LARUS Gliding Sensor Unit

Installation Manual and Operating Instructions

Version 1.8

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1 Preliminary Remarks

1.1 Important Notices

Before using any part of the system, please read and understand this manual. All information in this document is subject to change without notice. The latest version can be downloaded from www.stefly.aero.

CoTexx GmbH does not accept responsibility for damages which are the result of installation and operation of the device.

1.2 Limited Warranty

The LARUS unit as well as its accessories are warranted to be free from defects in materials or workmanship for two years from the date of purchase. Within this period, CoTexx will, at its sole discretion, 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 and labour, provided that the customer shall be responsible for any transportation cost. This warranty does not cover failures due to abuse, misuse, accident, or unauthorised alterations or repairs.

1.3 Conventions and Pictograph Definitions

The safety instructions in SteFly operating manuals are the result of risk evaluations and hazard analyses. In this document, the following hazard levels and information are considered:

	Pay special attention to critical notes marked with a yellow caution symbol, because non-observance may result in damage or any other critical situation.
	A red caution symbol signalizes that non-observance may result in injuries.
	Command to perform an action or task associated with a source of danger, the disregarding of which may result in serious accidents.
	A blue cloud indicates useful information or tips.

2 Safety

2.1 Safety Precautions

Duty to inform
Each person involved in the installation or operation of LARUS must read and observe the safety-related parts of these operating instructions.

2.2 Proper Use

LARUS was designed to calculate direction and strength of thermals and wind quickly and reliably. Therefore, the sensor unit combines data from high-precision sensors and GNSS receivers in sophisticated algorithms. A separate display device is required to display the data, such as an OpenVario or a Bluetooth-enabled device with XCSoar.

LARUS sensor unit as well as the GNSS antenna(s) shall be installed in the inside of the fuselage.

This gliding sensor unit is an additional feature to supply glider pilots with accurate information about wind, vertical air movement as well as additional attitude of the aircraft. Its use is limited to day VFR conditions. Security decisions must be made regardless of having installed LARUS.

2.3 Improper Use

Improper use will cause all claims for liability and guarantees to be forfeited. Improper use is deemed to be all use for purposes deviating from those mentioned above, especially:

- Using LARUS data in non-VFR conditions or during night is forbidden. LARUS is not certified. Although LARUS provides AHRS data to XCSoar you must not rely on the artificial horizon display.
- Using LARUS data during aerobatics or during flight conditions with high angle of attack (stall) or high g-forces. The algorithm was optimized for normal flight conditions.
- Operating it outside the operation conditions defined in technical data section, e.g. input voltage, temperature and humidity.
- Operating LARUS without connected WiFi / Bluetooth antenna, even if Bluetooth is not needed

3 LARUS Quick Start Manual

LARUS is an advanced variometer with real time wind measurement capabilities. It incorporates state of the art pressure sensors, an advanced IMU and GNSS receivers to gather precise flight information data.

LARUS may be operated out of the box. Simply perform the following actions:

1. Connect the GNSS antenna(s) to the sensor unit. For LARUS DUAL-GNSS: connect the front antenna to GNSS1, the rear antenna to GNSS2.
2. Insert the SD-card, that is part of the delivery.
3. Mount the sensor unit in the aircraft as far away from metal and magnetic parts as possible while paying attention to the orientation of the unit, which is provided by the label on the sensor unit.
4. Connect the sensor unit's static and total pressure ports.
5. Power the sensor unit through one of the USB-ports, the CAN-port or the RS232-port. Power can be provided to the device through all four connectors. If the CAN- or RS232-port is used to provide power to the sensor unit, the voltage shall be in the range of 8-28V.

6. Connect LARUS Vario Display or a glider navigation system on which XCSoar / OpenSoar is running, like the SteFly NAV or your smartphone, to the sensor unit to display LARUS' data. If a smartphone is used, OpenSoar has to be installed, a bluetooth connection to the sensor unit must be established, LARUS must be selected within Opensoar's device-menu and the LARUS-driver must be used for operation.
7. Your LARUS is ready to fly and will continuously optimize its calibration during flight!

4 Product Description

4.1 Scope of Delivery

The scope of delivery contains the following:

- LARUS sensor unit in black anodized aluminum housing
- 1 GNSS antenna (LARUS Essential) or 2 GNSS antennas (LARUS Dual-GNSS)
- Ground plane for GNSS antenna(s)
- brass mounting screws and nuts
- 2 fastening clamps
- Min. 32 GB micro SD card with adapter
- RJ45 cable 1 m

A separate display device is required to display the data, such as an LARUS Vario Display, or SteFly NAV /OpenVario / Bluetooth-enabled device like a smartphone with XCSoar / OpenSoar

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4.2 Design and Function

LARUS is a sensor unit specially designed for gliders by the LARUS project team led by Prof. Dr. Klaus Schäfer, Horst Rupp and Maximilian Betz. The hardware is licensed accordingly to **Creative Commons NonCommercial Share-alike 4.0 International**, Larus software accordingly to **GNU General Public License v3.0**.

LARUS incorporates state of the art pressure sensors, an advanced IMU and GNSS receivers as well as sophisticated algorithms to gather precise flight information data, e.g.

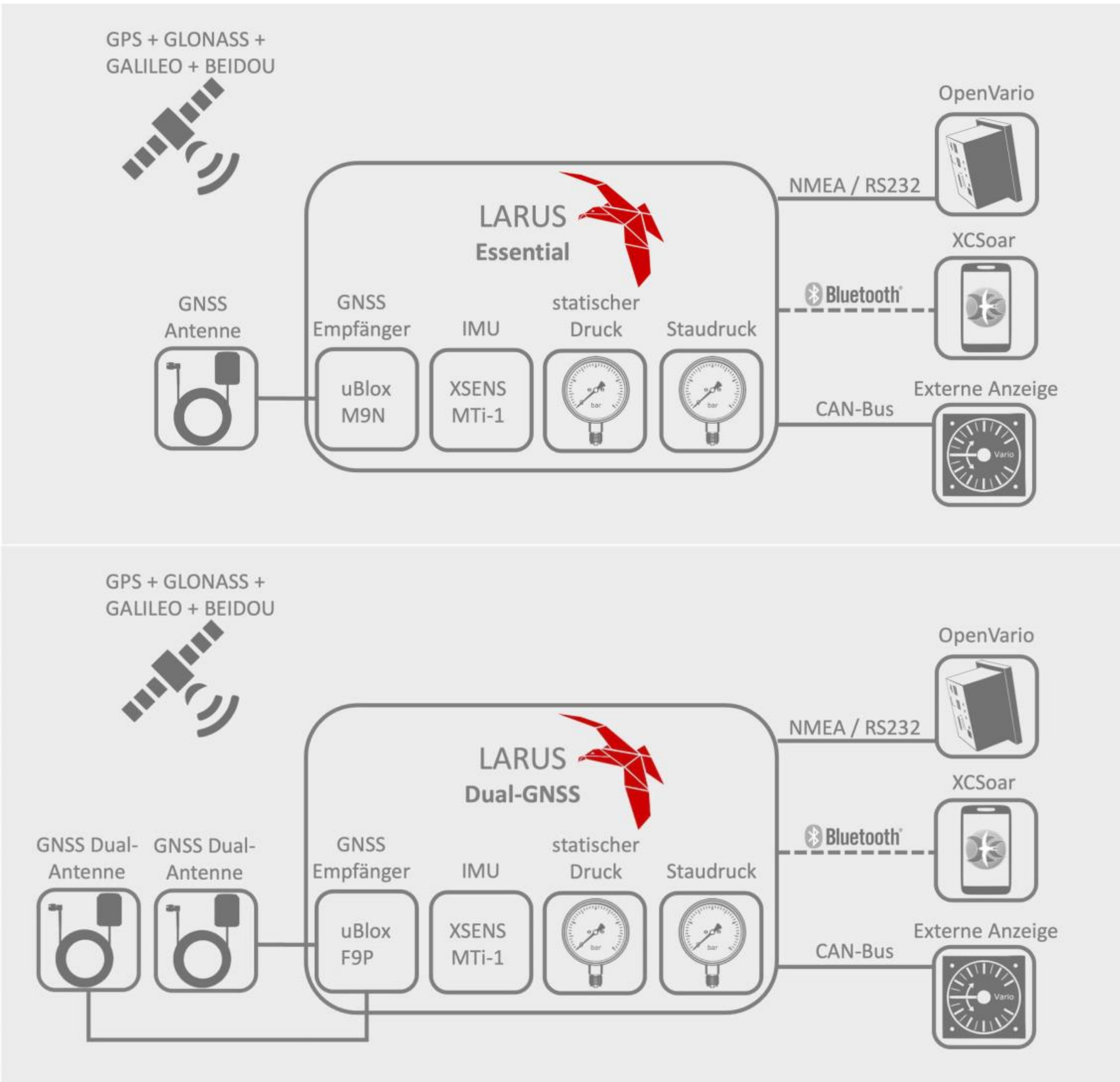
- energy-compensated climb or sink (variometer)

- horizontal wind speed as an instantaneous value (live / real-time wind) and a value averaged over an adjustable period (e.g. 30 s)
- attitude for display in an artificial horizon
- pressure altitude / flight level FL
- true airspeed (TAS)
- course over the ground (track)
- drift angle (difference between track and heading)

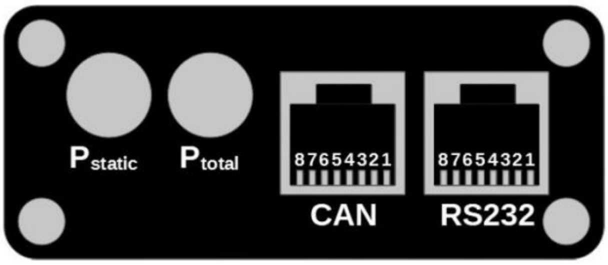
LARUS is a self-learning system that automatically adjusts some parameters saved in its memory during flight. These include e.g. 3D magnetic calibration parameters or magnetic calibration error.

There are two different LARUS versions available, LARUS ESSENTIAL and LARUS DUAL-GNSS. In the Essential variant, LARUS is equipped with a precise GNSS receiver with an external active antenna. In the LARUS Dual-GNSS variant, on the other hand, a high-precision dual-band receiver is connected to two active, multi-frequency band antennas.

The system architecture of LARUS ESSENTIAL and LARUS DUAL-GNSS is shown below.



4.3 CAN and RS232 Ports



Pin	CAN	RS232
1	GND (internally connected)	GND (internally connected)
2		
3	NC	RS232_1_RX
4	CAN Low	RS232_1_TX
5	CAN High	RS232_2_RX
6	NC	RS232_2_TX
7	VCC [9-28V DC] (internally connected)	VCC [9-28V DC] (internally connected)
8		

4.4 Status LEDs

LARUS has four status LEDs:

- SD-CARD (blue)
  - Off: No uSD-Card detected
  - On: uSD-Card detected
  - Flashing: Actively logging (writing) to card
- SYSTEM (blue)
  - Off: System not working at all
  - Flashing: Indicates that FreeRTOS and the tasks are running.
- GNSS (blue)
  - Off: No GNSS fix
  - Flashing: GNSS fix
- ERROR (red)
  - Flashing: at least one of the sensors IMU, static pressure, dynamic pressure or GNSS is not working.
  - Sporadic flashing: DGNSS heading fix is briefly missing.

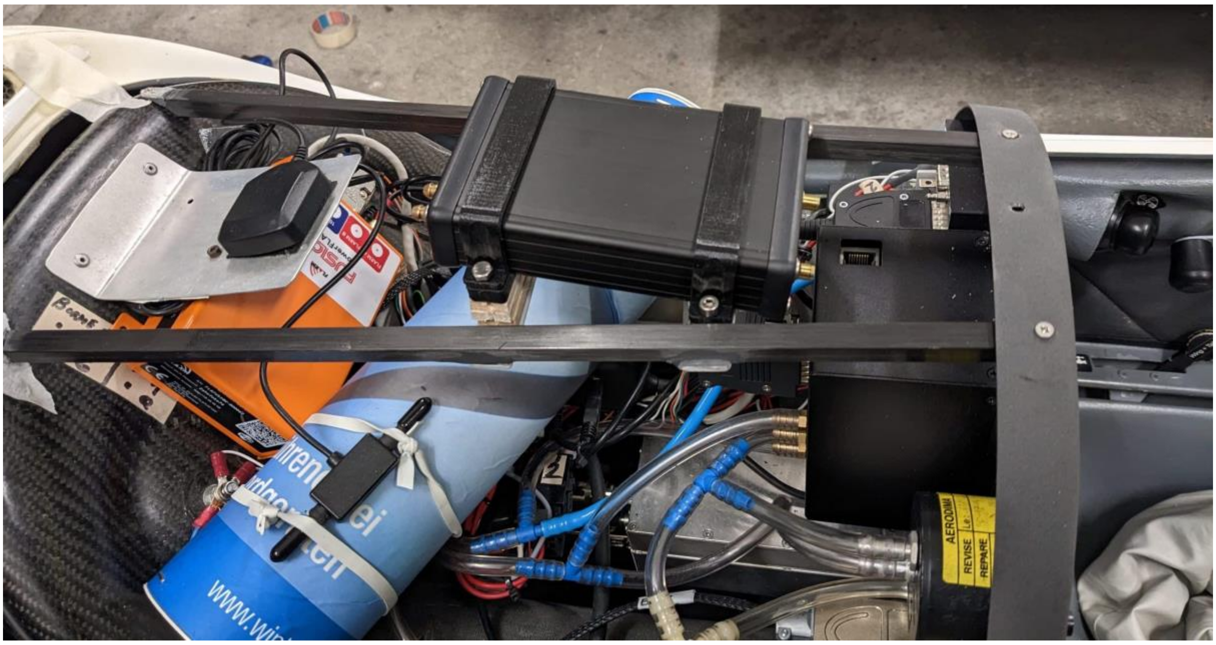
5 Installation Hardware

LARUS needs to be protected by an external fuse (500 mA to max. 3A) like it is common practice for all electric devices in aviation. If LARUS gets its energy from another main instrument (e.g. SteFly NAV) via USB, CAN or RS232, please make sure that the main instrument is protected by an external fuse.

5.1 LARUS Sensor Box

The installation orientation of the LARUS box is possible in all directions and only needs to be adjusted in the configuration file "larus_sensor_config.ini".
Nevertheless, we recommend selecting the orientation with regard to the longitudinal axis of the aircraft during assembly according to the coordinate system printed on the LARUS housing (pressure hose connectors in the front of the box, sticker on top).

The following picture shows a typical installation situation of the LARUS Sensor Box in front of the instrument panel of a glider.



To obtain accurate flight information, please note the following information:

- Mount the sensor unit absolutely fix so that the position of the sensor unit in relation to the aircraft structure does not change under the influence of acceleration forces
- Fastening elements in the immediate vicinity of the sensor should be made of stainless steel, brass, plastic, aluminum or fiber composite materials. Nuts and bolts made of steel should be avoided. Iron parts are unsuitable because they generate a variable interference field with every movement of the aircraft.
- We recommend mounting the LARUS box with the 3D-printed clips (scope of delivery) and not with Velcro tape. This ensures that the box is always placed in the same position should it need to be removed. Otherwise, the installation position may no longer match the settings in larus_sensor_config.ini.

- The integrated inertial measuring unit "IMU" can only work precisely if LARUS box (especially LARUS Essential) is positioned as far away as possible from:

  - magnetic fields (loudspeaker, magnets (sometimes integrated in antennas, check with another magnet), analog compass); distance at least 20 cm
  - power supplies and voltage converters
  - bigger iron parts, especially if they are moving during flight like rudder pedals.
  - radio
  - Flarm antenna
  - Spot Satellite Communication Device
- If possible, make sure that the SD card slot is easily accessible.

5.2 GNSS Antennas

5.2.1 GNSS Antenna Installation Position for good Reception

LARUS uses high-precision GNSS receivers and antennas. This allows a horizontal positioning accuracy of 2 cm with LARUS Essential and 0.5 cm with LARUS Dual GNSS. To achieve these values, please note the following information:

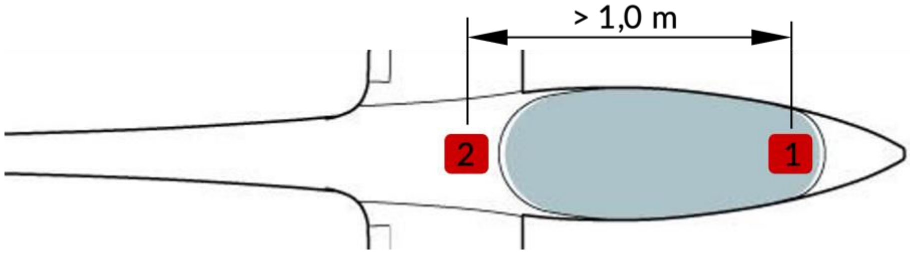
- Typical installation locations are
  - on top of the instrument panel (also hidden below the panel cover)
  - in the nose of the glider
  - at the top end of the canopy
  - inside the fuselage tube (baggage compartment) as high as possible (only possible if fuselage is made of glass fiber / GFRP)
  - engine compartment (if the engine doors are made of glass / aramide)
  - aerodynamic external antenna on the back of the fuselage
- The GNSS antennas must be mounted in such a way that there is "line of sight" to as many satellites as possible. For this reason, they must be installed approx. in-flight-horizontal, pointing upwards (type plate label on the bottom)
- There must be no electrically conductive materials (metal, CFRP / carbon fiber, water tank) between the GNSS antenna and the sky.
- The antennas can only work precisely if they are positioned as far away as possible from:

  - Other GNSS antennas (e.g. FLARM GPS antenna, keep distance of 20 cm)
  - Transponder antenna
  - Spot Satellite Communication Device
- GNSS antennas are not sensitive to magnetic fields.

5.2.2 LARUS Dual-GNSS and its´ two GNSS antennas

For LARUS Dual-GNSS it is important

- that the two GNSS antennas are installed with at least 1,0 m distance
- the laminate above the antenna is made of GFRP and not CFRP, because carbon fibers block satellite signals. In case of aircraft with a CFRP fuselage without GFRP areas, however, mounting the antennas in the front and rear area of the canopy can also be considered. Special antenna solutions are available from us.



GNSS 1 (=front) antenna is usually mounted at the level of the instrument panel or in front of it, in the nose of the aircraft.
GNSS 2 (=rear) antenna should be mounted on the inside of the fuselage tube (luggage compartment / end of the canopy / engine compartment), ideally near the center of gravity of the aircraft. The shorter the distance between the rear antenna and the center of rotation around the pitch axis, the less the influence of pitching movements (forward or backward movement of the stick) on the measured altitude.
The cables leading from both antennas to the LARUS sensor box must exit the antenna housings on the same side for high precision differential GNSS:

5.2.3 Ground Plane

Ground planes are mounted directly underneath the GNSS antennas and significantly improve the GNSS position accuracy. Furthermore, they mitigate multipath interference and if coaxial antenna cables are routed underneath ground planes, negative effects on the radiation patterns are avoided.

Ground planes are made of solid aluminum sheets or copper plated printed circuit boards (PCBs). We recommend using round ground planes with a diameter of 150 mm to get best results (scope of delivery).

For further information please see e.g. Stefan Punzet and Thomas F. Eibert "Impact of Additional Antenna Groundplanes on RTK-GNSS Position Accuracy of UAVs", https://ars.copernicus.org/articles/20/23/2023/ars-20-23-2023.pdf) or https://www.navtechgps.com/wp-content/uploads/Tallysman_Ground-Planes.pdf

5.3 Connecting Pressure Hoses

Please connect the pneumatic tubes to the correct port of the sensor unit and perform a leak test after final installation.

- P_{static}: static pressure connector
- P_{total}: pitot or total pressure connector

Some gliders with engines have a switch to change between different static pressure or dynamic pressure ports, if the airflow is affected from the propeller. Not every port gives correct pressure values, but this is crucial for correct functioning of LARUS.

- If LARUS always calculates strong constant head- or tailwind, please check the correct function of the pressure ports and that hoses are not bent.
- If LARUS vario and wind values are completely wrong and changing significantly with airspeed, please check that hoses for static and dynamic pressure are not mixed up

6 Software

6.1 SD Card

6.1.1 Configuration File “larus_sensor_config.ini” (valid for firmware version 0.4.0 and newer)

The Larus sensor is configured with an ini file, which may look like this example:

```
larus_sensor_config.ini
[sensor-orientation]
SensTilt_Roll = 0
SensTilt_Pitch = 0
SensTilt_Yaw = 0

[pressure-calibration]
Pitot_Offset = 0.0
Pitot_Span = 1.0
QNH-delta = 0.0

[preferences]
Mag_Auto_Calib = 1
Vario_TC = 2
Vario_Int_TC = 30
Wind_TC = 5
Mean_Wind_TC = 30

[GNSS-type]
GNSS_CONFIG = 1.0

[D-GNSS-configuration]
ANT_BASELEN = 1.0
ANT_SLAVE_DOWN = 0.0
ANT_SLAVE_RIGHT = 0.0
```

A file named “larus_sensor_config.ini” should not be present on the card during normal operation. Put it on the SD card if you need to change the configuration, but before the next flight delete this file or rename it (e.g. larus_sensor_config.ini.used). Otherwise, the data of the automatic magnetic configuration may be overwritten the next time you switch on the device!

Resetting the Parameters to the Factory Settings

Should it be necessary to reset the LARUS configurations to the factory settings, proceed as follows:

1. Remove the micro SD card from LARUS and connect it to a computer (via an SD card adapter)
2. Download the "larus_sensor_config.ini" file from Larus GITHUB page https://github.com/larus-breeze/sw_sensor/tree/master/configuration
3. Delete the old "larus_sensor_config.ini" or “…ini.used” and copy the downloaded one on the SD card
4. Insert the micro SD card into the SD-card slot of the LARUS housing, switch on LARUS and wait for one minute; the configuration parameters are now saved on the EPROM
5. Remove the micro SD card and rename "larus_sensor_config.ini" in "larus_sensor_config.ini.used". Insert the micro SD card into the SD-card slot of the LARUS housing

Individual Adjustments of the Parameters

In order to set LARUS parameters individually, proceed as follows:

1. Remove the micro SD card from LARUS (may be switched on) and connect it to a computer (via an SD card adapter)
2. Create / copy "larus_sensor_config.ini" on the SD card and open it with a text editor
3. Change the numerical values of individual parameters (see "Overview of Parameters" below)
4. Save and then close the file. If a copy of the file was created on the SD card automatically, delete it.
5. Insert the micro SD card into the SD-card slot of the LARUS housing, switch on LARUS and wait for one minute to be sure that the configuration was copied to the internal memory of LARUS EEPROM
6. Remove the micro SD card and rename "larus_sensor_config.ini" in "larus_sensor_config.ini.used". Insert the micro SD card into the SD-card slot of the LARUS housing

Overview of Parameters:

The larus_sensor_config.ini configuration file consists of any combination of configuration lines. Only the numbers after the equal sign may be changed. Other changes (e.g. changing the parameter designation) must not be made, otherwise LARUS will ignore the respective configuration line.

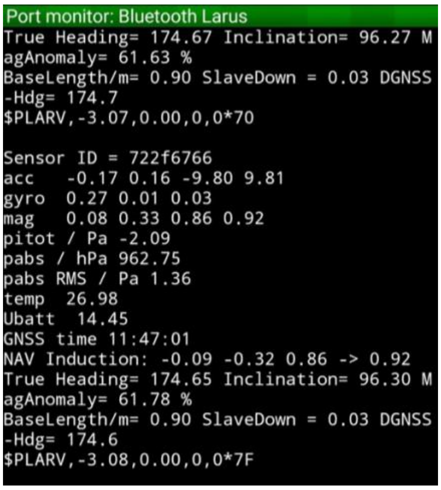
The file contains any combination of the following configuration lines (parameters that are particularly important are marked in yellow, additional parameters required for LARUS Dual-GNSS are marked in blue):

Configuration Line with Standard Value	Description
SensTilt_Roll = 0	Rotation of the sensor around the roll axis (sensor - longitudinal axis) in degrees; larger values in sensor_increase this value for rolling to the left on the attitude indicator
SensTilt_Pitch = 0	Rotation of the sensor around the pitch axis in degrees; increase this value for moving the nose down on the attitude indicator
SensTilt_Yaw = 0	Rotation of the sensor around the vertical axis in degrees; increase this value for yawing to the left
Pitot_Offset = 0.0	Preset from us before delivery. Offset of the differential pressure sensor in Pa (read out the value “pitot / Pa” (e.g. -5.0) out of the NMEA data stream when sensor.readings file is on the SD card; then set this value for 04 Pitot_Offset in sensor_config.txt (here -5.0). Check if displayed wind speed returns slowly to 0 when the aircraft is on the ground (V_{IAS} = 0 km/h), after having slightly blown into the pitot tube.
Pitot_Span = 1.0	Gradient correction of the differential pressure measurement (IAS → CAS)
QNH-delta = 0.0	Zero point correction of the absolute pressure measurement
Mag_Auto_Calib = 1	Turns on automatic compass calibration
Vario_TC = 2	Damping time constant of the instantaneous variometer in seconds. Reasonable values between 0.5 and 5 s. A higher value smoothens the vario needle.
Vario_Int_TC = 30	Damping time constant of the variometer integrator in seconds
Wind_TC = 5	Short term damping time constant of the wind measurement in level flight in seconds
Mean_Wind_TC = 30	Long term damping time constant of the wind measurement in level flight in seconds

Horizon_active = 1.0	If it is necessary to disable the artificial horizon (e.g. for competitions), set the value to 0
GNSS_CONFIG = 1.0	1.0 for LARUS ESSENTIAL with uBlox M9N; 2.0 for LARUS DUAL_GNSS with uBlox F9P
ANT_BASELEN = 1.0	Distance of the D-GNSS antennas in flight direction in meters
ANT_SLAVE_DOWN = 0.0	Position of the front D-GNSS antenna (=antenna 1) relative to the back antenna (=antenna 2) downwards in meters
ANT_SLAVE_RIGHT = 0.0	Position of the front D-GNSS antenna (=antenna 1) relative to the back antenna (=antenna 2) to the right in meters

6.1.2 Display Current Sensor Values using sensor.readings

This file makes it possible to output a NMEA dataset that can be easily read by the user in OpenSoar / XCSoar. If a file named sensor.readings is on the SD card, LARUS is connected to OpenSoar / XCSoar and “Port monitor” is activated under OpenSoar / XCSoar “Devices”, you will see the following:



Helpful for the initial configuration of LARUS are:

- For Dual-GNSS:
  - exact distances between the two DUAL GNSS antennas “BaseLength/m”(this is relevant for the configuration file "larus_sensor_config.ini")
  - altitude difference of the front antenna compared to the back antenna “SlaveDown”
- Evaluating the extent of magnetic field interference: When the aircraft is on the ground observe the “MagAnomaly” value when everything in the copckpit is switched on, then gradually switch electrical devices off or move iron parts such as control rods. The MagAnomaly should not exceed a value of 30 %, in good installation situations values of < 5 % are achieved.

To display the values, proceed as follows:

1. Remove the micro SD card from the LARUS housing (LARUS and OpenSoar do not need to be turned off)
2. Open the SD card folder on a computer, rename the file “sensor.readings_disabled” in sensor.readings and save it on the micro SD card
3. Insert the micro SD card into the slot of the LARUS housing
4. In OpenSoar click twice on the middle of the screen, click on “Config” -> “Devices” and select the line with Larus, then click "Monitor"

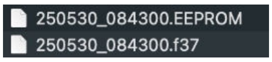
5. The current measured values are now displayed (see picture above). Click “Pause” for easier reading.
6. After the relevant measured values have been read out:
    a. Remove the micro SD card from the LARUS housing
    b. Rename the sensor.readings file in “sensor.readings_disabled” and save it
    c. Insert the SD card into the slot in the LARUS housing
    d. Wait until LARUS has GNSS connection again

A file with the name sensor.readings must not be present on the SD card during normal use, because otherwise no data is displayed in the Info Boxes of OpenSoar.

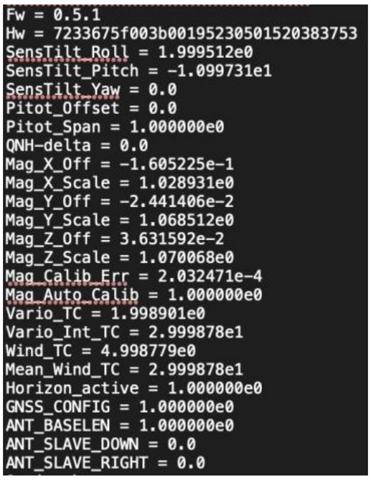
6.1.3 Logger Folder

If there is a folder with the name “logger” on the SD card, log files are stored here. These log files can be used to analyze a flight. For example, roll and pitch angles, airspeed and altitude, magnetic field data and satellite reception are always recorded during the flight. This data can be processed graphically using an analysis program, which reveals potential for optimization regarding the installation location or the configuration in larus_sensor_config.ini.

Two files with the same name but different file formats are created for each flight. The file name contains the date of the flight and the UTC time at which LARUS was switched on.



- The EEPROM file contains information about the firmware as well as all configuration values that are saved in the internal memory of the LARUS Sensor Unit. The file may be opened with a text editor and is helpful to check, whether firmware updates or changes via larus_sensor_config.ini were successful.



```
Fw = 0.5.1
Hw = 7233675f003b00195230501520383753
SensTilt_Roll = 1.999512e0
SensTilt_Pitch = -1.099731e1
SensTilt_Yaw = 0.0
Pitot_Offset = 0.0
Pitot_Span = 1.000000e0
QNH-delta = 0.0
Mag_X_Off = -1.605225e-1
Mag_X_Scale = 1.028931e0
Mag_Y_Off = -2.441406e-2
Mag_Y_Scale = 1.068512e0
Mag_Z_Off = 3.631592e-2
Mag_Z_Scale = 1.070068e0
Mag_Calib_Err = 2.032471e-4
Mag_Auto_Calib = 1.000000e0
Vario_TC = 1.998901e0
Vario_Int_TC = 2.999878e1
Wind_TC = 4.998779e0
Mean_Wind_TC = 2.999878e1
Horizon_active = 1.000000e0
GNSS_CONFIG = 1.000000e0
ANT_BASELEN = 1.000000e0
ANT_SLAVE_DOWN = 0.0
ANT_SLAVE_RIGHT = 0.0
```

- The f37 file contains all the data of the flight and may be opened with LARUS Analyzer.

6.2 Software Update

The LARUS team is continuously improving the software. New software versions are released here: https://github.com/larus-breeze/sw_sensor/releases

For updates until sw_sensor version 0.3.0 it was necessary to connect a computer to LARUS STM port via USB cable. Please see the manual “STM 32 Update” published on our webpage https://www.stefly.aero/product/larus_glider_sensor/

From firmware version 0.3.1 onwards it is possible to do the update without using any micro-controller programming hardware using a firmware image "larus_sensor_V2_image.bin" on the microSD. If you upgrade from version 0.5.0 or higher, use “larus_sensor_v1_v0-x-x-x.bin” instead, where x-x-x represents the number of the new firmware version.

6.3 Disable AHRS

For competition flying it is possible to manually disable AHRS.

Create a “larus_sensor_config.ini” with the line “Horizon_active = 0" and insert it in the LARUS.

```
larus_sensor_config.ini — Bearbeitet
[preferences]
Horizon_active = 0
```

The output of roll and pitch angle will be disabled. Changing the attitude of the aircraft will not be displayed, the artificial horizon is fixed. Simulate a roll movement or lift the tail of the glider to verify.

It is not possible to perform the update via RJ45 ports or WLAN / Bluetooth. For this reason, the competition organizer / contest official should seal the SD card slot as well as the two USB-C sockets of the LARUS housing during technical approval.

To activate the artificial horizon set "“Horizon_active = 1" in “larus_sensor_config.ini” and insert it in the LARUS.

7 Operation

7.1 Initial Operation and Function Test

For initial operation please follow these steps:

1. The LARUS housing is mounted in the aircraft as described in chapters 5.1 - 5.3
2. Connect the GNSS antenna(s) to the sensor unit. For LARUS DUAL-GNSS: connect the front antenna to GNSS1, the rear antenna to GNSS2.
3. Ensure that the WiFi / Bluetooth antenna is connected to the LARUS housing

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⚠ LARUS must not be connected to supply voltage without connected WiFi / Bluetooth antenna, even if Bluetooth is not needed

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4. Insert the micro SD card, that is part of the delivery.
5. Connect the sensor unit’s static and total pressure ports.
6. Power the sensor unit through one of the USB-ports, the CAN-port or the RS232-port. Power can be provided to the device through all four connectors. If the CAN- or RS232-port is used to provide power to the sensor unit, the voltage must be in the range of 8-28V. USB power is 5V.
7. Connect at least either

   - LARUS Vario Display on the CAN port
   - SteFly NAV/ OpenVario on the RS232 port
   - Android device like smartphone with OpenSoar / XCSoar via Bluetooth

8. a glider navigation system on which XCSoar / OpenSoar is running, like the OpenVario or your smartphone, to the sensor unit to display LARUS’ data. but OpenSoar can be downloaded here:

9. Establish the data connection between LARUS and the glide computer / smartphone via an RJ45 cable or Bluetooth
10. In the OpenSoar "Device" menu, the port needs to be set to "ttyS…" (choose the right port according to the physical connection); "38400 baud", driver "LARUS"; if the connection is established via Bluetooth, then the Bluetooth device "LARUS" and the driver "LARUS" must be selected
11. Now the flight information determined by LARUS should be shown in OpenSoar.
12. Jack up the aircraft so that it is approximately in normal flight attitude.
13. If LARUS DUAL-GNSS is installed:

    - Determine the exact x and y position of the front GNSS antenna in relation to the back antenna. Either use the "sensor.readings" file (this is the best solution, see chapter 5.4.2) or by measuring with a meter rule.
    - Enter the values for ANT_BASELEN and ANT_SLAVE_DOWN in "larus_sensor_config.ini" on the SD card (as described in chapter 5.4.1)
    - Restart LARUS

14. Activate the attitude indicator (artificial horizon) in one info box of OpenSoar or on a new page. If the displayed artificial horizon does not correspond to the real attitude of the aircraft, pitch and roll need to be adjusted with "larus_sensor_config.ini (as described in chapter 5.4.1). Therefore, eject the Micro-SD Card of LARUS, insert it in a computer and open / create the file "larus_sensor_config.ini". Change the numbers (unit is degrees) of the category [sensor-orientation]. E.g. if the artificial horizon should roll to the right, increase the value of SensTilt_Roll, if it should nick down then increase SensTilt_Pitch. Insert the SD card back into LARUS and wait some seconds, until the artificial horizon has changed.
15. Plausibility check before first flight:

    - display current sensor values using sensor.readings (see chapter 6.1.2). Check the number of satellites received. Check, if displayed "True Heading" corresponds to the aircraft orientation. Please note for Larus Dual-GNSS: the value for the "True Heading" is provided by the magnetic compass as long as there are not enough satellites available. Afterwards, the "True Heading" heading is calculated from the two GNSS positions of the antennas ("D-GNSS Heading").
    - carefully blow into the tube for total pressure from a little distance. The displayed wind and airspeed must increase.

16. Your LARUS is ready to fly and will continuously optimize its calibration during flight!

7.2 OpenSoar

OpenSoar is a fork of XCSoar made of Uwe Augustin and is therefore similar to use. It contains some features and drivers adapted to LARUS, as well as other benefits like SkySight integration.

OpenSoar is already installed on SteFly NAVs when they are delivered. But it is also possible to install it on other Android devices. The open source software and updates are available from https://opensoar.de/releases/

The following settings in OpenSoar are important:

- Config / Wind / Wind setting: "External wind" on, "ZigZag wind" off and "Circling wind" off
- It is recommended to set the connected IGC logger, e.g. Flarm, to device A and LARUS to device B, because then the IGC logger height is displayed in XCSoar/ OpenSoar. In competition flights, only the altitude recorded by the IGC logger is used for task evaluation.

This may deviate from the altitude determined by LARUS, since LARUS automatically adjusts the QNH during the flight.

- The acoustic vario output can be activated under Menu - Gauges – Audio Vario. The volume can also be adjusted in the same menu.

You will see two wind arrows on the screen. The blue wind arrow indicates the average wind (e.g. 30 sec), the green arrow indicates the real-time wind (e.g. 5 sec). The time constants can be adjusted by changing the values in larus_sensor_config.ini on the SD card.

When circling, the short-term wind is the mean of the last circle, while the long-term wind is the accumulated mean over the entire time of the last circling phase

LARUS provides AHRS data to XCSoar. LARUS AHRS is not certified and you should not fly with it in non-VFR conditions!

7.3 First Flight

Unrealistic wind and variometer values may be displayed during the first flight. The system requires at least 5 right and 5 left circles to calibrate itself. Calibration values are saved to the internal memory so that in the next flights you can rely on LARUS right from the start.

8 Maintenance

The whole system has no serviceable parts. To obtain warranty service, please SteFly directly.

Opening the housing of LARUS or the GNSS antennas or shortening the antenna cables will void the warranty!

9 Troubleshooting

Problem	Possible Causes	Solution
XCSoar / OpenSoar does not show the position of the aircraft, when the aircraft is on the ground	Larus is not connected to XCSoar / OpenSoar	Go to “Config” / “Devices” and check, if Larus is connected. Otherwise check port, baud rate and driver settings according to Initial Operation and Function Test
	Not enough time passed after Larus has booted up	Please wait. Depending on the number of received satellites it may take up to 5 minutes until the position has been determined.
	GNSS reception is poor and the status LED “GNSS” of the Larus box is not flashing blue	Move the aircraft away from surrounding buildings / trailers, allowing unobstructed view to GNSS satellites
XCSoar / OpenSoar does not show two wind arrows	Wrong configuration of OpenSoar	Config / Wind / Wind setting: “External wind” on, “ZigZag wind” off and “Circling wind” off
Displayed wind speed is too high during straight flight and correct during circling	For Larus Dual-GNSS: antenna 1 (front) and antenna 2 (rear) are interchanged	Trace the cables to find out which antenna is connected to which port. Alternatively, display current sensor values using sensor.readings (see chapter Display Current Sensor Values using sensor.readings) and check, that “D-GNSS Heading” is roughly the heading you expect. If it is 180° wrong, then the antennas at the Larus box must be interchanged.
	For Larus Essential: magnetic compass is disturbed by surrounding magnetic / electric fields	The LARUS sensor must be positioned as far away as possible from magnetic fields and bigger iron parts. Examples are loud speakers and electric wires for higher current flow.
Vario and wind is completely unrealistic (sudden changes between high sink rates and high climb rates / sudden changes of wind direction and speed)	Hoses for total pressure p_{tot} and static pressure p_{stat} are interchanged	Interchange the two hoses at the pressure connectors of the Larus box
	Number of satellites received is limited	Check the installation position of the GNSS antenna(s). Antennas must be installed horizontally in the fuselage, pointing to the sky with no metal parts / carbon fibre parts blocking the connection to the satellites. Also make sure there is a large lateral distance to metal parts like the cockpit ventilation flap, screws, canopy flasher.
	larus_sensor_config.ini file not configured	Check, if the config file was setup correctly. Turn on the artificial horizon

		in OpenSoar / XCSoar. Pay particular attention to the installation orientation of the Larus box and antennas
	For Larus Essential: function limited due to strong magnetic fields in the vicinity of the sensor box	Check the value MagAnomaly, when sensor.readings is active. Try to figure out, which ferromagnetic part / electric instrument causes the problem e.g. by switching off individual instruments. Mount the sensor far away from these disturbance sources.
No GNSS position and artificial horizon displayed, but if you click on “config”-> “devices” it says Larus GPS connected	The file “sensor.readings” is on the SD card	Rename the file to “sensor.readings_disabled”
Orientation of the aircraft symbol in OpenSoar / XCSoar does not match the true aircraft heading	larus_sensor_config.ini file not configured	Check, if the config file was setup correctly. Turn on the artificial horizon in OpenSoar / XCSoar. Pay particular attention to the installation orientation of the Larus box and antennas
Displayed wind direction constantly 0°	Wrong setting in OpenSoar / XCSoar	Check: Config / Wind / Wind setting: “External wind” on, “ZigZag wind” off and “Circling wind” off
	Software bug in sw_sensor version 0.3.1	Update sw_sensor version

10 Technical Data

Size	Unit	Value
mass LARUS Essential	g	300 (incl. GNSS antenna)
mass LARUS Dual-GNSS	g	630 g (incl. 2 GNSS antennas)
dimensions LARUS housing	mm (length x width x height)	145 mm x 79 mm x 28 mm (incl. antenna connectors and hose connectors)
input voltage	V DC	9 – 28 V DC (RJ45), 5 V DC (USB-C)
amperage LARUS Essential	mA (@ 13,0 V DC)	120
amperage LARUS Dual-GNSS	mA (@ 13,0 V DC)	150
interfaces		RS232 (x2) - RJ45 CAN (x1) - RJ45 Bluetooth – SMA reverse polarity GNSS-Antenna – SMA normal polarity microSD
pressure connectors	mm	6
operating temperature	°C	-30 to +60
operating rel. humidity	%	0 - 95
material housing		black anodized aluminium
cable length GNSS antennas	m	4,0 (LARUS Essential) 5,0 (LARUS Dual-GNSS)