SYMEO LOCAL POSITIONING RADAR

Product Family: LPR®-1DHP-200

Products:

LPR®-1DHP-220-R
LPR®-1DHP-260
LPR®-1DHP-281
LPR®-1DHP-290

Product Documentation

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The documentation for the LPR®-1DHP-200 Local Positioning Radar System is published by:

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HISTORY

Version	Date	Description
0001	28.05.2018	Initial Release
0002	09.08.2018	Comprehensive update
WORK		

SYMBOLS USED

The following symbols are used throughout the documentation:

⚠ Warning	This symbol appears before instructions that must be followed at all times. Failure to comply with these instructions will result in personal injury.
⚠ Caution	This symbol appears before instructions that must be followed at all times. Failure to comply with these instructions will result in damage to equipment.
i Note	This symbol appears before information of particular importance.
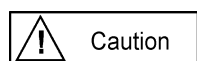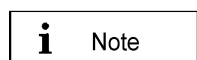
Wherever the term LPR®-1DHP-200 is used during this documentation, all products included in the LPR®-1DHP-200 product family are addressed.

Application specific documentation can be obtained from the Partner Login under www.symeo.com or from Symeo support.

Content

1 Safety Notes

General

The LPR®-1DHP-200 product family 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-200 radars are purely tracking and assistance systems. They do not satisfy special requirements for personal or functional safety or explosion protection.
	All personnel that commission or operate an LPR®-1DHP-200 radar have to be instructed that it does not satisfy norms and requirements for functional safety (e.g. IEC 61058, EN ISO 13849, EN 62061).
⚠ 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.
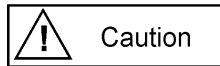
Installation
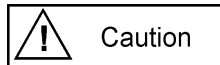
⚠ Caution	Installation must be carried out by qualified and trained technicians.
	When the system is mounted on fixed tubes, the necessary measures to prevent slippage of the system must be taken.
	Only screwed connections with safety against loosening may be used for mounting the radar.
	Adhere to the specified tightening torques for all screws and connectors.
	Screwed connections must be examined at regular intervals, especially if the radar is mounted exposed.

Repairs and Modifications
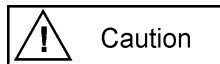
⚠ Caution	Repairs or modifications may only be performed by the manufacturer.
	Opening of the device is prohibited.
	Any change or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
	The warranty shall be voided if you cause defects to the device by installing or exchanging system extensions.

Safety Notes

Transport and Storage

i 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 to DIN EN 61643-21 and IEC 61643-21.

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 of 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.

System Extensions and Accessories

i 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

i 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).
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.

Exposure Requirements

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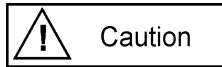
To satisfy FCC exposure requirements a separation distance of 20 cm or more should be maintained between the antenna of this device and persons during operation.
To ensure compliance, operations at closer distances than this are not recommended.

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 de 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-200 Product Family

The LPR®-1DHP-200 is a radar distance measurement sensor product family. The product family consists of different product types, which are based on the same hardware platform.

Depending on your purchased product type, your radar provides one or more of three different radar modes, namely a primary radar mode, a secondary radar mode and a diversity radar mode. Table 2.1 shows the different product types and their supported radar modes.

LPR®-1DHP-	220-R	260	281	290
Primary Radar Mode	X			X
Secondary Radar Mode		X		X
Diversity Radar Mode		X	X	X

Table 2.1: Supported radar modes for different LPR®-1DHP-200 product types.

Typical applications of the LPR®-1DHP-200 are:

- Positioning of cranes, crane trolleys, hoists and other railbound transport systems
- Process automation, monitoring and control
- Collision avoidance
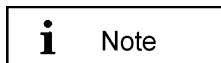
i Note	While reading this document keep in mind which radar modes are supported by your device.
i Note	All LPR®-1DHP-200 product types can be configured with the help of a Web User Interface (WebUI), which is described in chapter 8.
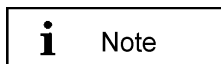
3 Radar Basics

3.1 Radar Distance Measurement Principle

The LPR®-1DHP-200 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.

Radar Basics

3.2 Radar Beam and Opening Angle

The LPR®-1DHP-200 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 3dB diameter vs. distance
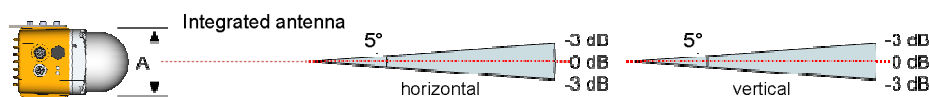
Figure 3.1: Radar beam and opening angle.

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.

i Note	The Fresnel zone has to 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 wave length and d the distance between the two radar devices or a radar device and a reflective target For a frequency of 61 GHz a wave length λ of approx. 0.005 m is calculated. The maximum radius of the first Fresnel Zone is indicated by r. The maximum radius for different distances is given in Table 3.2.

Radar Basics
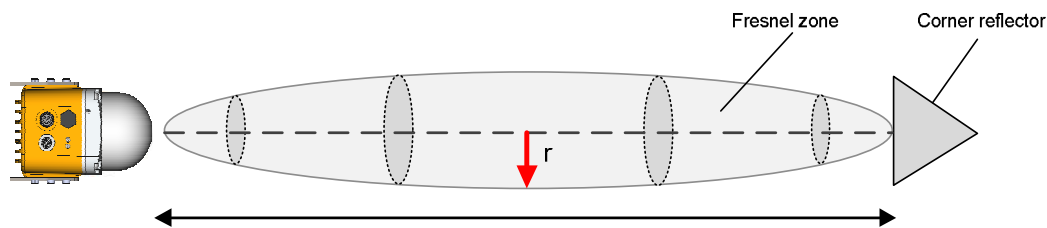
Figure 3.2: Fresnel zone

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 (e.g. in a radar barrier)

- Profile / measurement (e.g. of bulk material)

- Detection of arbitrary objects (e.g. of personell or vehicles)

Figure 3.3 shows the typical setup of a LPR®-1DHP-220-R radar and a corner reflector for a primary radar distance measurement.

Radar Basics
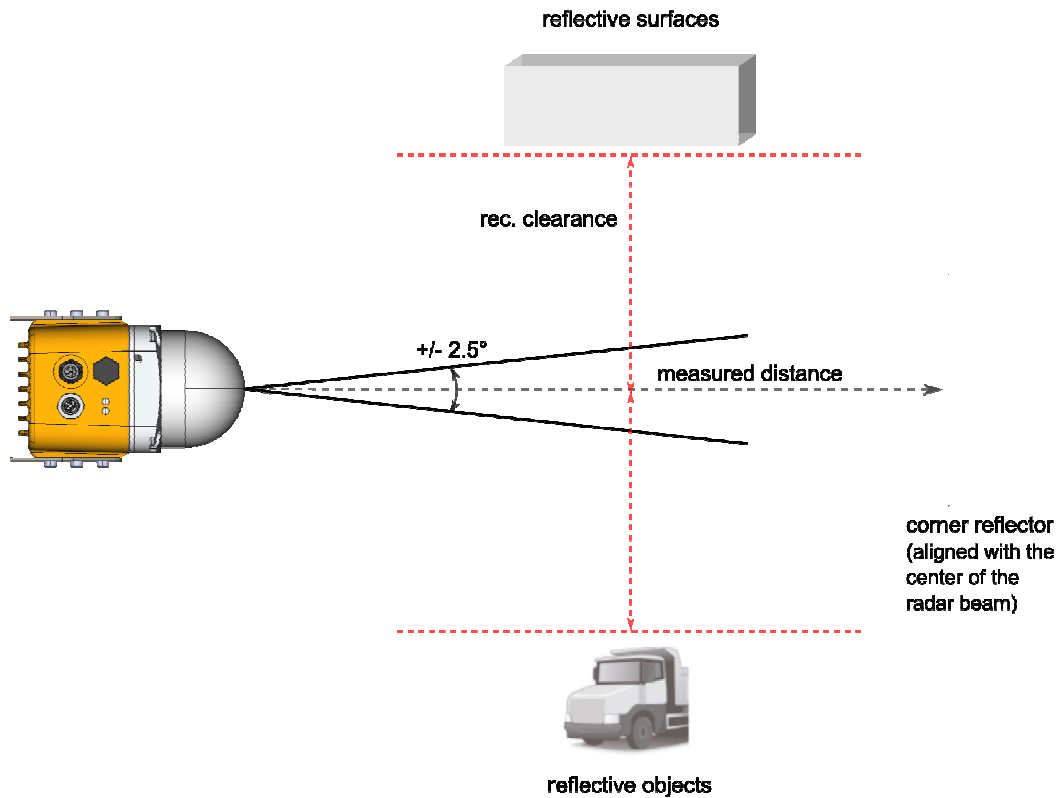
Figure 3.3: Primary radar mode measurement setup

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-260 radars for a secondary radar range measurement.

Radar Basics
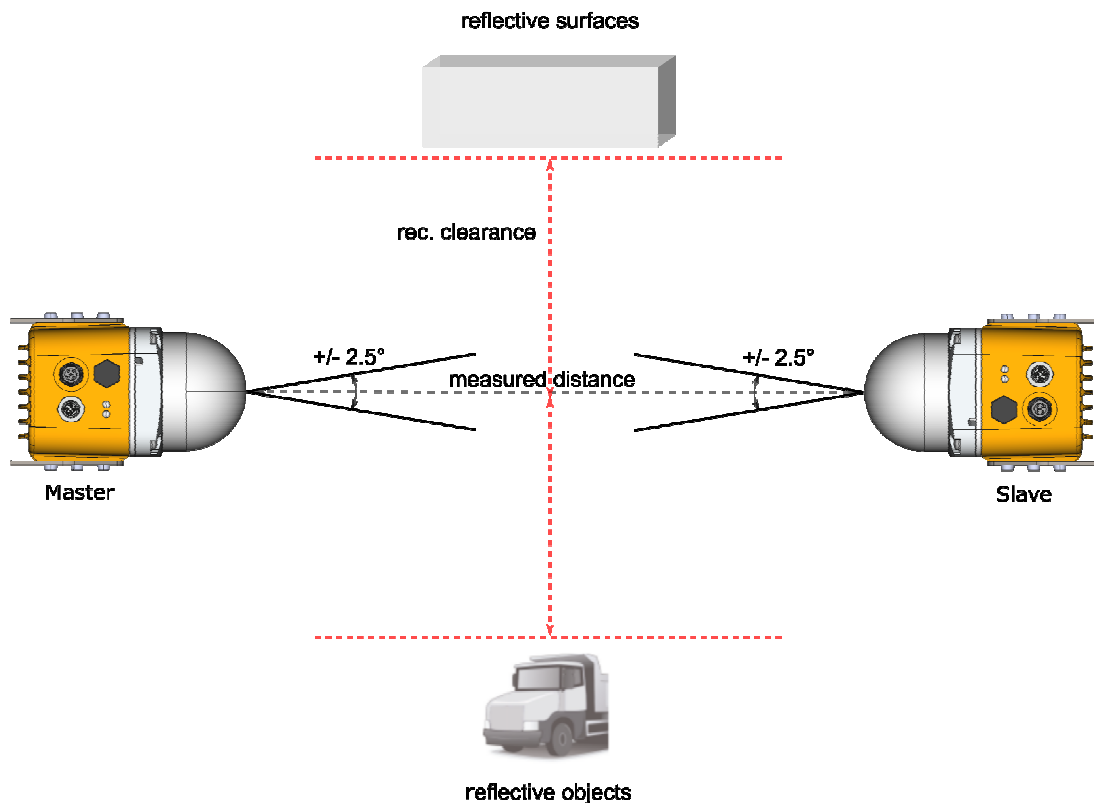
Figure 3.4: Secondary radar mode measurement setup

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 range 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

- No clearance to reflective surfaces / objects required (see chapter 5.1; Fresnel zone still needs to be free of obstacles)

- 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-281 radars for a diversity radar range measurement.

Radar Basics
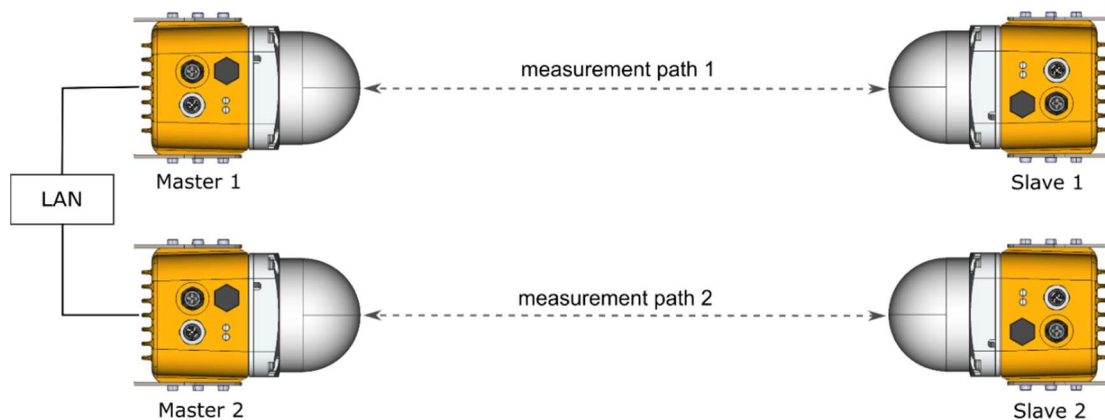
Figure 3.5: Diversity radar mode measurement setup

3.5   Bandwidth Modes

The LPR®-1DHP-200 is able to operate 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 the 0.5 GHz or 2 GHz bandwidth mode for standard applications.

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

3.6   Accuracy

To maximize the accuracy of a LPR®-1DHP-200 measurement setup, different error sources which influence the accuracy need to be taken into account:

- 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
    - Reflections of the radar signal, e.g. from walls, can cause distance errors in primary and secondary radar mode 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, noise will increase with range and decrease with target radar cross section

Radar Basics

(dependent on target size, shape and material). In secondary radar mode noise is constant within the specified range and will increase for ranges above.

- Temperature drift
  - o 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 warm up phase of 30 minutes before operation or by using a calibration reference.

3.7 Range

To maximize the range of a LPR®-1DHP-200 measurement setup the following aspects have to be taken into account:

- Mounting position
  - o 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
  - o Ensure the Fresnel zone is free of absorbing or reflecting objects
- Reflective surfaces and objects
  - o 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)
  - o 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 the maximum range is required use targets with a high RCS (e.g. the corner reflector MTE000958)
- VGA value
  - o For maximum range set the "VGA value" to the highest possible value that is allowed in you regulatory domain. The WebUI will use your region settings to limit the "VGA value" and hence range is reduced in certain regions (see chapter 10).

The minimum range of the sensors can be reduced to values below the specified minimum distance by adapting the "VGA value", the "RX attenuator" and the threshold settings (for primary radar). This however affects the maximum range and the accuracy of the radar and shall therefore only be applied by trained personell.

Radar Basics

4　Components

4.1　Device Overview

The LPR®-1DHP-200 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 power supply connector (C1) and the M12 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 IP65 protection class and heat dissipation
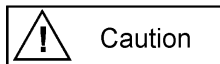
⚠ Caution	The housing must not be opened.
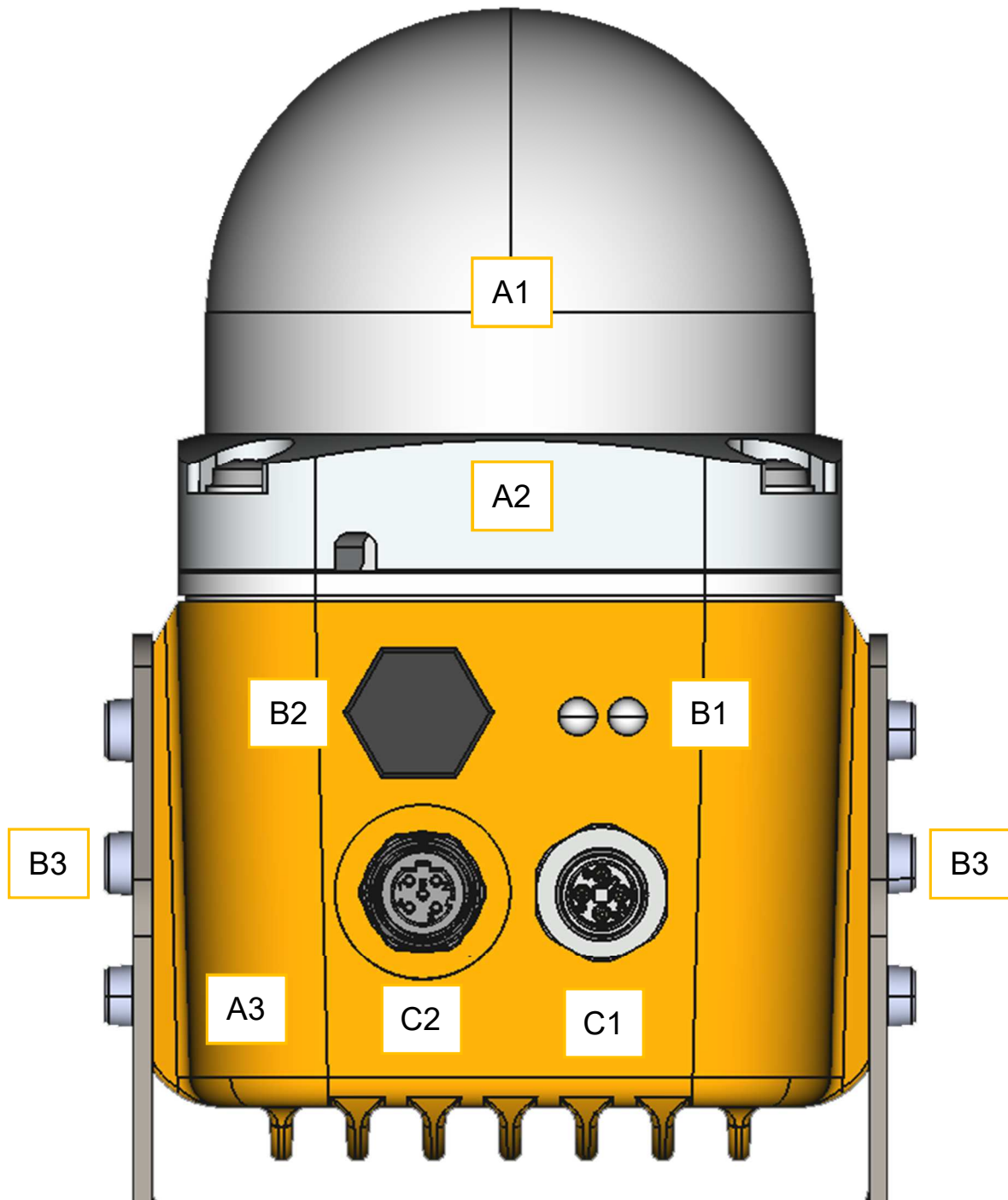
Figure 4.1: Front view of the LPR®-1DHP-200

Components
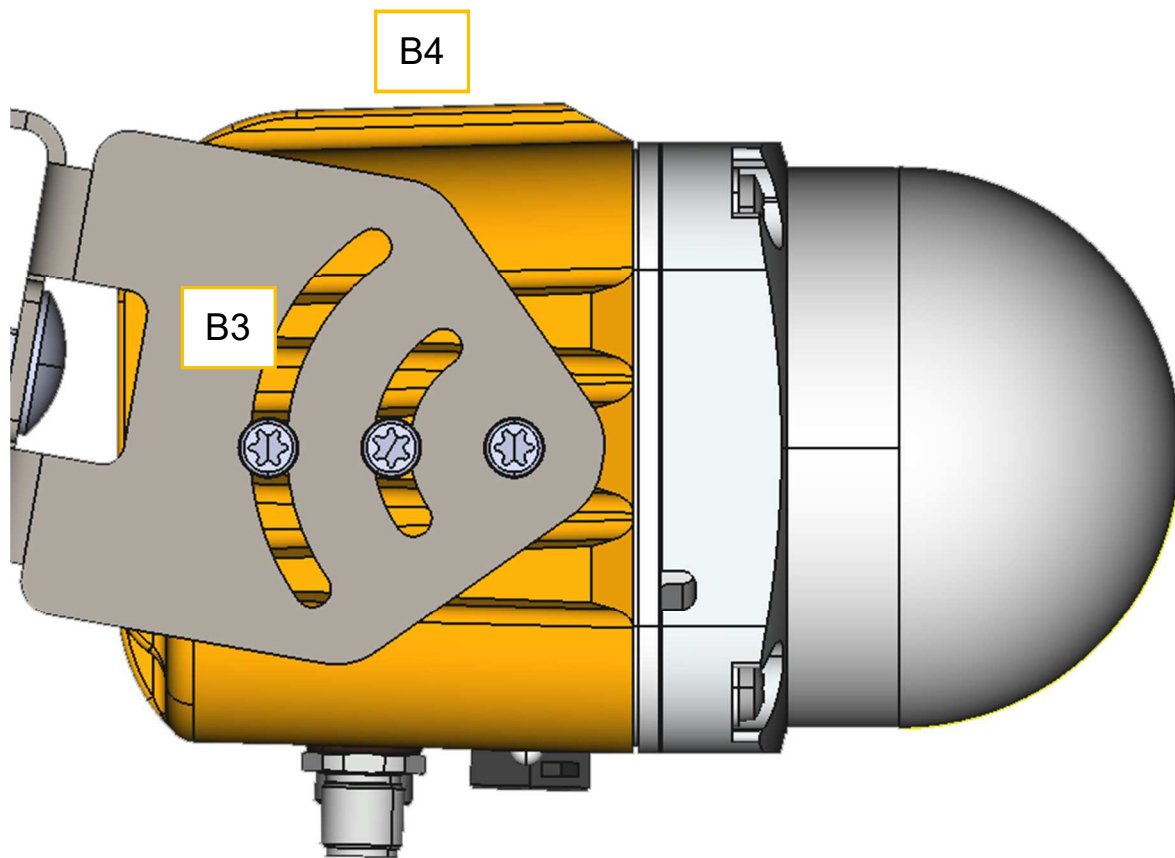
Figure 4.2: Side view of the LPR®-1DHP-200
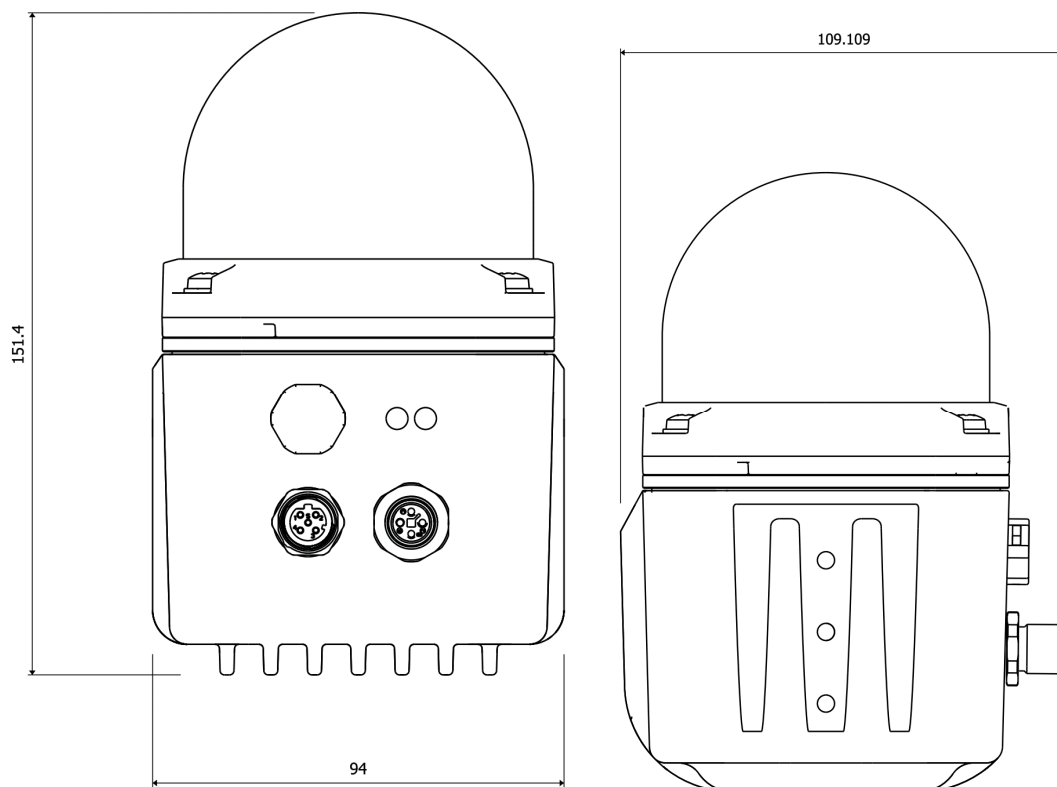
Figure 4.3: LPR®-1DHP-200 housing dimensions

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

Components

4.3 Connectors

The housing of the LPR®-1DHP-200 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.

4.3.1 Power Supply

The LPR®-1DHP-200 is powered by a 4-pin M12-Connector.

Plugs

Recommended connector:

- **SACC-M12FST-4PECON-PG 9-M – 1418052 (obsolete)**
  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

Schematic diagram

Dimensioned drawing

Pin assignment of M12 socket, 4-pos., T-coded, socket side view

M12 X 1 socket, straight
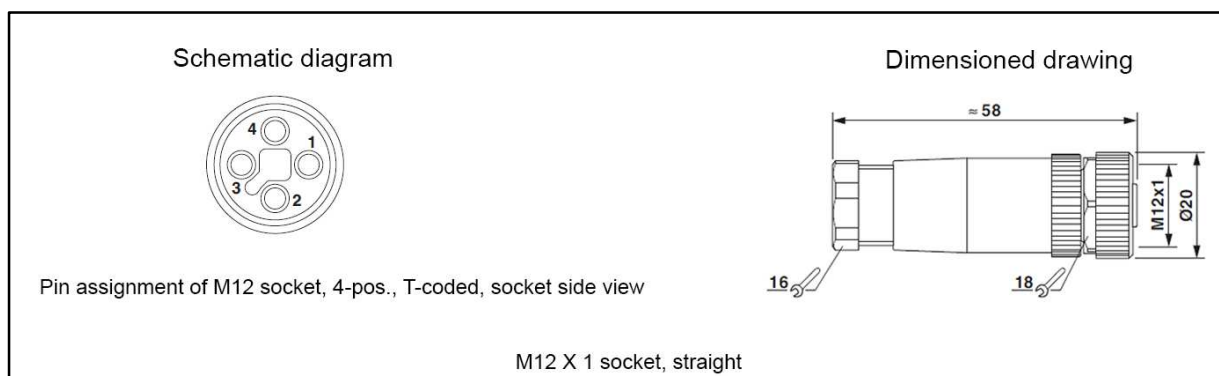
Figure 4.4: M12 power supply connector

Components

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

The LPR®-1DHP-200 can be connected to a LAN or a Profinet bus system (Production Code "n" required) via an M12 Ethernet Connector.

Plugs

Recommended connector:

- **SACC-M12MSD-4CON-PG 7-SH – 1521258**

    o   Cable diameter: 4 – 6 mm (PG7)
    Tightening torque: 0.4 Nm

    o   **Symeo order number:** MTE101768

    o

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

- **M12 connector set (Ethernet + Power supply)**
    o   **Symeo order number:** MTE102366
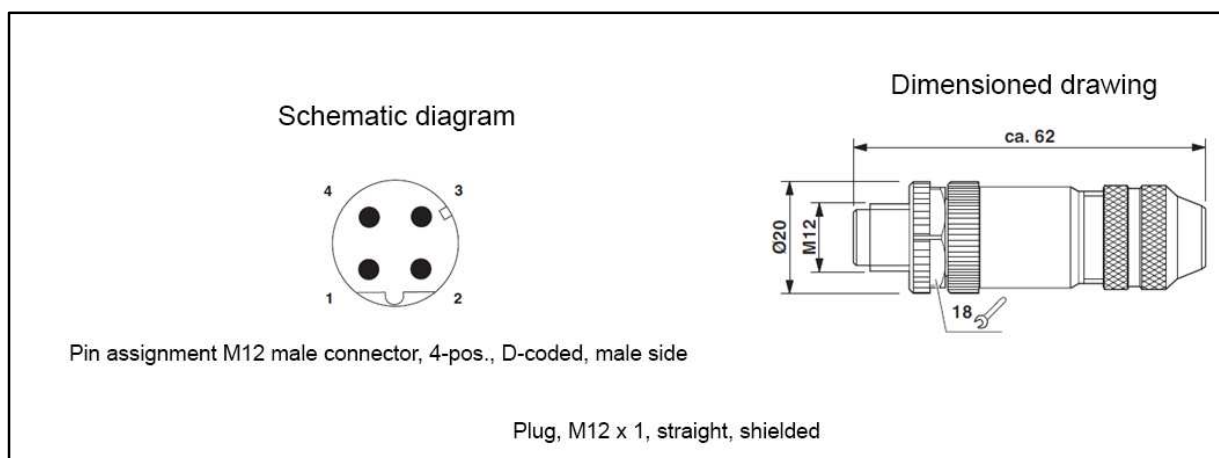
Figure 4.5: M12 Ethernet connector

Components

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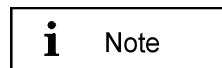
i Note	If the Ethernet connecter is left unused, install the protective cap of the connector.

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-200 to a pipe, a mounting bracket is available from Symeo. The pipe diameter should measure between 40 and 75 mm.

Components
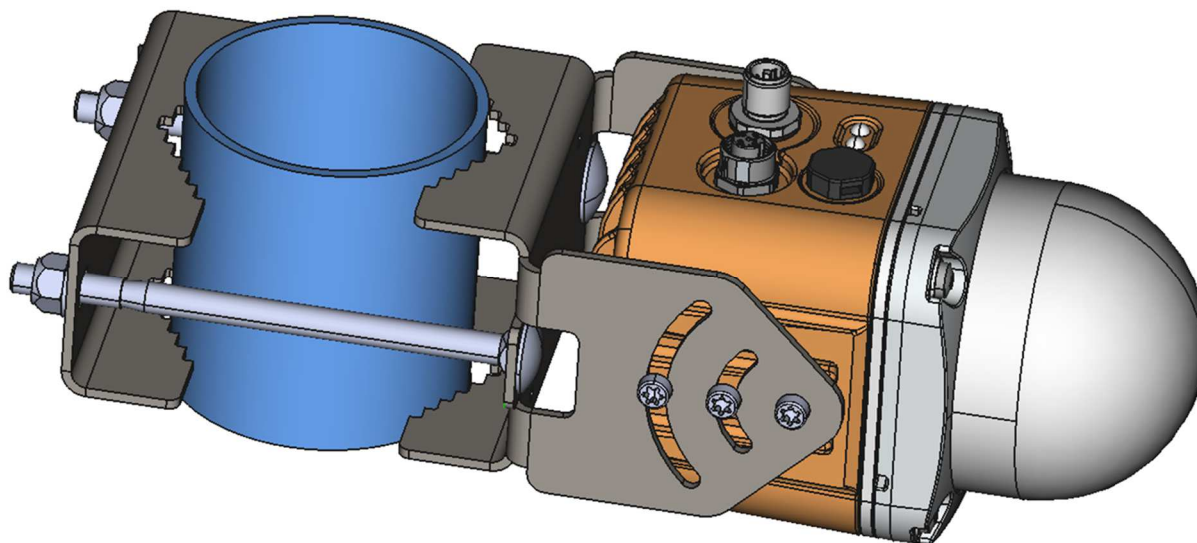
Figure 4.6: LPR®-1DHP-200 mounted to a pipe with the mounting bracket.
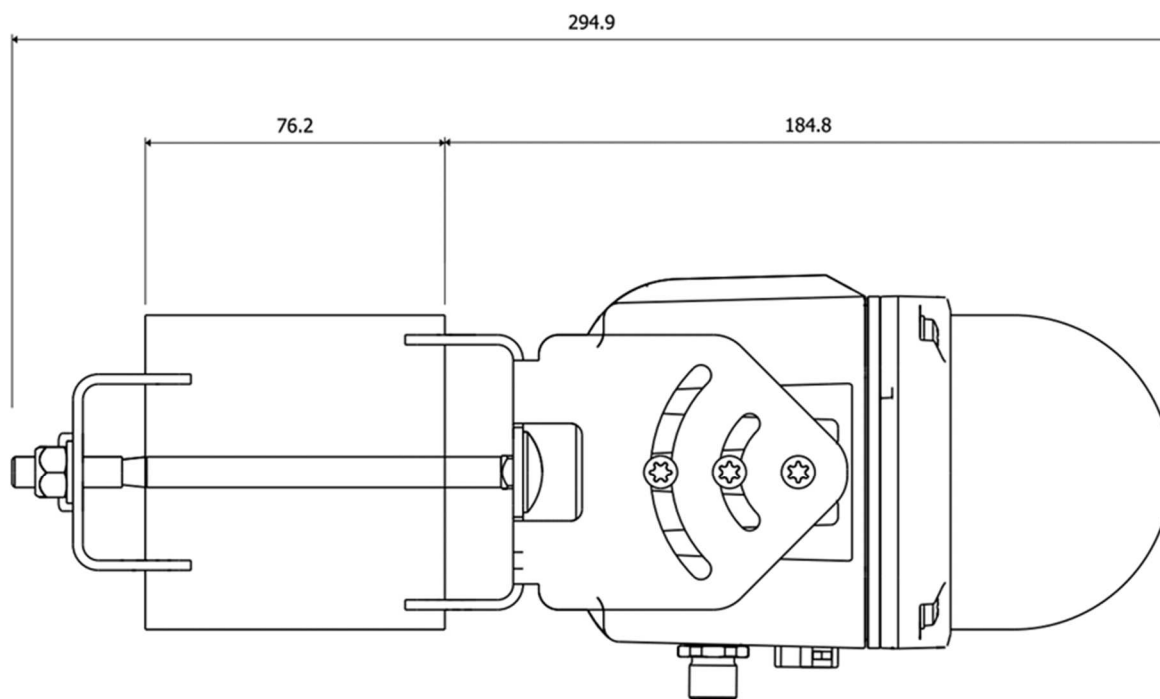
Figure 4.7: MTM102513 dimensions.

Adhere to the following tightening torques for mounting:

• LPR®-1DHP-200 to mounting bracket (6x M5 screws): 4Nm

• Tube clamp (2x M8 screws): 8Nm

4.4.2   Diversity Mounting Bracket – MTM102512

For mounting two LPR®-1DHP-200 for operation in the diversity radar mode a diversity mounting bracket is available from Symeo.
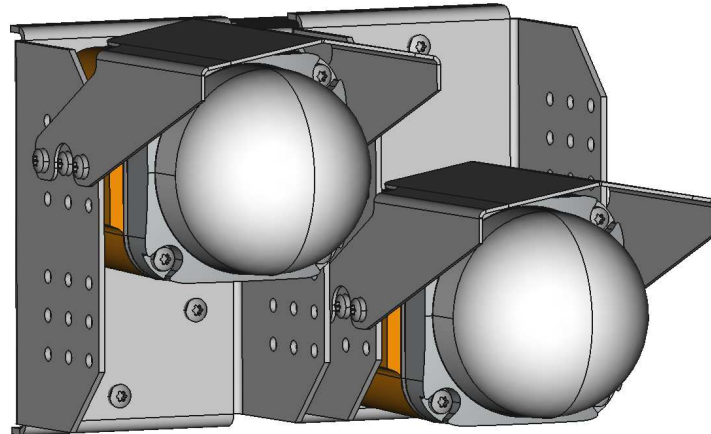
Figure 4.8: Two LPR®-1DHP-200 mounted in the diversity mounting bracket.

Adhere to the following tightening torques for mounting:

- LPR®-1DHP-200 to mounting bracket (2x 6x M5 screws): 4Nm
- Tube clamp (2x M8 screws): 8Nm

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 500mm – MTE000958

Corner reflector with edge length 500mm for maximum range.
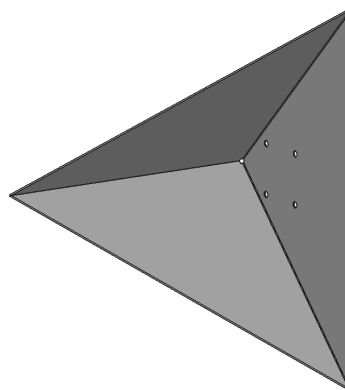
Figure 4.9: Corner reflector 500mm.

Components

4.5.2 Corner reflector 250mm – MTE001011

Corner reflector with edge length 250mm. Range is reduced to approx. 70% compared to MTE000958.
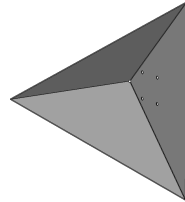
Figure 4.10: Corner reflector 250mm.

4.5.3 Mount for corner reflector – MTM000169

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

Components

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.

- The radar units and/or corner reflectors must move parallel to the radar beam in the installation.

- Ensure that the Fresnel Zone is free of obstacles.

- Ensure that your measured distances lie in the specified measuring range (see chapter 10)

- For primary and secondary radar mode (not for diversity radar mode) 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

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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
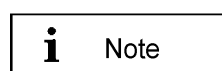
ℹ Note	The Primary Radar Mode is available for Product Types LPR®-1DHP-220-R and LPR®-1DHP-290.

Mounting

For a primary radar distance measurement, typically a single radar unit and a recommended corner reflector are mounted facing each other.

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.

- The reflector has to 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 (at least +/- 2,5°).

- 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.

⇨ Mount the corner reflector in a way, that the opening faces the radar. The 3 corners of the corner reflector opening must have 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 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

i Note	The Secondary Radar Mode is available for Product Types LPR®-1DHP-260 and LPR®-1DHP-290.

For a secondary radar distance measurement, two radar units, one configured as a "master" and one as a "slave" are mounted facing each other in a way, that the center of the emitted radar beam of each unit hits the other unit. The master unit initiates the measurement while the slave unit replies.

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 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 (at least +/- 2,5°).

Mounting

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.

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 unit 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.

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 basics*

  ○ 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-200 sensor in range; for neighboring measurement paths use only every fourth sync channel.

- *Device -> Settings -> Measurement details*

  - o Target search mode = "First" if the reflector is the first target in range, "Strongest" if the reflector is the strongest target in range.
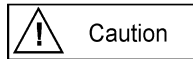
⚠ Caution | The setting "Target search mode" highly impacts the behavior of the radar, especially in multi target environments (see Figure 8.16). "First target" may lead to distance measurements to unintended targets in the vicinity of the radar (e.g. a person passing the radar beam). "Strongest target" 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 as described in chapter 6.4 to verify this setting.

⇨ Review and Calibrate your measurement as stated in chapter 6.4.

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.
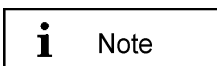
ℹ Note | Only the Master unit outputs range data.

Master

- *Device -> Settings -> Measurement basics*

  - o Station mode = Master

  - o Bandwidth mode = Choose a bandwidth that fits your required range and accuracy

  - o Channel block = Use recommended selection

  - o Sync channel = different than any other LPR®-1DHP-200 sensor in range (except the related Slave); for neighboring measurement paths use only every fourth sync channel.

Slave

- *Device -> Settings -> Measurement basics*

  - o Station mode = Slave

  - o Bandwidth mode = same as Master

  - o Channel block = same as Master

  - o Sync channel = same as Master

⇨ Review and Calibrate your measurement as stated in chapter 6.4.

6.4 Review and Calibration of the Measurement Setup

- *Diagnostics -> Range measurement statistics -> Live range measurement*

Quick Setup

- o Run a warm up phase of 30 minutes before calibration.

- o Compare the "current distance" to the actual distance in your measurement setup for all ranges.

- o The mean value of the difference between the actual distance and the measured distance is the reference-offset value, which needs to be added to the current distance to match the radar's and installation's coordinate systems. The radar therefore offers the setting "*Measurements Details -> Customer specific offset*".

- o Make sure that the maximum and standard deviation of the difference between the offset corrected measured and actual distance meets your accuracy requirements for all possible distances in your measurement setup.

i Note	The LPR®-1DHP-200 are delivered with the fixed TCP/IP IP-Address **192.168.1.99**.

7   Establishing a TCP/IP Connection

For configuration of the radar units, a TCP/IP connection has to 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 must be equal.

- No firewall is blocking the communication between PC and radar.

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**.
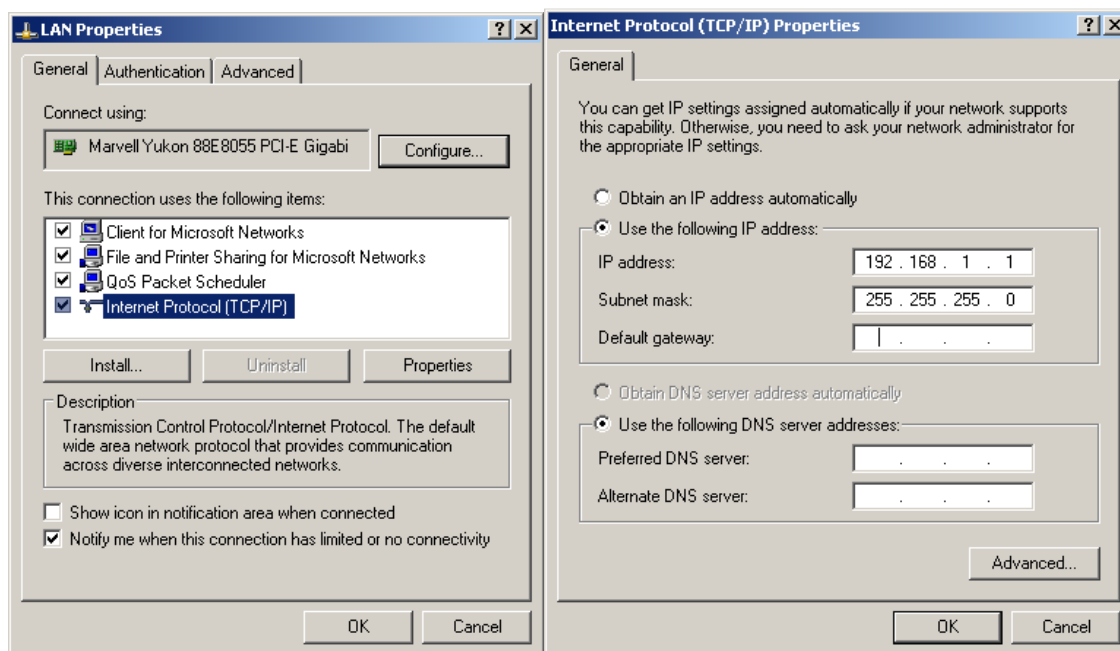
Figure 7.1: Network Settings under Microsoft Windows

The LPR®-unit should be available via your PC now. You can check the connection with a *ping* to the LPR®-1DHP-200 unit:

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-200 unit in the cmd.exe window and confirm

The LPR®-1DHP-200 should answer with a *Reply*.
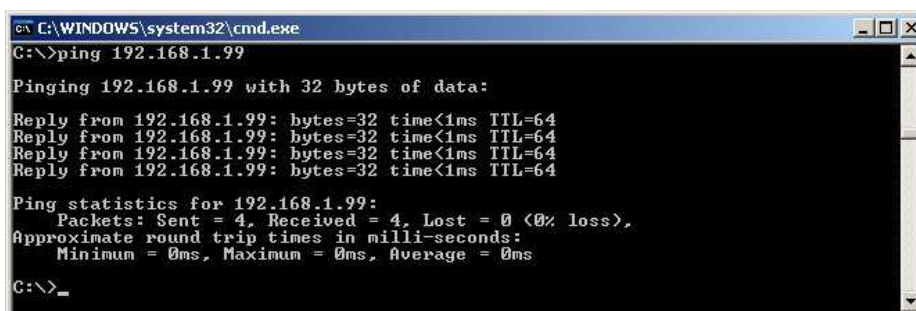
Figure 7.2: Ping LPR®-1DHP-200 Unit

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** in the Partner Login 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

i 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-200: e.g. http://192.168.1.99.

The welcome page for the LPR®-1DHP-200 WebUI should appear.

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

Device Setup via the Web User Interface

Information overview

Hostname	symeo-lpr
IP address	192.168.1.99
Firmware	v0.11.0-54-g3aedb9f
Radar Mode	Primary
System time	2018-08-08 14:04:31 UTC

Device Status

Services	Distance measurement
Interfaces	Binary protocol
Remote	No modem installed PPP disabled
Access	VPN disconnected

Environment uninitialized

The working environment of this station has not been set, yet.

Before you can use this device, you need to configure the operating country. This is necessary to abide to the radio signal restrictions enforced by the local authorities. Since this is a very important setting, all functionality of this device will remain disabled, until the working environment is confirmed. To configure the working environment, please use the button below.

[Configure environment]

Product properties

Model number: BSW200290
Product name: LPR-1DHP-290
Serial number: D34AJM0004
Unit production code: ⑤

Introduction

LPR®-1DHP-290
Robust Long-Range Distance Measurement in the Millimeter Domain with Highest Accuracy

LPR®-1DHP-290 radar system performs 1D distance measurements for short, medium and long ranges with highest accuracy. By performing primary, secondary and diversity radar measurements it can detect position and speed - for example of cranes and railbound transport systems - in real-time and make the data available via the device interfaces. The sensors are simple to install and easy to put into operation with the aid of a web interface. A directional antenna is integrated into the robust housing.
The LPR®-1DHP-290 radar system is a successor to the LPR®-1DHP and features an even higher accuracy and measurement rate in a more compact design. The device furthermore supports the latest ultra-wideband technology, allowing it to achieve highly-precise measurements in the millimeter range. The sensor can be optimally configured for the required accuracy and range by selecting individual measurement modes. Even under the harshest conditions and weather environments such as rain, fog, snow, dust, smoke or vibrations, the maintenance- and wear-and-tear-free wireless technology operates reliably and with a high degree of availability - indoors and outdoors.

Figure 8.1: Open Web User Interface

Device Setup via the 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 8.1).
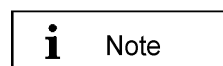
i Note	During the initial operation, you need to configure the operating country, in which you want to use this unit. This is necessary to abide to the radio signal restrictions enforced by the local authorities. Your selection will have impact on the selectable Bandwidth Modes as well as on the maximum 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 8.3: Initial setup of environment of the LPR®-1DHP-200

⇨ Select your country to determine the operating environment and confirm it with the "*Save*" button (see *Figure 8.3*).

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

⇨ Now activate the settings by clicking the "*Activate changes*" button (see Figure 8.4).

Figure 8.4: Initial setup of environment - Activate changes

The following window appears:

Figure 8.5: 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.
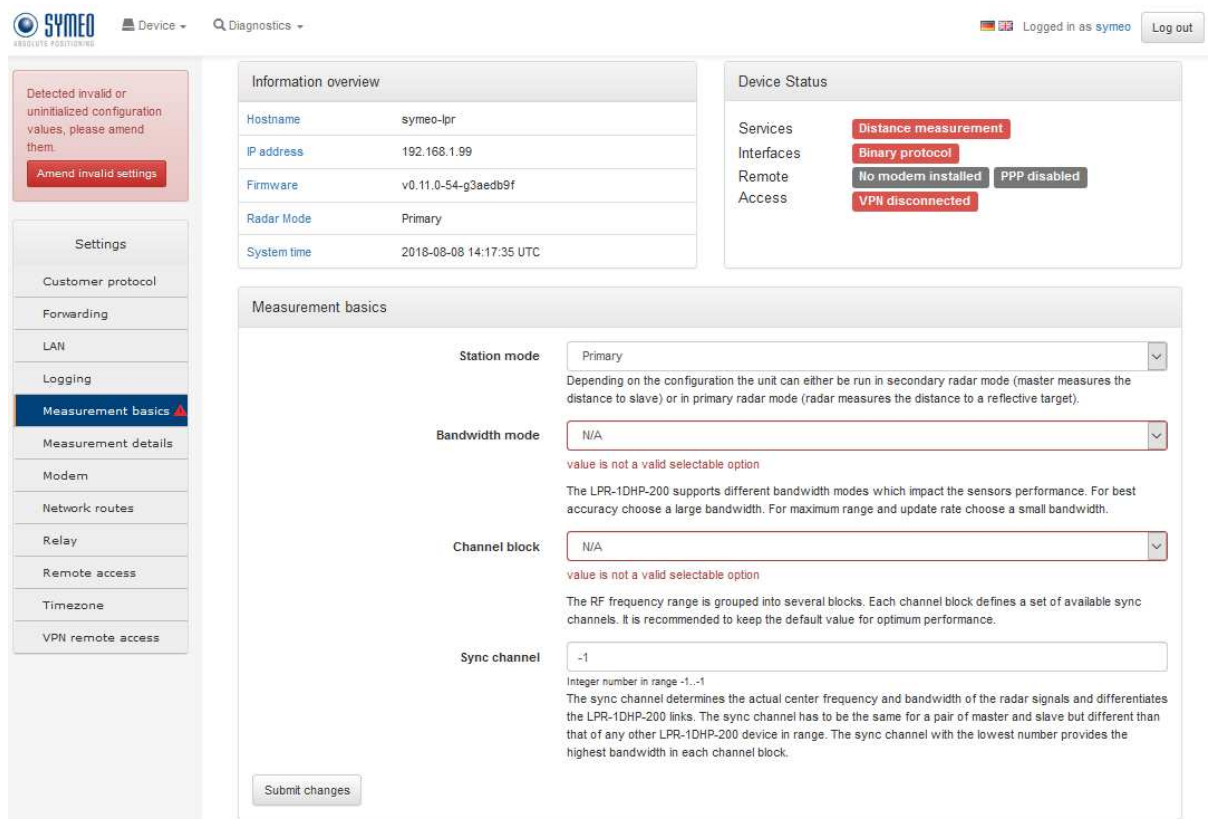
Figure 8.6: Settings window for mandatory values

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

Device Setup via the Web User Interface

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

Figure 8.7: 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 adapted to your made changes. The settings will however not be applied to the radar until you *"Save all changes"* in the the *"Review changes"* page or in the top left corner of this page.

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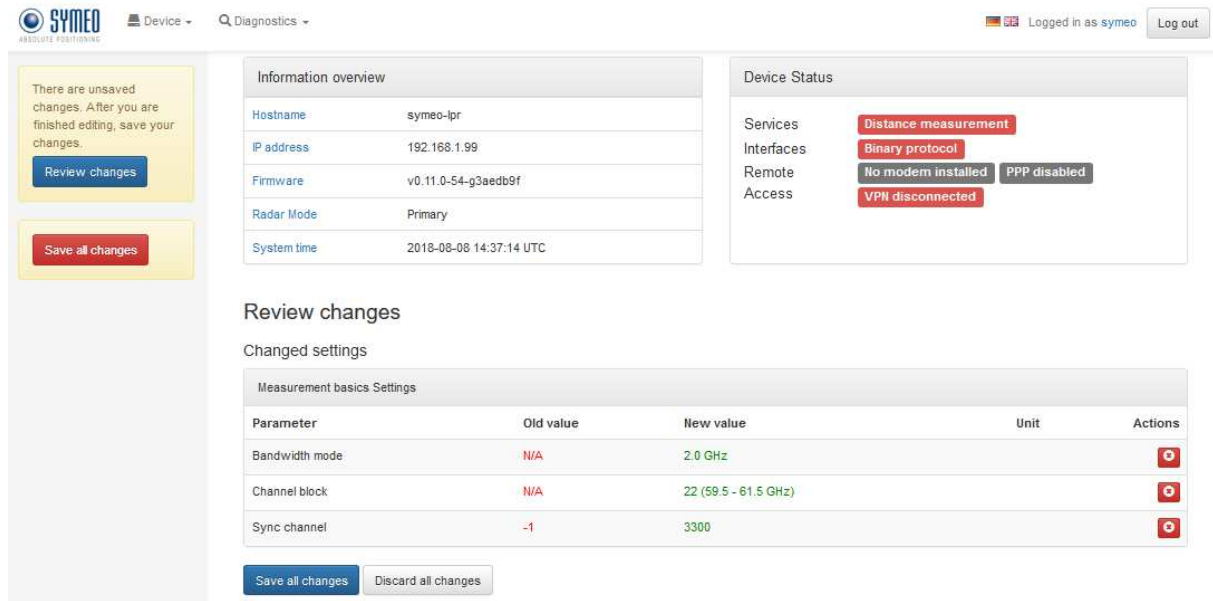
Figure 8.8: Save or discard all changes

⇨ Confirm the changes by clicking the "*Save all changes*" button. The dialog box "*Changes have been applied*" will appear (see *Figure 8.9*).

If you would like to discard all changes made after the last save, press *"Discard all changes"*.

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

Figure 8.9: Changes have been saved

8.5   Home Page

On the home page (see *Figure 8.10*), important information about the LPR®-1DHP-200 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.
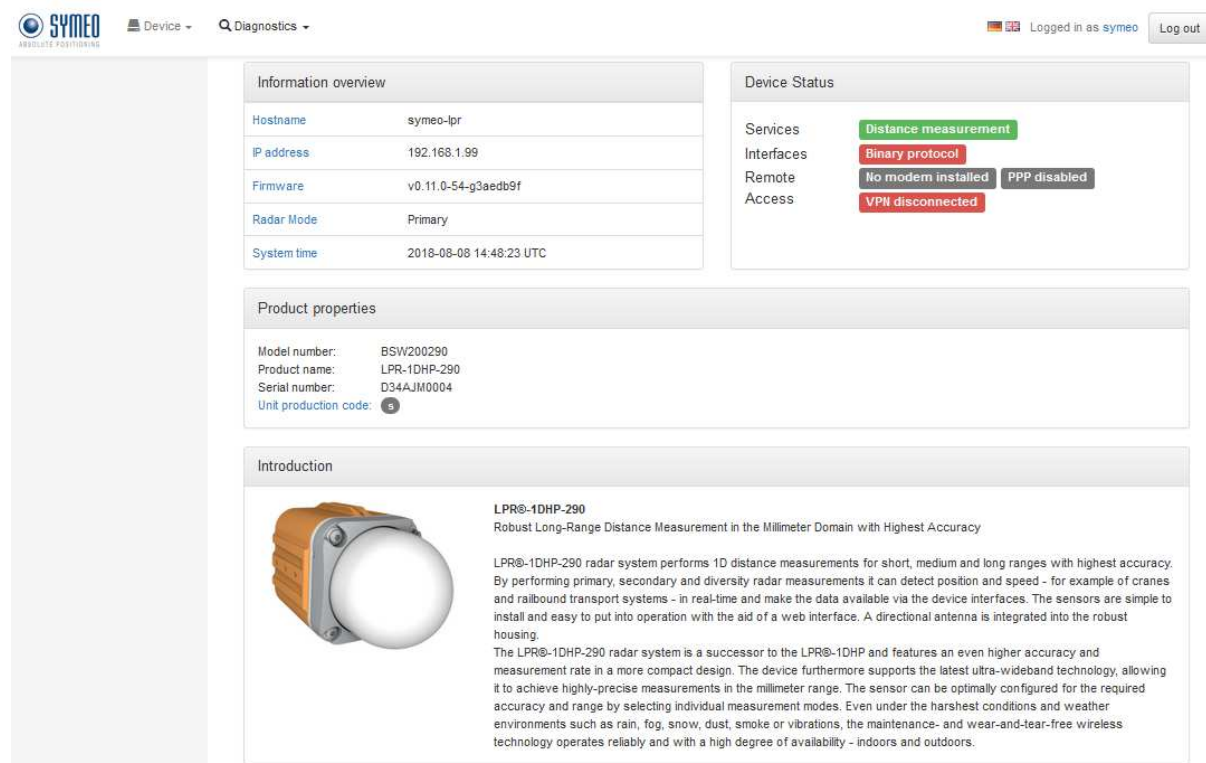
Figure 8.10: The home page of the LPR®-1DHP-200

On top of every page, the device status is shown (see *Figure 8.11*):
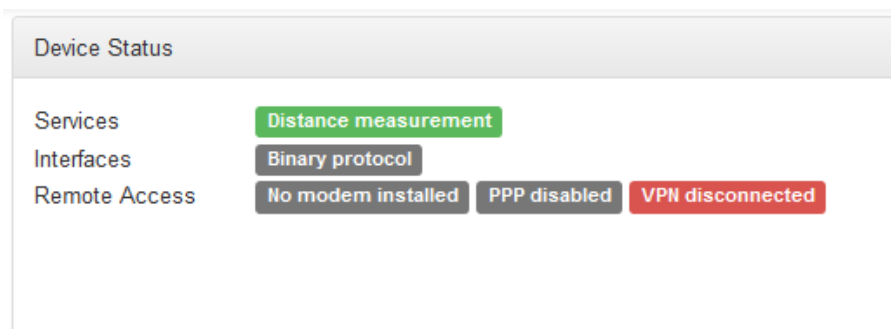
Figure 8.11: WebUI - Device Status

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

Device Setup via the Web User Interface

- 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 "*Binary protocol*" button turns green if a client is successfully connected to the customer port.

The "*Information overview*" window (see *Figure 8.12*) shows:

- Hostname of the LPR®-1DHP-200 unit
- IP-address
- Application version
- Mode: Primary, Master or Slave
- System time

Information overview	
Hostname	DHP200Vertrieb
IP address	192.168.98.44
Application	v0.10.0
Mode	Primary
System time	2018-05-09 11:35:57 UTC

Figure 8.12: WebUI Information overview

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 8.13*).

Product properties	
Model number:	BSW200290
Product name:	LPR-1DHP-290
Serial number:	D34AJM0004
Unit production code:	Ⓢ

Figure 8.13: WebUI - Product properties

⇨ Click the "*Unit production code*" button under the menu item "*Product properties*" (see *Figure 8.13*). The table with the product features will be displayed.

Device Setup via the Web User Interface

DOC.EDO.000341.WORK.EN_LPR-1DHP-200_Product-Documentation.docx

The table below shows a complete list of all features available for this unit (see *Figure 8.14*).

Product features		
Please inspect the table below to see a complete list of all features available for this unit.		
Feature description	**Production code element**	**Active**
Profinet	n	No
LPR®-1DHP-200 series metal housing with integrated antenna, 1D controller, interface TCP/IP	s	Yes

Figure 8.14: WebUI - Product features

i Note	Not all product features can be combined with each other.

Device Setup via the Web User Interface

8.1 Device

In this menu (see *Figure 8.15*), the following subpages are available:

- Settings
- Upload configuration
- Downloads
- Firmware update
- Factory reset
- Reboot device
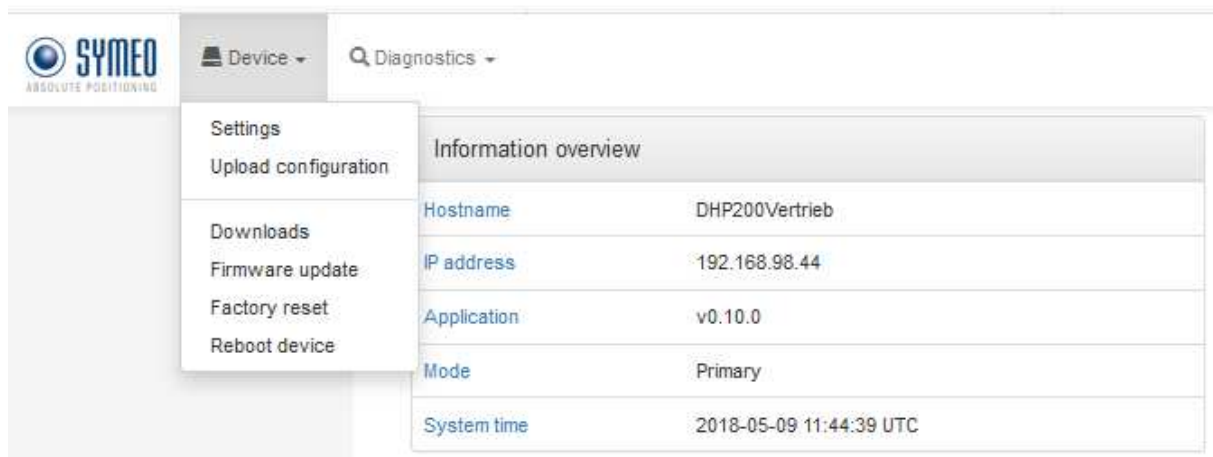
Figure 8.15: Device Menu

8.1.1 Device - Settings

In this menu, the following settings are available:

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

Device Setup via the Web User Interface

Device - Settings – Customer Protocol

In this menu, the following settings are available:

- Mode of customer protocol
  - Interface to customer - either TCP or 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
  - Output interval of own measured distance in milliseconds (Integer number in range 10..60000 ms)

Device - Settings – Forwarding

In this menu, the following settings are available:

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

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

- Destination IP address
  - Destination IP address of connected LPR®-1D24 unit

- Enable custom forward interval
  - Enable a custom forward interval of own distance. If disabled, the own measured distance is forwarded with measurement rate

Device - Settings – LAN

In this menu, 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)

Device Setup via the Web User Interface

Device - Settings – Logging

In this menu, the following settings are available:

- Logging mode
    - Defines whether unit logs system events and measurements to a storage device.
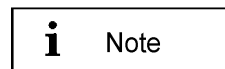
ⓘ Note	Stock units do not have a storage device installed and are therefore not ready for logging.

The following settings are available:

- 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

Device - Settings – Measurement Basics

In this menu, 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)

- Bandwidth mode
    - The LPR®-1DHP-200 supports different bandwidth modes, which impact the sensors performance. For best accuracy, choose a large bandwidth. For maximum range and update rate, choose a small 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 LPR®-1DHP-200 links. The sync channel has to be the same for a pair of master and slave but different than that of any other LPR®-1DHP-200 device in range. The sync channel with the lowest number provides the highest bandwidth in each channel block.
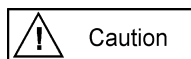
⚠ Caution	Changing bandwidth mode, channel block or sync channel influences the sensors performance and reference plane. A recalibration and test of the installation (see chapter 6.4), is therefore necessary after changing these settings.

Device Setup via the Web User Interface

Device - Settings – Measurement Details

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

Measurement Details for Primary Radar Mode

In this menu, the following settings are available:

- Customer specific offset
  - The offset can be used to calibrate the reference plane for the distance measurements according to the customer's setup. The value is added to the measured distance.

- Average spectra
  - Spectra can be averaged before applying the peak search algorithm. Averaging more spectra will reduce the noise but it will also reduce the measurement rate.

- Peak 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.

Device Setup via the Web User Interface

- 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
    - 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 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.

- VGA value
    - The VGA value determines the power of the transmitted signal.

The LPR®-1DHP-200 in primary radar mode can either output the distance to the first or the strongest valid target. A target is valid, if its signal level is higher than a set signal level threshold level profile, which is segmented into 3 range zones (short range, mid range, long range). The start and end positions of the 3 range zones and their corresponding signal threshold levels can be configured individually with the settings described above. An example of the radar target spectrum (target signal strength vs. distance) recorded in a multi target environment is shown in where the window for valid targets defined by the range zones and their threshold levels is marked green. Targets outside of this window will be ignored.

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 personal.
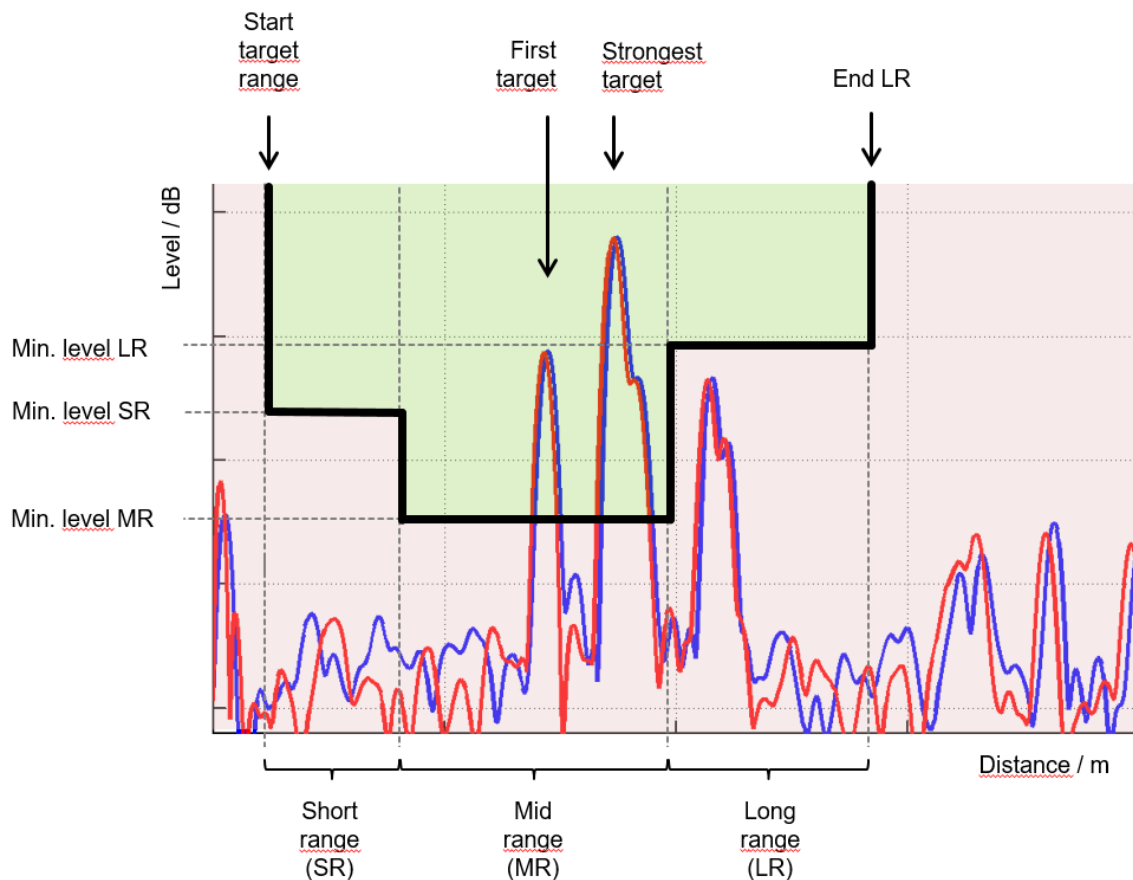
Figure 8.16: Radar target spectrum in a multiple target environment

Measurement Details for Secondary Radar Mode

In this menu, the following settings are available:

- Customer specific offset (only Master mode)
  - This offset can be used to calibrate individual LPR® links to account for tolerances. It is added to the measured distance

- 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 mode)
  - The maximum occurring speed is used internally to validate the measurement results

- Diversity mode (only Master mode)
  - In diversity mode the measurement results of two LPR®-1DHP-200 units are combined for optimum performance

- Raw data output
  - Raw data can be provided by the unit for further analysis

- RX attenuator mode
  - The RX attenuator can be enabled when the received signal is too strong.

- VGA value

Device Setup via the Web User Interface

- o The VGA value determines the power of the transmitted signal.

Measurement Details for Diversity Radar Mode

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

Device - Settings – Modem

In this menu, the following settings are available:

- PPP Point to Point protocol connection
- APN address
- APN username
- APN password

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.

⇨ Press the „*add route"* button.

Device - Settings – Relay

In this menu, 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, the following settings will additionally appear:

- Relay destination address
  - LPR®-B address of destination 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

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, the following setting are available:

- HTTP
- OpenVPN Client

⚠ 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, the following settings are available:

- NTP Server
    - IP or hostname of time server (network time protocol)
- 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.

Device - Settings – VPN Remote Access

In this menu, 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.

Device Setup via the Web User Interface

8.1.2 Device - Upload Configuration

In this menu (see *Figure 8.17*), you can upload a local configuration file:

Upload configuration

Please choose a local configuration file for upload:

Browse...

Upload configuration
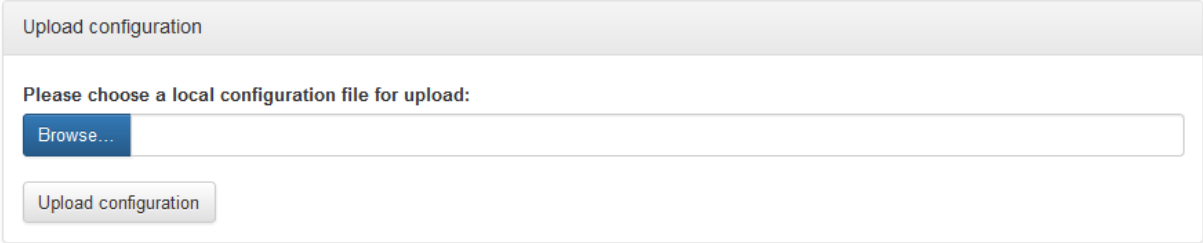
Figure 8.17: Device - Application Settings

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

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

8.1.3 Device - Downloads

In this menu, 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)

8.1.4 Device - Firmware Update

In this menu (see *Figure 8.18*), 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 8.19)*

⇨ Wait until firmware update and automatic reboot are finished.

Firmware update

Please choose a local file for the update:

Browse...

Upload firmware

Figure 8.18: Device - Firmware update

Device Setup via the Web User Interface
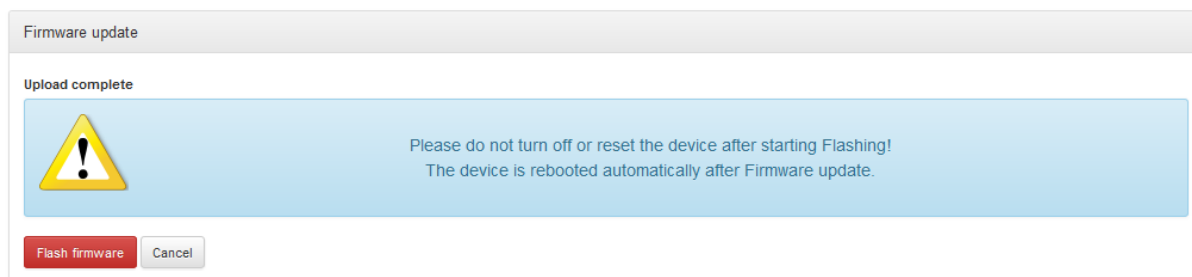
Figure 8.19: Device - Device configuration - Firmware update success message
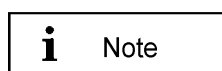
ⓘ Note	All stations that measure or forward together should have the same firmware version.

8.1.5   Device - Factory Reset

In this menu, (see *Figure 8.20*), you can restore factory settings.
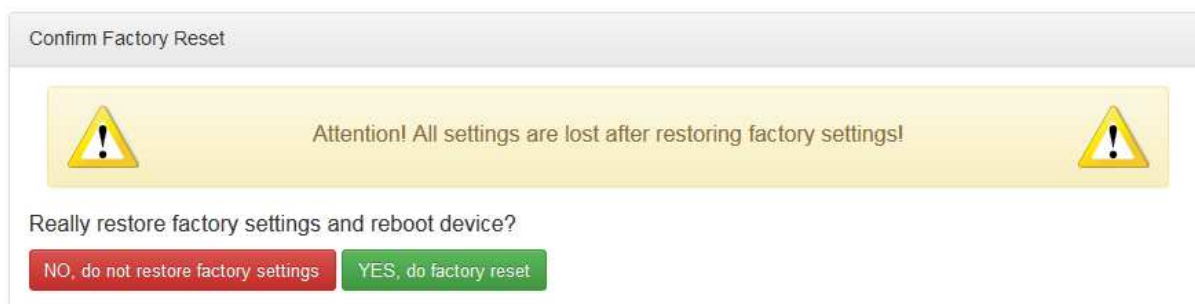
Figure 8.20: Device - Factory Reset
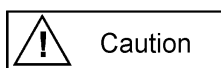
⚠ Caution	All settings are reset by restoring factory settings.

8.1.6   Device - Reboot Device

In this menu (see *Figure 8.21*), you can reboot the device:

• Reboot the device
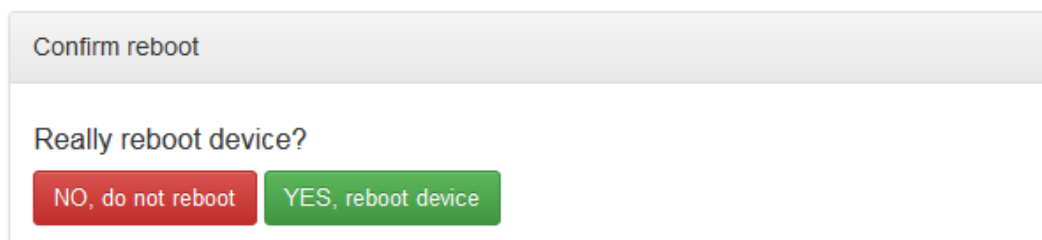
Figure 8.21: Device - Reboot Device

Device Setup via the Web User Interface

8.2   Diagnostics

In this menu (see *Figure 8.22*), the following subpages are available:

- Operating System Status
- Hardware Status
- Storage device
- Range measurement statistics
- Record measurement data
- Packet inspector
- Station scan
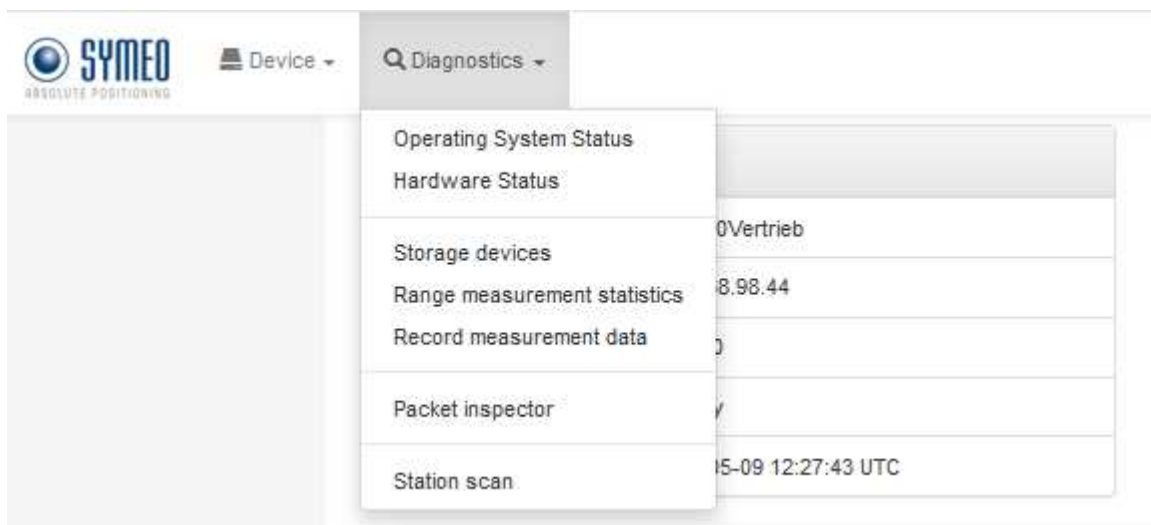
Figure 8.22: Diagnostics Menu

8.2.1   Diagnostics – Operating System Status

Under this menu (see *Figure 8.23*), 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-g72c3633 (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 8.23: Diagnostics - Operating System Status

Device Setup via the Web User Interface

8.2.2 Diagnostics – Hardware Status

In this menu (see *Figure 8.24*), system values and system voltages are displayed.

In case of problems, this information may be requested by Symeo support.
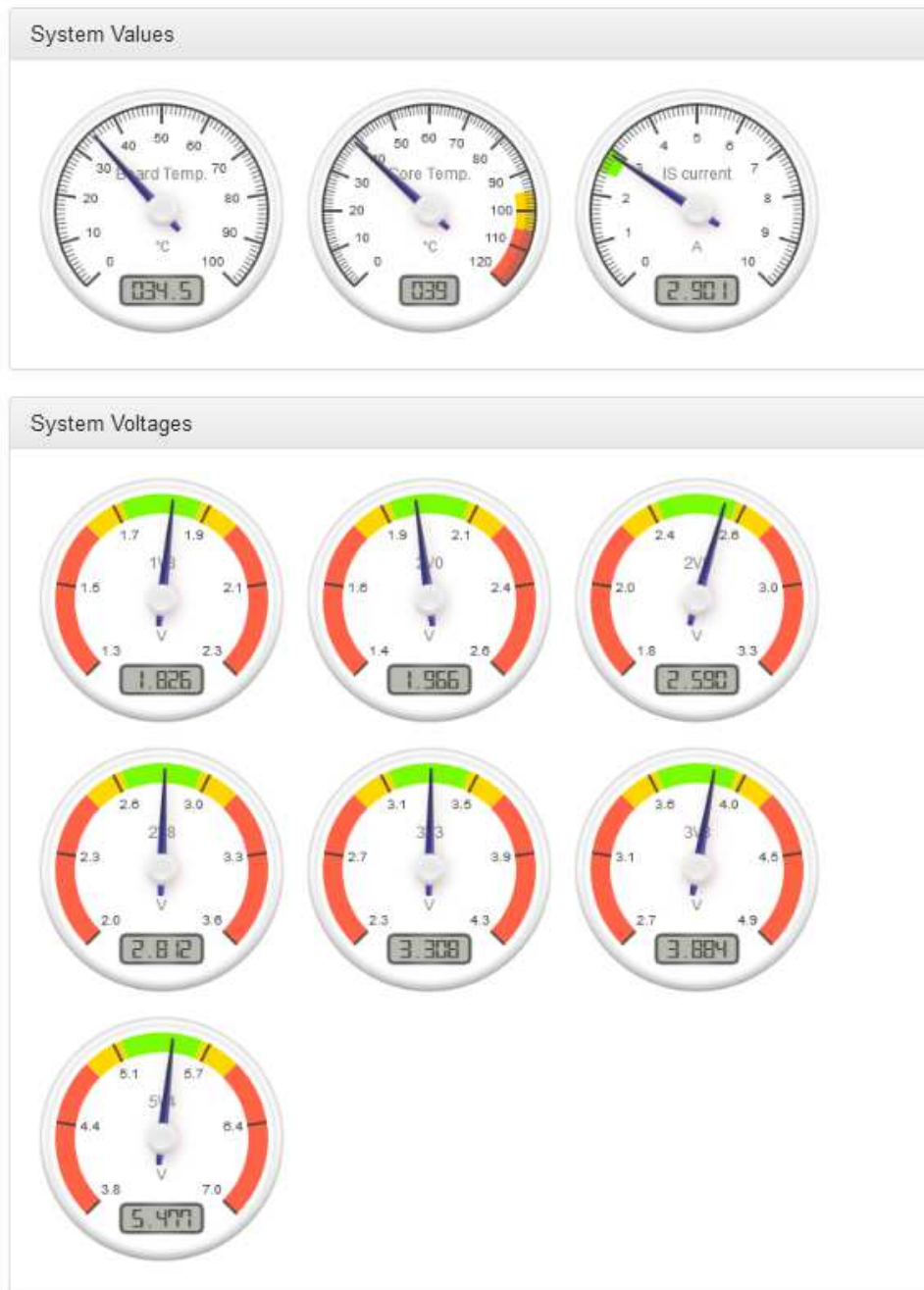
Figure 8.24: Diagnostics - Hardware Status

This display is automatically refreshed every 5 seconds.

Device Setup via the Web User Interface

8.2.3 Diagnostics – Storage Devices

Here (see *Figure 8.25*) you can see available storage devices and format them if necessary.
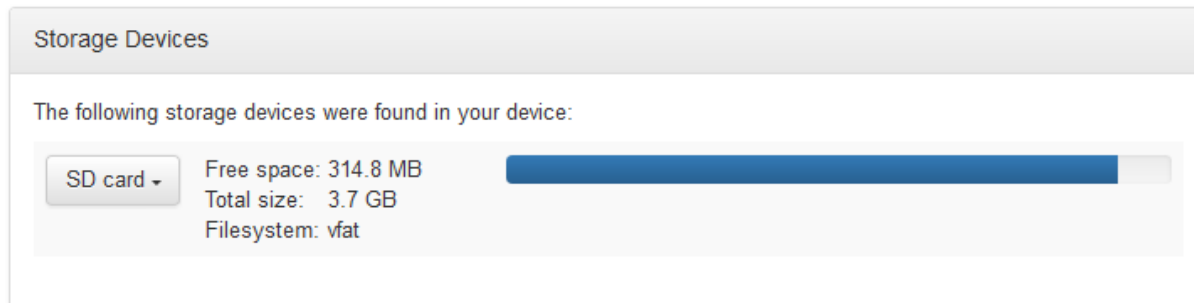
Figure 8.25: Diagnostics - Storage Devices

8.2.4 Diagnostics – Range Measurement Statistics

This section (see *Figure 8.26*) allows you to view raw measurements and range statistics.

⇨ Please select a topic from the menu on the left (see *Figure 8.26)* to view the corresponding information:

• Live range measurement

• Signal strength statistics

• Measurement rate statistics
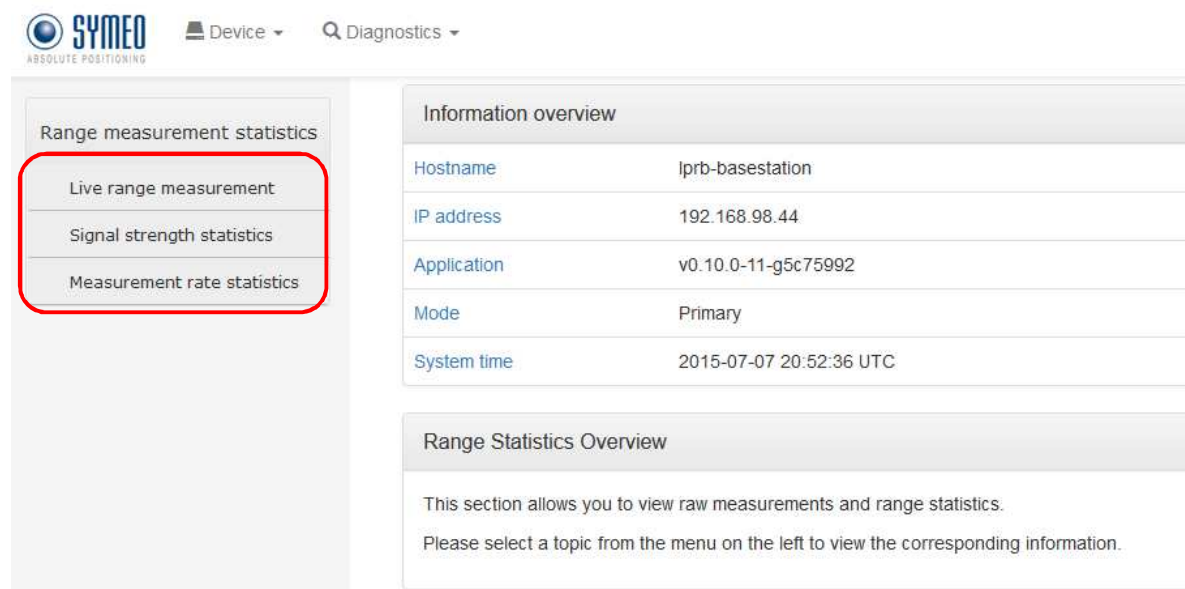
Figure 8.26: Diagnostics - Range Measurement Statistics

Device Setup via the Web User Interface

Live Range Measurement

In this menu (see *Figure 8.27*), the current distance and the current RSSI value (Signal strength) will be displayed, furthermore, the distance over time graph.
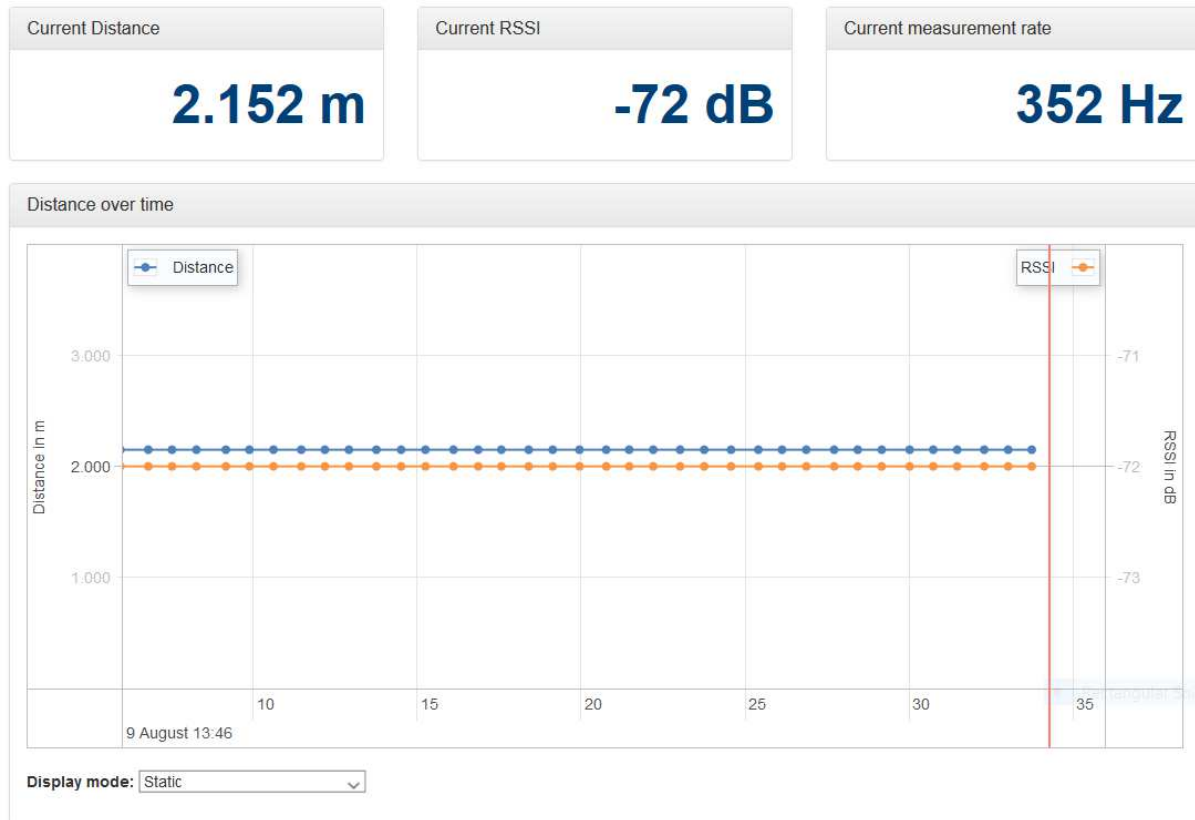
Figure 8.27: Diagnostics - Distance over time graph

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

Signal Strength Statistics

Figure 8.28: 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.

Device Setup via the Web User Interface

Measurement Rate Statistics

Figure 8.29: 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.

Device Setup via the Web User Interface

8.2.5 Diagnostics – Record Measurement Data

In this menu, you can

- Change logging mode

- View recorded measurements

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

The following options are available:

- Disabled
- Log to SD card if available
- Log to USB stick if available, use SD card as fallback
- Log to USB stick if available (recommended

⇨ Choose one of the settings (recommended log to USB stick if available) and refresh the page using the F5 key.

8.2.6 Diagnostics – Packet Inspector

In this menu (see *Figure 8.30*), you can see the output of the binary port.

For it, you must press the "*Get new data*" button to get at first the last 10 records. Then you must select one record by driving over with the mouse and pressing the left mouse button.

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

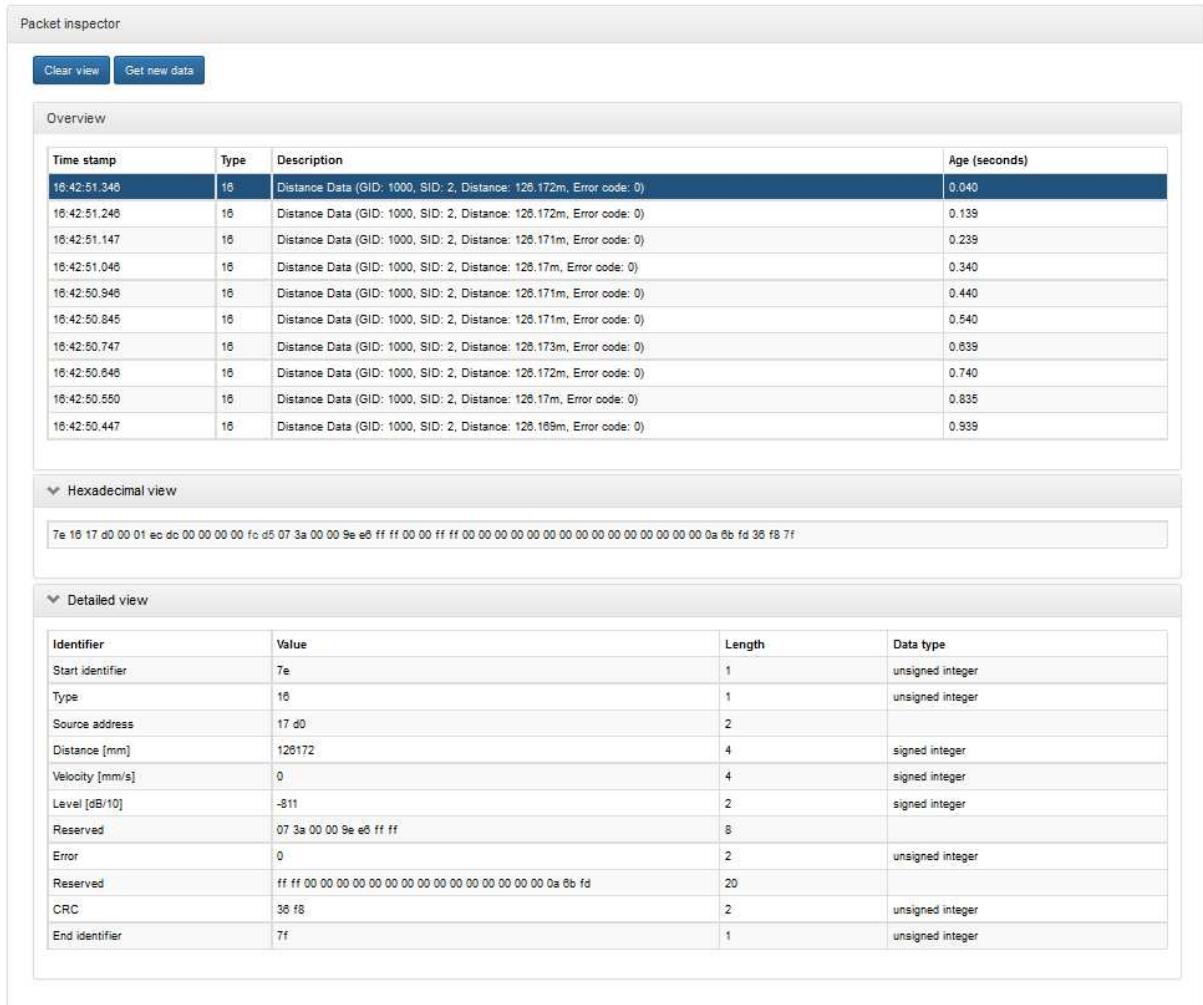Device Setup via the Web User Interface

.

Figure 8.30: *Diagnostics - Packet inspector*

8.2.7 Diagnostics – Station Scan

In this menu (see *Figure 8.31*), all Symeo units found in your current local area network (LAN) will be displayed.

Figure 8.31: Diagnostics - Station scan

9   The Customer Protocol

The customer protocol (Binary Protocol XP) is the standard data protocol between LPR®-1DHP-200 units 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.

i Note	All settings related to the customer protocol can be found in the WebUI under *Device -> Settings -> Customer protocol*
i Note	The default TCP/IP and UDP port of the customer protocol interface is 3046.
i 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.

i 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.

The Customer Protocol

9.2 Data Types

9.2.1   Type 0x16 – Distance Data

Direction: LPR®-1DHP-200 Unit → 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.

i Note	The standard customer protocol length of the LPR®-1DHP(-R) sensor (predecessor) was 50 bytes which has to be taken into account if a LPR®-1DHP-200 is used to replace it.

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

i 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)

The Customer Protocol

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

The Customer Protocol

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
0x05	Measurement botched	Measurement is not feasible
0x06	Currently not used	
0x07	Currently not used	
0x08	Currently not used	
0x09	Settling	VCXO has just been tuned, 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	Currently not used	
0x10	Currently not used	
0x11	ARM sync failed	The ARM9 boards of the Group Master have not been synchronized.
0x12	Target out of range	Error 18 (0x12) will be reported if no valid target is detected within system range and an internal system check will confirm error-free system operation.

Table 9.2: Distance error codes
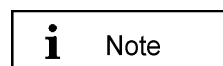
i	Note	Only measurements with error code 0 are valid.

9.2.2   Type 0x03 – Relays Switching Commands

Direction: LPR®-1DHP-200 Unit → User / LPR®-1D24

The Customer Protocol

The data type 0x03 is typically used for sending relay switching commands to a LPR®-1D24 radar unit (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.

The Customer Protocol

9.2.3 LPR®-1D24 Address

LPR® unit addresses are completely defined by a 16 bit value:
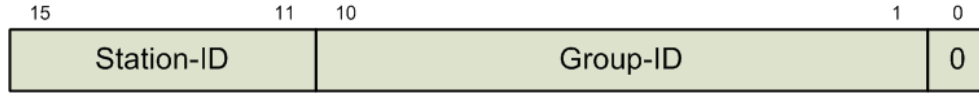
0	Reserved
Group-ID:	The Group-ID of the unit (1..1022)
Station-ID:	The Station-ID of the unit (SID)
for Distance Data:	Master and Slave SID is *always* 2 (SID = 2)
for Relays Switching Command:	SID = 1 for Master und SID = 2 for Slave

Table 9.4: LPR®-1D24 address

10 Technical Data

10.1 General Technical Data

	LPR®-1DHP-220-R LPR®-1DHP-260 LPR®-1DHP-281 LPR®-1DHP-290	LPR®-1DHP-280 (2x LPR®-1DHP-281 + MTM102512)
Frequency range	57,0 – 64,0 GHz	57,0 – 64,0 GHz
Supply voltage	11 - 36 V	11 - 36 V
Power consumption	7 W	2 x 7 W
Ambient Temperature	-40 °C to +70°C	-40 °C to +70°C
Protection class housing	IP65	IP65
Housing dimensions (LxWxH); weight	95 x 95 x 155 mm; 800g	160 x 230 x 220 mm; 4kg
Interfaces	Ethernet (TCP/IP, Profinet)	Ethernet (TCP/IP, Profinet)
External connector	Ethernet (M12), supply voltage (M12)	2 x Ethernet (M12), 2 x supply voltage (M12)
Antenna	Integrated, beam width = +-2,5°	Integrated, beam width = +-2,5°
Compliance	CE, FCC, IC (others on request)	CE, FCC, IC (others on request)

Technical Data

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	0,5 GHz	2 GHz
Measurement accuracy	up to +- 10 mm	up to +- 5 mm
Repeatability	up to +- 6 mm	up to +- 3 mm
Measurement rate	up to 350 Hz	up to 350 Hz

ETSI Specific Technical Data

Bandwidth Mode	0,5 GHz	2 GHz
Measuring range	2 m to 50 m	1 m to 50 m

FCC Specific Technical Data

Bandwidth Mode	0,5 GHz	2 GHz
Measuring range	2 m to 50 m	1 m to 20 m

10.2.2   Secondary Radar Mode

General Technical Data

Bandwidth Mode	0,5 GHz	2 GHz
Measurement accuracy	up to +- 10 mm	up to +- 5 mm
Repeatability	up to +- 6 mm	up to +- 3 mm

Technical Data

Measurement rate	up to 110 Hz	up to 110 Hz

ETSI Specific Technical Data

Bandwidth Mode	0,5 GHz	2 GHz
Measuring range	2 m to 300 m	0,5 m to 300 m

FCC Specific Technical Data

Bandwidth Mode	0,5 GHz	2 GHz
Measuring range	2 m to 300 m	0,5 m to 225 m

10.2.3   Diversity Radar Mode

General Technical Data

Bandwidth Mode	0,5 GHz	2 GHz
Measurement accuracy	up to +- 10 mm	up to +- 5 mm
Repeatability	up to +- 6 mm	up to +- 3 mm
Measurement rate	up to 110 Hz	up to 110 Hz

ETSI Specific Technical Data

Bandwidth Mode	0,5 GHz	2 GHz
Measuring range	2 m to 500 m	0,5 m to 500 m

FCC Specific Technical Data

Technical Data

Bandwidth Mode	0,5 GHz	2 GHz
Measuring range	2 m to 500 m	0,5 m to 225 m

10.3 Product Name vs. Model Number

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

Model / Product name	Model Number
LPR®-1DHP-220-R	BSW200220
LPR®-1DHP-260	BSW200260
LPR®-1DHP-281	BSW200281
LPR®-1DHP-290	BSW200290