SYMEO LPR®

ABSOLUTE POSITIONING

Product: LPR®-2DB

Product Documentation

CONTENT

The documentation for the LPR Local Positioning Radar System is published by:

SYMEO GmbH
Prof.-Messerschmitt-Str. 3
85579 Neubiberg
www.symeo.com

If you have any questions or suggestions, please contact:

Email: info@symeo.com
phone: +49 89 660 7796 0

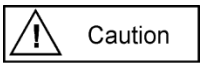
HISTORY

Version	Date	Description
3.17	2009-05-20	Initial release
3.18	2009-07-07	Added documents to one document
3.19	2010-02-01	Updated SYMEO Map and FusionEngine description
4.00	2010-06-30	Completely revised

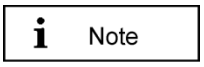
VERWENDETE SYMBOLE

The following symbols are used in the documentation:

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

Published by SYMEO GmbH

1 General

1.1 Safety Instructions

Warning

LPR systems are purely tracking and assistance systems. They therefore do not satisfy the safety class 3 requirements and must not be used as standalone systems in safety-critical applications, such as automation or anti-collision.

Caution

Follow the safety instructions in the operating instructions for the device and the additional documentation!

Keep these safety instructions and other documents together with the device.

1.2 Installation

Caution

All installation, repair and servicing work must be carried out by qualified and trained technicians!

1.3 Repairs

Caution

Repairs to the device must be carried out by authorized technicians. Unauthorized opening and incorrect repairs could result in severe danger to the user (danger of electric shock, radiated energy, fire hazard).

1.4 Transport and Storage

Note

Use the original packaging or other suitable packaging for returns and whenever the system is to be transported. This ensures protection from crushing, impacts, moisture and electrostatic discharge.

During setup and before operation, refer to the instructions for environmental conditions included in the operating instructions for the device.

Route the wires in such a way that they do not cause a hazard and are not damaged. When connecting the wires, refer to the corresponding instructions in the operating instructions for the device.

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

1.5 Power Supply

Caution

A safety-inspected power cable that satisfies the regulations of the country of use is required for the device. Devices with metal housings must only be connected to a grounded, shock proof socket.

The device must not be operated unless the nominal voltage of the device matches the local supply voltage. Check the supply voltage of the device in stationary devices.

When connecting and disconnecting wires, refer to the instructions in the operating instructions for the device.

Do not use any damaged wires (damaged insulation, exposed wires). A faulty wire poses a risk of electric shock or fire hazard.

1.6 Setup and Operation

Caution

During installation, make sure that no objects or fluids get inside the device (risk of electric shock, short circuit).

In emergencies (e. g. if there is damage to the housing, control elements or the mains cable, if fluids or foreign bodies have infiltrated the equipment), switch off the power supply to the device immediately and notify your SYMEO Service.

Protect the contacts of all of the device's sockets and plugs from static electricity. Do not touch the contacts. If it is ever necessary to touch the contacts, take the following precautionary measures: Touch a grounded object or carry a ground strap before touching the contacts. This will divert static charges.

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). If necessary, refer to the corresponding instructions in the operating instructions for the device.

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

1.7 System Extensions and Accessories

Note

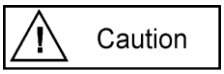
Data links to peripheral devices must be provided with adequate shielding.

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.

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

1.8 Additional Instructions Regarding Compact Type and Integral Type Stations



The Compact type LPR station must not be opened except for installation. The Compact station contains no serviceable components.

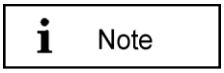
When opening, ensure that no fluid gets into the housing. When sealing the station, ensure that the seal is included in the cover and that the Compact station is completely closed. Otherwise, moisture can penetrate the station and damage it.

In order to install the Integral type LPR station, the hood must be detached from the serviceable components. Refer also to the instructions on installing the transponder.

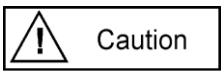
Please take note of the safety and operating instructions in the operating instructions for the system in which you want to install the component.

2 Introduction

2.1 Details

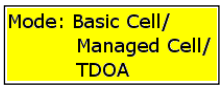


This symbol appears before information of particular importance.



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 instructions that must be followed at all times. Failure to comply with these instructions will result in personal injury.



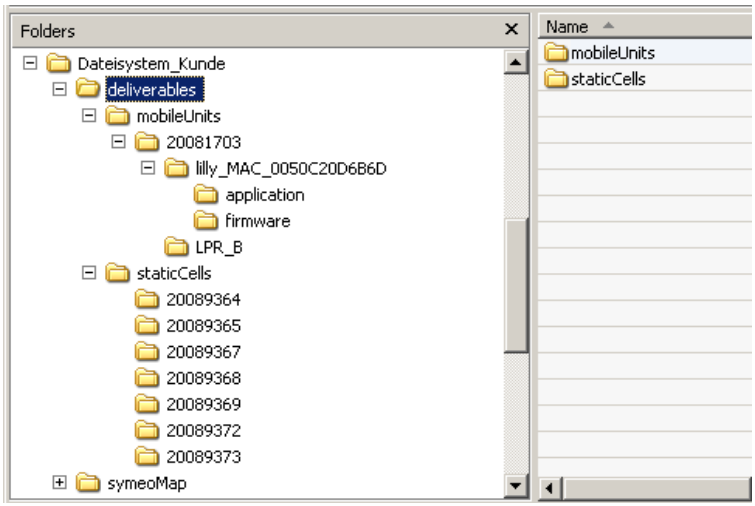
This symbol appears if the following sub-chapter describes difference in the operating mode. An overview about the operating modes is given in chapter 3.2.

2.2 Overview of Files

LPR-2DB Station (Mobile unit / base station):	- master_basestation_config.txt or Basestation_config.txt (depending on the selected operating mode)
LPR-2DB Integral Stations (transponders):	- **STATION010_CONFIG.TXT** - **STATION011_CONFIG.TXT** - **STATION012_CONFIG.TXT** - **STATION013_CONFIG.TXT** - **STATION014_CONFIG.TXT** - **STATION015_CONFIG.TXT**
Master LPR-2DB Integral Station (optional):	- station01M_config.txt (depending on the selected operating mode)
Symeo MAP (optional)	- SYMEO Map XP Installer
FusionEngine:	- FusionEngine.exe - const_pos.ini - field.ini - fusion.ini - LPR_B.ini - movingcell.ini - multi_cell.ini (TDOA) - HoverTrack.ini / VehicleTrack.ini or TDOA.ini (depending on

	the selected model, application and operation mode) - symeo_map.ini - symeo_2D.ini

All files are delivered in the structure shown in Figure 1 (“deliverables” and “symeoMap”).



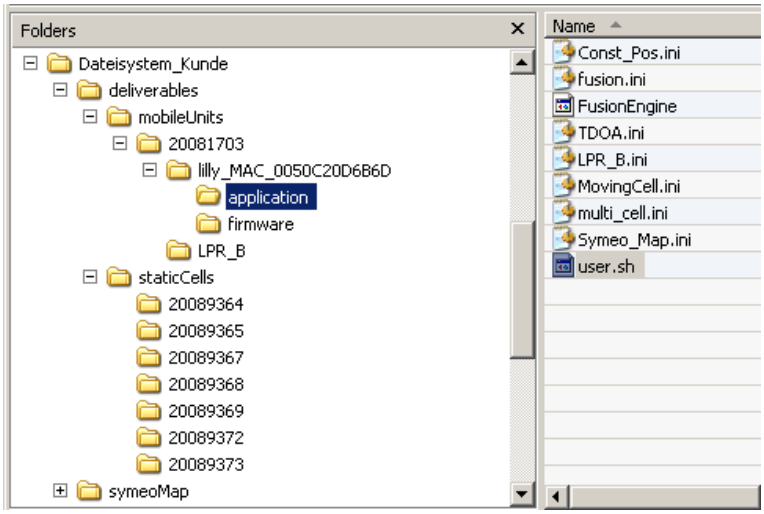
The folder “mobileUnits” contains all files for the vehicles. The folder “staticCells” contains all files for the LPR-2DB Integral Station including the master LPR-2DB Integral Station. The folder name for all LPR stations is named with the serial number.

Figure 1- folder structure

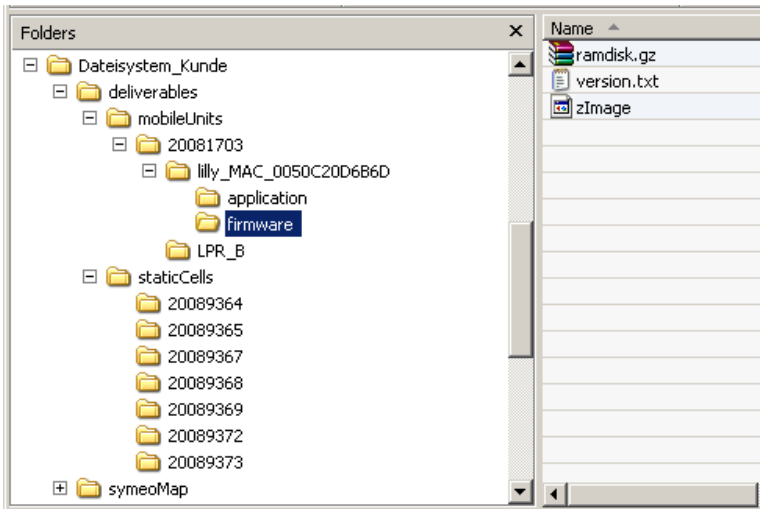
Note

To allocate the stations for the customer, it makes sense to create a text-file that describes the function of that LPR station, i.e. “forklift_123_customer.txt”.

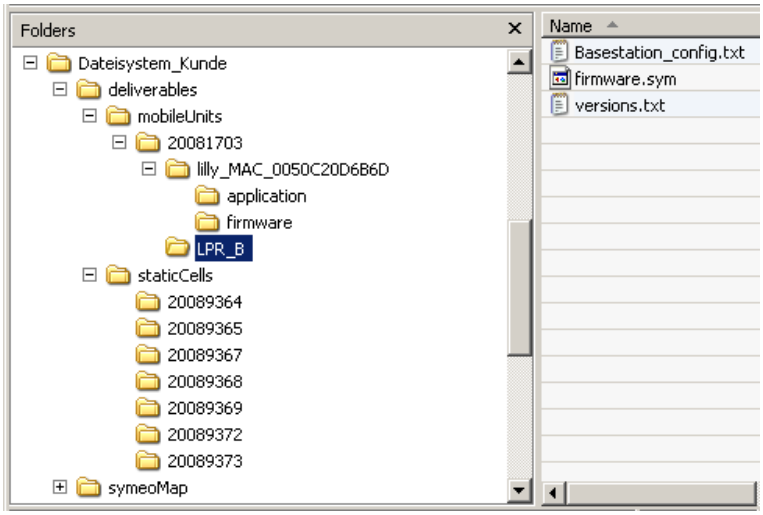
If it is later necessary to replace a LPR unit (e.g. due to a defect) you can find easily the necessary configuration files for the appropriate station.



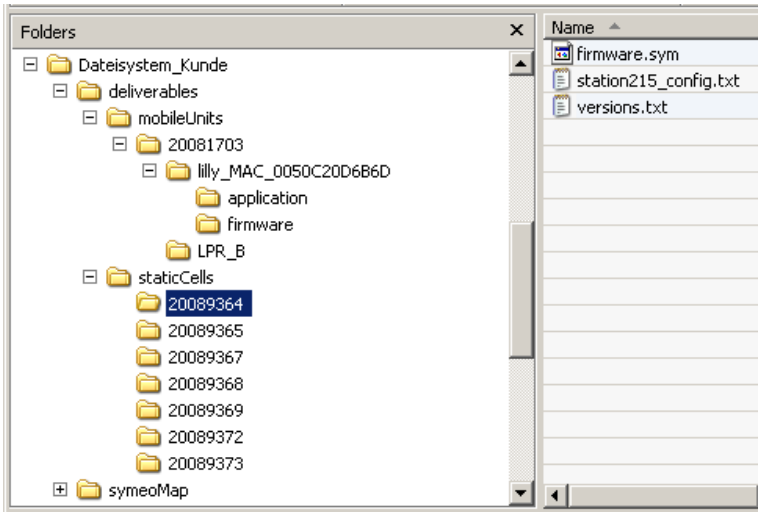
Folder for the files of the FusionEngine



Folder for the files of the firmware for the mobile unit



Folder for the configuration files of the DSP for the mobile unit



Folder for the configuration files of the DSP for the transponder unit

2.3 Project Planning

The planning from identifying the position for the transponders to the commissioning with Symeo MAP is separate into intermediate steps. In the following all possible steps are listed with refer to the relevant chapter in this document.

ToDo		Description	Responsible	Relevant chapter
1	Definition of measurement area/cell	Analyzing of layout, pictures, definition of mounting positions	Customer provides information to Symeo	---
2	Definition of local coordinate system, point of origin	Local Coordinates available? Coordinates of light towers available?	Customer	---
3	Definition of operating mode	3 operating modes are available. Operating mode depends on the number of vehicles and the number of cells	Symeo	Chapter 3.2
4	Definition of vehicle model	HoverTrack-model or VehicleTrack-model	Symeo	Chapter 3.3
5	Definition of antenna positions and position of mobile unit on the vehicle for mounting	Defining mounting position of 1, 2, 3 or 4 antennas on the vehicle	Customer/ Symeo	Chapter 5.3
6	Definition of the height of the antenna above ground level	The height of the top of the antennas above ground has to be calculated to set the appropriate height for the mounting of the transponders, height of transponders ideally 0.5meters over antennas level, up to 2.5meters is possible	Customer	Chapter 6.3
7	Definition of protocol for interface	Structure of the protocol can be configured.	Customer/ Symeo (if information is provided)	Chapter 0
8	Mounting of the LPR-2DB Integral Station on the LTs	Mounting of the LPR-2DB Integral Station (labeled XX0, XX1, XX2, XX3, XX4, XX5 and Master XXM) according to the files Visio-LPR_CellPlanning.pdf and	Customer	Chapter 5.2

		CellPlanning.xlsx		
9	Mounting of the antennas	Mounting on defined positions on vehicle with installation brackets	Customer	Chapter 5.3
10	Mounting of the mobile station on the vehicle	Mounting of the mobile station, connection to the 1, 2, 3 or 4 antennas, power 10-36VDC and TCP/IP	Customer	Chapter 5.1
11	Surveying of LPR-2DB Integral Station	Surveying of the mounted LPR-2DB Integral Stations needs to be done to local coordinates with best possible accuracy (+- 2cm)	Customer	Chapter 6.1
12	Surveying of vehicle	Surveying of the antenna positions on to the vehicle. Depending on the steering of the vehicle (front and/or back) the definition of point of origin on vehicle has to be set. Offset from point of origin to container center has to be determined.	Customer	Chapter 6.2/ chapter 6.3
13	Implementation of Surveying coordinates in configuration files	The surveying coordinates have to be provided in a data format provided from Symeo. Transponder coordinates have to be implemented into configuration files for the master transponder or the mobile unit. Vehicle coordinates have to be implemented into the configuration files of the mobile station on the vehicle.	Customer	Chapter 6.1.4 and 6.3.1 Chapter 7.2.2 or 7.4.2
14	Upload of configuration files	Configuration files to be uploaded to the Master-Transponder (operating mode 2b and 3b) or mobile unit (operating mode 1, 2a, 2b) and mobile station on vehicle	Customer/ Symeo	Chapter 7.3
15	Modifying of ini-files for software FusionEngine	Modification of ini-files	Customer	Chapter 7.4
16	Upload of files for software fusion engine	Upload of ini-files via WinSCP	Customer	Chapter 7.5

17	Testing of correct positions	Testing cell with analyzing Software Symeo MAP	Customer/ Symeo	Chapter 0

3 System Description

SYMEO Industrial Local Positioning Radar (LPR) is a system for contactless, real-time determination of distances and positions.

LPR B 2D is a distance measurement system which is particularly well suited for use in very harsh, industrial environments, in which other systems such as mechanical rotary encoders or lasers cannot function for long periods.

The system composes of mobile units and fixed, wall-mounted units at known positions. The mobile units compute its position using the delay time of the radio-signals between wall mounted units and the mobile unit.

LPR-2DB has an in-build communication channel to handle all background communication necessary for operation of the positioning system. LPR-2DB units use the same frequency band and the same hardware for communicating as for measuring distance. This means that no external WLAN or cable networks are needed for transmitting measurement values and other reference data.

The system is organized in a cellular fashion. 4 to 6 wall-mounted units are arranged to form a group with a unique group-ID and an individual measurement ID ranging from 0-5 for each wall-mounted unit. For the communication between the mobile unit and the 6 transponders 6 different measurement channels separated in frequency (FDMA) are used, allowing instant position computation.

For arrangements with more than 6 transponders neighboring cells with different group IDs can be set up. To separate the communication of neighboring cells different communication frequency channels can be assigned for different cells. For some system topologies an additional cell-master is required to handle measurement timing and communication.

3.1 Technical Data

Frequency range 5.725-5.875 GHz	5.725-5.875 GHz
Transmitting power*[1]	Max. 0.010 W / 10 dBm output on the antenna port Output power is adjustable For overall output power antenna gain and cable attenuation must be added
Range*[2]	Max. 300 m
Measurement accuracy*[2]	up to ± 10 cm
Measurement frequency	Max. 20 Hz
Power supply	10-36 V DC
Ambient temperature *[2]	-40°C bis +70°C

*[1] Transmitting power can be adjusted to assure that emission limits at the antenna are within legal limits, e.g. 25 mW EIRP in the EU and 10 mW EIRP in the US

*[2] Depending on the antenna type, mounting position and environment

*3 Temperature inside the housing can range from -40°C to 85°C.

3.2 Operating Mode

There are different system topologies to determine a 2D position with a Symeo LPR® system. Which operating is best suited depends on the application and the environment. It depends on the number of mobile units you want to track and on the number of cells which are necessary to cover the environment.

Operating Mode	Properties
Mode 1: Basic Cell	6 fixed wall-mounted units [LPR-2DB Integral Station], 1 mobile unit [LPR-2DB Station]; measurement principle: RTOF (round trip of flight)
Mode 2a: Managed Cell	6 fixed wall-mounted units [LPR-2DB Integral Station], 1Master, up to 5 mobile units [LPR-2DB Station] ; measurement principle: RTOF (round trip of flight); cell coordinates are stored on the mobile unit(s)
Mode 2b: Managed Cell	6 fixed wall-mounted units [LPR-2DB Integral Station], 1 Master, up to 10 mobile units [LPR-2DB Station] ; measurement principle: RTOF (round trip of flight); cell coordinates are stored at the master
Mode 3a: TDOA	6 fixed wall mounted units [LPR-2DB Integral Station], 1 Master, no limitation of mobile units [LPR-2DB Station] ; measurement principle: TDOA (time difference of arrival); cell coordinates are stored on the mobile unit(s)
Mode 3b. TDOA	6 fixed wall mounted units [LPR-2DB Integral Station], 1 Master, no limitation of mobile units [LPR-2DB Station] ; measurement principle: TDOA (time difference of arrival); cell coordinates are stored at the master

i Note

The operating mode is normally set by Symeo after consulting the customer.

3.2.1 Operation Mode 1: Basic Cell

4-6 fixed mounted units (i.e. at a wall or on light poles) at known positions as basic cell and one single mobile unit form the setup for mode 1. The fixed mounted units are configured as reply units or “slave transponders”. Each fixed mounted unit has the same group ID and a different measurement ID ranging from 0...5. Additionally, the units within the same group must be set to the same communication channel. The positions of the fixed mounted units are known to the mobile unit. The measurement of mode 1 is based on the measurement principle RTOF (Round Trip Of Flight). It is organized as follows:

The mobile unit acts as “master base-station” and sends a measurement command to the fixed mounted units. The fixed mounted units synchronize to this signal and transmit a return

signal with precisely known delay and an individual frequency offset corresponding to the fixed mounted unit measurement ID. The mobile unit computes the round-trip time-of-flight and therefore the 1D distance to each transponder. Finally, the mobile unit calculates of all single 1D distances a 2D position.

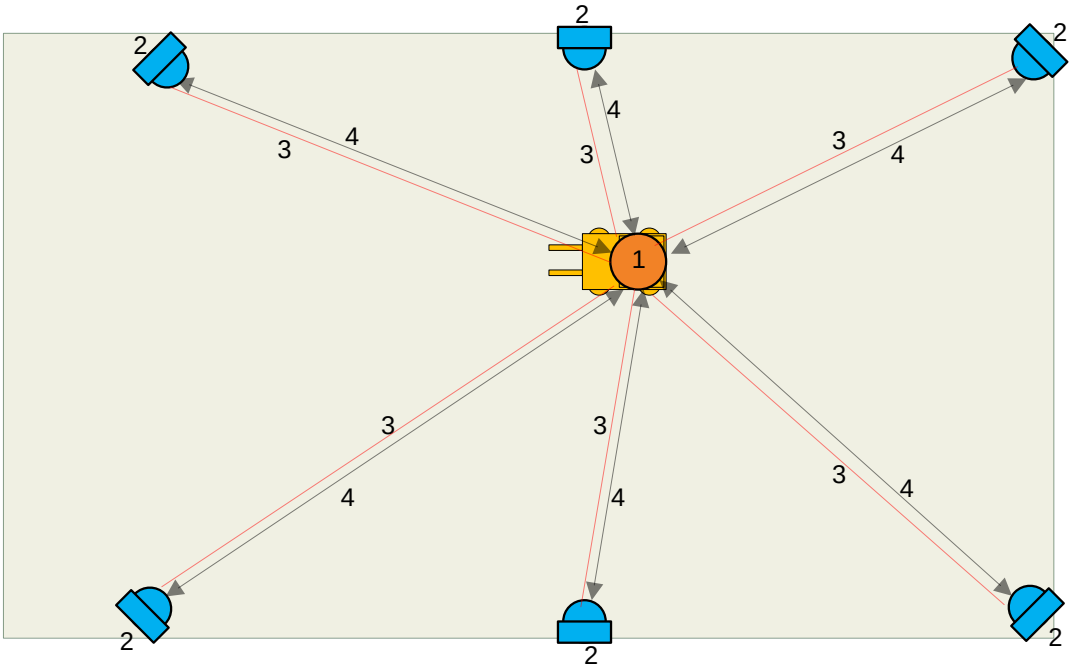


Figure 2 - System setup for mode 1
1: Mobile unit
2: Wall-mounted unit
3: Communication channel (commands)
4: Broadband measurement signals

3.2.2 Operation Mode 2: Managed Cell

Mode 2 is used when several mobile units are present at the same time within the cell. In this case the measurement intervals between the mobile units are synchronized. This is done by using the setup of mode 1 and an additional master transponder for coordination. The master transponder assigns the measurement slots for different mobile units. The mobile unit no longer initializes the measurement and simply acts as base-station. The measurement of mode 2 is based on the measurement principle RTOF (Round Trip Of Flight). The detailed measurement procedure is as follows:

The master transponder repeatedly broadcasts his group-ID. Base-stations in range reply to this broadcast with their ID. The master transponder keeps a list of active base-stations in range, assigns measurement slots to the stations and broadcasts them to the individual stations in range. The base-station then transmits the broadband measurement signal and computes its position as described in mode 1.

Measurement rate for the stations present can be set to equal distribution for all mobile units or to a preferred channel with maximum measurement rate for one base-station and slower measurement rate for the remaining stations.

If desired the master transponder can store the coordinates of the cell (**mode 2b**). The master transponder then repeatedly broadcasts his coordinates and all base-stations in range receive the data. Alternatively the coordinates can be kept on the mobile unit permanently as in mode 1 (**mode 2a**).

Finally, depending on the master-transponder type, the position data of the mobile units can also be transmitted to the master transponder and can be retrieved by the user.

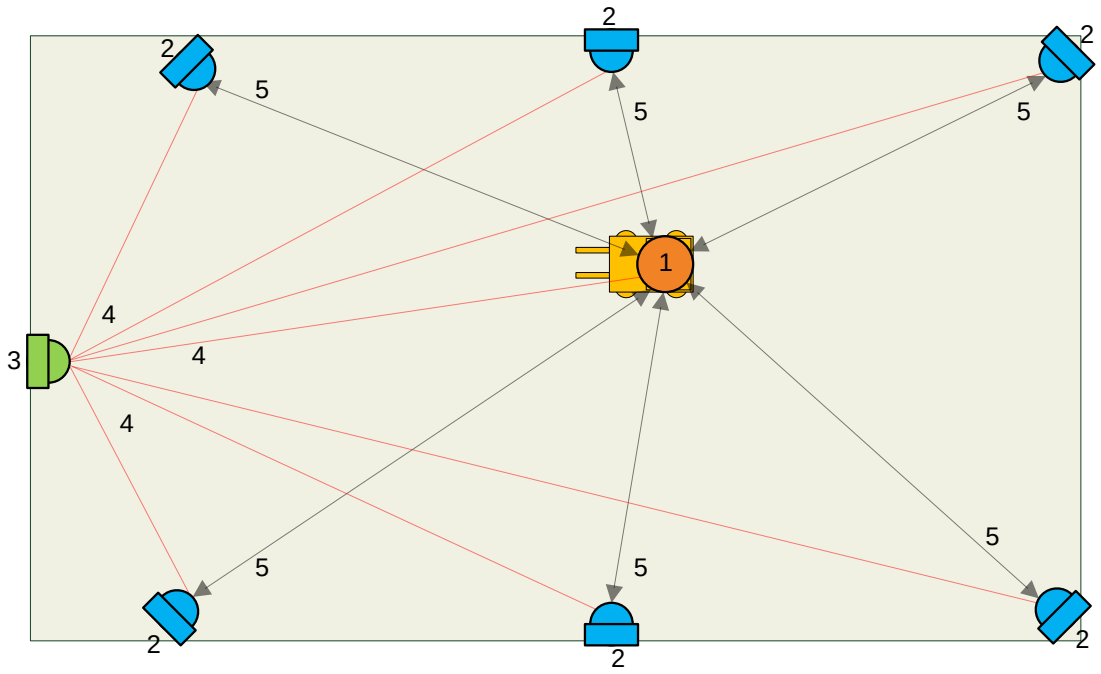


Figure 3 - System setup for mode 2
1: Mobile unit
2: fixed mounted units
3: Master unit
4: Communication channel (commands)
5: Broadband measurement signals

3.2.3 Operation Mode 3: TDOA

Sometimes many mobile units are present in a cell, or measurement of the position of mobile units at exactly the same time is desired. Using mode 3, only the fixed mounted units transmit broadband measurement signals. The mobile unit receives these signals and computes its position from the time-differences of the signals.

Mode 3 has the same basic hardware as mode 2, but the organization of the measurement is completely different:

The master transponder sends a broadband synchronization signal preceded by the group ID of the cell. The slave transponders precisely synchronize to this signal and in turn each transponder transmits the broadband measurement signal. All base-stations within the cell receive the signal and compute the time-difference between the received signals. The time-difference is used to obtain the position.

If desired the master transponder can store the coordinates of the cell (**mode 3b**). The master transponder then repeatedly broadcasts his coordinates and all base-stations in range receive the data. Alternatively the coordinates can be kept on the mobile unit permanently as in mode 1 (**mode 3a**).

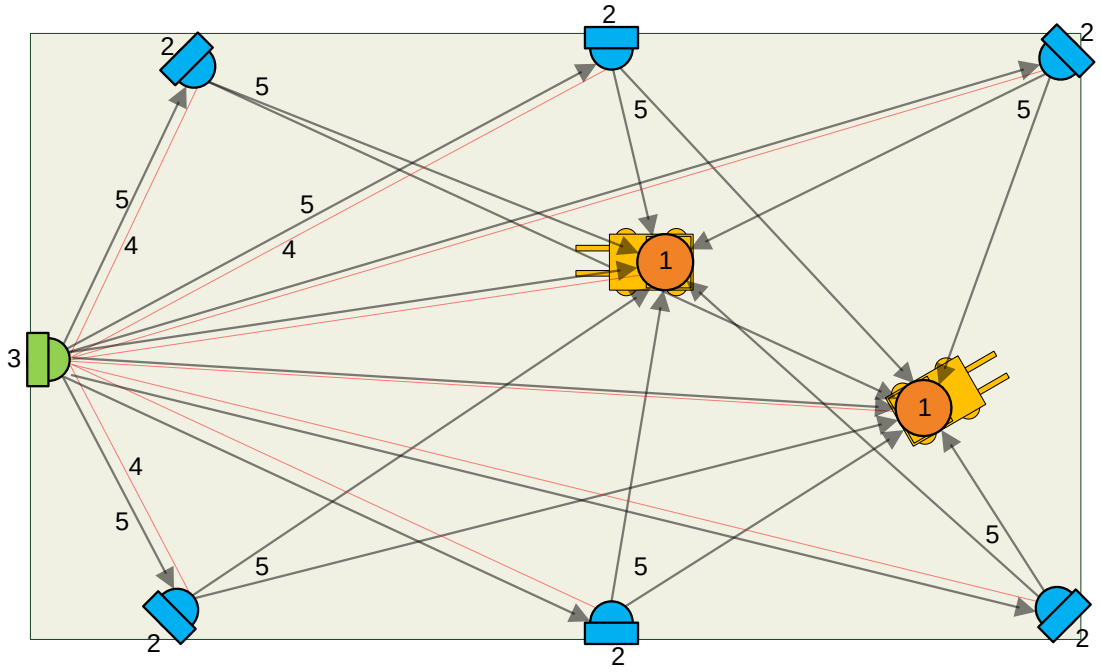


Figure 4 - System setup for mode 3
1: Mobile units
2: fixed mounted units
3: Master unit
4: Communication channel (commands)
5: Broadband measurement signals

Note	Additionally to the described solution of a fixed master, there is the possibility to use a moving master. In this case each fixed mounted unit can be the master. The sequence is set by the user.

3.3 Vehicle Model

To determine a 2D-position with an LPR-2DB system a Kalmar filter is used. Therefore a system model is necessary which represents the system. Depending on the vehicle type in your application different models can be used:

- Hover-Track-Model
- Vehicle-Track-Model

Depending on the chosen model for the Kalman filter different numbers of states are estimated (position, velocity, acceleration, angle, etc).

Hinweis	The model is set by Symeo by delivery.

3.3.1 Hover-Track

The HoverTrack model is used for vehicles that can move in x- and y-direction but cannot turn over its center. A typical example is the trolley of a crane. The name based on a hovercraft which can move forward and backward as well as sideward.

To make a 2D-positioning the mobile unit needs at least one antenna. The usage of a second, third or fourth antenna results in more robust and more reliable position.

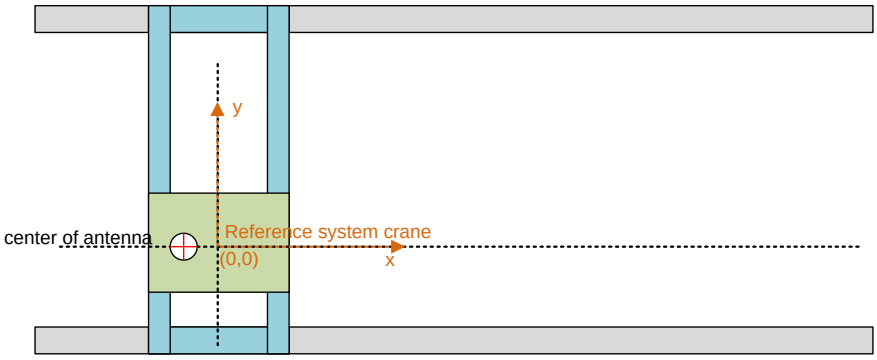


Figure 5 – HoverCraft model for a trolley

3.3.2 Vehicle-Track

If the object can also turn around its center the vehicle-track model is used. Examples for the vehicle model are each kind of steerable vehicles (fork lift, van carrier, automobile, etc.). It is possible to determine besides the 2D position also the orientation of the vehicle. For this it is at least a second antenna necessary.

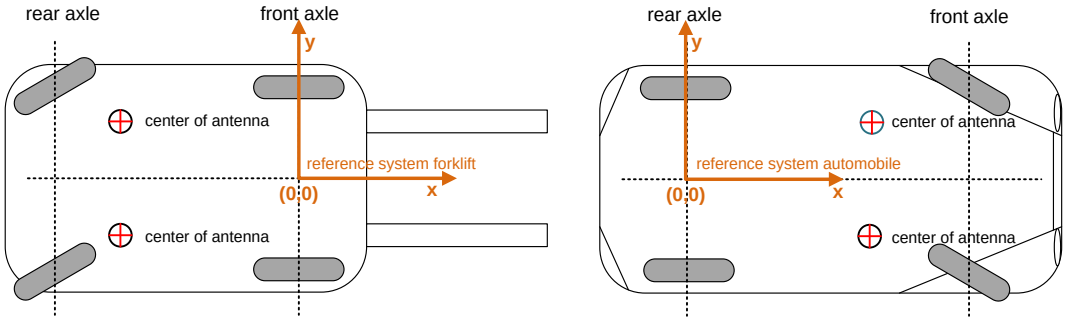


Figure 6 – Vehicle Model for a forklift and a trolley

3.4 System Design

Each LPR unit (base station, integral station) contains a DSP. For each LPR unit a configuration file is provided by SYMEO.

The configuration files are:

LPR-2DB Station (Mobile unit):	basestation_config.txt	
LPR-2DB Integral Station (Fixed-mounted unit / transponder):	stationXX0_config.txt stationXX1_config.txt stationXX2_config.txt stationXX3_config.txt stationXX4_config.txt stationXX5_config.txt	(XX: Cell-ID)
Master LPR-2DB Integral Station (Fixed-mounted master unit /master transponder):	stationxxM_config.txt	(XX: Cell-ID)

The settings for the files are described in chapter 7.2.

The access to the LPR-2DB Station can either be done via TCP/IP or via RS232 interface. The LPR-2DB Integral Station and the master LPR-2DB Integral Station can only be accessed via the frequency channel of the mobile station.

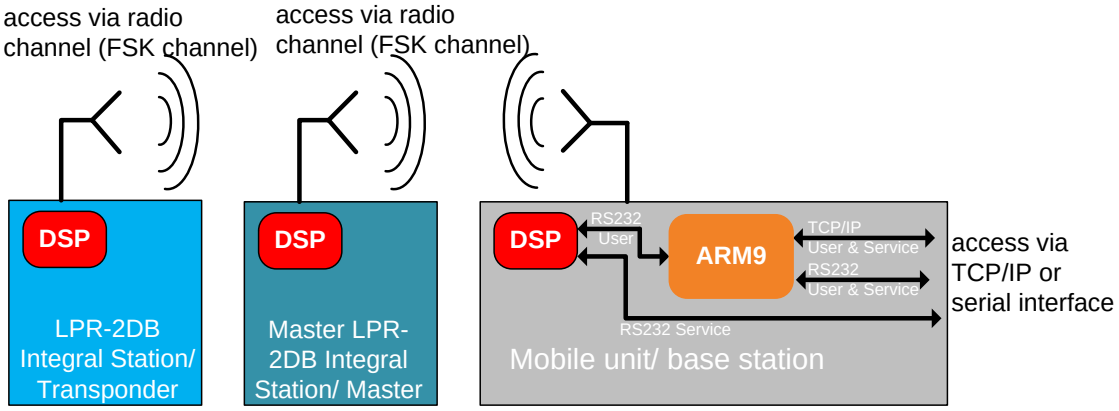


Figure 7 – LPR units including DSP: Access to the DSP via TCP/IP, RS232 or frequency channel

In chapter 7.3 all different connections to the LPR stations are described. To configure the connection via TCP/IP web interface exists (chapter 0).

3.4.1 2D Positioning

Each mobile unit calculates the distance of its antennas to each LPR-2DB Integral Station/ transponder. A positioning does not happen in this moment, only the calculation of 6 single 1D distance measurements.

These 1D distances are forwarded to the software FusionEngine. The FusionEngine can either be on the ARM9 board of the mobile unit or on a separate PC of the customer. In the software FusionEngine all 1D distance measurement are merged to a 2D positioning.

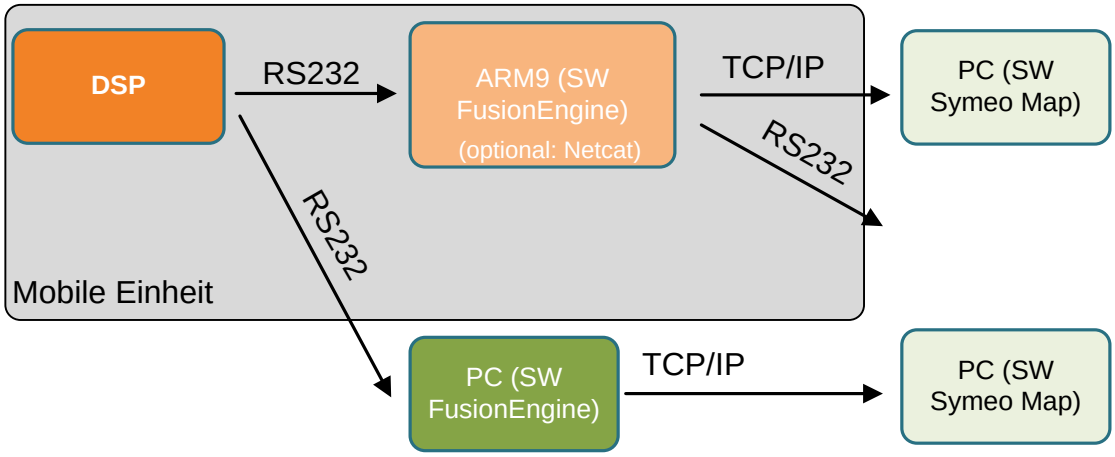


Figure 8 – cycle of a 2D positioning measurement and possible interfaces

Mode: Basic Cell/ Managed Cell/ TDOA

In mode 1 (Basic Cell) and in mode 2a (Managed Cell) the cell coordinates of the transponders are stored in the Fusion Engine. In mode 2b (Managed Cell) and mode 3 (TDOA) the coordinates of the transponders are stored in the cell master.

Furthermore in the files for the FusionEngine are set the parameters of the model (see chapter 3.3) as well as the settings for the antennas (coordinates, calibration).

The position calculated in the FusionEngine can be graphical shown with the software Symeo MAP (see chapter 0).

4 Hardware

Warning All corresponding installation, repair and servicing work must be carried out by qualified and trained technicians.

4.1 System components – Overview

The system can exist of multiple cells and mobile units for the vehicles. Each cell exists of 4 to 6 LPR transponder stations (type integral). Depending on the chosen operating mode a master is added to each cell. The 4 to 6 LPR-2DB Integral Stations/ Transponders as well as the master LPR-2DB Integral Station/ maser transponder is mounted at a fixed place, e.g. a wall or light poles. On the mobile units LPR stations (type: compact, BSB000313, BSB000319, BSB000603, BSB000604, BSB000605, BSB000606) are installed.

Additional hardware for the mobile units are connector boxes, connector cables and antennas.

For the determination of the position of the LPR-2DB Integral Station at the light poles or at the wall the system range of max. 300 meters and the position of the antennas on the vehicles are important.

4.2 LPR-2DB Station (mobile station)

4.2.1 Overview compact station

Following hardware exists for an LPR station on the mobile unit:

- BSB000313 (single receiver, TCP/IP interface, 2 antenna ports)
- BSB000319 (single receiver, RS232 interface, 2 antenna ports)
- BSB000603 (double receiver, TCP/IP interface, 4 antenna ports)
- BSB000604 (double receiver, RS232 interface, 4 antenna ports)
- BSB000605 (double receiver, TCP/IP interface, 2 antenna ports)
- BSB000606 (double receiver, RS232 interface, 2 antenna ports)

4.2.2 Technical data compact station

Technical Data	
Power draw	RS232 port, 4 W TCP/IP port, 6 W
Voltage range	10-36VDC
Dimensions (LxWxH)	260 x 160 x 91 mm
Type of protection	IP 65 with appropriate cable connectors
Connections	Power-Supply and Communication: Plugged connection Antenna: Screwed cable gland

	Ethernet: Plugged connection
Antennas	Connection of up to 4 independent antennas
Compliance	CE mark

4.2.3 Station BSB000313, BSB000319

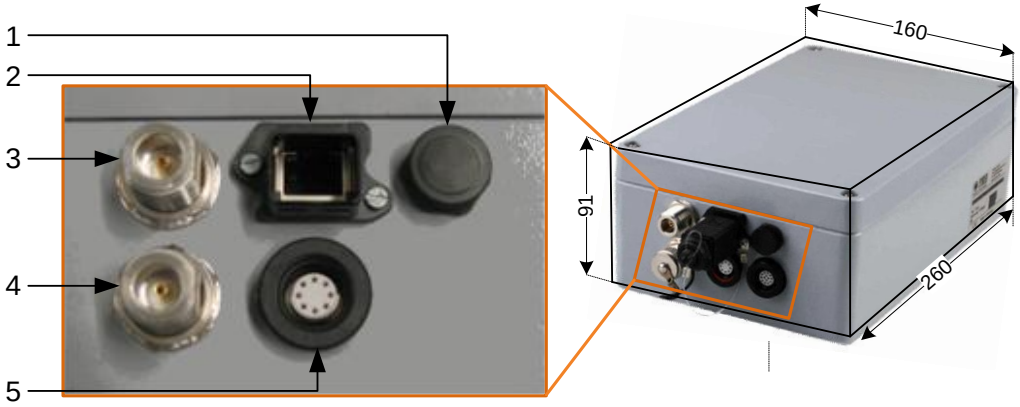


Figure 9- interfaces of LPR station on vehicle as a single receiver

Description of Interfaces	
1	Pressure equalization membrane. The membrane prevents forming of condensation water inside the Compact Station. The pressure equalization membrane must not be changed or covered!
2	Network (optional). The standard industrial Ethernet port of the station is designed as a Harting type push pull connector.
3, 4	Antenna connections. The antennas are connected to the Compact Station via a specially converted low-loss HF cable with N-plug. 3: Antenna port no. 1, 4: Antenna port no. 2.
5	Power supply with integrated communication ports. Power is supplied via a Lumberg Type 0233 08 push pull connector. There is no power switch because of the intended area of application. A 3 Ampere (slow blow) fuse is mounted inside the Compact Station.

4.2.4 Station BSB000603, BSB000604, BSB000605, BSB000606

Figure 10 - interfaces of LPR station on a vehicle as double receiver

Technical Data and Description of Interfaces	
1, 3, 5, 7	Antenna connections. The antennas are connected to the Compact Station via a specially converted low-loss HF cable with N-plug. 1: Antenna port no. 1, 3: Antenna port no. 2, 5: Antenna port no. 4, 7: Antenna port no. 3,
2	Network (optional). The standard industrial Ethernet port of the station is designed as a Harting type push pull connector.
4	Pressure equalization membrane. The membrane prevents forming of condensation water inside the Compact Station. The pressure equalization membrane must not be changed or covered!
6	Power supply with integrated communication ports. Power is supplied via a Lumberg Type 0233 08 push pull connector. There is no power switch because of the intended area of application. A 3 Ampere (slow blow) fuse is mounted inside the Compact Station.

4.2.5 Lumberg Connector Type 0233 08

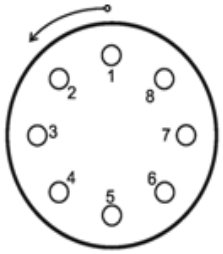


Figure 11 - Solder side view of the pin assignment of the Lumberg power connector plug (power supply with integrated service port)

Pin	Function
1	UBB (+)
2	UBB (-)
3	LPR data port RXD
4	LPR data port TXD
5	Network diagnostic port RXD
6	Network diagnostic port TXD
7	GND-RS232
8	GND RS232

Note

For configuration of the connector with cables, you have to identify the matching pin assignment on the solder side.

The connectors have an anti twist device.

Option 1: It is possible to order cables (length: 5 m) by Symeo with integrated Lumberg connector and cut cable head (see chapter 4.3).

Option 2: It is possible to order a connector box to wire all cables (see chapter 4.3.2).

Note

When plugging the push pull connectors into their sockets check that the plug doesn't slip out of the socket when pulling slightly at the cable.

4.3 Cables for Compact Station

4.3.1 Cable for Power Supply

Cables are delivered with a cable length of 5m and can be cut to the required length.

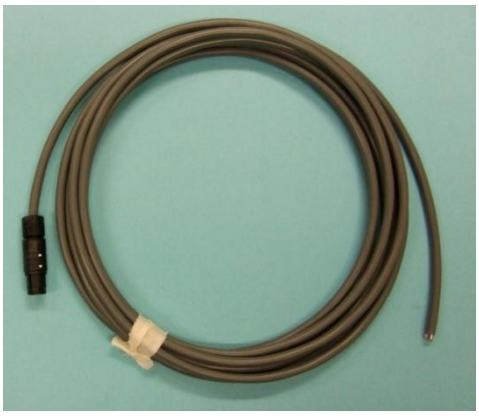


Figure 12 – Cable for power supply with integrated RS232 interface

PIN-Assignment of Cable Lumberg Connector 0223 08		
Plug	Lumberg 0223 08	
Cable	8-wire AWG24 UL/CSA; cladding diameter = 6.4mm	
Color according to DIN 47100)	Pin / color	Function
	1 – white	UBB (+)
	2 – brown	UBB (-)
	3 – green	LPR Dataport RXD
	4 – yellow	LPR Dataport TXD
	5 – grey	Network diagnostics port RXD
	6 – pink	Network diagnostics port TXD
	7 – blue	GND-RS232
	8 – red	GND-RS232 and shielding

Warning

Consider the dependency of the maximum baud rate according to the cable length:

15m: 19.200baud

5m: 57.600baud

<2m: 115.200baud

According to the cable length the baud rate at the stations has to be adjusted.

Warning

If this cable is only used for power supply, the TXD-wires of the cable must be terminated. Otherwise signals from other systems can disturb the system via the TXD-wire. Then measurements can fail. You have to

ground the TXD-wires (PIN 4 and PIN 6) with PIN 7 and 8.

4.3.2 Recommended Cable Types HARTING Push Pull Connector

If the station is delivered with a HARTING Push Pull connector following type of cable should be considered for assembling:

- HARTING RJ Industrial® Ethernet Shielded Twisted Pair Standard Cable, AWG 22 solid, according Category 5 cabling standard (ISO/IEC 11801:2002)
- HARTING RJ Industrial® Ethernet Shielded Twisted Pair Trailing Cable, AWG 22/7 stranded, according Category 5 cabling standard (ISO/IEC 11801:2002)

Transmission characteristics according Category 5 ISO/IEC 801:2002 and EN 50173-1:

Technical Data: HARTING Push Pull Connector	
Wire gauge data	AWG 22 – 24 stranded AWG 22 – 23 solid
Wire isolation	Max. 1.6 mm Ø
Cable diameter	6.5 mm – 7.2 mm

The assembly instruction of the HARTING Push Pull Connector is delivered with the product.

4.4 Connector box

The connection box is configured with 14 clamps. Therefore the connector box can be used either for power supply or for relays.

Figure 13 – Connector box

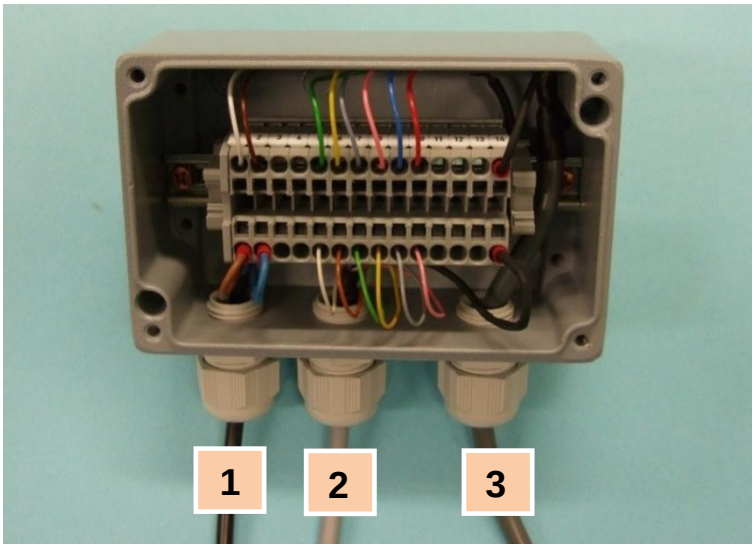
Connection Box	
Size (LxWxH)	125mm x 80mm x 57mm (without cable bushing)
Position mounting holes	4 x diameter 4.3mm; 52 x 113mm
Clamps	Wago 870-911 for cable diameter 0.08 till 2,5mm² (till 4mm² if flexible cables)

Cable bushing	3 x PG Connection for cladding diameter 5 – 10 mm 1 x sealing cap
Protection category	IP65 If usage of appropriate cables (diameter 5 till 8mm) and correct connection of cap and cable bushing is assured

i Note	If the cable bushing are not used the sealing cap (including the sealing ring) has to be mounted to keep the protection category IP65.

4.4.1 Example: Connector Box

Connection of an 8-pin cable



1: Power consumption (by customer)

2: Serial Interface (by customer)

3: From LPR

Figure 14

In this example the power supply is at pin1 and 2. The serial interface is at pin 5 to 10 and the shielding at pin 14.

i Note	The shielding has to be allocated.

For safety of clamping use appropriate wires end sleeves according to AWG24.

If this cable is only used for power supply, the TXD-wires of the cable must be terminated. Otherwise signals from other systems can disturb the system via the TXD-wire. Then measurements can fail. You have to ground the TXD-wires (PIN 4 and PIN 6) with PIN 7 and 8.

4.5 LPR-2DB Integral Station (fixed mounted unit)

Following hardware exists for an LPR-2DB Integral Station on the light poles:

- TPB000250 (LPR-2DB Integral)
- TPB000251 (LPR-2DB Integral)
- TPB000530 (LPR-2DB Integral, cell coordinator)

Warning

The electronics inside LPR-2DB Integral Station hood itself do not include any components that can be serviced by the user. They must not be detached from the hood because they contain parts that are electrically charged inside when connected to the LPR-2DB Integral Station base.

All corresponding installation, repair and servicing work must be carried out by qualified and trained technicians.

Caution

If the LPR-2DB Integral Station is installed on a pole, it must be secured to ensure that it does not slip.

If the direct current is incorrectly connected, the LPR-2DB Integral Station will be damaged and must be returned to the SYMEO service for further inspection.

Note

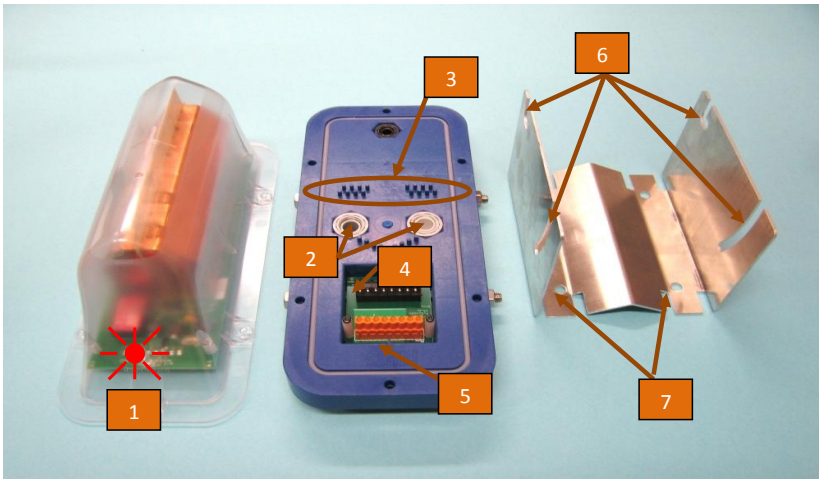
The plugged connection between the LPR-2DB Integral Station hood and base provides protection against direct contact, i.e. it can be connected and disconnected while it is under load.

Refer to the general design notes regarding your LPR system.

4.5.1 Technical Data: LPR-2DB Integral Station

Technical Data	
Power draw	4W, 10-36VDC
Dimensions (LxWxH)	212 (incl. mounting bracket) x 126 x 281 mm
Type of protection	IP 65 with feasible cables according to the cable gland
Antenna	Integrated inside the housing
Compliance	CE mark

4.5.2 Components of LPR-2DB Integral Station



1	LED
2	Cable feedthrough
3	Terminal pin
4	Terminal block
5	Plug
6	Transponder locating slot
7	Installation points

Figure 15 – Hood, Base and Bracket (from left to right)

The base is where the terminal block for the electrical connection and the plug for connecting the hood is located.

Strain relief clamps are applied to the base to avoid mechanical stress on the power supply cables.

The LPR-2DB Integral Station can be fixed onto the mounting bracket with the two screws provided with the base.

Depending on the requirements and application, the LPR-2DB Integral Station can be adjusted vertical with an angle from 0° to 25°.

4.6 LPR Antennas

There are different antennas that can be installed depending on the required directional characteristic.

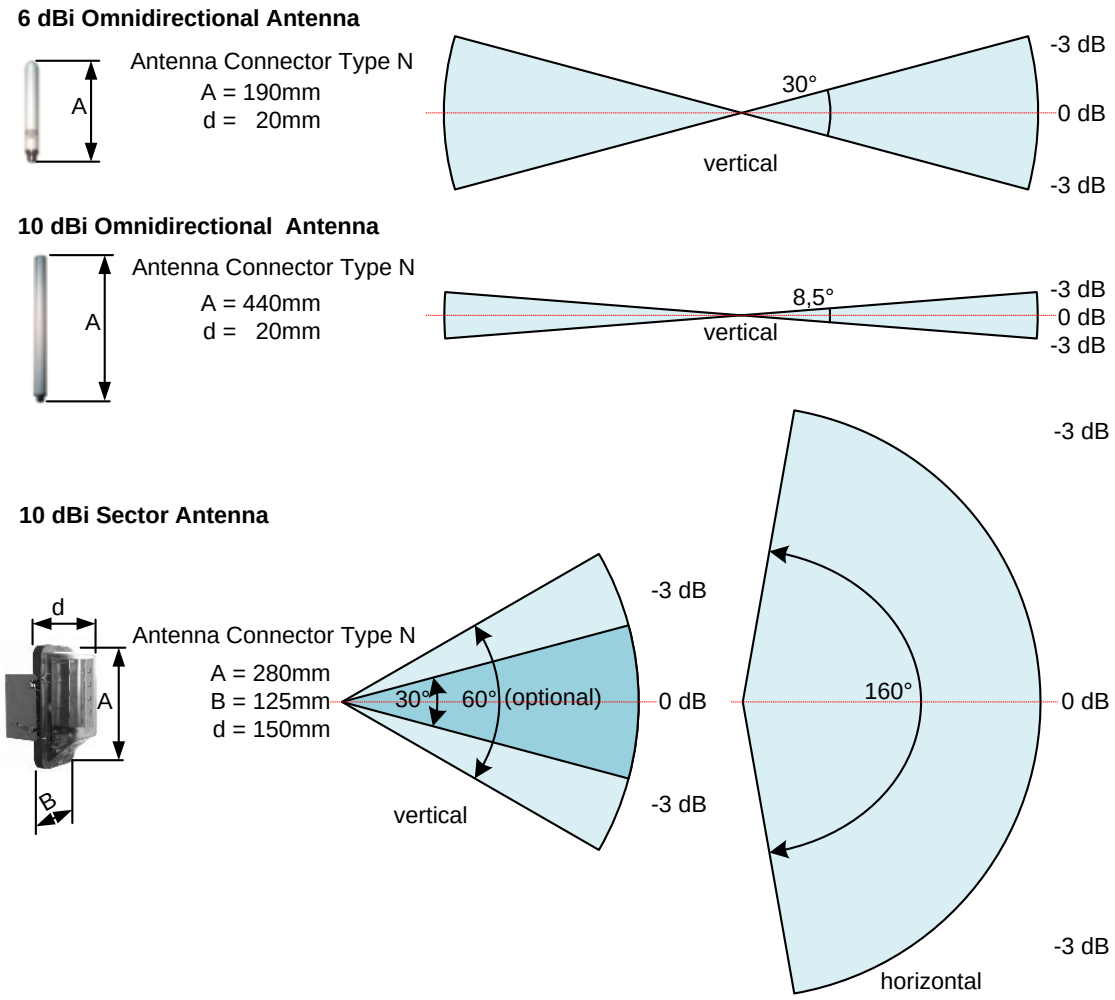


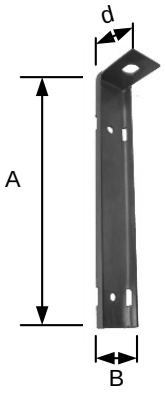
Figure 16- Typical LPR antennas for 2D applications

Note	The LPR-2DB integral station contains an integrated 10 dBi antenna.

4.6.1 Mounting devices of LPR Antennas

Depending on the required antenna, different adapters are available

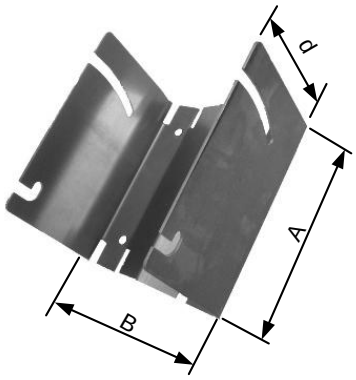
6 dBi and 10 dBi Omnidirectional Antenna



applicable for wall and pole mounting

A = 228mm
B = 38mm
d = 50mm

10 dBi Sector Antenna



applicable for wall and pole mounting

A = 150mm
B = 128mm
d = 100mm

Figure 17 - Available Adapters for different Antenna Types

5 Installation

5.1 Installation of the LPR-2DB Station (mobile unit)

- BSB000313 (single receiver, TCP/IP interface, 2 antenna ports)
- BSB000319 (single receiver, RS232 interface, 2 antenna ports)
- BSB000603 (double receiver, TCP/IP interface, 4 antenna ports)
- BSB000604 (double receiver, RS232 interface, 4 antenna ports)
- BSB000605 (double receiver, TCP/IP interface, 2 antenna ports)
- BSB000606 (double receiver, RS232 interface, 2 antenna ports)

Caution

During Installation, the LPR-2DB Station has to be opened. Therefore it is important to avoid ingress of moisture, dust or any particles into the housing during the installation process. Make sure that there is enough room for the connectors, and particularly that the antenna cable is accessible; pay attention to the permitted bending radius (center of radius to cable core) for standard cables of 10,5cm (for multiple bending under mechanical load) and 4cm (unloaded and static bending).

The LPR-2DB Station should preferably be installed so that the connecting sockets point downwards. In this way, the connections are protected from rain and dust.

Note

To install the LPR-2DB Station, you require 4 round head M6 x 30 screws (at least).

⇨ Check the position of the station on the device on which the LPR-2DB Station is to be installed (e.g. a crane bridge). Bear in mind the installation instructions listed above.

⇨ Drill holes in the device on which the LPR-2DB Station/ Rubber pads are to be installed. Drill-hole distances: 11 cm wide, 24 cm high.

⇨ Rubber pads are provided by Symeo (see Figure 18). The rubber pads reduce vibration to the LPR station. Place 4 rubber pad into the drill holes ad fasten the screws.

⇨ Open the LPR-2DB Station: With a Phillips screwdriver (Size 0), loosen the top four screws of the LPR-2DB Station lid.

⇨ Screw the LPR-2DB Station tightly to the device. The installation holes of the rubber pads are provided for this purpose. Check that the station is mounted securely.

⇨ Close the station: Place the cover of the LPR-2DB Station on top and fasten the cover with the four screws. Make sure that the cover is securely attached to the housing.

Figure 18 – Rubber pad for Compact station

5.2 Installation of the LPR-2DB Integral Station

- TPB000250 (LPR-2DB Integral)
- TPB000251 (LPR-2DB Integral)
- TPB000530 (LPR-2DB Integral, cell coordinator)

Warning All installation, repair and servicing work must be carried out by qualified and trained electrical technicians!

5.2.1 Electrical Interface

The bases can be connected via the terminal block.

Warning Polarity reversal or incorrect connection will damage the Integral Station. If this happens, the LPR-2DB Integral Station must be returned to the SYMEO service for inspection.

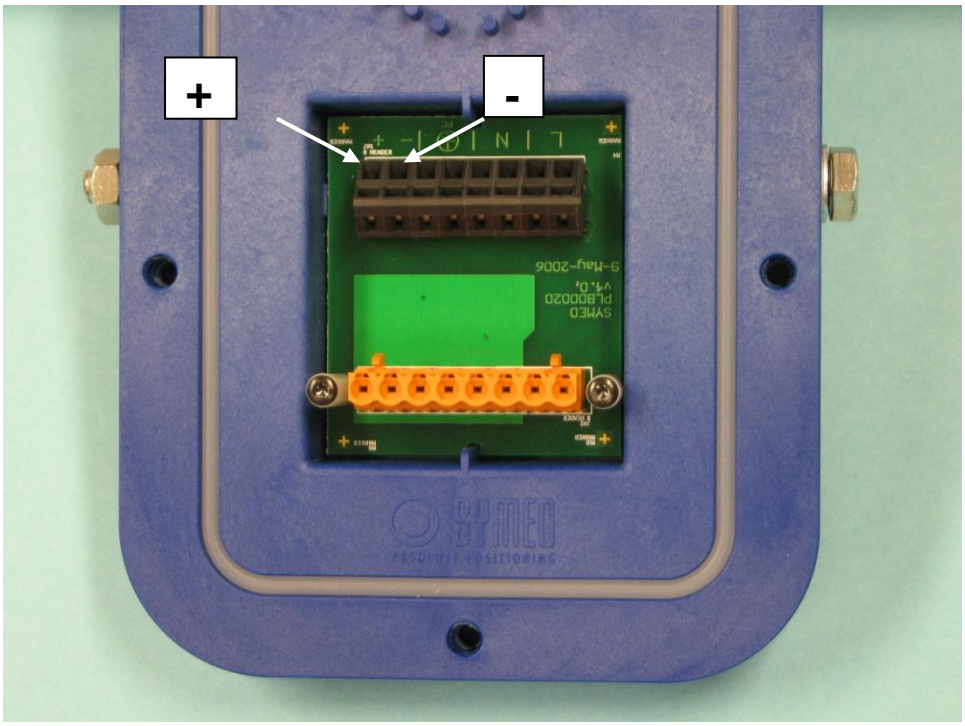


Figure 19 – Connecting the power supply

5.2.2 Installation

The LPR-2DB Integral Stations are supplied already preassembled (hood + base) and with the bracket separate. Figure 20 shows various views of the assembled LPR-2DB Integral Station including the mounting bracket.

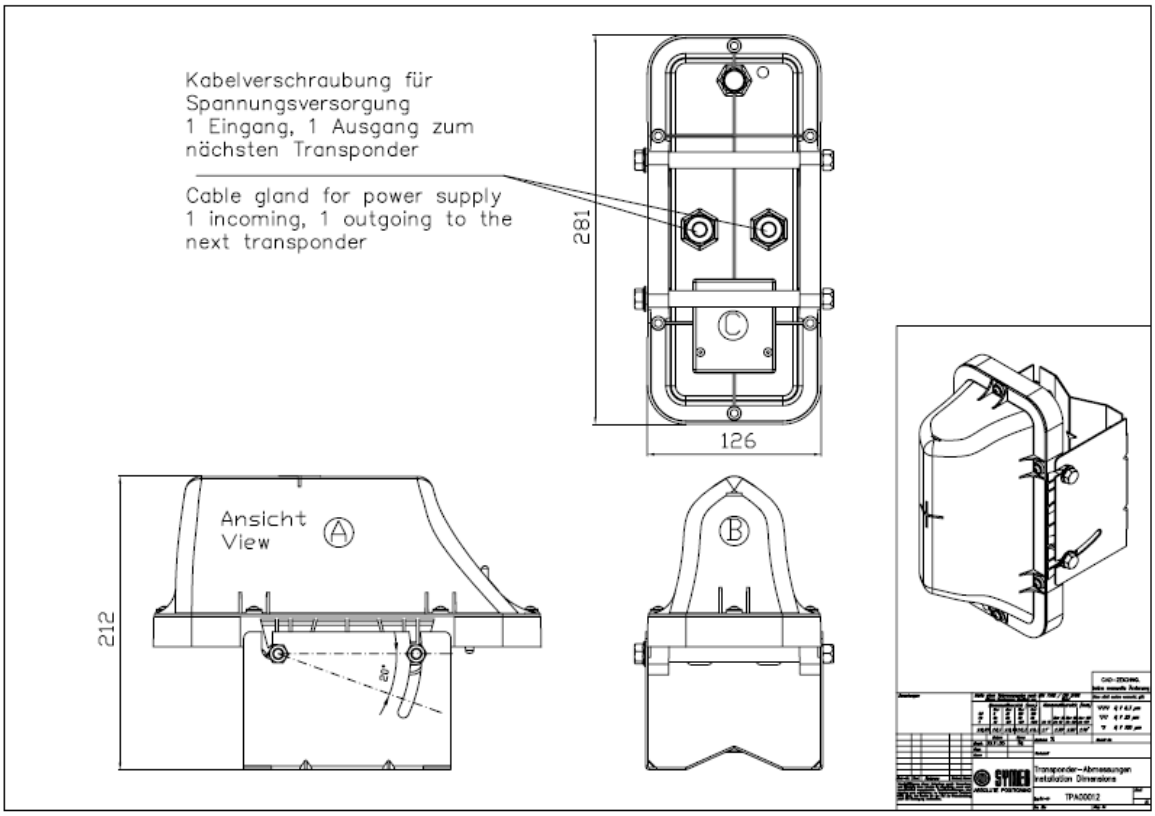


Figure 20 – Complete LPR-2DB Integral Station including mounting bracket

The bracket can be bolted directly to the wall. The LPR-2DB Integral Station can also be secured to posts/poles with two pipe clips (not included).

⇨ Mount the bracket on the wall or a pole.

⇨ Detach the hood from the base with the Torx-head screwdriver T25.

⇨ Insert the cable through the feedthrough.

⇨ Fit the LPR-2DB Integral Station base onto the bracket and tighten it with an SW13 fork wrench.

⇨ Pass the cable through the terminal pins to the terminal block and clamp it according to the instructions on the terminal block.

⇨ Tighten the screwed cable gland on the feedthroughs with an SW 19 fork wrench.

⇨ Fit the LPR-2DB Integral Station hood (note the assignment of 90°/160° in the installation plan).

⇨ Screw the LPR-2DB Integral Station hood tightly onto the base.

⇨ You can use the slots in the LPR-2DB Integral Station bracket to adjust the vertical orientation of the LPR-2DB Integral Station between 0° and 25° (mandatory if so indicated in the installation plan). Tilt the LPR-2DB Integral Station to the required angle ("View" on the antenna of the base station) and tighten the screws with an SW 13 fork wrench.

5.2.3 Allocation of LPR-2DB Integral Stations and Installation Points

If a cell plan and/or a light pole allocation table is drawn by Symeo or together with Symeo, the position and orientation of the LPR-2DB Integral Station must be installed referred to this master document. The cell plan contains the LPR-2DB Integral Stations with a definite identifier installed at the wall or on the light poles (compare chapter 7.1.1).

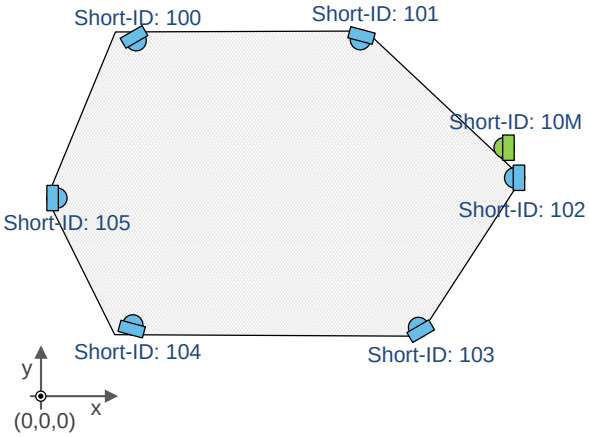


Figure 21 – Example Cell plan for one cell

LPR-2DB Integral Station Installation			
Cell	ID	Angle	Pole
10	0	-143	LT-11
10	1	-90	LT-08
10	2	-41	LT-05
10	3	0	LT-06
10	4	180	LT-09
10	5	-180	LT-12
10	M	-40	LT-05

Table 1 – Example of light pole allocation table

5.3 Installation of LPR antennas

5.3.1 Connection of antenna cables to the mobile units (LPR-2DB Station)

Caution

If several antennas are used, ensure that they are connected to the correct ports.

When installing the cable, ensure that electrostatic charging does not occur.

Make sure that the cable is not kinked or trapped during installation. The minimum bending radius must always be maintained. With the standard antenna cables delivered, the minimum bending radius (center of radius to cable core) for standard cables is 10,5cm (for multiple bending under mechanical load) and 4cm (unloaded and static bending). The cable must not be attached in a way that alters its cross-section. On demand, cables with different flexibility characteristics are available.

The antenna plug must not be removed (e.g. for installation purposes) or repaired because the specified electrical properties can only be achieved with mechanical installation assistance.

When installing the antenna cable, ensure that the screw connection is seated properly. The antenna cable plugs should be finger-tightened before tightening with an appropriate tool to no more than 1.3 Nm

tightening torque.

5.3.2 Mounting of LPR antennas

Note

The line of sight between the antennas on each unit must not be obstructed. Therefore, when installing the antenna fixture, ensure that no components are blocking the line of sight between the antennas. If necessary, contact the SYMEO technical department.

If you change the position of one antenna, this will affect the measurement data that is output.

⇨ Install the antenna fixture according to the accompanying operating instructions.

⇨ Secure the antenna in the fixture.

⇨ Connect the antenna to the antenna cable.

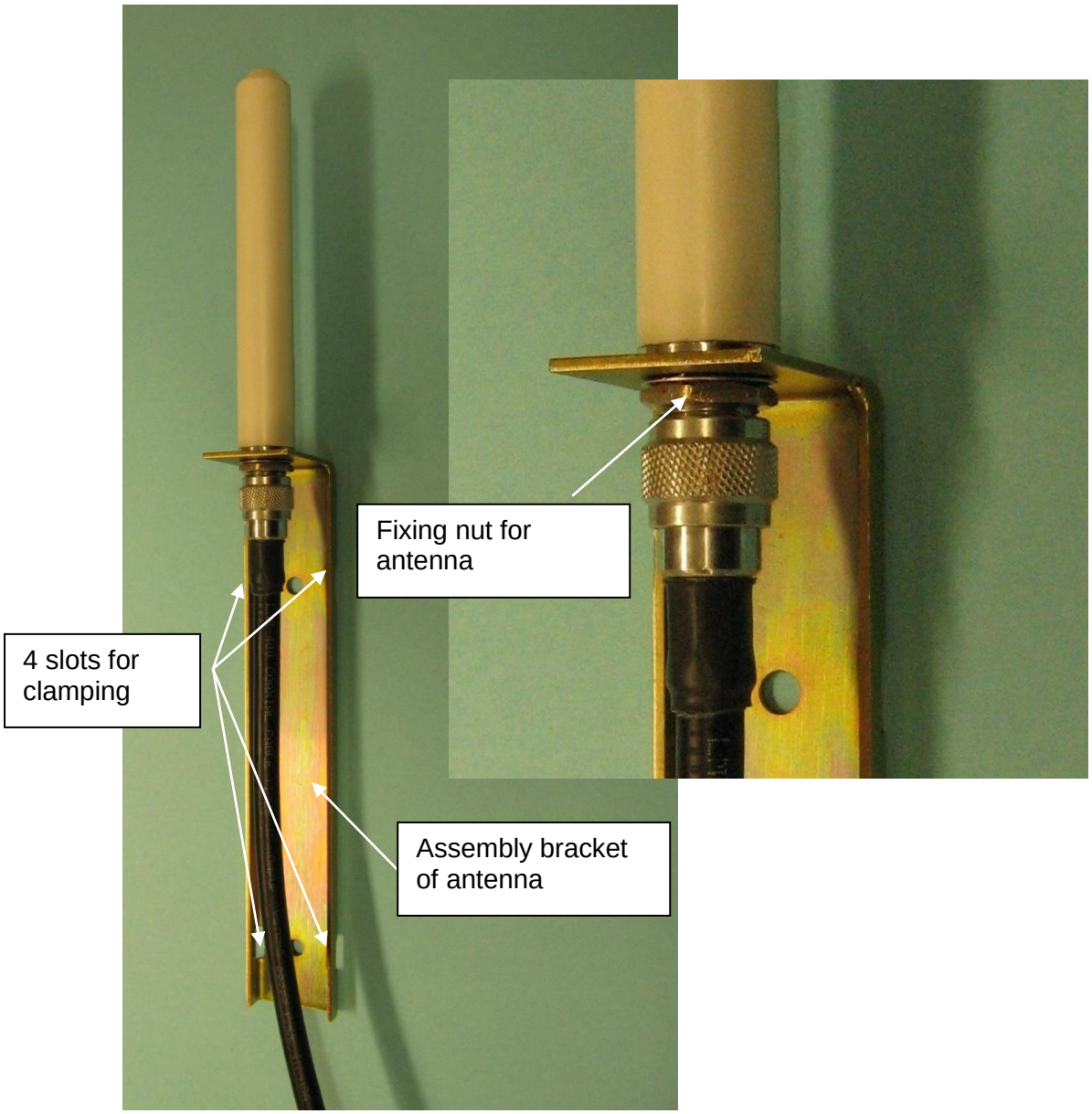


Figure 22 – Antenna with assembly bracket and antenna cable

5.3.3 Notes for mounting position of LPR antennas on the mobile unit

Considering the correct mounting position of the antennas you have to take care to guarantee a free line of sight between the antenna(s) on the vehicle and all LPR-2DB Integral Stations.

If construction on the vehicle partly interfere the free line of sight (e.g. driver cabin), the distance between the antennas and this construction barrier should be chosen big to make the “blind” sector small.

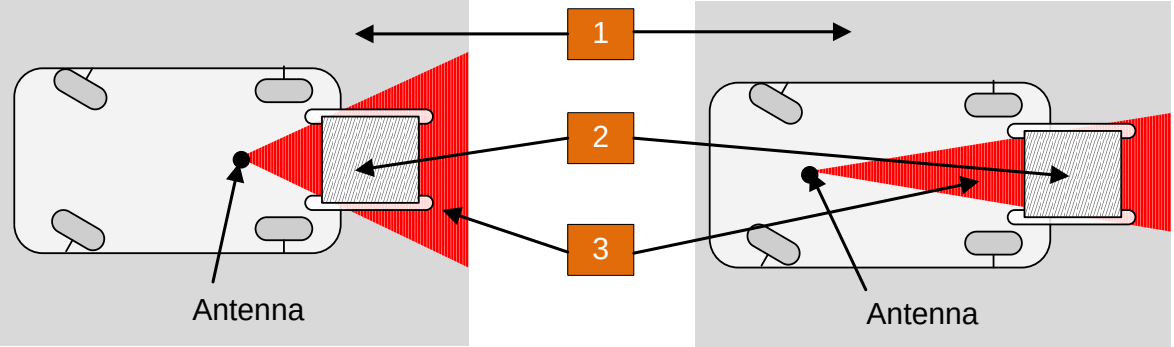


Figure 23– Mounting position of antenna

1	Free visual range of antennas
2	Construction (e.g. driver cabin)
3	„blind“ sector

On the other hand the antenna should be close to the center of rotation of the vehicle type to make the positioning error due to the rotation of the vehicle as small as possible (see Figure 24).

The position of the antenna(s) is in some cases a trade-off between minimizing the error due to construction barrier on the vehicle and the minimizing the rotation error. Contact Symeo if there are questions regarding the installation position of the antenna.

If a second antenna is used on the vehicle the distance to the first antenna should be at least 1 meter to calculate an orientation of the vehicle. The orientation is necessary to determine a load position if the antenna is not mounted above the load position.

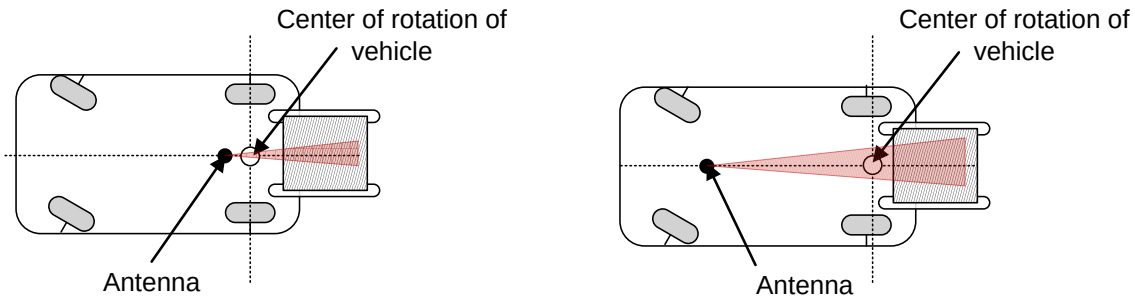


Figure 24 – Mounting position of antenna

Depending on the position of the LPR-2DB Integral Stations different minimum system ranges result. The system range depends on the selection of the antennas and the antenna cable length as well as of the antenna cable length. In general the antenna cable length on the vehicle should be as short as possible to minimize the signal loss in the cable.

6 Coordinate System

The LPR-2DB Integral Station and the antennas of the mobile stations must be surveyed.

6.1 Survey Instructions for the LPR-2DB Integral Station

The Integral Stations are supplied already preassembled (hood + base) and with the bracket separate. Figure 25 shows various views of the assembled LPR-2DB Integral Station including the mounting bracket

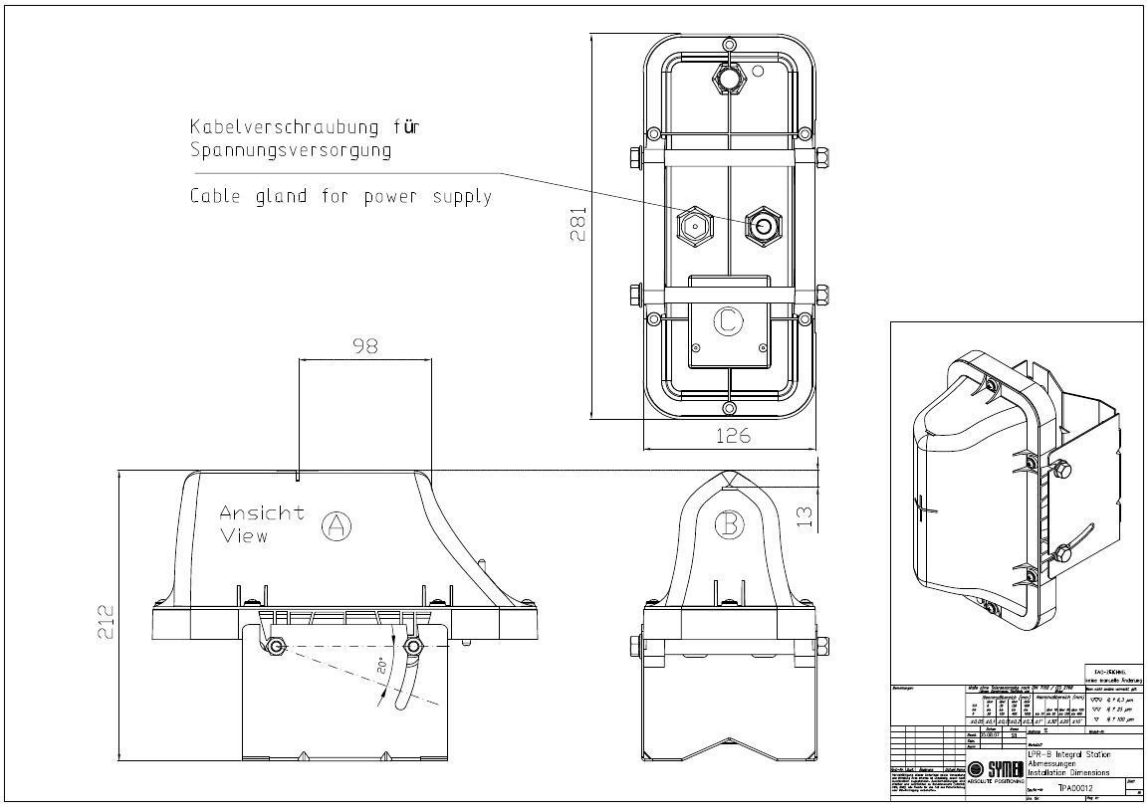


Figure 25 – Complete LPR-2DB Integral Station including mounting bracket

6.1.1 Coordinate system of LPR-2DB Integral Station

The accuracy of the position output depends in large part on the exact recording of the positions of the LPR-2DB Integral Station. Accordingly, the positions of the installed stations must be calibrated to a tolerance of +/- 2 cm (in each direction). At the same time, the orientation of each Integral Station in the x-y direction is also recorded. The inclination of the stations is not recorded.

LPR works with a Cartesian coordinate system, which is spanned by the x-y plane (see Figure 9). The positions of the Integral Stations are identified in this coordinate system. By default, the coordinate system has a positive effective direction.

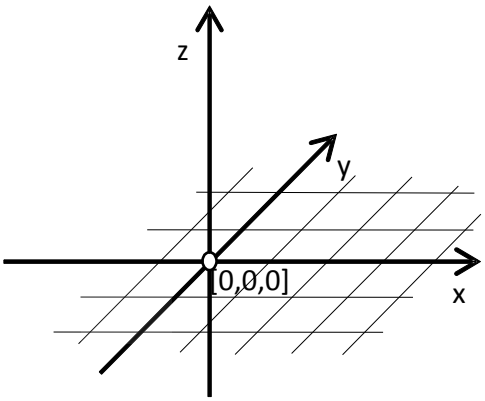


Figure 26 – transponder coordinate system

Positions in all four quadrants can be measured in the transponder coordinate system: LPR calculates the 2D position in the plane spanned by x and y.

Since it is not always possible to mount all the LPR components (LPR-2DB Integral Station, LPR-2DB Station antennas) in this plane, the deviation of the installation position in "z" relative to this plane must be specified for all LPR components.

In plane areas the z-position can be estimated directly towards the ground level.

The LPR-2DB Integral Stations must be measured in x-/y- and z-direction.

6.1.2 Reference point of LPR-2DB Integral Station

The position of the measuring point is critical for measuring the LPR-2DB Integral Station. The measuring point is marked by matting on the stations housing.

In a top view, the measuring point is located at the same level as the antenna patches (horizontal structures, roughly in the middle of the board portion above the copper reflector).

In the front view, the zero point is located midway between the copper reflectors.

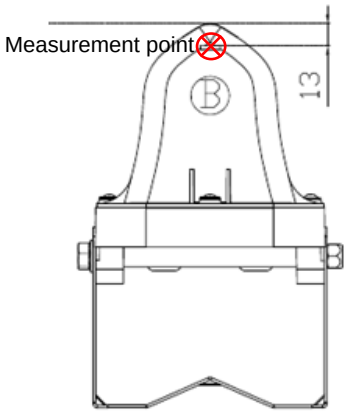


Figure 27 – Position of the measuring point on the LPR-2DB Integral Station

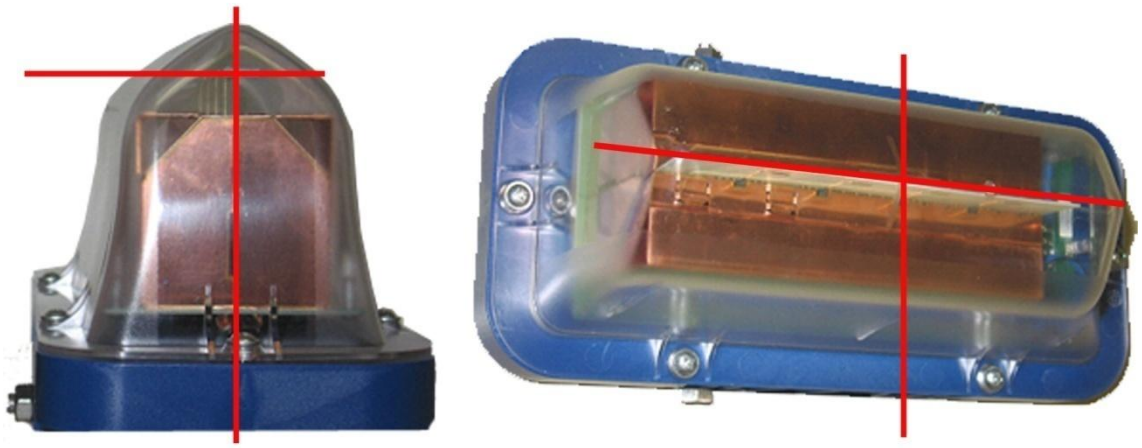


Figure 28 – Position of the measuring point on the Integral Station

6.1.3 Orientation of LPR-2DB Integral Station

The alignment of the stations is recorded as a vector in the coordinate system that is defined for the application, and is entered as an ex/ey value. Integer values are possible for ex/ey. The following diagram illustrates this principle (corresponding negative values for an opposite alignment).

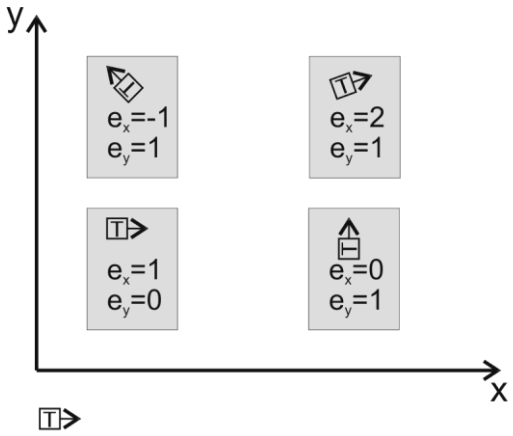


Figure 29 – Examples of LPR-2DB Integral Station alignment with ex/ey value

It is also possible to compute the orientation vectors from the angle of the integral station in the plane:

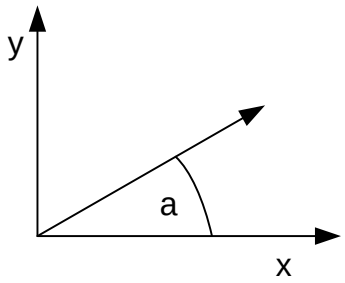


Figure 30 – Computation of ex/yx from angle a

Hereby is ex = cos(a) and ey = sin(a).
So just compute the values and multiplicate with 10 and truncate the decimal place:

Example: a = 12°, 10*cos(a)=9,78; 10*sin(a)=2,08 → ex = 9; y = 2

6.1.4 Formatting of coordinates

The coordinates of the integral stations must be provided as EXCEL-file in following format:

Short ID		**LPR-2DB Integral Station formatting**												
Cell	ID	TID	x	,	y	,	height	,	direction x (ex)	,	direction y (ey)	,	beam width	
12	0	T0=(		,		,		,		,		,	200	)
12	1	T1=(		,		,		,		,		,	200	)
12	2	T2=(		,		,		,		,		,	200	)
12	3	T3=(		,		,		,		,		,	200	)
12	4	T4=(		,		,		,		,		,	200	)
12	5	T5=(		,		,		,		,		,	200	)
12	M	T30=(		,		,		,		,		,	200	)

Description	Meaning
Cell	Cell number
ID	LPR-2DB Integral Station ID
TID	Fixed allocated
x	x-position of the transponder in own coordinates in mm

y	y-position of the transponder in own coordinates in mm
height	Height of transponders above ground in mm
direction x	x-component of orientation vector of transponder in own coordinates
direction y	y-component of orientation vector of transponder in own coordinates
beam width	Horizontal opening angle of transponder

6.2 Surveying of LPR-2DB Compact Station on mobile unit

The position of the antennas must be surveyed in the coordinate system of the vehicle. The origin of the coordinate system for the vehicle depends on the vehicle type.

6.2.1 Reference system for vehicle type: forklift

The origin of the reference system for the forklift is on the front axle. The x-axis shows in positive driving direction. Referring to this origin the antennas and the load position must be surveyed. The coordinates of the rotation point are in the middle of the fixed axis for a fork lift.

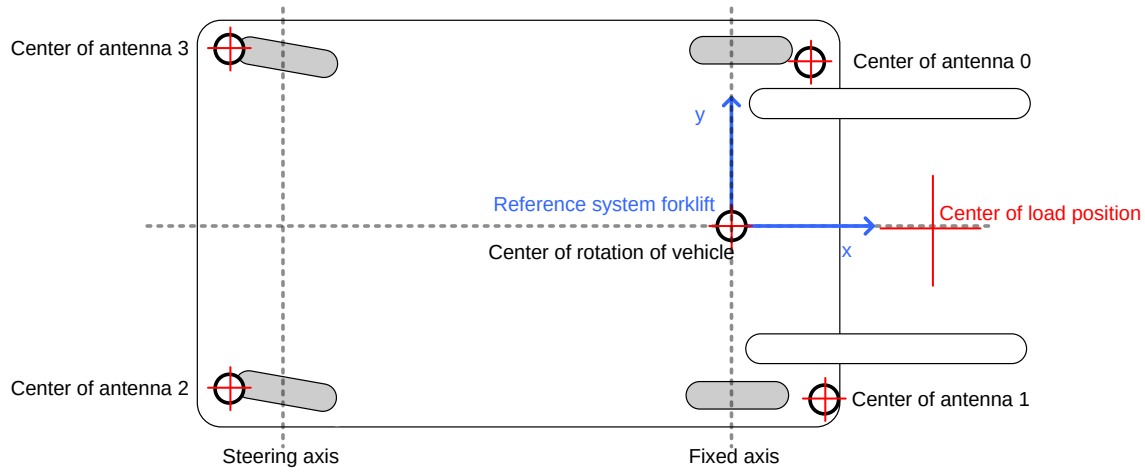


Figure 31 – reference coordinate system and installation position of antennas on a forklift

The z-direction shows the height of the antennas related to the ground (compare chapter surveying of antennas).

6.2.2 Reference system for vehicle type: Van Carrier

The origin of the reference system for the van carrier is on the rotation point of the vehicle. The x-axis shows in positive driving direction. The coordinates of the rotation are identical to the load position. Therefore the coordinates for the load position can be set to zero.

The z-direction shows the height of the antennas related to the ground (compare chapter surveying of antennas).

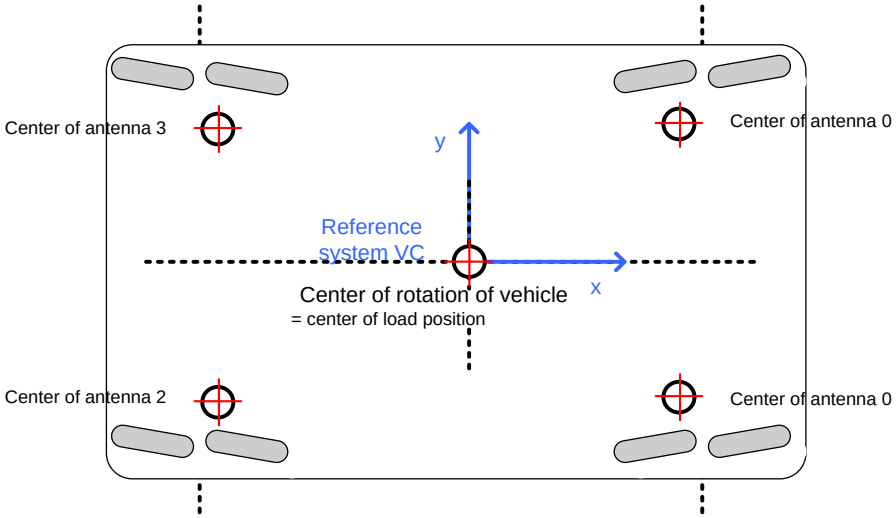


Figure 32 - reference coordinate system and installation position of antennas on a van-carrier

6.2.3 Reference system for vehicle type: passenger car

The origin of the reference system for the automobile is on the rear axle. The x-axis shows in positive driving direction. Referring to this origin the antennas and the load position must be surveyed. The coordinates of the rotation point are in the middle of the fixed axis for an automobile.

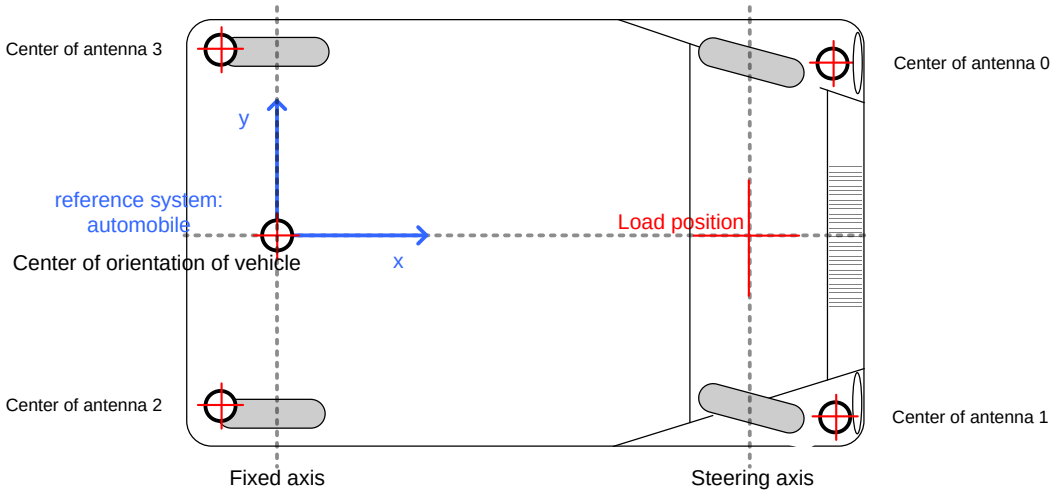


Figure 33 – reference coordinate system and installation position of antennas on an automobile

The z-direction shows the height of the antennas related to the ground (compare chapter surveying of antennas).

6.2.4 Reference system for vehicle type: crane/ trolley

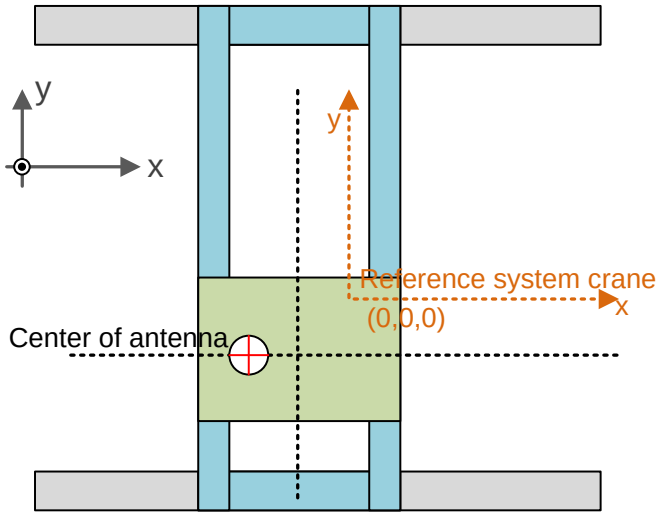


Figure 34 – reference coordinate system and installation position of antennas on a crane
The origin of the reference system for the crane can be chosen anywhere, because there is no rotation. The x-axis shows in positive driving direction.

The z-direction shows the height of the antennas related to the ground (compare chapter surveying of antennas).

6.3 Surveying of LPR antennas

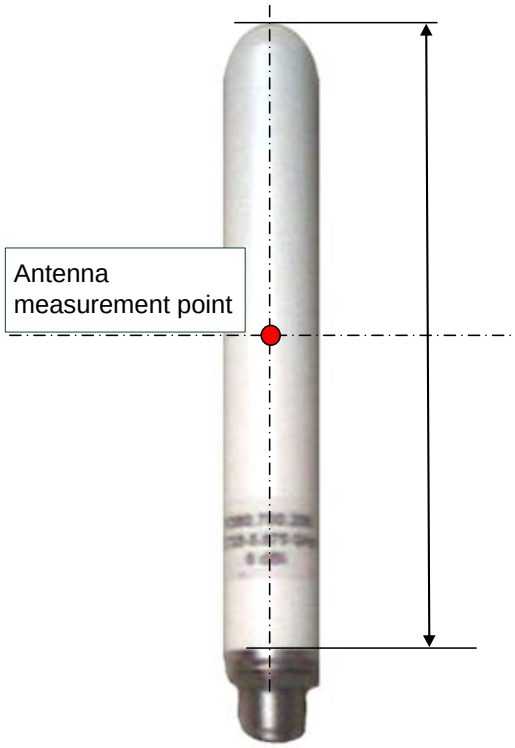


Figure 35 – measurement point of antenna

The reference point of the antenna for surveying is in the middle of rotational solid of the antenna.

6.3.1 Formatting of coordinates

The position of the antennas must be provided to Symeo in the following EXCEL format (compare Table 2).

The following values must be entered into the file by the surveyor:

Antenna position:

Antenna position			
Port	x	y	Height
(0)	2.576	3.456	12.300
(1)	1.000	2.876	12.345
(2)	-2.123	-1.200	12.816
(3)	3.378	4.503	12.461
Load position			

[Load Position]

Table 2 – Antenna position

Description	Meaning

Port	Antenna port of the connected antenna. (0) means antenna port 1, (1) means antenna port (2) etc.
x	x-position of the antenna at the connected port in coordinates of the vehicle. Specification is in meters and with 3 decimal numbers.
y	y-position of the antenna at the connected port in coordinates of the vehicle. Specification is in meters and with 3 decimal numbers.
height	Height of the antenna over ground. Specification is in meters and with 3 decimal numbers.
LoadPosition	Operation point ; e.g. center of spreader (x, y, z)

7 Commissioning

The commissioning part consists of following steps:

- Checking of installation
- Configuration and upload of files for the DSP to the LPR units
- Configuration and upload of files for the FusionEngine
- Commissioning the LPR system with Symeo MAP

7.1 Check list installation and surveying

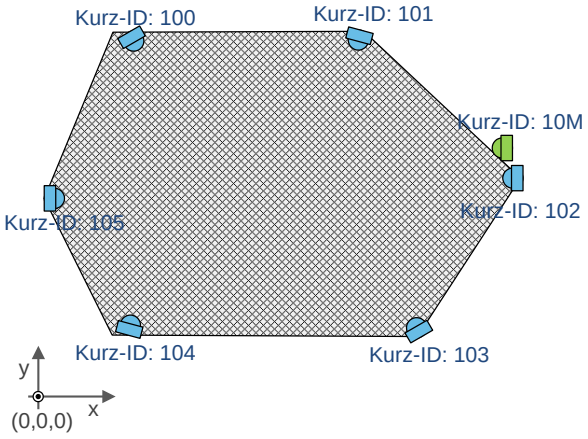
After mechanical and electrical installation the following steps should be succeeded:

7.1.1 Cells, Integral stations

⇨ LPR-2DB Integral Station are mounted (position and orientation) like shown in the cell plan

⇨ The three-digit short-ID of each LPR-2DB Integral Station is the same as in the cell plan.

Each LPR-2DB Integral Station has a three-digit short ID, which consist of a two-digit Cell-ID and a one-digit Station-ID.



Cell-ID	Station-ID	Short-ID
10	0	100
10	1	101
10	2	102
10	3	103
10	4	104
10	5	105
10	30	10M

Figure 36- Cell plan

i Note

The Master LPR-2DB Integral Station always has the station-ID 30. In the Short-ID the master is indicated with “M”. The Master LPR-2DB Integral Station is only relevant in the operating mode 2 (Managed Cell) and 3 (TDOA).

⇨ Between all fixed mounted stations (LPR-2DB Integral Station) is a free line of sight

⇨ The power supply for the LPR-2DB Integral Station is connected. (LPR-2DB Integral Station flash, Master LPR-2DB Integral Station lightens)

⇨ Screwing of external antennas of LPR station (type: compact) is installed correctly.

7.1.2 LPR-2DB Station (Mobile units)

⇨ Antennas have a free line of sight

⇨ Screwing of external antennas is correct

⇨ Antennas are labeled to allocate them to the right port of the mobile station. This is necessary for the orientation of the vehicle.

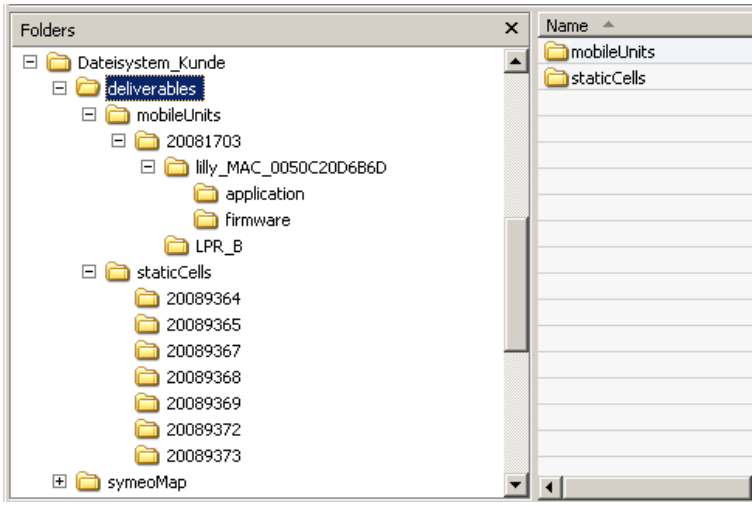
⇨ The maximum bending radius of external antenna cables is correct

7.1.3 Formatting of coordinates

Compare the coordinate data from the surveyor with the plan coordinates of the cell plan.

7.1.4 Folders structure

The configuration files for the mobile units and the fixed mounted units are delivered in the following directory to the customer (compare chapter 2.2):



The folder “mobile units” contains the parameter for mobile LPR unit. “Static cells” contains the parameter for the fixed mounted LPR station (e.g. surveyor data). All LPR units are labeled with their serial number in the folder structure.

Figure 37

7.2 Editing of configuration files for the DSP

Mode: Basic Cell/ Managed Cell/ TDOA

In the mode 1 (Basic Cell) all configuration files for the DSPs are preconfigured and no changes of the files are allowed. In the mode 2 (Managed cell) and 3 (TDOA) the configuration file of the master transponder has to be changed as long as no surveyor data was available to Symeo by delivery.

If changes of a configuration for a DSP are necessary or a replacement unit is used, the following files must be uploaded and/or modified:

File	Modification
basestation_config.txt	No modification necessary
stationXXM_config.txt	Input of Transponder coordinates (only mode 2b and 3b)

(only Mode 2 and 3 – master transponder)	No modification necessary for mode 1, 2a and 3a
stationXX#_config.txt (all transponders)	No modification necessary

Note	The “XX”-sign replaces the Cell number of the master transponders, the „M“-sign indicates the master station-ID 30. The “XX”-sign replaces the Cell number of the transponders, the „#“-sign the station-ID.

7.2.1 File basestation_config.txt

Note	This file is preconfigured by delivery and needs no changes.

7.2.2 File stationXXM_config.txt

Mode: Basic Cell/ Managed Cell/ TDOA

This file for the master transponder only exists in mode 2b (Managed cell) and mode 3b (TDOA). In mode 1 (Basic cell) the base station(s) organize(s) the measurements and the master transponder is not be applied. In 2a and 3a a file XXM_config.txt exists but no changes of this file should be done.

```
[Master]
MWD=0            # master wants data (0: no data is sent to transponder,
                 #   1: distances are sent to master)
OCS=0            # own coordinate system (0: global coordinate system,
                 #   1: private coordinate system)
MOC=0            # cell is static cell
MSQ=(0,3,1,4,0,2,5) # measure sequence

T0= (-100000,-100000,2000, 0,-1,200)
T1= (-120000,-100000,2000, 0,-1,200)
T2= (-140000,-100000,2000, 0,-1,200)
T3= (-140000,-140000,2000, 0, 1,200)
T4= (-120000,-140000,2000, 0, 1,200)
T5= (-100000,-140000,2000, 0, 1,200)
T30=(-110000,-140000,2000, 0, 1,200)

[SymeoBasic]
```

Figure 38 – Entry of transponder coordinates in the file XXM_config.txt (only mode 2b and 3b)

Enter the coordinates from the surveyor for each transponder (T0 – T5) and for the master transponder (T30) into the file for the master transponder. The values are x- , y-, z-direction and the orientation of all transponders in x- and y-direction (see chapter 6.1).

Station-ID	x-coordinate	y-coordinate	z-coordinate	dir_x (x-direction of transponder)	dir_y (y-direction of transponder)	beam width

Station-ID (0,1, 2, 3, 4, 5, 30) and beam width are entered by Symeo and are not allowed to be changed. All coordinates must be provided in mm.

7.2.3 File stationXXY_config.txt

Note

These files is preconfigured by delivery and needs no changes.

7.3 Upload of configuration files for the DSP

Each LPR unit (base station, transponder, master) has its own DSP. Each DSP of each LPR station has its own configuration file.

The configuration files are:

Mobile unit (Base station)	Basestation_config.txt
Transponder	StationXX0.txt … stationXX5.txt (XX: Cell-ID)
Master (optionally)	StationXXM.txt (XX: Cell-ID, M: Master)

The access to the DSP of the mobile units is done via TCP/IP or serial interface. For the fixed mounted units (transponder and master) the access to the DSP happens via the radio communication from the mobile station.

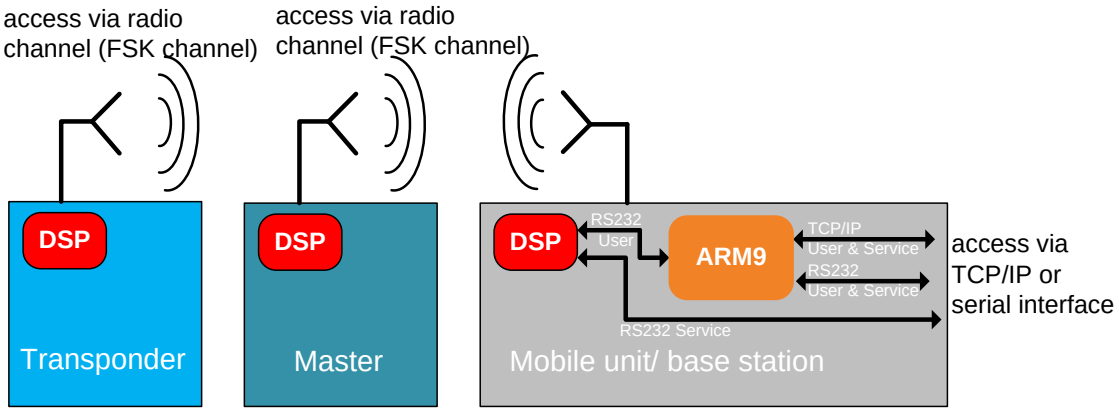


Figure 39 – LPR units including DSP: Access to the DSP via TCP/IP, RS232 or frequency channel

7.3.1 Connection with LPR mobile unit (type: compact) via TCP/IP

Note	If you have an LPR station (mobile unit) with TCP/IP interface read this chapter. If you have an LPR station (mobile unit) with RS232 interface read the next chapter (7.3.2).

⇨ Connect your PC and the mobile unit with a LAN cable

⇨ Keep in mind the necessary settings for the network (e.g. same network for PC and LPR station). Compare chapter 9.1. The SCIA port (ttyAM0) must be opened for configuration. The port is per default 3045 but is changeable via the web-interface of the station (9.3.3.1).

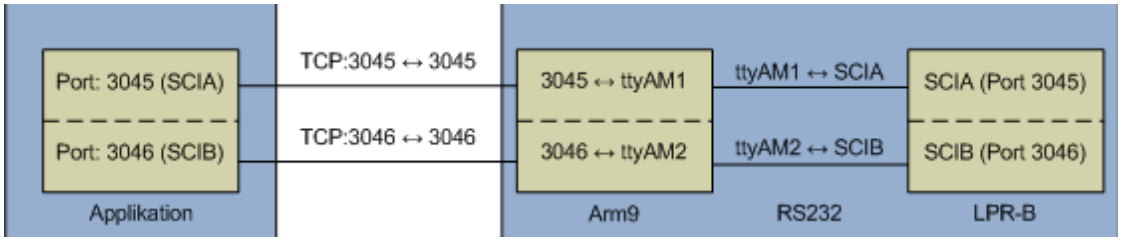
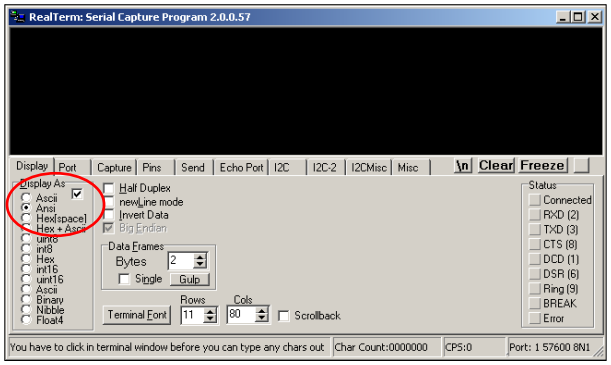


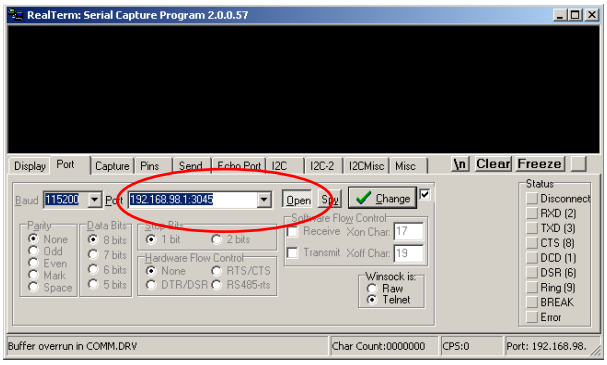
Figure 40 – ports of LPR station

⇨ To check a successful a network connection, ping the IP-address of the station “ping 192.168.1.99”. The IP-address is per default 192.168.1.99 but is changeable via the web interface of the station (9.3).

⇨ Open the terminal program “RealTerm”



⇨ Click in the tab Display on Ansi



⇨ Enter the IP-address and the port in the tab Port, e.g. 192.168.1.99:3045

⇨ Click on open

The system data is shown in the terminal window.

If the access failed, check if the port 3045 of the LPR station is opened and the IP-address is correct (compare 9.3).

7.3.2 Connection with LPR mobile unit (type: compact) via RS232

Note

If you have an LPR station (mobile unit) with RS232 interface read this chapter. If you have an LPR station (mobile unit) with TCP/IP interface read the previous chapter (7.3.1).

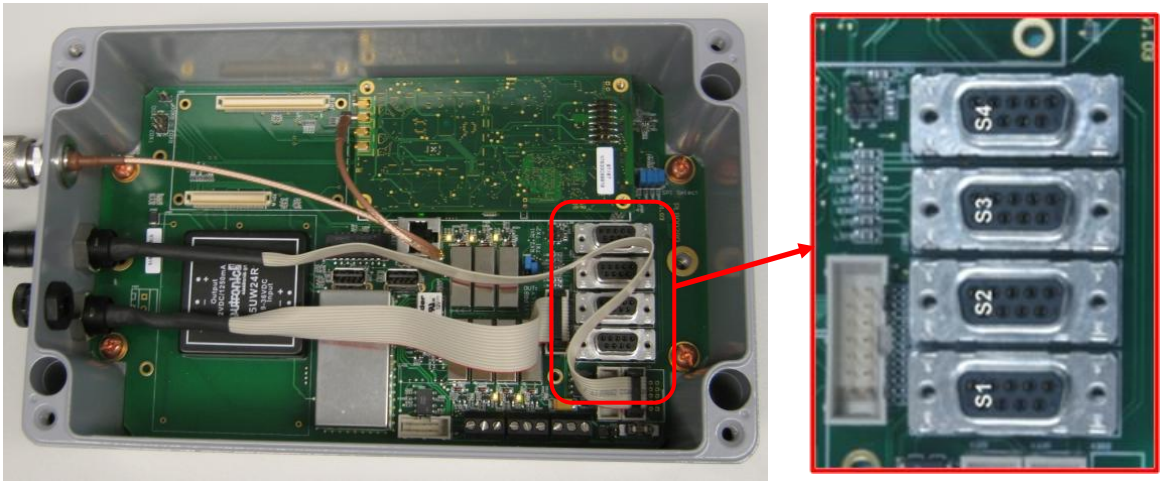
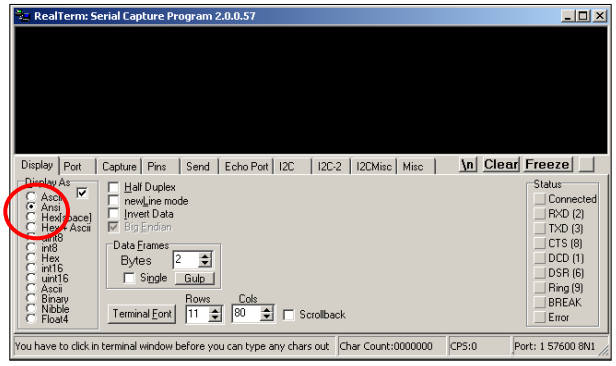


Figure 41- serial ports of the LPR station (type: compact)

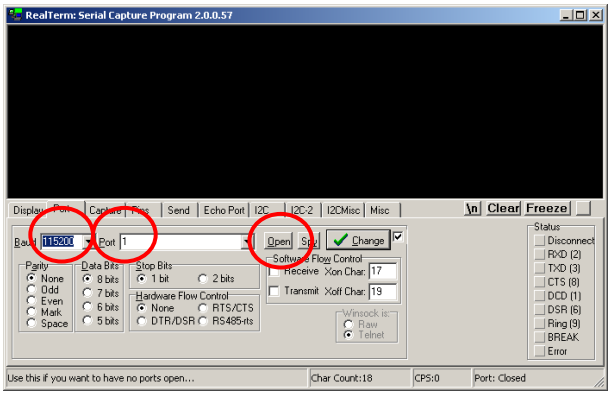
Data interfaces	
S4	SCIA Port/ ASCII Port (ASCII protocol) and configuration
S3	A9 seriell
S2	SCIB Port (binary protocol)
S1	ARM9 seriell

Connect the serial port S4 (SCIA port) of the LPR station and the COM port of the PC via a serial cable (<2 m).

⇨ Open the terminal program „RealTerm“



⇨ Click in the tab “Display” on Display as ANSI.



⇨ Choose the baud rate to 115.200

⇨ Select your COM-port

⇨ Click on Open

7.3.3 Upload DSP configuration file for LPR mobile unit (base station)

Note	This file for the mobile station is preconfigured by delivery and needs no changes. An Upload of the configuration file for the DSP only happens if the mobile station must be replaced due to a defect LPR station.

⇨ Open the terminal program RealTerm as described in chapter 7.3.1 or chapter 7.3.2.

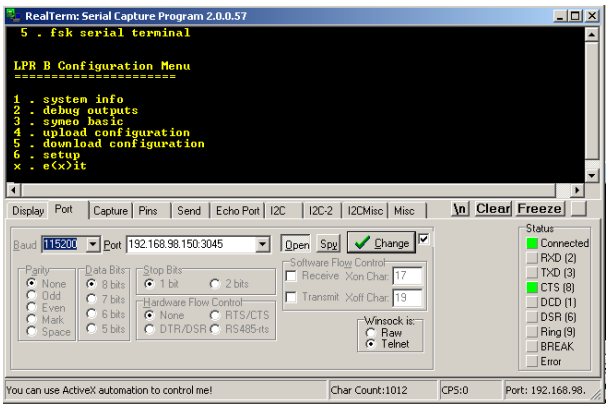


Figure 42

⇨ Press button 4 in the window of the terminal program to open the “LPR B Configuration Menu”.

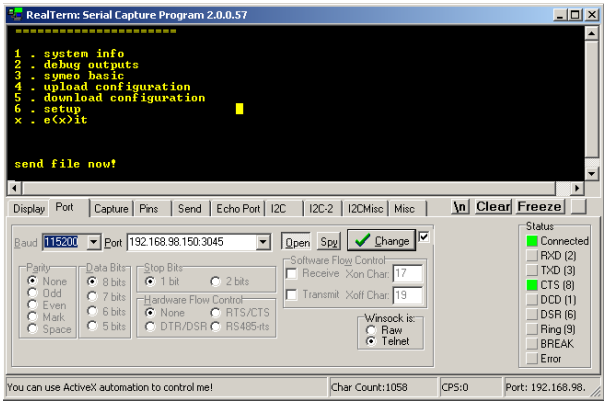


Figure 43

⇨ Press button 4 in the window of the terminal program for “Upload Configuration”.

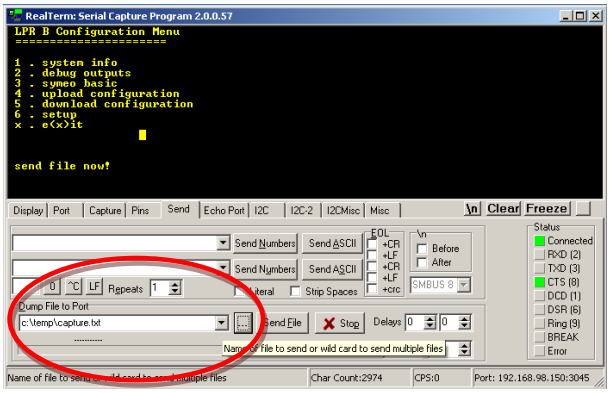


Figure 44

⇨ Change to tab “Send”

⇨ Choose the path and your file for the mobile station (Basestation_config.txt).

⇨ Press the “Send File”-button.

A successful upload is confirmed in the terminal window.

7.3.4 Upload DSP configuration file for master transponder unit

Mode: Basic Cell/ Managed Cell/ TDOA

The master transponder only exist in mode 2 (Managed Cell) and mode 3 (TDOA). Only in mode 2b and mode 3b the following upload of the DSP configuration file must be done. In mode 2a and mode 3a the DSP configuration file is preconfigured.

In mode 2b (Managed Cell) and mode 3b (TDOA) the transponder coordinates must be stored in the configuration file of the master transponder. If the coordinates were not transferred to Symeo before delivery or the coordinates/ transponder positions were changed you have modify (7.2.2) and upload the configuration file for the master.

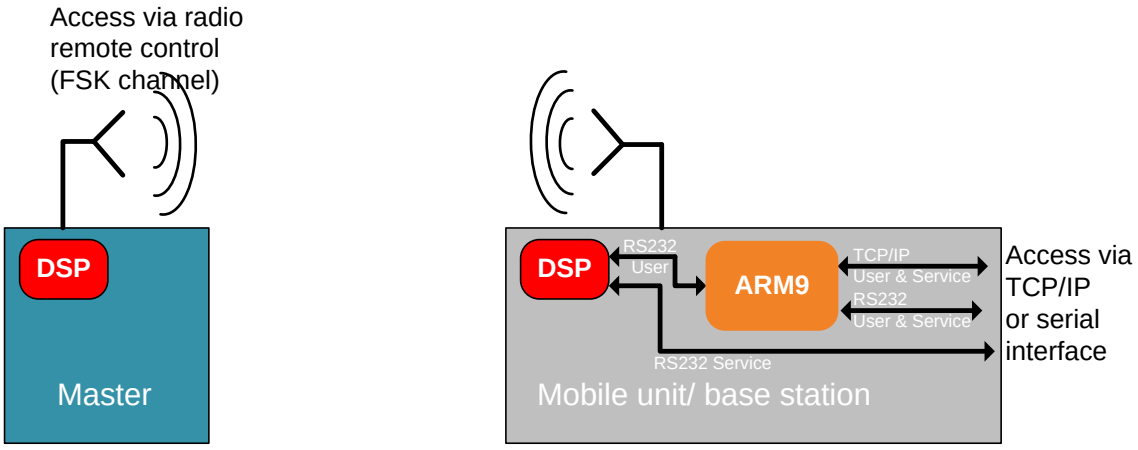


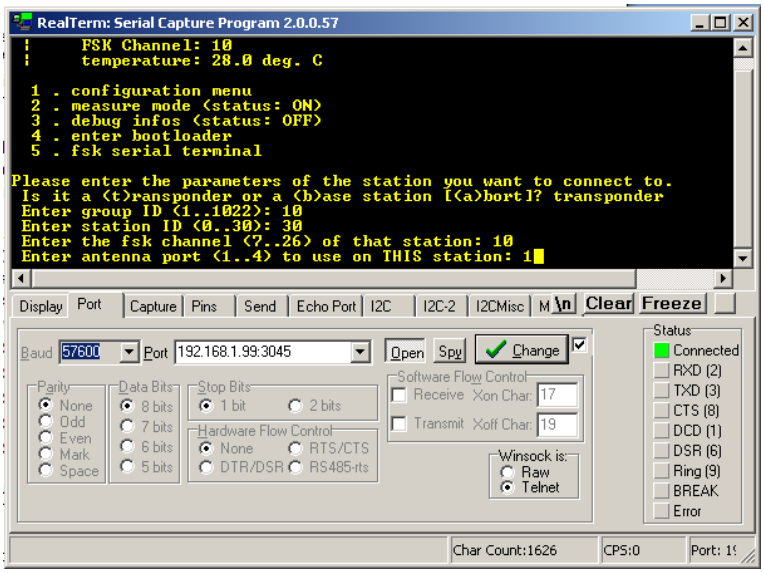
Figure 45 – Access to the master transponder

An access to the master transponder happens via radio communication from the mobile station.

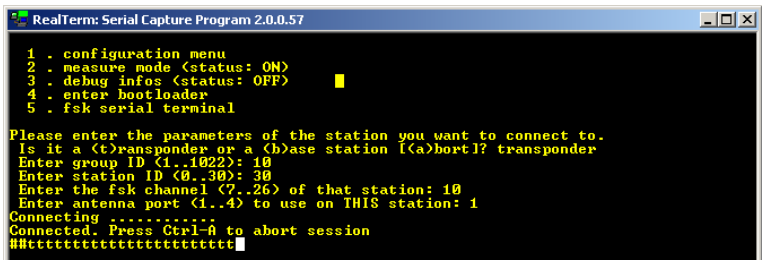
⇨ Establish a connection between your PC and the mobile station (7.3.1 or 7.3.2)

⇨ Keep ready the following data of the master transponder: group-ID, station-ID, fsk-channel. These data can be read out from the short ID labeled on the master transponder. Example short-ID 10M: The first 2 digits for the cell-ID are consistent with the group-ID. The third digit is the station-ID. The station-ID for the master is labeled with “M”. The master has always the station-ID 30. The FSK-channel is consistent with the cell-ID/ group-ID for the first 40 cells.

⇨ Open a FSK-connection with the master transponder:



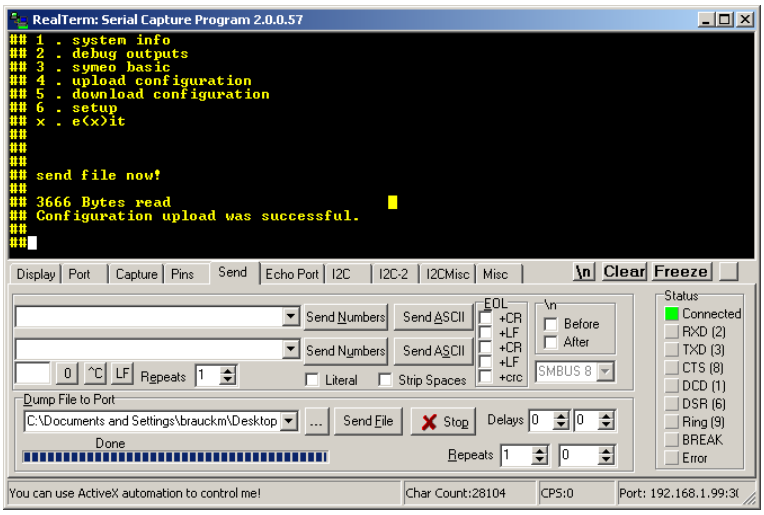
- ⇨ Enter in the terminal window key “5” for “fsk serial terminal”.
- ⇨ Enter “t” for transponder
- ⇨ Enter the group-ID of the transponder
- ⇨ Enter the station-ID of the transponder (30)
- ⇨ Enter the FSK channel
- ⇨ Enter “1” for the antenna port of this station



- ⇨ Press “Enter”

After a moment the mobile unit is connected via radio channel with the master transponder. This is indicated with 2 hash keys at the beginning of the row.

Now, you can upload the configuration file of the DSP of the master transponder. Do the following:



⇨ Press button 1 in the window of the terminal program to open the “LPR B Configuration Menu”.

⇨ Press button 4 in the window of the terminal program for “Upload Configuration”.

⇨ Change to tab “Send”

⇨ Choose the path and your file for the master station (StationXXM_config.txt).

⇨ Press the “Send File”-button. Wait a moment until the master transponder responses.

A successful upload is confirmed in the terminal window.

7.3.5 Upload DSP configuration file for transponder unit

Note

These files for the fixed mounted stations (transponder) are preconfigured by delivery and need no changes. An Upload of the configuration file for the transponder only happens if the fixed mounted station must be replaced due to a defect LPR station.

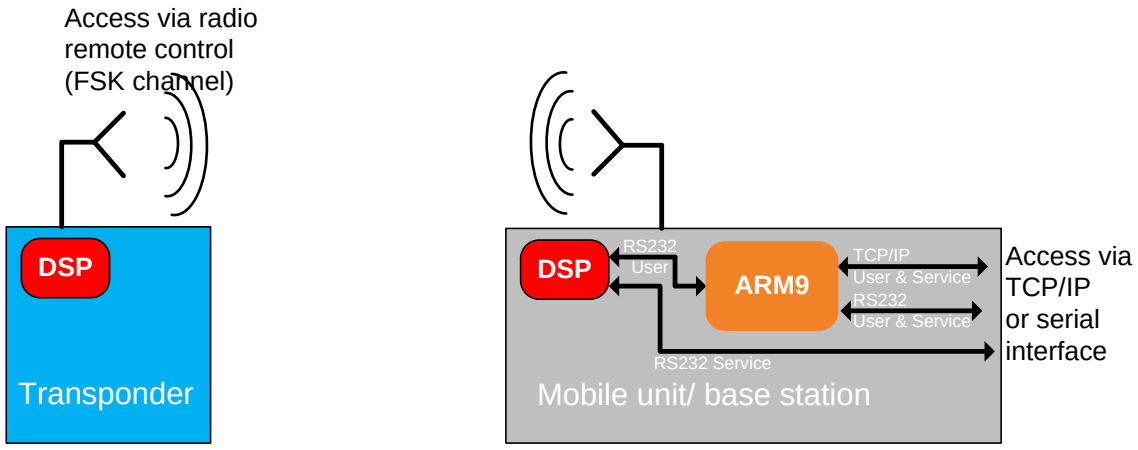


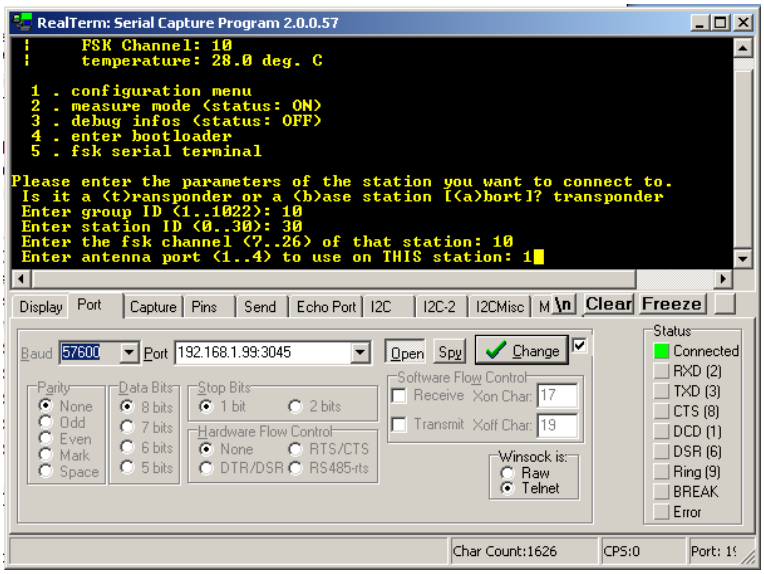
Figure 46 – Access to the transponder(s)

If an access to the transponder is necessary, this is described in the following chapter. The access happens via radio communication from the mobile station.

⇨ Establish a connection between your PC and the mobile station (7.3.1 or 7.3.2)

⇨ Keep ready the following data of the master transponder: group-ID, station-ID, fsk-channel. These data can be read out from the short ID labeled on the master transponder. Example short-ID 101: The first 2 digits for the cell-ID are consistent with the group-ID. The third digit is the station-ID. The FSK-channel is consistent with the cell-ID/ group-ID for the first 40 cells.

⇨ Open a FSK-connection with the master transponder:



⇨ Enter in the terminal window key “5” for “fsk serial terminal”.

⇨ Enter “t” for transponder

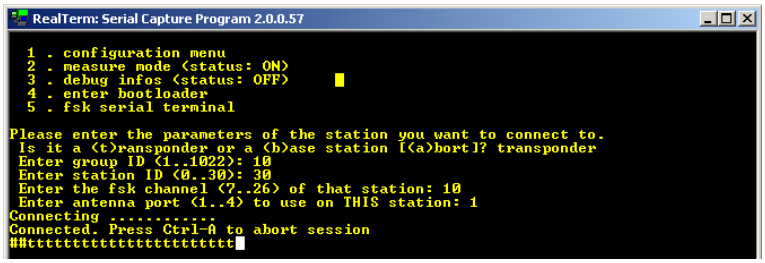
⇨ Enter the group-ID of the transponder

⇨ Enter the station-ID of the transponder (0…5)

⇨ Enter the FSK channel

⇨ Enter “1” for the antenna port of this station

Figure 47



⇨ Press “Enter”

After a moment the mobile unit is connected via radio channel with the transponder. This is indicated with 2 hash keys at the beginning of the row.

Figure 48

Now, you can upload the configuration file of the DSP of the transponder. Do the following:

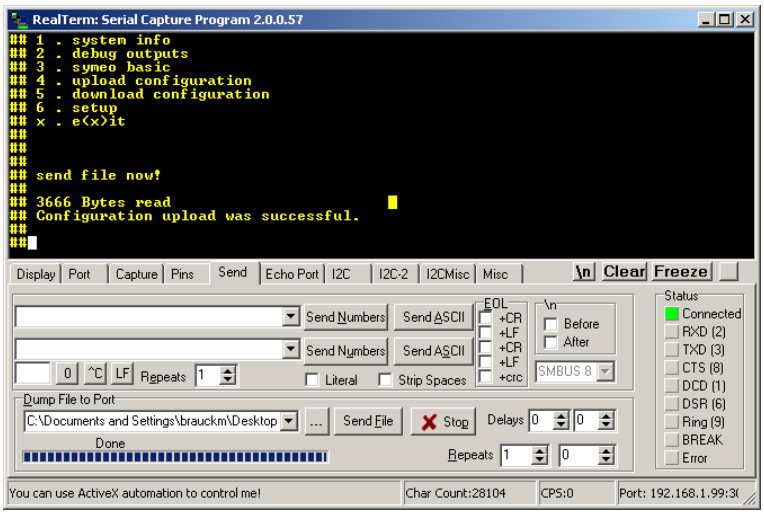


Figure 49

⇨ Press button 4 in the window of the terminal program to open the “LPR B Configuration Menu”.

⇨ Press button 4 in the window of the terminal program for “Upload Configuration”.

⇨ Change to tab “Send”

⇨ Choose the path and your file for the transponder (Station??x_config.txt).

⇨ Press the “Send File”-button. Wait a moment until the transponder responses.

A successful upload is confirmed in the terminal window.

7.4 Editing of configuration files for Fusion Engine

The software FusionEngine is the central unit for calculating the 2D position. Either it runs internally on the mobile unit (ARM9 on the LPR-2DB Compact Station) or it runs on a separate PC.

If using the mobile unit (ARM9), the FusionEngine is already pre-configered and only a few adaptations must be made. If it runs on an extern PC some more configuration is required.

The following files and contents exist and must be checked and modified by the customer:

File	Change(s)
fusion.ini	If running on mobile unit: no changes. If running on extern PC: Measurement path and connection parameters must be set
field.ini	Only with operation mode 1, 2a and 3a: Transponder coordinates must be entered. With the other operation modes (2b, 3b) the transponder coordinates are saved in the master transponder.
LPR_B.ini (LPR_B1.ini and LPR_B2.ini)	Antenna positions (in vehicle coordinates) of the mobile unit antennas. Only with operation mode 1, 2a and 2b: antenna cable length. Single receiver: LPR_B.ini Double receiver: LPR_B1.ini and LPR_B2.ini

LoadPos.ini	Load position (in vehicle coordinates).
Customer.ini or Symeo_2D.ini	Configuration of customer interface (Symeo 2D protocol)
all other files	No changes

7.4.1 fusion.ini

This file contains all connection settings and some general settings of the software FusionEngine.

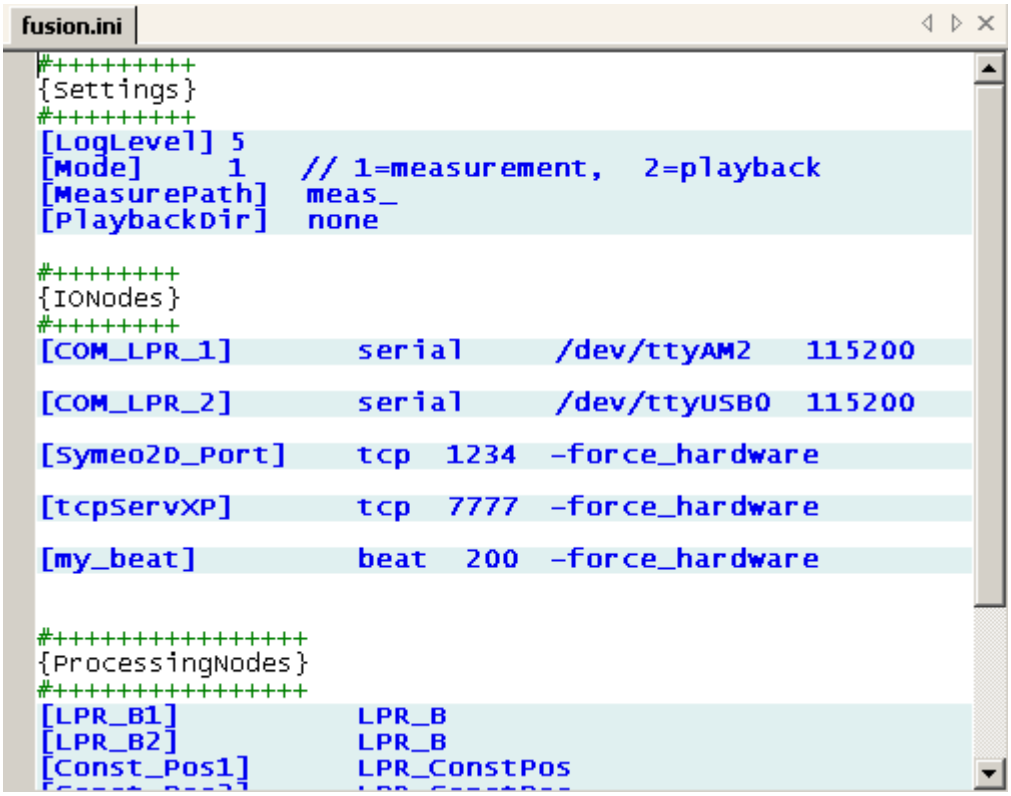


Figure 50 – fusion.ini (example)

[MeasurePath]
The path where the FusionEngine recordings (measurements) are saved.
Must only be changed if FusionEngine is running on extern PC.

[COM_LPR] or **[COM_LPR_1]** and **[COM_LPR_2]**
The physical ports (e.g. 1 for COM-Port 1) of the connected LPR-B stations.
Must only be changed if FusionEngine is running on extern PC.

[Symeo2D_Port]
The TCP listening port for the customer interface (SYMEO 2D protocol), default: port 1234.

7.4.2 field.ini

This file contains the transponder coordinates (coordinates of mounted integral stations), if using operation mode 1, 2a or 3a. If using operation mode 2b or 3b the transponder coordinates are saved in the master transponder.

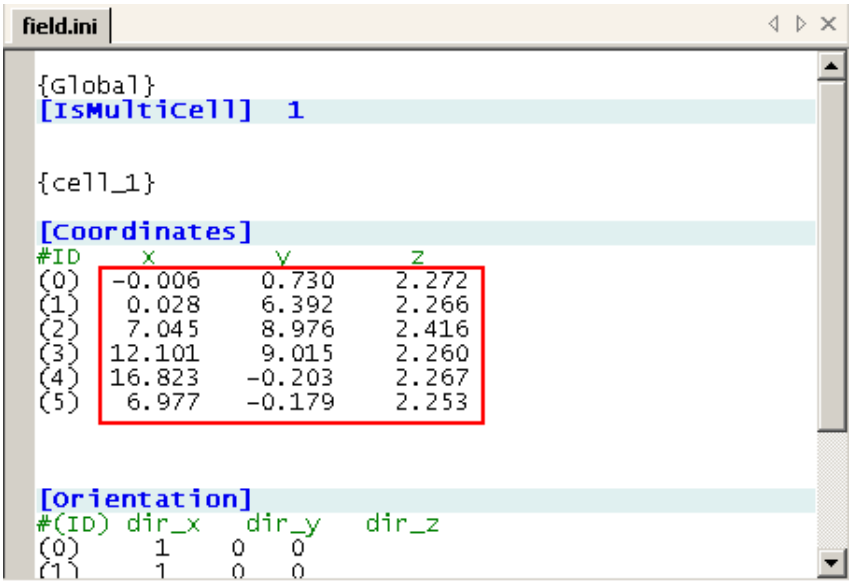


Figure 51 – field.ini (example)

Mode: Basic Cell/ Managed Cell/ TDOA

The transponder coordinates is only be done in mode 1 (Basic Cell), mode 2a (Managed Cell) and mode 3a (TDOA). In mode 2b (Managed Cell) and 3b (TDOA) the coordinates are entered directly in the file for the DSP of the master transponder (compare chapter 7.2.2 - file „stationXXM_config.txt“).

{cell_1}
Every LPR-2DB cell is identified with **{cell_#}**, where **#** is the number of the cell.

[Coordinates]
The coordinates (x, y, z) of every transponder of this cell.

The columns have the following meaning:

ID	x	y	z
Station-ID (0..5 for transponder, 30 for master)	x-coordinate of transponder	y-coordinate of transponder	height of transponder

Note

All positions must be entered in m and with a decimal point.

[Orientation]
The orientation (ex, ey,ez) of every transponder of this cell.

The columns have the following meaning:

ID	ex	ey	ez
Station-ID (0..5 for transponder, 30 for master)	x-orientation vector of transponder	x-orientation vector of transponder	z-orientation vector of transponder

7.4.3 LPR_B.ini

This file contains the antenna positions (in vehicle coordinates) of the mobile unit antennas. Additionally in operation mode 1, 2a and 2b (all RTOF modes), this file contains the cable length of the used antennas.

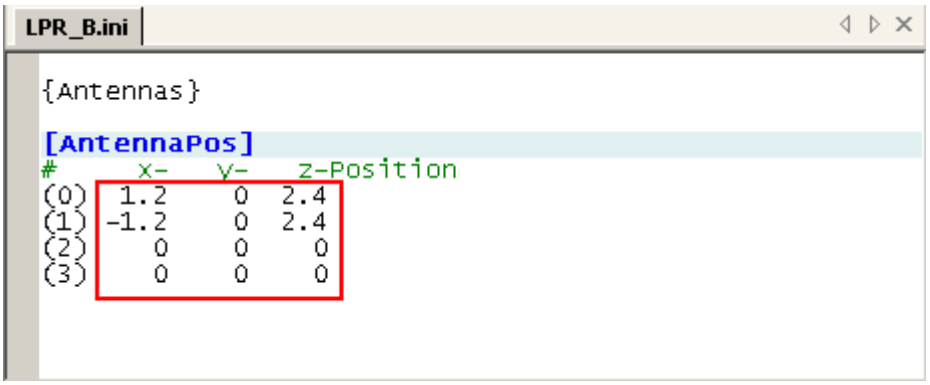


Figure 52 – LPR_B.ini (example)

For all LPR-2DB stations with single receiver, there is one file LPR_B.ini with settings for up to 4 antennas. For all LPR-2DB stations with double receiver, there are two files (LPR_B1.ini and LPR_B2.ini) with settings for two antennas.

[AntennaPos]
The antenna position on the vehicle. All coordinate of the antenna are relative to the local coordinate system of the vehicle.

The columns have the following meaning:

ID	x	y	z
antenna port[1)]	x-coordinate of antenna	y-coordinate of antenna	z-coordinate of antenna

[1)] single receiver: 0..3 for antenna port 1..4,
double receiver: 0 in file LPR_B1.ini for port 1, 0 in file LPR_B2.ini for port 2

Note	All positions must be entered in m and with a decimal point.

[CabelLength]
Only in all RTOF modes (operation modes 1, 2a and 2b), the electrical cable length of antenna must be set.

7.4.4 LoadPos.ini

This file contains the load position of the vehicle. It is entered in vehicle coordinates in m. The load position indicates the 2D position which is output in the customer interface.

LoadPos.ini

```
{Parameter}
# reference position of load in vehicle coordinates
[dx]   3.0
[dy]   0.0
```

Figure 53 – LoadPos.ini (example)

[dx], **[dy]**
Offset of load position in vehicle coordinates.

7.4.5 Customer.ini (or Symeo_2D.ini)

This file contains the settings for the customer interface (Symeo 2D protocol).

Symeo_2D.ini

```
{Settings}
[Format]          ascii
[SendTimestamp]   1
[SendVelocity]    1
```

Figure 54 – Symeo_2D.ini (example)

[Format]
The format of the protocol output (ascii or binary).

Additional settings for customizing customer protocol can be found in chapter 10.

7.5 Upload configuration files for FusionEngine

The ARM9 board of the mobile unit has the operating system LINUX. If the software FusionEngine operates on the ARM9 board and not on the PC, the following files for the FusionEngine are stored on the ARM9 board:

- FusionEngine
- fusion.ini
- field.ini
- HoverTrack.ini, VehicleTrack.ini or TDOA.ini
- LPR_B.ini (if double receiver: LPR_B1.ini and LPR_B2.ini)
- LoadPos.ini
- user.sh
- multi_Cell.ini (if double receiver: multi_cell1.ini and multi_cell2.ini)
- Const_Pos.ini (if double receiver: Const_Pos1.ini and Const _ Pos2.ini)
- Symeo_2D.ini or customer.ini

Note	If the software FusionEngine operates on the PC, optionally data is available via RS232 interface. In this case the following chapter can be skipped.

7.5.1 Upload of files via WinSCP

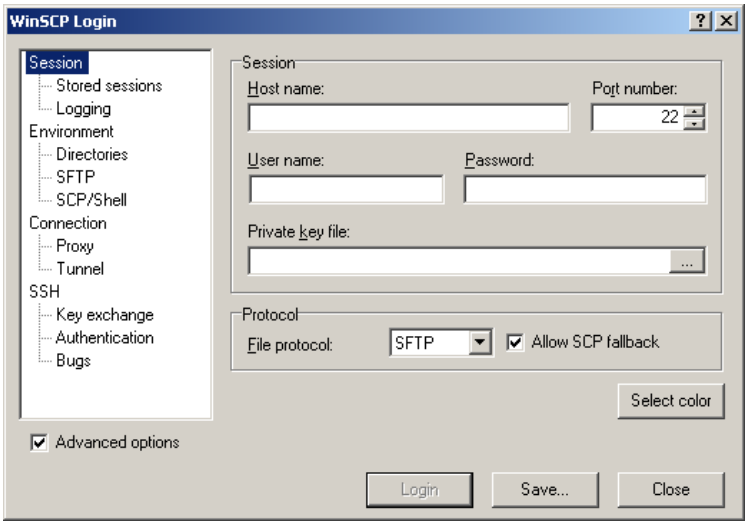
An update of the configuration files of the software FusionEngine can be done in various ways, as an example, the following guide will show the data transfer using the freeware program WinSCP and consists of these steps:

- Step 1 – Connecting
- Step 2 – Browsing the file system
- Step 3 – Upload files via "drag & drop"
- Step 4 – Exiting WinSCP
- Step 5 – Station Reboot

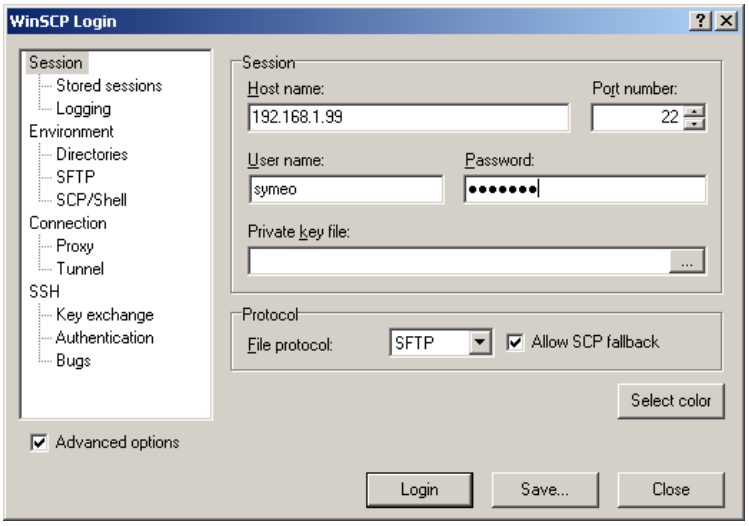
WinSCP download, installation and program help can be found on this website:
http://winscp.net/

⇨ Open a TCP/IP connection to the LPR mobile station (type: compact).

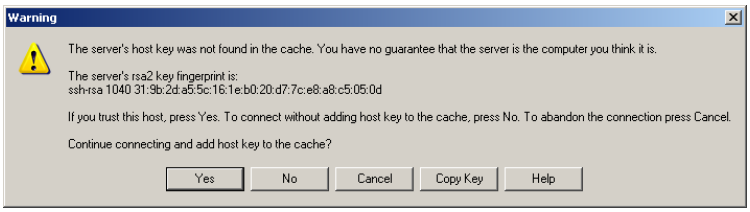
7.5.1.1 Step 1 – Connecting



⇨ Start WinSCP and a login screen will appear. Enter connection parameters like the IP-address ('Host name', e.g. 192.168.1.99), user name ('symeo') and password (default password: '54all2u').

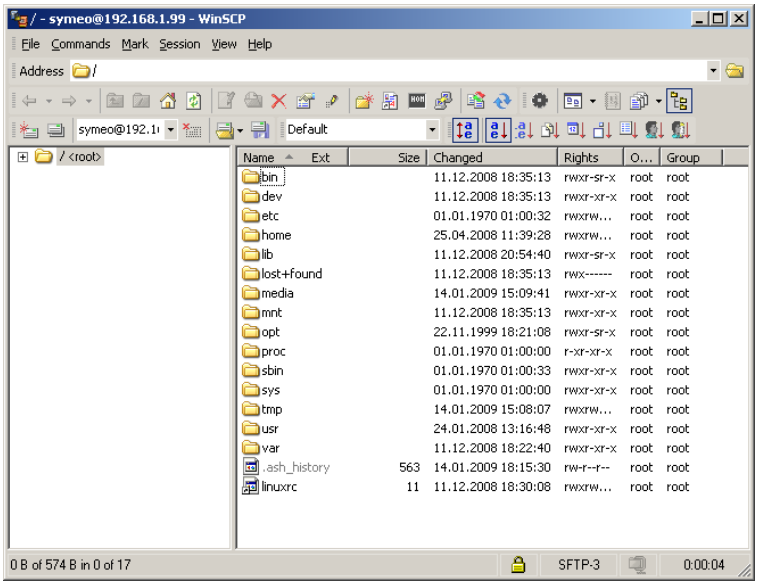


⇨ After optionally saving the connection parameters ('Save…'), press 'Login' in order to establish a connection. For the first time connecting to the remote machine, the server host key must be stored pressing 'Yes' in the following dialog box.

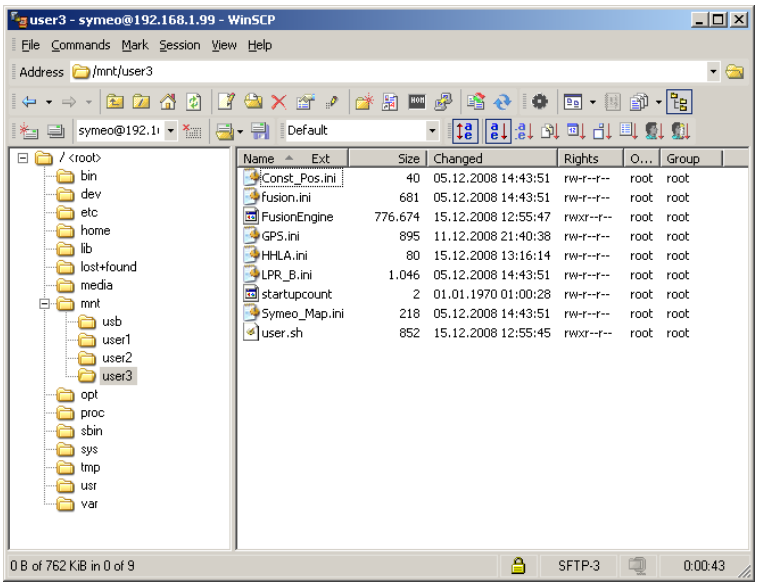


7.5.1.2 Step 2 – Browsing the file system

You are now connected to the remote station's file system. Keep in mind, that only the path '/mnt/user3/' is located in a persistant memory location (Flash memory), whereas all other folders are located in the volatile memory (Ram) and changes will be lost during restart.



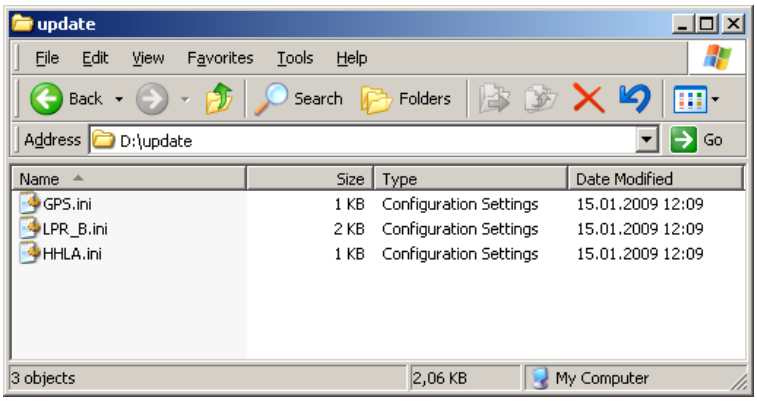
In order to upload and update configuration files, browse to the path '/mnt/user3/'.



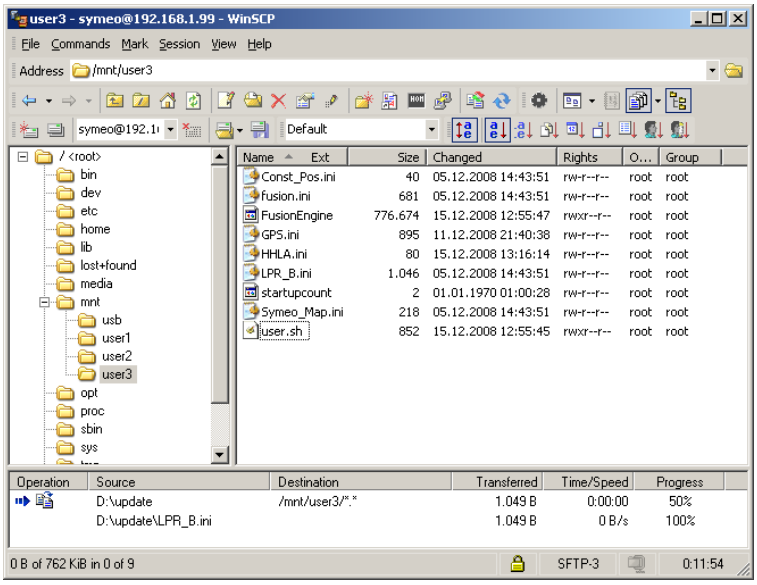
The content of the the non-volatile memory in '/mnt/user3/' is now shown. Keep in mind, that deleting, renaming, editing and permission changes may lead to malfunctions.

7.5.1.3 Step 3 – Upload files via “drag & drop”

First, open the location containing the new files on your local machine.

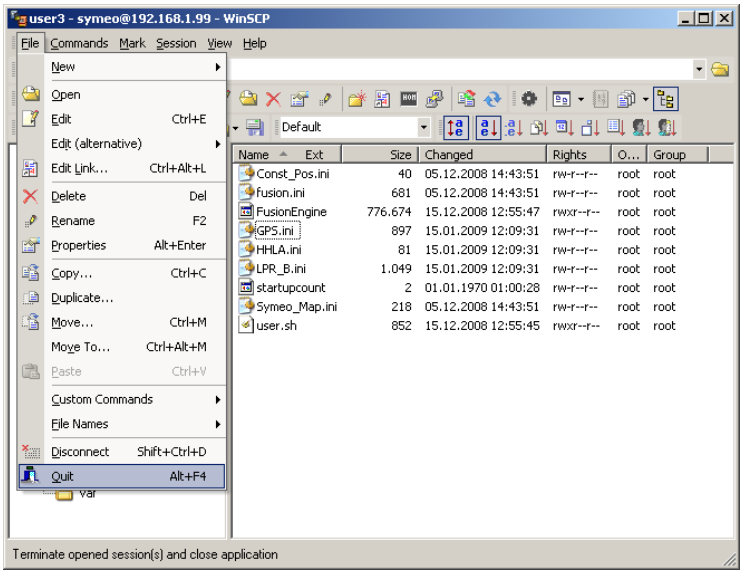


The update of the files shown above can be done via "drag & drop" by selecting the files by mouse and dragging the files from the explorer window to the WinSCP window. Release the mouse button and the transfer will start.



Depending on your WinSCP version and settings the transfer will be shown either in a dialog box or in the transfer queue (shown above).

7.5.1.4 Step 4 – Exiting WinSCP

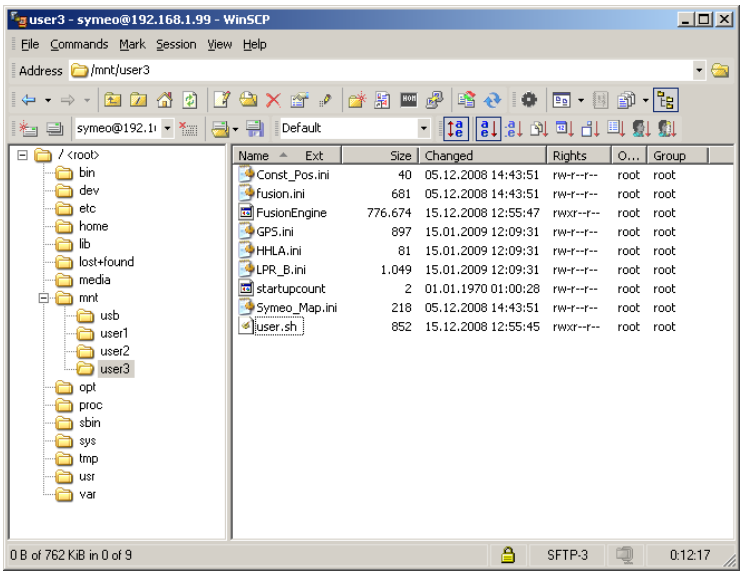


After successful transfer, close the WinSCP program.

7.5.1.5 Step 5 – Station reboot

Execute a reboot, changes will take effect during startup.

Reboot can be executed via the website of the station, by a power cycle or by using the 'reboot' command in a telnet resp. ssh session.



After the transfer has finished, you may check success by the new timestamps ('Changed') of the files or you may view the content of the files.

8 Symeo MAP

Symeo MAP is the software package for visualizing and monitoring LPR systems. The movement of a single base station and the status of the entire system is available at a click.

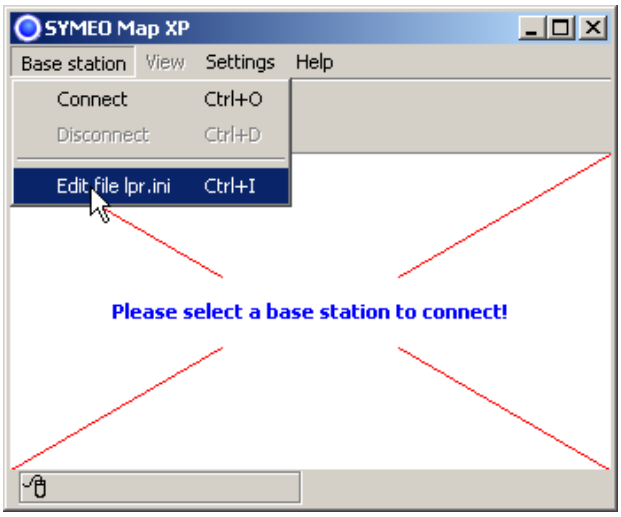
Symeo MAP requires a PC (Windows XP or Vista), that can access the LPR base station (the computer were FusionEngine runs) via a TCP/IP connection. Symeo MAP can connect to any base station to display the current position and the quality of the position measurement.

8.1 Configuration and Connection with Symeo MAP

8.1.1 lpr.ini

The file lpr.ini must be modified for commissioning of Symeo MAP. This file contains the connection parameters (hostname and ports) of the mobile units.

The file lpr.ini can either be opened in the installation directory of Symeo MAP or by open the software Symeo MAP:



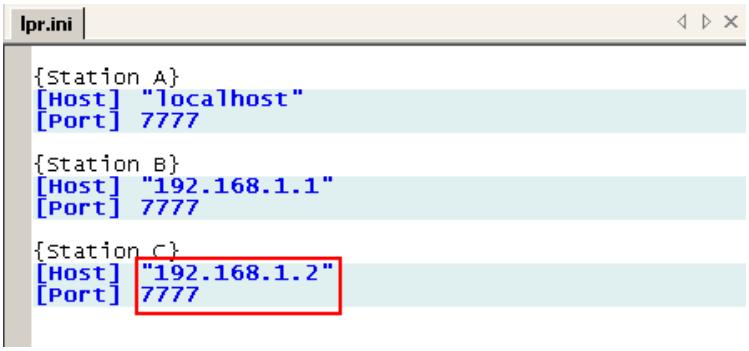
⇨ Open the file Symeo_MAP.exe

Cancel the following dialog: “Select connection”.

⇨ Click in „Base station“

⇨ Click on „Edit file lpr.ini“

The file LPR.ini is opened in text editor. After modification save the changes and close the file.



Here only the TCP/IP address and port must be entered. The port must be consistent with the port entered in the file fusion.ini (see 7.4.1). Default port is 7777.

⇨ Allocate a name for the Fusion Engine, i.e. Station_A or forklift1.

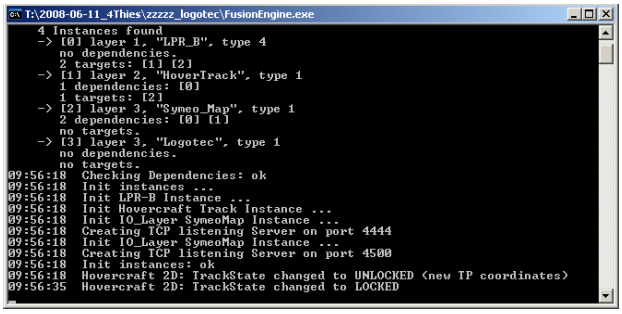
Note	For each mobile unit it is possible to specify a FusionEngine. There are unlimited entries of Fusion Engines possible.

⇨ Enter the IP-address of the mobile unit. The Host is either an external PC where the FusionEngine operates or the mobile unit. If the FusionEngine and Symeo MAP operate on the same PC, enter “localhost”.

⇨ Enter the port of that mobile unit. The default port is 7777. It must be consistent with the port entry in the file fusion.ini (chapter 7.4.1). If you change the port in the file fusion.ini you have to upload this file to the mobile unit with the program WinSCP (7.5).

8.1.2 Starting FusionEngine

In the case the software Fusion Engine is running on an external PC, the software FusionEngine must be executed. If the software FusionEngine operates on the mobile unit skip this chapter.

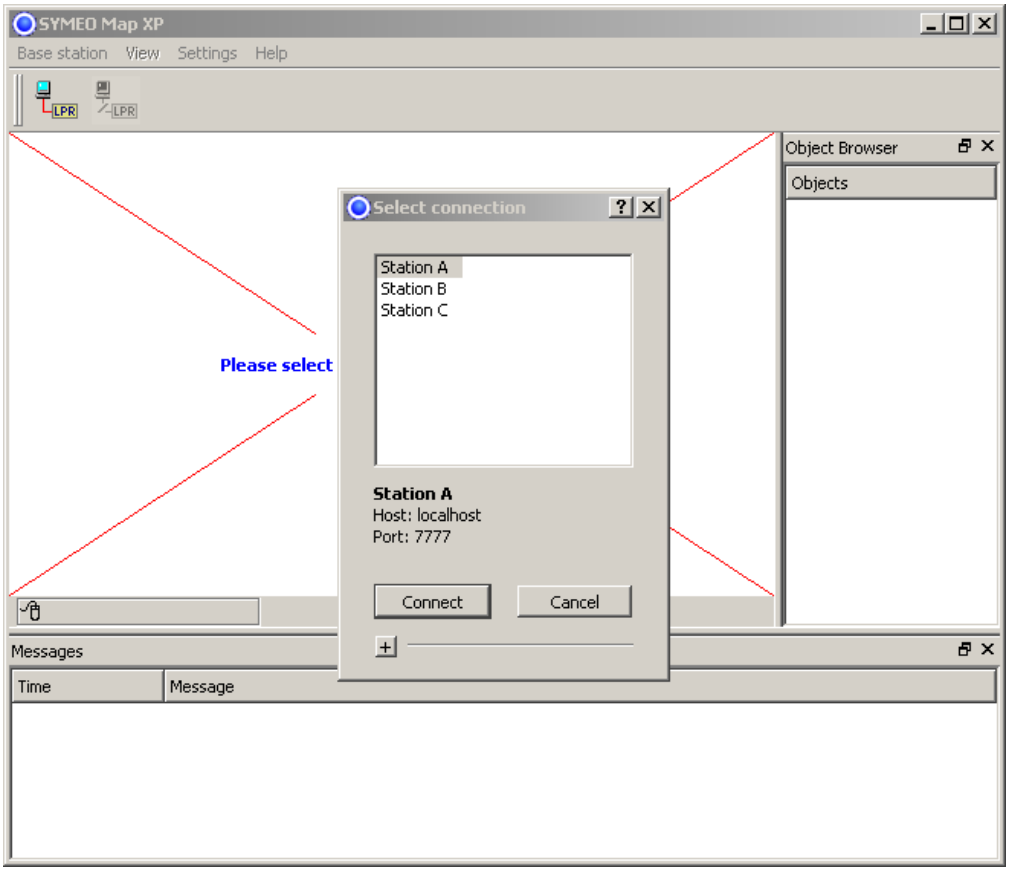


⇨ Open the file FusionEnine.exe

The picture on the left is shown.

Let this window open as long you want to make a position.

8.1.3 Starting Symeo Map

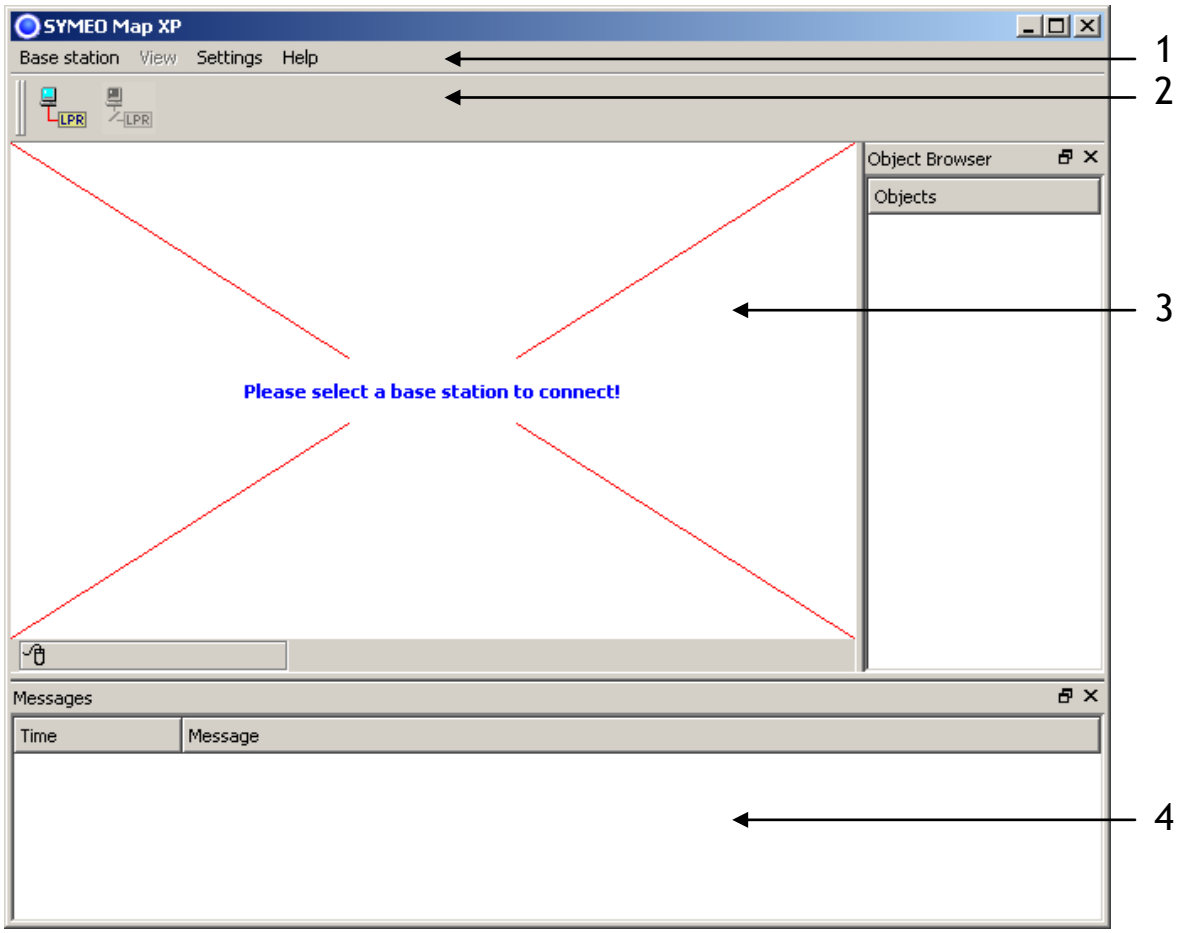


Double-click the "SYMEO_Map.exe" executable file.

The main window for the application opens:

Depending on how many fusion engines are defined in the lpr.ini file you can choose a mobile unit that is connected to the PC.

Note	If you have not modified the lpr.ini file as described in chapter 8.1.1 press „Cancel“ for canceling the dialog and modify the file like described in chapter 8.1.1.



The main window of Symeo MAP is divided into the following areas:

1 - MENU BAR

The menu bar offers the menus of Symeo MAP. Click a menu to display additional functions. The following menus are available:

- **Base station**: You can connect or disconnect to a FusionEngine base stations and edit the lpr.ini file.
- **View**: This menu is only active if you are connected to a FusionEngine. You can show/hide the display elements (grid lines, coordinate axes, transponder radii etc.). You can carry out actions (measure distances and calibrate antenna cables).
- **Settings**: Selection of the language (German/English).

Note	You have to restart Symeo MAP if the language was changed.

- **Help**: You can display the version number of Symeo MAP.

2 - TOOLBAR

The toolbar offers you the following options:

- The *Connect* button: Select a mobile unit and establish a connection (only active if no connection is open).
- The *Disconnect* button: Terminate an active connection with the mobile unit (only active if a connection is open).

3 - POSITION DISPLAY

If you are connected to a FusionEngine, the LPR-2DB transponders and the current position of the mobile unit are displayed in this area. In the *View* menu, you can customize your LPR display.

4 - MESSAGE WINDOW

The message window provides additional information about the current task.

8.1.4 Connection with mobile unit

Note	The base stations must be connected to the PC on which the software is running.

⇨ To terminate the connection, click the →*Disconnect* button on the toolbar or select the menu item → *Base station - Disconnect*.

8.2 Display of Symeo MAP

In Symeo MAP there is number of settings and displays for visualization.

8.2.1 Level of Transponders

The signal levels from the transponders that are being received are displayed in color according to the following scale:

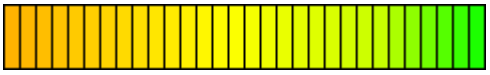


Figure 50: Color scale representing transponder levels

- green: very good reception
- yellow: normal reception
- orange: weak reception

The following colors are also used:

- gray: the transponder was not included in the measurement.
- red: the transponder has been reported as faulty.

8.2.2 Radius/ Hyperboloids of Transponders

R To enable/disable the radius/ hyperboloids of the transponders press the r-key.

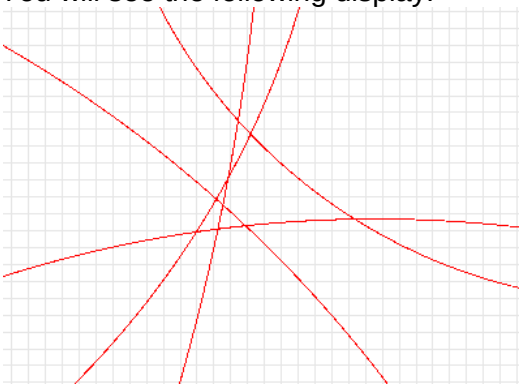
8.3 Antenna Calibration

Mode: Basic Cell/ Managed Cell/ TDOA

The antenna calibration must only be done in mode 1 (Basic Cell) and mode 2a, 2b (Managed Cell). In mode 3a, 3b (TDOA) this chapter can be skipped.

If the transponder radio signals do not intersect at a point in the LPR display, the parameter for the length of the antenna cable must be calculated and entered in the parameter file.

You will see the following display:



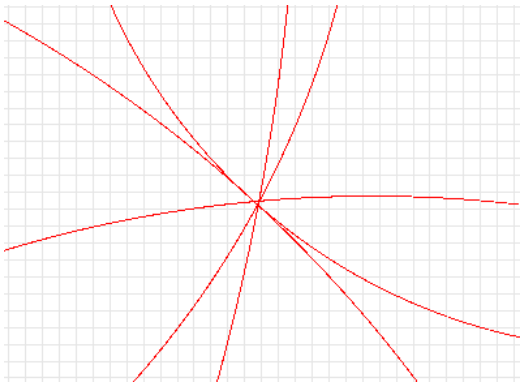


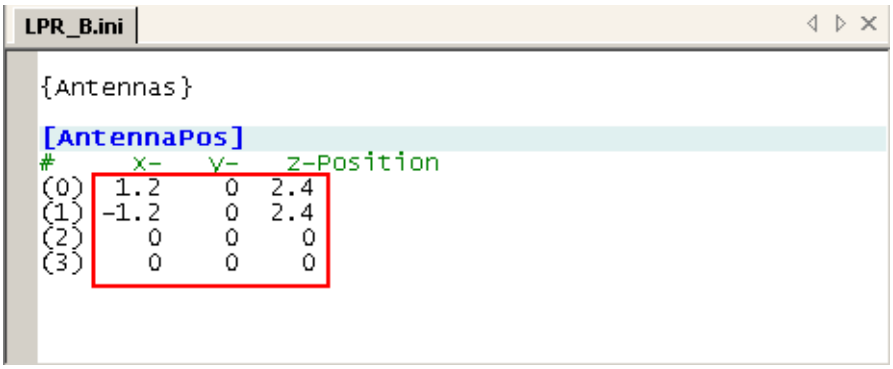
Figure 55 - Incorrect length value (left) and correctly adapted cable offset (right)

To get the cable offset values for all connected antennas:

- ⇨ If several antennas are connected to the base station, first select an antenna by pressing the 'A' key
- ⇨ The antenna should be located in the middle of the measurement range.
- ⇨ Start the antenna calibrating mode by selecting menu item *View → Actions → Calibrate antenna cable*
- ⇨ Press the +/- keys until the transponder radii all intersect at roughly the same point.

The calculated length of the cable offset will be displayed as a blue text in the position display window together with the number of the associated parameter. You must transfer this value to the LPR_B.ini file (see chapter 7.4.3).

If a second, third or fourth antenna is used you have to repeat the procedure.



Caution

The antennas in the file LPR_B.ini are labeled from 0 to 3. The calibration value for antenna 1 must entered at (0), the value for antenna 2 at (1), etc.

If the FusionEngine operates on the mobile unit (ARM9), you have to upload the modification in the file LPR_B.ini to the mobile unit (see chapter 7.5.1).

9 Network Settings

Having a LPR station with TCP/IP interface the network settings for this station are described in this chapter.

Therefore it is necessary to open a TCP/IP connection between your computer and the LPR station.

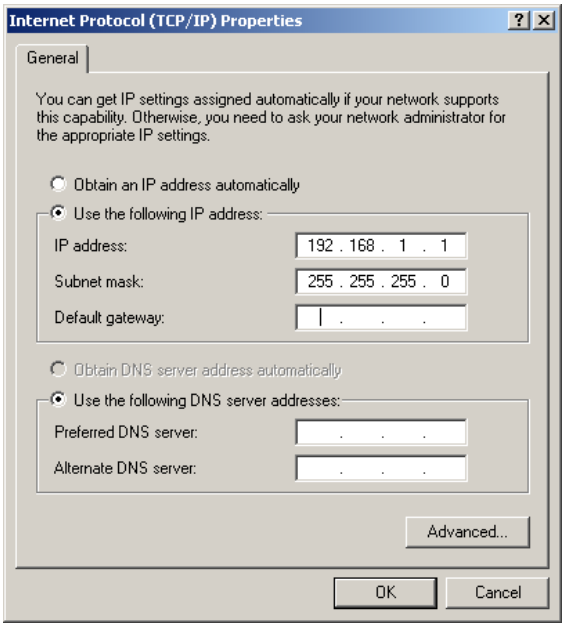
9.1 TCP/IP connection between PC and LPR-2DB station

Note	With delivery the LPR-2DB stations have the fixed IP-Address 192.168.1.99.

You can change the IP-Address of the LPR-2DB Station via the web interface of the LPR-Station (see chapter 9.3).

Note	To get a connection between your PC and the mobile station it is maybe neccessary to change the network parameters of your computer. Both units must be located in the same network. That means in this example that the first three numeric pads of both IP-addresses must be the same.

Disconnect your PC from the network. Connect the LPR-2DB station and the computer with a network cable. Open your network settings of your computer.



Enter the following fixed IP-Address i.e. 192.168.1.1. The subnet mask should be set to 255.255.255.0.

Click in both windows OK.

Note	If you firewall settings are too restrictive, you may not get access to the LPR-1D station. In this case temporarely deactivate the firewall under the tab „Advanced“ in the dialog window “Network settings”.

The LPR-2DB Station should be available via your PC now. You can check the connection with a „ping” to the LPR station:

Open the Command-Window:

⇨ Windows Start Button

⇨ Choose Run

⇨ Enter cmd and click OK

⇨ Enter in the cmd.exe window: ping 192.168.1.99 or the IP-address of the LPR-2DB station.

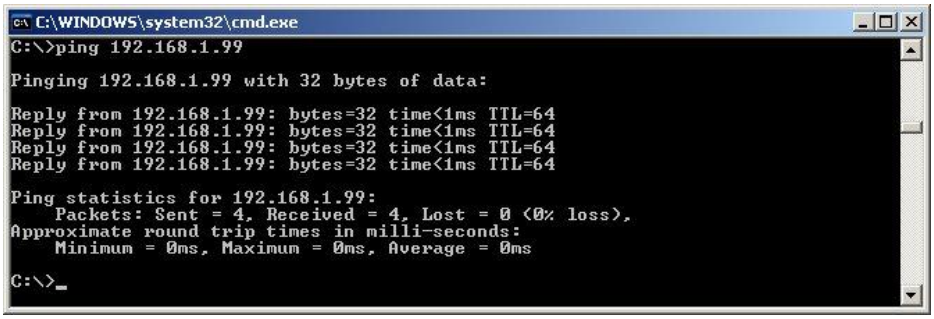


Figure 56 – Ping LPR-2DB Station

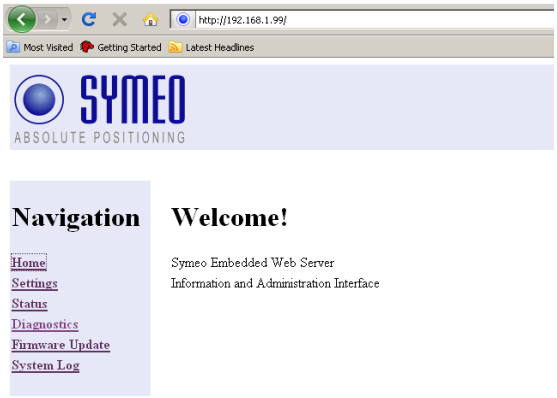
The LPR-2DB Station should answer with a ‚Reply'.

9.2 Open Web Server

Open your web browser. In the address bar of the web browser enter the IP-address of the LPR station: http://192.168.1.99. Press Enter.

i Note	The IP-address of the LPR station is 192.168.1.99 per delivery status except another IP-address is labeled outside the box.

i Note	You can establish a connection with your LPR stations Web server either via HTTP or HTTPS if the station has been configured for this (see section "Settings", "HTTP" and "HTTPS" fields in the "Remote Access" area). In HTTP connections, the data is transmitted unencrypted. In HTTPS connections, it is encrypted for transmission (AES-256, 256-bit encryption).

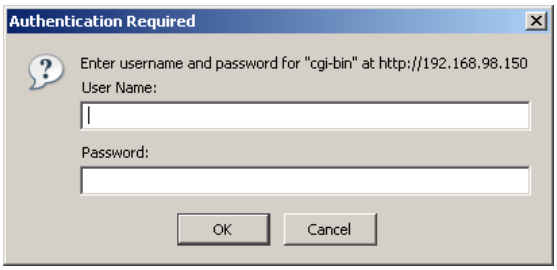


A connection is established with your LPR station.

In the case of an HTTPS connection, you may see two dialog boxes. Confirm them both with OK.

Then the Welcome page for the LPR station's Web server will appear.

⇨ Click the function you want in the navigation bar. The individual functions are described in the following sections.



You will be prompted to enter your information for authentication.

⇨ Enter user name "symeo" and the password, and click "OK". The password has been set to "54all2u" by the manufacturer.

Note

In order to protect your system from being reconfigured by unauthorized persons, you should change this to a company password that is only provided for authorized personnel.

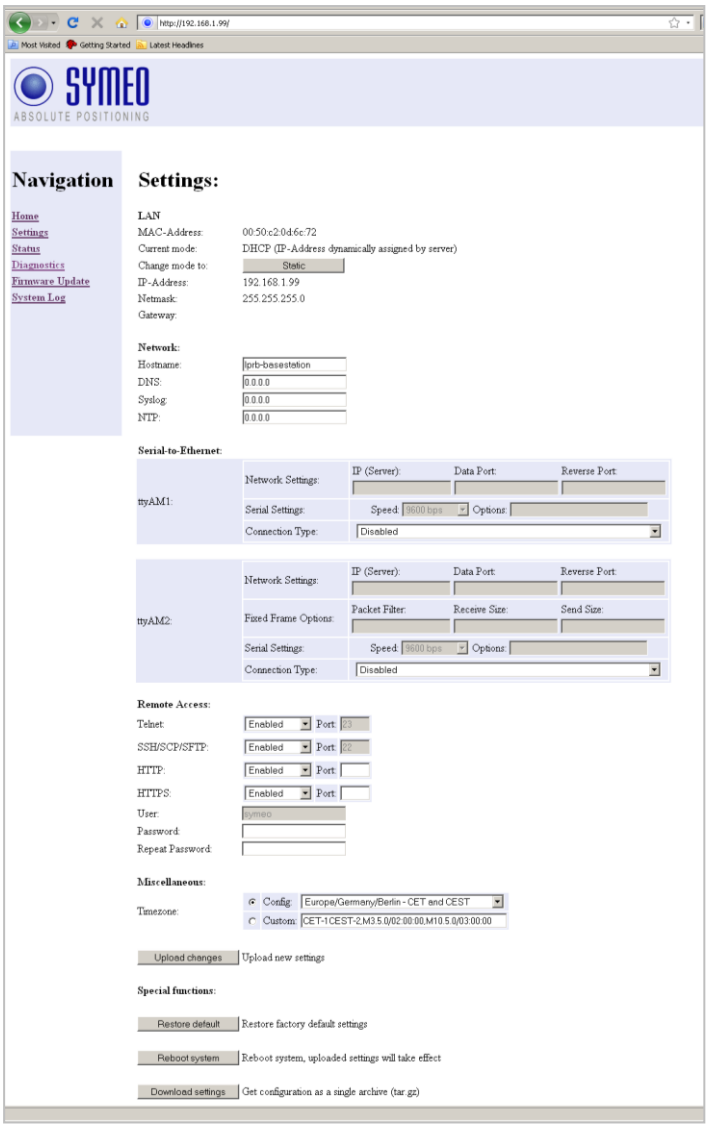
9.3 Settings

With this function you can define the network settings on your LPR station and the network access settings and reboot the system.

⇨ Click "Settings" in the navigation bar.

⇨ If you have not yet provided authentication information you will be prompted to do so now.

The Settings page for the LPR station's Web server is displayed.



The following menu is displayed:

LAN:

⇨ Overview about LAN settings of LPR station (static or dynamic IP address) (see chapter 9.3.1)

Network:

⇨ Network settings (see chapter 9.3.2)

Serial-to-Ethernet:

⇨ Settings of parameterization port (see chapter 9.3.3.1)

Remote Access:

⇨ (See chapter 9.3.4)

Miscellaneous:

⇨ Setting of time zone (see chapter 9.3.6)

Special Functions:

⇨ (see chapter 9.3.6)

i Note

To accept the changings of the LPR station press button „Upload changes“. Afterwards press button “Reboot System“ to reboot the LPR station with the new settings.

9.3.1 LAN

MAC-Address	Unique hardware address of the LPR station on the LAN (Ethernet ID) (not editable)
Current Mode	Shows the current mode: "Static IP-Address" or "DHCP Active". Per default the IP-address is set to the static IP-address 192.168.1.99. In "DHCP Active" mode, the LPR station receives a dynamic or reserved IP address from the DHCP server. You can also ask your administrator or

	the SYMEO technical department about this. Note If the LPR station is set to „DHCP“ but does not get after the reboot within 60 sec an IP-address from the DHCP server the last applied fixed IP-address is used.
Change Mode	A button is labeled "DHCP" or "Static" depending on the "Current mode" field. Click this button to switch from "DHCP Active" mode to "Static IP-Address" mode or vice versa.
IP-Address	IP address of the LPR station (default: 192.168.1.99) In "DHCP Active" mode, this address is assigned by the server and cannot be edited. In "Static IP-Address" mode you can assign a fixed (static) address here.
Netmask	Net mask of the LPR station (default: 255.255.255.0) In "DHCP Active" mode, the net mask is assigned by the server and cannot be edited.
Gateway	IP address of the standard gateway Other LAN segments can be reached with the standard gateway. In "DHCP Active" mode this address is assigned by the server and cannot be edited.

9.3.2 Network

Hostname	Hostname of the system (default: "lprb-basestation"). In "DHCP Active" mode, this hostname is also communicated to the DHCP/DNS server. A name that will be reserved on the DNS server can be entered here. You can also ask your administrator or the SYMEO technical department about this.
DNS	IP address of the DNS server: The DNS server is able to translate hostnames into IP addresses. In "DHCP Active" mode this address is assigned by the server and cannot be edited.
Syslog	IP address of the Syslog server (default: 0.0.0.0, i.e. this service has been disabled). The Syslog server is a server on the network to which it is planned to have system messages (system log) transmitted. Transmission is packet-based (UDP) and unencrypted.
NTP	IP address of the NTP server (default: 0.0.0.0, i.e. this service has been

	disabled). The NTP server is a server on the network from which the system can request the current time.

9.3.3 Serial-to-Ethernet

ttyAM1	Port number of the TCP/IP port via which the data from serial port (ttyAM1) is sent and received. ttyAM1 is the port for the parameterization interface (Service Port). (default: 3045)
ttyAM2	Port number of the TCP/IP port via which the data from serial port ttyAM2) is sent and received. ttyAM2 is the port for the data interface (Binary Port). If the software FusionEngine is operating on the ARM9 Board of the mobile unit, this port must be disabled! If the software FusionEngine is operating an external PC, this port ttyAM2 must be enabled. (default: 3046)

i Note	Per default these two ports are not enabled. Choose the Connection Type between the LPR station and your PC or PLC for each port. Depending on the connection you select different masks are editable.

9.3.3.1 ttyAM1/ Parameterization port

Network Settings

IP (Server)	If applying Connection Type „TCP – Connecting to Data Port using Reserve Port“ you enter here the IP-address of the server, to which the connection should be established.
Data Port	Port-Number of TCP/IP Port. Data of serial interface (ttyAM1) is sent and received. ttyAM1 is the parameterization port. Default value is 3045.
Reverse Port	If applying Connection Type „TCP – Connecting to Data Port using Reverse Port“ you enter here the port, which the server should use for the reverse channel.

Serial Settings Area

Speed	Baud rate of serial interface (ttyAM1). The baud rate of the parameterization port is set to 115200 baud per default.
Options	Settings of serial interface ttyAM1 for the data protocol. These settings are not necessary to change and are set per default to raw –echo –ixon (Raw data, no echo, no control character).

Connection Type Area

Disabled	The port is disabled and not reachable via TCP/IP.
TCP – Listening on Data Port	The LPR station is waiting for incoming connection on the “Data Port”. If the connection is opened successful you can open the parameterization port.
TCP – Connection to Data Port using Reserve Port	The LPR station establishes the connection to the entered server address. Setting “Random” means both communication partners arrange the reverse channel autonomously. If the connection is opened successful you get access to the parameterization port.

9.3.3.2 ttyAM2 binary port

Network Settings

IP (Server)	For all active Connection Types the IP-address of the server is required to which the connection should be established.
Data Port	Port-Number of TCP/IP Port. Data of serial interface (ttyAM2) is sent and received. ttyAM2 is the binary port. Default value is 3046.
Reverse Port	For all active Connection Types a reverse channel for data transmission is required.

Serial Settings Area

Packet Filter	If selected type “Fixed Frame” it is possible to filter packed data. Default value is „none”. Example: “2,3” filters the data type 0x02 (Send request) and data type 0x03 (relay switching command).
Receive Size	If selected type “Fixed Frame” it is possible to set the frame size of the received data packed. Example: For 1D-application a frame size of 15 Byte is sufficient. A smaller telegram must me filled with 0x00.
Send Size	If selected type “Fixed Frame” it is possible to set the frame size of the sent data packet. Example: For 1D-applicaiton a frame size of 21 Byte is sufficient. A smaller telegram is filled with 0x00 by the LPR station.

Connection Type Area

Disabled	The port is „Disabled“ and not be reachable via TCP/IP.
TCP – Variable Frame – Listening on Data Port	The LPR station is waiting for incoming connection on the “Data Port”. If the connection is opened successful you can open the binary port. „Variable Frame“ means activated „Byte Stuffing“ (no fixed protocol length).
TCP – Variable Frame – Connecting to	The LPR station establishes the connection to the entered server IP-address. Setting “Random” means both communication partners arrange the reverse channel autonomously. If the connection is opened

Data Port	successful you get access to the binary port. „Variable Frame“ means activated „Byte Stuffing“ (no fixed protocol length).
TCP – Fixed Frame – Listening on Data Port	The LPR station is waiting for incoming connection on the “Data Port”. If the connection is opened successful you can open the binary port. „Fixed Frame“ means deactivated „Byte Stuffing“ (fixed protocol length).
TCP – Fixed Frame – Connecting to Data Port	The LPR station establishes the connection to the entered server IP-address. Setting “Random” means both communication partners arrange the reverse channel autonomously. If the connection is opened successful you get access to the binary port. „ Fixed Frame“ means deactivated „Byte Stuffing“ (fixed protocol length).
UDP – Fixed Frame – Sending to Data Port	The LPR station sends and receives data (UDP) to and from the entered server IP-address. The reverse channel uses also the data port. „Fixed Frame“ means deactivated „Byte Stuffing“ (fixed protocol length).

9.3.4 Remote Access

Telnet	Click this checkbox to allow or prevent console accesses to port 23 via Telnet (checked: accesses are allowed). The port number is not editable. See also section "Extended system access".
SSH/SCP/SFTP	Click this checkbox to allow or prevent console accesses to port 22 via SSH (Secure SHell and data transmission via SCP (Secure CoPy) or SFTP (Secure File Transfer Protocol) (checked: accesses are allowed). The port number is not editable. See also section "Extended system access".
HTTP	Click this checkbox to permit or forbid accesses to the LPR station's Web server via HTTP (unencrypted transmission) (checked: accesses are allowed). You must also enter the corresponding port number as appropriate. The port number is set to 80 (http protocol standard) by the manufacturer.
HTTPS	Click this checkbox to permit or forbid accesses to the LPR station's Web server via HTTPS (encrypted transmission) (checked: accesses are allowed). You must also enter the corresponding port number as appropriate. The port number is set to 443 (http protocol standard) by the manufacturer.
User	User ID for access to the TCP/IP port. It has been set to "symeo" by the manufacturer and cannot be changed.
Password	Enter the new password here if you want to change the password. The password has been set to "54all2u" by the manufacturer.
Repeat Password	Enter the new password again here if you want to change the password.

Extended system access („Remote Access“) enables console access via Telnet, SSH (Secure SHell), SCP (Secure CoPy) and via the serial port. This enables extended system information to be retrieved and troubleshooting to be carried out. We recommend that you disable all functions that are not required, see section "Settings".

Caution	In extended system access, the user "SYMEO" has 'ROOT' privileges, i.e., full access to the system. Depending on the settings made, the system can also be damaged and such damage may or may not be reparable. If you have any questions, please contact the SYMEO technical department.

The enormous range of functions that are available to console access means that only some can be documented here. To find out more, please contact your IT administrator or Symeo Support.

9.3.5 Miscellaneous

Timezone	If a NTP-server is available and the IP-address of the NTP-server is entered you can choose the time zone of the LPR station. It is alos possible to enter the time zone manually.

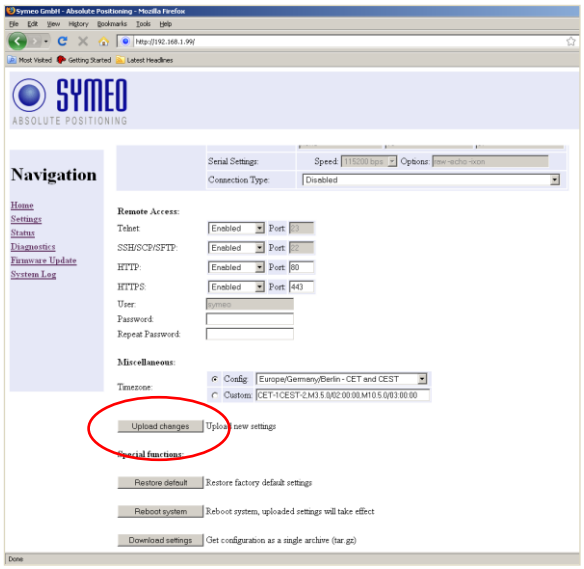
9.3.6 Special functions

Restore default	Click this button to restore the settings made by the manufacturer. Click the "Execute" button (Restore factory default settings) in the "Special functions" area to cancel all changed settings and restore the factory settings. The settings made by manufacturer are activated first after a reboot of the LPR station. This means that changes of the settings (i.e. IP-address) are possible. Caution The settings affected will be deleted and populated directly with the factory settings. Note When the factory settings have been restored, it may be necessary to proceed as if commissioning the system again.
Reboot system	To accept the settings the LPR station must be rebooted. Click this button to reboot the system. Note Before you reboot the system the settings must be loaded to the LPR station by pressing button “Upload changes”.
Download	Press the button „Download Settings“ to download a copy of the

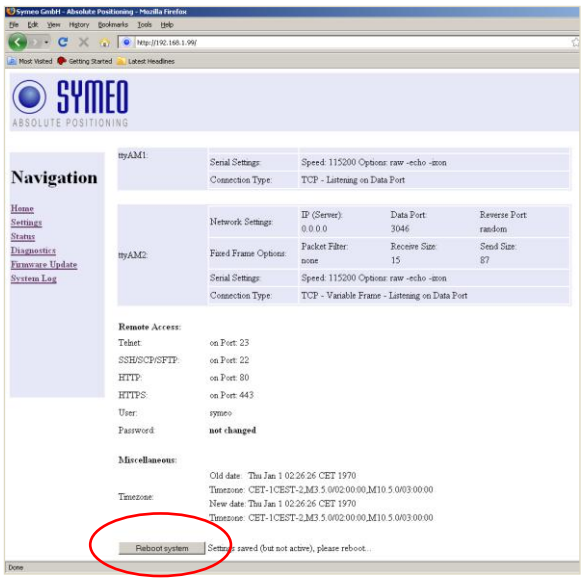
settings	configuration as a backup.

9.3.7 Accept settings/ System reboot

As described in chapter 9.3.6 it is necessary to transmit the changes to the LPR station and afterwards reboot the station.



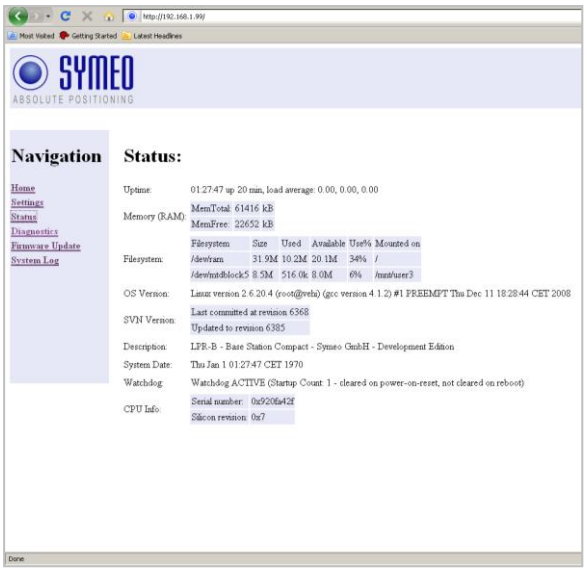
⇨ Press button „Upload changes“ to load the changes.



⇨ Scroll down to the end of the page and press „Reboot System“ to reboot the LPR station.

9.4 System status

With this function, you can display the current system status.



⇨ Click “Status" in the navigation bar.

If you have not yet provided authentication information, you will be prompted to do so now (see section "Starting and using the Web server").

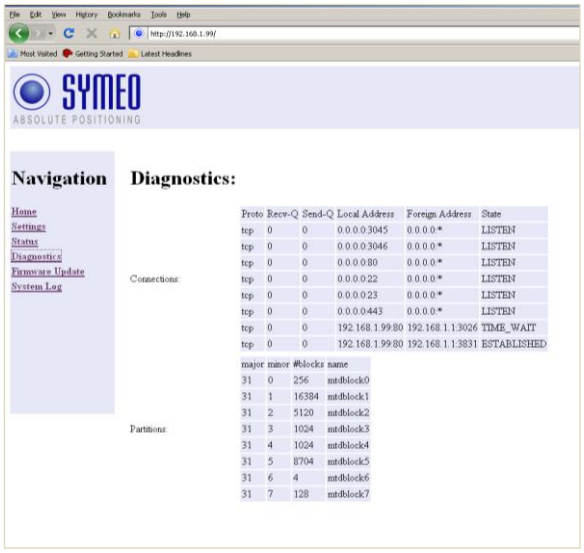
The Status page for the LPR station's Web server is displayed.

The fields have the following meanings:

Uptime	01:27:47 – Current system time up 20 min – Time since the last system start load average: 0.00, 0.00, 0.00 – Average system load for the last 1, 5 and 15 minutes. The load indicates how many processes are waiting to receive computing time
Memory (RAM)	MemTotal: Total usable working memory (physical RAM less a number of reserved bits and the kernel code) MemFree: Free working memory
Filesystem	Details about the active file systems and associated statistics.
OS Version	Operating system, kernel, compiler and compiling date
SVN Version	Current version of software
Description	Description of the system
System Date	Current system time
Watchdog	Status of the hardware watchdog, including counter of start operations since the last switch-on (connection of the power supply). A value between 2 and 127 means that the watchdog has triggered that number of system restarts. The counter is reset at 'power-on-reset' (connection of the power supply) and 'user-rest' (jumper on motherboard). In a reboot (e.g. from the Web page), the current counter status is not reset.
CPU Info	Serial Number: Globally unique identification number of the processor used (applied to each chip individually with a laser during production). Silicon Revision: Version of the processor used 0x0 Rev. A 0x1 Rev. B

	0x2 Rev. C 0x3 Rev. D0 0x4 Rev. D1 0x5 Rev. E0 0x6 Rev. E1 0x7 Rev. E2

9.5 Diagnostics



Connections: State of the active and inactive connection to the LPR station

Partitions: Size and name of available partition of non-volatile memory.

Note

The size of receive buffer (Recv-Q) and send buffer (Send-Q) should be zero if possible. A long lasting value grater zero means problems when receiving or sending data. This happens if the data cannot be readout fast enough.

Example 1 – waiting for incoming connection:

Proto	Send-Q	Recv-Q	Local-Address	Foreign Address	State
tcp	0	0	0.0.0.0:3045	0.0.0.0:*	LISTEN

If Connection Type „TCP - Listening on Data Port“ (ttyAM1) is enabled this table shows further connection information.

Proto: Protocol (TCP, UDP)

Recv-Q: Number of buffered Bytes, which are received from the LPR station

Send-Q: Number of buffered Bytes, which the LPR station should send

Local-Address: LPR Interface address (0.0.0.0 – listening to all interfaces)

Foreign Address: IP-address of opposite station

State: Status of connection

Example 2: - successful established connection

Proto	Recv-Q	Send -Q	Local-Address	Foreign Address	State
tcp	0	1	192.168.1.99:3045	192.168.1.1:1333	ESTABLISHED

Of Connection Type „TCP - Listening on Data Port“ (ttyAM1) is enabled this table shows further connection information.

Proto: Protocol (TCP, UDP)

Recv-Q: Number of buffered Bytes, which are received from the LPR station

Send-Q: Number of buffered Bytes, which the LPR station should send

Local-Address: LPR Interface address (192.168.1.99) with port (3045)

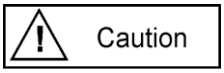
Foreign Address: IP-address of opposite station (192.168.1.1) with port (1333)

State: Status of connection

9.6 Update Firmware

With this function you can update the firmware.

The firmware can be updated for example when a firmware with improved functional scope is available for the LPR system.

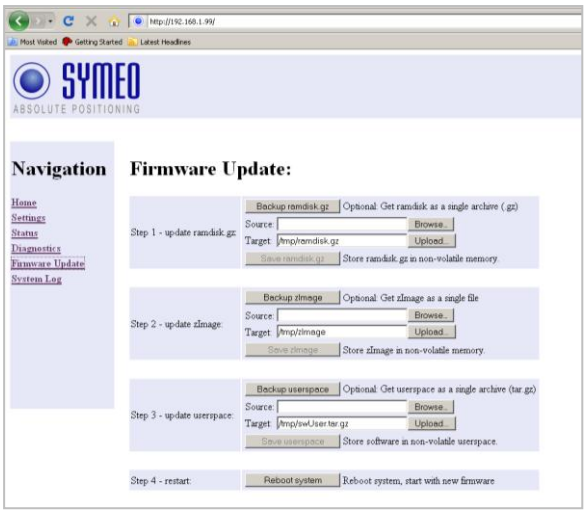


But the system can also be irreparably damaged by a firmware update. Please make absolutely sure that the files are correct (file names and the version has been released by SYMEO), and proceed carefully and methodically. If the firmware update has not been carried out properly, or if problems arise of the system can no longer be accessed, contact Symeo Support.

⇨ Click "Firmware Update" in the navigation bar.

If you have not yet provided authentication information, you will be prompted to do so now.

The Firmware Update for the LPR station's Web server is displayed.



The page Firmware Update of the Web-Servers of the LPR station is displayed.

A firmware update is performed in several steps:

Step 1: File system

Step 2: Linux-Kernel

Step 3: Optional (2D Application)

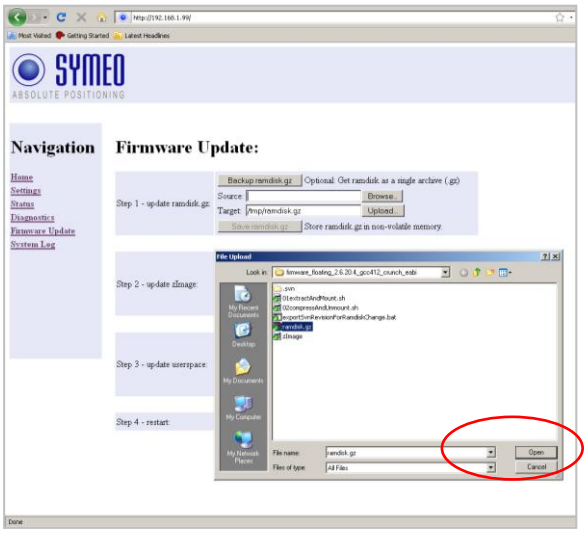
Step 4: Restart

Step 3 is exclusively for an update for 2D application. Otherwise this part can be skipped.

9.6.1 Step 1 – File system

Note

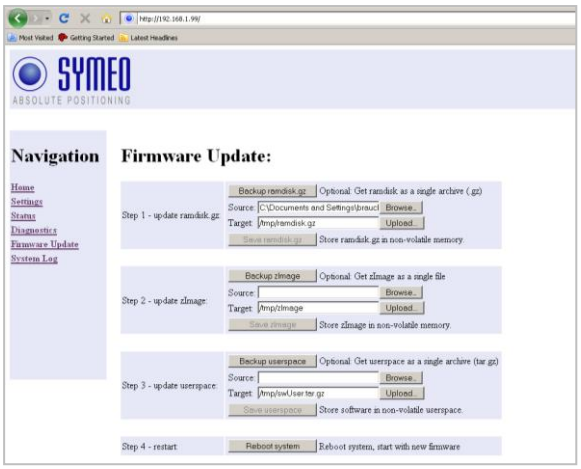
It is possible to make a copy of the actual firmware by downloading the firmware from the LPR station. Click the button „Backup ramdisk.gz“.



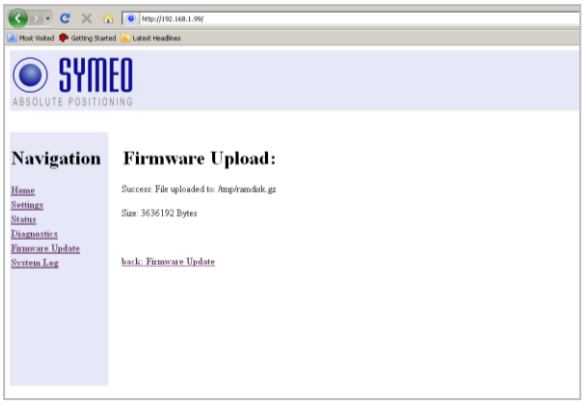
⇨ Click the "Browse" button in the "Step 1 – flash ramdisk.gz" area.

A file browser window will open.

⇨ Navigate to the file you want and click "Open".

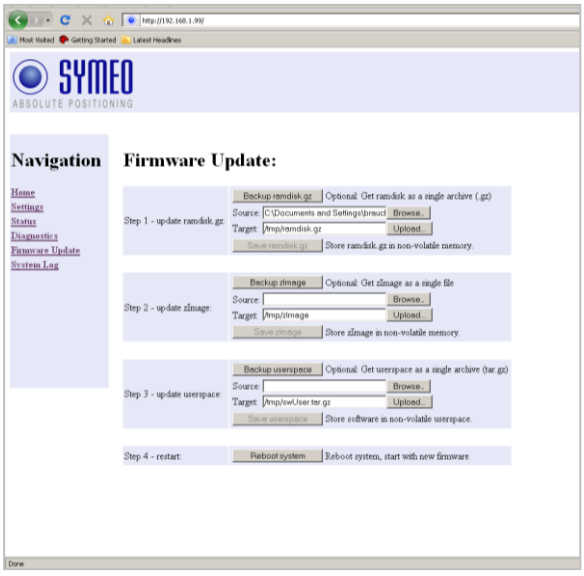


⇨ Click the "Upload" button in the "Step 1 – flash ramdisk.gz" area.

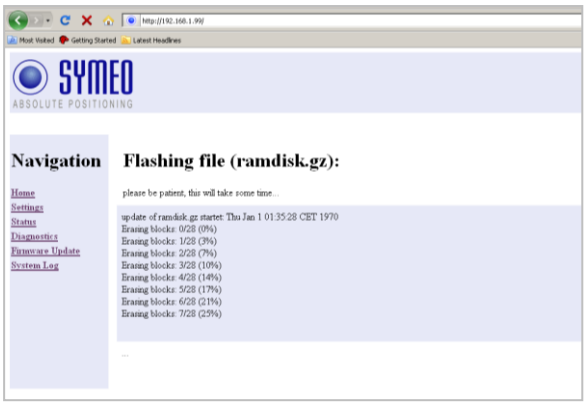


The file has been transferred.

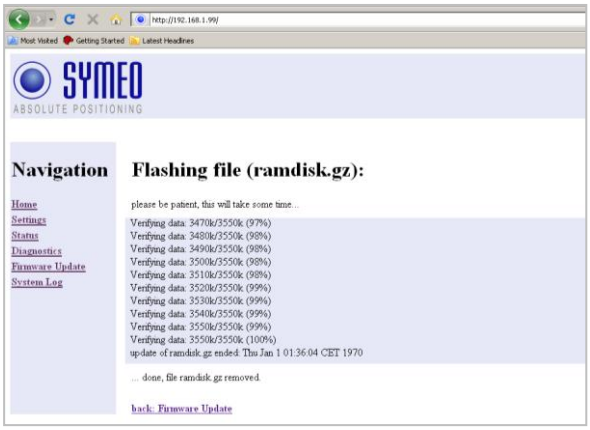
⇨ Click the "back: Firmware Update" link.



⇨ Click the "Execute" button in the "Step 1 – flash ramdisk.gz" area to transfer the file to the non-volatile memory.



Transfer progress is displayed in a message window.Transfer progress is displayed in a message window.



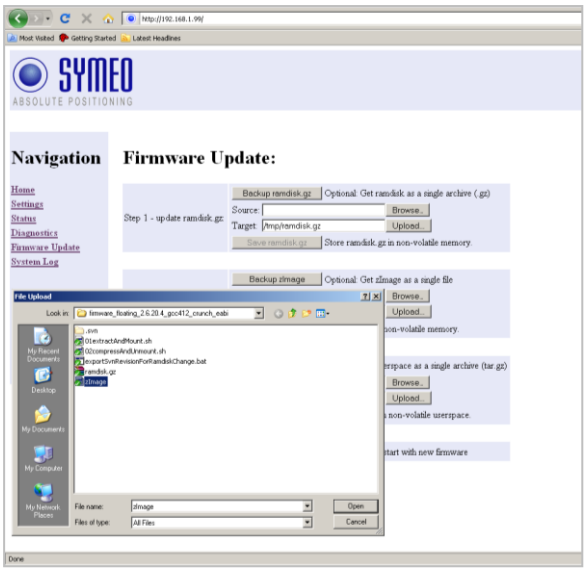
You will know when this operation is complete because a message: "... done, file ramdisk.gz removed" will be output and a link "back: Firmware Update" is provided

⇨ Click the "back: Firmware Update" link.

9.6.2 Step 2 – Linux Kernel

i Note

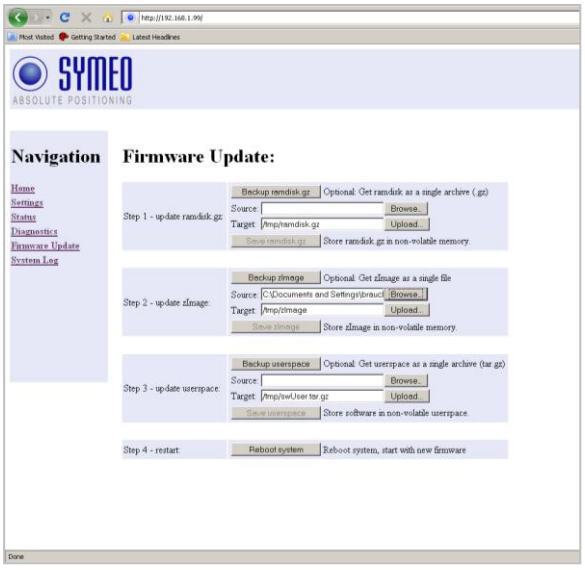
It is possible to make a copy of the actual firmware by downloading the firmware from the LPR station. Click the button „Backup zImage “.



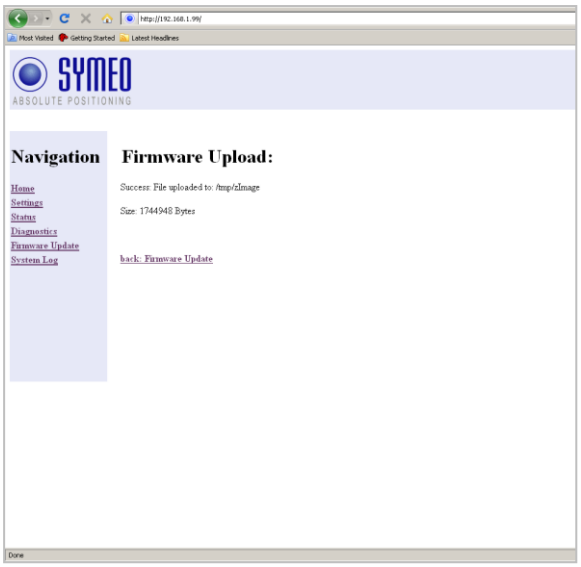
⇨ Click the "Browse" button in the "Step 2 – flash zImage" area.

A file browser window will open.

⇨ Navigate to the file you want and click "Open".

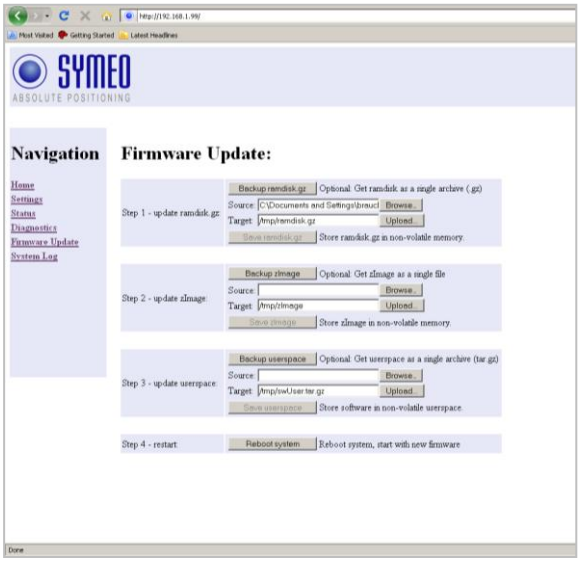


⇨ Click the "Upload" button in the "Step 2 – flash zImage" area.

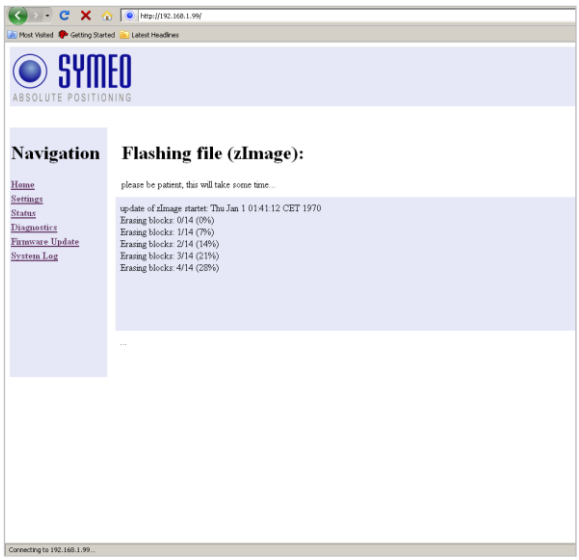


The file has been transferred.

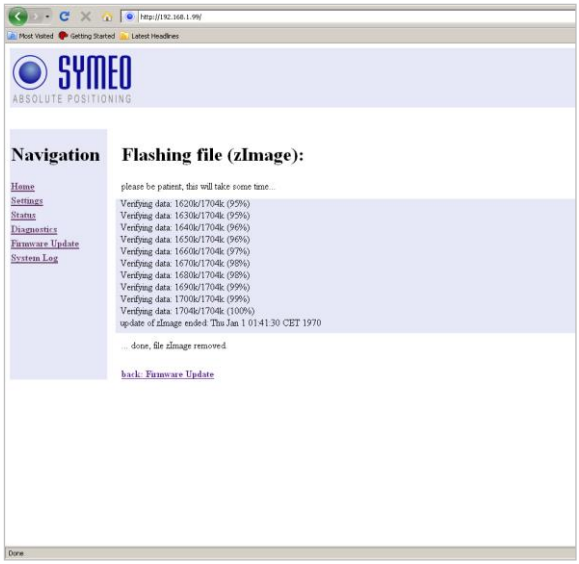
⇨ Click the "back: Firmware Update" link.



⇨ Click the "Execute" button in the "Step 2 – flash zImage" area to transfer the file to the non-volatile memory.



Transfer progress is displayed in a message window.



You will know when this operation is complete because a message: "... done, file zImage removed" will be output and a link "back: Firmware Update" is provided

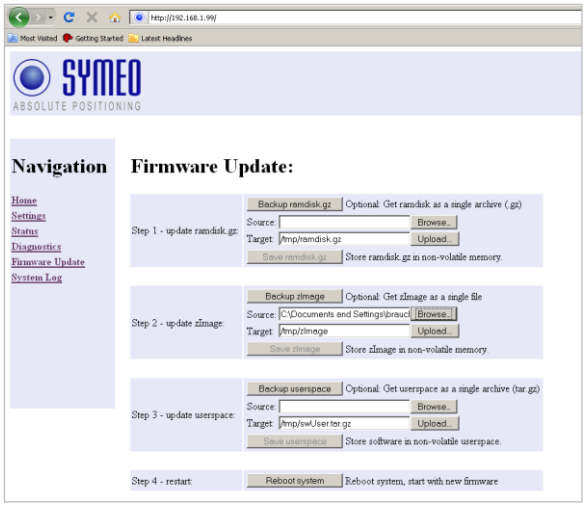
⇨ Click the "back: Firmware Update" link.

9.6.3 Step 3 – User space (optional)

This step is exclusively for 2D-applications necessary and is executed the same way as described before.

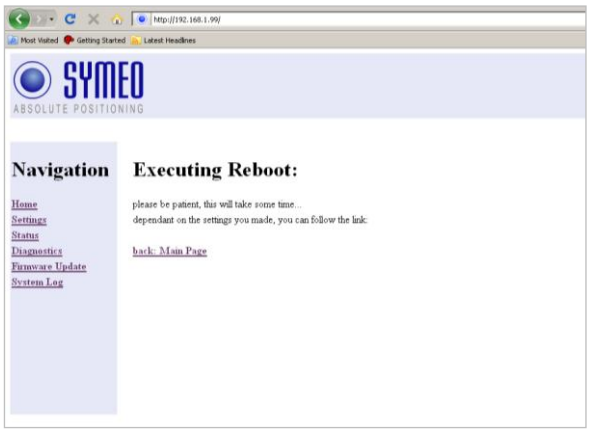
9.6.4 Step 4 – Restart

To complete the firmware update, you must restart the system.



⇨ To do this, click the "Execute" button in the "Step 3 – Restart" button.

The system will be restarted.



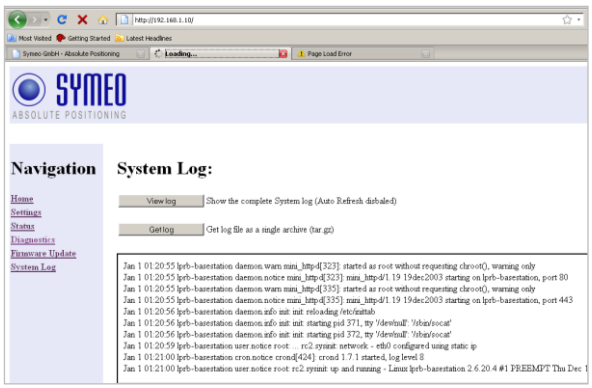
Note If the new firmware contains additional configuration files the settings you made are set to factory settings. This would be also applied for the IP-address which iss et the tot he default value 192.168.1.99.

Symeo recommends restoring the factory settings after a firmware update and reenter the customer settings.

9.7 System Log

With this function, you can display the system messages (system log). The system messages are written to a 200KB capacity memory. When the memory is full, the oldest messages are overwritten. All messages are deleted upon restart.

Note The system messages can also be transmitted to a server on the network at the same time, see the "Syslog" field in the "Network" area in section "Settings".



⇨ Click "System Log" in the navigation bar.

⇨ If you have not yet provided authentication information, you will be prompted to do so now.

The last 10 system messages will be displayed. The message window is updated about once per second.

10Symeo 2D Protocol

10.1 Introduction / Basics

The Symeo 2D protocol is the interface between the LPR 2D system and the user. To keep the protocol simple (i.e. easy to parse) the following aspects are considered:

- consistent data packet

  The protocol has a standard data packet with a fixed length.

- configuration

  The structure of the protocol can be configured by the user. It is possible to output only the required data. Therefore you can use also a slower data interface when using less data.

The protocol is unidirectional. The LPR 2D system sends data to the user, but the LPR 2D system does not receive any data from the user.

You can choose between the binary format and the ASCII format. The formal structure of both protocols is the same.

10.1.1 Configuration file Symeo_2D.ini

To configure the protocol you have to set the parameters in the configuration file for the protocol (Symeo_2D.ini).

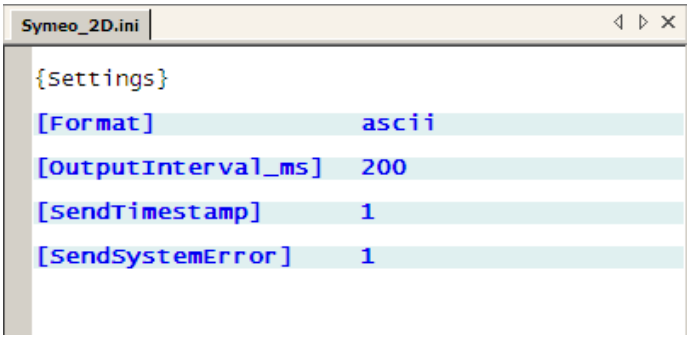


Figure 57 – configuration file Symeo_2D.ini (example)

The following text must be contained in the configuration file to choose the format of the protocol:

```
[format]   binary
```

or

```
[format]   ascii
```

A protocol output is sent at regular intervals - independent of the availability of a valid position.

The default output interval is 100 milliseconds. To set another output interval (e.g. 200 ms), insert the following parameter in the configuration file of the protocol:

```
[OutputInterval_ms]   200
```

i Note

With the default configuration (`OutputOnlyLockedTracks`=1 in data field POSITION), only valid positions are sent (`LOCKSTATE`=2). If there is no valid position available, no protocol output is generated – even if other data available (e.g. system errors).

If the default configuration is overwritten (`OutputOnlyLockedTracks`=0), an output is generated after each `[OutputInterval_ms]` ms, even if no valid position is available. In this case a position output of (0,0) is sent and `LOCKSTATE` has a value of 0 or 1.

10.2 Binary format of the protocol

For the binary format the entire data packet of the 2D protocol is transferred as binary data. This means that the binary format is more compact than the ASCII format, but is not human-readable.

10.2.1 Data types

The length of all data fields is a multiple of one byte.

The data types are exclusively bit field or integer. Integers can be signed or unsigned. This is specified in the description of each integer data field. Integer data fields with a length of more than one byte are all encoded in network byte order (Big Endian).

10.2.2 Byte Stuffing

The data packets are transmitted continuously with a constant length. The problem is here to identify the beginning of a data packet. Although an identification character for the beginning of the data packet is sent, exactly this identification can happen to appear in the following data packet. Without an additional technique it is not possible to detect the beginning of the data packet.

If the protocol is used with a TCP/IP interface, the first data packet is first sent when the socket is connected. The first byte of the socket is always the beginning of the data packet. Because all data packets have the same length and the transmission via TCP/IP is error proof, it is possible to read always the same length (bytes) of data packets on the receiver side.

If you use the RS-232 interface there is no proven failure free transmission of data. The receiver might start reading the data at an arbitrary moment. There is no possibility to detect the beginning of the data packet.

To use the protocol for a RS-232 interface the binary data must apply byte stuffing. When byte stuffing is active, reserved symbols are used to identify the beginning and the ending of a data packet. These symbols cannot be used in the regular data stream. Figure 58 shows the principal layout of this binary packet.

Data field	Symbol
`BINARY-START`	`0x7e`
Content of data packet …	…
`BINARY-STOP`	`0x7f`

Figure 58 – Detection of beginning and ending of data packet

If the reserved symbols are used in the data packet, they have to be substituted by the following symbols:

Original symbol	substituted in the

	protocol by
0x7d	0x7d 0x5d
0x7e	0x7d 0x5e
0x7f	0x7d 0x5f

Figure 59 – Substitution rules for byte stuffing

Each time one of the three exclusive symbols occurs in the data packet it is replaced by two other symbols. In the worst case the whole data packet consists of exclusive symbols. In this case the length of the data packet is doubled.

The byte stuffing makes sure that the receiver can identify the `BINARY-START` field definitively, even if the payload data contains the reserved symbol.

Decoding the byte stuffing at the receiver side can be implemented as following:

When reading symbol `0x7d`, discard this symbol and combine the next symbol via XOR-function with `0x20`, which will restore the original symbol.

The byte stuffing can only be used for the binary format of the 2D protocol. It is activated per default. If you want to disable byte stuffing you have to enter in the configuration file the following line:

```
[DisableBytestuffing]  1
```

10.2.3 General Structure

The structure of the data packet of the 2D protocol is identified in the configuration file. For one configuration all data packets have the same length and the same structure. In the configuration file you identify the desired data fields. Figure 60 shows the structure of the data packet for the standard configuration.

Data field
START
POSITION
END

Figure 60 - General structure of data packet with standard configuration

If required additional data fields can be activated. The sequence of the activated data fields is fixed and cannot be changed. Figure 61 shows the structure of the data packet with all activated data fields.

Data field
START

TIMESTAMP
POSITION
VELOCITY
ORIENTATION
POSITION-ERROR
VELOCITY-ERROR
ORIENTATION-ERROR
USER-DATA
SYSTEM-ERROR
SATELLITE-STATE
CRC
END

Figure 61 - General structure with all possible data fields

The data fields START and END cannot be deactivated. All other data fields can be enabled and disabled in the configuration file.

10.2.4 Data fields

In this chapter all data fields are described. Except the two data fields START and END (included in each data packet) each data field can be enabled and disabled by the user.

The unit of data length is one byte.

10.2.4.1 START

The data field START indicates the beginning of a data packet. It contains furthermore the data length of the whole data packet. One bit mask indicates which data fields are enabled.

Name	Length	Type	Description
`BINARY-START`	1	unsigned int	Exclusive Symbol `0x7e`, which identify the beginning of a data packet
`LENGTH`	2	unsigned int	Length of the entire data packet in byte (including the start and end field)
`SELECTED-FIELDS`	4	bitmask	The bit mask indicates which data fields are enabled and disabled in the data packet (see chapter 10.4).

Entire length of data packet: 7 Byte

10.2.4.2 END

The data field END indicates the end of each data packet.

Name	Length	Type	Description
BINARY-STOP	1	unsigned int	Exclusive symbol 0x7f to identify the end of a data packet.

Entire length of data packet: 1 Byte

10.2.4.3 TIMESTAMP

This data field specifies the time when a position was taken. Due to the calculation time for the position this time is always in the past.

Note

If the hardware does not have a battery-buffered RTC (real time clock) the clock is set to 1.1.1970 00:00:00 at each reboot (e.g. if FusionEngine is running on ARM9).

Name	Length	Type	Description
TS-SEC	4	unsigned int	Number of seconds since 01.01.1970 00:00:00
TS-MSEC	2	unsigned int	Additional number of milliseconds (0..999)

Entire length of data packet: 6 Byte

This data field can be activated by the following line in the configuration file:

```
[SendTimestamp]  1
```

10.2.4.4 POSITION

This data field displays the 2D position (x,y). Furthermore it shows the reliability of the position.

Name	Length	Type	Description
POS-X	4	signed int	signed x-position in mm
POS-Y	4	signed int	signed y-position in mm
LOCKSTATE	1	unsigned int	reliability of position: 0,1: position is not reliable 2: position is reliable

Entire length of data packet: 9 Byte

This data field is enabled in each data packet per default. It can be disabled via the following line in the configuration file:

```
[SendPosition]  0
```

The protocol is configured per default, that only a reliable position is output (`LOCKSTATE` 2). If also unreliable positions should be output the following line in the configuration file has to be changed:

```
[OutputOnlyLockedTracks]  0
```

10.2.4.5 VELOCITY

This data field indicates the velocity in x- and y- direction.

Note

Without knowing the orientation of the vehicle (data field ORIENTATION) it is not possible to identify if the vehicle is moving forward or backward.

Name	Length	Type	Description
`VEL-X`	4	signed int	Signed velocity in x direction in mm/s
`VEL-Y`	4	signed int	Signed velocity in y direction in mm/s

Entire length of data packet: 8 Byte

This data field can be enabled in the configuration file in the following line:

```
[SendVelocity]  1
```

10.2.4.6 ORIENTATION

This data field indicates the orientation of the vehicle. The angle is measured counter-clockwise, beginning at the x axis.

Name	Length	Type	Description
`ANGLE`	2	unsigned int	Orientation of vehicle in degree (0..359°)

Entire length of data packet: 2 Byte

This data field can be enabled in the configuration file via the following entry:

```
[SendOrientation]  1
```

10.2.4.7 POSITION-ERROR

This data field indicates the estimated position error (EPE). The EPE is always a positive value.

Name	Length	Type	Description
POS-ERR-X	4	unsigned int	estimated error of x-position in mm
POS-ERR-Y	4	unsigned int	estimated error of y-position in mm

Entire length of data packet: 8 Byte

This data field can be activated in the configuration file via the following line:

```
[SendPosError]  1
```

10.2.4.8 VELOCITY-ERROR

This data field indicates the estimated velocity error. The value is always positive.

Name	Length	Type	Description
VEL-ERR-VX	4	unsigned int	estimated error of velocity in x-direction in mm/s
VEL-ERR-VY	4	unsigned int	estimated error of velocity in y-direction in mm/s

Entire length of data packet: 8 Byte

This data field can be activated in the configuration file via the following line:

```
[SendVelError]  1
```

10.2.4.9 ORIENTATION-ERROR

This data field indicates the estimated error of orientation. The value is always positive.

Name	Length	Type	Description
ANGLE-ERR	2	unsigned int	Estimated error of orientation in degree

Entire length of data packet: 2 Byte

This data field can be activated in the configuration file via the following line:

```
[SendOrientationError]  1
```

10.2.4.10 USER-DATA

This data field is used to indicate a user data packet. The meaning of the user data packet depends on the application.

Name	Length	Type	Description
USER-DATA-SET	8	unsigned int	User data

Entire length of data packet: 8 Byte

This data field can be activated in the configuration file via the following line:

```
[SendUserData]  1
```

10.2.4.11 SYSTEM-ERROR

This data field provides information about possible errors of the system. Up to five errors can be displayed simultaneously in one data packet. An error code is sent as long as an error exists.

Name	Length	Type	Description
ERROR-CODE-1	1	unsigned int	Error code of 1st error
ERROR-VALUE-1	2	unsigned int	Error value of 1st error
ERROR-CODE-2	1	unsigned int	Error code of 2nd error
ERROR-VALUE-2	2	unsigned int	Error value of 2nd error
ERROR-CODE-3	1	unsigned int	Error code of 3rd error
ERROR-VALUE-3	2	unsigned int	Error value of 3rd error
ERROR-CODE-4	1	unsigned int	Error code of 4th error
ERROR-VALUE-4	2	unsigned int	Error value of 4th error
ERROR-CODE-5	1	unsigned int	Error code of 5th error
ERROR-VALUE-5	2	unsigned int	Error value of 5th error

Entire length of data packet: 15 Byte

A detailed description of all errors is written in chapter 10.6. If more than 5 errors exist at the same time, the special error code `0xff` is sent as the `ERROR-CODE-5`.

This data field can be enabled by the following instruction in the configuration file:

```
[SendSystemError]  1
```

10.2.4.12 SATELLITE-STATE

This data field is used for satellite-based localization and holds information about the positioning quality.

Name	Length	Type	Description
SAT-COUNT	1	signed int	Number of satellites tracked The single allowed *negative* value is “-1”, it means “unknown”, e.g. in case of hardware failure.
SAT-HDOP	2	signed int	10 * horizontal dilution of precision So the integer 123 would mean a 12.3 HDOP. A HDOP value of “-1” (given as “-10” in this format) means “unknown”, e.g. in case of hardware failure.

Entire length of data packet: 3 Byte

This data field can be activated in the configuration file via the following line:

```
[SendSatelliteState]  1
```

10.2.4.13 CRC

This data field displays the CRC (*cyclic redundancy check*) of each data packet.

Name	Length	Type	Description
CRC-16	2	unsigned int	CRC value of message

Entire length of data field: 2 Byte

A detailed description of CRCs can be found in chapter 10.5 as well as source code for the CRC.

This data field can be enabled by the following line in the configuration file:

```
[SendCRC]  1
```

10.3 ASCII format of the Protocol

For the ASCII format of the 2D protocol the entire data packet is transmitted as ASCII-code by letters, numbers and some special characters. This means the ASCII code is human-readable. Due to the fewer encoding characters the data is transmitted not as compact as for the binary protocol, so the amount of data increases.

10.3.1 Data Types

Each data packet consists of characters/strings, numbers (optional with decimal point und sign) and underline character. Each data packet consist of one row, terminated by the special character LF (*line feed* \n, ASCII-Code `0x0a`).

All numbers have a prescribed fixed quantity of characters. If less numbers are required for the value, the value has to be filled by zeros.

Integer values exist as well as floating point numbers. The numbers in each data field are described as follows:

+	Sign, always (+ or -)
-	Sign, only if value is negative (then -)
#	Single decimal number / character
.	Decimal point (only for floating point numbers)

Example:

The floating-point number to encode is: 12.34

description: `+###.####`

→ coded number: `+012.3400`

10.3.2 General Structure

A configuration file is the basis of the 2D protocol. Each data packet consists of one text row – the end of each data packet is terminated by the ASCII-STOP sign `\n` (ASCII code `0x0a`).

Once configured the each data packet has the same length and the same structure. The configuration file specifies the data fields. Figure 62 shows the structure of the data field for the default configuration:

Data field
START
POSITION
END

Figure 62 - General structure of data field for the standard configuration

If desired additional data fields can be activated. The sequence of data field is hereby fix and cannot be changed. Figure 63 the structure of a data packet with all possible data fields in one data packet.

Data field
START
TIMESTAMP
POSITION
VELOCITY
ORIENTATION
POSITION-ERROR
VELOCITY-ERROR
ORIENTATION-ERROR
USER-DATA
SYSTEM-ERROR
SATELLITE-STATE
CRC
END

Figure 63 - General structure of data packet with all possible data fields

The data fields START and END cannot be deactivated. All other data fields can be enabled and disabled in the configuration file.

10.3.3 Data fields

In this chapter all data fields are described. Except the two data fields START and END (included in each data packet) all data field can be enabled and disabled by the user.

The unit of data length is one byte.

10.3.3.1 START

The data field START indicates the beginning of a data packet. It contains furthermore the data length of the whole data packet. A bit field indicates which data fields are enabled.

Name	Length	Description
`ASCII-START`	1	ASCII sign **A** (`0x41`)
`LENGTH`	3	Length of the entire data packet in byte (including the start and end field) Character Coding: `###`

SELECTED-FIELDS	8	The bit mask indicates which data fields are enabled and disabled in the data packet. (see chapter 10.4). Character coding: ######## The bit field is coded hexadecimal!
UNDERLINE	1	Underline character (ASCII Code 0x5F)

Entire length of data field: 13 Byte

10.3.3.2 END

The data field END indicates the end of each data packet. It consists of the single symbol \n.

Name	Length	Description
ASCII-STOP	1	ASCII sign \n (0x0a)

Entire length of data packet: 1 Byte

10.3.3.3 TIMESTAMP

This data field specifies the time when a position was taken. Due to the calculation time for the position this time is always in the past.

Note

If the hardware does not have a battery-buffered RTC (real time clock) the clock is set to 1.1.1970 00:00:00 at each reboot (e.g. if FusionEngine is running on ARM9).

Name	Length	Description
TIME	4	ASCII string **time**
TS-SEC	10	Number of seconds since 01.01.1970 00:00:00 Character coding: ##########
UNDERLINE	1	Underline character (ASCII Code 0x5F)
TS-MSEC	3	Additional number of milliseconds (0..999) Character coding: ###
UNDERLINE	1	Underline character (ASCII Code 0x5F)

Entire length of data packet: 19 Byte

This data field can be activated by the following line in the configuration file:

```
[SendTimestamp]  1
```

10.3.3.4 POSITION

This data field displays the 2D position (x,y). Furthermore it displays the reliability of the position.

Name	Length	Description
X	1	ASCII character **x**
POS-X	10	Signed x-Position in meters Character coding: +#####.###
UNDERLINE	1	Underline character (ASCII Code 0x5F)
Y	1	ASCII sign **y**
POS-Y	10	Signed y-Position in meters Character coding: +#####.###
UNDERLINE	1	Underline character (ASCII Code 0x5F)
LOCKSTATE	1	Number for the reliability of the position: 0,1: position is not reliable 2: Position is reliable Character coding: #
UNDERLINE	1	Underline character (ASCII Code 0x5F)

Entire length of data packet: 26 Byte

This data field is enabled in the default configuration. It can be deactivated by the following entry in the configuration file:

```
[SendPosition]  0
```

The protocol is configured per default, that only a reliable position is output (LOCKSTATE 2). If unreliable positions should be output as well, the following line in the configuration file has to be changed:

```
[OutputOnlyLockedTracks]  0
```

10.3.3.5 VELOCITY

This data field indicates the velocity in x- and y- direction.

Note	Without knowing the orientation of the vehicle (data field ORIENTATION) it is not possible to identify if the vehicle is moving forward or backward.

Name	Length	Description
VX	2	ASCII string **vx**

VEL-X	6	Signed velocity in x-direction in m/s Character coding: +##.##
UNDERLINE	1	Underline character (ASCII Code 0x5F)
VY	2	ASCII string **vy**
VEL-Y	6	Signed velocity in y-direction in m/s Character coding: +##.##
UNDERLINE	1	Underline character (ASCII Code 0x5F)

Entire length of data packet: 18 Byte

This data field can be enabled in the configuration file via the following line:

```
[SendVelocity]  1
```

10.3.3.6 ORIENTATION

This data field indicates the orientation of the vehicle. The angle is measured counter-clockwise, beginning at the x axis.

Name	Length	Description
O	1	ASCII character **o**
ANGLE	3	Orientation of vehicle in degree (0..359°) Character coding: ###
UNDERLINE	1	Underline character (ASCII Code 0x5F)

Entire length of data packet: 5 Byte

This data field can be enabled in the configuration file via the following entry:

```
[SendOrientation]  1
```

10.3.3.7 POSITION-ERROR

This data field indicates the estimated position error (EPE). The EPE is always a positive value.

Name	Length	Description
EX	2	ASCII string **ex**
POS-ERR-X	5	Estimated error of x-position in m Number coding: ##.##
UNDERLINE	1	Underline character (ASCII Code 0x5F)

EY	2	ASCII string **ey**
POS-ERR-Y	5	Estimated error of y-position in m Number coding: ##.##
UNDERLINE	1	Underline character (ASCII Code 0x5F)

Entire length of data packet: 16 Byte

This data field can be activated in the configuration file via the following line:

```
[SendPosError]  1
```

10.3.3.8 VELOCITY-ERROR

This data field indicates the estimated velocity error. The value is always positive.

Name	Length	Description
EVX	3	ASCII string **evx**
POS-ERR-X	5	Estimated error of velocity in x-direction in m/s Character coding: ##.##
UNDERLINE	1	Underline character (ASCII Code 0x5F)
EVY	3	ASCII string **evy**
POS-ERR-Y	5	Estimated error of velocity in y-direction in mm/s Character coding: ##.##
UNDERLINE	1	Underline character (ASCII Code 0x5F)

Entire length of data packet: 18 Byte

This data field can be activated in the configuration file via the following line:

```
[SendVelError]  1
```

10.3.3.9 ORIENTATION-ERROR

This data field indicates the estimated error of orientation. The value is always positive.

Name	Length	Description
EO	2	ASCII string **eo**
ANGLE-ERR	3	Estimated error of orientation in degree Character coding: ###
UNDERLINE	1	Underline character (ASCII Code 0x5F)

Entire length of data packet: 6 Byte

This data field can be activated in the configuration file via the following line:

```
[SendOrientationError]  1
```

10.3.3.10 USER-DATA

This data field is used to indicate a user data packet. The meaning of the user data packet depends on the application.

Name	Length	Description
USER	4	ASCII string **user**
USER-DATA-SET	16	User data Character coding: ################ User data is coded hexadecimal!
UNDERLINE	1	Underline character (ASCII Code 0x5F)

Entire length of data packet: 21 Byte

This data field can be activated in the configuration file via the following line:

```
[SendUserData]  1
```

10.3.3.11 SYSTEM-ERROR

This data field provides information about possible errors of the system. Up to five errors can be displayed simultaneously in one data packet. An error code is sent as long as an error exists.

Name	Length	Description
ERR	3	ASCII string **err**
ERROR-CODE-1	2	Error code of 1st error Character coding: ## Value is coded hexadecimal!
ERROR-VALUE-1	4	Error value of 1st error Character coding: #### Value is coded hexadecimal!
UNDERLINE	1	Underline character (ASCII Code 0x5F)
ERROR-CODE-2	2	Error code of 2nd error
ERROR-VALUE-2	4	Error value of 2nd error
UNDERLINE	1	Underline character (ASCII Code 0x5F)

ERROR-CODE-3	2	Error code of 3rd error
ERROR-VALUE-3	4	Error value of 3rd error
UNDERLINE	1	Underline character (ASCII Code 0x5F)
ERROR-CODE-4	2	Error code of 4th error
ERROR-VALUE-4	4	Error value of 4th error
UNDERLINE	1	Underline character (ASCII Code 0x5F)
ERROR-CODE-5	2	Error code of 5th error
ERROR-VALUE-5	4	Error value of 5th error
UNDERLINE	1	Underline character (ASCII Code 0x5F)

Entire length of data packet: 38 Byte

A detailed description of all errors is written in chapter 10.6. If there are more than five errors the special error 0xff is sent as the ERROR-CODE-5.

This data field can be enabled by the following instruction in the configuration file:

```
[SendSystemError]  1
```

10.3.3.12 SATELLITE-STATE

This data field is used for satellite-based localization and holds information about the positioning quality.

Name	Length	Description
SAT	3	ASCII string **sat**
SAT-COUNT	2	Number of satellites tracked Character coding: ## (or “-1” for “unknown”)
UNDERLINE	1	Underline character (ASCII Code 0x5F)
SAT-HDOP	4	Horizontal dilution of precision Character coding: ##.# (or “-1.0” for “unknown”)
UNDERLINE	1	Underline character (ASCII Code 0x5F)

Entire length of data packet: 11 Byte

This data field can be activated in the configuration file via the following line:

```
[SendSatelliteState]  1
```

10.3.3.13 CRC

This data field displays the CRC (*cyclic redundancy check*) of each data packet.

Name	Length	Description
CRC	3	ASCII string **crc**
CRC-16	4	CRC-value of message Character coding: #### Value is coded hexadecimal!

Entire length of data field: 7 Byte

A detailed description of CRCs as well as source code for the CRC can be found in chapter 10.5.

This data field can be enabled by the following line in the configuration file:

```
[SendCRC]  1
```

10.4 Bit Mask SELECTED-FIELDS

The bit mask SELECTED-FIELDS is part of the data field START. It indicates which bit fields are activated. Once the bit mask is configured, each data packet has the same length and the same structure. Therefore the value of the bit mask SELECTED-FIELDS is constant. By evaluation of the bit mask at the receiver side it is possible to check for plausibility of the configuration file.

Each data field is presented as a single bit in the bit mask. If the data field is activated the related bit is set.

Figure 64 shows the allocation of the single bits and data fields. Bit 31 is the most significant bit and is found in the ASCII format of the protocol on the left most side.

Important: The order of bits in this bit mask does not correspond to the order of data fields in a data packet. The order of the data fields is described in chapter 10.2.3 (binary format) or chapter 10.3.2 (ASCII format).

Bit	Data field
31	-
30	-
29	-
28	-
27	-
26	-

Bit	Data field
15	-
14	-
13	-
12	-
11	-
10	SATELLITE-STATE

25	-	9	CRC
24	-	8	SYSTEM-ERROR
23	-	7	USER-DATA
22	-	6	ORIENTATION-ERROR
21	-	5	VELOCITY-ERROR
20	-	4	POSITION-ERROR
19	-	3	ORIENTATION
18	-	2	VELOCITY
17	-	1	POSITION
16	-	0	TIMESTAMP

Figure 64 - Mapping Bitmask – Data fields

10.5 CRC Calculation

To detect errors during data transmission, the data field CRC can be activated. For CRC the CRC-16-IBM is used with the polynomial $x^{16}+x^{15}+x^2+1$. The CRC is applied to all previous data fields of the data packet except the data field START.

Example source code for CRC calculation in C:

```
// Holds a table to calculate crc16 values
static Uint16 crc_table[256];

// Initializes the CRC table
// MUST BE RUN before first crc calculation
Void InitCRCtable( void )
{
      int i, j;

      Uint16 k;

      for (i = 0; i < 256; i++)
            crc_table[i] = i;

      for (i = 0; i < 256; i++)
      {
            k = 0xC0C0;
            for (j = 1; j < 256; j <<= 1)
            {
                  if (i & j)
                        crc_table[i] ^= k;
                  k = ((k & 0x7FFF) << 1) ^ 0x4003;
            }
      }
}
```

```
// Adds calculation for an 8 bit value to crc.
// Initially crc should be zero.
Uint16 CalcCRC8(Uint16 crc, Uint8 value)
{
      crc = (crc >> 8 ) ^ crc_table[(crc & 0xFF) ^ value];
      return crc;
}
```

10.6 Error Codes

If the system identifies self-contained an error (self-diagnosis), a system error is sent. The error is sent as long as the error is not repaired. I.e. if a broken transponder is recognized as broken then the appropriate error code is sent until the transponder is able to make a correct measurement.

A special case is the error code `0xff`. This error is sent if more than 5 errors appear at the same time. Therefore not all error codes can be transmitted. This special error code is only sent for the last error code of the system failure (`ERROR-CODE-5`).

An error consists always of the error code. Optional it can feature an error value which consists of additional information to the error code.

10.6.1 Overview

Overview of error codes:

Code	Meaning
`0x01`	broken TDOA cell master
`0x02`	broken transponder
`0x05`	broken LPR antenna
`0x06`	broken hardware component
`0xff`	Further errors active

10.6.2 Error codes

10.6.2.1 0x01 – broken TDOA cell master

If a TDOA cell master is broken, no measure commands are sent to the transponder of the cell. If a transponder doesn't receive a measure command, it broadcasts an IDLE message once per second. But this can also happen if the line of sight between cell master and a single transponder is broken (e.g. an obstacle between in the line of sight).

To detect a broken master, we count the number of IDLE messages of a single cell in the last 60 seconds. If we receive at least one IDLE message of at least two different transponders during this time and received no valid transponder measurement during the observation interval and the oldest IDLE message is at least 30 seconds old, we assume the cell master is broken.

The error value contains the cell ID of the broken master.

10.6.2.2 0x02 – broken transponder

If a single transponder is broken, it is not measured by the base station, so the basestation measures only the remaining transponders of a cell. But such failures can be position dependent, so we have to check, if a transponder isn't measured at several positions of the basestation.

To detect a broken transponder, we count the number of “positions bins”, in which the other transponders of a cell was measured. A “position bin” is a square of 5x5 meter. If at least 50% of all cell transponders were successfully measured in at least 5 position bins (per measured basestation antenna) and the observed transponder was not measured in any position bin, we assume the transponder is broken.

The error value contains the LPR-B address (see chapter 10.6.3) of the broken transponder.

10.6.2.3 0x05 – broken LPR antenna

To detect a broken LPR antenna, we count the number of “positions bins”, in which we measured another LPR antenna. A “position bin” is a square of 5x5 meter.

For the detection at least one LPR antenna must be measured at 10 “popular places” in the last 10 minutes. A “popular place” is a position bin, visited for at least 10 times. If the observed LPR antenna was never measured at any popular place, we assume the antenna is broken.

The error value contains the antenna port of the broken LPR antenna. If the mapping of antenna ports is not configured, the error value is set to -1.

10.6.2.4 0x06 – broken hardware component

The software FusionEngine communicates with the attached hardware components (sensors etc.) via different interfaces (e.g. RS-232, TCP sockets etc.). If an communication timeout occurs at one of these interfaces, the respective hardware component is marked as failed.

This error code can also caused by wrong FusionEngine configuration.

The error value contains the index of the concerned FusionEngine node. To find out the hardware component of a FusionEngine node, the FusionEngine logfile must be analyzed.

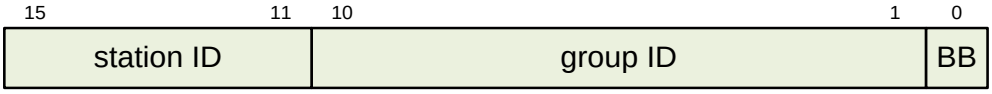
10.6.2.5 0xff – more than five errors active

There are currently more than five errors active.

The error value is set to `0xffff`.

10.6.3 LPR-B address

LPR-B station addresses are completely defined by a 16 bit value:



BB – Base station bit:	Indicates, if the LPR-B station is defined as a basestation or as a transponder (1=basestation, 0=transponder)
group ID:	Cell ID of the station (1..1022)
station ID:	Station ID of the station (0..30)