User’s Manual

Triple-IN
Experts in Laser Distance Measurements

INvention INnovation INterfacing

PS HT Laser Scanner for hot surfaces

PS HT1200 Prototype
PS HT900 Prototype

Triple-IN | Poppenbütteler Bogen 64 | D-22399 Hamburg

Content

1 About this document

This document describes the PS HT Laser Scanner. It is related to the

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PS Firmware Version 3.05.xx.xx
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The sensors PSHT Laser Scanners are used for measuring range profiles of hot surfaces. Hot surfaces occur in steel and copper production. There it is necessary to measure to glowing the surfaces of glowing cooper pieces or steel pieces.
There are three temperature ranges to be distinguished:

- Up to 900°C: For tracking and positioning of glowing slabs and measurement of forgings
- Up to 1200°C: For very hot slabs shortly after leaving the extrusion machine and to measure the level of liquid copper.

This User Manual is part of a set of documents:

Manual	Targeted persons	Content
PS HT User's Manual	Technical personnel	Transport, mounting and installation Wiring and maintenance Operating means, system configuration Technical data
PS HT Protection housing	Technical personnel	Installation of the PSHT protection housing.
Programmer's Manual	Software developers	Data formats Commands and responses
APU Developer's Manual	Software developers	Developer environment setup Specific APU features

If you or your colleagues have any comments on this manual, we would be grateful to hear from you. Please write to:

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2 Safety Instructions

2.1 General warnings

Caution!

Before using a PS HT Laser Scanner, the user manual must be read, and all the instructions must be carefully observed.

Warning!

The PS HT Laser Scanner must be installed, configured and serviced by qualified personnel only.
National and international rules and regulations must be applied according to the field of application and usage.
PS HT Laser Scanner cannot be used as a safety device.

Warning!

Risk of eye injury!
Measurement Laser is a laser class 1 product. Emits invisible light (905 nm). Do not look directly into the laser beam!
Red laser marker is a laser class 2 product. Emits visible light (635 to 678 nm). Do not look directly into the laser beam!

Warning!

Connect and disconnect electrical linkages only under de-energized conditions.
Always connect a protective earth first.
Check the protective earth!

2.2 Limited warranty

Triple-IN's General Condition of Sales grants limited warranty for defects in material or workmanship in the PS HT Laser Scanner.

Caution!

The limited warranty does not cover:

- Any problem that is caused by accident, abuse, neglect, shock, electrostatic discharge, degaussing, heat or humidity beyond product specifications, improper installation, operation, maintenance or modification;
- Any use contrary to the instructions in this and other related manuals;
- Lost firmware passwords;
- Malfunctions caused by other equipment;
- Damage resulting during shipment.
  Claim must be presented and examined by the shipper.
- Damages resulting from modifications or alterations to the product in any way, including any alterations or removal of its identification marks and labels.

3 Introduction

3.1 Triple-IN's KEM Time-of-Flight Technology

The technological basis for the Triple-IN's PS HT Laser Scanner is "Time-of-Flight" (ToF): the travel time of light emitted by a laser diode to natural surface.
Triple-IN's KEM method ("kontinuierliche Event Messung", "Continuous Event Measurement) improves this well-known technology:

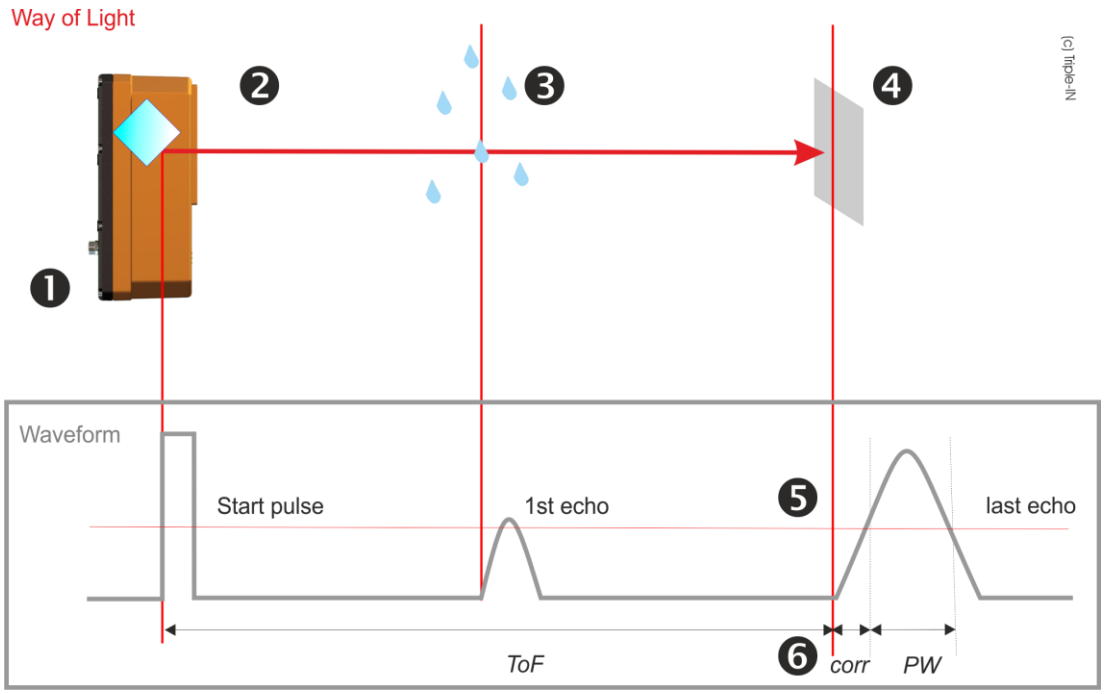


Figure 1: Principle of operation

1. The angle encoder triggers the laser diode in regular angle steps. The laser diode emits an infrared laser beam, defining the reference "Start pulse" which marks the beginning of the time-of-flight measurement.
2. The mirror, which is connected to the angle encoder, reflects the laser beam in certain directions. An even scan area is formed by the rotation of the mirror.
3. The laser beam is reflected by natural surfaces. Several echoes can be the result of window panes, rain drops, snowflakes and similar objects which reflect parts of the laser pulse's energy. This effect is called "multi-echo". PS HT Laser Scanner can record the results of up to 4 echoes for each laser beam.
4. The echo signal varies depending on the surface reflectivity and the distance to the object. The echo signal will be detected as soon as it passes a receiver

threshold. The sensor measures the time-of-flight and the pulse width of the echo signal.

5. The KEM technology applies various corrections to compensate deviations from the echo signal strength.

The result is an accurate time-of-flight measurement, independently of the temperature, reflectivity, and target distance. The distance to the target is calculated by

$$D = \frac{ToF * c}{2} + Corr_{PW}$$

with the following variables:

D = distance
ToF = measured time-of-flight
c = speed of light in ambient atmosphere
$Corr_{PW}$ = echo signal corrections

3.2 Laser Spot Sizes

The laser beam divergence is a measure for how fast the beam expands over distance. As smaller the beam divergence as better the beam quality. A low beam divergence can be important for applications that require high object resolutions.
The next diagrams are drawn using data collected by a sensor model PS HT Laser Scanner.

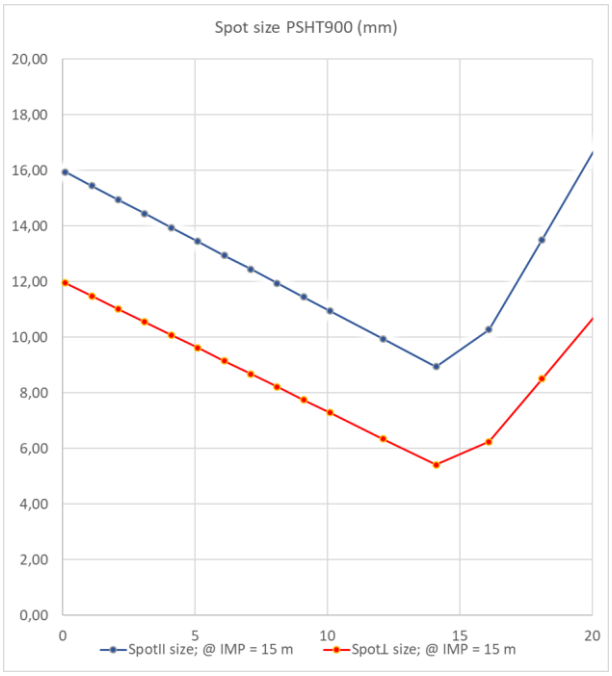


Figure 2: PS HT900 Laser spot size as function of the distance

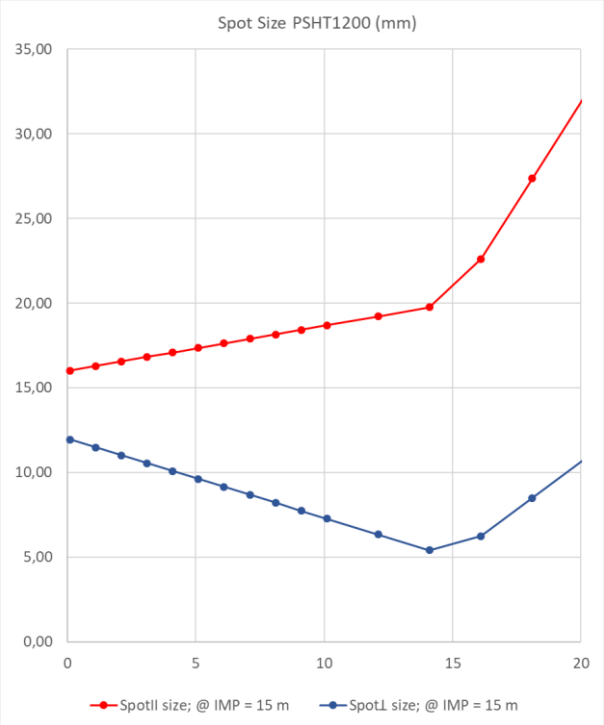


Figure 3: PS HT1200 Laser spot size as function of the distance

3.1 Distance Standard Deviation

Sigma is the standard deviation calculated from a set of samples. For Triple-IN's KEM technology, the reported sigma of repeated measurements gives the precision of a single measurement. Sigma depends on the distance and the reflectivity of the target surface. A strong echo signal results in a better Sigma.

3.2 Point of origin and Scan Area

PS HT Laser Scanner sensors trigger 1000 laser beams on a 90° scan field:

- The angle encoder zero-direction is to vertical axis of the sensor.
- The scan field starts at angle encoder position 45° and ends after 90° at encoder position 135°.
- The working distance range of the PSHT900 on hot surfaces is 2 to 10 meters.
- The working distance range of the PSHT1200 on hot surfaces is 3 to 15 meters
- The laser source is located with a parallax of 17 mm beside the vertical axis.

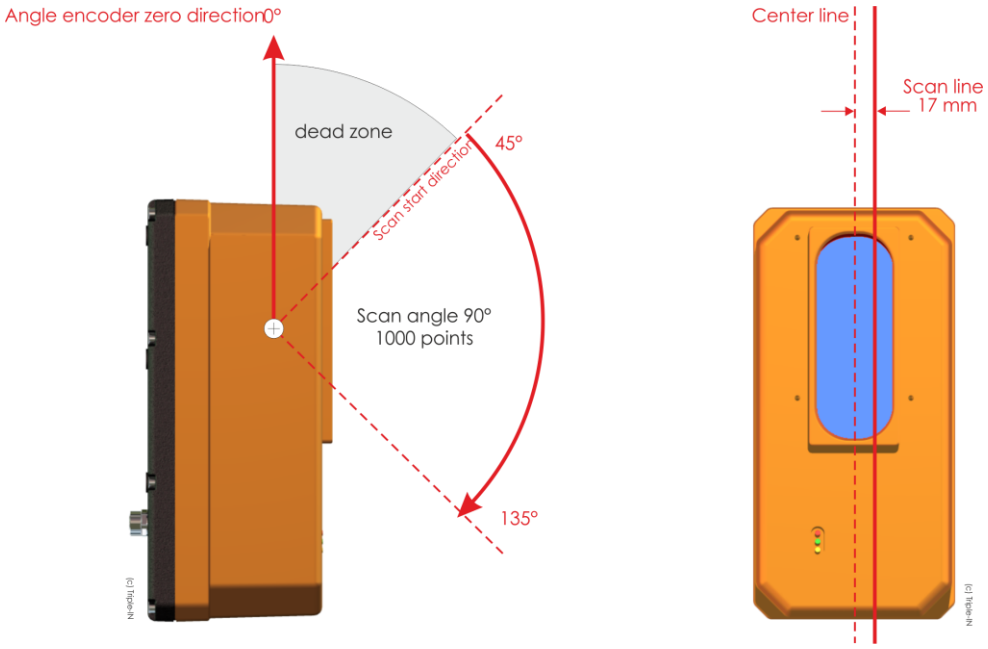


Figure 4: PS HT Laser Scanner scan area and point of origin

4 Operating features

4.1 Sensor System parts

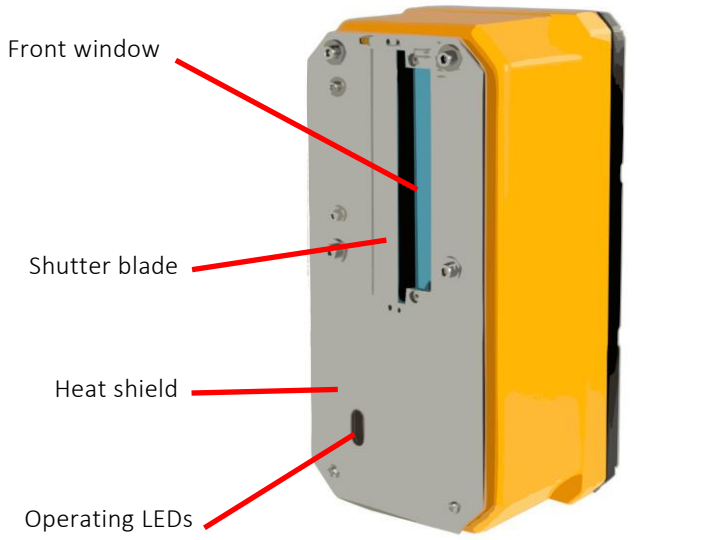


Figure 5: PS HT Laser Scanner front side

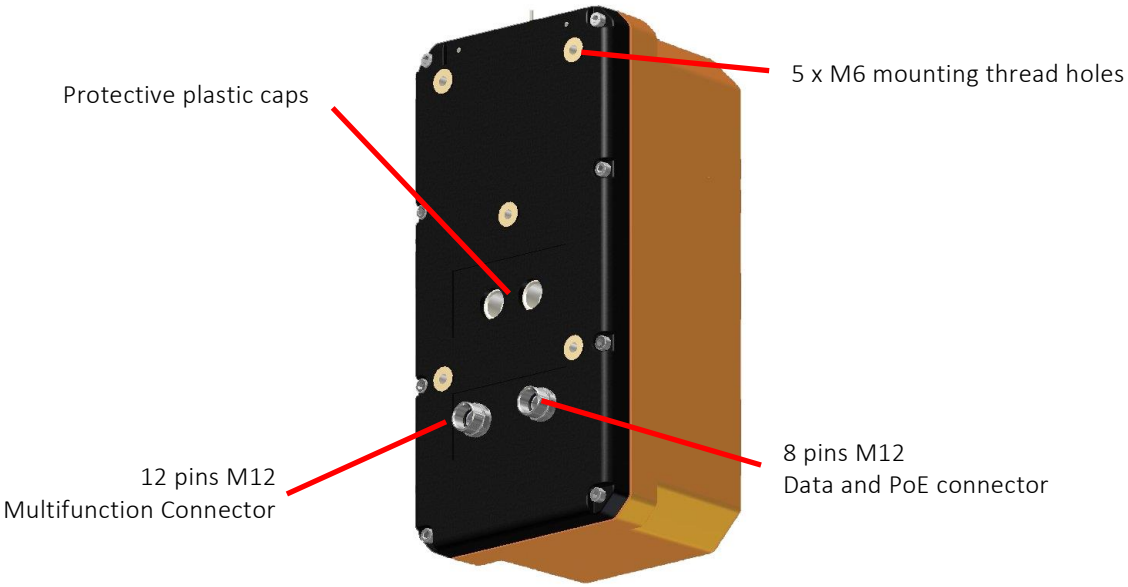


Figure 6: PS HT Laser Scanner rear side

Measurement Laser

Emits a 905 nm invisible laser beam.

Receiver

Contains a receiver diode and is connected to the KEM-IC.

Measurement Processing Unit (MPU)

Contains a microcontroller and a Triple-IN KEM-IC chip to record time-of-flight events.

Application Processing Unit (APU)

It is a processing board with Linux OS, providing the Ethernet functionality and the option to run customized applications directly inside of the sensor.

Angle Encoder

It is an encoder with a resolution of 32000 coder counts.

Mirror cube

Reflects the laser beam. The 2D profile is generated due to its rotation.

Motor unit

Drives the mirror cube with a constant rotation frequency. The motor can be switched off by software.

Digital outputs

Two configurable isolated switching outputs are available, with a voltage working range from 3.3 VDC to 5 VDC.

Digital inputs

Two configurable digital inputs are available, in the same voltage range of the digital outputs. One of them can be configured to be used as a PPS (Pulse Per Second) signal for time synchronization.

Heat shield

As a supplement to Triple-IN standard sensors, PSHT sensors have an additional heat shield and a shutter blade.

4.2 Heat shield and shutter blade

The heat shield protects the sensor front side against heat radiation and overheating.

Warning! Risk of overheating!

Protect the sensor against overheating!
Maximum operating temperature of the PSHT Laser Scanner is +50 °Celsius.
At higher temperatures, the sensor requires an air-conditioned protection, such as the Triple-IN PS HT Protection Housing.
Check at target distances shorter than 3 m whether a protection housing is necessary.

The shutter blade is located directly in front of the protection window. Adjusting the shutter blade will reduce thermal light to which the laser receiver is exposed.
The shutter plate reduces the thermal light falling from glowing surfaces onto the laser receiver.
The shutter blade is hold in position with 2 socket head screws. After the fixing screws have been loosened, the shutter blade can be moved with pins that are inserted into the two holes:

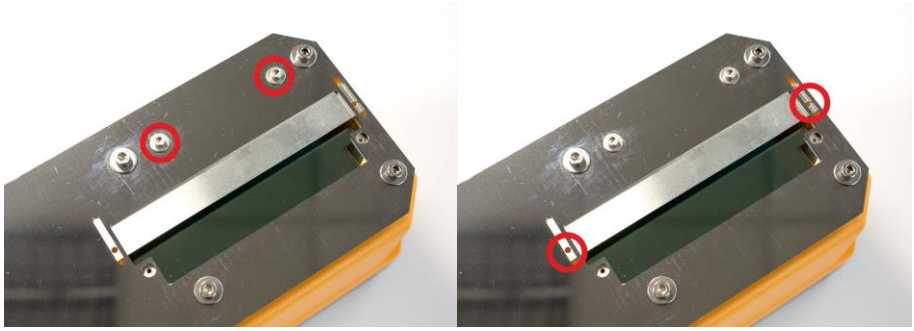


Figure 7: Shutter blade fixing screws and adjustment holes

The correct position of the shutter blade must be set during commissioning under real measuring conditions. A computer with the PSControlProgram are used. The complete procedure is described in chapter “8.11 Measurement for adjusting the Shutter blade”.

4.3 Status LEDs

The PS HT Laser Scanner has three status LEDs:

- Green LED: Power indicator; blinks if the scanner is in Terminal mode.

- Yellow LED: Measurement laser indicator.
- Red LED: Error indicator.

The following table shows the meaning of the different combinations of the three LEDs:

LED Status	Description	Meaning
	All LEDs off	Power off
	all LEDs are on	For about one second during power-on.
	All LEDs are blinking	Self-test is running.
	Yellow is off	Measurement laser is switched off
	Green is blinking Yellow is blinking	Starting the motor. Waiting for SCAN command.
	Green is steady on Yellow is steady on	Usual operation.
	Green is blinking	Terminal mode, waiting for user input
	Green is steady on Yellow is steady on	Terminal mode, Scan in process
	Red is steady on	System error. Check system health status. See chapter “Troubleshooting”

Figure 8: LED status indicators

5 Transport, installation and maintenance

5.1 General handling instructions

- Ensure during the installation that the entire system is disconnected from power supply.
- Mount the sensor at a location where the device is protected from damages, pollution and high humidity.
- Mount the PS HT Laser Scanner in a way that it is not exposed to direct sunlight.
- Route cables such that danger is excluded for persons and all cables are protected from damages.
- Do not remove the device identification label.
- Follow the safety instructions in chapter 2 Safety Instructions.

5.2 Packaging and transport

1. PS HT Laser Scanner is an optical instrument. Such equipment must be transported with special caution and sufficient packaging to protect the sensors from possible damage.
2. Use original Triple-IN packing material to transport the sensor.

Figure 9: Packaging

Caution!

Your warranty may be voided if returned sensor is received with inadequate packaging. Please always use the same package you received from Triple-IN for sending the sensor back.

3. At the time of delivery, the user should examine the shipment for loss or damage. If there is evidence of loss or damage, note it on the delivery receipt; this will be used as evidence to back up the claim. Do not use or install a defective device.

5.3 Condensation avoidance

If the PS HT Laser Scanner is suddenly brought in from the cold into a warm room, condensation may form on the optics.
If condensation forms on the sensor, do not install the sensor. This is to avoid damages to the connectors during installation. If there is condensation, remove the power supply from the sensor, and wait until the condensation has evaporated.

5.4 Cleaning

PS HT Laser Scanner is mainly free of maintenance. The front window must be checked regularly and must be cleaned from dust and dirt.

- Use a clean and moistened cloth to clean the body.
- Use a microfiber cloth to clean the front window. Don’t put pressure on the cloth while cleaning the front window.

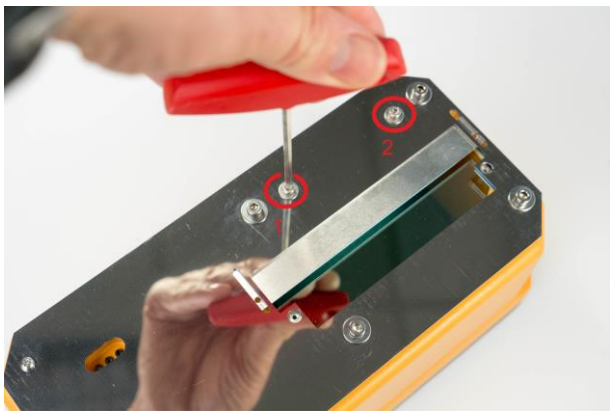
Caution!

Don't use abrasives, aggressive household cleaners, or other aggressive liquids.

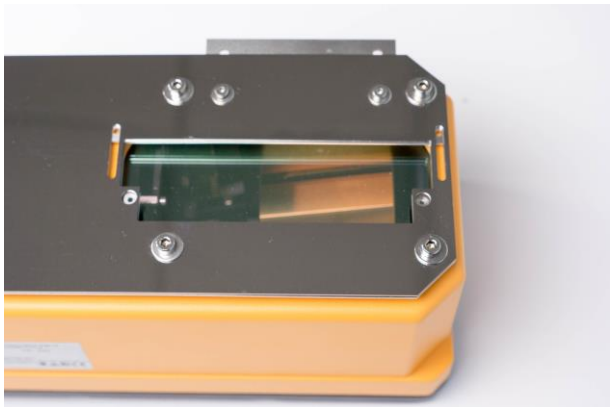
To clean the sensor:

1. Remove the PS HT Laser Scannerfrom the protection housing.

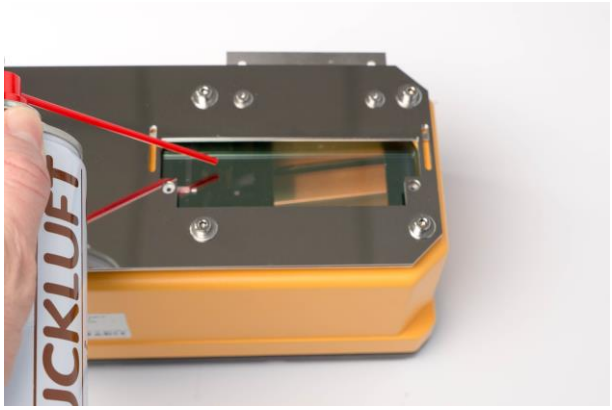
2. Loosen the two bracket screws which hold the shutter blade in position.



3. Completely open the shutter blade.



4. Remove dust particles with compressed air.



5. Use a clean microfibre cloth to clean the front window.
   For cleaning, a mild detergent can be used.

6. Follow the instructions in chapter “8.11 Measurement for adjusting the Shutter blade” to adjust the shutter blade.

5.5 Mechanical integration

PS HT Laser Scanner can be fitted at the rear side with five socket head screws with washers.

- Maximum Screw-in depth is max. 10 mm.
- Minimum screw-in depth is 4 mm.
- Maximum tightening torque is 12 Nm.

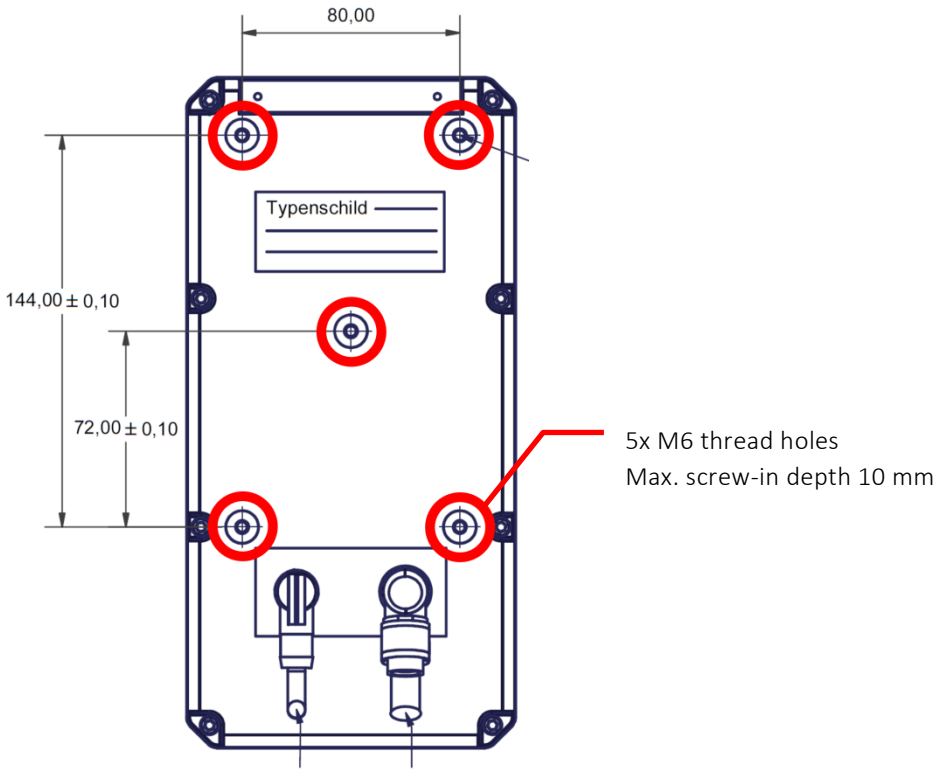


Figure 10: Mounting thread holes

5.6 Triple-IN's PSHT Protection housing

For use in harsh and hot environments, Triple-IN offers a special protective housing for PSHT.

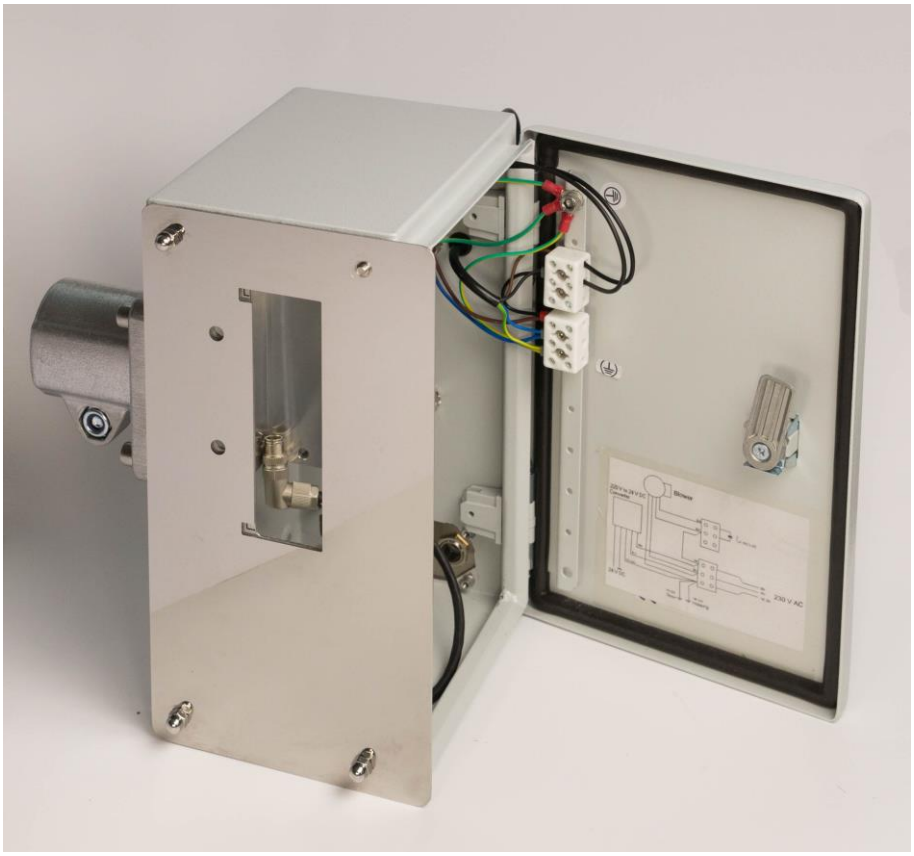


Figure 11: PSHT Protection housing

6 Connectors

6.1 Phoenix SPEEDCON® quick locking system

Caution!

Before attaching the connectors, make sure the sealing rubber rings in the sockets are all in place.
Always fit sealing connector caps onto plugs which are not used.

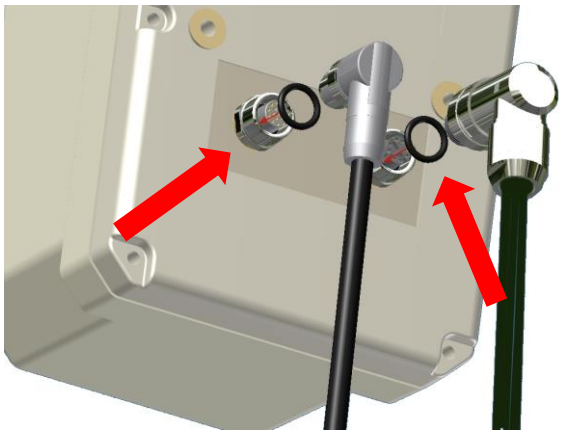


Figure 12: Connector rubber gasket

PS HT Laser Scanner are equipped with Phoenix SPEEDCON® M12 quick locking connectors.

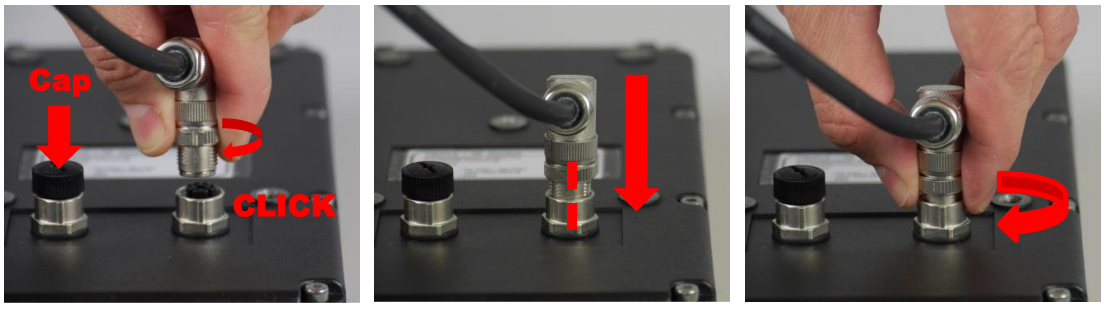


Figure 13: Using the quick locking connectors

1. Make sure the rubber gaskets in the sockets are in place.

6. Turn the retainer ring until you notice a distinct “click”.
7. Align marks at the retainer ring and the socket.
8. Push the connector into the socket.
9. Turn the retainer ring to secure the connection.

6.2 Data and PoE connector

6.2.1 Layout of the Data and PoE Connector

The Data and PoE Connector connects the sensor with the local network and includes Power over Ethernet.

- M12 connector/ IP67/CAT6 connector
- Type Phoenix Contact
  "Flush-type socket - SACC-CI-M12FS-8CON-L180-10G - 1402457"
- Adapter type reference is Phoenix Contact
  " Bus system plug connector - VS-08-M12MR-10G-P SCO - 1417443".

The pin/pair assignment conforms with the T568B standard.

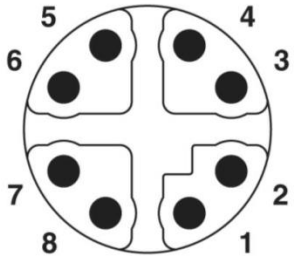


Figure 14: M12 Data and PoE scheme (plug side view)

Pin	Colour	Signal	Purpose
1	White/Orange	TX+	Transmit
2	Orange	TX-	Transmit
3	White/Green	RX+	Receive
4	Blue	24VDC+	Positive supply voltage
5	White/Blue	24VDC+	Positive supply voltage
6	Green	RX-	Receive
7	White/Brown	24VDC-	Negative supply voltage
8	Brown	24VDC-	Negative supply voltage

6.2.2 Power over Ethernet (PoE)

PS HT Laser Scanner use the Power over Ethernet (PoE) technology. PoE systems pass electrical power along with data on Ethernet cabling. This allows a single cable to provide both data connection and electrical power.

Warning!

Use correct power supply:

- 24 Volt DC +/- 10%
- Power consumption with heater: 0.33 Ampere, 8 Watt.
- Power consumption without heater: 0.33 Ampere, 8 Watt.

Warning!

Power-over-Ethernet (PoE) and Multifunction connector are cross-linked.
The power lines on the Multifunction connector become outputs if PoE is used.
The Ethernet interface of the control computer shall be protected by an Ethernet Splitter to prevent short circuits if power is connected to the serial interface connector.

Danger! Risk of electrical shock and damages!

To reduce the risk of electric shock and damages, use suitable PoE devices and CAT6 Ethernet cables.

These input/output lines were originally designed to provide power to an external device, such as a turn table. These output lines must not be used with PS HT Laser Scanner.

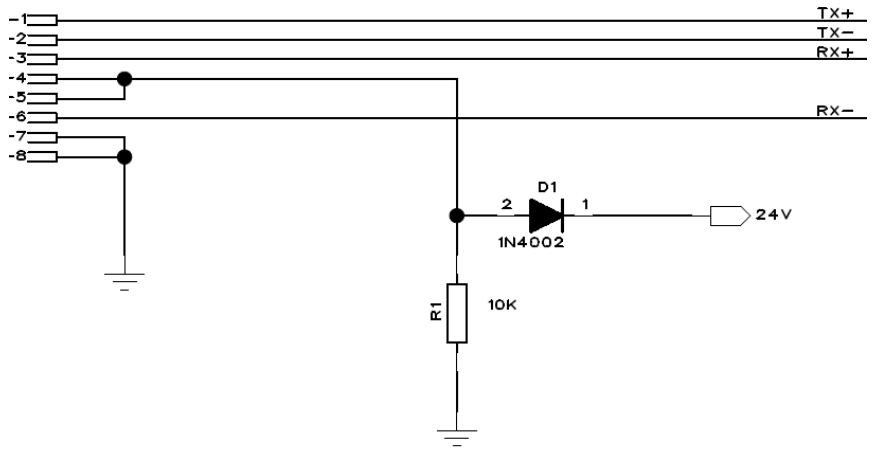


Figure 15: Scheme of the cross-linked power connectors

The PoE injector is not part of the PS HT Laser Scanner delivery.

6.3 Multifunction Cable connector

6.3.1 Layout of the Multifunction Cable connector

The Multifunction cable connects the control computer with the RS232 interfaces of the Ethernet board and the measurement board.
The connector type is M12 connector/IEC 61076-2-101.

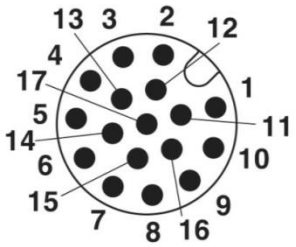


Figure 16: M12 Multifunction cable connector scheme (plug side view)

Pin	Colour	Signal	Comment	Direction
1	Brown	24 VDC-	Ground	-
2	Blue	24 VDC+	Positive power supply voltage	-
3	White	GND	RS232 ground	-
4	Green	-	Reserved for future use	Do not connect
5	Pink	ORX	RS232 RxD Application Programmable Board	
6	Yellow	OTX	RS232 TxD Application Programmable Board	
7	Black	-	Reserved for future use	Do not connect
8	Gray	-	Reserved for future use	Do not connect
9	Red	IN1	Isolated digital input	Input
10	Purple	IN2	Isolated digital input	Input
11	Gray/Pink	CH_A	External incremental encoder, channel A	Input
12	Red/Blue	CH_B	External incremental encoder, channel B	Input
13	White/Green	VCC_IO	Supply voltage for I/O, 3.3VDC to 5VDC	Input
14	Brown/Green	OUT2	Isolated digital switching output	Output
15	White/yellow	OUT1	Isolated digital switching output	Output

Pin	Colour	Signal	Comment	Direction
16	Yellow/Brown	STD_RXD	RS232 RxD Measurement Board	Input
17	White/Grey	STD_TXD	RS232 TxD Measurement Board	Output

Warning! Risk of damages!

If Pin 1 and 2 are used for power supply, the Power-over-Ethernet connection (PoE) must be disconnected by use of a PoE splitter.

Otherwise there can be a short circuit in the Ethernet connector to the gateway.

Warning! Risk of damages!

In the table, any grey field marks a pin reserved for future extension.
Do not connect these signals!

6.3.2 Power over the Multifunction connector

The Multifunction connector includes 24 Volt power lines cross linked with the PoE adapter. These input lines are designed to supply power over the serial interface connector.

Danger! Risk of electrical shock and damages!

Use correct power supply:

- 24 Volt DC +/- 10%
- Power consumption with heater: 0.33 Ampere, 8 Watt.
- Power consumption without heater: 0.33 Ampere, 8 Watt

6.3.3 Wiring the MPU RS232 Serial Interface

The Multifunction cable includes RS232 to the MPU.
The RS232 interface to the MPU is used for system configuration, e.g. to setup the network parameter.
PS HT Laser Scanner are classified as Data Terminal Equipment (DTE). According to the standard, PS HT Laser Scanner shall be equipped with male connectors.
A “null modem cable” consisting only of transmit data, receive data, and ground, is commonly used since the full facilities of RS232 are not required.
A DSUB9 connector must connect the following leads:

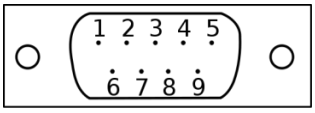


Figure 17: MPU DSUB9 male DTE pin layout (socket view)

DSUB9 pin	Connector	Name	Signal
3	17	STD_TXD	RS232 MPU transmit
2	16	STD_RXD	RS232 MPU receive
5	3	GND	Common ground

6.3.4 Wiring the APU RS232 Serial Interface

The Multifunction cable includes the RS232 to the the APU.
The APU itself provides the Ethernet interface. The RS232 interface is only used as a console access to the Linux system.
PS HT Laser Scanner are classified as Data Terminal Equipment (DTE). According to the standard, PS HT Laser Scanner shall be equipped with male connectors. A “null modem cable” consisting only of transmit data, receive data, and ground, is commonly used since the full facilities of RS232 are not required.

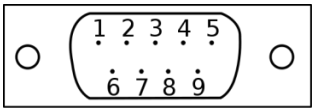


Figure 18: APU DSUB9 male DTE pin layout (socket view)

DSUB9 pin	Connector	Name	Signal
2	5	ORX	RS232 Communication board receive
3	6	OTX	RS232 Communication board transmit
5	3	GND	Common ground

6.3.5 Wiring Digital Outputs

PS HT Laser Scanner have two isolated digital switching outputs, called OUT1 and OUT2. These outputs can be programmed for different purposes.

- Maximum output current is 50 mA;
- Maximum voltage to be applied is 5 V;
- Output residual voltage is < 1 V;
- Power supply range at VCC_IO is 3.3 to 5 VDC (+/- 10%).

Connector	Name	Signal	Purpose
15	OUT1	Digital output 1	Digital switching output
14	OUT2	Digital output 2	Digital switching output

13	VCC_IO	Digital output support voltage	Support voltage for the digital inputs and digital outputs
2	24V DC-	Power supply	Ground

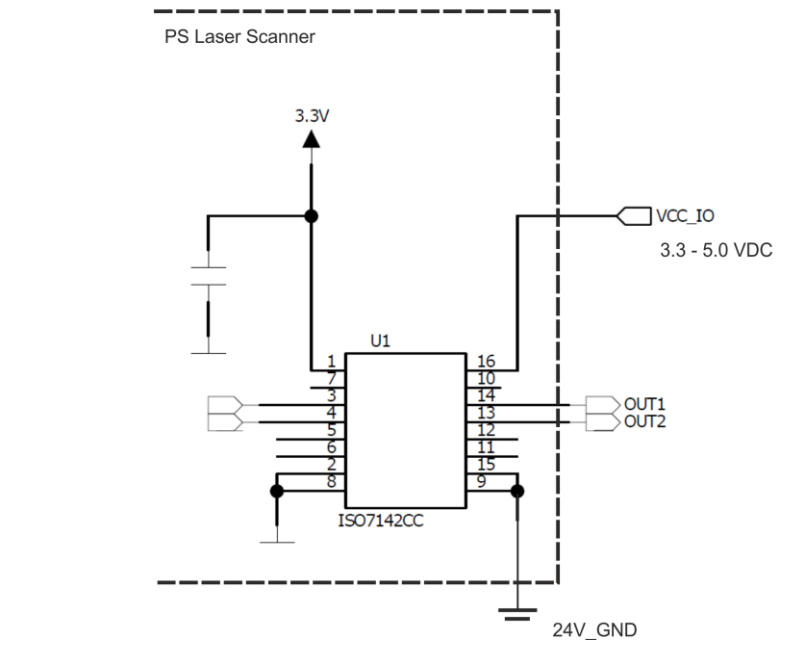


Figure 19: Digital outputs wiring scheme

6.3.6 Wiring Digital Inputs

PS HT Laser Scanner have two digital inputs, called IN1 and IN2. These inputs can be programmed for different purposes.

- Inputs are TTL;
- Maximum voltage to be applied is 5 V;
- Output residual voltage is < 1 V;
- Power supply range at VCC_IO is 3.3 to 5 VDC (+/- 10%).

Connector	Name	Signal	Purpose
9	IN1	Digital input 1	Digital input
10	IN2	Digital input 2	Digital input
13	VCC_IO	Digital output support voltage	Support voltage for the digital inputs and digital outputs
2	24V DC-	Power supply	Ground

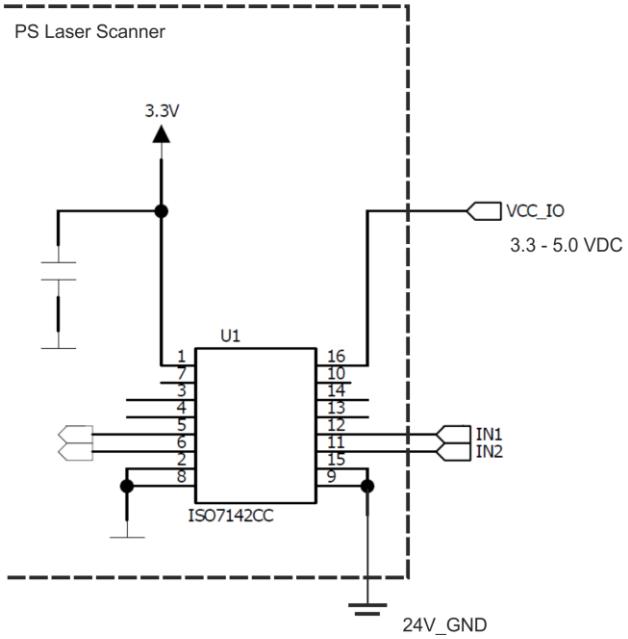


Figure 20: Digital inputs wiring scheme

6.3.7 Wiring an external incremental encoder

The PS HT Laser Scanner provide one 3.3 to 5.0 Volt incremental encoder input. Purpose of the external incremental encoder is to report changes in the horizontal position of the sensor.
The incremental encoder must provide two pulses A and B. The PS Sensor firmware counts these pulses in both directions by use of 32 bits register.
Input is limited to 128.000 counts/second.
Reset of the counter is done at startup or by software.

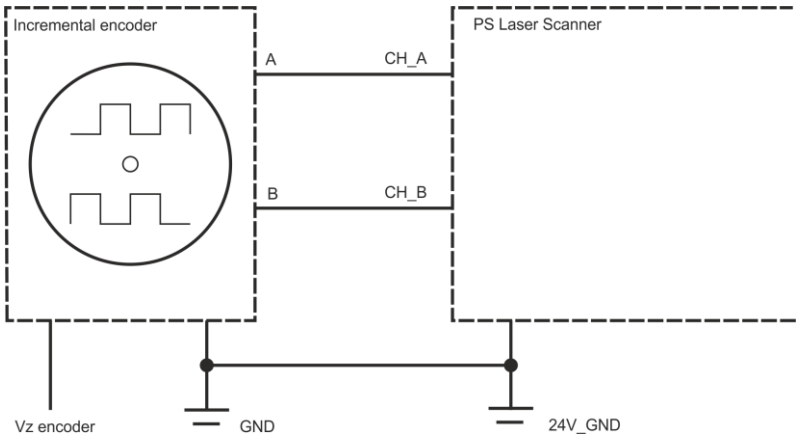


Figure 21: Incremental encoder wiring scheme

7 Microsoft Windows Software Tools

7.1 TeraTerm for the RS232 Serial Interface

TeraTerm is a very suitable program for the so-called Terminal Mode of the PS HT Laser Scanner. TeraTerm (author: T. Teranishi) is a free software terminal emulator and serial communication program for Windows.
Any other terminal program will be suitable as well.

1. Download TeraTerm from Triple-IN's web server.
2. Run the TeraTerm program installer.
3. Connect the EDM via a RS232 connection, using either a generic COM port or an USB-to-serial adapter.
4. Open TeraTerm and navigate to "`Setup > Serial port...`"
5. Choose the correct COM port.
6. Set the baud rate to 115200, 8 data bits, no parity, 1 stop bit, no flow control.

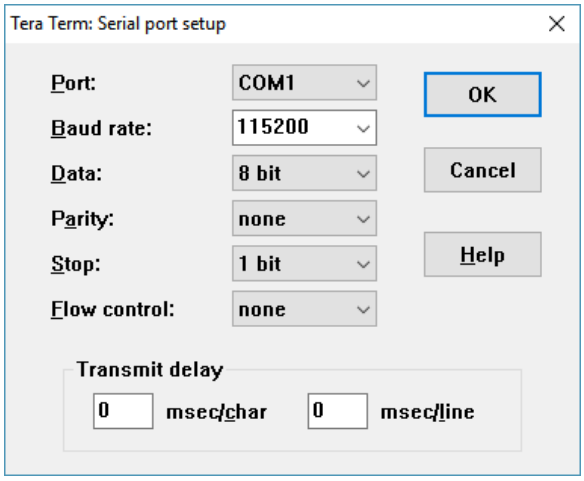


Figure 22: TeraTerm Serial Port setup dialog

7. Close the setup dialog.
8. If you want to store these settings for future use, go to "`Setup > Save setup…`"
9. Navigate to the TeraTerm installation directory and store the setup in TERATERM.INI.

7.2 TCP/IP Manager for managing network configurations

Triple-IN recommends the open-source Freeware “TCP/IP Manager” (author: A. C. Tundrea) to prepare the computer’s network settings for PS HT Laser Scanner. With this tool, you may simply save and restore network settings for PS HT Laser Scanner and standard Windows applications in different profiles.

1. Download TCP/IP Manager from Triple-IN’s web server.
2. Run the installer resp. unpack the ZIP file.
3. Start TCP/IP Manager.
4. Select in “`TCP/IP Settings > Network connection name`” the network adapter connected with the PS HT Laser Scanner.
5. Check if “`IP address`” matches the Gateway IP address as stored in the PS HT Laser Scanner. The default Gateway address is 10.0.10.0.
6. Check if “`Subnet mask`” matches the subnet mask as stored in the PS HT Laser Scanner. The default network mask is 255.255.0.0.
7. For later use, consider “`Network profile > Create a new profile`” to save the setup.
8. Choose “`Apply Settings`”.
9. To connect a PS HT Laser Scanner with the default settings:

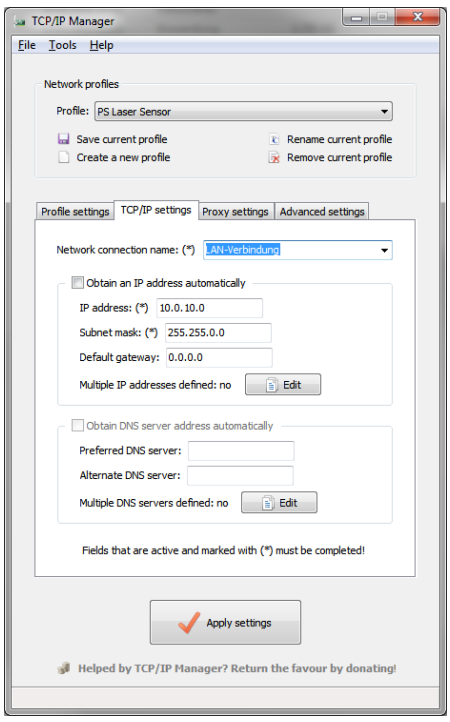


Figure 23: Network configuration with TCP/IP Manager

After disconnecting the sensor, you may use TCP/IP Manager to restore the Windows standards:

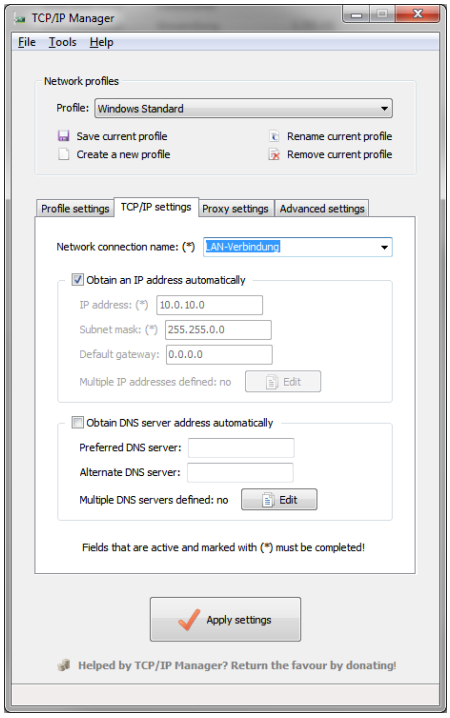


Figure 24: Restore the network configuration with TCP/IP Manager

1. Start TCP/IP Manager.
2. Select in "`TCP/IP Settings > Network connection name`" the network adapter connected with the PS HT Laser Scanner.
3. "`Obtain an IP address automatically`" should be checked.
4. For later use, consider "`Network profile > Create a new profile`" to save the setup.
5. Choose "`Apply Settings`".

7.3 Triple-IN PSControlProgram

Triple-IN's PSControlProgram is a PC application for controlling the functionality of Triple-IN Laser sensors via Ethernet connection. It makes the user able to set the user parameters of the sensor, start measurements, record the scans to files or show it on the chart or in the table.
The program is available on Triple-IN's web server.

To install the application please follow the instructions:

1. Start Windows installation program.
2. Confirm that you have administrator permissions to install the program.
3. The installer inspects the version information to use it during the installation process.
4. The product information (company, product name and version) is displayed on the screen if it's found during the analysis process.
5. Confirm installation.

A full description of the program can be found in the “PSControlProgram User’s manual”. The manual is part of the program distribution.

8 Setting into operation

8.1 Startup Procedure

Warning!

The device may only be switched on if it has been installed properly and in accordance with its intended use, including the required safety mechanisms and professional electrical hookup. This also applies for devices which have already been equipped with plugs and terminals or similar connectors by the customer.

To start the system:

1. Connect the control computer to the same network of the PS HT Laser Scanner.
2. Connect the power supply to the PS HT Laser Scanner.
3. After switching on the supply voltage, the scanner runs through a self-test. All LEDs are flashing. The firmware of the device checks important hardware components and parameters. Commands will respond to the control computer with a “device not ready” error.
4. The red LED is switched off after the self-test has passed successfully.
5.

Caution!

After disconnecting the sensor from power supply, you must wait 30 seconds before turning it back on. Otherwise capacitors not being discharged could leave the sensor peripheral not fully reset.

8.2 Serial RS232 Communication

8.2.1 Setting up the serial communication

PS HT Laser Scanner has serial RS232 interfaces to connect a control computer with the MPU. The RS232 is used for the initial setup of the PS Laser scanner.
The standard communication settings are:

Parameter	Value
Baud rate	**115200** bauds
Data bits	**8**
Parity	None
Stop bits	**1**
Handshake	No hardware or software handshake

The first serial interface, internally connected with the MPU, is used to program the TCP/IP connection parameters and to update the Measurement board firmware. This interface supports the so-called Terminal Mode (see next paragraph). After startup the terminal displays the sensor's serial number, IP address and self-test results.

```
PSxxx-90 HT
[PSFirmWare; 03.05.00.00; (c) Triple-IN GmbH 2019]

SN:         1234
Local IP:   10.0.12.34:1024
Gateway IP: 10.0.10.0:1025

- Running self-test…
- Self-test done.

Type 4 x ENTER to switch to Terminal Mode
```

Figure 25: MPU start-up and self-test messages

The second serial interface is connected to the APU and is used to access the Linux console.

8.2.2 Entering the Terminal Mode

The PS HT Laser Scanner provides a Terminal Mode as an additional user interface.
This is an ASCII oriented, human-readable menu structure and user interface.
The Terminal mode is entered after the user sends 4 successive carriage return characters from a RS232 terminal console.

```
_____________________________________________________________________________

 Terminal Mode
_____________________________________________________________________________
 1 - Show user parameter
 2 - Show system health status
 3 - Network configuration ...
 4 - Restore to factory settings
 5 - Show reference tables...

 E - Edit a parameter
 S - Take a scan

 0 - Exit to Run Mode
```

Figure 26: MPU terminal mode

Caution!

The Ethernet interface is not available while the sensor operates in the Terminal Mode.

Show user parameter

Lists the parameters set by the user. With the function "Edit parameter" these values can be edited.

Show system health status

Lists the results of the self-test. See Appendix A for information about the meaning of the single statuses.

Network configuration

Changes the IP settings to standard configurations.

Restore to factory settings

This function is used to set parameters to their default values.

Caution!

“Reset to factory settings” will reset all previously modified parameter values!

Show reference tables

Displays the firmware versions and parameter code reference tables.

Edit parameters

This function is used to change any parameter. The parameter codes are needed for this. After entering the parameter code, the firmware shows the current value, the measurement unit and the valid range of values. The program then asks whether the changed parameters should be stored in the flash.

```
> E
> Enter parameter ID:
3_

> Enter parameter "Scan mode: 0=off, 1=normal, 2=fast, 3=fine":
2_
```

Figure 27: Editing a parameter in Terminal Mode

Take a scan

Starts the motor and carries out a single scan. The result is presented as CSV table. This function shall be used to check the basic functionality of the sensor.

Switch laser marker

Switches the red laser marker on and off.

8.2.3 Binary Command/Control Interface

Control computer programs, such as PSControlProgram, communicate with PS HT Laser Scanner over Ethernet or serial RS232 by use of binary commands. A full reference of the binary command/control interface can be found in the “PS Plus Programmer’s Manual”.

8.3 Ethernet connection

8.3.1 About Network settings

PS HT Laser Scanner uses the Internet Socket Interface for communications over Ethernet. The sensor socket address is a combination of the IP address (the location of the sensor) and a port (which is mapped to the application program process) into a single identity.

8.3.2 Ethernet IPv4 addresses and ports to be configured

In the described communication pattern, the sensor provides some functionalities accessible through the Ethernet. Each one of these functionalities is identified as a "Service", and the control computer is the "Client".
More information can be found in the "PS Plus Programmer's Manual".

8.3.2.1 Sensor IPv4 addresses

The sensor has two different IP addresses configured and exposed to the outside:

- Predefined. Is automatically calculated from the serial number and cannot be changed. The network mask is `255.255.0.0` and it is calculated this way:

```
IP = 10.255.(serial / 100).(serial MOD 100)
```

- Custom. This address can be modified by the user. It is initially set with a default value calculated similarly to the Predefined:

```
IP = 10.0.(serial / 100).(serial MOD 100)
```

Example:

- The predefine IP address of sensor with serial number "1234" is `10.255.12.34`.
- The default IP address of the same sensor is `10.0.12.34`.

Caution!

The IP address set by the user cannot be the same as the Predefined.

The Port set by the user cannot be one of: `22`, `80`, `3007`, `6969` and `6996`.

8.3.2.2 Default client IPv4 address

The sensor has the possibility to start sending a scan data stream automatically on power on. This function is called "`AutoStart`". With AutoStart enabled, the sensor sends data to a predefined Client immediately. That predefined client is called the "`default client`". The user can define the IP address and port of the default client.

8.3.2.3 Gateway IPv4 Address

The Gateway in an Ethernet network serves the forwarding hosts to other networks when no other route specification matches the destination IP address of a packet. Often is the Gateway the router used to connect the local network with the World Wide Web.

8.3.3 Ports and Services

The sensor socket addresses are a combination of an IP address and a port (which is mapped to the application program process). Every available combination identifies a "Service".
The following are the services available by default on a sensor. As an example, we list the IP addresses for a sensor with the serial number as **1234**:

Service IP/Port	Protocol	Service	Description
10.255.12.34: 6969	TCP/IP	Scan and commands	Command communication line for configuration and online data stream
	UDP/IP	Scan and commands	Command communication line for configuration and online data stream
10.0.12.34:1024	TCP/IP	Scan and commands	Command communication line for configuration and online data stream
	UDP/IP	Scan and commands	Command communication line for configuration and online data stream
10.0.12.34:6996	UDP/IP	Announcement	A defined command sent to this channel will respond with the announcement message
10.0.12.34:3007	TCP/IP	Update	Used to send firmware updates to the sensor
10.0.12.34:22	TCP/IP	SSH	SSH access to the sensor
10.0.12.34:80	TCP/IP	Web interface	Access to the sensor web interface

8.3.4 Concurrent connections

Update and Commands TCP/IP listening Services are limited to one connection at a time. This means that if a TCP/IP Service is connected to a client, no other Client can use that service.

8.3.5 Using the RS232 Terminal Mode to change the Ethernet configuration

The sensor IP address and the Gateway IP address can be set in the RS232 Terminal Mode with the parameters "`Sensor IPv4 address`", "`Default client IPv4 address`", "`Gateway IPv4 address`", and "`IP Subnet Mask`".
The Terminal Mode includes a function "`3 - Network configuration ...`" for a simple IP setup. The following configurations are available and can be changed individually:

```
_____________________________________________________________________
 Network configuration menu

 Sensor IPv4 address is  10.0.12.34
 Client computer IPv4 address is 10.0.10.0
 Gateway IPv4 address is 0.0.0.0
_____________________________________________________________________

 1 - Set default sensor IPv4 address
 2 - Set static sensor IPv4 address
 3 - Set private sensor address (APIPA)
 4 - Edit sensor IPv4 address
 5 - Edit client computer IPv4 address
 6 - Edit Gateway IPv4 address
 7 - Edit network mask

0 – Exit
```

Figure 28: Network configuration in Terminal Mode

- Default sensor IP address which is created in address space 10.0.x.x according to the sensor serial number.
- A static sensor IP address which is 192.168.0.10 by default.
- Private sensor IP address (APIPA) which is 169.254.0.10 by default. APIPA addresses are for standalone Windows computers.

These IP settings can be changed individually after the default has been set:

```
> Enter Parameter “Sensor IP Address AAA.xxx.xxx.xxx”:
192
> Enter parameter “Gateway IP Address xxx.BBB.xxx.xxx”:
168
[…]
```

Figure 29: Network address edit in Terminal Mode

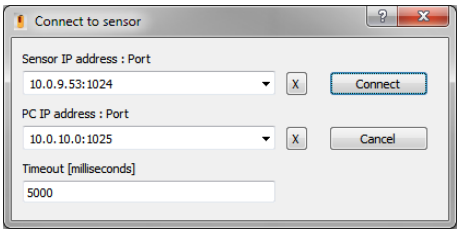
Caution!

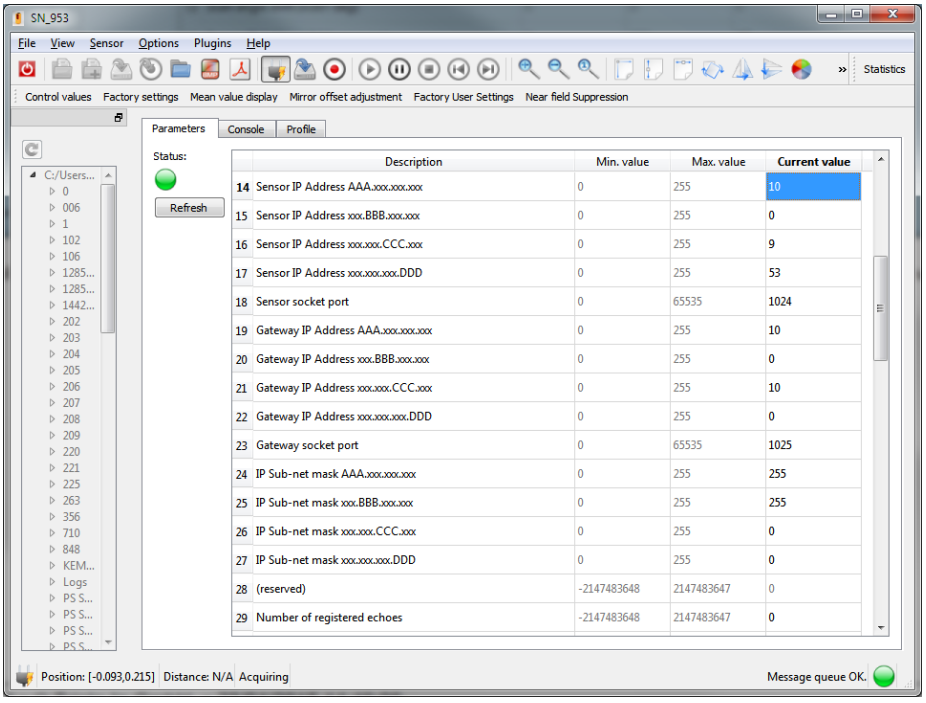
The sensor needs to be restarted after the network configuration has been changed.

The Ethernet interface is disabled while the Terminal Mode is active.

8.3.6 Changing the Sensor's network configuration using PSControlProgram

PSControlProgram is useful to change the sensors' default network settings over Ethernet:

1. Start PSControlProgram.
2. Choose button "Connect" to connect the application with a sensor. The IP and port dialog appears on the beginning of the connection progress.
3. Enter the sensor's standard IP address and the computer's IP address. Note that both addresses must be part of the same network.
4. 

5. PSControlProgram network connection dialog
6. Once the connection has been made, all parameters including the network settings can be changed on the "Parameters" view.


7. PSControlProgram parameters view
8. Switch-off and restart the sensor to apply the changed network settings.

8.4 Configuration

8.4.1 Ways of configuration

You can configure the PS HT Laser Scanner in different ways:

- Using the commands “GPRM get parameter” and “SPRM set parameter” of the binary command/control interface. This way is most suitable for computer programs, such as PSControlProgram;
- Interactively using the RS232 Terminal Mode;
- Interactively using the sensor’s web interface.

8.4.2 About User Parameters

The entire sensor configuration is stored in a table of user parameters. Every parameter has a number as unique parameter identification code. The user can edit the parameter either by use of the Terminal Mode, or over RS232 and Ethernet by use of binary commands.
A list of parameters can be found in the “PS Plus Programmers Manual”.

Caution!

Parameter identifiers always refer to a certain firmware version. Therefore, an individual parameter reference table exists for every firmware version.
You find the description of the binary commands for the processing of the user parameters in the “PS Plus Programmer’s Manual”.

8.5 Taking Scans

8.5.1 Setting up the Scan Mode

With each of the scan modes, the following measurement parameters are set:

1. Scan rate: number of scans per second.
2. Scan start direction: direction of the first measurement point of a scan.
3. Scan angle: size of the scan area in degree.
4. Scan angle step: small angle between two subsequent measurement points. Defined by the scan angle size and the number of measurement points.
5. Scan Angle Shift: small angle between the start directions of subsequent scans.

The scan mode can be set with the user parameter:

```
Scan mode: 0=off, 1=normal, 2=fast, 3=fine
```

8.5.1.1 Normal scan mode

The “Normal Scan Mode” is defined by the following parameters:

- Scan start direction: min. 45°
- Scan angle: max. 90° with 1000 points.
- Scan angle step: 90°/1000 points = 0.090°
- Scan Angle Shift: Normal-Mode scans are not shifted.

8.5.1.2 Fast scan mode

To achieve an increase on the scan rate, the point density must be reduced. In “Fast Scan Mode” the point density is halved, with the scan rate doubled accordingly.

- Scan start direction: min. 45°
- Scan angle: max. 90° with 500 points.
- Scan angle step: 90°/500 points = 0.180°
- Scan Angle Shift: Fast-Mode scans are not shifted.

8.5.1.3 Fine scan mode

If the scan rate is not important but the lateral resolution is, a shift between the scans may be introduced. This leads to more “scans/profile” and consequently to a better lateral resolution with overlapping spots and a reduced profile rate. This measurement mode is called “Fine Scan Mode” and is implemented by interlacing 4 Normal scan lines with 1/4 angle shift.

- Scan start direction: min. 45°.
- Scan angle: max. 90° with 4x1000 points interlaced.
- Scan angle step: 90°/1000 points = 0.090° that will be interlaced.
- Scan Angle Shift: each scan is shifted by 0.0225°.
- Four scans can be interlaced to a single profile with 4000 points.

8.5.2 Taking scans in Terminal Mode

The Terminal Mode function “Take a scan” creates a table with the latest profile scan. The ASCII format is “comma separated” and can be easily imported into Excel or Open Office.

1. Enter the Terminal Mode
2. Open in TeraTerm “File > Log...”. Check “Plain text” and disable “Append”

3. Choose a log file name and close the dialog. TeraTerm will now record all sensor outputs.
4. Choose “S – Take a Scan”
5. Close TeraTerm
6. The log file can be opened directly with a common spread sheet program like Excel or OpenOffice Calc.

```
Scan;
_____________________________________________________________________________
    1490.489; 1st Pulse time stamp[s];
    1490.489; Last pulse Time stamp [s];
           0; UTC[s];
           0; Incremental encoder position [counts];
      45.000; Scan start direction [dg];
       0.900; Scan angle [dg];
       0.090; Scan angle step [dg];
          10; Points in scan;
           0; Master echo (0=last echo);
        31.7; Temperature [Celsius];
           3; Mirror ;


_____________________________________________________________________________
 Pulse ;  Echo ;   Direction ;    Distance ; Pulse width ;      Signal;
       ;       ;      [deg]  ;        [m]  ;       [ps]  ;
_____________________________________________________________________________
     1 ;     1 ;      45.000 ;     24.6281 ;       10343 ;         103;
     2 ;     1 ;      45.090 ;     24.6317 ;       10343 ;         103;
     3 ;     1 ;      45.180 ;     24.6410 ;       10417 ;         104;
     4 ;     1 ;      45.270 ;     24.6412 ;       10368 ;         103;
```

The header of the table contains:

- Time stamp [s]: is the time in seconds since the sensor was started
- The UTC time as provided by the GPS, if available.
- Incremental encoder position [count]: is the count of the optional external incremental encoder.
- Profile start direction is the start direction of the profile, where 0 is upwards to the zenith.
- Scan angle: is the scanned area in degrees.
- Angle steps: give the scan resolution in degrees.
- Points in profile: give the length of the following measurements table.
- Master echo: 1 for the first echo or 0 for the last echo.
- Number of echoes: the number of echoes processed.

- Temperature: is the reading from the internal temperature sensor in Celsius degrees.

The measurements table contains:

1. Point: the number of the current point in the scan
2. Echo: the number of the evaluated echo. This value is always 1 if the Master Echo parameter has been set to “1=first echo”. The echo number varies from 1 to 4 if the Master Echo has been set to “0=last echo”.
3. Direction: direction to the target in degree.
4. Distance: distance in meters to the target surface.
5. Pulse width: echo signal pulse width in pico-seconds

8.5.3 Taking scans with Triple-IN’s PSControlProgram

Triple-IN’s PSControlProgram is a Windows application with user menu, toolbar, status line, workspace explorer bar and the data output widgets ordered in the tabs. User menu and main toolbar are providing the basic functionality for the system actions like connecting the program with a sensor, performing the scans, recording, loading or, exporting the data to “`*.csv`” files.
The program is available on Triple-IN’s web server.

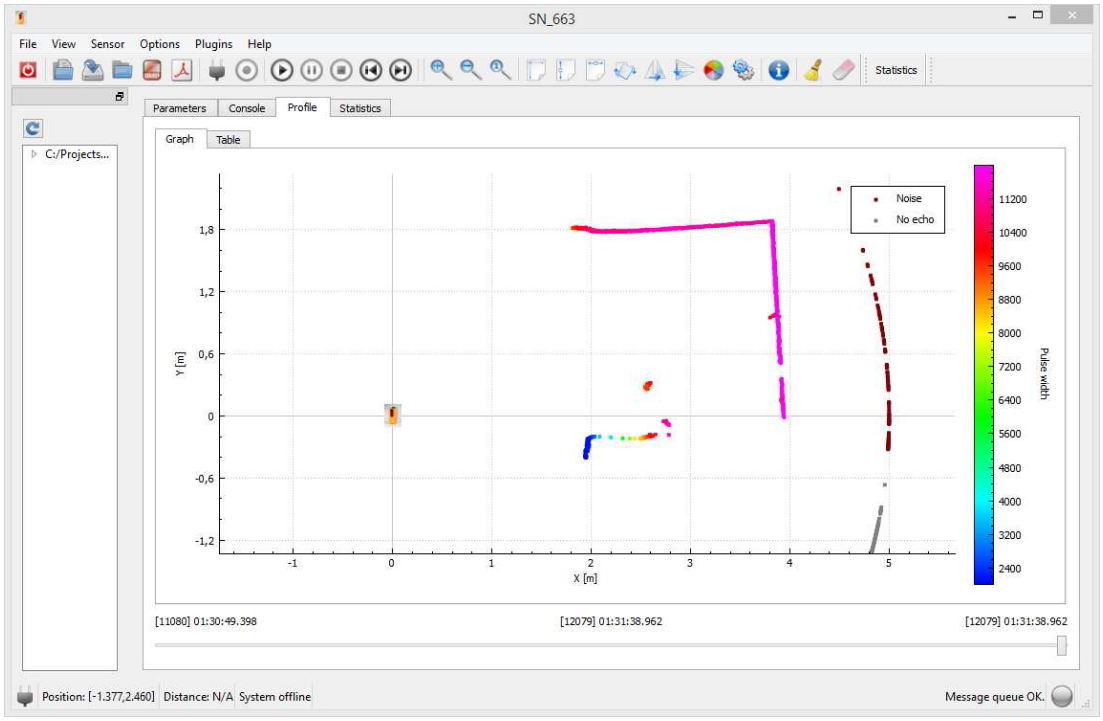


Figure 30: A scan taken with PSControlProgram

1. Connect to the PS HT Laser Scanner
2. Once online, the record button allows the user to write the scans to the binary files for later evaluation.
3. If the recording starts successfully the application starts to write the binary data to files. Every minute a new file of recorded profiles is created.
4. To easily find the files press “Open output directory” button on the toolbar and a File explorer window will be opened pointing at the correct directory.

8.6 Measurement filters

8.6.1 Near field suppression filter

The near-field suppression is used to suppress measurements to targets close to the sensor. This prevents the sensor to detect contamination of the optics.
PS HT Laser Scanner has optional, adjustable near-field suppression. This is divided up in zones, each with a width of 760 millimeter. Zone 0 defines the closest distance.
The near field suppression zone can be configured with the user parameter:

```
Near-field suppression zone, min=0
```

The current near field range can be obtained by the parameter

```
Const: Near field suppression range [0.1 mm]
```

Example:

Zone 3 has been set as near field suppression range. Any echo from a target in the range will be ignored:

```
Near_field_range = zone0 + zone1 + zone2 + zone3
```

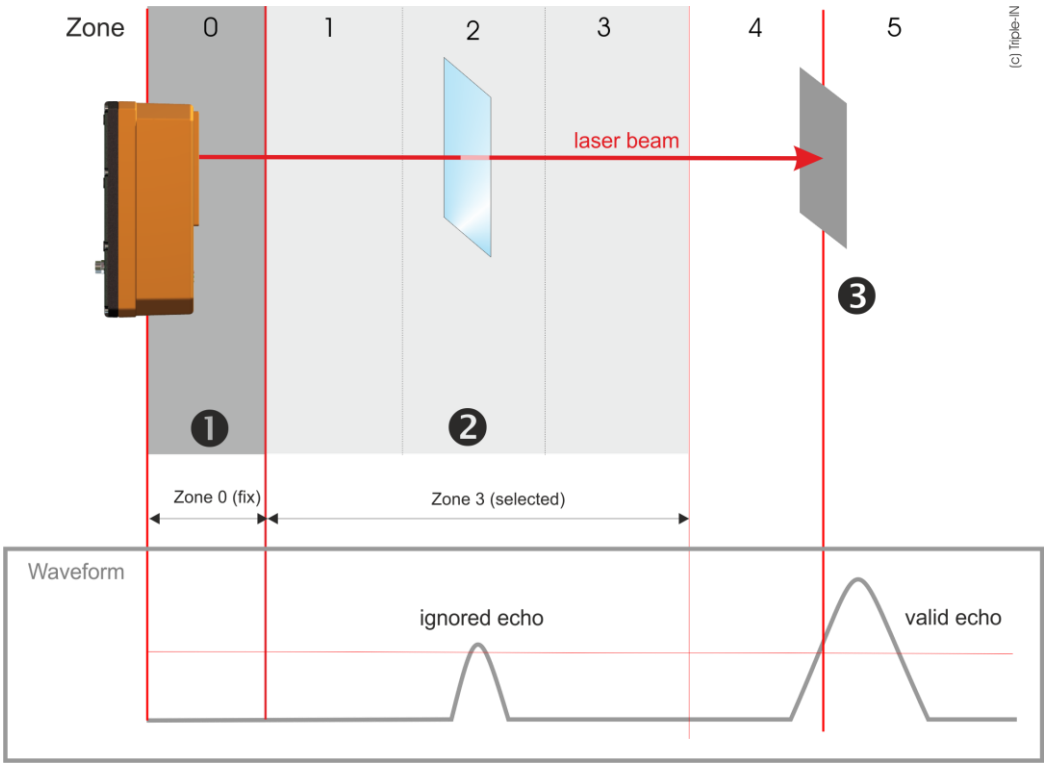


Figure 31: Near-field suppression: example with zone 3

8.6.2 Low echo filter

If the laser spot is only partly reflected by object edges, incorrect measurements may arise. A “low echo filter” removes measurements with echo signals less than 3%. To use the full range of sensitivity, the low echo filter can be disabled. The user parameter must be set to 0.

```
Low echo filter; 0=disabled, 1=enabled
```

8.6.3 High echo filter

If the laser spot is reflected by several surfaces, incorrect measurements may arise due to deformations of the echo signal. The “high echo filter” removes measurements which appear with very wide echo signal amplitudes.
The high echo filter can be disabled to allow measurements on reflectors and reflecting foil. The user parameter must be set to 0.

```
High echo filter: 0=disabled, 1=enabled
```

8.7 Master echo selection

At measuring through rain, through protection windows, or in dusty surroundings several objects may reflect the laser beam. PS HT Laser Scanner can process until 4 echoes but some of the data format can return only one or two. In those formats, the “Master Echo” identifies which echo of the 4 processed is returned.

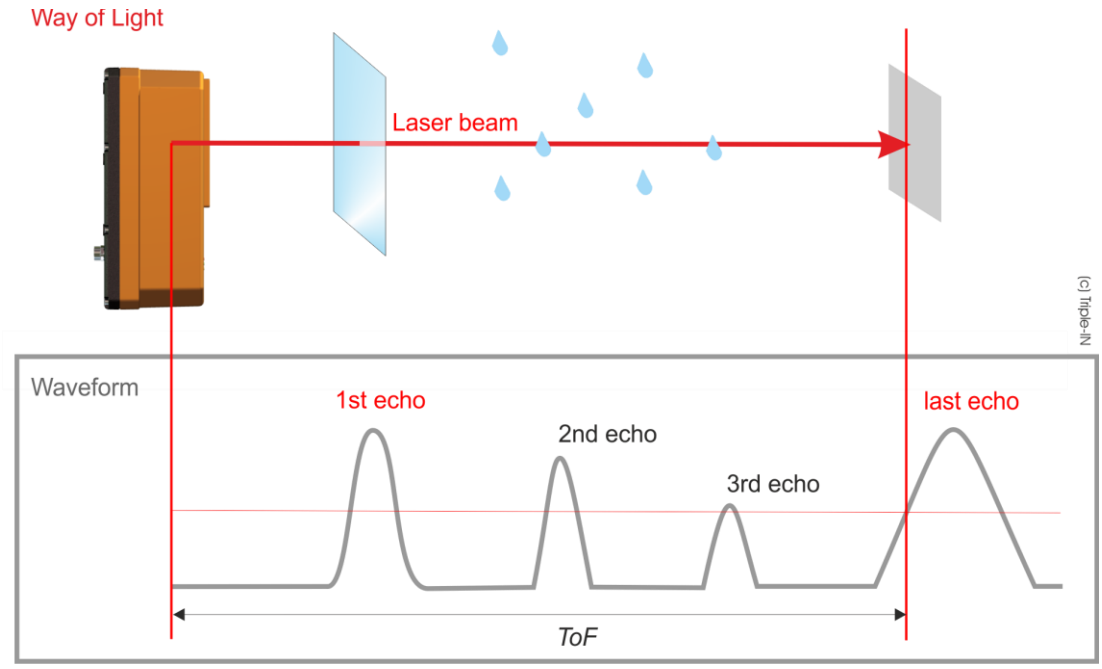


Figure 32: Multi-echo

The user parameter “Master echo” is used for configuration:

```
Master echo: 0=last, 1-4=echo index
```

- Scans contain the first echo (closest object) if the parameter has been set to “1”.
- Scans contain the second, third or fourth echo if the parameter is set respectively to “2”, “3” or “4”.
- If the parameter is set to “0”, the last and furthest measuring is returned.

8.8 Using Digital Outputs

8.8.1 Using the digital outputs as scan synchronization signal

One single digital output can be configured to provide a scan synchronization signal. The signal is set active with the first laser pulse, and it is set inactive with the last laser pulse of a scan.
The scan synchronization signal allows an accurate synchronization with other devices.
The scan synchronization signal is set active by setting the user parameter

```
Digital output function: 1=sync
```

8.8.2 Using the digital outputs as pulser

User applications can set a counter value in advance to produce output signals of a specific count.
This function permits a control computer to transmit a counting stand or volume information as digital signals to another system. All digital switching outputs can be used independently. The pulser feature is set active by setting the user parameter

```
Digital output function: 3=pulser
```

The counter value must be written into the parameter:

```
Digital output pulser setup
```

The sensor firmware copies this value, sets the parameter register back to 0, and starts the count down. After this, new counts can be added to current output by writing another counter value. Make sure that the parameter “Digital output pulser setup” has reached 0 before adding new counts.
The hold time can be defined by the user parameter:

```
Digital output hold time [ms]
```

The delay between counter signals can be defined by the user parameter:

```
Digital output delay [ms]
```

The resolution of both timing parameters is about 10 ms.

Example:

The following parameter setup:

```
53;  3; 1st Digital output function: 0=off, 1=sync, 2=switch, 3=pulser;
56; 10; 1st Digital output hold time [ms];
57; 20; 1st Digital output delay [ms];
58;  0; 1st Digital output logic: 0=normal, 1=low active;
59;  3; 2nd Digital output function: 0=off, 1=sync, 2=switch, 3=pulser;
62; 30; 2nd Digital output hold time [ms];
63; 40; 2nd Digital output delay [ms];
64;  1; 2nd Digital output logic: 0=normal, 1=low active;
```

In conjunction with the counter parameters:

```
55;  4; Temp: 1st Digital output: pulser setup;
61;  2; Temp: 2nd Digital output: pulser setup;
```

Results in the following signal pattern:

Figure 33: Digital output example signal pattern

8.9 Using digital inputs

8.9.1 Pulse per second PPS

A pulse per second (PPS) is an electrical signal that has a width of less than one second and a sharply rising or abruptly falling edge that accurately repeats once per second. PPS

signals are typically provided by GPS receivers and are used for precise timekeeping and time measurement.
PS HT Laser Scanner supports the PPS signal in the following way:

1. The internal sensor clock provides an internal counter on millisecond base.
2. Each rising edge of the PPS signal increases a full second counter and resets the millisecond counter to 0.

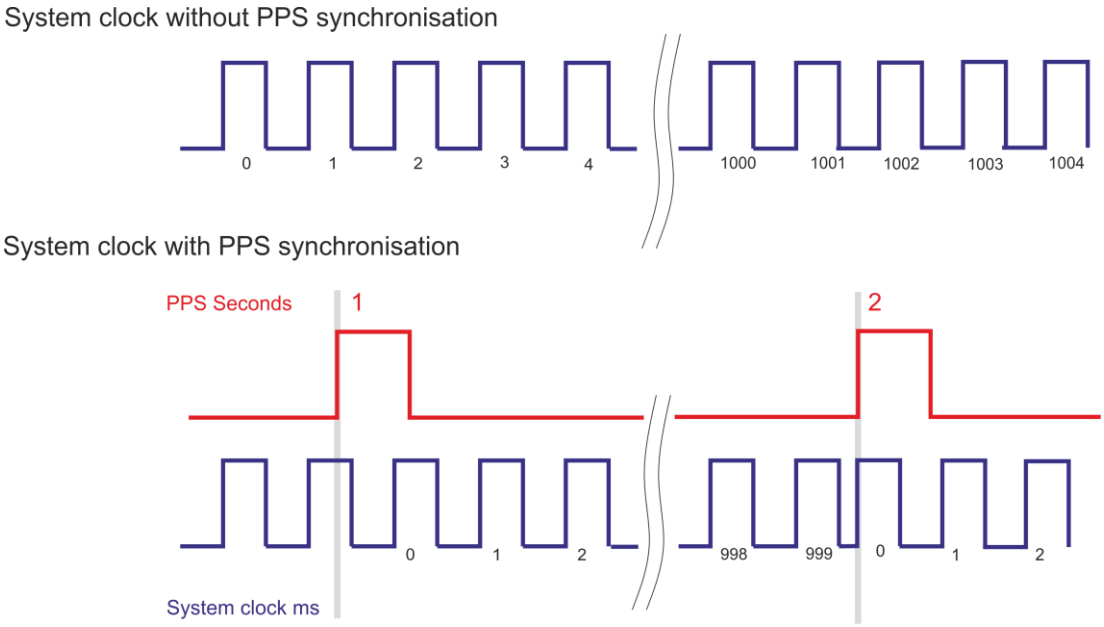


Figure 34: PPS signal

3. If the PPS signal occurs before a full sensor second, then the time stamps between PPS and sensor seconds are skipped.
4. If the PPS signal occurs after a full sensor second, time stamps may occur twice.
5. If the PPS input has been enabled, but no PPS source is connected, the internal clock continues to count milliseconds and provides the time stamp.

Only one single digital input can be used for the PPS signal. The sensor selects the first digital input defined.
The feature is set active by setting the parameter `IN function` to "`2=PPS`":

```
Digital Input function: 2=PPS
```

The current number of PPS signals received can be obtained with the temporary user parameter "Digital input status".

8.9.2 Configure PPS and GPS

PPS source is commonly a GPS receiver, which provides also the accurate UTC time stamp. PS laser scanners provide a RS232 input to receive GPS NMEA protocols.
To activate and use the UTC time, the following parameter must be set:

```
95; GPS NMEA sentence: 0=off, 1=prev. PPS, 2=next PPS;
96; GPS Receiver RS232 baudrate;
```

Parameter “95 GPS NMEA sentence” defines the relation of the PPS signal with the NMEA sentence that contains the UTC timestamp:

- `1=prev`:
  PPS occurs before the related NMEA sentence. This is a kind of standard for most GPS receivers.
- `2=next`:
  First the NMEA sentence gives the UTC, then the related PPS signal will be set.

After the connection has been made, the parameter “97 UTC Unix time stamp [s]” is updated periodically with the sensor system time. The unix time stamp is the number of seconds since the Unix Epoch on January 1st, 1970.

8.10 Disabling the Status LEDs

The PS HT Laser Scanner has three status LEDs, which can be permanently turned off with the user parameter:

```
Front side LEDs: 0=disabled
```

8.11 Measurement for adjusting the Shutter blade

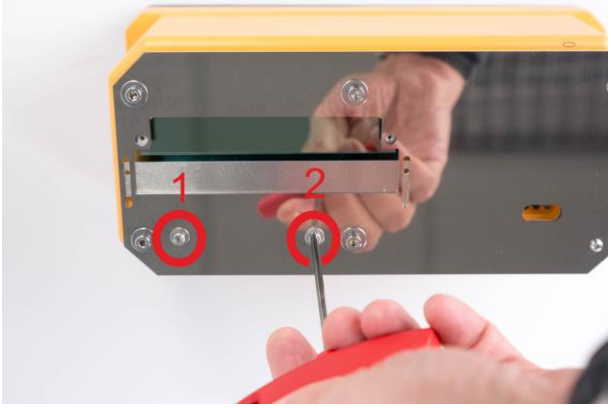
Adjusting the shutter blade will reduce thermal light to which the laser receiver is exposed. The shutter plate reduces the thermal light falling from glowing surfaces onto the laser receiver.

Danger!
The surface of the heat shield may be hot. Wear protective gloves!

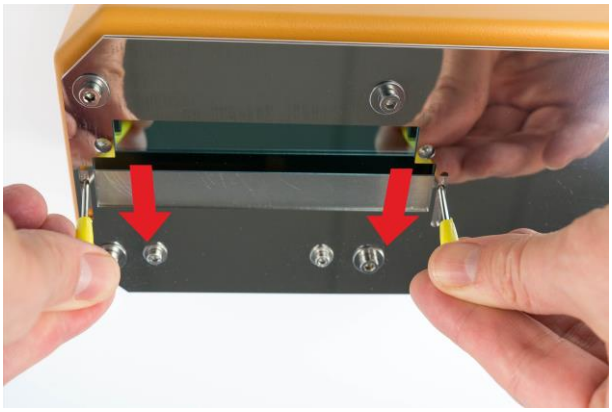
To adjust the shutter blade, the following tools must be used:

- A 2.0 mm hexagon socket screw driver to unlock the fixing screws
- two 2.0 mm diameter metal pins to move the shutter blade

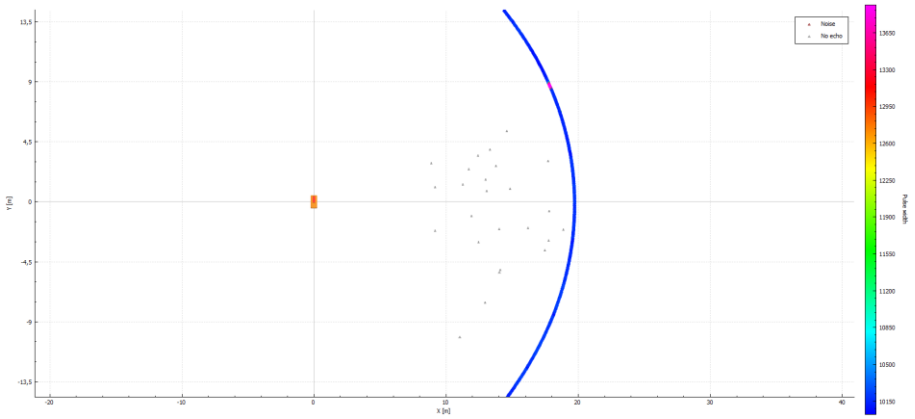
1. Loosen the two fixing screws by use of the hexagon screw driver.



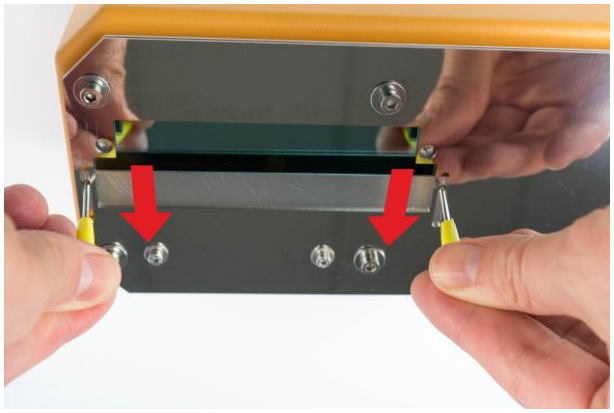
2. Put the metal pins into the holes of the shutter blade.
   Push the shutter blade back to the stop position. The window must be completely open.



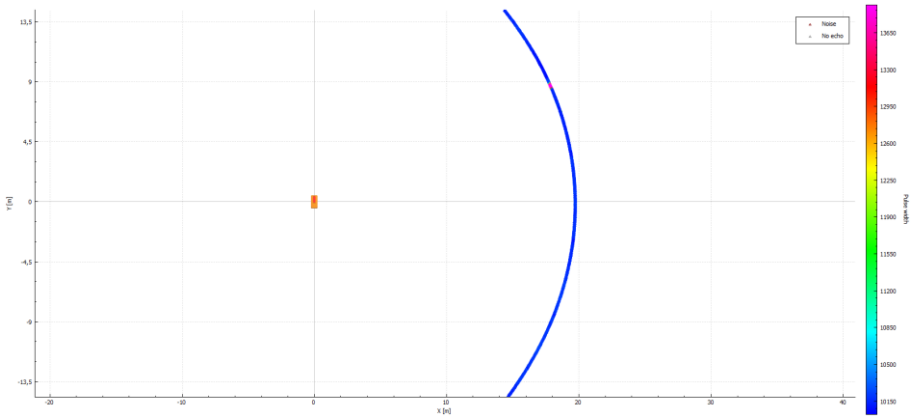
3. Start PSControlProgram. Watch on the monitor if noise measurements appear.



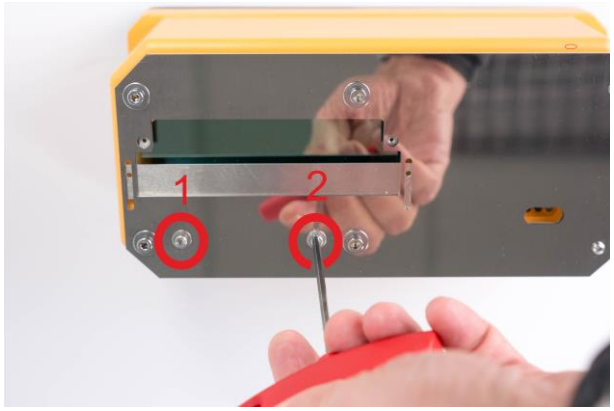
4. Close the shutter blade carefully. Watch on the monitor how the noisemeasurements decrease.



5. As soon as no noise measurements can be observed, stop closing the shutter.



6. Fix the blade with the two fixing screws.



9 Web interface

The PS HT Laser Scanner provides a Web interface useful to check the sensor status and to make some configurations, like quick changes on user parameters.

9.1 Sensor information page

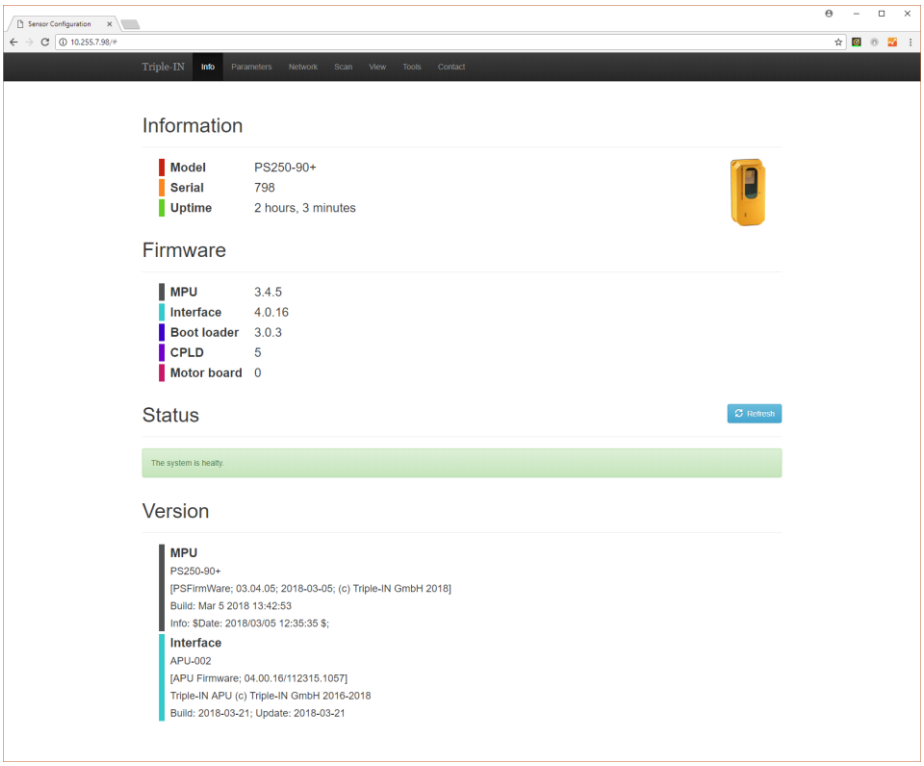


Figure 35: Web interface Info page

The Info page offers a glance on the sensor status and version. The four sections described below are available.

Information

Contains the sensor model, serial number and uptime (time since the previous power-up/restart of the APU).

Firmware

Shows the firmware version of the various sensor parts:

1. MPU, Measurement Processing Unit

2. APU, Application Processing Unit
3. Boot loader (MPU boot loader)
4. CPLD (Internal controlling circuit)
5. Motor board (vertical deflection unit motor controller)

Status

In this section are shown all the issues the sensor can incur into. See Appendix A for more information.

Version

Shows detailed version information for the MPU and for the APU.

9.2 User parameters page

In this page, all the User Parameters are shown.

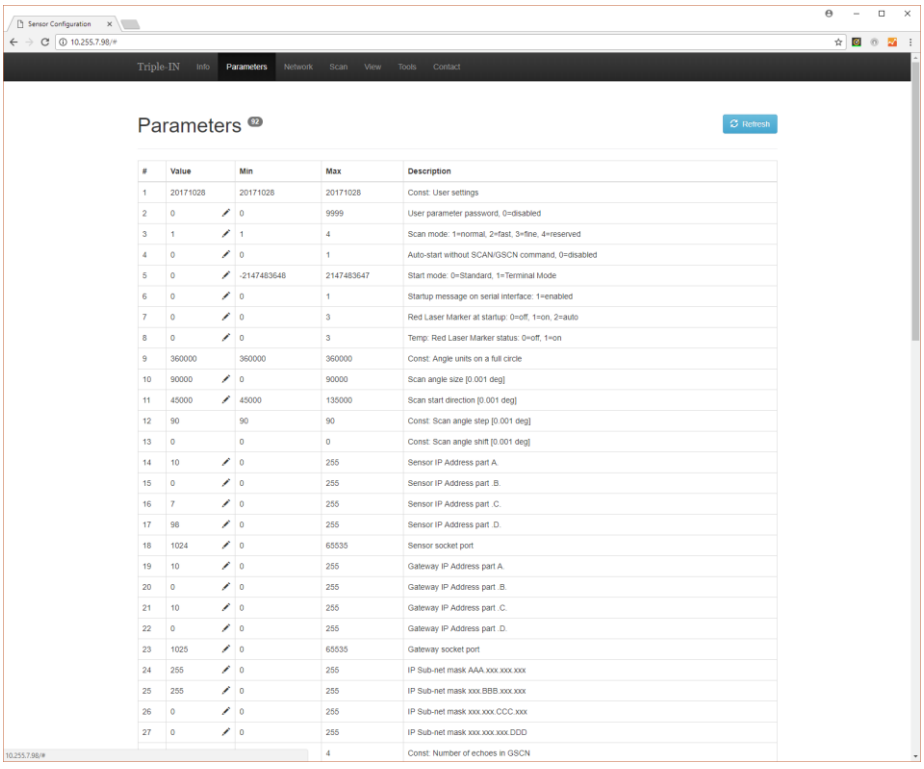


Figure 36: Web interface Parameters page

The value of editable parameters can be modified just clicking on the pencil icon placed on the right of the value.

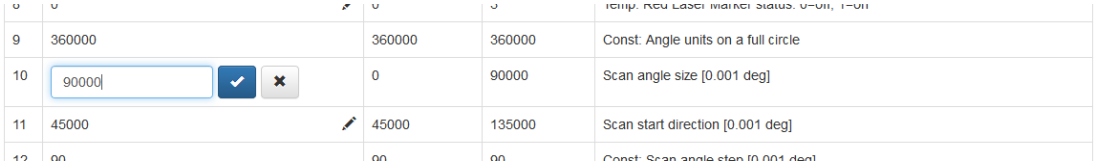


Figure 37: Changing a parameter value on the Web interface

To confirm the modified value just click on the blue button on the right. Click on the gray button to keep the previous value.

9.3 Network page

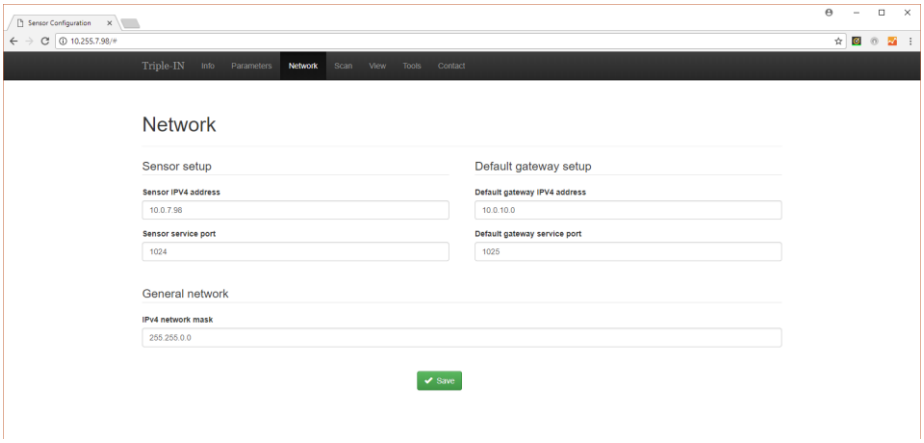


Figure 38: Web interface Network page

The Network page, offers a simple way to modify the sensor network settings. Just modify the values as needed and press on the green **Save** button.

9.4 Scan page

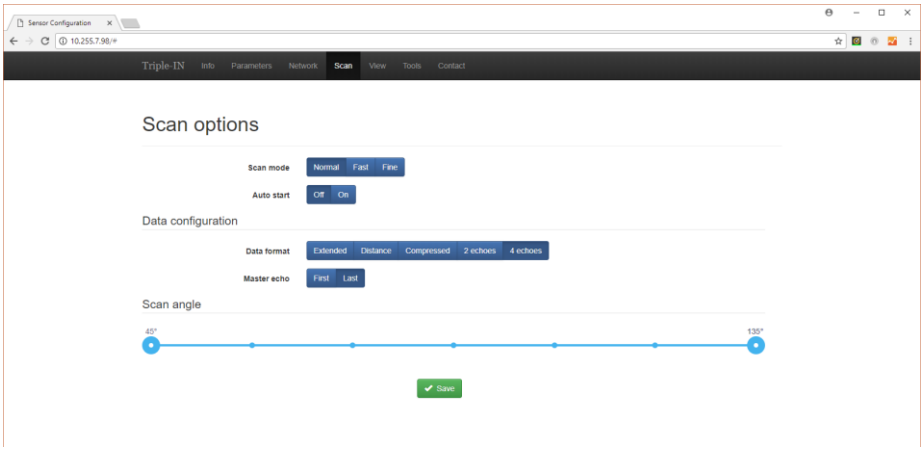


Figure 39: Web interface Scan page

In the Scan page, it is easy to modify in one shot the user parameters defining the returned scan lines.

1. Scan mode
2. Auto-start feature
3. Data format
4. Master echo
5. Scan start direction
6. Scan angle size

9.5 View page

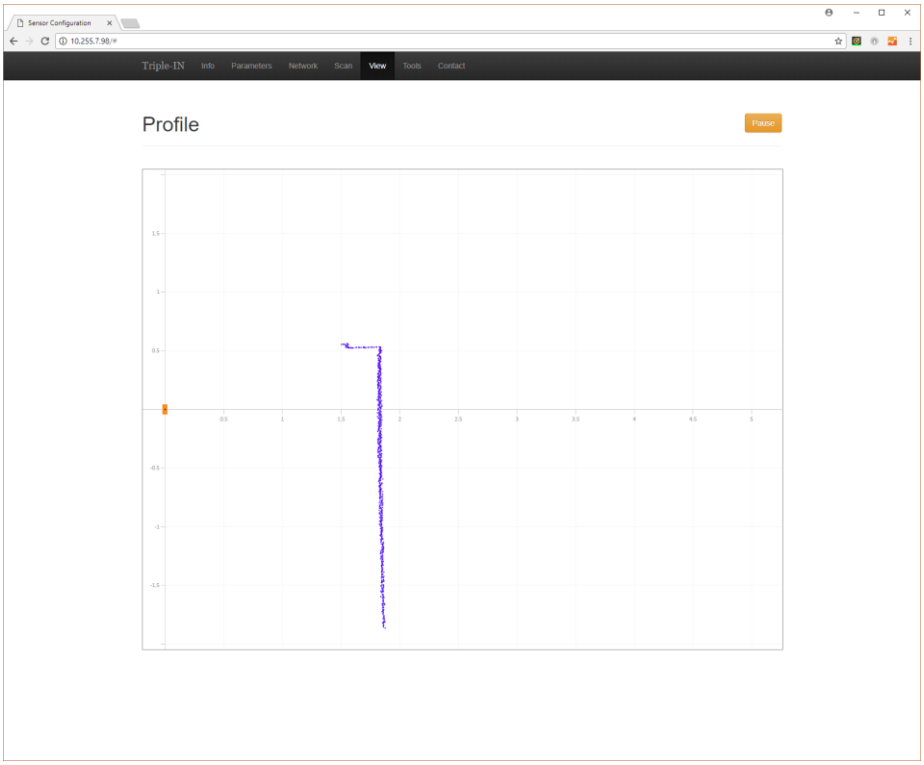


Figure 40: Web interface View page

The View page offers a preview of the scan line produced by the sensor.

Caution!

The display frequency in this page is sensibly lower than the real scan frequency. Delays between the acquisition time and display time can be in the order of few seconds.

9.6 Tools page

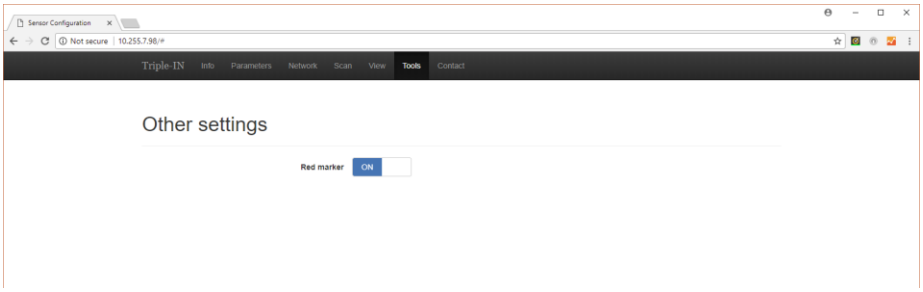


Figure 41: Web interface Tools page

This page offers the possibility to access to some special tools or settings.

9.7 Contacts page

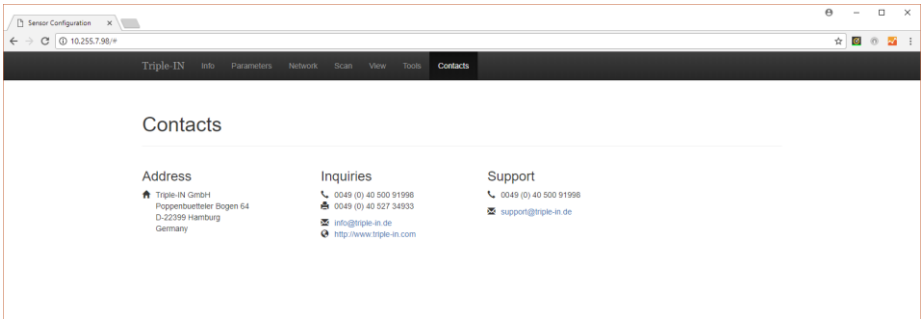


Figure 42: Web interface Contacts page

This page shows the various way to contact Triple-IN.

10 Firmware update

10.1 Updating MPU firmware

The MPU firmware of the PS HT Laser Scanner can be updated over the serial interface by use of the XMODEM protocol. The sensor supports XMODEM-CRC and XMODEM-1K variants to improve performance and transfer safety.

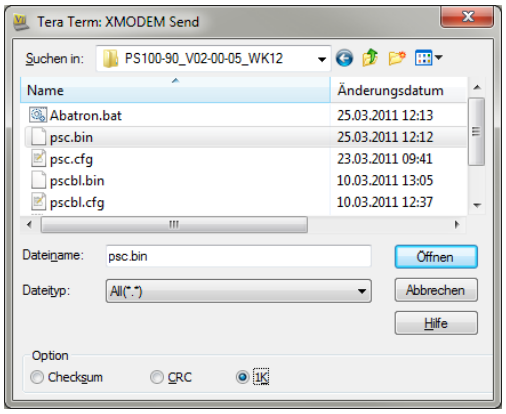
Warning! Risk of malfunctions.

Carefully read this entire instruction before you start updating your sensor.
Do not power off the sensor until the firmware is updated!

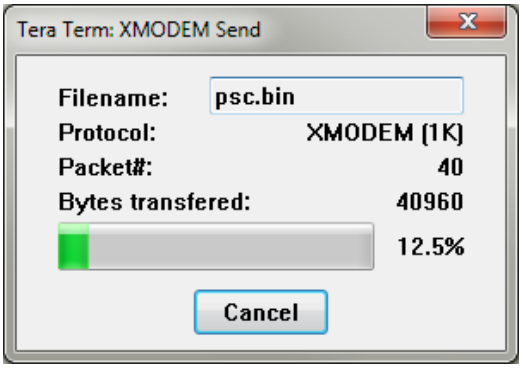
1. Download the latest firmware image from Triple-IN's Homepage.
2. Make sure that the "MPU RS232" lines of the serial interface connector are connected to the serial interface of your computer.
3. Switch the sensor **on**.
4. Start TeraTerm. Wait until the following message has appeared on the terminal:

```
Type 4 x ENTER to launch Terminal Mode
```

5. Switch the sensor **off**.
6. Choose `File > Transfer > XModem > Send...`
7. Locate and single click on the required firmware binary file.
8. Select 1K from the options at the foot of the dialogue and click "Open"



9. When the XMODEM Send dialogue is displayed in TeraTerm, power the sensor on
10. Data will start transferring to the sensor. TeraTerm will display progress:



11. Once the firmware has been transferred, the sensor will update the firmware in the flash memory. This process needs about 30 seconds.

```
- new firmware; size: 328704
- unlock and erase 20 blocks from 1 to 20
- Programming from RAM 0x04001000  to ROM 0x00008000  = 164352 words
```

12. The sensor will now reboot the new firmware.

```
PS Laser Scanner
[PS Firmware; 03.05.xx; 2019-01-20; (c) Triple-IN GmbH 2018]

SN:         1234
Local IP:   10.0.12.34:1024
Gateway IP: 10.0.10.0:1025
```

For a clean restart, finally switch the sensor off and on again.

10.2 Updating APU firmware

The APU firmware of the PS HT Laser Scanner can be performed using the Ethernet connection.
Download from the Triple-IN's web server the command line utility "TISendUpdate" and decompress the content of the archive. The folder directory will look like this:

```
02/06/2015  17:09           119 822 libgcc_s_dw2-1.dll
02/06/2015  17:09         1 537 038 libstdc++-6.dll
02/06/2015  17:09            80 384 libwinpthread-1.dll
06/11/2017  14:07               456 README.txt
06/11/2017  14:28         1 043 549 tisendupd.exe
```

The firmware upgrade is performed using a reserved TCP/IP connection on the port 3007. Using the tool "tisendupd.exe" the update is easy and safe. Just open a command prompt and write the command using this format:

```
tisendupd.exe –o UPDATE_FILE –a IPADDRESS[:PORT]
```

The PORT field can be omitted, and the default port will be used (3007).

```
C:\tisendupdate>tisendupd.exe -o 20180321.ttu -a 10.255.7.98
APU-002
[APU Firmware; 1.00/111B06.3315(rc2)]
Triple-IN Ethernet Updater (c) Triple-IN GmbH 2015-2017

- Connecting to: 10.255.7.98:3007 ...
  Connected!
- The device has accepted our request.
  > 256.0 KB transferred by now...
  > 512.0 KB transferred by now...
  > 768.0 KB transferred by now...
  > 1024.0 KB transferred by now...

…

  > 7.3 MB transferred by now...
  > 7.5 MB transferred by now...
  > 7.8 MB transferred by now...
  File completely sent. 7.9 MB transferred.
  The update process may take a while. Please wait...
- The device has received the update file.
- The device has checked the update file.
- The device is processing the update file.
  System is still updating. 4 minutes until timeout

…

  System is still updating. 4 minutes until timeout
- The update process is complete.
The device is updated.
Please restart it if needed!
```

As soon as the tool will finish its work, the APU will be restarted to complete the update.

11 Troubleshooting

11.1 Self-test messages and System Health status

PS HT Laser Scanner performs a self-test at startup and check various hardware components. All LEDs are blinking during the self-test.
The result of the self-test is reported on the RS232 of the MPU board.

```
PSHT Laser Scanner
[PSFirmWare; 03.05.00.00; (c) Triple-IN GmbH 2019]

SN:         1234
Local IP:   10.0.12.34:1024
Gateway IP: 10.0.10.0:1025

- Running self-test ...
- Warning: Check Ethernet!
- Error: Measurement clock error
- Self-test done.

Type 4 x ENTER to switch to Terminal Mode
```

Figure 43: Startup message with errors and warnings

The Terminal mode provides the function “2 - Show system health status”:

```
 System Status & Self-test results;
_____________________________________________________________________
 Bit;       Result;  Message
_____________________________________________________________________
   0;           OK;  Warning: System not ready.
   1;           OK;  Warning: Scan buffer is empty.
   2;        check;  Warning: Sensor operates in Terminal Mode.
   3;     disabled;  Digital output failure!
   4;           OK;  Warning: Digital input failure!
   5;           OK;  Warning: Check external incremental encoder!
   6;           OK;  Warning: Check mirror motor!
   7;           OK;  Warning: Check angle encoder!
   8;     disabled;  Check field of view!
   9;           OK;  Warning: Temperature out of operating range!
  10;           OK;  Warning: Check Ethernet!
  11;     disabled;  (reserved)
  12;           OK;  Warning: Factory setup not complete!
  13;     disabled;  (reserved)
  14;     disabled;  (reserved)
```

```
   15;     disabled;  (reserved)
   16;     disabled;  (reserved)
   17;           OK;  Warning: Laser Power Control is switched off!
   18;           OK;  Warning: Check KEM-IC delay unit!
   19;           OK;  Error: Measurement clock error
   20;     disabled;  (reserved)
   21;     disabled;  (reserved)
   22;     disabled;  (reserved)
   23;     disabled;  (reserved)
   24;     disabled;  (reserved)
   25;        check;  Warning: Measurement laser is switched off.
   26;     disabled;  (reserved)
   27;           OK;  Warning: Measurement laser failure.
   28;           OK;  Warning: Firmware update needs factory reset.
   29;           OK;  Warning: Check Communication Board version!
```

Figure 44: System Health and Self-test bits in Terminal Mode

The following problems can be solved by the user:

11.2 Fixing self-test warnings

11.2.1 "Warning: User Parameter File was restored!"

The user parameter setup got lost, probably due to a power-off while parameters were written to the internal non-volatile memory.
Enter the terminal mode and check the user parameter setup.

11.2.2 "Error: Temperature out of operating range!"

The sensor is too hot or too cold. Disconnect immediately from power supply and check the environmental conditions. Let the sensor operate only in its specified temperature range.

11.2.3 "Warning: Check Ethernet!"

Check the Ethernet connections.
Restart the sensor to apply changed IP settings.

11.2.4 "Warning: Firmware update needs factory reset."

The firmware has been updated, but the parameter setup does not match for the new version. Restart the sensor. The sensor will ask for a parameter update.

11.2.5 “Error: Check I/O Board version!”

The MPU firmware has been updated and requires a newer version of the communication board firmware.

11.2.6 “Warning: System needs to restart”

Restart the system by power-off and power-on.

12 Technical Information Technical Specification

12.1 Ordering information

Model	Article number
PS HT1200	SR-HTXX-110Q-00
PS HT900	SR-HTXX-110P-00

12.2 Technical Data

Sensor		PS HT1200	PS HT900
	Article No.	SR-HTXX-110Q-00	SR-HTXX-110P-00
WORKING RANGE			
	@ Surface Temperature	1200°C > T > -10°C	900°C > T > -10°C
	Working range	15 m > range > 3 m	10 m > range > 2 m
ACCURACY DATA			
	Resolution (mm)	1	1
	Repeatability 1 σ @ strong signal (mm)	5	5
	Repeatability 1 σ @ weak signal (mm)	20	20
	Accuracy (systematic error) (mm)	≤ 5	≤ 5
SPOT PROPERTIES			
	Divergence in scan direction (°)	0.076	0.041
	Divergence in scan direction (mrad)	1.33	0.71
	Divergence perpendicular to scan direction (°)	0.029	0.029
	Divergence perpendicular to scan direction (mrad)	0.5	0.5
	Spot close to the sensor window (mm)	12 x 16	12 x 18
	Focusing distance (m)	20	20
SCAN AND PROFILE PROPERTIES			
	Maximum scan and profile angle (°)	90	90
	Scan mirror type	4-mirror polygon	4-mirror polygon
	Maximum scanning duty cycle	50%	50%
OPERATIONAL MODES			
Normal Mode			
	Scan angle step (°)	0.09	0.09
	Measurements in 90° scan	1000	1000
	Scan rate (Hz)	30	30

Sensor		PS HT1200	PS HT900
	Scan time @ 90° scan (ms)	16.65	16.65
	Gap between spots in scan (°)	0.014	0.049
Fine Mode			
	Scan angle step (°)	0.0225	0.0225
	Measurements in 90° scan	1000	1000
	Scan rate (Hz)	30	30
	Scan time @ 90° scan (ms)	16.65	16.65
	Number of scans per profile	4	4
	Profile rate (Hz)	7.5	7.5
	Profile time @ 90° scan (ms)	134	134
	Measurements per profile	4000	4000
	Gap between spots in scan (°)	-0.0535(overlap)	-0.0185 (overlap)
Fast Mode			
	Scan angle step (°)	0.18	0.18
	Measurements in 90° scan	500	500
	Scan rate (Hz)	60	60
	Scan time @ 90° scan (ms)	8.5	8.5
	Gap between spots in scan (°)	0.104	0.139

Sensor		PS HT1200	PS HT900
MULTI-ECHO EVALUATION			
	Evaluated echoes	Up to 4	
	Selectable echoes	From 1st to 4th or “first echo” or “last echo”	
LASER DATA			
Measurement Laser			
	Measurement laser type	Pulse Laser Diode	
	Wavelength (nm)	905	
	Safety Class; EN 60825-1; 94,96,01	1	
	Measurement or pulse rate (kHz)	Up to 60	
PROGRAMMABLE INTERNAL BOARD			
	Processor	ARM Cortex A8	
	Processing power	1 GHz	
	Board memory	512 MB	
	On-board flash storage	4 GB	
	Operating system	Linux OS	
HARDWARE INTERFACES			
	Ethernet		
	RS232	115 kBaud, 8n1	
	Digital outputs	2	
	Digital inputs	no	
	External encoder input	yes	
POWER SUPPLY			
	Power supply without heater	24 VDC +/- 10%	
	Power consumption without heater	0.33 Ampere, 8 Watt	
	Power consumption with heater	1.35 Ampere, 33 Watt	
	Direct power supply	✓	
	PoE power supply	✓	
	Start-up time (s)	< 30	
SENSOR PROTECTION			
	Ingress Protection rating	IP67	
	Operating temperature range	-10°C to +50°C	
	Storage temperature range	-10°C to +70°C	
	Enclosure	Aluminum, Die Cast; Seawater resistant	
	Enclosure finish	Powder coated	
	Front window	AR-coated glass	
	Ambient light protection	Ambient light control Mechanical shutter blade	
DIMENSIONS & WEIGHT			
	Height x Width x Length (mm)	247 x 121 x 109	
	Weight (kg)	2.8	

12.3 Dimensional drawings and outlines

Caution!

All drawings are without scale.

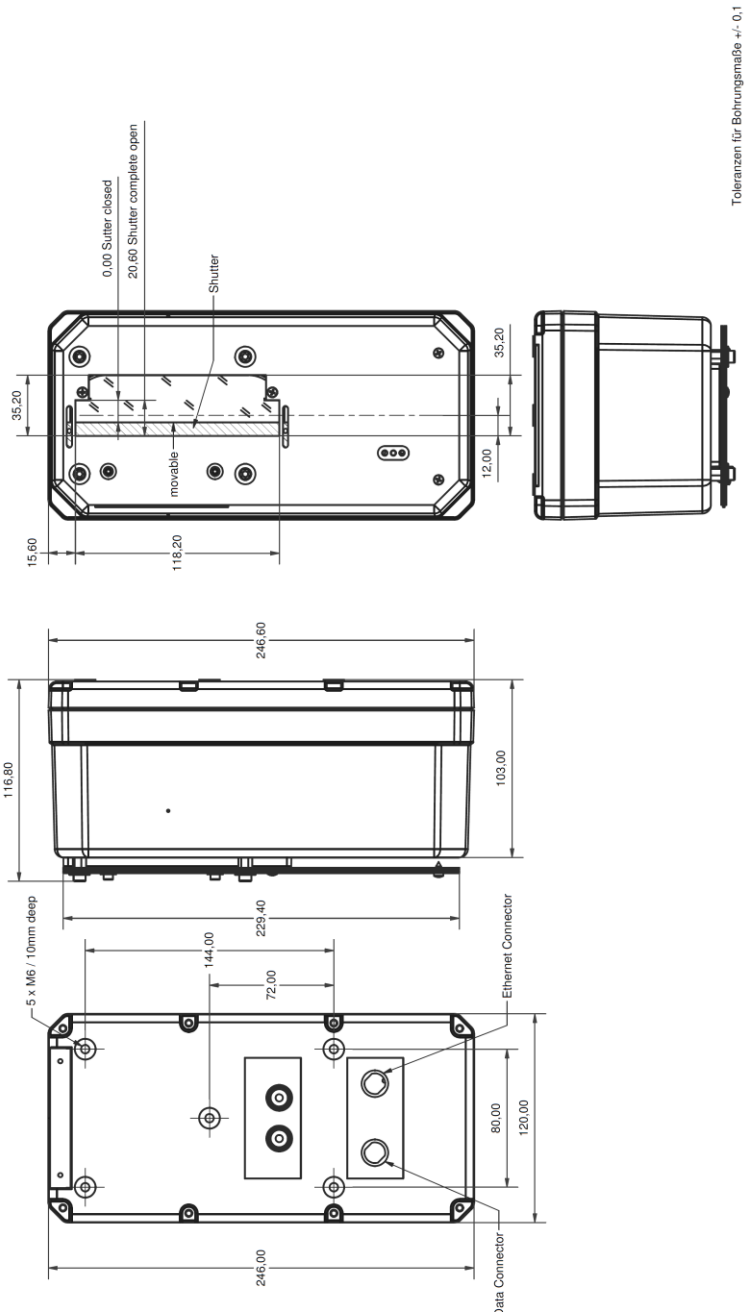


Figure 45: PS HT Laser Scanner Laser Scanner outlines (no scale)

12.4 Multifunction cable layout

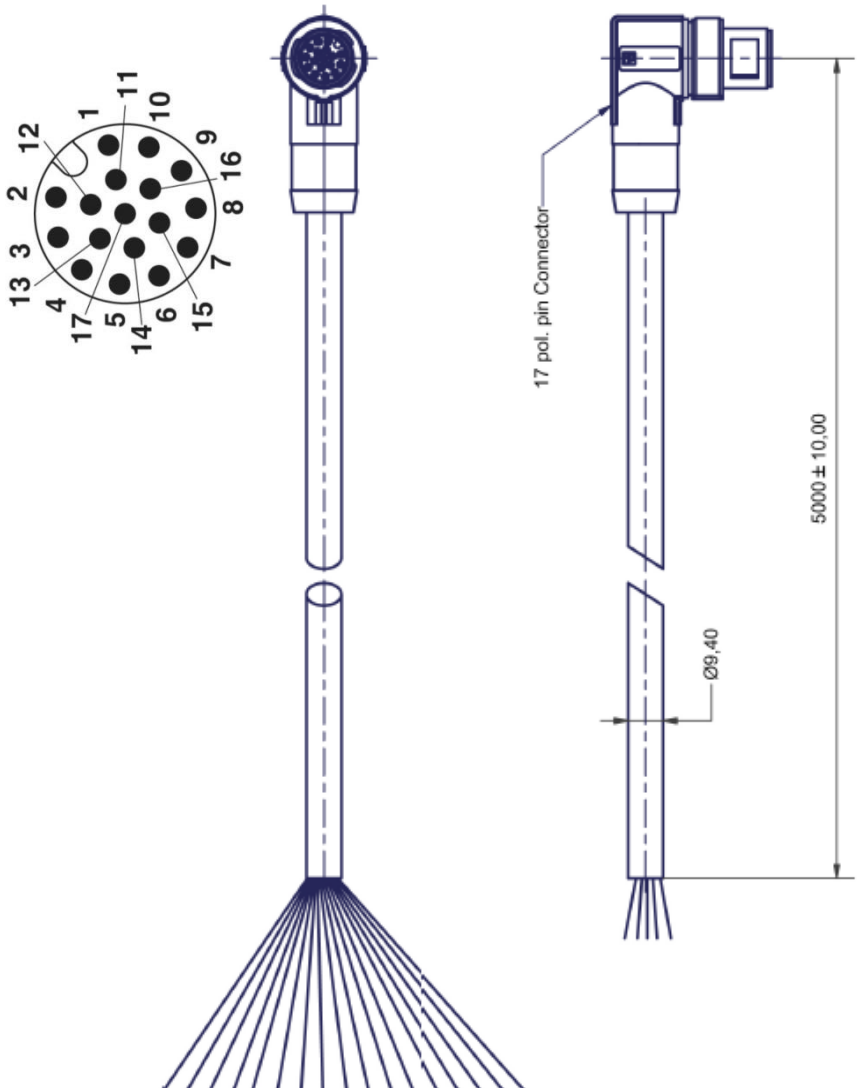
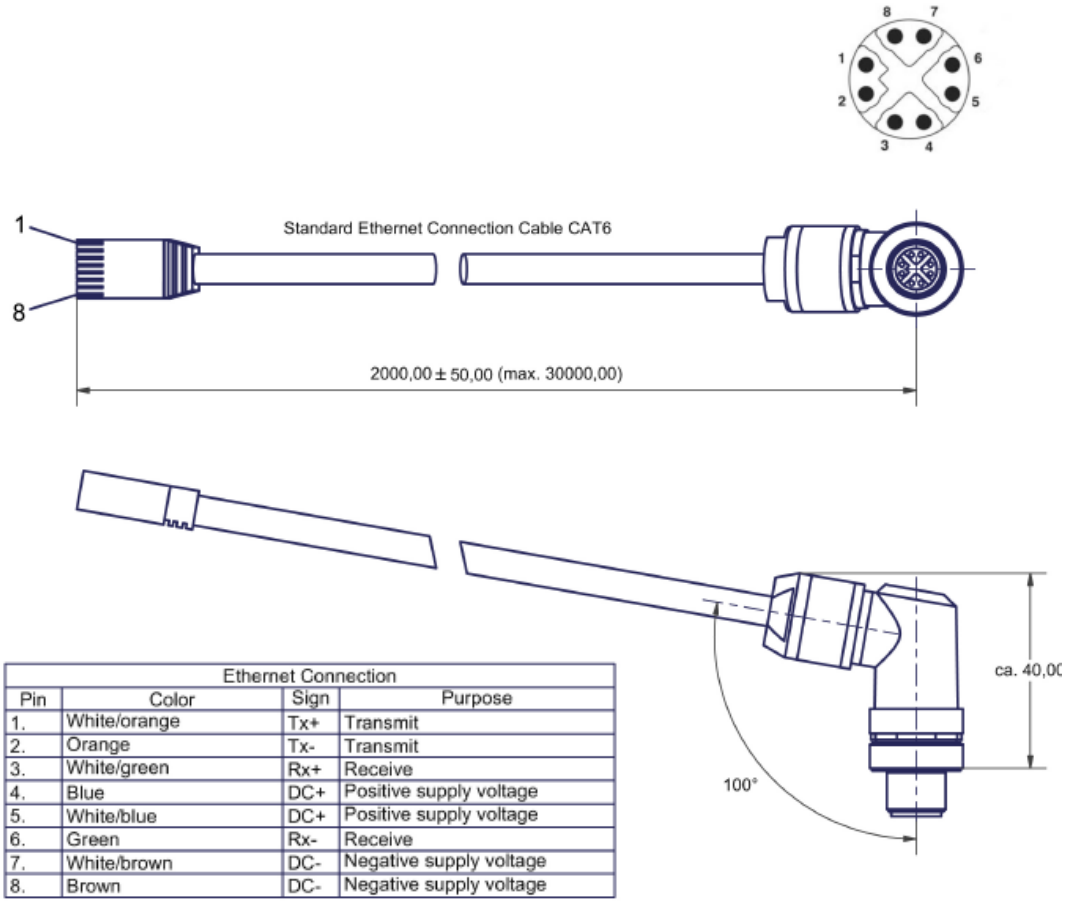


Figure 46: Multifunction cable

12.5 Ethernet and PoE cable layout



Ethernet Connection			
Pin	Color	Sign	Purpose
1.	White/orange	Tx+	Transmit
2.	Orange	Tx-	Transmit
3.	White/green	Rx+	Receive
4.	Blue	DC+	Positive supply voltage
5.	White/blue	DC+	Positive supply voltage
6.	Green	Rx-	Receive
7.	White/brown	DC-	Negative supply voltage
8.	Brown	DC-	Negative supply voltage

Figure 47: Ethernet and PoE cable

12.6 3D CAD Model

A 3D CAD model (STEP format) of the PS HT Laser Scanner outlines is available on demand.