SYMEO
RADAR NEXT LEVEL

SYMEO LOCAL POSITIONING RADAR

Product: LPR®-1DHP-291

Product Documentation

Content

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The documentation for the LPR®-1DHP-291 Local Positioning Radar System is published by:

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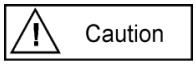
HISTORY

Version	Date	Description
0001	12.08.2022	Initial Release for FCC/RED
0002	03.11.2022	Image for “Surface may be Hot” explained in the chapter 1 "Safty Notes" -> “Setup and Operation”
0003	13.01.2023	Updated power consumption and IP rating
0004	08.02.2023	Added chapter 7: Establishing a TCP/IP connection and chapter 8: WebUI description
0005	05.04.2023	Added compatibility and difference to LPR®-1DHP-290 (chapter 2.1); Updated: Distance error codes, Diagnostics -> Record Measurement Data
0006	31.08.2023	New layout & logo; Safety Notes completed; updated link to User Documentation & Manuals

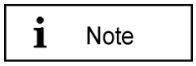
SYMBOLS USED

The following symbols are used throughout the documentation:

This symbol appears before instructions that must be followed at all times. Failure to comply with these instructions will result in personnel injury.



This symbol appears before instructions that must be followed at all times. Failure to comply with these instructions will result in damage to equipment.



This symbol appears before information of particular importance.

The following additional device-specific material can be obtained on the website of Symeo GmbH in the main menu "*Service & Support -> Download Product Documentation & Manuals*" under www.symeo.com or from Symeo support:

- Product Documentation
- Application Notes
- Firmware
- Datasheets
- Profinet GSDML file
- Python Raw Data Visualization (Library and Tool Documentation)
- Tools

1 Safety Notes

General

The LPR®-1DHP-291 is a radar distance measurement sensor that may be used to measure distances between a radar unit and a reflector or between two radar units.

Warning

LPR®-1DHP-291 radars are purely tracking and assistance systems. They do not feature a functional safety level, e.g., Safety Integrity Level (SIL) or Performance Level (PL), as specified in functional safety standards (e.g., IEC 61508, EN ISO 13849, EN 62061).

Do not expose the radar to flames or heat above the specified temperature range.

Caution

Read the documentation before operation of the radar and follow the included safety notes.

Take note of the safety and operating instructions of the system in which you want to install the device.

Follow national safety norms and regulations.

Note

Please make sure that you are aware of the latest technical document revision date. You can find it online on the website of Symeo GmbH in the main menu "*Service & Support -> Download Product Documentation & Manuals*" under:

https://www.symeo.com/en/service-support/download-product-documentation-manuals/

Installation

Caution

Installation must be carried out by qualified and trained technicians.

When the system is mounted on tubes, measures to prevent slippage of the system must be taken.

Only screwed connections with safety against loosening may be used for mounting the radar.

Adhere to the specified tightening torques for all screws and connectors.

Warning

Screwed connections, mounting structures and the device itself must be examined at regular intervals, with respect to external damage and loosened connections especially if the radar is mounted exposed or is exposed to high stress.

Repairs and Modifications

Caution

Repairs or modifications may only be performed by the manufacturer.

Opening of the device is prohibited.

Any change or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

The warranty shall be voided if defects are caused to the device by installing or exchanging system extensions.

Transport and Storage

Note

Do not drop the device and do not expose it to strong vibrations.

Power Supply

Caution

While installing or using it in open-air, transient overvoltage cannot be excluded. Overvoltage protection is to be used for low voltage in accordance with DIN EN 61643-21 and IEC 61643-21.

While connecting the plug and sockets, please observe the corresponding chapter in this document "Connectors" and adhere to the specified tightening torques.

Do not use damaged cables (damaged insulation, bare wires). A defective cable may cause a fire hazard.

Be careful that the device can be damaged by reverse polarity despite implementation of polarity reversal protection.

Setup and Operation

Caution

Protect the contacts of all the device's sockets and plugs from static electricity.

Proper operation (in accordance with IEC60950/EN60950) of the device is only assured if the housing and integral covers for mounting slots are fully installed (electric shock, cooling, fire protection, noise suppression).

In case of intense, direct solar radiation or other radiant heat, it may be necessary to provide a sun or heat shield.

Be aware, that misuse, modification or damage of the sensor can lead to erroneous distance measurements.

After mounting and commissioning, compare the actual distance to the distance measured by the radar sensor with respect to your needed accuracy. This step must be repeated after major changes to your measurement setup.

Caution

Surface may be Hot.

System Extensions and Accessories

Note

For LAN cabling, the requirements in accordance with EN 50173 and EN 50174-1/2 apply. Use of either a Category 5 shielded cable for

10/100 Ethernet or Category 5e shielded cable for gigabit Ethernet is a minimum requirement. The specifications of standard ISO/IEC 11801 must be complied with.

General Requirements for Compliance of Radio Apparatus

Note

The operation of this device requires compliance with regional radio regulations.
This device complies with Part 15 of the FCC Rules and with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

For Canada: The device shall not be used as automotive vehicular radar.

Exposure Requirements

Caution

To satisfy FCC exposure requirements a separation distance of 20 cm or more should be maintained between the antenna of this device and persons during operation.
To ensure compliance, operations at closer distances than this are not recommended.

To satisfy ISED exposure requirements a separation distance of 20 cm or more should be maintained between the antenna of this device and persons during operation.
To ensure compliance, operations at closer distances than this are not recommended.

Pour satisfaire aux exigences d'exposition ISED, une distance d-e sépa
ration de 20 cm ou plus doit être maintenue entre l'antenne de cet appareil et les personnes pendant le fonctionnement.
Pour assurer la conformité, les opérations à plus courte distance ne sont pas recommandées.

2 The LPR®-1DHP-291

Model number of LPR®-1DHP-291 is BSW200291.

The LPR®-1DHP-291 is a radar distance measurement sensor, which performs 1D distance measurements for short, medium, and long ranges with highest accuracy.

The radar sensor can be operated in three different radar modes: primary radar mode, secondary radar mode and diversity radar mode. Table 2.1 shows the radar modes.

LPR®-1DHP-291	
Primary Radar Mode	**X**
Secondary Radar Mode	**X**
Diversity Radar Mode	**X**

Table 2.1: Supported radar modes for LPR®-1DHP-291 product types

Typical applications of the LPR®-1DHP-291 are:

- Positioning of cranes, crane trolleys, hoists and other railbound transport systems
- Process automation, monitoring and control
- Collision avoidance
- Radar barriers

i Note

All LPR®-1DHP-291 product types can be configured with the help of a Web User Interface (WebUI), which is described in chapter 8.

2.1 Compatibility and Difference to LPR®-1DHP-290

The LPR®-1DHP-291 is the successor of the LPR-1DHP-290. As such, the LPR®-1DHP-291 devices use the same frequency settings (sync channels) as the LPR®-1DHP-290 units. The measurement range is similar as both generations of the system use similar TX levels and feature a similar RX sensitivity. Therefore, the LPR®-1DHP-290 and the LPR®-1DHP-291 devices can be operated together.

In general, it is recommended to pair *the LPR®-1DHP-290 units with the LPR®-1DHP-290 units* and *the LPR®-1DHP-291 units with the LPR®-1DHP-291 units* for secondary radar mode. However, care must be taken when replacing the LPR®-1DHP-290 units with the LPR®-1DHP-291 units or operating the LPR®-1DHP-291 at short ranges. Two parameters are important for the performance at short ranges: the TX signal level and the bandwidth of the radar signals.

The TX signal level of the LPR®-1DHP-291 units can be set in the WebUI by switching the *range mode* parameter between *long* (high TX level) and *short* (low TX level). On the LPR®-1DHP-290 the corresponding parameter is *VGA value* which is typically 20 or 25 (high TX level) or 13 (low TX level). The bandwidth of the radar signals is set by the parameters *bandwidth mode* / *channel block* / *sync channel*.

If the distance between the units is too short, an additional measurement error is introduced to the range measurement results of the LPR®-1DHP-291 or mixed systems. Typically, an additional measurement error of up to 3cm range has been observed at high TX signal level with sync channel 3200, i.e., a bandwidth of 1.9GHz, when operating the system at a range of 0.5m. The additional error decays as the distance increases. In sync channel 3200 it is typically below 1 cm for ranges above 3 m. When the bandwidth of the signals is reduced, the maximum error and the affected short-range area are both increased.

System performance at short ranges can be improved by reducing the TX level of the radar units. On the LPR®-1DHP-291 devices the range mode can be set to short if needed. On the LPR®-1DHP-290 devices the VGA value can be reduced to, e.g., 13 when operating the system with an LPR®-1DHP-291 unit at short ranges. However, reducing the TX level of the signals will reduce the maximum range which can be covered with the system. Therefore, the optimum configuration depends on the application the systems are being used in.

3 Radar Basics

3.1 Radar Distance Measurement Principle

The LPR®-1DHP-291 radar distance sensors use electromagnetic waves to measure the distance and speed between two radars (secondary radar mode) or a single radar and a reflector (primary radar mode).

The underlying measuring principle is based on the Round-Trip Time-Of-Flight (RTOF) measurement between a transmitted radar signal and a received signal. The radar estimates the time *τ* the radar signal needs to travel the unknown distance *d* from one radar to the other (or to a reflector) and back. The distance is then calculated with the formula

$$d = 0.5\,\tau\,c$$

where *c* is the speed of light.

3.2 Radar Beam and Field of View (FoV)

The LPR®-1DHP-291 emits a high frequency electromagnetic radio signal with its integrated antenna. The EM-wave is focused by a dielectric lens and creates a radar beam with an opening angle (half power beam width, HPBW) of +/-2,5°.

Distance d in m	1	3	10	30	50	70	100	200	300	400	600
Radar beam 3dB diameter in m	0.1	0.3	0.9	2.6	4.4	6.1	8.7	17.5	26.2	34.9	52.4

Table 3.1: Radar beam 3 dB diameter vs. distance

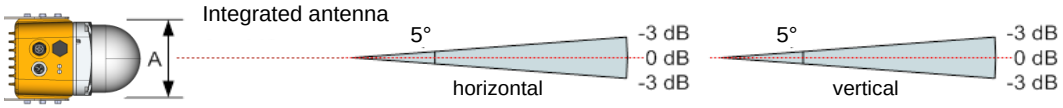


Figure 3.1: Radar beam and field of view

3.3 Fresnel Zone

The area for radio transmission between two antennas is called Fresnel zone. The main part of energy is concentrated in the first Fresnel zone.

Note	The Fresnel zone must be free of any obstacles to ensure that the signal is not attenuated or interrupted.

The maximum radius of the first Fresnel zone (in the middle between two antennas) can be calculated as follows:

$$r = 0.5 \cdot \sqrt{\lambda \cdot d}$$

λ is the wavelength and d the distance between the two radar devices or a radar device and a reflective target. For a frequency of 61 GHz the wavelength λ equals to 0.005 m. The maximum radius for different distances is given in Table 3.2.

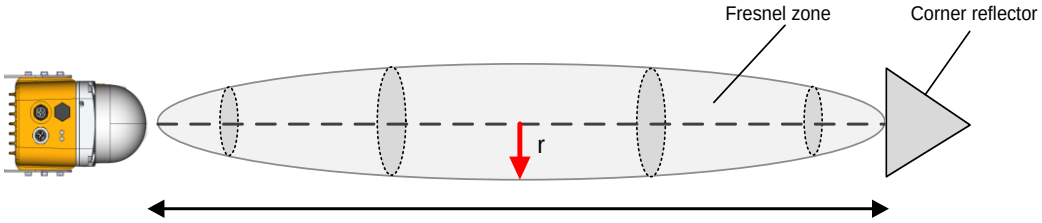


Figure 3.2: Fresnel zone

Distance d in m	10	20	30	40	50	70	100	200	300	400	600
Fresnel zone Radius r in m	0.11	0.16	0.19	0.22	0.25	0.30	0.36	0.50	0.62	0.71	0.86

Table 3.2: Fresnel zone radius vs. distance

3.4 Radar Modes

3.4.1 Primary Radar Mode

In primary radar mode, a single radar measures the distance and speed to a reflective object / target, typically a metal corner reflector. The following features differentiate the primary radar mode from the other radar modes:

- Suitable for ranges up to 50 m
- Range depends on target radar cross section (RCS)
- Very high update rate (up to 350 Hz)
- Cost effective installation with a single radar

Distance measurements to passive objects enable additional applications for primary radar mode:

- Presence / absence check
- Profile measurement (e.g., of bulk material)
- Detection of arbitrary objects (e.g., of personnel or vehicles)

Figure 3.3 shows the typical setup of an LPR®-1DHP-291 radar and a corner reflector for a primary radar distance measurement.

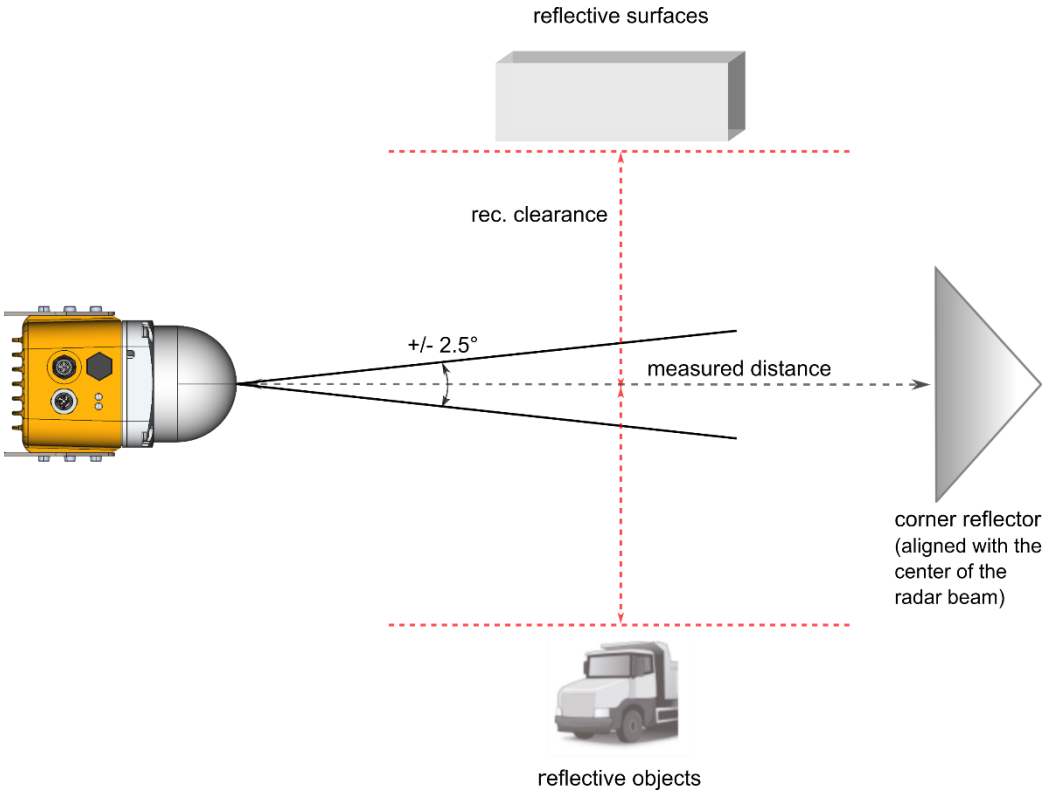


Figure 3.3: Primary radar mode measurement setup

3.4.2 Secondary Radar Mode

In secondary radar mode, two radars measure the distance and speed between each other. The following features differentiate the secondary radar mode from the other radar modes:

- Suitable for ranges up to 300 m
- Distance is always measured to the partner unit and not to passive objects.

Figure 3.4 shows the typical setup of two LPR®-1DHP-291 radars for a secondary radar range measurement.

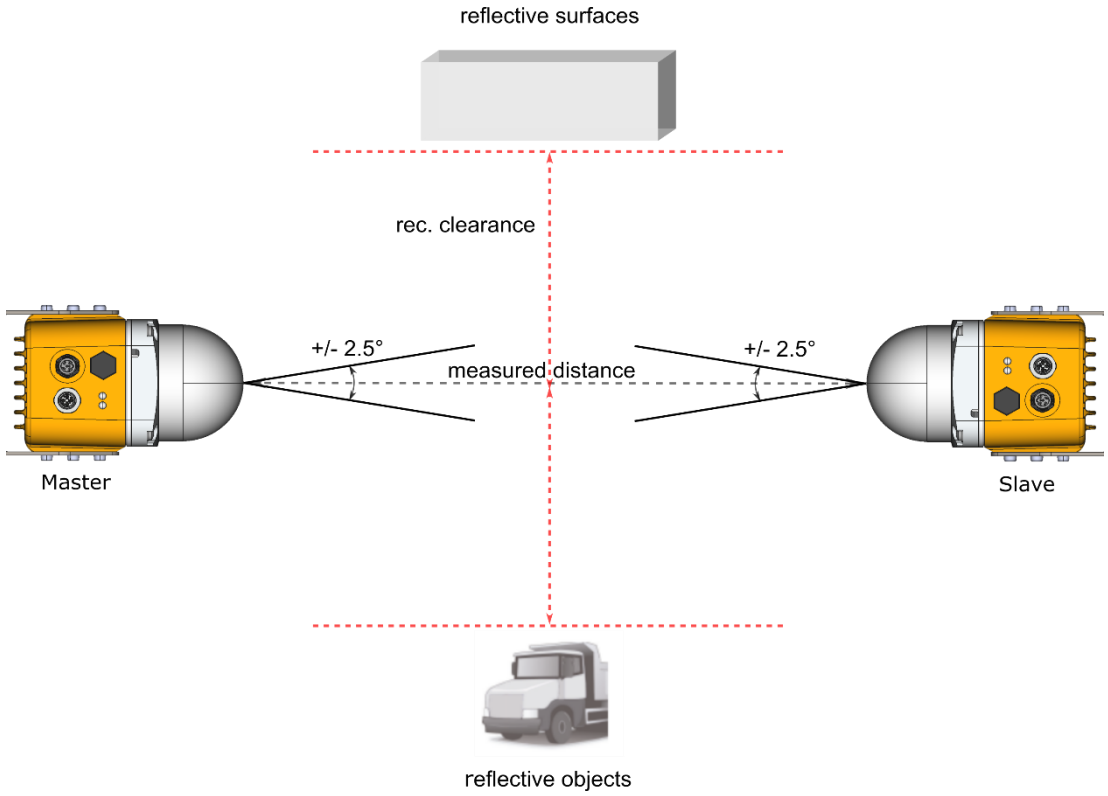


Figure 3.4: Secondary radar mode measurement setup

3.4.3 Diversity Radar Mode

In diversity radar mode, four radar units are grouped into two pairs, which are mounted in a way that two secondary radar measurements are performed side by side separated by a defined distance. The following features differentiate the diversity radar mode from the other radar modes:

- Suitable for ranges up to 500 m
- Distance is always measured to the partner unit and not to passive objects
- If one of the two measurement paths fails, the system falls back to operation in secondary radar mode and is therefore still available (error is indicated in diversity status byte).

Figure 3.5 shows the typical setup of four LPR®-1DHP-291 radars for a diversity radar range measurement.

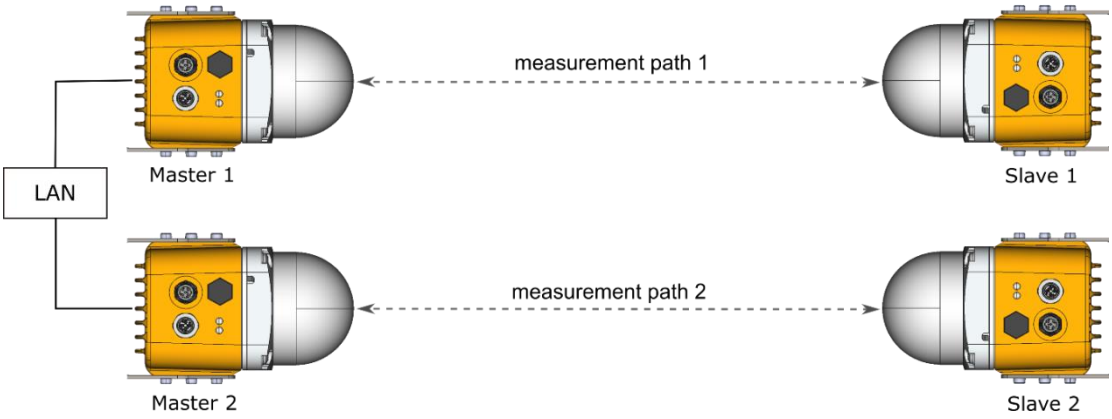


Figure 3.5: Diversity radar mode measurement setup

The master units need to be connected via Ethernet and must be set to diversity mode. The diversity distance result is then calculated from the individual measurements of the two LPR links. This calculation is done in each master unit. Therefore, both units will provide similar results. From an accuracy point-of-view it is sufficient to monitor the distance results from only one of the diversity units. However, redundant transmission of the distance results may be required by the application.

3.5 Bandwidth Modes

The LPR®-1DHP-291 operates in the 57 - 64 GHz band. Depending on your used region and regulatory authority setting, a limited number of bandwidth modes are available for selection in the WebUI.

The selected bandwidth modes have impact on the accuracy, resolution, and range of the radar. The dependency of performance and bandwidth mode with respect to regional restrictions is depicted in chapter 10. It is recommended to use at least 2 GHz bandwidth mode for standard applications where possible.

Within a single bandwidth mode, multiple sync channels are available. For each channel block, the effective bandwidth of a sync channel slightly reduces with increasing sync channel number.

3.6 Accuracy

To maximize the accuracy of an LPR®-1DHP-291 measurement setup, different error sources which influence the accuracy need to be considered:

- Mounting position
  - Adhere to the mounting instructions (see chapter 5) to minimize systematic errors (e.g., horizontal or vertical offset and alignment)
- Reflective surfaces and objects
  - Unwanted reflections of the radar signal, e.g., from crane tracks or walls, can cause distance errors which vary with the measured distance. Ensure the recommended clearance to surfaces and objects described in chapter 5.1 or use diversity radar mode to minimize errors caused by reflections
- Measurement noise

  - Measurement noise caused by the radar itself is the lower limit to the overall accuracy. The noise will decrease with increasing bandwidth. For primary radar mode the influence of noise will increase with range and decrease with target radar cross section (dependent on target size, shape, and material). In secondary radar mode noise is mostly constant within the specified range and will increase for longer ranges.

- Temperature drift
  - Changes in device and air temperature can lead to measurement offsets of approx. +/-10mm. These errors vary slowly with time and can be countered by ensuring constant environmental conditions, running a warmup phase of 30 minutes before operation or by using a calibration reference.
- Weather and environmental conditions
  - Under severe weather and environmental conditions such as very heavy rain or snow fall and layers of ice, snow, dust, or other absorbing and reflecting material being attached to the lens the measurement may be prone to distance offsets of up to +/-10mm.

The typical achievable 1σ distance errors are given in the technical specification in chapter 10. The typical absolute error range in an industrial environment is approximately +/-25 mm.

3.7 Range

To maximize the range of an LPR®-1DHP-291 measurement setup the following aspects must be considered:

- Mounting position
  - Adhere to the mounting instructions (see chapter 5). Ensure minimum alignment error and vertical / horizontal offset and equal orientation (for secondary and diversity radar mode)
- Fresnel zone
  - Ensure the Fresnel zone is free of absorbing or reflecting objects.
- Reflective surfaces and objects
  - Reflections of the radar signal, e.g., from walls, can lead to a reduction of the received signal strength and hence maximum range. Ensure the recommended clearance to surfaces and objects described in chapter 5.1 or use diversity radar mode to counter the effects caused by reflections.
- Target RCS (only primary radar mode)
  - In primary radar mode the maximum range depends on the target RCS (radar cross section) which is a function of target size, material and shape. If a high range is required use targets with a high RCS (e.g., the corner reflector MTE000958).
- Range mode
  - The range mode determines the power of the transmitted signal. Short range mode uses lower signal levels, thus reducing the range but improving the accuracy of the system for short ranges. Check the customer specific offset after changing the range mode and adjust it if necessary.
- Weather and environmental conditions

- Under severe weather and environmental conditions as stated in chapter 3.6 the maximum operating range may be decreased.

The measurement range given in the technical specification in chapter 10 and the datasheets is the typical range in which operation is possible under most conditions. The sensor may be operated at higher or lower ranges if circumstances permit.

4 Components

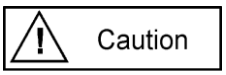
4.1 Device Overview

The LPR®-1DHP-291 consists of the following parts (see Figure 4.1 and Figure 4.2):

- Dielectric lens (A1)
  - focuses the radar beam

- Metal gland (A2)
  - fixes the lens to the housing with four screws
  - seals the device against water and dirt
  - holds the inner parts of the device in place

- Housing (A3)
  - provides LEDs (B1) and a pressure equalization membrane (B2)
  - provides the M12 T-coded power supply connector (C1) and the M12 D-coded Ethernet connector (C2)
  - provides 2 x 3 M6 screwing holes (B3) for mounting in the mounting bracket
  - provides an adjustment guide for usage with a laser level for exact radar beam alignment (B4)
  - ensures IP67 protection class and heat dissipation



The housing must not be opened.

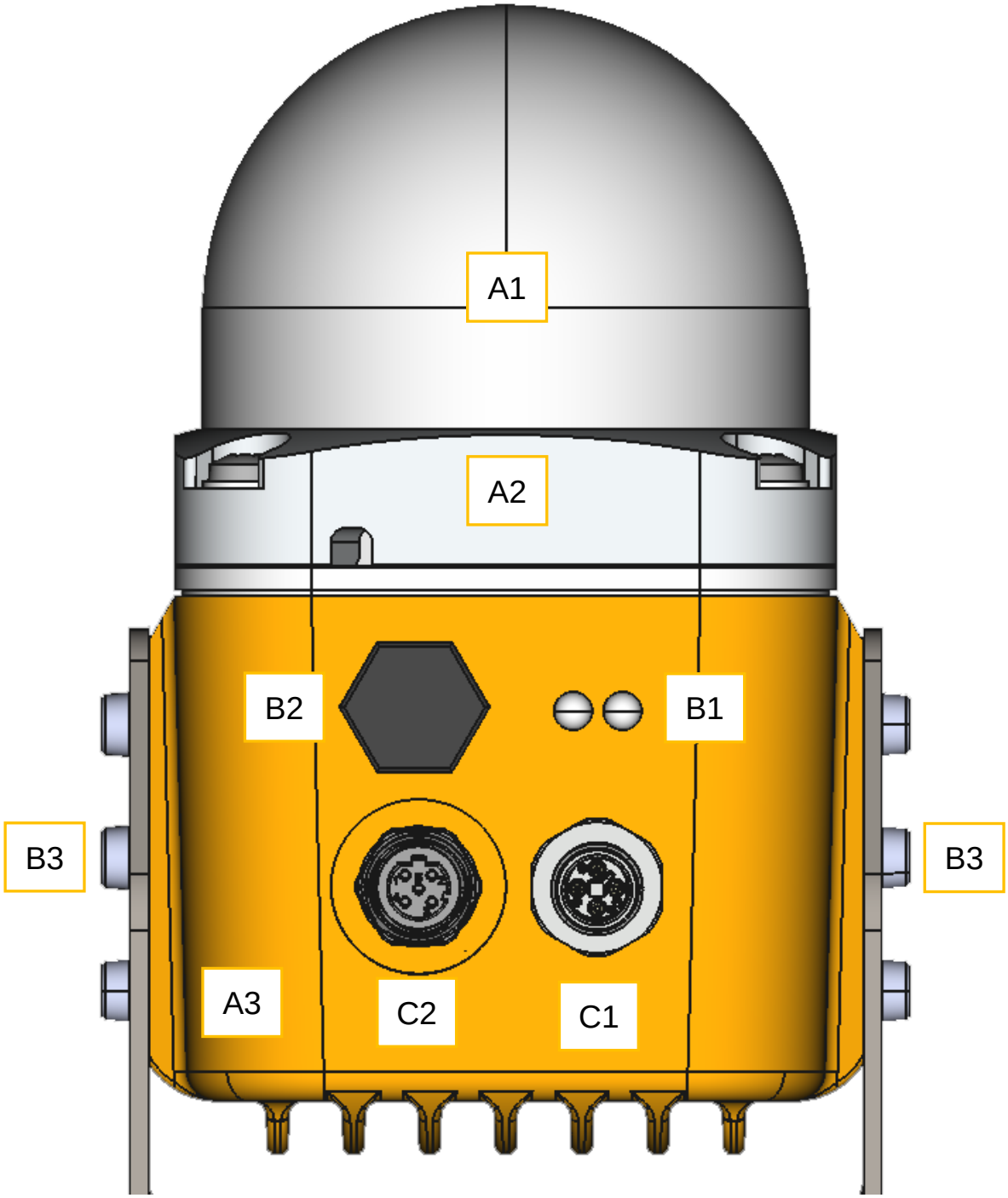


Figure 4.1: Front view of the LPR®-1DHP-291

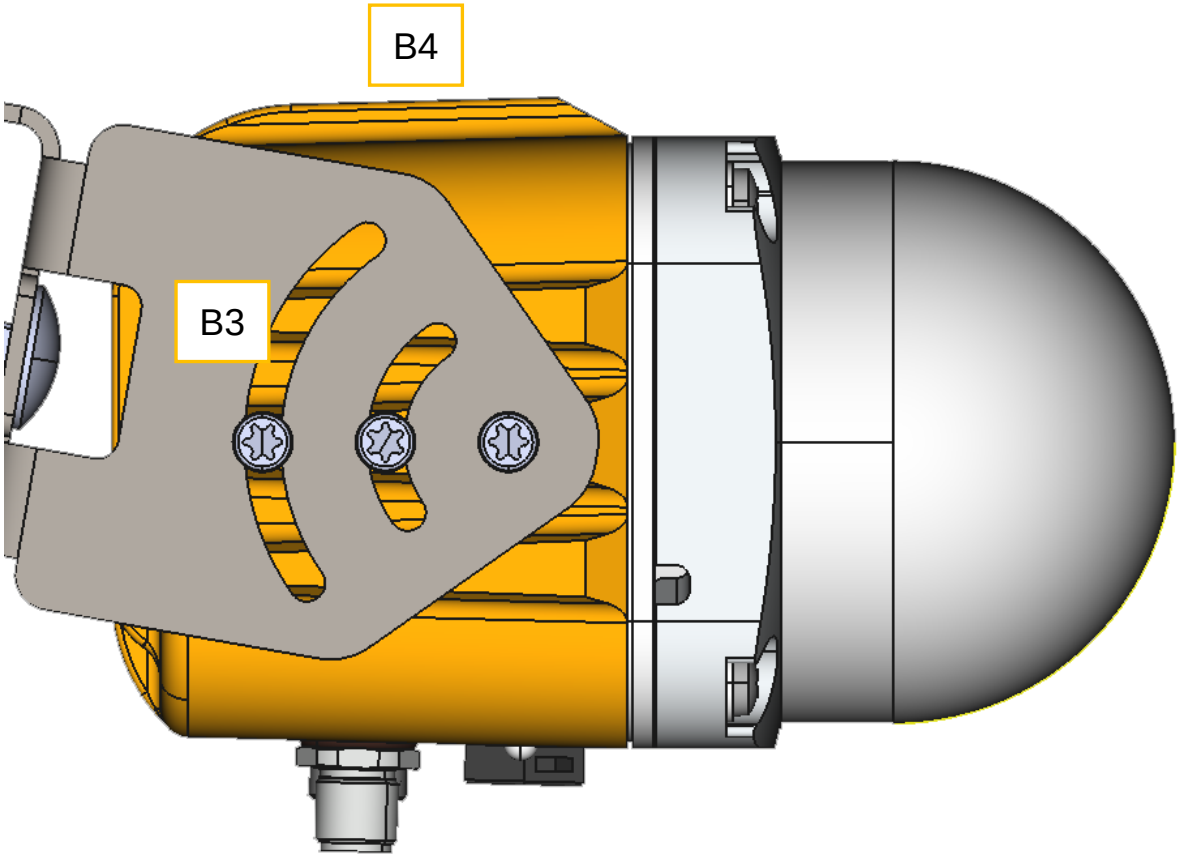


Figure 4.2: Side view of the LPR®-1DHP-291

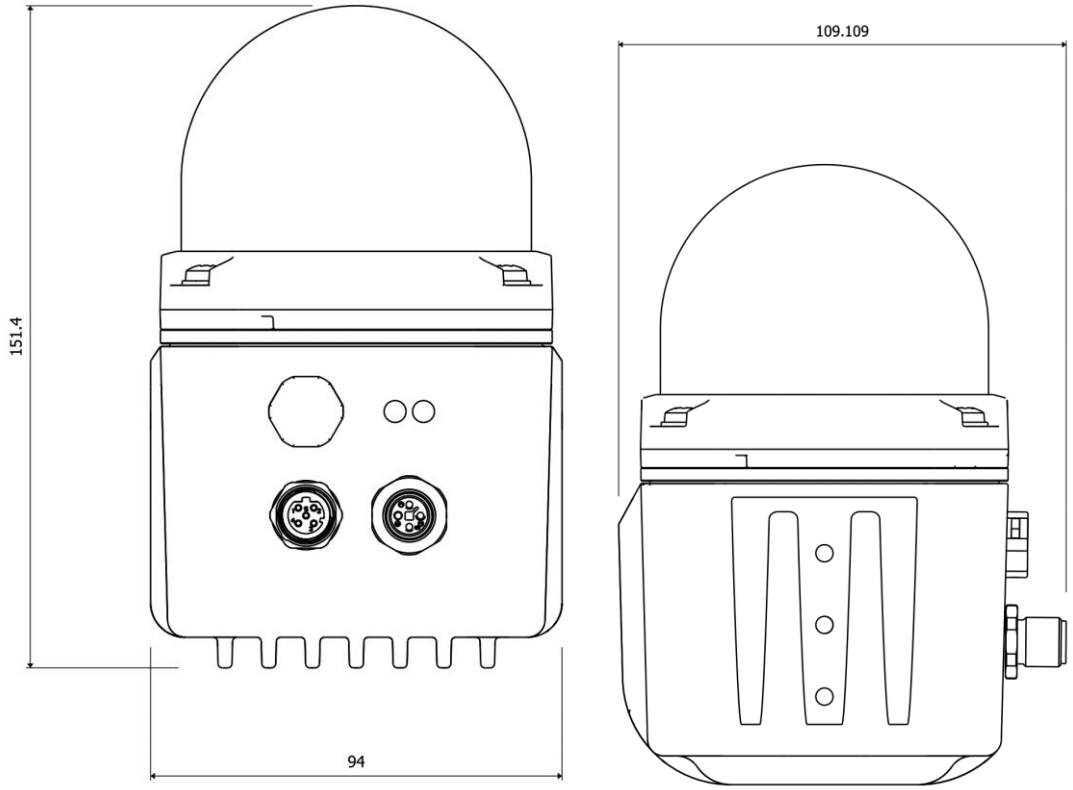


Figure 4.3: LPR®-1DHP-291 housing dimensions

4.2 LED Display

The LEDs (Status LED on the left and Ethernet LED on the right) indicate the different states of the device (see Table 4.1).

LED Indication	Status of the Device
Status LED lights up BLUE	Device is booting up
Status LED lights up RED	Invalid measurement
Status LED lights up GREEN	Valid measurement
Status LED flashes BLUE	Firmware update in progress
Ethernet LED lights up WHITE	Ethernet interface established
Ethernet LED flashes WHITE	Ethernet interface transmits data

Table 4.1: LED Display

4.3 Connectors

The housing of the LPR®-1DHP-291 provides the following M12 connectors (see Figure 4.1 and Figure 4.2*)*:

- Power supply input (C1)
- Ethernet connector (C2) for network connection

The necessary connectors for manufacturing cables that fit your installation and cable length are available from Symeo and are described in the following chapters.

We recommend the following tool set from PHOENIX CONTACT for proper M12 torque moment screwing:

- **Torque head - SAC BIT M12-D15 – 1208432**
- **Grip - TSD 04 SAC – 1208429**

4.3.1 Power Supply

The LPR®-1DHP-291 is powered via a 4-pin T-coded M12-Connector.

Plugs

Recommended connector:

- **SACC-M12FST-4CON-PG 9-M - 1418052**
  - Cable diameter: 6 - 8 mm
    Tightening torque: 0.4 Nm
  - **Symeo order number:** MTE101761

The connector is also part of the following M12 connector set:

- **M12 connector set (Ethernet + Power supply)**
  - **Symeo order number:** MTE102366

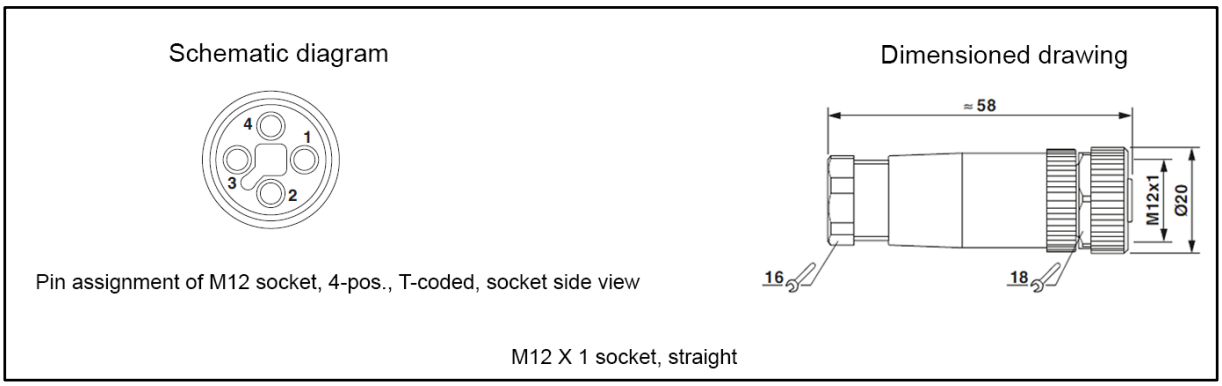


Figure 4.4: M12 power supply connector

Pin Assignment

Power Supply 11 V DC – 36 V DC	M12 Connector
V_{DC}+	Pin 1
V_{DC}+	Pin 2 (bridged to Pin 1)
V_{DC}-	Pin 3
V_{DC}-	Pin 4 (bridged to Pin 3)

Table 4.2: Pin assignment power supply

4.3.2 Ethernet M12 (TCP/IP or Profinet)

The LPR®-1DHP-291 can be connected to a LAN Network via an M12 D-coded Ethernet Connector. The communication can be establish via TCP/IP or Profinet (Production Code "n" required).

i Note

A Profinet interface application note is available for download on the website of Symeo in the main menu "*Service & Support -> Download Product Documentation & Manuals*".

Plugs

Recommended connector:

- **SACC-M12MSD-4CON-PG 7-SH – 1521258**
  - Cable diameter: 4 – 6 mm (PG7)
    Tightening torque: 0.4 Nm
  - **Symeo order number:** MTE101768

The connector is also part of the following M12 connector set:

- **M12 connector set (Ethernet + Power supply)**
  - **Symeo order number:** MTE102366

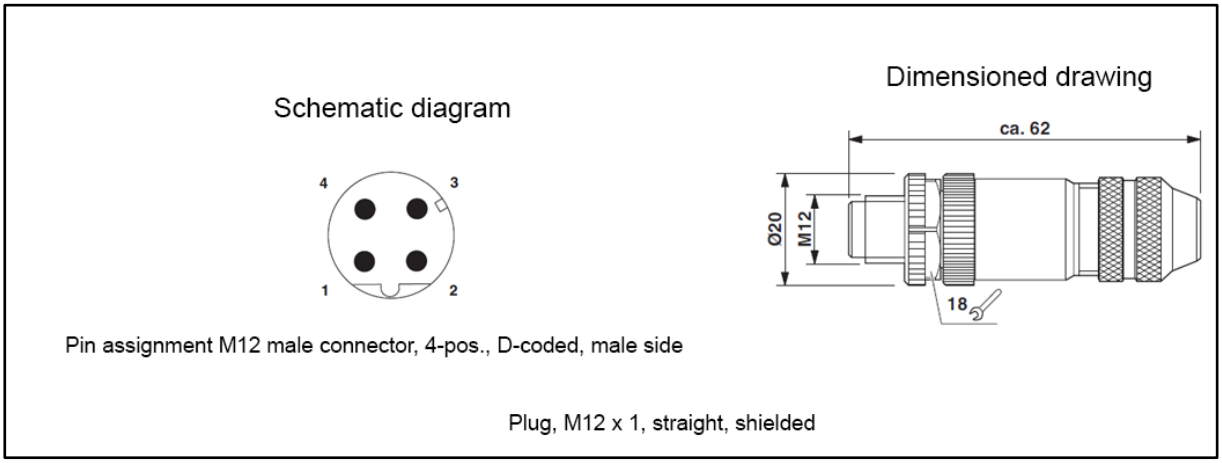


Figure 4.5: M12 Ethernet connector

Pin Assignment

Signal	Color of Wire PROFInet®	Color of Wire EIA/TIA 568B	Pin Assignment
TD+	Yellow	White/Orange	1
TD-	Orange	Orange	3
RD+	White	White/Green	2
RD-	Blue	Green	4

Table 4.3: Pin assignment for Ethernet M12

Note	If the Ethernet connector is left unused, install the protective cap of the connector.

Connector Cable M12 – RJ45

A connector cable M12 – RJ45 (2m) for connecting the radar to a PC for initial commissioning and configuration is available from Symeo:

- **Symeo order number**: MTE102007

4.4 Mounting Brackets

4.4.1 Mounting Bracket – MTM102513

For mounting the LPR®-1DHP-291 to a pipe, a mounting bracket is available from Symeo. The pipe diameter should measure between 40 and 75 mm.

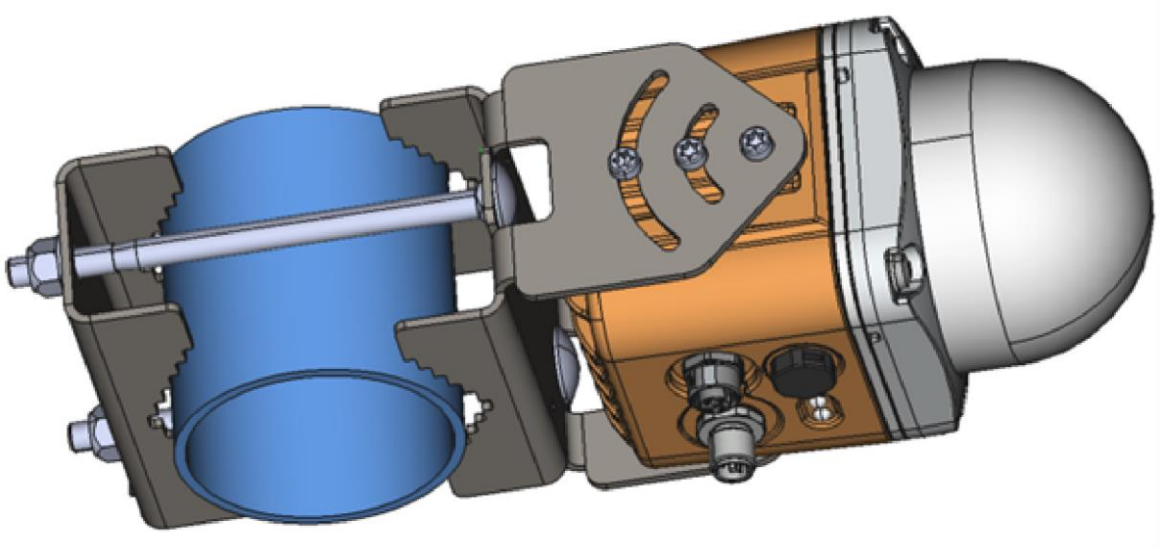


Figure 4.6: LPR®-1DHP-291 mounted to a pipe with the mounting bracket

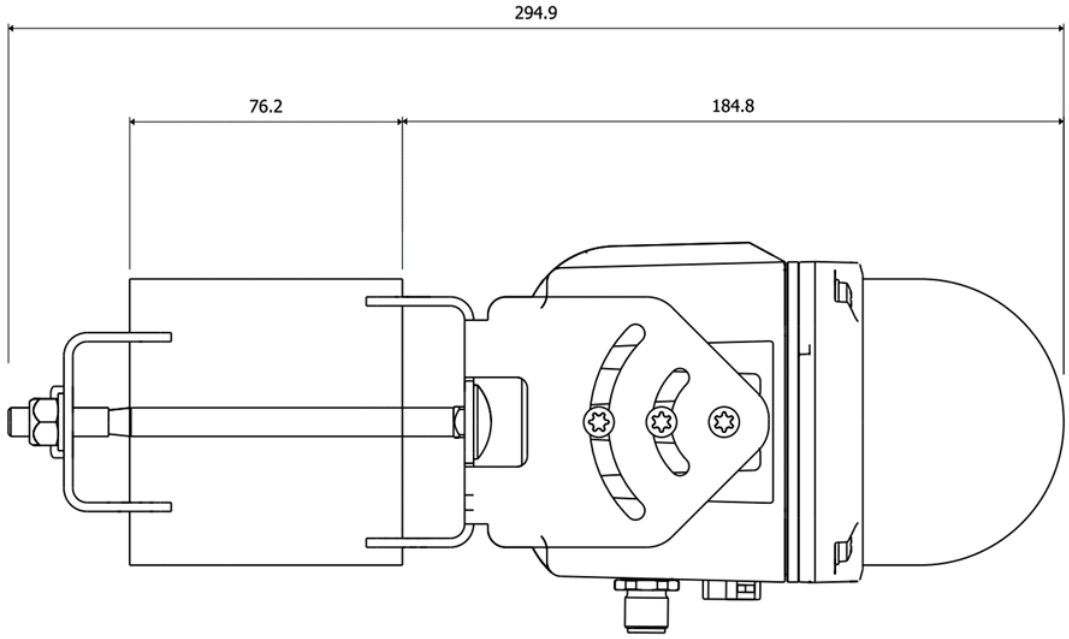


Figure 4.7: MTM102513 dimensions

Adhere to the following tightening torques for mounting:

- LPR®-1DHP-291 to mounting bracket (6x M5 screws): 3.5 Nm
- Tube clamp (2x M8 screws): 8 Nm

4.4.2 Diversity Mounting Bracket – MTM102467

For mounting two LPR®-1DHP-291 for operation in the diversity radar mode a diversity mounting bracket (Symeo part number MTM102467) is available from Symeo.

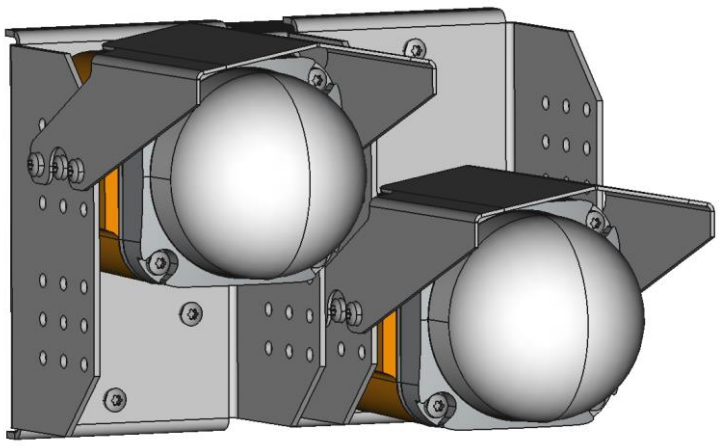


Figure 4.8: Two LPR®-1DHP-291 mounted in the diversity mounting bracket

Adhere to the following tightening torques for mounting:

- LPR®-1DHP-291 to mounting bracket (2x 6x M5 screws): 3.5 Nm
- Tube clamp (2x 2x M8 screws): 8 Nm

For more information how to assemble Diversity Mounting Bracket, please refer to our application note "DOC.EDO.000546.0001.EN_app_note_Assembly_Diversity_Mounting_Bracket_LPR-1DHP-291.pdf". This can be found on the website of Symeo in the main menu "*Service & Support -> Download Product Documentation & Manuals*":

4.4.3 Protective cover – MTM102512

In addition to mounting brackets MTM102513 and Diversity mounting bracket MTM102647, protective covers (Symeo part number MTM102512) are available for use in snowy or extreme dusty environments.

Figure 4.9: MTM102512 Cover

4.5 Corner Reflectors

For operation in the primary radar mode, different types of corner reflectors used as targets for the distance measurement are available from Symeo.

4.5.1 Corner Reflector 500 mm – MTE000958

Corner reflector with edge length 500 mm for maximum range.

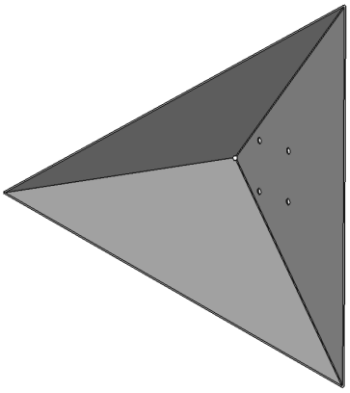


Figure 4.10: Corner reflector 500 mm

4.5.2 Corner Reflector 250 mm – MTE001011

Corner reflector with edge length 250 mm. Range is reduced to approx. 70% compared to MTE000958.

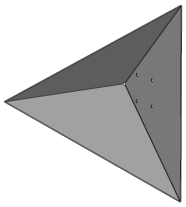


Figure 4.11: Corner reflector 250 mm

4.5.3 Adjustable Mounting Device Tube/Wall – MTM000169

For mounting the corner reflector, a pipe mounting bracket is available from Symeo. The pipe diameter should be between 40 and 75 mm.

5 Mounting

5.1 General Mounting Instructions

- Site-specific mounting instructions must be followed if available.
- The more accurately the radar units and reflectors are aligned to each other, the better the performance of the measurement setup will be in terms of accuracy and range.
- Ensure that the Fresnel Zone is free of obstacles.
- Ensure that your measured distances are in the specified measuring range (see chapter 10).
- Ensure that reflective surfaces (e.g. walls, the roof, the floor, crane tracks) and other reflective objects (e.g. poles, tubes, bridges, vehicles) have the recommended clearance to the center of the radar beam that is in accordance with Table 5.1 (see also Figure 3.3 and Figure 3.4).

Measuring distance d in m	10	20	30	50	70	100	150	200	250	300
Recommended clearance in m	0.2	0.5	0.7	1.1	1.6	2.2	3.3	4.4	5.5	6.6

Table 5.1: Recommended clearance to reflective surfaces and objects

5.2 Mounting for Primary Radar Mode

For a primary radar distance measurement, typically a single radar unit and a recommended corner reflector are mounted facing each other (see Figure 5.1 and Figure 3.3).

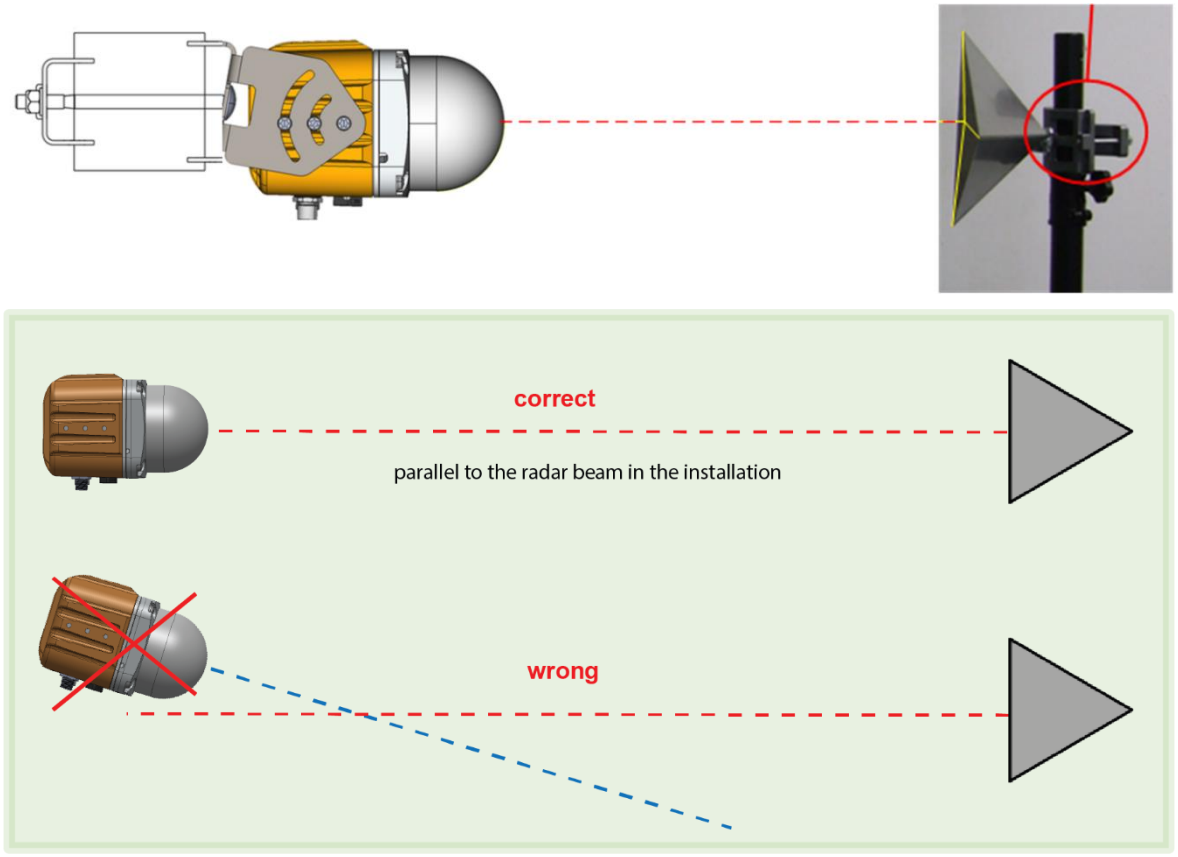


Figure 5.1: Mounting alignment of radar and reflector

For operation in the primary radar mode the following issues must be considered:

- The radar and the corner reflector must be installed in a way that the center of the corner reflector is aligned with the center of the radar beam (see Figure 5.1 and Figure 3.3).
- The radar units and/or corner reflectors must move parallel to the radar beam in the installation (see Figure 5.1).
- The reflector must be either the nearest (first) target or the strongest target to be detected properly.
- Radar and radar reflector must be aligned to each other with maximum accuracy (better than 1°).
- Minimum horizontal and vertical offset between radar and reflector must be ensured.

Follow the subsequent steps for proper installation of radar unit and reflector:

⇨ Mount a standard mounting bracket on one side of your measurement setup.

⇨ Mount the radar into the mounting bracket.

⇨ Mount a corner reflector to the other side of your measurement setup in a way, that the opening faces the radar. The 3 corners of the corner reflector opening should have about equal distance to the radar.

⇨ Carefully align the radar to the corner cube reflector. To do so, it is recommended to use a laser level fitted into the alignment aid, which should point at the middle of the reflector.

⇨ Fix the system by tightening the screws of the mounting bracket and the pipe clamp with the correct tightening torques.

⇨ Connect the power supply and Ethernet cable with M12 connectors as specified in chapter 4.3.1 and 4.3.2.

5.3 Mounting for Secondary Radar Mode

For a secondary radar distance measurement, two radar units, one configured as a “master” and one as a “slave” are mounted facing each other (see Figure 5.2 and Figure 3.4). The master unit initiates the measurement while the slave unit replies.

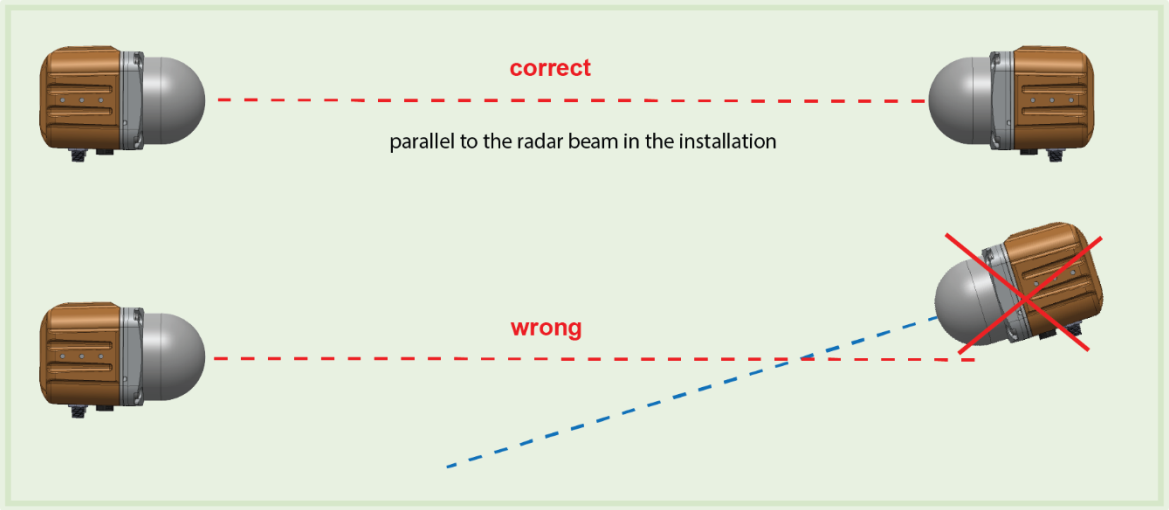


Figure 5.2: Mounting alignment of radars

For operation in the secondary radar mode the following issues must be considered:

- The two radar units must be installed in a way, that the center of the emitted radar beam of each unit hits the other unit.
- The radar units must move parallel to the radar beam in the installation (see Figure 5.2 and Figure 3.4).
- The two radar units must be oriented exactly equally or turned by 180° along the radar beam axis (e.g., connectors of both devices facing downwards).
- Minimum horizontal and vertical offset between both radar units must be ensured.
- Both radar units must be aligned to each other with maximum accuracy (better than +/- 1°).

Follow the subsequent steps for proper installation of the radar units:

⇨ Mount a standard mounting bracket to one side of the measurement setup.

⇨ Mount the radar unit into the mounting bracket.

⇨ Repeat the first two steps on the other side of the measurement setup.

⇨ Carefully align both radar units to each other. To do so, it is recommended to use a laser level fitted into the alignment aids. The laser dot should point to the other sensor for both directions (Master -> Slave, Slave -> Master).

⇨ Fix the systems by tightening the screws of the mounting brackets and the pipe clamps with the correct tightening torques.

⇨ Connect the power supply and Ethernet cable with the M12 connectors as specified in chapter 4.3.1 and 4.3.2 to both stations. The Ethernet connection at the Slave unit is only required for configuration and can be removed during operation. If removed install the protective cap of the connector.

5.4 Mounting for Diversity Radar Mode

For a diversity radar distance measurement, four radar units are grouped into two pairs, which are mounted in a way that two secondary measurement paths are established side by side separated by a defined distance. As depicted in Figure 3.5 the setup contains 2 radars configured as master which must be visible to each other via LAN and 2 radars configured as slave.

For operation in the diversity radar mode the following issues must be considered:

- The radars must be installed in a way that the center of the radar beams emitted by the master units each hit one of the slave units.
- The radar units must move parallel to the radar beam in the installation.
- The radar units must be oriented exactly equally or turned by 180° along the radar beam axis (e.g., connectors of both radars facing downwards).
- Minimum horizontal and vertical offset between the radars of one measurement path must be ensured.
- The radar units of one measurement path must be aligned to each other with maximum accuracy (better than 1°).

Follow the subsequent steps for proper installation of the radar units:

⇨ Mount a diversity mounting bracket to one side of the measurement setup.

⇨ Mount two radars into the mounting bracket. Use the exact mounting positions shown in Figure 5.3.

⇨ Repeat the first two steps on the other side of the measurement setup. Make sure to switch the mounting positions in a way, that the sensors face each other without horizontal or vertical offset (see Figure 5.3).

⇨ Align the mounting brackets with the radars to each other. To do so, it is recommended to use a laser level fitted into the alignment aids. The laser dot should point to the other sensor for both directions (Master -> Slave, Slave -> Master).

⇨ Fix the systems by tightening the screws of the mounting brackets and the pipe clamps with the correct tightening torques.

⇨ Connect the power supply and Ethernet cable with the M12 connectors as specified in chapter 4.3.1 and 4.3.2 to all stations. The Ethernet connection at the slave units is only required for configuration and can be removed during operation. If removed install the protective cap of the connector. Make sure that both master units are visible to each other via LAN.

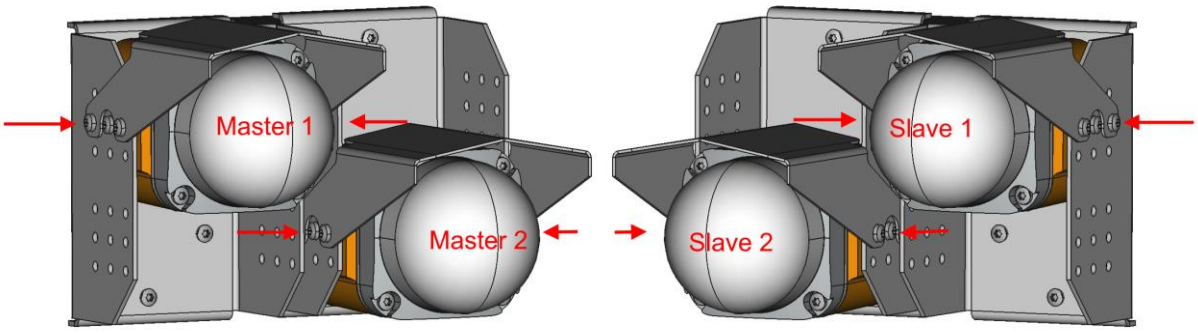


Figure 5.3: Mounting positions for mounting in the diversity mount for the master and slave side

6 Quick Setup

This chapter gives a short introduction for the setup of the radar sensors with the help of the WebUI. For detailed information on all possible settings, please refer to chapter 8.

6.1 Initial Setup

The following steps must be followed for the initial setup of all radar units:

⇨ Mount and align the radar units as outlined in chapter 5.

⇨ Connect the radar units to a power source (11 – 36V) and wait until booting is finished (blue LED switches to red or green).

⇨ Connect the radar units to a PC via Ethernet and open the Webinterface (WebUI) in a Webbrowser (http://192.168.1.99). See chapter 7 for a detailed description.

⇨ Sign in to the WebUI (see chapter 8.2).

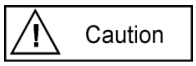
⇨ Choose country and regulatory authority.

⇨ Change the IP addresses of all radars in your measurement setup to unique values in the same TCP/IP subnet (see chapter 8.6.1).

6.2 Quick Setup for Primary Radar Mode

The following settings must be set in the WebUI for operation in primary radar mode:

- *Device -> Settings -> Measurement*
  - Station mode = Primary
  - Bandwidth mode = Choose a bandwidth that fits your required range and accuracy
  - Channel block = Use recommended selection
  - Sync channel = different than any other LPR®-1DHP-291 sensor in range; for neighboring measurement paths use only every fourth sync channel.
- *Device -> Settings -> Measurement details*
  - Target search mode = “First” if the reflector is the first target in range, “Strongest” if the reflector is the strongest target in range.



The setting “*Target search mode*” highly impacts the behavior of the radar, especially in multi target environments (see Figure 8.24*)*. “First target” may lead to distance measurements to unintended targets in the vicinity of the radar (e.g., a person passing the radar beam). “Strongest target” may lead to distance measurements to unintended targets present in the background of your intended target (e.g., a wall behind a corner reflector). Perform therefore always a test to verify this setting.

6.3 Quick Setup for Secondary Radar Mode

The following settings must be set in the WebUI of the master and slave sensor for operation in secondary radar mode.

Note	Only the Master unit outputs range data.

Master

- *Device -> Settings -> Measurement*
  - Station mode = Master
  - Bandwidth mode = Choose a bandwidth that fits your required range and accuracy
  - Channel block = Use recommended selection
  - Sync channel = different than any other LPR®-1DHP-291 sensor in range (except the related Slave); for neighboring measurement paths use only every fourth sync channel.

Slave

- *Device -> Settings -> Measurement*
  - Station mode = Slave
  - Bandwidth mode = same as Master
  - Channel block = same as Master
  - Sync channel = same as Master

6.4 Quick Setup for Diversity Radar Mode

The following settings must be set in the WebUI of all 4 sensors for operation in diversity radar mode.

Note	• Only the master units output range data. • Both master units must be visible to each other via LAN. • Both master units output similar distance data. • Master 1 must face slave 1 and master 2 must face slave 2 without horizontal or vertical offset.

⇨ Configure the following settings:

Master 1

- *Device -> Settings -> Measurement*
  - Station mode = Master
  - Bandwidth mode = Choose a bandwidth that fits your required range and accuracy
  - Channel block = Use recommended selection
  - Sync channel = different than any other LPR®-1DHP-291 sensor in range (except the related Slave 1); for neighboring measurement paths use only every fourth sync channel.

Slave 1

- *Device -> Settings -> Measurement*
  - Station mode = Slave
  - Bandwidth mode = same as Master 1
  - Channel block = same as Master 1
  - Sync channel = same as Master 1

Master 2

- *Device -> Settings -> Measurement*
  - Station mode = Master
  - Bandwidth mode = same as Master 1
  - Channel block = same as Master 1
  - Sync channel = different than any other LPR®-1DHP-291 sensor in range (except the related Slave 2). Also, different to Sync channel of Master 1 and Slave 1; for neighboring measurement paths use only every fourth sync channel.

Slave 2

- *Device -> Settings -> Measurement*
  - Station mode = Slave
  - Bandwidth mode = same as Master 2
  - Channel block = same as Master 2
  - Sync channel = same as Master 2

⇨ Run a warmup phase of 30 minutes. Adjust the "*Measurements details -> Customer specific offset"* parameter on both master units such, that both measurement paths show the same distance under *"Diagnostics -> Range measurement statistics -> Live range measurement".*

⇨ Continue configuring the following settings:

Master 1

- *Device -> Settings -> Measurement details*
  - Diversity mode = Enabled
  - Diversity partner IP address = IP address of Master 2
  - Diversity partner sync channel = Sync channel of Master 2

Master 2

- *Device -> Settings -> Measurement details*
  - Diversity mode = Enabled
  - Diversity partner IP address = IP address of Master 1
  - Diversity partner sync channel = Sync channel of Master 1

7 Establishing a TCP/IP Connection

For configuration of the radar units, a TCP/IP connection must be set up. Make sure that:

- The unit is running.
- The radar unit is connected with an appropriate Ethernet cable to a PC or a similar device, which has a web browser installed.
- The radar and the PC are located in the same subnet of the TCP/IP network. That means that the first three numbers of the radar's and PC's IP-addresses should be equal (for a subnet mask of 255.255.255.0).
- No firewall is blocking the communication between PC and radar.

Start Windows 10, type 'network status' into the search field of the taskbar and open the system control applet to configure your PC's Ethernet interface. Under 'Change Adapter Settings' look for the Ethernet interface that is connected to the sensor and double click it. Open 'Properties' and look for 'Internet Protocol Version 4 (TCP/IPv4)'. Edit the 'Use following IP address' settings. By default, the IP address of the sensor is set to 192.168.1.99.

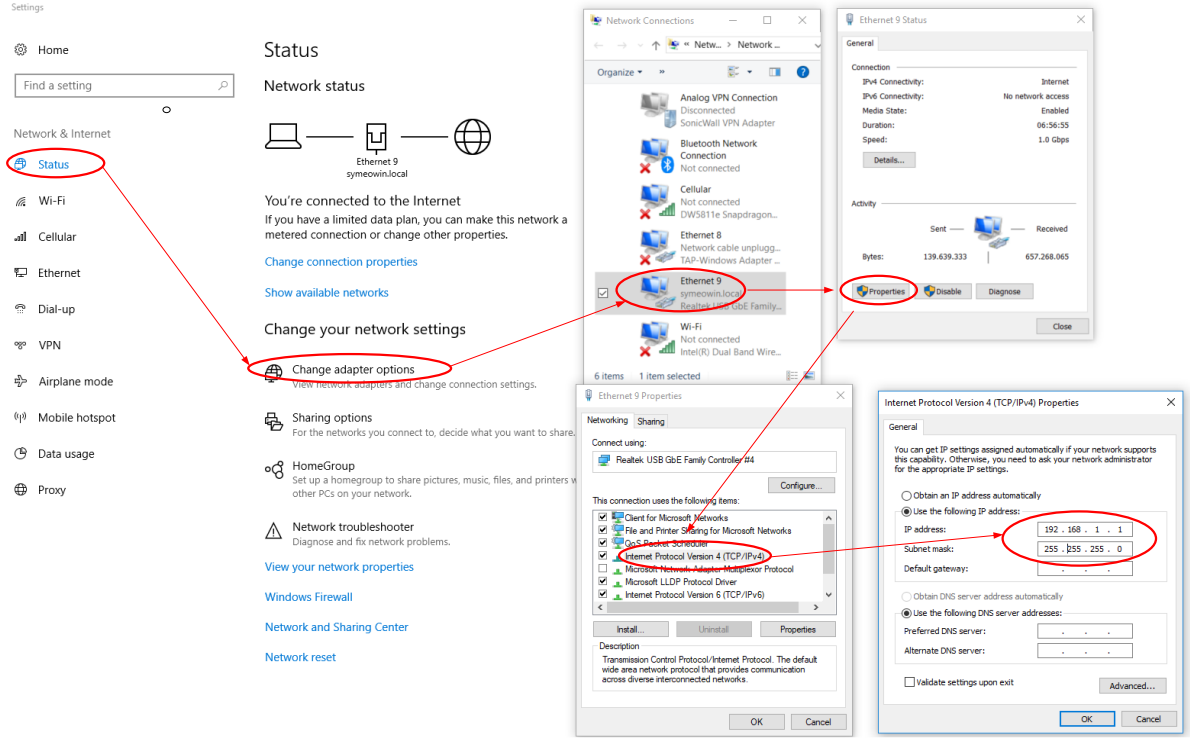


Figure 7.1: Network Settings under Microsoft Windows

If PC and radar are not located in the same subnet, open the TCP/IP network settings of your network adapter in your operating system.

⇨ Enter a fixed IP-Address e.g., **192.168.1.1** and the subnet mask **255.255.255.0**.

The LPR® should be available via your PC now. You can check the connection with a *ping* to the LPR®-1DHP-291:

1. Push the Windows **Start** Button
2. Choose **Run** (Skip under Windows 10)
3. Enter **cmd** and confirm
4. Enter: **ping 192.168.1.99** or the IP-address of the LPR®-1DHP-291 unit in the cmd.exe window and confirm

The LPR®-1DHP-291 should answer with a *Reply*.

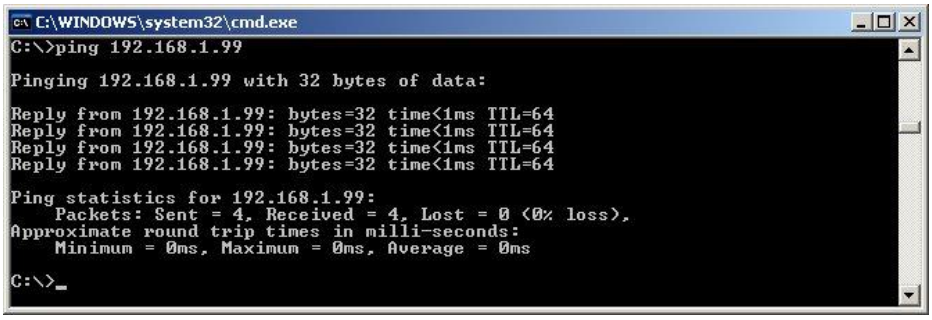


Figure 7.2: Ping LPR®-1DHP-291

For detection of all Symeo devices located in your network (useful if the IP-Address of a radar unit is unknown), you can download the tool **Symeo IP Discover** on the website of Symeo in the main menu "*Service & Support -> Download Product Documentation & Manuals*" under www.symeo.com.

8 Device Setup via the Web User Interface

The Web User Interface allows you to change all settings, perform firmware updates, view system status and diagnostic information and much more.

8.1 Open the Web User Interface

Note	A TCP/IP Connection is required.

⇨ Open your web browser. In the address bar of the web browser, enter the IP address of the LPR®-1DHP-291: e.g., http://192.168.1.99.

The welcome page for the LPR®-1DHP-291 WebUI should appear.

A language selection can be made using the flags in the top right corner of the interface.

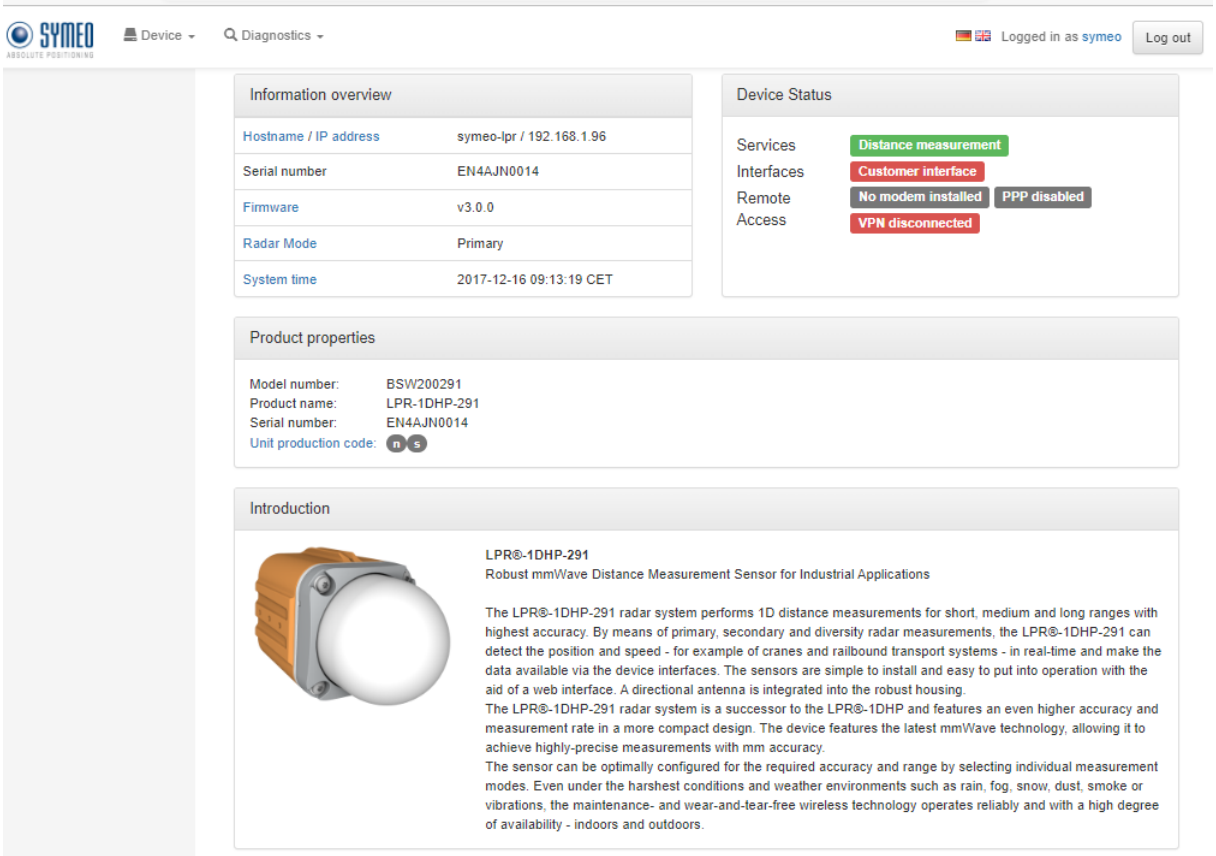


Figure 8.1: Open Web User Interface

8.2 Sign In

In order to be able to change settings a sign in to the WebUI is necessary. Press therefore *“Sign In”* in the upper right corner of the WebUI. You will be prompted to enter your

information for authentication. The dialog box with the username and password field will appear (see Figure 8.2).

Figure 8.2: WebUI Login

⇨ Enter the user name "**symeo**" and the password "**54all2u**" and press "*Login*". Now your status is displayed as "*Logged in*".

8.3 Initial Operation

When the WebUI is opened for the first time or after a software reset, the note "*Environment uninitialized*" will appear (see Figure 8.3).

Figure 8.3: Initial operation - Environment uninitialized

i Note

During the initial operation, you need to configure the operating country, in which you want to use this unit. This is necessary to abide to the radio signal restrictions enforced by the local authorities. Your selection will have impact on the selectable Bandwidth Modes as well as on the maximum transmit power and hence range of the radar unit.

Since this is a mandatory setting, all functionality of this device will remain disabled, until the country setting has been successfully configured.

⇨ Click the "*Configure environment*" button to configure the working environment.

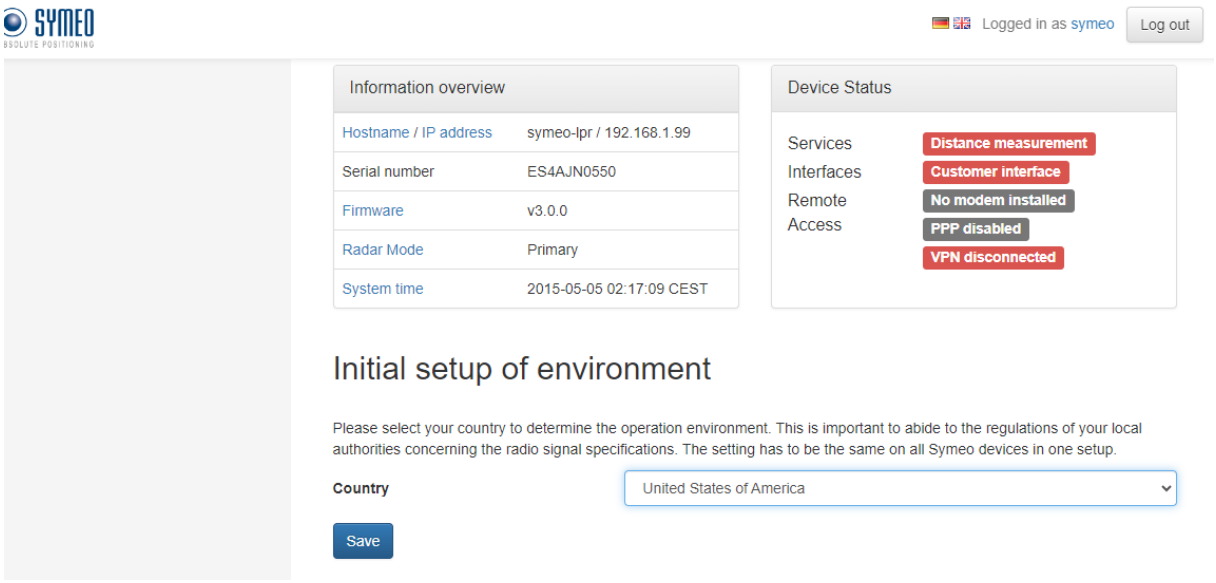


Figure 8.4: Initial setup of environment of the LPR®-1DHP-291

⇨ Select your country to determine the operating environment and confirm it with the "*Save*" button (see Figure 8.4).

The setting must be the same on all Symeo devices used in a specific country.

⇨ Now activate the settings by clicking the "*Activate changes*" button (see

⇨ Figure 8.5).

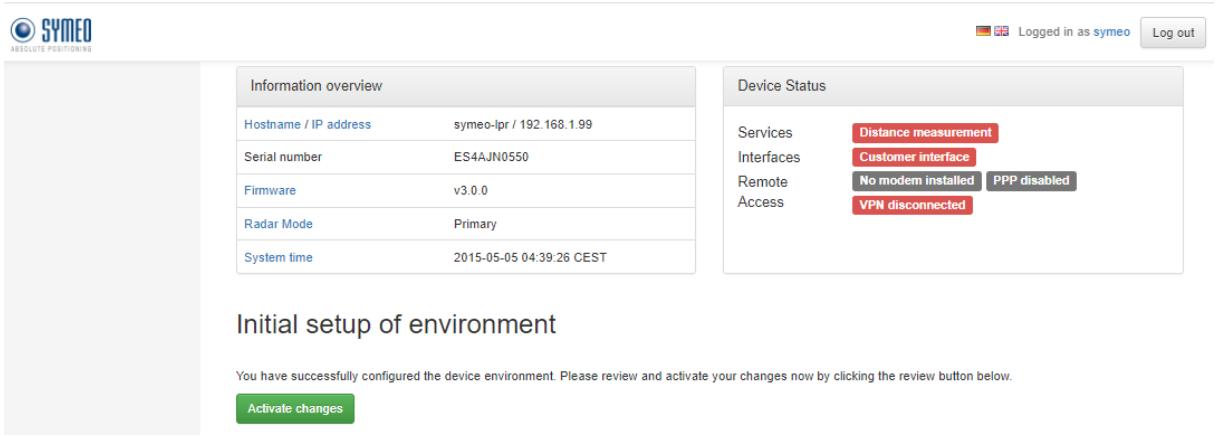


Figure 8.5: Initial setup of environment - Activate changes

The following window appears:

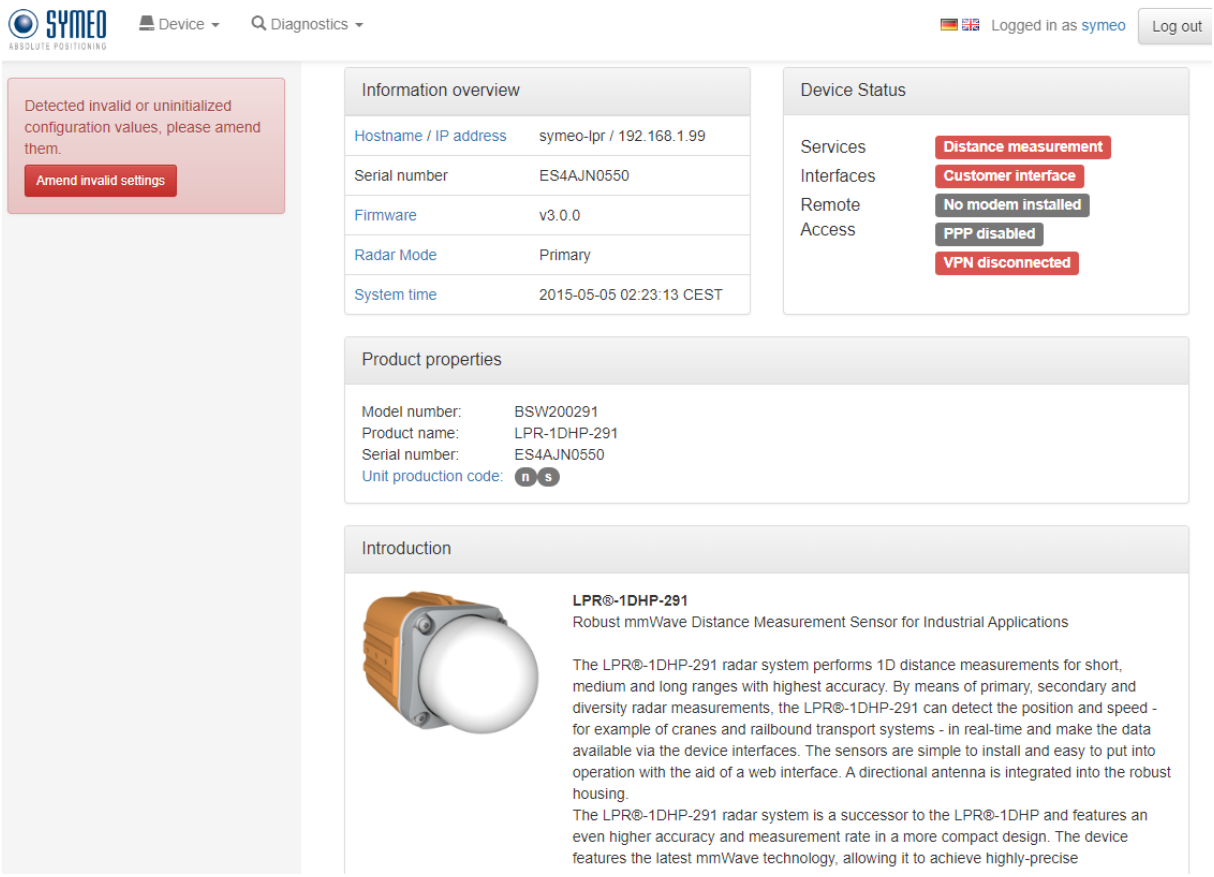


Figure 8.6: Initial setup of environment - Amend invalid settings

In the top left corner, a red frame appears which indicates that for a functioning measuring distance, the measurement values, which have not yet been set or which are invalid, are still to be processed.

⇨ Click the “*Amend invalid settings*” button.

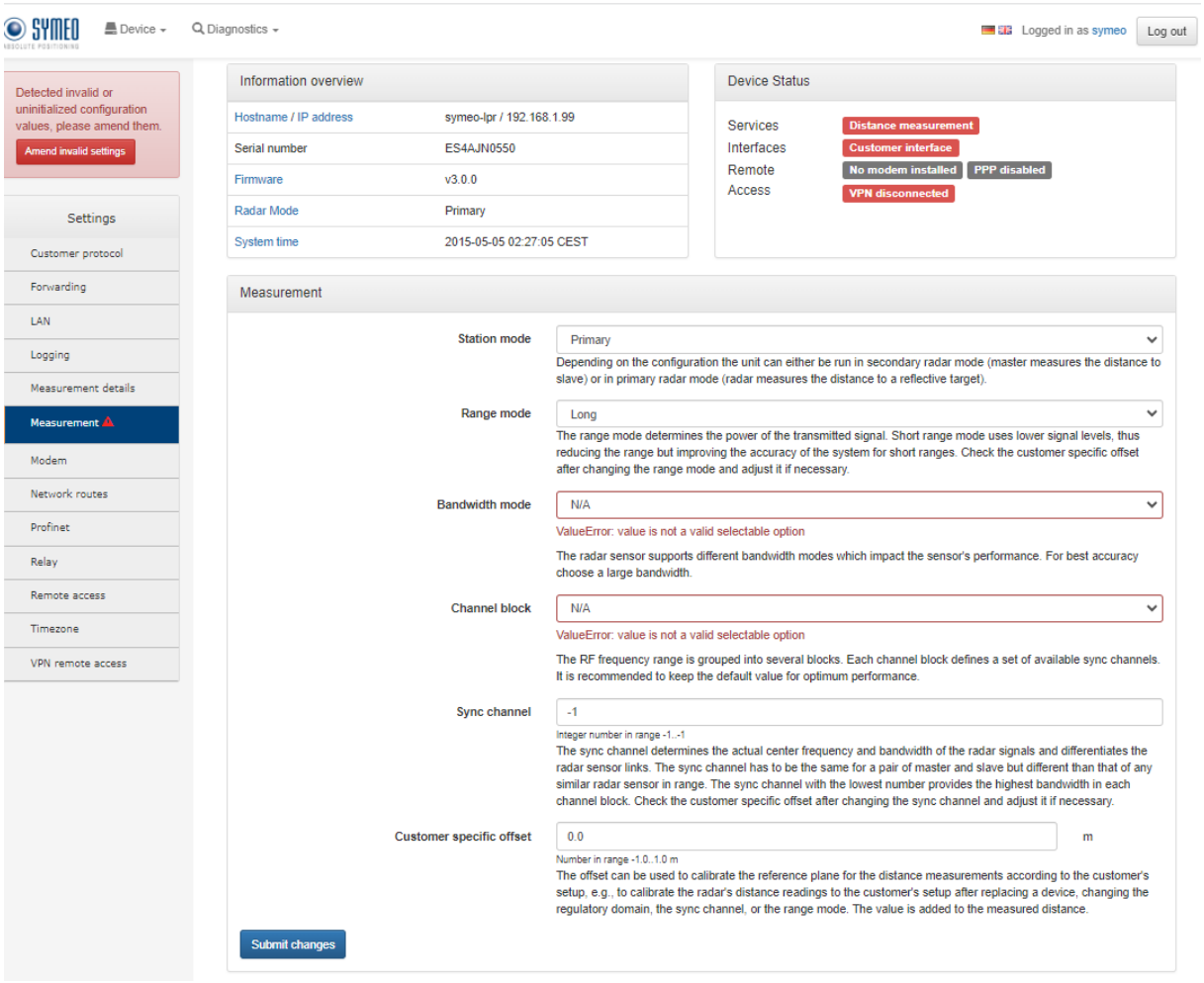


Figure 8.7: Settings window for mandatory values

You will be automatically guided to the settings menu sub-item "*Measurement*", where strictly necessary parameters must be set. For further information about these mandatory settings, please refer to the chapter Device - Settings - Measurement

If you have entered all these settings, click the "*Submit Changes*" button.

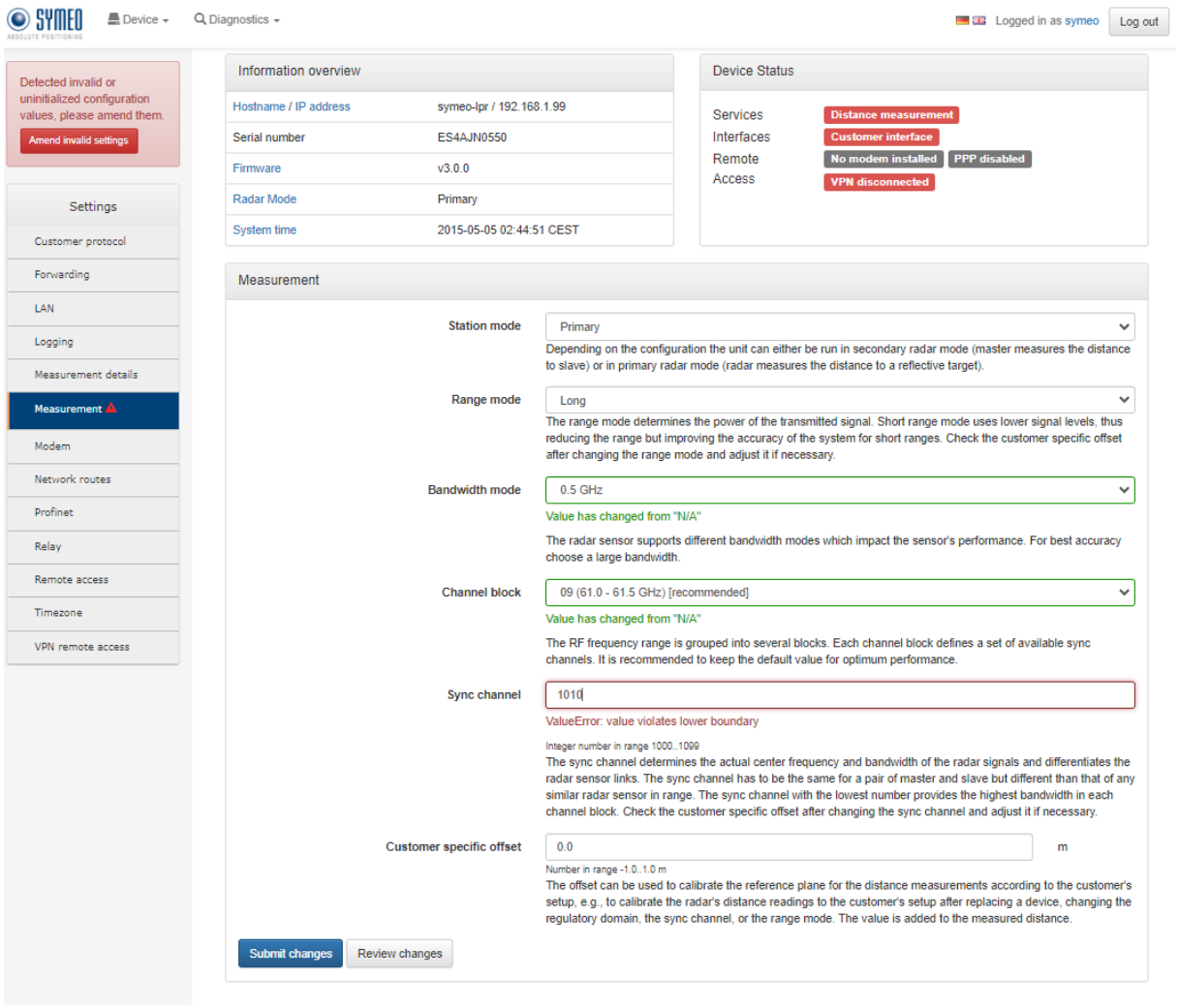


Figure 8.8: Change of mandatory values

8.4 Change Settings, Review and Save Changes

Upon pressing the *"Submit Changes"* button in any settings sub item, the WebUI is updated and the choice of valid settings is updated to your made changes. The settings will however not be applied to the radar until you press the *"Save all changes*" button in the *"Review changes"* page or the *"Save all changes without reviewing"* button in the "*Review*…" dropdown menu in the top left corner of this page.

⇨ You can review your changes by clicking the "*Review*…" button in the top left corner of the homepage (see Figure 8.9) or the "*Review changes*" button at the bottom of the screen (see Figure 8.8).

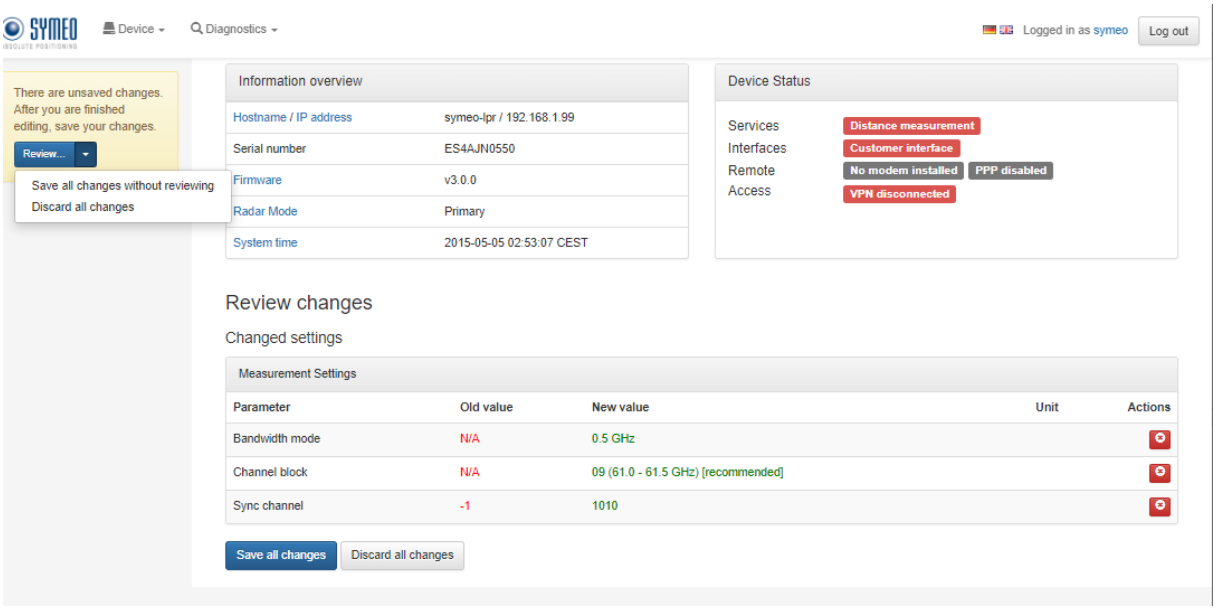


Figure 8.9: Save or discard all changes

⇨ Confirm the changes by clicking the "*Save all changes*" button. The dialog box "*Changes have been saved*" will appear (see Figure 8.10).

⇨ If you would like to discard all changes made after the last save, press *"Discard all changes"* in the dropdown menu in the top left corner of this page or at the bottom of the screen.

After saving, it takes several seconds until the measurement is restarted with the new settings. Some settings additionally require a reboot of the radar.

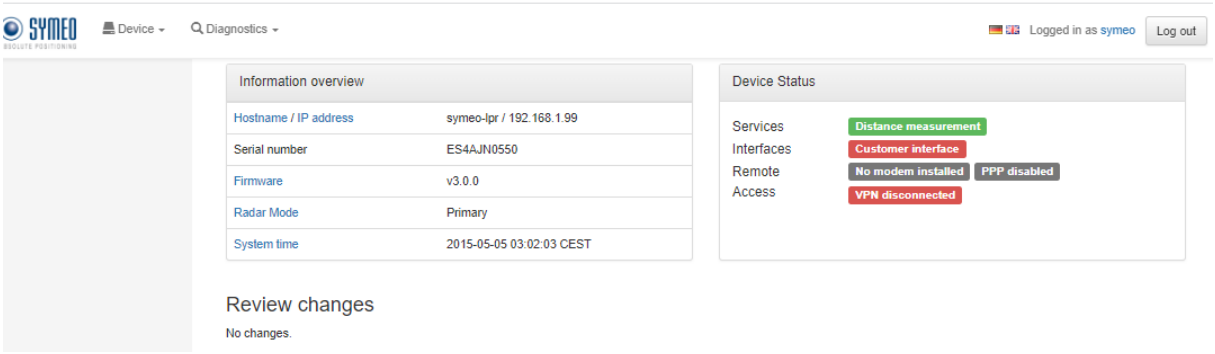


Figure 8.10: Changes have been saved

8.5 Home Page

On the home page (see Figure 8.11), important information about the LPR®-1DHP-291 is displayed.

You can always return to the start page if you press on the Symeo symbol SYMEO in the top left-hand corner of this page.

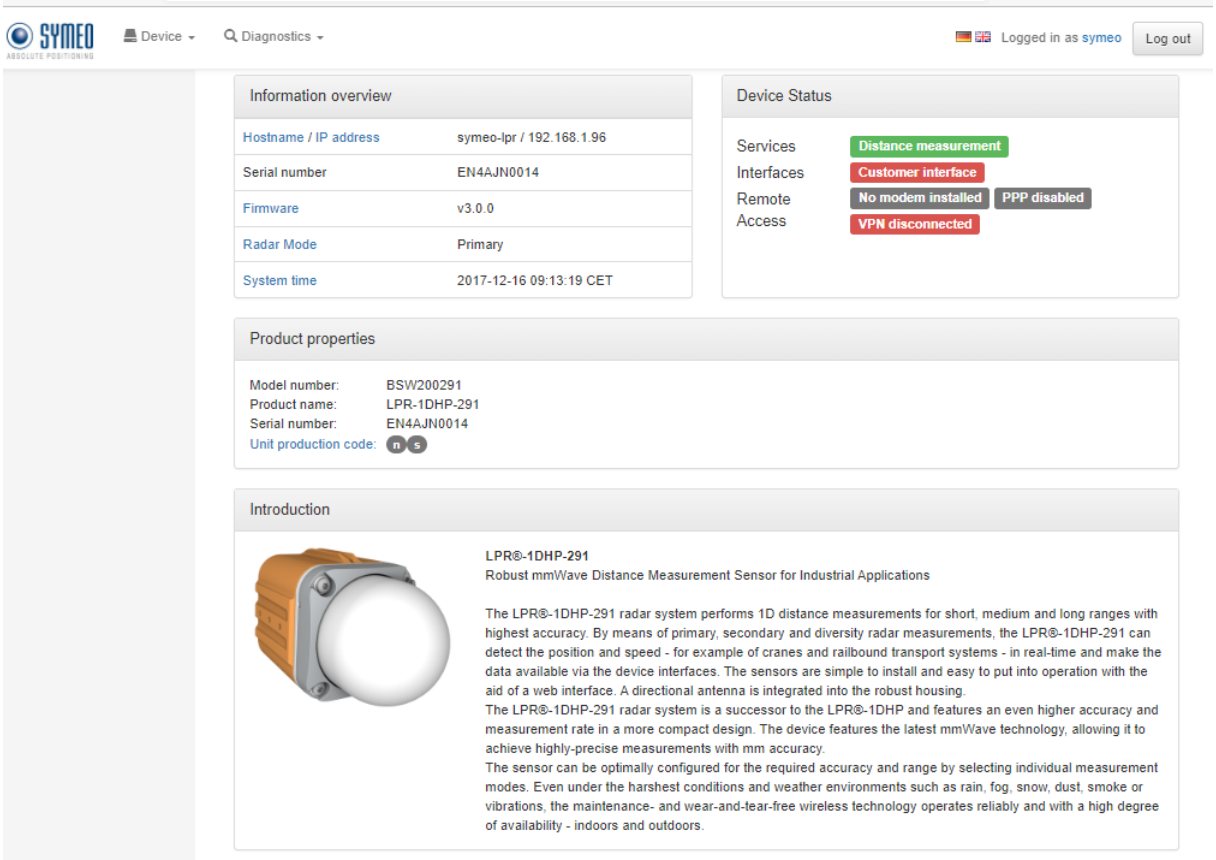


Figure 8.11: The home page of the LPR®-1DHP-291

On top of every page, the device status is shown (see Figure 8.12):

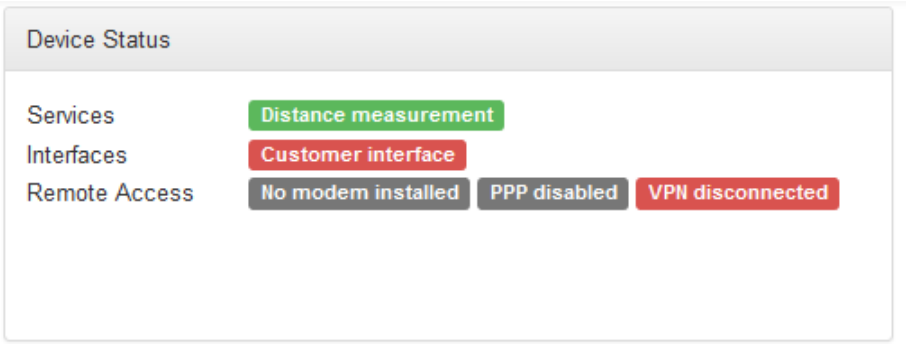


Figure 8.12: WebUI - Device Status

The "*Device Status*" window shows the status of the Services, of the Interfaces and the Remote Access status.

- The service status "Distance measurement" is green if the measurement is setup correctly.
- This also applies to the Remote Access Option if it is available, configured and connected.
- The interface status "Customer Interface" button turns green if a client is successfully connected to the customer port.

The "*Information overview*" window (see Figure 8.13) shows:

- Hostname / IP address of the LPR®-1DHP-291
- Serial number
- Firmware
- Radar Mode: Primary, Master or Slave
- System time

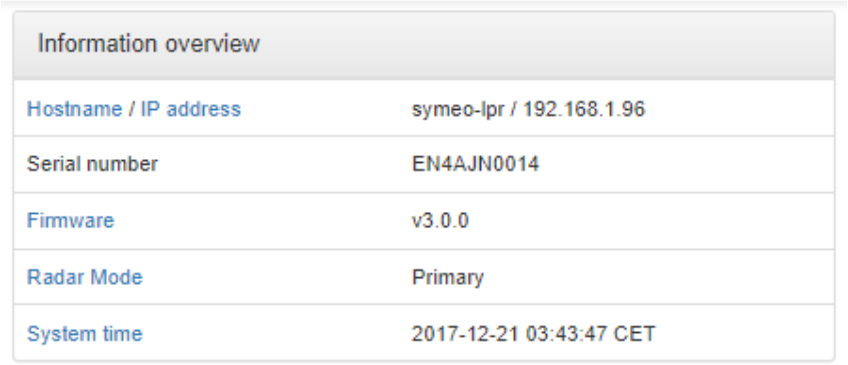


Figure 8.13: WebUI Information overview

By clicking on the "*System time*" button, the "Set system time" window will appear. Here you can either choose to

- use the system time of your computer or
- enter the time in the current timezone configured for the unit or as UTC time.

The "*Product properties*" window displays:

- Model number
- Product name
- Serial number
- Unit production code
  - States the available and active performance features of the purchased product (see Figure 8.14).

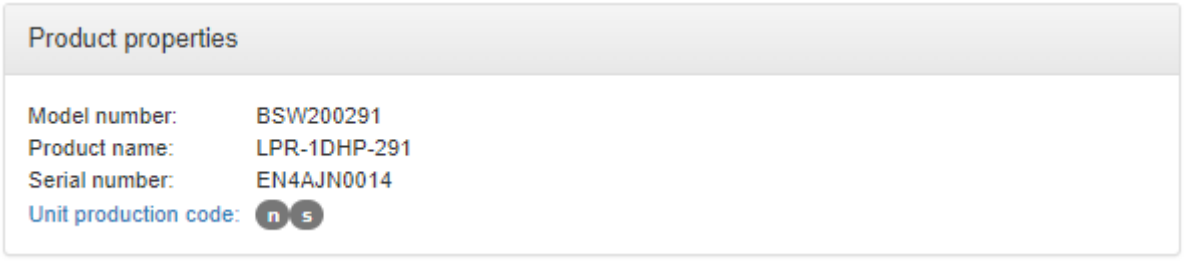


Figure 8.14: WebUI - Product properties

⇨ Click the "*Unit production code*" button under the menu item "*Product properties*" (see Figure 8.14). The table with the product features will be displayed.

The table below shows a complete list of all features available for this unit (see Figure 8.15).

Figure 8.15: WebUI - Product features

8.6 Device

In this menu (see Figure 8.16), the following subpages are available:

- Settings
- Upload configuration
- Downloads
- Firmware update
- Factory reset
- Reboot device

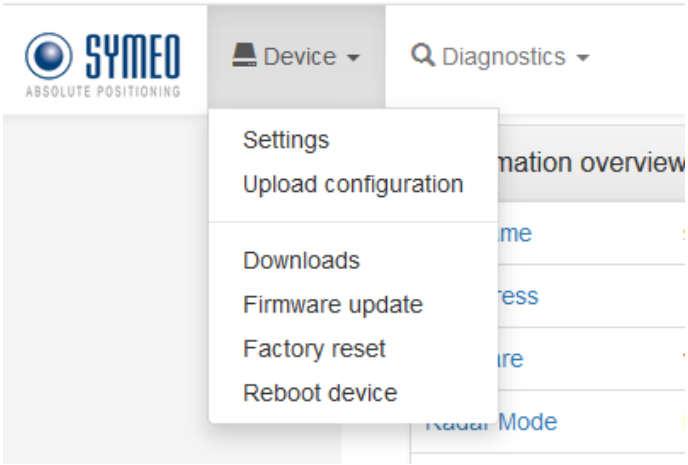


Figure 8.16: Device Menu

8.6.1 Device - Settings

In this menu, the following settings are available:

- Customer protocol
- Forwarding
- LAN
- Logging
- Measurement
- Measurement details
- Modem
- Network routes
- Profinet
- Relay
- Remote access
- Timezone
- VPN remote access

Device - Settings - Customer Protocol

In this menu (see Figure 8.17), the following settings are available:

- **Mode of customer protocol**
  - Interface to customer - either TCP or UDP
    - TCP server (customer connects to LPR®-1DHP-291)
    - TCP client (LPR®-1DHP-291 connects to customer server)
    - UDP
- **Port**
  - Port of customer protocol binary XP (Integer number in range 1100..65535)
- **Protocol frame length**
  - Frame length of customer protocol binary XP (default value 47 bytes). Each data packet is zero-padded to the selected protocol frame length before the data packet is sent (Integer number in range 47..100 byte)
- **Enable custom output interval**
  - Enable a custom output interval of own distance. If disabled, the own measured distance is output with the internal measurement rate
- **Output interval of own distance** (if the "*Enable custom output interval*" is enabled)
  - Output interval of own measured distance in milliseconds (Integer number in range 10..60000 ms).

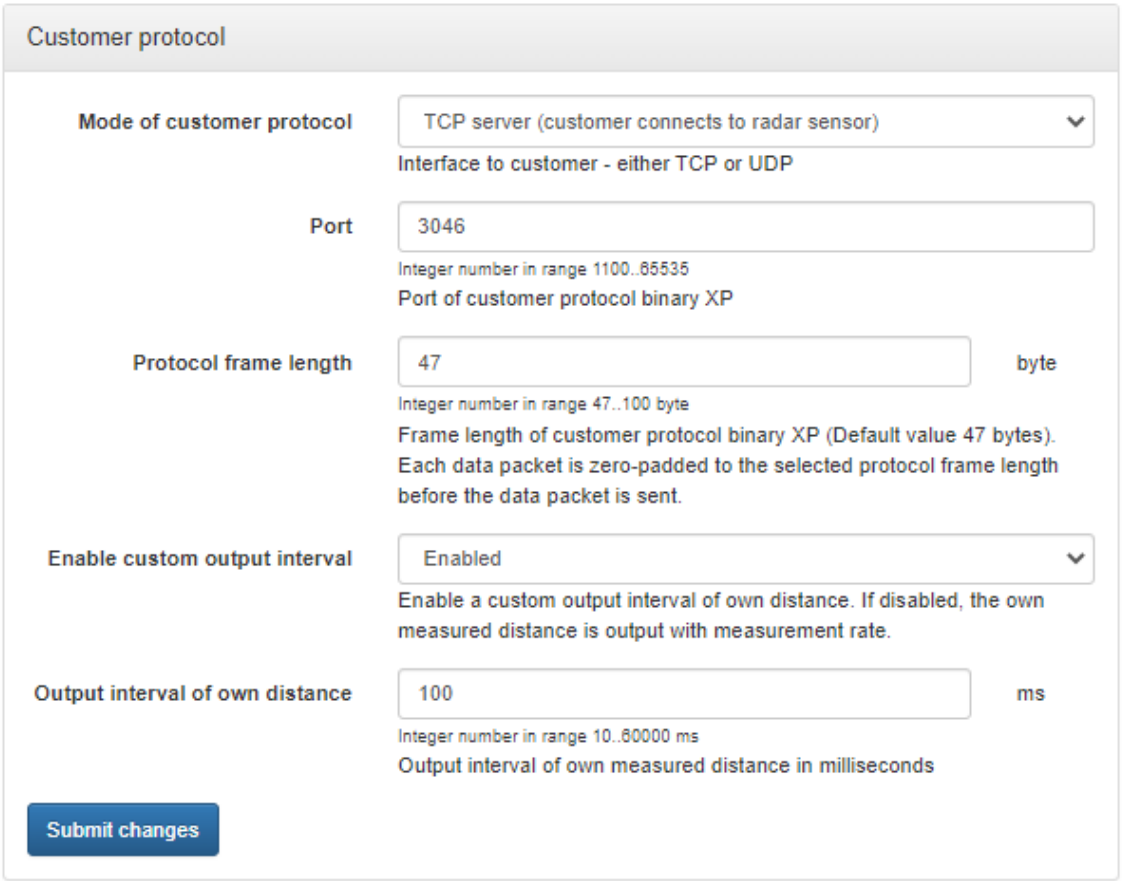


Figure 8.17: Device - Settings - Customer protocol

Device - Settings - Forwarding

In this menu (see Figure 8.18), the following settings are available:

- **LAN forwarder** (must be first activated by the user)
  - Forward packages via LAN to connected LPR®-1D24 radar

The following extra options will be available after enabling LAN forwarding:

- **Destination IP address**
  - Destination IP address of connected LPR®-1D24 radar
- **Enable custom forward interval**
  - Enable a custom forward interval of own distance. If disabled, the own measured distance is forwarded with measurement rate
- **Output interval of own distance** (if **"***Enable custom forward interval* **"**enabled)
  - Output interval of own measured distance to be forwarded over LAN.

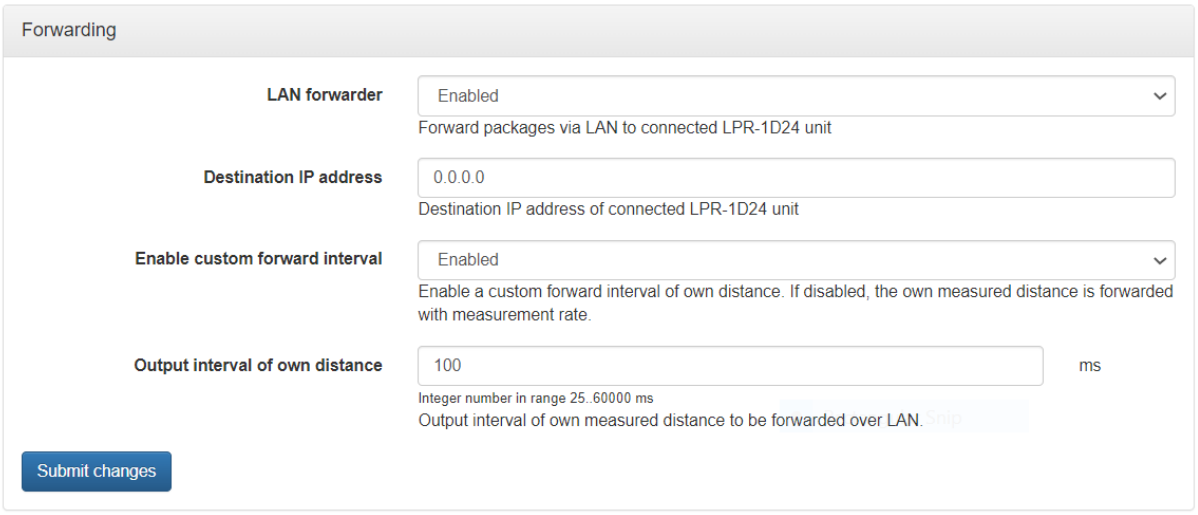


Figure 8.18: Device - Settings - Forwarding

Device - Settings - LAN

In this menu (see Figure 8.19), the following settings are available:

- **Link type**
- **Address Mode**
- **IP-Address**
- **Netmask**
- **Gateway**
- **Hostname**
  - Local hostname, this name will also be offered to the DHCP server in DHCP mode
- **DNS**
  - IP of name server (domain name system)
- **Syslog**
  - IP of server for syslog messages
- **NTP Server**
  - IP or hostname of time server (network time protocol).

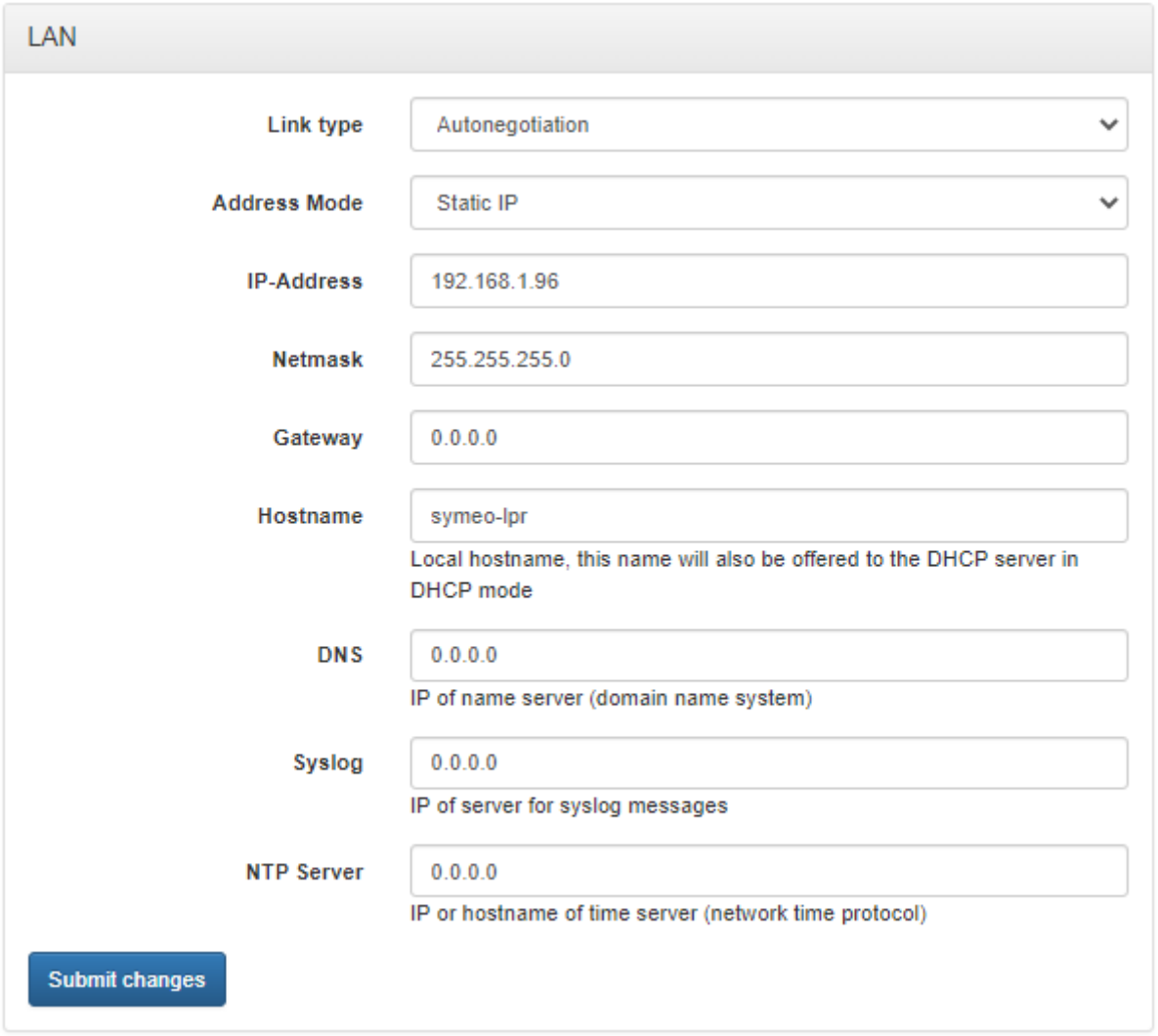


Figure 8.19: Device - Settings - LAN

Device - Settings - Logging

In this menu (see Figure 8.20), the following settings are available:

- **Logging mode**
  - Defines whether unit logs system events and measurements to a storage device.

Note	The logging function is only to be activated temporarily in case of trouble shooting. The Symeo Support Team must be informed under support@symeo.com prior to the activation.

Here you can choose from the options shown below.

- Disabled
- Log to SD card if available
- Log to USB stick if available (recommended)
- Log to USB stick if available, use SD card as fallback
- Log to volatile memory only
  For LPR®-1DHP-291, only logging to volatile memory is supported.

- **Customer logging ports**
  - Enables additional ports to record customer data, e.g., additional sensor input, which must be sent to the LPR®-1DHP-291 via TCP or UDP connections.

If the "*Customer logging ports*" is enabled, the following settings will additionally appear:

  - Customer logging TCP port 1
  - Customer logging TCP port 2
  - Customer logging UDP port 1
  - Customer logging UDP port 2

- **PC external logging**
  - When enabled, detailed measurement data can be forwarded to another device running Symeo's FusionEngine, e.g., to collect data from multiple sensors on a single device.

If the "*PC external logging*" is enabled, the following settings will additionally appear:

  - PC IP address
    IP address of PC for logging detailed LPR data externally
  - PC logging slot
    This slot determines the UDP ports for logging radar sensor data externally. These ports are used to forward, e.g., the distance and temperature readings.

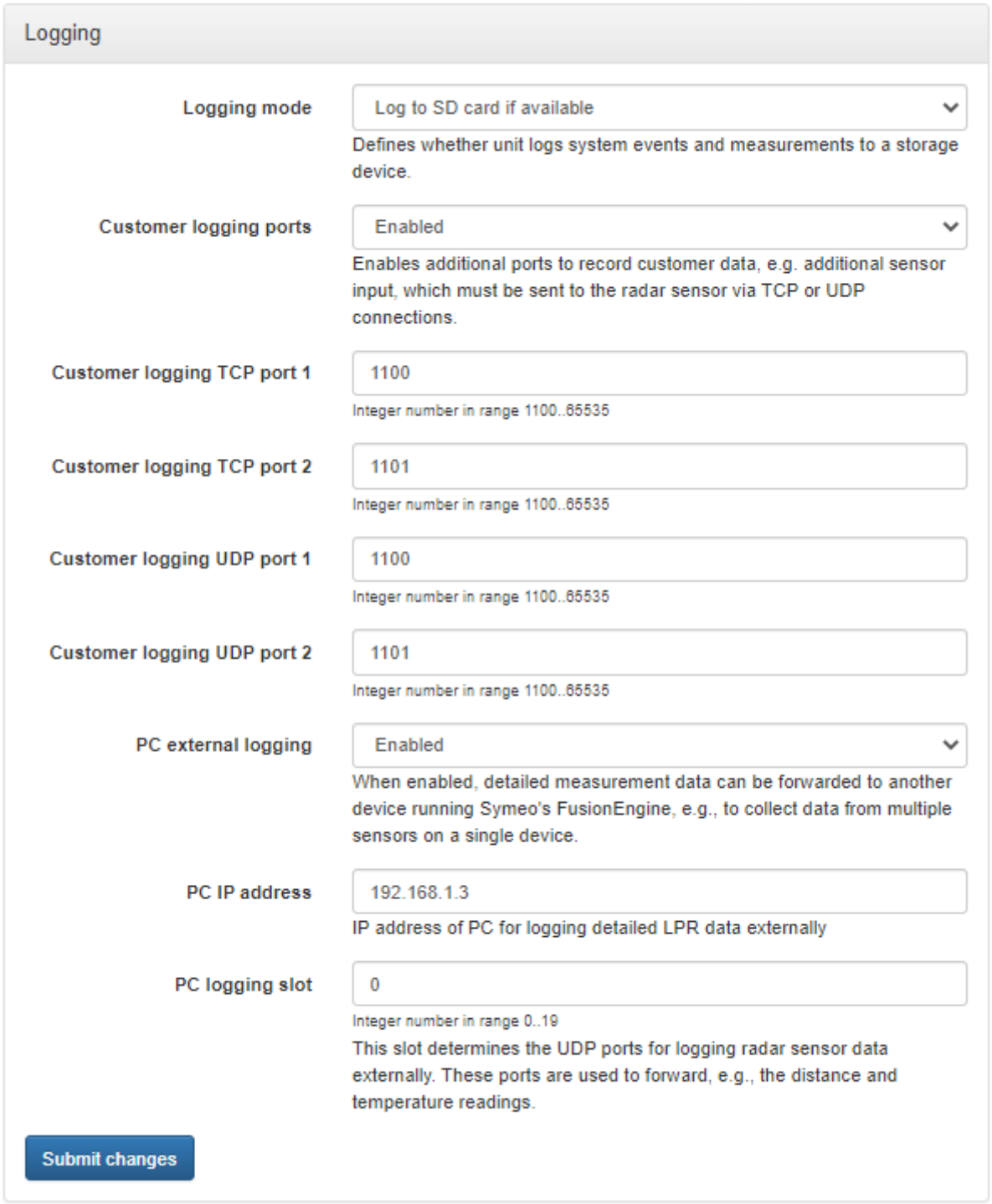
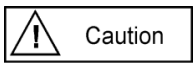


Figure 8.20: Device - Settings - Logging

Device - Settings - Measurement

In this menu (see Figure 8.21), the following settings are available:

- **Station mode**
  - Depending on the configuration the unit can either be run in secondary radar mode (master measures the distance to slave) or in primary radar mode (radar measures the distance to a reflective target)
- **Range mode**
  - The range mode determines the power of the transmitted signal. Short range mode uses lower signal levels, thus reducing the range but improving the accuracy of the system for short ranges. Check the customer specific offset after changing the range mode and adjust it if necessary
- **Bandwidth mode**
  - The radar sensor supports different bandwidth modes which impact the sensor's performance. For best accuracy choose a large bandwidth.
- **Channel block**
  - The RF frequency range is grouped into several blocks. Each channel block defines a set of available sync channels. It is recommended to keep the default value for optimum performance
- **Sync channel**
  - The sync channel determines the actual center frequency and bandwidth of the radar signals and differentiates the radar sensor links. The sync channel has to be the same for a pair of master and slave but different than that of any similar radar sensor in range. The sync channel with the lowest number provides the highest bandwidth in each channel block. Check the customer specific offset after changing the sync channel and adjust it if necessary.
- **Customer specific offset** (not available in Slave mode)
  - The offset can be used to calibrate the reference plane for the distance measurements according to the customer's setup, e.g., to calibrate the radar's distance readings to the customer's setup after replacing a device, changing the regulatory domain, the sync channel, or the range mode. The value is added to the measured distance.



Changing bandwidth mode, channel block or sync channel influences the sensors performance and reference plane. A recalibration and test of the installation is therefore necessary after changing these settings.

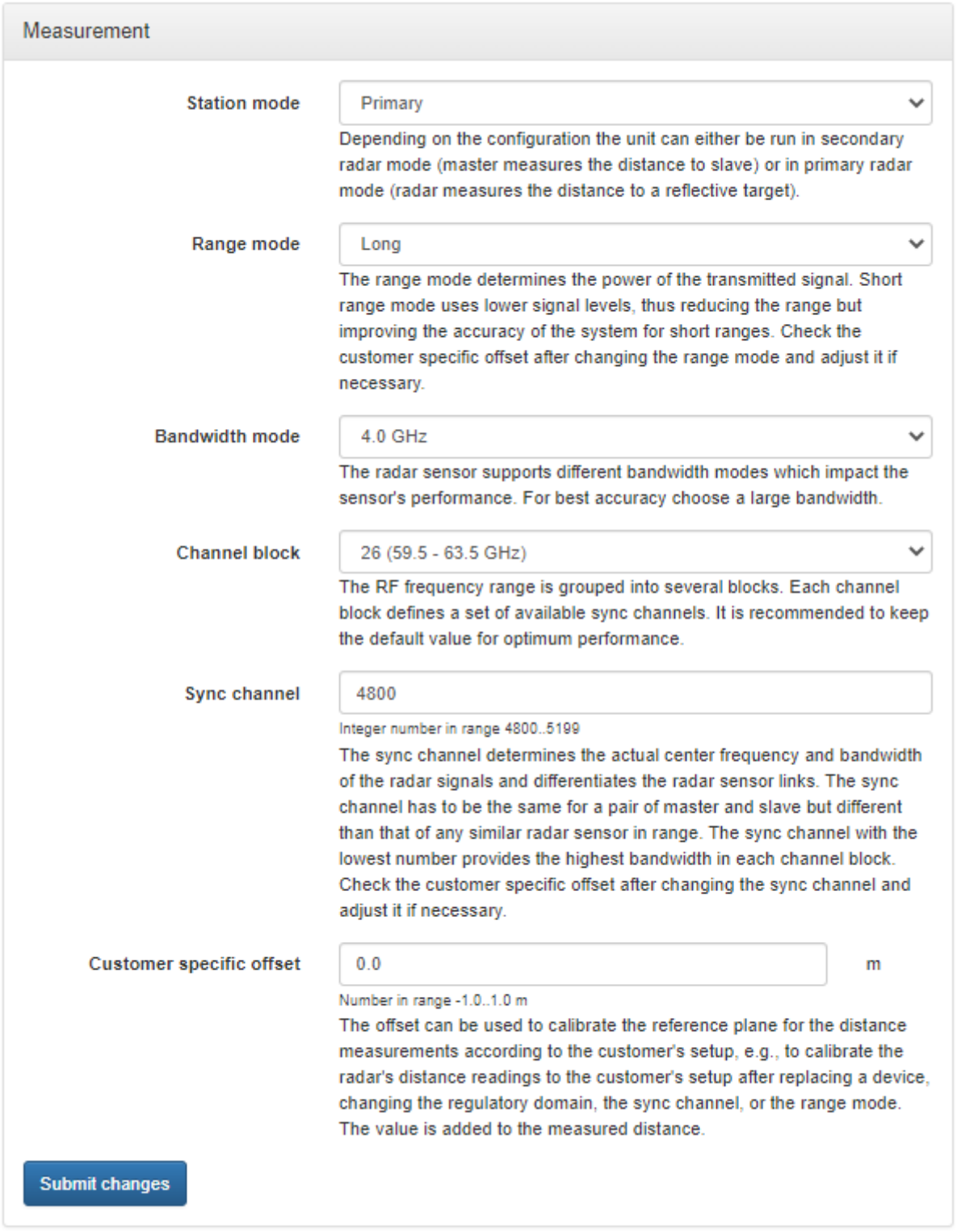


Figure 8.21: Device - Settings - Measurement

Device - Settings - Measurement Details

The available measurement details settings depend on your selected radar mode:

Measurement Details for Primary Radar Mode

In this menu (see Figure 8.22 and Figure 8.23), the following settings are available:

- **Average spectra**
  - Spectra can be averaged before applying the target search algorithm. Averaging more spectra will reduce the noise but it will also reduce the measurement rate
- **Target search mode**
  - The radar will either detect the first or the strongest target above the thresholds defined below
- **Start target range**
  - This parameter defines the start of the target search area. Targets below this distance will be ignored
- **Minimum level short range**
  - This parameter defines the required minimum level for valid targets in the short range area. Targets with a lower signal level will be ignored
- **End short range**
  - This parameter defines the end of the short range area where the respective minimum level is required for valid targets
- **Minimum level mid range**
  - This parameter defines the required minimum level for valid targets in the long range area. Targets with a lower signal level will be ignored
- **End mid range**
  - This parameter defines the end of the mid range area where the respective minimum level is required for valid targets
- **Minimum level long range**
  - This parameter defines the required minimum level for valid targets in the long range area. Targets with a lower signal level will be ignored
- **End long range**
  - This parameter defines the end of the long range area where the respective minimum level is required for valid targets
- **FFT size**
  - The maximum range and update rate of the sensor is limited internally by the FFT size. For maximum range, choose the large FFT. For maximum update rate, choose the small FFT
- **Maximum occurring speed**
  - The maximum occurring speed is used internally to validate the measurement results
- **Kalman filter**
  - The Kalman filter reduces the noise of the distance measurement output for standard measurement setups with linear motion. For non-standard applications in primary radar mode, it may be advantageous to disable the filter
- **Raw data output**
  - Raw data can be provided by the unit for further analysis

- **Raw data mode** (the "*Raw data output*" field is enabled)
  - Depending on the configuration the unit can provide raw ADC data, FFT spectra and/or the configured threshold values
- **Raw data rate** (the "*Raw data output*" field is enabled)
  - The raw data rate can be used the scale the amount of data which has to be recorded. Data is sent every n measurements
- **RX attenuator mode**
  - The RX attenuator can be enabled when the received signal is too strong

A change of the range zones and their threshold level settings is only necessary in a multi target environment and should only be conducted by trained personnel.

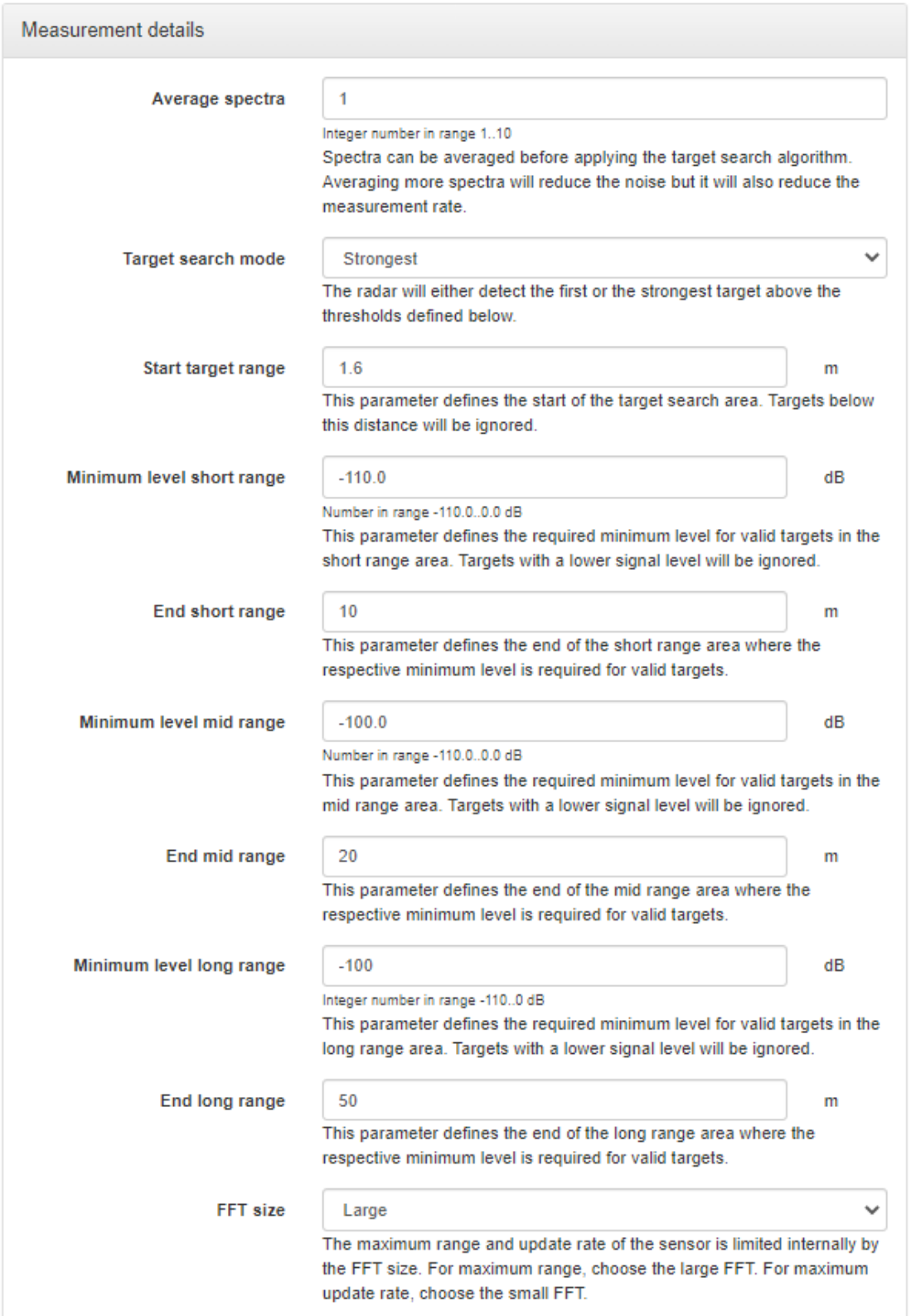


Figure 8.22: Device - Settings - Measurement details - Primary radar mode - part 1

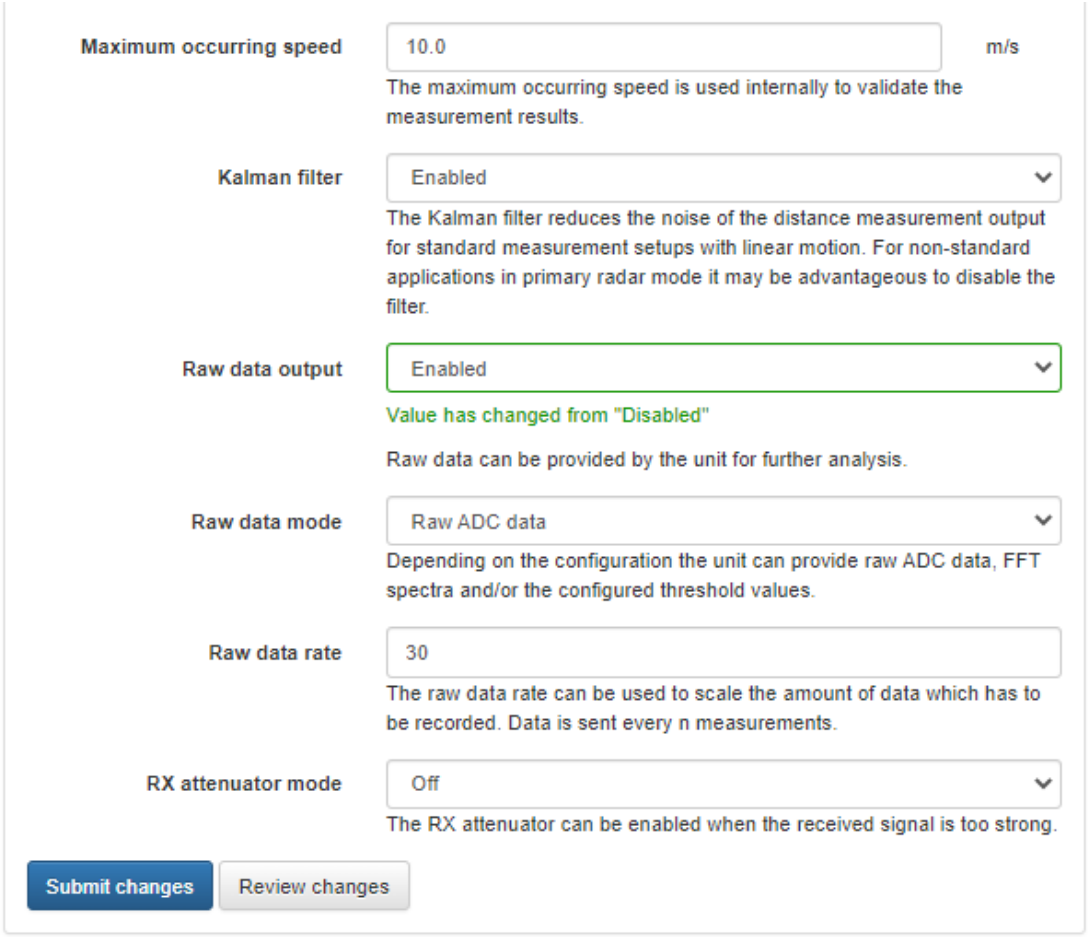


Figure 8.23: Device - Settings - Measurement details - Primary radar mode - part 2

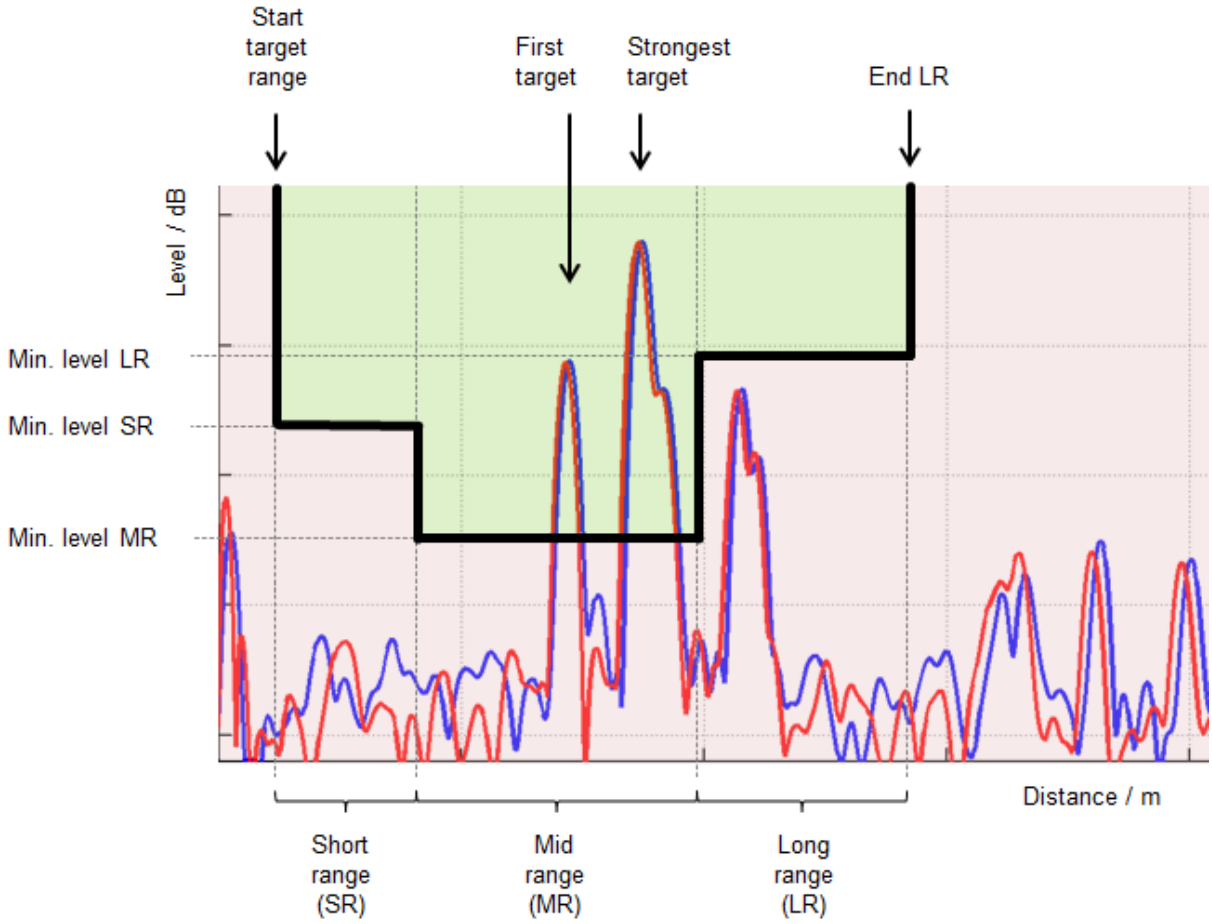


Figure 8.24: Radar target spectrum in a multiple target environment

Measurement Details for Secondary Radar Mode

In this menu (see Figure 8.25 and Figure 8.26), the following settings are available:

- **Target search mode**
  - The radar will either detect the first or the strongest target above the thresholds defined below
- **Minimum level**
  - This parameter defines the required minimum level for valid measurements in secondary radar mode. Measurements with a lower signal level will be discarded
- **Maximum occurring speed** (only Master)
  - The maximum occurring speed is used internally to validate the measurement results
- **Diversity mode** (only Master)
  - In diversity mode the measurement results of two LPR®-1DHP-291 are combined for optimum performance
- **Raw data output**
  - Raw data can be provided by the unit for further analysis
- **Raw data rate** (“*Raw data output*” field is enabled)
  - The raw data rate can be used to scale the amount of data, which has to be recorded Data is sent every n measurements
- **RX attenuator mode**
  - The RX attenuator can be enabled when the received signal is too strong.

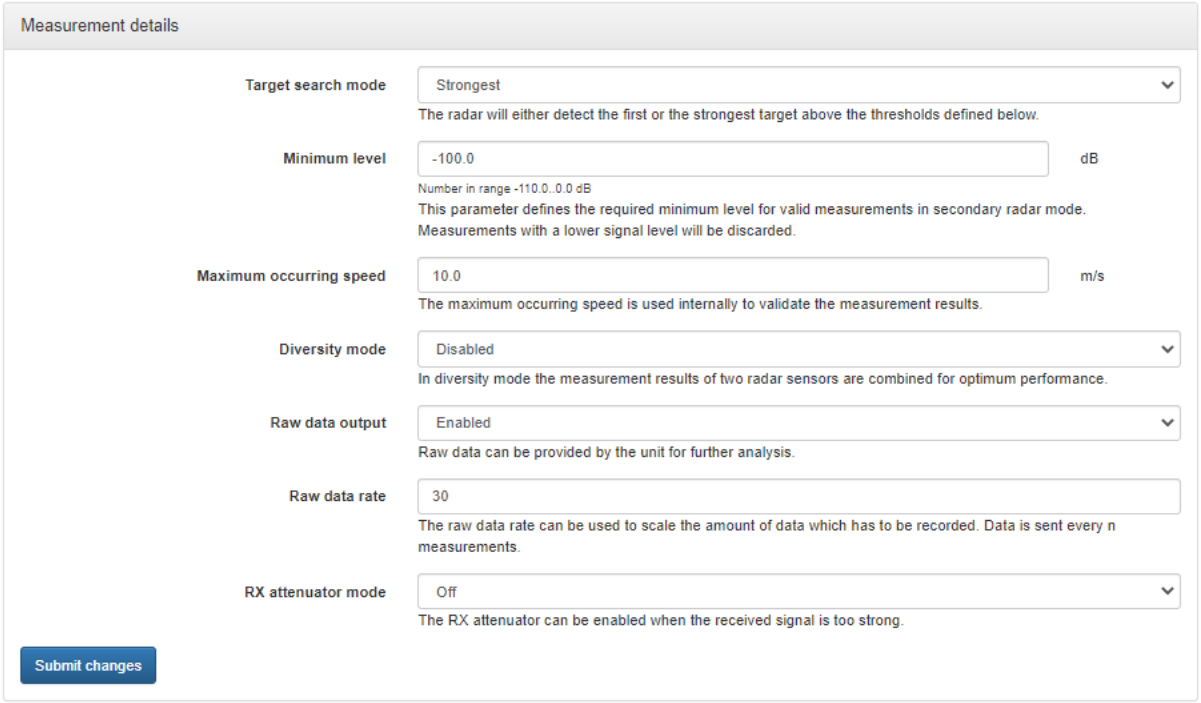


Figure 8.25: Device - Settings - Measurement details for Master

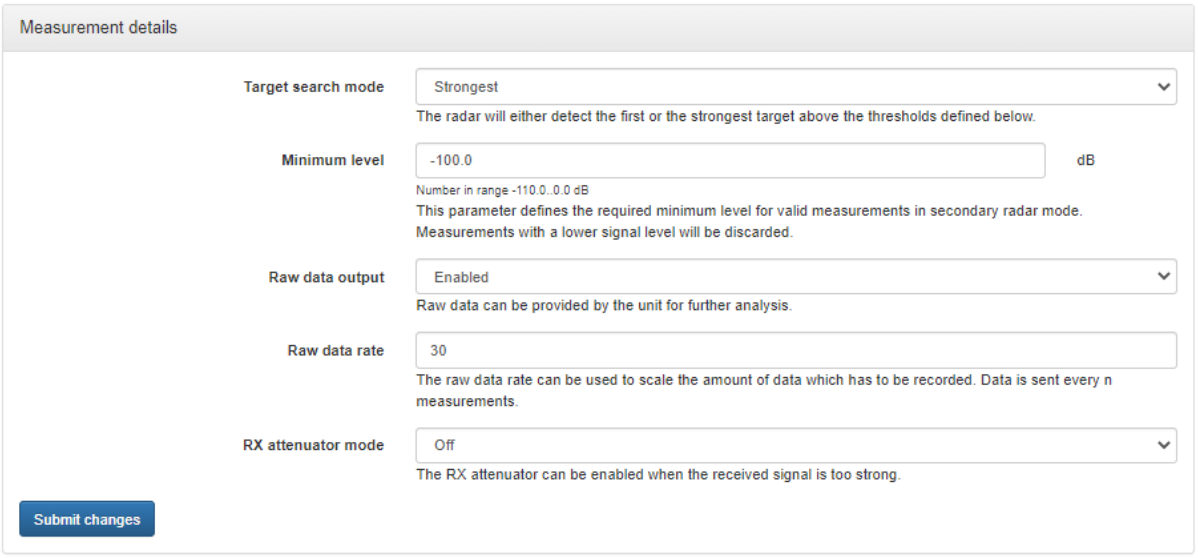


Figure 8.26: Device - Settings - Measurement details for Slave

Measurement Details for Diversity Radar Mode

Diversity radar mode is available only for Master radar mode.

For diversity radar mode, you must enable the "*Diversity mode*" setting under the *Settings -> Measurement details* (see Figure 8.27).

The following settings will additionally appear:

- **Diversity partner IP address**
  - In diversity mode the unit will connect to the diversity partner at the specified IP address
- **Diversity partner sync channel**
  - The sync channel of the diversity partner unit must also be specified. It is used internally to verify data from the correct partner unit is received.

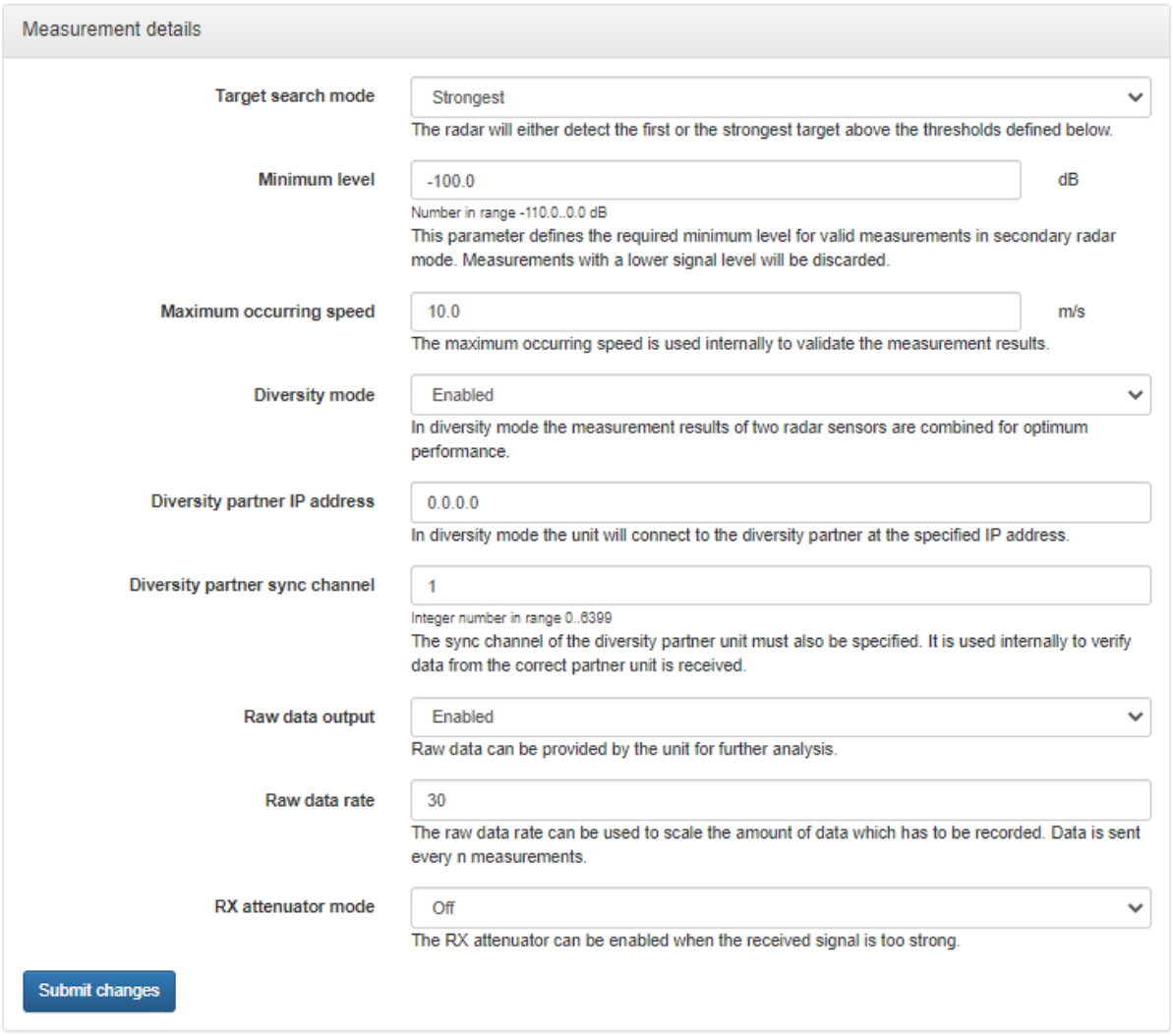


Figure 8.27: Device - Settings - Measurement details for Diversity radar mode

Device - Settings - Modem

In this menu (see Figure 8.28), the following settings are available:

- **PPP** (Point to Point protocol connection, enabled/disabled)
- **APN address**
- **APN username**
- **APN password**

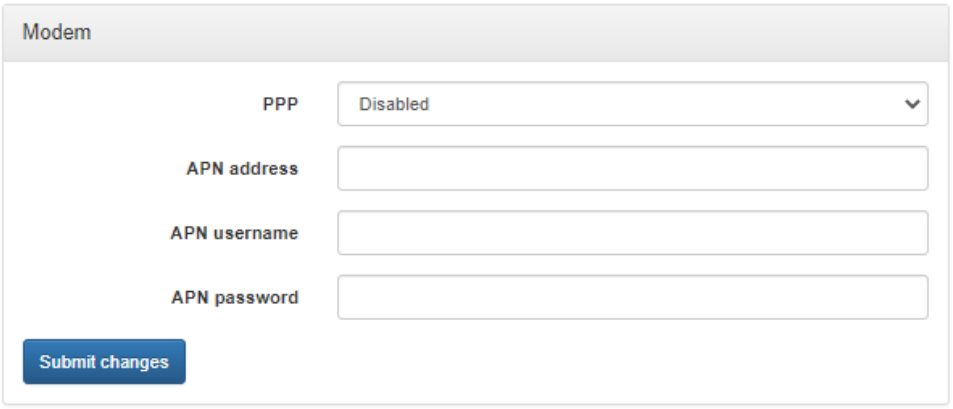


Figure 8.28: Device - Settings - Modem

Device - Settings - Network Routes

In this menu, you can adapt the network routes.

⇨ Click the "+ *add route*" button.

The dialog box "*add route*" will appear.

In this window, the following setting must be set:

- **Type** (Host or Network)
- **Target IP address**
- **Netmask** (for Network)
- **Gateway**

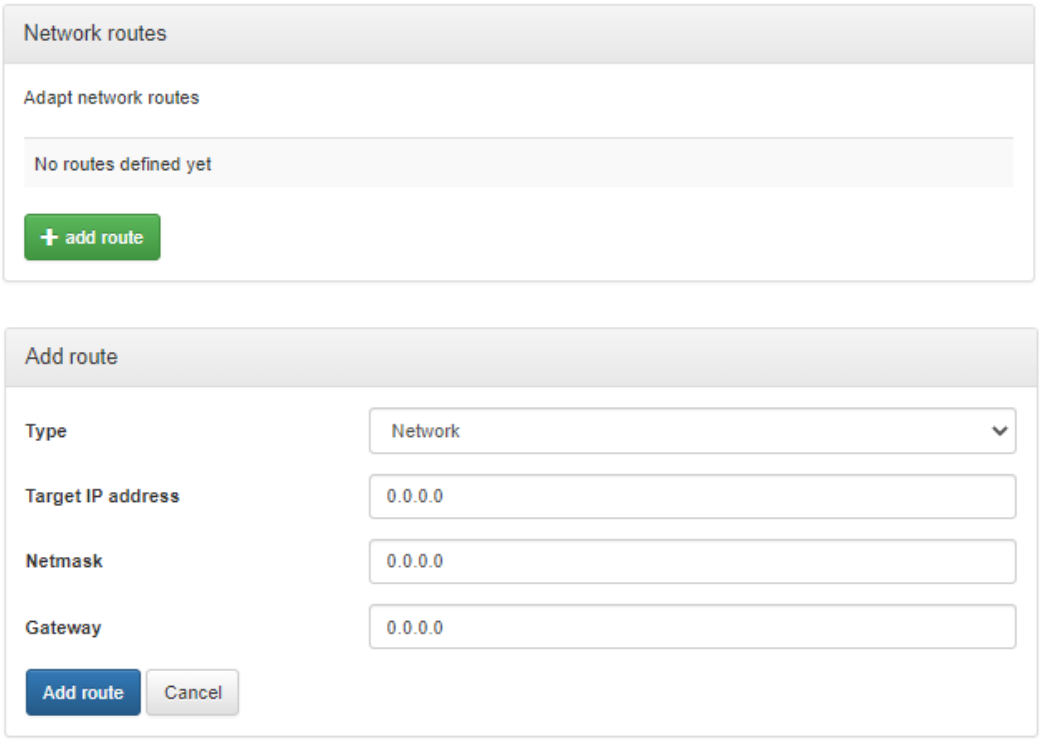


Figure 8.29: Device - Settings - Add route

⇨ After the settings are done, press the „*add route”* button.

Device - Settings Profinet

Note	This function is only available under the menu „*Device -> Settings*” if the unit production code "n" (Profinet) is available.

In this menu, (see Figure 8.30), you can view the settings of the Profinet interface. The following settings are obtained from the Profinet controller. You cannot change them here.

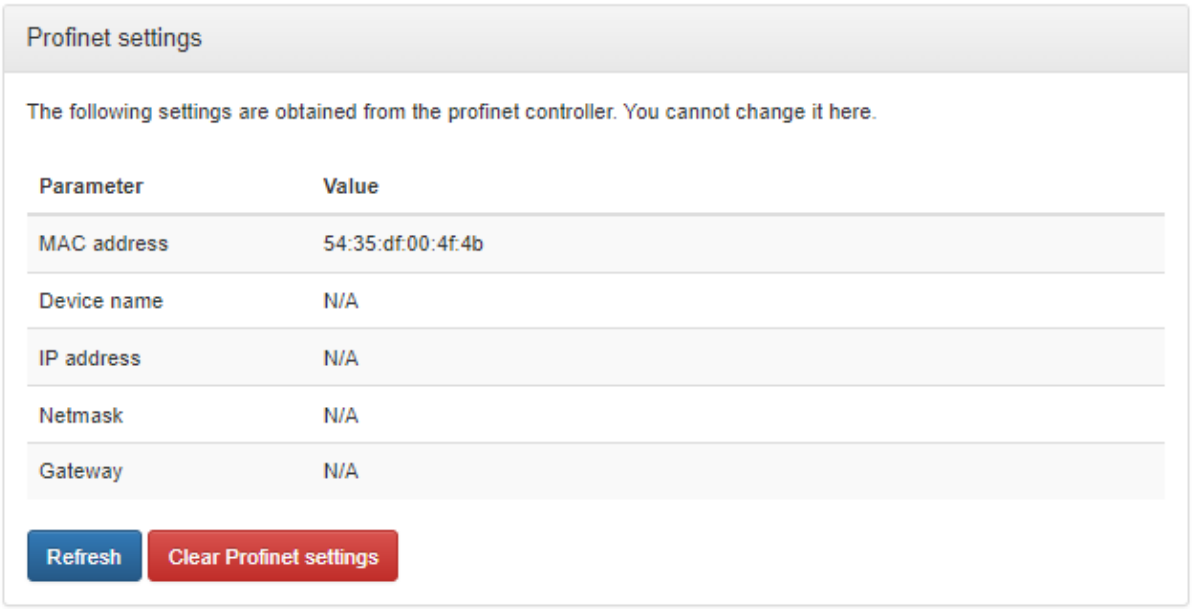


Figure 8.30: Device - Settings - Profinet

⇨ Click the „*Refresh*" button to reload the view or press „*Clear Profinet settings*" to delete the current settings.

Caution	This device complies with Profinet Conformance Class A. It has one Ethernet interface (M12-Connector), one MAC address and up to two IP addresses: **an IPv4 IP address (default 192.168.1.99) and a Profinet IP address (optional).** IPv4 address and Profinet IP address of a device must not be the same, i.e., all IP addresses in the network segment must be unique. For example, if two devices are connected via a network switch, up to 4 (four) different IP addresses must be assigned.

Device - Settings - Relay

In this menu (see Figure 8.31), the following setting are available:

- **Relay data output**
  - Relay switch commands can be used to control relays at other LPR® units, e.g., at LPR®-1D24 devices

If the "*Relay data output*" is enabled (see Figure 8.31), the following settings will additionally appear:

- **Relay destination address**
  - Address of the target device where the relays are switched (hex value)
- **Zone 1 distance**
  - Relays assigned to zone 1 will open when measured distance is below this value
- **Zone 2 distance**
  - Relays assigned to zone 2 will open when measured distance is below this value

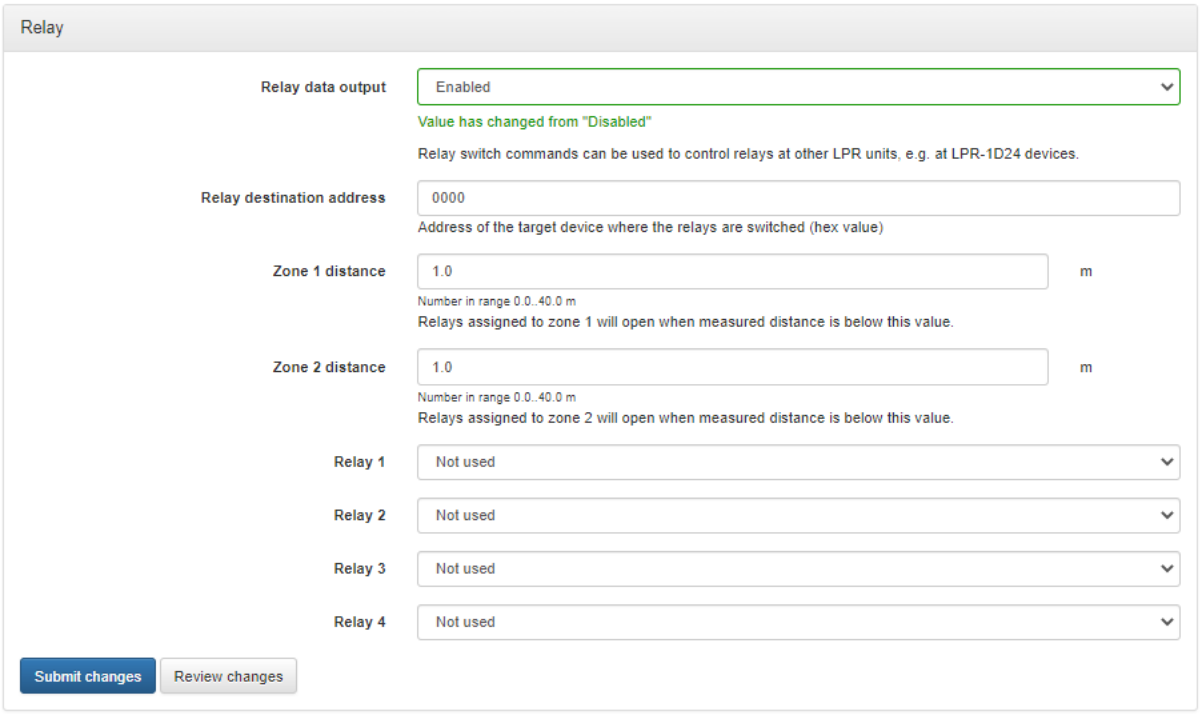
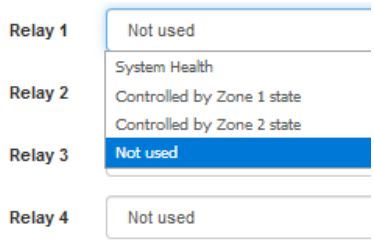


Figure 8.31: Device - Settings - Relay

The virtual relays 1-4 can be assigned to switch according to system health, Zone 1 state or Zone 2 state:



Device - Settings - Remote Access

This function allows to configure a VPN-access if required.

In this menu (see Figure 8.32), the following setting are available:

- **HTTP** - enabled / disabled
- **OpenVPN Client** - enabled / disabled

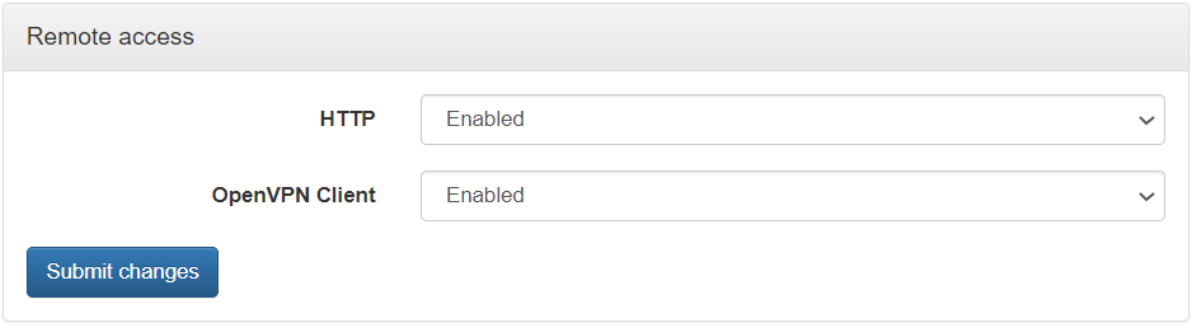


Figure 8.32: Device - Settings - Remote access

Warning If you disable http, the access to the WebUI of this unit will be disabled. An access to the WebUI is then only possible via HTTPS.

Device - Settings - Timezone

In this menu (see Figure 8.33), the following settings are available:

- **Timezone**
  - Must be set to custom timezone if needed timezone is not in the dropdown menu
- **Custom timezone**
  - Needs to be filled if customer specific timezone is used.

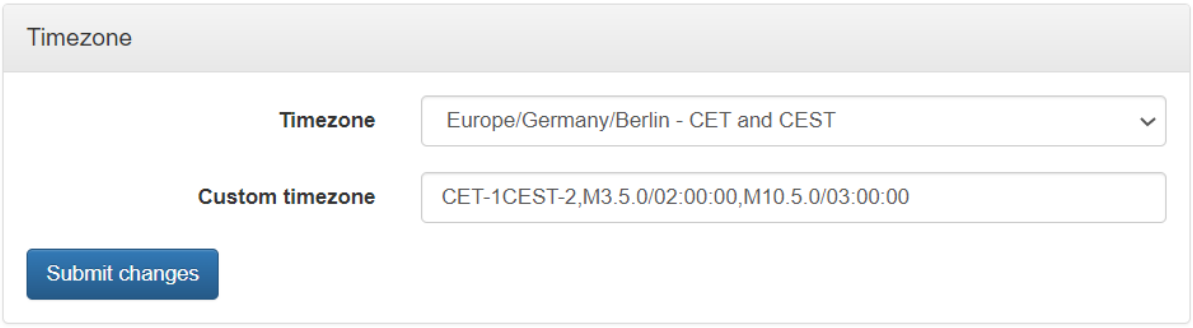


Figure 8.33: Device - Settings – Timezone

Device - Settings - VPN Remote Access

In this menu (see Figure 8.34), the following settings are available:

- **Settings:**
  - OpenVPN Client - enabled / disabled
  - PPP - enabled / disabled
  - APN address
  - APN username
  - APN password
- **Current VPN certificate**
  - Certificate name
- **Change VPN certificate**
  - Choose new certificate
    The certificate must be an All-In-One certificate. All keys and certificates must be contained in the same file.

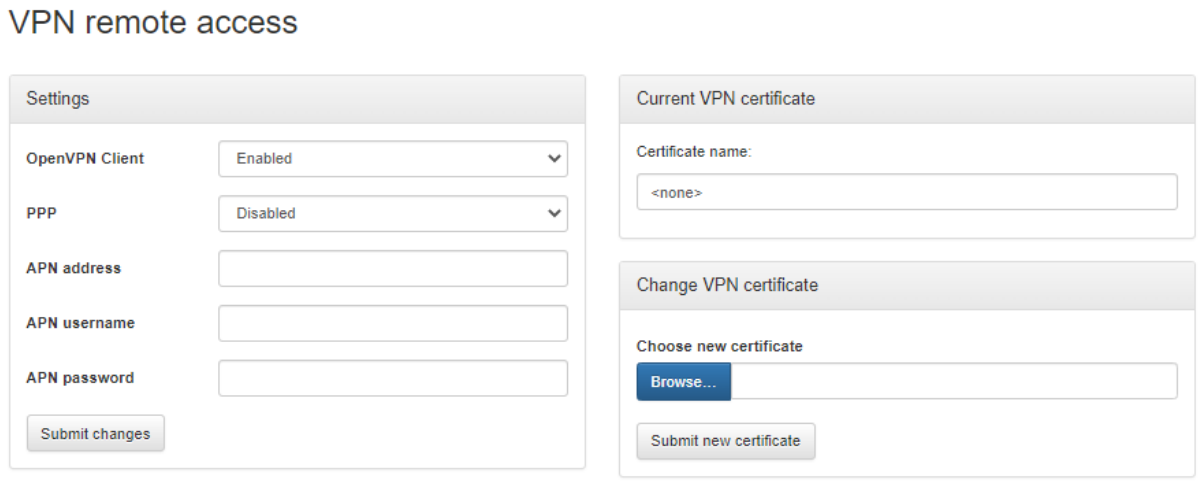


Figure 8.34: Device - Settings - VPN remote access

8.6.2 Device - Upload Configuration

In this menu (see Figure 8.35), you can upload a local configuration file:

Figure 8.35: Device - Upload configuration

⇨ Click the "*Browse*" button to choose a local configuration file for upload.

⇨ Click the "*Upload configuration*" button to upload your configuration.

8.6.3 Device - Downloads

In this menu (see Figure 8.36), you can download several files from the unit:

- **Settings** - downloads settings of this unit (all configuration parameters)
- **Profinet GSDML file** - downloads Profinet GSDML file (if Profinet available)

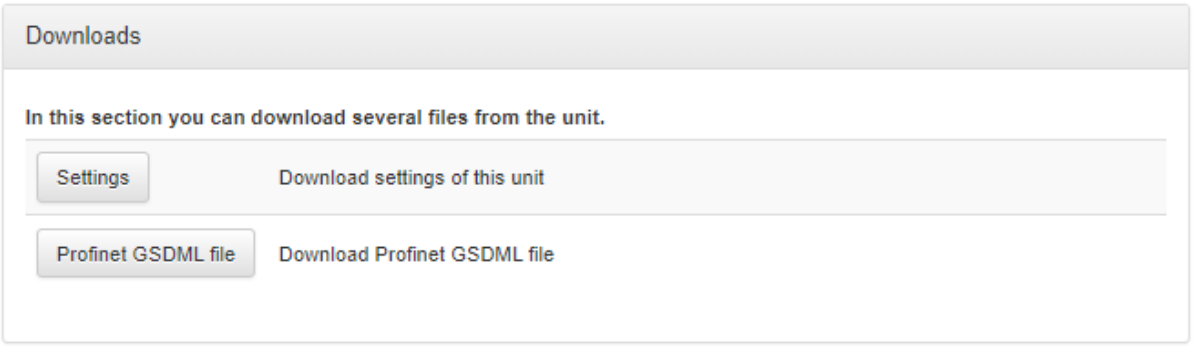


Figure 8.36: Device - Downloads

8.6.4 Device - Firmware Update

In this menu (see Figure 8.37), you can update the firmware:

⇨ Use the „*Browse*“ button to find the firmware file provided by Symeo and press “*Upload firmware*“.

⇨ Press *“Flash Firmware” (*see Figure 8.38*)*

⇨ Wait until firmware update and automatic reboot are finished.

Figure 8.37: Device - Firmware update

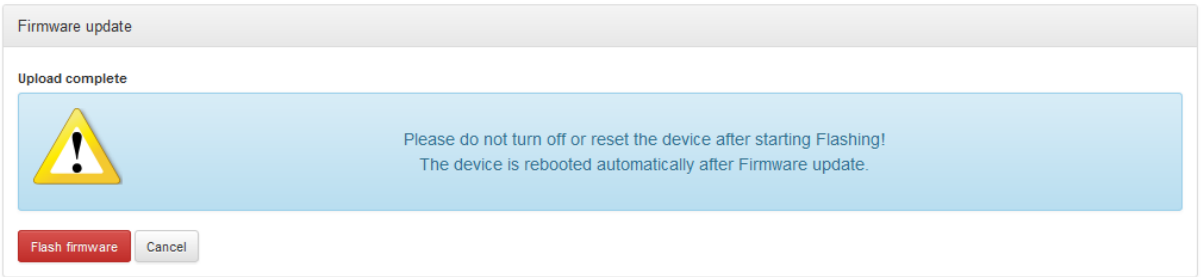


Figure 8.38: Device - Device configuration - Firmware update success message

Caution	All stations that measure or forward together should have the same firmware version.

8.6.5 Device - Factory Reset

In this menu, (see Figure 8.39), you can restore factory settings.

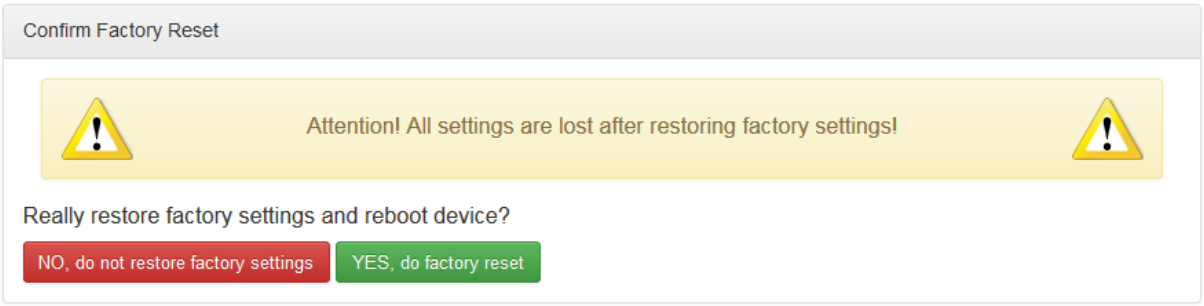


Figure 8.39: Device - Factory Reset

Caution	All settings are reset by restoring factory settings.

8.6.6 Device - Reboot Device

In this menu (see Figure 8.40), you can reboot the device:

- Reboot the device

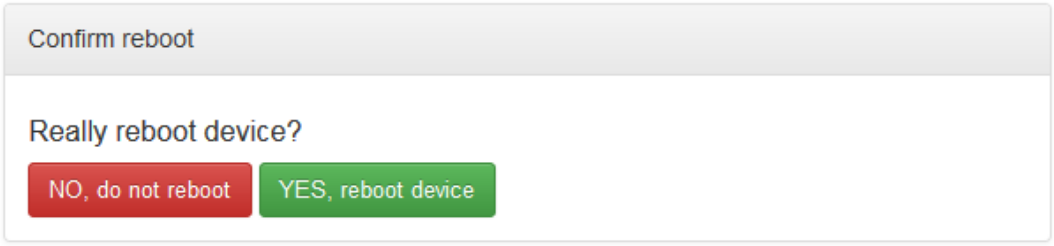


Figure 8.40: Device - Reboot Device

8.7 Diagnostics

In this menu (see Figure 8.41), the following subpages are available:

- Operating System Status
- Hardware Status
- Storage device
- Radar signal spectrum
- Range measurement statistics
- Record measurement data
- Packet inspector
- Station scan

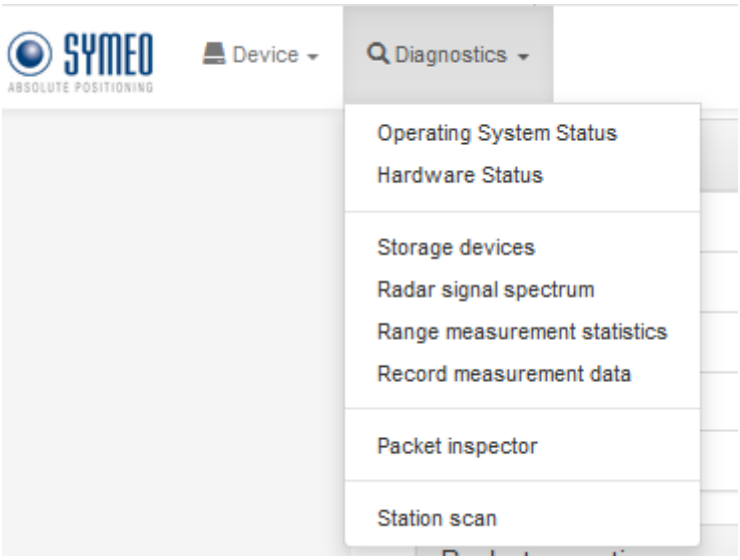


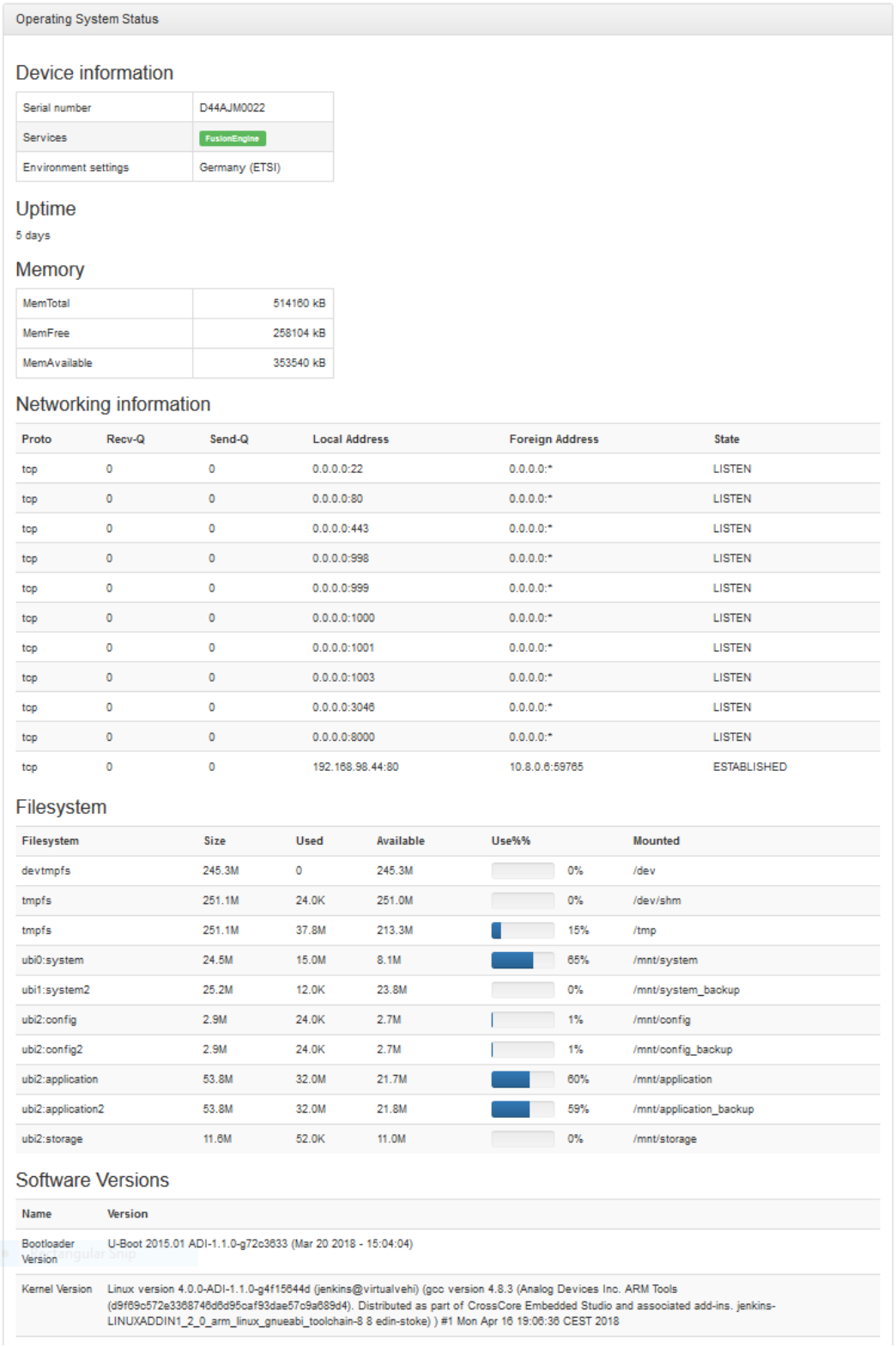
Figure 8.41: Diagnostics Menu

8.7.1 Diagnostics - Operating System Status

Under this menu (see Figure 8.42), following information is available:

- Device information
- Uptime, Memory
- Networking information
- Filesystem
- Software version

In case of problems, this information may be requested by Symeo support.



Operating System Status

Device information

Serial number	D44AJM0022
Services	FusionEngine
Environment settings	Germany (ETSI)

Uptime

5 days

Memory

MemTotal	514160 kB
MemFree	258104 kB
MemAvailable	353540 kB

Networking information

Proto	Recv-Q	Send-Q	Local Address	Foreign Address	State
tcp	0	0	0.0.0.0:22	0.0.0.0:*	LISTEN
tcp	0	0	0.0.0.0:80	0.0.0.0:*	LISTEN
tcp	0	0	0.0.0.0:443	0.0.0.0:*	LISTEN
tcp	0	0	0.0.0.0:998	0.0.0.0:*	LISTEN
tcp	0	0	0.0.0.0:999	0.0.0.0:*	LISTEN
tcp	0	0	0.0.0.0:1000	0.0.0.0:*	LISTEN
tcp	0	0	0.0.0.0:1001	0.0.0.0:*	LISTEN
tcp	0	0	0.0.0.0:1003	0.0.0.0:*	LISTEN
tcp	0	0	0.0.0.0:3046	0.0.0.0:*	LISTEN
tcp	0	0	0.0.0.0:8000	0.0.0.0:*	LISTEN
tcp	0	0	192.168.98.44:80	10.8.0.6:59765	ESTABLISHED

Filesystem

Filesystem	Size	Used	Available	Use%%	Mounted
devtmpfs	245.3M	0	245.3M	0%	/dev
tmpfs	251.1M	24.0K	251.0M	0%	/dev/shm
tmpfs	251.1M	37.8M	213.3M	15%	/tmp
ubi0:system	24.5M	15.0M	8.1M	65%	/mnt/system
ubi1:system2	25.2M	12.0K	23.8M	0%	/mnt/system_backup
ubi2:config	2.9M	24.0K	2.7M	1%	/mnt/config
ubi2:config2	2.9M	24.0K	2.7M	1%	/mnt/config_backup
ubi2:application	53.8M	32.0M	21.7M	60%	/mnt/application
ubi2:application2	53.8M	32.0M	21.8M	59%	/mnt/application_backup
ubi2:storage	11.6M	52.0K	11.0M	0%	/mnt/storage

Software Versions

Name	Version
Bootloader Version	U-Boot 2015.01 ADI-1.1.0-g72c3833 (Mar 20 2018 - 15:04:04)
Kernel Version	Linux version 4.0.0-ADI-1.1.0-g4f15644d (jenkins@virtualvehi) (gcc version 4.8.3 (Analog Devices Inc. ARM Tools (d9f69c572e3368746d6d95caf93dae57c9a689d4). Distributed as part of CrossCore Embedded Studio and associated add-ins. jenkins-LINUXADDIN1_2_0_arm_linux_gnueabi_toolchain-8 8 edin-stoke)) #1 Mon Apr 16 19:06:36 CEST 2018

Figure 8.42: Diagnostics - Operating System Status

8.7.2 Diagnostics - Hardware Status

In this menu (see Figure 8.43), system values and system voltages are displayed.

In case of problems, this information may be requested by Symeo support.

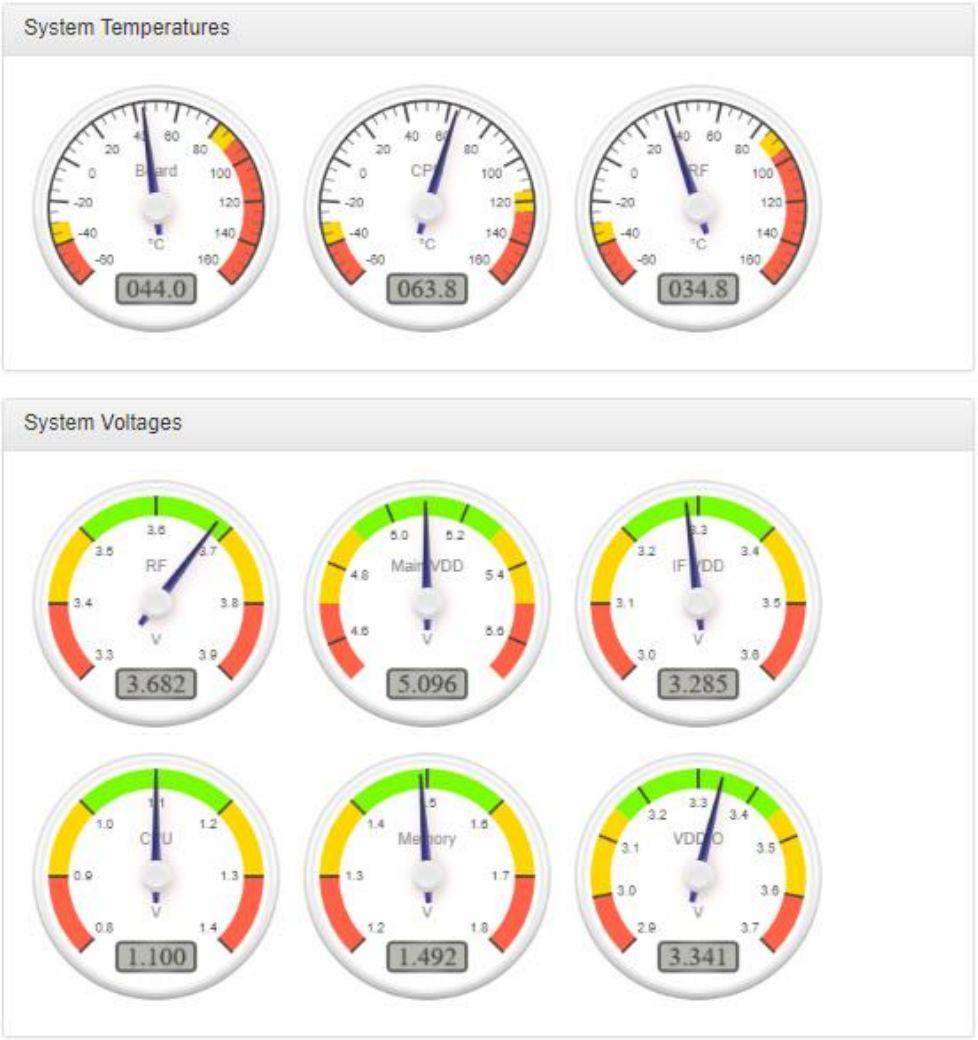


Figure 8.43: Diagnostics - Hardware Status

This display is automatically refreshed every 5 seconds.

8.7.3 Diagnostics - Storage Devices

In this section, available storage devices are displayed and can be formatted. Standard devices do not have a storage device implemented.

8.7.4 Diagnostics - Radar Signal Spectrum

In this section, the live view of the FFT spectrum of the radar signals will be shown (see Figure 8.44). The plot shows the echo strength over frequency or distance and allows to

evaluate the measurement situation and helps with defining threshold levels and target detection modes (first or strongest target) or observing multipath reflections and signal to noise ratios.

Note

- The "*Radar Signal Spectrum*" is only available if the Setting "*Device -> Settings -> Measurement details -> Raw Data Output"* is enabled and "*Raw Data Mode"* is set to *"Raw ADC data.*
- The *"Device Status*" is available again after leaving the "*Radar Signal Spectrum*" page.

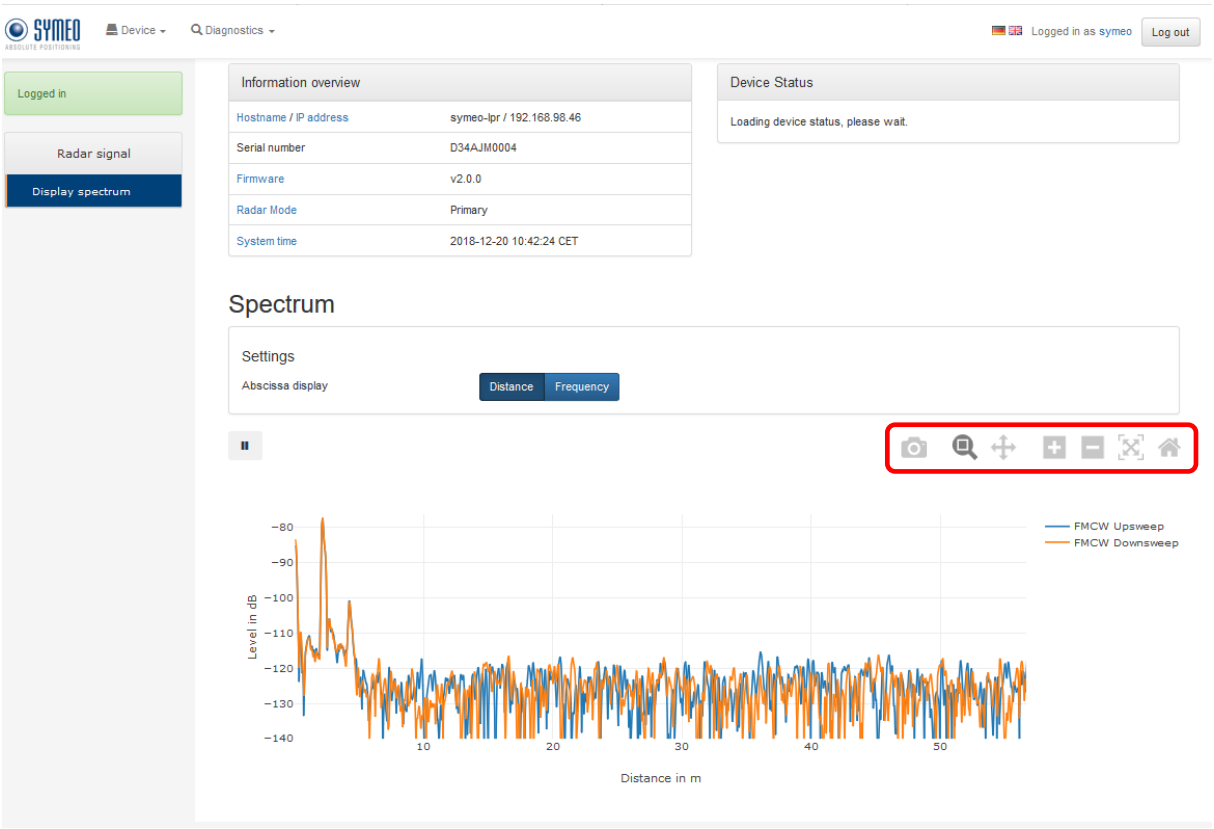


Figure 8.44: Diagnostics - Radar Signal Spectrum

Figure 8.45: Diagnostics - Radar Signal Spectrum toolbar

The toolbar buttons in the spectrum graph (see Figure 8.45) have the following options: Download plot as a png, Zoom, Pan, Autoscale, Reset axes.

8.7.5 Diagnostics - Range Measurement Statistics

This section (see Figure 8.46) allows you to view raw measurements and range statistics (only available on master units).

⇨ Please select a topic from the menu on the left (see Figure 8.46) to view the corresponding information:

- Live range measurement
- Signal strength statistics
- Measurement rate statistics

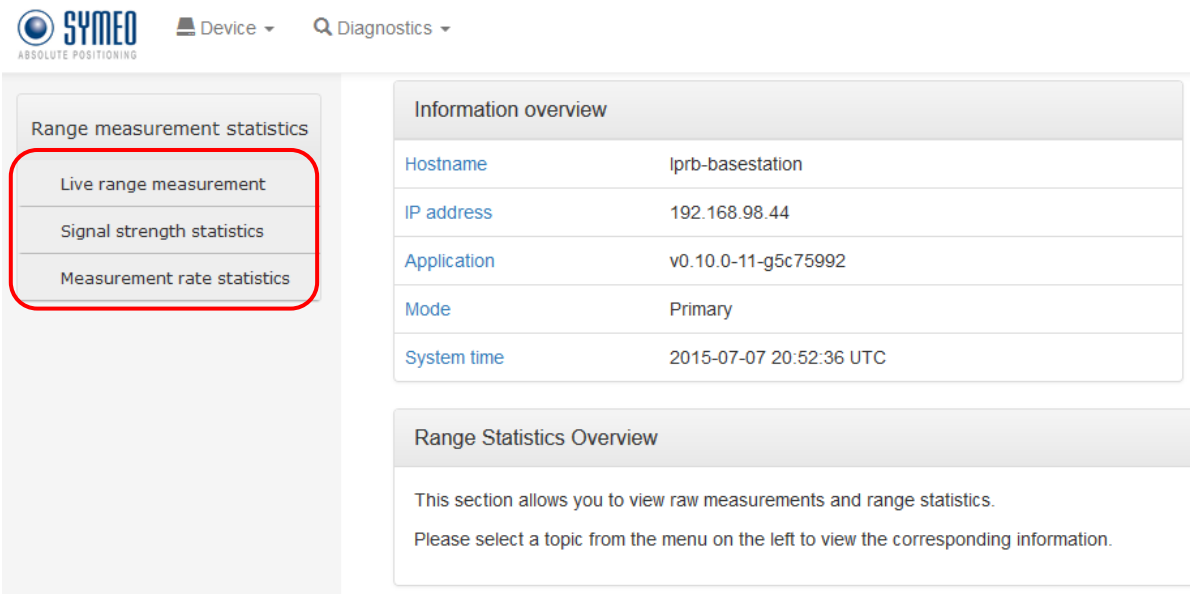


Figure 8.46: Diagnostics - Range Measurement Statistics

Live Range Measurement

In this menu (see Figure 8.47), the current distance and the current RSSI value (Signal strength) will be displayed, furthermore, the distance over time graph.

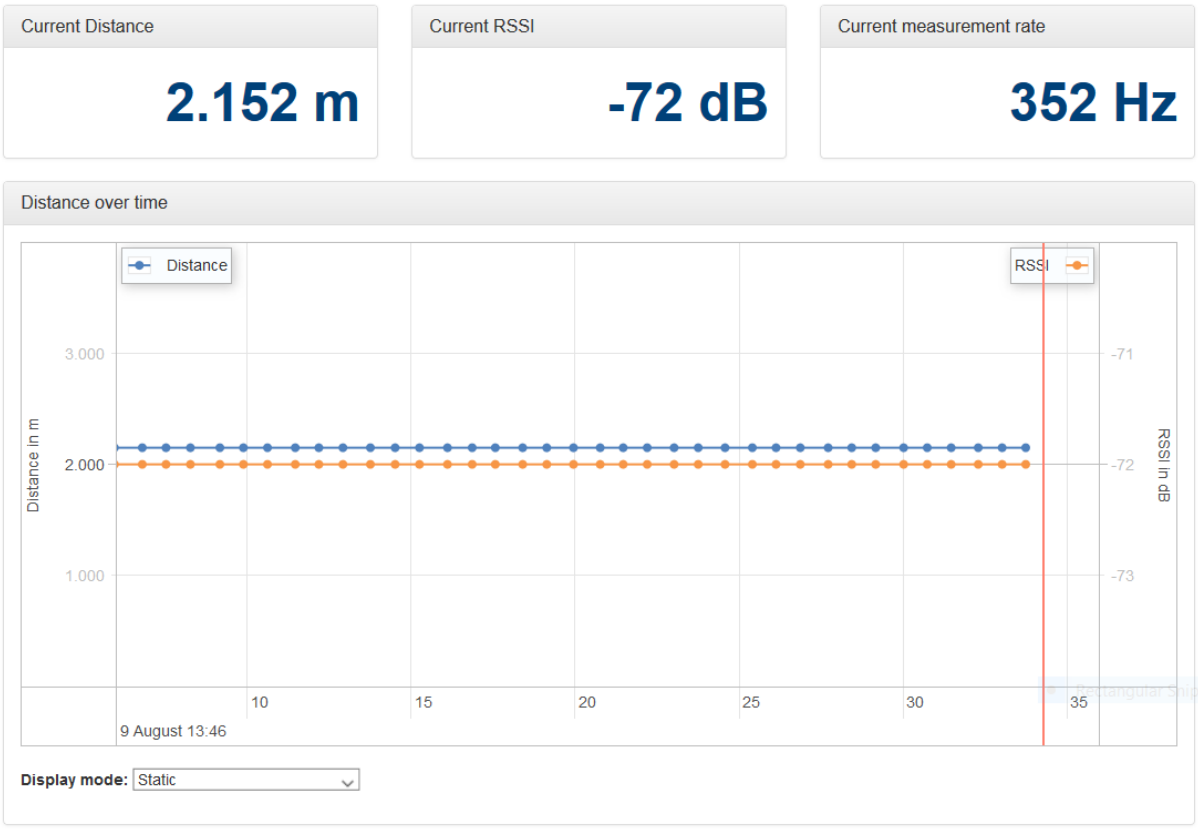


Figure 8.47: Diagnostics - Distance over time graph

By pointing the mouse in the graph and using the scroll wheel, you can downsize or enlarge the timeline.

Signal Strength Statistics

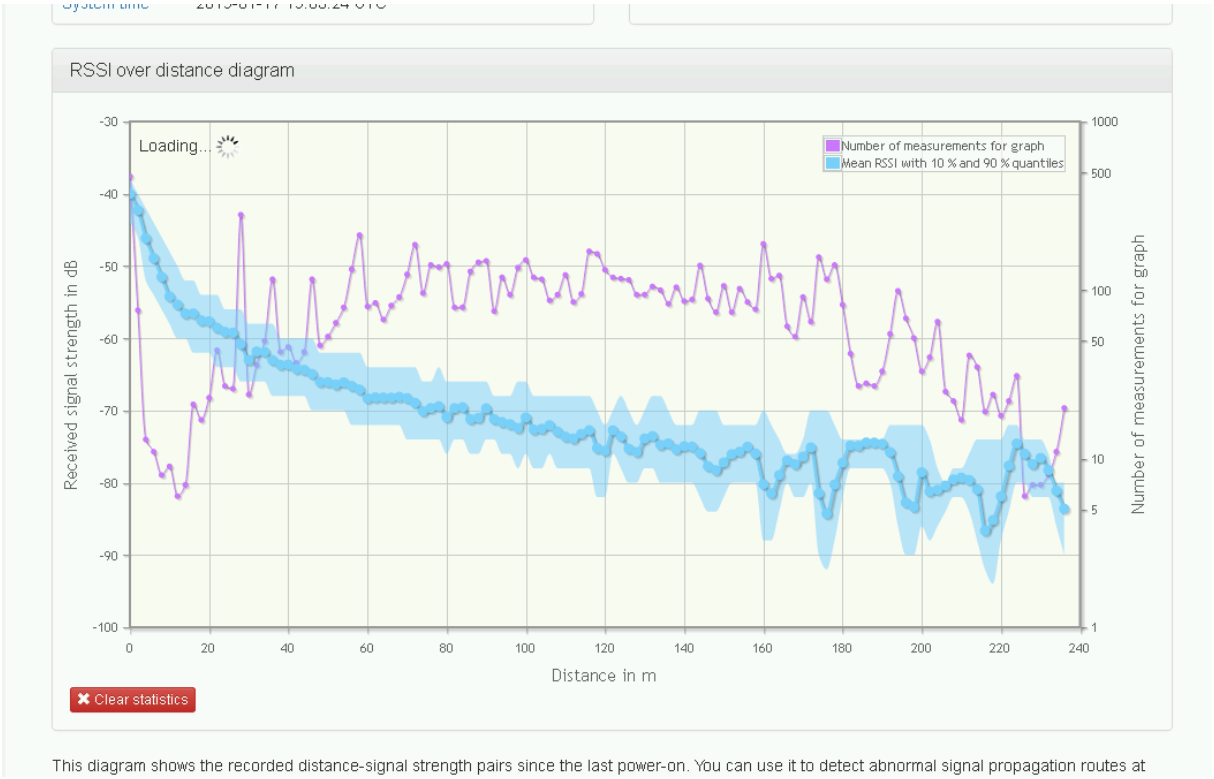


Figure 8.48: Diagnostics - RSSI over distance diagram

This diagram shows the recorded distance-signal strength pairs since the last power-on. You can use it to detect abnormal signal propagation routes at certain constellations of the two LPR® stations, as the signal strength should decrease with increasing distance.

The diagram is automatically refreshed every 10 seconds.

The distance axis displays the distance between the two LPR® stations, and the RSSI axis the received signal strength in dB. As the signal strength at specific distances may vary, the statistical distribution of the signal strength is also recorded. Displayed are the mean received signal strength, the 10 % quantile and the 90 % quantile. The quantiles give you information about how many recorded signal strength values were lower than the corresponding line. 10 % of the recorded signal strengths were lower than the 10 % quantile line and 90 % were lower than the 90 % quantile line, leaving 80 % in between those two lines. This way you get an idea of the signal strength distribution per distance without including extreme outliers. This helps identifying distances with increased signal distortions (e.g., due to multipath signal propagation), as the variance of the signal strength there usually increases.

Measurement Rate Statistics

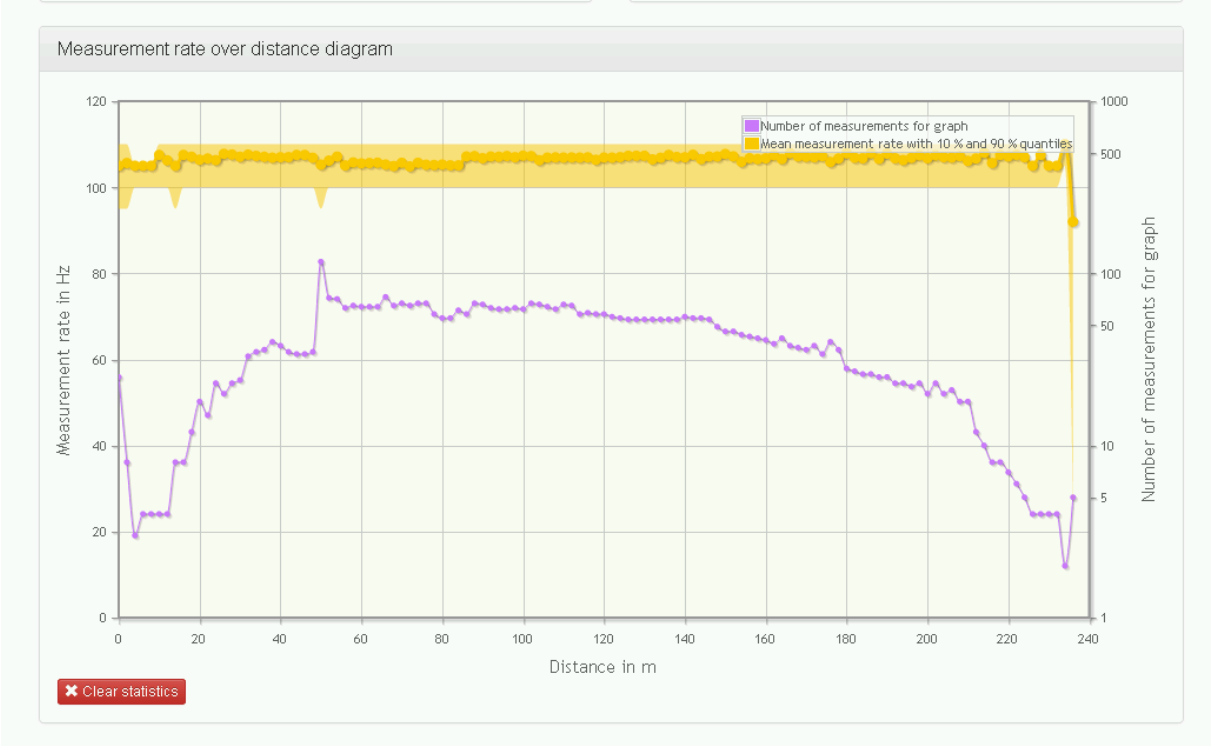


Figure 8.49: Diagnostics - Measurement rate over distance diagram

This diagram shows the recorded distance-measurement rate pairs since the last power-on. You can use it to detect systematical measurement errors at certain constellations of the two LPR® stations, as the measurement rate decreases in this case.

The diagram is automatically refreshed every 10 seconds.

The distance axis displays the distance between the two LPR® stations, and the measurement rate axis the current rate of range measurements in Hertz. As the measurement rate at specific distances may vary, the statistical distribution of the measurement rate is also recorded. Displayed are the mean measurement rate, the 10 % quantile and the 90 % quantile. The quantiles give you information about how many recorded measurement rate values were lower than the corresponding line. 10 % of the recorded measurement rates were lower than the 10 % quantile line and 90 % were lower than the 90 % quantile line, leaving 80 % in between those two lines. This way you get an idea of the measurement rate distribution per distance without including extreme outliers. This helps identifying distances with increased errors in range measurement (e.g., due to multipath signal propagation), as the measurement rate decreases as errors are encountered.

8.7.6 Diagnostics - Record Measurement Data

In this menu (see Figure 8.50), you can:

- Change logging mode
- View recorded measurements
  - Measurements from all logging devices
  - Measurements from volatile memory

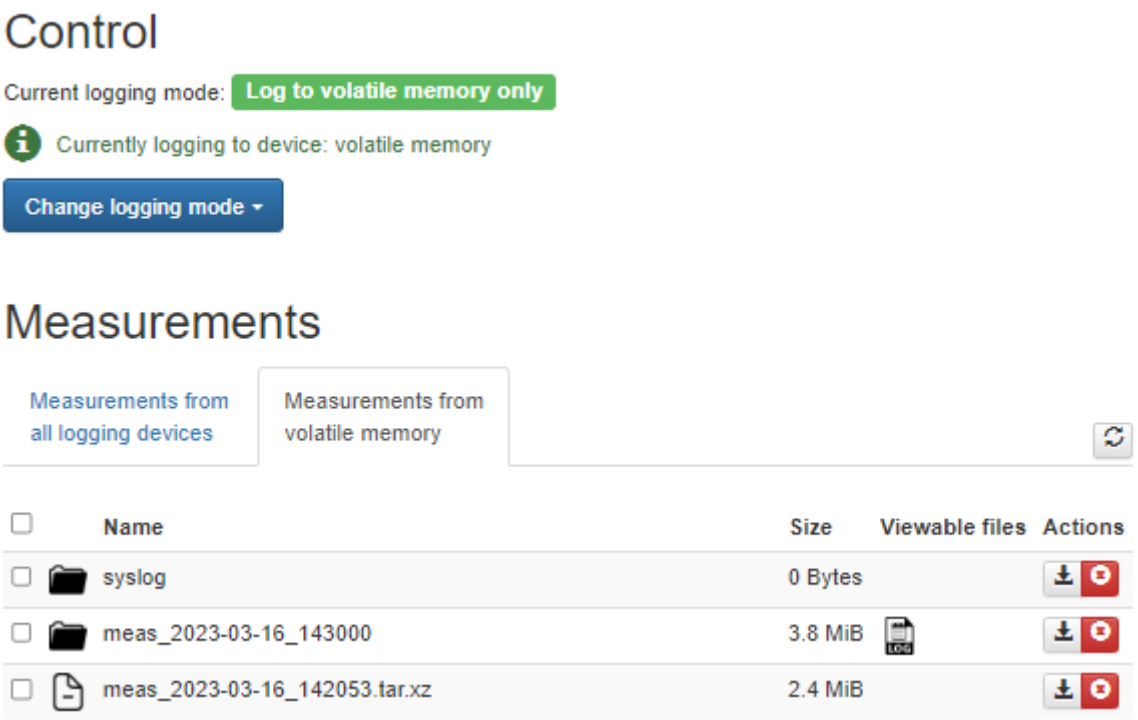


Figure 8.50: Diagnostics - Record measurement data

⇨ Click the drop-down menu window "*Change logging mode*" to choose the logging mode.

The following options are available (see Figure 8.51):

- Disabled
- Log to SD card if available
- Log to USB stick if available (recommended)
- Log to USB stick if available, use SD card as fallback
- Log to volatile memory only
  For LPR®-1DHP-291, only logging to volatile memory is supported.

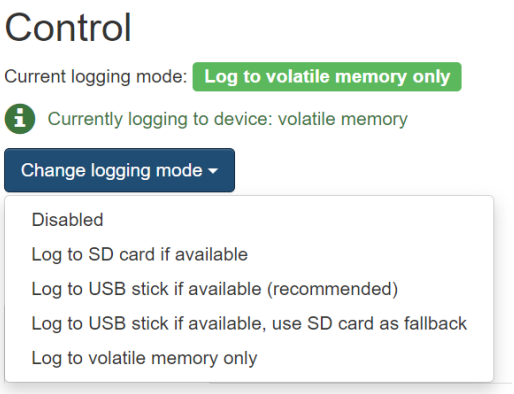


Figure 8.51: Diagnostics - Record measurement data - change logging mode menu

Note	Only “*Disable*” and “*Log to volatile memory*” settings can be used here.

8.7.7 Diagnostics - Packet Inspector

In this menu (see Figure 8.52), you can see the output of the binary port.

⇨ Press the "*Get new data*" button to get at first the last 10 records. Then you must select one record.

By expanding of “*Hexadecimal view*” and/or “*Detailed view*”, you can view this data in the appropriate format.

Under the “*Outgoing packets/Incoming packets*” button, the outgoing and incoming data packets will be shown.

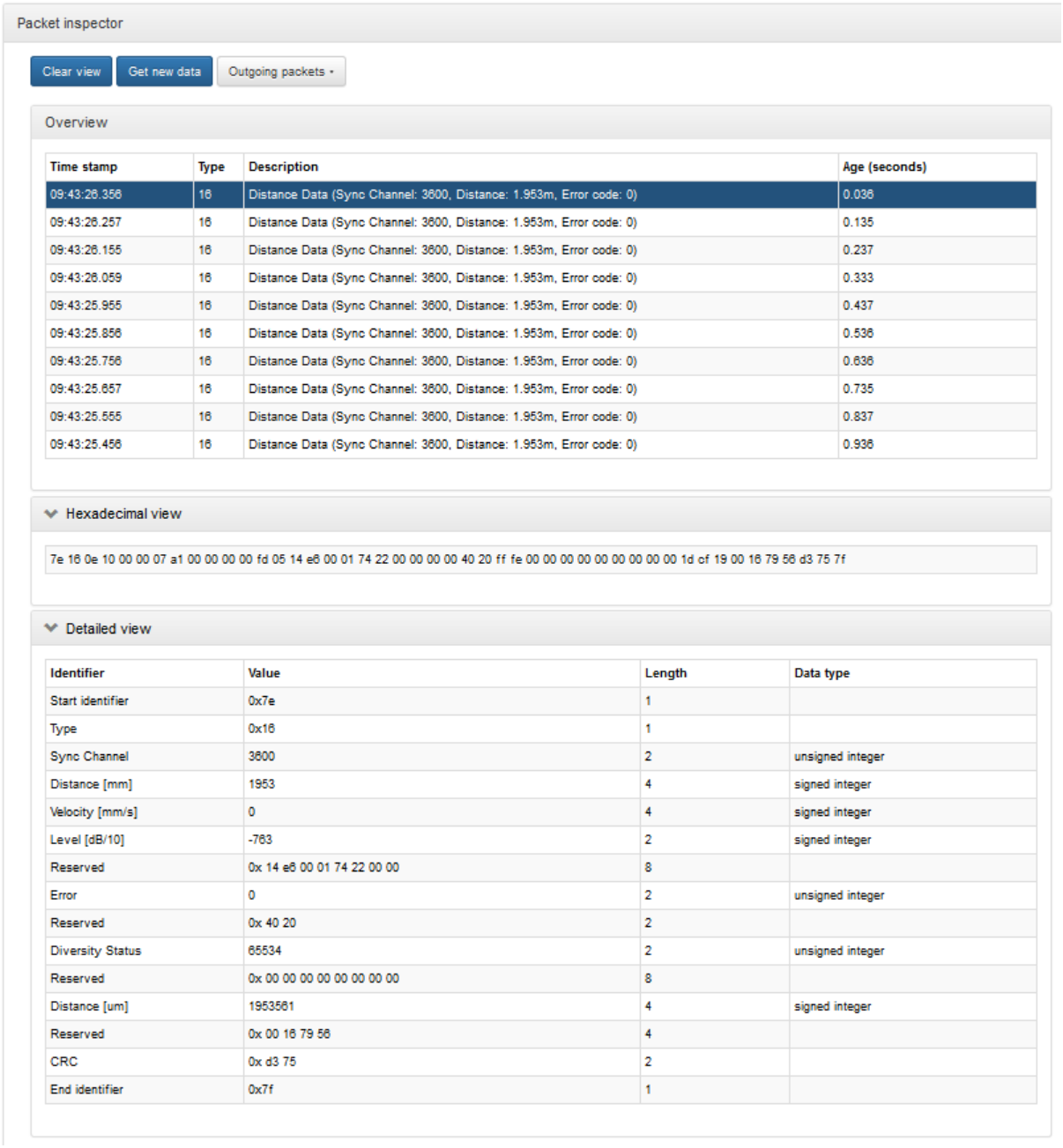


Figure 8.52: Diagnostics - Packet inspector

8.7.8 Diagnostics - Station Scan

In this menu (see Figure 8.53), all Symeo units found in your current local area network (LAN) will be displayed.

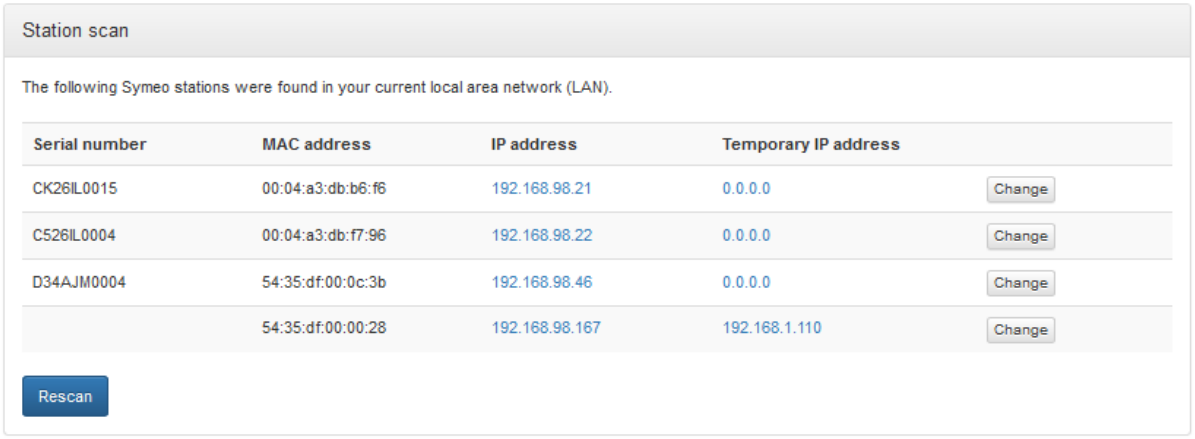


Figure 8.53: Diagnostics - Station scan

9 The Customer Protocol

The customer protocol (Binary Protocol XP) is the standard data protocol between LPR®-1DHP-291 and users for exchanging measurement and relay data with the help of different data types in binary data format. The transfer of a data packet of a certain data type is done in single data frames. The data can be transferred either via TCP/IP or UDP protocol.

Note	All settings related to the customer protocol can be found in the WebUI under *Device -> Settings -> Customer protocol*
Note	The default TCP/IP and UDP port of the customer protocol interface is 3046.
Note	The customer protocol is not output on slave units.

9.1 General Description

9.1.1 Structure of a Data Type

Each data type has a fixed structure and length. Figure 9.1 shows the general structure of a data type.

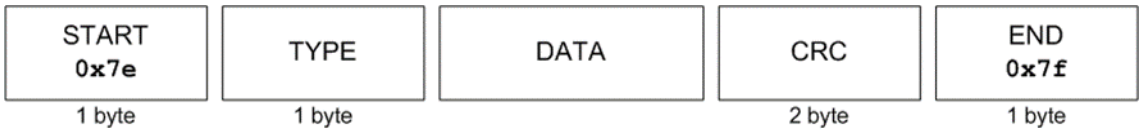


Figure 9.1: Structure of a data type

Each data packet begins with the START symbol (0x7e). TYPE indicates the type of the data packet. The DATA field contains the relevant data. The CRC-field contains the check sum. The data type ends with the END symbol (0x7f).

All multi byte integers (e.g., CRC field) are encoded in Network-Byte-Order (Big-Endian). All signed integers are represented in two's complement.

Note	A custom protocol length which is bigger than the standard protocol length can be set. The data packet is then zero-padded (after the END symbol) to the selected protocol frame length before the data packet is sent.

9.1.2 CRC

The CRC-16-IBM with polynomial $x^{16}+x^{15}+x^2+1$ is used for the CRC. The CRC is calculated over the TYPE and DATA field.

9.2 Data Types

9.2.1 Type 0x16 - Distance Data

Direction: LPR®-1DHP-291 → User

The data type 0x16 is the standard output data type. It contains measurement data, system status information and settings. The default protocol frame length is 47 bytes.

Table 9.1 shows the structure of a 0x16 data packet.

Note

The standard customer protocol length of the LPR®-1DHP(-R) sensor (predecessor) was 50 bytes which must be taken into account if an LPR®-1DHP-291 is used to replace it.

The data packets are output with the internal update rate or the chosen update rate.

Note

The internal measurement rate depends on the used radar mode, FFT size and averaging setting. The output rate of the interface equals the internal measurement rate if no custom output interval is set.

Content	Length (byte)	Value	Data type
START	1	0x7E	unsigned integer
TYPE	1	0x16	unsigned integer
Sync Channel	2	0x####	unsigned integer
Distance [mm]	4	0x#### ####	signed integer
Velocity [mm/s]	4	0x#### ####	signed integer
Signal Level [dB/10]	2	0x####	signed integer
Temperature [°C/100]	2	0x####	signed integer
Counter	4	0x#### ####	unsigned integer
Age	2	0x####	unsigned integer
Error	2	0x####	unsigned integer
System Mode	2	0x####	unsigned integer (Bit mask)
Diversity Status	2	0x####	unsigned integer
Internal service information	16		
CRC	2	0x####	unsigned integer
END	1	0x7F	unsigned integer

Table 9.1: Data Type 0x16 - Distance Data Output for Group Master (47 bytes)

Diversity Status:

- The last bit refers to the current station
- The second last bit refers to the partner station
- 0: indicates errorless operation
- 1: indicates an error at the corresponding station or that the station is not visible via Ethernet

Current Station	Partner Station	Diversity Status
OK	**OK**	**0xfffc**
Error	**OK**	**0xfffd**
OK	**Error**	**0xfffe**
Error	**Error**	**0xffff**

Example of Distance Data (hex):

7E 16 10 24 00 00 0B 11 FF FF FF 35 FC C6 11 C6 00 02 54 AE 00 00 00 00 FF FF 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 0C 7D 48 C6 74 7F

7E hex	START byte
16 hex	TYPE (0x16: Distance Data)
10 24 hex	Sync channel
00 00 0B 11 hex = 2833 dec	Distance: 2833 mm
FF FF FF 35 hex = -203 dec	Velocity: -203 mm/s
FC C6 hex = 64710 dec	Level: 64710 – 65536 = -826 -> -82.6 dB
11 C6 hex = 4550 dec	Temperature: 45.5 C
00 02 54 AE hex = 152750 dec	Counter
00 00 hex	Age
00 00 hex	Error status: 0 means no error; unequal 0 means error (error description see section "*Distance Error Codes*" below)
FF FF hex	System mode
00 00 hex	Diversity status
00 00 00 00 00 00 00 00 00 00 00 00 00 0C 7D 48 hex	internal service information
C6 74 hex	Cyclic redundancy check
7F hex	END byte

Distance Error Codes

The following errors are indicated in the error field in the distance data type:

Value (hex)	Content	Description
0x00	No error	Measurement valid
0x01	No peak detected	No measurement signal
0x02	Peak too low	Measurement signal is imprecise
0x03	Currently not used	
0x04	Implausible speed	Velocity is outside the defined velocity limits (Velocity is too high)
0x05	Measurement botched	Measurement is not feasible
0x06	Currently not used	
0x07	Currently not used	
0x08	Currently not used	
0x09	Settling	VCXO has been tuned or PT2 filter reset, needs time to settle
0x0a	PT2 filter reset	Filter reset after inconclusive distance measurements
0x0b	Planned reset	System is going to reboot
0x0c	Currently not used	
0x0d	Currently not used	
0x0e	Distance out of Range	Peak is close to the edge of the spectrum. Value is unreliable
0x0f	Offset in Time too Large	The offset in time during synchronization is larger than expected
0x10	Offset in Frequency too large	The offset in frequency during synchronization is larger than expected
0x11	Currently not used	
0x12	No target in range	No target has been found in range, but internal hardware check is ok
0x15	EPE above threshold	Estimated Position Error above configured threshold
0x18	Backscatter level mismatch	Level of the two peaks in the backscatter spectrum differs too much
0x19	PLL unlocked	PLL does not lock
0xfe	Rejected outlier	Distance has been rejected because it is implausible
0xff	No data yet	The LPR® has not sent any data yet

Table 9.2: Distance error codes

Note	Only measurements with error code 0 are valid.

9.2.2 Type 0x03 - Relay Switching Commands

Direction: LPR®-1DHP-291 → User / LPR®-1D24

The data type 0x03 is typically used for sending relay switching commands to an LPR®-1D24 radar (with installed relays) or to a PLC. The default protocol frame length is 9 bytes. Table 9.3 shows the structure of a 0x03 data packet.

Content	Length (byte)	Value	Data Type
START	1	0x7E	unsigned integer
TYPE	1	0x03	unsigned integer
Destination (LPR®-1D24 address)	2	0x####	See chapter 9.2.3
Relay Selection (Bitmask) (Bit 1..4 → Relay 1..4) Bit significance 0-7 starting with 0 as the lowest (set) Bit value.	1	0x##	unsigned integer
Relay Switch (Bitmask)	1	0x##	unsigned integer
CRC	2	0x####	unsigned integer
END	1	0x7F	unsigned integer

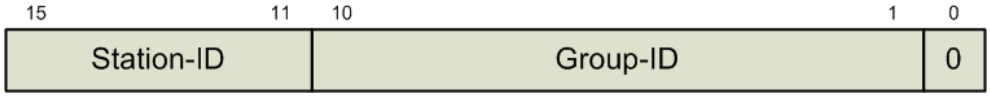
Table 9.3: Data Type 0x03 - Relays Switching Command (9 bytes)

With the relay selection (bitmask) the relays which shall be controlled are selected. The relays that are chosen within the relay selection bitmask will be switched according to the relay switch bitmask.

Example: A relay selection value = $0x14_{hex}$ = 00010100_{bin} and a relay switch value = $0xFF_{hex}$ = 11111111_{bin} will switch relays 2 and 4 ON - the state of the other relays remains unchanged.

9.2.3 LPR®-1D24 Address

LPR® addresses are completely defined by a 16 bit value:



0	Reserved
Group-ID:	The Group-ID of the unit (1..1022)
Station-ID: for Distance Data: for Relays Switching Command:	The Station-ID of the unit (SID) Master and Slave SID is *always* 2 (SID = 2) SID = 1 for Master und SID = 2 for Slave

Table 9.4: LPR®-1D24 address

10 Technical Data

10.1 General Technical Data

Feature	Value
Radar measuring mode	Primary, secondary, diversity radar
Frequency range	57,0 – 64,0 GHz
Supply voltage	11 - 36 V DC
Power consumption	6 W
Ambient temperature	-40°C to +75°C
Protection class housing	IP67
Housing dimensions (LxWxH); weight	95 x 110 x 150 mm; 940 g
Interfaces	Ethernet (TCP/IP, Profinet)
Response Time	<11 ms[1)]
MTBF	42.2 a[1)]
External connector	Ethernet (M12 D-coded), supply voltage (M12 T-coded)
Antenna	Integrated, beam width = ±2,5°
Compliance	CE, FCC, KCC (IC coming soon, others on request)

Table 10.1: General technical data

[1)] *Preliminary value*

10.2 Mode Dependent Technical Data

The following tables depict the technical data, which are dependent on the used radar mode, the used bandwidth mode and your regional settings.

10.2.1 Primary Radar Mode

General Technical Data

Bandwidth Mode[1)]	0,5 GHz	2 GHz
Measurement accuracy[2)]	up to ± 10 mm	up to ± 5 mm
Repeatability[2)]	up to ± 6 mm	up to ± 3 mm
Measurement rate	up to 350 Hz	up to 350 Hz

ETSI Specific Technical Data

Bandwidth Mode[1)]	0,5 GHz	2 GHz
Measuring range[3)]	2 m to 50 m	1 m to 50 m

FCC Specific Technical Data

Bandwidth Mode[1)]	0,5 GHz	2 GHz
Measuring range[3)]	2 m to 50 m	1 m to 20 m

[1)] Multiple bandwidth modes can be selected in the device settings. The selection is limited by regional radio regulations.
[2)] Error under consistent ambient conditions. Depending on the measurement distance.
[3)] Depending on the environment, the selected bandwidth mode and the backscatter quality of the target.

10.2.2 Secondary Radar Mode

General Technical Data

Bandwidth Mode[1)]	0,5 GHz	2 GHz
Measurement accuracy[2)]	up to ± 10 mm	up to ± 5 mm
Repeatability[2)]	up to ± 6 mm	up to ± 3 mm
Measurement rate	up to 110 Hz	up to 110 Hz

ETSI Specific Technical Data

Bandwidth Mode[1)]	0,5 GHz	2 GHz
Measuring range[3)]	2 m to 300 m	0,5 m to 300 m

FCC Specific Technical Data

Bandwidth Mode[1)]	0,5 GHz	2 GHz
Measuring range[3)]	2 m to 300 m	0,5 m to 225 m

[1)] Multiple bandwidth modes can be selected in the device settings. The selection is limited by regional radio regulations.
[2)] Error under consistent ambient conditions.
[3)] Depending on the environment and the selected bandwidth mode.

10.2.3 Diversity Radar Mode

General Technical Data

Bandwidth Mode[1)]	0,5 GHz	2 GHz
Measurement accuracy[2)]	up to ± 10 mm	up to ± 5 mm
Repeatability[2)]	up to ± 6 mm	up to ± 3 mm
Measurement rate	up to 110 Hz	up to 110 Hz

ETSI Specific Technical Data

Bandwidth Mode[1)]	0,5 GHz	2 GHz
Measuring range[3)]	2 m to 500 m	0,5 m to 500 m

FCC Specific Technical Data

Bandwidth Mode[1)]	0,5 GHz	2 GHz
Measuring range[3)]	2 m to 500 m	0,5 m to 225 m

[1)] Multiple bandwidth modes can be selected in the device settings. The selection is limited by regional radio regulations.
[2)] Error under consistent ambient conditions.
[3)] Depending on the environment and the selected bandwidth mode.

10.3 Product Name vs. Model Number

Each device is labeled with a product name, which corresponds to a unique model number.

Product Name	Model Number
LPR®-1DHP-291	BSW200291