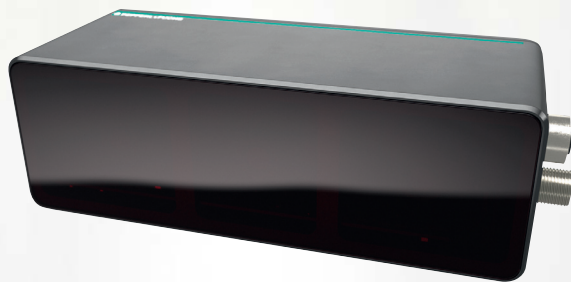


SmartRunner Measurer 3-D

3-D Stereo Sensor

Manual



With regard to the supply of products, the current issue of the following document is applicable:
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1 Introduction

1.1 Content of this Document

This document contains information required to use the product in the relevant phases of the product life cycle. This may include information on the following:

- Product identification
- Delivery, transport, and storage
- Mounting and installation
- Commissioning and operation
- Maintenance and repair
- Troubleshooting
- Dismounting
- Disposal



Note

For full information on the product, refer to the further documentation on the Internet at www.pepperl-fuchs.com.



Note

For specific device information such as the year of construction, scan the QR code on the device. As an alternative, enter the serial number in the serial number search at www.pepperl-fuchs.com/device-information.

The documentation comprises the following parts:

- This document
- Datasheet

In addition, the documentation may comprise the following parts, if applicable:

- EU-type examination certificate
- EU declaration of conformity
- Attestation of conformity
- Certificates
- Control drawings
- Instruction manual
- Functional safety manual
- Other documents

1.2 Target Group, Personnel

Responsibility for planning, assembly, commissioning, operation, maintenance, and dismantling lies with the plant operator.

Only appropriately trained and qualified personnel may carry out mounting, installation, commissioning, operation, maintenance, and dismantling of the product. The personnel must have read and understood the instruction manual and the further documentation.

Prior to using the product make yourself familiar with it. Read the document carefully.

1.3 Symbols Used

This document contains symbols for the identification of warning messages and of informative messages.

Warning Messages

You will find warning messages, whenever dangers may arise from your actions. It is mandatory that you observe these warning messages for your personal safety and in order to avoid property damage.

Depending on the risk level, the warning messages are displayed in descending order as follows:



Danger!

This symbol indicates an imminent danger.

Non-observance will result in personal injury or death.



Warning!

This symbol indicates a possible fault or danger.

Non-observance may cause personal injury or serious property damage.



Caution!

This symbol indicates a possible fault.

Non-observance could interrupt the device and any connected systems and plants, or result in their complete failure.

Informative Symbols



Note

This symbol brings important information to your attention.



Tip

This symbol brings an useful tip to your attention.



Example

This symbol provides an example of the issue described.



Action

This symbol indicates a paragraph with instructions. You are prompted to perform an action or a sequence of actions.

2 Product Specifications

2.1 Overview of Versions

This manual describes three versions of the VSM*000-F400-B12-A1000 3-D stereo sensor.

- VSM1000-F400-B12-A1000
- VSM2000-F400-B12-A1000
- VSM3000-F400-B12-A1000



Note

Terminology

The term **sensor** is used generally throughout this manual. Unless expressly stated otherwise, the descriptions refer to all three versions. Where content refers solely to a specific version, this is clearly indicated by the respective type designation.

Sensing Range

The three sensor versions differ in their sensing range. This is shown in the following diagram.

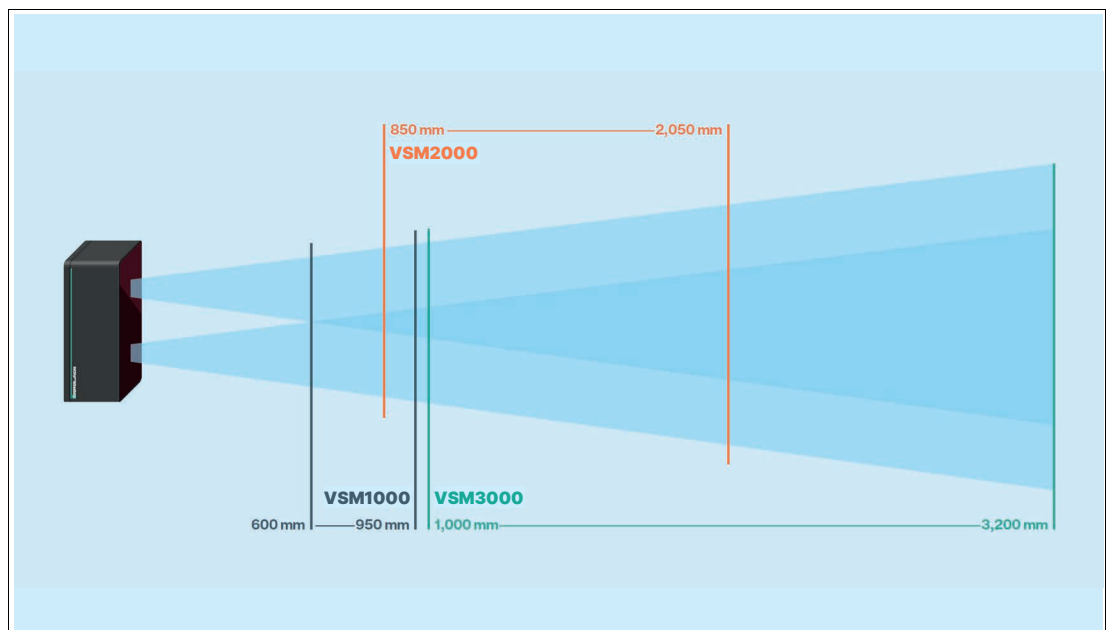


Figure 2.1 Versions and detection ranges

2.2 Use and Application

Function and data output

The SmartRunner Measurer 3-D is a vision sensor that performs precise 3-D evaluations using an integrated measuring algorithm. All data processing takes place directly in the device, eliminating the need for external image processing.

The sensor outputs the following data directly for use in your application:

Output value	Unit	Description
Rotation	°	Determines the rotation of an object through the longer side of the object relative to the x-axis.
Volume	L	Calculates the volume of a captured object.
Item	mm	Returns the coordinates of the center of an object surface.
Dimensions	mm	Determines the length, width, and height of an object.

The integrated stereo vision technology makes the sensor suitable for both static and dynamic applications. Measurements are possible at object speeds of up to 2.5 m/s.

The sensor delivers measurement results quickly and reliably and reduces the integration effort and system costs, because no additional image processing systems are required.

Rotation

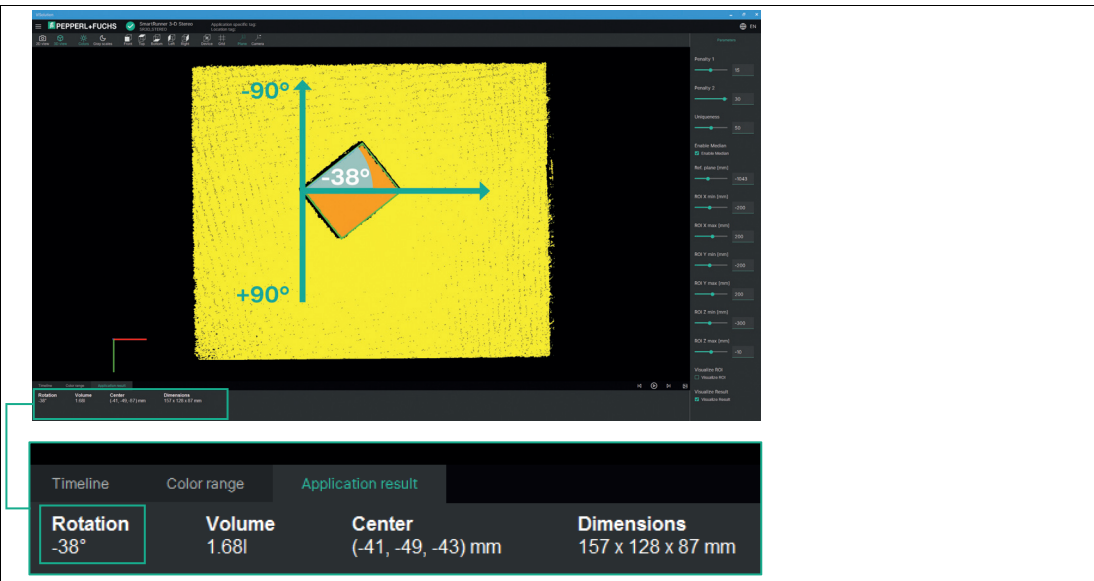


Figure 2.2

- The rotation describes the orientation of the longest object side relative to the x-axis of the sensor.
- It enables precise determination of the position of the object and is required for automated gripping and sorting processes.

Volume

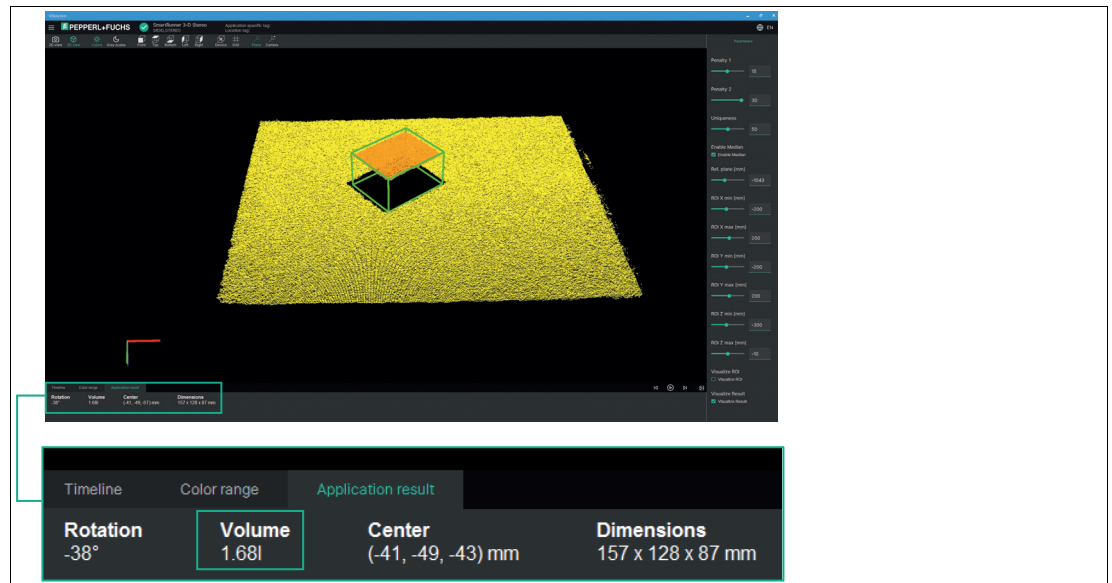


Figure 2.3

- Direct volume calculation from the 3-D point cloud.
- Captures the complete visible object surface and determines the volume as an integral part of the visible object surface.
- Enables high measurement accuracy even with complex, non-cubic object shapes.

Position (Center)

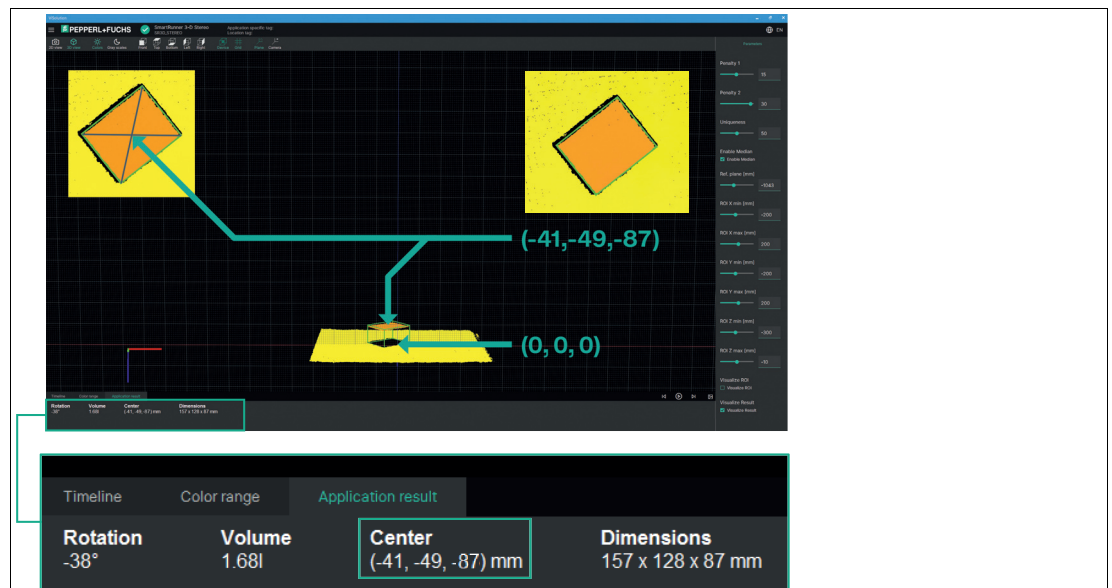


Figure 2.4

- The coordinates of the object center point describe the exact position of the object in the coordinate system.
- They serve as a reference for robot, operating, and quality inspection systems.

Dimensions (Dimensions)

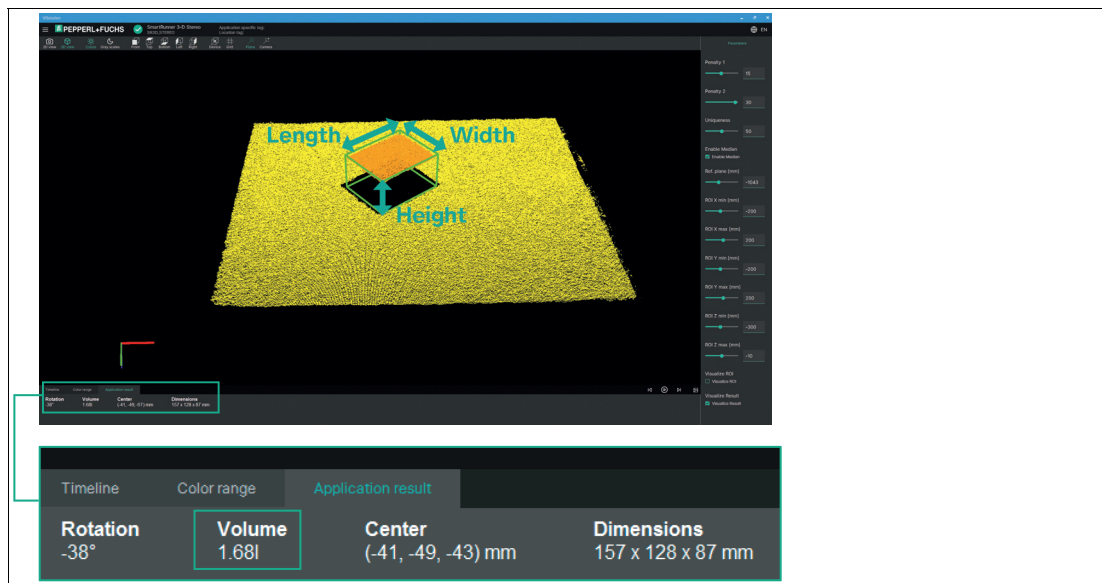


Figure 2.5

- Length, width, and height are determined by the smallest possible bounding box.
- Enables reliable measurement and comparison even with irregular object shapes.

How stereo vision technology works

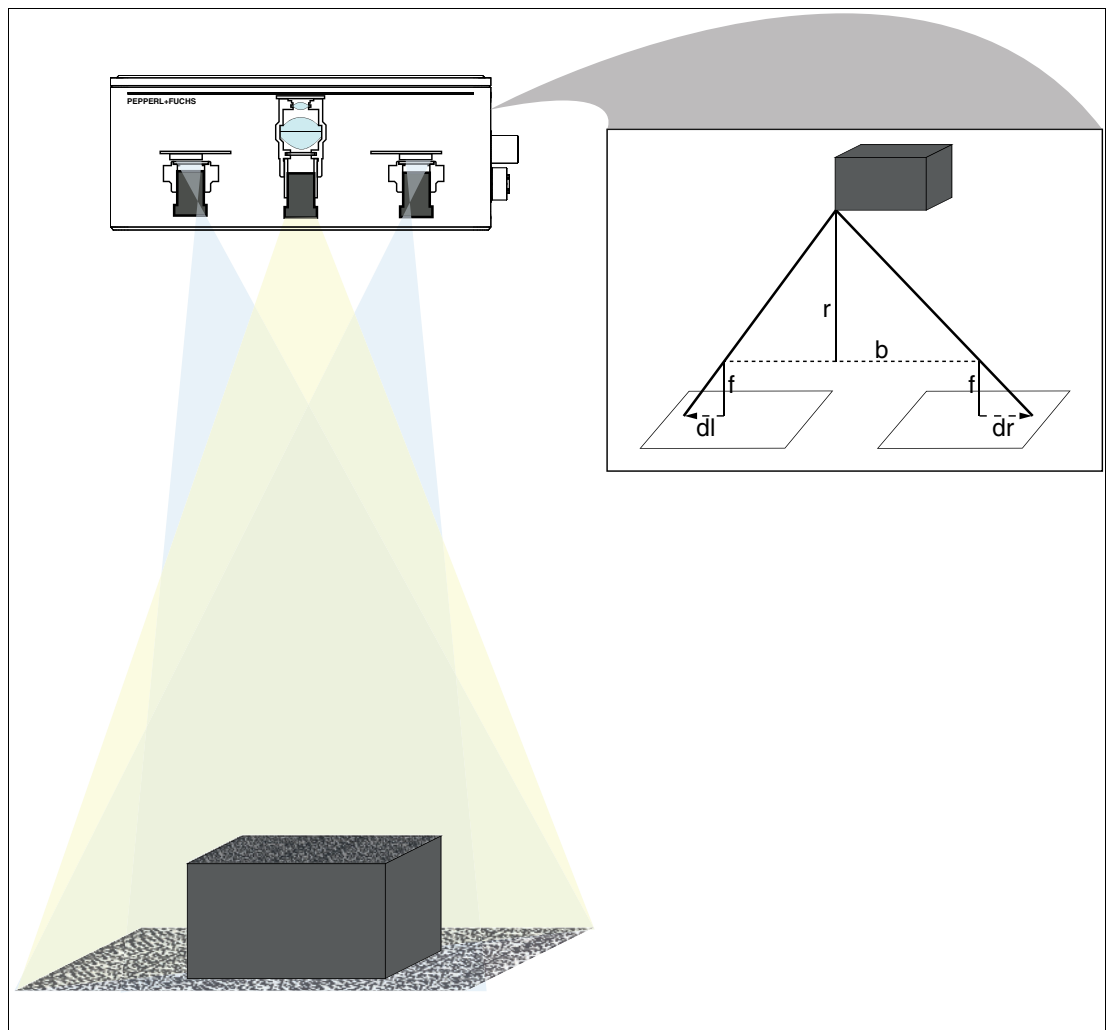


Figure 2.6 A sketch representing how it works

The two single cameras, which are offset, capture images of the same situation at the same time. The disparity, or offset, between the two images is calculated. The disparity (d), the focal length (f), and the base length (b) are used to create a depth in the image based on the geometric principle of triangulation.

1st Step: Capture two images from different positions.

2nd Step: Find matches between the two images.

3rd Step: Create a depth image.

The sensor is connected to a PC via a Gigabit Ethernet network.

Typical Applications

Optimized Palletizing

The sensor is ideal for automating palletizing processes. Precise data acquisition and processing directly in the sensor ensures efficient material handling.

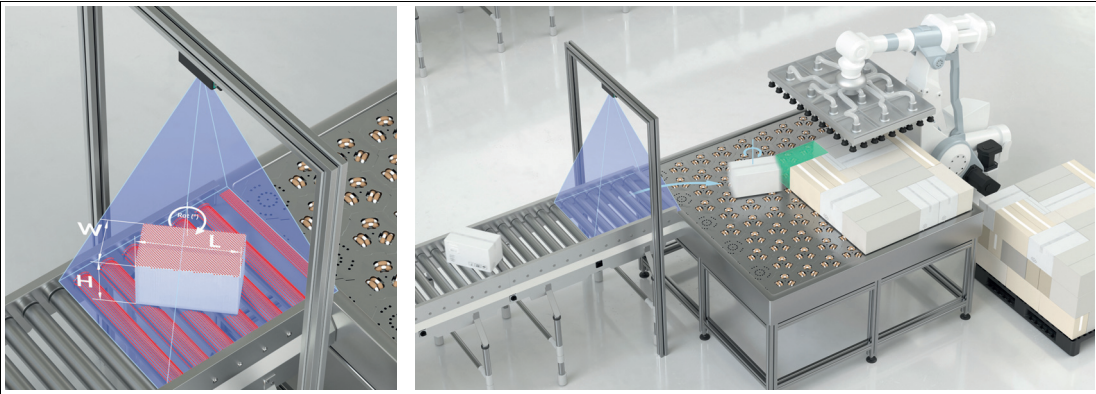


Figure 2.7

The process can be divided into the following steps:

Process step	Description
1. Object Detection	The sensor accurately detects the 3-D dimensions and the exact rotation of each individual package fed to the robot.
2. Position calculation	This data is used to calculate the optimum orientation and the exact transfer position for the palletizing robot.
3. Layering	The exact positioning of the packages enables even layering and therefore ensures highly stable pallet stacks.
4. Process integration	The seamless integration of the sensor into the robot's control system ensures reliable and fully automatic material handling.

Efficient Sorting Systems

The sensor optimizes automated sorting systems in logistics centers by ensuring a smooth material handling and efficient system control.

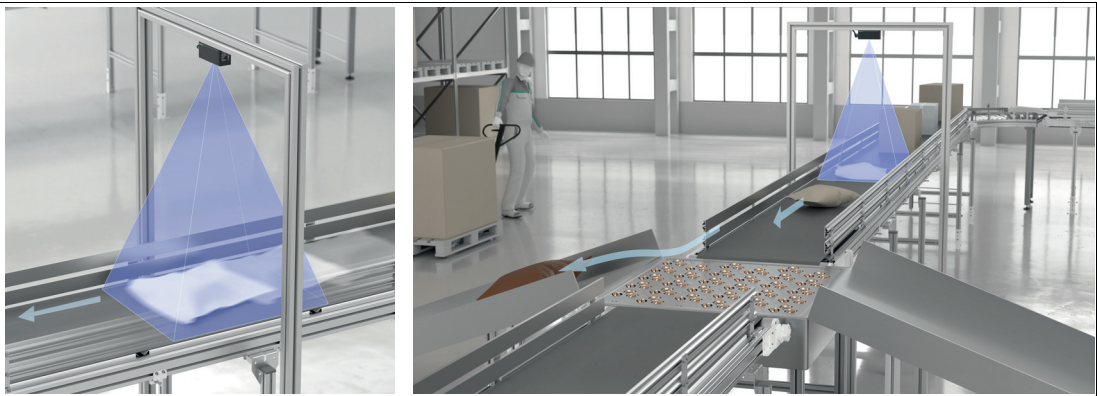


Figure 2.8

The process is designed for speed and reliability:

Process step	Description
1. Dynamic 3-D detection	The sensor accurately detects passing packages and irregularly shaped polybags in the automated flow of goods.
2. Integrated data calculation	Immediately after detection, the sensor calculates the exact volume and dimensions of each individual object directly in the device.
3. Automatic assignment	The finished measurement data is immediately transferred to the sorting system, which categorizes the objects and assigns them to the correct target ejector.

Dynamic Gripping

The sensor enables robot systems to grip objects directly from a running conveyor belt.



Figure 2.9
The procedure is as follows:

Process step	Description
1. Measurement in motion	As packages move at speeds of up to 2.5 m/s on a roller conveyor, the sensor accurately detects their size, position, and rotation.
2. Dynamic gripping point calculation	The data is transferred to the robot system.
3. Precise placement	After the successful gripping process, the robot places each package exactly at the intended position, for example on a pallet for further processing.

2.3 Security Information

General

- Regularly check the manufacturer portal for cybersecurity alerts at <https://www.pepperl-fuchs.com/cybersecurity>.
- Report all cybersecurity incidents to the manufacturer.
- To protect devices, machines, systems, technical infrastructure, and networks against cyber threats, a comprehensive cybersecurity concept is required from the operator, which must be continuously monitored and maintained. For general recommendations, visit <https://www.bsi.bund.de/dok/6603576>.

Security Context

This device is intended for operation in an automation network. This is a secure network with known and trusted participants that is separated (physically or logically) from the company network.

Do not connect the device directly to the internet. Operate the device in a protected network area. Use a firewall when connecting the internal protected network to external networks. Configure them with restrictive rules.

Available protocols and services

Protocol/ Service	Protocol/ Port number	Factory setting	Service status can be configured	Notes
DHCP	UDP/68	Enabled	No	Only in rescue mode
HTTP	TCP/80	Enabled	No	Only in rescue mode
VSX/Discovery	UDP/50004 UDP/50005	Enabled	No	
Modbus	TCP/502	Deactivated	Yes	

Protocol/ Service	Protocol/ Port number	Factory setting	Service status can be configured	Notes
VSX/Parameter	TCP/50005 (unencrypted) TCP/50105 (encrypted)	Enabled	See notes	During commissioning, you can select whether the parameter channel should be encrypted and password-protected.
VSX/Results	TCP/50010 (unencrypted) TCP/50110 (encrypted)	Enabled		Self-generated certificates The device generates self-signed TLS certificates based on EC secp384r. Encryptions TLSv1.2 is supported. The supported encryption suites are: • TLS_ECDHE_ECD-SA_WITH_AES_128_GCM_SHA256 • TLS_ECDHE_ECD-SA_WITH_AES_256_GCM_SHA384 • TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256 • TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384 • TLS_ECDHE_ECD-SA_WITH_AES_128_CM • TLS_ECDHE_ECD-SA_WITH_AES_256_CM • TLS_ECDHE_ECD-SA_WITH_AES_128_CM_8 • TLS_ECDHE_ECD-SA_WITH_AES_256_CM_8 Recommendation: The presence of a self-signed certificate does not protect against so-called man-in-the-middle attacks. To prevent this, it is recommended that the sensor is commissioned in an isolated network and that the certificate received from the sensor is saved. This certificate can then be compared with the certificate used for the connection when further connection is established. Deviations may indicate attacks.

2026-04

Hardening of the device

- Physically protect the device and application from unauthorized access.
- Deactivate any services that are not required.
- Ensure that all passwords and user-generated private keys are protected from unauthorized access.
- Avoid reusing passwords for different users and systems.
- Replace passwords, certificates, and keys as soon as you identify potential vulnerabilities.
- Renew certificates regularly.
- Change passwords regularly.
- Use a suitable password manager to create and store passwords.
- Verify that the certificate used by the device does not change.

Security functions

- The device is protected against brute force attacks to prevent unauthorized access by password guesses.
- The device implements a session timeout to automatically disconnect connections after a specified period of inactivity.
- The device is shipped in a setup mode that initially requires you to set a password or disable password protection.

User Roles and Rights

The VSX interface of the device has the following user roles and rights.

User profile	Username	Permissions	Factory Settings	Comment
Administrator	admin	No restrictions	Enabled	Standard user

- No further user profiles can be defined or users can be created.
- The rights and names of the existing users cannot be changed.
- During commissioning, it is possible to switch off encryption and password protection for the result channel or for both the result channel and the parameterization channel.

Firmware

Use firmware from trusted sources only. Keep the software up to date. Always use the latest device firmware/software version. Regularly check <https://www.pepperl-fuchs.com> to check whether security updates are available for the products and install them. After a new version is released, older versions are no longer supported and maintained.

Decommissioning

Reset the device to factory settings. Please note that passwords and other data reset in this way may be able to be recovered using forensic data recovery. To rule out this possibility, the memory modules of the sensor must be physically destroyed.

2.4 Symbols on the Sensor

Overview of Labeling



Figure 2.10 Overview of labeling

Nameplate



Figure 2.11 Nameplate

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The nameplate provides the following information:

- Part number
- CE marking
- MAC ID: 00-0D-81-0B-66-A8
- Standard IP: 192.168.2.4
- Serial number: 40000049969849
- Manufactured 02/2020 Mannheim
- UL marking
- Class 2 power source
- UB = 24 V $\pm$ 10 %
- IB = 500 mA
- P0 = 12 W
- Made in Germany 07
- 68307 Mannheim, Germany
- www.pepperl-fuchs.com
- Crossed-out garbage can symbol

Disposal



Figure 2.12 Disposal

Devices marked with this symbol must not be disposed of with household waste. These devices must only be disposed of by specialist companies approved at the operating location.

Hot Surface



Figure 2.13 Hot surface

This label indicates a possible risk of burns from hot surfaces. Exercise the necessary caution when touching the sensor in this area.

2.5 Dimension Drawing

The housing of the SmartRunner 3-D Stereo has the following dimensions.

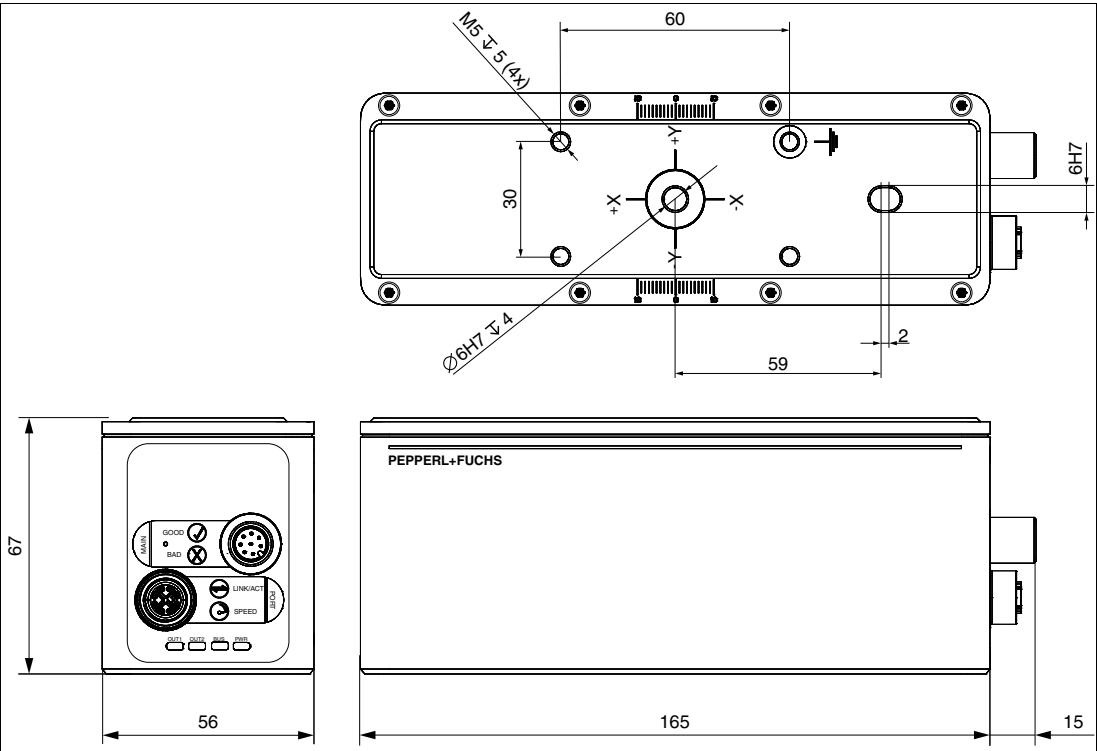


Figure 2.14 Aligning the sensor
All dimensions in mm.



Note
Further technical data can be found on the datasheet for the sensor. You will find the datasheets on our website.

2.6 Display Elements

The sensor has eight LEDs that signal various operating states or events.

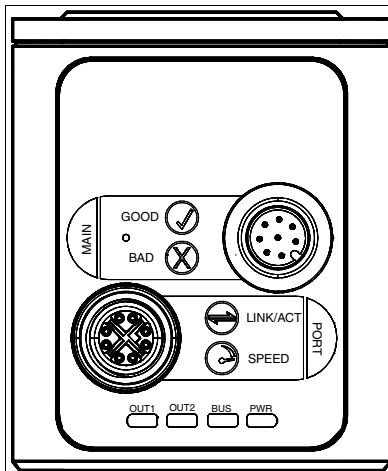


Figure 2.15 Display elements

Designation		LED color	Description
MAIN	GOOD	Green	Reserved
	BAD	Red	Reserved
PORT	LINK/ACT	Yellow	The LED flashes at short intervals when bus data is being exchanged.
	SPEED	Green/yellow	- No connection or 10 MBit connection—LED off 100 MBit connection—LED lights up yellow 1 Gbit connection—LED lights up green
Operating mode	OUT1	Green/yellow	Reserved
	OUT2	Yellow	The OUT2 LED flashes once briefly when a new evaluation starts.
	BUS	-	No function
	PWR	Red	- The LED lights up red when the sensor restarts or is in update mode. - The LED lights up red in the event of a system-related malfunction.

2.7 Accessories

Model number	Description
LTGLÜT 24V 2xM12 Xm 8pol ROB	M12 plug, 8-pin, straight, to M12 socket, 8-pin, straight, A-coded, 360° shielding, self-locking screw connection, PUR cable, torsion-proof, shielded, halogen-free
V19SX-G-GN5M-PUR-ABG-V45-G	Bus cable, Ethernet, M12 plug, X-coded, 8-pin to RJ45, Ethernet-coded, 8-pin, PUR cable, green, Cat6A, shielded
V19-G-BK1.5M-PUR-U/ABG	Single-ended female cordset, M12, straight, A-coded, 8-pin, PUR cable, black, shielded, UL-approved

Additional accessories can be found online at www.pepperl-fuchs.com.

3 Installation

3.1 Storage and Disposal

Keep the original packaging. Always store and transport the device in the original packaging. Store the device in a clean and dry environment. The permitted ambient conditions must be considered, see datasheet.

The device, built-in components, packaging, and any batteries contained within must be disposed in compliance with the applicable laws and guidelines of the respective country.

3.2 Preparation



Unpacking the Device

1. Check the packaging and contents for damage.
↳ In the event of damage, inform the shipping company and notify the supplier.
2. Check the package contents against your order and the shipping documents to ensure that all items are present and correct.
↳ Should you have any questions, direct them to Pepperl+Fuchs.
3. Retain the original packaging in case the device is to be stored or shipped again at a later date.

3.3 Mounting



Note

Mounting the Sensor

To obtain reliable measurements, follow these instructions when mounting:

- Protect the sensor against direct and prolonged sunlight.
- Do not point the sensor into the sun.
- Prevent condensation from forming by ensuring that the sensor is not subjected to any major temperature fluctuations.
- Avoid placing objects in the scene that are not part of the target shot, especially mirrors or other shiny surfaces/objects.
- Avoid placing the sensor flat in the middle of a surface.
- Keep the glass on the device clean. Use soft cloths and standard glass cleaner to clean the device if necessary.
- Maintain a stable housing temperature during operation.
- Secure the sensor.

We recommend that the optical surfaces are cleaned, and that screws and electrical connections are checked, at regular intervals.

The surface must be level to prevent the housing from becoming misaligned when the fittings are tightened. Ensure that there is still sufficient space to connect the connection cable to the sensor once the sensor is mounted.



Caution!

Damage to the equipment caused by improper mounting!

Device components can be damaged if the permissible screw-in depth and the maximum permissible tightening torque is exceeded.

Note that the threads on the rear of the housing are not thru-holes.

Observe the maximum permissible screw-in depth of 5 mm to avoid damaging the device or mounting it incorrectly.

Never exceed the maximum permissible tightening speed for the fixing screws. The maximum tightening torque of the fixing screws must not exceed 2 Nm.



Note

Positioning the Sensor

The sensor has two reference bores on the rear of the housing with a diameter of 6 mm and a depth of 3.5 mm. One of these bores is located in the exact center of the sensor. The other bore is designed as a slot to prevent over-specification.



Securing the Sensor

The sensor has 4x M5 threads on the rear of the housing to ensure simple and stable mounting in your plant.

1. Carefully place the sensor in the desired location in your plant. Make sure that the M5 threaded bushings on the sensor are correctly aligned with the corresponding bores or tapped holes on the plant.
2. Turn the M5 screws clockwise by hand to ensure that they engage with the threads.



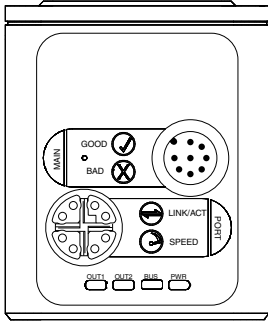
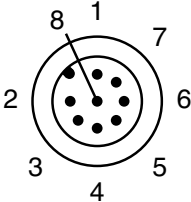
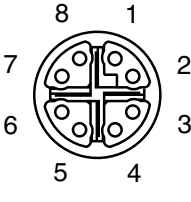
Note

One of the four fixing screws is not anodized, so it can be used to ground the device.

3. Tighten the M5 screws using the screwdriver. To prevent damage to the thread or sensor, do not overtighten the screws. The maximum tightening torque is 2 Nm.
4. Finally, check that the sensor is securely and firmly attached to your plant. Make sure that the connection is not loose and there is no play.

3.4 Electrical Connection

Connection Assignment

	MAIN	
	M12 plug, A-coded, 8-pin	
		1. IN trigger 2. + UB 3. nc 4. nc 5. nc 6. nc 7. GND 8. nc
	PORT	
	M12 socket, X-coded, 8-pin	
		1. MDX0+ 2. MDX0- 3. MDX1+ 4. MDX1- 5. MDX3+ 6. MDX3- 7. MDX2+ 8. MDX2-



Connecting the Supply Voltage

The sensor is connected electrically via an 8-pin M12 **MAIN** connector plug on the front of the housing. The power is supplied via this connection. To connect the sensor, proceed as follows:

- 1. Plug the M12 8-pin socket into the plug on the front of the housing.
- 2. Screw the union nut onto the connector until it reaches the end stop. This ensures that the power cable cannot be pulled out inadvertently.

3.5 Setting up Windows Network Communication between the Sensor and a PC/Laptop

When the sensor is delivered, it has a fixed IP address: **192.168.2.4**. To enable communication within the network, the network settings of your PC/laptop must be synchronized with the sensor and may need to be adjusted. To do so, proceed as follows:



Note

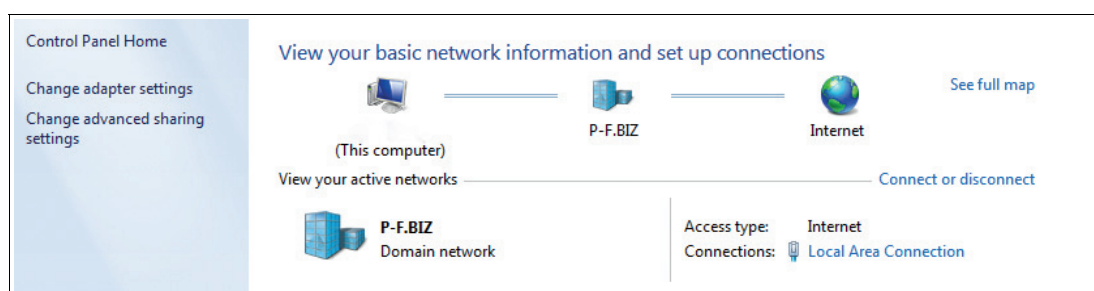
Due to the large amount of data supplied by the sensor per second, the sensor(s) must be connected to the PC via a Gigabit Ethernet network without any other interfering data traffic.



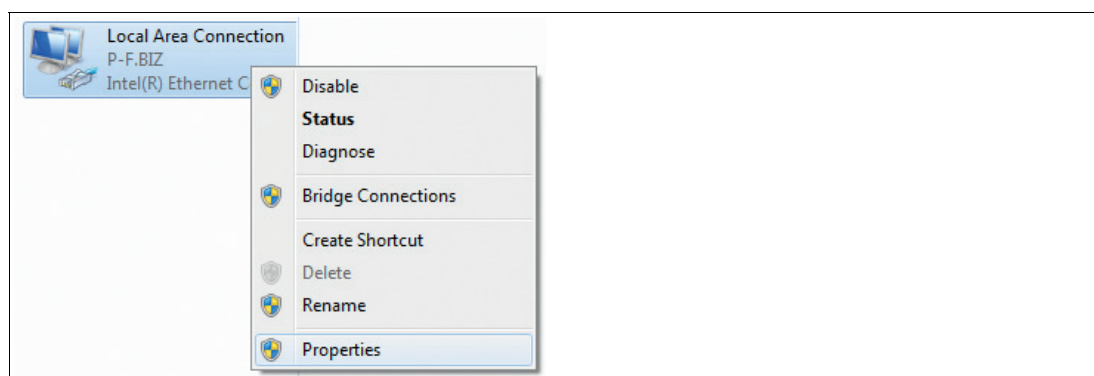
Setting the IP Address

The following section describes how to check the network connection settings of your Windows PC and adapt them accordingly. The illustrations in this description were created using Windows 7. The description below also applies to later versions of Windows.

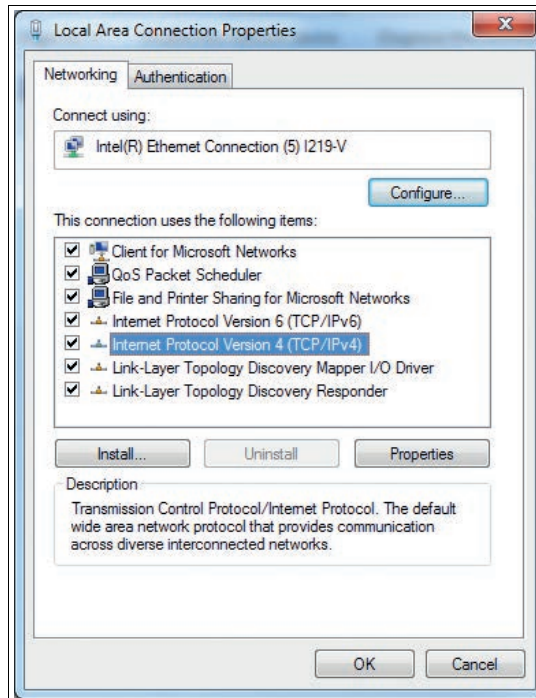
1. Click the Windows **"Start"** button.
2. Select **"Control Panel > Network and Sharing Center."**
3. Click **"Change adapter settings."**



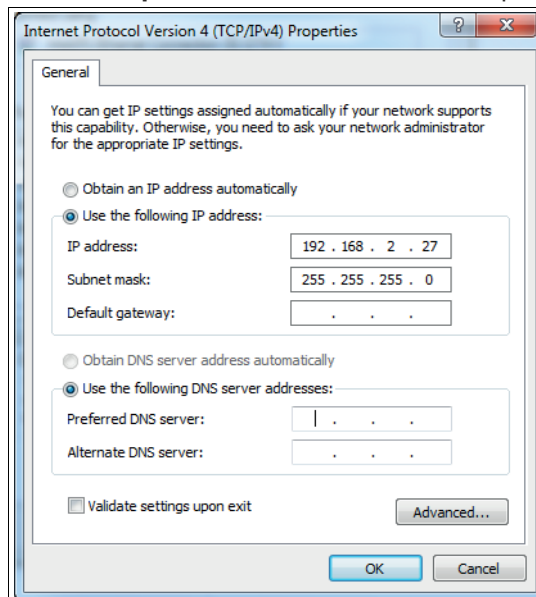
4. Select the required connection and right-click on your selection. In the selection window, select **Properties**.



5. Double-click **"Internet Protocol Version 4 (TCP/IPv4)."**



→ The **Properties** window for the TCP/IP protocol opens.



6. Select the **"General"** tab.
7. Select the input function **"Use the following IP address."**
8. Enter the IP address of the sensor, but only the first three segments of the IP address. The last segment must be different from the IP address of the sensor.
9. In this example, enter the following IP address and subnet mask:
 - **IP address: 192.168.2.27**
 - **Subnet mask: 255.255.255.0**
10. Click **OK** and click **Cancel** in the next dialog.

→ This completes the network configuration so that the device can be used.

**Note**

Changes to the network settings of the PC/laptop require advanced user rights. If necessary, consult with your administrator.

3.6**Access Protection**

To establish communication with the sensor, the desired access protection must be specified once.

**Note**

After the access protection is selected, it can only be subsequently changed by completely resetting the sensor. see chapter 7.2.4

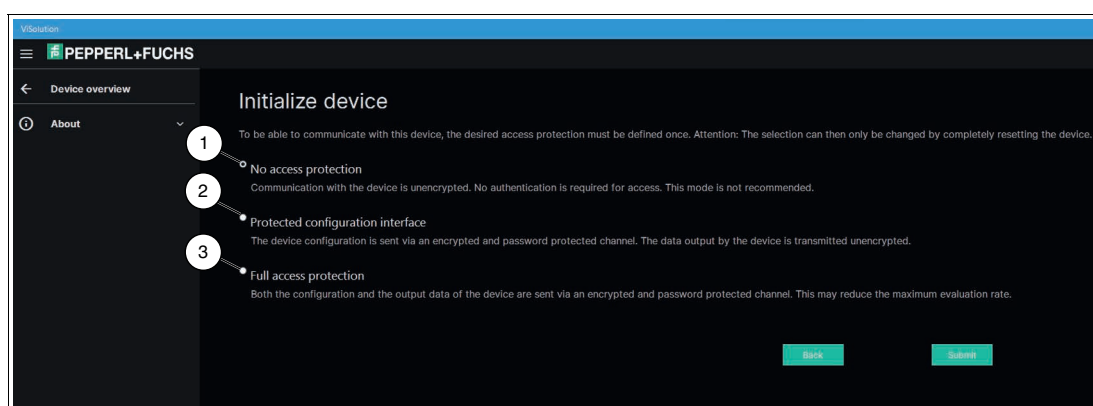
Access Protection Options

Figure 3.1

1. No access protection
 - Communication with the sensor is unencrypted.
 - No authentication is required for access.
 - **Recommendation:** This setting is not recommended for safety reasons.
2. Protected configuration interface
 - The sensor configuration is transmitted via an encrypted and password-protected channel.
 - The data output by the sensor is transmitted unencrypted.
3. Full access protection
 - Both the configuration and the output data of the sensor are sent via an encrypted and password-protected channel.
 - **Note:** This option can reduce the maximum evaluation rate.

Setting Up Access Protection

The login information must be defined before setting up the access protection. This will be used to log in to the sensor in the future.

- **Username:** The username is set to "**admin**" and cannot be changed.
- **Password:** The user sets their own password.

Initial password

To complete the access protection setup, initial login data must be set. These are required to be able to log in to the device in future. The user name is set to "admin" for this purpose. A password can be freely selected.

WARNING: Please remember your password for the future. Without your password, it will no longer be possible to connect to the device.

User name
admin ✓

Password
Password ✗

Please enter an initial device password.

Confirm password
Confirm password ✗

Please confirm initial device password.

Back Submit

Figure 3.2



Note

Please make a note of the password and keep it in a safe place. The sensor cannot be accessed without the password.

4 Commissioning

Overview of the commissioning steps:

1. Mount the sensor, see chapter 3.3
2. Establish the electrical connection, see chapter 3.4
3. Set up Windows network communication between the sensor and a PC/laptop, see chapter 3.5
4. Configure the sensor using the ViSolution configuration software, see chapter 7

5 Configuration

5.1 Parameters (Features)

Before the sensor can be used in the system, it must be parameterized. The features (parameters) used for the sensor are listed below.

The "read (r)/write (w)" column indicates whether the feature is readable ("r"), writable ("w"), or both ("r/w").

Evaluation Settings

Feature Name	Data Type	Read(r)/write(w)	Value		enum Values/ Default String Value	Description
			Min	Max		
Ref. plane	float	-	-5000	5000	-	Distance of reference plane: Z translation of reference plane to sensor
Ref. plane angle X	float	-	-45	45	-	Angle of the ref. plane relative to the x-axis
Ref. plane angle Y	float	-	-45	45	-	Angle of the ref. plane relative to the y-axis
Height averaging	bool	-	-	-	-	Average determination for the height instead of the highest point
Foreground threshold	uint	-	1	5000	-	Z threshold value for valid data points relative to the reference plane: Noise points are excluded
ROI X min	float	-	-2000	2000	-	ROI relative to the reference plane
ROI X max	float	-	-2000	2000	-	ROI relative to the reference plane
ROI Y min	float	-	-2000	2000	-	ROI relative to the reference plane
ROI Y max	float	-	-2000	2000	-	ROI relative to the reference plane
ROI Z min	float	-	-3000	3000	-	ROI relative to the reference plane
ROI Z max	float	-	-3000	3000	-	ROI relative to the reference plane
Output data format	enum	-	-	-	DisparityC DisparityCAndRectified Result only	Specifies the content for the output data
Visualize ROI	bool	-	-	-	-	Generate ROI as a cube for visualization
Visualize Result	bool	-	-	-	-	Create the bounding box of the object for visualization

Capture Settings

Feature Name	Data Type	Read(r)/ write(w)	Value		enum Values/ Default String Value	SFNC 2.6	Description
			Min	Max			
Trigger source	enum	-	-	-	Auto trigger Hardware trigger Software trigger	-	Specifies the internal signal or physical input line to be used as the trigger source.
Autotrigger frequency	float	-	1	10	-	-	Controls the capture rate (in hertz) at which the images are captured. Frame rate in Hz (Autotrigger)
Trigger enabled	bool	-	-	-	-	-	Defines whether the sensor can be triggered.
Hardware trigger event	enum	-	-	-	Falling Edge Rising Edge	-	Specifies the trigger activation mode.
Exposure time	uint	-	10	10,000	-	-	Specifies the exposure time (in ms)
Gain	uint	-	0	480	-	-	Amplification of light sensitivity in 1/10 dB
Light source	enum	-	-	-	None Onboard LEDs Projector	-	Light source to be used
Penalty 1	uint	-	1	30	-	-	Tuning parameter (effort to smooth a disparity jump of 1 in the output)
Penalty 2	uint	-	2	31	-	-	Tuning parameter (effort to smooth a disparity jump of more than 1 in the output)
Uniqueness	uint	-	0	100	-	-	Tuning parameter (maximum relative effort for the best disparity compared to the second best disparity, in percent)
Median filter	bool	-	-	-	-	-	Allows media filtering of the output disparity card
Binning mode	enum	-	-	-	None 2x2	-	Full sensor resolution is used Pixels are grouped together: Smoothing and reduced amount of data

5.2 VsxProtocolDriver

General

The **VsxProtocolDriver** is used to facilitate creating a graphical user interface for sensors that use the VSX protocol. It handles connection to and communication with the sensor and provides related functions, for example, for setting, querying, or saving parameters. It can also receive sensor data, such as images.

The driver is implemented in C#.

Documentation is automatically generated for the driver, which is included in the Driver-Package.

A "DynamicContainer" received by the sensor may contain the following Messages:

TagName	Type	Status	Description
"LeftRectified"	ImageData2[Mono8]	Optional	Corrected image from the left camera
"RightRectified"	ImageData2[Mono8]	Optional	Corrected image from the right camera
"DisparityC"	ImageData2 [Coord3D_C16]	Optional	Disparity map
"DisparityDesc"	DisparityDescriptor	Optional	Required for disparity image
"CalibratedA" ¹	ImageData2 [Coord3D_A16]	Optional	X level of the calibrated grid
"CalibratedB" ²	ImageData2 [Coord3D_B16]	Optional	Y level of the calibrated grid
"CalibratedC" ³	ImageData2 [Coord3D_C16]	Optional	Z level of the calibrated grid
"Transformation"	Transformation	Optional	Transformation of XYZ
"Result"	XML text	Optional	Message with the results of the application

1. The three layers "CalibratedA," "CalibratedB," and "CalibratedC" are not sent on the device side. The "ProcessDeviceData" function (VsxDynamicContainerMessage container) generates these three messages and calculates the respective level of the "PointCloud."
2. The three layers "CalibratedA," "CalibratedB," and "CalibratedC" are not sent on the device side. The "ProcessDeviceData" function (VsxDynamicContainerMessage container) generates these three messages and calculates the respective level of the "PointCloud."
3. The three layers "CalibratedA," "CalibratedB," and "CalibratedC" are not sent on the device side. The "ProcessDeviceData" function (VsxDynamicContainerMessage container) generates these three messages and calculates the respective level of the "PointCloud."

6 MODBUS Communication

Modbus TCP principles

Modbus is an application protocol (application layer) and enables communication in the client/server model between devices in different networks. It operates on the basis of the request/response principle, whereby the services are defined via function codes.

More information: modbus.org

Modbus TCP uses the Modbus protocol over TCP/IP.

- Standard port: 502
- Transmission via standard Ethernet hardware and software
- Exchange of process data (I/O) and diagnostic information

The SmartRunner Measurer 3-D only provides the server functionality.

Client (for example PLC, robot, gateway):

- Establishes a TCP connection to the server (port 502)

Server (sensor – SmartRunner Measurer 3-D application):

- Waits for incoming connections (port 502)

Supported Modbus function codes

The following function codes are supported:

- (4) Read Input Registers
- (6) Write Single Holding Register
- (16) Write Multiple Holding Registers
- (3) Read Multiple Holding Registers (optional)

Reference: <https://www.modbus.org/modbus-specifications>

Trigger modes

The SmartRunner Measurer 3-D supports three trigger modes:

Software Trigger

- Requirement: **TriggerSource = Software**
- Triggering is performed by the client via Modbus TCP
- For details, see the "Software Trigger" sequence

Hardware Trigger

- Requirement: **TriggerSource = Hardware**
- Trigger is initiated via an external signal (for example PLC, light barrier, optical sensor)
- The signal is routed directly to the corresponding I/O pin of the sensor
- The advantage is less delay between trigger and image capture

Auto Trigger

- The sensor continuously captures images at a defined frequency and continuously calculates results
- Use with external trigger sources (for example light barriers) is not recommended.

Register overview

Input register (Sensor >> Client)

- Access via function code (4) Read Input Registers
- Address range: 3xxxx (Modbus 984 diagram)

Address	Name	Unit	Value range	Type	Description
0x0000	Status Register	-	-	16-bit	Status Bits See the bit structure in the following table
0x0001	Volume	1/100 l	0 ... 65535	uint16	-
0x0002	Center x	1 mm	-32768 ... 32767	int16	Coordinates of the surface center point relative to the reference plane
0x0003	Center y	1 mm	-32768 ... 32767	int16	-
0x0004	Center z	1 mm	-32768 ... 32767	int16	-
0x0005	Rotation	1/100°	-9000 ... 9000	int16	Rotation relative to the positive x-axis
0x0006	Dimension "length"	1 mm	0 ... 65535	uint16	length ≥ width
0x0007	Dimension "width"	1 mm	0 ... 65535	uint16	length ≥ width
0x0008	Dimension "height"	1 mm	0 ... 65535	uint16	-
0x0009	Frame counter	-	0 ... 65535	uint16	The last 16 bits of the internal frame counter

Bit structure status register (0x0000)

Bit	Name	Description
0	Trigger ACK	Confirmation of the software trigger
1	Results Available	New results available
2 ... 7	Reserved	Reserved
8 ... 15	Result Code	• Bit0: 1 = Found, 0 = Not found • Bit 1–7: reserved

Holding Register (Client >> Sensor)

- Access via function codes (6), (16), and optional (3)
- Address range: 4xxxx (Modbus 984 diagram)

Address	Name	Type	Description
0x0000	Status Register	16-bit	Control bits See the bit structure in the following table

Bit structure holding register (0x0000)

Bit	Name	Description
0	Trigger	Only if TriggerSource = Software: 0 >> 1 (rising edge) triggers a sensor software trigger
1	Results ACK	Acknowledge the results
2 ... 15	Reserved	Reserved

Sequence processes

Software Trigger

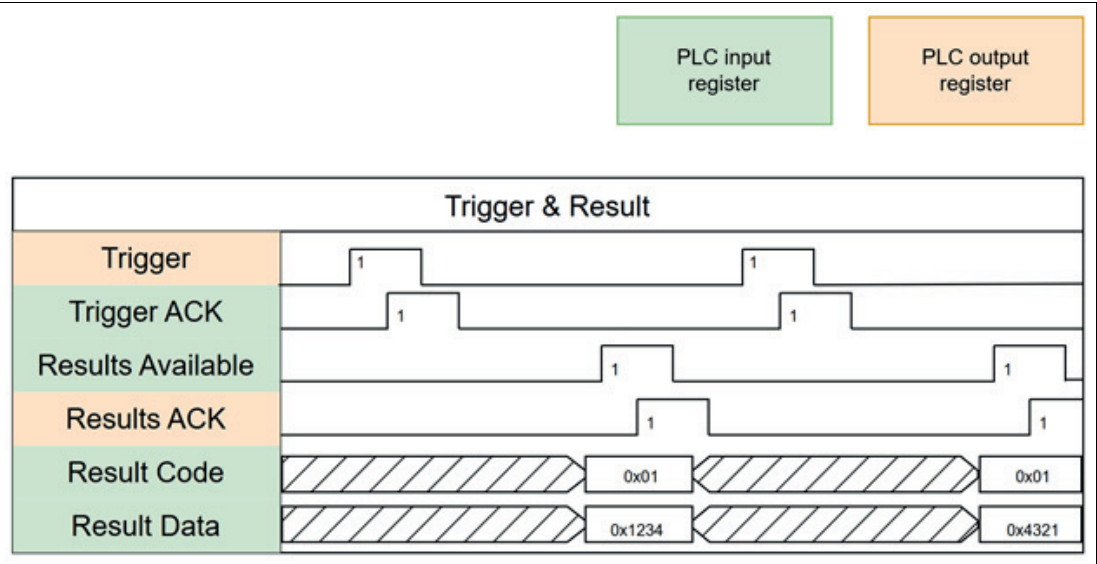


Figure 6.1

Hardware Trigger

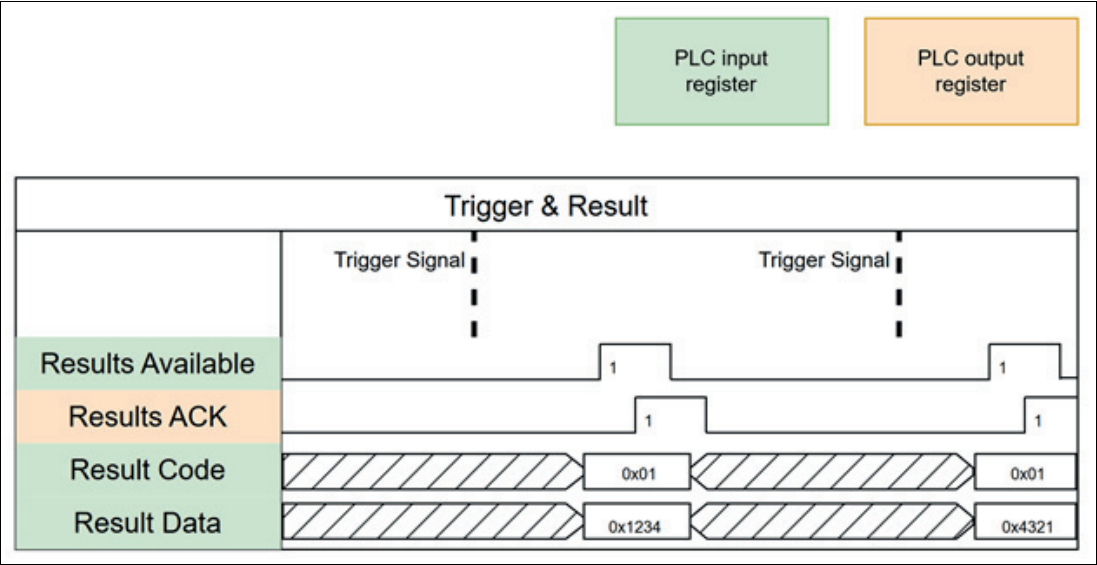


Figure 6.2



Note

Data update

The sensor only updates the result data after **Results ACK** has been reset to 0. If the sensor is triggered again before the previous results have been acknowledged, only the last result generated is saved.

7 Operation with ViSolution

The **ViSolution** software can be used to configure sensor parameters, evaluate measurement results, and visualize recordings. The software is also very helpful when commissioning the sensor, for adjusting camera parameters such as the exposure time.

The user interface offers various options for displaying the measurement results and image data. You can also save image data to a file for later use. You can change the settings for the sensor and immediately see how the changes affect the measurement result. The user interface is therefore useful for determining the best parameter settings for a particular application.

After the sensor has been set up to provide measurement data, the settings can be saved to a parameter file on the PC.

To do this, you must have the **ViSolution** configuration software installed on your PC/laptop. This configuration software for a PC/laptop can be downloaded free of charge from www.pepperl-fuchs.com.

7.1 Establishing a Connection to the Sensor

After starting the ViSolution software, the following "Device overview" window is displayed:

Device Overview

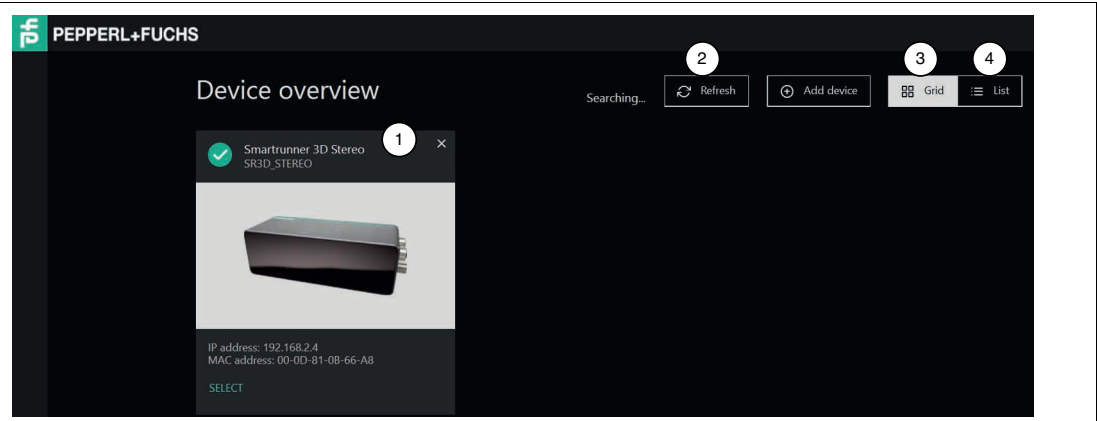


Figure 7.1 Device overview

Position	Designation	Function
1	Device overview	All identified sensors are displayed here. You will also receive information about the sensor. • Name of the sensor • Sensor type • IP address of the sensor • MAC address of the sensor SELECT is highlighted in green for sensors to which a connection can be established; if no connection can be established, SELECT is grayed out. If the list contains multiple sensors, you can use the SELECT button to select the sensor that you wish to connect to.
2	Refresh	You can use the "Refresh" button to start a sensor search.
3	Grid	You can use the "Grid" button to change the way the sensors found are displayed. If you select "Grid," the sensors found are displayed as tiles.
4	List	You can use the "List" button to change the way the sensors found are displayed. If you select "List," the sensors found are displayed in a list.

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Selecting a Sensor

1. Click the button highlighted in green **SELECT** for the sensor that has been found.

↳ A connection to the sensor is established. The main screen of the software opens.

If your sensor is not recognized in the device overview, connect your sensor as follows:

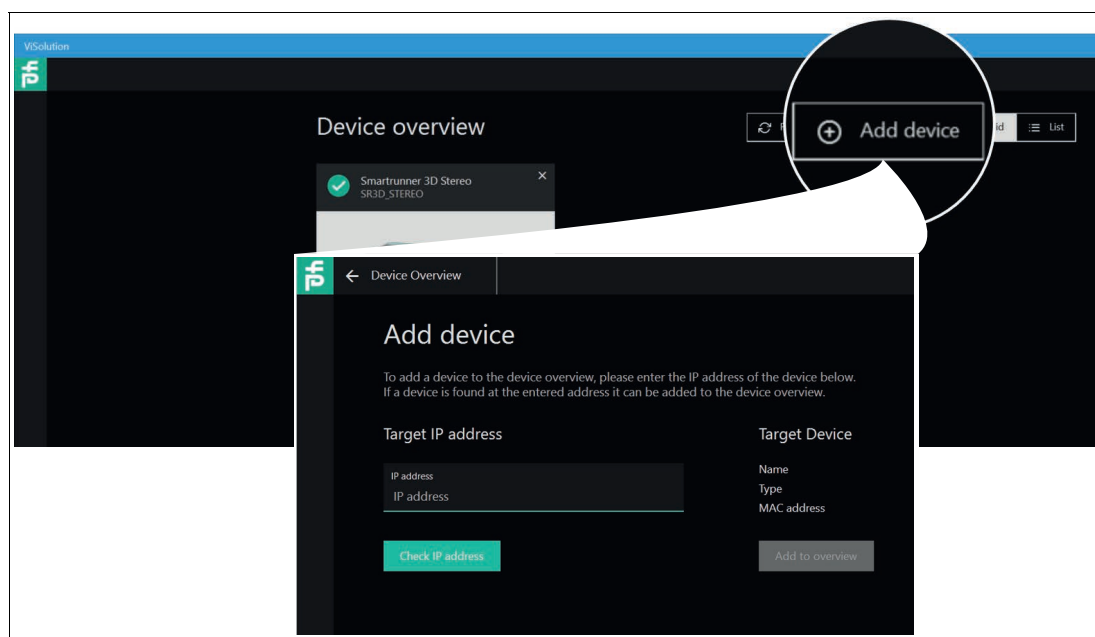


Figure 7.2 Device overview



Finding a Sensor

This function can be used to search for connected sensors. Proceed as follows:

1. Ensure that the sensor and the PC/laptop are ready for operation and that there is an Ethernet connection.
2. Click the "Add device" button to search for sensors.

↳ The "Add device" input window opens.

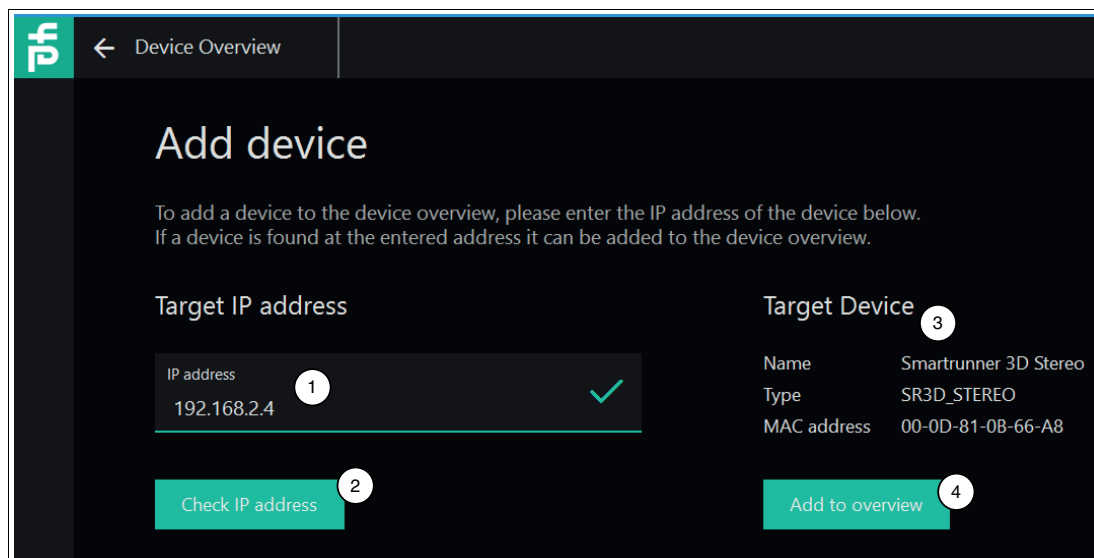


Figure 7.3 Entering the IP address

3. Enter the IP address of your sensor in the "Target IP address" input field (1). The default IP address of the sensor can be found on the device.
4. Click the "Check IP address" button (2) to search for the device with the entered IP address.
 - ↳ A green check mark in the search field indicates that the device with the entered IP address has been found. In addition, the following information on the sensor is displayed under "Target Device" (3):
 - Name of the sensor
 - Sensor type
 - MAC address
5. Click the "Add to overview" button (4).
 - ↳ The sensor is displayed on the overview screen (see "Device Overview" on page 37) of all sensors found.

**Note**

If no sensor is detected:

- Check that the sensor is connected properly and ready for operation. See chapter 3.4, .
- Check that Windows network communication is set up correctly between the device and the PC/laptop; see chapter 3.5.

7.2 ViSolution Main Screen

The basic ViSolution functions can be selected on the main screen.

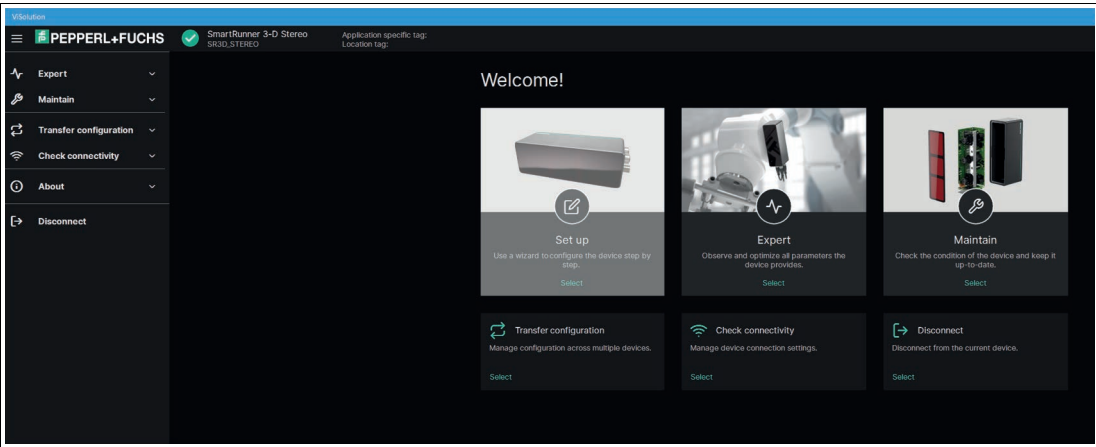


Figure 7.4 Main screen
Basic functions on the main screen:

Designation	Description
Expert	Managing and configuring the sensor parameters. See chapter 7.2.3area.
Maintain	You can use the Maintain function to check the status of the sensor and keep it up to date. See chapter 7.2.4area.
Transfer Configuration	Manage configurations across multiple sensors. area.
Check connectivity	Use this menu to manage connections to the network and display connection data. See chapter 7.2.6area.
Disconnect	Use "Disconnect" to exit the user interface and access the device overview screen. See chapter 7.2.7area.

7.2.1 User Interface

The ViSolution user interface is structured as follows:

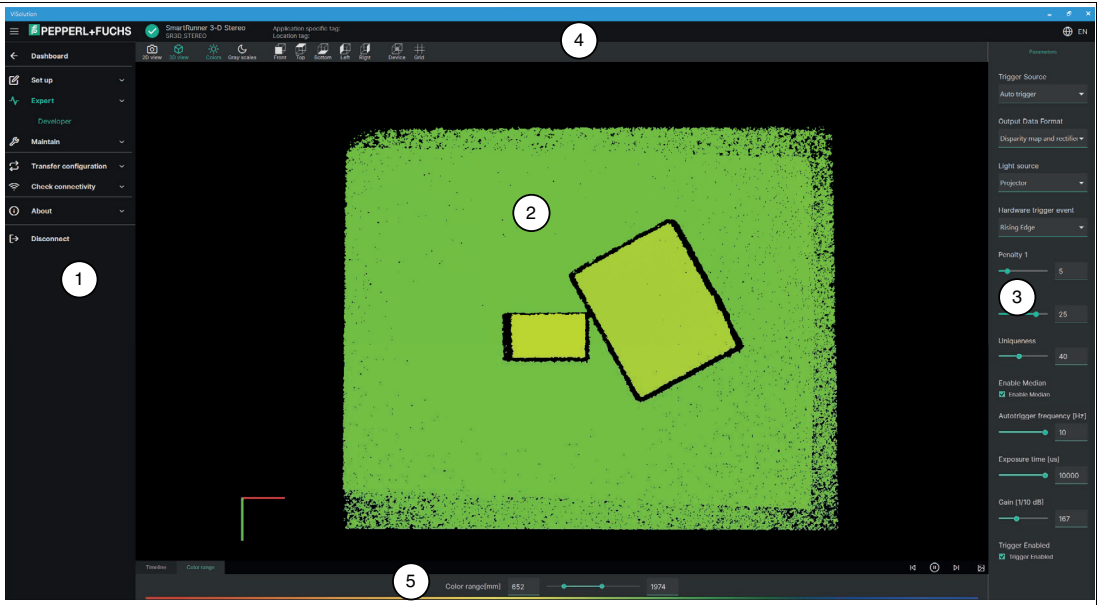


Figure 7.5 Structure of the user interface

Item	Designation	Function
1	Menu bar	Use the menu bar to access the sensing modes.
2	Main area	The image data can be displayed in the main area.
3	Configuration window	The sensor-specific parameters for the sensor can be set in this area.
4	Navigation bar	The desired option can be selected from the navigation bar.
5	Information bar + Controls + Display results (dimensions, volume, rotation, and center)	The information bar provides information about the captured scene. In addition, other controls are available for visualizing the captured scene.

Controls in the Navigation Bar

Different controls are displayed in the navigation bar depending on whether you select "2D view" or "3D view".

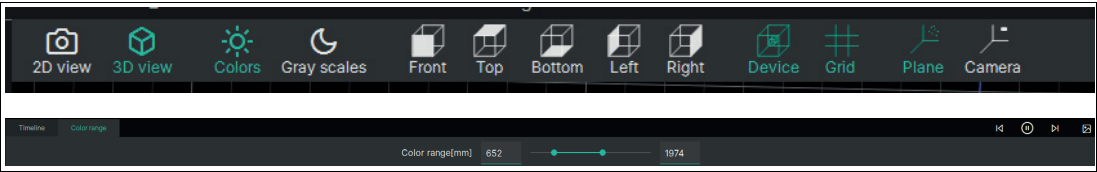
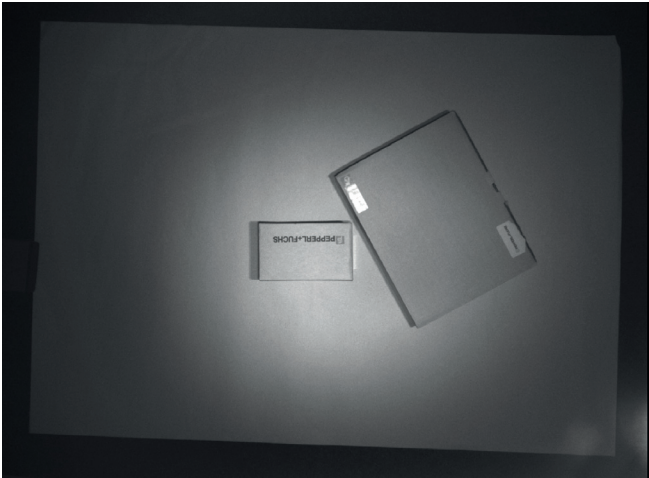
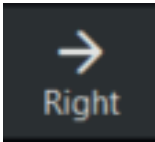
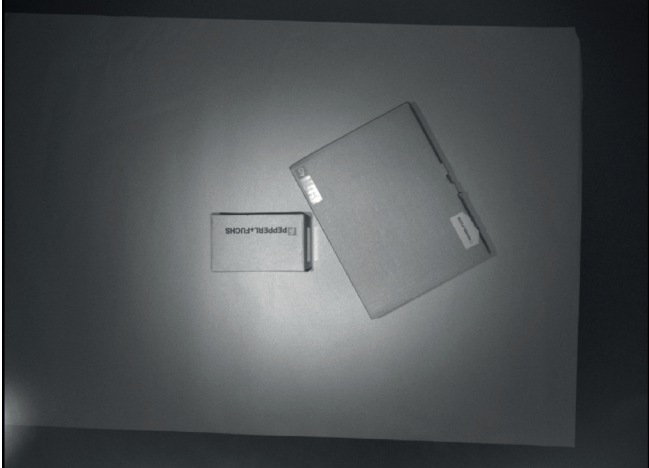
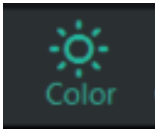
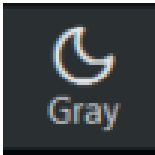
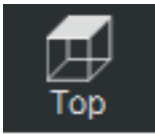


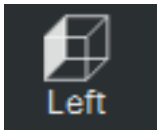
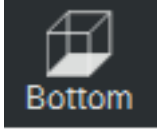
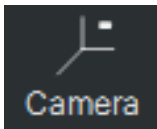
Figure 7.6 Navigation bar

Controls

Control	Designation	Function
	2D view	Switch to camera. Raw images, disparity images, or camera images illuminated with area lighting can be displayed here.
	3D view	Output of the point cloud
	Disparity	Display of the disparity map

Control	Designation	Function
 Left	Left	Left image 
 Right	Right	Right image 
 Color	Color	The disparity map and the generated point cloud can be displayed either in grayscale or in color.
 Gray	Gray	Switch from color image to grayscale.
 Front	Front	3-D orientation: Front view
 Top	Top	3-D orientation: Top view

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Control	Designation	Function
 Left	Left	3-D orientation: Side view, left
 Right	Right	3-D orientation: Side view, right
 Bottom	Bottom	3-D orientation: Bottom view
 Device	Device	Show or hide sensor in 3-D view
 Grid	Grid	Show or hide coordinate system
 Plane	Plane	Displays the offset origin of the coordinate system on the reference plane
 Camera	Camera	Displays the origin of the coordinate system on the front of the sensor

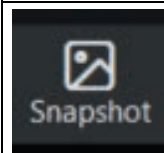
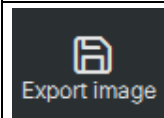
The Plane and Camera functions enable the display of the coordinate system to be switched between the camera coordinate system and the set reference plane. The reference plane coordinate system display is used to check whether the reference plane is set up correctly.

Information Bar + Controls

Timeline



Figure 7.7 Timeline

Control	Designation	Function
Framecounter	Framecounter	Displays all captured images
Timestamp	Timestamp	Sensor-internal timestamp of the acquired images
FPS	Frames per Second	Displays the actual frequency
Mmissed Frames	Mmissed Frames	Shows the number of frames that were not received by the ViSolution as data containers, for example when triggers occur too quickly in succession.
 Playback option		Start Previously recorded process data can be played back with this function
		Stop Stop recording
		Forward Fast-forward the recording
		Back Rewind the recording
		Progress bar The progress bar indicates the current position in the recording. Clicking on a position in the progress bar will resume play-back from the corresponding image.
	Snapshot	Single image capture when the sensor is in the "Pause" position. NOTE: Only for TriggerSource = Software
	Export image	Export image.

Color Range

The slider bar can be used to manually adjust the color range of the display. This will not cause the results of the application to change.

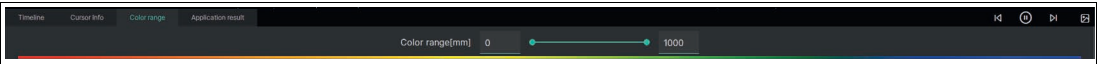


Figure 7.8

Control	Designation	Function
Color range [mm]	Color range	The shade depends on the measured distance of the point and the color scale setting. Red (black for grayscale): z coordinate value $\leq$ minimum of the set color scale. Blue (white for grayscale): z coordinate value $\geq$ maximum of the set color scale.

7.2.2 Device Settings

The adjustable parameters are divided into the two tabs Evaluation Settings and Capture Settings.

- Evaluation Settings Contains all parameters that are relevant for the evaluation and calculation of the results.
- Capture Settings Contains all parameters that are relevant for image capture.

Evaluation Settings

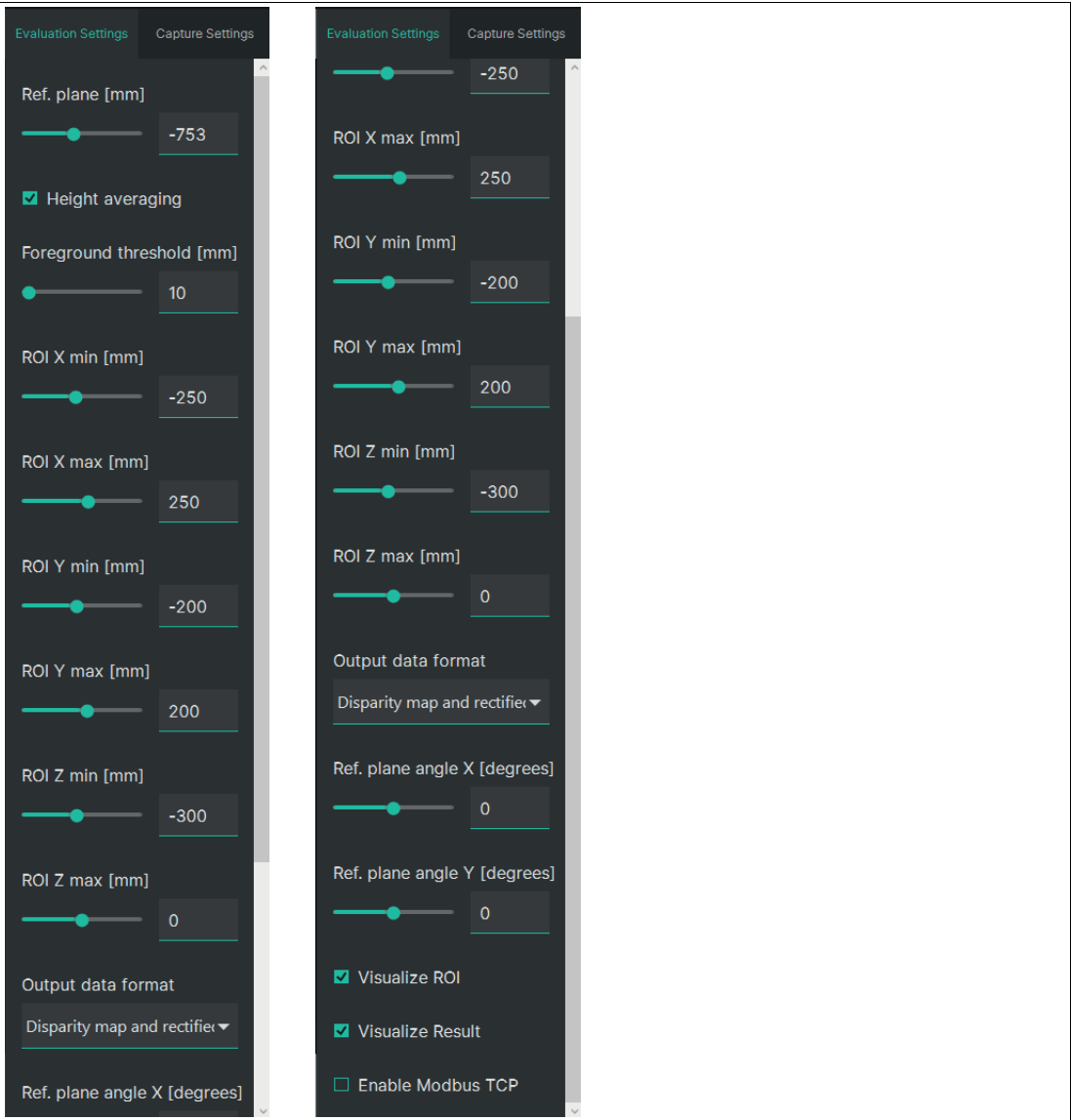


Figure 7.9 Evaluation Settings

Ref plane [mm]

- Specifies the distance between the sensor and the ground. The input moves the zero point of the coordinate system from the front of the sensor to the ground. For example: For a distance of 1000 mm, the value must be entered as "-1000".
- The maximum distance of the reference plane is limited by the sensor range.

Ref plane angle x [degrees]

- Specifies the rotation of the reference plane around the x-axis.
- Used to compensate for an inclination of the sensor.
- NOTE: Larger angles can have a negative effect on the measurement result. If possible, mount the sensor without tilting it relative to the reference plane.

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- Adjustment range: -45° ... $+45^{\circ}$

Ref plane angle y [degrees]

- Specifies the rotation of the reference plane around the y-axis.
- Used to compensate for an inclination of the sensor.
- NOTE: Larger angles can have a negative effect on the measurement result. If possible, mount the sensor so that it is not tilted relative to the reference plane
- Adjustment range: -45° ... $+45^{\circ}$

Height averaging

- Improves the measurement results for objects with a surface parallel to the reference plane.
- More precise values for the object height can be determined by taking the surface information into account.
- The function is not suitable for objects with different heights.

Foreground threshold [mm]

- Defines the distance threshold from which an object is detected as such.
- The value can be used as a filter for noise via the reference plane.

Region of interest (ROI)

- Defines a freely definable area within which objects are taken into account for the measurement.
- Objects outside the ROI are not captured.
- If an object is only partially within the ROI, only the part within the ROI is taken into account.

ROI x min [mm]

- Defines the minimum x value of the region of interest (ROI).

ROI x max [mm]

- Defines the maximum x value of the region of interest (ROI).

ROI y min [mm]

- Defines the minimum y value of the region of interest (ROI).

ROI y max [mm]

- Defines the maximum y value of the region of interest (ROI).

ROI z min [mm]

- Defines the minimum z value of the region of interest (ROI).
- The value is above the reference plane.
- Due to the offset of the zero point of the coordinate system to the reference plane, the value is specified as negative.

ROI z max [mm]

- Defines the maximum z value of the region of interest (ROI).
- The value is usually on the reference plane.
- Due to the offset of the zero point of the coordinate system to the reference plane, the value is typically declared as "0".

Output data format

- Specifies the output format of the data. Available options:
- Disparity map and rectified
- Disparity map
- Result only

Visualize ROI

- Displays the defined region of interest (ROI) as a bounding box in blue.

Visualize result

- Displays the detected object as a minimum bounding box around the object in green.

Enable Modbus TCP

- Enables Modbus TCP communication.

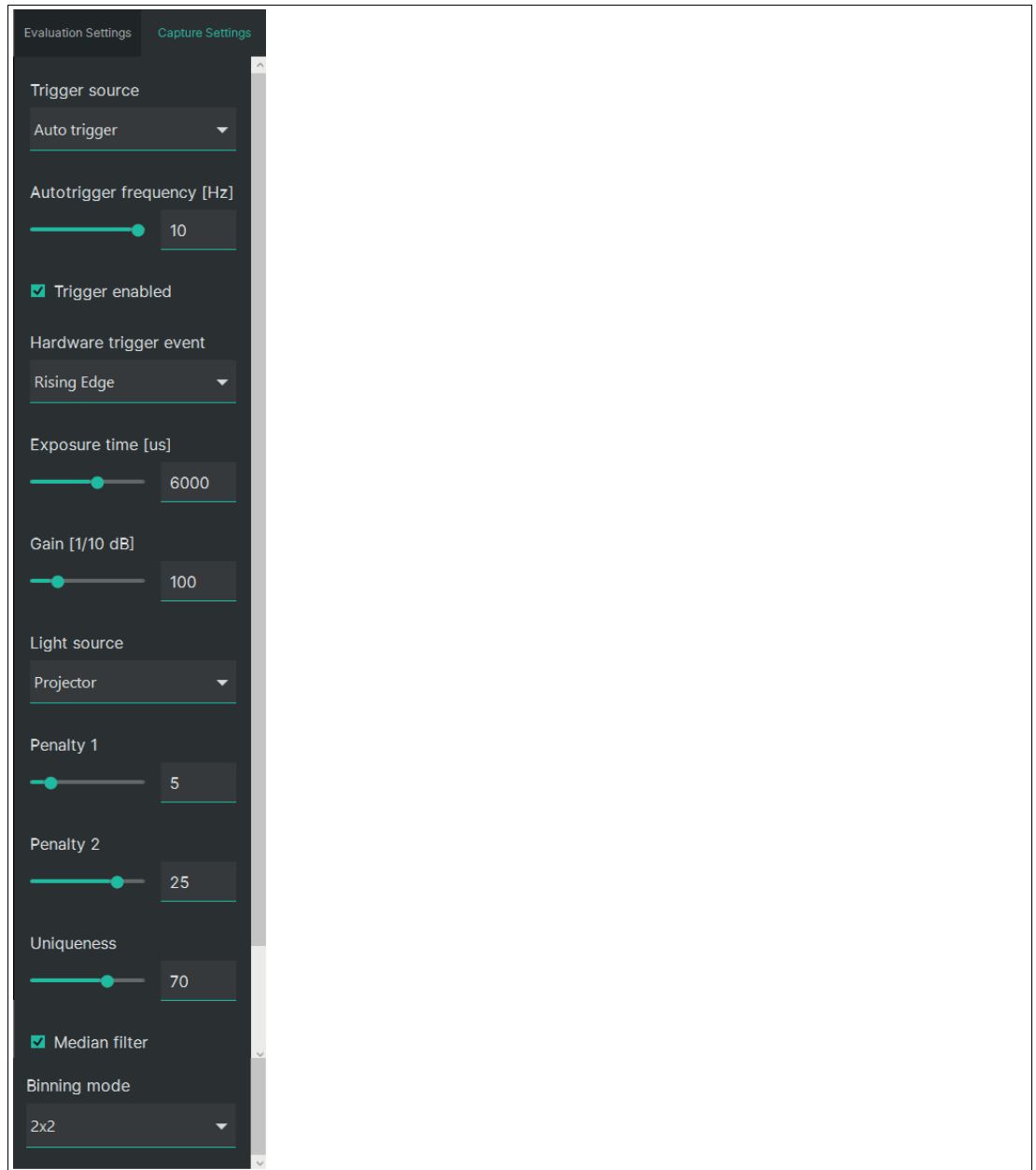
Capture Settings

Figure 7.10 Capture Settings

Trigger source [Trigger source]

- Specifies how the image capture and evaluation is started.
- Autotrigger: The sensor continuously detects images at an adjustable frequency (see "Autotrigger frequency [Hz]").
- Hardware Trigger: Triggering takes place via an external signal at the hardware input "IN Trigger".
- Software Trigger: Triggering takes place via the process interface (for example PLC).

Autotrigger frequency [Autotrigger frequency] [Hz]

- Specifies the frame rate in Autotrigger mode.
- The setting can be made via a slide control or by direct input.
- Maximum frequency: 10 Hz.

Hardware trigger event [Hardware trigger event]

- Specifies the signal edge to which the hardware trigger responds.
- Rising Edge: Triggers on rising edge of the input signal.
- Falling Edge: Triggers on falling edge of the input signal.

Exposure time [Exposure time] [μs]

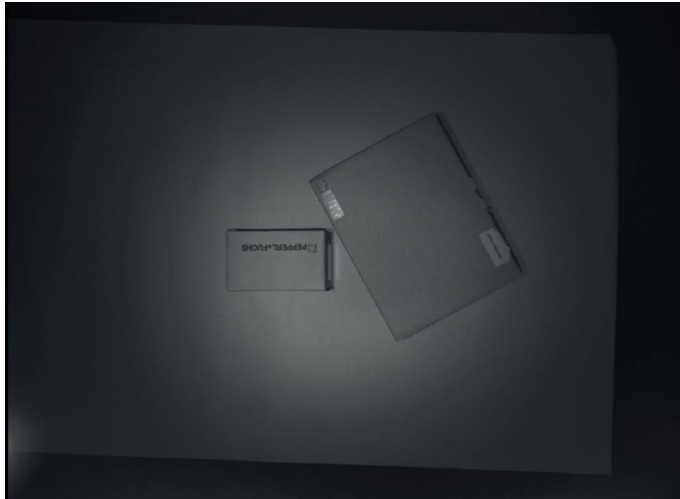
- Determines the duration of the exposure in microseconds.
- The value can be set via a slider or by direct input.

Gain

- Used when the image is too dark and the exposure time cannot be increased further due to moving objects.
- Higher gain also increases image noise.
- Specification in decibels [1/10 dB].

Light source [Light source]

- Specifies the illumination source used.
- None: Only existing ambient light is used.
- Onboard: Use of integrated lighting, suitable for monochrome 2-D images.



- Projector: Use of a structured light projector to support 3-D data generation.



Penalty 1

- Tuning parameter for smoothing small disparity jumps (difference = 1).

Penalty 2

- Tuning parameter for smoothing larger disparity jumps (difference > 1).

Uniqueness

- Tuning parameter for evaluating the uniqueness of the disparity assignment.
- Specifies the maximum relative difference in percent between the best and second best solution.

Median filter

- Activates a median filter to smooth the point cloud.

Binning mode

- Specifies whether the full sensor resolution is used or pixels are combined.
- None: Disables pixel aggregation; full sensor resolution is used.
- 2x2: Combines four pixels into one pixel (reduced resolution, less data).

7.2.3**Expert**

The "Expert" menu is available in Expert mode. It can be used to monitor the performance data of the sensor in real time during operation and optimize this data in a targeted manner if necessary.

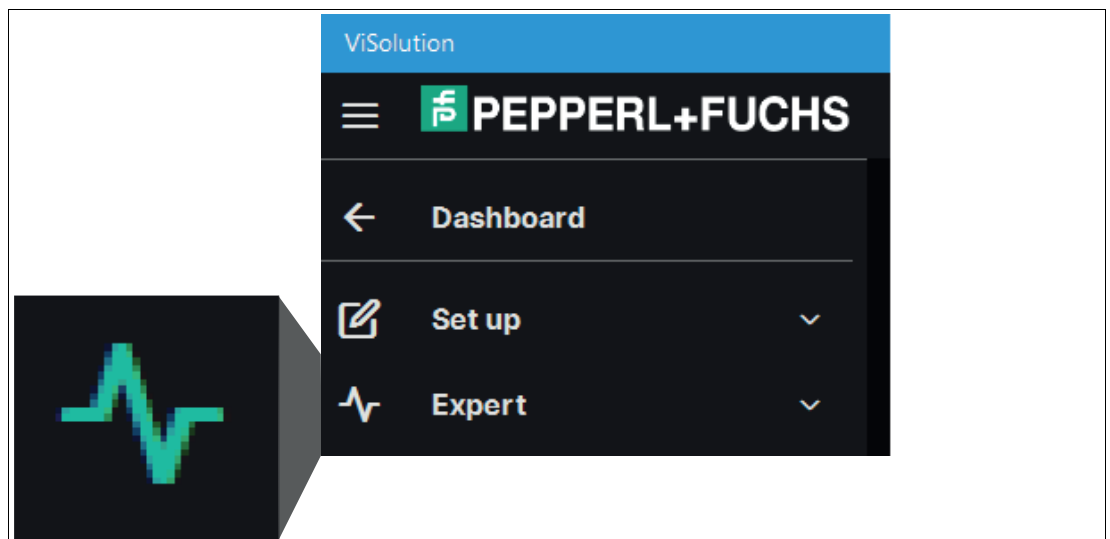


Figure 7.11

7.2.4 Maintain

The Maintain function can be used to check the status of the sensor and keep the device functionality up to date.

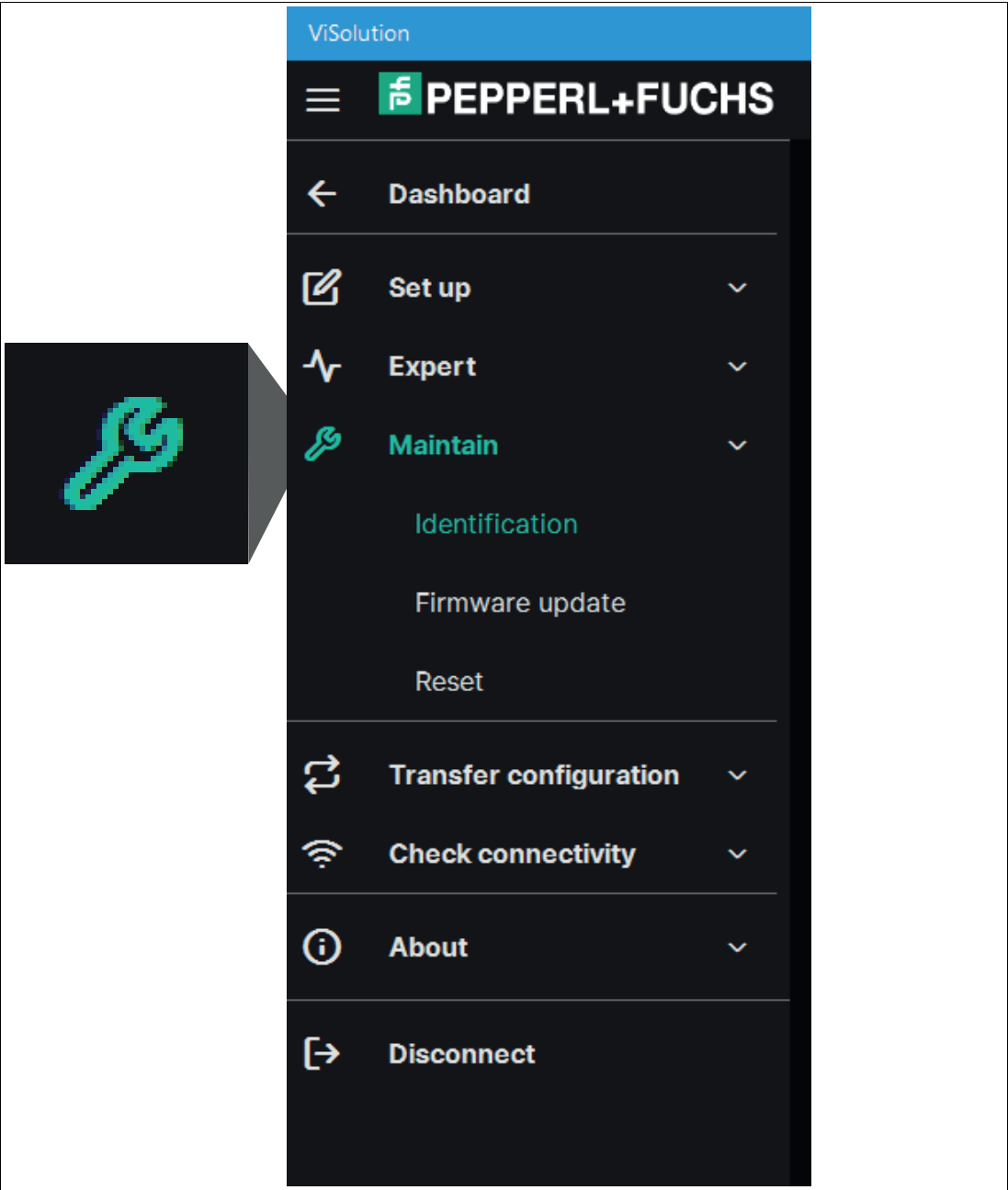


Figure 7.12 Maintain

Identification

Use "Maintain" > "Identification" to access the "Identification" window.

Information	Description
Application specifictag	Application-specific tag
Functionspecifictag	Function-specific tag
Locationtag	Location tag

Identification parameters

ID card	Description
VendorName	Manufacturer
VendorURL	Manufacturer's URL
ProductName	Product name
PartNumber	Product number
ProductClass	Product class
SerialNumber	Serial number
FirmwareVersion	Firmware version
HardwareVersion	Hardware version
ProtocolStackRevision	Protocol stack revision
UniqueProductID	Unique product ID

Firmware Update

Use "Maintain" > "Firmware update" to access the "Firmware Update" screen.



Updating Firmware

To update the firmware on your device, proceed as follows:

1. Select a valid update file.
2. Start the update process.

↳ The selected file is uploaded to the sensor. Once it is uploaded, the update will start automatically.



Note
The update process may take a few minutes. Do not switch off the sensor during this time.

Reset

In the reset menu, the sensor settings can be reset to the factory defaults. Two options are available for this purpose, each of which is executed via its own button:

Parameter Reset

- Resets only the sensor settings (parameters).
- Security-relevant settings such as encryption and password protection remain unchanged.
- The process is started by clicking on the "Reset parameters" button (1).

Factory Reset

- Fully resets the sensor to the delivery state.
- In addition to the sensor settings, all security configurations (e.g., encryption and password protection) are also deleted.
- All settings must be re-initialized after a factory reset.
- The process is started by clicking on the "Factory reset" button (2).

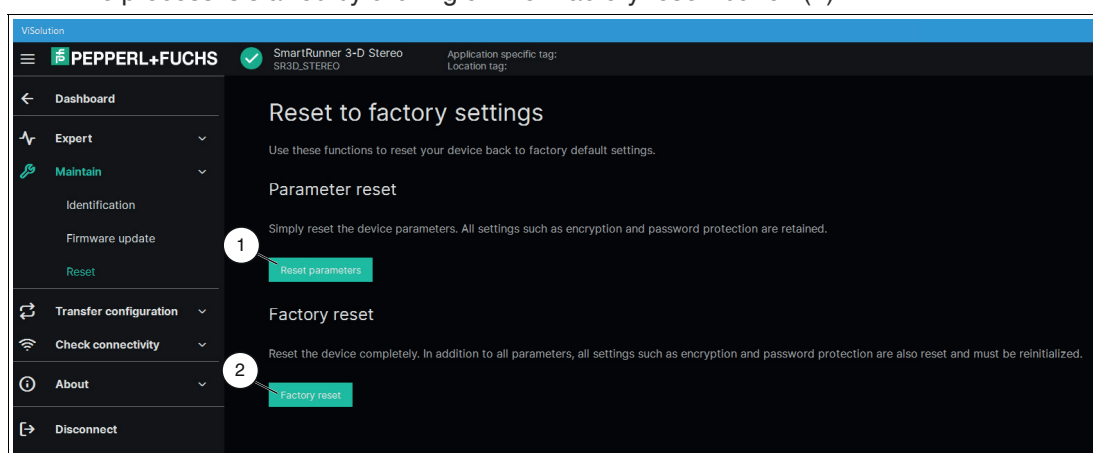


Figure 7.13

7.2.5 Transfer Configuration

The "Transfer Configuration" menu allows you to manage configurations across multiple sensors.

7.2.6 Check Connectivity

Manage connections to the network.

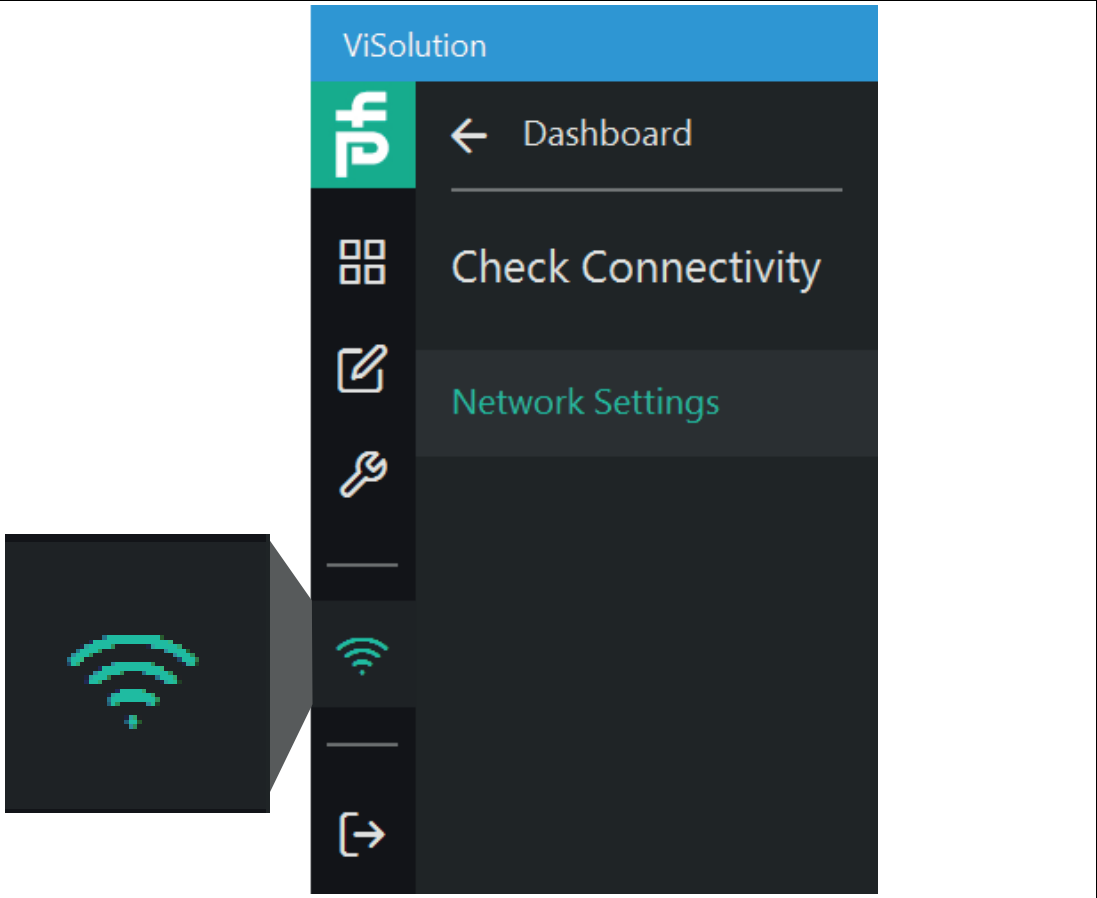


Figure 7.14 Check Connectivity

Link to chapter

Function	Link
Network Settings	See chapter 7.2.6.1.

7.2.6.1 Network Settings

Use "Check Connectivity" > "Network Settings" to access the "Network Settings" window.

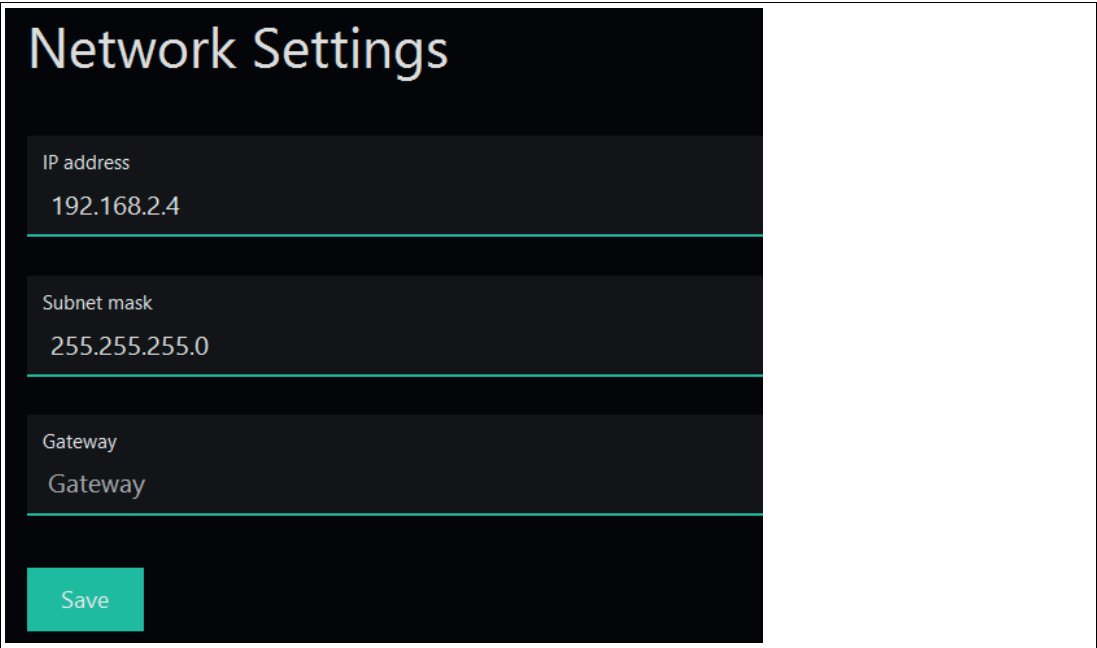


Figure 7.15 Network settings

Information	Description
IP address	IP address setting
Subnet mask	Subnet mask setting
Gateway	Gateway setting

7.2.7

Logout

Use "Logout" to exit the user interface and access the device overview screen (see "Device Overview" on page 37).

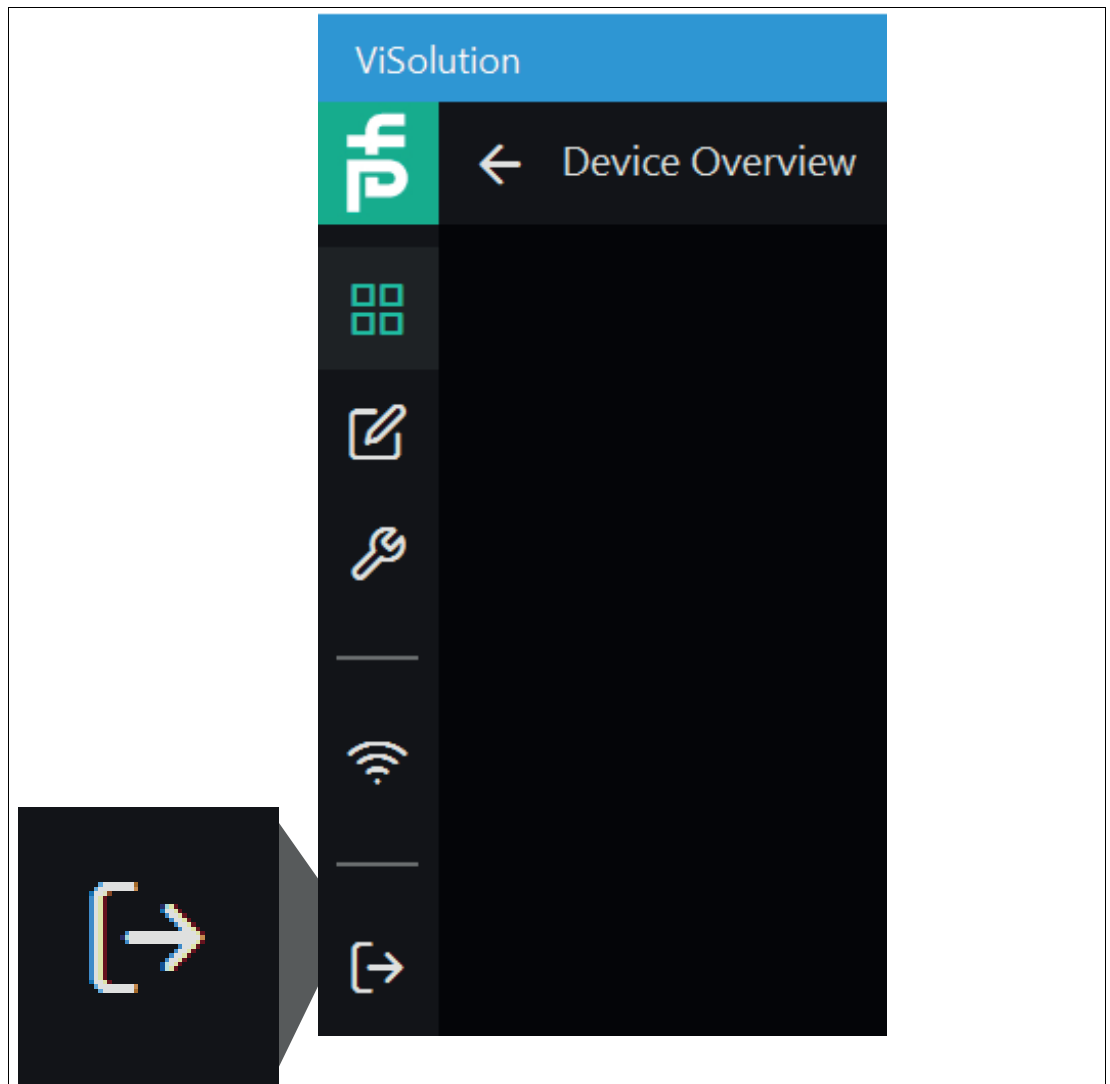


Figure 7.16 Logout

8 Maintenance and Repair

8.1 Servicing

**Danger!**

Danger to life due to electrical current!

Contact with live parts causes immediate danger to life.

- Allow only qualified electricians to carry out work on the electrical installation.
- Switch off the power supply before carrying out servicing, cleaning, and repairs, and prevent the supply from being switched on again.
- Keep the live parts free from moisture.

The device is maintenance-free. To get the best possible performance out of your device, keep the optical unit on the device clean, and clean it when necessary.

Observe the following instructions when cleaning:

- Do not touch the optical unit with your fingers.
- Do not immerse the device in water. Do not spray the device with water or other liquids.
- Do not use abrasive agents to clean the surface of the device.
- Use a cotton or paper cloth moistened (not soaked) with water or isopropyl alcohol.
- Remove any residual alcohol using a cotton or paper cloth moistened (not soaked) with distilled water.
- Wipe the device surfaces dry using a lint-free cloth.

8.2 Repair

The device must not be repaired, changed, or manipulated. In case of failure, always replace the device with an original device.

9 Troubleshooting

9.1 What to Do in Case of a Fault

Before you have the device repaired, perform the following actions:

- Test the system according to the checklist below.
- Contact our service center to pinpoint the problem.

Checklist

Fault	Cause	Remedy
"PWR" LED does not light up	The power supply is switched off	Check whether there is a reason why the power supply is switched off (installation or maintenance work, etc.). Switch on the power supply if necessary.
	Wiring error, cable break	Check the wiring carefully and repair any faults with the wiring. Check the cables to ensure that they are functioning properly. See chapter 3.4.
Control panel receiving no measurement data	Connection cable not connected	Connect the connection cable.
	Incorrect connection cable used	Use the appropriate connection cable only. See chapter 2.7.
	Sensor incorrectly parameterized	Make sure that you have set the correct parameterization. See chapter 7.
Test object not detected	Incorrect operating distance	Set the operating distance;
	Front panel dirty	Clean the front panel. See chapter 8.1.
	Reflections	Avoid reflections.
	Foreign exposure	Avoid foreign exposure.
Measurement errors	Test object outside the sensing range	Better positioning of the test object.
	Incorrect distance to the test object	Observe the distance values;
	Housing incorrectly mounted	Mount the housing correctly;
No connection to the sensor	Alternating-current voltage or supply voltage too high	Connect the sensor to direct-current voltage (DC) only. Ensure that the supply voltage level is within the specified sensor range.
	Network settings	Set up Windows network communication between the sensor and a PC/laptop; see chapter 3.5
		Due to the large amount of data supplied by the sensor per second, the sensor(s) must be connected to the PC via a Gigabit Ethernet network.

- If none of the above remedies the problem, please contact our service center. Please have the error images and the firmware version number available. The firmware version number can be found at the top right of the user interface.

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