



# SensorBox

## AHRS, ADS-B, ILS

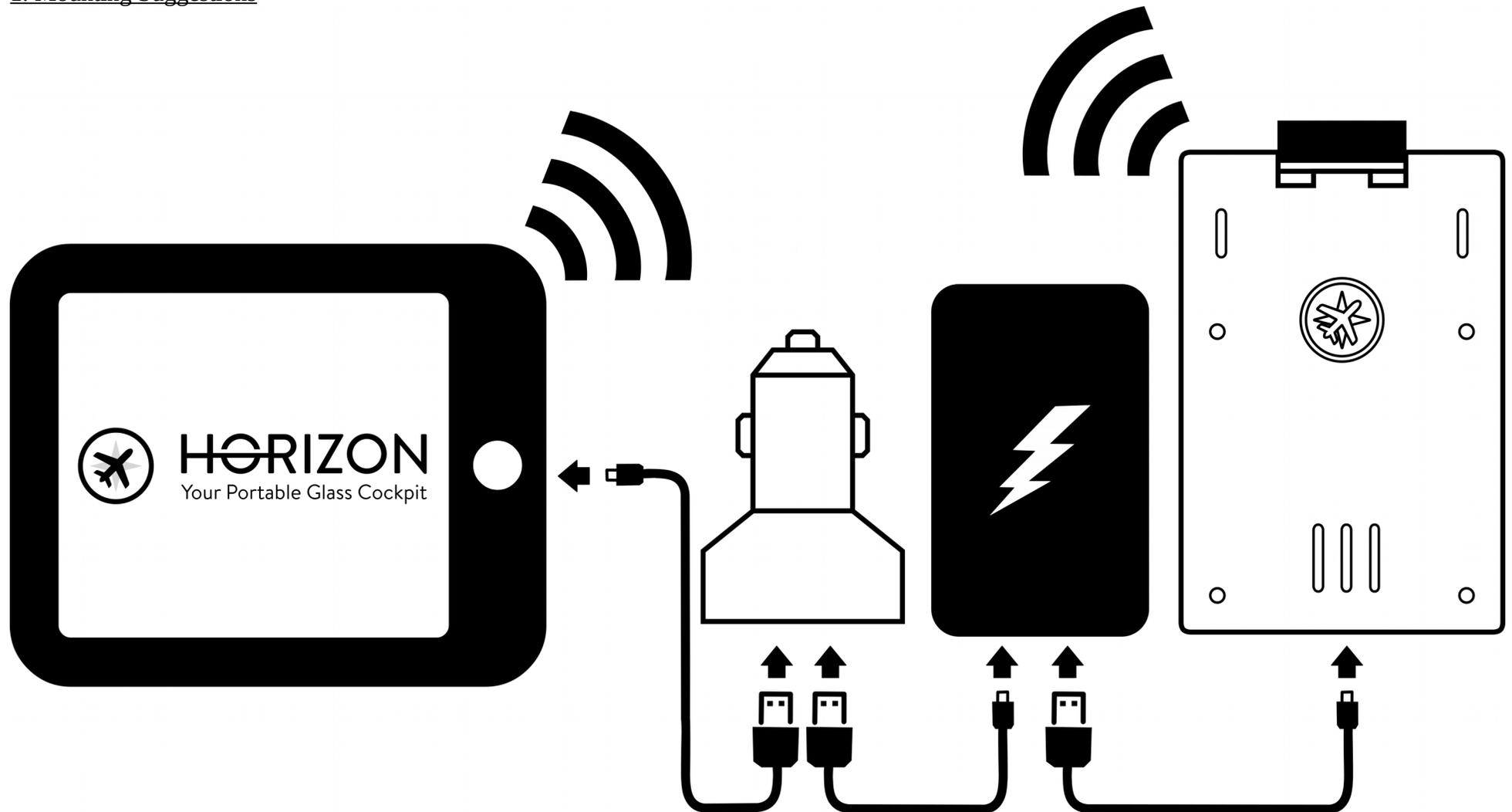
made for “Horizon – Your Portable Glass Cockpit”

# Manual

### Table of Contents

1. Mounting Suggestions
2. Safety Information
3. Power Supply
4. Wifi Connection
5. Firmware Updates
6. Features
  - 6.1 AHRS
    - 6.1.1 Calibration for Installation Error
    - 6.1.2 Calibration for Gyroscope Error/Bias
    - 6.1.3 Automatic Gyroscope Calibration
  - 6.2 Software Defined Radio
    - 6.2.1 ADS-B
    - 6.2.2 ILS (Localizer and Glideslope)
  - 6.3 GNSS Reception

## 1. Mounting Suggestions



Hint: The Power Bank (2<sup>nd</sup> from the right) and the SensorBox (right) can easily be mounted with velcro tape on the dashboard. The cigarette lighter adapter is optional; you can also run the SensorBox using the Power Bank and run your tablet using its own internal battery. DO NOT use the Power Bank as a power supply for multiple devices simultaneously. Low voltage results in an instability of the SensorBox. Please also read the “Mounting Suggestions” chapter of the manual for “Horizon – Your Portable Glass Cockpit”.

## 2. Safety Information

DO NOT cover vent holes.

DO NOT block the fan.

DO NOT expose the SensorBox to high temperatures, such as leaving it in the sun in an unattended aircraft (normal operating temperatures are 20°C to 50°C / 68°F to 120°F with less than 90% relative humidity).

DO NOT use the SensorBox or Horizon as primary source for navigation or orientation. You must not use Horizon or the SensorBox as a flight instrument. The pilot in command is solely responsible for a safe and lawful flight in all circumstances. Do not attempt to use the SensorBox for any purpose requiring precise measurement of direction, distance, location, or topography. This product should not be used to determine ground proximity for aircraft navigation.

Use any information only as an aid to situational awareness. Such information is merely supplemental and advisory in nature and is not intended to be relied upon as safety-critical information in connection with any aviation, vehicle, or marine usage. The user should always exercise caution and common sense when confronted with severe conditions.

Traffic information is provided as an aid to visually acquiring traffic. Pilots must maneuver the aircraft based only upon official guidance or positive visual acquisition of conflicting traffic.

The pressure altitude information provided by the SensorBox in a pressurized airplane will not be accurate.

The SensorBox does not contain any user-serviceable parts. Repairs should only be made by Helios Avionics GmbH. Unauthorized repairs or modifications void the warranty.

ONLY use fitting power supplies (5V @ 2A) with **high quality** micro USB cables.

TURN OFF all other devices which may interfere with the Wifi connection.

When installing the SensorBox in an aircraft, place the unit securely so that it does not interfere with the aircraft operating controls or obstruct the pilot's view.

It is the sole responsibility of the owner/operator of the SensorBox to place, mount and secure the unit so that it will not interfere with the aircraft's operating controls and safety devices, or cause damage or personal injury in the event of an accident or turbulence. Do not mount the SensorBox where the pilot or passengers are likely to impact in an accident, collision, or turbulence. The mounting hardware provided by Helios Avionics is not warranted against turbulence, collision damage, or related consequences.

For safety reasons, the operational procedures of the SensorBox must be learned on the ground.

All visual depictions contained within this document including images of the SensorBox and the bezel, displays, and screens of other products are subject to change and may not reflect the most current software or hardware. Depictions of equipment may differ slightly from the actual equipment.

### 3. Power Supply

Requirement: 5V @ 2A max. via **high quality** micro USB cable

The SensorBox can be powered from a Power Bank, a Cigarette Lighter Adapter or any other power supply at 5V which can supply at least 2A.

For reliability issues it is recommended to use a Power Bank and an external power supply (such as a Cigarette Lighter Adapter) simultaneously. Just connect your external power supply with a Power Bank and the Power Bank with the micro USB port of the SensorBox.

For this setup your Power Bank must support pass through charging for simultaneous power delivery and charging.

In case your power supply can power multiple devices please make sure that the sum of the power requirements of all connected devices does not exceed the rating of the power supply (e.g.: if your power supply's rating is 2.1 A and you connect the SensorBox to it, all other devices, powered by this particularly supply, must not consume more than 0.1 A). If your power supply is not sufficient the SensorBox will become unstable (due to low voltage) and outputs become unreliable.

The same happens if you use low quality micro USB cables. High quality micro USB cables have a low resistance for a minimal voltage drop.

It is very important to use a high quality power supply and high quality micro USB cables!

### 4. Wifi Connection

SSID: SensorBox<Serial Number>

Password: HorizonGlassCockpit

A wifi connection must be established before the SensorBox can be used. To do that please open your operating systems's wifi settings and connect with the parameters as written above.

As long as the wifi connection persists the SensorBox can be used by "Horizon – Your Portable Glass Cockpit". Just select "Use our SensorBox ..." at startup.

The SensorBox uses wifi channel 7 (2442 Mhz). In case of connection problems please make sure no other devices are interfering.

### 5. Firmware Updates

Updates can be done by sending the new firmware via wifi to the SensorBox. Please note that connections may be interrupted until the update is complete.

### 6. Features

#### 6.1 AHRS

The SensorBox has a gyroscope, an accelerometer, a magnetometer and a GPS/GNSS receiver. With the sensor fusion algorithms running on the CPU of the SensorBox an aircraft's attitude can be determined during flight.

AHRS is only to be used as an aid and should not be used as a primary attitude indicator.

To improve the accuracy a calibration is recommended. Especially the calibration for a non-straight mounting inside the cockpit (installation error) is highly recommended.

Please also note: Extreme attitudes may degrade AHRS accuracy.

Also heavy linear accelerations can result in a temporary pitch angle indication change.

Please read the following subchapters to get all information you need for a precise attitude determination:

### 6.1.1 Calibration for Installation Error

The SensorBox is usually not perfectly aligned with the aircraft. This results in a difference between the SensorBox's attitude and the aircraft's attitude. To get the best attitude estimation for the aircraft this "installation error" must be compensated.

This is done by defining the rotation of the SensorBox inside the cockpit by setting the Pitch (Nose Up and Down), Yaw (Heading) and Roll (Bank) angles. In the calibration menu you can press the arrow buttons next to the corresponding values to alter each angle. The result will be shown in the 3D Rotation Preview as well as in the Attitude and Heading Indicator.

To make it easier it is possible to automatically determine the Pitch and Roll angles from the direction of gravity. For this the aircraft must be in a straight and level attitude.

Manual calibration is not necessary if your SensorBox is aligned with the aircraft's heading. If it is not aligned you can still determine Pitch and Roll automatically and afterwards manually adjust the Yaw angle.

### 6.1.2 Calibration for Gyroscope Error/Bias

The gyroscope measures the angular velocity of all three axis. The measurements are afflicted with an error. If this error is large it results in an inaccurate attitude estimation. The error can be determined by averaging the gyroscope output over a given time period while the gyroscope is at rest. If you start the gyroscope calibration from inside Horizon this error will be determined and later on subtracted from the gyroscope measurements. It is important that the SensorBox is at rest, otherwise it results in a bad calibration.

Please note that the gyroscope bias may drift over a long time.

Please note: In contrary to internal sensors the external gyroscope of the SensorBox usually has a very low bias. Therefore you should also get good results without manual gyroscope calibration.

### 6.1.3 Automatic Gyroscope Calibration

There's an automatic gyroscope calibration built in the SensorFusion algorithms. It determines the gyroscope bias from the fusion steps. This automatic calibration runs all the time (while estimating attitude), which means you can even get a useful gyroscope calibration if you haven't done the manual calibration. The results of the automatic calibration are usually less good than the results of the manual calibration and it also may take some time until a good calibration is determined automatically.

## 6.2 Software Defined Radio

The SensorBox is equipped with two Software Defined Radio receivers, which are controlled by the firmware of the SensorBox. In the current version they are used to receive ADS-B and ILS (Localizer and Glideslope) signals.

In the Radio menu in Horizon you can enable different radio modes such as "ADS-B", "ILS", "ADS-B and Localizer" etc. . To save energy you can also turn off the radios.

The two SDR antennas need to be plugged into the SensorBox to use SDR.

### 6.2.1 ADS-B

ADS-B signals can be received on 1090Mhz. This makes it possible to see traffic equipped with ADS-B out transponders on your own screen.

This is an aid for visually acquiring nearby aircraft. It must never be assumed that the SensorBox is providing complete information about the traffic in the area.

### 6.2.2 ILS (Localizer and Glideslope)

The ILS (Instrument Landing System) consists of the Localizer and the Glideslope signal. The frequencies are paired so that you only need to specify the Localizer frequency. When ILS is enabled, one SDR receiver is used to receive the Localizer signals while the other one is used to receive the Glideslope signals.

The resulting data is sent to Horizon and indicated as an overlay over the Synthetic Vision.

Please note that there's a difference between the 1. published runway heading; 2. real runway heading; 3. Localizer approach course. For this reason an extrapolated approach via GNSS may differ from the Localizer course even if the threshold position is known perfectly. The difference is usually within a few degrees and less noticeable with a smaller distance from the threshold.

Please note: Obstructions in the "line of sight" between SDR antennas and ILS senders may degrade the reception. This needs to be considered when mounting the SDR antennas.

### 6.3 GNSS Reception

Number of channels: 72

Supported GNSSs (Global Navigation Satellite Systems): GPS, Galileo, GLONASS, QZSS

Supported SBASs (Satellite-Based Augmentation Systems): WAAS, EGNOS, GAGAN, MSAS

Operational Limits: Dynamics: 4 g; Altitude: 50000m; Velocity: 500m/s

Although GPS is not required to get an attitude indication, it is the only source of speed information. Speed information is used to precisely derive lateral acceleration to improve the attitude estimation. Therefore please make sure that you have a good GPS/GNSS reception for best accuracy.

A warning indicates if your pose (attitude and position) might have low accuracy due to a bad GPS / GNSS signal.

## **Software License Agreement**

By using the SensorBox, you agree to be bound by the terms and conditions of the following Software License Agreement. Please read this Agreement carefully.

Helios Avionics GmbH grants you a limited license to use the software embedded in this device (the "Software") in binary executable form in the normal operation of the product. Title, ownership rights, and intellectual property rights in and to the Software remain with Helios Avionics GmbH.

You acknowledge that the Software is the property of Helios Avionics and is protected under the international copyright treaties. You further acknowledge that the structure, organization, and code of the Software are valuable trade secrets of Helios Avionics GmbH and that the Software in source code form remains a valuable trade secret of Helios Avionics GmbH. You agree not to decompile, disassemble, modify, reverse assemble, reverse engineer, or reduce to human readable form the Software or any part thereof or create any derivative works based on the Software.

## LIMITED WARRANTY

The SensorBox is warranted to be free from defects in materials or workmanship for three years.

Within this period, Helios Avionics will, at its sole option, repair or replace any components that fail in normal use. Such repairs or replacement will be made at no charge to the customer for parts or labor, provided that the customer shall be responsible for any transportation cost.

This warranty does not apply to:

1. Cosmetic damage, such as scratches, nicks and dents.
2. Consumable parts, such as batteries, unless product damage has occurred due to a defect in materials or workmanship.
3. Damage caused by accident, abuse, misuse, water, flood, fire, or other acts of nature or external causes.
4. Damage caused by service performed by anyone but Helios Avionics GmbH.
5. Damage to a product that has been modified or altered without the written permission of Helios Avionics GmbH.
6. Helios Avionics GmbH reserves the right to refuse warranty claims against products or services that are obtained and/or used in contravention of the laws of any country.

Helios Avionics GmbH retains the exclusive right to repair or replace (with a new or newly-overhauled replacement product) the product or software or offer a full refund of the purchase price at its sole discretion. Such remedy shall be your sole and exclusive remedy for any breach of warranty.

### **Online Auction Purchases:**

Products purchased through online auctions are not eligible for warranty coverage. Online auction confirmations are not accepted for warranty verification. To obtain warranty service, an original or copy of the sales receipt from the original retailer is required. Helios Avionics GmbH will not replace missing components from any package purchased through an online auction.

To obtain warranty service please contact [horizon@helios-avionics.com](mailto:horizon@helios-avionics.com).