OPERATING INSTRUCTIONS

FREE FLOW PROFILER

Profiling systems

SICK
Sensor Intelligence.

Product described

Product name: Free Flow Profiler

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Manufacturer

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Legal notes

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Contents

1 About these operating instructions

Please read through this chapter carefully before you use the documentation and work with the *Free Flow Profiler* profiling system (also abbreviated to FPS in these operating instructions).

1.1 Described software versions

Software	Function	Status
TEMS Info interface	Profiling software for recording and processing measurement data	V 2.0
TEMS platform	Profiling software	V 2.8

Tab. 1: Software versions

1.2 Purpose of this document

These operating instructions are designed to give **technical personnel** instructions on the safe mounting, configuration, electrical installation, commissioning, operation, and maintenance of the profiling system.

These operating instructions do **not** provide information on operating the customer system into which the profiling system has been or is going to be integrated. More information on this can be found in the customer documentation.

1.3 Target group

These operating instructions are intended for persons integrating and operating the profiling system. They are also intended for the planners and integrators of the customer system, as well as the operating entity with responsibility for it.

Target group	Activities
Entity operating the customer system	
System user	Operating the system: site view and display of the measurement results in TEMS Manager → The system user reports faults to the system manager.
System manager	Mounting, electrical installation, maintenance, and replacement of system components. → The system manager submits support requests to SICK.
SICK	
SICK service technician	Commissioning, configuration, and support.

Tab. 2: Target group

1.4 Information depth

Note

These operating instructions contain information about the following topics related to the profiling system:

- System description
- Mounting
- Electrical installation
- Commissioning
- Operation
- Maintenance and care
- Fault diagnosis and troubleshooting
- Technical data and dimensional drawings

When planning and using profiling systems, technical skills are required that are not covered by this document.

The official and legal regulations for operating the system must always be complied with.

Further information about the device components used in the profiling system can be found in the accompanying operating instructions.

1.5 Abbreviations used

3D point cloud The 2D cross-sections recorded by the 2D LiDAR sensors during the measurement process are merged together to form a 3D point cloud. The point cloud is used as the basis for calculating the vehicle dimensions and for vehicle classification.

FPS Free-flow profiling system = a system for measuring and classifying vehicles in free-flowing traffic

FTP File Transfer Protocol = a network protocol for transferring data between different systems

LMS Laser measurement scanner = 2D LiDAR sensor from SICK AG

SNMP Simple Network Management Protocol = a protocol for managing and controlling networks

TEMS Traffic Enhanced Measurement System

TEMS Info client Customer side of the TEMS Info interface

TEMS Info interface TCP/IP interface for communication with the TEMS Recorder

TEMS Manager Configuration software for the profiling system

TEMS Recorder Profiling software on the Traffic Controller FPS; it processes the data from the 2D LiDAR sensors and outputs the results

UNC Entering a UNC path (Universal Naming Convention) allows a path in a network to be accessed without the need for a drive letter. The UNC path does not need to be visible in Windows Explorer. Windows shared folders can also be used as UNC destinations.

UPS Uninterruptible Power Supply

1.6 Symbols used

Recommendation

Recommendations are intended to help you make a decision regarding the use of a particular function or technical feature.

Note

Notes provide information about the features of a device, application tips, or other useful information.

1. / 2. ... step by step

Instructions that must be carried out in the described order are referred to as step-by-step instructions and are indicated by numbered lists. Carefully read and follow the instructions for action.

➢ **Action**

Instructions requiring specific action are indicated by an arrow. Carefully read and follow the instructions for action.

● ☼ , ○

LED icons describe the status of a diagnostics LED.

- ● The LED is illuminated continuously.
- ☼ The LED is flashing.
- ○ The LED is off.

Display symbols show the status of the 7-segment display:

- UU Constant display of characters, e.g., U
- 8 Flashing display of characters, e.g., 8
- L↻2 Alternating display of characters, e.g., L and 2

2 On safety

This chapter provides information that concerns your own safety as well as the safety of the plant operator.

▶ Please read this chapter carefully before you begin working with the profiling system.

2.1 Qualified safety personnel

The profiling system must only be mounted, commissioned, and maintained by properly qualified safety personnel.

A person is considered qualified safety personnel if he/she

- Has sufficient skills in the field of the respective equipment based on his/her technical training and experience **and**
- Has been instructed by the manufacturer on system operation and all applicable safety guidelines **and**
- Is familiar with all relevant country-specific occupational safety regulations, work safety regulations, guidelines, and generally accepted technical rules and standards (e. g., DIN standards, VDE regulations, country-specific rules) to such an extent that he/she is able to evaluate the safe condition of the power-driven machinery **and** he/she
- Has access to and has read the operating instructions.

2.2 Applications of the system

The *Free Flow Profiler* profiling system is designed for automated measurement of vehicle dimensions using eye-safe laser scanners. The system takes the measurements automatically in free-flowing traffic without any need for manual operation.

The profiling system is designed for use in multi-lane, free-flowing traffic and stop-and-go traffic as part of electronic toll systems. It can also be used for traffic management and analysis.

The modules available for the profiling system support the system functions described below:

System function for measuring vehicle dimensions

The **Dimension Measurer** system function can be used to identify the following vehicle data (depending on the system variant): length, width, height, speed, measurement start and end times, 3D measuring points for the vehicle including – where applicable – excess dimensions.

System function for classifying vehicles

The **Vehicle Classifier** system function sorts vehicles into up to 30 vehicle classes using predefined category systems. The vehicle class can be output based on the 3D measurement results for the vehicle.

System function for automatically counting axles

The **Axle Detector** system function can be used to determine the number of axles and their positions.

Data output

All the data recorded by the individual system functions are made available via a TCP/IP interface (TEMS Info interface).

2.3 Intended use

The profiling system may only be used as described in section **2.2 Applications of the system**. It may only be used by qualified personnel in the environment in which it was mounted and initially commissioned by qualified safety personnel in accordance with these operating instructions.

Notes The profiling system is not a safety device for human protection and it therefore does not comply with any safety standards.

It is purely a measurement system without any safety functions and must only be used in this capacity.

Consequently, any responsibility on the part of SICK is restricted to these defined and limited properties of the measurement system.

Note If used in any other way or if alterations are made to the profiling system – including in the context of mounting and installation – this will render void any warranty claims directed to SICK AG.

2.4 General safety notes and protective measures

2.4.1 Safety notes and symbols

The following safety and hazard notes concern your own safety, the safety of third parties, and the safety of the devices. You should therefore observe them at all times.

DANGER

Denotes an immediate hazard that may result in severe to fatal injuries.

The symbol shown on the left-hand side of the note refers to the type of hazard in question (the example here shows a risk of injury resulting from electrical current).

WARNING

Denotes a potentially dangerous situation that may result in severe to fatal injuries.

The symbol shown on the left-hand side of the note refers to the type of hazard in question (the example here shows a risk of damage to the eye by laser beams).

WARNING

Denotes a potentially dangerous situation that may result in minor personal injury or possible material damage.

NOTE

Denotes a potential risk of damage or functional impairment of the device or the devices connected to it.

This symbol refers to supplementary technical documentation.

2.4.2 General safety notes

The profiling system has been designed in a way that allows for safe operation. Protective devices reduce potential risks to the maximum possible extent. However, a certain level of risk will always remain.

Awareness of potential hazardous points in the system will help you to work in a safer manner and thus prevent accidents.

To avoid risks, please also observe the special warnings in each of the individual chapters.

⚠ WARNING

Safety notes

Observe the following to ensure the safe use of the profiling system as intended.

- The notes in these operating instructions (e.g., regarding use, mounting, installation, or integration into the machine controller) must be observed.
- All official and statutory regulations governing the operation of the profiling system must be complied with.
- National and international legal specifications apply to the installation and use of the profiling system, to its commissioning, and to recurring technical inspections, in particular:
  - Work safety regulations and safety rules
  - Any other relevant safety provisions
- The checks must be carried out by qualified safety personnel or specially qualified and authorized personnel, and must be recorded and documented to ensure that the tests can be reconstructed and retraced at any time.
- These operating instructions must be made available to the operator of the system in which the profiling system is used.
- The operator of the profiling system must be instructed by qualified safety personnel and must read the operating instructions.

⚠ WARNING

Risk resulting from improper operation

Improper installation and commissioning, damaged components, and unsuitable ambient conditions such as excessively cold or warm temperatures and high levels of dust, fog or spray, may cause faults and faulty alarms and may result in a complete system crash.

⚠ WARNING

System does not comply with safety standards

The profiling system is not suitable for the protection of humans within the meaning of the applicable safety standards for machines. The system therefore does not comply with safety standards.

⚠ WARNING

Location of use

The profiling system is intended exclusively for use in traffic-related applications.

2.4.3 Potential hazardous points

Laser protection

⚠ WARNING

Damage to the eye by laser beams

The 2D LiDAR sensors used in the profiling system conform to Class 1 laser (eye-safe) criteria according to IEC 60825-1 (latest version); see laser warning plate on the device for publication date. This ensures compliance with 21 CFR 1040.10 except for the tolerances according to Laser Notice No. 50 of July 26, 2001.

The laser beam operates at a wavelength of γ = 905 nm (invisible infrared light). The laser beam is not visible to the human eye.

The radiation emitted in normal operation is harmless to human skin and eyes.

WARNING Improper use (e.g., opening the housing and stopping the motor) can result in dangerous exposure to radiation.

- ▶ Never open the 2D LiDAR sensor housing. Opening the housing does not interrupt the operation of the laser beam.
- ▶ Observe the laser safety regulations as per IEC 60 825Q1 (latest version).

Important

- No maintenance is required to ensure compliance with laser class 1.
- The laser output aperture is the inspection window on the 2D LiDAR sensor.
- The laser warning is located on the right-hand side of the 2D LiDAR sensor.

Electrical current

DANGER

Risk of injury and damage caused by electrical current

Improper handling of live devices may lead to severe personal injury or death by electric shock!

- ▶ Electrical installation and maintenance work must always be carried out by personnel authorized to do so.
- ▶ Be sure to disconnect the voltage supply before attaching or detaching any electrical connections.
- ▶ Select and implement wire cross-sections and their correct fuse protection in accordance with the applicable standards.
- ▶ Do not touch any live parts.
- ▶ In the event of danger, immediately disconnect the profiling system from the power supply.
- ▶ Always use original fuses with the specified current rating.
- ▶ Report any damaged cables to the maintenance team without delay.
- ▶ Observe the current safety regulations when working on electrical systems.

DANGER

Damaging potential equalization currents due to different ground potentials

The profiling system has been designed and tested for electrical safety according to EN 60 950L1 (2006L04) and EN 60 950L1 / A11 (2009L03).

The profiling system is connected to the peripheral devices (voltage supply, PLC/host, any other sensors, etc.) via shielded cables. The shield of each cable is connected to the metal housing of the corresponding system components via the system plug.

If the peripheral devices have metal housings and if the cable shields are also connected to these housings, it is assumed that all devices involved in the system have the same ground potential.

This is achieved by fulfilling the following conditions, for example:

- Mounting the devices on conductive metal surfaces.
- Correctly grounding the devices and metal surfaces in the system.
- Low-impedance and current-carrying equipotential bonding between areas with different ground potentials, if necessary.

If these conditions are not met, e.g., on devices in a widely distributed system spanning several buildings, different ground potentials may cause potential equalization currents to flow along the cable shields between the devices, thereby creating hazards.

DANGER

Risk of injury and damage caused by potential equalization currents

Potential equalization currents between the profiling system and the peripheral devices can have the following effects:

- Dangerous voltages on the metal housing, e.g., of the 2D LiDAR sensors
- Incorrect functioning of or irreparable damage to the devices
- Damage/irreparable damage to the cable shields due to heating and cable fires.

Commissioning/operation/maintenance

⚠ WARNING

Risk resulting from incorrect commissioning and configuration!

Do not commission without testing by qualified personnel!

Before carrying out initial commissioning of the profiling system, you must have it checked and approved by qualified safety personnel.

⚠ WARNING

Avoid strong vibrations and jolts at the measurement site

Do not allow the system components of the profiling system to be exposed to excessive vibrations or jolts as a result of construction work ***at the*** measurement site or within its immediate vicinity (work involving compressors, road rollers/compactors, etc.).

► Switch off all components of the profiling system if strong vibrations are anticipated.

NOTE

Claims under the warranty rendered void

The housings of the devices must not be opened. The devices are sealed.

If the device is opened, any warranty claims against SICK AG will be void.

⚠ WARNING

Risk resulting from faults

Cease operation if the cause of the malfunction has not been clearly identified!

► Immediately stop system operation if you cannot clearly identify the fault and if you cannot safely remedy the problem.

2.5 Protecting the environment

The profiling system has been designed to minimize its impact on the environment. It consumes very little energy.

Always act in an environmentally responsible manner at work. For this reason, please note the following information on disposal.

Disposal after final decommissioning

- Always dispose of unusable or irreparable devices in accordance with the applicable waste disposal regulations specific to your country.
- Remove the plastic parts and recycle the aluminum housing of the 2D LiDAR sensor.
- Dispose of all electronic assemblies as hazardous waste. The electronic assemblies can be easily removed.

Note SICK AG does not take back devices that are unusable or irreparable.

3 System description

This chapter describes the layout and operating principle of the FPS, in particular the interaction of the different components.

Note

Always read this chapter before mounting, installing, or commissioning the FPS.

NOTE

Thorough inspection for completeness and damage

It is recommended that you carefully check for and report transport damage of any kind as soon as possible after receiving the system.

Also verify that the delivery includes all components listed on the delivery note.

- ▶ Report any incomplete or damaged deliveries to Customer Service.
- ▶ Always document the damage by taking photographs.

The FPS profiling system comprises a Traffic Controller FPS with profiling software and three 2D LiDAR sensors. An Ethernet switch, mounting kits, and cables are available as SICK accessories.

Fig. 1: FPS system components

Additional 2D LiDAR sensors can be added to the FPS depending on the monitoring tasks.

Scope of delivery

Quantity	Part No.	Description
	1088784	**Free Flow Profiler**
3	(1091458) *	LMS511 SE (system extension) 2D LiDAR sensor
1	(2094695) *	Traffic Controller FPS with profiling software USB stick with TEMS analyzer, TEMS info sample client, source code for TEMS info sample client, and operating instructions
* For spare parts order		

Accessories

Quantity	Part No.	Description
1–4	6050687	Voltage supply (20 m) connecting cable for the LMS511 SE (system extension)
1–4	6050685	Ethernet cable (20 m) for connecting the 2D LiDAR sensors to the Ethernet switch
1	6026083	Ethernet cable (3 m) for connecting the Ethernet switch to the Traffic Controller FPS

3.1 The measurement site

When fully configured with all available options, the FPS features the following system functions:

- The initial **vehicle detection** system function provides a 3D point cloud for the vehicle, which serves as the basis for calculating the measurements. This system function typically comprises two **LMS Width** system components and one **LMS Length** system function. The system components each use an LMS511 SE (system extension) 2D LiDAR sensor, hereinafter referred to as LMS511.
- The system function for measuring the vehicle dimensions does not require its own sensors. It uses the vehicle detection data.
- The system function for classifying vehicles does not require its own sensors either. It uses the vehicle detection data.
- The system function for automatically counting the number of vehicle axles consists of the **LMS Axle** system component. This system component uses one LMS511 2D LiDAR sensor.

Note All the sensor components of the system communicate with the Traffic Controller FPS via TCP/IP.

3.1.1 Typical layout of the measurement site

The **Layout** of the measurement site depends on the local conditions and on the system functions to be used. Typically, the system components for vehicle detection are mounted either above the road on a gantry or to the side of the road on a cantilever arm or post. This position enables the profile of the vehicle to be captured perfectly and the length to be calculated. Depending on the system configuration, one or more 2D LiDAR sensors are responsible for monitoring up to four lanes of a road. One direction of travel is assigned to each lane.

Within all layouts, the system components are precisely positioned in a 3-dimensional coordinate system.

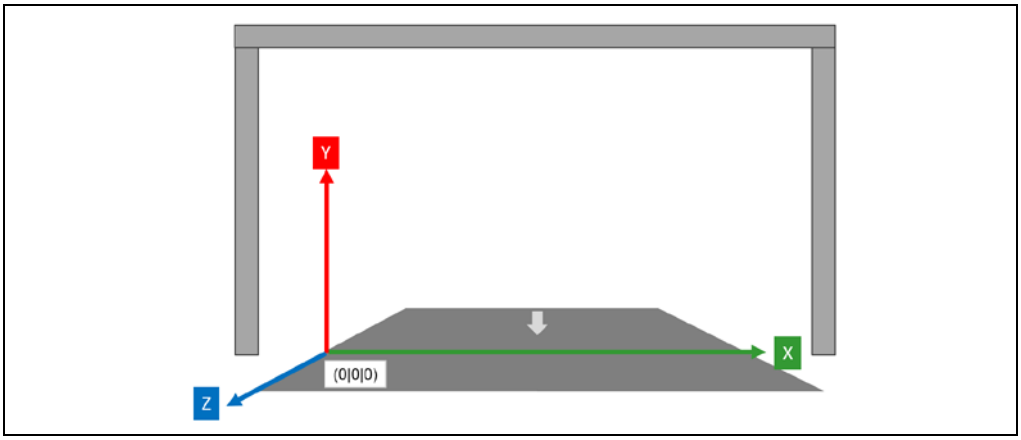


Fig. 2: Coordinate system

The following axes are used in this coordinate system:

- The horizontal axis (X-axis) points orthogonally across the lane. The zero-point of this axis is the right-hand edge of the lane (when viewed in the direction of travel).
- The vertical axis (Y-axis) points upward perpendicular to the road surface.
- The movement axis (Z-axis) points in the direction of travel. The zero-point is located on the profile measuring plane comprising one or more LMS Width laser scanners.

3.1.2 Possible layouts

The following chapters illustrate a selection of possible layouts for the measurement site.

Note The suggested mounting positions can, of course, be adapted to suit the specific on-site conditions.

3.1.2.1 Layouts for vehicle detection, vehicle measurement, and vehicle classification

The figure below shows a profiling system with two **LMS Width** laser scanners mounted at the sides of the gantry and one **LMS Length** laser scanner mounted in the middle. This layout allows you to measure vehicle dimensions and to classify vehicles.

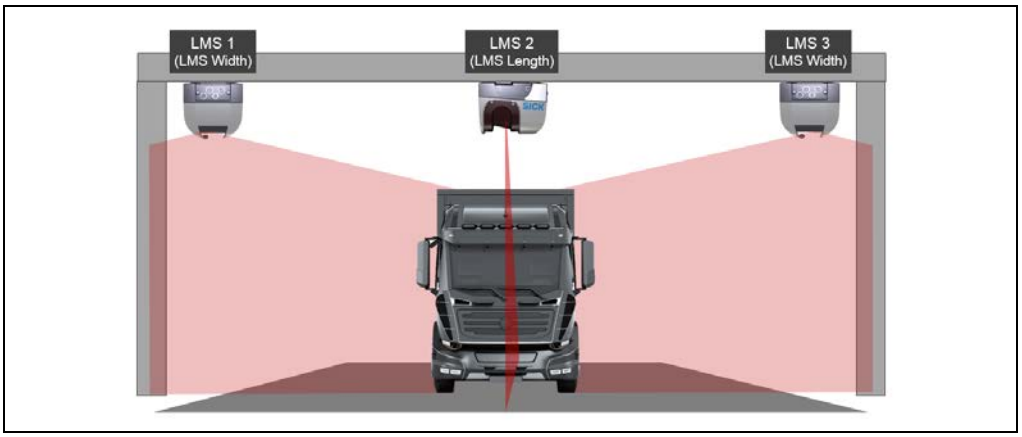


Fig. 3: Layouts – 1 lane, 3 x 2D LiDAR sensors

The two **LMS Width** laser scanners mounted on the gantry above the lane are used to **capture the profile** of the vehicle using individual 2D cross-sections. The beam of the LMS Width is emitted perpendicular to the road surface. To capture the profile of both sides of the vehicle, two LMS Width laser scanners are normally used. The purpose of this is to increase the density of the measuring points in the 3D point cloud and to ensure that the vehicle is measured on both sides.

The **LMS Length** (which is aligned along the lane) is responsible for vehicle tracking, measures changes in vehicle speed, and provides the time axis to which the individual 2D cross-sections are assigned. The beam of the LMS Length is emitted along the direction of travel.

The accuracy of the length and speed measurements can be increased by using a second **LMS Length**. This should be mounted slightly further along the road from the other one in the direction of travel. Additionally, the LMS Length detects the front of the vehicle that is within the measuring range. This approach is particularly good for improving the accuracy of measurements in stop-and-go traffic.

The additional 2D LiDAR sensor further along the road can be mounted on a post or cantilever beam. It does not have to be mounted overhead.

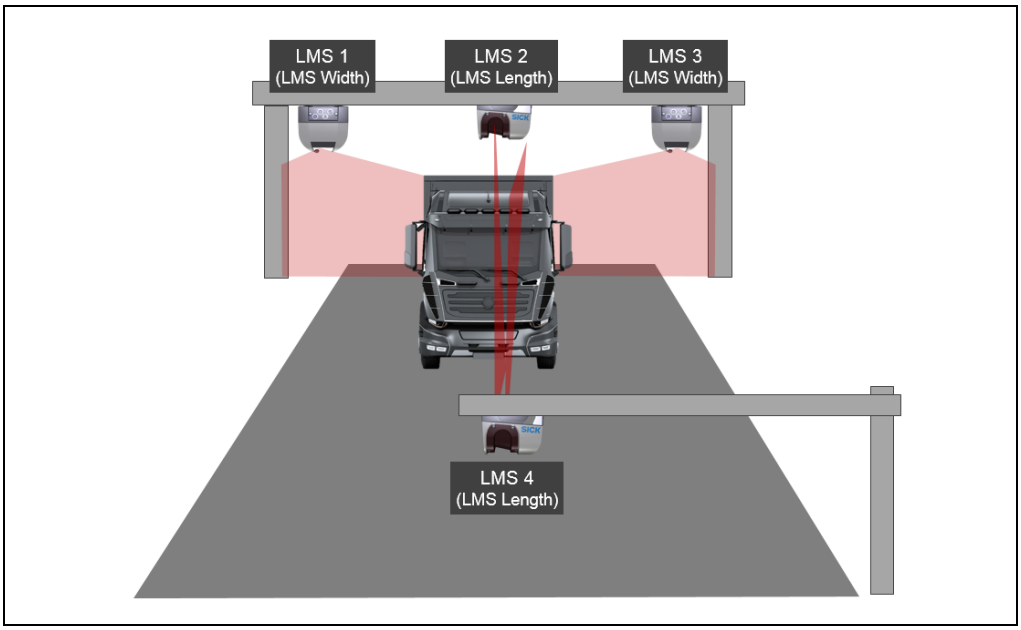


Fig. 4: Layouts – 1 lane, 4 x 2D LiDAR sensors

A single 2D LiDAR sensor can also handle system functions for more than one lane at once. In the example below, the LMS Width has been mounted centrally between two lanes so that it can capture the profile of the vehicles in both of them.

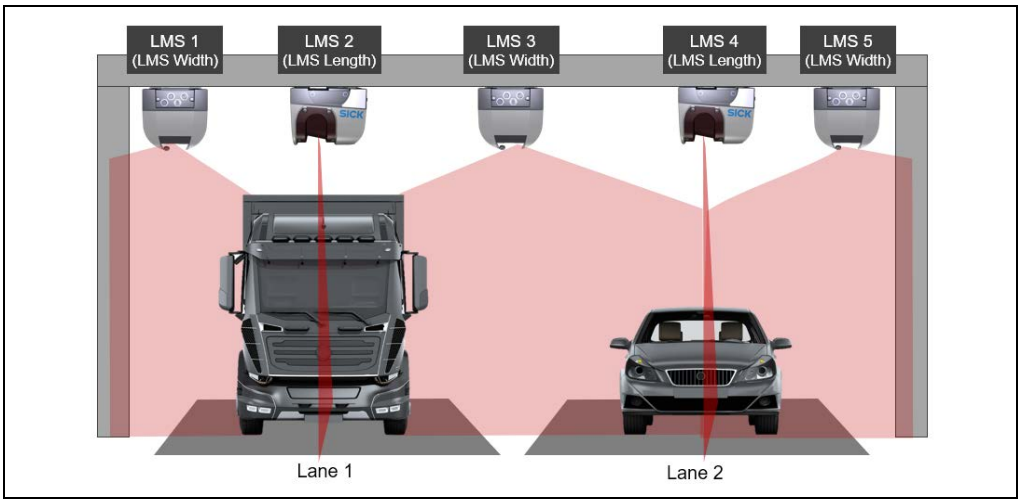


Fig. 5: Layouts – 2 lanes, 5 x 2D LiDAR sensors

Alternatively, a single LMS Width can also be used to capture the profile when monitoring two lanes. Vehicle tracking takes place via two LMS Length laser scanners mounted above each lane.

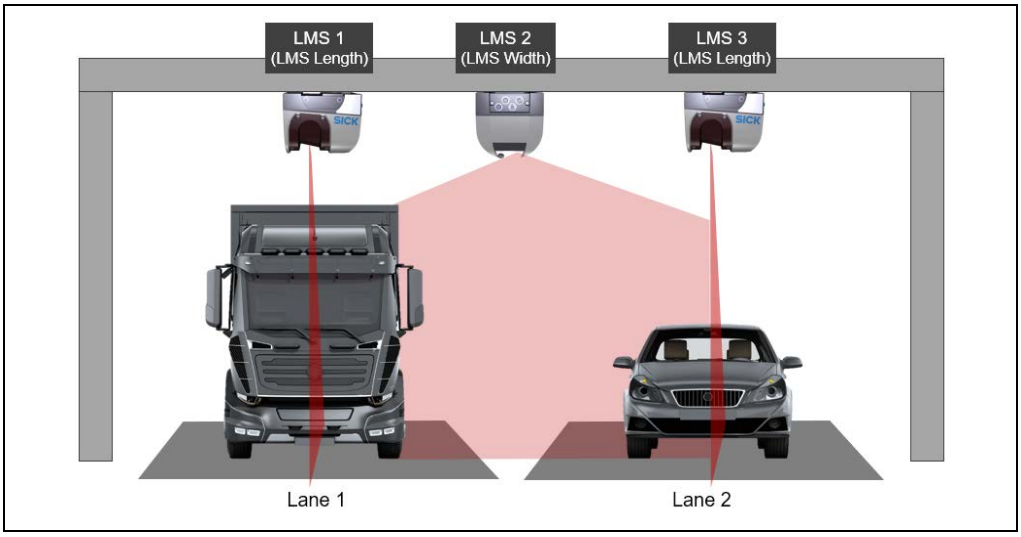


Fig. 6: Layouts – 2 lanes, 3 x 2D LiDAR sensors

Note It is not mandatory to use an LMS Length laser scanner as part of the profiling system. However, if – for example – only two LMS Width laser scanners are used, it will not be possible to calculate a vehicle length from the resulting 3D point cloud. Nor will it be possible to determine the speed or to assign a 2D cross-section to the time axis.

3.1.2.2 Layouts for the axle counting function

The **LMS Axle** system component for counting axles is mounted at the side of the lane. This mounting position ensures that the side of the vehicle is captured.

As well as incorporating the **LMS Axle** system component, this 2D LiDAR sensor is usually responsible for the **LMS Width** system component as well (shared function).

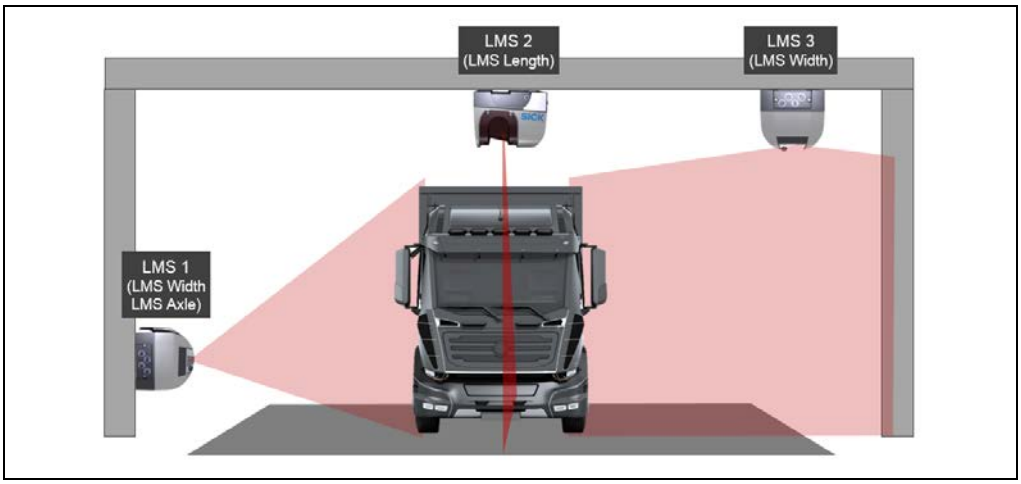


Fig. 7: Layouts – Axle counting for a single lane with 3 x 2D LiDAR sensors

The following example shows the layout for the axle counting function above two lanes with a total of five 2D LiDAR sensors.

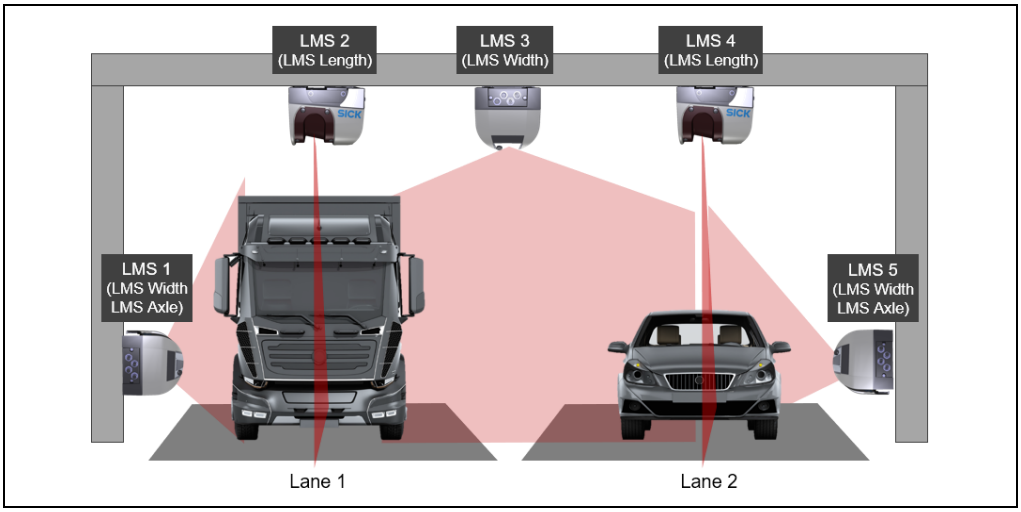


Fig. 8: Layouts – Axle counting for two lanes with 5 x 2D LiDAR sensors

3.2 The system components in detail

3.2.1 2D LiDAR sensors

The 2D LiDAR sensor records the contour of the passing vehicle. To do this, it establishes a measuring range and scans the vehicle using a non-contact time-of-flight process. The laser beam is emitted through the inspection window. The scan plane position is indicated by a housing marking next to the inspection window (see the circle in the figure below).

Fig. 9: System components – 2D LiDAR sensors

A 3D model of the vehicle is generated in the Traffic Controller FPS using the measurement data that has been obtained. This model then serves as the basis for further processing (see *3.3.1 Operating principle of vehicle detection*).

Note The 2D LiDAR sensor automatically measures contamination on the inspection window. The level of contamination is displayed directly on the device or displayed via the Traffic Controller FPS and/or transmitted to the downstream customer system.

For detailed information about the operating principle of the 2D LiDAR sensors, please refer to the operating instructions for the LMS5xx product family.

3.2.2 Traffic Controller FPS

The Traffic Controller FPS uses the installed profiling software to calculate the vehicle dimensions, vehicle class, and number of axles. These calculations are based on the vehicle contour that has been recorded and the position of the vehicle within the lane.

At the same time, the Traffic Controller FPS acts as the central control unit for the profiling system. Using its TCP/IP Ethernet interface, it constantly provides the downstream systems with all system data, the measuring points, measurement results, and system messages.

The TCP/IP interface is also used for set-up, calibration, and fault analysis with the aid of tools.

Fig. 10: System components – Traffic Controller FPS

3.3 System operating principle

3.3.1 Operating principle of vehicle detection

As soon as a vehicle passes through the measurement site, the 2D LiDAR sensors record its contour.

The 2D LiDAR sensors do this by establishing the measuring range and using a non-contact process to scan the vehicle. The profiling system does not require any reflectors or position marks to do this. It is an active system featuring eye-safe infrared lasers.

Fig. 11: Operating principle of vehicle detection

The system uses the measurement data obtained to generate a three-dimensional model of the vehicle. The 3D model serves as the basis for further calculations, such as dimensioning, vehicle classification, or axle counting.

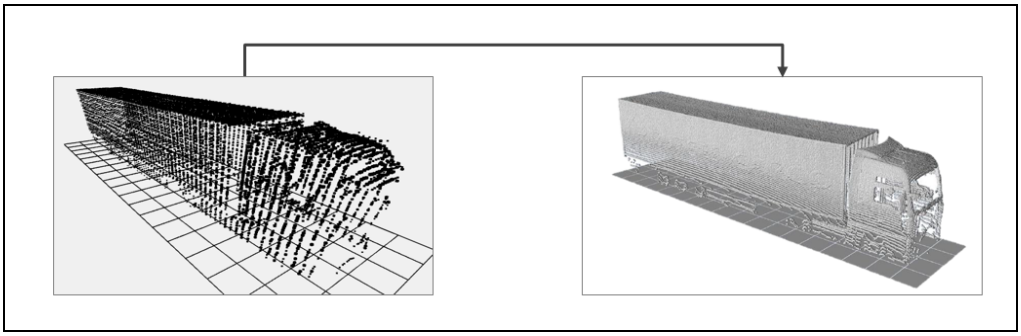


Fig. 12: 3D point cloud

Notes Any measuring points resulting from environmental influences (such as fog, rain or snow) that cannot be attributed to the object are suppressed using special filters. This means that the measurement process can be optimized and refined to a considerable extent, even in harsh ambient conditions.

Operating principle of the LMS Width

The beam of the **LMS Width** is emitted perpendicular to the road surface. Depending on the mounting situation, the LMS Width detects the side and top of the vehicle.

The recording process starts as soon as a vehicle is detected by the LMS Width. The recording process stops when the LMS Width detects the final point on the vehicle. After the vehicle has passed through, 2D cross-sections are generated and sent to the Traffic Controller FPS.

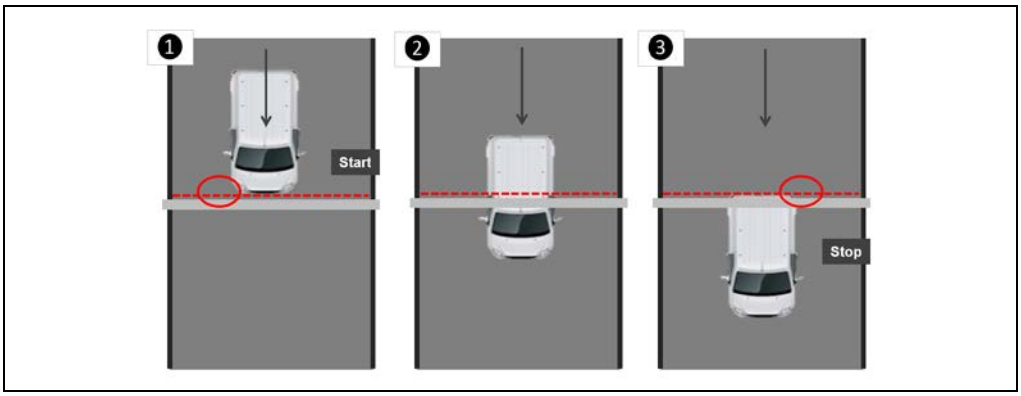


Fig. 13: Operating principle of vehicle measurement – LMS Width

Operating principle of the LMS Length

The beam of the gantry-mounted **LMS Length** is emitted along the direction of travel. It detects the top, front, and tail of the vehicle. The data captured by the LMS Length are used to calculate the length and speed of the vehicle.

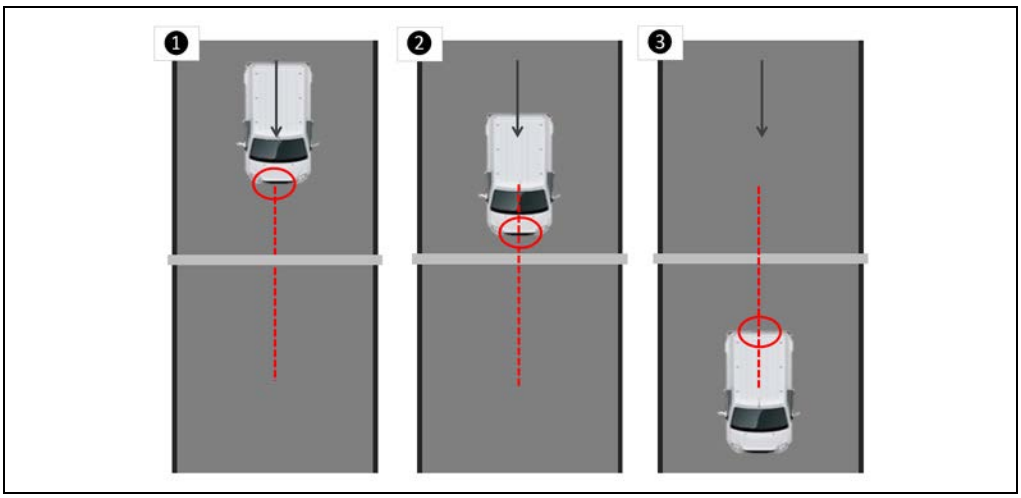


Fig. 14: Operating principle of vehicle measurement – LMS Length

3.3.2 Operating principle of the function for calculating the vehicle dimensions

The Traffic Controller FPS combines the individual 2D sections of the vehicle. When the speed and the position of the vehicle on the measured section are taken into account, a 3D point cloud can be generated and the Traffic Controller FPS can then use this to determine the vehicle dimensions.

With the standard version of the profiling system, the vehicle dimensions are **calculated** in accordance with the following formulas:

Height = Ymax(S)

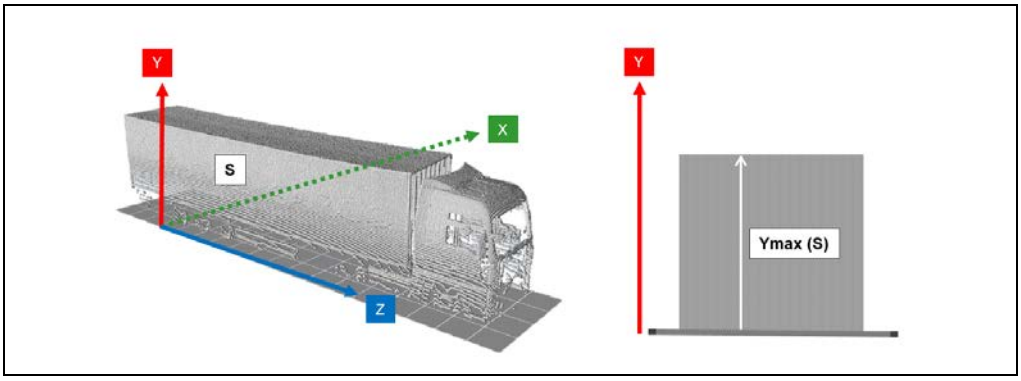


Fig. 15: Dimensioning operating principle – Height

The maximum vehicle height is determined from the maximum Y value of the 3D point cloud **S**.

Length = Zmax(S) – Zmin(S)

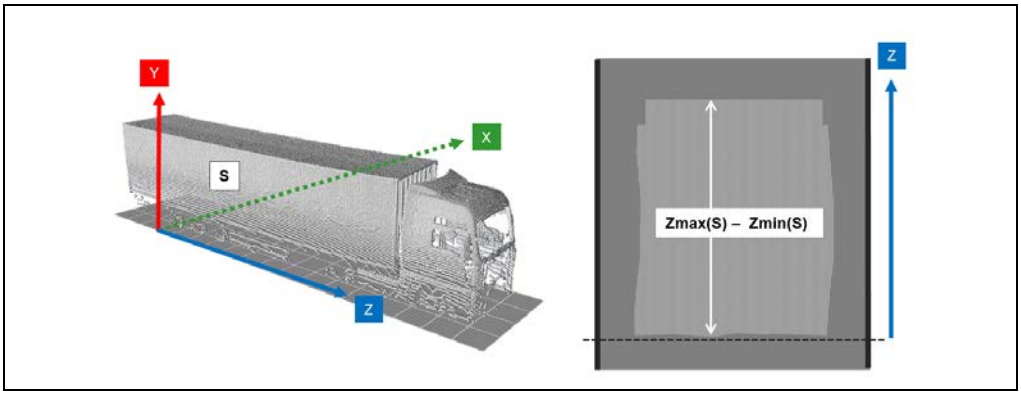


Fig. 16: Dimensioning operating principle – Length

The maximum vehicle length is calculated by subtracting the minimum Z value from the maximum Z value of the 3D point cloud **S**.

Width = max_Si (Xmax(Si) – Xmin(Si))

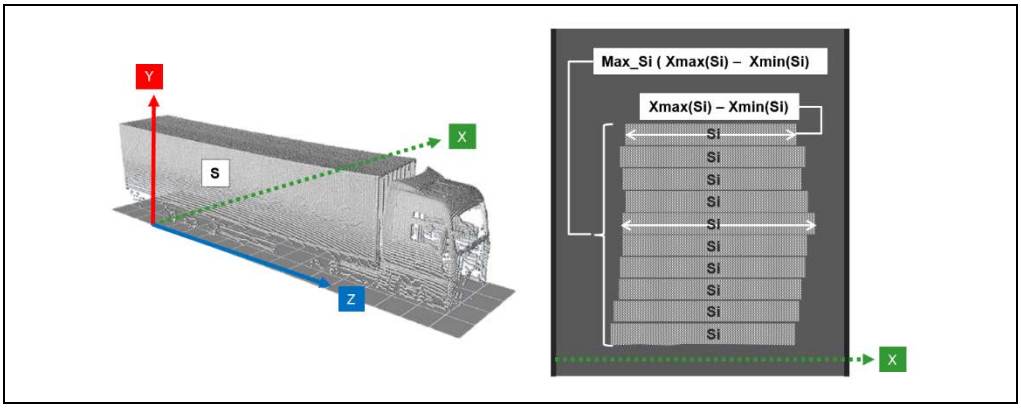


Fig. 17: Dimensioning operating principle – Width

To calculate the width of the vehicle, sections (**Si**) are generated from the 3D point cloud (S). The width is calculated for each section from the 3D point cloud. The maximum vehicle width is determined by considering the maximum width of all sections from the 3D point cloud.

This calculation method makes it possible to compensate for errors in cases where vehicles follow a slightly curved path through the measurement site instead of traveling in a perfectly straight line.

Note

With the default calculation method, all the attachments on the vehicle (e.g., roof antenna and side rearview mirrors) are included when calculating the dimensions. If country-specific regulations stipulate that the vehicle dimensions must be calculated without including the antenna or side rearview mirrors, the calculation method can be adapted accordingly.

For instance, the system can be configured so that the maximum width is only measured as of a defined distance on the Z-axis, thereby excluding the side rearview mirrors from the calculation.

3.3.3 Operating principle of the vehicle classification function

The vehicle class is calculated on the basis of the 3D point cloud.

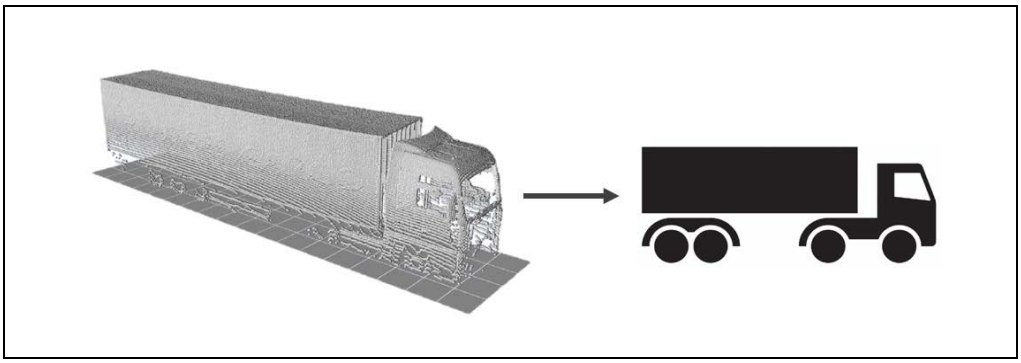


Fig. 18: Operating principle of vehicle classification

The classification criteria are defined by the choice of category system. The category system depends on the local conditions that apply in the country where the profiling system is being used.

Europe uses a detailed category system with 28 vehicle classes. Vehicles are identified by comparing them against the vehicle classes. The class representing the closest match is allocated to the vehicle.

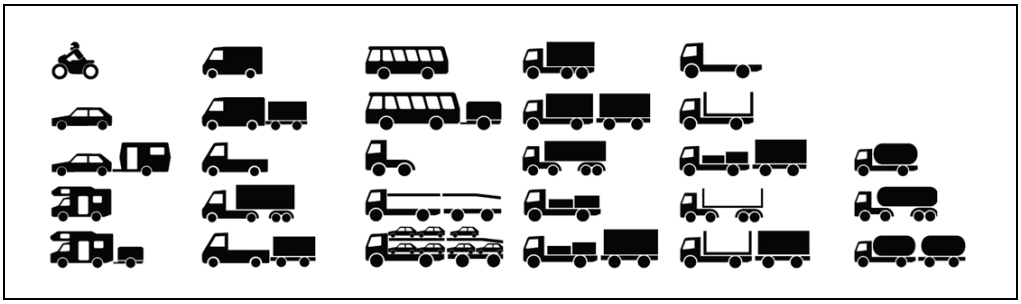


Fig. 19: Vehicle classes in the European category system

The categories can be grouped together into various **output category systems**, such as **Swiss10** with 10 categories, **TLS 8+1** with 8 categories, **TLS 5+1** with 5 categories, and **TLS 2+0** with 2 categories. Other groupings are also possible.

With the **output category system**, vehicles are no longer identified on the basis of the individual vehicle classes within the category system. Instead, they are identified on the basis of classification groups. For example, the **TLS 2+0** output category system includes two classification groups: **Car or similar** and **Truck or similar**.

Notes

Vehicles are classified on the basis of the 3D point cloud without considering the total permissible weight.

Extreme weather such as heavy rain or snowstorms may affect the accuracy of output data.

3.3.4 Operating principle of the vehicle axle counting function

The 2D LiDAR sensor for counting the number of axles is mounted at the edge of the lane and captures the side of the passing vehicle. In order to count the number of axles and (where applicable) locate their positions, the system also needs to access the measuring points of the 3D point cloud.

Determining the number of axles

- In order to determine the number of axles, the first step is to analyze point patterns of the wheels and shadow patterns on the roadway. Combining the two analysis methods helps to achieve a high level of measurement accuracy.

  The areas containing wheels (and, by implication, axles) can be expected to generate very few measurement points, if any at all.

  In contrast, a large number of measurement points will be detected in areas of the vehicle where there are no wheels (and, in turn, no axles) and the 2D LiDAR sensor is able to look “underneath” the vehicle to a certain extent.

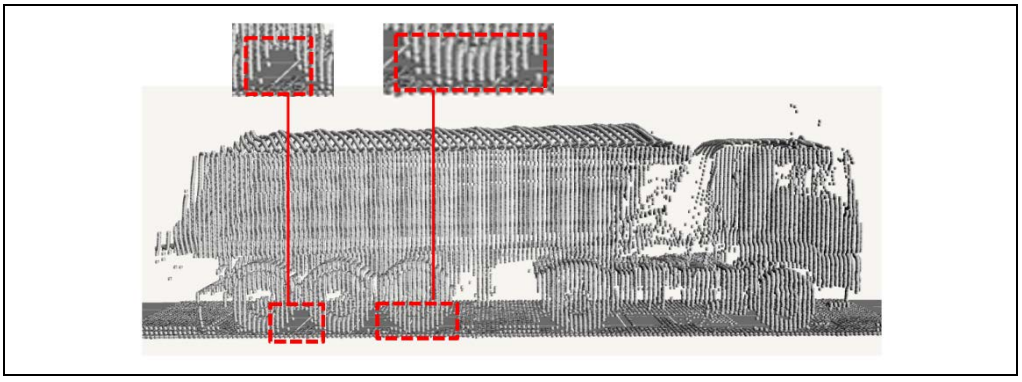


Fig. 20: Operating principle of axle counting – Wheel detection using shadow patterns

- In a second step, the shadow patterns undergo a plausibility check. This means that each shadowed area is checked to see whether there is a corresponding point pattern for a wheel.

  Every wheel detected is counted as one axle. Twin wheels count as one axle. Wheels on a raised axle (at least 10 cm above the ground) will not be counted.

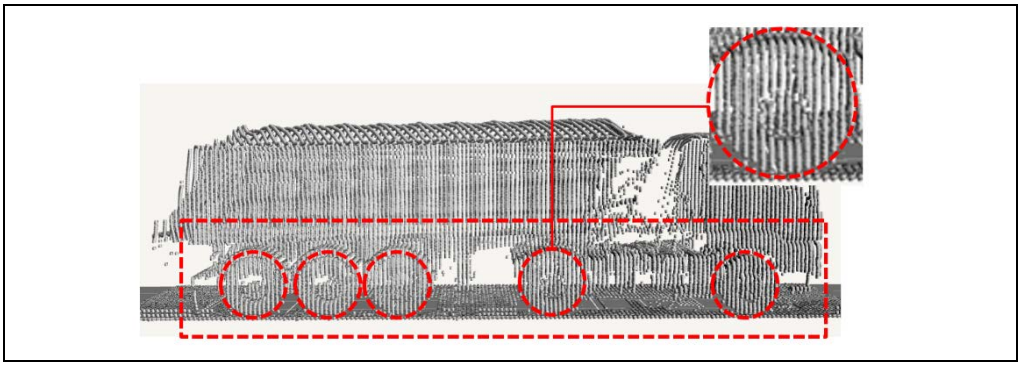


Fig. 21: Operating principle of axle counting – Wheel detection using a point pattern

Axle positions

The axle positions are determined on the basis of the point cloud starting from the front of the vehicle.

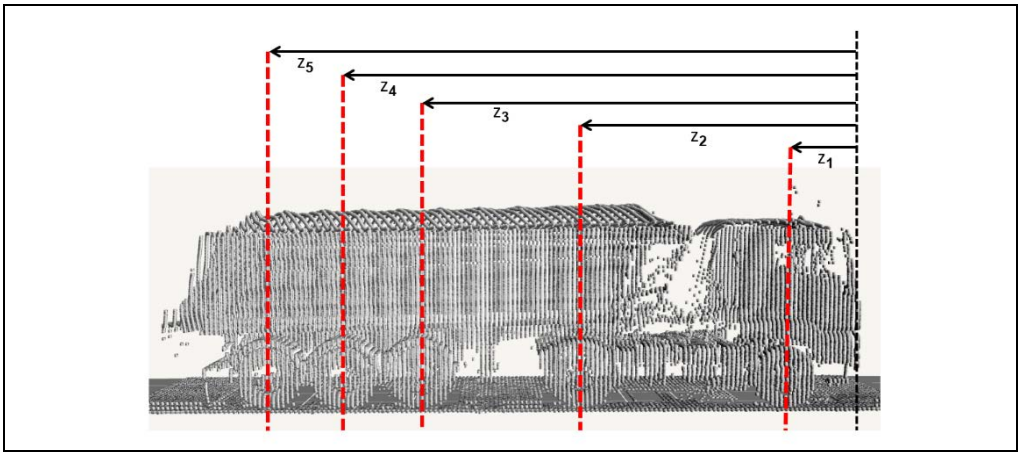


Fig. 22: Operating principle of axle counting – Determining the position of the axles

Notes

- The axle counting accuracy decreases if the vehicle's axles are difficult to detect. This affects vehicles with a lower chassis, vehicles with a small wheelbase, and vehicles that have lots of small wheels located very close to one another.
- When the road is very wet and there is a high level of spray, the axle counting accuracy will reduce significantly.

3.3.5 Emission of object location messages

In addition to vehicle-related information, the system also delivers so-called object location messages. These messages provide information on the time at which the vehicle was located at a defined position in the lane. In order to integrate third-party systems such as license plate cameras, these messages must be assigned with a time stamp.

It is possible to define trigger lines before and after the measuring plane. If a vehicle passes over this line during the measurement process, a message is emitted.

Note Stable time synchronization (NTP) is essential for this type of integration.

The LMS Length supplies the information about the vehicle's location within the lane. To do this, it scans the front and rear end of the vehicle.

The time stamps for the vehicle location are sent to the Traffic Controller 20 ms after the position line is passed.

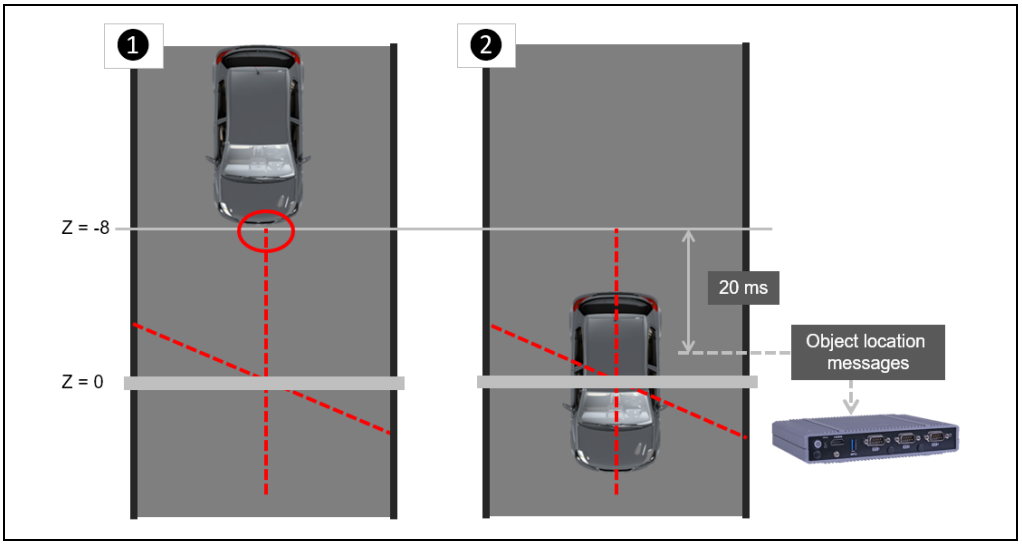


Fig. 23: Determination of object location messages

Adjustable distance of the trigger lines from the zero point of the Z-axis

System	Maximum distance in both directions
FPS Pro	max. 15 m

3.3.6 Data processing in the Traffic Controller FPS

All the measured values converge in the Traffic Controller FPS. The TEMS Recorder processes the raw data supplied in a continuous data stream. The data in this stream are supplemented and consolidated. At the end of the data processing flow, data are output via the TCP/IP interface (TEMS Info interface).

All of the profiling system functions are structured **hierarchically** for data processing. This structure is defined in the system configuration.

- At the start of the process, the **initial system function** records the basic data. This supplies the vehicle data.
- The **subsequent system functions** add to the basic data.

The figure below illustrates how the initial vehicle data are continuously supplemented by the measurement results of the individual system functions.

At the end of the data processing flow, data are output to the higher-level system via the TCP/IP interface.

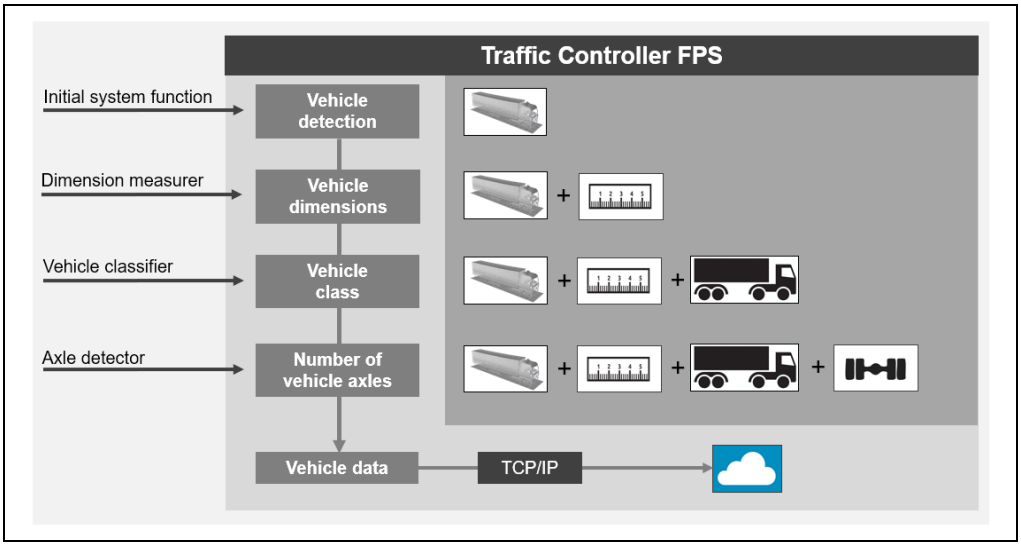


Fig. 24: How data are processed in the Traffic Controller FPS

3.3.7 Output data

In addition to the vehicle data, the profiling system also outputs the measurement site data and the system status.

The output of vehicle data is customer-specific and so the exact nature of the data depends on which system functions are installed.

Dimension measurer

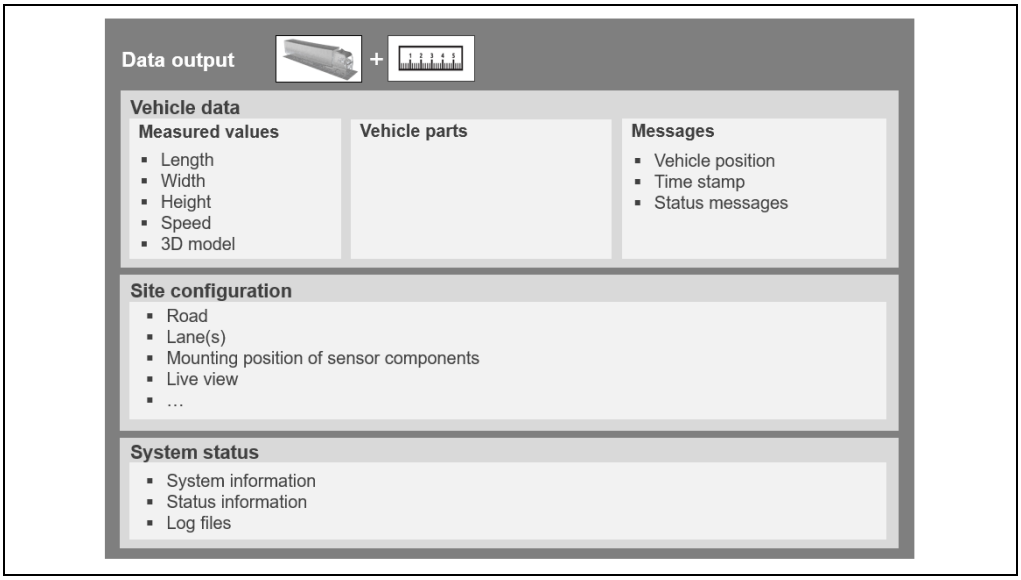


Fig. 25: Output data – Dimension Measurer

Dimension Measurer + Vehicle Classifier

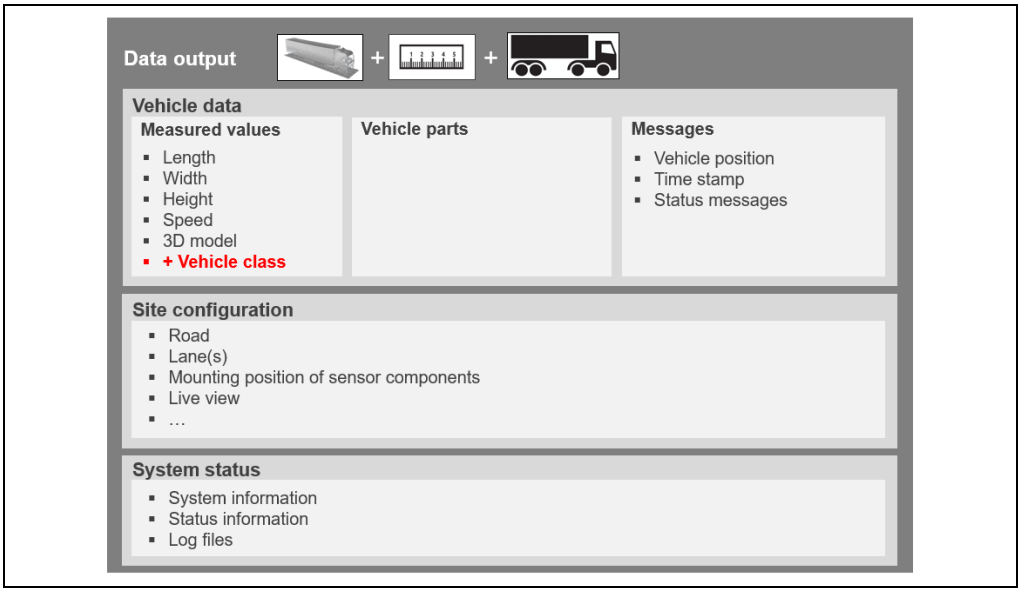


Fig. 26: Output data – Dimension Measurer + Vehicle Classifier

Dimension Measurer + Vehicle Classifier + Axle Detector

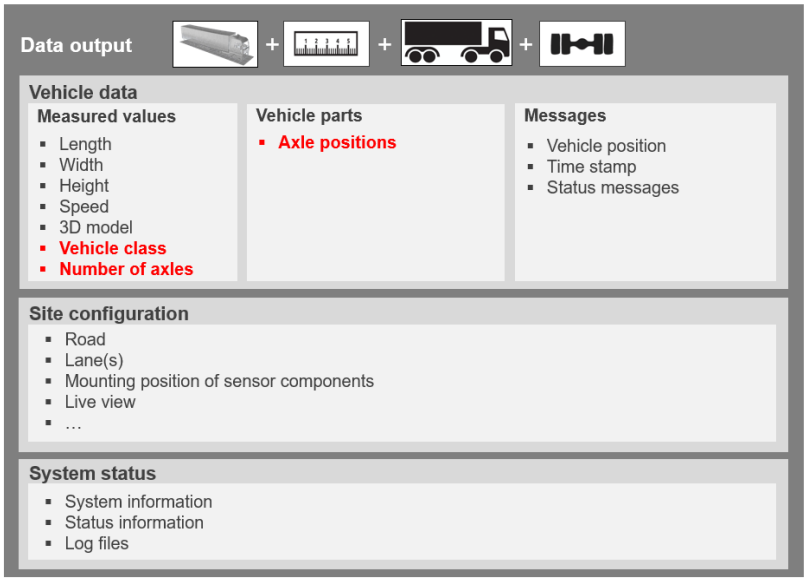


Fig. 27: Output data – Dimension Measurer + Vehicle Classifier + Axle Detector

3.4 System interfaces

Communication between the system components and the downstream components takes place via TCP/IP interfaces. The interfaces can, for example, be utilized by a traffic checkpoint or system operator.

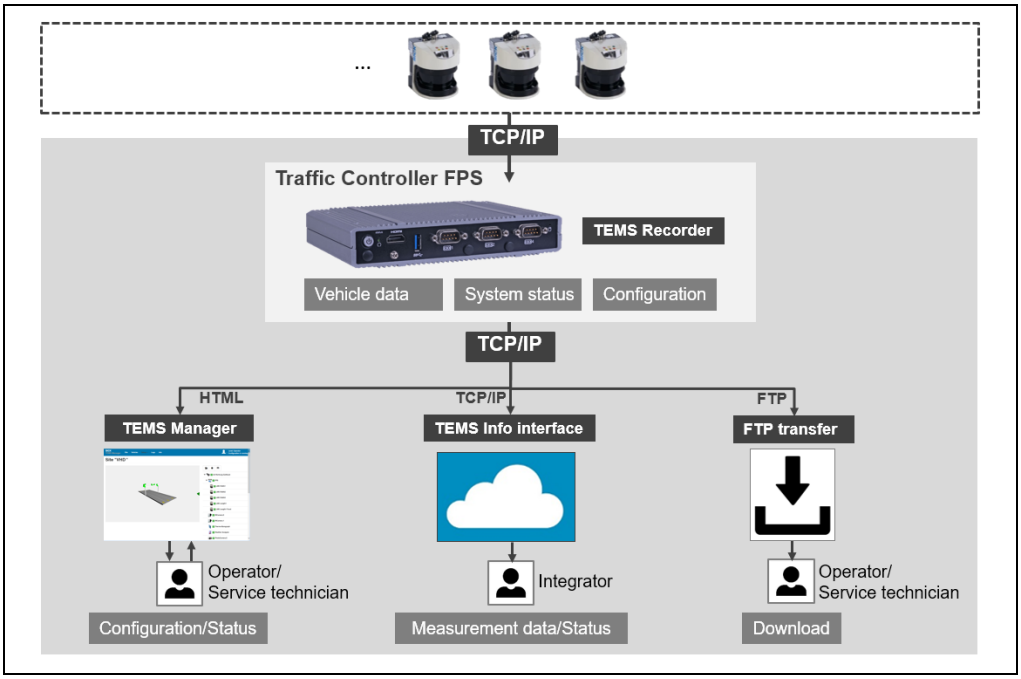


Fig. 28: Interfaces of the profiling system

All sensors are connected to the Traffic Controller FPS via an Ethernet interface. The TEMS Recorder with profiling functionality comes pre-installed on the Traffic Controller FPS. The recipients of the data output via the TCP/IP interface are:

- **TEMS Manager Web**. This allows you to check that the profiling system is operating correctly from any computer that is connected to the Traffic Controller FPS. It also provides a detailed view of the measurement results. TEMS Manager is used by operators and service technicians.

  Provided that you have the relevant access authorization, you can also use **TEMS Manager Web** to configure and monitor the system. As an alternative to TEMS Manager, you can also use **TEMS Manager Command Line** if you wish to configure the system using command lines.
- **TEMS Info interface**. This receives measurement results as messages. The interface distinguishes between messages containing vehicle information and messages containing data on the positioning of the vehicle in the lane. The TEMS Info interface also delivers all system status messages.
  Integrators can use the TEMS Info interface to integrate the system into third-party systems (traffic routing system, alert systems, etc.).
- The **FTP interface** can be used to download vehicle data stored in the Traffic Controller FPS and the TEMS Recorder log files. Alternatively, vehicle data can also be uploaded automatically to a customer FTP server (see chapter *3.4.3 Plug-ins for saving and downloading the vehicle data* and *3.4.3 Downloading log files*).

3.4.1 Integration into existing IT infrastructure

The Traffic Controller FPS network is divided into internal and external network structures. For this reason, the Traffic Controller FPS has two ports.

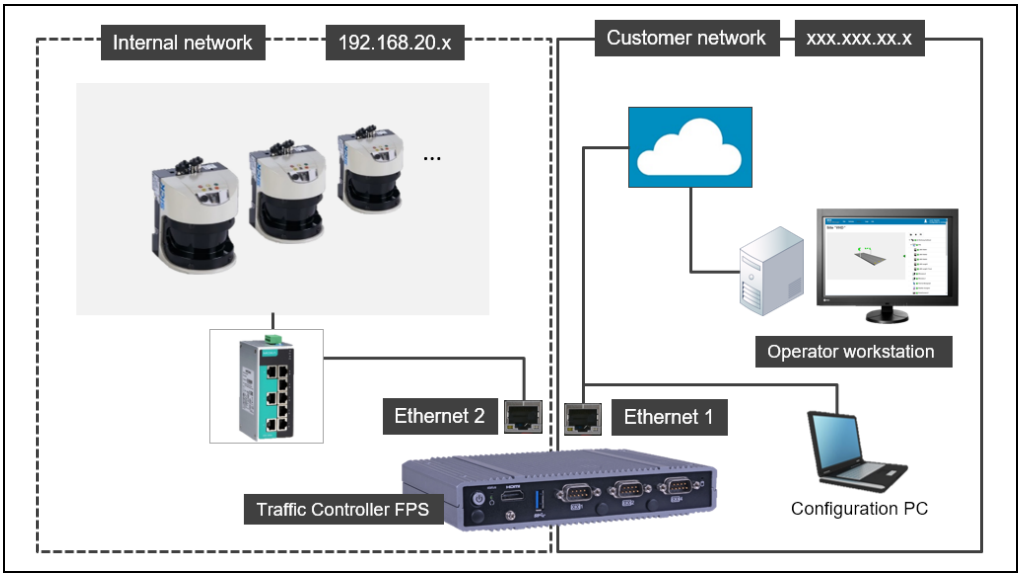


Fig. 29: Integration of the profiling system into existing IT infrastructure

The IP address of the **external** network interface card (**Ethernet 1**) is freely configurable so that the profiling system can be integrated into the existing customer network.

Meanwhile, all the system components are connected to **one another** via the **internal** network (**Ethernet 2** with network address **192.168.20.x**).

3.4.2 Site view in TEMS Manager

The TEMS Manager can be used to check that the profiling system is operating correctly from any computer that is connected to the Traffic Controller FPS.

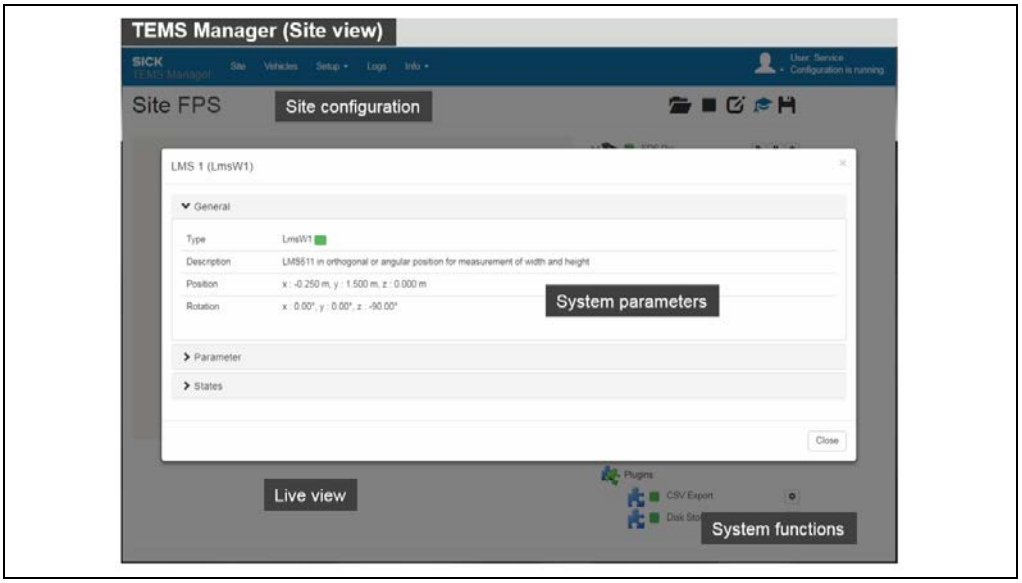


Fig. 30: Interfaces – TEMS Manager (site view)

In addition, TEMS Manager serves as a visualization platform for the measurement results.

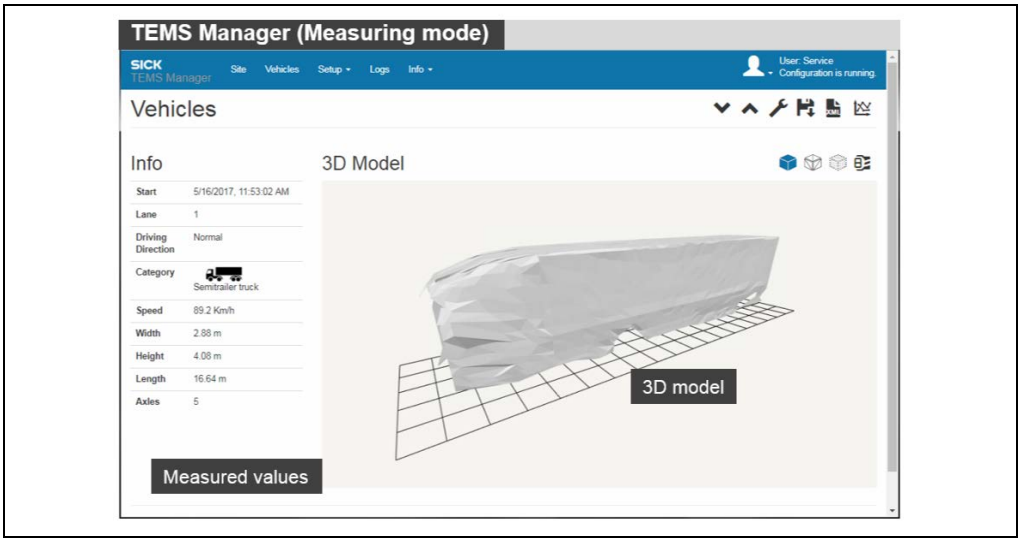


Fig. 31: Interfaces – TEMS Manager (measuring mode)

Note Provided that they have the relevant access authorization, service technicians can also use TEMS Manager to configure the system.

3.4.3 Plug-ins for saving and downloading the vehicle data

By activating certain plug-ins, you can take the vehicle data that are temporarily stored in TEMS Manager and save them permanently on the Traffic Controller FPS and/or can transfer them to an external storage medium.

The plug-ins support various storage formats and transfer methods.

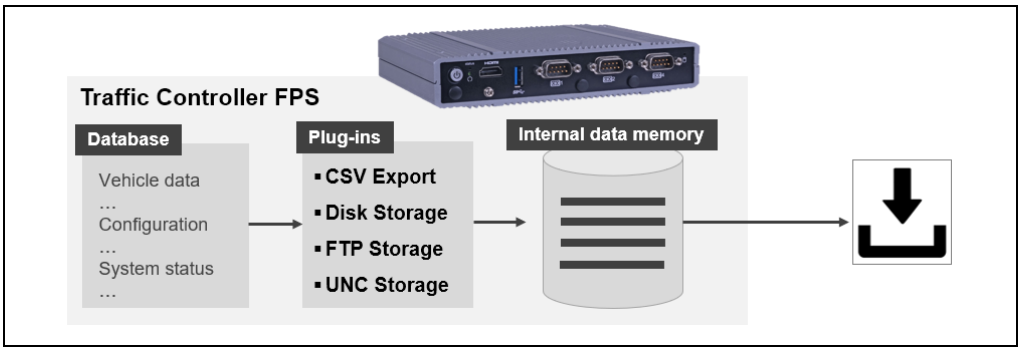


Fig. 32: Plug-ins for saving and downloading the vehicle data

Saving vehicle data on the Traffic Controller FPS

The **CSV Export** and **Disk Storage** plug-ins are both used for saving vehicle data on the Traffic Controller FPS.

- The **CSV Export** plug-in saves the vehicle data obtained to a tabular csv file, which is located inside the **/lists** directory. A separate table row is created in the csv file for each vehicle. As part of this process, you can also specify the period to be covered by a file. Usually, a csv file contains the vehicle data for a particular day. This makes the csv file very suitable for statistical purposes.

Note The time stamp appears in UTC time as the reference time.

- The **Disk Storage** plug-in stores each detected vehicle in a separate file using the **vehicle** file format. The vehicle file is placed in the **/data** directory.

  The vehicle file contains all the information recorded for a vehicle. In addition to the vehicle data, it includes (among other things), the 3D point cloud data or information about when and where the vehicle was located within the measuring range when the data was collected.

Notes

- Please note that the storage space is limited. The storage space is overwritten cyclically for as long as the plug-ins remain active.
- For both plug-ins, you can specify in the parameter definition how often the vehicle data should be deleted from the Traffic Controller FPS data memory (see also chapter *6.7.1 Displaying the system parameters and system status*). The delete operation is only performed if the plug-ins are active.
- If the plug-ins have been deactivated, the data inside the **/data** and **/lists** directories must be deleted **manually**.
- Any directories that you have created in or under the FTP directory must also be deleted manually. This process is not automated either.
- When there is no space left on the internal memory card, the data from the Traffic Controller must be overwritten. This shortens the service life of the Traffic Controller.

Downloading vehicle data from the Traffic Controller FPS via FTP

Both csv files and vehicle files can be downloaded from the Traffic Controller FPS via FTP by using an FTP client on the customer network.

For this reason, the Traffic Controller FPS has an integrated FTP server. This FTP server is accessed via the **client** user account with the corresponding password. For an overview of the default passwords, please see the following section of the annex: *9.5 Users and authorizations*.

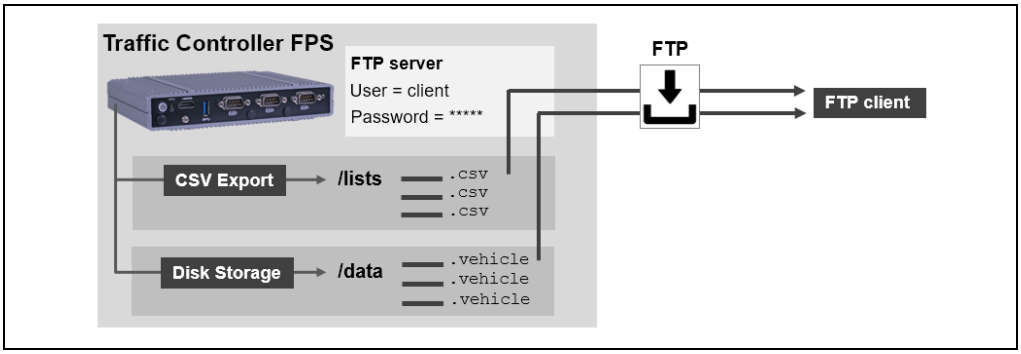


Fig. 33: Downloading vehicle data via FTP

Transferring vehicle data directly to an external storage medium

The **FTP Export** and **UNC Export** plug-ins do not allow you to save the vehicle data permanently on the Traffic Controller FPS. Instead, they are used to transfer the data directly to an external storage medium.

- The **FTP Storage** plug-in works in a similar way to the **Disk Storage** plug-in by generating vehicle files in the **vehicle** format. It then uploads these automatically to a customer FTP server. For this reason, the Traffic Controller FPS has an integrated FTP client. The connection settings for the FTP server are stored in the plug-in itself.

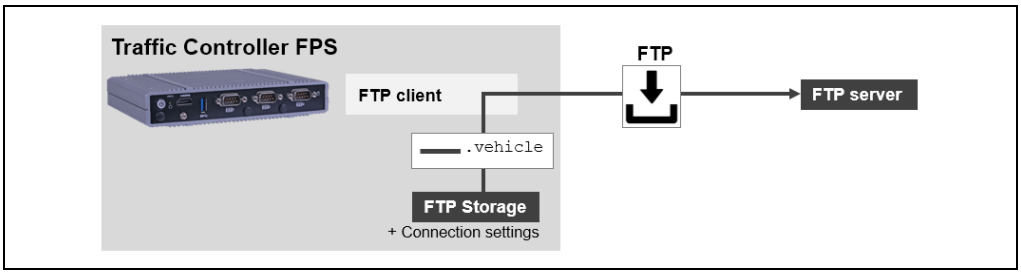


Fig. 34: Automatically uploading vehicle data to a customer FTP server

- The **UNC Storage** plug-in also creates vehicle files in the vehicle format, but it saves these in a UNC path. Entering a UNC path (Universal Naming Convention) allows a directory in a network to be accessed without the need for a drive letter. The UNC path does not need to be visible in Windows Explorer. Windows shared folders can also be used as UNC destinations. The storage location is specified in the plug-in itself.

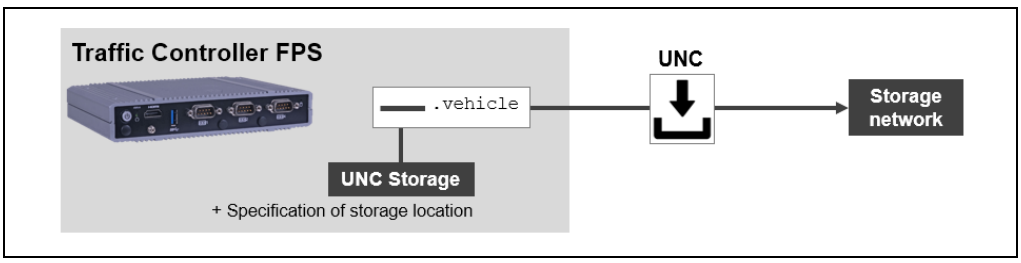


Fig. 35: Automatically saving vehicle data in a UNC directory

3.4.4 Downloading log files

All TEMS Recorder operations are saved to log files in the Traffic Controller FPS, which are kept in the **/logs** directory.

A new file is created for each day. The system automatically deletes any log files older than three months.

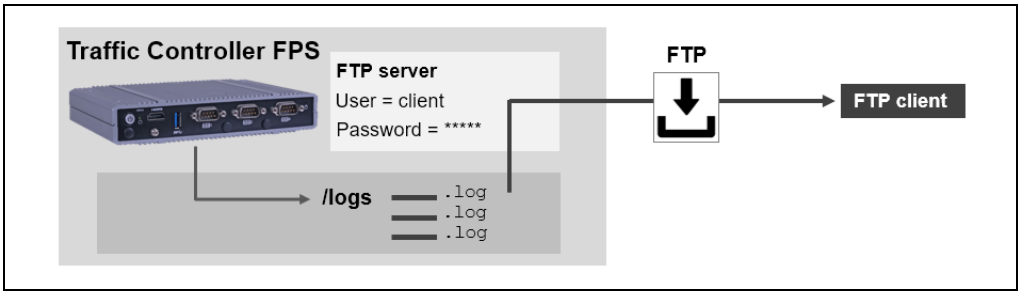


Fig. 36: Downloading log files via FTP

Just like the csv and vehicle files that are stored on the Traffic Controller, log files can also be downloaded via FTP. These can then be sent to SICK Support for fault diagnosis. Alternatively, the files can be downloaded via TEMS Manager.

This download process relies on the FTP server that is installed on the Traffic Controller FPS. This FTP server is accessed via the **client** user account with the corresponding password. For an overview of the default passwords, please see the following section of the annex: *9.5 Users and authorizations*.

Note The log files can also be transferred onto a local data card from TEMS Manager. Additional information can be found in chapter *6.10 Downloading log files*.

3.5 Project planning

Reliable and problem-free use of the profiling system depends on a number of different factors.

3.5.1 General system requirements

To operate the profiling system, the following are required:

- A supply voltage of 24 V DC (12 V DC to 36 V DC) for the Traffic Controller FPS.
- A supply voltage of 19.2 V to 28.8 V for the LMS511 SE 2D LiDAR sensor.
- Customer computer with a TCP/IP data interface for setting up the system, processing the measurement results further, and monitoring the system
- If no Ethernet cables are purchased from SICK for the connection between the 2D LiDAR sensor and Ethernet switch or between the Ethernet switch and Traffic Controller FPS, or if no connectors have to be assembled, we recommend testing the cable quality in accordance with CAT 5e (10/100 Mbit/s) requirements.

Requirements for the client computer

An up-to-date version of a web browser must be installed on the client computer. This browser must support **HTML5** and **WebGL**.

Requirements for the customer network

The following ports must be open on the customer network:

- Port 80 for TEMS Manager Web
- Port 21 for FTP access (log files, vehicle files)
- Port 40,000 to 45,000 for FTP data transfer
- Port 123 for NTP time synchronization
- Port 5900 for remote access via VNC

3.5.2 Requirements for vehicles

The profiling system can be used to measure all types of vehicle.

The vehicles must have the following properties:

Dimension	Min.	Max.
Length	1.0 m	30.0 m
Width	0.6 m	5.0 m
Height	0.6 m	5.0 m

Tab. 3: Project planning – Vehicle properties

3.5.3 General requirements at the measurement site

A **flat** road with a route as **straight** as possible is needed for use of the profiling system. The length of the straight section before and after the measuring point is defined by the maximum vehicle length to be checked.

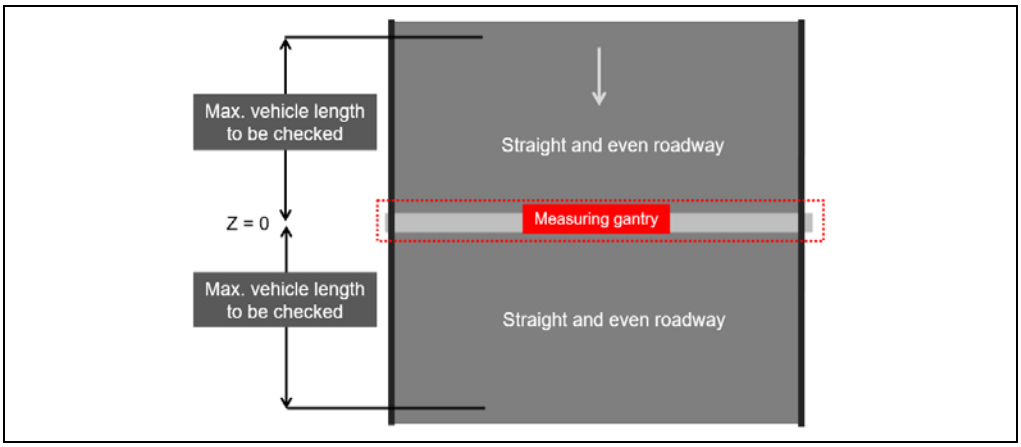


Fig. 37: Measurement site project planning

To ensure optimum measurement results, there must be a gap of at least 2 m between vehicles passing through the measurement site. The faster the speed, the longer the distance between the vehicles has to be.

3.5.4 Requirements for mounting the vehicle detection components

The measurement system requires a stable gantry that is twist-resistant and free of vibrations. This gantry must also have sufficient load bearing capacity to support the 2D LiDAR sensors used for vehicle detection.

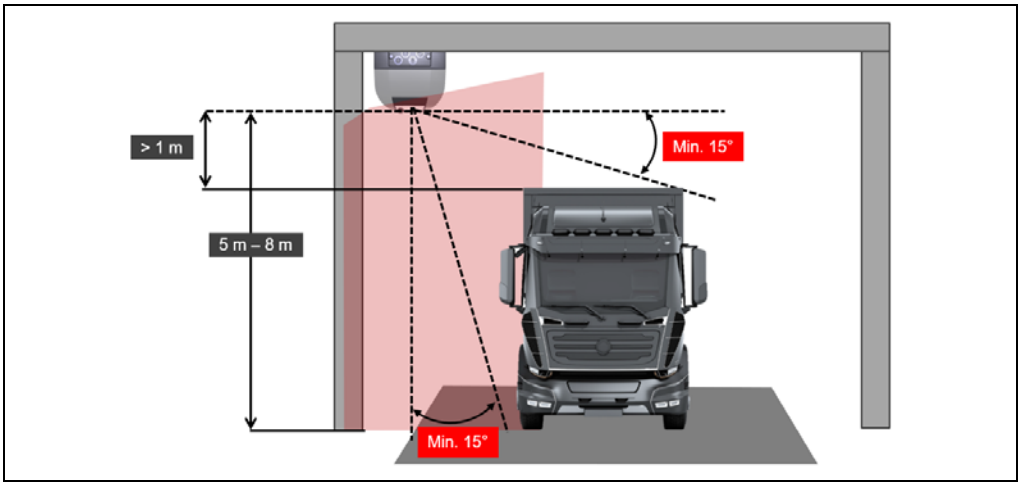


Fig. 38: Vehicle detection project planning

LMS Width

The LMS Width must be mounted 5 m to 8 m above the ground. The ideal mounting height is approx. 6 meters, measured from the lower edge of the 2D LiDAR sensor. Take care to ensure that the mounting height is at least 1 m higher than the maximum vehicle height.

Design the measuring site so that the angle between the LMS Width and the largest vehicle to be measured is at least 15°. The size of the angle must not be below this value, as otherwise it is not possible to capture a network of measuring points with the necessary density during the vehicle measurement process.

The angular resolution of the LMS Width is 0.5° at a frequency of 75 Hz.

Note All the 2D LiDAR sensors mounted on the gantry must be in **a single measuring plane**.

LMS Length

Depending on the system and the application, the LMS Length can either be mounted to one side or can be mounted on a gantry or cantilever arm. As with the LMS Width, the permissible mounting height for the LMS Length is 5 m to 8 m above the ground. The beam must be emitted parallel to the direction of travel.

The crucial factor here is that the LMS Length must always be able to detect the front of the passing vehicle. It is also essential to observe the detection range of the LMS Length. If the LMS Length is positioned further down the road, it must be no more than 30 m away from the measuring gantry.

The angular resolution of the LMS Length is 0.25° at a frequency of 35 Hz.

Notes

- ► It is important to ensure that all the 2D LiDAR sensors have an unobstructed view of the measuring range at all times.
- ► The 2D LiDAR sensors must always be mounted free of vibrations and oscillations.

3.5.5 Requirements for mounting the axle counting components

The LMS Axle 2D LiDAR sensor must be positioned so that it is able to record the entire flank of the vehicle and, in particular, the entire axle area. Consequently, it must be mounted at the side of the lane.

Notes

- The area between the LMS Axle and the vehicle must be free from any optical obstacles. Please note that items such as guardrails or bushes should not restrict the scanner's view.
- The LMS Axle must be in the same measuring plane (X-axis) as the LMS Width.
- The LMS Axle must have a good view of the road surface. A good view means that it must be able to detect as many measurement points on the ground as possible.

Requirements for optimum measurement results

The LMS Axle achieves optimum measurement results when as many measurement points can be generated in the analysis area (shadow pattern, point patterns for wheels) as possible. In order to obtain the minimum number of measurement points required, a mounting position for the LMS Axle must be selected so that the distance between the 2D LiDAR sensor and the wheels is not too large and so that the laser beam's angle of incidence is not too steep.

The flatter the angle of incidence and the closer the 2D LiDAR sensor is to the lane, the more measurement points will be generated.

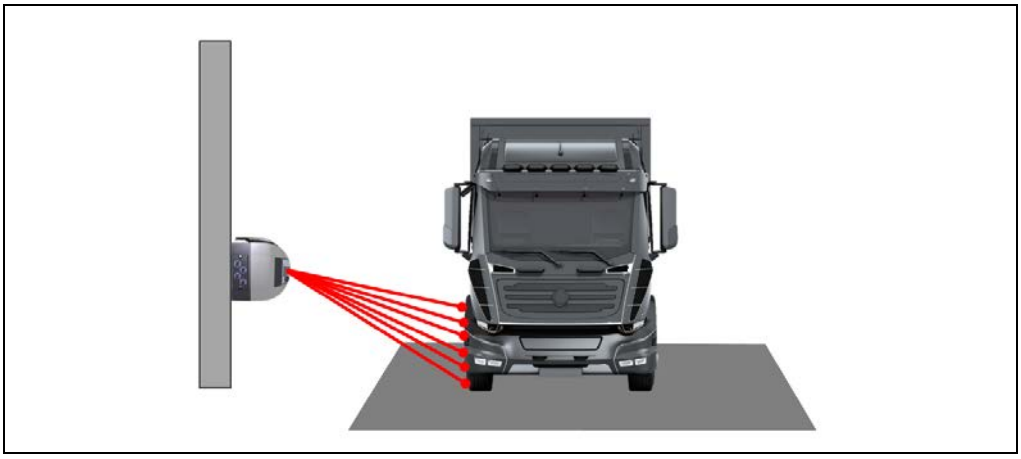


Fig. 39: AxleDetector project planning – Angle of incidence for the LMS Axle (optimum)

Note The angular resolution of the LMS Axle is 0.67° at a frequency of 100 Hz.

In the following figure, the mounting position is too high and, because the laser scanner is too close to the edge of the lane, the angle of incidence is too steep. This means that fewer measurement points are generated in the analysis area (shadow pattern, point pattern for the wheels).

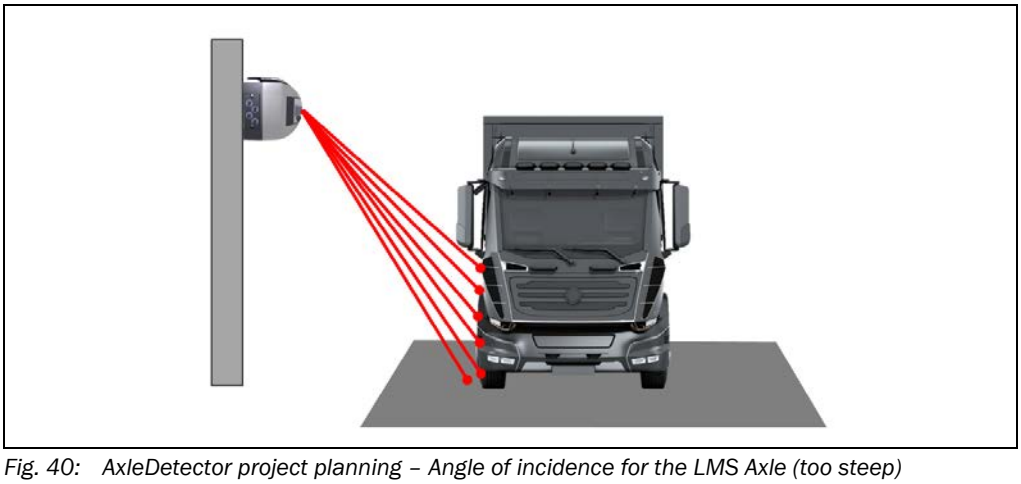


Fig. 40: AxleDetector project planning – Angle of incidence for the LMS Axle (too steep)

The following figure shows the combination of the vertical and horizontal distance for the LMS Axle that generates the best measurement results.

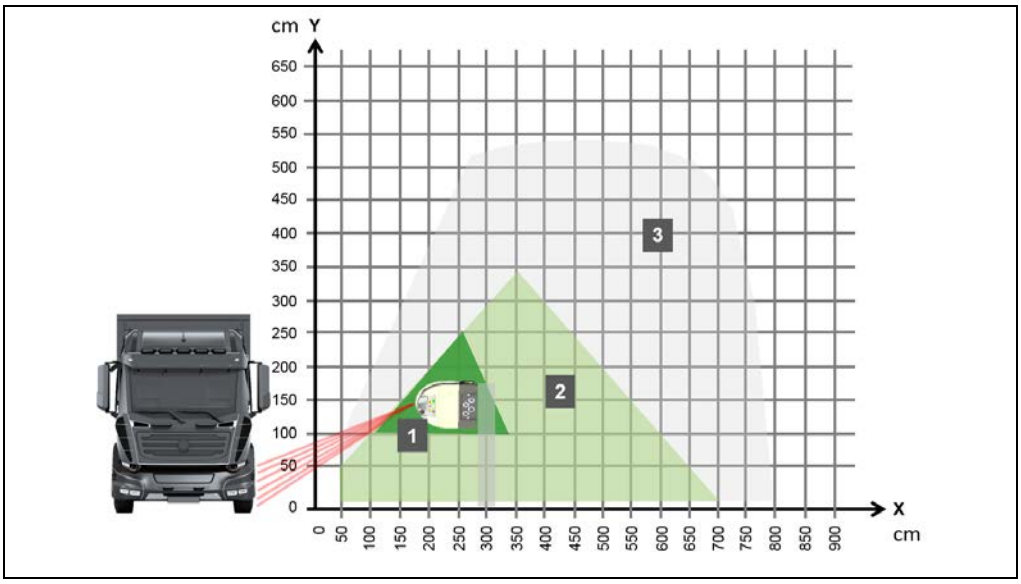


Fig. 41: AxleDetector project planning – Ideal mounting position for the LMS Axle

The chart can be interpreted as follows:

- The dark green triangle (1) marks the area where the LMS Axle will achieve the best possible performance.
- A mounting position within the light green triangle (2) will provide good to very good results.
- If the LMS Axle is mounted within the gray area (3), the system's ability to count axles accurately will be reduced.

Requirements for the mounting position and rotation

Position

The laser scanner that is mounted at the side of the lane must be in the **same measuring plane** as the LMS Width.

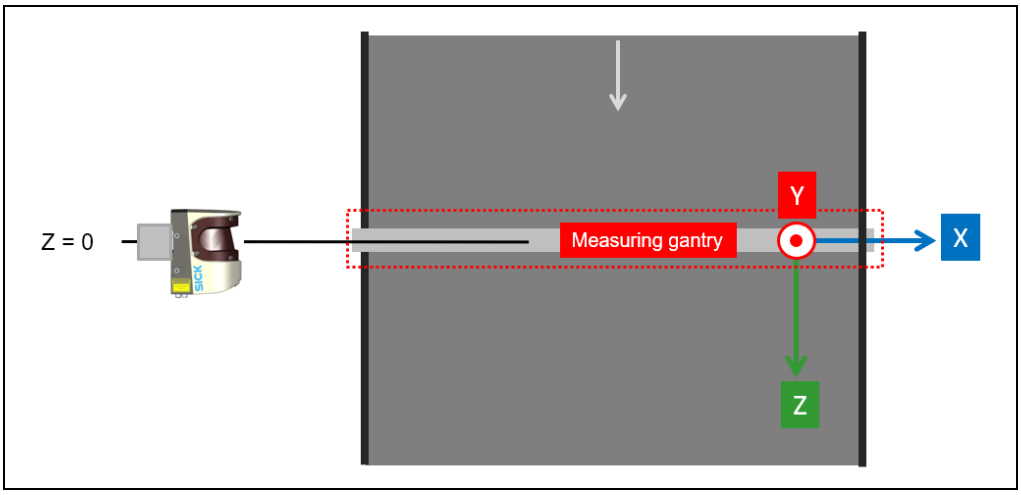


Fig. 42: AxleDetector project planning – Distance of the LMS Axle (on the Z-axis)

Rotation

When mounting the device, make sure that the LMS Axle is aligned correctly on all three axes.

You can tell whether the rotation of the 2D LiDAR sensor is correct by considering the top, side, and front views.

- **Rotation about the Y-axis**: The signal must be output at an angle of 90° in relation to the **direction of travel**. The system tolerates a rotational error of ± 2° about the Y-axis.

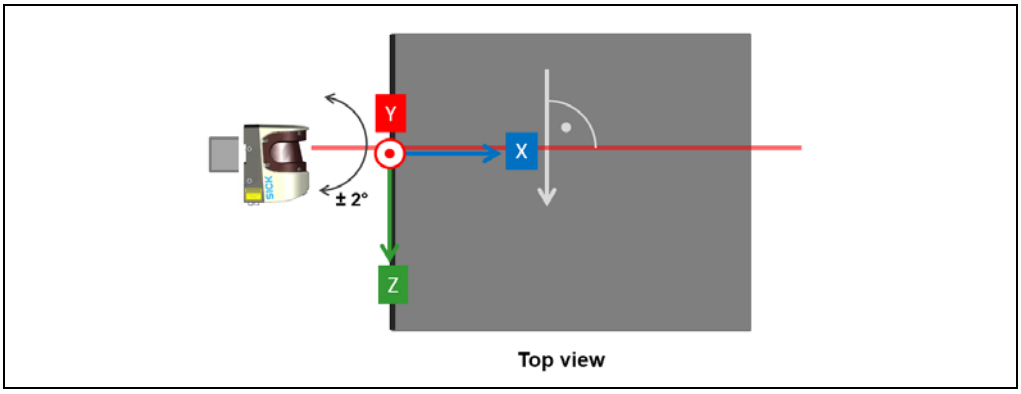


Fig. 43: AxleDetector project planning – Rotation of the LMS Axle about the Y-axis

- **Rotation about the X-axis**: The signal must be output at an angle of 90° in relation to the **road surface**. The system tolerates a rotational error of ± 2° about the X-axis.

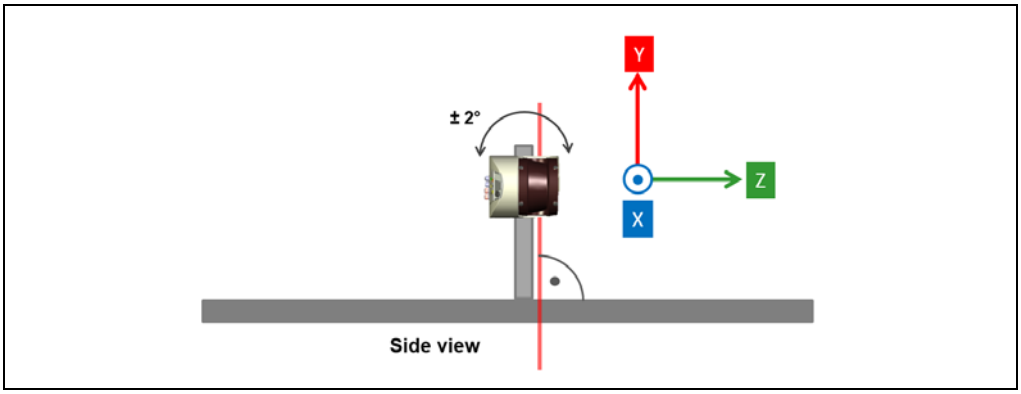


Fig. 44: AxleDetector project planning – Rotation of the LMS Axle about the X-axis

- **Rotation about the Z-axis**: The device's rear panel must be perpendicular to the road surface. The system tolerates a rotational error of ± 2° about the Z-axis.

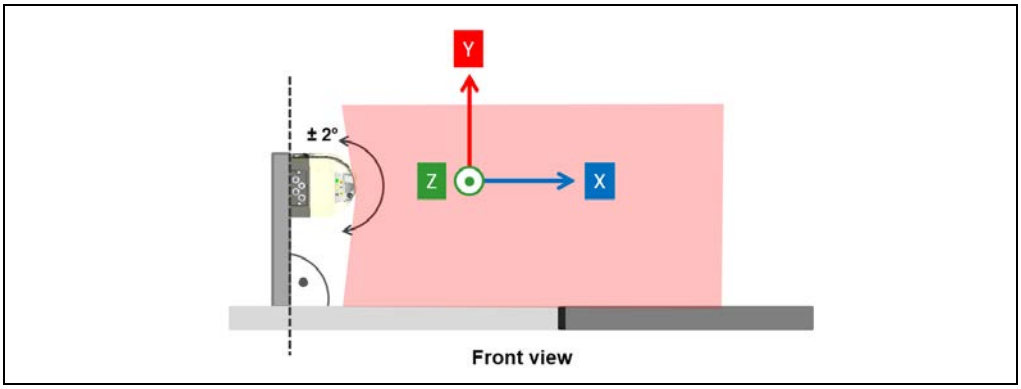


Fig. 45: AxleDetector project planning – Rotation of the LMS Axle about the Z-axis

3.6 Status indicators

3.6.1 Status indicators for the 2D LiDAR sensors

The LEDs (1) signal the operational status of the 2D LiDAR sensor.

In addition, the 7-segment display (2) is also available for diagnostics when errors or faults occur (see chapter *8.2.1 Fault indicator for the 2D LiDAR sensors*).

Above the inspection window you will find a key that explains the meaning of the status indicators (3).

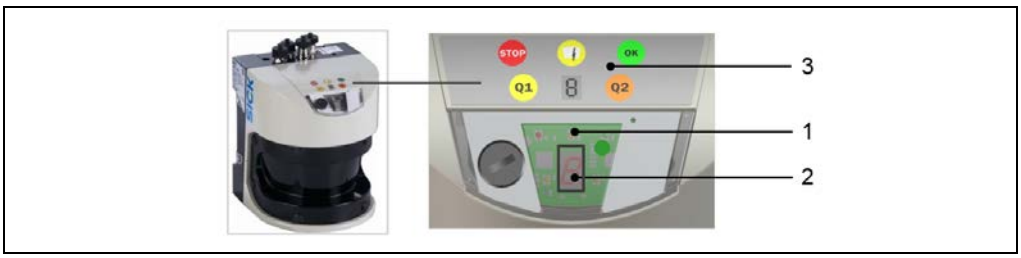


Fig. 46: Status indicators – 2D LiDAR sensors

Display	Meaning
OK	2D LiDAR sensor in operation, no evaluation cases are reporting an event
STOP	2D LiDAR sensor in operation, at least one evaluation case reports an event
	Optics cover is dirty
Q1	Switching output switched
Q2	2D LiDAR sensor in teach-in mode

Tab. 4: Status indicators –2D LiDAR sensors

3.6.2 Status indicators and controls on the Traffic Controller FPS

On the front of the Traffic Controller FPS, you will find the following status indicators and controls:

Fig. 47: Status indicators – Traffic Controller FPS

No.	Meaning
1	Status LED: Lights up green when device is ready for operation
2	Power ON/OFF
3	Reset
4	HDD LED: Lights up green when the hard drive is being accessed

Tab. 5: Status indicators – Traffic Controller FPS

4 Mounting

4.1 Mounting 2D LiDAR sensors

4.1.1 General advice

Always mount the 2D LiDAR sensors in accordance with the specifications and technical drawings to ensure that they can detect the vehicles correctly.

Observe the detailed drawings and information contained in the annex to these operating instructions and in the operating instructions for the 2D LiDAR sensor.

⚠ WARNING

Risk of damage to devices during mounting

- ▶ Mount the 2D LiDAR sensors so that they are protected from dirt and damage.
- ▶ Ensure that the field of view of each 2D LiDAR sensor is not restricted.
- ▶ Make sure that the connectors can be plugged in and unplugged without any difficulty.
- ▶ Avoid exposing the 2D LiDAR sensors to excessive shock and vibration.

⚠ WARNING

Legal provisions

- ▶ When mounting the system components, please observe any national and local legal stipulations and official instructions.

⚠ WARNING

Prevent the 2D LiDAR sensors from falling

- ▶ We recommend that you secure the components that have been mounted above the lane so that they cannot fall down, e.g., by using a chain or rope.

4.1.2 Mounting positions of the 2D LiDAR sensors

The 2D LiDAR sensors must be mounted in the designated positions.

The adhesive labels attached to the 2D LiDAR sensors indicate which system function a sensor supports. The sensors are mounted according to this label.

Note The LMS Width and LMS Axle must be in the same measuring plane.

The scan plane position is indicated by a housing marking next to the inspection window (see the arrow in the figure below).

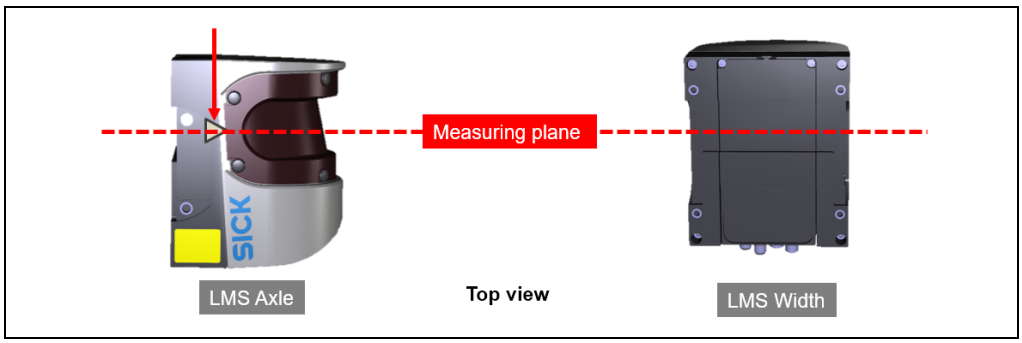


Fig. 48: Mounting – LMS Width (measuring plane)

NOTE

Refer to the project planning notes

- Always observe the notes provided in chapter *3.5 Project planning*.

Mounting the LMS Width

- Mount the **LMS Width** so that the laser beam is emitted **crosswise to the direction of travel** as it hits the road surface.

It should usually be mounted at one end of the gantry with the connections pointing in the direction of travel.

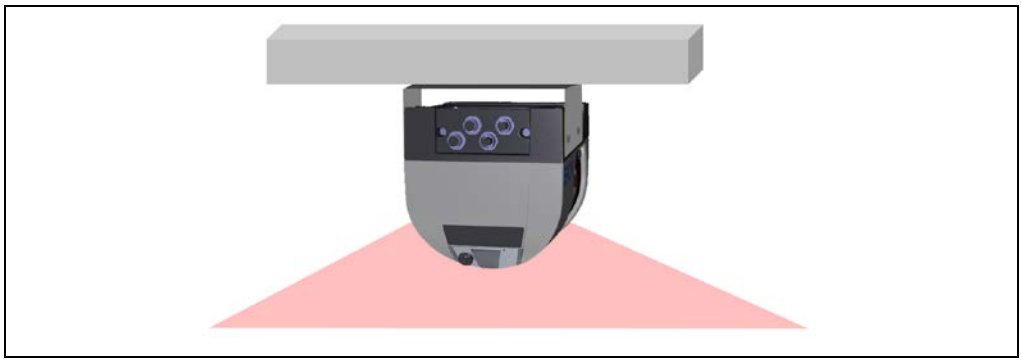


Fig. 49: Mounting – LMS Width

In the case of multiple LMS Width laser scanners, the sensors must be in the same scan plane. We therefore do not recommend using an alignment aid. The better and more accurately the sensors are aligned, the more accurate the vehicle data.

Mounting the LMS Length

▶ Mount the **LMS Length** so that the laser beam is emitted **in the direction of travel** and so that the front of the passing vehicle is always detected.

It should usually be mounted in the middle of the gantry above the lane with the connections pointing toward the right-hand edge of the lane (when viewed in the direction of travel). The LMS Length variant that is intended for mounting slightly further along the road can be attached to a structure such as a cantilever arm.

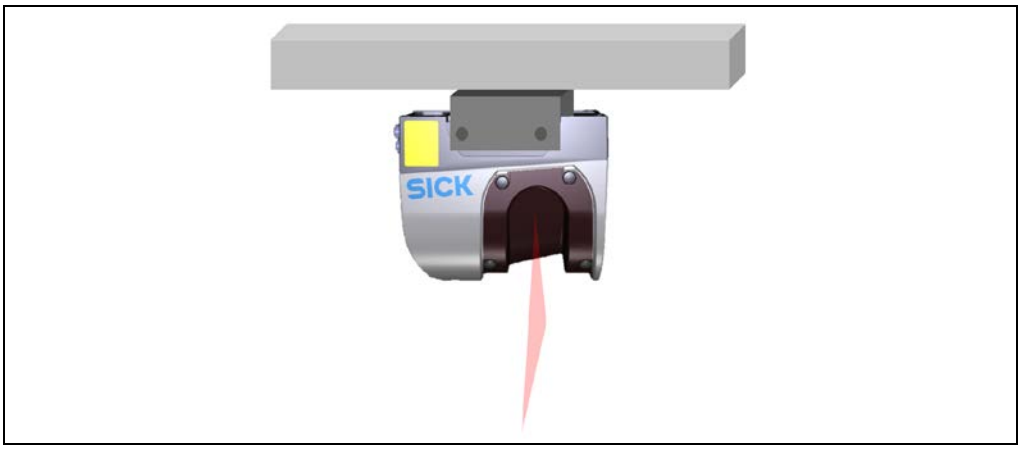


Fig. 50: Mounting – LMS Length

Mounting the LMS Axle

▶ Mount the LMS Axle at the edge of the lane so that the laser beam is emitted perpendicular to the lane. The connections should usually point in the direction of travel.

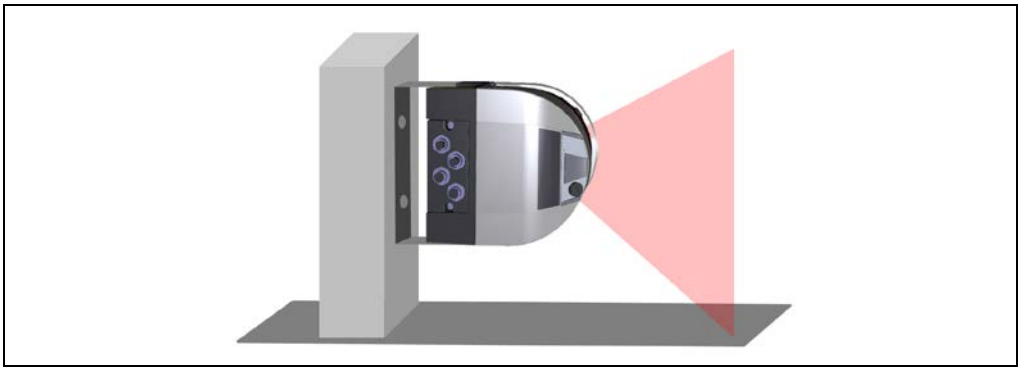


Fig. 51: Mounting – LMS Axle

Note Please refer to the diagram below to see how the vertical and horizontal distances of the LMS Axle should be combined for the best possible measurement results.

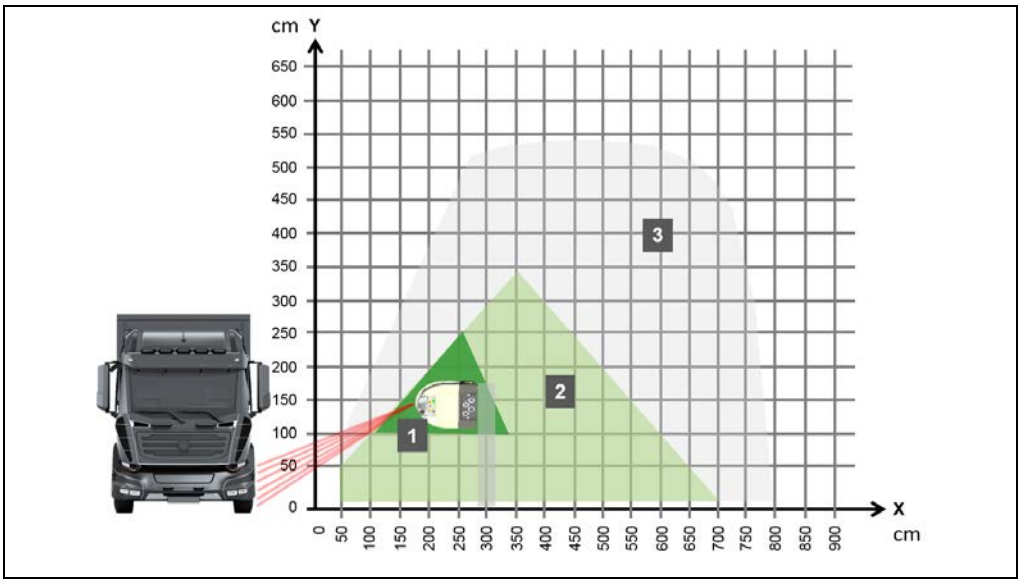


Fig. 52: AxleDetector project planning – Ideal mounting position for the LMS Axle

- The dark green triangle (1) marks the area where the LMS Axle will achieve the best possible performance.
- A mounting position within the light green triangle (2) will provide good to very good results.
- If the LMS Axle is mounted within the gray area (3), the system's ability to count axles accurately will be reduced.

4.1.3 Mounting accessories for the LMS511 2D LiDAR sensor

Recommendation In order to protect the 2D LiDAR sensor housing against the weather, we recommend fitting a **weather hood**.

The weather hood also protects the 2D LiDAR sensor from direct sunlight on the 2D LiDAR sensor housing (overheating) and, to a great extent, from dazzle resulting from sunlight or other light sources.

Mounting brackets

Suitable mounting kits for mounting the LMS511 2D LiDAR sensors (with or without the weather hood) can be purchased from SICK AG.

If the bracket is provided by the user, the following points must be observed:

- Stable mounting bracket that allows adjustable alignment of the 2D LiDAR sensor in the X- and Y-axes.
- 4 x M6 screws for the LMS511.
- The screw length must be selected in accordance with the wall thickness/bracket used

Recommendation

To ensure that the back of the LMS511 is also protected against the weather when a weather hood (1) is fitted, we recommend mounting a plate (2) to cover the device housing.

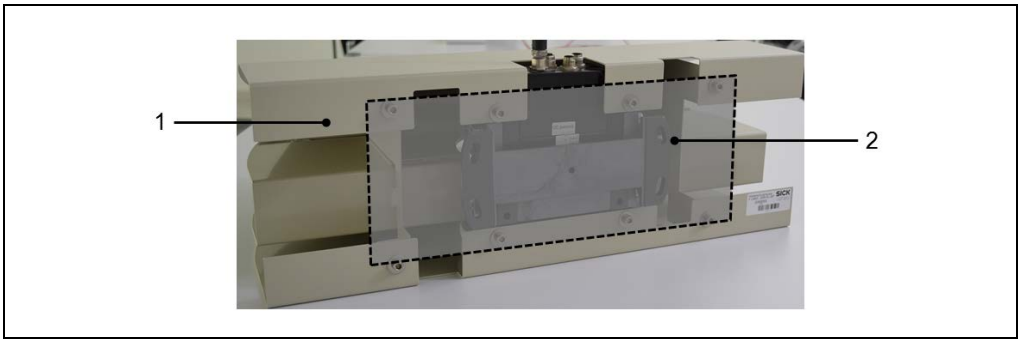


Fig. 53: Mounting the LMS511 weather hood

Weather protection covers for LMS511

	Accessories	Description	Part number
	Protection hood	Recommended for protection from direct sunlight (heat) and environmental influences Color: RAL 7032 gray	2056850
	Weather hood	Recommended for protection from direct sunlight (heat) and environmental influences Color: RAL 7032 gray	2063050

Mounting kits for LMS511

	Accessories	Description	Part number
	Mounting kit 1	Mounting kit 1 to assist with mounting	2015623
	Mounting kit 2	Mounting kit 2 to assist with mounting Mounting kit 1 required	2015624
	Mounting kit 3	Mounting kit 3 to assist with mounting Mounting kits 1 and 2 required	2015625

	Accessories	Description	Part number
	Mounting bracket	For retrofitting, if mounting bracket 2018303 is already in use	2059271
	Mounting kit	Mounting kit for wall mounting (adjustment bracket)	2018303

Mast mounts for LMS511

	Accessories	Description	Part number
	Post/wall bracket	Post/wall bracket with adapter plate	1081412
	Mast mount	Mast mount requires adapter plate (2059271) or wall bracket (2018303)	2018304
	Adjustable strap for mast mount	Adjustable strap for mast mount (2018304)	5306222
	Adjustable strap lock	Adjustable strap lock for tightening, 2 pieces required	5306221

Scan finder

The scan finder helps locate the laser beam.

Devices	Accessories	Description	Part number
	LS80b scan finder	Infrared receiver for locating the laser beam	6020756

Note For additional accessories, please visit *www.sick.com*.

4.2 Mounting the Traffic Controller FPS

⚠ WARNING

Consider the protection class

- The Traffic Controller FPS has an IP 20 protection class rating and must always be mounted in an electric or control cabinet.

NOTE

The Traffic Controller FPS must not be opened. The hard drive is already integrated into the device.

The Traffic Controller FPS should be mounted in a suitable location inside the control cabinet at the measurement site.

Ideally, it should be mounted near the higher-level control but never in the vicinity of transformers or other power units.

In order to accommodate the leads and wiring, there must be enough terminals available.

Mounting

- Install the Traffic Controller FPS in a suitable location inside the control cabinet.

To do this, use the M4 thread in the Traffic Controller FPS.

Note The Traffic Controller FPS does not have active cooling. For optimum heat dissipation inside the control cabinet, we recommend mounting it on a metal plate.

4.3 Mounting the Ethernet switch

The profiling system requires an Ethernet switch with at least **4 ports**.

- Mount the Ethernet switch in a suitable location inside the control cabinet.

5 Electrical installation

5.1 General advice

DANGER

Disconnect the power to the system

- Make sure that all the components of the profiling system are disconnected from the power supply during the electrical installation work.

DANGER

Risk of injury due to electrical current

- Comply with standard safety requirements when working on electrical plants.
- Be sure to disconnect the voltage supply before attaching or detaching any electrical connections.

WARNING

Protect cables against slack

- Make sure that the cables are routed correctly. The cables must not loop down or fall slack in any way. They must never pose a hazard to the vehicles driving under the gantry.

5.2 Wiring overview

All system components are supplied with voltage separately and are connected to an Ethernet switch.

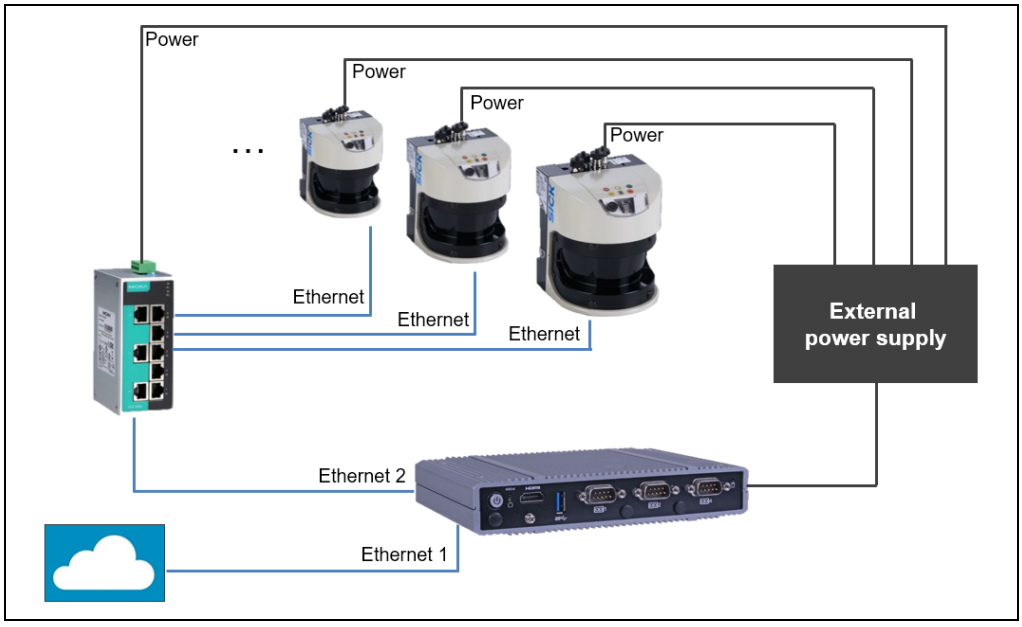


Fig. 54: Wiring overview

5.3 Connecting the Traffic Controller FPS

5.3.1 Connections on the Traffic Controller FPS

The Traffic Controller FPS has the following connections:

Front

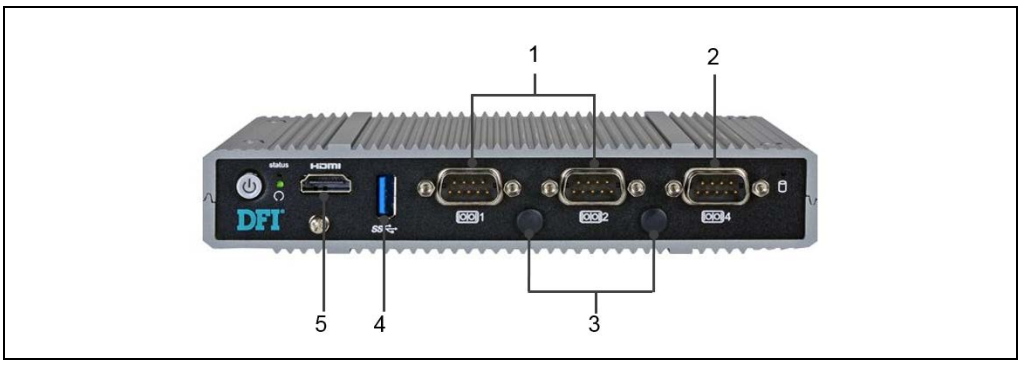


Fig. 55: Electrical installation of the Traffic Controller FPS – Connections on the front

No.	Meaning
1	COM 1/2
2	COM 4 (8-bit DIO)
3	Antenna connection
4	USB 3.0
5	HDMI

Tab. 6: Electrical installation of the Traffic Controller FPS – Connections on the front

Back

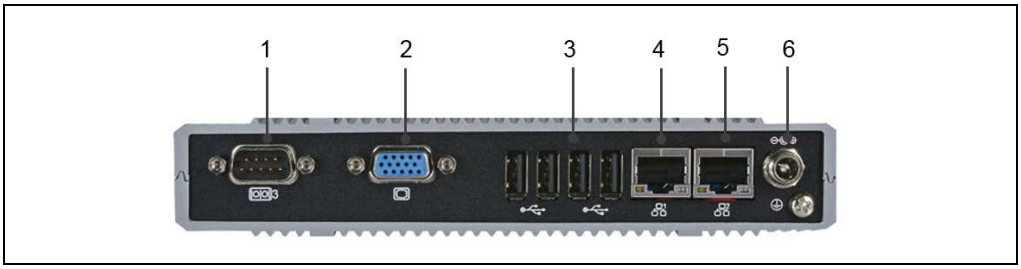


Fig. 56: Electrical installation of the Traffic Controller FPS – Connections on the back

No.	Meaning
1	COM 3
2	FGS
3	USB 2.0
4	Ethernet 1: Customer network
5	Ethernet 2: Sensor network
6	DC-in

Tab. 7: Electrical installation of the Traffic Controller FPS – Connections on the back

5.3.2 Connecting to the voltage supply

The Traffic Controller FPS should be connected to the voltage supply using the power cable included with delivery. One end of the cable has a plug connector and the other is open. The white and black wire must be connected to the voltage supply in the control cabinet.

Note The Traffic Controller FPS and the 2D LiDAR sensors can be connected to the same voltage supply.

- ▶ Plug the male connector of the power cable into the female connector on the Traffic Controller FPS and screw the connection tight.
- ▶ Connect the Traffic Controller FPS to the voltage supply.

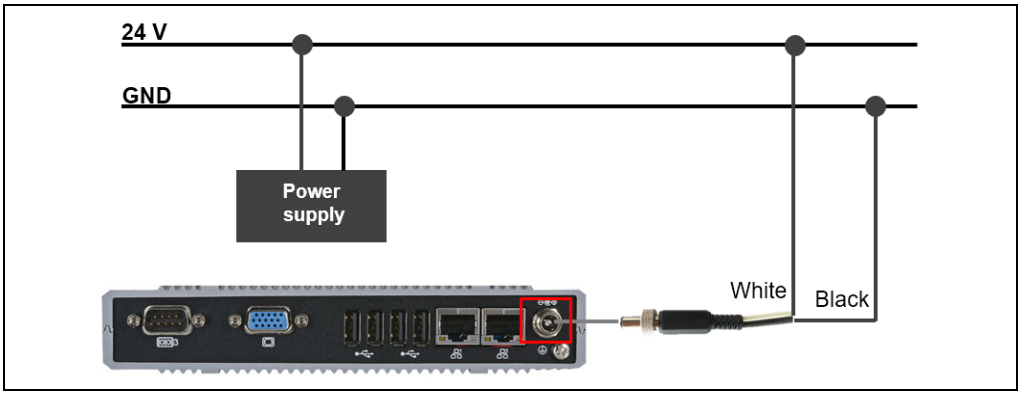


Fig. 57: Electrical installation of the Traffic Controller FPS – Connecting the voltage supply

- ▶ Connect the wires of the black and white cable in the control cabinet as follows:

Wire color	Voltage supply
White	12 V ... 36 V DC
Black	0 V

Tab. 8: Electrical installation of the Traffic Controller FPS – Connecting the voltage supply

5.3.3 Connection to Ethernet switch

The Traffic Controller FPS that has been mounted inside the control cabinet must be connected to the Ethernet switch. The Ethernet switch connects the three 2D LiDAR sensors to the Traffic Controller FPS.

- ▶ Connect the **Ethernet 2** connection of the Traffic Controller FPS to the Ethernet switch.

Fig. 58: Electrical installation of the Traffic Controller FPS – Connection to the Ethernet switch

5.3.4 Connecting to the customer interface

Set up the client interface for TEMS Manager to enable the transfer of measurement results and status messages.

- ▶ Connect the **Ethernet 1** connection of the Traffic Controller FPS to the Ethernet connection of the relevant client.

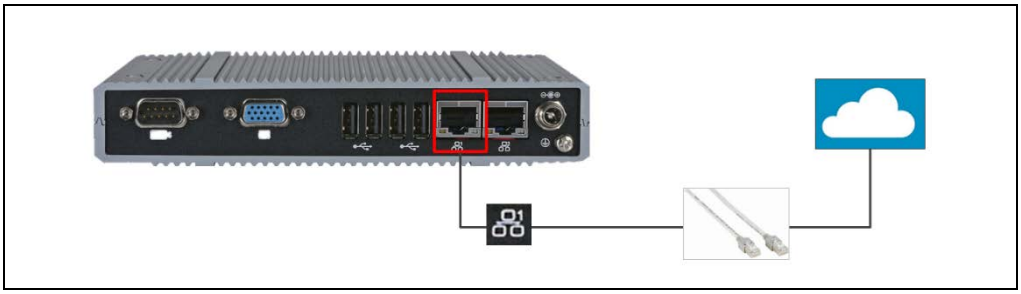


Fig. 59: Electrical installation of the Traffic Controller FPS – Connecting the client interface to the client

5.4 Connecting the Ethernet switch to the voltage supply

The cable for connecting the Ethernet switch to the voltage supply must be supplied by the customer.

- ▶ Connect the Ethernet switch (which can be ordered as an accessory under part number **6043482**) to the voltage supply as shown below.

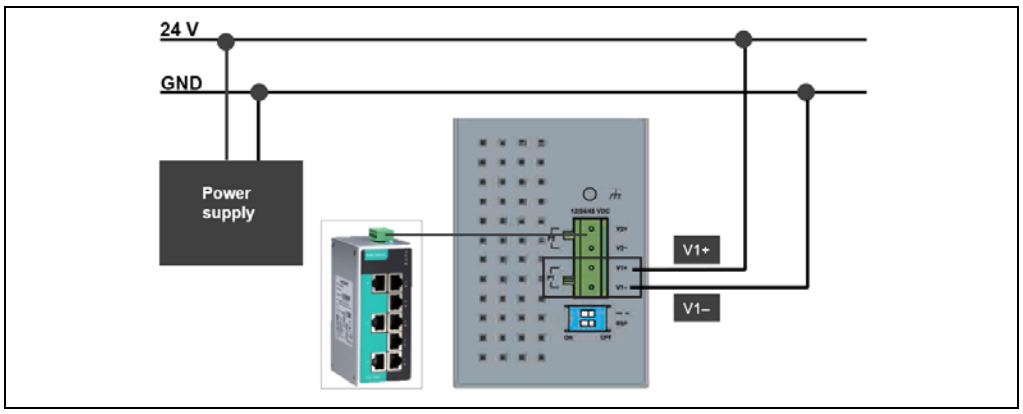


Fig. 60: Electrical installation of Ethernet switch

5.5 Connecting the 2D LiDAR sensors

5.5.1 Connections on the 2D LiDAR sensor

The LMS511 2D LiDAR sensor has the following connections:

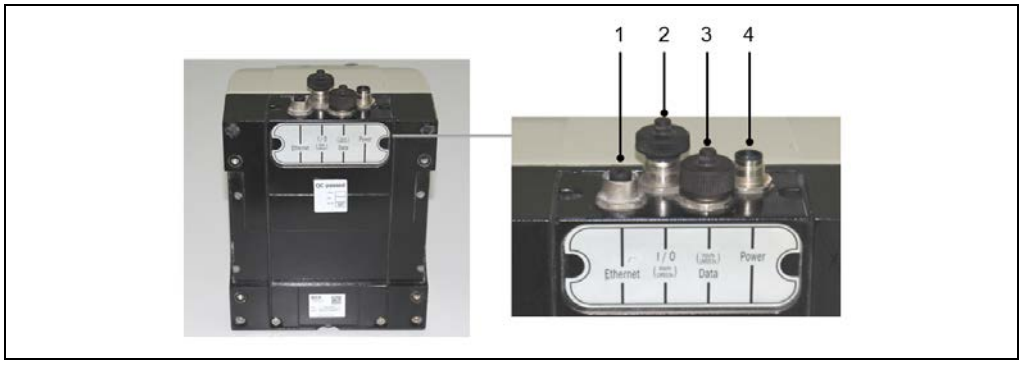


Fig. 61: Electrical installation of the 2D LiDAR sensor – Connections on the LMS511

No.	Connection	Description
1	Ethernet	Ethernet connection to a switch
2	I/O	Not assigned
3	Data	Not assigned
4	Power	Connection to the voltage supply

Tab. 9: Electrical installation of the 2D LiDAR sensor – Connections on the LMS511

5.5.2 Connecting to the voltage supply

Each 2D LiDAR sensor is connected to the voltage supply separately.

Please use the cables for connecting to the voltage supply that are available as accessories. This cable has an M12 plug connector for connection to the 2D LiDAR sensor on one end. The other end is open with shielding for connection to the voltage supply.

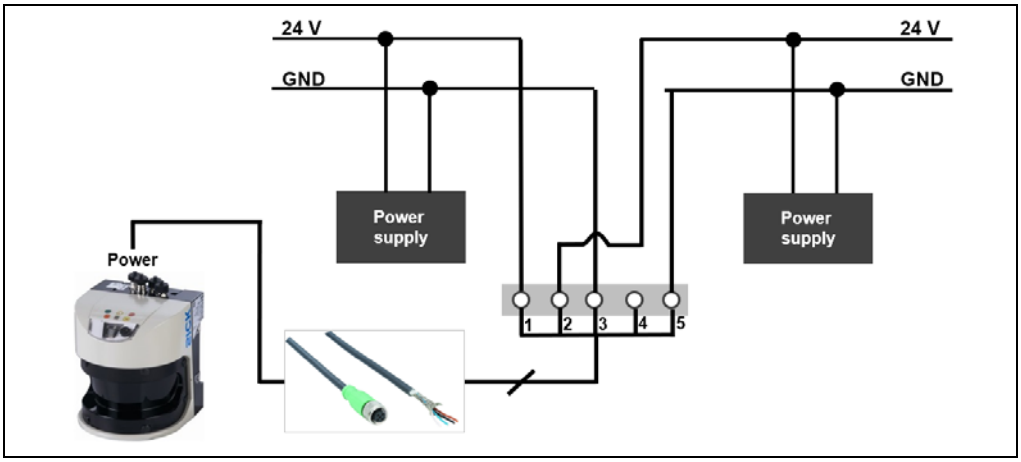


Fig. 62: Electrical installation of the 2D LiDAR sensor – Connecting to the voltage supply

Connection notes

A voltage of 19.2 V to 28.8 V is required. The power consumption per 2D LiDAR sensor is 22 W plus another 55 W for the heating, where applicable. We recommend using separate power supply units for the 2D LiDAR sensor and its heater.

- ▶ Wire all connections using copper cables.
- ▶ Use the following wire cross-sections:

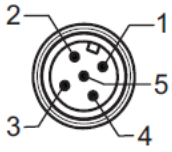
Connection of	Cable cross-section
Supply voltage	At least 0.25 mm^2 if local voltage supply (power supply unit) is in the immediate proximity
	At least 1.0 mm^2 with a maximum length of 20 m when connected to available 24 V DC network.

For additional information on the electrical installation work, please see the operating instructions for the 2D LiDAR sensor.

Connecting the 2D LiDAR sensor

1. Screw the M12 round connector of the cable into the **Power** female connector on the 2D LiDAR sensor.
2. Run the cable to the control cabinet or to the distribution box.
3. Connect the wire ends of the connecting cable to the terminals of the control cabinet.

▶ Connect the wires to the power supply in the control cabinet as follows:



Pin	Wire color	Connection
1	Brown	Voltage (+24 V)
2	White	Heating (+24 V)
3	Blue	Ground
4	–	–
5	Black	Heating ground

Tab. 10: Electrical installation of the 2D LiDAR sensor – Connecting to the voltage supply

5.5.3 Connection to Ethernet switch

Each 2D LiDAR sensor is connected to the Ethernet switch separately via the Ethernet interface. The Ethernet cable has an M12 plug connector so that it can be connected to the 2D LiDAR sensor and an RJ45 male connector so that it can be connected to the female connector of the switch.

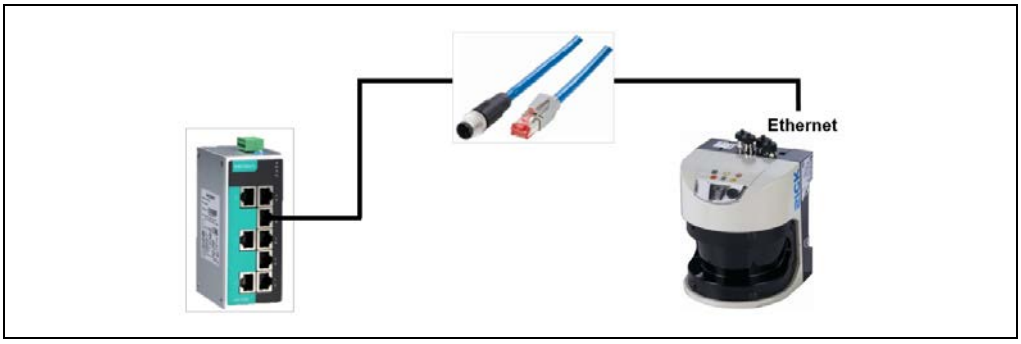
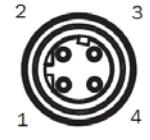


Fig. 63: Electrical installation of the 2D LiDAR sensors – Connecting to the Ethernet switch

1. Screw the Ethernet cable into the female **Ethernet** connector on the respective 2D LiDAR sensor.
2. Run the Ethernet cable from the 2D LiDAR sensor to the switch.
3. There, insert the RJ45 male connector into a free female connector.

Ethernet cable



Pin	Wire color	Description of the Ethernet interface
1	Ethernet_TX+	Transmit+
2	Ethernet_RX+	Receive+
3	Ethernet_TX–	Transmit–
4	Ethernet_RX–	Receive–

Tab. 11: Electrical installation of the 2D LiDAR sensor – Ethernet cable pin assignment

5.6 SICK connecting cables

LMS511 2D LiDAR sensor

	Accessories	Description	Part number
	Power connecting cable	Voltage supply with 5-pin M12 coupling / open cable end (electronics and heating) 05 m 10 m 20 m	 6054495 6054494 6050687
	Connecting cable Ethernet from 2D LiDAR sensor to Ethernet switch	Connecting cable with M12 male connector 4-pin / RJ45 05 m 10 m 20 m	 6054493 6054492 6050685
	Ethernet data cable from network switch to Traffic Controller FPS	Head A connection type: male connector, RJ45 Head B connection type: male connector, RJ45 –3 m	6026083

Ethernet switch

	Accessories	Description	Part number
	Ethernet switch	8 ports, permissible operating temperature –40 °C ... +75 °C	6043482

Note For additional accessories, please visit *www.sick.com*.

6 Commissioning

WARNING

Avoid strong vibrations and jolts at the measurement site

- ▶ Do not allow the system components of the profiling system to be exposed to excessive vibrations or jolts as a result of construction work at the measurement site or within its immediate vicinity (work involving compressors, road rollers/compactors, etc.).
- ▶ Switch off all components of the profiling system if strong vibrations are anticipated.

6.1 Starting the profiling system

Switch on the voltage supply.

The system starts up automatically when the power supply is connected.

Checking operating state

All components of the profiling system are checked for operational readiness.

The LED display for the connected devices indicates the device status during the power-up cycle.

Operating state after 60 s

The system is ready for operation after approximately 60 seconds.

- ▶ Check the operational status of the components by looking at the status indicators.

6.2 Connecting to TEMS Manager

In principle, TEMS Manager can be started from any client computer that is connected to the Traffic Controller FPS via the external customer network.

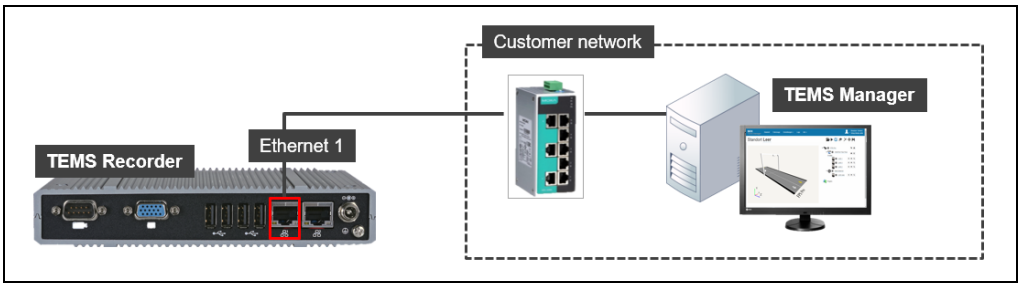


Fig. 64: Connection between TEMS Manager and client computer

Prerequisites

- An up-to-date version of a web browser must be installed on the client computer.
- This browser must support **HTML5** and **WebGL**.

6.3 Configuring the IP address of the Traffic Controller FPS

Upon delivery, the default IP address of the Traffic Controller FPS is 192.168.10.200.

The IP address of the Traffic Controller FPS is configured in TEMS Manager. If you want to connect to TEMS Manager from a client computer, the IP addresses of the Traffic Controller and the client computer must be in the same address range.

The default IP address of the Traffic Controller FPS usually differs from the address range of the customer network. Therefore, the first step is to change the IP address of a configuration PC that is not connected to the customer network to make it compatible with the address range of the Traffic Controller FPS.

Only then will you be able to access TEMS Manager and change the IP address of the Traffic Controller FPS to the address range of the customer network.

Changing the IP address of the configuration PC

1. Change the IP address of the configuration PC. Assign an IP address within the address range of the Traffic Controller FPS.
2. Connect the configuration PC directly to the Traffic Controller FPS via the **Ethernet 1** interface.

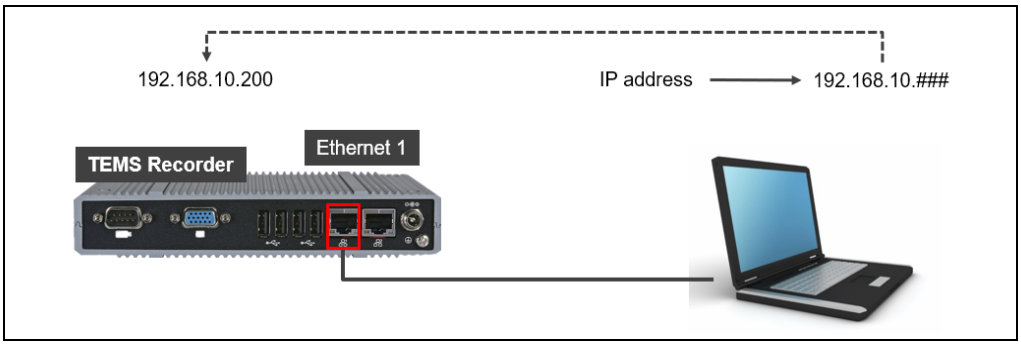


Fig. 65: Changing the IP address of the configuration PC

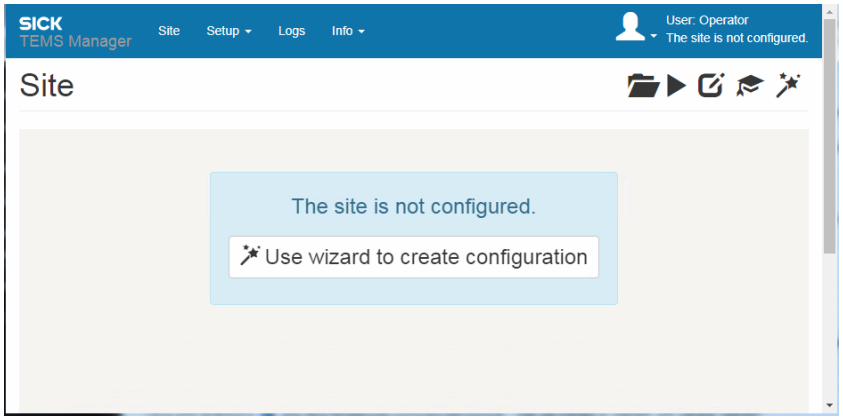
Starting TEMS Manager

Now connect to TEMS Manager via the configuration PC.

An up-to-date version of a web browser must be installed on the configuration computer. This browser must support **HTML5** and **WebGL**.

1. Start the web browser on the configuration PC.
2. Enter the default IP address of the Traffic Controller FPS in the address line.

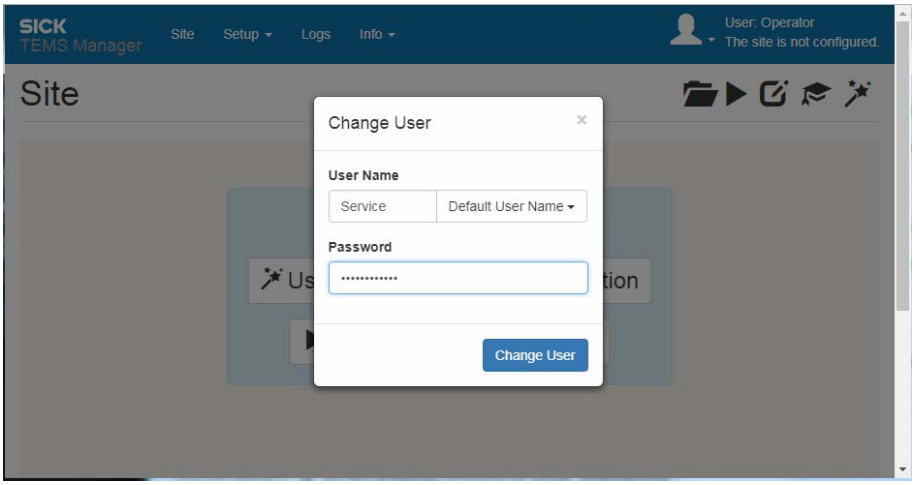
As soon as the connection to the Traffic Controller FPS has been established, the TEMS Manager web interface opens.



Adjusting the IP address of the Traffic Controller FPS

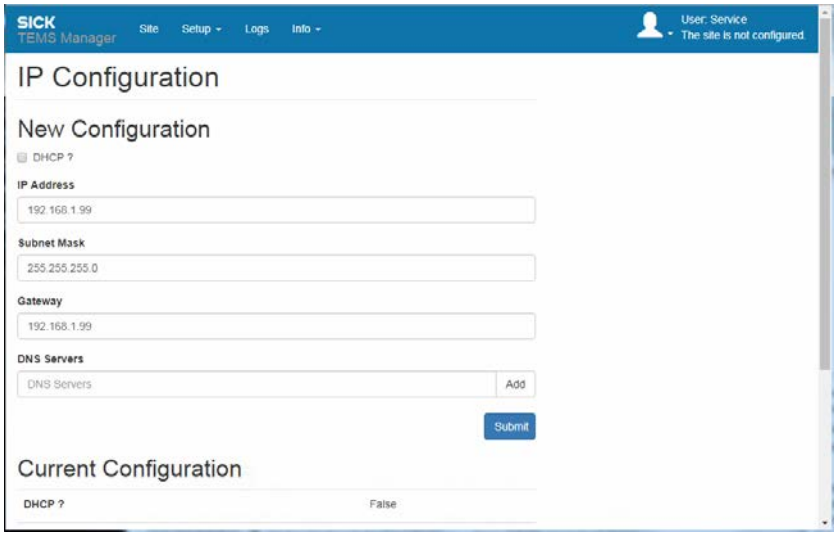
1. Click the **Setup** menu and select the **IP Configuration** function.

   The authorization must be **Service**.



2. Click in the **User name** field. Enter **Service** in the user name field and log in with the default password set up for this purpose (for more information, see appendix at *9.5 Users and authorizations*).

The IP address configuration interface opens. The Traffic Controller FPS is displayed with its default IP address.



3. Define the IP address that is to be used for accessing the Traffic Controller FPS on the customer network.
4. Enter the customer network **Gateway**. If no IP gateway has been defined or if none is required, use the same address as for step 3 above.

Note Take care to enter the IP address correctly so that the Traffic Controller can be subsequently found on the customer network.

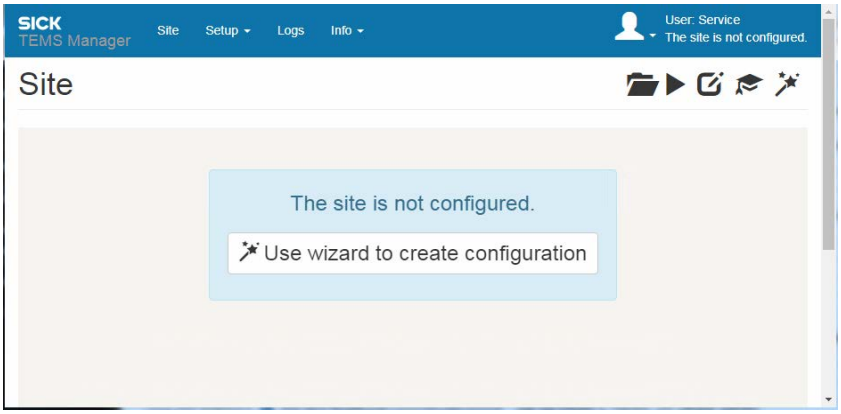
5. Press **Submit** to confirm.

Resetting the IP address of the configuration PC

As soon as the IP address has been changed, TEMS Manager is automatically accessed via the new IP address. Consequently, communication between the configuration PC and the Traffic Controller FPS is no longer possible.

Now the configuration PC must be configured to an IP address within the address range of the customer network.

1. Change the IP address of the configuration PC. Assign a free IP address from the address range of the customer network.
2. Start the web browser on the configuration PC.
3. Establish a connection with TEMS Manager via the new IP address of the Traffic Controller FPS.



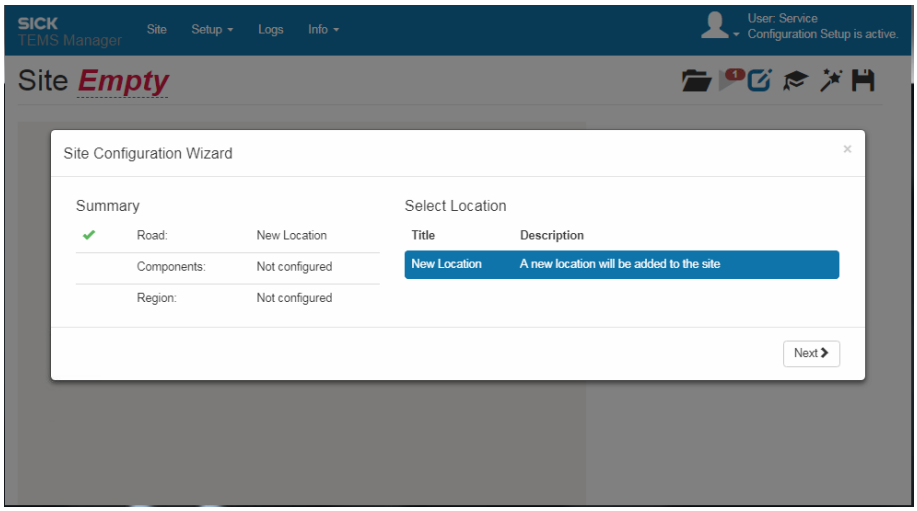
6.4 Setting up the site configuration with the wizard

A wizard is used to help you select system functions. The selected system functions can then be adjusted to the measuring site in the next step.

Launching the wizard

Start the wizard for selecting the site configuration on the start page.

- ▶ Click on **Set up site configuration with the wizard**. The site configuration wizard opens.



The **summary** on the left-hand side shows the pages of the wizard that must be completed depending on the components selected. When you have completed configuration on one of these pages, it will be marked with a tick.

On the right-hand side, settings are adjusted for the page selected. As no site configuration has been created yet, the **New site** option is highlighted.

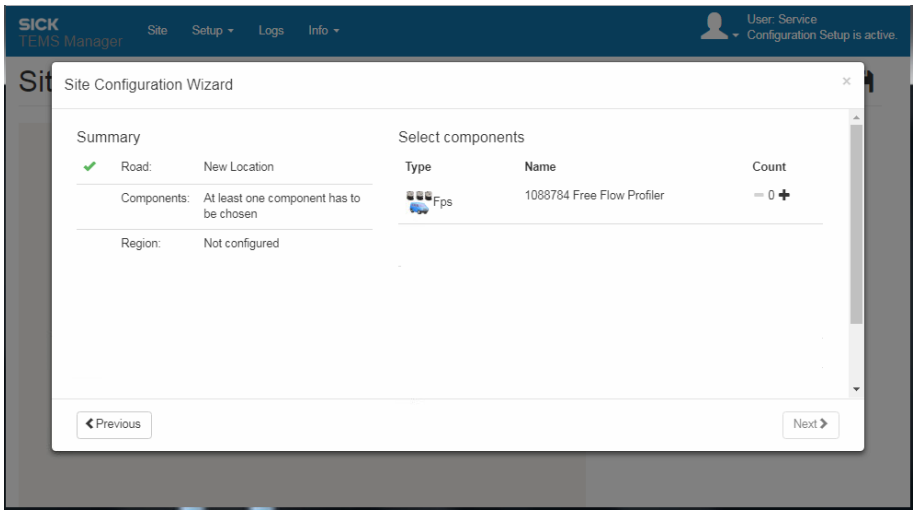
Click **Next** to switch to the next page of the wizard.

Note

On a smaller screen, the **summary** area appears above the input area.

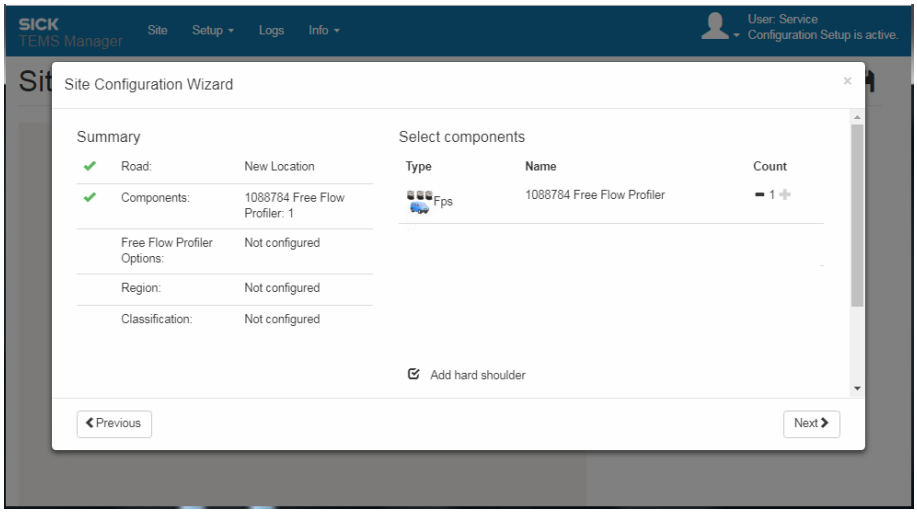
6.4.1 Selecting components

On the second page, start by selecting the components for vehicle detection.



► Click on the plus icon in the master bar. The counter increases by one. The selected system function appears at the top under **Components**.

The plus icon is then deactivated as only one FPS with three 2D LiDAR sensors can be selected.



► You can use the minus icon to delete selected system functions from the site configuration.

Side strip

Also clarify whether the site provides a side strip. This information only affects the visualization of the measurement site in TEMS Manager.

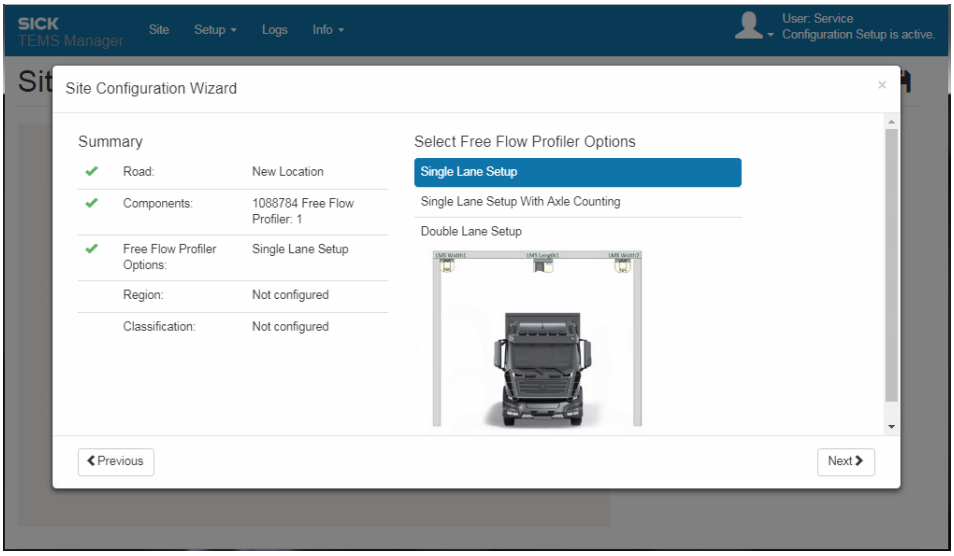
The system component for counting axles is shown at a distance from the lane.

The side strip is not included in any system function.

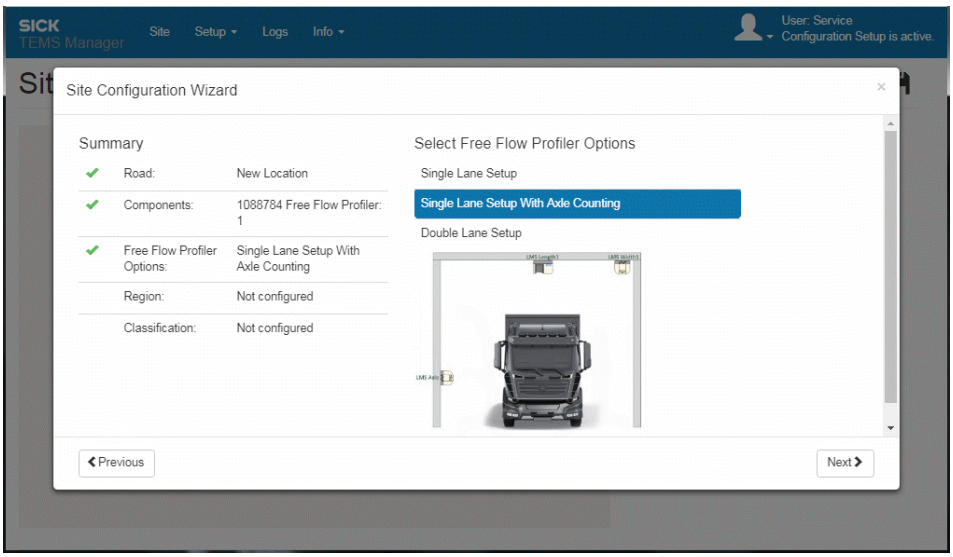
6.4.2 Specifying the measurement site layout

The third page, **Free Flow Profiler Options**, allows you to define the layout of the measurement site along with the function of the 2D LiDAR sensors.

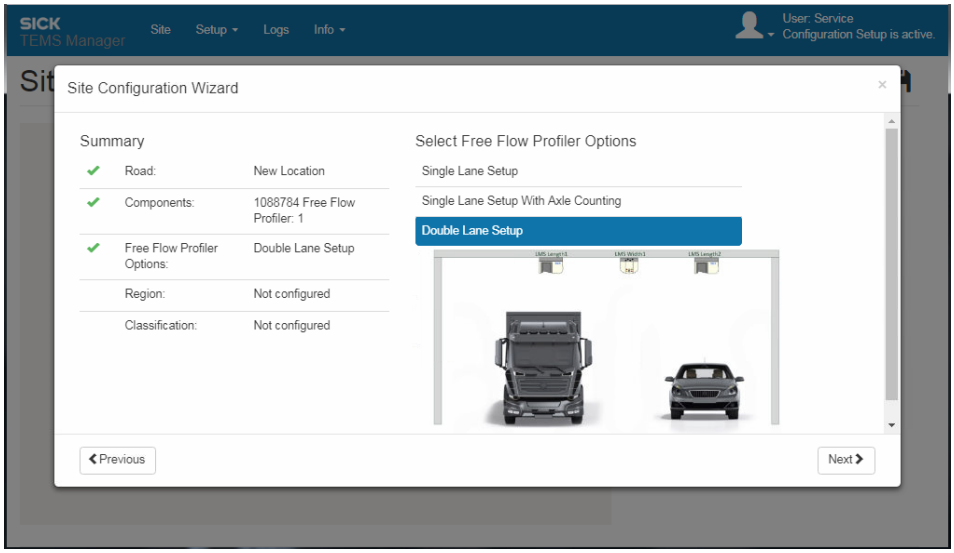
- The **Single Lane** option allows you to configure a profiling system with two **LMS Width** laser scanners mounted overhead on the gantry and one **LMS Length** laser scanner mounted in the middle. This layout allows you to measure vehicle dimensions and to classify vehicles.



- With the **Single Lane with Axle Counting** option, an LMS Width mounted at the side of the lane also provides the system function for axle counting. The two other 2D LiDAR sensors are mounted overhead on the gantry.



- With the **Two Lane** option, a single LMS Width can be used to capture the profile when monitoring two lanes. Vehicle tracking takes place via two LMS Length laser scanners mounted above each lane.

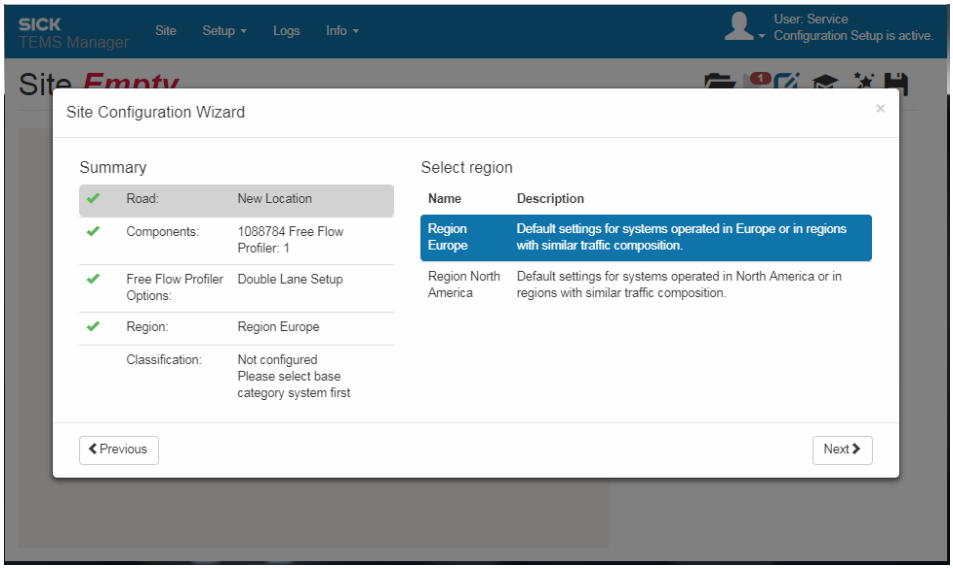


▶ Select the preferred option (for example: **Single Lane with Axle Counting**) and click **Next** to confirm.

6.4.3 Selecting a region

On the fourth page, define the region in which the category system will be used.

This limits the number of category systems available on the next page of the wizard.

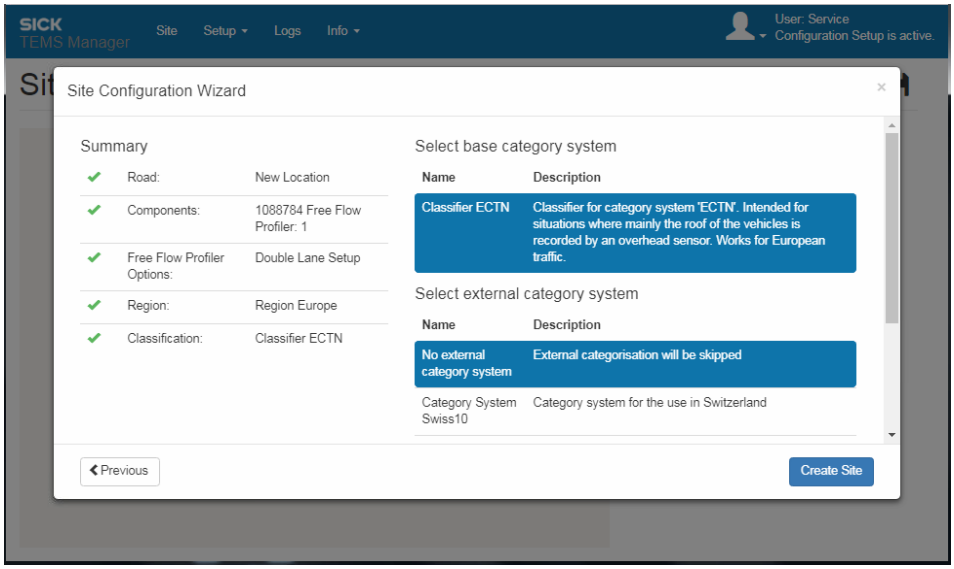


- ▶ Select **Region Europe** for all European countries. Vehicles are identified by comparing criteria for 28 vehicle classes. The class representing the closest match is allocated to the vehicle.
- ▶ Select **Region North America** for the USA and Canada. Vehicles are identified by comparing them against 30 vehicle classes. The class representing the closest match is allocated to the vehicle.

Note The most appropriate classification system can be evaluated with your SICK representative.

6.4.4 Defining the classification system

On the **Classification** page, specify the basis for which the vehicles are to be classified.



Selecting the basic category system

- If you have selected the **Europe** region, the **ECTN classifier** basic category system is automatically assigned to the region.
- If you have selected the **North America** region, the **NorthAmericaDetailed** basic category system is automatically assigned to the region.

Selecting an external category system

▶ Specify which external **output category system** you want to use depending on the selected region.

With the **output category system**, vehicles are no longer identified on the basis of the individual vehicle classes within the category system. Instead, they are identified using classification groups (traffic checking regulations).

If you have selected the **ECTN classifier** for the **Europe** region, the external categories available to choose from are **Europe**, **Swiss10**, **TLS 2+0, TLS 5+1**, and **TLS 8+1**. For example, the **TLS 2+0** external category system includes two classification groups: **Car or similar** and **Truck or similar**.

6.4.5 Completing site configuration

Once you have completed all the entries and all the pages are marked with a tick, you can quit the wizard.

▶ Click the **Set up site** button. The wizard closes.

The site opens in editing mode in TEMS Manager.

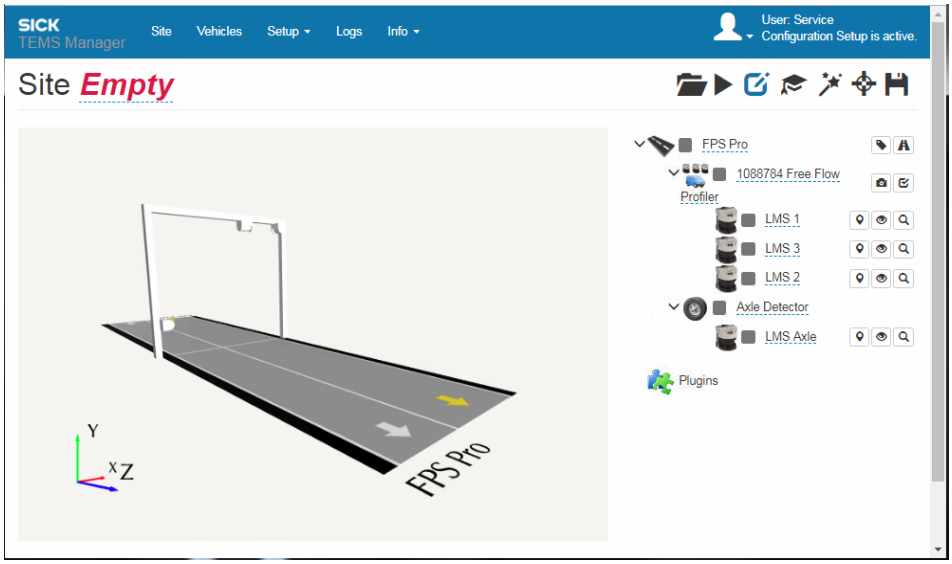
6.5 Working in TEMS Manager

This chapter provides an overview of how to visualize the measurement site in TEMS Manager once the configuration file has been loaded and it tells you what editing methods are available for displaying the system parameters.

6.5.1 The user interface

The **menu bar** containing the main workspaces is visible in every working context.

The layout and structure of each workspace depends on which working context has been selected.



For users with the **Operator** and **Authorized user** authorizations, the **Location**, **Vehicles**, **Logs**, and **Info** registers are available.

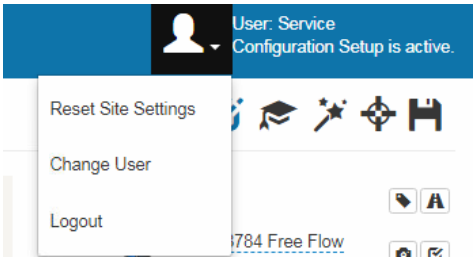
The **Settings** register is restricted to users with the **Service** authorization.

Working range	Meaning
Location	Shows the measurement site in a live view. It also allows you to display the system parameters and current system status.
Vehicles	Displays the measurement results during operation.
Settings	Contains administrative functions. This allows you to change passwords or update the system, for example.
Logs	Contains the system log files.
Info	This provides information to the TEMS Recorder and facilitates file uploads and downloads.

Note The menu bar also contains notes on system faults.

Login information

The right-hand side of the menu bar shows which users are logged in as well as the operating status. The **Configuration is running** entry tells you that the profiling system is operating properly.



The user symbol opens a menu with the following functions:

Function	Meaning
Resetting page settings	Sets all display settings (zoom, rotation in 3D displays, table displays, etc.) back to standard values. This function is particularly useful if the gantry is no longer visible in the live view because of the adjustments you have made to the 3D scenery.
Change users	Log out current user and log in another user.
Logout	Log out current user.

Reopening the start page

Clicking the program name reloads TEMS Manager. This makes the start page reappear with the **Site** workspace open.

Notes concerning system faults

The navigation bar also alerts you to any system faults.

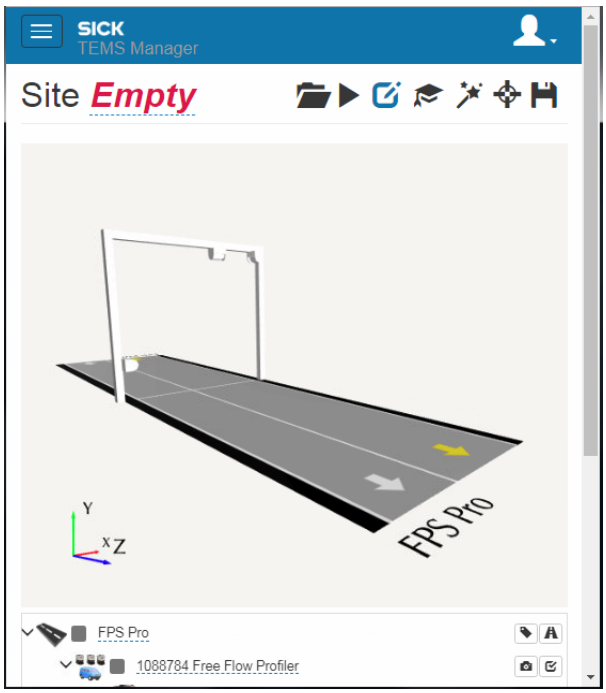
In this case, a red exclamation point appears in the **Site** workspace.

On the right-hand side, a corresponding note is displayed in red.

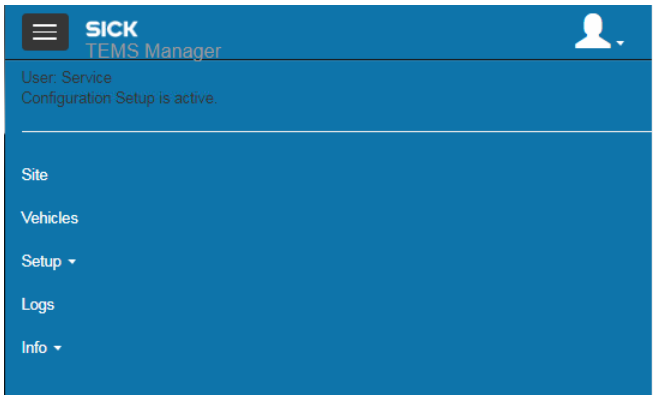
Please see *8.3.1 Fault diagnosis in TEMS Manager* for details of how to proceed.

Display format on small screens

The TEMS Manager display format automatically adjusts to the size of the screen. On a smartphone or tablet, the content is arranged from top to bottom.

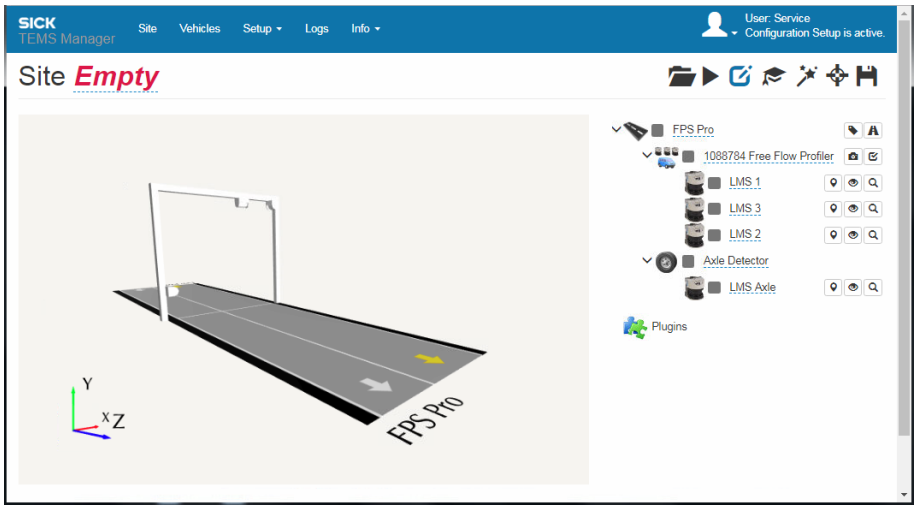


▶ Click the menu icon to access the individual workspaces in TEMS Manager.



6.5.2 Displaying the measurement site

The **Site** register is divided into two.



- The **navigation area** on the right-hand side contains all the system functions that have to be adapted to the measurement site. These are all functions that are connected to a system component.

  The system functions are displayed in a hierarchical structure:
  Lane → System function → System components.

  The lower section lists plug-ins for selecting and configuring the recorded measured values, vehicle data, and status information.

- The view on the left-hand side shows the **measurement site** with the road, lane(s), and direction of travel, along with the **system components**, the installation site, and the status display.

  During operation, this is where the vehicles detected by the profiling system are displayed as a live 3D model in TEMS Manager (see chapter *6.8.1 Checking operational readiness*).

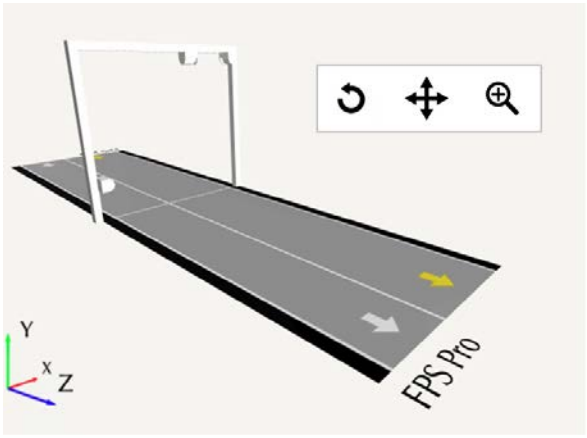
  The raw measurement data supplied by the 2D LiDAR sensors can also be displayed here.

The toolbar above the navigation tree offers the following functions in editing mode:

Symbol	Meaning
	**Load site configuration and start/edit it** Allows you to load a configuration file. You can either start the configuration or open it in editing mode instead.
	**Start current site configuration** Starts the configuration that is currently open in editing mode. A red number in the icon indicates that the configuration is erroneous. Erroneous configurations cannot be started.
	**Edit site configuration** To quit editing mode, click the blue icon. The configuration remains loaded. To reopen the configuration file in editing mode, click the icon again. Click the ▶ icon to restart the loaded configuration file.
	**Activate/deactivate expert mode** Switches the export mode on and off. Expert mode displays all system functions in the navigation area and functions for editing the parameter values, etc., (see chapter *6.7 Working in expert mode*).
	**Start the configuration wizard** Opens the configuration wizard with the current site configuration. The site configuration can be edited and stored in the wizard.
	**Save current site configuration on hard drive** Saves the current site configuration onto a data card.
	**Reset site configuration** Resets all the changes that have been made to the system parameters in editing mode, but only after you confirm the prompt. The navigation tree will then be completely blank. The icon only appears in expert mode.

Adapting the graphic display

You can use the tools in your browser to adjust the view of the measurement site. In the TEMS Manager graphical user interface (GUI), you can zoom in and out of the site, move the view, and rotate it about the vertical and horizontal axes. To do this, you have to click on the graphic interface.



Function	Meaning
Rotate 	Rotates the site clockwise or counterclockwise on the GUI when you press and hold the **left** mouse button
Move 	Moves the site up, down, right, and left when you press and hold the **right** mouse button
Zoom in/ out 	Enlarges or reduces the display of the site via the mouse wheel when the mouse pointer is on the graphical display. If you want to increase or decrease the zoom increments, press and hold the Shift key at the same time.

Tab. 12: Functions for displaying the measurement site in TEMS Manager

Controlling the graphical display with touch gestures

If you are using a computer with a touchscreen, you can control the graphical display with certain touch gestures. This involves swiping or dragging your fingers across the screen.

Function	Meaning
Enlarge 	To zoom in, touch the graphical display with your thumb and index finger, and spread them apart. This is called the “zoom gesture”.
Reduce 	To zoom out, touch the graphical display with your index finger and thumb, and slide them together. This is called the “pinch gesture”.
Rotate 	Place your index fingers on the graphical display and drag them in the desired direction to make the measurement site rotate accordingly.

6.6 Adapting system functions to the measurement site

Once you have completed the site configuration wizard, all the system functions should be available, and correctly interconnected.

All system functions that then have to be adapted to the measurement site are displayed in the navigation area.

You have to enter information about the measurement site, store the correct position and rotation of the system components, assign devices to the system components, and configure the IP addresses.

Recommendation

- ► Work through the hierarchical structure in the navigation tree from top to bottom when editing the system parameters.

Note

You can still configure the measurement site and system functions even if you have not yet connected or linked any devices. You must know the mounting position of the system components.

If it is necessary to assign the devices to the system components and configure the IP addresses, this takes place in a subsequent step.

6.6.1 Configuring the measurement site

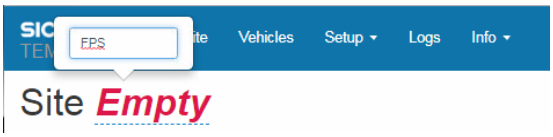
6.6.1.1 Adapting information about the measurement site

The first step is to adjust the details of the measurement site.

All the designations underlined in blue can be changed by clicking the relevant designation. An input field then appears so that you can enter the desired text.

Specifying the measurement site designation

1. Click the current designation underneath the header and enter the new name.

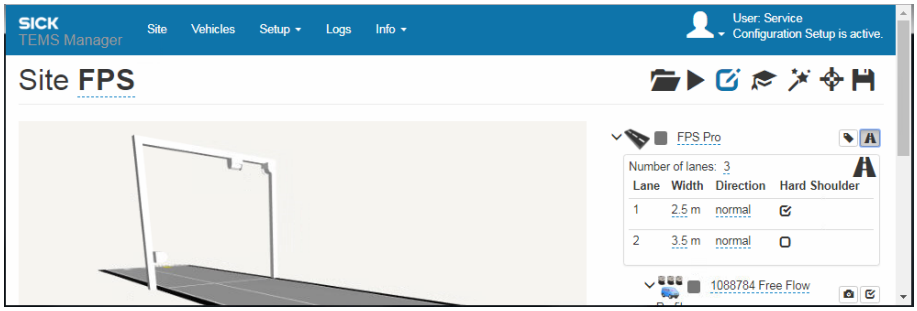


2. Click the Enter key to confirm.

Defining the number of lanes and the lane width

1. Go to the road level in the navigation tree and click the **Edit road configuration** icon.

An input line appears underneath the road per lane. The side strips are also listed as a lane.



The values that you are allowed to change are underlined in blue.

2. Click the road name underlined in blue in the navigation tree.
3. Change the designation and click Enter to confirm.

Configuring the lanes, lane width, and direction of travel

1. The number of lanes to be monitored is defined by the information provided in the configuration wizard. The current value can be changed here if necessary.
2. To complete the input process, press Enter.
3. Enter the width of the lane(s) in exactly the same way.
4. Define how you want the direction of travel to be displayed in the live view. With the “normal” setting, the arrow points from the top left to the bottom right.

6.6.1.2 Signing the configuration

By applying a signature, you can – for example – document that a particular configuration has been checked and approved. The signature is encrypted. It is generated when the configuration is saved and written to the XML configuration file. Among other things, the signature contains a reference to the configuration PC, the details of the logged-in user, and the date of saving.

Once a configuration has been signed it cannot be changed without removing the signature. This offers a reliable way of checking whether the configuration has been changed (e.g., following the latest standardization procedure).

1. Go to the road level in the navigation tree and click the **Sign road configuration** icon.

   Two input fields appear underneath the road.

2. Enter the name of the person who approved the configuration and add any other comments about the approval process.

3. The signature information is supplemented by a date field. Once the signature has been applied, the **Name**, **Notes**, and **Date** fields are deactivated and can no longer be changed.

   The **Sign road configuration** icon turns green.

4. To hide the signature area, click the **Sign road configuration** icon again.

Quitting editing mode

- To hide the input line in the navigation tree, click the **Edit road configuration** icon again.

6.6.2 Configuring system functions for vehicle detection

6.6.2.1 Defining the position and rotation of the 2D LiDAR sensors

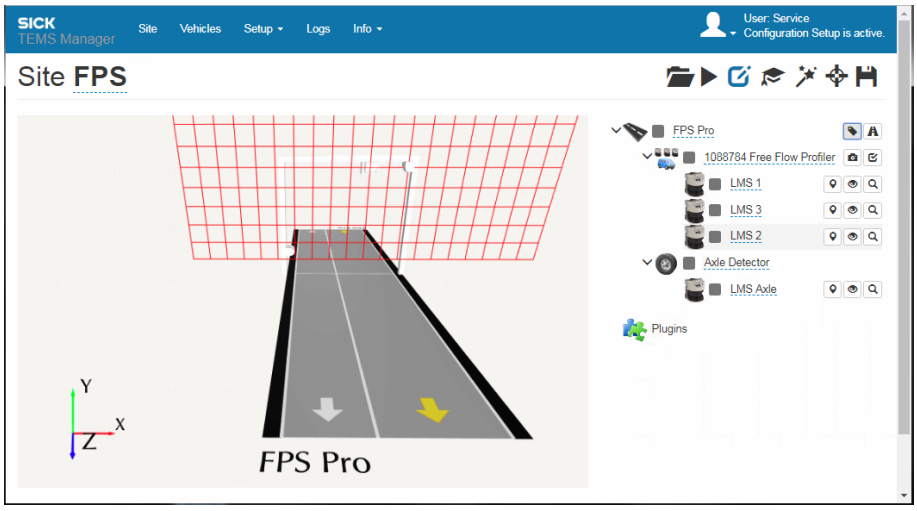
Define the exact positions of the sensor components used for vehicle detection on the gantry. The values entered must be based on the zero-point of the coordinate system.

Note The **LMS** Axle must be in the same Z-plane as the LMS Width.

Roughly aligning components

Provisionally align the sensor components in the graphical display of the live view.

1. Click on a component in the live display.
2. Click on the component again and keep the mouse button pressed. A grid appears to serve as a guide.
3. Now move the component to the relevant plane.



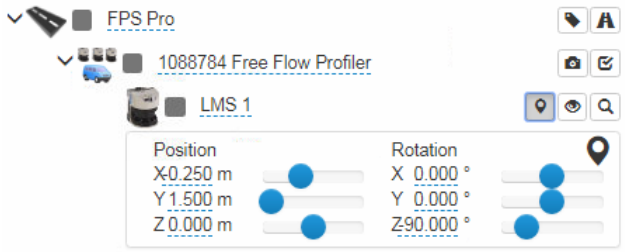
Note The orientation of the grid will automatically adapt to the current perspective of the live view. Rotate the measurement site in the live view to switch between displaying the grid along the X-axis and the Z-axis, respectively.

Precisely adjusting components

Now define the exact positions of the sensor components.

1. Go to the relevant sensor component level in the navigation tree and click the “Edit system component position” icon.

   The input lines appear. These already contain the position values defined during rough alignment.



2. The position and angle can be defined using either the slide controls or by entering the values manually.

Tip Place the mouse pointer on a slide control and turn the mouse wheel. The values increase/decrease in “standard” increments. To increase/decrease the zoom increments, simultaneously press and hold the *Shift* key or the *Ctrl* key, respectively.

3. Where necessary, adapt the view so that the effects of your changes are clearly visible in the GUI.

Position When entering the position, please observe the alignment of the coordinate system:

- The X-axis lies straight across the width of the road. The first distance parameter X is measured from the origin of the right-hand edge of the lane (when viewed in the direction of travel).
- The Y-axis defines the height at which the component is mounted. The second distance parameter Y is measured from the surface of the road.
- The Z-axis points in the direction of travel. The third distance value is measured in relation to the measuring plane.

Rotation The components can be rotated about the X-, Y-, and Z-axes.

- The components that are mounted overhead on the gantry must be attached so that they point down vertically. The Z value is preset at 180°.

Note Accurate entries for the position and alignment of the system components will help to improve measurement accuracy later in the process.

NOTE

If the same LMS is used for several functions (e.g., for profile detection and axle counting), it can be worth having the configuration checked by your SICK representative.

6.6.2.2 Calibrating the 2D LiDAR sensor

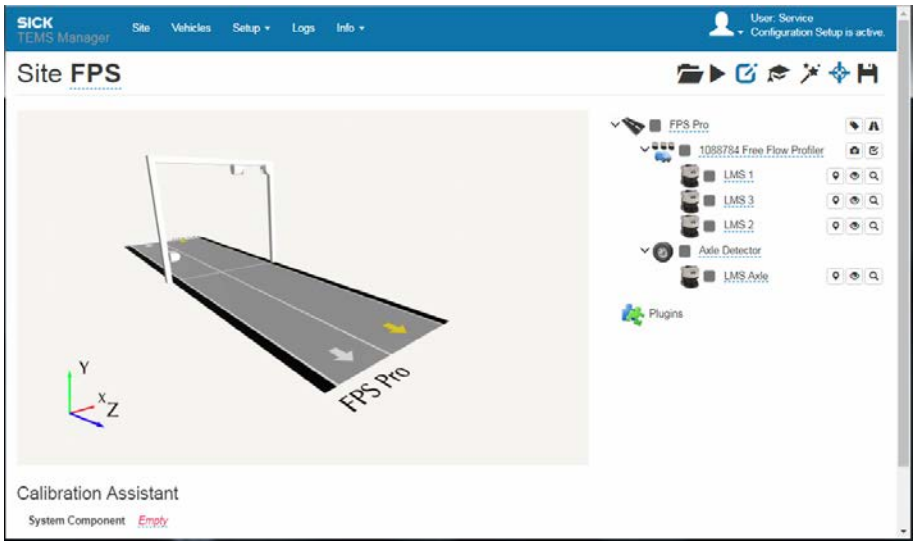
Once you have correctly aligned and adjusted the sensors, you can use the calibration wizard to detect and correct sensor errors of measurement based on a reference object with known dimensions.

A suitable reference object can be purchased from SICK.

Note Customers can also use their own reference objects with known dimensions.

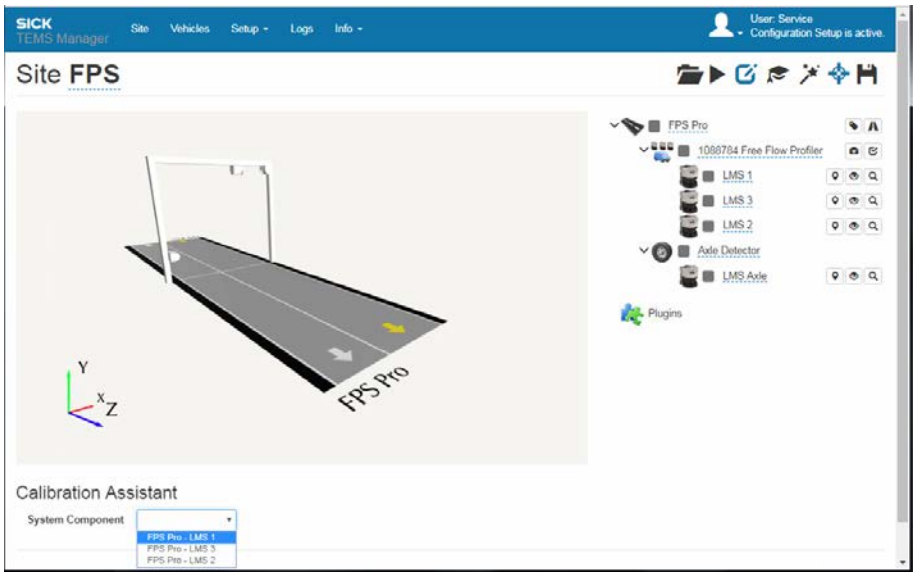
Getting started

1. Place the reference object underneath the measuring gantry on the lane that you want to monitor. Make sure that the object is located in the measuring plane of the sensors.
2. In TEMS Manager, click the **Calibration wizard** icon.



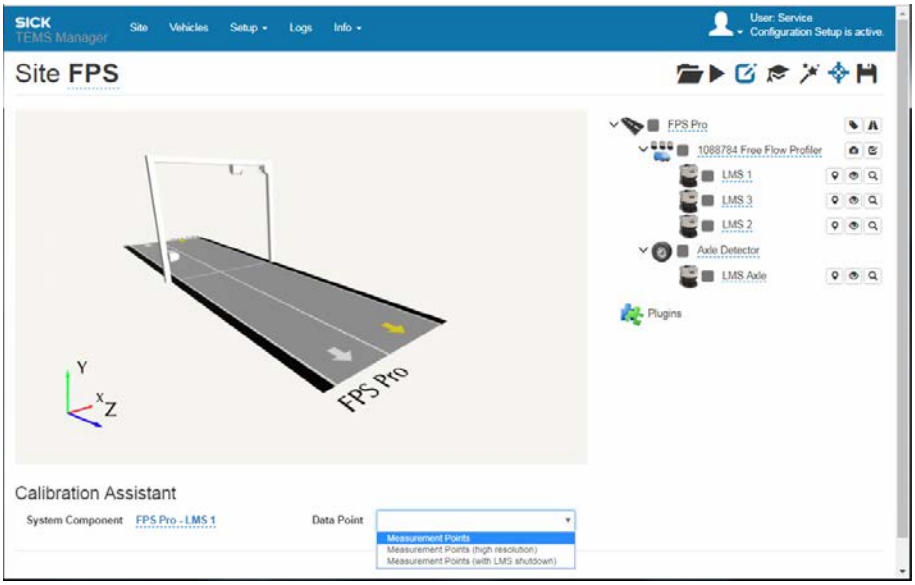
Specifying the basis of the calibration measurement

1. Go to the bottom section of the screen and click **Empty** next to the **System Component** field. From the list, choose the sensor component that you want to calibrate.

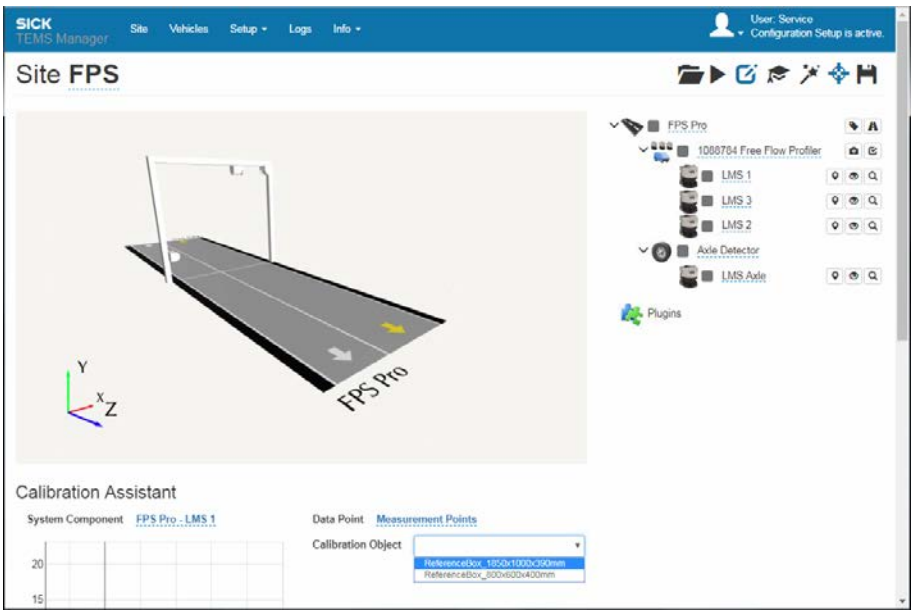


2. The **Data Point** field appears.

3. Click the **Empty** link and specify which measurement points the calibration wizard should use for calibration. Typically, the raw sensor data are used for this purpose.



4. The **Calibration Object** field appears.
5. Click the **Empty** link and specify the reference object. By default, the list only offers SICK calibration objects.

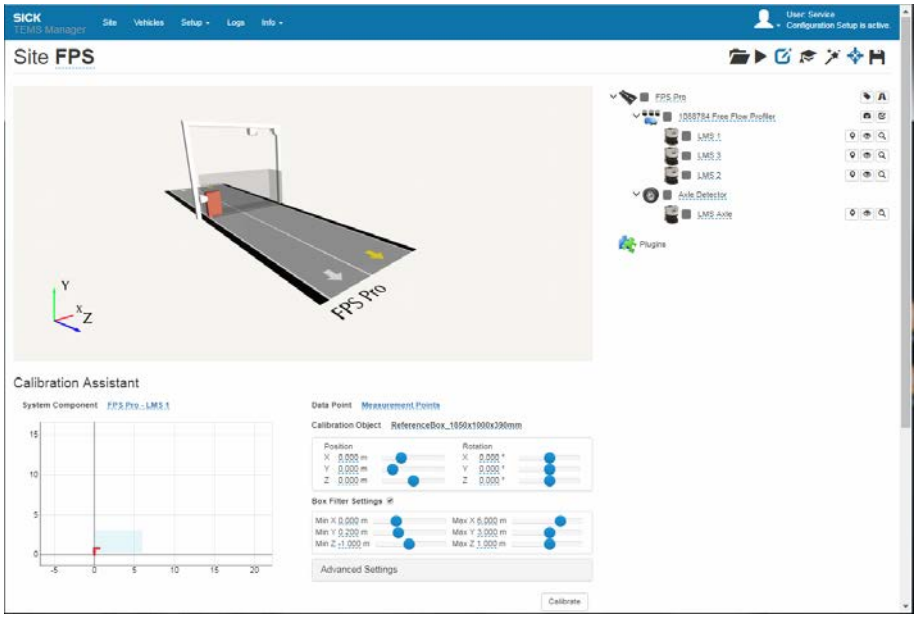


Visualization of the calibration range

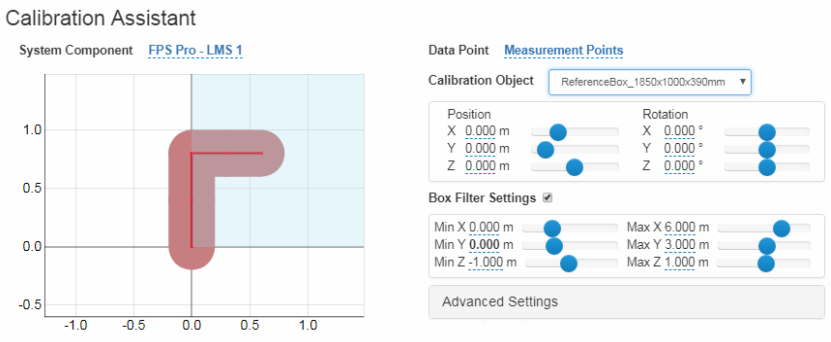
Once you have selected it, the reference object appears in the live view.

The value table at the top of the **Calibration wizard** area shows the position of the reference object within the coordinate system. The **Box Filter Settings** table allows you to set the range for recording measurement points as part of the calibration process.

The graphical display shows the sides of the reference object that can be “seen” by the 2D LiDAR sensor and the current positions of the measurement points. Use the display to help you set the calibration range exactly.



- ▶ Place the mouse pointer on the graphical display and zoom in on a section of the image where the reference lines of the object and the measurement points can be clearly identified.



Important The reference object must be positioned within the measuring range so that the 2D LiDAR sensor will definitely be able to detect two sides. The reference lines and measurement points should always be L-shaped.

The continuous red line represents the contour of the reference object. Meanwhile, the dotted red line indicates the current positions of the measurement points. The measurement points do not yet coincide exactly with the line of the reference object. The discrepancy is corrected by carrying out calibration.

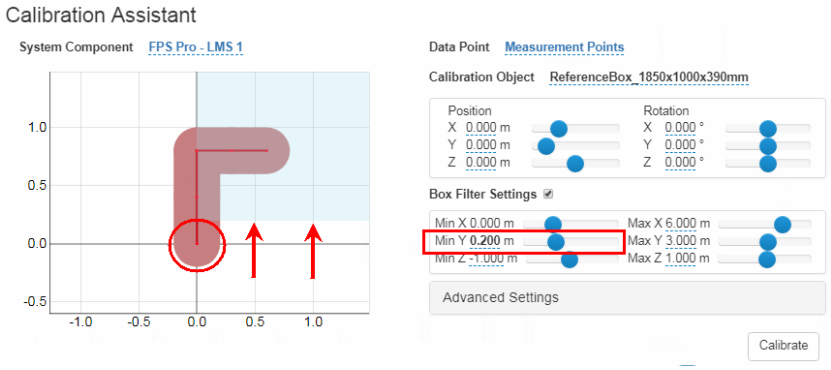
The light-red area defines the calibration range within which the measurement points are processed and optimized so that they end up coinciding exactly with the reference line of the object.

The blue rectangle represents the box filter. This defines a kind of prefilter for determining which measurement points should be included in the calibration process.

Box filter settings

To prevent the points on the ground from being included in the calibration process and distorting the results, you have to blank them out.

► To do this, drag the blue area up by approximately 20 cm. You can either enter the value directly in the **Min Y** field or you can use the slide control instead.



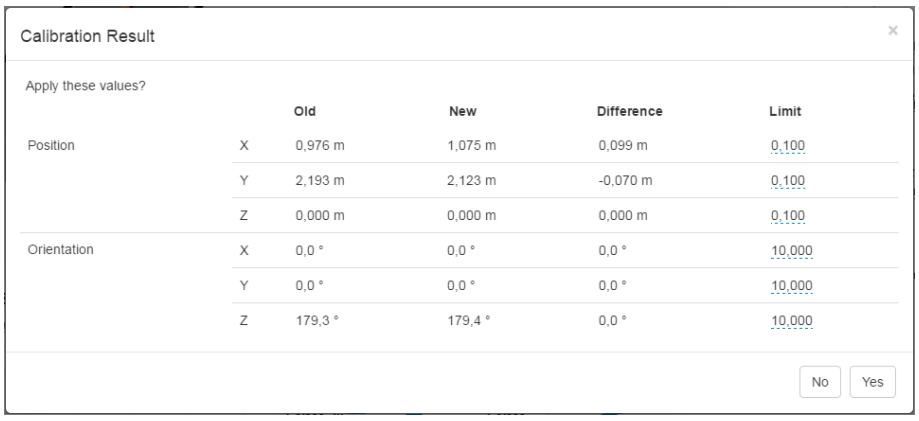
The points on the ground within the red calibration area (red circle) will now be ignored during calibration.

Starting calibration

► Click the **Calibrate** button.

The measurement points are optimized during the calibration process and moved onto the red contour line of the reference object.

The calibration result is displayed in a separate window. This shows the previous and corrected position values as well as the difference between them.



Applying the correction

▶ Click **Yes** to apply the new position values.

The position values are automatically updated in the navigation tree.

Calibrating additional sensors

▶ Calibrate the other sensor components of the profiling system by following the procedure described above.

NOTE

Do not move the reference object

The reference object must occupy the same position for all calibration processes.

▶ Leave the reference object exactly where it is throughout the entire calibration period.

▶ Do not move the reference object.

6.6.2.3 Defining lines for determining the position of the vehicle

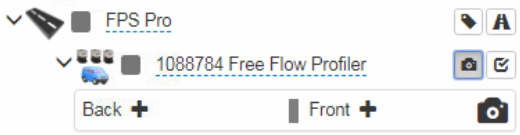
You can add the configuration of lines to determine the position of the vehicle in the lane. If a vehicle passes over this line during the measurement process, a corresponding object location message will be sent via the TEMS Info interface.

The message contains the exact time at which the vehicle crossed over the line. This means that third-party systems (such as license plate cameras or DSRC antennas) can assign events from other components or select the correct image from a video stream.

Note This mechanism is not suited for triggering time-critical tasks!

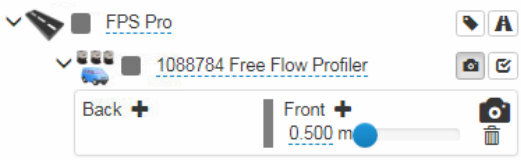
1. Go to the system function level in the navigation tree and click the **Edit system component trigger positions** camera icon.

   The input line opens for determining the positions of trigger lines.



   Using the plus icon in the **Back** and **Front** areas defined trigger lines based on the zero point of the Z-axis.

2. Use the slide control to position the position line or enter a value manually using the input field. The line will be displayed in the visualization.



Note A maximum of three trigger lines can be defined.

6.6.3 Configuring system functions for axle counting

If single-lane monitoring with axle counting is selected in the configuration wizard, the 2D LiDAR sensor is responsible for not only the **LMS Width** system component, but also the **LMS Axle** (shared function).

While this is, of course, one and the same device from a physical perspective, the system components are handled entirely separately in terms of data technology. For this reason, two system components are depicted in the tree, although the same sensor is assigned to both.

As only one 2D LiDAR sensor can be positioned and calibrated, it is recommended to position and calibrate the **LMS Width** and then transfer the calibration values to the **LMS Axle** system component.

Positioning and calibrating the LMS Width

Define the exact position and rotation of the **LMS Width** as shown in *6.6.2.1 Defining the position and rotation of the 2D LiDAR sensors*.

1. Go to the component level in the navigation tree and click the **Edit system component position** icon. The position and angle can be defined using either the slide controls or by entering the values manually.

The live view shows that the symbol for the LMS Width system component is positioned according to your input. The graphic symbol for the LMS Axle system component remains in the same position.

The two symbols had been overlapping in the default position.

Position

When entering the position, please observe the alignment of the coordinate system:

- The X-axis lies straight across the width of the road. The first distance parameter X is measured from the origin of the right-hand edge of the lane (when viewed in the direction of travel).
- The Y-axis defines the height at which the laser 2D LiDAR sensors is mounted. The second distance parameter Y is measured from the surface of the road.
- The Z-axis points in the direction of travel. The third distance value is measured in relation to the measuring plane of the sensor components (when viewed in the direction of travel).

Rotation

Align the LMS Width so that the setting is also suitable for the LMS Axle.

- Rotation about the **X-axis** (first field): The signal must be output at an angle of 90° in relation to the **road surface**.
- Rotation about the **Y-axis** (second field): The signal must be output at an angle of 90° in relation to the **direction of travel**.
- Rotation about the **Z-axis** (third field): The device's rear panel must be perpendicular to the road surface.

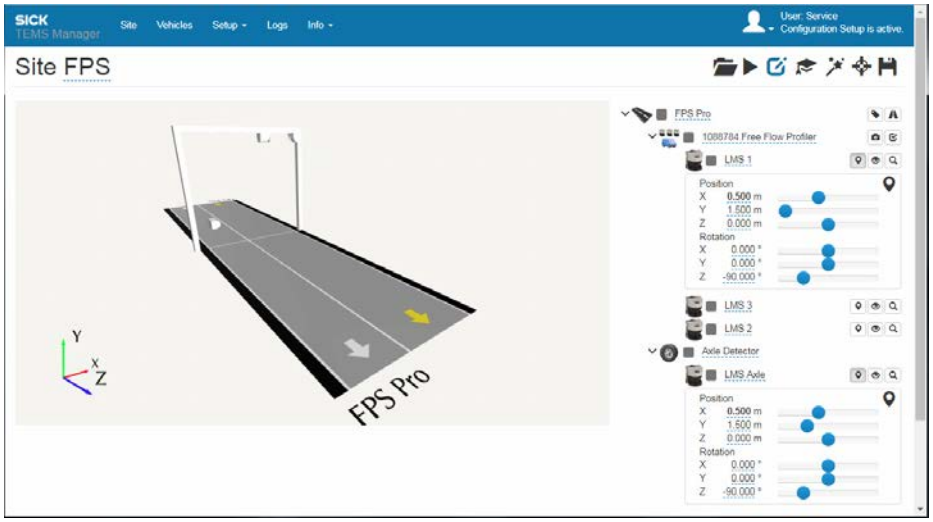
  A rotational error of ± 2° is tolerated for all axes.

Calibrating the LMS Width

▶ Calibrate the **LMS Width** using the calibration wizard (see *6.6.2.2 Calibrating the 2D LiDAR sensor*).

Applying the calibration positions from LMS Width

1. Take the calibration positions from the **LMS Width** system component and apply them to the **LMS Axle** system component.
2. The symbols for both system components are now congruent again in the live view.

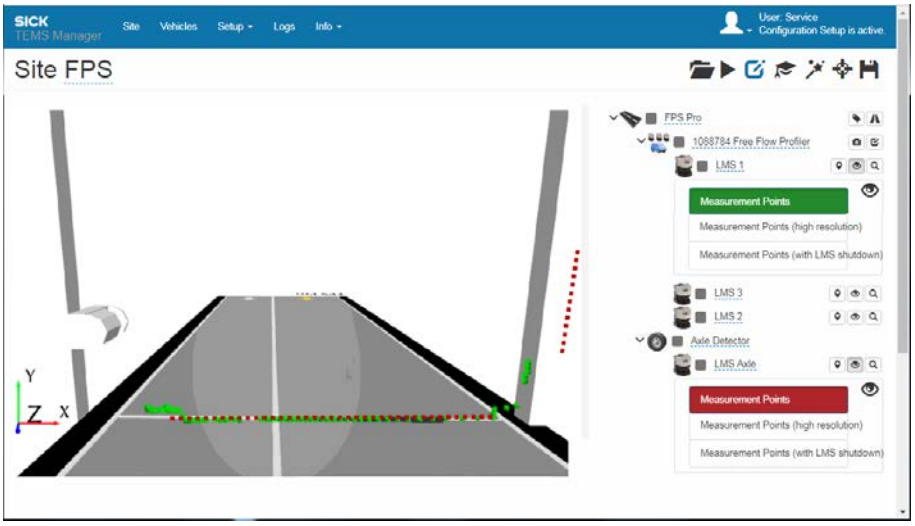


Checking that the mounting position is correct

In the live view, check that the mounting position is correct by referring to the unfiltered raw data of the 2D LiDAR sensor (see also *6.8.2 Displaying measurement points*).

1. Go to the component level and click the **Visualize live data for device** icon and then on **Measurement points** in the input line below.

   The measurement points appear. LMS Width and LMS Axle each provide their own measurement data as two independent system components to be considered in their own right.



Note The area at the bottom provides a detailed display of the measurement points within the coordinate system.

2. Adjust the Y-axis position so that all measurement points are visible on the road surface.
3. Adjust the angle of rotation and use the measurement points to check that the signal is being output as required.
4. Adjust the X position so that no permanent measurement points (e.g., lane dividers or borders) are visible within the lane. This is because the profiling system automatically limits the processing of measurement points to the width of the lane.
5. Filter the permanent measurement points by moving the 2D LiDAR sensor out of the measuring range on the X-axis.

Note If you click on the expanded function again, the measurement points disappear from view.

6.7 Working in expert mode

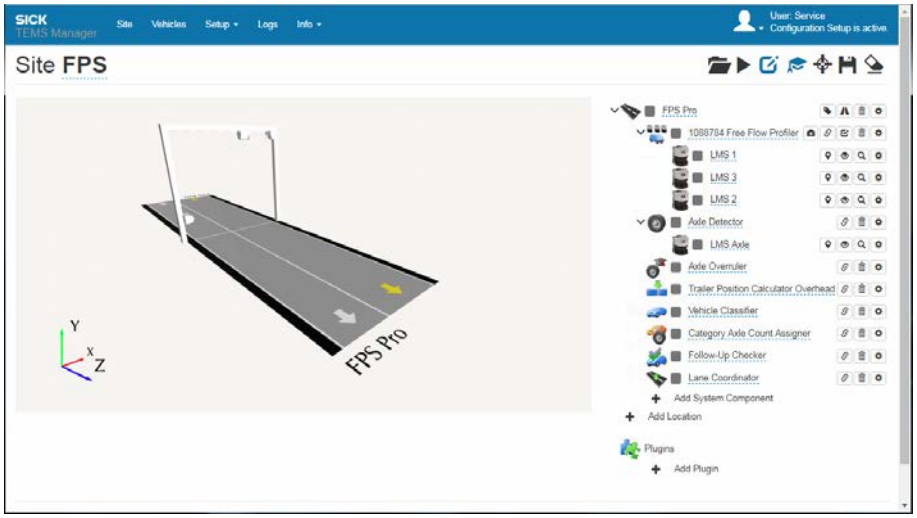
In expert mode the navigation area also displays system functions that do not have any device components. These include the system function for vehicle classification.

In expert mode, functions also appear which allow system and device parameters to be edited and plug-ins to be added.

Activating expert mode

▶ Go to the toolbar above the navigation area and click the **Activate/deactivate expert mode** icon.

The navigation area is expanded to include system functions and editing functions.



Notes on links

NOTE

Do **not** change the **links** to other system functions that have been set up using the chain-link icon .

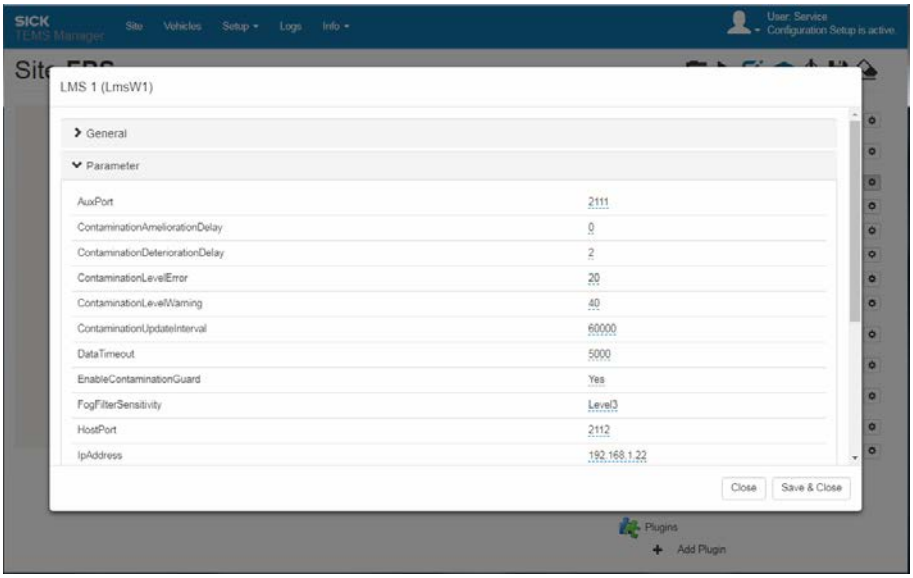
6.7.1 Displaying the system parameters and system status

The system parameters for the relevant system function/system component can be visualized by opening the detail window. Users with **Operator** authorization are only allowed to display the parameters. Users with **Authorized User** authorization or higher are permitted to edit them as well.

Opening the detail window

1. Expand the tree that contains the system functions.
2. Mark a system function or system component in the navigation area and click the **Show Details** icon.

   In the example, we open the parameters for a 2D LiDAR sensor. The number of displayed parameters depends on the authorization.

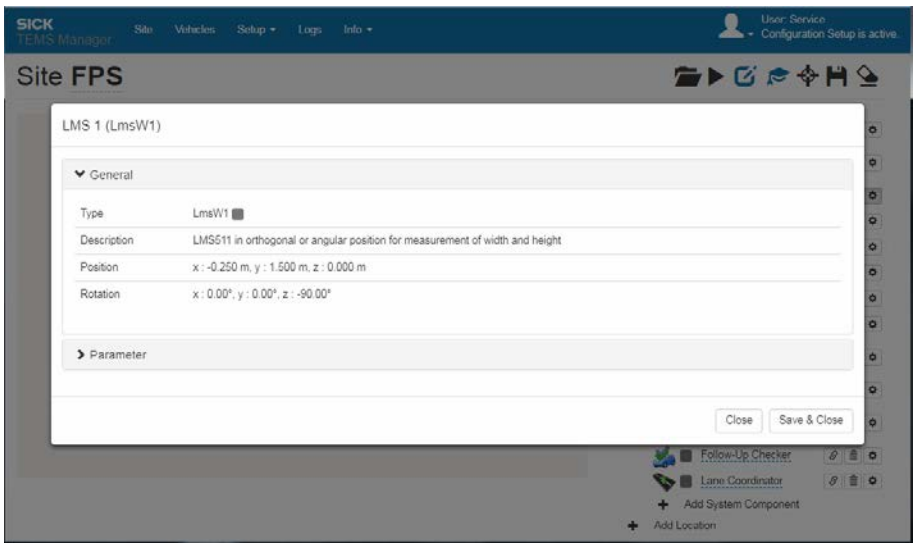


IP address

Upon delivery, the 2D LiDAR sensors are preconfigured with the correct IP address and label. The assignment of the sensors to the corresponding system components takes place via the configuration wizard. The IP address can also be changed here.

Checking the position and alignment of the 2D LiDAR sensors

► Take the position and alignment of the 2D LiDAR sensors from the **General** area. These must tally with the specified values and the installation situation.



6.7.2 Displaying system functions for vehicle classification

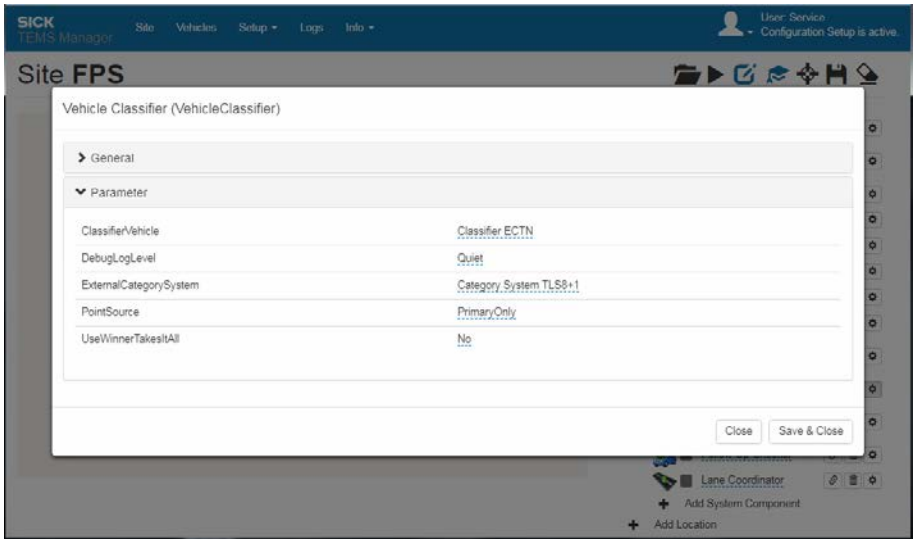
When the profiling system is used for vehicle classification, it is the category system that defines the criteria used to classify the recorded vehicles. The category system is selected via the wizard.

The same applies for the additional classification via an external output category system. With the **output category system**, vehicles are no longer identified on the basis of the individual vehicle classes within the category system. Instead, they are identified using classification groups (traffic checking regulations).

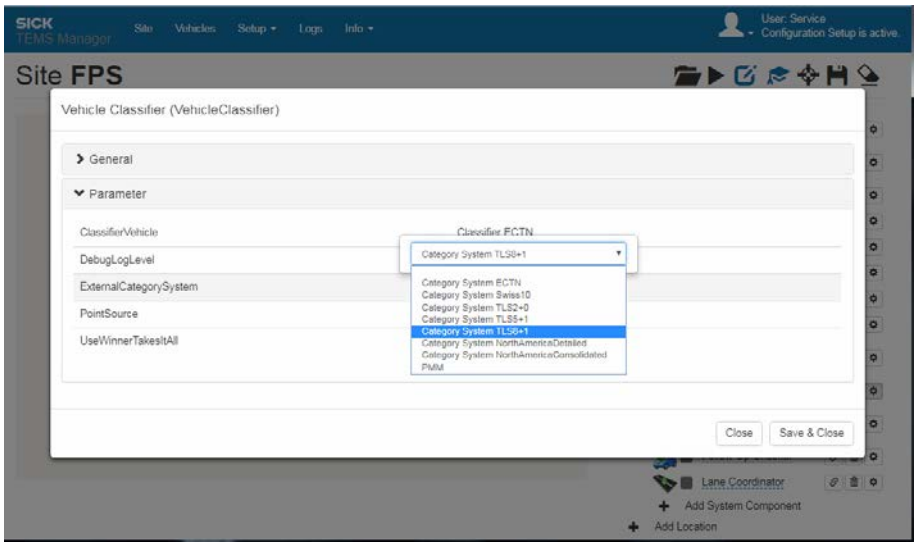
You can check the selected category system via the system parameters and make changes if necessary. An external category system can also be selected if you did not do this in the configuration wizard during initial commissioning.

1. Go to the level of the **Vehicle Classifier** system component and click the **Show Details** icon.

   The category system is preset within the **ClassifierVehicle** parameter.



2. You can define your preferred external category system via the **ExternalCategorySystem** parameter.



6.7.3 Working with the Axle Overruler

The **Axle Overruler** system function enables you to set up rules for checking how many axles the system has counted for a vehicle. If one of the rules is applicable, the figure can be **corrected** and thus **overwritten**.

Depending on which vehicle classes are checked under the rule and the probability of the vehicle belonging to one of these classes, the number of axles can be changed to an exact value or narrowed down to a minimum or maximum number of axles.

Examples For example, the axle number 4 can be entered for all vehicles belonging to the **car carrier transporter** class because their low-lying trailers make it difficult for the LMS axle to identify the axles clearly. For vehicles placed in the **Car** and **Bike** classes, the number of axles can be restricted to a maximum of 2.

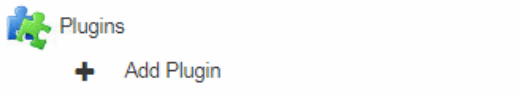
Note The rules have to be defined in conjunction with your local SICK contact.

6.7.4 Configuring plug-ins

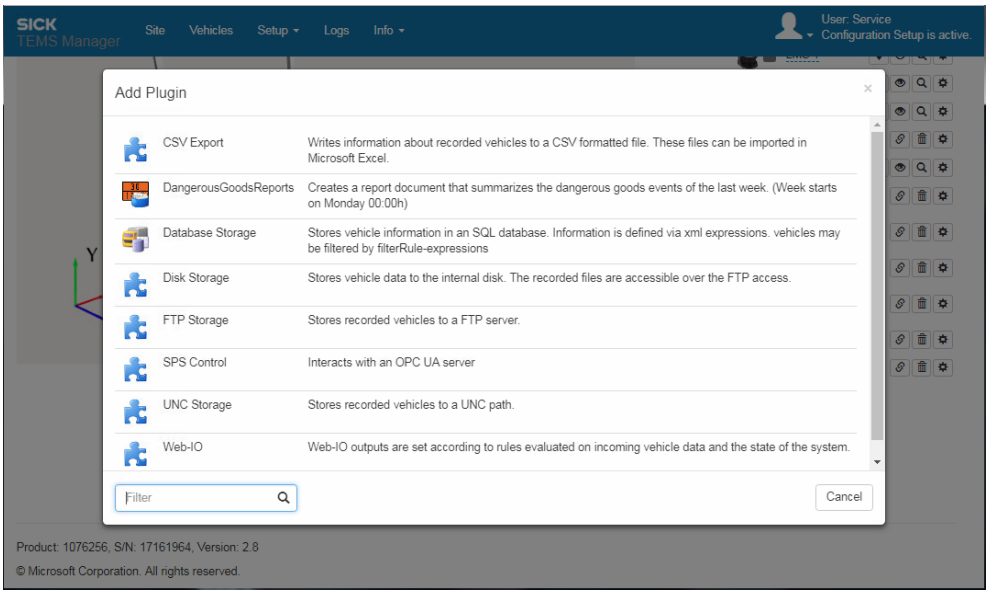
TEMS Manager includes a range of plug-ins for processing the recorded vehicle data. The following plug-ins can be selected and configured as standard: **CSV Export**, **Disk Storage**, **FTP Storage**, and **UNC Storage** (see also chapter *3.4.3 Plug-ins for saving and downloading the vehicle data)*. Only a few settings are required for the configuration process.

Adding plug-ins

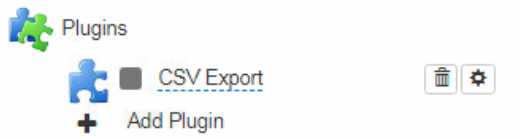
1. Click on the **Add Plugin** link in the navigation area.



2. A list of all available plug-ins opens.



3. Click on the required plug-in in the list; it is then applied to the navigation area.

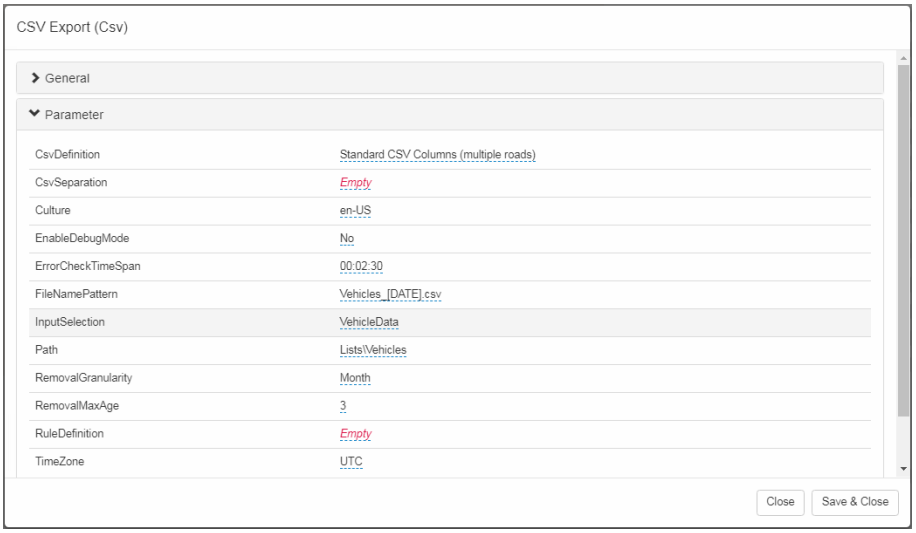


A plug-in can be configured using the gear icon **Show Details**.

CSV Export

The **CSV Export** plug-in saves the vehicle data obtained to a csv file, which is located inside the **/lists** directory. A separate data set is created in the csv file for each vehicle. As part of this process, you can also specify the period to be covered by a file. Usually, a csv file contains the vehicle data for a particular day.

► Open the detail window for the **CSV Export** plug-in.



The following parameters usually play a key role in determining the output structure of the csv file:

Parameters	Description
CsvDefinition	Determines whether measured values are identified for one lane, more than one lane, or for several lanes in conjunction with the axle counting function.
Culture	Defines the number format to be used.
TimeZone	Defines the time stamp for the measurement results when exported to the csv file.

Disk Storage

The **Disk Storage** plug-in stores each detected vehicle in a separate file using the **vehicle** file format. The vehicle file is placed in the **/data** directory. The vehicle file contains all the information recorded for a vehicle.

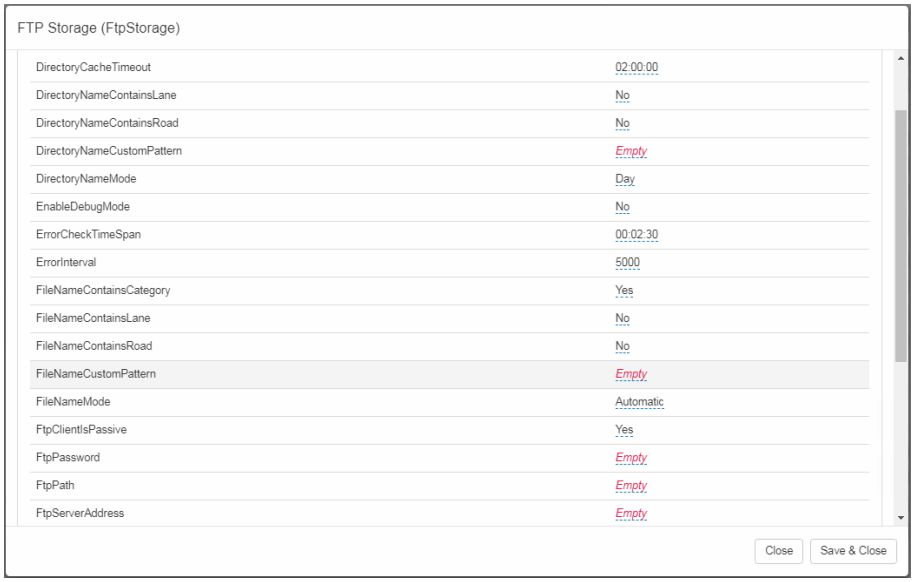
► Open the detail window for the **Disk Storage** plug-in.

Where necessary, specify the directory and file names. You do not have to configure any of the other parameters.

FTP Storage

The **FTP Storage** plug-in enables vehicle data to be uploaded to an FTP server automatically. The data are not stored on the Traffic Controller FPS.

► Open the detail window for the **FTP Storage** plug-in.



Set the following parameters to configure the FTP transfer:

Parameters	Description
FtpBasePath	FTP root directory
FtpPassword	FTP password for accessing the customer's FTP server.
FtpServerAddress	IP address of the customer FTP server to which the measurement results are to be uploaded. If the IP address is not in the same number range as the Traffic Controller FPS, the (correct) IP gateway must be set within the IP configuration.
FtpServerPort	The port via which the connection to the FTP server is to be established.
FtpUserName	FTP user name granting access to the FTP server.

UNC Storage

The **UNC Storage** plug-in enables vehicle data to be saved in a UNC path automatically. UNC paths allow a directory on the network to be accessed without the need for a drive letter. The data are not stored on the Traffic Controller FPS.

▶ Open the detail window for the **UNC Storage** plug-in.

Configure the UNC path as follows:

Parameters	Description
BasePath	Defines the network directory. The network directory has to be shared so that it can be accessed.
UNCDomainName UNCPassword UNCUsername	A Windows user must have been granted write access to the shared network directory. If this user is not a domain user, the computer name must be entered under the **UNCDomainName** parameter. Example **\\SRV1\Vehicles\Road1** UncDomainName: ***SRV1*** UncUserName: **tems_user** UncPassword: **sAfE_PassWord**

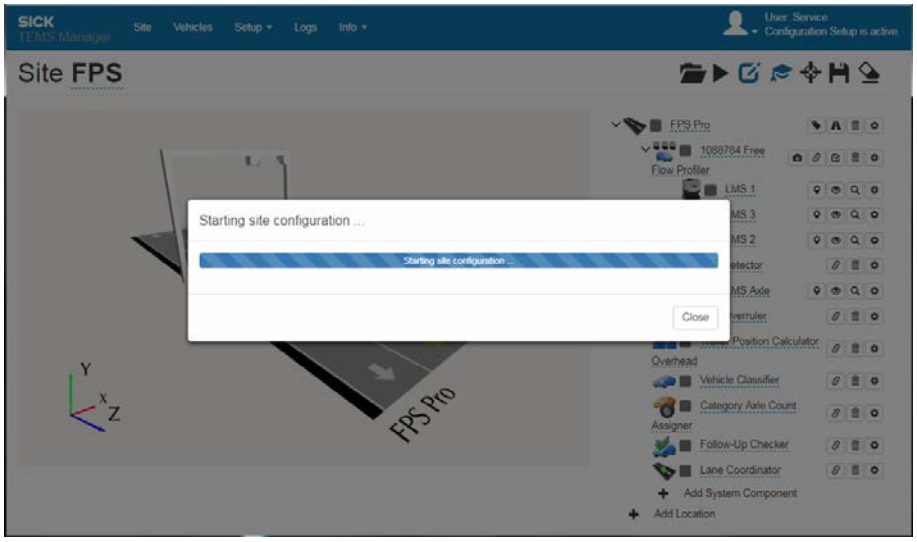
6.8 Running the configuration

You can now complete the configuration of the measurement site and run it in the TEMS Recorder straight away. The system components are automatically calibrated when starting the configuration.

Start configuration

- Click the **Start site configuration** icon.

A progress bar is displayed to visualize the start of configuration.

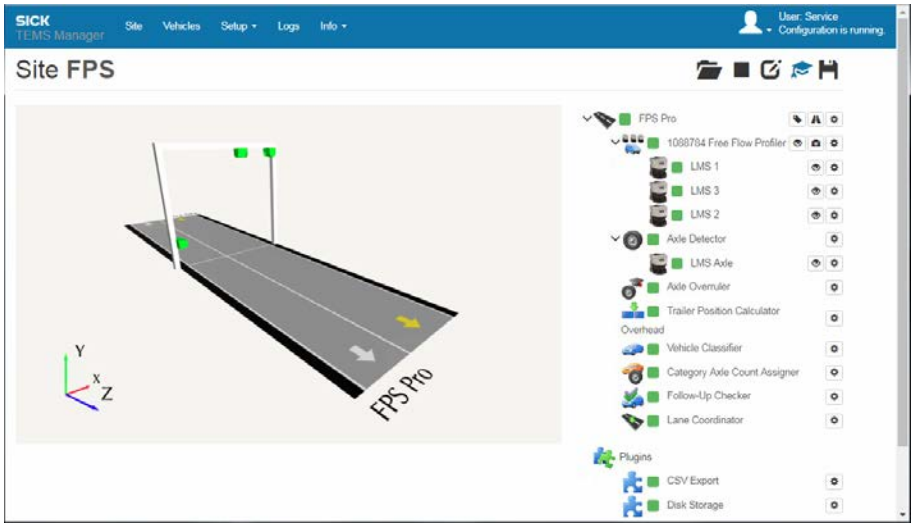


Notes

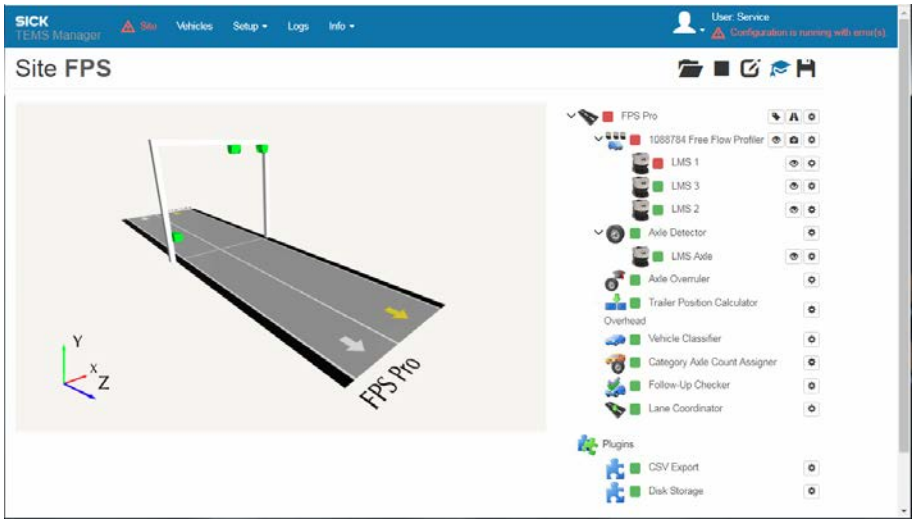
- If the configuration cannot be started, we recommend that you first check the voltage supply for the system components (to make sure it is correct), the network connectivity, and the IP addresses.
- Also make sure that the system components have been mounted according to the specifications (see chapter *3.5 Project planning*).
- Check the position and alignment of the system components in TEMS Manager. The position and alignment must match the actual conditions.

6.8.1 Checking operational readiness

If all the system components in the live view are **green** once the configuration has been successfully started, they are ready for operation. In the navigation tree, the operational readiness of the system functions and system components is indicated by a **green square**. A gray icon signals that a device status is currently unknown.



Note When the configuration starts, the sensor components remain red until a connection has been established. Depending on the network connectivity, this may take up to two minutes.
If a sensor component remains permanently **red**, it could be that an incorrect IP address has been assigned to it. The problem could also be caused by a missing or inadequate voltage supply or poor network connectivity.



Additional information on fault detection can be found in chapter *8.3.1 Fault diagnosis in TEMS Manager*.

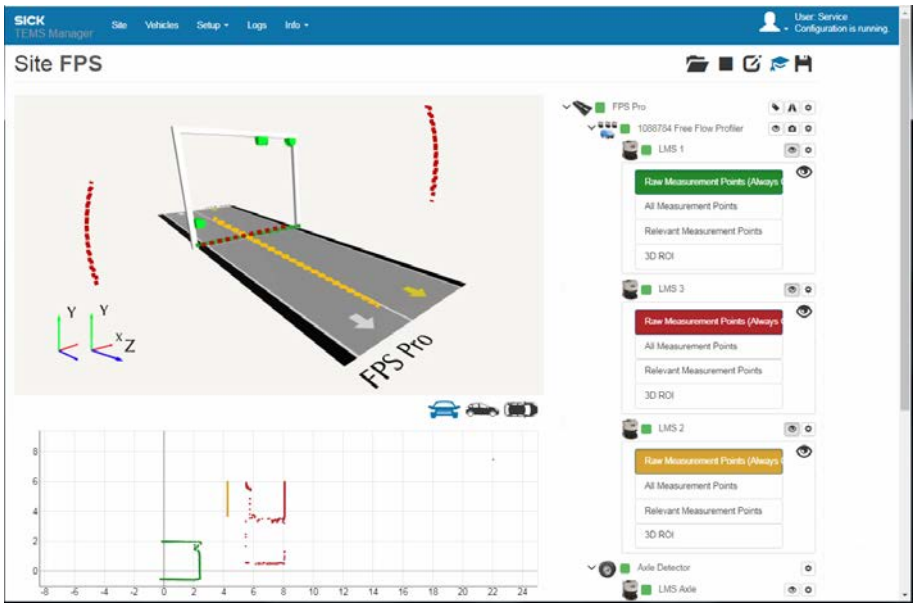
The toolbar above the navigation tree offers the following functions in operating mode:

Symbol	Meaning
	**Load and start site configuration** Loads the configuration file containing the key system parameters into TEMS Manager and starts the configuration. If a configuration is loaded while another configuration is running, the system will automatically stop the current configuration. The new configuration is loaded and started. System operation is paused during this process. The function requires login as a user with **Authorized User** authorization or higher.
	**Stop current site configuration** Stops the configuration that is currently running in measuring mode. The function requires login as a user with **Authorized User** authorization or higher.
	**Edit site configuration** Stops the configuration that is currently running and switches the system to editing mode. Once in editing mode, you can change the system parameters. The function requires login as a user with **Authorized User** authorization or higher.
	**Activate/deactivate expert mode** Switches the export mode on and off. Expert mode displays all system functions in the navigation area and functions for editing the parameter values, etc.
	**Save current site configuration on hard drive** Saves the current site configuration onto a data card. The configuration that is saved in the file can help SICK Support to resolve fault situations quickly. The function is available for all authorizations.

6.8.2 Displaying measurement points

In the live view, you can show the measurement points to visualize what a 2D LiDAR sensor can see on the basis of the system parameters. This helps to localize any errors when launching a configuration.

1. Go to the device level in the navigation tree and click the **Visualize live data for device** icon. The functions for visualizing the measurement points in the live view appear.
2. Click **Raw measuring points**. The measurement points detected by the 2D LiDAR sensor are displayed in the live view of TEMS Manager. The display is based on the unfiltered raw data for the 2D LiDAR sensor's entire visual range.



3. Click **Relevant Measurement Points**. The live view of TEMS Manager now shows the **filtered measurement data** from the 2D LiDAR sensors. The filtered measurement data are used as the basis for the 3D point cloud and the resulting calculations.

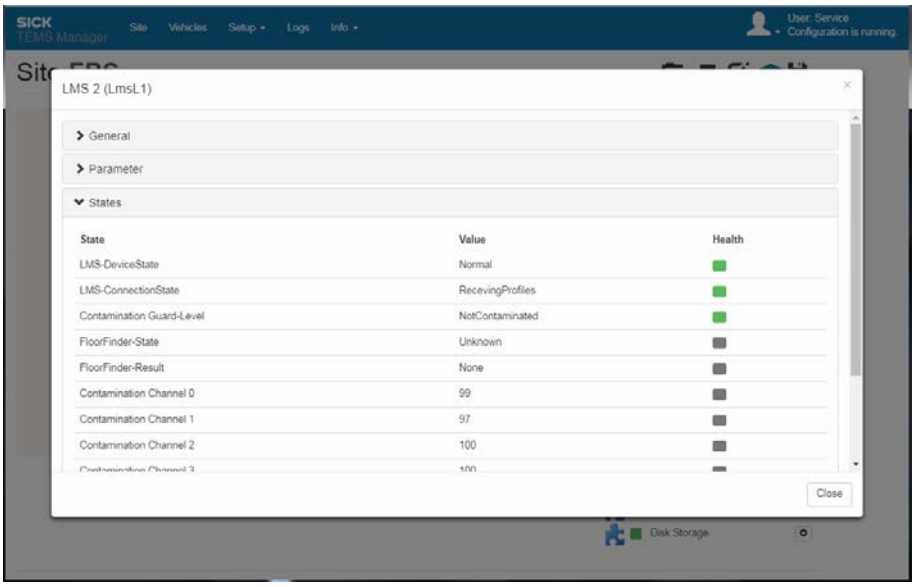
Note If you click on the expanded function again, the measurement points disappear from view.

6.8.3 Displaying the device status

In expert mode, you can access status information on the individual system components during operating mode.

1. Go to the toolbar above the navigation area and click the **Activate/deactivate expert mode** icon.

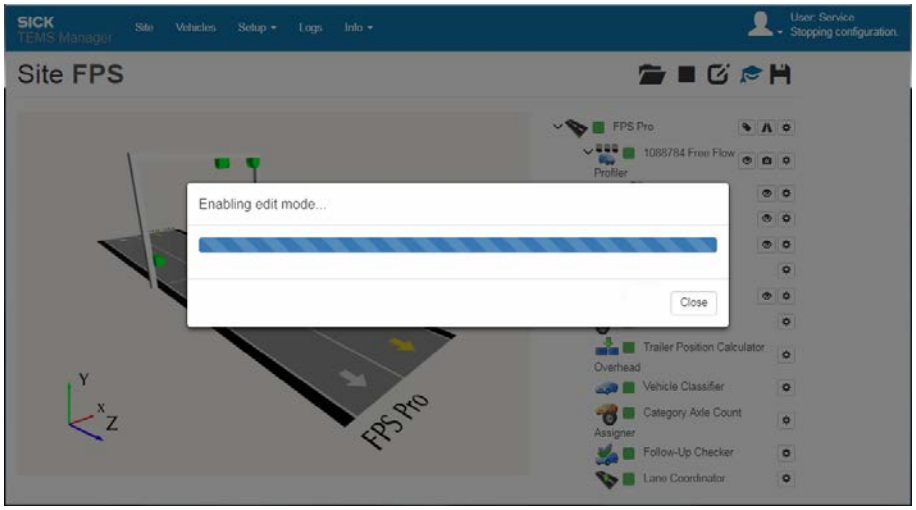
2. Click the **Show Details** icon for one of the system components.
3. Open the **States** area to display the status information for the system component concerned. In the event of a fault, you can (for example) refer to this information to see if the 2D LiDAR sensor is affected by contamination (see also *8.3.1 Fault diagnosis in TEMS Manager*).



6.8.4 Switching back to editing mode

When in operating mode, you can return to editing mode, change settings, and restart configuration directly at any time.

▶ Go to the toolbar above the navigation area and click the **Edit site configuration** icon.



Note You can only switch to this mode if you are logged in as a user with **Authorized User** authorization or higher.

6.8.5 Saving the configuration on the hard drive

To be able to resolve fault situations quickly, SICK Support often needs to have the current configuration file for the measurement site. This file can be saved onto the hard drive of a computer so that it can be sent to SICK Support. The computer must be connected to the Traffic Controller FPS.

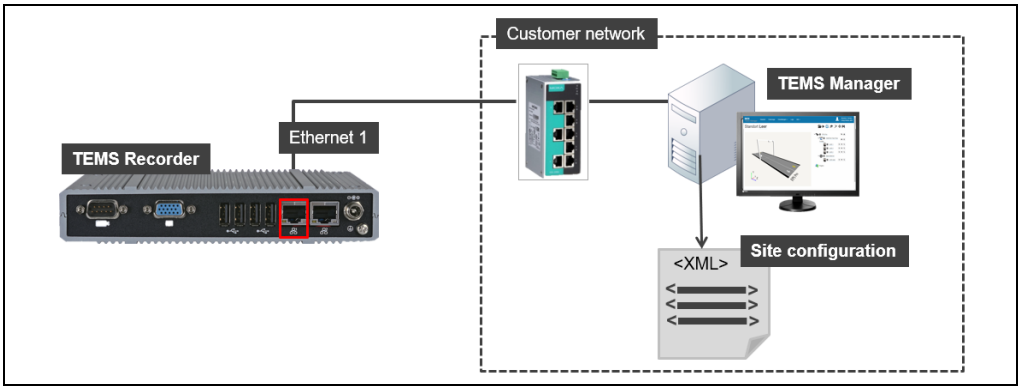


Fig. 66: Saving the configuration on the hard drive

Note The site configuration can be stored while a configuration is running. The process for saving a site configuration does not affect the current system status.

1. Click the **Save current site configuration on hard drive** icon in the toolbar.
2. The download dialog box of the browser opens right away.
3. Specify the location for saving the configuration file. The site configuration is saved in **XML file format**.

   The XML file contains a range of information on the site configuration, including:

   - IP address for the 2D LiDAR sensors
   - Mounting positions and names of the 2D LiDAR sensors
   - Definitions and names of the roads and lanes

Editing the XML file manually

Experienced users can also edit the XML file containing the site configuration directly, and can adjust the names of the roads and lanes or the position of the system components accordingly.

The XML file is loaded in TEMS Manager by clicking the **Load and start site configuration icon** as described previously (see chapter *6.14.4 Using a configuration file to load system parameters*).

6.9 Checking that measuring mode is working properly

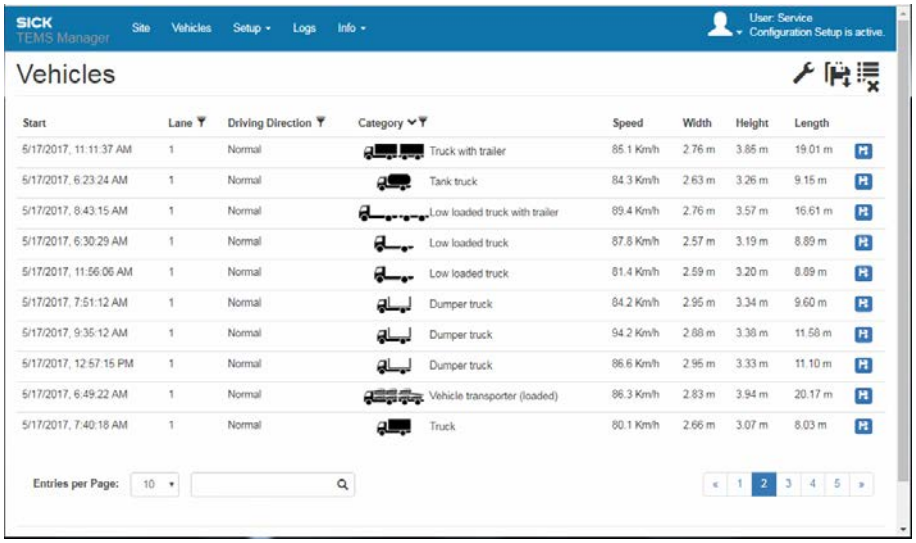
Finish commissioning the system by performing a test run. The test run must make sure that the system components are working correctly and that they are delivering plausible measured values.

The test run can only be performed if the site configuration process has been successfully completed and all of the system functions and system components in the navigation tree have a green square next to them.

6.9.1 Displaying vehicles with measured values

Whenever TEMS Manager is connected to the TEMS Recorder, the **Vehicles** working range contains a table of the last 50 vehicles recorded chronologically (or vehicles with a maximum memory of 50 MB). The order in which the vehicles are displayed depends on the column selected and the sorting setting.

The display shows the time of the recording, the detected vehicle category together with a pictogram, the lane, the speed, and the vehicle dimensions.



Changing the number of vehicles displayed

By default, ten vehicles are displayed per page.

- To change this, go to the **Entries per Page** field underneath the table and enter the desired number (in increments of five). The maximum number of vehicles that can be displayed in the table is 25.
- You can use the search field to filter the list of vehicles on the page. Enter a character string. The list is automatically narrowed down so that only those vehicles with a matching character string in one of the columns remain.

Navigating within the vehicle view

To switch between the individual pages of the vehicle overview, use the page numbers on the right-hand side below the table.

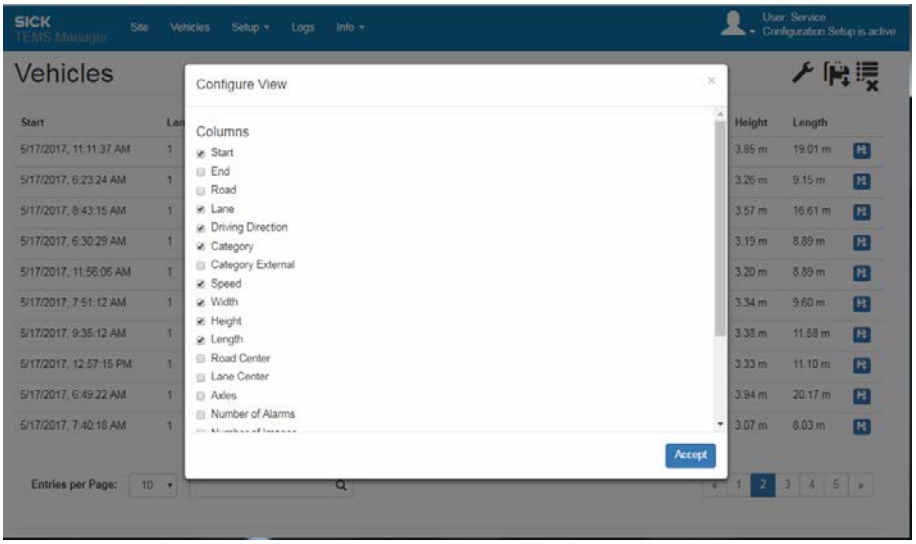
The icons have the following meanings:

Symbol	Meaning
«	Opens the first page.
»	Opens the last page.
3	The icon for the currently open page is highlighted in blue.
...	Click this icon to switch to the previous or next page from the current one.
... 5 ...	Allows you to open a specific page directly.

Editing the list view settings

You can show and hide the various columns that make up the vehicle table.

1. Go to the toolbar in the **Vehicles** workspace and click the tool icon.
2. To control which columns are visible, select/deselect the relevant checkboxes.



Checking the measurement results

Use the table to verify that the measurement site is in proper condition.

- ► Check that the vehicles are being continuously detected by the profiling system.
- ► Make sure that the profiling system is delivering plausible measured values.

6.9.2 Saving vehicle data

The “Vehicles” list view also allows you to save the measured values for the vehicles onto a local hard drive.

- To save the data for a specific vehicle, click the associated “Save” icon on the right-hand side of the list.

- If you want all the vehicles currently listed in TEMS Manager to be written to a local hard drive, go to the toolbar and click the **Save all vehicles** icon. Please note that only the last 200 measured vehicles can be displayed and saved in TEMS Manager.

Note

If the **Disk Storage** plug-in has been activated, **all** of the vehicle data stored on the Traffic Controller FPS under the **/data** directory can be downloaded using an FTP download (see chapter *3.4.3 Plug-ins for saving and downloading the vehicle data*).

1. Connect to the FTP server of the Traffic Controller FPS using an FTP client (e.g., FileZilla).
2. Log in by entering **client** for the user name and **client** as the password.

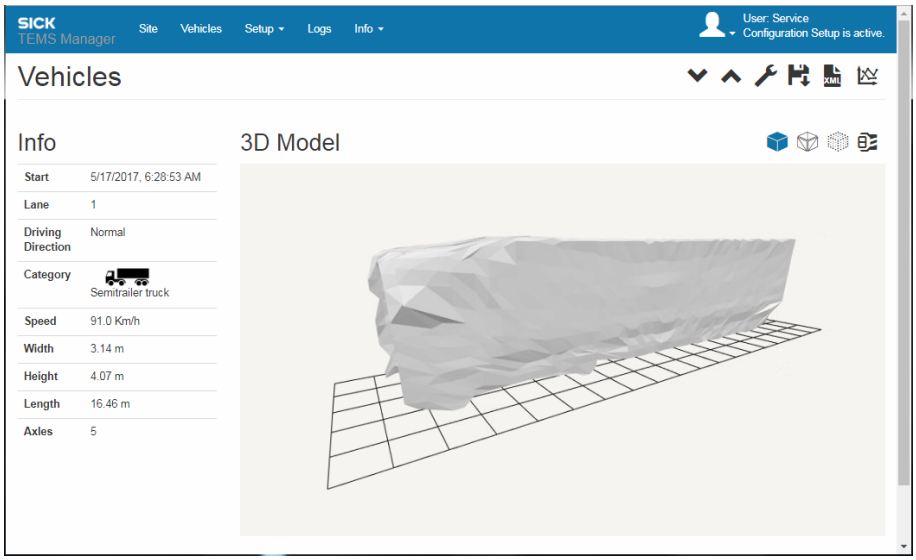
6.9.3 Accessing detailed information about a vehicle

6.9.3.1 3D model and measurement results

For each vehicle, you can open a details page that contains additional information.

► To do this, click inside the relevant vehicle line. The details page appears in the same browser window.

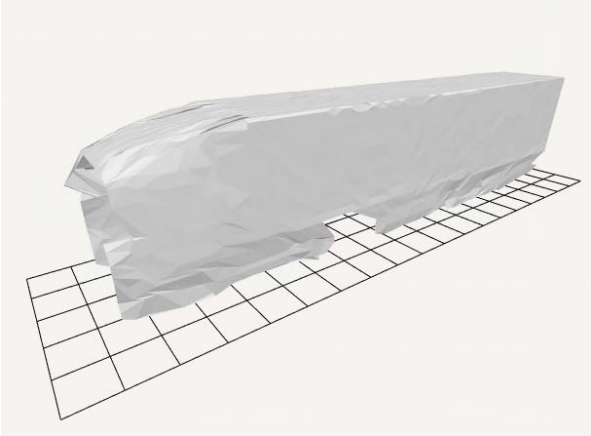
The measured values for the vehicle are displayed in the **Info** area. The **3D-Model** area contains the three-dimensional model of the vehicle.



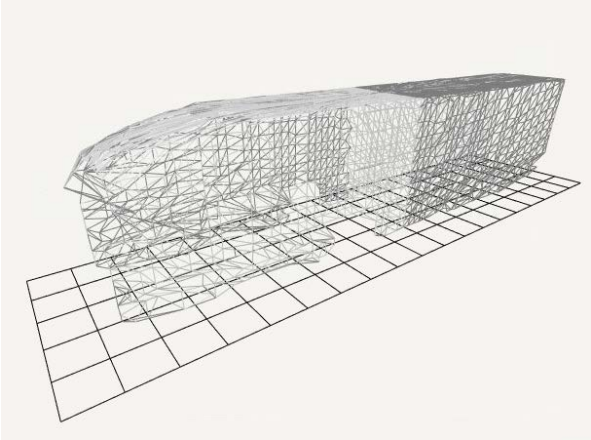
Changing the view of the 3D model

You can rotate and move the 3D model of the vehicle – and zoom in and out – in exactly the same way as with the graphical display of the site.

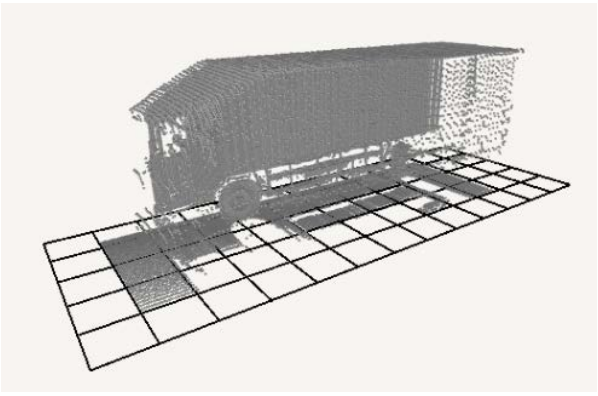
- To display the surface of the vehicle, select the **Show continuous surfaces in the 3D view** icon.



- Alternatively, you can select the **Show grid structure in the 3D view** icon if you want to see a framework view of the vehicle.



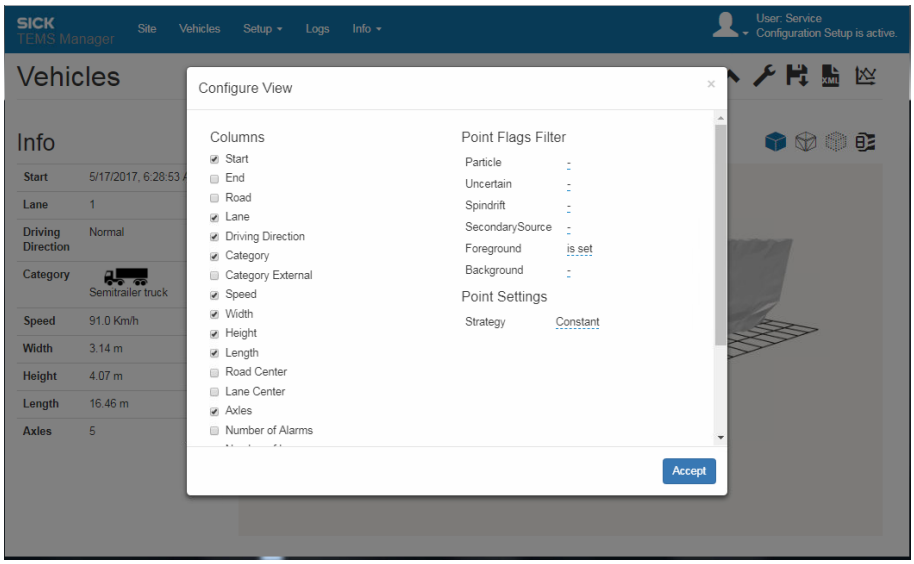
- The **Show point data in the 3D view** icon provides a point view.



Adjusting how much data is displayed

You can define the scope of the data to be displayed on the details page in a similar way as for the “Vehicles” table view.

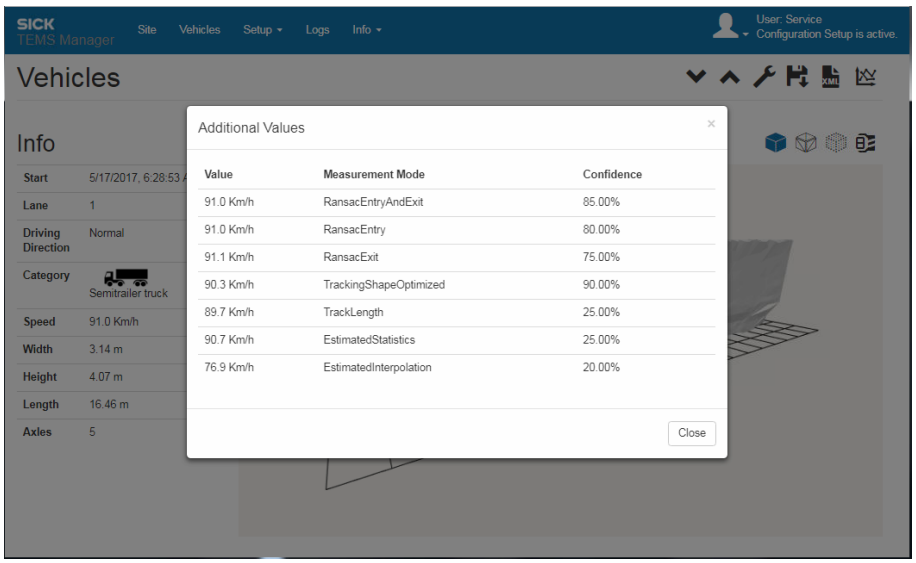
1. Click the tool icon on the top right-hand side of the details page.
2. To control which data items are visible, select/deselect the relevant checkboxes and click **Accept** to confirm your choices.



Displaying values together with the confidence level

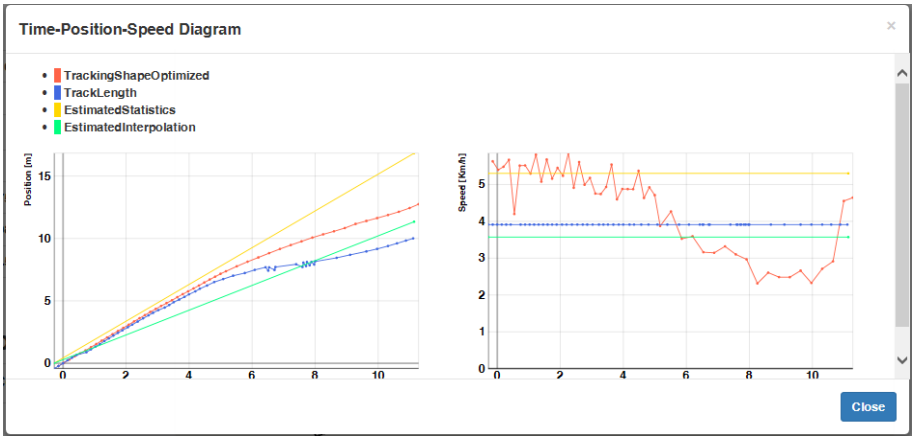
Alternative values with a calculated confidence level are available for most measured values. These can be displayed in a separate window.

► Move the mouse over a measured value and click to open the **Additional Values** window, which contains alternative information on the measured value (e.g., speed plus confidence level according to different calculation methods).



Displaying a time-position-speed diagram

From the time-position-speed diagram you can see how the alternative values have been calculated. This diagram plots the measurement points that have been obtained for each calculation method in time and space (Z-axis). The positions are determined from the moment when the front of the vehicle passes through the measuring plane.



Note The time-position-speed diagram is an expert function that can be used to analyze errors. For instance, the diagram can shed light on distorted 3D models of vehicles that appear “elongated” or “compressed”. In such cases, it may be that the system was unable to obtain any measurement points within a particular area.

Switching to the details page for the previous/next vehicle

You can switch to the details page for the next or previous vehicle directly from the current one without having to return to the list of vehicles first.

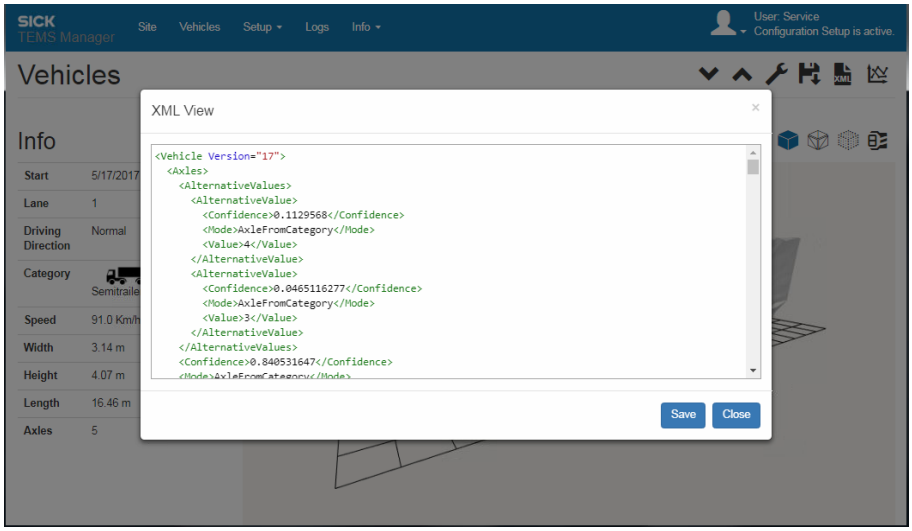
▶ To do this, use the two arrows in the toolbar.

Saving vehicle data

▶ Click the **Save vehicle locally** icon on the details page to save the measured values for the vehicle that is currently on display to a local hard drive.

Displaying the vehicle data in XML format

► Click the **Display vehicle data as XML** icon to display the vehicle data in the **Info** area in XML format. This is the format that is used for transferring the measurement results to the customer system.



Returning to the vehicle list

► Go to the menu bar and click the **Vehicles** workspace option.

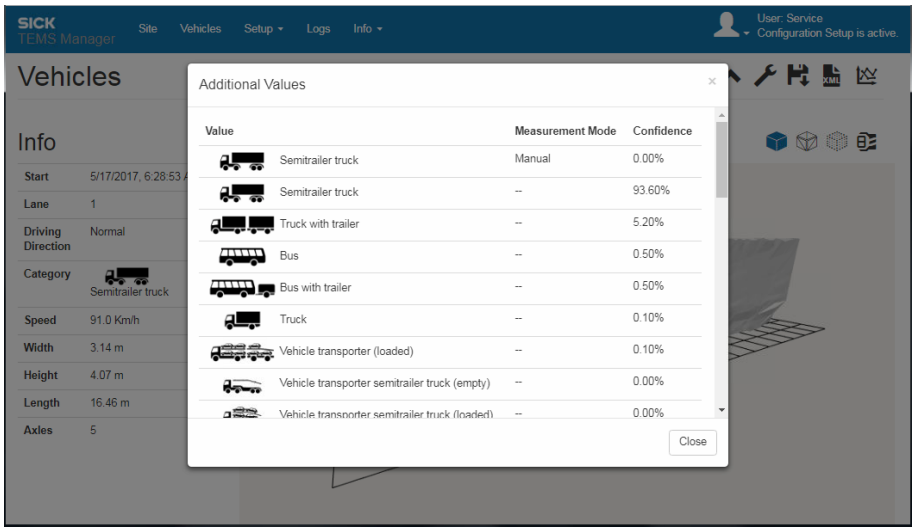
This opens the list of the last 200 vehicles measured.

6.9.3.2 Vehicle classes

The **Vehicle Classifier** system function is used to report the vehicle class in the detail window under **Info**. The class is chosen from all classes in the set category system.

► Click inside the “Category” field to open the **Additional Values** window, which displays a list of all the vehicle classes within the category system.

This enables you to see the confidence level with which the vehicle has been assigned to the class in question.

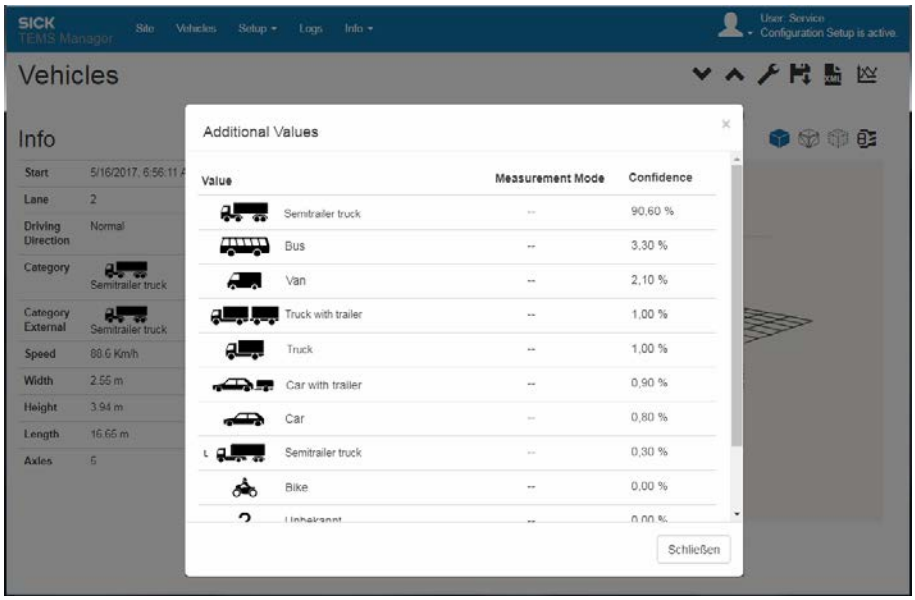


Displaying the vehicle class on the basis of the output category system

1. Show the **Category External** column using the tool icon.

   In the **Category External** area, the vehicle class is determined and reported on the basis of the selected output category system. In this case, reference is no longer made to all the vehicle classes within the selected category system because the configured classification groups are used instead (see also chapter *3.3.3 Operating principle of the vehicle classification function*).

2. Click inside the “Category External” field to open the **Additional Values** window. This enables you to see the confidence level with which the vehicle has been assigned to the output category in question.



Note By grouping the vehicle classes together in this way, a higher confidence level can be achieved than when the vehicle is assigned on the basis of all the classes within the set category system.

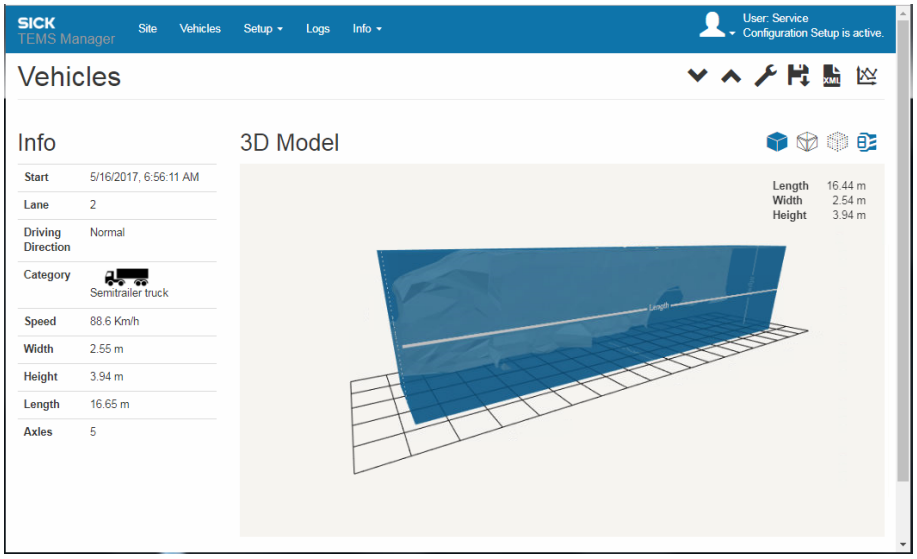
6.9.3.3 Measuring the vehicle area in the 3D model

The 3D model on the details page has a function you can use to measure individual areas of the vehicle shown. This allows you to identify and check the dimensions of the towing vehicle or the distance between the towing vehicle and the trailer, for example.

► Go to the toolbar in the **3D model** area and click the **Measure** icon.

Regardless of which graphical display you have selected, a box containing the maximum vehicle dimensions appears above the vehicle. The dimensions of this box are displayed in the upper right area of the 3D view. The values correspond to the maximum vehicle dimensions after invoking the function.

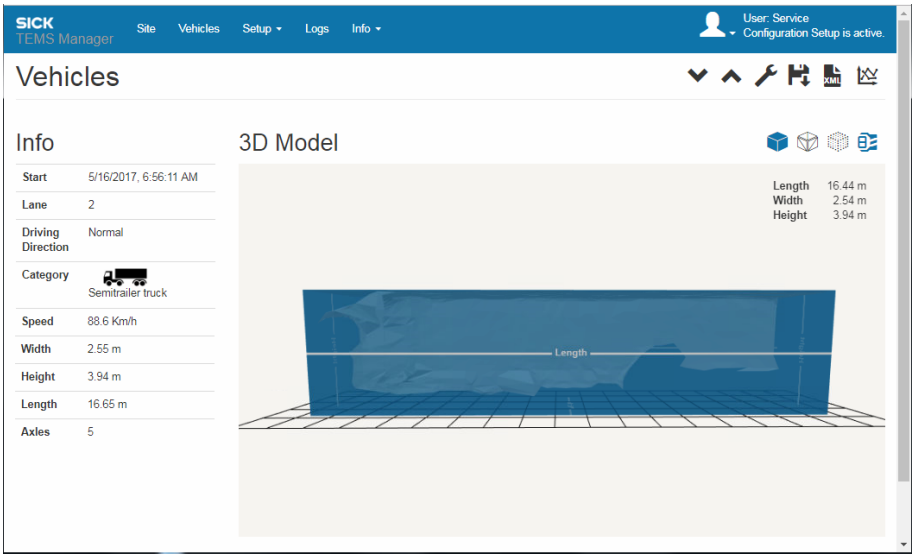
Depending on the selected perspective, the 3D model creates a visualization of the measurements by means of a length, width, and height line.



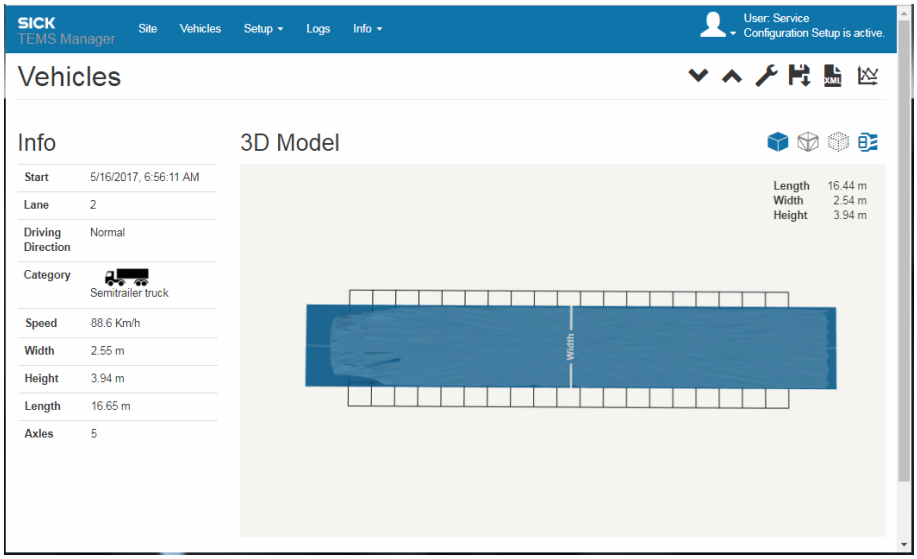
Selecting the view

Rotate the model so you can clearly see the relevant dimension line.

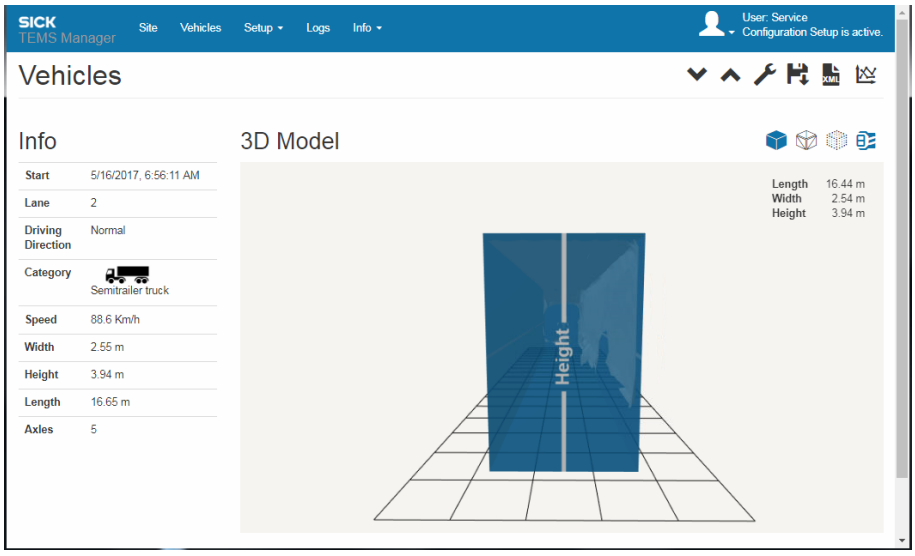
- The **side view** visualizes the length line of the box. This view makes it possible to measure the length (and height) with ease.



- The **top view** visualizes the width line of the box. This view makes it possible to measure the width (and length) with ease.



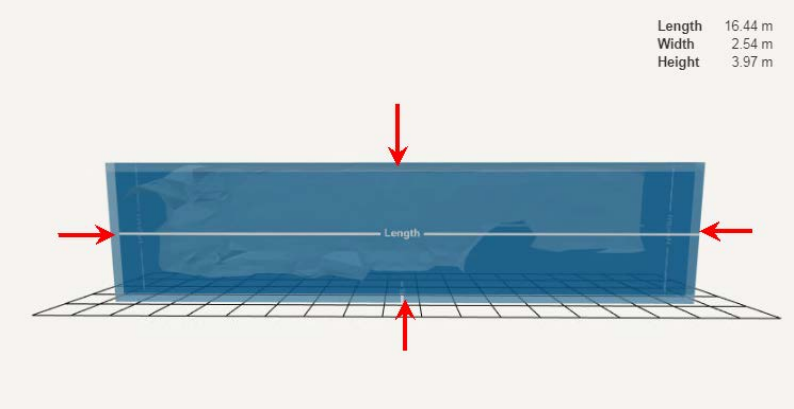
- The **front/rear view** visualizes the height line of the box. This view makes it possible to measure the height (and width) with ease.



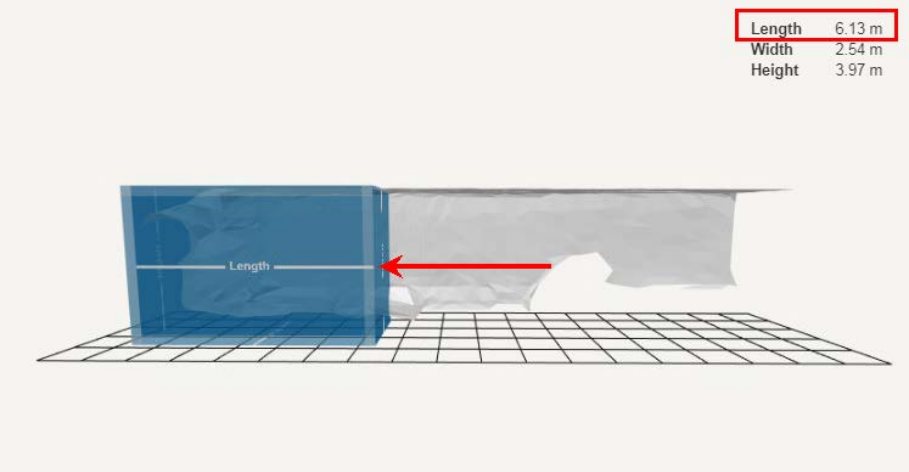
Taking measurements

The example below identifies the length of the tractor. This principle is the same for all measurements.

1. Select the appropriate perspective. In this example, it is the side view.
2. Double-click on the box. The box edges are activated.



3. Click on the edge you would like to move.
4. Move the edge along the corresponding axis for the shape to be measured. The box dimensions (here the box length) is updated.



Note The dimensions of the box are always crucial. There is no specific zero point

5. Check the plausibility of the dimensions shown. In this example, the length dimensions of the tractor.

Note Double-clicking on the box edge shows the box with the original (maximum) vehicle measurements.

Deactivating measurements

► Click the **Measure** icon again. The box disappears again.

6.10 Downloading log files

To help SICK Support with fault analysis, it is often necessary to forward the latest system logs. You can download these logs via the **Logs** workspace and send them as an e-mail attachment.

All system actions are written to a log file of the **Recorder** type. A separate log file is created for each day.

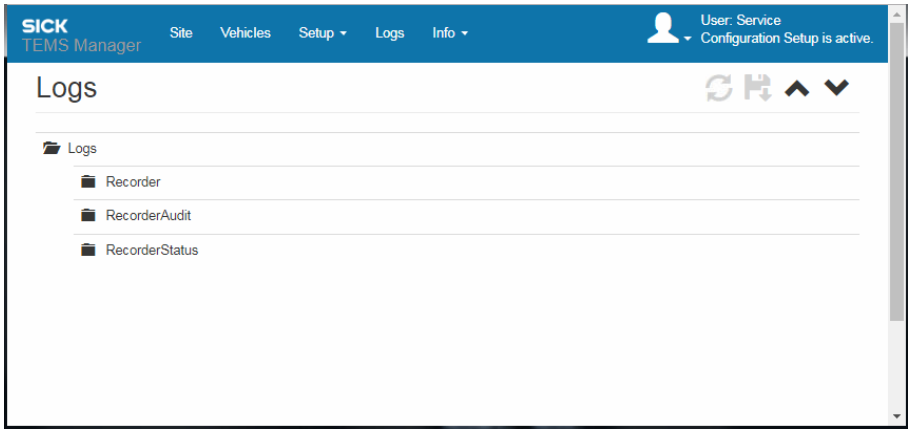
In addition, the availability status of the Traffic Controller is checked and logged continuously. The results of the internal self-check are recorded using the **RecorderStatus** log type. Once again, a separate log file is created for each day.

The **RecorderAudit** log type delivers a list of all login processes and changes to user rights.

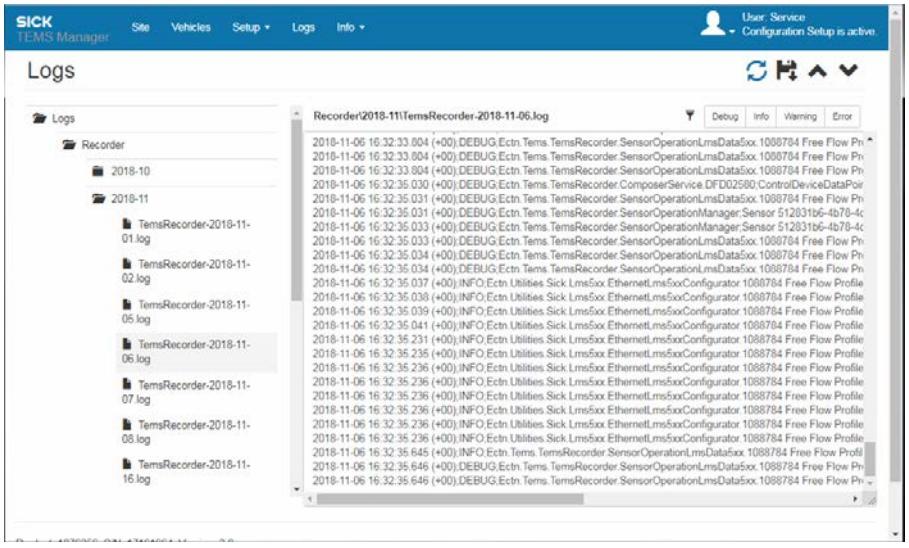
Displaying the list of log files

1. Open the **Logs** workspace via the menu bar.

   Both log types are listed in a tree structure.



2. Expand the folders for each log type to display the individual logs. The logs are sorted by month and date. The right-hand side of the window shows an excerpt of each logged entry.



Updating the list

In the toolbar, there are two different options for updating the list of log entries.

- If you click on this icon, the list will be updated automatically. New log entries are continuously added.

- Alternatively, you can update the log entries manually with this icon.

Filtering the list according to log entry type

- You can filter the list based on the following types: **Debug**, **Info**, **Warning**, and **Error**. Click one of the four buttons to activate and deactivate the relevant filter.

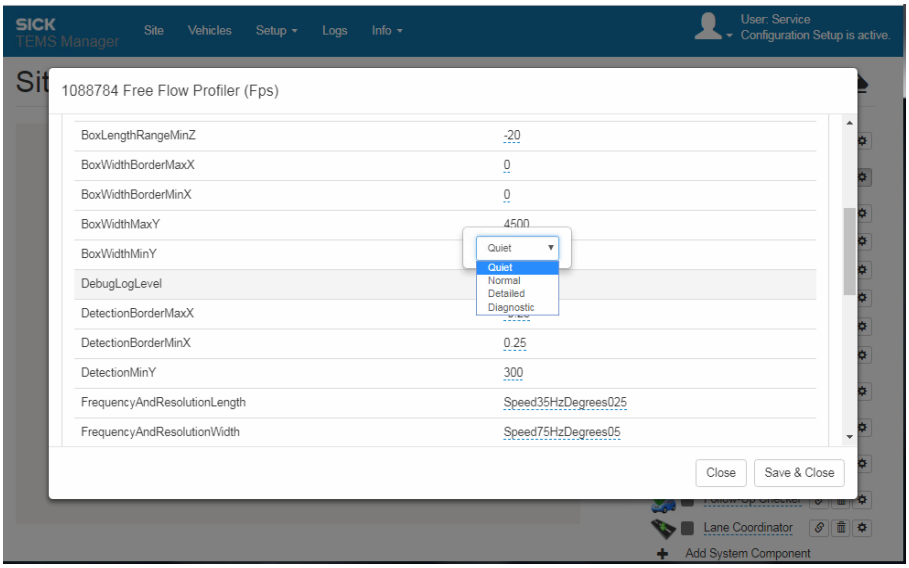
Note You can combine several filters.

Defining the level of detail for “Recorder” log type entries

You can define a different level of detail for the log entries in the **Recorder** log type. Support will let you know which level of detail is required to provide further assistance.

1. Switch to editing mode using the **Edit default configuration** icon.
2. Expand the tree that contains the system functions.

3. Mark a system function or system component in the navigation area (here a 2D LiDAR sensor) and click the **Show Details** icon.
4. Select the level of detail advised by Support in the **DebugLogLevel** parameter. A distinction is made between **Quiet**, **Normal**, **Detailed**, and **Diagnostics** detail levels.



5. Click the **Start site configuration** icon. All system actions are now written to the log file of the **Recorder** type with the set level of detail.

Sending log files

Support will usually ask for the latest version of each log file or a log file containing the reported fault.

1. Select the log file of the relevant type in the list.

2. Go to the toolbar and click the **Download log file** icon.
3. Save the log files in a directory of your choice.

Downloading log files via FTP

Alternatively, all the logs can be downloaded from the Traffic Controller via FTP. The status logs are stored inside the **/logs** directory (see also chapter *3.4.4 Downloading log files*).

1. Connect to the FTP server of the Traffic Controller using an FTP client (e.g., FileZilla).
2. Log in by entering **client** for the user name and **client** as the password.

If the raw 2D LiDAR sensor data are also required for fault analysis, please refer to chapter *8.3.4 Providing raw data to help Support*.

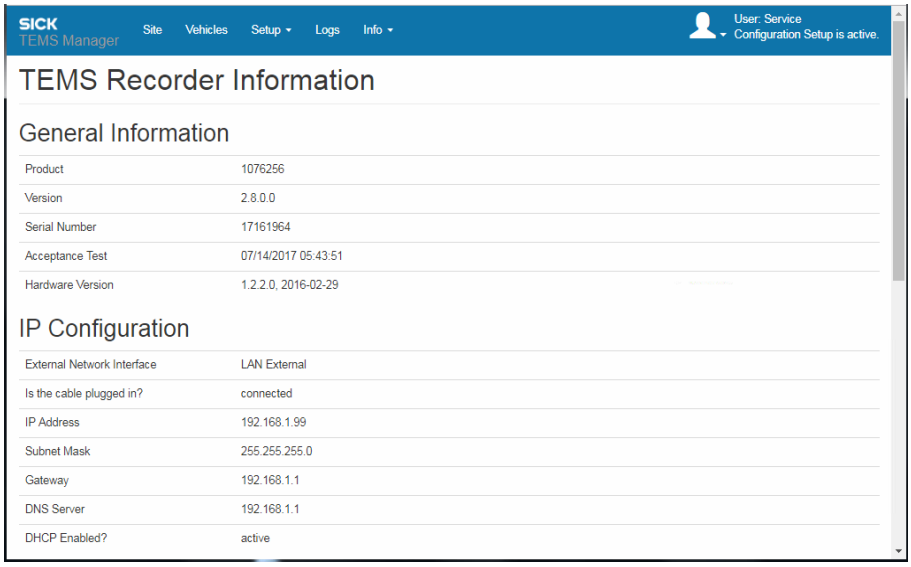
6.11 Updating the TEMS Recorder and packages

6.11.1 Displaying information on the TEMS Recorder

During operation, information on the TEMS Recorder can be displayed and analyzed in TEMS Manager. In addition to general data and information on the IP configuration, you can also check other data here, including the UTC (**U**niversal **T**ime **C**oordinated) time setting.

Note Upon delivery, the Traffic Controller always uses UTC time as the reference time. The local web browser and the TEMS Analyzer then convert the UTC times into local time for the displays.

► Go to the TEMS Manager menu bar and switch to the **Info** → **Info** workspace.



6.11.2 Updating the TEMS Recorder

Patches and service packs for the TEMS Recorder are supplied in the **temsUpdate** file format and installed via TEMS Manager.

Note The configuration that is currently running has to be stopped for this.

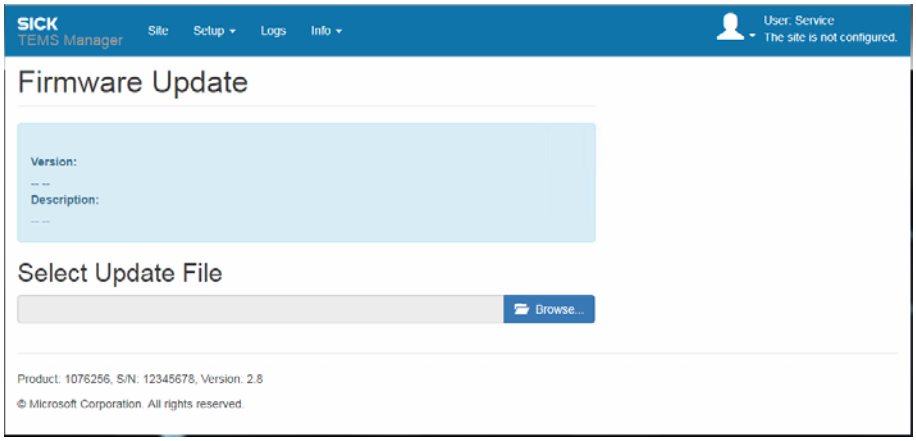
Getting started

1. Save the update file in a directory of your choice on the customer network.
2. Start TEMS Manager from a client computer.

Note The client computer must be able to access the directory containing the update file.

3. Go to the **Setup** workspace and click **Firmware Update**.

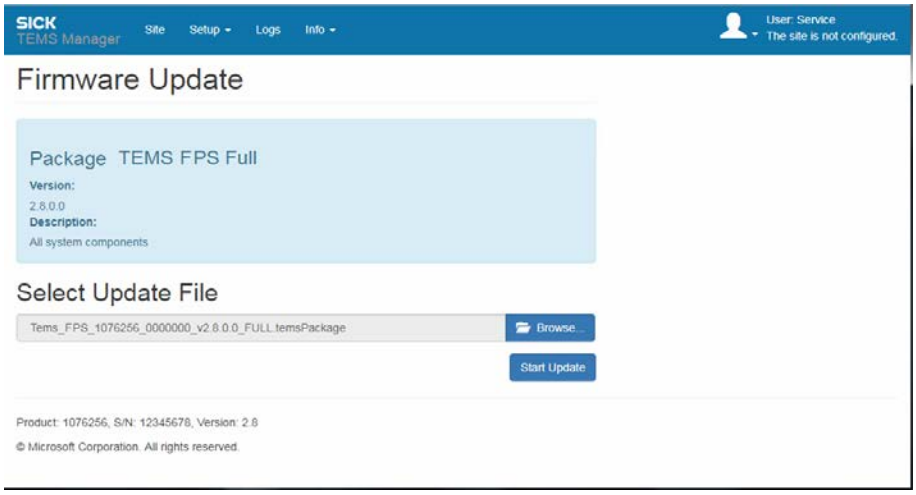
Note When logging in, the user must have **Service** authorization. If you are not yet logged in at this level, please do so now (for more information, see appendix at *9.5 Users and authorizations*).



Performing an update

1. Click the **Browse** button and select the update file.

   First of all, the file is copied to the Traffic Controller.
2. Once it has been copied across, the update version number and description are displayed.



3. Click the **Start Update** button. You will see a message indicating that a maintenance process is about to be started on the TEMS Recorder.
4. Click **Continue**. The TEMS Recorder update is installed on the Traffic Controller. This process may take a little while.
5. You will receive a notification once the process has finished.
6. To complete the operation, confirm the message by clicking **OK**.

6.11.3 Updating packages

Additional system components, plug-ins, and configuration files (e.g., Vehicle Classifier) are supplied as separate files in the **temsPackage** file format. Once again, they are installed via TEMS Manager.

The procedure is very similar to the one for TEMS Recorder updates.

Note The configuration that is currently running has to be stopped for this.

1. Save the temsPackage file in a directory of your choice on the customer network.
2. Go to the **Setup** workspace and click **Update Packages**.
3. Select the temsPackage file. First of all, the file is uploaded to the Traffic Controller FPS. After that, installation commences.
4. Install any additional temsPackage files (where applicable) using the same process as described above.

6.12 Using the TEMS Info interface

The TEMS Info interface is available while the Traffic Controller FPS is running. The TEMS Info interface selects measured values, measurement results, and status messages at the customer end from a permanent TCP/IP data stream.

The data to be transferred are freely definable. You can see which data protocol the interface uses by referring to the source code (C#) for the **TEMS Info sample client**.

Notes

- Further details on the message categories, types, and layout can be found in the **separate interface description for the TEMS Info interface** (8017178).
- Please note: A maximum of 10 TEMS Info clients can be connected via the TEMS Info interface. TEMS Manager does not count as a TEMS Info client.

Establishing a connection

The TCP/IP connection is established via the Info client. Several connections to the TEMS Info server can be established, but each one has to be configured separately.

The connection is set up using the following sequence of messages:

TEMS Recorder	Direction	TEMS Info client
	←	Establishing a socket connection
	←	Message “Initialize”
Message “Information”	→	
	←	Message “Configuration”

Tab. 13: TEMS Info interface (messages: establishing a connection)

If the server does not accept the client connection, the following messages are exchanged:

TEMS Recorder	Direction	TEMS Info client
	←	Establishing a socket connection
	←	Message “Initialize”
Message “Error”	→	

Tab. 14: TEMS Info interface (messages: connection not accepted)

Heartbeat

If “Heartbeat” messages are activated, they are sent regularly by the TEMS Recorder. Based on the heartbeats received, the TEMS Info client can detect that the TEMS Info server is ready for operation and can still complete its tasks.

TEMS Recorder	Direction	TEMS Info client
Message “Heartbeat”	→	

Tab. 15: TEMS Info interface (message: heartbeat)

Vehicle data

A series of messages are sent whenever a vehicle is detected by the profiling system.

TEMS Recorder	Direction	TEMS Info client
Message “Object Start”	→	
Message “Object Stop”	→	
Message “Vehicle Result” or Message “Vehicle Result Extended”	→	
Message “Object Location” This message is sent once while the vehicle is passing through the measurement site.	→	

Tab. 16: TEMS Info interface (messages: vehicle data)

Status messages

When “Status Messages” are activated, they are sent regularly by the Traffic Controller FPS if the status changes (provided that this has been configured).

TEMS Recorder	Direction	TEMS Info client
Message “Status”	→	

Tab. 17: TEMS Info interface (status messages)

Disconnecting

The connection is terminated when the TCP/IP connection is closed by either the TEMS Info client or by the TEMS Recorder.

6.13 Installing the security certificate for the HTTPS connection

6.13.1 Uploading the supplied HTTPS certificate

Access from the client computer to TEMS Manager is via an HTTP connection by default. To establish a secure HTTPS connection, a corresponding security certificate can be downloaded from TEMS Manager and installed on the client computer.

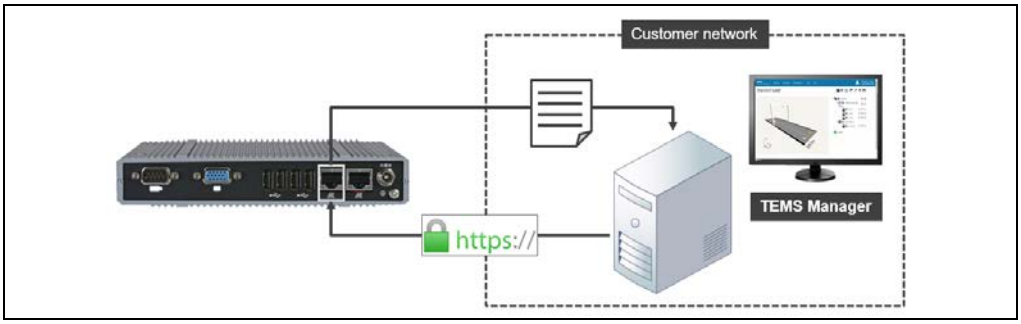
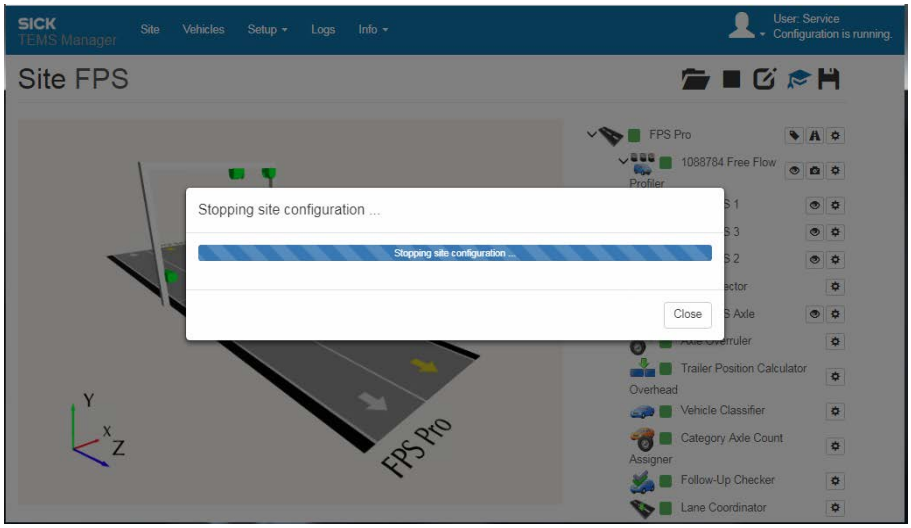


Fig. 67: Uploading the supplied HTTPS certificate

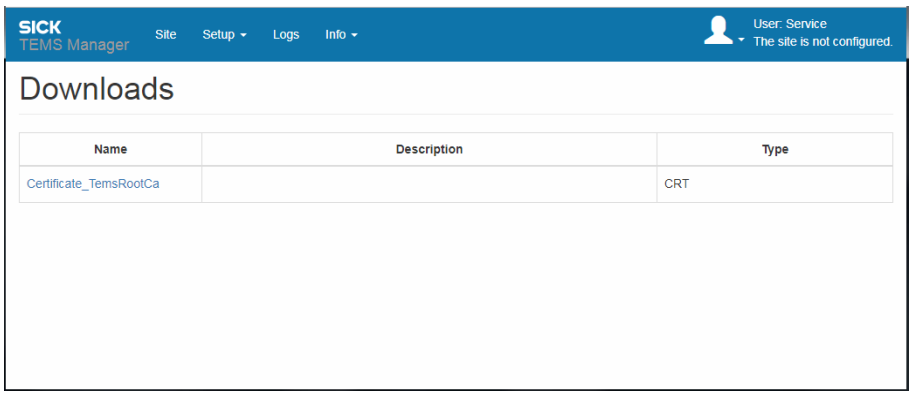
Stopping the current configuration

1. Click the **Stop current site configuration / Exit editing mode** icon.



Downloading the certificate

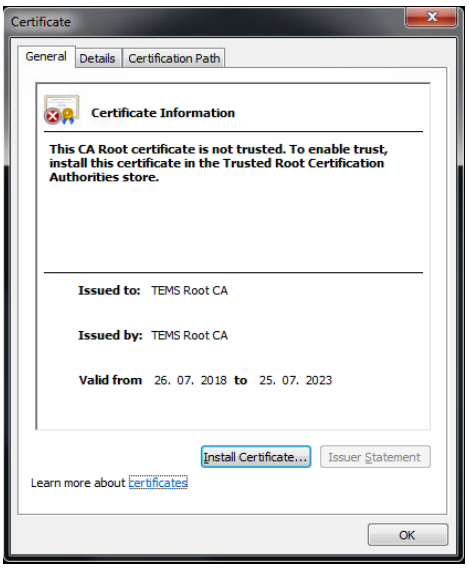
1. Select **Downloads** in the Info working range.



2. Download the CRT file onto the local client computer.

Installing the certificate

1. Double-click the CRT file to open it. The **Certificate** window opens containing the certificate details.



2. Click on the **Install certificate** button. The certificate import wizard opens.

3. Go through the wizard and save the certificate in the certificate memory on the client computer.

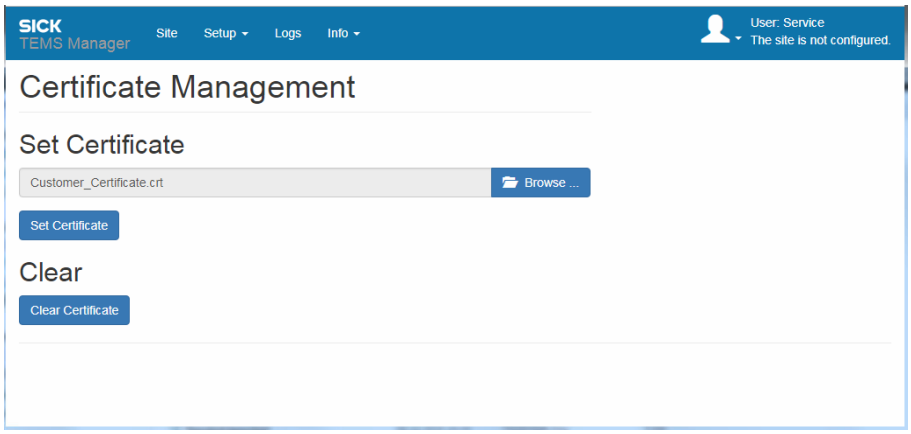
Starting TEMS Manager

▶ Then connect to TEMS Manager via a secure HTTPS connection.

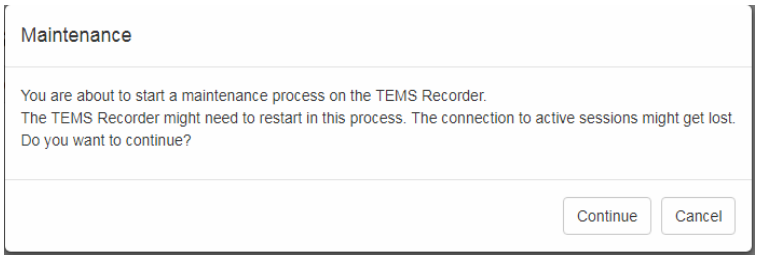
6.13.2 Uploading your own HTTPS certificate

Alternatively, you can also use your own HTTPS certificate. This certificate must be uploaded to the Traffic Controller.

1. Navigate to the **Settings** working range and select **SSL certificate → Set certificate**.
2. Click **Browse** and select the local **CRT** file.



3. Click **Set certificate**. The following safety note appears.



4. Press **Continue** to confirm.

   The certificate for setting up the secure HTTPS connection is uploaded to the Traffic Controller.

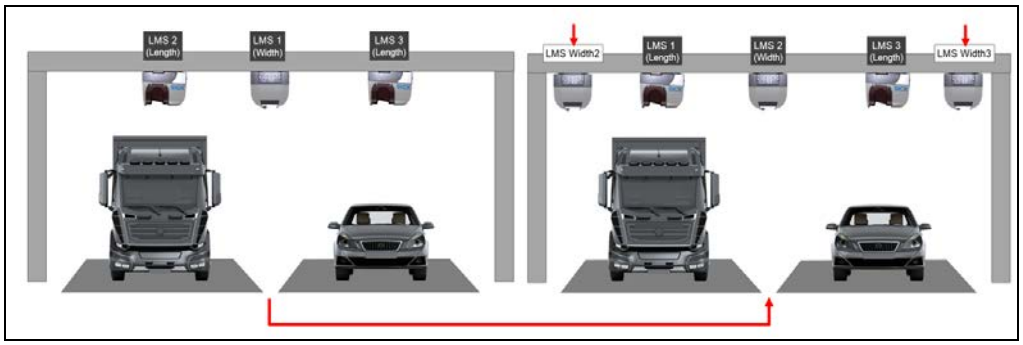
6.14 Extending/changing the site

An FPS configuration can be extended or even changed.

- The control elements in the navigation tree allow you to extend the measurement site to include additional sensor components or configure the offset mounting of a sensor.
- An additional road, for example, can be added to the measurement site via the configuration wizard.
- If a site cannot be extended using the configuration wizard functions, system parameters can be loaded by means of an XML configuration file.

6.14.1 Adding system components

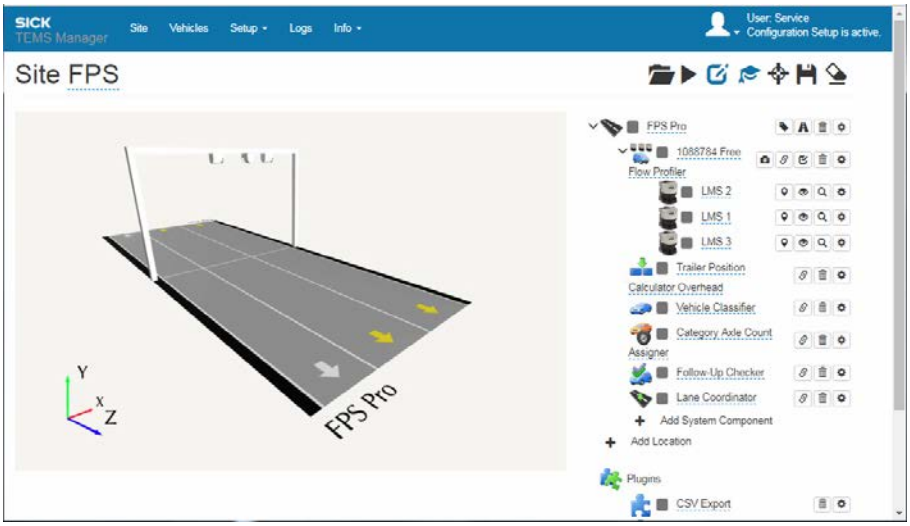
In this example, a site configuration is extended to include two additional sensor components for two-lane monitoring. The sensor components are added to the site configuration via the TEMS Manager navigation area.



Getting started

1. Open the site in editing mode and activate expert mode.

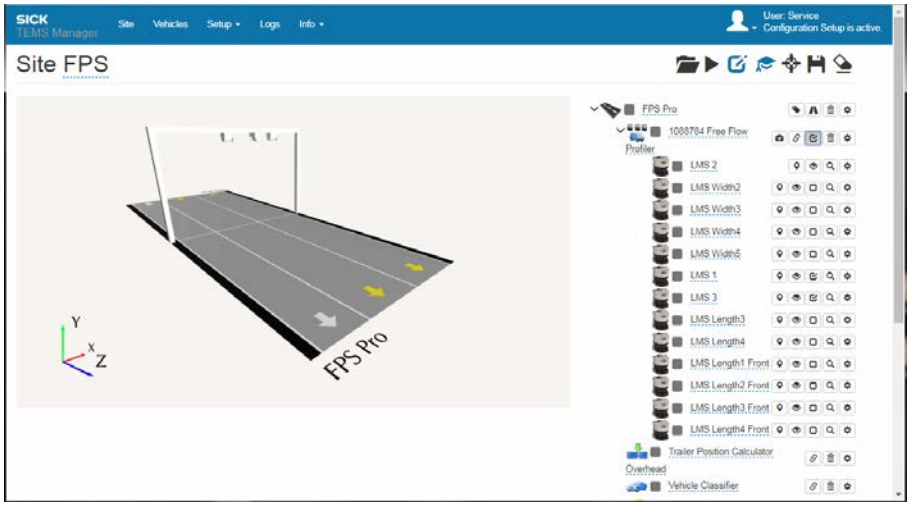
   The site has been configured to monitor two lanes. The LMS Width has been mounted centrally between two lanes so that it can capture the profile of the vehicles in both of them. Vehicle tracking takes place via two LMS Length laser scanners mounted above each lane.



Note

The numbering of the 2D LiDAR sensors in TEMS Manager is always from left to right. The LMS Width mounted between the lanes is therefore number 2, while the LMS Length mounted on the right in the direction of travel is number 1.

2. Go to the Free Flow Profiler system function level and click the **Show/hide control elements for activating/deactivating subsystem components**. The list of system components is extended. The components for the current site configuration are activated.



Note In the current configuration, the LMS Width for recording profiles (**LMS 2** in the tree) is always activated. The system components cannot be deactivated.

Adding system components

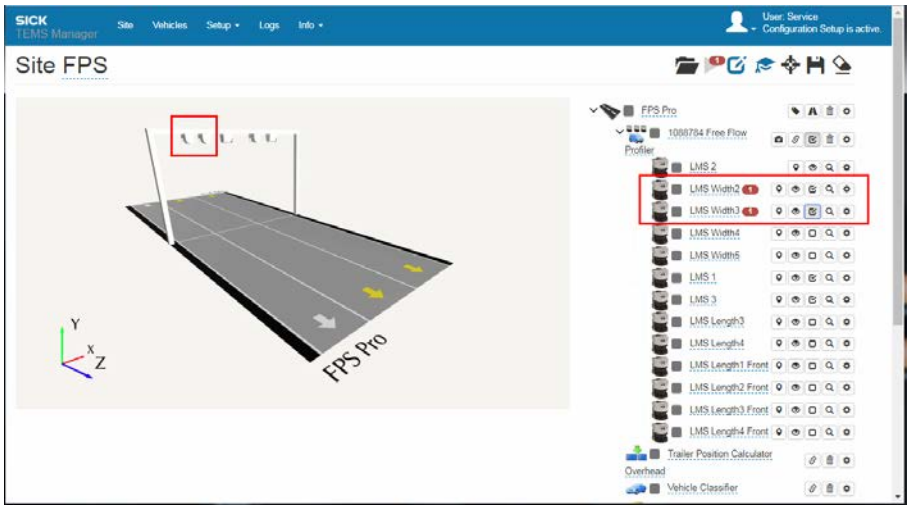
Add additional system components by activating these in the component row.

1. To do this, go to the corresponding row and click the **Activate/deactivate system components** icon.

   In this example, two additional **LMS Width** laser scanners have to be activated. The devices are visualized in the live view on the gantry. Both

2. In the navigation area, both system components are listed with a red number as neither of the two 2D LiDAR sensors can be assigned automatically. There is also a conflict as the IP addresses are the same.

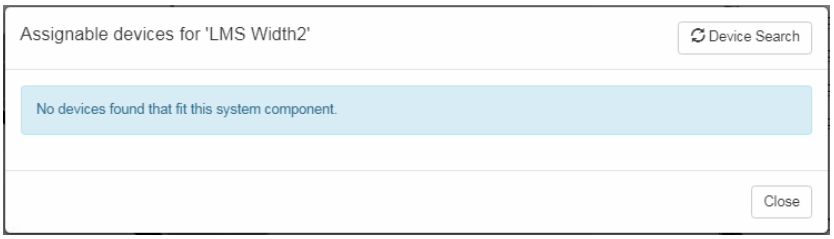
   Move your cursor over the number to open a window with the corresponding details.



Assigning sensors to system components via the device search

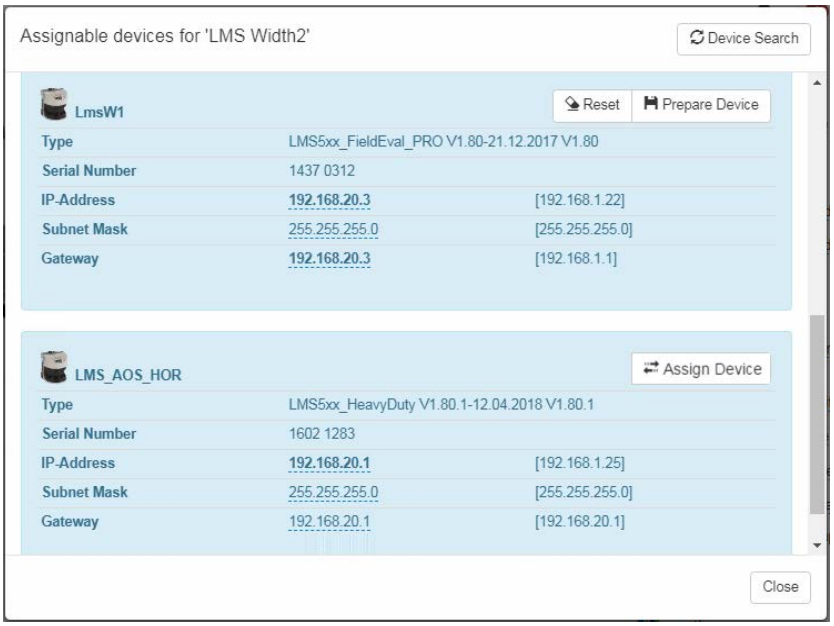
The device search function is used to assign the two new 2D LiDAR sensors to the **LMS Width2** and **LMS Width3** system components. As part of the device assignment process, the conflict between the identical IP addresses is also resolved by changing the IP addresses.

1. Go to the level of the **LMS Width2** component and click the **Start device search** magnifying glass icon.

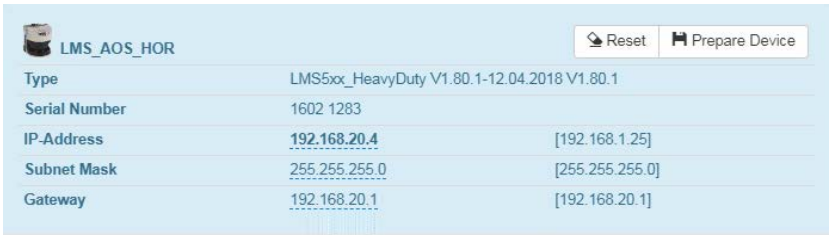


2. Click the **Device Search** button. The devices connected to the Traffic Controller FPS appear in the list of devices along with their IP address, firmware, and serial number.

   2D LiDAR sensors with a blue background are yet to be assigned.



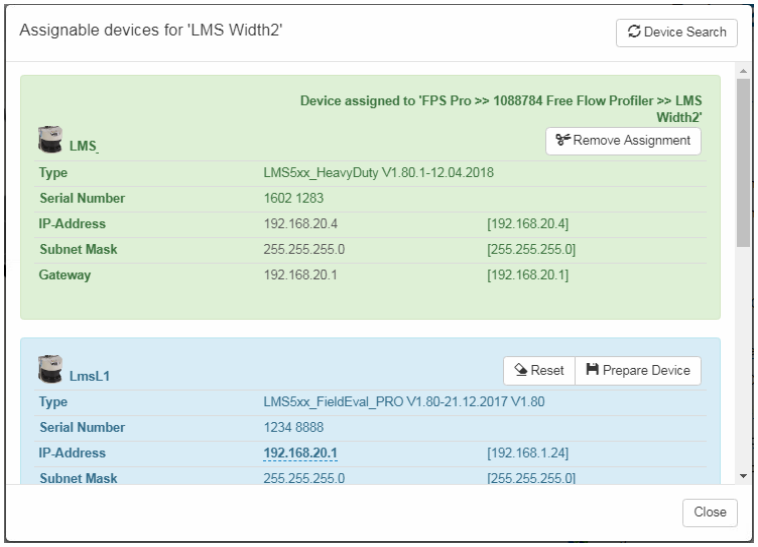
3. Change the IP address. To do this, click on the IP address underlined blue. Make sure that the new IP address is unique. It must not be the same as the default IP address.
4. The label for the **Assign device** button changes as a result of changing the IP address in **Prepare device**.



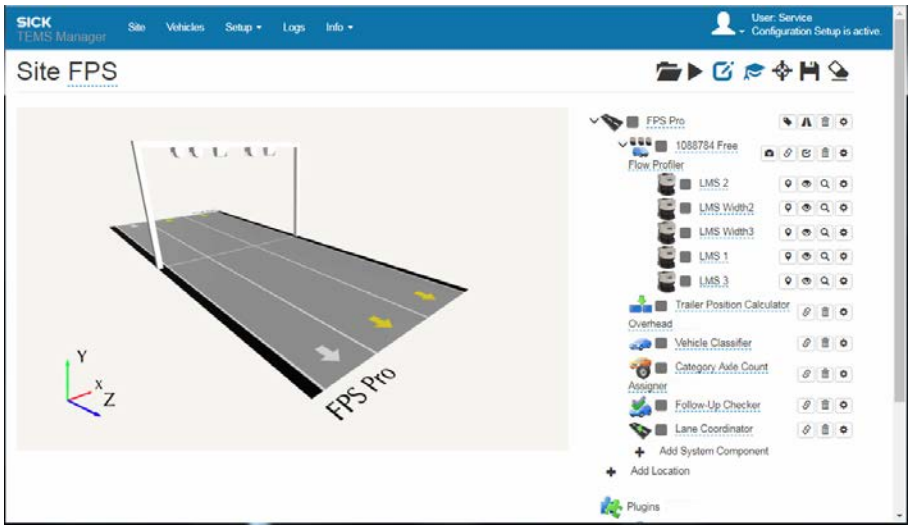
5. Click **Prepare component** in the LMS Width with the correct IP address. The button then reverts to **Assign device.**

6. Click **Assign Device**. The sensor is assigned to the **LMS Width2** system component. In the list of devices, the 2D LiDAR sensor now appears with a green background.

   The green background color indicates that the assigned device belongs to the current system component. The devices yet to be assigned are still blue.



7. Click **Close**. The device search closes. The red circle containing the error number has now disappeared from both LMS Width listings.



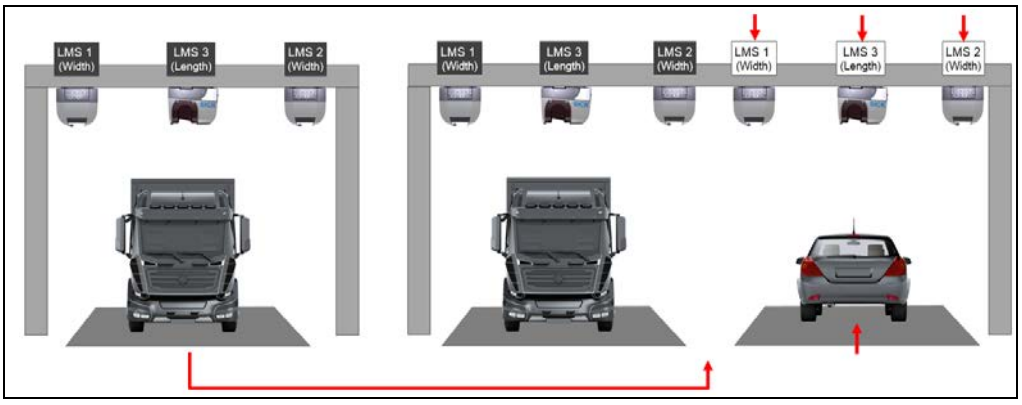
8. Apply the same process when assigning devices for the other 2D LiDAR sensor to the **LMS Width3** system component.

Configuring system components

1. Provisionally align the sensor components in the graphical display. To do this, position them in the right and left corners of the gantry.
2. Then determine the exact position of the sensor components by inputting the position values or using the slide control (see *6.6.2.1 Defining the position and rotation of the 2D LiDAR sensors*).
3. Calibrate the sensors using the calibration wizard (see *6.6.2.2 Calibrating the 2D LiDAR sensor*).

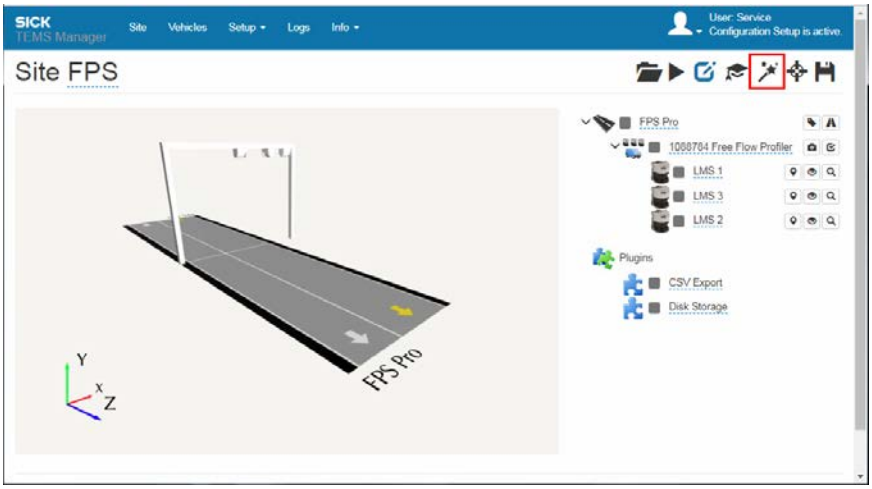
6.14.2 Adding a second road

In this example, a site configuration is extended from single-lane monitoring with three sensors to include a road for monitoring oncoming traffic with three additional sensors. The road is added using the configuration wizard.

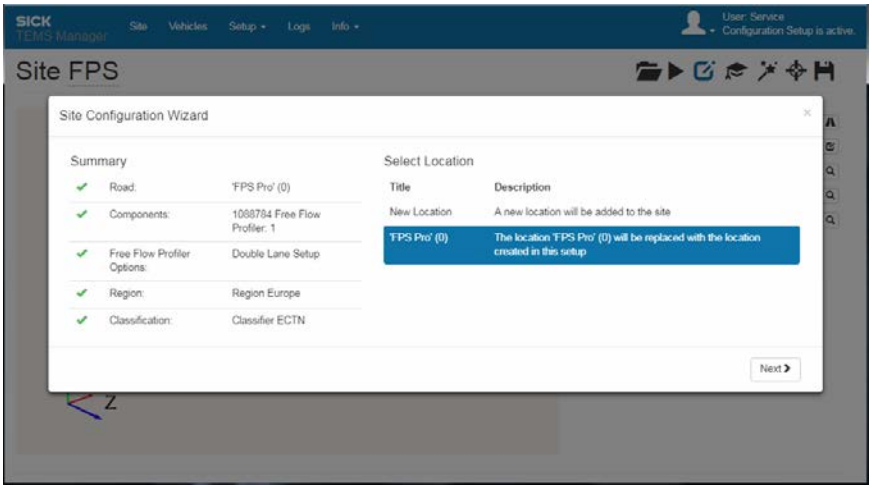


Getting started

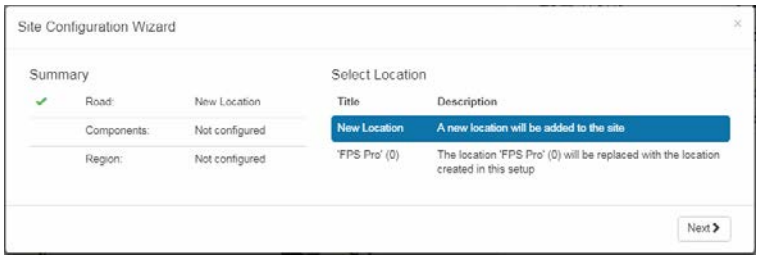
1. Open the site in editing mode and deactivate expert mode. The symbol for the configuration assistant appears.



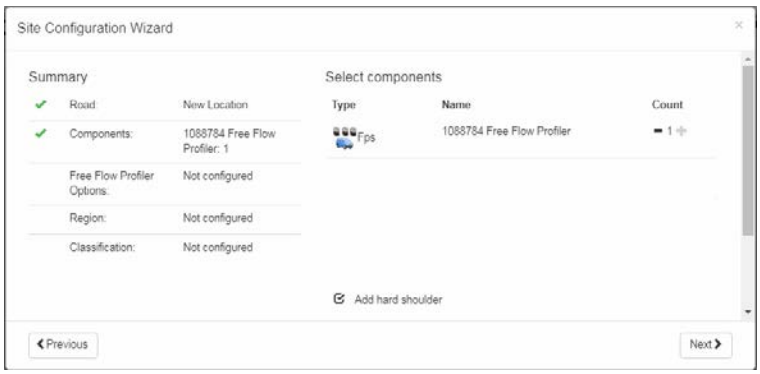
2. Click on the **Start the site configuration wizard** icon. The current configuration is shown on the left-hand side. The right-hand side is where you can create a new site or edit the current one.



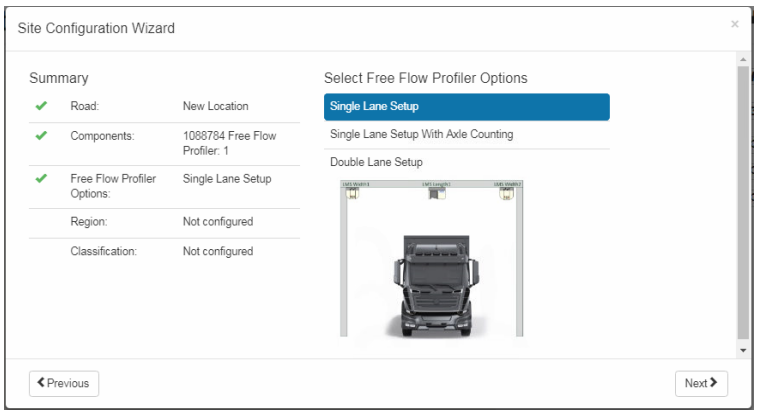
3. To add a new road, select the **New site** option as shown in the example.



4. Click **Next** and select the **Free Flow Profiler** component for vehicle detection.

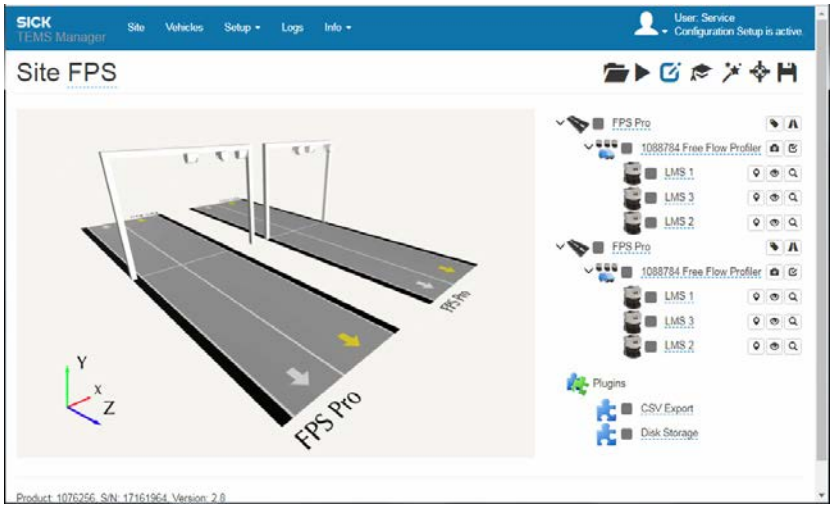


5. Define the measurement setup on the next page. In this example, we have chosen the **Single lane** option for the second road.



6. Define the region and the classification system on the next two pages of the wizard and complete the wizard with **Create site**.

   The wizard closes. The measurement site is extended to include a second road.



Subsequent work

1. Configure the road as shown in chapter *6.6.1.1 Adapting information about the measurement site*. Define the number and width of the lanes as well as the direction of travel.
2. Configure the system functions for vehicle detection (see *6.6.2 Configuring system functions for vehicle detection*).

6.14.3 Configuring an additional LMS Length in an offset position

In this example, the length and speed measurement in stop-and-go traffic is to be increased through the use of a second **LMS Length**. The LMS Length is mounted in an offset position in Z position on a post. It scans the front of the vehicles.

The first step involves adding the LMS Length to the site configuration via the TEMS Manager navigation area. The offset position is then configured.

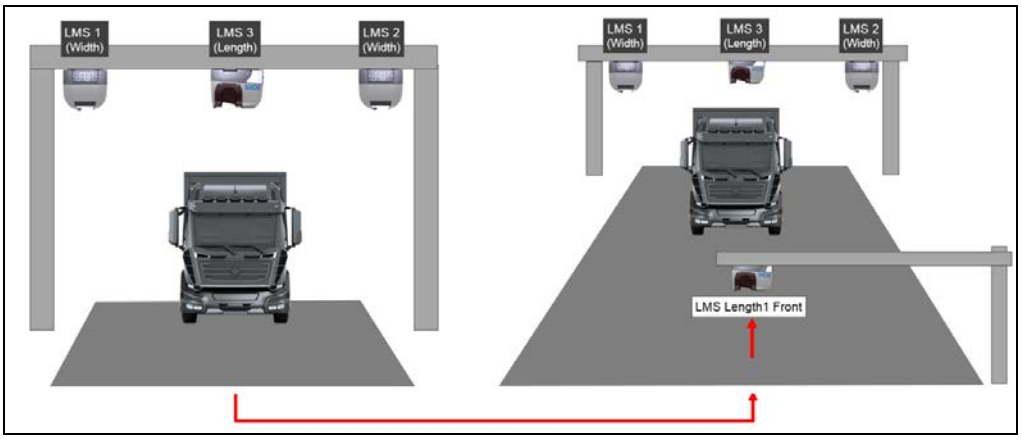
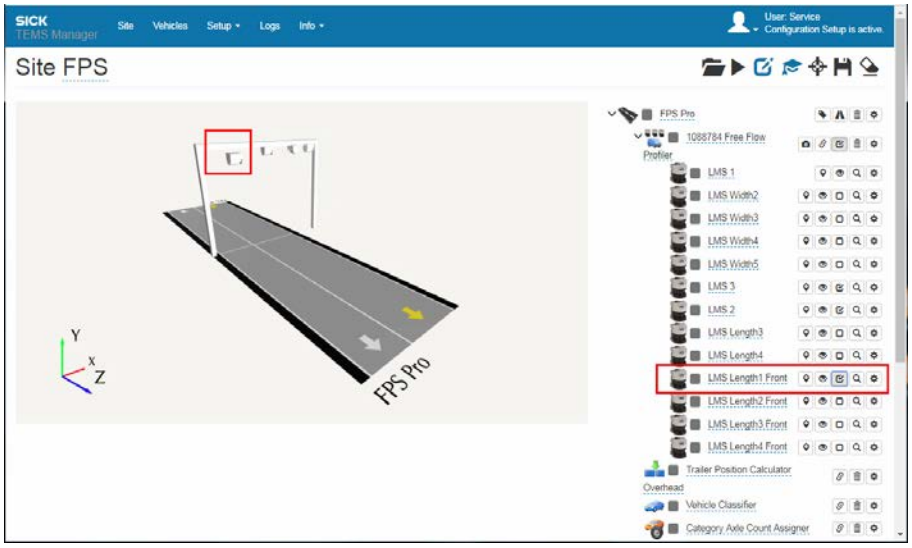


Fig. 68: Configuring an additional LMS Length

Adding a 2D LiDAR sensor

1. Open the site in editing mode and activate expert mode.
2. Go to the Free Flow Profiler system function level and click the **Show/hide control elements for activating/deactivating subsystem components** to display additional system components.

3. In this example, activate the **LMS Length1 Front** system component. Detailed information on extending system functions can be found at *6.14.1 Adding system components*.

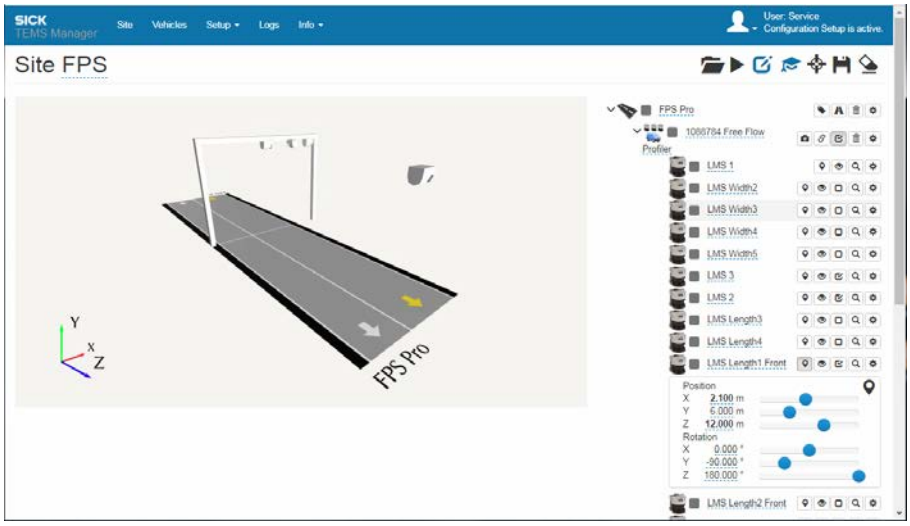


Performing a device search

4. Assign the offset 2D LiDAR sensor to the **LMS Length1 Front** via the device search.
5. Change the IP address of the device accordingly. Detailed information on the device search can be found at *6.14.1 Adding system components*.

Configuring the offset position

1. Define the offset position of the 2D LiDAR sensor via the slide control or by entering the position vales (see *6.6.2.1 Defining the position and rotation of the 2D LiDAR sensors*).
2. Calibrate the sensors using the calibration wizard (see *6.6.2.2 Calibrating the 2D LiDAR sensor*).

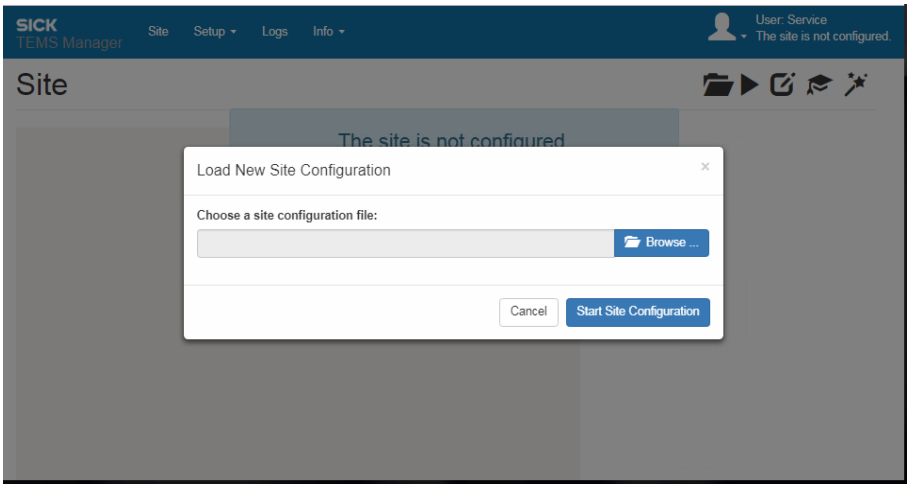


6.14.4 Using a configuration file to load system parameters

In the following example, the site configuration includes an XML file with the key system parameters. The system parameters are loaded in TEMS Manager, where they are subsequently adjusted to the conditions at the measurement site.

When logging in, the user must have **Service** authorization.

1. In TEMS Manager, click the icon for **Load site configuration and start/edit it**.
2. Select the configuration file and click **Start Configuration**.



3. The configuration is loaded in TEMS Manager.

Note If a configuration is loaded while another configuration is running, the system will automatically stop the current configuration. The new configuration is loaded and started. System operation is paused during this process.

7 Maintenance

7.1 Overview of maintenance tasks

In general, the system components are maintenance-free.

All 2D LiDAR sensors installed in the devices feature an integrated contamination monitoring function. The optical surfaces of the 2D LiDAR sensors are subject to certain maintenance intervals.

The following maintenance work must be carried out at the specified time intervals:

Component	Maintenance task	Interval *	Design
2D LiDAR sensor	Cleaning the inspection window	▪ In the event of a contamination message: as soon as possible ▪ Aside from this: As and when required	System manager
General	Visually inspect the electrical cabling and wiring for damage	1x/year	System manager
* The intervals depend on the ambient conditions and degree of contamination. In addition, the intervals must be defined according to how important they are for the customer process.			

Tab. 18: Maintenance intervals

7.2 Maintenance during operation

7.2.1 Visual inspection

Perform the following thorough checks at regular intervals:

Check PG connectors

Check the PG connectors on the devices and inside the control cabinet and, if necessary, tighten them.

Checking plug connectors

Unscrew the plug connectors and check the male contacts for moisture and traces of corrosion.

⚠ WARNING

Plug connectors damaged by corrosion

Plug connectors that have been damaged by corrosion must be replaced straight away. Corroded plug connectors can have a major impact on 2D LiDAR sensors' performance.

Cables

Regularly check the electrical installation. Make sure that all cable connections are secure.

⚠ WARNING

Loose connections or scorched cables

- ▶ Defects such as loose connections or scorched cables must be rectified immediately.

⚠ WARNING

Damaged cable insulation

If the insulation on the cables is damaged, there is a risk of fatal electrocution.

⚠ WARNING

Protect cables against slack

- ▶ Make sure that the cables are routed correctly. The cables must not loop down or fall slack in any way. They must never pose a hazard to the vehicles driving under the gantry.

Brackets

- ▶ Check the sturdiness of the brackets by looking for cracks and other signs of damage.
- ▶ Check the screw connections once a year.

7.2.2 Cleaning the 2D LiDAR sensors

The 2D LiDAR sensors are largely maintenance-free.

To achieve the full optical output of the 2D LiDAR sensors, the inspection window must be checked for contamination and cleaned accordingly. This is especially true in harsh operating environments (dust, humidity, etc.).

Displaying the degree of contamination in TEMS Manager

The 2D LiDAR sensors feature a contamination indicator that will issue a message in TEMS Manager in the event of excessive contamination. In addition, the degree of 2D LiDAR sensor contamination is indicated in the TEMS Manager live view by a corresponding color icon (see also chapter *8.3.1 Fault diagnosis in TEMS Manager*).

Requesting the degree of contamination via the TEMS Info interface

The customer can also call up the contamination message via the **TEMS Info interface**.

Cleaning the inspection window

- ▶ Use a clean, soft brush to remove dust from the inspection window.
- ▶ Then wipe the inspection window with a clean, damp cloth.

⚠ *WARNING*

Damage to the inspection window

The optical output is weakened by scratches and streaks on the inspection window.

- ▶ Do not use aggressive cleaning agents.
- ▶ Do not use abrasive cleaning agents.
- ▶ Avoid scratching and chafing movements on the inspection window.

Note Static charging may cause dust particles to stick to the inspection window. You can mitigate this effect by using anti-static plastic cleaner (part no. 5600006) and a SICK lens cloth (part no. 4003353).

Cleaning the housing and weather hood

- ▶ Where necessary, remove the worst of the contamination from the 2D LiDAR sensor housings and weather hoods. To do this, use a damp cloth.

7.3 Replacing components

7.3.1 Basic procedure

Faulty or damaged system components must be dismantled and replaced with new or repaired components.

After a component has been replaced, the measurement site must be updated (see also chapter *7.3.4 Updating the measurement site*).

DANGER

Disconnect the power to the plant

- Make sure the power supply for the entire plant is disconnected throughout the entire time that you are carrying out maintenance and repair work.

DANGER

Risk of injury due to electrical current

Only a qualified electrician or trained persons working under the guidance and supervision of a qualified electrician are permitted to work on electrical plants or equipment and must comply with electrical regulations when doing so.

NOTE

Claims under the warranty rendered void

Some of the housing screws on the devices are sealed.

Any claims against SICK AG under the warranty will be rendered void if the seals are damaged or if the device is opened.

The housing must only be opened by authorized SICK service personnel.

7.3.2 Replacing the 2D LiDAR sensors

Defective 2D LiDAR sensors can be replaced individually. Order the device by quoting the following part number:

Part number	Description
1091458	LMS511 SE 2D LiDAR sensor

Replacing the device

1. Loosen the M12 round connector on the 2D LiDAR sensor and remove the connecting cables from the 2D LiDAR sensor.
2. Dismantle the defective 2D LiDAR sensor from the mounting.
3. Mount the replacement device.
4. Connect the cables to the new 2D LiDAR sensor and screw together the plug connectors.

Note

▶ Update the measurement site. Additional information can be found in chapter *7.3.4 Updating the measurement site*.

7.3.3 Replacing the Traffic Controller FPS

To order the replacement device, please contact your responsible SICK sales unit.

Replacing the controller

1. Undo the screw connection on the male connector for the voltage supply and pull the voltage cable out of the female connector of the Traffic Controller FPS.
2. Pull the connected Ethernet cables out of the respective female connectors.
3. Undo the wall bracket fixing screws and remove the Traffic Controller FPS together with the assembled wall brackets.
4. Undo the four M4 screws and remove the two wall brackets from the back of the Traffic Controller FPS.
5. Mount the replacement device inside the control cabinet using the wall brackets.
6. Connect the voltage supply to the new Traffic Controller FPS and screw together the plug connectors.
7. Plug the two Ethernet cables into the designated female connectors.
8. Switch the supply voltage on again.

Note

▶ Update the measurement site. Additional information can be found in chapter *7.3.4 Updating the measurement site*.

7.3.4 Updating the measurement site

After replacing a system component, you will have to update the measurement site using TEMS Manager in order to guarantee continued measurement accuracy.

The procedure you should follow depends on whether you have replaced a sensor or the Traffic Controller FPS.

Requirements

- Using the installed TEMS Manager program, you have connected to the Traffic Controller FPS via the **Ethernet 1** TCP/IP interface (see chapter *6.2 Connecting to TEMS Manager*).
- The **site configuration** has been **stored** on a backup data card.

7.3.4.1 Updating after replacing a sensor

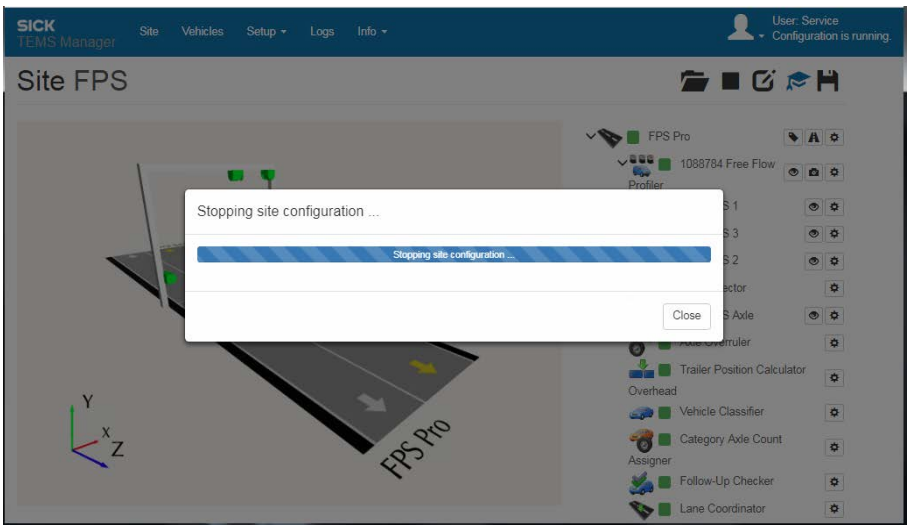
In this case, the Traffic Controller FPS is not affected by the component replacement and so you can update the configuration that is currently running on the TEMS Recorder.

Establishing a connection with the TEMS Recorder

1. Connect to TEMS Manager.
2. In TEMS Manager, log in as a user with the **Authorized User** authorization or higher.

Stopping the current configuration

1. Click the **Stop current site configuration / Exit editing mode** icon.



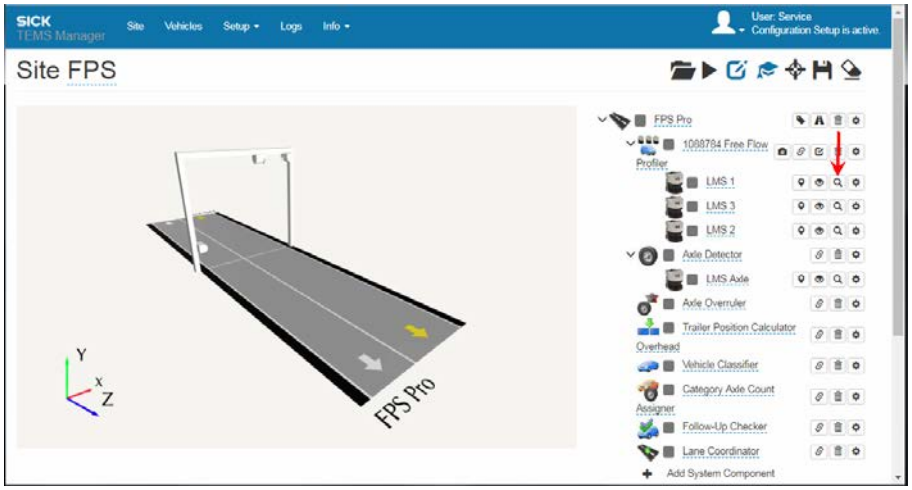
2. Switch to editing mode. To do this, click the **Edit site configuration** icon.

Reassigning the IP address for the replacement device / Assigining the device

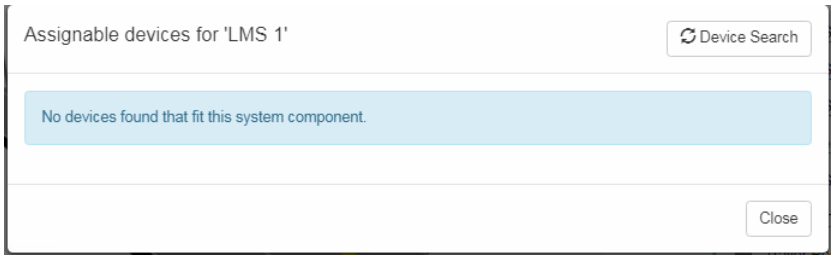
The replacement device is still set to its default IP address. The IP address must be changed using the device search when assigning the device. The replacement device must have the same IP address as the device it replaced.

If the device has already been addressed using its default IP address at the measurement site, you do not need to change the IP address. The device can be assigned directly. Detailed information on the device search can also be found at *6.14.1 Adding system components*.

1. Go to the navigation area and click the magnifying glass icon for the sensor component that has been replaced (in this case: **LMS 1**).

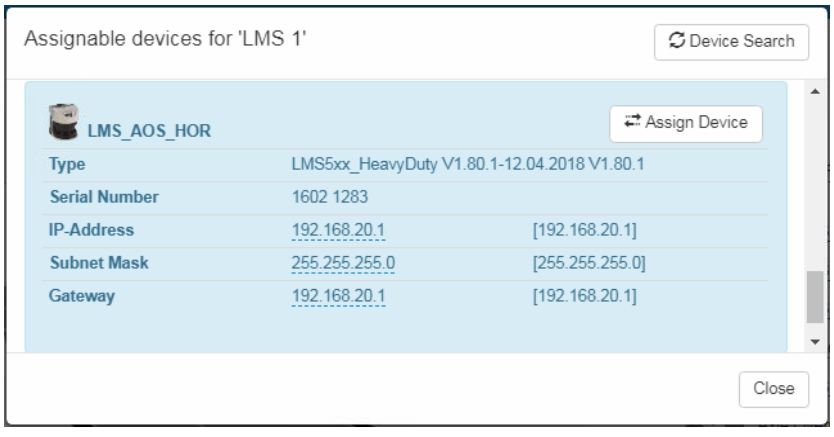


2. The list of assignable devices is currently empty.

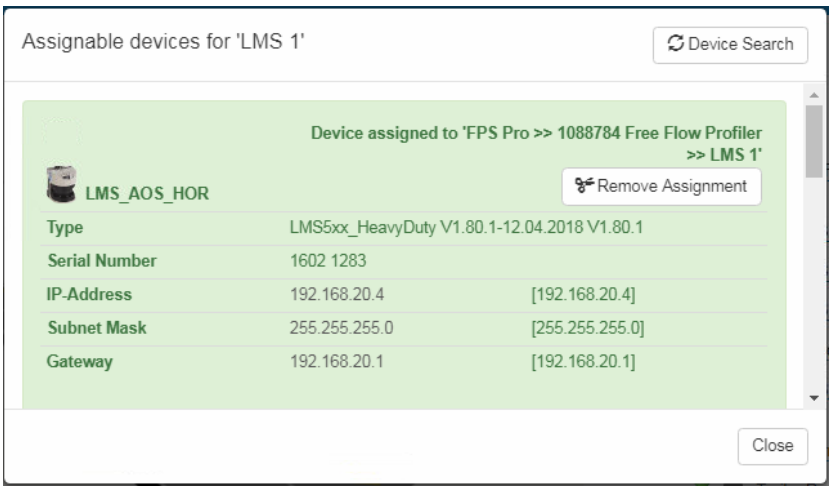


3. Click the **Device Search** button. The devices connected to the Traffic Controller FPS appear in the list of devices.

   The replacement device is displayed together with its default IP address (192.168.0.1).



4. Click the IP address and adjust it as appropriate.
5. Click **Assign Device**. The replacement device is assigned to the **LMS Width1** system function.



6. Once the change has been made, click **Close** in the device search.

Loading the site configuration

► Click the **Load site configuration** icon.

Once the loading process is complete, all of the system functions and system components should be green.

This means that the profiling system is ready for operation again.

7.3.4.2 Updating the configuration after replacing the Traffic Controller FPS

If only the Traffic Controller FPS has been replaced, the first thing you have to do is establish a connection with the new TEMS Recorder.

You can then upload a site configuration to the new TEMS Recorder from a site configuration file using TEMS Manager.

Changing the IP address of the Traffic Controller FPS

Upon delivery, the default IP address for the replacement device is 192.168.10.200.

Before you can establish a connection with the Traffic Controller FPS, you have to change the IP address.

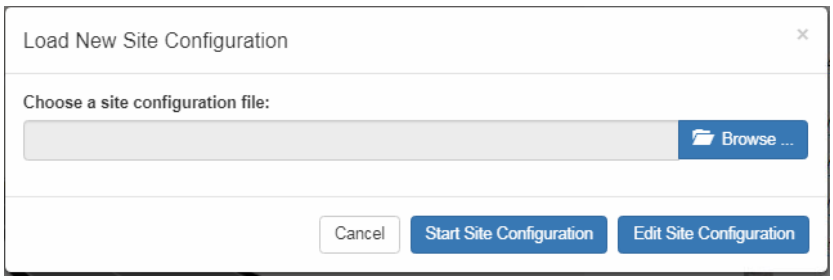
This procedure is described in detail in *6.3 Configuring the IP address of the Traffic Controller FPS*.

Establishing a connection with the TEMS Recorder

1. Connect to TEMS Manager.
2. In TEMS Manager, log in as a user with the **Authorized User** authorization or higher.

Loading the site configuration

1. Click the icon for **Load site configuration and start/edit it**.



2. Select the XML file containing the site configuration. The site configuration is transferred from the file to the TEMS Recorder and started.

Note If a configuration is loaded while another configuration is running, the system will automatically stop the current configuration. The new configuration is loaded and started. System operation is paused during this process.

8 Fault diagnosis

This chapter describes how to identify and remedy faults in the profiling system.

⚠ WARNING

Danger in the event of malfunction!

Cease operation if the cause of the malfunction has not been clearly identified!

- ▶ Immediately stop system operation if you cannot clearly identify the fault and if you cannot safely remedy the problem.

8.1 SICK Support

If you cannot remedy the error with the help of the information provided in this chapter, please contact your SICK subsidiary.

To deal with your inquiry quickly, we will require the following information:

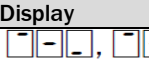
- Exact name of system component
- Firmware version (see chapter *6.11.1 Displaying information on the TEMS Recorder*)
- Log files (see chapter *8.3.3 Detecting system errors using log files*)
- Configuration file (see chapter *6.8.5 Saving the configuration on the hard drive*)

8.2 Fault indicators at component level

This section explains what the fault indicators for the individual devices mean and how to respond to them.

8.2.1 Fault indicator for the 2D LiDAR sensors

The 7-segment display on the 2D LiDAR sensors provides the following information:

Display	Possible cause	Remedy
	No error has occurred.	Device is in measuring mode
	Idle mode, outputs are in the OFF state, laser is switched off.	No error has occurred. If the criteria for IDLE mode are withdrawn, operational readiness is restored.
	Motor starting	No error has occurred.
	Fault in the 2D LiDAR sensor	▶ Send the 2D LiDAR sensor to the manufacturer for repair.
	Connection to slave broken	▶ Re-establish the connection to the slave.
	Heater not connected or temperature too low	▶ Wait until the device has warmed up. ▶ Check the connection of the heater. ▶ Send the 2D LiDAR sensor to the manufacturer for repair.

Tab. 19: 2D LiDAR sensor fault indicator (7-segment display)

8.2.2 Traffic Controller FPS fault indicators

The LEDs on the Traffic Controller FPS provide the following information in the event of a fault:

Display	Possible cause	Remedy
Status LED on power button does not light up 	▪ Supply voltage missing or too low ▪ Traffic Controller FPS defective.	▶ Check the voltage supply. ▶ Replace the Traffic Controller FPS.
LED on female Ethernet connector does not light up 	▪ Ethernet cable disconnected ▪ Network component (e.g., Ethernet switch) is defective	▶ Check the Ethernet connection. ▶ Replace the defective network component.

Tab. 20: Status indicator – Traffic Controller FPS

8.3 Fault indicators at system level

Faults that occur on the profiling system are divided into two basic categories: **warnings** and **errors**:

- In the event of a warning, the system remains operational. However, the cause of the fault must be eliminated as quickly as possible.

  Warnings indicate things like minor contamination on a 2D LiDAR sensor.

- In the event of an error, the system is still operational in principle. However, it can no longer be relied on to function correctly.

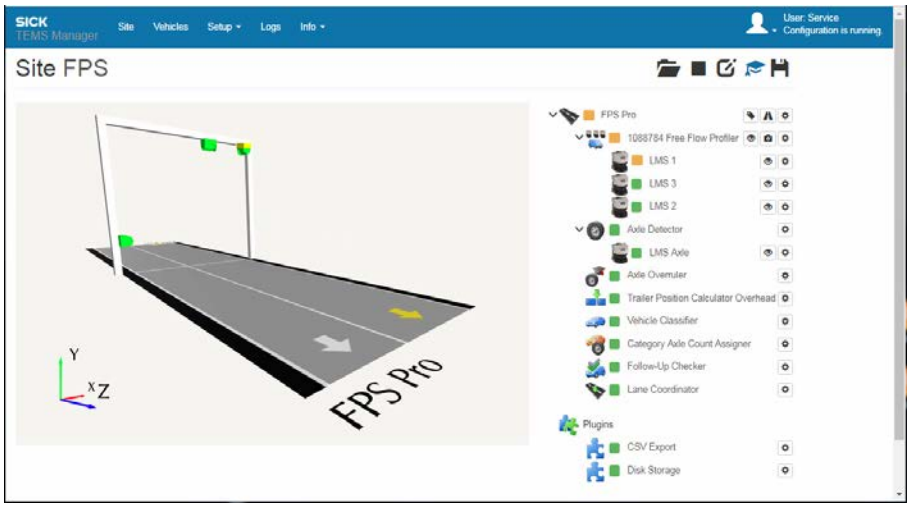
General system fault

Display	Possible cause	Possible measures
No connection to the Traffic Controller TIC	▪ Traffic Controller FPS supply voltage missing or too low.	▶ Check the voltage supply.
	▪ Ethernet connection to the Traffic Controller FPS interrupted.	▶ Check the Ethernet connection.
	▪ Fault in network configuration	▶ Check the network configuration.
	▪ Traffic Controller FPS defective.	▶ Replace the Traffic Controller FPS.

Tab. 21: General system fault

8.3.1 Fault diagnosis in TEMS Manager

In TEMS Manager, warnings and errors are displayed at every level of the hierarchy – i.e., at device level, system function level, road level, and site level.



Warnings and errors at a lower level affect all the superordinate levels.

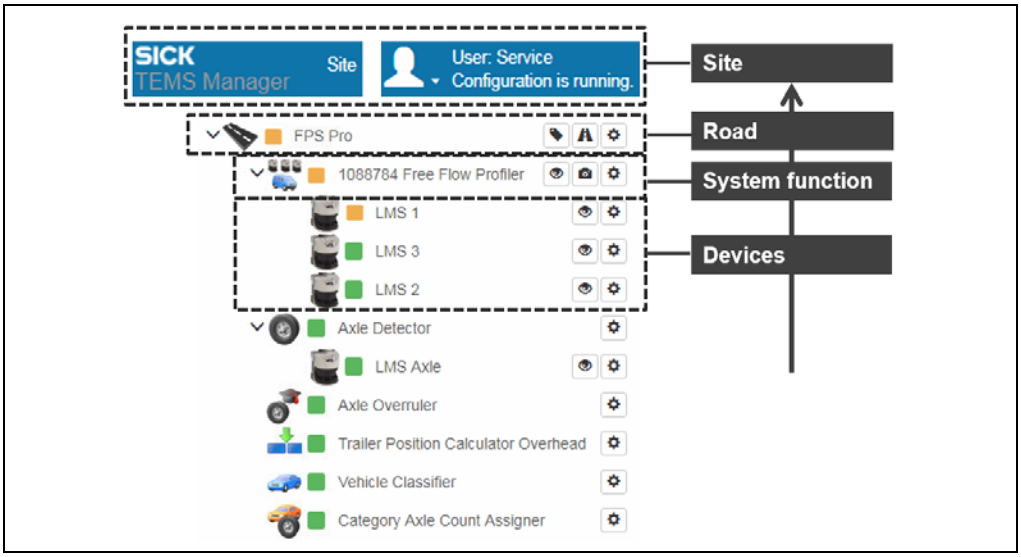


Fig. 69: Fault diagnosis in TEMS Manager

8.3.1.1 Standardized visualization symbols

In the **live view**, attention is drawn to errors and warnings by highlighting the system components in different colors. The following color coding system applies:

- If a system component is shown in **green** in the live view, it is ready for operation.
- **Yellow** highlighting indicates a fault of the **warning** type.
- **Red** highlighting signals the presence of a device error. You can narrow the problem down by right-clicking the system component's red symbol. This opens a window containing further detailed information.

Green, yellow, or red icons are also used in the **navigation tree** to indicate whether the system components and system functions are ready for operation.

A **gray** icon signals that the current status is unknown. This is the case during initialization of the profiling system, for example.

8.3.1.2 Fault indicators at site level

Errors at site level are only shown in the menu bar.

- If the profiling system is only ready for operation to a limited extent, the **Site** workspace is highlighted in red font.
- In addition, a red exclamation point appears.
- On the right-hand side, the following information message is displayed in red: **Configuration is running with error(s)**.

Notes

- A site error is displayed if there is an error (red symbol) on at least one of the subordinate levels.

Example

A 2D LiDAR sensor outputs a contamination message. However, this does not affect the operational readiness of the overall system in general. Consequently, the profiling system remains ready for operation. Although the configuration is affected by the error, it is still able to run.

- Warnings do not affect the site level.

Example

Minor contamination of a 2D LiDAR sensors does not impair the operational readiness of the profiling system.

8.3.1.3 Fault indicators at all subordinate levels

Road		
Display	**Possible cause**	**Possible measures**
Road red (navigation tree)	▪ An error has occurred at a subordinate level	▶ Check the live view or navigation tree to see which component is causing the error.
Road yellow (navigation tree)	▪ A warning has occurred at a subordinate level	▶ Check the live view or navigation tree to see which component is causing the warning.

2D LiDAR sensors		
Display	**Possible cause**	**Possible measures**
Inspection window yellow	▪ Minor contamination on the inspection window of the 2D LiDAR sensor	▶ Clean the inspection window of the 2D LiDAR sensor when possible.
Inspection window red	▪ Heavy contamination on the inspection window of the 2D LiDAR sensor	▶ Clean the inspection window of the 2D LiDAR sensor immediately.
Housing yellow	▪ Minor contamination on the inspection window of the 2D LiDAR sensor Inspection window of the 2D LiDAR sensor is yellow	▶ Clean the inspection window of the 2D LiDAR sensor.
Housing red	▪ Heavy contamination on the inspection window of the 2D LiDAR sensor	▶ Clean the inspection window of the 2D LiDAR sensor.
	▪ No voltage supply to the 2D LiDAR sensor or voltage is too low	▶ Check the voltage supply.
	▪ Ethernet connection to the 2D LiDAR sensor interrupted	▶ Check the Ethernet connection.
	▪ 2D LiDAR sensor heater not connected or temperature too low	▶ Check the connection of the heater.
	▪ 2D LiDAR sensor defective.	▶ Note the fault indicator on the 2D LiDAR sensor's 7-segment display.

System functions without devices
* The icon is green when the system function is running properly. A red icon indicates that system functions have not been linked correctly, for example.

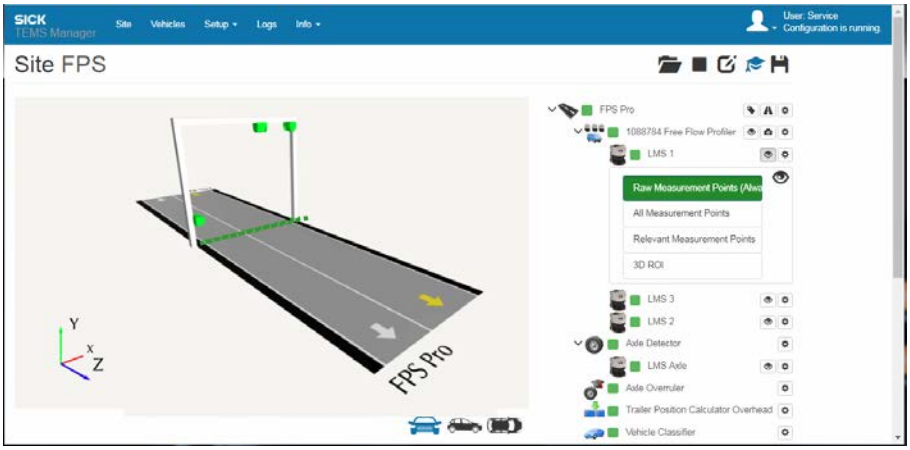
Plug-ins (Disk Storage)		
Display	**Possible cause**	**Possible measures**
Plug-in red	▪ Insufficient memory available on the hard drive ▪ Directory not present on hard drive ▪ Hard drive not available	▶ Check the hard drive's storage capacity. ▶ Check the directory. ▶ Check the connection.

8.3.1.4 Analyzing the error situation

Narrow down the system fault by visualizing the measurement points.

Visualizing the live data for the device component

1. Go to the device in the navigation tree and click the **Visualize live data for device** icon.
2. Click **Raw measuring points**. The live view in TEMS Manager shows the **unfiltered raw data** for the 2D LiDAR sensor. You are able to see what the 2D LiDAR sensor can see in its visual range.

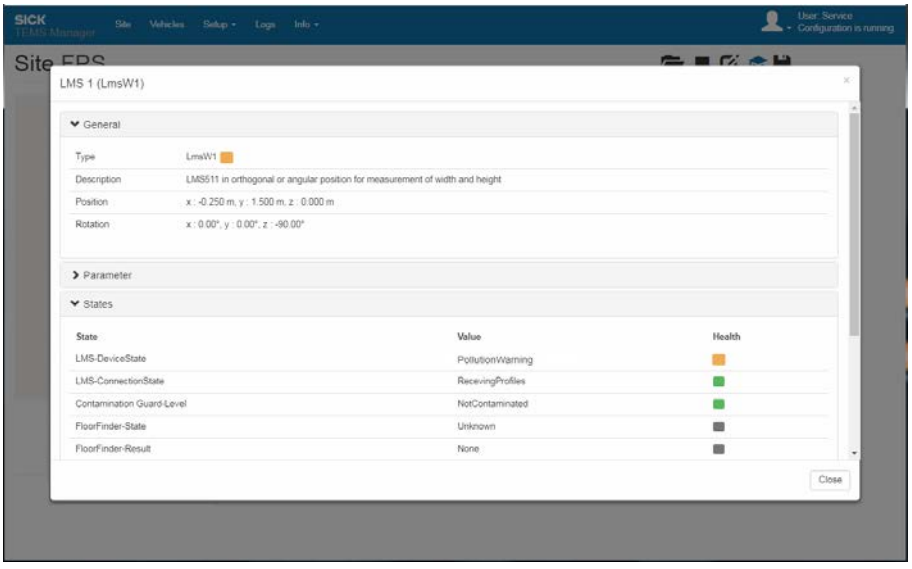


- Click **Relevant Measurement Points**. The live view now shows the **filtered measurement data** from the 2D LiDAR sensors. The filtered measurement data are used as the basis for the 3D point cloud and the resulting calculations. Visualization of the filtered measurement data helps to detect faults.

Showing the details

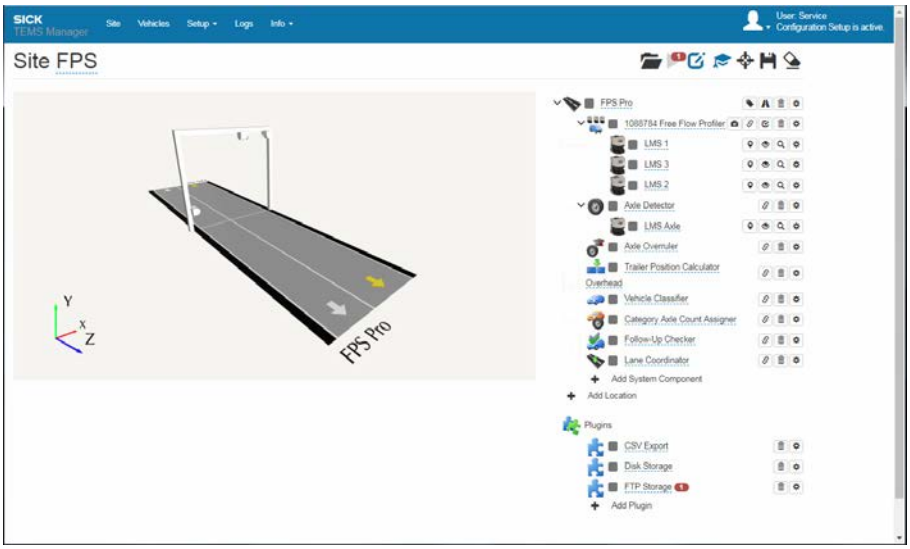
The detail window helps you narrow down the system fault even further. Other status messages can also be accessed here.

1. Switch on expert mode.
- 2. Go to the relevant device component level in the navigation tree and click the **Show Details** icon. The detail window opens. The following example shows what the window looks like when the ***LMS 1*** 2D LiDAR sensors is contaminated.



8.3.1.5 Fault indicators in editing mode

In editing mode, fault numbers appear in the navigation tree to indicate when configurations are affected by faults.



Red numbers signal the presence of an error. Erroneous configurations cannot be started. Yellow numbers signal a warning. Warnings do not prevent the configuration from starting.

The number shows how many errors or warnings there are in each case.

You can narrow the problem down by right-clicking the fault number. This opens a window containing further detailed information.

In the example, no IP address has been entered for the **FTP Storage** plug-in.

8.3.2 Fault diagnosis via the TEMS Info interface

The customer can also conduct a detailed fault diagnosis by requesting status messages from the TEMS Info client.

The data protocols used for accessing data in the TCP/IP data stream are listed in the separate description for the TEMS Info interface (available on the USB stick).

8.3.3 Detecting system errors using log files

All TEMS Recorder operations are logged on the Traffic Controller FPS.

To help SICK Support with fault analysis, it is often necessary to forward the latest system logs. You can download these logs via the **Logs** workspace and send them as an e-mail attachment.

All system actions are written to a log file of the **Recorder** type. A separate log file is created for each day.

See also chapter *6.10 Downloading log files*.

Alternatively, all the logs can be downloaded from the Traffic Controller FPS via FTP. The status logs are stored inside the **/logs** directory (see also chapter *3.4.4 Downloading log files*).

1. Connect to the FTP server of the Traffic Controller FPS using an FTP client (e.g., FileZilla).
2. Log in by entering **client** for the user name and **client** as the password.

8.3.4 Providing raw data to help Support

Sometimes, the measurement points recorded by the 2D LiDAR sensors also have to be forwarded to Support to assist it with its tasks. Under the default configuration for the profiling system, these raw data are not saved. You have to initiate the saving process yourself.

NOTE

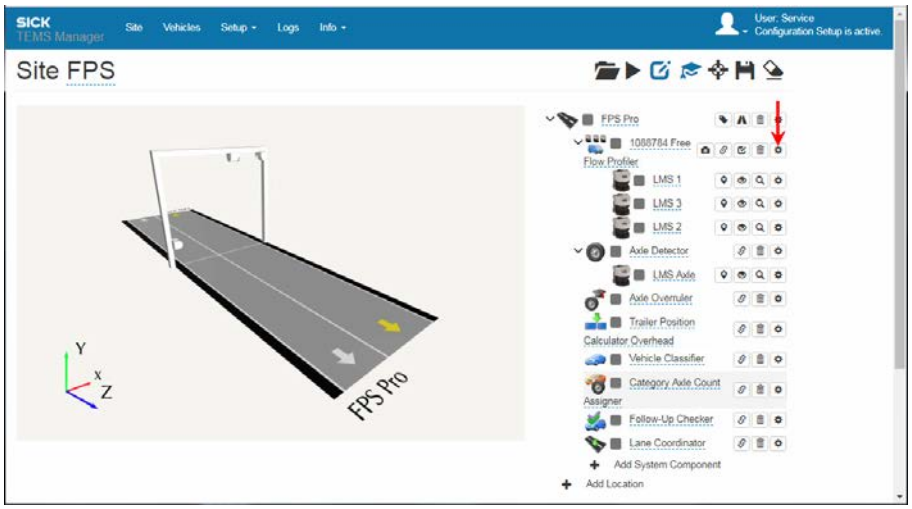
Due to the large volume of data involved, we recommend only recording raw data for a maximum of one hour at a time. To enable a detailed fault analysis, it is usually sufficient to record raw data for a period of 20 minutes.

▶ Therefore, you should deactivate the function for recording raw data after 20 minutes.

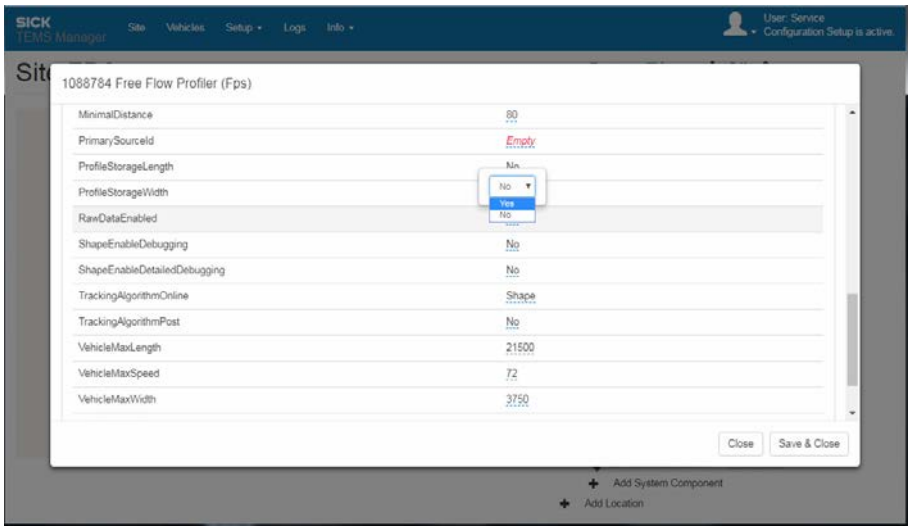
Recording raw data

You can only activate the function for recording raw data if you are a user with **Service** authorization.

1. In the editing mode for the site configuration, log in as a user with **Service** authorization.
2. Switch on expert mode.
3. In the navigation tree, go to the level of the relevant system function (not the system component) and click the **Show Details** icon.



4. In the detail window for the system function, set the **RawDataEnabled** parameter to **Yes**.



5. Close the detail window and start the configuration.

   The raw 2D LiDAR sensor data are then saved inside the **/RawData** directory on the Traffic Controller FPS.

Stopping raw data recording

1. After approximately 20 minutes, switch back to editing mode and open the detail window for the system function.
2. Set the **RawDataEnabled** parameter to **No**.

Downloading raw data via FTP

Perform an FTP download to transfer the raw data from the **/RawData** directory on the Traffic Controller FPS.

1. Connect to the FTP server of the Traffic Controller FPS using an FTP client (e.g., FileZilla).
2. Log in by entering **client** for the user name and **client** as the password.

Important **Deleting raw data**

Once the raw data has been downloaded from the **/RawData** directory on the Traffic Controller FPS, you must **manually delete** the data. Otherwise, the data will clog up the SSD by taking up unnecessary storage capacity.

The raw data are **not** deleted automatically when you deactivate the function for recording raw data.

8.3.5 Sensor component failures

In the event of a sensor component failure, the configuration continues running. However, the profiling system is only operable to a limited extent (see also chapter *8.3.1.2 Fault indicators at site level*).

Note Once a configuration affected by errors has been stopped, the profiling system can no longer be started.

The configuration can only be restarted once the fault has been resolved.

8.4 Typical fault situations

The Floor Finder will not switch off

Possible cause	Remedy
The 2D LiDAR sensors do not have a clear view of the measuring range. The LMS Width is hanging down too low (lower than 5 m) or is not perpendicular to the road (Z-axis rotation greater than 5°). The positions and alignment of the 2D LiDAR sensors do not match the actual conditions.	▶ Use the filtered raw data to check whether the 2D LiDAR sensor's visual range is clear (see chapter *8.3.1 Fault diagnosis in TEMS Manager*). ▶ Check the position and alignment of the 2D LiDAR sensors in TEMS Manager. The position and alignment must match the actual conditions. ▶ Carry out mounting in accordance with the specifications. ▶ Use the **FloorFinderState** and **FloorFinderResult** parameters to analyze the status messages of the Floor Finder. **FloorFinderState** ▪ **Unknown**: No status available (yet) ▪ **Recording**: Collecting data ▪ **Calculating**: Performing calculation ▪ **Finished**: Result is available **FloorFinderResult** ▪ **None**: No result available (yet) ▪ **NotEnoughPoints**: The number of visible measurement points is insufficient → Wrong configuration ▪ **NoiseTooHigh**: Too much "interference" in measurement data → Snow, trash, dust, spray ▪ **TooClose**: Result too near to scanner → Is there an object in the way? ▪ **AngleDeviationTooLarge**: Result skewed → Is the scanner hanging crooked? ▪ **DistanceSigmaTooLarge**: Too much difference between measurements → Too much traffic? ▪ **AngleSigmaTooLarge**: Too much difference between measurements → Mounting too unstable? ▪ **Calculated**: Final result is available
There is heavy contamination on the inspection window of the 2D LiDAR sensor.	▶ Clean the inspection window of the 2D LiDAR sensor.
The surface of the road is not level. There is snow or there are leaves on the road. Road surface is extremely dark (e.g., due to new paving) Road is extremely wet	▶ Clear away anything located in the measuring range of the 2D LiDAR sensor. ▶ Make sure that the 2D LiDAR sensor's visual range is clear.

Several outputs for the same vehicle

Possible cause	Remedy
This suggests that the distance between the system components in the configuration does not match the distances in real life.	▶ Check the configuration.

There is no vehicle, no fault

Possible cause	Remedy
The 2D LiDAR sensors' visual range has been blocked by outside ambient conditions, e.g., snow or dirt.	▶ Clear away anything that is blocking the 2D LiDAR sensor's measuring range. ▶ Check that the 2D LiDAR sensor's visual range is clear.
The IP addresses of the 2D LiDAR sensors (e.g., those of the LMS Width and the LMS Length) have been interchanged.	▶ Check the configuration.

Problems with length measurement/speed measurement

Possible cause	Remedy
Static objects are located in the LMS Length's field of view, e.g., concrete lane barriers, guardrails, sections of the gantry or a bridge, bumps in the surface of the road, etc.	▶ Use the filtered raw data to check whether the LMS Length's visual range is clear (see chapter *8.3.1 Fault diagnosis in TEMS Manager*). ▶ Check the inspection window of the LMS Length for contamination. ▶ Clean the inspection window of the 2D LiDAR sensor.

Speed measurement with opposite sign

Possible cause	Remedy
The direction of travel was configured incorrectly in TEMS Manager.	▶ Check the direction of travel for the lanes in TEMS Manager. The configuration does not have to be stopped for this.

Classification keeps delivering poor results (unclear 3D point clouds)

Possible cause	*Remedy*
The orientation of the 2D LiDAR sensors was incorrectly rotated by 180° when configuring it in TEMS Manager.	▶ Check the configuration.
There is heavy contamination on the inspection window of the 2D LiDAR sensor.	▶ Clean the inspection window of the 2D LiDAR sensor.
There are problems with length measurement. Static objects are located in the field of view of the LMS Length, e.g., concrete lane barriers, guardrails, sections of the gantry or a bridge, or bumps in the surface of the road.	▶ Use the **filtered** raw data to check whether the visual range of the LMS Length is clear (see chapter *8.3.1 Fault diagnosis in TEMS Manager*). ▶ Check the inspection window of the LMS Length for contamination. ▶ Clean the inspection window of the 2D LiDAR sensor.

Incorrect number of axles

Possible cause	Remedy
The LMS Axle was not mounted in accordance with the specifications (mounted too high, angle of incidence too steep, etc.)	▶ Make sure that the device is mounted in accordance with the specifications (see chapter *3.5.5 Requirements for mounting the axle counting components*).
The LMS Axle's visual range has been blocked by outside ambient conditions, e.g., snow, temporary lane barriers.	▶ Clear away anything that is blocking the 2D LiDAR sensor's measuring range. ▶ Check that the visual range of the 2D LiDAR sensor is clear.

9 Annex

9.1 Technical data

9.1.1 FPS data sheet

9.1.2 Excerpt from the Traffic Controller FPS data sheet

Functions	Receipt and filtering of sensor data, processing for vehicle data, output of vehicle and diagnostic data via the user interface
Application	Indoor
Optical indicators on the device	LED status and function indicators
Supply voltage	24 V DC (12 V DC ... 36 V DC)
Operator interface	Female Ethernet connector LAN 1 on Traffic Controller FPS
Sensor interface	Female Ethernet connector LAN 2 on Traffic Controller FPS
Housing dimensions	180 mm x 33 mm x 121.2 mm (W x H x D)
Weight	800 g
Mounting	Screwable
Enclosure rating	IP 20
Internal memory	32 GB
Data log	TEMS Info interface WCF TEMS Manager
NTP synchronization	Yes
Ambient temperature, operation	–20 °C ... +60 °C (SSD) –40 °C ... +80 °C (storage)
Ambient temperature, storage	–20 °C ... +85 °C

Tab. 22: Excerpt from the Traffic Controller FPS data sheet

9.1.3 Excerpt from the LMS511 SE data sheet

Application	Outdoor
Light source	Infrared (λ = 905 nm)
Laser class	Laser class 1 (IEC 60825-1 (2007-3)), eye-safe
Aperture angle	190°
Scanning frequency	25 Hz ... 100 Hz
Sensing range	80 m maximum 40 m maximum for objects with remission under 10%
Statistical error	+/– 6 mm
Systematic errors	+/– 25 mm
Ambient light immunity	70,000 lx
Optical indicators	5 x LED; 1 x 7-segment display
Voltage supply	24 V DC (19.2 V DC ... 28.8 V DC)
Power consumption	22 W + 55 W heating (typical)
Enclosure rating	IP 67, acc. to EN 60529
Weight	3.7 kg
Ambient temperature (operation)	–40 °C ... +60 °C
Storage temperature range	–40 °C... +70 °C
Dimensions	160 mm x 155 mm x 185 mm

Tab. 23: LMS511 SE data sheet

9.2 Dimensional drawings

9.2.1 Dimensional drawing for LMS511 SE 2D LiDAR sensor

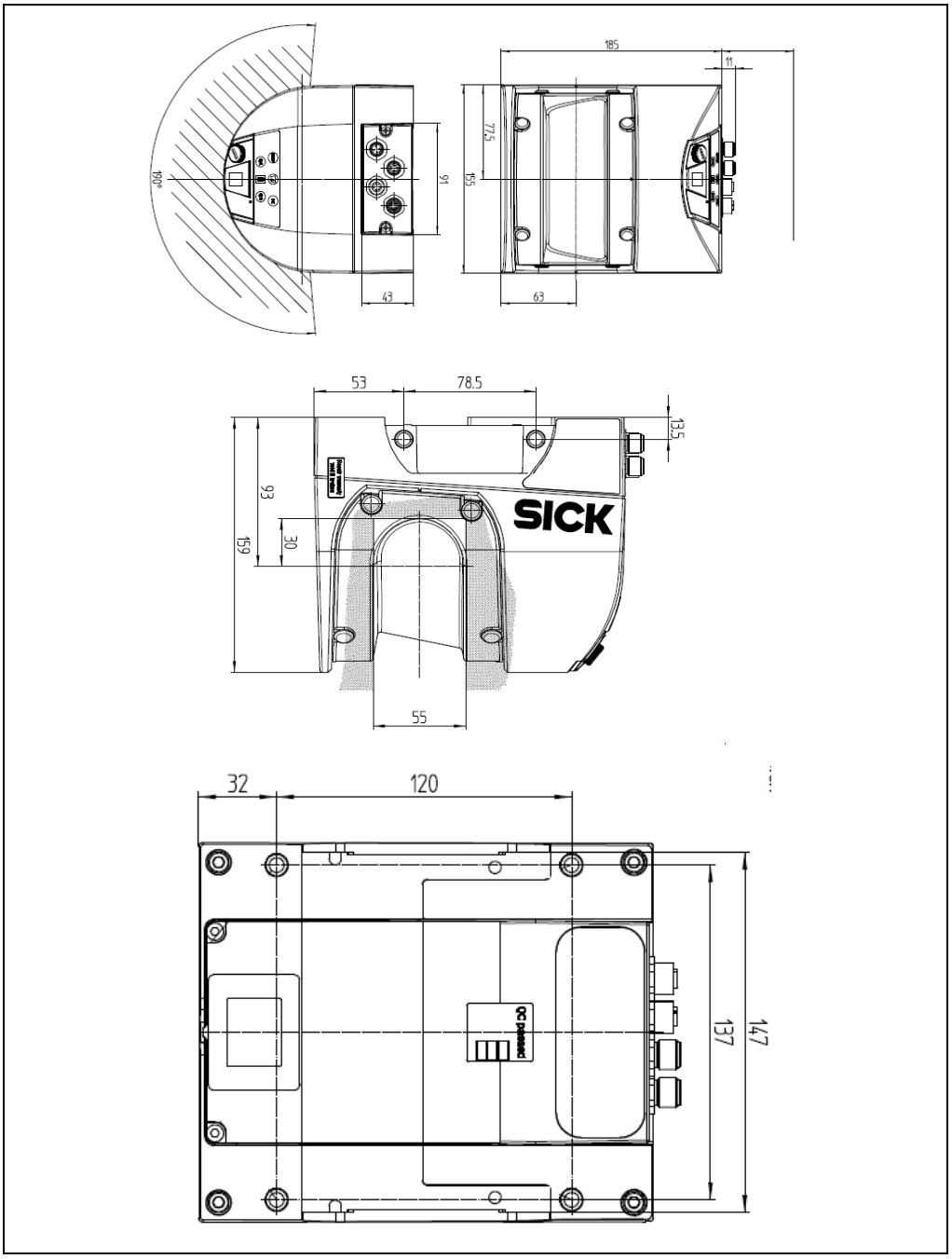


Abb. 70: Dimensional drawing for the LMS511 SE 2D LiDAR sensor

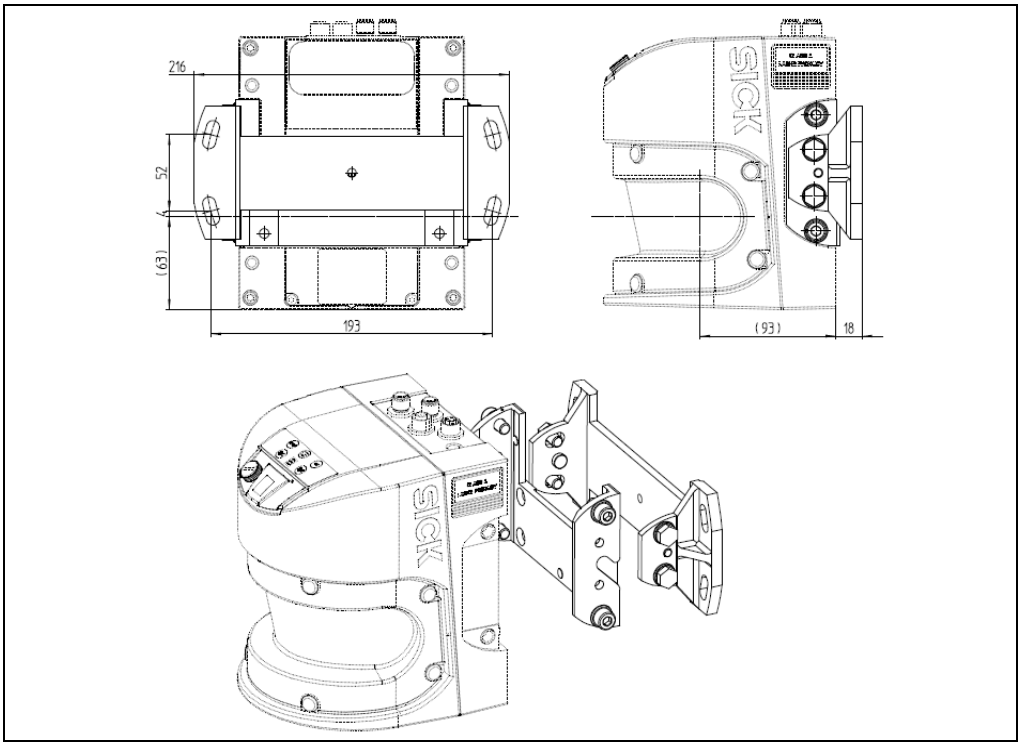


Fig. 71: Dimensional drawings of the LMS511 SE with mounting kits 1 and 2

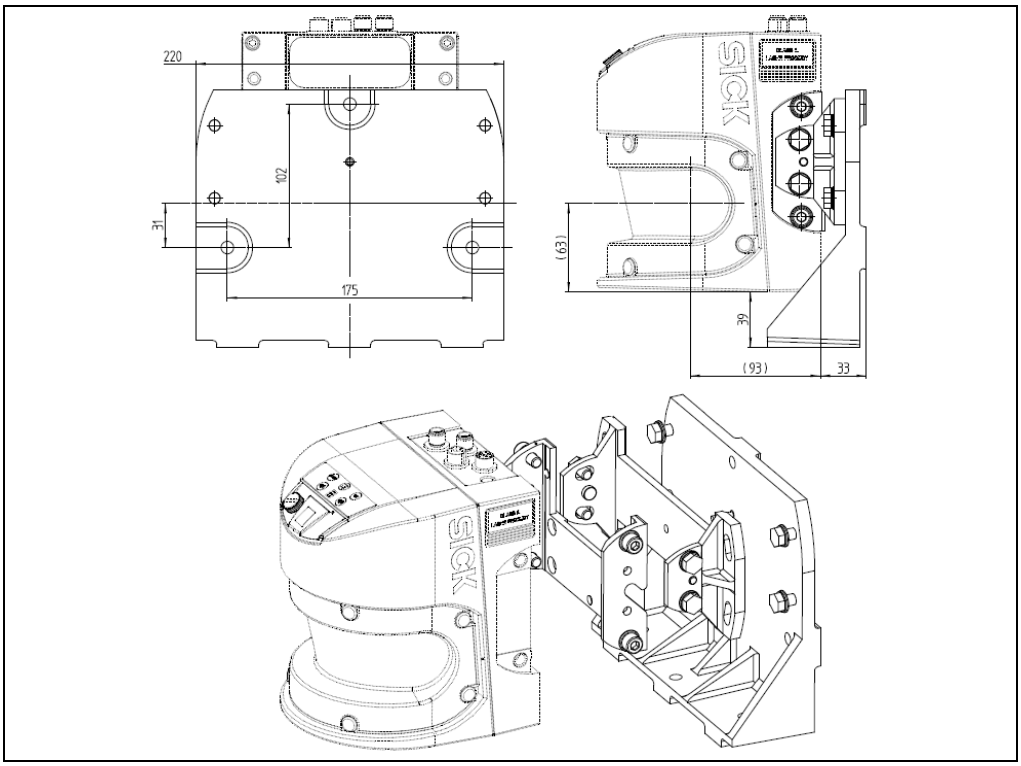


Fig. 72: Dimensional drawings for the LMS511 SE with mounting kits 1, 2, and 3

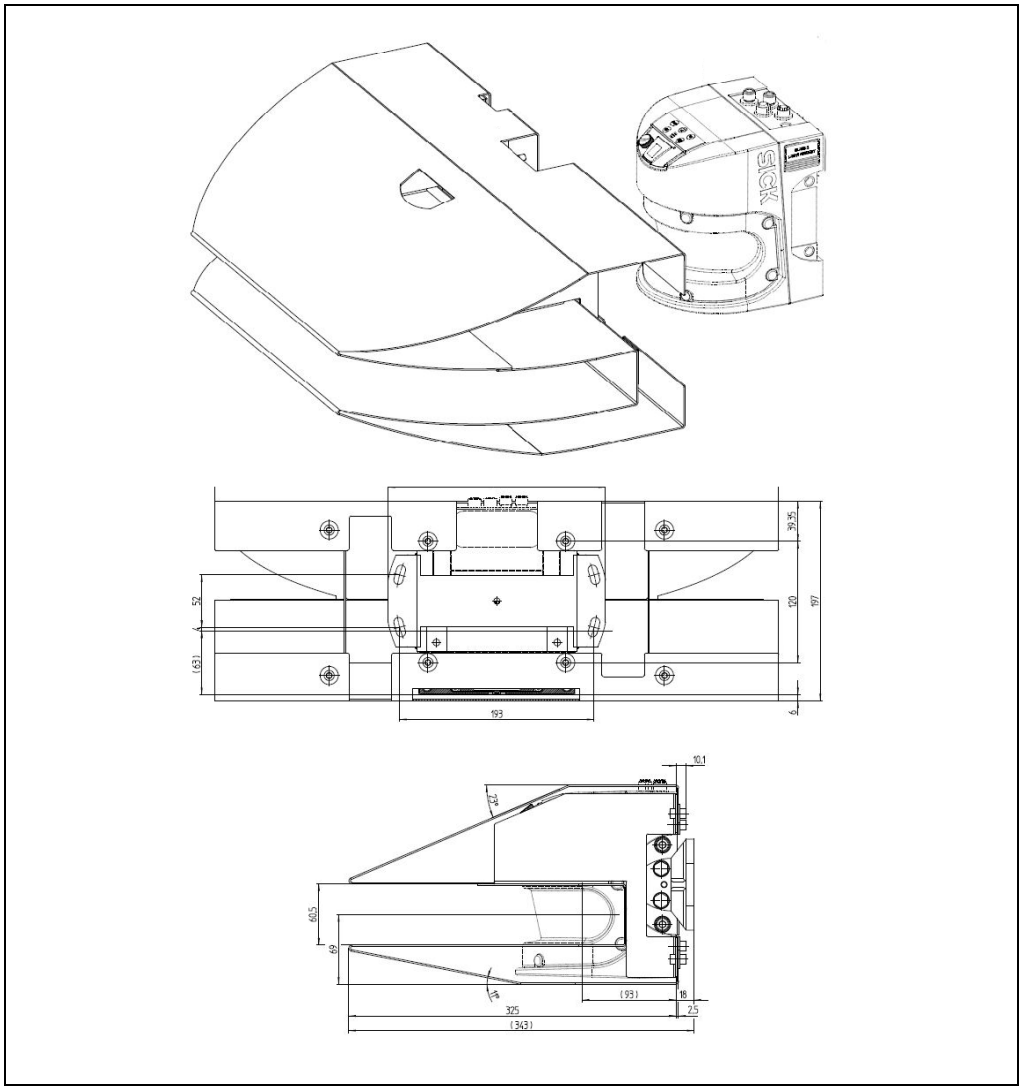


Fig. 73: Dimensional drawings for the LMS511 SE with weather hood (large)

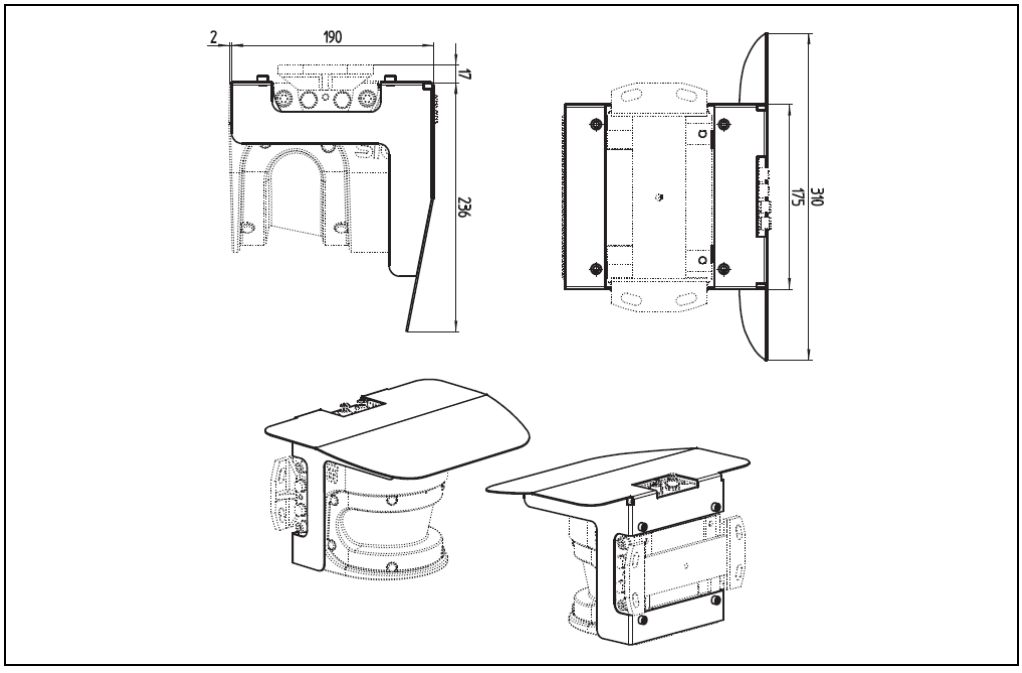


Fig. 74: Dimensional drawings for the LMS511 SE with weather hood (small) – variant 1

9.2.2 Dimensional drawings for the Traffic Controller FPS

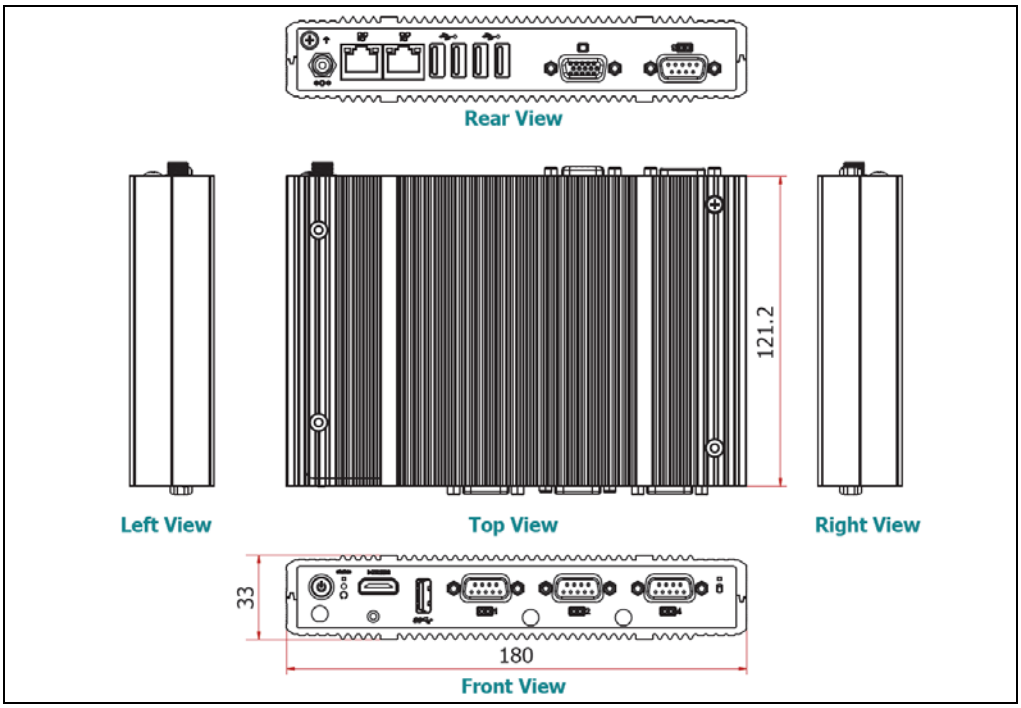


Fig. 75: Dimensional drawing for the Traffic Controller FPS

9.3 Category systems

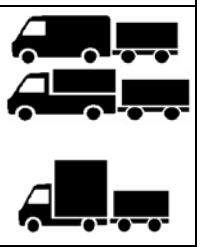
9.3.1 European region

Europe uses a detailed category system with 28 different categories. These categories are broken down into 4 further category systems: **Swiss10** with 10 categories, **TLS 8+1** with 8 categories, **TLS 5+1** with 5 categories, and **TLS 2+0** with 2 categories.

In vehicle information, these categories are described as follows:

```
...
<Category>
        <Value>ECTN.Car</Value>
</Category>
<CategoryExternal>
        <Value>TLS 8+1.Car</Value>
</CategoryExternal>
...
```

Note The weight data is used purely for the purpose of describing the relevant vehicle class. The external vehicle geometry is the definitive factor when determining the classes, not the effective and total permissible weight.

Category systems							
ECTN	**Swiss 10**	**TLS 8+1**	**TLS 5+1**	**TLS 2+0**	**ECTN (output via interface)**	**Description**	**Symbol**
000	0	6	6	32	Unknown	Vehicle has been detected but cannot be classified	
110	2	10	1	32	Bike	Motorbike or scooter (but not bicycles or mopeds)	
210	3	7	1	32	Car	Car (up to 9 seats, total weight ≤ 3.5 t)	
211	4	2	2	33	CarWithTrailer	Car with trailer (up to 9 seats, total weight ≤ 3.5 t)	
310	5	11	1	32	Van	Van with tapered front, body at least the same height as the driver's cab (including small vans and removal trucks, weight 2.8 t up to 3.5 t)	
311	6	2	2	33	VanWithTrailer	Van with trailer (weight 2.8 t to 3.5 t)	

320	5	11	1	32	VanPickup	Pick-up with or without a small load (front driver's cab, no body, weight ≤ 3.5 t)	
321	6	2	2	33	VanPickupWith Trailer	Pick-up without or with a small load, with trailer (front driver's cab, no body, weight ≤ 3.5 t)	
330	5	11	1	32	CamperVan	Motor home (cube design, roof without extension (e.g., bunk extension) weight ≤ 3.5 t)	
331	6	2	2	33	CamperVanWith Trailer	Motor home with trailer (cube design, roof without extension (e.g., bunk extension) weight ≤ 3.5 t)	
340	7	9	4	33	ArticVan	Van with semitrailer (weight ≤ 3.5 t)	
410	8	3	3	33	Truck	Truck with body (up to 12 m long, weight > 3.5 t)	
411	9	8	4	33	TruckWithTrailer	Truck with body and trailer (up to 18.75 m long, weight > 3.5 t)	
420	8	3	3	33	TruckDumpster	Dumper truck with empty or almost empty loading surface (up to 12 m long, weight > 3.5 t)	
421	9	8	4	33	TruckDumpster-WithTrailer	Dumper truck with empty or almost empty loading surface, with trailer (up to 18.75 m long, weight > 3.5 t)	
430	8	3	3	33	TruckTanker	Tanker for transporting liquids (oval cross-section, up to 12 m long, weight > 3.5 t)	
431	9	8	4	33	TruckTankerWith Trailer	Tanker for transporting liquids, with trailer (oval cross-section, up to 18.75 m long, weight > 3.5t)	
440	8	3	3	33	TruckLowLoaded	Low-loader without body or with low freight (freight lower than driver's cab, up to 12 m long, weight > 3.5 t)	
441	9	8	4	33	TruckLowLoaded WithTrailer	Truck without body or with low freight, with trailer (freight lower than driver's cab, up to 18.75 m long, weight > 3.5 t)	
450	9	8	4	33	TruckCarTransporterLoaded	Car carrier transporter, loaded, with trailer (2 loading surfaces, length up to 21.5 m, weight > 3.5 t)	
451	9	8	4	33	TruckCarTransporterEmpty	Car carrier transporter, not loaded, with trailer (2 loading surfaces, length up to 21.5 m, weight > 3.5 t)	
510	10	9	4	33	ArticTruck	Truck with semitrailer (loaded, up to 16.5 m long, weight > 3.5 t)	

520	10	9	4	33	ArticTruck Dumpster	Dumper truck with semitrailer, with empty or almost empty loading surface (up to 16.5 m long, weight > 3.5 t)	
530	10	9	4	33	ArticTruckTanker	Tanker with semitrailer (oval cross-section, up to 16.5 m long, weight > 3.5 t)	
540	10	9	4	33	ArticTruckLow Loaded	Low loader with semitrailer (up to 16.5 m long, weight > 3.5 t)	
590	8	3	3	33	TractorTruck	Articulated truck without semitrailer	
610	1	5	5	33	Bus	Bus for transporting large numbers of people (overland bus, regional bus, > 9 seats)	
611	1	5	5	33	BusWithTrailer	Bus for transporting large numbers of people, with trailer (overland bus, regional bus, > 9 seats)	

Tab. 24: Category systems – European region

9.3.2 North American region

North America uses a detailed categorization system, the **North America Detailed**, with 30 categories. These categories are grouped into 11 broader categories under the **North America Consolidated** category system.

In vehicle information, these categories are described as follows:

```
...
<Category>
        <Value>NorthAmericaDetailed.AutomobileWithTrailer</Value>
</Category>
<CategoryExternal>
        <Value>NorthAmericaConsolidated.AutomobileWithTrailer</Value>
</Category>
...
```

Category Systems					
North America Detailed (Class No. and Name)		**North America Consolidated (Class No. and Name)**		**Description**	**Symbol**
0	Unknown	0	Unknown	Detectable, but not classifiable vehicle	?
110	Motorcycle	1	Motorcycle	Motorbike or scooter (without bicycle or moped)	
111	MotorcycleWithTrailer	2	MotorcycleWith Trailer	Motorbike or scooter with trailer of all types	
210	Automobile	3	Automobile	Automobiles of all types, with load on the roof, with bicycle attached at the back	
211	AutomobileWithTrailer	4	AutomobileWith Trailer	Automobiles with trailer of all types, empty / nearly empty / loaded	
320	Pick-up	5	VanPickup	Pick-ups of all types, with / without load at the back, on the top	
310	Van			Van with tapered front, including school van and pickup with hard top	
350	VanCommercial			Vans with tapered front and high cubical back	
1302	PickupSnowPlow			Pick-ups with a snow-plow mounted in the front	
321	PickupWithTrailer	6	VanPickupWith Trailer	Pick-ups with trailer of all types, empty / nearly empty / loaded	
311	VanWithTrailer			Vans with trailer of all types, empty / nearly empty / loaded	
351	VanCommercialWith Trailer			Vans with tapered front and high cubical back, with trailer of all types, empty / nearly empty / loaded	
340	PickupKingpin			Pick-ups with kingpin, regardless of loading	

410	Truck	9	Truck	Trucks with cubical loading in the back	
360	PickupFlatbed			Pick-up flatbeds with wide load area, often also double tires on the second axle, including pick-up tow trucks	
440	TruckFlatBed			Trucks with flat loading area at the back, empty / nearly empty / loaded	
1402	TruckSnowPlow			Trucks, normally with flatbed, with a snow-plow mounted in the front	
1404	TruckConcrete			Trucks used for concrete transportation (special form in US)	
411	TruckWithTrailer	10	TruckWithTrailer	Trucks with trailer of all types, empty / nearly empty / loaded, includes moving truck pulling an automobile	
361	PickupFlatbedWith Trailer			Pick-up flatbeds with trailer of all types, empty / nearly empty / loaded	
441	TruckFlatBedWith Trailer			Trucks with flat loading area with trailer of all types, empty / nearly empty / loaded, includes also tractor unit with trailer	
510	TractorTrailerCombo	11	TractorTrailer Combo	Semitrailer trucks with cubical loading in the back, regardless of the shape of the cab	
530	TractorTrailerCombo Tanker			Semitrailer trucks transporting cylindrical loading	
540	TractorTrailerCombo LowLoaded			Semitrailer trucks with low loading area in the back, empty / nearly empty / loaded, also tractor trailer pulling a recreation vehicle	
550	Autotransporter			Semitrailer trucks transporting cars, loaded or empty	
1502	TractorTrailerCombo-HouseTransportation			Semitrailer trucks transporting house, very wide (above 3.5 m) and high load (above 4 m)	
590	TractorUnit			Semitrailer tractor truck	
511	TandemTrailerCombo	12	TandemTrailer Combo	Semitrailer trucks with 1 trailer	
610	BusRV	7	Bus	Bus for transportation of people, coach, overland bus, includes recreation vehicles	
620	SchoolBus			Bus for transportation of school pupils	
611	BusRVWithTrailer	8	BusRVWith Trailer	Bus with trailer of all types, empty / nearly empty / loaded	

Tab. 25: Category systems – North American region

9.3.3 Brief overview of grouped category systems

Category system	Class No.	Description	Output via interface
TLS 8+1	6	Unknown	Unknown
	10	Motorbike	Bike
	7	Car	Car
	11	Delivery van	Van
	2	Car with trailer	CarWithTrailer
	3	Truck	Truck
	8	Truck with trailer	TruckWithTrailer
	9	Articulated truck	TruckArtic
	5	Bus	Bus

Category system	Class No.	Description	Output via interface
TLS 5+1	6	Unknown	Unknown
	1	Car group	Car
	2	Car with trailer	CarWithTrailer
	3	Truck	Truck
	4	Truck combinations	TruckWithTrailer
	5	Bus	Bus

Category system	Class No.	Description	Output via interface
TLS 2+0	32	Car or similar	Car
	33	Truck or similar	Truck

Category system	Class No.	Description	Output via interface
Swiss 10	0	Unknown	Unknown
	1	Bus, car	Bus
	2	Motorbike	Bike
	3	Car	Car
	4	Car with trailer	CarWithTrailer
	5	Delivery van	Van
	6	Delivery van with trailer	VanWithTrailer
	7	Delivery van with semitrailer	VanArtic
	8	Truck	Truck
	9	Truck with trailer, freight truck	TruckWithTrailer
	10	Truck with semitrailer, articulated truck	TruckArtic

Category system	Class No.	Output (interface)
NorthAmerica Consolidated	0	Unknown
	1	Motorcycle
	2	MotorcycleWithTrailer
	3	Automobile
	4	AutomobileWithTrailer
	5	VanPickup
	6	VanPickupWithTrailer
	9	Truck
	10	TruckWithTrailer
	11	TractorTrailerCombo
	12	TandemTrailerCombo
	7	Bus
	8	BusRVWithTrailer

9.4 Terminology relating to statistical measurement accuracy

The statistical measurement accuracy of the system involves two different quantities: the accuracy of the counting process and the accuracy of the classification process. As these operating instructions repeatedly refer to these quantities, a simple example will now be used to demonstrate the difference between the two.

In the example, measurement accuracy is determined on the basis of 10,000 vehicles. For ease of understanding, the vehicles consist of cars (5,000) and trucks (5,000) only.

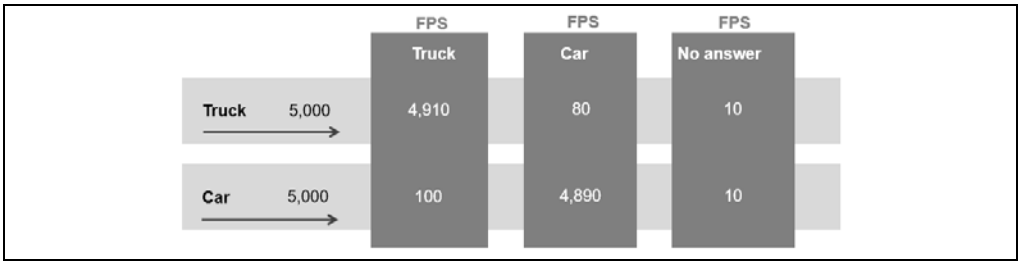


Fig. 76: Counting accuracy and classification accuracy

Counting accuracy

The counting accuracy shows how many of the vehicles have been correctly detected and – consequently – counted. Counting accuracy is independent of the type of vehicles in the traffic.

In our example, 20 of the 10,000 vehicles were not detected. This gives a counting accuracy of 99.8%.

Classification accuracy

The classification accuracy shows how many of the vehicles have been correctly classified. In our example, 9,800 of the 10,000 vehicles have been correctly classified. The system's classification accuracy amounts to 98%.

The classification rate for trucks is higher than for cars.

- Trucks: 4,910 of 5,000 vehicles were correctly classified = 98.2%
- Cars: 4,890 of 5,000 vehicles were correctly classified = 97.8%

The classification accuracy of the entire system therefore depends on the type of vehicles in the traffic and the category system used. Depending on the type of vehicles in the traffic and the category system used, the measurement accuracy of the entire system may increase or decrease.

Confidence

For most of the data recorded for a vehicle, there is a confidence level (between 0 and 100%). The confidence level expresses the level of certainty with which the value was correctly identified by the system component.

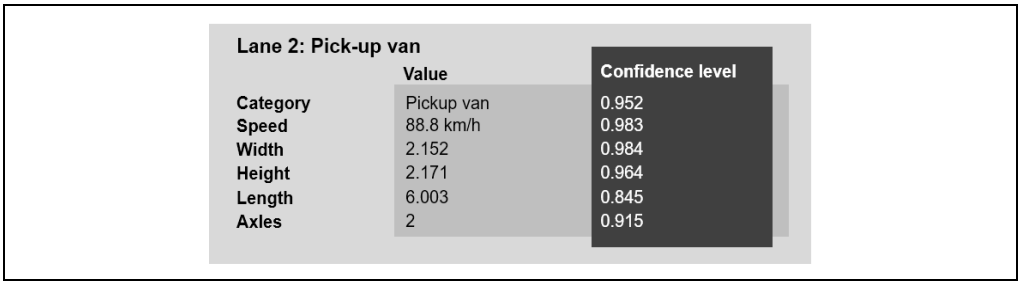


Fig. 77: Output data with confidence level

The confidence level can be processed internally as well as during analysis in downstream systems.

9.5 Users and authorizations

9.5.1 Overview

Three standard users are differentiated for working in TEMS Manager: **Operator**, **Authorized User**, and **Service**.

The users are assigned the following authorizations:

User	Authorization	Password	Rights
Operator	Operator	–	▪ Change own password ▪ View basic parameters
AuthorizedClient	Authorized Client	Client	▪ Change own password ▪ View basic parameters ▪ View advanced parameters ▪ Edit configuration ▪ Load and start configuration
Servicing	Servicing	Service level	▪ Change passwords of all users ▪ View basic parameters ▪ View advanced parameters ▪ View expert parameters ▪ Manage users ▪ Edit configuration ▪ Load and start configuration
Production	Production		▪ Program-internal user. ▪ Can neither be edited nor deleted.
Developer	Developer		▪ Program-internal user. ▪ Can neither be edited nor deleted.

Tab. 26: User and authorizations - TEMS Manager

Note Change **AuthorizedClient** and **Service** default passwords straight after initial login to protect TEMS Manager against unauthorized access.

Access regulation on user management

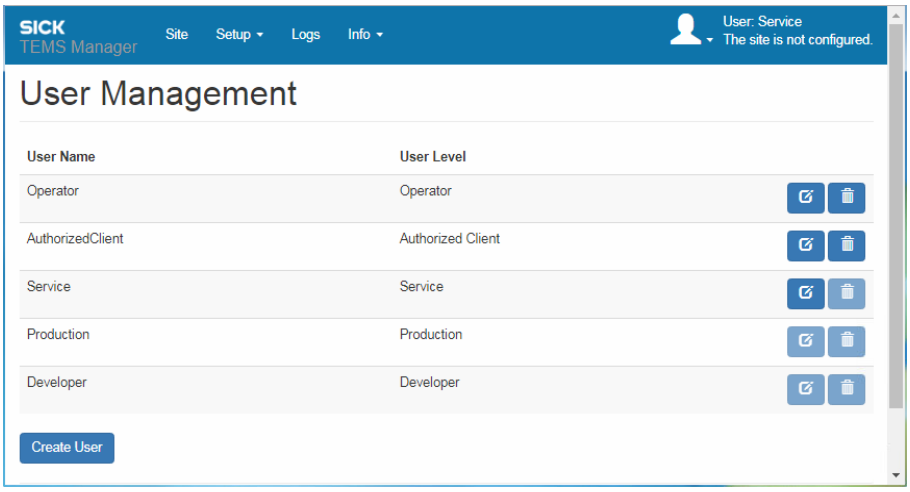
Users with the **Service** authorization have access to all users. They can create new users and delete existing users (except the logged-in user) and change user passwords.

Users with the **Authorized user** or **Operator** authorization can only change their password in user management. Other functions are not available.

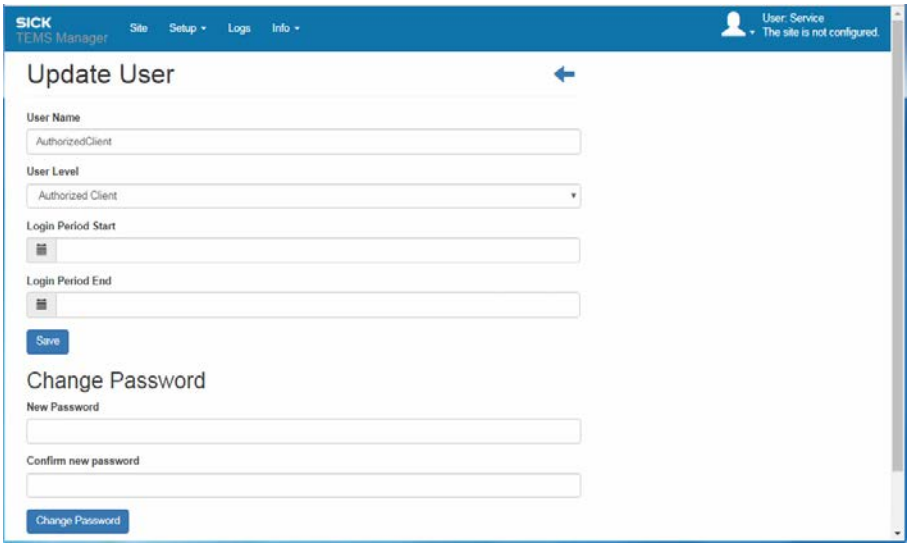
Note User management can only be called up if configuration is stopped.

9.5.2 Changing default passwords

1. Stop the current configuration.
2. Register as a user with the **Service** authorization.
3. In the **Settings** register, select the **User management** function.



4. Click on the Edit icon in the user line.



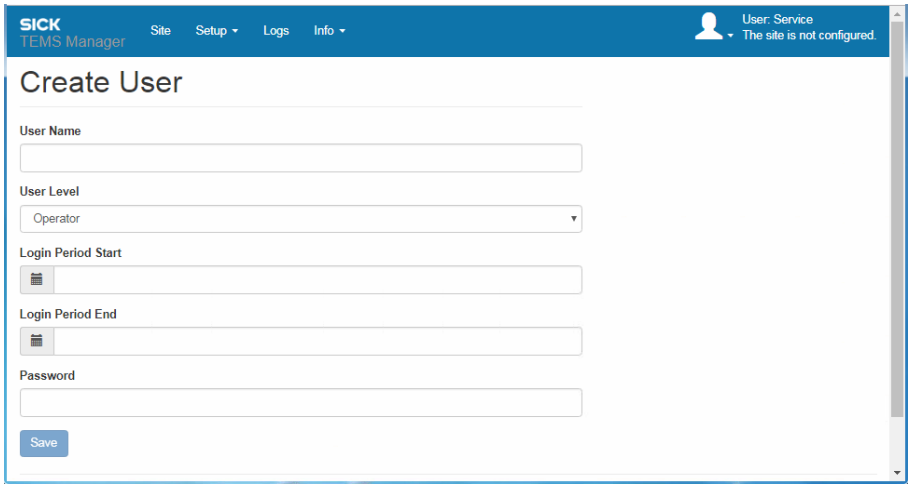
5. Define the new password in the **Change password** area. The new password must not be identical to the previous one.
6. Enter the new password again. This ensures that you wish to use the spelling entered in the previous field.
7. Confirm with **Change password**. Successful adaptation of the password is confirmed.

8. Return to the list of users using the arrow icon.

Note A password can be assigned for the **Operator** user, which is delivered without a password by default, with this function.

9.5.3 Creating users

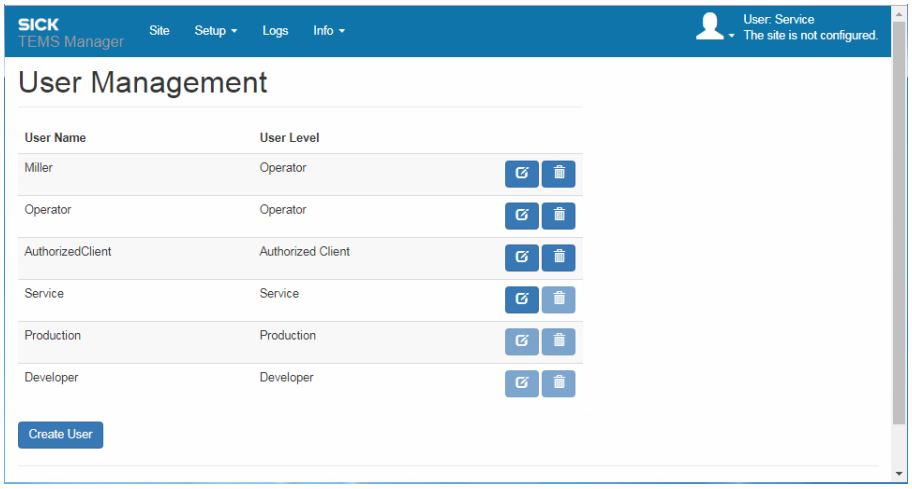
1. Register as a user with the **Service** authorization.
2. Open user management.
3. Click on **Create user**.



4. Enter user name.

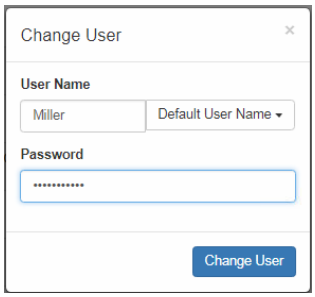
Note The user name is case-sensitive. Note upper-/lowercase letters.

5. Assign the user one of the three authorizations.
6. As an option, you can limit the log-in time of the user.
7. Assign password.
8. Complete with **Save**. The list of standard users is extended to include the newly created user.



Logging in

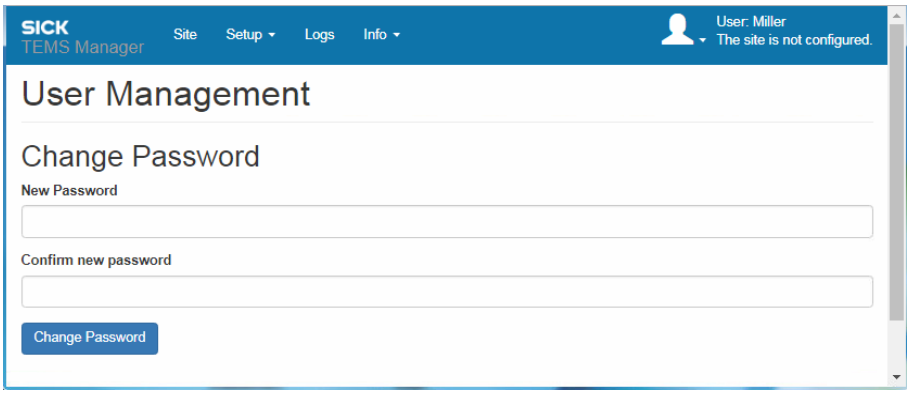
Logging in is done later with user name and password.



9.5.4 Change password

Users with the **Authorized user** or **Operator** authorizations can only change their password in user management.

1. In the **Settings** register, select the **User management** function.



2. Enter new password and confirm by entering it again.
3. Click on **Change password**.

9.5.5 User data for accessing the FTP server of the Traffic Controller

The Application Processing Unit features an integrated FTP server for downloading vehicle data and log files via FTP. This FTP server is accessed by entering set user data.

User name	Client
Password	Client

Tab. 27: Accessing the FTP server of the APU

Note The user name and password of the FTP server cannot be changed.

9.6 IP addresses

The 2D LiDAR sensors are pre-set with the following IP addresses at the factory:

Component	IP address
LMS 1	192.168.20.1
LMS 2	192.168.20.2
LMS 3	192.168.20.3

Tab. 28: Pre-set IP addresses for the 2D LiDAR sensors

10 Disposal

NOTE

The applicable local and statutory environmental regulations and guidelines for the disposal of industrial and electrical waste must be observed.

NOTE

Disposal of batteries, electrical and electronic devices.

- In accordance with international directives and regulations, batteries, accumulators, and electrical or electronic devices must not be disposed of with household waste.
- The owner is obligated to dispose of the devices at the end of their service life via the appropriate public disposal points.
- This symbol on the product, packaging, or in this document indicates that a product is covered by these provisions.

The following component groups may contain substances that need to be disposed of separately:

- **Electronics:**

  Capacitors, accumulators, batteries.
- **Displays:**

  Liquid in the LC displays.

10 DISPOSAL

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