LARUS Gliding Sensor Unit

Installation Manual and Operating Instructions

Version 1.31

November 2023

info@stefly.aero www.stefly.aero

Table of Contents

1 PRELIMINARY REMARKS 3

1.1 Important Notices 3
1.2 Limited Warranty 3
1.3 Conventions and Pictograph Definitions 3

2 SAFETY 4

2.1 Safety Precautions 4
2.2 Proper Use 4
2.3 Improper Use 4

3 LARUS QUICK START MANUAL 4

4 PRODUCT DESCRIPTION 5

4.1 Scope of Delivery 5
4.2 Design and Function 5
4.3 CAN and RS232 Ports 6
4.4 Status LEDs 7

5 INSTALLATION 7

5.1 Installation Location 7
5.2 Installation Orientation 8
5.3 Hardware Installation Process 9
5.4 SD Card 9
5.4.1 Configuration File "sensor_config.txt" 9
5.4.2 Display Current Sensor Values using sensor.readings 11
5.5 Initial Operation and Function Test 12

6 OPERATION 13

7 MAINTENANCE 14

8 TECHNICAL DATA 15

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.
- 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 a glider navigation system on which XCSoar / OpenSoar is running, like the OpenVario 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)
- brass mounting screws and nuts
- 2 fastening clamps
- 4 GB micro SD card with adapter
- RJ45 cable 1 m

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

4.2 Design and Function

LARUS is a sensor unit specially designed for gliders by the LARUS project team led by Dr. Klaus Schäfer, Horst Rupp and Max 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**.

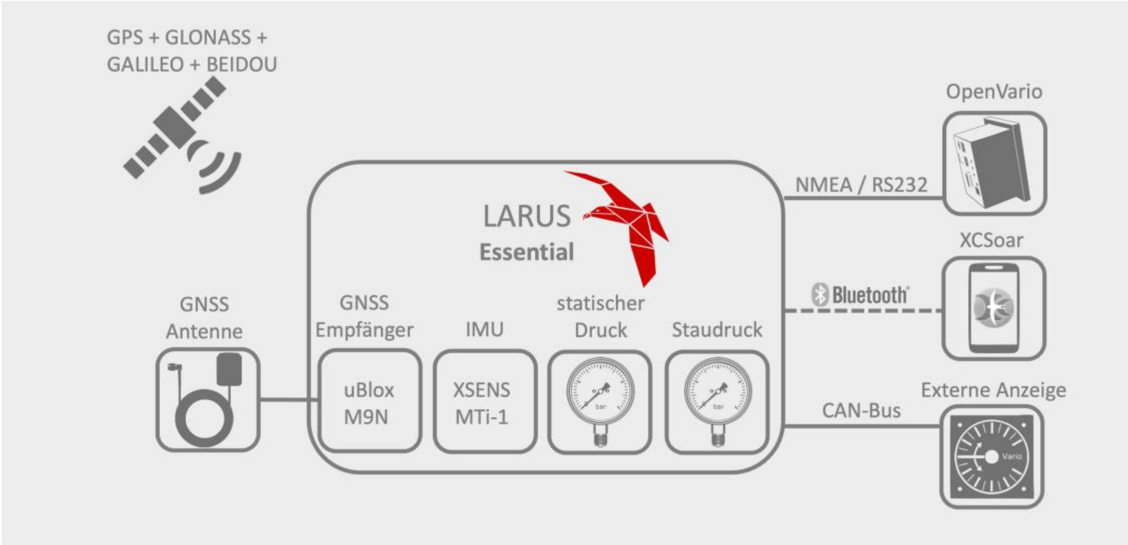
LARUS incorporates state of the art pressure sensors, an advanced IMU and GNSS receivers as well as sophisticated algorithms to gather precise flight information data, e.g.

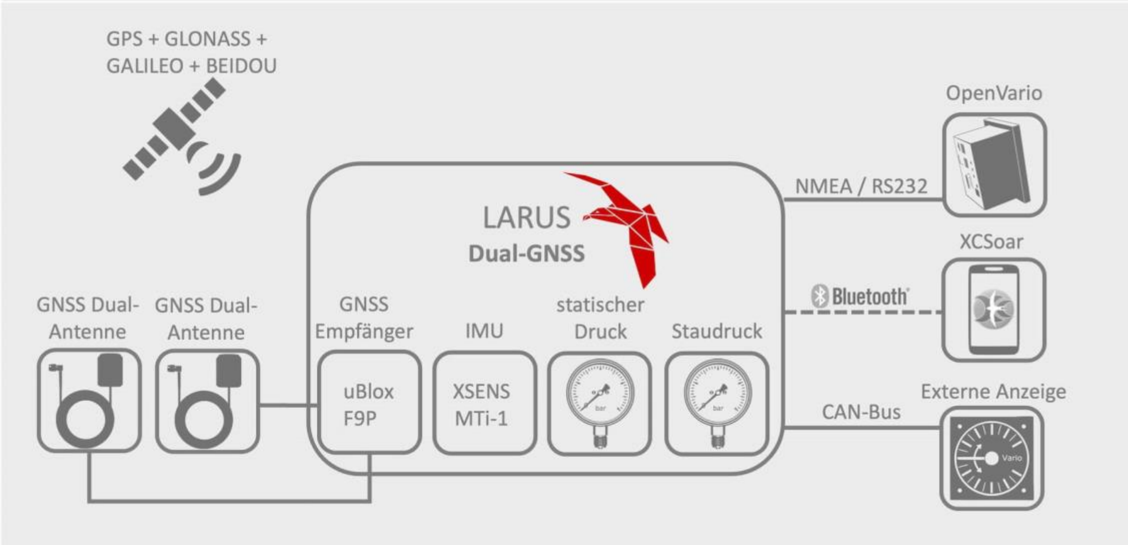
- energy-compensated climb or sink (variometer)
- horizontal wind speed as an instantaneous value (live / real-time wind) and a value averaged over an adjustable period (e.g. 30 s)
- attitude for display in an artificial horizon
- pressure altitude / flight level FL
- true airspeed (TAS)
- course over 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.

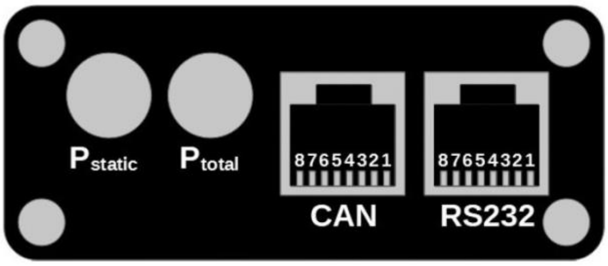
There are two different LARUS versions available, LARUS ESSENTIAL and LARUS DUAL-GNSS. In the Essential variant, LARUS is equipped with a precise GNSS receiver with an external active antenna. In the LARUS Dual-GNSS variant, on the other hand, a high-precision dual-band receiver is connected to two active, multi-frequency band antennas. Please note that the GNSS front antenna needs to be connected to the connector marked with GNSS1, the rear antenna to GNSS2.

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





4.3 CAN and RS232 Ports



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

4.4 Status LEDs

LARUS has four status LEDs:

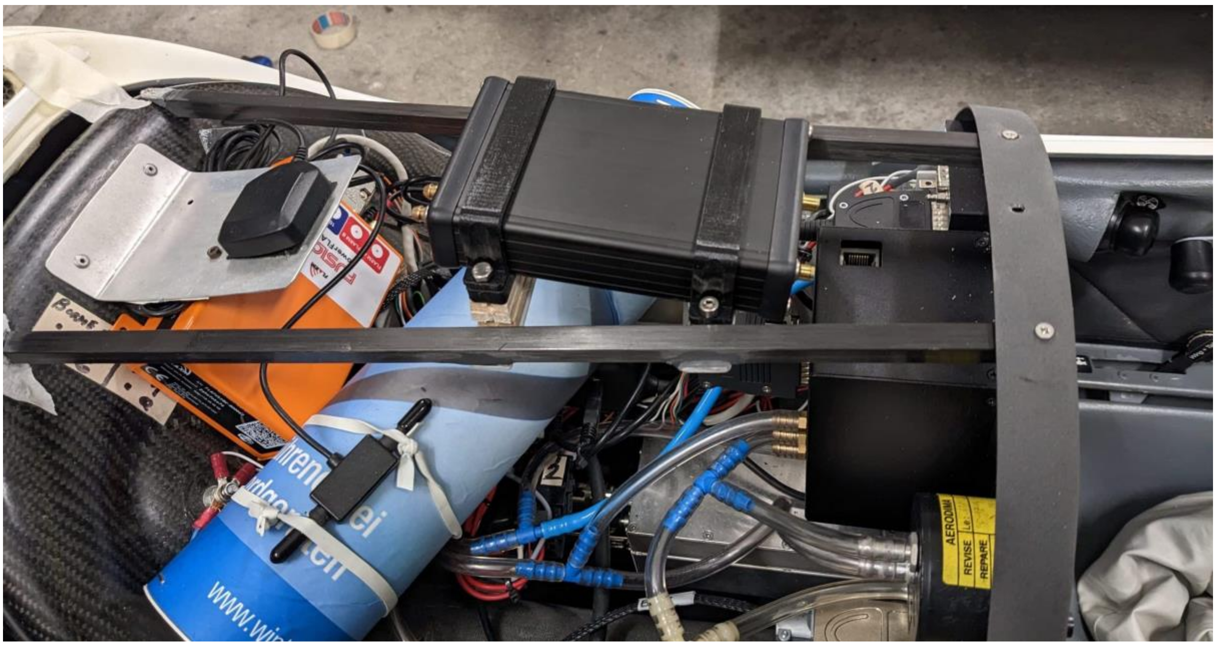
- LED SD: flashes in normal operation (SD card inserted)
- LED SYSTEM: flashes in normal operation
- LED GNSS: flashes in normal operation
- LED ERROR: off in normal operation

5 Installation

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. OpenVario) via USB, CAN or RS232, please make sure that the main instrument is protected by an external fuse.

5.1 Installation Location

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



For obtaining flight information data as precise as possible, please take account of the following advice:

- 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
- The LARUS sensor (especially LARUS Essential) must be positioned as far away as possible from magnetic fields and bigger iron parts
- 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 in the instrument panel or fuselage tube approx. in-flight-horizontal and above electrically conductive materials. CFRP is also one of the electrically conductive materials.
- For LARUS DUAL-GNSS: connect the front antenna to GNSS1, the rear antenna to GNSS2.

Explanations regarding LARUS Essential

A requirement for the high accuracy of LARUS Essential is that the disruptive influence of magnetic fields in the vicinity of the sensor unit is minimized. This is particularly high priority for LARUS Essential. In particular, the correct operation of the inertial measuring unit IMU, which among other things measures the magnetic induction, is severely impaired by magnets, changing magnetic fields or iron parts. We recommend keeping the LARUS sensor unit as far away as possible (at least 20 cm), especially from speakers and magnets (often contained in GPS / GNSS antennas, simply check with magnets). In addition, the fastening elements in the immediate vicinity of the sensor should be made of stainless steel, brass, plastic, aluminum or fiber composite materials and the usual 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.
The GNSS antenna, on the other hand, is not sensitive to magnetic fields.

Explanations regarding LARUS Dual-GNSS

With LARUS Dual-GNSS, on the other hand, it is important that the two GNSS receivers are at least 1.0 meters apart.
The master GNSS antenna should be mounted on the inside of the fuselage tube (luggage compartment / end of the canopy) approximately above the center of gravity of the aircraft. Because the shorter the distance between the antenna and the center of gravity, which is also the center of rotation of the aircraft around the pitch axis, the less the influence of pitching movements (forward or backward movement of the stick) on the measured altitude.
The second antenna (slave GNSS antenna), on the other hand, is mounted at the level of the instrument panel or in front of it in the nose of the aircraft.
For all GNSS antennas, it is important that the laminate above the antenna is made of GRP and not CFRP, otherwise the electrical conductivity of carbon fibers would cause the attenuation between the GNSS satellite and the receiver in the aircraft to be too great. In the case of aircraft with a CFRP fuselage, however, mounting the antennas in the front and rear area of the canopy can also be considered, provided the antennas are then at a sufficient distance (> 1,0 m) from one another.

5.2 Installation Orientation

The installation orientation of the LARUS box is possible in all directions and only needs to be adjusted in the configuration file "sensor_configuration.txt".

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. Ideally, the LARUS sensor unit is also mounted in such a way that it is roughly horizontal in normal flight.

5.3 Hardware Installation Process

The scope of delivery contains 2 3D-printed fastening clamps for the sensor unit, which may be used to fix the box to the fuselage in a position and orientation as described above.

If the clamps are not ideal in your installation situation, please make sure to use only fastening material made of nonferrous materials (GFRP, aluminium, plastic, brass or stainless steel (test the latter with a magnet prior usage).

For attaching the GNSS antennas we suggest using Velcro.

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

LARUS sensor unit does not have a total energy TE connector.

5.4 SD Card

The SD card is part of scope of delivery and is already configured for standard installations. Nevertheless, the following sections describe what to do if an adjustment of parameters or a reset to factory settings are required.

5.4.1 Configuration File “sensor_config.txt”

The Larus sensor is configured with this TXT file.

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 "sensor_config.txt" file from Larus GITHUB page https://github.com/larus-breeze/sw_sensor/tree/master/configuration
3. Replace the existing "sensor_config.txt" file on the SD card with the downloaded one
4. LARUS and the OpenVario / OpenSoar / XCSoar have to be switched off at this point at the latest
5. Insert the micro SD card into the SD-card slot of the LARUS housing, switch on LARUS and wait until both LARUS and the OpenVario / OpenSoar / XCSoar have booted up completely

Individual Adjustments of the Parameters

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

1. Remove the micro SD card from LARUS and connect it to a computer (via an SD card adapter)
2. Open the “sensor_config.txt“ file
3. Change the numerical values of individual parameters (see "Overview of Parameters" below)
4. Save and then close the file
5. LARUS and the OpenVario / OpenSoar / XCSoar have to be switched off at this point at the latest
6. Insert the micro SD card into the SD-card slot of the LARUS housing, switch on LARUS and wait until both LARUS and the OpenVario / OpenSoar / XCSoar have booted up completely

Before an SD card with changed parameters is inserted into the LARUS, LARUS and the OpenVario / OpenSoar / XCSoar must be switched off. Otherwise, the values stored in the file will not be fully adopted by the system.

Overview of Parameters:

The sensor_config.txt configuration file consists of any combination of configuration lines. Only the numbers after the equals 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 color):

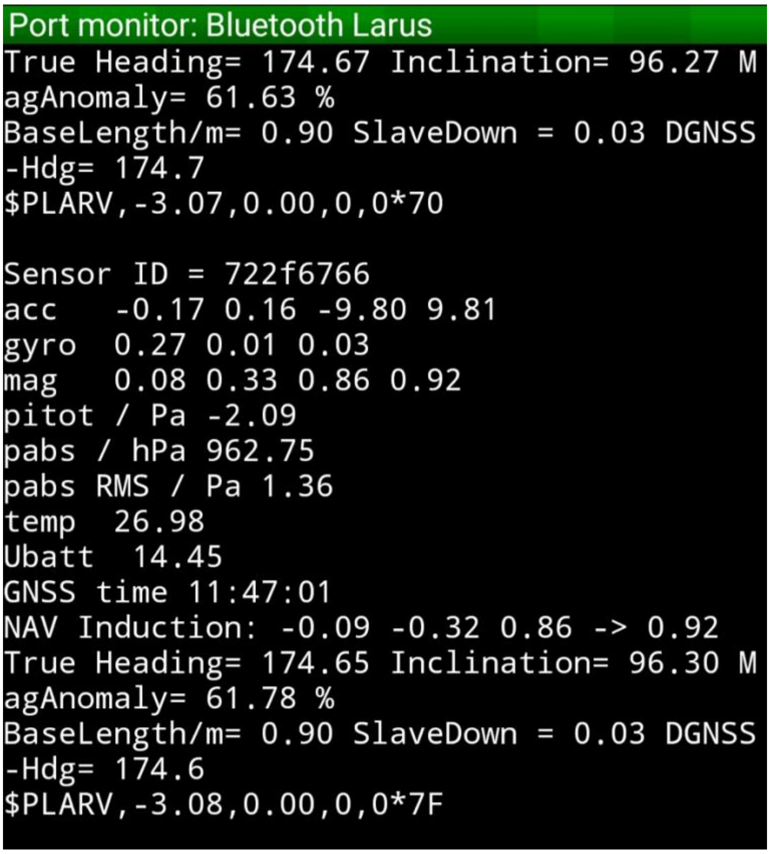
Configuration Line with Standard Value	**Description**
01 SensTilt_Roll = 0	Rotation of the sensor around the roll axis (sensor - longitudinal axis) in degrees
02 SensTilt_Nick = 0	Rotation of the sensor around the pitch axis in degrees
03 SensTilt_Yaw = 0	Rotation of the sensor around the vertical axis in degrees
04 Pitot_Offset = 0.0	Offset of the differential pressure sensor in Pa (can be determined with "sensor.readings" ...)
05 Pitot_Span = 1.0	Gradient correction of the differential pressure measurement (IAS → CAS)
06 QNH-delta = 0.0	Zero point correction of the absolute pressure measurement
17 Mag_Auto_Calib = 1	Turn on automatic compass calibration
20 Mag_Declination = 3.5	Magnetic declination in the area of operation
21 Mag_Inclination = 66	Magnetic inclination in the area of operation
22 Mag_Earth_Auto = 0	Optional: Automatic determination of inclination and declination from the measurements
30 Vario_TC = 2	Damping time constant of the instantaneous variometer in seconds
31 Vario_Int_TC = 30	Damping time constant of the variometer integrator in seconds

32 Wind_TC = 5	Short term damping time constant of the wind measurement in level flight
33 Mean_Wind_TC = 30	Long term damping time constant of the wind measurement in level flight
34 VrtclEnrgTuning = 1.0	Tuning constant for vertical kinetic energy compensation in the variometer speed compensation. A matter of taste. 1.0 or slightly smaller to a minimum of 0.7 is recommended.
40 GNSS_CONFIG = 1.0	1.0 for LARUS ESSENTIAL with uBlox M9N; 2.0 for LARUS DUAL_GNSS with uBlox F9P
41 ANT_BASELEN = 1.0	Distance of the D-GNSS antennas in flight direction in meters
42 ANT_SLAVE_DOWN = 0.0	Position of the front D-GNSS antenna relative to the main antenna downwards
43 ANT_SLAVE_RIGHT = 0.0	Position of the front D-GNSS antenna relative to the main antenna to the right

5.4.2 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. For example, the following values can be read out:

- the exact distances between the two DUAL GNSS antennas (this is relevant for the configuration file "sensor_config.txt")
- the current orientation of the LARUS sensor unit – useful for the calibration of the magnetic compass
- the estimated standard deviation of all magnet data from the current measurement (parameter 16) in order to assess how strong the effect of ferromagnetic fields due to the installation situation is



To display the values, proceed as follows:

1. Turn off LARUS and OpenVario / OpenSoar / XCSoar
2. Remove the micro SD card from the LARUS housing
3. Create an empty file named sensor.readings and save it on the micro SD card
4. Insert the micro SD card into the slot of the LARUS housing, switch on LARUS and wait until both LARUS and the OpenVario / OpenSoar / XCSoar have booted up completely
5. For the OpenVario, for example, click on "Monitor" under "NMEA Settings".
6. The current measured values are now displayed
7. After the relevant measured values have been read out:
    a. Turn off LARUS and OpenVario / OpenSoar / XCSoar
    b. Remove the micro SD card from the LARUS housing
    c. Delete the sensor.readings file from the SD card
    d. Insert the SD card into the slot in the LARUS housing, switch on LARUS and wait until both LARUS and the OpenVario / OpenSoar / XCSoar have booted up completely

---

The sensor.readings file must not be present on the SD card during normal use.

5.5 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

---

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

---

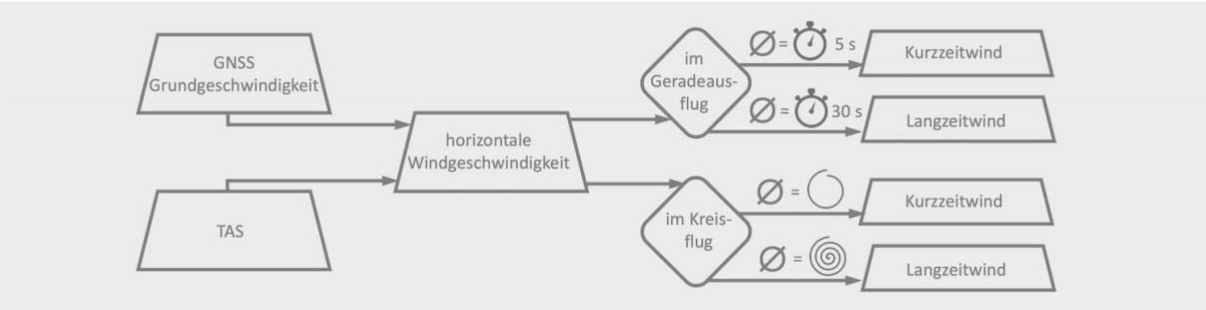
4. Insert the micro SD card, that is part of the delivery.
5. Connect the sensor unit's static and total pressure ports.
6. Power the sensor unit through one of the USB-ports, the CAN-port or the RS232-port. Power can be provided to the device through all four connectors. If the CAN- or RS232-port is used to provide power to the sensor unit, the voltage must be in the range of 8-28V. USB power is 5V.
7. Connect a glider navigation system on which XCSoar / OpenSoar is running, like the OpenVario or your smartphone, to the sensor unit to display LARUS' data. XCSoar has not yet implemented a LARUS driver, but OpenSoar can be downloaded here: https://opensoar.de/releases/
8. Establish the data connection between LARUS and the glide computer / smartphone via an RJ45 cable or Bluetooth
9. In the OpenSoar "Device" menu, the port needs to be set to ttySX; 38400 baud, LARUS; if the connection is established via Bluetooth, then the Bluetooth device "LARUS" and the driver "LARUS" have to be selected
10. Now the flight information determined by LARUS should be shown in OpenSoar.
11. Jack up the aircraft so that it is approximately in normal flight attitude.
12. If LARUS DUAL-GNSS is installed:

- Determine the exact distances between the two DUAL GNSS antennas either using the "sensor.readings" file (as described in chapter 5.4.2) or by measuring with a meter rule
- Enter the values in configuration lines 42 and 43 of the configuration file "sensor_config.txt" on the SD card (as described in chapter 5.4.1)
- Restart LARUS and OpenSoar

13. If the displayed artificial horizon does not correspond to the real attitude of the aircraft, the configuration lines 01 - 03 of the configuration file "sensor_config.txt" on the SD card need to be adjusted (as described in chapter 5.4.1). Afterwards LARUS and OpenSoar have to be restarted.
14. Your LARUS is ready to fly and will continuously optimize its calibration during flight!

6 Operation

OpenSoar is based on XCSoar and is therefore similar to use. However, for example two wind arrows are now displayed on the map. These differ as follows, whereby the time constants can be adjusted by adjusting the respective configuration line in the "sensor_config.txt" file as described in chapter 5.4.1:



- In straight flight, the time period for short-term wind is by default 5 s and for long-term wind 30 s (default setting; both times are configurable)
- 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

The following settings in OpenSoar important:

- Wind setting: external on, zigzag off and circling off! Otherwise the external wind is not used.
- 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.

The blue wind arrow indicates the average wind (e.g. 30 sec), the green arrow indicates the real-time wind (e.g. 5 sec).

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

7 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!

8 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 Essential housing	mm (length x width x height)	145 mm x 79 mm x 28 mm (incl. antenna connectors and hose connectors)
dimensions LARUS Dual-GNSS housing	mm (length x width x height)	145 mm x 79 mm x 43 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)