sleep ball and turn coordinator) of A-EFIS. Sliding a track-bar to the right means higher responsiveness for the corresponding component. Sliding to the left means lower responsiveness (more "smoothing") to the corresponding component.

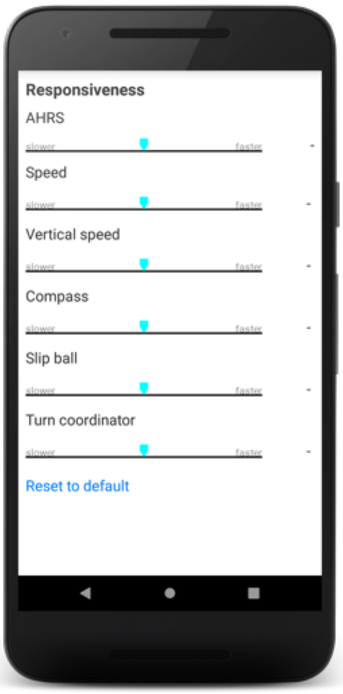


Figure 18: The responsiveness screen

The "Default" button bellow the responsiveness track-bars can be used to quickly reset the responsiveness values to default.

13 Sensor status screen

The Sensor status screen (Figure 19) displays information about the availability of all supported types of sensors and status information.

(a) (b)

Figure 19: Sensor status screen. (a) A-EFIS with internal sensors, (b) A-EFIS connected to X-Plane flight simulator

The sensor status information is organized in a tabular format. Each row corresponds to a different type of sensor data. There are three columns. The first column is the name of the sensor.

The second column displays the source of the data and can have one of the following values:

- Internal. Means that the internal sensors of your mobile phone/tablet is used.
- X-Plane. Means that this particular type of data comes from the X-Plane simulator.
- A-EFIS. Means that this type of data is generated (computed) by A-EFIS itself.
- No data. Means that this type of sensor data is not available. This may vary according to the sensor type (e.g. The GPS sensor is usually slower than the accelerometers and the gyroscopes) and the brand/model of your smartphone/tablet.

The third column displays the average time interval between two successive sensor readings.

X-Plane simulator

Here you can enable/disable data reception from X-Plane and you can also check the connection status with X-Plane.

For more information on how to setup A-EFIS to work with X-Plane see Section 18.

14 Flight plan screen

The flight plan screen (Figure 20) is used to create and modify a fight plan.

In the context of A-EFIS, a flight plan is an ordered list of waypoints that describes an aircraft flight (see for example Figure 20a).

For each waypoint in the flight plan, the following elements are displayed.

- Waypoint number. This is the position of the waypoint within the flight plan. By tapping on the waypoint number, the waypoint becomes highlighted, which means that this waypoint is now the active destination waypoint (Figure 20e).
- Waypoint name. In the context of A-EFIS, this is an arbitrary name which is used to easily identify the waypoint. If the waypoint is an airport selected from the list of airports, then the waypoint name is by default the name of the airport and its ICAO code.
- Waypoint coordinates.
- Waypoint distance. This is the direct distance from the aircraft's current position to this specific waypoint.
- Waypoint bearing. This is the bearing of the current location of the aircraft to this waypoint.
- Delete button. Used to remove this specific waypoint from the flight plan list.
- Edit button. Brings up the edit dialog which can be used to edit the name and the coordinates of this specific waypoint.

The button "Add" located at the bottom left corner of the flight plan screen brings up a menu to add waypoints to the flight plan (Figure 20e). The "add" menu allows the user to add a waypoint in the flightplan using five different ways:

- Insert current location. This option creates a waypoint using the aircraft's current location. The new waypoint is automatically named using the current UTC time (The new waypoint is defined as the location of the aircraft at this specific time). The new waypoint is inserted before the active destination waypoint, becoming the previous (already "visited") waypoint in your flight plan. Hence, the HSI display is adjusted to display the course from your current location (which has now become your previous waypoint) to your existing destination waypoint.
- Add home. This option adds your home base to the end of the current flight plan. The home base location is defined in the flight plan settings screen (Section 16).
- Add airport. This option brings up a search-as-you-type edit box where the user can start typing the name, the ICAO code or the location of any airport. A drop down list displays the airports that match the typed characters, for the user to select and add to the flight plan. The airports are sorted by their distance to the current location.
- Add current location. This option adds the current location at the end of the list. The option is similar to the first option with the exception that the new waypoint is added to the end of the current flight plan.

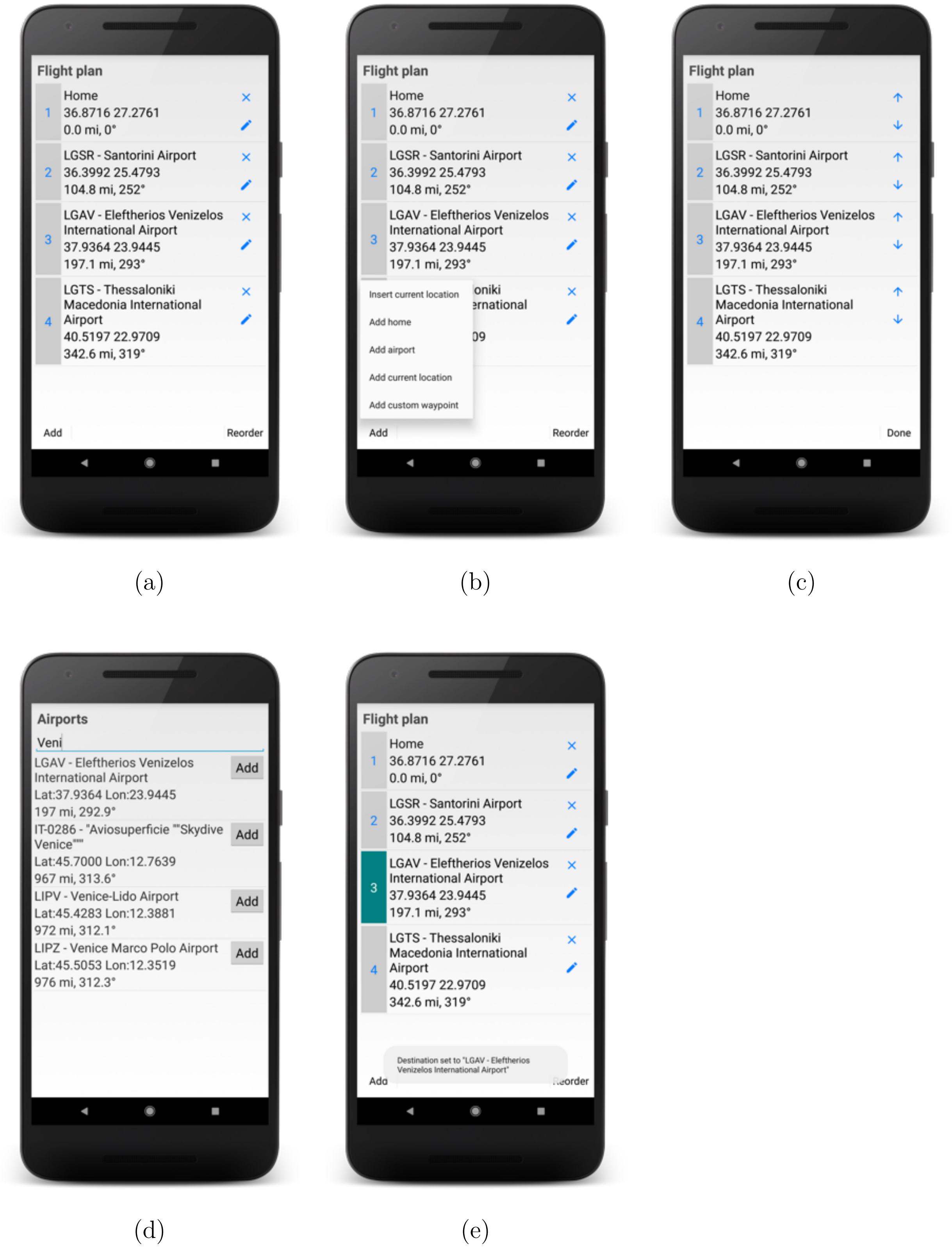


Figure 20: Flight plan screen. (a) Flight plan. (b) Tap "Add" to add a waypoint to the flight plan. (c) Tap "Reorder" and then use the up/down arrows to change the order of the waypoints within the flight plan. (d) Adding an airport. (e) Long-tap on a waypoint or tap on its number to select the next destination (shown with teal color).

- Add custom waypoint. This option brings up a dialog to define a new arbitrary waypoint and add it to the end of the flight plan. The user is asked to give a name for the new waypoint, as well as its coordinates. The coordinate format can be selected to be either DEC (Decimal e.g. 37.3398, 24.6241), DMM (Degrees and decimal Minutes, e.g. 37°20.39', 24°37.45'), or DMS (Degrees,Minutes,Seconds e.g. 37°20'23", 024°37'27").

The button "Reorder" located at the bottom right corner of the flight plan screen allows the user to reorder the waypoints within a flight plan. When pressed, the flight plan is put in "re-order mode" (Figure 20c). While in "re-order mode", there are "up" and "down" arrows besides each waypoint, allowing the user to easily change the order of waypoints within the flight plan. When the flight plan is ready, the user can press the "done" button to leave "re-order mode".

15 Flight plan view screen

The Flight plan view screen (Figure 21) displays a schematic diagram of the current airplane position and the list of waypoints in the current flight plan. This is useful in order to have a very quick verification that the entered flight plan is, at least, topologically, correct.

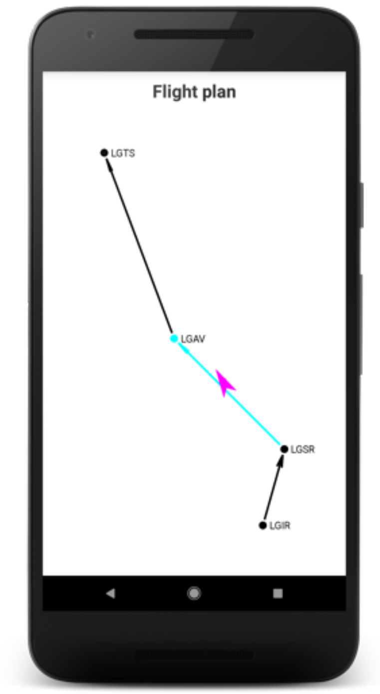


Figure 21: Flight plan view. The aircraft is shown as a magenta arrow. Waypoints are shown as circles, connected with line segments.

The flight plan view screen is automatically zoomed in order to fit all the waypoints as well as the current airplane position.

The airplane is depicted as a magenta-colored arrow.

If the GPS signal is lost, the airplane is depicted in the last know position with red color.

Waypoints are depicted as circles, connected with line segments according to their order in the flight plan.

The current target and the current track (from the previous waypoint to the current target waypoint) are shown with cyan color.

16 Flight plan settings screen

The Flight plan settings screen (Figure 22) allows the configuration of various parameters related to the flight plan.

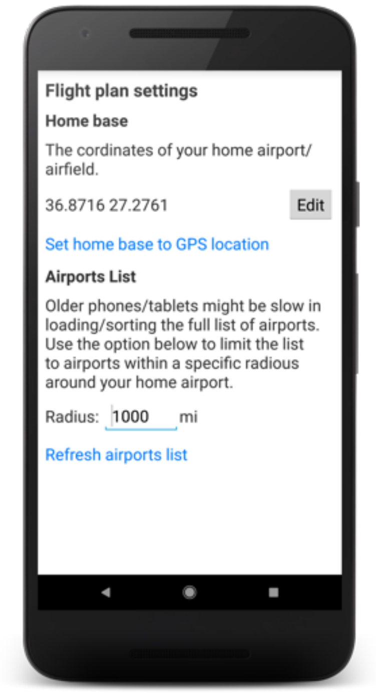


Figure 22: Flight plan settings.

Home base

Here the user can configure the coordinates of his/her home airport or home airfield. The home base can be added as a waypoint in the flight plan and it is also used by various components of A-EFIS to provide a default location when there is no GPS signal. E.g. It is used to sort airports according to distance when entering a flight plan and there is no GPS signal.

The home base is also used to limit the airports list as described in the next paragraph.

Airports list

This option allows the user to define a radius around the home base and limit the list of airports displayed in the flight plan menu only to airports within this radius. This option is useful for older smartphones and tablets which might be slow in loading and sorting the full airports list. Use this option if your smartphone/tablet halts for more than a few seconds in the “Loading airports” screen when A-EFIS starts or when there is a noticeable delay each time you are trying to bring up the “add airport” screen in the flight plan menu.

A radius of “0” or a very large radius (i.e. more than half the earth’s circumference) will load the full airport’s list.

17 Quick Setup Guide

17.1 Sensor and compass calibration

Important notice: In order for the sensors to work correctly, at least in some smartphones, it maybe necessary for the user to lock the interface orientation of his/her device before starting A-EFIS, using the standard method provided by the device/OS manufacturer.

Before using your device for the first time you will need to calibrate the inertial sensors (accelerometers and gyroscopes) and the compass.

The accelerometers and gyroscopes calibration procedure is initiated via the “Calibrate sensors” button, located in the main menu. See Section 6.2 (Calibrate sensors) for more information.

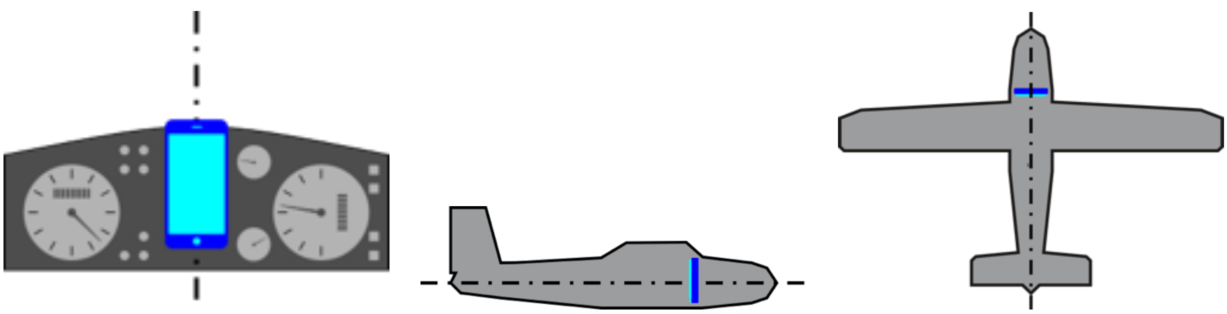
Next, you should calibrate the compass. Compass calibration should be performed inside the aircraft, as close as possible to the mounting point of the device. The procedure is initialed by pressing the “Calibrate compass” button, located in the main menu. For more information about the compass calibration procedure see Section 6.3.

17.2 Mounting your mobile device on the cockpit

Your smartphone/tablet should be mounted in a convenient dry place, as far away as possible from heat and magnetic sources.

Moreover, for the GPS receiver to be able to receive signal from the GPS satellites the mobile phone or tablet should be mounted in such a way that it has a good view of the sky.

If possible, mount your device vertically, parallel and as close as possible to the symmetry axes of the airplane (see Figure 23).



(a) (b) (c)

Figure 23: Your smartphone or tablet should be mounted vertically, parallel to the axes of the airplane and as close as possible to the symmetry axes of the airplane.

The device can normally be mounted in any of the four possible orientations: portrait, landscape, reverse portrait (upside down), or reverse landscape. Notice that you will need to lock your device's user interface to the desired orientation and then close and restart A-EFIS, in order for any orientation changes to take effect. Please also note that the reverse portrait (upside down) orientation is not possible on some devices due to operating system limitations.

17.3 AHRS Leveling

After mounting your device to its final location (and whenever you move the device to a new location), the artificial horizon leveling procedure is necessary in order to compensate with placement inaccuracies and to level the horizon. The AHRS leveling procedure is initialed by pressing the "Level AHRS" button, located in the main menu. For more information on the artificial horizon leveling procedure, see Section 6.1.

18 Using A-EFIS with the X-Plane simulator

A-EFIS can act as a virtual EFIS screen for your simulated flight using X-Plane, the flight simulator from Laminar Research (https://www.x-plane.com).

To enable reception of flight simulator data, use the following procedure:

- Make sure that both your computer (running X-Plane) and your mobile device (running A-EFIS) are connected on the same network.
- Swipe-right to the "sensor status" screen and then scroll down until you reach the "X-Plane simulator". Make sure the relevant switch is in the enabled position (Figure 24a).
- Note the IP address of your device, displayed below the switch. The IP address consists of four numbers separated by dots. In the example of Figure 24a, the IP address is "192.168.2.49".
- Setup X-Plane to send data 1-21 to the IP address you have noted in the previous step, at port 49000. Use Figure 24b (for X-Plane 11), or Figures 24c and 24d (for X-Plane 10), for reference.

Additionally, you will need to configure X-Plane to send flight data to A-EFIS. For this purpose, You will also need to configure X-Plane to send data to A-EFIS.

When used with the X-Plane simulator, A-EFIS displays all the above-mentioned quantities as well as Indicated Air Speed (IAS).

Indicated Air Speed (IAS) is normally provided via a Pitot-Static system. A-EFIS does not support input from the Airplane's Pitot-static input. Hence, the displayed speed is not IAS, but, rather, the ground speed, as provided by the GPS. This is indicated by the "GPS" sign displayed at the right side of the speed box (Figure 1c).

IAS is only available when connected to the simulator. When connected to the simulator, an "IAS" sign at the right side of the speed box indicates that the displayed speed is the Indicated Air Speed (Figure 1a). In this case, the user can switch between IAS and GPS speed by tapping on the "IAS" or "GPS" signs. The default speed source (IAS or GPS) can also be configured on the "default data sources" screen (Section 10).

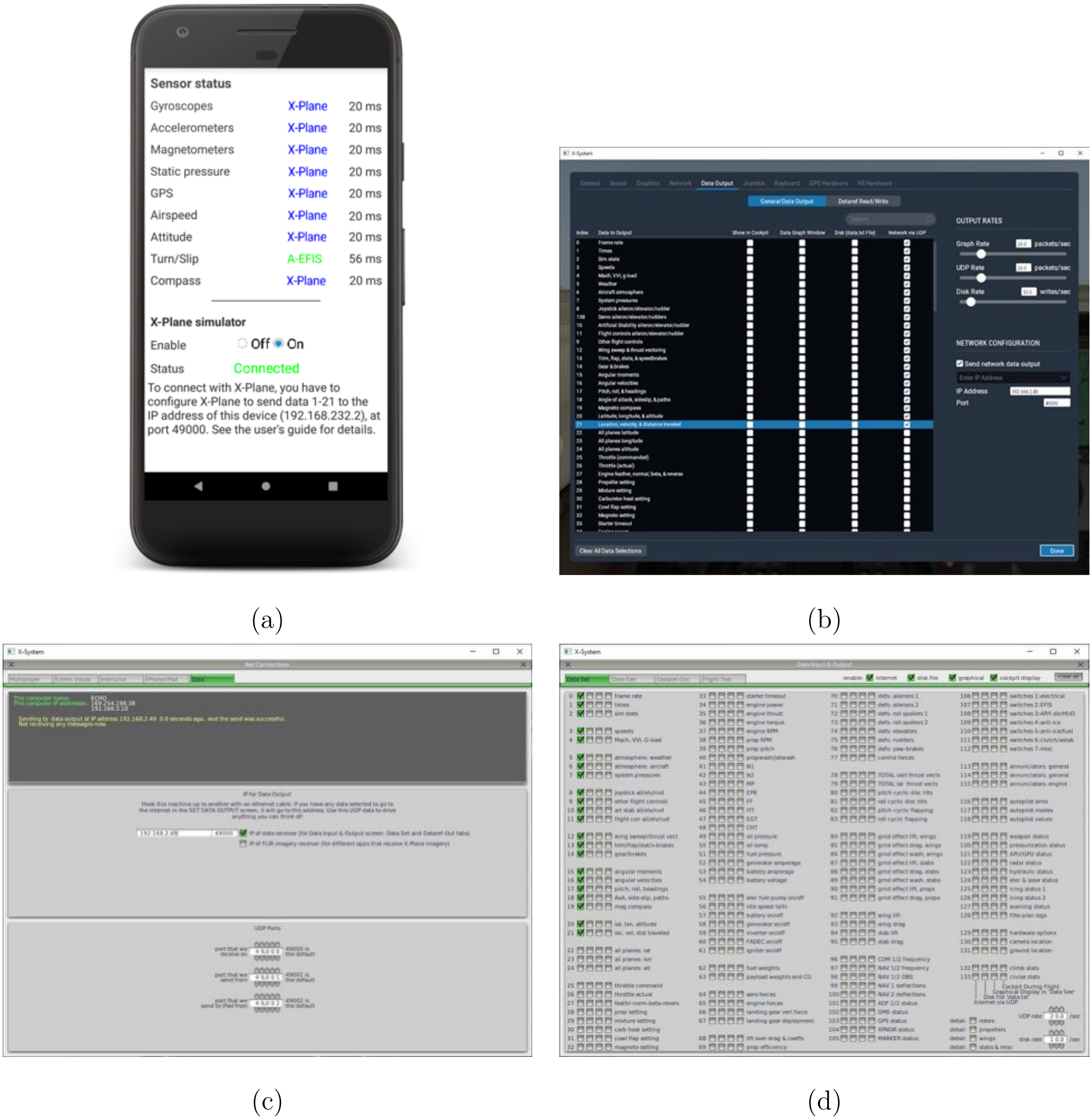


Figure 24: X-Plane configuration. (a) Enable X-Plane reception on the sensor status screen (b) X-Plane 11 configuration. (c,d) X-Plane 12 configuration.

19 Support and contact information

For support via email, please contact:

support@a-efis.com

For voice support, please use the following telephone line:

+30 28 1111 2775

For general questions & feedback, please contact:

info@a-efis.com