Sensoric Solutions

OMS Race
Manual



Description

The OMS Race is a robust and lightweight non-contact optical sensor integrated with inertial measurement technology. Building on the technology known from the OMS 7, it has been miniaturized to an unprecedented form, with a focus on weight savings.

The sensor incorporates the proven spatial filter principle, enhanced with an Inertial Measurement Unit (IMU) and a novel signal processing approach. The combination results in improved accuracy and lower noise levels compared to similar products in the market.

The OMS Race sensor is particularly well-suited for motorsport applications, including elite racing series.

Features

- Proven spatial filter principle
- Highest dynamics due to 1kHz update rate
- Parameterizable sensor fusion
- CAN / CAN FD output
- Diagnostic data via CAN
- Sensor / ECU exchangeable
- Long-life IR-LED lighting
- Easy handling
- Precise optics / optomechanics

Applications

- Innovative motorsport series
- Motor racing
- Longitudinal and lateral dynamics
- Tire and brake performance
- Indoor testing
- Land Survey
- ADAS testing
- Mobile machines
- Motorcycle
- Parking tests
- Industrial Applications
-

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Changes and errors excepted

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Disclaimer

This documentation has been prepared with great care and checked for conformity with the hardware and software described. Nevertheless, deviations and errors cannot be excluded, so that we do not assume any liability for complete conformity.
We reserve the right to make technical changes.

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All information and notes in this document have been compiled taking into account the applicable standards and regulations, the state of the art and our many years of knowledge and experience. The documentation has been checked for conformity with the hardware and software described. Nevertheless, deviations and errors cannot be excluded, so that we do not assume any liability for complete conformity. We reserve the right to make technical changes.
The manufacturer assumes no liability for damages due to:
- Non-observance of the manual
- non-intended use.

Calibration

Every measuring instrument must be calibrated at regular intervals. The standard norm in almost all branches of industry is annual calibration. Before delivery, our products are calibrated and the calibration certificates are delivered with the product or supplied on request.

Warranty

Each device undergoes various tests during production. Continuous tests as well as calibration ensure the quality of the product. Thus, possible damages or deviations can be detected and repaired before delivery.
Should a defect occur during operation, Sensoric Solutions grants a functional warranty of two years.
The prerequisite is that no changes have been made in / to the device.
Unauthorized intervention in the device voids all warranty claims.

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1. Overview

1.1 Sensor system

The sensor system combines non-contact measuring, optical sensor technology with inertial measurement technology and provides the user with a wide range of precise measured values for the applications in road tests and in motorsport applications.

The main components of the sensor system are the sensor and the ECU.

The sensor contains all sensory elements for the acquisition of the vehicle speed, as well as the vehicle movement. These signals are acquired, processed and transmitted to the ECU by means of a cable.
In the ECU, synchronization, coordinate transformation, signal filtering, sensor fusion and calculation of the measured variables take place. The sensor can be configured via an internal web server. It is not necessary to install an external program.

The measured variables are output via CAN / CAN FD or Ethernet stream.

For parameterization the sensor system can be connected to a PC via Ethernet interface. By means of a web browser the parameters of the sensor system can be read, changed, and graphically displayed.
The compact and lightweight sensor head allows the sensor to be mounted on the vehicle as well as on the wheel.



Figure 1: Sensor system OMS Race

1.2 Sensor

The sensor includes optics, illumination, and an Inertial Measurement Unit (IMU).

The optics are used to acquire raw signals for the measurement of longitudinal, lateral, and absolute velocity as well as for the tire drift or slip angle.

An IMU, consisting of 3 axes each of acceleration and rate of rotation, enables the vehicle motion to be recorded.

The connector supplies power to the sensor and transmits the individual raw signals from the above sensors to the ECU.

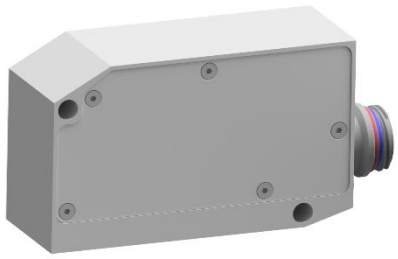

Figure 2: Sensor unit including optics and IMU

The optics and the illumination source should be protected from stone chips and dirt.

The sensor housing has a protection class of IP67 and is therefore also suitable for use in wet conditions. To achieve the protection class, the sensor cable must be connected.

On the sensor housing there are markings such as serial number and mounting direction.

1.3 ECU

The ECU receives the signals from the sensor, processes them and digitizes them. It calculates the individual measured variables and converts them to the point of interest (POI) or corrects a mounting angle caused by the attachment.

The measured values are output via a galvanically isolated CAN / CAN FD interface. Baud rate, format, identifier as well as the termination of the bus can be set. Due to its CAN / CAN FD interface, the sensor is compatible with all common data acquisition systems.



Figure 3: The Electronic Control Unit

In addition to Ethernet and CAN, a digital input and output are available via the Com port. The digital input/output can be configured for different purposes.

2 Feature

2.1 Sensor fusion

OMS Race can combine measured values from an optical method and from an inertial measurement unit (IMU). This sensor fusion can be switched off in the settings.

Note: The sensor fusion assumes that the optical method and the IMU measure the same movement. If the sensor is mounted on a moving vehicle, this is the case. However, if the sensor is fixed above a moving surface, the optical method will detect changes in speed, but the IMU will not. This leads to incorrect behavior of the algorithm. If such a measurement is to be carried out, the fusion algorithm should be switched off.

2.2 Direct measuring principle

The acquisition of the velocities and slip angle of the vehicle is carried out by means of an optical system, the spatial frequency filter method. This method enables non-contact and slip-free measurement of the velocities and the slip angle. It is characterized by its high accuracy as well as its long-term stability.

2.3 Measurement of rotation rates and accelerations

An IMU integrated in the sensor enables the measurement of the rotation rates and accelerations in x, y, z direction at the same time as the measurement of the velocities / slip angles.

All sensors are mechanically aligned to each other. The outer edges and the reference point of the sensor serve as reference. This simplifies the setup of the sensor on the vehicle.

2.4 Simple setup

The sensor is attached to the vehicle or tire by means of a bracket. Only the mounting height and the alignment of the sensor type (longitudinal/transverse) to the road must be considered.
The sensor coordinate system is aligned with the coordinate system of the car once by driving straight ahead (recommended: 100m at 50km/h). The measured value of the slip angle represents the angular offset between sensor and car. This offset can now be corrected in the sensor or in the data acquisition. The adjustment wizard supports the determination of the offset.

2.5 CAN-Interface

The ECU has a galvanically insulated CAN interface. Therefore, these is independent of the supply voltage and other GND connections. This increases the interference immunity of the CAN transmission.

2.6 CAN-Termination

The ECU contain 120 Ohm resistor for bus termination. These can be optionally switched on and off in the CAN area of the sensor parameterization. There is also the option of having the CAN terminating resistor permanently fitted or removed at the factory. The variable switching function is then removed.

3 Scope of delivery

The components shown below are part of the scope of delivery:



Figure 4: Scope of delivery

Sensor	
Sensor cable 2m	MT0000372
Power cable	MT0000374
CAN Cable	MT0000376
ETH Cable	MT0000377

Transport Case	
USB Stick	MT0000212
Set of screws	
Screwdriver	MT0000214

4 Startup procedure

4.1 Installation of Side Mount M2

The M2 magnetic side holder is suitable for use on ferromagnetic surfaces such as iron or steel. The surfaces of the vehicle and the magnets must be free of contamination, otherwise adhesion will be impaired.

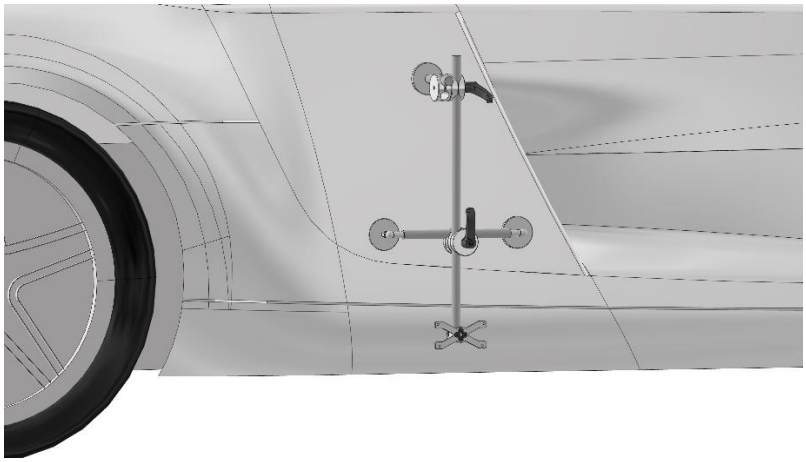

Figure 5: Mounting Side Mount M2

The holder can be easily aligned on the vehicle using the adjustment elements. Care must be taken to ensure that all screw connections are firmly tightened.

4.2 Installation of Side Mount S2

The S2 side holder with its suction cups is suitable for use on all smooth surfaces. The surfaces of the vehicle and the suction cups must be free of contamination, otherwise adhesion will be impaired. The connection to the surface is made by flipping the toggle lever on the suction cup.

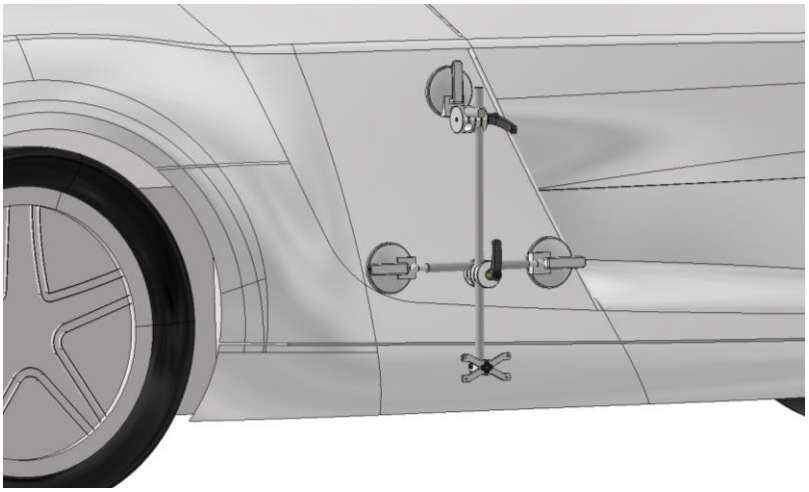

Figure 6: Mounting Side Mount S2

The holder can be easily aligned on the vehicle via the adjustment elements. Care must be taken to ensure that all screw connections are tight and that the suction cups adhere well to the surface.

4.3 Installation of Towing Lug Mount T2

The towing lug holder T2 allows easy mounting on the chassis of the vehicle. For this purpose, the original towing lug is first attached to the vehicle according to the manufacturer's specifications.

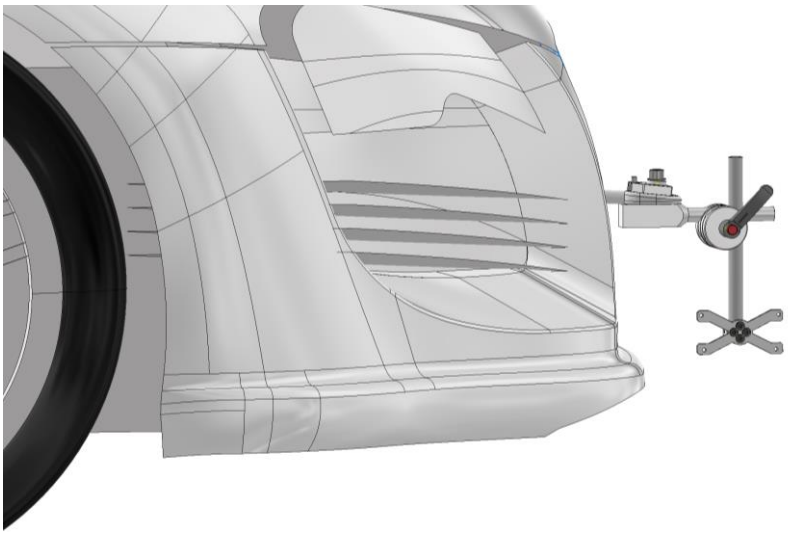

Figure 7: Mounting of Towing Lug Mount T2

The lower part of the towing lug holder T1 uses the breakout of the towing lug for attachment.

First, the crossbar, washer and screw are removed. The holder grips through the breakout. Now the crossbar, washer and nut are put back on and the screw is tightened.

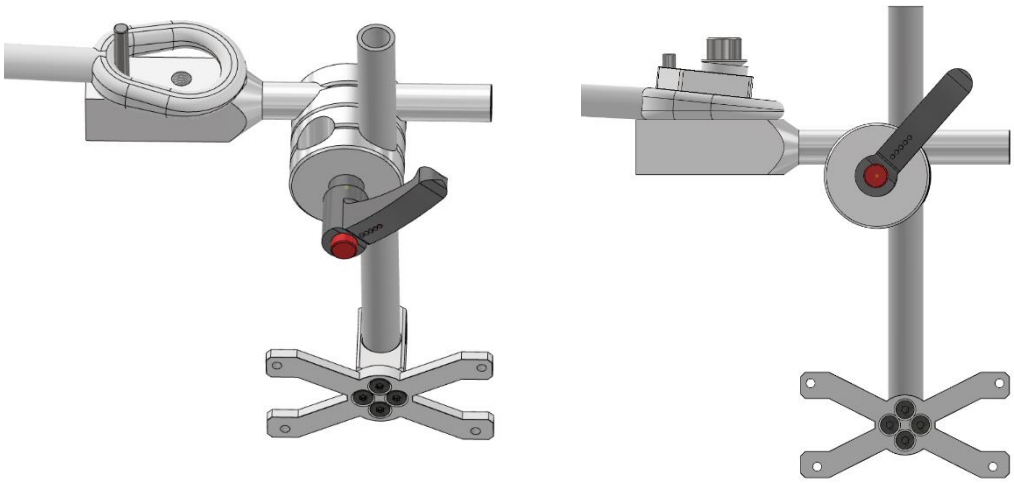

Figure 8: Details of Towing Lug Mount T2

4.4 Mounting Sensor

The sensor is mounted on the bracket with two M5 screws including washers.
The bracket allows different mounting directions of the sensor.



Figure 9: Mounting of sensor on bracket

Ensure that the screws are firmly seated.

4.5 Working range

The OMS Race has a working range of 180 mm +/- 60 mm. Within this working range, the values shown in the specifications are adhered to.

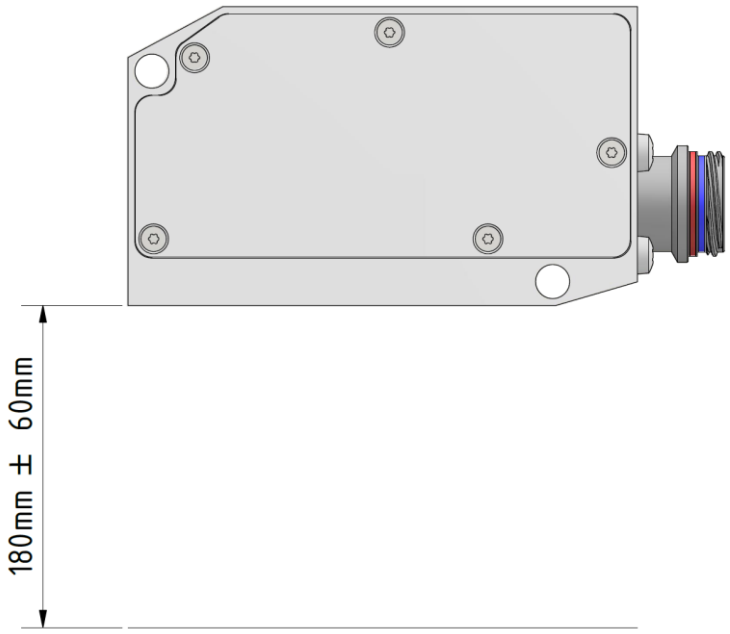

Figure 10: Measurement spot of working range

When selecting the mounting height, the possible change in distance between the vehicle and the road surface during driving must be taken into account.

4.6 Sensor orientation

There is an arrow next to the QR code on the nameplate. The arrow indicates the forward direction of the sensor.

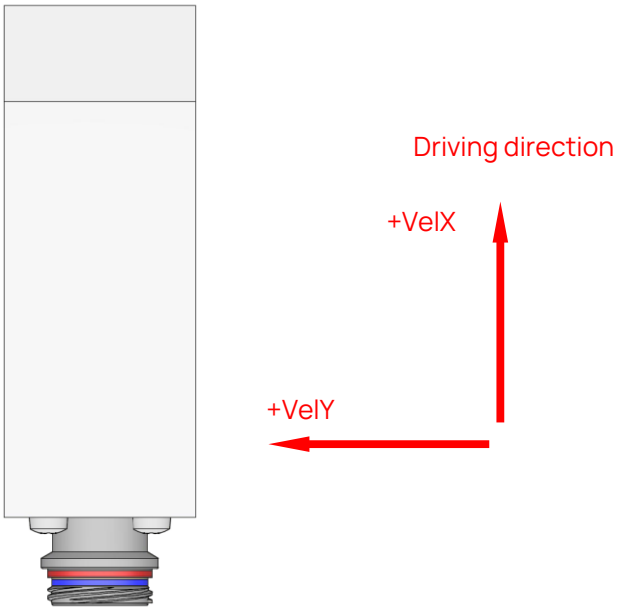

Figure 11: Driving direction of the Sensor

4.7 Reference point

All data calculated in the sensor refers to a defined point on the sensor:
the reference point.

This reference point is required for a correct calculation of the Point of Interest (POI) signals.
The mounting position of the sensor can be entered via the configuration page for conversion to the POI (see section 4.10.6).



Figure 12: Position of reference point

The reference point is in the center of the optics and is 14 mm from each of the outer edges of the housing.

4.8 Establishing the cable connections

For commissioning, the connection between sensor and ECU must be established first. This is followed by the connections for Ethernet or CAN interface.



Figure 13: Electrical connection

Finally, the power cable is connected between the ECU and the power supply. As soon as the sensor is supplied with voltage via the power cable, the sensor starts and is ready for measurement after a few seconds.

4.9 Establishing an Ethernet connection

To be able to view or change the sensor settings, an Ethernet connection must be established between the ECU and the PC.

The IP address at delivery is: 192.168.1.10

If necessary, other network connections must be deactivated.

4.9.1 Setting a fixed IP address on a Windows® based PC

In the Windows user interface you reach the corresponding settings via Start › Settings › Network and Internet › Ethernet.

The selection of the Ethernet interface to which the ECU is to be connected is necessary.

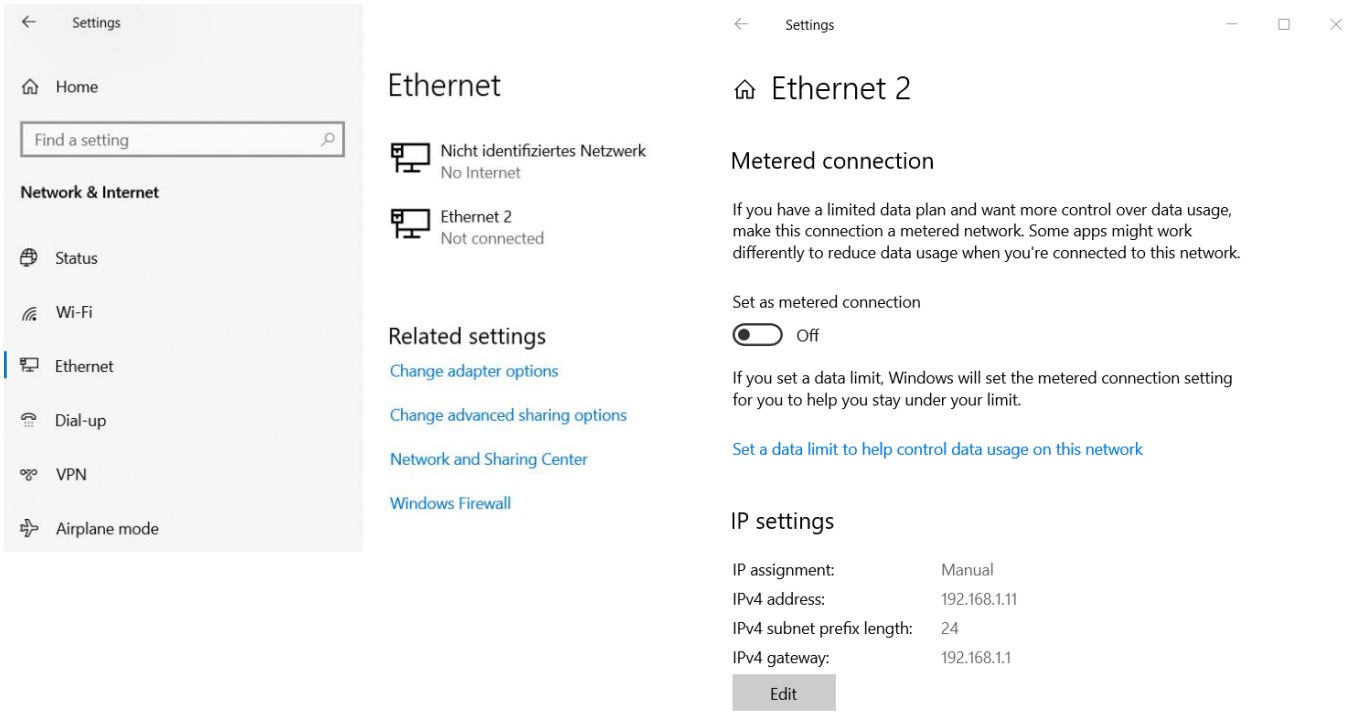

Figure 14: Network settings

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alternative:

Change adapter options, select Ethernet interface, and set the network parameters in the subitem "Internet protocol TCP / IPv4".

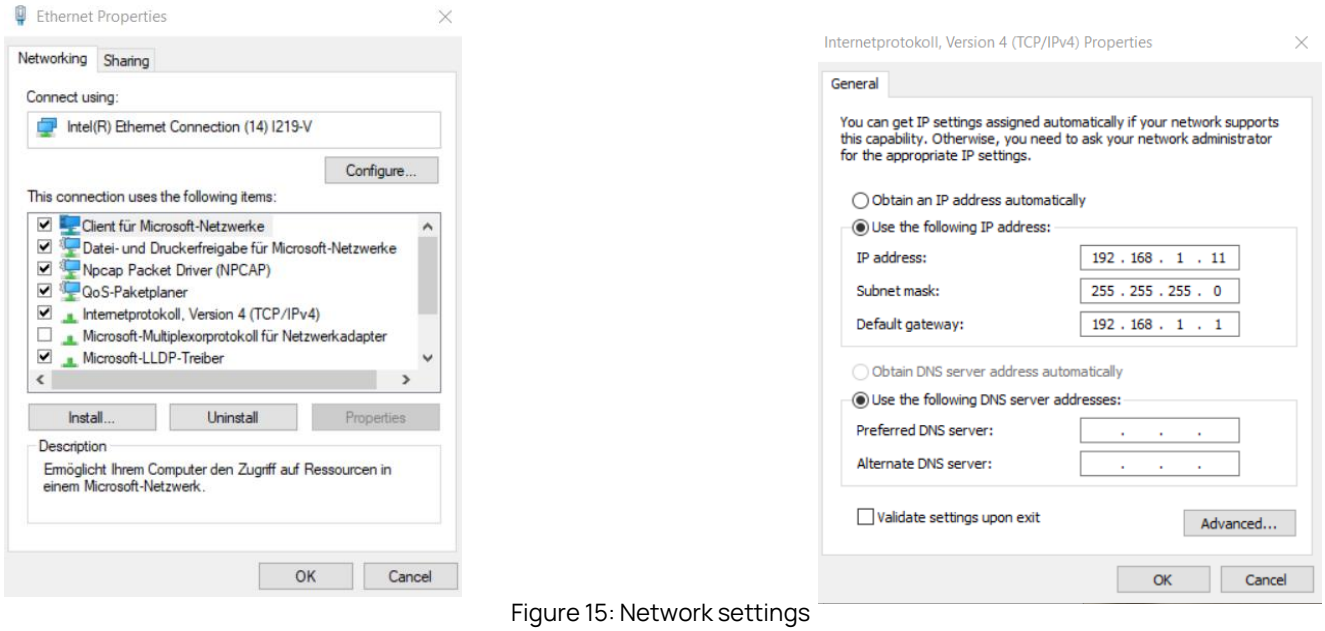


Figure 15: Network settings

The IPv4 connection must be configured manually.

The following settings should be entered:

IP-Assignment:	Manual	
IPv4-Address:	192.168.1.11	(the last digits can be varied from 0 to 255, must be different from the IP address of the ECU)
IPv4-Subnet prefix length:	24	(alternative IPv4-Subnetmask: 255.255.255.0)
IPv4-Gateway:	192.168.1.1	

4.9.2 Call up the sensor parameters via Internet browser

The browsers commonly used on the market can be used as browsers.

Open your browser and type the IP address of the sensor: **192.168.1.10** in the address bar and confirm the entry.



Figure 16: IP input in Internet browser

The overview page of the sensor now opens in the browser.

4.9.3 Resetting the IP address

The IP address of the system can be reset to the delivery status. To do this, please proceed as follows:

a) Sensor system must be switched off and the sensor must not be connected.
b) The DIG_IN and DIG_OUT pins from COM Port must be connected.
c) Connect the sensor system to a suitable power supply
d) Wait approx. 20 seconds and disconnect the sensor system from the power supply again
e) Remove the connection between DIG_IN and DIG_OUT
f) At the next start, the sensor system will have the delivery address 192.168.1.10 again

4.10 Configuration of the sensor parameters

4.10.1 Overview page

The header of the overview page shows the sensor type, the serial numbers of the ECU and the sensor (in brackets), and the firmware version. In the work area, a menu appears with sub-items under which information is displayed and settings can be made. The areas open by mouse click on the respective subitem.

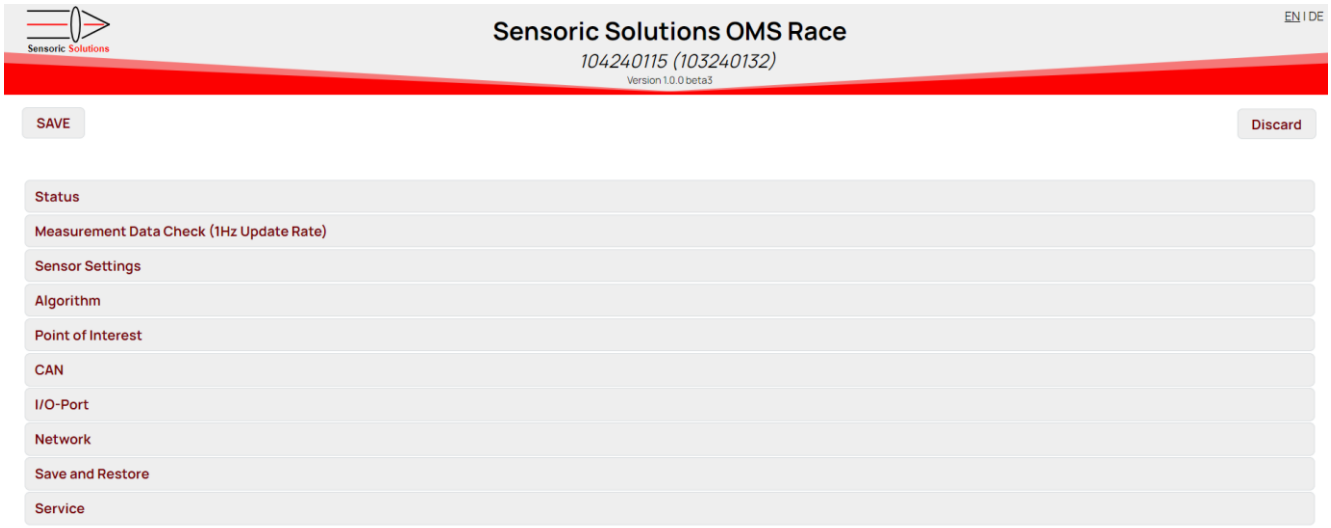


Figure 17: Overview page

The language setting is stored in the ECU. The button in the upper right corner can be used to switch manually between German (DE) and English (EN).

Changes that have not yet been saved can be discarded at any time using the "Discard" button. To save changes, the "Save" button must be pressed. There is no automatic saving of the changed parameters.

4.10.2 Status area

In the status area details about the sensor are displayed:

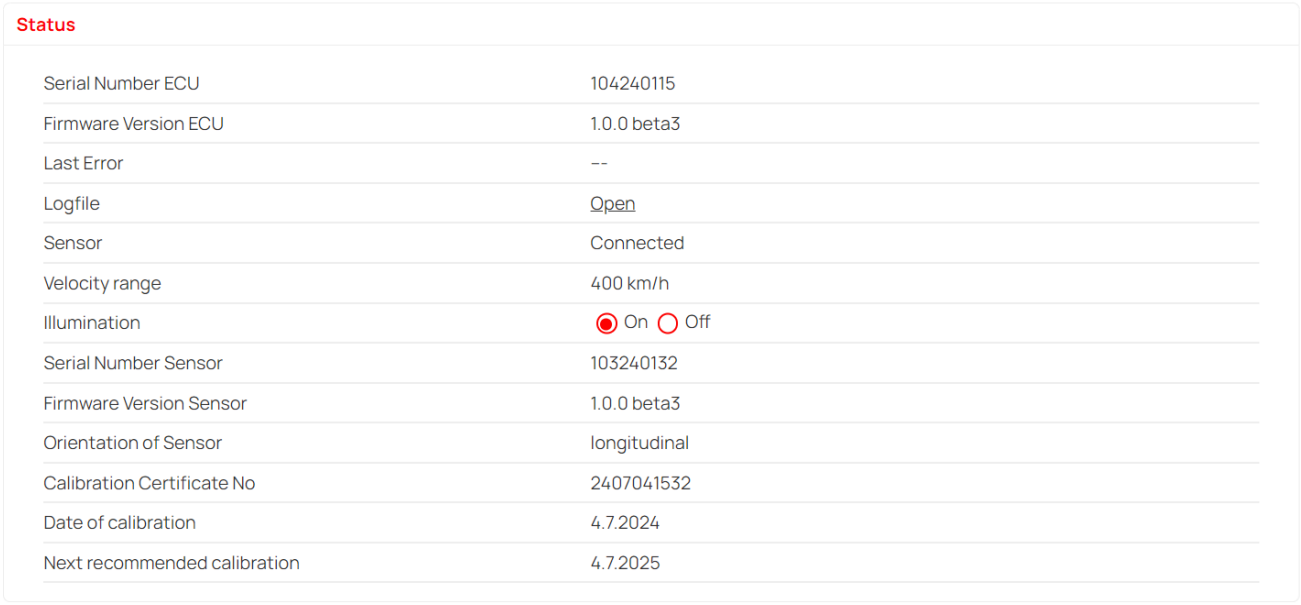


Figure 18: Status Area

Information about the sensor:
Among other things, the serial number, firmware version, different status information and possible errors are shown here.

Log file:
In the log file, relevant data of the sensor is recorded during operation and are thus available for analysis in the event of an error.

Illumination:
The illumination can be switched on or off manually. This setting is not saved. After a restart, the illumination is always on.

Calibration information:
The calibration number and date of the current calibration certificate can be seen. In addition, the date of the next recommended calibration is displayed.

4.10.3 Measurement data control area

In the measurement data control area, sensor data is displayed live. Using characteristic values, the correct functioning of the sensor can be quickly checked here. The output rate is 1Hz.

The measurement time and the distance or only the distance can be reset to zero with the buttons at the end of the “Sample Time” and “Distance DistA” lines.

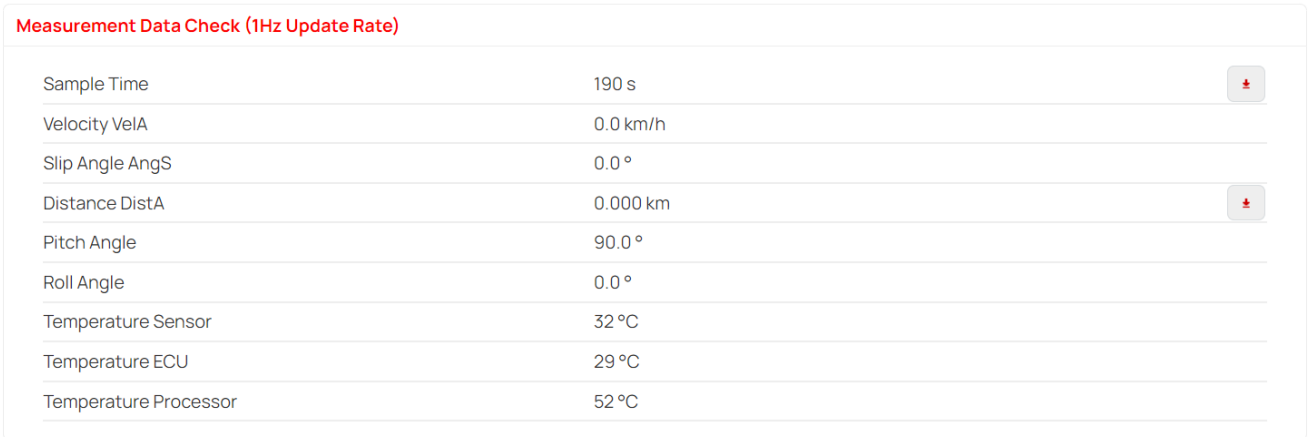


Figure 19: Measurement data control area

4.10.4 Sensor settings area

Various parameters can be set in this area. Depending on the application of the sensor, settings can be optimized.

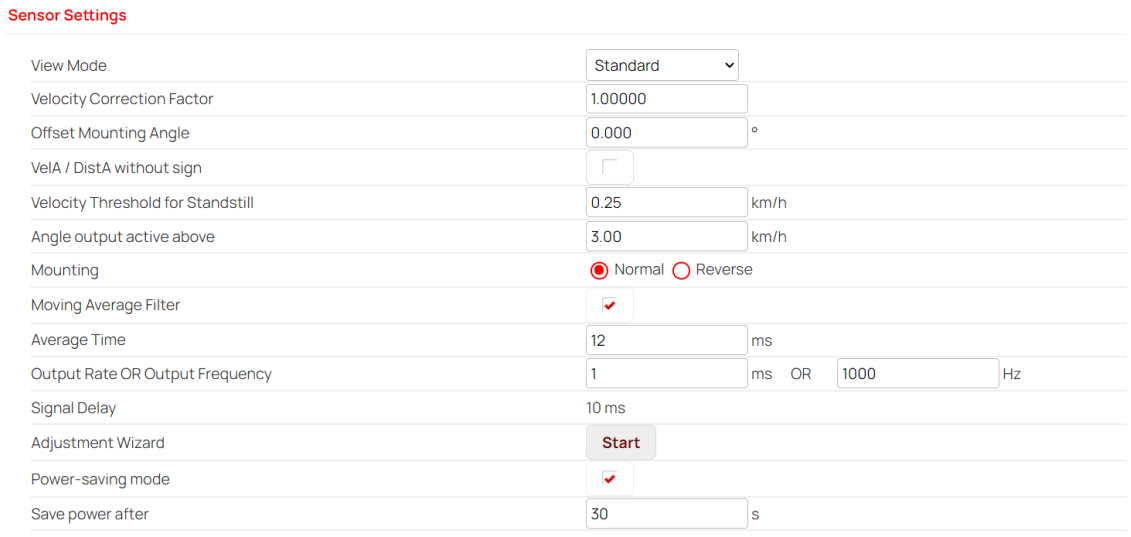


Figure 20: Sensor settings area “standard view”

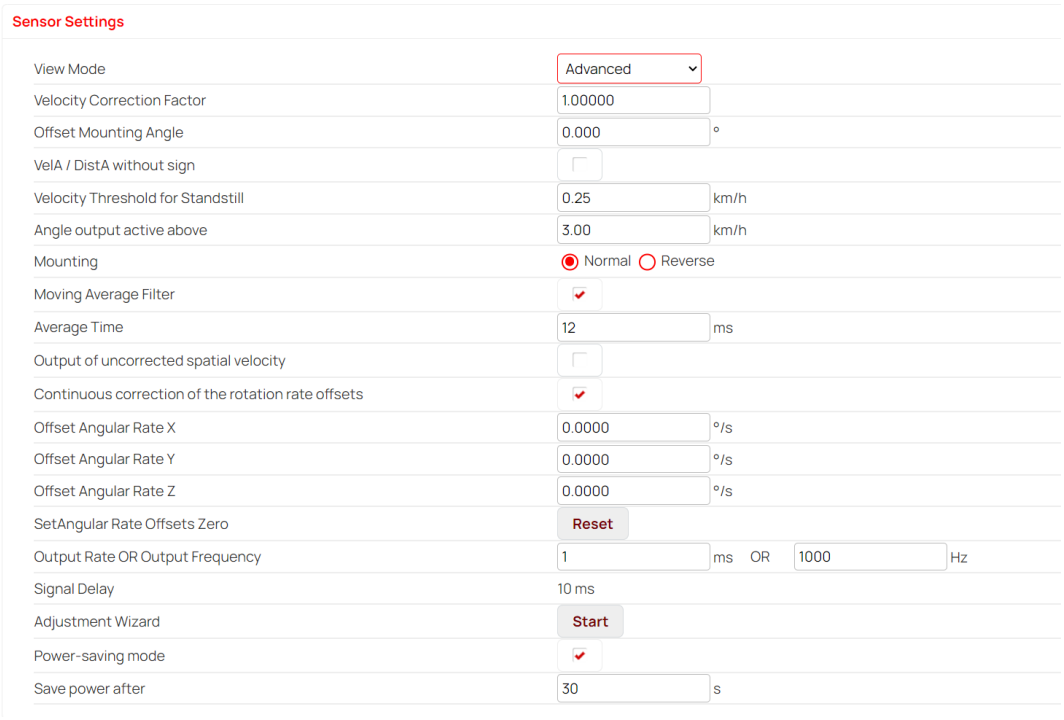


Figure 21: Sensor settings area “advanced view”

View Mode:
All important settings are available in the standard view. Some special settings are only visible in the advanced view. Changes to the view mode are applied immediately without saving.

Velocity correction factor:
If there is a deviation in speed, a correction factor can be entered at this point.

Mounting angle offset:
This parameter can be used to correct the mounting angle offset. In doing so, the coordinate system of the sensor is rotated around the Z-axis of the sensor by the entered value. The adjustment wizard can support the determination of the offset (see section 4.11).

Velocity threshold for standstill:
Speeds smaller than the set threshold are ignored. In this case, the output of all velocities as well as the slip angle is set to 0.

Angle output active above:
No angle signal is output below the set threshold.

Mounting:
If the sensor is mounted rotated 180° to the direction of travel (sensor travels backwards), the user specifies this by selecting an option. The orientation of the sensor coordinate system is then adjusted accordingly.

Moving average filter:
All signals (except status signals) are filtered with the specified averaging time. This results in a delayed output of the measured values. The delay can be read under the item "Signal delay".

Output of uncorrected spatial velocity (advanced view only):
The spatial filter velocities (signals ending with "Sp") are normally converted to the IMU position. However, if the corresponding option is activated, no conversion takes place and the uncorrected spatial filter velocities are output. In such cases, there may be differences between the spatial filter velocities and the calculated velocities.

Continuous correction of the angular rate offset (advanced view only):
If the function is activated, any offsets of the angular rate signals are continuously adjusted during standstill. This function is activated by default and it is recommended that you leave it activated.

Offsets Angular Rate X/Y/Z (advanced view only):
Offsets on the angular rates lead to deviations in the results. The sensor system offers continuous correction of the angular rate offsets in order to correct these deviations automatically. Please note, however, that the system can only correct the offsets at standstill and requires some time to do so. The angular rate offsets can be used to correct constant offsets and minimize the time required for an optimal measurement. It is recommended that the angular rate offsets are only determined using the calibration wizard (see section 4.11.2). If necessary, the offsets can be reset by clicking on the "Reset" button in the "Set Angular Rate Offsets Zero" line.

Output rate:
The output rate determines the interval at which the measured variables are output. The smallest interval is 1 ms and can be changed in multiples of 1 ms. Starting from an interval ≥ 2 ms, an averaging of the measured quantities takes place (anti-aliasing).

Signal delay:
Due to the internal signal calculation as well as the set average filter / output rate, there is a delay in the output of the signals. The delay time is calculated and displayed here.

Adjustment wizard:
See section 4.11 Adjustment Wizard

Power save mode:
If no velocity is detected for an adjustable period of time, the illumination current is turned off. When an acceleration is detected, the illumination is automatically switched on again. This function prevents excessive warming up of the sensor during longer standstills. The first approach movement can be displayed incorrectly for a short period of time.

4.10.5 Algorithm area

The behavior of the algorithm can be adjusted in this area.

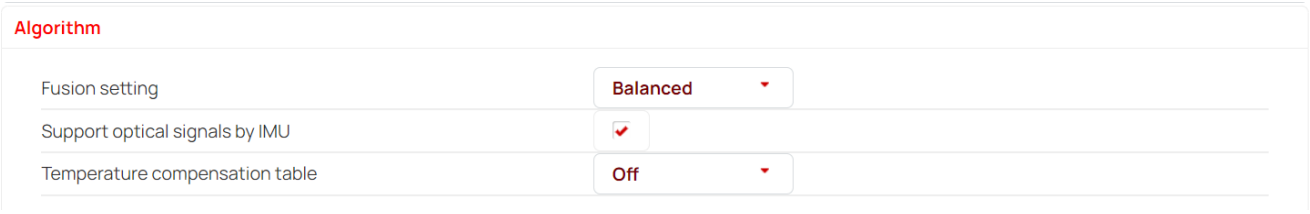


Figure 22:Algorithm area

Setting for the fusion:
This setting influences the behavior of the fusion algorithm. With the No fusion setting, no IMU data is used to calculate the speed and slip angle. With the Optical Prio setting, the optical data is given more priority than with the Balanced setting. As a result, the signals are rougher.

Supports optical signals from IMU:
If this option is activated, the IMU data can be used in critical situations to internally support the speed obtained from the optical data.

Approach with IMU support (only if the fusion setting is set to no fusion):
Uses the speed determined by the IMU data before the optical data provides a speed. As soon as a speed is available from the optical data, only this speed is used.

Temperature compensation table:
A compensation table with 2 to 15 steps can be activated to compensate for temperature deviations. The correction is always entered as a temperature and factor pair. Interpolation takes place between the individual values.

4.10.6 Settings of Point of Interest

The Point of Interest (POI) enables the conversion of the sensor signals to any point on the vehicle. For this purpose, the distances between the reference point of the sensor and the point of interest must be determined and entered. In addition, the relative position of the sensor to the POI (in front of/behind, left/right, above/below) must be correctly selected.

Both the uncalculated sensor signals and the point of interest signals are output on the CAN bus.

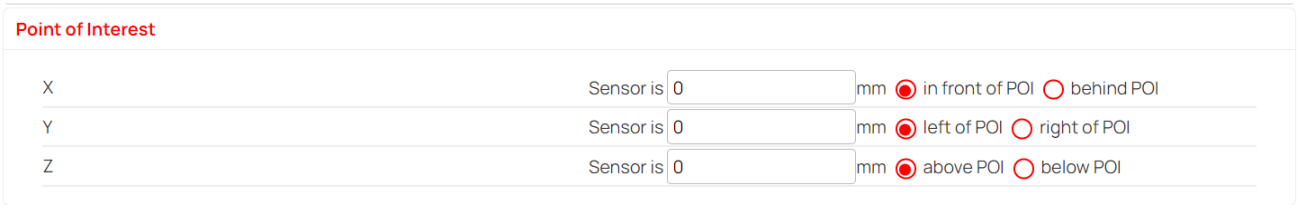


Figure 23: Settings of Point of Interest

4.10.7 CAN area

In this area, the CAN bus can be parameterized for operation on the CAN interface. You can switch between CAN (classic) and CAN FD. Settings such as identifier, baud rate, data format, CAN termination, etc. can be changed.

Individual data frames can be switched on or off.. An overview of the signal contents of the individual frames is shown in the appendix.

The identifiers of the individual frames are assigned consecutively from the base address. It is possible to set the identifier in standard or extended format. This setting is valid for all frames.

The command frame enables the control of sensor functions. By sending a corresponding CAN message, individual functions of the sensor can be triggered. Details can be taken from the appendix.

The approximate bus load is displayed for each individual CAN node. Thus, a potential overload can already be detected during parameterization.

The CAN description file (DBC file) can be downloaded via the CAN DBC button.

With classic CAN, the InfoFrame is only sent at 1Hz as it does not contain any time-critical information. With the StaticInfoFrame, you can choose between 1Hz output and output on change / on request. In this case, the frame is only sent when the data changes or when it is requested via the CAN command frame.

Important:

The CAN BUS of the OMS Race requires an acknowledge for communication. Please deactivate the "Listen Only Mode" in your data acquisition.

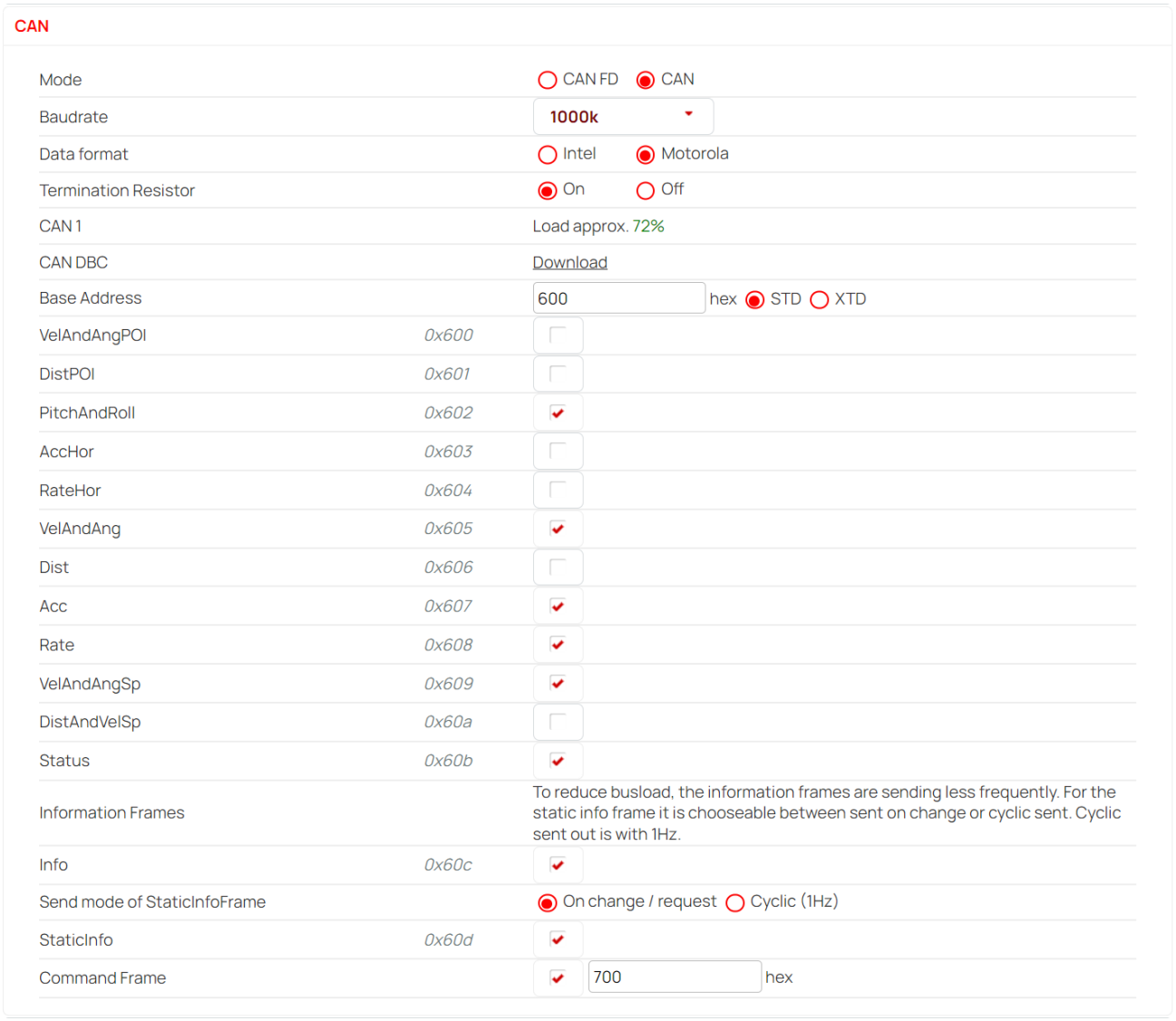


Figure 24: CAN parameter (CAN classic)

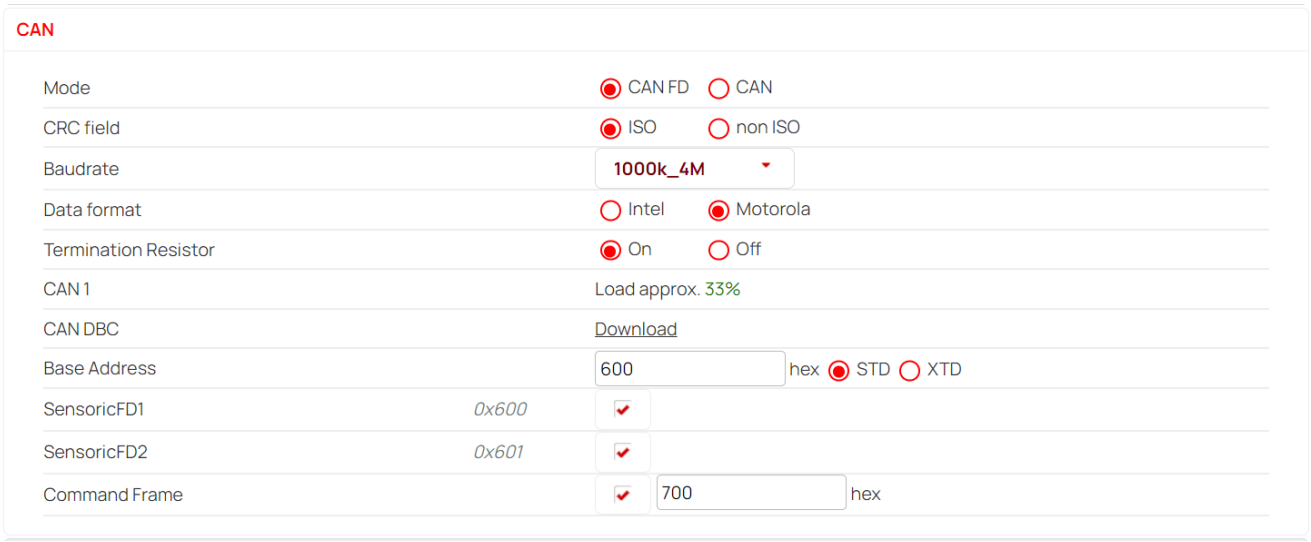


Figure 25: CAN Parameter (CAN FD)

4.10.8 IO-Port Area

The functionality of the IO port can be set in this area.

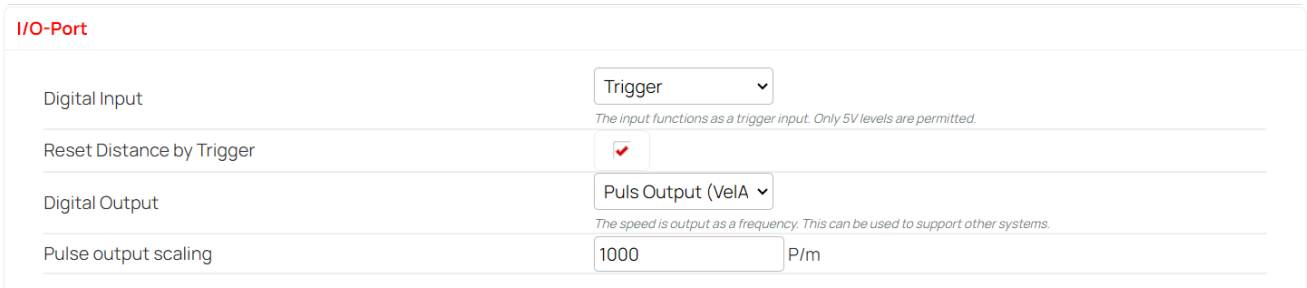


Figure 26: Overview IO-Port

Digital input:

External clock:

An external 1 kHz signal can be read in for synchronization. The time base of the sensor needs approx. 2 s for synchronization. It is possible to synchronize to the rising, falling or both edges.

PPS Synchronization:

Synchronization is to an external clock at one pulse per second (1 Hz). A PPS signal is usually provided by a GNSS receiver.

Trigger:

The digital input can be used as a trigger for various tasks. It is possible to reset the distance signal with the trigger. Please note that the digital input is a TTL input with max. 5V levels.

Digital output:

Clock output:

The sampling generated by the sensor is output via the clock signal. Sampling takes place on rising edge.

Pulse output:

When the pulse output is activated, the pulses are output to the DIG_OUT equivalent to a wheel encoder without a sign. The number of pulses per meter can be set.

4.10.9 Network area

In this area you can set the parameters of the network connection.

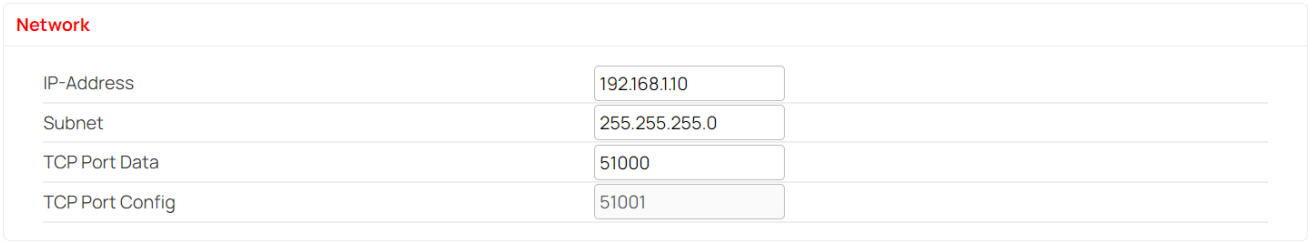


Figure 27: Overview network parameter

IP address:
The IP address of the sensor can be set manually (factory default 192.168.1.10).

Subnet:
This input can be used to adjust the segmentation of the network range (default: 255.255.255.0).

TCP Port Data:
This port is used for data output via TCP/IP stream (factory setting 51000).

TCP Port Config:
For configuration via TCP/IP this port is used (factory setting 51001).

4.10.10 Save and restore area

Parameters can be saved and restored in the Save and restore area. Parameters can be saved and loaded as a file or stored as parameter sets on the sensor system.

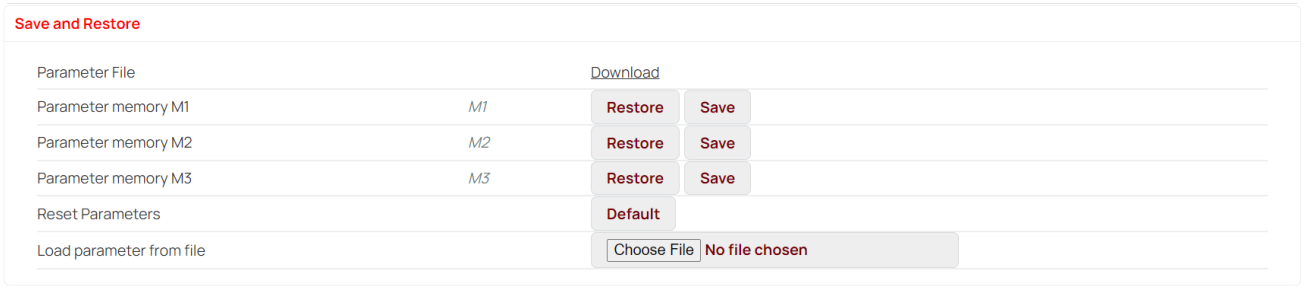


Figure 28: Overview save and restore area

Parameter file:
All settings are stored in the parameter file. The transmission of this file provides the service with basic information about the sensor and simplifies the processing of the service procedure. In addition, the settings in the parameter file can be reloaded on this or another sensor system of the same type.

Parameter memory M1..M3:
Three memory locations for parameter sets are available on the sensor system. To save the current settings in a parameter memory location, the corresponding “Save” button must be pressed. In the dialog that appears, the parameter set can be given a short, individual name, which is then displayed in the overview. A meaningful name makes it easier to identify the settings.

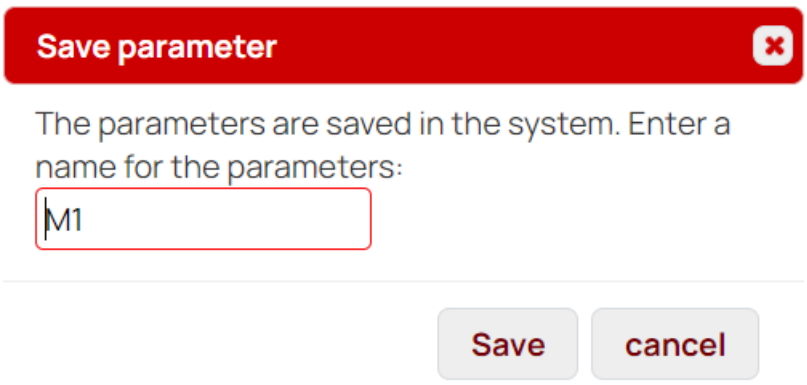


Figure 29: Save dialog

To restore the settings of a parameter set, simply press the “Restore” button after the corresponding memory location. In the subsequent dialog, the restore operation must be confirmed again to prevent the current settings from being overwritten unintentionally.

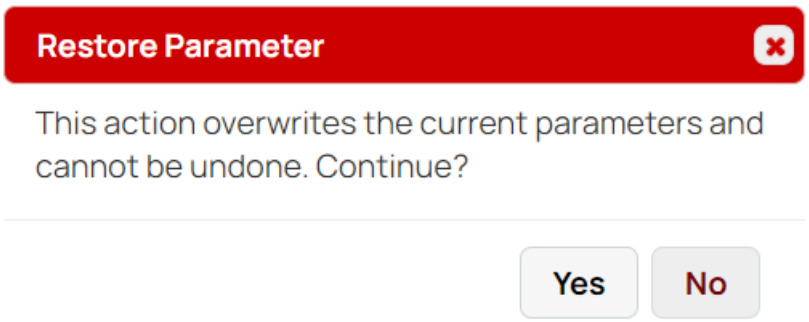


Figure 30: Restore dialog

The parameter sets can also be loaded using a CAN command (see 8.2). This makes it possible to save the parameters in different memory locations for different applications and to load the corresponding parameter sets for the individual applications via CAN without an Ethernet connection.

Reset parameters:
Pressing the button resets the parameters to the factory settings.

Load parameters from file:
Selecting a parameter file loads it after a prompt (see Figure 30). Parameter files of the same sensor system or a sensor system of the same type can be loaded.

4.10.11 Service area

In the Service area, information about the sensor can be called up and firmware updates can be performed.

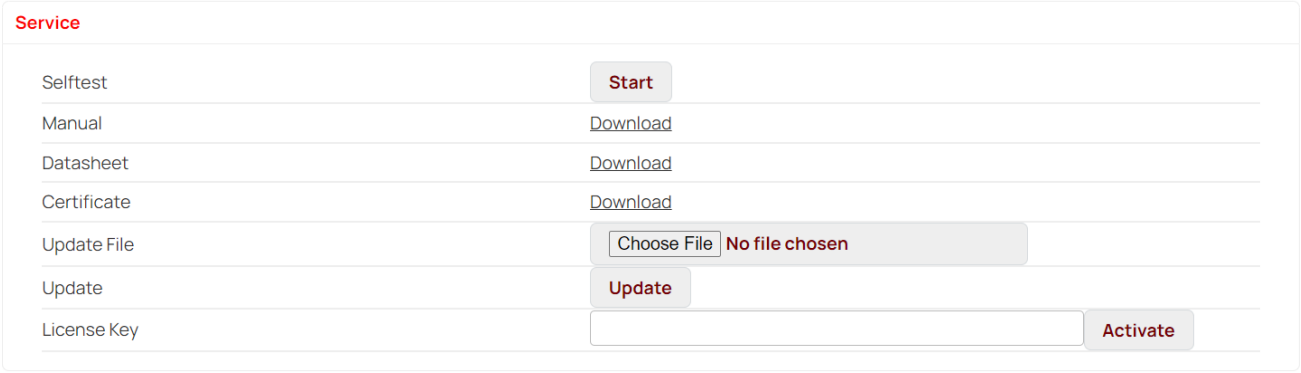


Figure 31: Overview service area

Operating instructions, data sheet, calibration certificate:
These files are stored in the ECU and can be viewed and downloaded by clicking the Open button.

Selftest:
The button must be pressed to start the selftest. This tests various functions of the sensor. See below for details.

Update:
A firmware file can be selected under the "Update file" item. The "Update" button then starts the update process.
(The browser type Mozilla Firefox® does not support the "Update File" function. Use an alternative browser for updating).

License Key:
Software extensions can be activated by entering a valid license key and then pressing the "Activate" button.

Firefox® is a registered trademark of Mozilla Corporation

4.10.11.1 Selftest

The results of the individual steps are displayed while the selftest is running. The self-test is OK if all results are green and labeled ok.

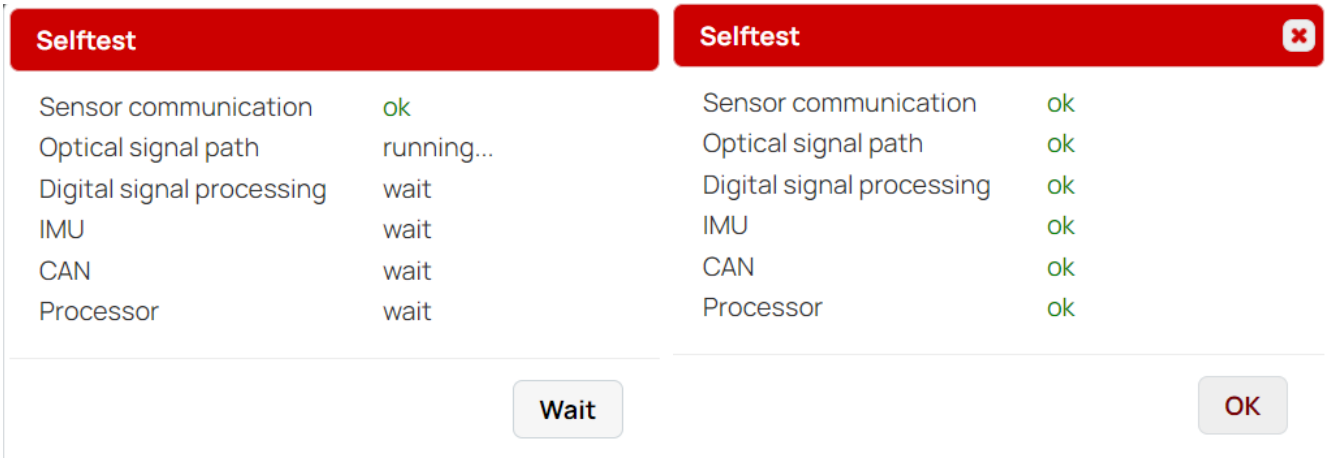


Figure 32: Selftest dialog during (left) and after (right)

Communication to the sensor:
Checking the digital communication to the sensor. Test information is exchanged and checked for correctness. If no sensor is connected to the ECU, this leads to an error.

Optical signal path:
The illumination LEDs are switched on and off cyclically to simulate an optical signal on the surface. It is checked whether a signal is detected. For this test, it is important that a sensor is connected and that it is at a valid working distance from a surface. Otherwise the test will fail.

Digital signal processing:
At the beginning of digital signal processing, a raw signal is simulated and compared with an expected value at the end of the evaluation.

IMU:
Electrical pulses are used to simulate signals within the IMU and compare them with an expected value. The sensor must be connected and at rest for this test, otherwise the test will fail.

CAN:
The CAN module is switched to a loop mode, whereby transmitted data is received again without being physically output on the CAN bus. In this mode, test data is sent and compared with the received data.

Processor:
Various internal processor parameters are checked for plausibility.

4.11 Adjustment wizard

The adjustment wizard supports the adjustment of the sensor on the vehicle in order to be able to make attachment-related corrections or an adjustment for special surfaces. The angular rate offsets can also be determined (in advanced view only).

4.11.1 Surface alginment

The surface adjustment determines the correction factor for the speed. A surface adjustment is usually not necessary because the sensor has been calibrated at the factory on a speed test rig. For common surfaces, the possible influence on the scaling factor of the velocity is small.

However, if highly accurate displacement measurements are to be made, the adjustment may be useful. For this purpose, an accurately measured calibration distance should be available. A light barrier should be used for triggering.

If possible, the calibration run should be carried out at constant speed in order to minimize the influence of possible distortion times between sensor and trigger.

The mounting angle adjustment is necessary to correct the angle error when mounting the sensor.

For manual triggering, the measurement should not be started at standstill. A speed of at least 50 km/h is recommended.

The adjustment for the surface and the mounting angle can optionally be performed separately or simultaneously.

The adjustment assistant is very large, so that it can be operated using the touch display at any time while driving.

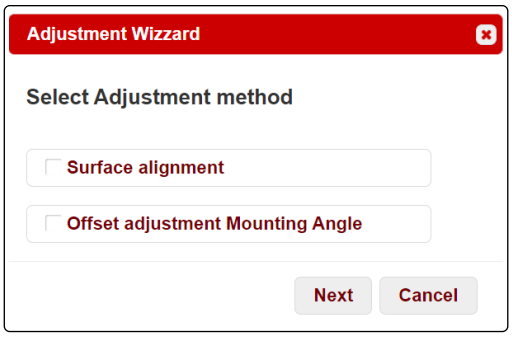


Figure 33: Selection menu of the adjustment wizard

The adjustment is performed by means of a straight travel over a defined distance. The length of the path and the conditions (triggers) for starting and stopping the adjustment can be set.

It is possible to start and stop the adjustment by means of light barrier, CAN signal or manually via keyboard.

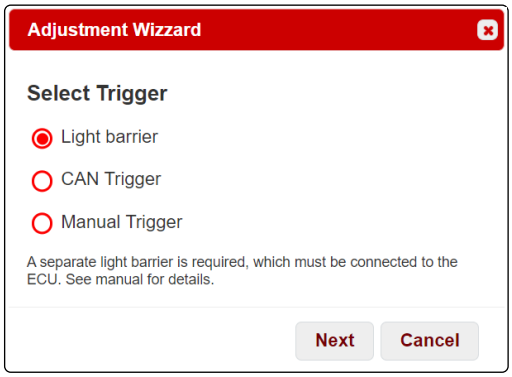


Figure 34: Trigger selection of the adjustment wizard

Trigger by using a light barrier

The adjustment is triggered by a light barrier. To do this, the signal from a light barrier must be sent to the digital input as a TTL signal. This must be set to Trigger in the settings (see 4.10.8). The adjustment is started and stopped when the reflector is passed.

If additional unwanted trigger signals are detected during the travel distance (further reflectors on the travel distance), individual triggers can be suppressed before start and stop.

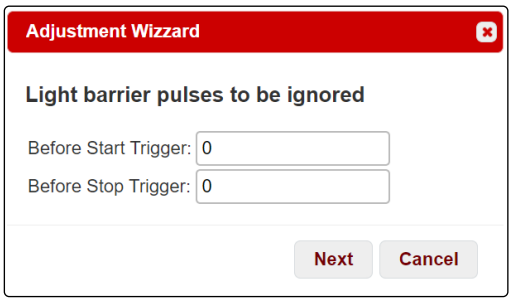


Figure 35: Setting to skip unwanted trigger

Trigger by means of CAN signal

The trigger can be initiated by means of a CAN message to the command frame (see section Annex 8.2)

Manual trigger

The trigger can be initiated using the space bar or trigger button.
A manual trigger during a surface adjustment is not recommended.
Subsequently, the length of the path is entered (only required for surface calibration). This completes the preparations for the adjustment.

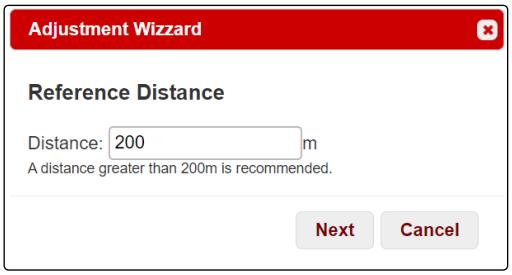


Figure 36: Setting of reference distance

When passing the reflector (or triggering the manual trigger during straight travel), the adjustment is started. The recommended driving speed is 50 km/h.

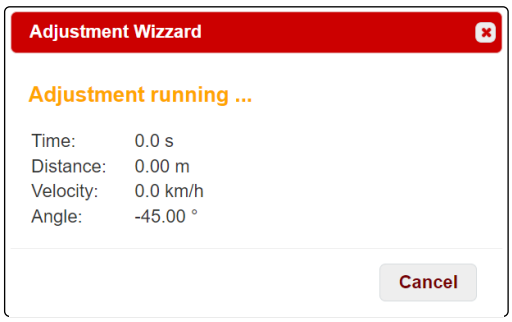


Figure 37: Display during adjustment run

Once the preset distance has been traversed or the 2nd trigger has been released, the measurement is automatically stopped and the values for the surface adjustment and the mounting angle are displayed. Now the determined values can be accepted or discarded.

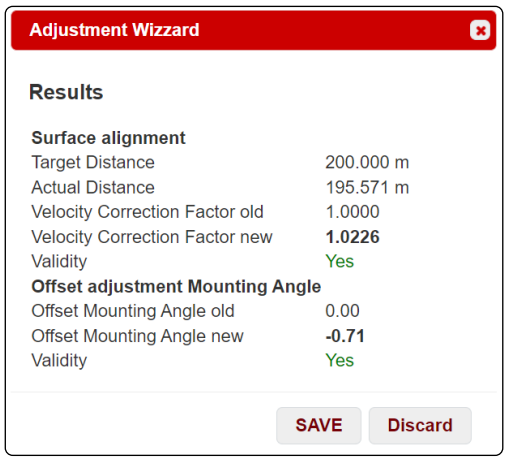


Figure 38: Results of adjustment run

With "SAVE" the new values are taken over into the sensor settings.

If a "No" appears for validity, the determined values are not plausible or outside the permitted value range.

4.11.2 Offset adjustment angular rates

The offset adjustment of angular rates is only available if the view mode is set to advanced.

The calibration wizard is used to determine the angular rate offsets over a certain period of time. The sensor must be at rest for this.

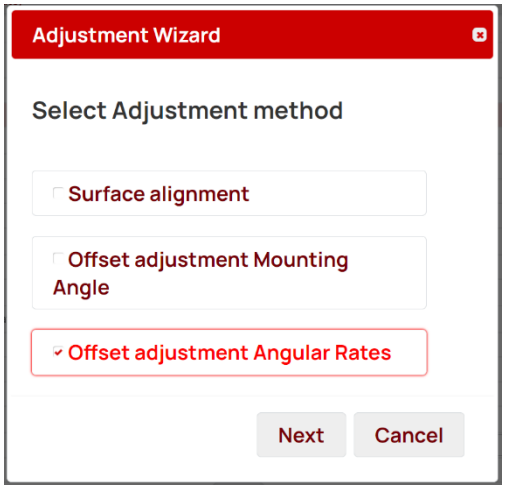


Figure 39: Selection options of the adjustment wizard

To adjust the angular rate offsets, the corresponding entry must be selected in the adjustment wizard. It is not possible to select the angular rate offset adjustment at the same time as the other adjustments.

Averaging takes place over an adjustable period of time.

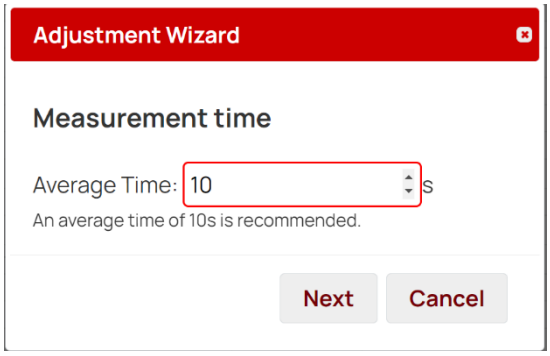


Figure 40: Enter average time

After pressing the "Next" button, the system switches to measuring mode. The calibration is started via the "Trigger" button and runs for the set time. The adjustment can be ended prematurely by pressing the "Trigger" button again. Active averaging can be recognized by the green color of the text "Adjustment running ...".

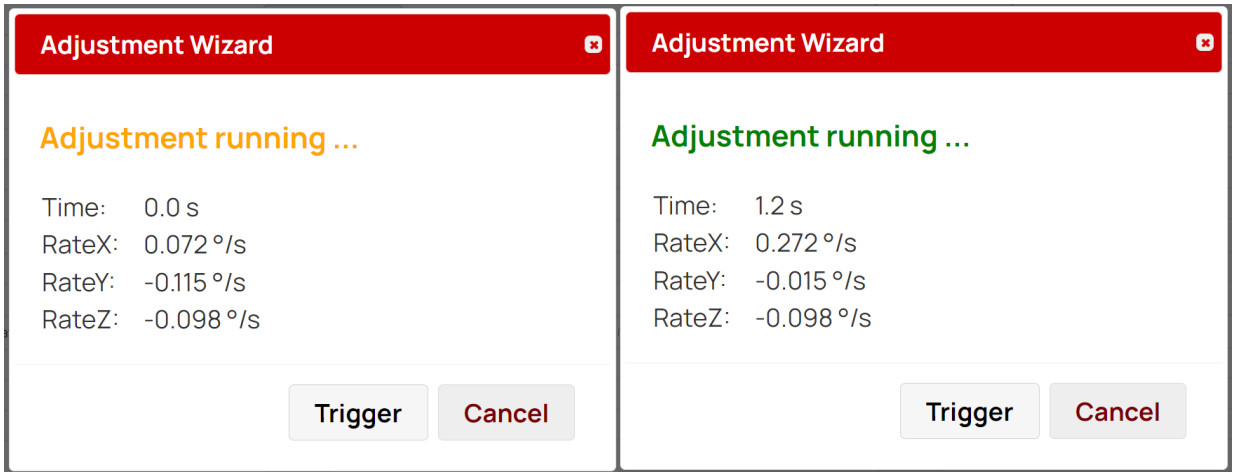


Figure 41: Offset adjustment before and during measurement

Once the preset time has elapsed or the trigger has been triggered again, the measurement is automatically stopped and the values for the offset adjustment of the angular rates are displayed. The determined values can now be accepted or discarded.

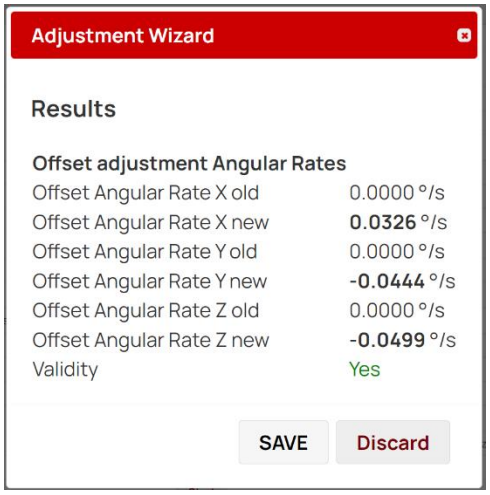


Figure 42: Results after adjustment

Press "SAVE" to write the new values into the sensor settings.

If a "No" appears for Validity, the values determined are not plausible or are outside the permitted value range.

4.12 Status LEDs

There are 2 LEDs on the front panel of the ECU. The green LED next to the power plug indicates a correct power supply.

The yellow LED indicates the status of the sensor:

On	Ready for operation
Slow flashing	No sensor is connected
Fast flashing (6s)	Error. Please call up the configuration for error details.
Fast flashing (continuous)	Serious exception error. Please contact support.

5 Specifications

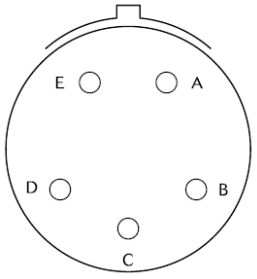
5.1 Pin assignment ECU



Figure 43: ECU front view with connectors

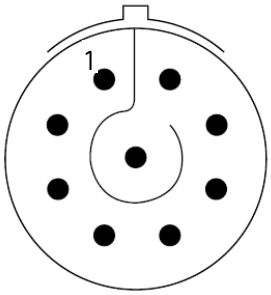
5.1.1 Power

Pin assignment		
Unit		ECU
Connector		Power
Connector Manufacturer:		Souriau
Connector No:		8STA2-06-35PN
Pin	Signal name	Description
A	NC	
B	VIN_{EXT}	Input voltage
C	VIN_{EXT}	Input voltage
D	GND_{EXT}	Ground for input voltage
E	GND_{EXT}	Ground for input voltage
Housing	Shield	



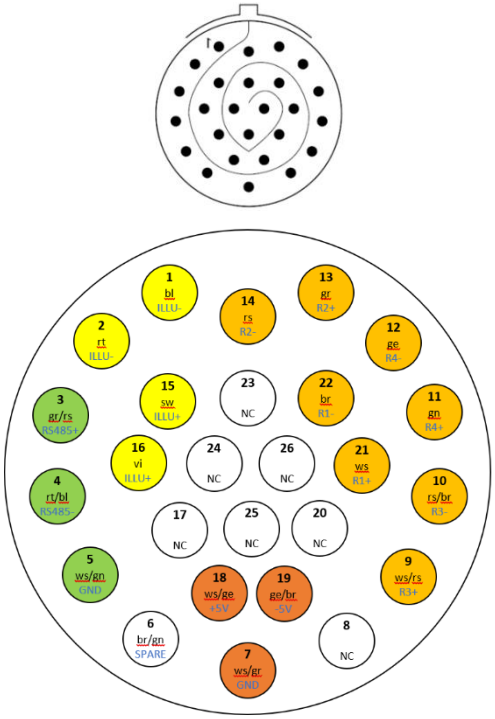
5.1.2 COM

Pin assignment		
Unit		ECU
Connector		COM
Connector Manufacturer:		Souriau
Connector No:		8STA2-0609SN
Pin	Signal name	Description
1	ETH_RX+	Ethernet
2	ETH_RX-	Ethernet
3	ETH_TX+	Ethernet
4	ETH_TX-	Ethernet
5	CAN-H	CAN
6	CAN-L	CAN
7	DIG_OUT	5V Digital Output
8	DIG_IN	5V Digital Input
9	GND_{ISO}	Isolated GND for CAN, DIG_IN and DIG_OUT
Housing	Shield	



5.1.3 Sensor

Pin assignment			
Unit		ECU	
Connector		Sensor	
Connector Manufacturer:		Souriau	
Connector No:		8STA2-1026SN	
Pin	Signal name	Description	Direction
1	ILLU-	GND_{LED} for Illumination (0V; 500mA (tbd.))	
2	ILLU-		
3	RS485+	Sensor head communication	Bid.
4	RS485-	Sensor head communication	Bid.
5	GND	Internal signal ground	
6	SPARE		
7	GND	Internal signal ground	
8	NC		
9	RAW3+	Diff. analogue sensor signal (+-5V)	IN
10	RAW3-	Diff. analogue sensor signal (+-5V)	IN
11	RAW4+	Diff. analogue sensor signal (+-5V)	IN
12	RAW4-	Diff. analogue sensor signal (+-5V)	IN
13	RAW2+	Diff. analogue sensor signal (+-5V)	IN
14	RAW2-	Diff. analogue sensor signal (+-5V)	IN
15	ILLU+	V_{LED} for Illumination (approx. 10V; 500mA (tbd.))	
16	ILLU+		
17	NC		
18	+5V	Internal sensor head supply +5V	
19	-5V	Internal sensor head supply -5V	
20	NC		
21	RAW1+	Diff. analogue sensor signal (+-5V)	IN
22	RAW1-	Diff. analogue sensor signal (+-5V)	IN
23	NC		
24	NC		
25	NC		
26	NC		
Housing	Shield		



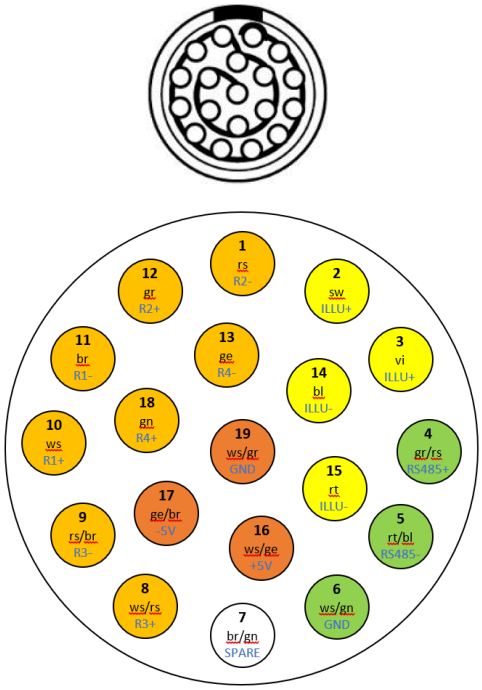
5.2 Sensor connector



Figure 44: Connector view of sensor

5.2.1 Sensor

Pin assignment			
Unit		Sensor head	
Connector		Sensor	
Connector Manufacturer:		LEMO	
Connector No:		EDS.2M.319.XLB	
Pin	Signal name	Description	Direction
1	RAW2-	Diff. analogue sensor signal (+-5V)	OUT
2	ILLU+	V_{LED} for Illumination (approx. 10V; 500mA (tbd.))	
3	ILLU+		
4	RS485+	Sensor head communication	Bid.
5	RS485-	Sensor head communication	Bid.
6	GND		
7	NC		
8	RAW3+	Diff. analogue sensor signal (+-5V)	OUT
9	RAW3-	Diff. analogue sensor signal (+-5V)	OUT
10	RAW1+	Diff. analogue sensor signal (+-5V)	OUT
11	RAW1-	Diff. analogue sensor signal (+-5V)	OUT
12	RAW2+	Diff. analogue sensor signal (+-5V)	OUT
13	RAW4-	Diff. analogue sensor signal (+-5V)	OUT
14	ILLU-	GND_{LED} for Illumination (0V; 500mA (tbd.))	
15	ILLU-		
16	+5V	Internal sensor head supply +5V	
17	-5V	Internal sensor head supply -5V	
18	RAW4+	Diff. analogue sensor signal (+-5V)	OUT
19	GND		
Housing	Shield		

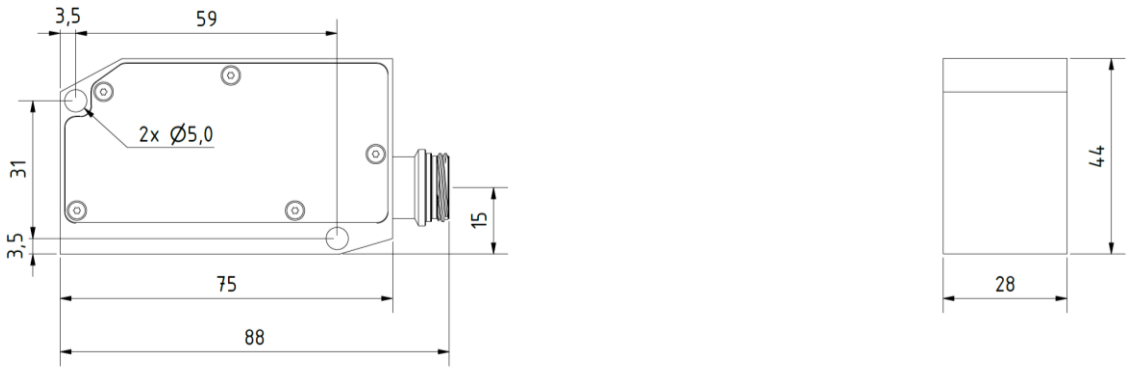


5.3 Recommendations for cable assemblies

- Use shielded cable
- Use of twisted pairs for following signals:
  - RAW1+/-
  - RAW2+/-
  - RAW3+/-
  - RAW4+/-
  - RS485+ /-
- Maximum separation between the analoque signals (RAW1 .. RAW4) and the digital signals (RS485) inside the cable and the connector wiring. Crosstalk between analoque and digital signals must be avoided.

5.4 Dimensions

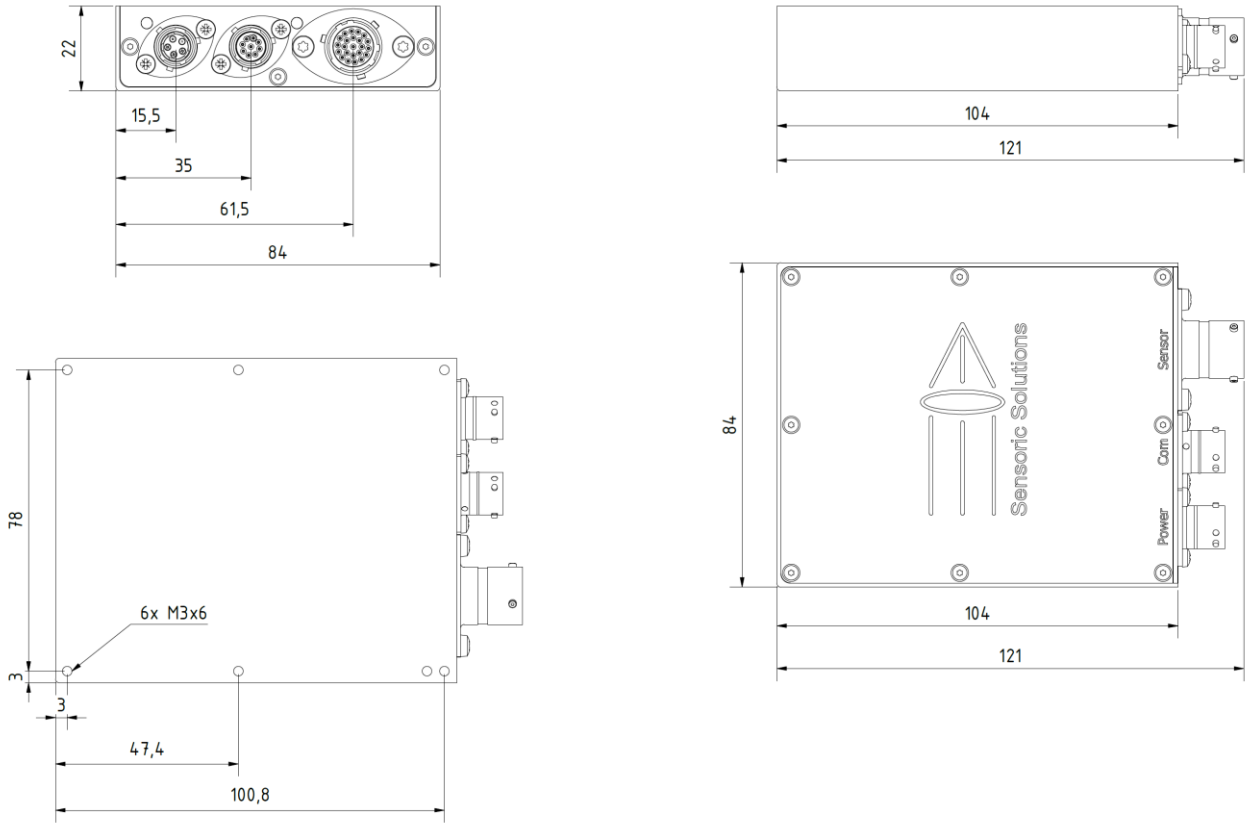
5.4.1 Dimensions sensor



All dimensions in mm

Figure 45: Dimensions sensor

5.4.2 Dimensions ECU



All dimensions in mm

Figure 46: Dimensions ECU

5.5 Technical data

Speed		
Measuring range	400	km/h
Nonlinearity	< ±0.2	%FS
Angle		
Measuring range	±30	°
Measuring accuracy ±10°	< 0.1	°
Measuring accuracy ±30°	< 0.2	°
Optical resolution	≈ 0.5	mm
Working distance	180 ±60	mm
Angular Rates		
Measurement range	±500	°/s
Accelerations		
Measurement range	±20	g
Measurement frequency	1000	Hz
Signal delay	3.75	ms
Sensor fusion	Balanced / Optical prio / No fusion (Change by parameter)	
Supply	Galv. isolated	
Voltage	10 … 36	V
Power consumption (at 12 V)	< 15	W
Environmental conditions		
Storage / Operation	-40 … 85 / -25 … 50	°C
Shock / Vibration (Sensor)	Tested with profiles from F1 Teams	
Dimensions		
Sensor	88 x 44x 28	mm
ECU	121 x 84 x 22	mm
Weight		
Sensor	140	g
ECU	270	g
Protection class		
Sensor (cable plugged)	IP67	
ECU (cable plugged)	IP67	
Illumination	IR	
Wavelength	850	nm
CAN Interface	FD / 2.0B (galv. isolated)	
Number of individual nodes	1	
Speed	125 / 250 / 500 / 1000 FD Data: up to 8	kBaud Mbit
Terminating resistor	Switchable or Fixed (user definable)	
Ethernet Interface	Galvanically insulated	
Parameterization	Webinterface	
Measurement data	TCPIP (protocol on request)	
I/O Interface	Digital In / Digital Out (TTL; galv. isolated)	

Figure 47: Tabular overview of the sensor specification

5.6 Ordering Code

OMS Race-□□□.□.□

Speed range [km/h]	250 400*
Orientation sensor	L: longitudinal* T: transversal
CAN Resistor	S: Switchable* P: Permanently R: Removed

*) Standard: OMS Race-400.L.S

5.7 Optional Accessories

Side Mount S2	MT0000381
Side Mount M2	MT0000382

Towing Lug Mount T2	MT0000380

Figure 48: List of optional accessories

6 Safety instructions

Use this product only under the conditions stated in the description or specifications to avoid possible hazards.

Read the manual before operating the product.

Do not leave the product unattended. You could unintentionally blind other persons or yourself.

Do not operate in explosive atmospheres where flammable liquids, gases or dusts are present. Sparks may be generated which ignite the dust or vapors.

Do not point the illumination at persons or animals and do not look into the direct or reflected light beam yourself. Doing so may blind persons, cause accidents or damage the eye.

Do not use optically collecting instruments such as binoculars or magnifying glasses to view the radiation source. You may damage your eye by doing so.

The connector plug of the measuring tool must fit the corresponding port. Note the level and type of supply voltage. An incorrect supply voltage can lead to a malfunction or even a defect.

Never operate the measuring tool directly on the power supply of the building. The measuring tool is not designed for this purpose. Use power supply units or a battery to supply the measuring tool. A direct connection to the mains supply will damage the measuring tool and increase the risk of electric shock.

Only use original plugs and cables.

Do not misuse the cable to carry or hang up the measuring tool or to pull the plug out of the socket. Keep the cable away from heat, oil, sharp edges or moving parts of the device. Damaged or tangled cables increase the risk of a defect or electric shock.

Do not modify, rebuild or open the entire system.

There is a high risk of receiving a dangerous electric shock.

Do not use the product if there is visible damage to the product and its accessories. Depending on the damage, there is a risk to life. Take the device out of operation and send it to the manufacturer for inspection.

The measuring tool becomes warm during operation. External heat sources such as sunlight or the vehicle's exhaust system contribute to increasing the surface temperature. Ensure sufficient ventilation or heat dissipation. Insufficient ventilation causes the measuring tool to heat up considerably. If too much heat is generated, the measuring tool can be damaged. There is a risk of injury.

The measuring tool must be firmly mounted on the vehicle. The measuring tool must be secured against falling down. Ensure proper mounting by using suitable components such as fasteners offered by the manufacturer. Falling parts can endanger and injure you and persons present.

The plug connector on the sensor must be closed by a cap or plug during operation. Moisture can penetrate the housing through the connector when it is open and plugged in. This will damage the sensor.

Do not switch on the supply voltage until all necessary plug connections have been made. Plugging or unplugging the connector during operation may cause damage under certain circumstances.

Check the installation of the sensor and its accessories before starting measurements. Falling equipment while driving can cause damage to the equipment itself, the vehicle and the surrounding area. There is a risk of injury to persons in the vicinity.

Damage caused by non-observance of these instructions will void the warranty.

NO liability is accepted for consequential damage.

The warranty is void in case of damage to property or personal injury caused by improper use or non-observance of the safety instructions.

Have your products repaired only by qualified personnel and only with original spare parts. This will ensure that safety is maintained.

Maintenance / service of the product may only be carried out by qualified personnel.

Attachments to the vehicle may result in the cancellation of the vehicle's operating permit. The guidelines vary worldwide. Find out in advance about the regulations in the region concerned.

7 ElektroG, WEEE

Sensoric Solutions Optic and Motion GmbH is registered with the authorities as follows:
WEEE Reg. No. DE88910879

8 Appendix

8.1 List of signals

8.1.1 Sensor signals

Signal name	Unit	Description	Coordinate System
SampleTime	s	Time since the beginning of the measurement data output	
VelXPoi	km/h	Longitudinal velocity in POI	Sensor
VelYPoi	km/h	Transversal velocity in POI	Sensor
VelAPoi	km/h	Absolute velocity in POI	Sensor
AngSPoi	°	Slip angle in POI	Sensor
DistAPoi	mm	Distance in POI	Sensor
RadiusPoi	m	Radius in POI	Horizontal
AccCPoi	m/s²	Centrifugal acceleration in POI	Horizontal
Roll	°	Roll angle (around X-axis)	Sensor
Pitch	°	Pitch angle (around Y-axis)	Sensor
AccXHor	m/s²	X-acceleration horizontal	Horizontal
AccYHor	m/s²	Y-acceleration horizontal	Horizontal
AccZHor	m/s²	Z-acceleration horizontal	Horizontal
RateXHor	°/s	X-rotation rate horizontal	Horizontal
RateYHor	°/s	Y-rotation rate horizontal	Horizontal
RateZHor	°/s	Z-rotation rate horizontal	Horizontal
VelX	km/h	Longitudinal velocity	Sensor
VelY	km/h	Transverse velocity	Sensor
VelA	km/h	Absolute velocity	Sensor
AngS	°	Slip angle	Sensor
DistA	mm	Distance	Sensor
Radius	m	Radius	Horizontal
AccC	m/s²	Centrifugal acceleration	Horizontal
AccX	m/s²	X-acceleration Axis error corrected (and adjusted)	Sensor
AccY	m/s²	Y-acceleration Axis error corrected (and adjusted)	Sensor
AccZ	m/s²	Z-acceleration Axis error corrected (and adjusted)	Sensor
RateX	°/s	X-rotation rate Axis error corrected (and adjusted)	Sensor

RateY	°/s	Y-rotation rate Axis error corrected (and adjusted)	Sensor
RateZ	°/s	Z-rotation rate Axis error corrected (and adjusted)	Sensor
VelASp	km/h	Absolut velocity from spatial filter	Sensor
AngSSp	°	Slip angle from spatial filter	Sensor
VelXSp	km/h	Longitudinal velocity from spatial filter	Sensor
VelYSp	km/h	Transverse velocity from spatial filter	Sensor
DistASp	mm	Distance from spatial filter	Sensor
QualityCh0		Qualitysignal from channel 0 of spatial filter	
QualityCh1		Qualitysignal from channel 1 of spatial filter	
TempSensor	°C	Sensor temperature	
TempPrecessor	°C	Precessor temperature (ECU)	
Standstill		1 - Standstill I 0 - No standstill	
DirectionNeg		1 - Negative direction of motion I 0 - Positive direction of motion	
Trigger		1 - Trigger level is high I 0 - Trigger level is low	
IlluOn		1 - Lighting is on I 0 - Lighting is off	
IlluOk		1 - Lighting is ok I 0 - Lighting is faulty	
SensorConnected		1 – Sensor is connected 0 – No sensor is connected	
AdjustmentActive		1 –An adjustment run (angle and/or distance) is currently taking place	
CanAngAdjFailed		1 – Mounting angle correction via CAN command failed. Please try again.	
StatusOk		1 - Sensor system ok I 0 - Sensor system faulty	
InfoInverseMounting		1 - Inverted direction set I 0 - Normal direction set	
InfoMovAvgActive		1 - Moving average filter set I 0 - Unfiltered	
InfoError		A failure occured	
InfoTransversal		1 – transversal sensor orientation I 0 – longnitudinal sensor orientation	
InfoPoi		Point of interest is enabled	
InfoIlluIncomp		A sensor whose lighting is incompatible with the ECU has been connected to 1. The lighting is not switched on and the sensor will not work.	
InfoServiceMode		Contact support if signal is 1	
LastErrorCode		Last error code. If there was no error this value is 0.	
FwVersion		Firmware version in format Byte.Byte.Byte	

SerialEcu		Last 4 digits of serial ECU	
SerialSensor		Last 4 digits of serial sensor	
ParamSetLoaded		Number of loaded ParameterSet. 255 if nothing is loaded.	

Figure 49: Tabular overview of the sensor signals

8.2 CAN command frame

The sensor system can receive control commands on the command frame. The command data must have the following structure:

Byte	0	1	2..7
	SyncID	CommandID	Command data (optional)

The SyncID must always be 0x53. The following commands are possible:

CommandID	**Data**	**Description**
0x4c	1 Byte	**Switch lighting** The data byte indicates whether the lighting is to be switched off (0x00) or on (0x01). Please note that after a reset of the sensor system the lighting is switched on again.
0x54	---	**Trigger during adjustment run** If CAN Trigger is set during the adjustment run, the adjustment routine reacts to this CAN message.
0x43	1 Byte	**Data reset** The measurement distance (data byte = 1) or the measurement distance and the measurement time (data byte = 2) are reset to zero.
0x41	2 or 3 Byte	**Mounting angle correction** This command can be used to start the mounting angle adjustment run via CAN. The first (mandatory) input value is the distance in meters as an unsigned short (2-byte little endian). If the distance is 0, the current mounting angle offset is reset to zero. Another parameter (1 byte) is optional and specifies the delay time in 0.1s increments, in which the angle adjustment run is to be started. The adjustment period can be read from the AdjustmentActive status signal. After the adjustment run, the offset of the angle is output on the angle signals AngSPoi and AngS for 1 second. In case of an error, the CanAngAdjFailed signal will go to 1.
0x53	1 Byte	**Loading parameters** The parameters from the corresponding parameter set M1...3 can be loaded using the data byte (value = 1...3).
0x4F	---	**Request StaticInfoFrame** If this command is received by the sensor system, the StaticInfo Frame is sent once via CAN.

Figure 50: Overview functions of the command frame

8.3 POI calculation

As a rule, speeds and slip angles are to be recorded at the vehicle's center of gravity. However, the sensor is usually mounted in the front, rear or on one side. For correction, the POI (Point of Interest) conversion can be activated, which calculates the signals at any position.

To activate the conversion, the distances in [mm] and the direction between POI and sensor in X, Y and Z axis must be entered.

The conversion to the POI can increase the signal noise. This is due to vibrations of the vehicle, which are detected by the angular rate sensors, as well as their basic noise.

With the following formulas it is also possible to perform a correction in postprocessing:

VelXPoi = VelX + PoiY * RateZ - PoiZ *RateY
VelYPoi = VelY - PoiX * RateZ + PoiZ * RateX
AngSPoi = arctan(VelYPoi / VelXPoi)

PoiX positive, if the sensor is positioned in front of the POI.
PoiY positive, if the sensor is positioned to the left of the POI.
PoiZ positive, if the sensor is positioned above the POI.

9 Troubleshooting

The sensor provides no or unusable signals

Proceed as follows for the error analysis:

a) Checking the power supply
After switching on the supply voltage of the sensor system, the Power LED must light up green. The display on the ECU shows the Sensoric Solutions logo followed by further information.

b) Checking the data connection
When using the CAN interface see "the sensor does not provide CAN signals".
When using the Ethernet interface see "No connection via Ethernet possible".

c) Checking the communication of the ECU with the sensor and the lighting.
Is the Status LED on and CAN signal IlluOn is 1?
Both: Communication and lighting are ok.
IlluOn is 0: The sensor system has a power saving mode. If this is set and the sensor does not detect any movement, the lighting is switched off. After a movement of the sensor the lighting should go on. The lighting can also be switched off automatically by the ECU if the sensor becomes too hot. This is also indicated by an error message. In this case, ensure sufficient cooling of the sensor. It is possible to switch off the lighting via CAN or via the configuration. Switch the lighting on again via these ways.
Status LED is flashing: Communication with the sensor is disturbed. Check the connection cable and the plug connections again. If the problem persists, please contact support.

d) Checking the mounting direction of the sensor type.
The sensor must be mounted in the mounting direction shown in section 4.6. You can check again on the status view of configuration whether the sensor type is longitudinal or transverse.

e) Checking the working distance
The sensor operates in a range of 120mm to 240mm. If possible, the sensor should not be mounted at the edge of this range, otherwise the OMS Race may come out of its working range due to vehicle movements.

f) Checking the contamination of the sensor
The contamination of the sensor may only be checked when it is switched off. If contamination is detected by inspection, dismantle the splash guard and carefully clean the lenses with a microfiber cloth. Make sure that there are no stones or other particles between the cloth and the lens, otherwise the lenses may be scratched. For stubborn dirt, use a mild cleaner to clean. Do not use aggressive cleaning agents.

Power LED do not light up

The sensor system requires an input voltage of min. 10V. Make sure that the power supply provides the necessary starting current. Otherwise, the system cannot start properly.

The Power LED lights up red

The polarity of the power supply is reversed.

The sensor does not supply CAN signals

Proceed as follows for error analysis:
a) Check the SampleTime signal
The signal SampleTime runs as soon as the sensor outputs data.

b) Check the CAN structure
The sensor system has a switchable terminating resistor.

c) Check the CAN speed
Check the CAN speed setting.

d) Check the measured value output of the sensor
Establish an Ethernet connection to the ECU and check with the Internet browser under measured value display whether signals can be seen. If no signals can be seen, please contact the support.

No connection possible via Ethernet

Proceed as follows for error analysis:

a) Check for the correct IP address.
The IP address of the sensor system is shown in the status display. Make sure that you enter it into the Internet browser.

b) Check the settings of your network adapter on the PC.
Make sure that the IP address used by the PC is not the same as the one used by the sensor but is in the same segment (first three numbers are the same and the last one is different). Make sure that no other network adapter uses the same network segment. If in doubt, switch off all other network connections for a test.
If the ECU still cannot be reached, reset the IP address (see section4.9.3) and reconnect according to the instructions in section 4.9.

c) Check the settings of your firewall and, if you are using a VPN connection, the VPN settings.
In some firewalls it is possible to block specific IP segments. To do this, please refer to the manual of your firewall. You may also deactivate the firewall temporarily for a check.
If you use a VPN connection, all or part of the requests are usually routed via the VPN connection and not via the local network card. However, it is usually possible to exclude certain IP segments. To do this, please refer to the manual of your VPN solution. For a check, disconnect the VPN connection and try to connect to the OMS Race again.

d) If no data is received via Ethernet, but the web server is working, check the port setting. The port can be set on the configuration pages. It must be the same for the application. The port must not be

used by another application. If this is the case change the port. Also make sure that the firewall does not prohibit communication with the device via the port.

The status LED is blinking fast

Please contact the support.

Other problems

Please contact the support. The following information is helpful for troubleshooting:

- Serial number(s)
- parameter file
- log file
- In case of error indications, the error code
- Result of Selftest

Sensoric Solutions

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