

SIEMENS

SIMATIC

Power Line Booster

Operating Instructions

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Legal information

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 WARNING
indicates that death or severe personal injury may result if proper precautions are not taken.
 CAUTION
indicates that minor personal injury can result if proper precautions are not taken.
NOTICE
indicates that property damage can result if proper precautions are not taken.


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Introduction

1.1 Preface

Purpose of the manual

This manual describes the hardware and software components of the Power Line Booster system (PLB system).

This manual provides information based on the requirements as defined by DIN EN 82079-1 regarding mechanical engineering documentation. This information relates to the place of use, transport, storage, installation, use and maintenance.

Target group

This manual is intended for:

- Installation personnel
- Configuration engineers
- Operating personnel
- Maintenance personnel

Required knowledge

General knowledge in the area of automation engineering is required to understand this manual.

Experience in the use of PROFINET is also helpful.

1.2 System overview and introduction

The Power Line Booster system is a communication system for data transmission on conductive media. The system provides Ethernet-based communication connections between stationary plant controllers and mobile plant units. The media can be sliding contact systems, such as in electric overhead conveyors, or flexible cables, such as the ones used in crane systems.

The Power Line Booster is designed for operation in industrial environments.

The PLB system has the following basic properties:

- It transmits Ethernet signals from a plant controller (e.g. SIMATIC CPU or controller) to up to 50 communication devices. In case of real-time requirements (e.g. for PROFINET/PROFIsafe), we recommend a maximum of 40 devices per master.
- It prioritizes cyclic PROFINET telegrams to ensure real-time conditions.

1.2 System overview and introduction

- It ensures that all devices can receive or send the high-priority PROFINET IO data within a defined period of time.
- It also provides good bandwidth for transmission of low-priority data
- It transmits the network frames transparently and without making changes to the data.
- It supports the use of the proven SIMATIC PROFINET automation components on mobile plant units.
- It can be easily integrated into the SIMATIC product portfolio, and it can be configured as a PROFINET device to retrieve status information for diagnostic purposes.
- Product maintenance and innovation are guaranteed in the course of further SIMATIC development

Note

If you have any questions regarding system design and installation, feel free to contact the technical support for the Power Line Booster (plb-support.industry@siemens.com (<mailto:plb-support.industry@siemens.com>)) or your local Siemens representative.

The typical configuration of a Power Line Booster application is shown in the figure below.

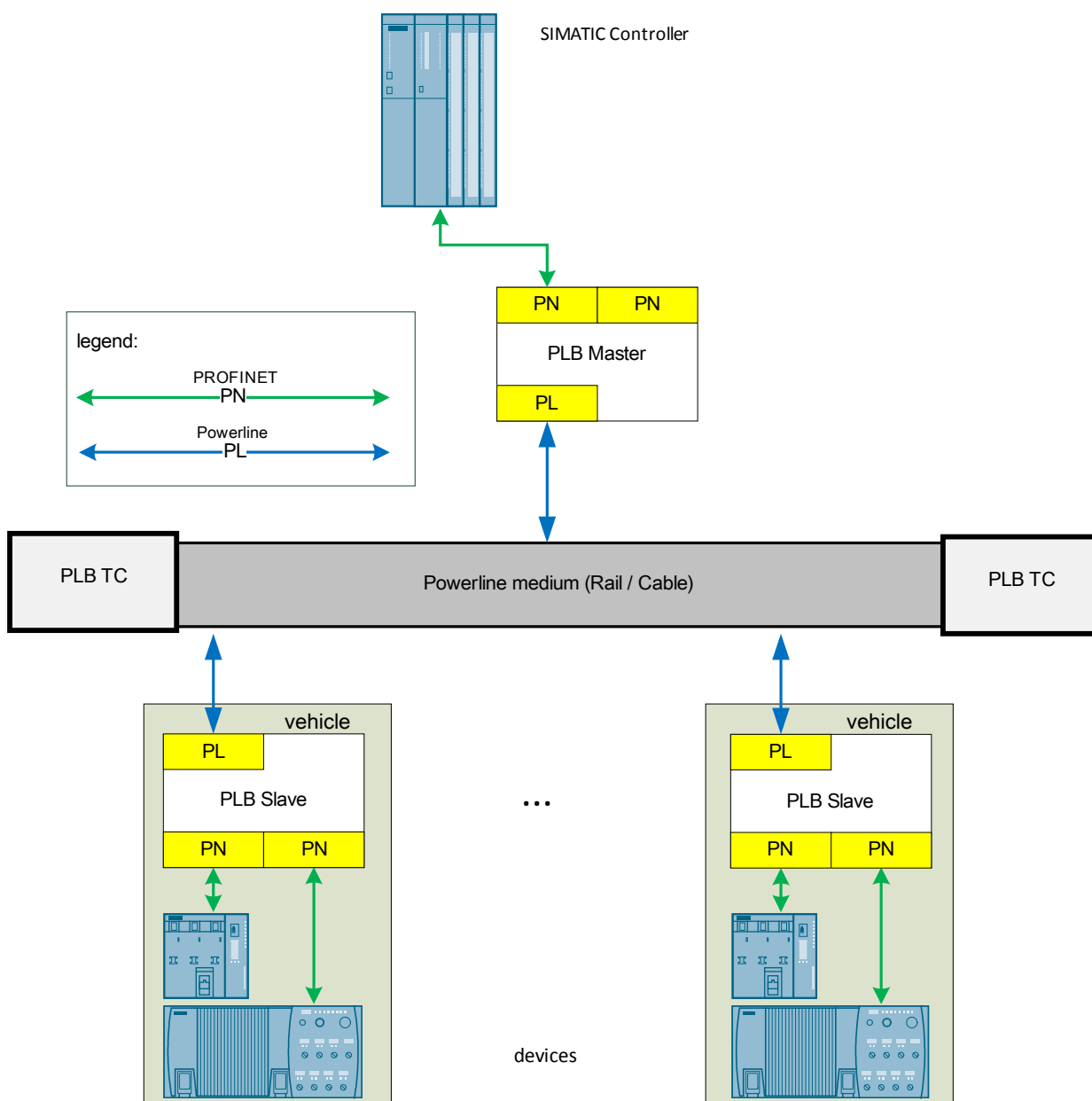


Figure 1-1 Design example of a Power Line Booster system

Technology

The Power Line Booster uses communication technology that can be used to implement the transmission of Ethernet-based frames, especially PROFINET, over power cables and/or control cables. One main area of application is in transport applications based on sliding contacts, such as electric monorail systems as well as storage and retrieval systems.

In this instance, the Power Line Booster modulates the data frames that are received by standard Ethernet (IEEE 802.3i / 10BASE-T; IEEE 802.3u / Fast Ethernet; IEEE 802.3y / 100BASE-T2) to different carrier frequencies. These carrier frequencies are located in the

range from about 2 MHz up to about 28 MHz. By the same token, the device demodulates the data telegrams it receives from the other end.

1.3 Rated conditions

- The operation of Power Line Booster devices in public supply networks is not permitted.
- The operation of standard powerline components in the PLB system environment is not permitted, because real-time requirements can no longer be guaranteed in this case.
- Only devices that are connected to a PLB master can communicate with devices that are connected to a PLB slave. Inter-device communication, that is, direct data exchange, between devices connected to different PLB slaves is not possible.
- We recommend operating the Power Line Booster in a separate communication network.

1.4 Insulation

The Power Line Booster or Power Line Booster system is intended for operation in low voltage systems with up to 500 V AC. The recommended components require that all voltages within the system are within the following limits:

- Low voltage: Max. 500 V AC +15% line-to-line voltage with symmetrical ground
This high limit applies to the **system supply lines**, e.g. L1, L2, L3 (not for the communication cables), and refers to the insulation system of the PLB system.
- Extra-low voltage: Max. 42 V AC +15%
This restriction applies to the **communication cables**. Operation of the system is also possible when these rails or cables are de-energized. Operation is not possible when both communication cables are short-circuited.
- PLB supply voltage: 24 V DC \pm 20%
The power supply unit for the **supply voltage** of the Power Line Booster must meet the "Safety Extra Low Voltage" (SELV) or "Low Voltage / Current" (LV/C) specification. The device cannot be supplied over the communication cables.

Device description

2.1 Introduction

You usually need the following components to implement a Power Line Booster system:

- Power Line Booster Module (PLB BM) as master and slave (see PLB Basis (Page 12)) with a Power Line Booster Modem Module (PLB MM) (see PLB Modem Module (Page 24)) and a BusAdapter (Page 21)
- Termination and coupling modules (PLB TC) see also "PLB TC Module (Page 28)"
- Carrier power supply (Page 29)
- Additional system-dependent components

Overview



Figure 2-1 Fully equipped device

Der Power Line Booster consists of a **PLB BM** (basic module) ① which is equipped with the following modules:

- 1 **ET200SP BA** (BusAdapter) ②
- 1 **PLB MM** (Modem Module) ③
- 1 **PLB EM** (Empty Module) ④

Accessories include the 24 V DC power supply connection plug ⑦ and the powerline connection plug ⑧.

You have the option to equip the Power Line Booster with

- the label ⑤,
- the shield ⑥ and
- the shield clamp ⑨.

You can configure the Power Line Booster as PLB master or PLB slave. There can be only one PLB master in a communication segment. It has to be mounted stationary. A PLB slave is usually mounted on the vehicle. You can use several slaves in one segment.

NOTICE
Plug or remove the Modem Module and the BusAdapter only in the de-energized state.

2.2 PLB Basic module



Figure 2-2 PLB Basic module

The Power Line Booster is available in this version.

PLB device	MLFB
PLB Basic module: PLB BM LV M/S	6ES7972-5AA10-0AB0

The basic module holds the Power Line Booster modem modules and the BusAdapter.

This device must receive its power supply only through the supply input X80 (24 V DC).

The voltage on the cables used for communication must not exceed 48 V AC (42 V AC +15%) in standard operation.

2.2.2 DIP switches

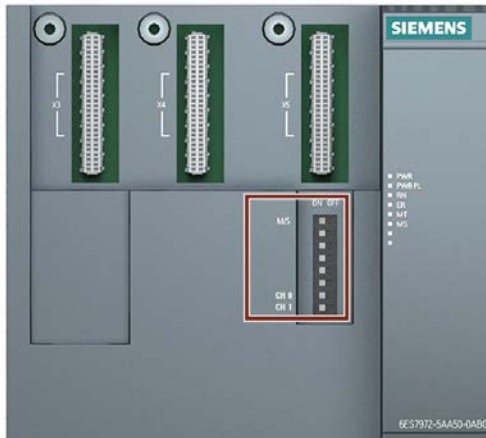


Figure 2-5 DIP switches

No settings are necessary (factory state) when you use the Power Line Booster as slave. To use the PLB as master, however, you must set the DIP switch "M/S" accordingly.

In some special cases, you may have to make additional settings. The possible settings are listed in the "Operator controls" table.

The switches are located below the PLB EM (Empty Module).

NOTICE

Use the DIP switches for configuration only in the de-energized state.

Table 2- 1 Operator controls

Operator control	Labeling	State			Function
DIP switch Master/Slave	M/S	Off (factory state)			PLB slave operation
		On			PLB master operation
DIP switch Channel	CH 0 CH 1	Channel	CH 1	CH 0	Setting of 4 different channels.
		1 (delivery state)	0	0	
		2	0	1	
		3	1	0	
		4	1	1	

By setting the channel you can separate communication on a logical level. Only devices (master and slaves) with identical channel settings can communicate with each other in a plant.

Table 2- 2 Set master/slave operating mode


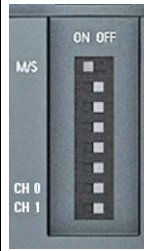


	
Power Line Booster in slave operating mode	Power Line Booster in master operating mode

Table 2- 3 Channel setting (examples)

	
Power Line Booster configured for channel 1	Power Line Booster configured for channel 2

2.2.3 LED display

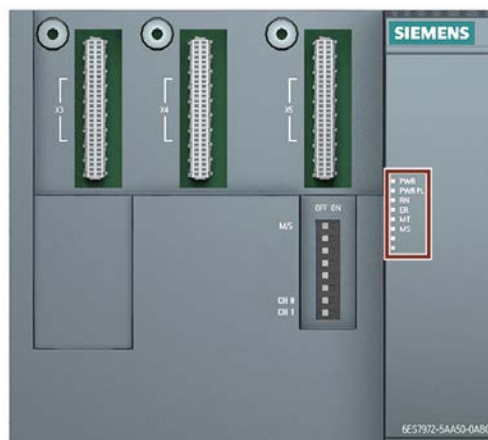


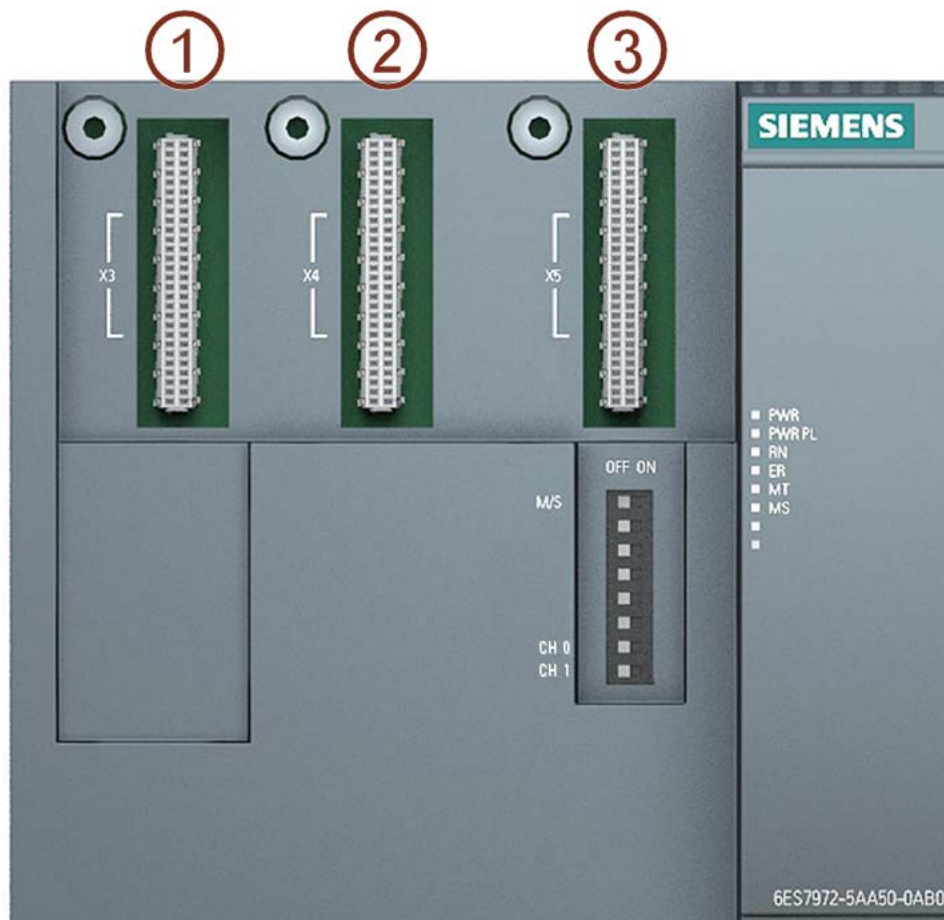
Figure 2-6 LED displays on the PLB basic module

Table 2- 4 LED PLB BM

LED labeling Meaning	Color	State	Description
PWR Power	Green	Off	24 V supply missing or too low
		On	LED test for about 0.5 s during startup 24 V supply
PWR PL Power - powerline	Green	Off	Normal operation
		Flashes (approx. 1 Hz)	Short-circuit of a powerline cable to PE or L1, L2 or L3
		On	LED test for about 0.5 s during startup
RN Run	Green	Off	Startup
		Flashes (approx. 1 Hz)	Waiting for PROFINET connection or operation without PROFINET Station flash test (PN) together with the port LEDs of the ET200SP BusAdapter (BA)
		Flashes (approx. 4 Hz)	Firmware update of the basis in progress (together with ER and MT)
		On	LED test for about 0.5 s during startup PN-AR with IO data exchange
ER Error	Red	Off	No error
		Flashes (approx. 1 Hz)	Station flash test (PN) together with the port LEDs of the ET200SP BusAdapter (BA) External error: Short-circuit between a phase and Rail A or Rail B External error: Ground fault of Rail A or Rail B
		Flashes (approx. 4 Hz)	Firmware update of the basis in progress (together with RN and MT)
		On	LED test for about 0.5 s during startup 2 modems inserted or modem installed incorrectly
MT Maintenance	Yellow	Off	No maintenance required
		Flashes (approx. 1 Hz)	Station flash test (PN) together with the port LEDs of the ET200SP BusAdapter (BA)
		Flashes (approx. 4 Hz)	Flashes synchronously with the LEDs of the PLB MM <ul style="list-style-type: none"> • Firmware update of the modem module is running. • When restarting after a configuration change ^{a)}
		Flashes (approx. 4 Hz)	Firmware update of the basis in progress (together with ER and RN)
		On	LED test for about 0.5 s during startup Maintenance required: e.g. FW update has failed. A new update is necessary.
MS Master	Green	Off	PLB slave
		On	LED test for about 0.5 s during startup PLB master

LED labeling Meaning	Color	State	Description
<p>Note: If all LEDs are flashing permanently at a frequency of 1 Hz, you are dealing with a configuration or device fault.</p> <p>a) Changing the DIP switch settings</p>			

2.2.4 Slots



- ① Slot X3 for the ET200SP BA (BusAdapter)
- ② Slot X4 for the PLB MM (Modem Module)
- ③ Slot X3 for the PLB EM (Empty Module)

Figure 2-7 Slots on the PLB basic module

2.2.5 Power supply connection

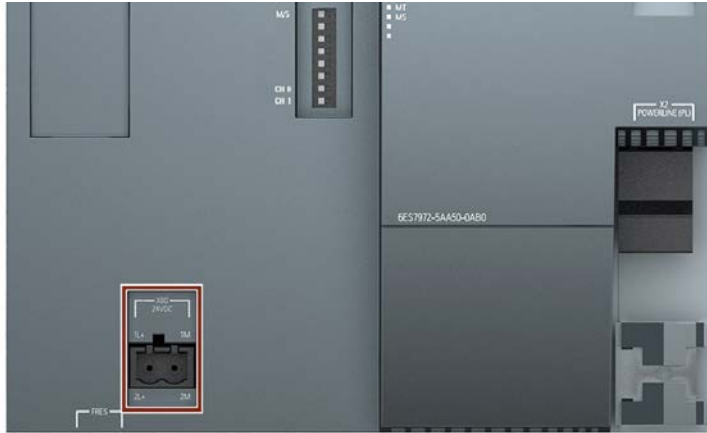


Figure 2-8 24 V DC power supply port X80

Terminal	Connection
X80.1	+ 24 V DC (SELV or LV/C)
X80.2	0 V

2.2.6 Powerline connection



Figure 2-9 Powerline port X2

Terminal	Connection	Name
X2.1	42 V AC	Rail A
X2.2		Rail B

2.2.7 PLB firmware update

You can update the Power Line Booster firmware. As part of this update, the modem module (PLB MM) firmware may also be updated. Each PLB modem that is plugged into the PLB basic module automatically receives the modem firmware stored there. You have two options for updating the Power Line Booster.

1. As of PLB firmware version V2.X, you can use the integrated web interface to update the firmware (see "Update (Page 88)").
2. You can update all PLB firmware versions using an SFTP connection. This option is described below.

Requirement for the update is that you have configured an IP address on the PLB that is going to be upgraded (see "Ethernet and IP address assignment (Page 71)"). To update, connect a PC to the Power Line Booster you want to upgrade. Due to the higher data transmission rate, we recommend performing the update directly via the Ethernet interface. However, you can also install the firmware via powerline. The update is installed via the "Secure File Transfer Protocol" (SFTP).

This means an SFTP client program, such as WinSCP (freeware), must be installed on the PC.

The update packet installed via SFTP always contains a *.tgz and a *.sig file.

NOTICE

Make sure that at least one firmware with version V1.3.0 is installed on the device and that a PLB modem with order number 6ES7972-5AA51-0AB0 is plugged in.

The PLB modem with order number 6ES7972-5AA50-0AB0 is no longer supported by the PLB as of version V2.X and results in an error (Page 16) when you start the PLB after the update.

Step 1: Installing the files

The PLB is connected using the IP address of the device. You must enter the following information to log in:

- User: update
- Password: powerline

You now switch to the "/upload" directory using the SFTP client and copy the two firmware files to this directory. Once both files have been loaded completely to the PLB, they are checked by the PLB. If the check were to fail (in case of incorrect files or transmission errors, for example), the PLB will not start the update and store an error file with a detailed error message in the upload directory. It may take a few seconds (< 20 s) to check the update packet.

Step 2: Update

The PLB indicates that the update is in progress through flashing of the "MT", "RN" and "ER" LEDs. This display mode starts as soon as the check of the firmware files has been completed successfully. The PLB applies the files as new operating software and restarts several times. The update can take up to 5 minutes.

Once the update has been completed, the PLB stops flashing and resumes its normal function. If necessary, the modem firmware may also be updated when the PLB is first booted after the update (see "PLB Modem Module (Page 24)").

If the update was not successful, the PLB will usually resume its normal function, but it will now indicate that maintenance is required through its "MT" LED (stays on). Please contact Technical Support in this case.

We recommend resetting the PLB to factory settings after the update (see "Reset button (Page 13)" or "Restart (Page 87)").

NOTICE
A firmware update can take up to five minutes.
When updating the Power Line Booster, the power supply must not be switched off. An interruption of the power supply may irreversibly destroy the PLB.

Note

Mixed operation with different firmware versions

A basic functionality of the system is also given in mixed operation with different firmware versions. However, there may be a restriction in the status and diagnostics data. We recommend you avoid mixed operation as much as possible in productive systems and that you upgrade the masters first in the case of a system update.

See also

LED display (Page 15)

2.3 BusAdapter



Figure 2-10 BA 2xRJ45 (BusAdapter RJ-45)

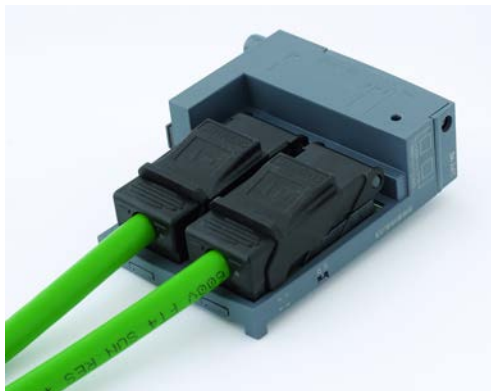


Figure 2-11 BA 2xFC (BusAdapter Fast Connect)



Figure 2-12 Slot for the BusAdapter

2.3 BusAdapter

Device	Area of application	MLFB
BusAdapter RJ-45 ET200SP BA 2xRJ45	This module is used for ETHERNET or PROFINET connections to the PLB system via RJ45 plug connectors.	6ES7193-6AR00-0AA0
BusAdapter Fast Connect ET200SP BA 2xFC	This module is used for direct connection of ETHERNET or PROFINET connections to the PLB system.	6ES7193-6AF00-0AA0

The BusAdapter offers to switch ports for the connection of Ethernet or PROFINET cables. Because the BusAdapter has two LAN ports, you can set up a line architecture.

Note

You cannot use any BusAdapters other than the ones described above (such as those with fiber optic cable port, for example).

2.3.1 LED display



Figure 2-13 LED displays on the BusAdapter

Table 2- 5 LED BusAdapter

LED labeling Meaning	Color	State	Description
LK1/LK2 Link Port 1 / Link Port 2	Green	Off	No link at Port 1 or Port 2
		Flashes (approx. 1 Hz)	Station flash test (PN) together with the MT, RN and ER LEDs of the basic module (PLB BM)
		On	LED test for about 0.5 s during startup Link at Port 1 or Port 2

Note: If all LEDs are flashing permanently at a frequency of 1 Hz (with deactivated station flash test), you are dealing with a configuration or device fault.

2.3.2 Network cable connection



Figure 2-14 LAN ports X1

You can connect up to two external Ethernet or PROFINET cables on the BusAdapter.

2.4 PLB modem module



Figure 2-15 PLB MM



Figure 2-16 Slot for the PLB MM

PLB device	MLFB
Modem module: PLB MM	6ES7972-5AA51-0AB0

This device modulates or demodulates the Ethernet data frames into a form that is suitable for the "Powerline" transmission medium (e.g. sliding contact lines).

NOTICE
The previous PLB modem module (6ES7972- 5AA50-0AB0) is no longer supported.

NOTICE

It is technically possible to plug the modem module into the right slot (X5). However, this configuration is not supported!

If you are plugging the modem into slot X5 on the right or if you are not plugging a modem at all, the Power Line Booster signals an error.

2.4.1 LED display



Figure 2-17 LED displays on the PLB modem module

Table 2- 6 LED PLB MM

LED labeling Meaning	Color	State	Description
PWR Power	Green	Off	Modem without power supply, inactive or in RESET
		Flashes (approx. 4 Hz)	Synchronous with the PL-LED and the MT-LED from the basis <ul style="list-style-type: none"> Firmware update of the modem module ^{a)} is running When restarting after a configuration change ^{b)}
		On	LED test for about 0.5 s during startup Modem power supply OK
PL Powerline	Green	Off	No powerline connection
		Flashes (approx. 4 Hz)	Synchronous with the PWR-LED and the MT-LED from the basis <ul style="list-style-type: none"> Firmware update of the modem module ^{a)} is running When restarting after a configuration change ^{b)}

LED labeling Meaning	Color	State	Description
		Flashes (approx. 8 Hz)	Powerline data traffic
		On	LED test for about 0.5 s during startup Modem active, PL connection exists

Note: If all LEDs are flashing permanently at a frequency of 1 Hz, you are dealing with a configuration or device fault.

a) When updating the modem firmware, the power supply must not be switched off!

b) Changing the DIP switch settings

NOTICE

A modem firmware update can take up to two minutes.

The modem firmware is part of the Power Line Booster basic firmware. During system startup, the PLB basic module checks the active firmware on the modem and, if necessary, starts the update on the modem.

When updating the modem firmware, the power supply must not be switched off. An interruption of the power supply may irreversibly destroy the modem.

You may only insert or remove the modem module from the PLB basic module when the modem module is de-energized.

2.5 PLB Empty module



Figure 2-18 PLB EM



Figure 2-19 Slot for the PLB EM

PLB device	MLFB
PLB Empty Module: PLB EM (5 pieces per packaging unit)	6ES7972-5AA80-0XA0

The empty module is used to cover the module bay and the DIP switches. The degree of protection IP20 applies to the fully equipped device, i.e. only including all plugged-in modules.

The slot of the empty module is intended for future expansions.

2.6 PLB TC module



Figure 2-20 PLB TC module

The PLB TC is used termination of segments. Both ends of the communication cables of the respective segment are terminated by the termination module. Details on installation of the TC module are available in the section Rail connection of the TC module (Page 49).

PLB device	MLFB
TC module PLB TC	6ES7972-5AB00-0XA0

2.7 Accessories

2.7.1 Carrier power supply

The AC carrier power supply, through its continuous current flow, keeps the contact between slider and rail clean. It is not necessary for actual powerline communication. No carrier voltage is required in applications without sliding contacts (e.g. communication over flexible cables) or those in which the materials used prevent oxidation of the contact surface.

Infeed system

The infeed system consists of the circuit breaker, transformer and filter.

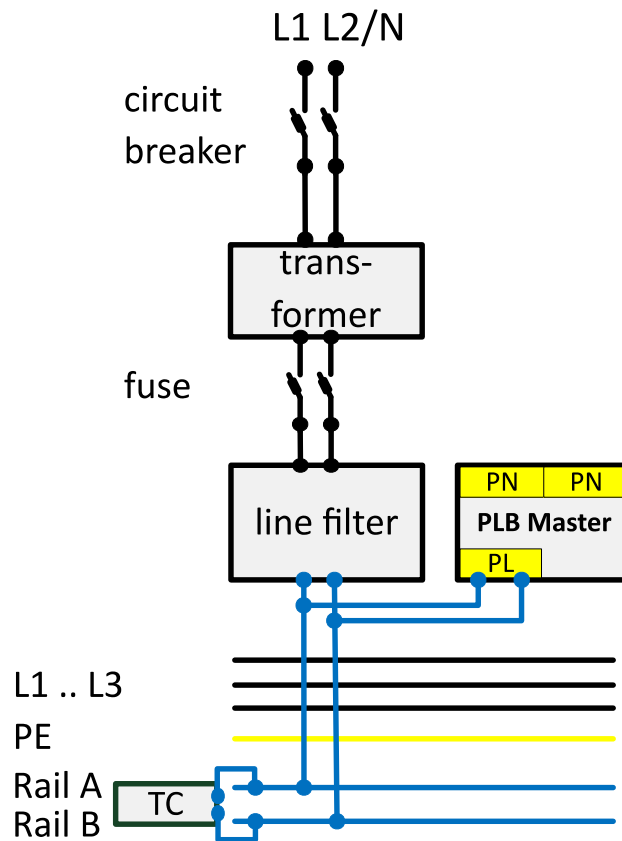


Figure 2-21 Segment infeed system

Carrier voltage transformer

The transformer for carrier power supply must meet the following requirements:

- Output voltage: 42 V AC at rated current
31 V AC to 48 V AC (42 V AC -26%/+15%)
- Insulation: Basic isolation of primary and secondary winding to parts that can be touched (e.g. core) 500 V; overvoltage category III
Reinforced isolation or double isolation from primary to secondary end for 230 V; overvoltage category III
Degree of pollution according to mounting position (usually VG 2)
The associated product standards are available in the section CE conformity (Page 127)
- Recommendation for rated current: min. 1.0 A

The transformer must be large enough so that it can supply sufficient current for the maximum number of possible PLBs. The current consumption of a PLB at the powerline connection plug is about 4 mA (at 42 V AC).

If the voltage tolerance of the supply network is in a range from -26% to +15%, we recommend that you use the transformer in the example below.

Table 2- 7 Example of a transformer for supply of the carrier voltage

Primary voltage	230/400 V AC
Secondary voltage	42 V AC
Secondary current	1.5 A
Rated power	63 VA
Manufacturer	mdexx
Order designation	TAM3242-8JV00-0EA0

Details on installation of the transformer are available in the section "Rail connection of the master and carrier power supply (Page 48)".

Circuit breaker

To prevent overheating of the cables and the transformer in case of a short-circuit, the cable must be protected with an automatic circuit breaker at the primary and secondary end. Select the circuit breaker so that the supply transformer, its supply cable, and all downstream components and cables are protected. The following table lists components that match the carrier voltage supply used as an example in this manual.

Table 2- 8 Circuit breaker, primary/secondary

Circuit breaker	Technical requirement/Recommendation	Product example
Primary (when using TAM3242-8JV00-0EA0)	2-pole, 1 ampere, tripping characteristic B	SIEMENS 3RV1011-1BA10
Secondary	2-pole, 2 amperes, tripping characteristic B	(1): SIEMENS 5SY4202-5 (2-pole, 2A, A characteristic) (2): SIEMENS 5SY4202-6 (2-pole, 2A, B characteristic)

Line filter

The line filter prevents crosstalk of the communication signals to other cables as well as coupling of interference to the communication lines. This is particularly important when you are supplying multiple segments from one carrier voltage or when you are operating multiple carrier voltage transformers in a shared low-voltage network.

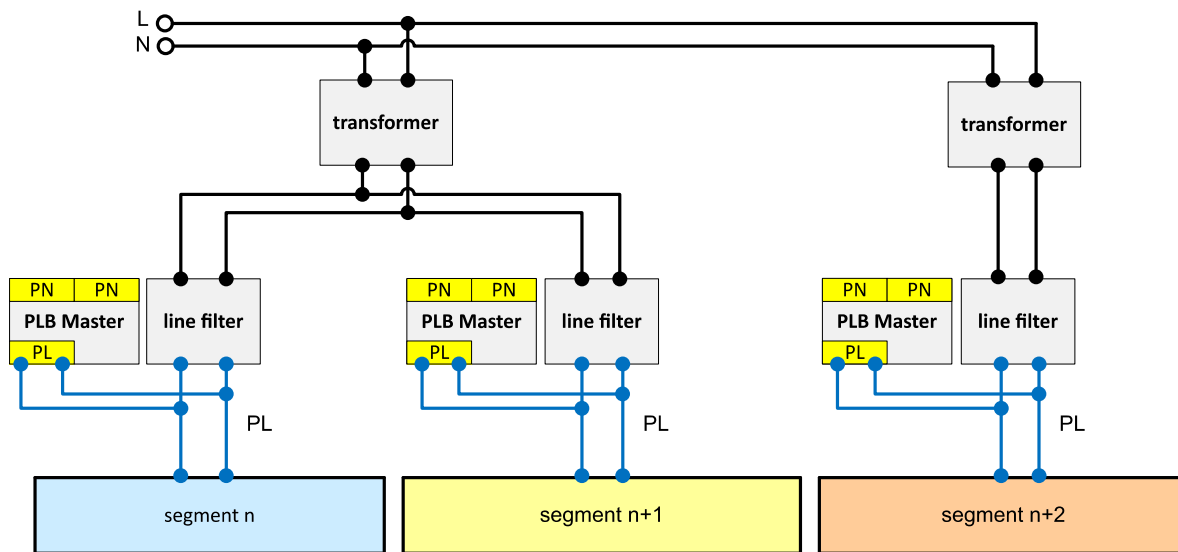


Figure 2-22 Application examples of the line filter

You must use a suitable line filter for decoupling the transformer from the segment.

Usually, one end on the filter is marked with "LINE" and the other with "LOAD". Connect the end marked with "LOAD" to the powerline and the "LINE" end to the transformer.

Table 2- 9 Requirements for the line filter

Attenuation for common-mode signals and push-pull signals between 1 MHz and 40 MHz	≥ 50 dB
Output impedance (between 1 MHz and 40 MHz)	> 100 Ω
The isolation strength of the filter (especially against PE/FE) has to be matched to the isolation coordination in the system.	

NOTICE

In sliding contact systems with dangerous contact voltages, there is the risk of a short-circuit between these voltages and the communication cables. This means you have to design the isolation of all components to prevent such a situation.

The short-circuit mentioned above is then considered to be the first fault. It must not result in a dangerous state.

The connected components must therefore have basic isolation. The dangerous contact voltage is then considered the rated voltage.

Example:

Faulty contacting of the sliding contact can result in a connection between the system supply (L1/L2/L3) and the communication cables (Rail A/B). The communication lines will then carry a voltage of 230 V to ground, for example. These 230 V are then the rated voltage for the basic isolation of the filter, the PLBs as well as additional components connected to the communication cables.

Table 2- 10 Example of a line filter

Manufacturer	Type	Order number
Schurter	Line filter (up to 16 A)	(1): 5500.2349 (with DIN rail clip) (2): 5500.2218.01 (with screw-type lugs)



Figure 2-23 Line filter up to 16 A

See also section "Rail connection of master and carrier power supply (Page 48)"

2.7.2 PLB connection cable

The connection cables in a powerline system have a strong impact on the signal attenuation and cause poles in the frequency range used. This is why the selection of cables also has an effect on the maximum configuration limit. For details on this, see section "Maximum number of stations (Page 40)".

It is generally true that all cables in the system must be of identical length so that the poles are located in the same frequency range. However, it is permissible to use a different cable length for the master than for the cables between PLB slave and the sliders.

For cable lengths of ≤ 1 meter, there are no specific requirements on the cable or shielding except for the electrical specifications (e.g. rated voltage 230 V).

If you need cable lengths of > 1 meter, you can, with reduced configuration limit, use high-voltage and insulation-tested PLB cables with a length of 8 meters.

Table 2- 11 PLB cables of 8 meters in length

PLB cable	8 m length
Without plug	6ES7903-1AH40-0AB0
With plug (male)	6ES7903-1AH41-0AB0
With two plugs (male + female)	6ES7903-1AH42-0AB0

The cables with plugs are fabricated with Harting HAN 3A EMC connectors.

Table 2- 12 Use the following HAN® connectors from Harting

Product	Type	Harting order number
Add-on housing straight	HAN® 3 EMC	09 62 003 0301
Add-on housing angled	HAN® 3 EMC	09 62 003 0801
Socket insert (female)	HAN® Q 5/0-F	09 12 005 3101
Contact insert (male)	HAN® Q 5/0-F	09 12 005 3001
Crimp contact (female)	HAN E®, 2.5 mm ² , gold-plated	09 33 000 6223
Crimp contact (male)	HAN E®, 2.5 mm ² , gold-plated	09 33 000 6123
Crimp contact (female)	HAN E®, 1.5 mm ² , gold-plated	09 33 000 6216
Crimp contact (male)	HAN E®, 1.5 mm ² , gold-plated	09 33 000 6116

The connector enclosure must have a surface contact to the supporting metal surface. An insulating seal is not allowed.

If even 8 meter cables are not sufficient, you can also use other shielded cables when taking into account the electrical specifications. However, this results in a further reduction of the configuration limit. This means you should only consider these cables in exceptional situations.

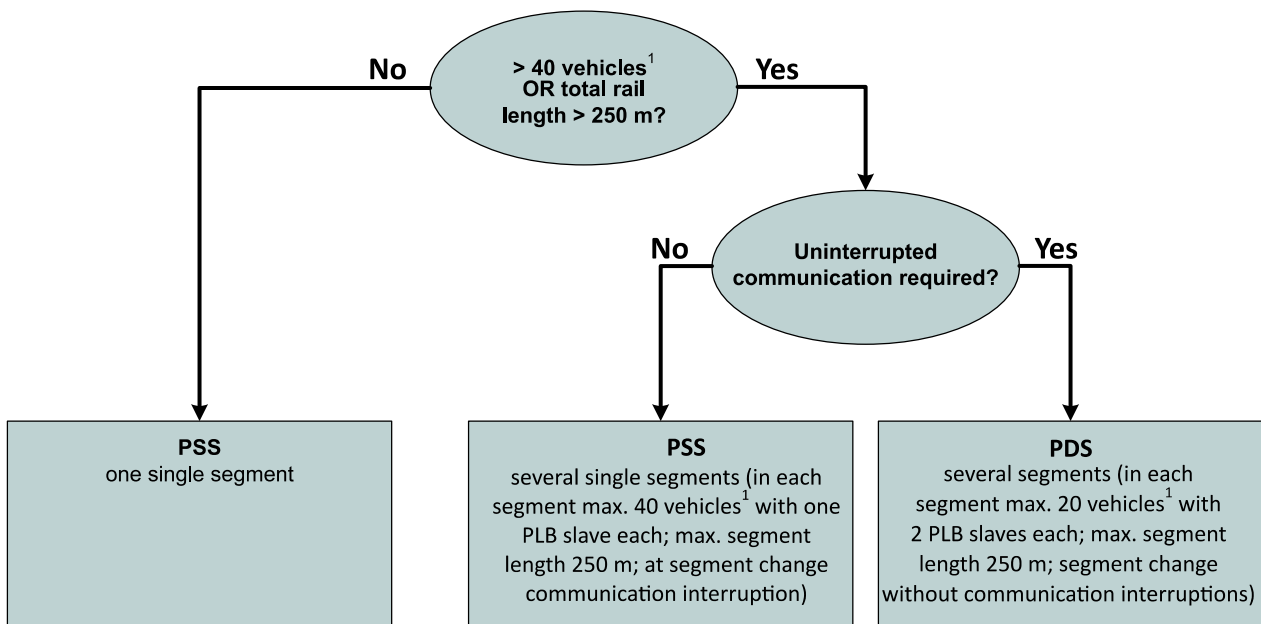
Table 2- 13 PLB cable with flexible length (example)

Manufacturer	Type	Lapp order number
Lapp	PROFIBUS cable	2170322

Plant planning

3.1 Overview of PLB applications

Depending on the application, we distinguish between "single-segment systems" and "multi-segment systems". If uninterrupted communication is required, two PLB slaves are used on the vehicle, each on its own slider (PDS = Powerline Double Slider). Otherwise, you only need one PLB slave per vehicle in case of a single slider application (PSS = Powerline Single Slider).



PSS = Powerline Single Slider
PDS = Powerline Double Slider

¹When using PLB connection cables ≤ 1meter

Figure 3-1 Overview of PLB applications

3.2 Single slider solution (PSS)

With the Powerline Single Slider (PSS) solution, data transmission via PROFINET, for example, takes place from the stationary end via a Power Line Booster configured as "master". The PLB converts the Ethernet data into a powerline signal and feeds this signal into the communication rails. One Power Line Booster in "slave" configuration is installed on each of the vehicles. This PLB converts the signal back into an Ethernet signal.

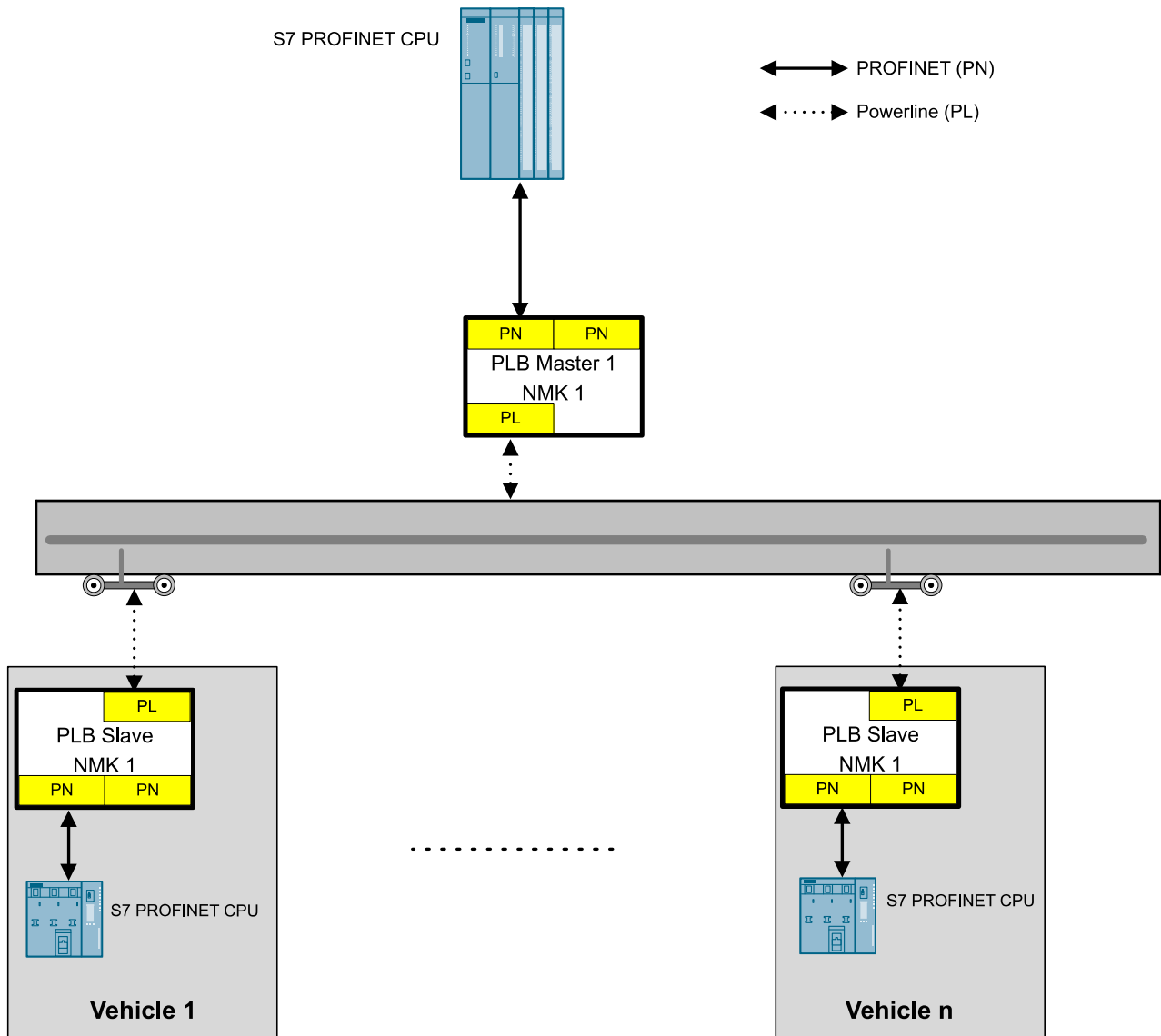


Figure 3-2 Basic principle of the single slider solution

Each powerline segment should be considered as an independent and separate communication area in which either a steady number of vehicles is located permanently (e.g. storage and retrieval system) or in which vehicles are continuously moving in and out.

An entire system can also contain multiple single segments that are all independent of each other. This means that, by design, a change of segments results in an interruption of communication.

A communication segment must always be terminated by a PLB TC module at the ends. Closed loops are not permitted because a "circular" signal results in suppressions and thus communication problems. The implementation of such a system topology in an application is described in the section "Loops (Page 55)".

3.3 Double slider solution (PDS)

If uninterruptible communication is also required across segment limits, it can be implemented with the Powerline Double Slider solution (PDS). Two Power Line Boosters in "slave" configuration on each vehicle are used in this case. Each of these PLBs is connected to a slider, whereby one slider is mounted at the front of the vehicle and one at the end. Communication takes place permanently and redundantly across both slaves, except for the segment transition, which further increases availability. All PLBs must be set to the same Powerline network key (NMK) (Page 15) in this case. You must set the Short Network ID (SNID) (Page 101) differently for neighboring masters to implement shorter transfer times.

During a segment change, the front slider of a vehicle travels out of the first communication segment (shown in red in the figure (Page 38) below), and the front PLB (PLB Slave B) loses the connection to the master of this segment (PLB Master 1). Thanks to the redundant communication, however, the connection is maintained by the PLB (PLB Slave A) mounted on the rear slider. As soon as the front slider enters the following second segment (shown in green in the figure (Page 38) below), the front PLB establishes a connection again and communication now takes place over the master of the first segment as well as the master of the second segment. This situation is shown in the following figure (Page 38) for "Vehicle 2". To prevent the formation of a loop on the Ethernet level in this configuration, PRP switches must be used (see also "Parallel and redundant communication via PRP (Page 39)"). If the PLB mounted to the rear slider leaves the segment in the next step and loses the connection to the system control, a connection already exists over the front PLB. As soon as both sliders are in the second segment shown in green, communication once again takes place redundantly over both communication pairs.

See also

DIP switches (Page 14)

Maximum permissible velocity during segment change (Page 38)

3.3.1 Maximum permissible velocity during segment change

There are generally no velocity limits for vehicles in PLB applications within a communication segment. Only a permanent electrical and mechanical connection between slider and rail must be ensured. During the segment change, the maximum permissible velocity depends on the distance of the sliders on a vehicle and the transfer time defined in the section "Registration and transfer times (Page 46)". It must always be ensured that the PLB on the front slider is securely registered before the rear slider leaves the segment.

The maximum velocity during segment change can be calculated as follows:

$$V_{\max_segment_change} = \text{slider distance} / \text{transfer time}_{\max}$$

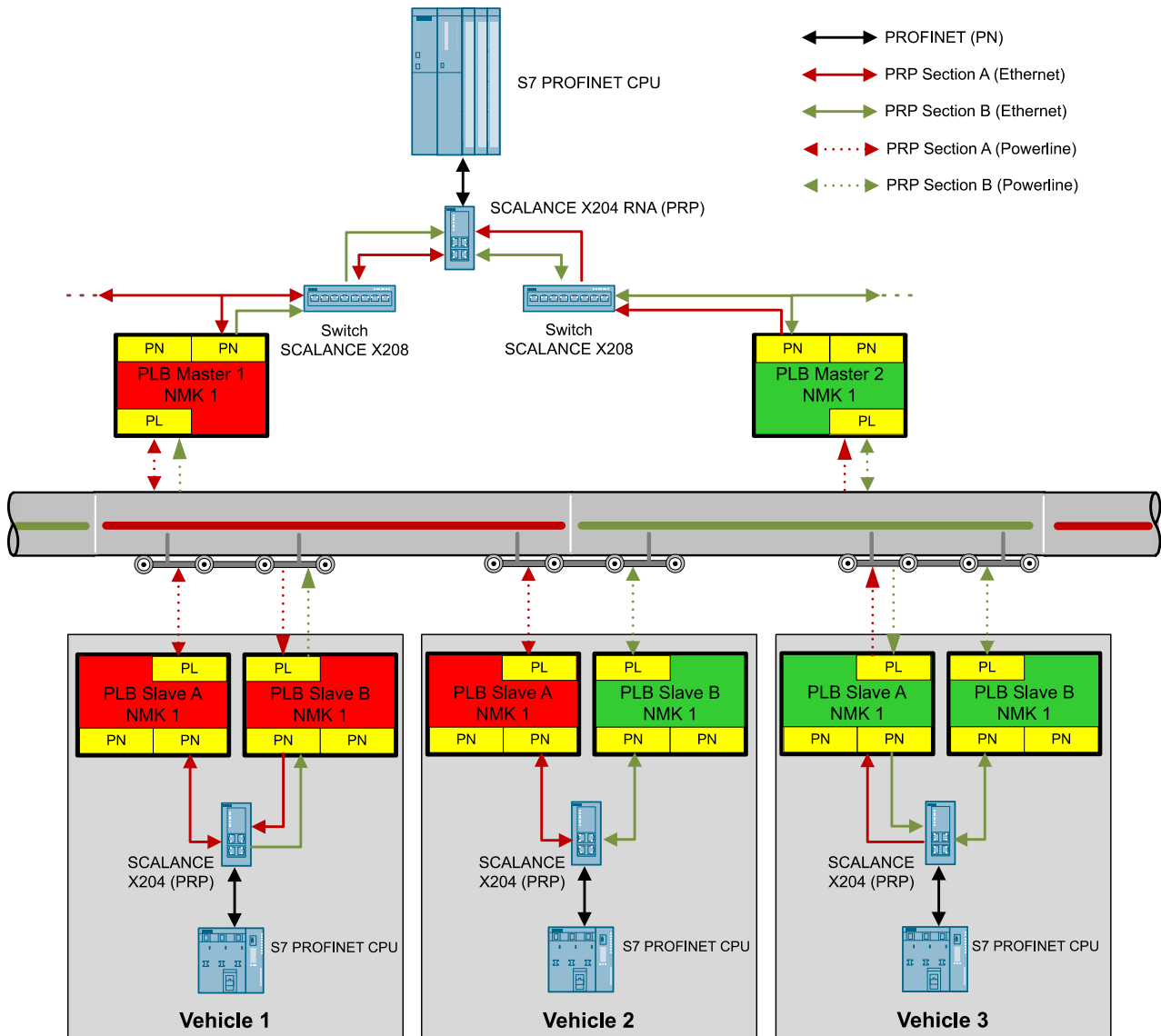


Figure 3-3 Basic principle of the double slider solution

3.3.2 Parallel and redundant communication via PRP

To prevent the formation of a loop on the Ethernet level in PDS applications at the time of the segment change, PRP switches are required (e.g. SCALANCE X204RNA). These switches ensure redundant communication over parallel Ethernet paths. To break up the loop, one PRP switch is required on each vehicle and a central switch at the stationary end. The stationary masters must be connected alternately to "PRP Section A" and "PRP Section B" so that a PLB segment with "PRP Section B" always follows a PLB segment with "PRP Section A". If required, the stationary subdistribution of the PRP sections can be achieved with standard switches, such as SCALANCE X208.

Observe the following points when using PRP:

Increased network load with non-PROFINET communication

Use of the "Parallel Redundancy Protocol" (PRP) in the higher-level network results in an increased network load in the Power Line Booster communication system. This is because all frames are transmitted redundantly here. These frames can only be delivered in the PRP section in which the receiver is located. In the other PRP sections, this data is flooded and thus sent to all PLB masters of the PRP section. This can lead to a high network load or a reduction of the broadcast bandwidth with a large number of stations.

Because the PLB master knows the Ethernet stations in its segment, it can block frames to unknown stations to prevent flooding. The process for handling frames to unknown stations can be configured via the Buffer configuration of the Traffic Manager (Page 96).

Jumbo frames with MTU

The standard MTU (Maximum Transmission Unit) for user data is 1500 bytes for Ethernet. All stations in an Ethernet network can thus, by default, transmit only frames with a maximum data packet size of 1500 bytes of user data. The redundancy required by using PRP provides the frames in the PRP section with an additional 6-byte PRP trailer. In the extreme case, the maximum data packet size can thus be exceeded in the PRP section. If switches are used in the PRP section, these packets may be rejected, depending on the switch configuration.

In the case of Siemens SCALANCE switches, for example, this can be prevented by activating "Oversize mode".

PROFINET devices in the PRP section

Direct PROFINET communication between a PROFINET controller outside a PRP section and a PROFINET device within a PRP section is not possible (see also the SCALANCE X204RNA manual). For example, it is not possible to configure a switch in the PRP section as a PROFINET device in the hardware configuration of the PLC.

Special adaptations were made for this on the Power Line Booster so that, in spite of this general PRP limitation, the PLBs can be configured as a PROFINET device in the PRP section.

3.4 System limits

3.4.1 Segment length

Plan the length of the communication segment so that it does not exceed the maximum permitted segment length of 250 meters.

You must also ensure that the maximum number of permitted vehicles in the segment is never exceeded during operation (see the Maximum number of stations (Page 40)).

You can maintain this, for example, by selecting the segment length in such a way that no more than the permissible number of vehicles can fit into the communication segment.

3.4.2 Maximum number of stations

You can only achieve the maximum number of stations in PSS as well as in PDS applications when you strictly adhere to all installation rules (cabling and positioning) and when you use PLB connection cables that are shorter than or equal to 1 meter.

The logical high limit of slaves that can be managed by a PLB master is 50. In case of real-time requirements, however, we recommend that you stay below this number. We will therefore only look at the maximum number recommended for real-time applications.

The rules for determining the maximum configuration limit are listed below. Note that the reductions per segment in percentage always apply in addition to the maximum configuration.

PLB connection cable \leq 1 meter long

For connection cables \leq 1 meter, a maximum of 40 vehicles are possible for PSS applications with one PLB slave per vehicle.

In PDS applications with uninterruptible communication, the maximum number of vehicles in a segment is 20. Two PLB slaves are mounted on each of these vehicles so that the total of slaves in the segment is also 40.

PLB connection cable 8 meters long

Through the attenuation and the poles of the 8 meter cables (Page 33) connected to the rail as spur line, the maximum number of PLBs per segment is reduced by 40% of the maximum configuration. This means a maximum of 24 vehicles are possible for PSS applications with one slave each. In PDS applications with uninterruptible communication, the maximum number of vehicles in a segment is then 12. Two PLB slaves are mounted on each of these vehicles so that the total of slaves in the segment is also 24.

PLB connection cable with individual length

If connection cables with individual length (Page 33) are used, this also results in smaller configuration limits. It does not matter in this case whether the cable is shorter or longer than 8 meters. The maximum possible cable length is 30 meters in this case. Cables with individual lengths are required, for example, when the distance between master and rail is too large or a lifter is to be supplied via PLB.

Each cable with individual length reduces the number of slaves per segment by 10% of the maximum configuration. If two cables with individual length are used, for example, in a segment of a PDS application with connection cables that are generally ≤ 1 meter, the configuration limit is reduced to $40 \text{ PLB} - (2 \cdot 10\%) = 32 \text{ PLB}$, which corresponds to a maximum number of 16 vehicles.

If connection cables ≥ 30 meters are required, 25% of the maximum configuration must be subtracted per cable. These cable lengths must then also be added to calculate the maximum segment length.

See also

PLB connection cable (Page 32)

Interruptions of the communication rail (switches/lifters/broken loops)

Each interruption of the integrated communication rail also results in increased attenuation of the high-frequency powerline signal. When using switches or lifters in a segment, the communication rail must be separated and the powerline signal must be transmitted to a different rail section via cables. Note that these cables must always be shielded. We recommend using PLB standard cables (Page 33).

As soon as a communication segment consists of multiple rail sections connected via cables instead of an integrated rail, the total of all rail sections of the segment must be calculated. For each rail section, you must subtract 7% from the maximum configuration for the maximum number of slaves. If a switch is located in a communication segment of a PSS application, for example, the powerline segment consists of 5 rail sections in total (1 rail before the switch, 2 rail sections after the switch, and the two short movable rail sections on the switch). This means the number of slaves must be reduced by $5 \cdot 7\% = 35\%$ of the maximum configuration, which means 26 slaves are still possible per segment.

The connection cables between the segments must be ≤ 8 meters in this case. If this is not possible, an additional 10% reduction must be subtracted for the connection cable with individual length. This can be the case, for example, when an inlet lifter with communication is required at the segment start and this lifter is connected, for example, with a 15 meter connection cable. The maximum number of stations is thus reduced by $(2 \cdot 7\%) + 10\% = 24\%$.

For more details on switches, lifters or broken loops and their cabling, see the sections "Switches (Page 57)", "Loops (Page 55)" and "Rail interruptions (lifters) (Page 55)".

Summary

The following table once again lists the most important indicators and examples of the configuration limit:

Table 3- 1 Configuration limits

Plant structure	Reduction in percentage of maximum configuration	Reduction compared to maximum configuration	Maximum number of slaves per segment
Connection cable ≤ 1 m	0%	0 slaves	40 slaves
8 m PLB connection cable	40%	16 slaves	24 slaves
Reduction per connection cable with individual length (but ≤ 30 m)	10%	4 slaves	36 slaves
Reduction with separated rail	7% per rail section	2.8 slaves	Depending on the rail sections
Inlet lifter already with powerline communication (2 rail sections + connection cable with approx. 15 m)	24% (2 • 7% + 10%)	10 slaves	30 slaves

See also

PLB connection cable (Page 32)

3.4.3 Master position

You must observe two rules to determine the PLB master position.

1. A maximum of 70% of the slaves permissible for the maximum configuration may be present between PLB master and rail end. This means that with a PSS application, the PLB slave farthest removed from a master may be located a maximum of 28 positions away from the master (40 slaves • 70% = 28 slaves).
2. A maximum of 40% of the slaves permissible for the maximum configuration may be present between PLB master and the registration location (rail start). A PLB slave entering the segment in a PSS application thus may be located a maximum of 16 positions away from the master (40 slaves • 40% = 16 slaves).

In systems where the vehicles only move in one direction during regular operation, the infeed position of the powerline signal by the PLB master should take place after about one-third of the travel distance (in vehicle travel direction). This ensures that an adequate signal level is present over the entire distance in a full segment and that the signal level is strong enough at the moment of registration. For PDS applications, it must be noted that there are two PLB slaves on each vehicle.

Also take into account the factors for signal attenuation described in the section "Maximum number of stations (Page 40)" when positioning the PLB master. The end of the master on which the signal attenuating factor has an effect is important here. From this end, you must reduce the number of slaves accordingly.

The following examples are given to clarify the calculation of the master position. The position information in this case always refers to the distance from the rail start in traveling direction.

Special case: Connection via TC module

If you feed in your application through a rail interruption (e.g. lifter) (Page 55) via a TC module, you must adjust the master position accordingly. The powerline signal is dampened by the TC module. This corresponds to an attenuation of about 25% of the maximum number of vehicles permitted and the master position must be moved accordingly. If the rail interruption is at the segment start, only 40% - 25% = 15% of the maximum number of vehicles permitted may be located between the entry point and the master.

Examples

Example 1 (PSS application with PLB connection cable ≤ 1 meter)

Segment length 180 m, vehicle length approx. 5 m.

PSS \rightarrow 1 slave per vehicle \rightarrow 40 vehicles

Maximum distance from rail start:

40 vehicles (maximum configuration PSS) \cdot 40% \cdot 5 m = 16 vehicles \cdot 5 m = 80 m

Maximum distance to rail end:

40 vehicles (maximum configuration PSS) \cdot 70% \cdot 5 m = 28 vehicles \cdot 5 m = 140 m

\rightarrow Position in reference to rail start: 180 m - 140 m = 40 m

Conclusion: The PLB master must be fed in somewhere in the range between 40 meters and 80 meters. The position after about one-third of the distance (equals 60 meters) is ideal.

Example 2 (PDS application with 8 meter PLB connection cable)

Segment length 100 m, vehicle length approx. 8 m.

PDS \rightarrow 2 slaves per vehicle \rightarrow 20 vehicles

8 meter PLB connection cable \rightarrow Reduction of the configuration limit by 40% \rightarrow The attenuation through the 8 meter cable corresponds to about 8 vehicles \rightarrow 20 vehicles - 8 vehicles = 12 vehicles per segment.

The attenuation resulting from the 8 m connection cable affects the area to the right and the left of the master position.

Maximum distance from rail start:

12 vehicles \cdot 40% \cdot 8 m = 4.8 vehicles \cdot 8 m = 38.4 m

Maximum distance to rail end:

12 vehicles \cdot 70% \cdot 8 m = 8.4 vehicles \cdot 8 m = 67.2 m

\rightarrow Position in reference to rail start: 100 m - 67.2 m = 32.8 m

Conclusion: The PLB master must be fed in somewhere in the range between 32.8 meters and 38.4 meters. The position after about one-third of the distance (equals 33 meters) is ideal.

Example 3 (PSS application with PLB connection cable ≤ 1 meter and lifter)

Based on example 1, a lifter is now going to be added to the communication area at the line start. This rail section is connected to the main segment using a TC module (see Special case: Connection via TC module (Page 42)).

For the master position, you must take into account the rule for the Interruptions of the communication rail (Page 40) as well as the shift of the master position due to the special case "Connection via TC module (Page 42)".

Reduction due to the interruptions of the communication rail:

A segment with a lifter consists of two separate rail segments ($2 \cdot 7\% = 14\%$). Besides, the lifter must be connected using a cable of individual length because the 8 m cable is not sufficient (10% reduction).

→ Number of stations reduced by $(14\% + 10\%) \cdot 40$ vehicles = 9.6 vehicles.

Due to the installation in front of the PLB master, the attenuation resulting from the lifter of about 10 vehicles only affects this area.

This means the maximum number of vehicles between master and segment start is 16 vehicles (see example 1) – 10 vehicles = 6 vehicles.

Reduction due to connection via TC module:

Because the lifter must be fed in via a TC module, the maximum number of vehicles permitted between master and the incoming vehicle is $40\% - 25\% = 15\%$.

→ The maximum distance from the PLB master to an incoming vehicle is $15\% \cdot 40$ vehicles = 6 vehicles

The result of both rules is that no more than 6 vehicles in total may be in front of the master, regardless of whether the vehicles are parked on the lifter or not.

3.5 Comparison PSS to PDS

Table 3- 2 Comparison

Technical specifications	Single slider solution (PSS)	Double slider solution (PDS)
Number of sliders per vehicle	1 slider	2 sliders
Number of PLB slaves per vehicle	1 slave (Page 36)	2 slaves (Page 37)
Max. segment length (Page 40)	250 m	250 m
Number of segments	Any	Any
Behavior at segment transition	Interruption of the powerline communication	No interruption of the powerline communication
Max. slaves/vehicles in the segment (Page 40)	50 vehicles, a maximum of 40 vehicles is recommended for real-time applications.	20 vehicles
PROFINET/PROFIsafe	Possible within a segment. Communication is interrupted during a segment change.	Possible within a segment and across segments.
Registration or transfer time during a segment change (Page 46)	≤ 4 s	≤ 4 s
PROFINET (PN) data volume (for standard configuration)	2048 bytes distributed over max. 8 PN stations per PLB slave	2048 bytes distributed over max. 8 PN stations per PLB slave
Recommended PN cycle time (Page 72) (vehicles, per segment)	40 vehicles: 64 ms 20 vehicles: 32 ms 10 vehicles: 16 ms 1 vehicle: 8 ms	20 vehicles: 32 ms 10 vehicles: 16 ms 1 vehicle: 8 ms
PN monitoring time (Page 73) PROFIsafe time (vehicles, per segment)	40 vehicles: min. 1600 ms 20 vehicles: min. 900 ms 10 vehicles: min. 650 ms 1 vehicle: min. 250 ms	20 vehicles: min. 1600 ms 10 vehicles: min. 900 ms 5 vehicles: min. 650 ms
UDP data throughput Throughput per vehicle	2 Mbps 2 Mbps / Number of vehicles in the segment	1 Mbps / Number of vehicles in the segment
Max. traveling speed	Unlimited	Dependent on slider distance (Page 38) (segment change)

3.6 System times

3.6.1 Startup time

Startup time is the time that a Power Line Booster needs to set up the first powerline connection from its de-energized state.

Startup time from switching on the 24 volt supply voltage until readiness for operation: max. 25 seconds

If the device configuration was changed using the DIP switches before the device is switched on or if a modem update was performed, the startup time is increased significantly.

3.6.2 Registration and transfer times

Registration time is the time that a PLB slave that is ready for operation needs to set up a connection to a master. This is the case, for example, when a vehicle in a PSS application travels from a segment without communication to a segment with communication. The values refer to the registration time of a slave into a segment with the maximum number of slaves.

The maximum registration time is 4 seconds. 98% of registrations take less than 1 second.

In the special case that the maximum number of 40 slaves register simultaneously on a master, the maximum time until all slaves have set up a connection is 15 seconds.

Transfer time is the time a slave with a communication connection needs to terminate the existing connection and set up a connection to a new PLB master. This is the case, for example, when a vehicle in a PDS application travels from one communication segment to the next communication segment with the maximum number of slaves.

The maximum transfer time is 4 seconds. 98% of transfers take less than 2 seconds.

	Time for 98% of registrations	Maximum time
Registration time of one slave into a full segment	1 second	4 seconds
Transfer time of one slave to a full segment	2 seconds	4 seconds
Registration time of 40 slaves into a segment	12 seconds	15 seconds

Note

A short transfer time can only be guaranteed if a different Short Network ID (SNID) is configured for neighboring masters.

The first identification of the powerline network is over the Short Network ID (SNID). To implement a fast segment change, you must ensure that the SNID of the master changes as well with each segment change. You can set the SNID in the Web user interface under Segment configuration (Page 101).

3.7 Data rate

The maximum data rate that can be transmitted is distributed across all slaves in a segment. If the connections are poor due to high contact resistances or unsuitable cables, for example, the data rate can be negatively affected. Depending on your application and needs, you can optimize the maximum data rate using the parameters of the Power Line Booster Traffic Manager (Page 95).

Plant installation

The following subsections describe the installation of the required components.

 WARNING
--

You must de-energize the plant before installation.
--

4.1 Cables in the powerline system and their shielding

Try to keep all cables in the powerline system as short as possible. It makes no difference whether these are grounding cables, the cables between the PLB and the rail or the slider, the cabling of the powerline cables in the control cabinet or the connection cables of the TC modules.

You can install short cables with a length of less than one meter unshielded and with 2.5 mm² single cores, for example. You should still ensure that these cables are separated in the control cabinet and that they are not installed parallel to other cables.

All cables that conduct powerline signals and are longer than one meter must always be shielded to prevent overcoupling to other plant parts.

If you are using shielded cables, these must be connected to suitable metal parts of the plant at both ends and in compliance with EMC. The connection of the shield must be extensive and low-resistance, for example, over shield clamps or EMC cable glands.

 WARNING
--

When selecting the cables, note that 230 volts can be present on the powerline rails in case of a fault.

4.2 Rail connection of master and carrier power supply

We recommend installing the Power Line Booster Master and the carrier power supply in one common control cabinet and to connect them to the rail using the same powerline connection cable (see section "PLB connection cable (Page 32)"). When using connection cables > 1 meter, note that the cable shield must be applied EMC-compliant to both ends.



Figure 4-1 Rail terminal box with shielding

The positioning of the master is described in the section "Master position (Page 42)". Make sure to keep all powerline cables in the control cabinet of the master (shown in blue in the figure below) as short as possible and to separate them so that there can be no overcoupling of the powerline signal to other cables. You can find the detailed structure of the carrier power supply including cable protection in the section "Power supply connection (Page 18)". You can either use a separate transformer per segment or supply multiple segments using a shared transformer. All cables on the primary side of the filter (black) have no powerline signal. There are no requirements regarding shielding or cable length for these cables.

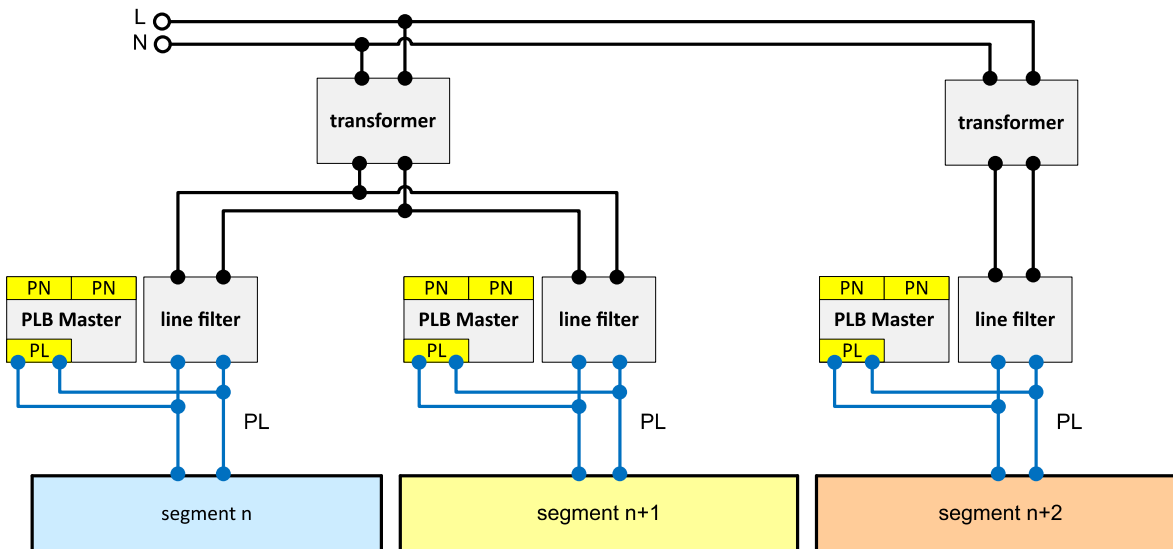


Figure 4-2 Connection of the PLB master

4.3 Connection of the PLB slave

To connect the PLB slave to the communication sliders, use the cables specified in section "PLB connection cable (Page 32)".

If you are not using the pre-fabricated 8 meter PLB connection cable, you must ensure that all cables in the entire system are of the same type and have the same length (+/- 5%).

4.4 Rail connection TC module

You must install the PLB TC module (Page 28) in an enclosure (e.g. a rail terminal box) to ensure its isolation.

Connect the end of the rail pair Rail A/ Rail B to the ports X1.1 and X1.2 of the PLB TC module. Use relatively short 2.5 mm² cables with a maximum length of 0.5 meters for the connection between rail and rail terminal box.

Terminal	Connection	Color
X1.1	A (Rail A)	Red
X1.2	B (Rail B)	Green
X2.1	A'	Brown
X2.2	B'	Violet

Note

The connections X2.1 (A') and X2.2 (B') are not used for termination at the rail end and must be isolated.

For example, you can connect the cables to empty or unused terminals in the rail terminal box.

4.5 Plant attenuation

The Power Line Booster uses permanently set sending and receiving levels for the communication signals. The height of these levels has been optimized to ensure communication within a plant unit while preventing communication to other plant units. You must adhere to the setup and configuration guidelines to meet both requirements.

The difference between the level that is sent at a certain point in the plant and the level that is received at another point in the plant is referred to as attenuation (usually given in dB and scaled logarithmically). We are referring to the attenuation within a communication area as longitudinal attenuation and between the different communication areas as lateral attenuation.

Note that communication takes place on carrier frequencies of 2 MHz to 28 MHz and that each of these frequencies may have a different attenuation. You must consider the minimum attenuation across all carrier frequencies in lateral attenuation.

The Power Line Booster has been developed and tested according to the current standards regarding electromagnetic compatibility. This means it is immune to interference tested according to current standards. If interferences were to occur in your plant environment that significantly exceed the scope tested according to current standards (e.g. through the cumulation of multiple faults or due to individual specific devices/machines), contact our Technical Support (<mailto:PLB-Support.industry@siemens.com>).

If you are operating the Power Line Booster with the factory settings, interferences up to 73 dB μ V (QPk, corresponds to 1 Vpp, see EN 61000-6-4:2007) do not result in communication errors.

If the incoming level of a PLB in the plant (e.g. of the master) is greater than the minimum receiving level of another PLB in the plant (e.g. a slave), then the two devices can communicate. If they are located in different plant units, this is an undesirable effect which is referred to as crosstalk. Crosstalk must be prevented by lateral attenuation. It must be at least 40 dB.

The following effects result in a low lateral attenuation:

- Cabling error in the vehicle, on the rails and at the ports of the carrier voltage.
- Missing or incorrectly connected termination at the cable ends.
- Cable sections of the communication cables (Rail A/B) and supply cables (L1, L2, L3) running parallel with very little distance. Compare Rail system and arrangement (Page 52).
- Connection elements between Rail A/B and L1, L2, L3 such as relays, short-circuits, etc.
- Missing / insufficient filter elements in the carrier power supply (Page 29) or connecting cables that are too long or unshielded.

The longitudinal attenuation is influenced by the following:

- Length of the distance (impedance per meter).
- Type and length of the Power Line Booster connecting cable (Page 32).
- Quality of the rails, connecting pieces, sliders and cables.
- Rail elements such as switches, lifters, etc.
- Number of vehicles in the segment (dynamic, attenuation per vehicle).

Because the number of vehicles in the segment can change dynamically, keep in mind that the outcome can be two extreme cases. The extreme case for lateral attenuation and crosstalk between the communication segments is two neighboring segments without vehicles. For longitudinal attenuation, it is one segment with the maximum number of vehicles. In the first case, there must still be no crosstalk of the signal; in the second case, stable communication between the master and all vehicles must still be possible. Hence the requirement for specific placement of the PLB master (see section Master position (Page 42)).

If there is crosstalk between two plant units, you will encounter communication failures (for example, when the two neighboring masters can detect each other or when slaves register in the wrong segment). The cycle times may also get significantly longer because both segments must now share the communication medium. This is also the case when a different channel is selected in a different plant (see DIP switches (Page 14)).

In contrast to digital transmission lines (buses or point-to-point connections), which can be shielded relatively easily and reliably, powerline connections are susceptible to interferences by any device in their proximity which, intermittently or continuously, can interfere on strictly limited channels or emit broadband radiation. These include, for example, welding equipment, large drives or inverters with poor interference suppression.

However, such interferences can already be counteracted before they occur by carefully planning the system (cabling, interference suppression measures). For these reasons, therefore, it is essential to observe the wiring and installation instructions described in this manual.

If you adhere to the specifications in this manual, it is possible to operate a segment with the maximum number of vehicles without crosstalk. If you are using switches, lifters, or similar, note the impact on the maximum configuration limit defined in the section Maximum number of stations (Page 40)

Note

For more complex plants, it may be best to involve Technical Support (<mailto:PLB-Support.industry@siemens.com>) **for the Power Line Booster as early as the planning phase.**

4.6 Rail system and arrangement

Select a combination for the rail/slider system which ensures a permanent low resistance contact (< 1 Ohm) when being operated under the conditions specified by the manufacturer. You must ensure that the contact is also guaranteed at transitions and expansion points.

Arrangement of the sliding contact lines

The examples and calculations shown in the preceding sections are based on the following arrangement which is recommended for reliable communication.

Rails: L1, L2, L3, PE, Rail A and Rail B.

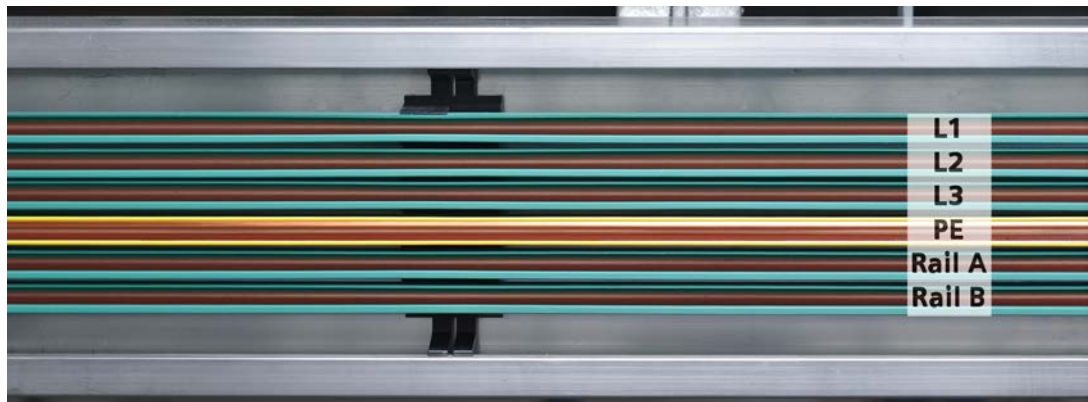


Figure 4-3 Arrangement of the rails

It is necessary, however, that except for the regularly grounded PE rail (Page 53), there are no other rails in addition to the powerline rails (Rail A and Rail B); otherwise, signal couplings and crosstalk will occur.

The PE rail is also used as shielding in this case. Due to the positioning, the PE rail provides additional spacing between the live parts with dangerous contact voltage (L1..L3) and the communication rails Rail A/B. This additional spacing reduces the crosstalk of the communication signals and the risk of short-circuits.

If additional sliding contact lines are required below the communication rails Rail A and Rail B, you must separate them with an additional regularly grounded PE rail.

NOTICE

You may use Rail A and Rail B for PL communication only!

Note

Missing PE rail

If the installation of a PE rail is not possible next to the powerline communication rails (e.g. plant modifications), the installation of shield plates may be considered in case of a reduced number of devices. Please contact Technical Support (<mailto:PLB-Support.industry@siemens.com>) for more information.

Rail quality

An electrical connection (contact resistance across the entire distance $< 1 \text{ Ohm}$) of the sliding contacts is required to ensure the function of the Power Line Booster.

4.7 Rail grounding (PE rail)

You must set up the powerline communication rails Rail A and Rail B as described in this manual. You need to pay particular attention to ensure that the powerline rails are always separated from the other rails by PE rails.

In addition, you must plan the system so that the PE rail is regularly grounded with low impedance at each connecting piece (about every 6 meters), as well as at the rail ends (e.g. at the segment end, at the segment change or at switches) on the carrier rail or over the steel construction with a short cable ($\leq 10 \text{ cm}$).

Note that a ground cable that is too long will be ineffective for the high-frequency powerline signal, and the PE rail will act as an antenna in this case.

Strict adherence to the grounding concept described below is essential for stable PROFINET communication.

Note

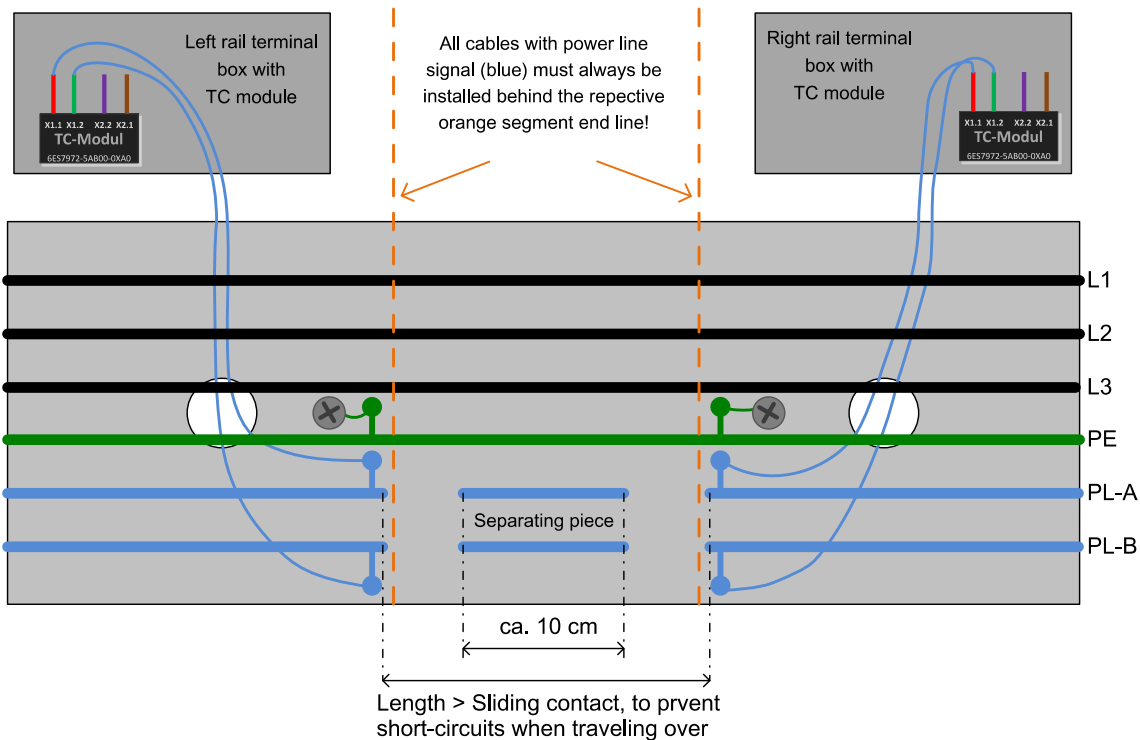
You must ground the PE rail at regular distances, as well as at the rail start and the rail end, with short cables ($\leq 10 \text{ cm}$) over the carrier rail.


4.8 Segment cut

At a change from one segment to another, you must cut the rails as shown in the following figure "Sample segment cut". The separating piece with the double cuts prevents a slider from directly interconnecting the two neighboring segments when traveling over the cut. You must terminate each segment with a PLB TC module. You must not exceed the maximum cable length of 50 cm in this case. We recommend installing the required TC modules directly in a rail terminal box (Page 48) to keep the cables as short as possible.

To minimize crosstalk between the segments via the PE rail, you must ground them with short cables (≤ 10 cm) to the support rail or via the steel construction at the level of the respective segment ends (orange line).

In addition, you must ensure that the powerline cabling of a segment never runs outside the imaginary orange segment end line.



 Connecting point of the PL rail; cable to rail terminal box **max. 50 cm**


 Double PE connection, each at the level of PL rail end, and direct connection, e. g. with screw, to support rail with **max. 10 cm** cable

Figure 4-4 Sample segment cut

See also

Rail connection of master and carrier power supply (Page 48)

4.9 Rail interruptions (e.g. lifter)

If it becomes necessary to interrupt the powerline rail and to route the powerline signal over a cable to another rail section, this entails a reduction in the number of stations in the segment according to the section Maximum number of stations (Page 40). This is necessary, for example, when the rails of the inlet lifter are already part of the communication segment.

Connect the main segment and the other rail sections (e.g. a lifter) using a shielded connection cable. The signal is routed via a TC module in this case. The TC module is used to attenuate the powerline signal. This prevents a closed loop from forming via the connection cable when a slider bridges the rail section. The TC module is installed directly at the beginning of the main segment in a rail terminal box, which means it also serves as the termination of this segment. The powerline cable is also connected to a rail end on the separate rail section. Note that the maximum number of vehicles permitted between master and the vehicles on the separate rail section is significantly reduced due to the signal attenuation by the TC module (Page 42).

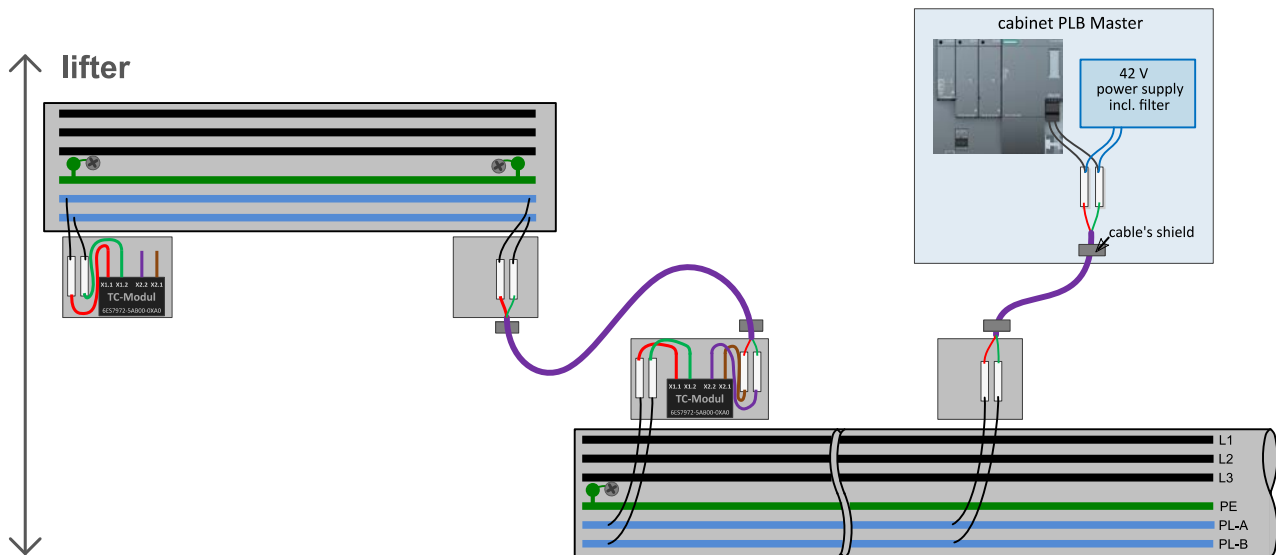


Figure 4-5 Rail interruption (for example) at a lifter

4.10 Loops

Closed loops are generally not possible in powerline applications, because the "circular" signal results in interferences and suppression of signals. Exceptions are loops with a circumference of ≤ 1 meter (e.g. loop sliders). For communication over loop sliders, only a point-to-point connection is possible between master and a slave.

If the application is a small plant with only a few vehicles in which permanent communication is required, the loop can be broken up with an interrupt section with communication according to the figure below. A PLB TC module is used for signal attenuation which is also used to supply the separator directly from the master. The length of the separator must be selected in such a way that the two rail sections can never be bridged simultaneously by a slider (\leq maximum vehicle length). The powerline signal for the main loop should be supplied as far away from the TC module as possible. Keep in mind that the limits specified in the

4.10 Loops

section Master position (Page 42) regarding vehicles between master and the most remote slave must be observed. From this value, you must then still subtract the number for the additional segment (see "Interruptions of the communication rail (Page 40)"). For the connection between master and rail, we recommend using the 8 meter PLB connection cable (Page 33).

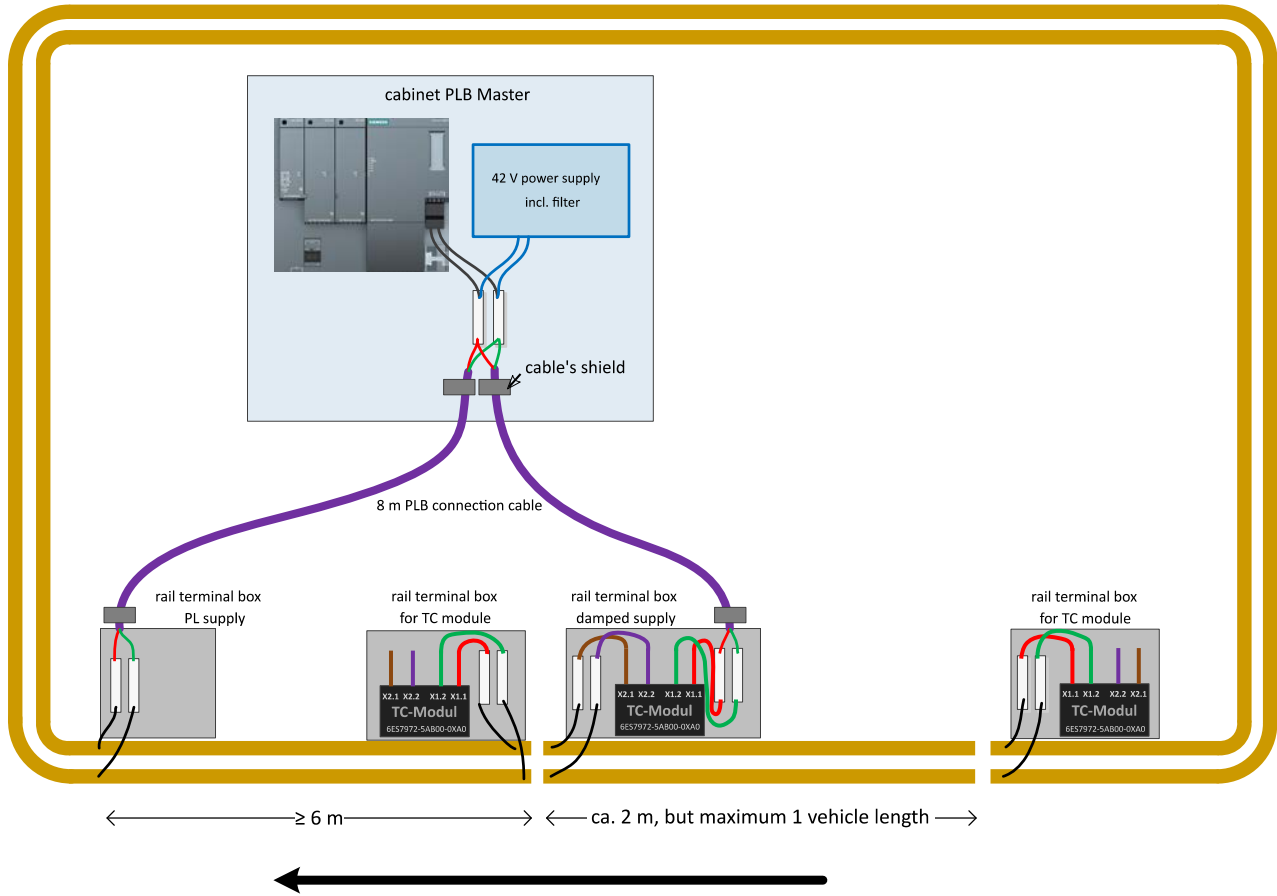


Figure 4-6 Loop with interrupt section

See also

PLB connection cable (Page 32)

4.11 Switches

If possible, use switches only for separation of segments during plant planning (as segment cut). If the switch must be used within a communication segment, this is possible with a reduction of the number of devices in the segment according to the section Maximum number of stations (Page 40).

4.11.1 Switch as segment cut

If you are using the switch for a segment change, the rails are replacing the separator on the moving switch section. Because two powerline segments are separated from each other in the process, you must ensure during cabling that there is no signal coupling between the high-frequency signal and the neighboring segment.

If this rail section/separator is longer than 1 meter, we recommend installing an additional short separator on the rail sections (see figure Segment cut (Page 54)) in front of and behind the switch. This prevents the vehicle sliders from temporarily connecting a long and non-terminated rail section with the communication segment when traveling over the cut. The sudden impedance change caused by such a connection would result in communication problems. The ends of the PL rails must be terminated with a PLB TC module as with each segment start/segment end.

As described in section Rail grounding (PE rail) (Page 53), it is essential to ground the PE rail at both ends with short cables against the steel structure. Also, it is necessary to ground the PE cable of the supply cables EMC-compliant with short cables against the steel structure. This can be, for example, at the location where the supply cables for the switch are connected. If the switch connector is designed as a plug-in connector, the connector can also be used for grounding the PE cable against the steel construction.

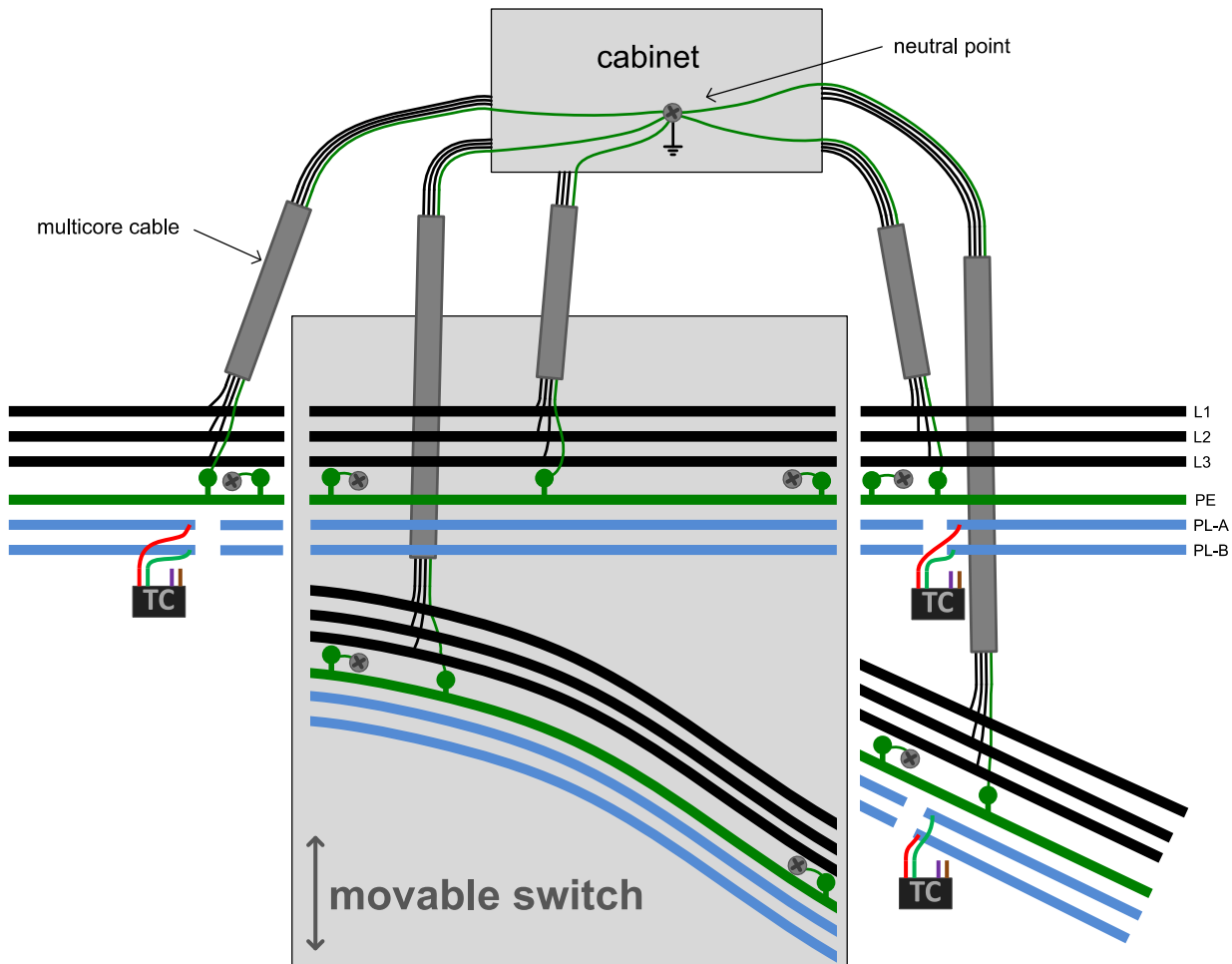


Figure 4-7 Wiring of the switch (switch as segment cut)

See also

Segment cut (Page 54)

4.11.2 Switch in the communication segment

If it is necessary to move across the switch without communication being interrupted, the switch can also be installed in the segment with a reduction of the maximum number of PLB slaves.

The cabling of the power cables can be done in accordance with the section Switch as segment cut (Page 57). The rail sections in front of and behind the switch are connected directly over the 8 meter PLB connection cable to the PLB master, for example. If possible, the cables should be installed relatively close to the switch to prevent open, non-terminated rail sections. A PLB TC module is not necessary in this case. We recommend installing a rail terminal box for the connection.

The master and the two moving rail sections on the switch are also connected using the 8 meter PLB connection cable, for example. The signal is routed via a PLB TC module in this case. This TC module is used to attenuate the powerline signal. This prevents a closed loop from forming via the two connection cables when a slider bridges the cut. We recommend installing the TC module directly at the rail in a rail terminal box. If this is not possible for mechanical reasons, the powerline connection cable can also be connected using a HAN® connector (see Selection table (Page 33)). In this case, the TC module must be installed in the control cabinet of the master.

Make sure that the 8 meter PLB connection cable shield is applied EMC-compliant to both ends.

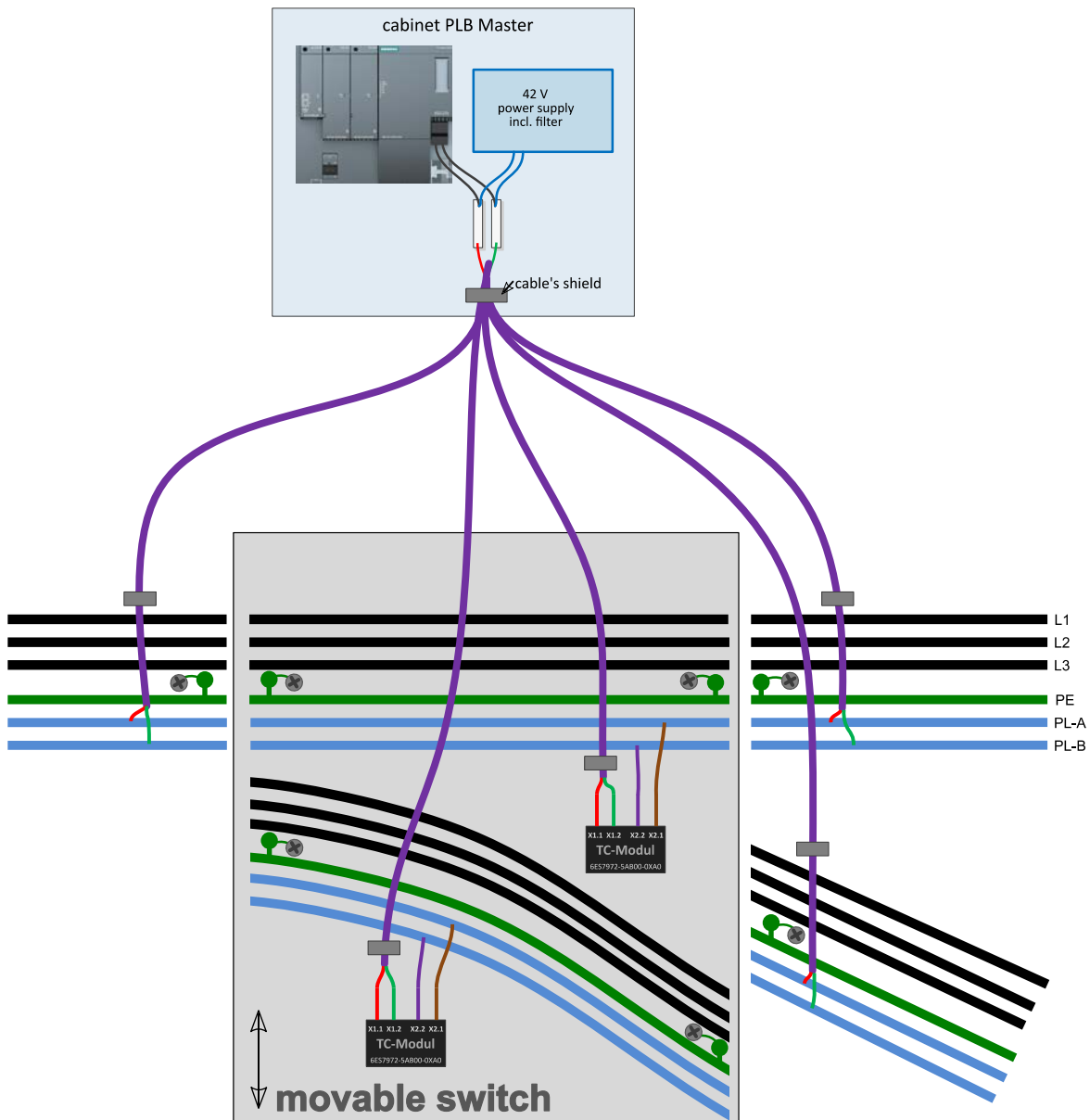


Figure 4-8 Switch wiring (switch in the communication segment)

See also

PLB connection cable (Page 32)

4.12 Insulation monitor

The operation of an insulation monitor may be necessary for safety reasons. This remains the responsibility of the plant constructor.



WARNING

The Power Line Booster system can be operated in low-voltage plants up to 500 V AC. A single short-circuit between a phase (L1 or L2 or L3) and Rail A or Rail B may represent a fault for this device as indicated by the error LED, but this does not prevent communication. However, this means that dangerous contact voltages are present on Rail A or Rail B (and the connected components) without the function being impaired. You need to consider this during maintenance.

If you are using an insulation monitor (such as Bender insulation monitor, in Europe) for safety reasons, it must be connected between the supply transformer and the line filter.

4.13 Installation

4.13.1 Power Line Booster (PLB BM)

Install the Power Line Booster onto a vertically mounted DIN rail (TS 35; DIN Rail) (see photo).



Figure 4-9 PLB mounted on a DIN rail; rear view

If you plug the Power Line Booster onto a vertical DIN rail or one installed horizontally, however, the maximum permissible ambient temperature is reduced to 50 °C.

You must always keep a clearance of 60 mm above and below the Power Line Booster.

4.13.2 PLB modem module/BusAdapter



Figure 4-10 Installation of the modules and the BusAdapter

Plug the modem and the empty module as well as the BusAdapter into the Power Line Booster and fasten the respective module with its fixing screw (tightening torque 0.2 Nm). Suitable tool: Preferably Torx screwdriver TX10 or slotted (Philips) screwdriver 0.5x3 (0.5x3.5).

Installation sequence:

1. PLB modem module, PLB empty module
2. BusAdapter

For stability reasons, you must attach the Ethernet connecting cables at a suitable location, for example, with a cable tie as strain relief.

4.13.3 PLB connector

The connectors to the ports X2 (Page 18) and X80 (Page 18) are spring-loaded terminals. If you are using flexible cables, it may be necessary to open the clamping spring with a 0.5x3 slotted (Philips) screwdriver to install the cables.

To remove the cables, you must use a 0.5x3 slotted (Philips) screwdriver to open the clamping spring.

See also

Power supply connection (Page 18)

Powerline connection (Page 18)

PROFINET/Ethernet

5.1 PROFINET IO

5.1.1 Introduction

PROFINET is a fieldbus standard of the PROFIBUS Users Organization that defines a heterogeneous communication and engineering model. As part of PROFINET, PROFINET IO is a communication concept that is used to implement modular, distributed applications. The Power Line Booster has a PROFINET interface and can be operated as an IO device on an IO controller (e.g. SIMATIC PLC) with the provided GSD file (Page 89).

Note

The PROFINET device and the mechanisms for assigning PN names and IP addresses are only available when the Ethernet connection to (X1P1 or X1P2) is connected.

The Power Line Booster system works with a "shared medium". This means all stations share one medium.

Topology recognition is not possible with a "shared medium".

The PLB system can forward **PROFIsafe**. When planning this safety function, you have to take into consideration the times from the section "Timing and runtimes (Page 72)".

For additional information on "PROFINET IO", refer to the STEP 7 online help and the PROFINET System Description (<http://support.automation.siemens.com/WW/view/en/19292127>).

5.1.2 Startup parameters

The Power Line Booster does not require adjustable startup parameters.

5.1.3 IO address space (cyclic data)

The figure below shows the IO address space of the Power Line Booster. Depending on the requirement, so-called slots with different input and output data can be plugged during configuration. The individual slots and the meaning of the data they contain are listed below. Input data is labeled with the letter 'I' and output data with the letter 'O' according to the SIMATIC configuration software STEP 7. In addition, bytes are labeled with the letter 'B' (8 bits), words with 'W' (16 bits) and double words with 'D' (32 bits). All slots can be configured on devices with the slave configuration as well as on masters, but may not contain any data depending on the configuration.

Slot 0 (PLB basic module):

No data

Slot 1 (Common Data):

Input byte operating mode IB x (unsigned 8):

Bit 0: Operating mode master/slave 0=Slave; 1=Master

Bits 1-7: reserved (status not defined)

Byte x							
7	6	5	4	3	2	1	0
Reserved							M/S

Input byte LED: IB x+1 / IB x+2 (unsigned 8 each):

2 bits per LED

00 = off

01 = on

10 = flashing

11 = unknown

Byte x+1							
7	6	5	4	3	2	1	0
PWR		PWR PL		RN		ER	
Byte x+2							
7	6	5	4	3	2	1	0
MT		MS		*		*	

*: reserved (status not defined)

Slot 2 (Powerline modem):

Input byte link: IB x (unsigned 8):

Bit 0: PL-Link

Bits 1-7: reserved (status not defined)

Byte x							
7	6	5	4	3	2	1	0
Reserved							PL-Link

Input word PLB cycle: IW x+1 (unsigned 16, master only):

16-bit value of the Power Line Booster cycle time (Page 72) in ms

For PLB slave: 0

word x+1															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Input word number of active slaves: IWB x+3 (unsigned 16, master only)

For PLB slave: 0

word x+3															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Input word PL channel: IW x+5 (unsigned16):

word x+5															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Power Line channel (1...4) set with DIP switches. See also setting DIP switch.

Slot 4 (Powerline status) IW x:

Input word PLB Errors: IW x (unsigned 16):

- Bit 0: Short circuit PL – Phase
- Bit 1: Short-circuit PL-B – FE
- Bit 2: Short-circuit PL-A – FE
- Bit 3: Overvoltage
- Bit 4: Core Dump
- Bit 5: Error at left modem
- Bit 6: Right modem inserted
- Bit 7: Log backup
- Bit 8: Rescue mode
- Bit 9 to 15: System reserve

Byte x							
7	6	5	4	3	2	1	0
LogBack	Modem R	Modem L	CoreD.	Overv.	PL_A-FE	PL_B-FE	PL-Phase
Byte x+1							
7	6	5	4	3	2	1	0
							Rescue

Input word PLB Warnings: IW x+2 (unsigned 16):

- Bit 0: Undervoltage
- Bit 1 to 15: System reserve

Byte x+2							
7	6	5	4	3	2	1	0
							Underv.
Byte x+3							
7	6	5	4	3	2	1	0

Input byte signal quality: IW x+4 (unsigned 8):

Status of the powerline connection.

- 0 = No connection;
- 100 = connection.

Byte x+4							
7	6	5	4	3	2	1	0

Slot 5 (In Out notification) IW x (master only):**Input byte Slave In counter: IW x+0 (unsigned 8):**

Infinite counter when slave enters. Identifies the entry of a slave or connection setup to a slave. A counter overflow occurs when the maximum value of 255 is reached.

For PLB slave: 0

Byte x							
7	6	5	4	3	2	1	0

Input byte Slave Out counter: IW x+1 (unsigned 8):

Infinite counter when slave exits. Identifies exit of a slave or a connection abort to a slave. A counter overflow occurs when the maximum value of 255 is reached.

For PLB slave: 0

Byte x+1							
7	6	5	4	3	2	1	0

Slot 6 (IP address master) IW x (slave only):**Input byte IP address of connected master: IW x+0 (4 * unsigned 8):**

The IP address can be used to determine the segment in which the slave is currently located. This position information may be useful for some applications.

For PLB master: 0

Byte x			
Byte 3	Byte 2	Byte 1	Byte 0
IP_3	IP_2	IP_1	IP_0

Slot 7 (Position) AD:**Output double word current position: AD x+0 (Integer32):**

If the vehicles in your plant have a position measuring system, you can send the current position from the vehicle control system to the PLB via PROFINET. The position is output in the web interface in the Status tables (Page 102) and the log messages (Page 85) for better diagnostics.

Double word x	
Current position	

5.1.4 Identification and maintenance data

Definition and features

The identification and maintenance data (I&M) is information saved in a module which supports you in the following tasks:

- Checking the plant configuration
- Locating hardware modifications in a plant

Identification data (I data) consists of module information (some of which may be printed on the module housing) such as the order number and serial number. I data consists of manufacturer information about the module and can only be read. Maintenance data (M data) returns system-specific information such as the location designation and installation date. M data is created during configuration.

Modules can be uniquely identified online by means of the I&M data.

The identification and maintenance data is information that is saved as read-only (I data) or read/write (M data) on the module.

Identification data (I&M0): Manufacturer information on the module to which you only have read access and some of which may be printed on the module housing, for example, article number and serial number.

Maintenance data (I&M1, 2, 3): System-dependent information, for example, the installation location.

Maintenance data is created during configuration and written to the module.

The basic module of the Power Line Booster supports the identification data (I&M0 to I&M3).

The identification data I&M support you in the following tasks:

- Checking the plant configuration
- Locating hardware modifications in a plant
- Correcting errors in a plant

Modules can be uniquely identified online by means of the I&M identification data. You can read the identification data I&M with STEP7 (see STEP7 online help).

Data record structure for I&M data

Read I&M data records (distributed over PROFINET IO)

You can directly access specific identification data by selecting **Read data record** (RDREC instruction). You obtain the corresponding part of the identification data under the associated data record index.

The data records are structured as follows:

Table 5- 1 Basic structure of data records which contain I&M data

Content	Length (bytes)	Coding (hex)
Header information		
BlockType	2	I&M0: 0020 _H I&M1: 0021 _H I&M2: 0022 _H I&M3: 0023 _H
BlockLength	2	I&M0: 0038 _H I&M1: 0038 _H I&M2: 0012 _H I&M3: 0038 _H
BlockVersionHigh	1	01
BlockVersionLow	1	00
Identification data		
Identification data (see table below)	I&M0/Index AFF0 _H : 54 I&M1/Index AFF1 _H : 54 I&M2/Index AFF2 _H : 16 I&M3/Index AFF3 _H : 54	

Table 5- 2 Structure of the data records for I&M identification data

Identification data	Access	Default	Description
Identification data 0: (data record index AFF0 hex)			
VendorIDHigh	Read (1 byte)	00 _H	The vendor name is stored here (42D = SIEMENS AG).
VendorIDLow	Read (1 byte)	2A _H	
Order_ID	Read (20 bytes)	6ES7972-5AA10-0AB0	Article number of the module
IM_SERIAL_NUMBER	Read (16 bytes)	-	Serial number (device specific)
IM_HARDWARE_REVISION	Read (2 bytes)	1	corresponding hardware version
IM_SOFTWARE_REVISION	Read	Firmware version	indicates the firmware version of the module
• SWRevisionPrefix	(1 byte)	00 – FF _H	
• IM_SWRevision_Functional_Enhancement	(1 byte)	00 – FF _H	
• IM_SWRevision_Bug_Fix	(1 byte)	00 – FF _H	

5.1.5 Device-specific data records

The following data records are implemented in the Power Line Booster.

Context:

- Basic Module (BM): The data record can be read by the basic module (slot 1).
- Modem Module (MM): The data record can be read by the modem module (slot 2).

Note

All values within the device-specific data records are transferred in BIG ENDIAN format.

Data record slave list of the master

Context: MM

Index: 100

Type: Read Only

The data record returns the following information:

Header

- MagicCode, for data plausibility (32 bits) (00504C42_H)
- Version of the data record (16 bits) (0000_H)
- Number of entries (16 bits) → number of slaves + master

Returning block for the master and subsequently all slaves that can be reached (The number of list entries transferred is limited to the number available.)

- Consecutive number for identification (Index)
- MAC address BM
- MAC address MM
- PROFINET device name
- IP address (only for permanently assigned IP address, otherwise 0.0.0.0)

The following illustration shows the structure of the PLC data type in STEP7 V15

typePlbSlaveList			
	Name	Data type	Default value
1	magicCode	DWord	16#00504c42
2	version	Word	16#0
3	numberOfEntries	Word	16#0
4	slaveList	Array[0..50] of Struct	
5	slaveList[0]	Struct	
6	index	Word	16#0
7	macBase	Array[0..5] of Byte	
8	macModem	Array[0..5] of Byte	
9	nameOfStation	Array[0..256] of Char	
10	IP	Array[0..3] of Byte	
11	reserved	Array[0..15] of Byte	
12	slaveList[1]	Struct	
13	slaveList[2]	Struct	
14	slaveList[3]	Struct	

Figure 5-1 typePLB Slave List

DIP switch information data record

Context: BM

Index: 110

Type: Read Only

The position of the DIP switches read during switch on of the PLB is transferred. The value is transferred as BYTE (unsigned8).

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
CH 1	CH 0	*	*	*	*	*	M/S

* DIP switch currently without function. The switch position read during switch on is transferred.

5.1.6 Interrupts/diagnostic message

There are no interrupts or diagnostic messages in the Power Line Booster.

5.2 Ethernet and IP address assignment

If you do not operate the Power Line Booster as a PROFINET device or do not couple it with an IO controller, you must use the PROFINET mechanisms (DCP) to assign the IP address (e.g. for update). Regardless of the application, you can use the same tools (STEP 7, PST, PRONETA, etc.) that are customary in the PROFINET environment. See the Function Manuals for more information.

Note

For additional information on "PROFINET IO", refer to the STEP 7 online help and the PROFINET System Description (<http://support.automation.siemens.com/WW/view/en/19292127>)

Note

The Power Line Booster supports a packet size of 1522 / 1518 bytes (VLAN tagged / untagged). Any larger packet sizes are discarded.

5.3 Timing and runtimes

5.3.1 Overview

The Power Line Booster system implements a transparent transmission of Ethernet frames via powerline. In addition, it ensures optimum utilization of the media with regard to real-time capability of IO data.

To do this, the PLB master runs the PLB cycle in which it contacts each accessible PLB slave one after the other; it also synchronizes the PROFINET IO data of the automation components connected downstream from this PLB slave. It also transmits Ethernet packets of other protocols, if present, but only so many that the normal PLB cycle time is not exceeded.

5.3.2 Configuring the PROFINET update time

You should set the PN update time somewhat shorter than the average PLB cycle time of a full segment. This ensures that the current PROFINET IO data is transferred with each PLB cycle.

The PLB cycle time is the time that a PLB master needs to contact the currently registered slaves once and to exchange data with them.

The PLB cycle time of a master depends on the number of slaves in the segment. For the average cycle time, we only want to consider the case when no vehicle enters or exits the segment.

The master needs about 2.3 ms for the data exchange with each slave. In addition, the so-called registration phase (Hello Phase) (see section "Traffic Manager time configuration (Page 95)") of about 5 ms is added at the beginning of the cycle.

This means the PLB cycle time can be calculated as follows:

$$\text{PLB cycle time} = (\text{number of connected slaves} \cdot 2.3 \text{ ms}) + 5 \text{ ms}$$

Table 5- 3 The dependency between the number of slaves, PLB cycle time and PN update time is listed in the following table

Number of connected PLB slaves	Average PLB cycle time	Recommended PN update time
40	$40 \cdot 2.3 \text{ ms} + 5 \text{ ms} = 97 \text{ ms}$	64 ms
20	$20 \cdot 2.3 \text{ ms} + 5 \text{ ms} = 51 \text{ ms}$	32 ms
10	$10 \cdot 2.3 \text{ ms} + 5 \text{ ms} = 28 \text{ ms}$	16 ms
1	$1 \cdot 2.3 \text{ ms} + 5 \text{ ms} = 7 \text{ ms}$	8 ms

With the PDS application (two slaves per vehicle), the master only queries one slave alternately per PLB cycle. This means that it is not the number of slaves per segment that must be used for the calculation of the PLB cycle time but the number of vehicles.

5.3.3 Configuration of the monitoring time

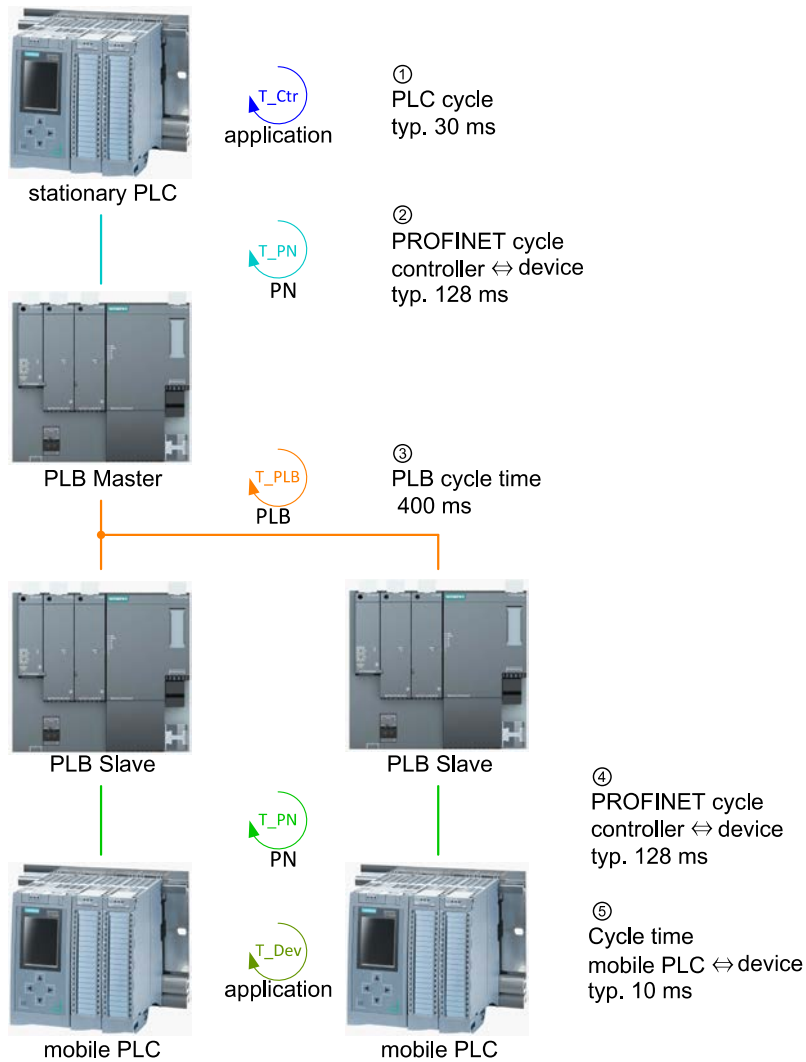
Due to the following effects, the average PLB cycle time calculated in the section Configuration of the PN update time (Page 72) is regularly exceeded:

1. Registration of PLB slaves in a segment.
Sounding of the carrier frequencies of the master and slave modem occurring during registration results in a media assignment that makes the media unavailable for the cycle.
2. Deregistration of PLB slaves from a segment.
As soon as a slave can no longer be reached, you experience interruptions in the PLB cycle due to timeout periods (see section "Traffic Manager time configuration (Page 95)").
3. Impedance change due to plant elements such as switches and trailing cables. The sounding of carrier frequencies can also result in a longer cycle in this case.
4. Interference on the medium, e.g. caused by EMC or short-term deterioration of the contact quality of the sliders.
5. Cyclic sounding of carrier frequencies to optimize the connection.
6. Crosstalk of the powerline signals (Page 116) from other plants or plant units. (This effect **must** be prevented by suitable insulation and attenuation during installation of the plant).

To determine the PN watchdog time, you must expect a significantly longer PLB cycle time in total for a segment with 40 vehicles. The current cycle time of the PLB master can be read via the web interface in the Cycle times (Page 104) table. In addition to this latency, additional effects (e.g. response time of PLC and field devices, processing times as well as upstream and downstream cycles, such as the PN cycle) must be taken into consideration.

Below you can find a calculation of the maximum system latency using PROFINET as an example.

It is based on a maximum PLB cycle time of 400 ms which is within the expected range for applications with 40 PLB slaves per segment.



- ① Cycle of the controller at which it can process IO data.
- ② PROFINET update time that is configured between controller and device.
- ③ PLB cycle at which the powerline system forwards data to the slaves. This cycle is independent of the number of slaves and from interference. You can assume 400 ms for this cycle.
- ④ PROFINET update time that is configured between controller and device.
- ⑤ Cycle between vehicle controller and the devices.

Figure 5-2 Example consideration of cycles between plant and vehicle controller

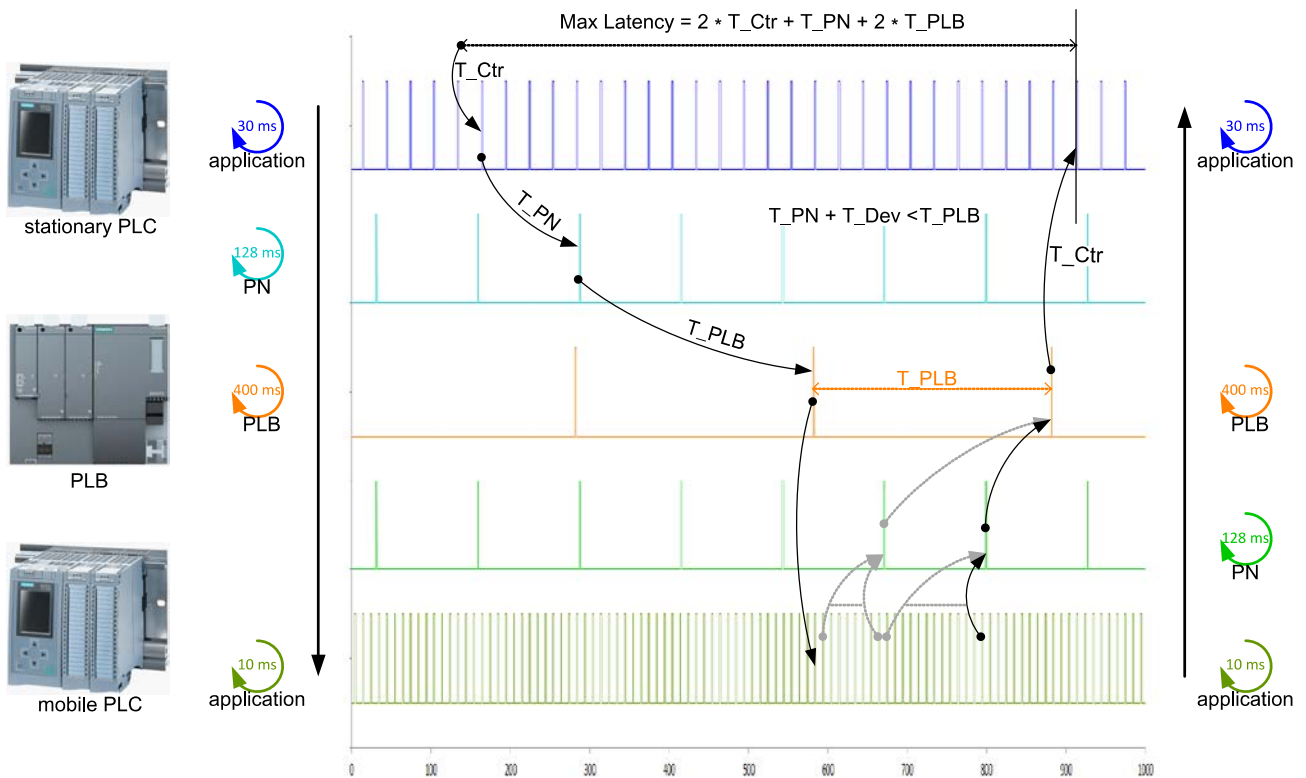


Figure 5-3 Maximum latency time for bidirectional communication

Bidirectional communication here means that the IO controller sends a query and the IO device responds using the same communication path, e.g. by sending an acknowledgment.

Bidirectional communication results in the chart as seen in the figure above. We assume here that the PN update time T_{PN} is significantly shorter than the latency time caused by the PLB system T_{PLB} .

The result is the time below:

$$T_{Lat} = 2 \cdot T_{Ctr} + T_{PN} + 2 \cdot T_{PLB}$$

When you replace these with typical values ($T_{Ctr} = 30 \text{ ms}$, $T_{PN} = 128 \text{ ms}$, $T_{PLB} = 400 \text{ ms}$, $T_{Dev} = 10 \text{ ms}$), you get:

$$T_{Lat} = 2 \cdot 30 \text{ ms} + 128 \text{ ms} + 2 \cdot 400 \text{ ms} = 988 \text{ ms}.$$

The following graphic serves as a starting point for determining the PROFINET times. The gray graph shows the calculated average PLB cycle time depending on the number of slaves. You can use the blue graph to determine the recommended PROFINET update time (see "Configuration of the PN update time (Page 72)"). The orange graph shows you the recommended minimum PROFINET/PROFIsafe watchdog time. It is specified in the configuration tool with the PN "update time" times the "accepted update cycles without IO data". For PROFIsafe applications, the PROFIsafe monitoring time should always be set shorter than the PROFINET watchdog time.



Figure 5-4 Graphic for determining the PROFINET times

For PDS applications, it is the maximum number of possible slaves in the segment that is the decisive factor for determining the PROFINET/PROFIsafe watchdog times, because the likelihood of faults and the times for sounding of the carrier frequencies grow exponentially with the number of slaves.

Note

The following configurations apply when using PROFINET

Set the PN watchdog time depending on the slaves as follows:

- 40 slaves: 1600 ms (25 update cycles at 64 ms PN update time)
- 20 slaves: 928 ms (29 update cycles at 32 ms PN update time)
- 10 slaves: 656 ms (41 update cycles at 16 ms PN update time)
- 1 slave: 265 ms (33 update cycles at 8 ms PN update time)

Note

With typical PLB applications (e.g. electric monorail system), we can assume that several vehicles do not leave the communication segments at the same time. This means we assume that no more than one vehicle and therefore one PLB slave exits the communication segment within a period of 1 s. If multiple PLB slaves were to exit the communication segment at the same time due to the application, the PLB cycle time may be significantly longer and the maximum latency time would therefore be exceeded.

System configuration and system status (web interface)

6

6.1 Overview of web interface

The Power Line Booster is commissioned and configured via the integrated web interface.

The web pages of the Power Line Booster differ depending on whether you are configuring a PLB master or a PLB slave. In this help document, you will always see the setting options of the PLB master. The web pages of the PLB slaves have fewer setting options. Note that you as the "admin" user have far-reaching options for configuring the device. It is also possible that you configure the system to the point that communication is no longer possible!

Note

Modern browsers cache the content of web pages to optimize loading. If you experience display problems or after switching a PLB from "Master" to "Slave" mode, it may therefore be necessary to restart the browser and delete the cache.

6.1.1 Print preview

All pages are also available in a view optimized for printing. If you want to save measurement results in particular, it is recommended to use this function via the respective save button and to archive the results as PDF. For measurement results, additional information is also output in this view.

Note

The Power Line Booster continuously checks the connection between the device and the web browser. If the connection is inadvertently terminated (network cable unplugged without previous logoff), the PLB automatically terminates the active sessions after a few seconds. Some browsers block all actions of the website during the print preview. Therefore, it can happen that you are logged out of the device if the print preview is open for too long and you then have to log on again.

6.1.2 Tooltip on the parameters

If you move the mouse pointer over a configuration field or a header (e.g. of tables), you receive additional information on the respective parameters. In the case of configuration parameters, for example, the selectable limit values and the recommended default value are displayed directly.

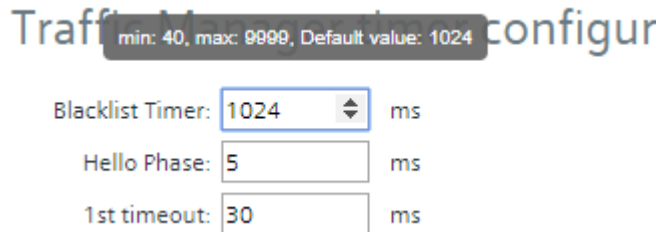


Figure 6-1 Tooltip on the parameters

6.1.3 Login

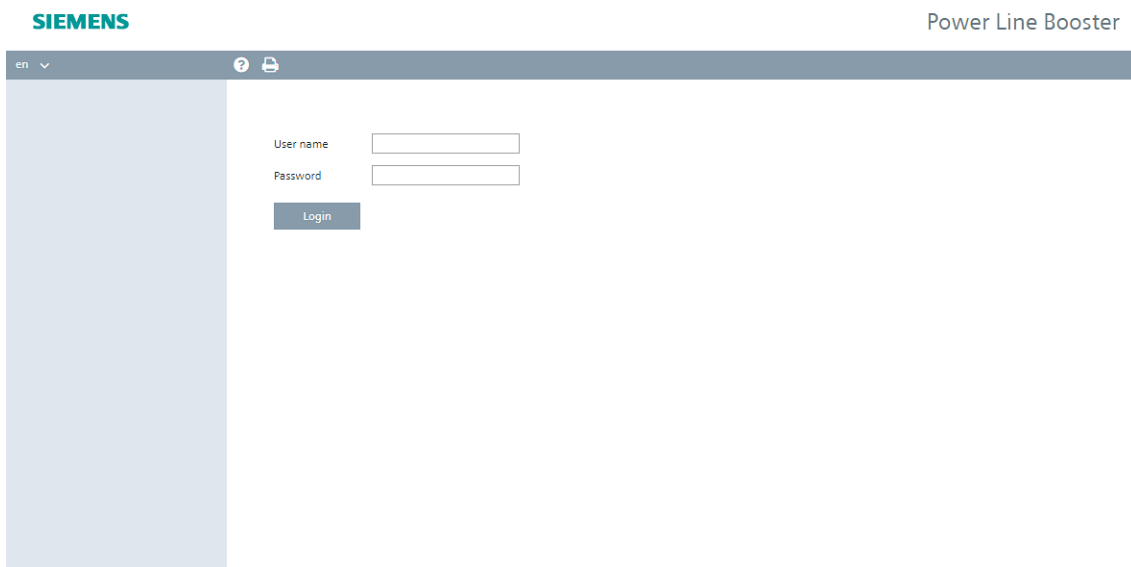


Figure 6-2 Login screen

To connect to the Power Line Booster (PLB), you must enter the IP address of this device in the address line of the browser. The IP address is assigned using the standard PROFINET tools (STEP7, PRONETA, PST, etc.). The browser and the PLB are connected via the encrypted HTTPS protocol and a self-signed SSL certificate. The browser will therefore point out that this is not a valid signature. Because this is a connection in an internal network, you can ignore the safety note and confirm the next step. You will land on the login page of the Power Line Booster.

If you want to call a different page of the PLB, you must first log in. To do so, enter the user name and password of the desired account. Then click the login button.

One "admin" and five "users" can be logged in simultaneously.

Table 6- 1 Default password (delivery state)

User name	Password	Description
admin	admin	The administrator has write permissions and can therefore configure the device.
user	user	Users only have read permissions. They cannot configure the device.

The password can be changed in the User administration.

NOTICE

Safety note

For security reasons, we recommend that you change the password.

If you cannot remember your login information, you can reset it to the factory settings with the factory reset button (FRES) on the device.

Note

The device will be reset to the factory settings with the factory reset.

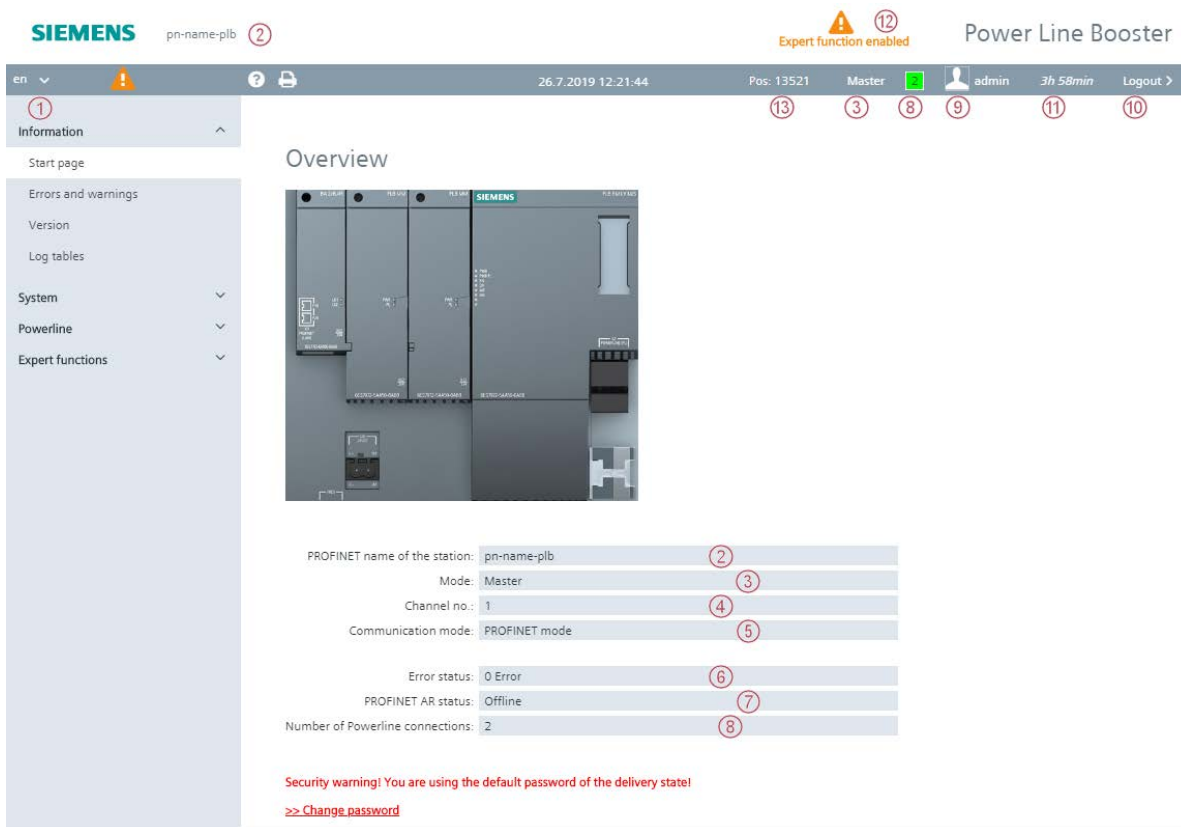
All settings, including IP address and PROFINET name, will be lost.

6.2 Information

6.2.1 Home page - System overview

Overview

On the start page you will see an overview with the most important information about the connected device.



- | | | |
|---|--|---|
| ① | Language selection | "de" (German) or "en" (English) |
| ② | PROFINET name of the device | e.g.: pn-name-plb |
| ③ | PLB mode | "Master" or "Slave" |
| ④ | Channel number | "1 .. 4" |
| ⑤ | Communication mode | "PROFINET Modus" or "Point-to-point connection" |
| ⑥ | Number of errors | "n errors" and orange exclamation mark for at least one warning or red exclamation mark for at least one error |
| ⑦ | PROFINET AR status | "Online" or "Offline" [AR = Application relation] |
| ⑧ | Number of active Powerline connections | "n" and "green display" if connected to at least 1 station
"gray display" when there is no active connection |
| ⑨ | User type | "admin" or "user" |
| ⑩ | Logout | Button for log off |

- | | |
|---|--|
| <ul style="list-style-type: none"> ⑪ Log off ⑫ Expert function active ⑬ Current position | <p>Time until automatic "Log off"</p> <p>If visible, the expert function is active.</p> <p>Current position of the PLB (only if this is transmitted via PROFINET IO)</p> |
|---|--|

Figure 6-3 System overview

When you use the default password you are notified on the home page that you need to change the password in the User administration.

NOTICE
Safety note
For security reasons, we recommend that you change the password.

6.2.2 Error status and warnings of the device

The screenshot shows the Siemens web interface for a Power Line Booster. The top navigation bar includes the Siemens logo, the device name 'pn-name-plb', and the title 'Power Line Booster'. The user is logged in as 'admin' with a session duration of '3h 59min'. The main content area is divided into two sections: 'Active errors' and 'Active warnings / notes'. The 'Active errors' section lists several status indicators, all marked as 'No' in green: Rescue Mode, Log backup available, Right modem inserted, Error at left modem, Modem Core Dump available, Overvoltage on PL, Short circuit PL A to PE, Short circuit PL B to PE, and Short circuit PL A/B to L. The 'Active warnings / notes' section shows 'Undervoltage on PL' marked as 'Yes' in red.

Figure 6-4 Error status of the device

Error status and warnings of the device

On this page you can see a list with all potential errors and warnings/notes of the device.

The status is marked with "Yes" in "red" or with "No" in "green".

6.2 Information

Rescue mode

This error indicates that the PLB is restarted with the Rescue firmware after a fatal error. For more details on this error, see the Log tables (Page 85). Contact SIEMENS Support (<mailto:PLB-support.industry@siemens.com>).

Log backup available

A backup of the log files is created before the restart in Rescue mode. This is the corresponding signal. See the backup log files to determine the cause of the error and forward them to Siemens Support (<mailto:PLB-support.industry@siemens.com>) as needed. You can download and reset the log backup via "Download & Save (Page 89)".

Right modem inserted

The PLB may only be operated with a modem inserted on the left. This error indicates that the modem is inserted on the right. Insert the modem into the left slot.

Error at left modem


This error indicates that the communication between base and left modem is faulty or that the modem is defective. Check the contacts or replace the modem.

Modem Core Dump available

When the modem firmware is restarted after a fatal error, a core dump including all log files of the modem is created for diagnostic purposes. You can download the core dump (see Modem Core Dump (Page 119)) and forward it to the SIEMENS Support (<mailto:PLB-support.industry@siemens.com>).

Overvoltage on PL

This error indicates that an overvoltage was detected on the Powerline rail instead of the 42 V. This is a wiring error.

 WARNING
A voltage that is dangerous to the touch is present on all Powerline rails and all cables and plant units connected to them.
Measure: Shut down plant!

Short circuit PL A to PE or short circuit PL B to PE

The PLB has detected a short circuit between the Powerline rail "A" or "B" and the protective earth (PE).

Short circuit PL A/B to L

The PLB has detected a short circuit between the Powerline rail "A" and/or "B" and a line conductor.

 **WARNING**

A voltage that is dangerous to the touch is present on all Powerline rails and all cables and plant units connected to them.

Measure: Shut down plant!

Undervoltage on PL

This warning indicates that no voltage was detected on the Powerline rail. This is normal for sections or areas without communication because they are not supplied with 42 V. Possible causes of error for supplied Powerline rails: Failure of the PLB supply voltage or the PLB is not connected to both sliders due to a cable break.

6.2.3 Versions

Version information of the device

On this page, you can see the version information of the existing hardware and software.

Note

The MAC address of the PLB Modem module is only required for the powerline communication and is not visible to the outside.

The screenshot shows the Siemens web interface for a Power Line Booster. The page title is "Power Line Booster". The interface includes a navigation menu on the left with options like "Information", "Log tables", "System", "Powerline", and "Expert functions". The main content area is titled "Version information" and contains two tables.

Hardware	Serial number	MAC	Version	Revision	Order number
Basic	LBJD456773	40:EC:F8:0D:93:1F	1	4	6E57972-5AA10-0AB0
Modem	LBJD413731	40:EC:F8:0D:7A:75	3	3	6E57972-5AA51-0AB0

Software	Description	Version
Basic	Power Line Booster firmware	V2.2.0.2821
Modem	Modem firmware	rel-stp-rel-stp-2_1plb5-bridge-release8k-360c22260a1a

Figure 6-5 Version information

6.2.4 Log tables

The screenshot shows the 'Log tables' page in the Siemens Power Line Booster web interface. The page has a sidebar on the left with navigation options: Information, Start page, Errors and warnings, Version, Log tables, System, Powerline, and Expert functions. The main content area is titled 'Log tables' and includes radio buttons for 'Long-term log' (selected) and 'Detail log', along with a 'Number of entries' input field set to 300. Below this is a table of log messages. At the bottom of the table, there are buttons for 'Update automatically' (checkbox), 'Update', and 'Download'.

Log message
2014-02-10 17:33:30.749 ; [D] ; systemservice ; 1743 ; setting date time manual to: 2019.08.01-15:45:16
2014-02-10 17:33:13.141 ; [D] ; webcat ; 1662 ; admin logged in
2014-02-10 17:33:13.109 ; [D] ; webcat ; 1662 ; login request 192.168.1.100: Host: 192.168.1.103 Connection: keep-alive Content-Length: 45 Accept: application/json, text/plain, */* Origin: https://192.168.1.103 User-Agent: Mozilla/5.0 (Linux; Android 6.0; Nexus 5 Build/MRA58N) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/75.0.3770.142 Mobile Safari/537.36 Content-Type: application/x-www-form-urlencoded Referer: https://192.168.1.103/plb/login Accept-Encoding: gzip, deflate, br Accept-Language: de-DE,de;q=0.9,en-US;q=0.8,en;q=0.7
2014-02-10 17:28:13.554 ; [D] ; tmm left ; 1885 ; Refresh IP, new ip adr.ip : 192.168.1.104, old: ip: 0.0.0.0
2014-02-10 17:27:42.705 ; [D] ; pndev ; 1888 ; Station Name = pn-name-plb received, Length=11 Remanent = 1
2014-02-10 17:26:23.501 ; [D] ; webcat ; 1662 ; master_ip: 0 fault: 0 warn: 1 black: 1 white: 2 quality: 100
2014-02-10 17:26:23.478 ; [D] ; webcat ; 1662 ; master_ip: 0 fault: 0 warn: 1 black: 1 white: 2 quality: 0
2014-02-10 17:26:23.476 ; [D] ; tmm left ; 1885 ; WHITELIST, Name: ., IP: 0.0.0.0, device mac: 40:EC:F8:0D:93:2D, tms mac: 40:EC:F8:0D:93:32 modem mac: 40:EC:F8:0D:7A:89, RX sfe: -20dB, RX ST sfe: 18dB, TX sfe: 6dB, ampname: ST2100_tone_2_72MHz_200Pg.txt, sw_version: T2.1.0.2810, base_hw_revision: 4, modem_hw_revision: 3, supported features: 3, number of slave: 1, loop cnt: 9447
2014-02-10 17:26:23.475 ; [D] ; tmm left ; 1885 ; refresh ip set for slave name: ., ip: 0.0.0.0
2014-02-10 17:26:14.959 ; [D] ; pndev ; 1888 ; IP address = 192.168.1.103, Subnet mask = ffffff00h, Default router = 0h
2014-02-10 17:25:49.301 ; [D] ; webcat ; 1662 ; master_ip: 0 fault: 0 warn: 1 black: 1 white: 1 quality: 0
2014-02-10 17:25:49.291 ; [D] ; webcat ; 1662 ; master_ip: 0 fault: 0 warn: 1 black: 1 white: 1 quality: 100
2014-02-10 17:25:49.290 ; [D] ; tmm left ; 1885 ; Node: removed

Figure 6-6 Log information of the device

Log information of the device

On this page, you can see the log information of the device.

From left to right, a log message consists of

- the time stamp,
- the log level (I = Info, M = Modem, D = Debug, W = Warning, E = Error, P = Panic),
- the module name of the respective software,
- the process ID and
- the log text.

Note

Log levels

In normal operation, the critical log levels "Panic", "Error" or "Warning" should not show up in the log.

The log level "Panic" only appears in case of a fatal error that results in a restart in "Rescue Mode" (see the section "Rescue Mode" and its log backup in the Device status (Page 103)).

You can receive a more detailed evaluation of the logs by contacting the SIEMENS hotline. To do so, send the log to the PLB Support (<mailto:plb-support.industry@siemens.com>).

You can display either the long-term or the detail log. The long-term log contains the log levels "Panic", "Error", "Warning" and "Debug". The detail log additionally contains the log levels "Info" and "Modem".

Various events are saved in the log. You can, for example, identify the affected PLB slave in case of connection problems using the PN name and the IP address and see the position (if transferred via PROFINET (Page 64)) at the time of the fault.

Using entry field, you can select the number of displayed log entries.

The table is reloaded with the "Update" button. The log entries of the download file go back much further in time than those that can be displayed over the web interface.

The long-term log usually records the log entries of several weeks. The detail log, due to its very frequent log messages (several messages per second), can only go back a few hours.

If you have selected the check mark "Update automatically", the latest entries are cyclically retrieved from the server.

Use the Download button to download all log files as *.zip file.

Note

The log entries are lost after restart of the device.

6.3 System

6.3.1 Restart & reset

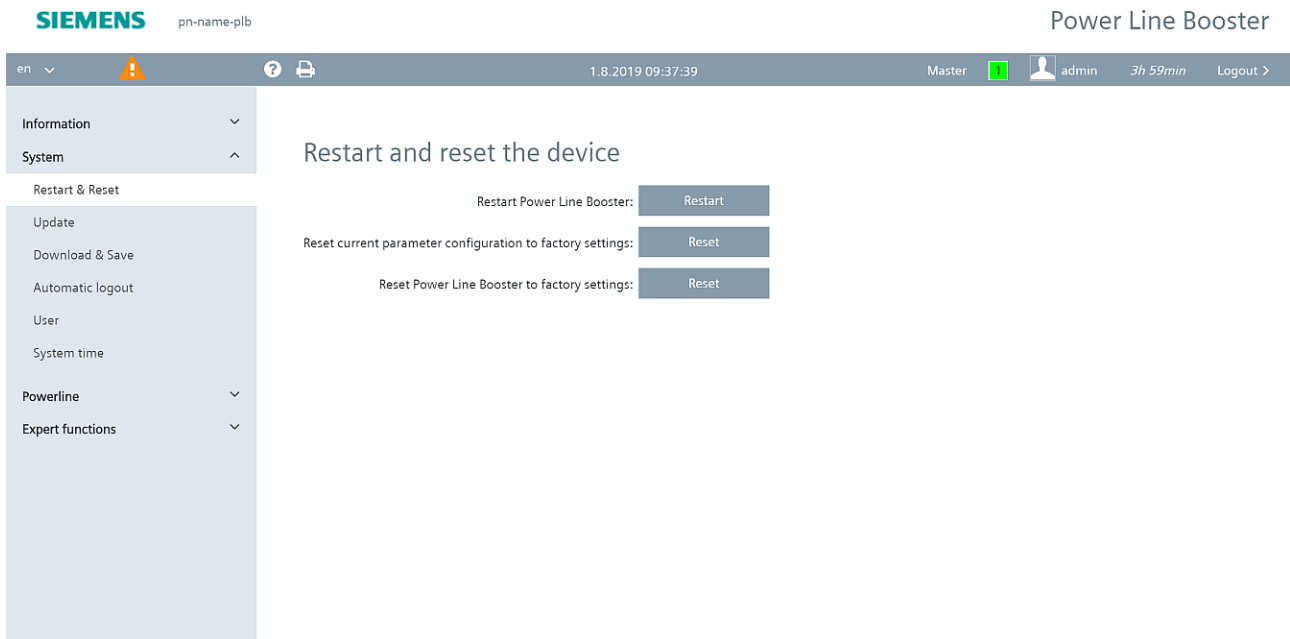


Figure 6-7 PLB restart and factory settings

Restart and reset to factory settings

On this page you can restart the Power Line Booster and reset it to the factory settings.

Restart

Press the "Restart" button to reboot the Power Line Booster. After confirming a dialog, you are directed to the login page and must log in again after the restart.

Reset configuration

This allows you to reset the parameter configuration of the PLB to the default values. In comparison to the reset to factory settings, the IP address, the PN name and the user database with the login passwords are retained.

6.3 System

Reset to factory settings

After clicking the "Reset" button and confirming a dialog, the Power Line Booster runs a factory reset and restarts. The factory reset resets all settings as well as the login passwords to the default values. The PROFINET name and the IP address are deleted as well. You are logged off from the system after your confirmation. Before you can log in again, you must assign an IP address to the device again.

6.3.2 Update

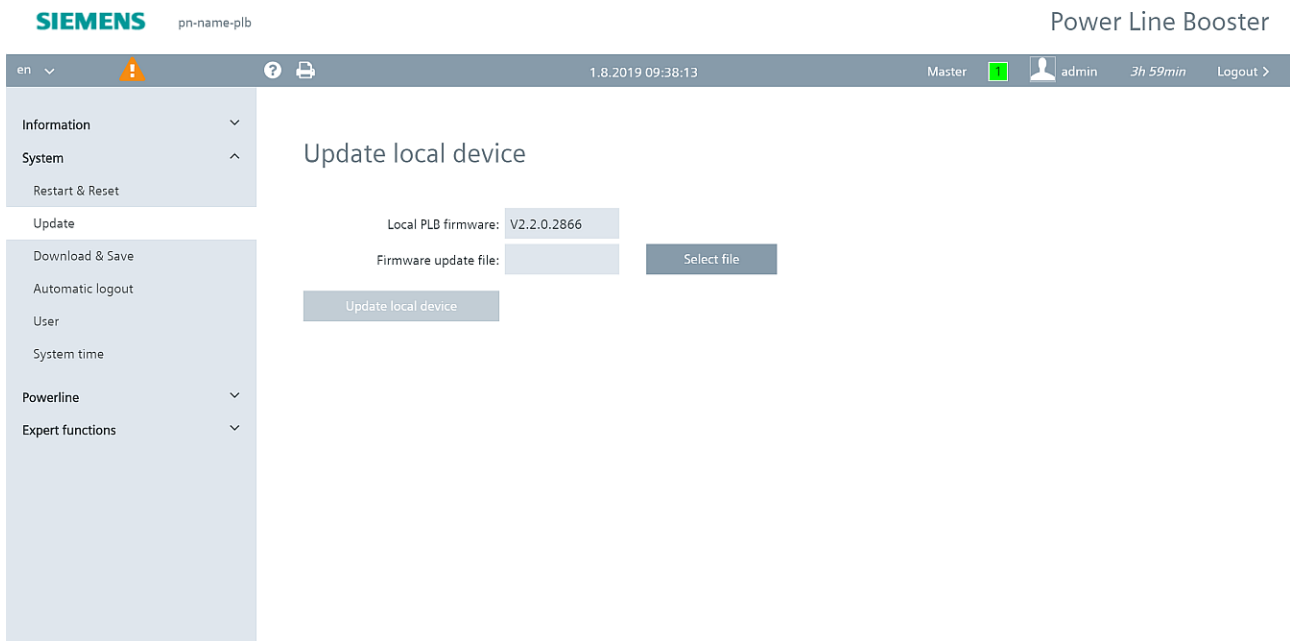


Figure 6-8 Firmware update of the local PLB

Firmware update of the local PLB

On this page, you can update the firmware.

By pressing the "Select file" button, you can navigate to the *.zip file with the firmware update and select it for an update. Then you start the update process by clicking the "Update local device" button. During the update, the PLB restarts (multiple times). The Power Line Booster checks the validity of the firmware file prior to the update. The configurations as well as the IP addresses and the PN name are retained. To prevent any potential compatibility problems, we recommend resetting the device to the factory settings after the update.

A basic functionality of the system is also given in mixed operation with different firmware versions. However, there may be a restriction in the status- and diagnostics data. It is recommended to avoid mixed operation as far as possible in productive systems and to upgrade the masters first in case of a system update.

NOTICE

Firmware update

Do not disconnect the Power Line Booster from the power supply during the update. This may cause irreparable damage to the device.

6.3.3 Loading and saving

The screenshot shows the Siemens Power Line Booster web interface. The top navigation bar includes the Siemens logo, the device name 'pn-name-plb', and the title 'Power Line Booster'. The status bar shows the language 'en', a warning icon, a help icon, the date and time '1.8.2019 09:38:43', the user role 'Master', a green status indicator, the user name 'admin', the session duration '3h 59min', and a 'Logout >' link. The left navigation menu is expanded to show 'Download & Save'. The main content area is titled 'Download & Save' and contains a table with the following data:

Type	Description	Upload	Download	Reset / Delete
All files	All existing files (log, configuration, etc.)		Download	
Log files	All PLB log files		Download	
Current configuration	Current parameter configuration	Upload	Download	Reset
Measured values / Runtime data	All measured values / Runtime data as csv file		Download	
Delete measured values / Runtime data of devices that are not connected	Delete all measured values / Runtime data of devices that are not connected			Delete
Log backup	Current log backup		Download	Delete
GSD file	Current GSD file		Download	

Figure 6-9 Upload/Download/Delete

On this page you can upload or download a variety of files or delete them.

All files

Here you can download all files on the device as zip file for diagnostic purposes. The zip file contains, among other things, log files, status information as well as the current device configuration.

6.3 System

Log files

Press this button to download the log files of the device as compressed zip archive. The archive contains the "long-term log" as well as the "detail log".

Current configuration

You can export, import or reset the configuration of the device to the default values. A configuration includes all system settings, except for the PROFINET parameters, such as the IP address or PN name and the user administration including the passwords. To prevent compatibility problems, we recommend you only swap configurations between devices with the same firmware.

Measured values / Runtime data

By pressing the Download button, you can download the measured values of the Status tables (Page 102) as .csv file for further analysis in a spreadsheet program. The file contains all data of the currently connected slaves as well as the list of all slaves that have been connected to the device since the last reboot. The list of devices that are not connected can be deleted with the "Delete measured values of devices that are not connected" function. The unique identification criterion of each entry here is the MAC address of the associated PLB basic module.

Delete measured values of devices that are not connected

The Power Line Booster saves all measured values/runtime data of all devices that were ever connected to it since the last reboot. You can view this data in the Status tables (Page 102) in the area "Devices not connected". You use the function key to delete the list.

Log backup

In case of a fatal error, the Power Line Booster saves the log files retentively. Here you can download the files or delete them from the system. After deleting the files, the note on Errors and warnings (Page 81) will disappear.

GSD file

You use this Download button to download the current GSD file of the device to use it in TIA Portal/Step 7.

6.3.4 Automatic logout

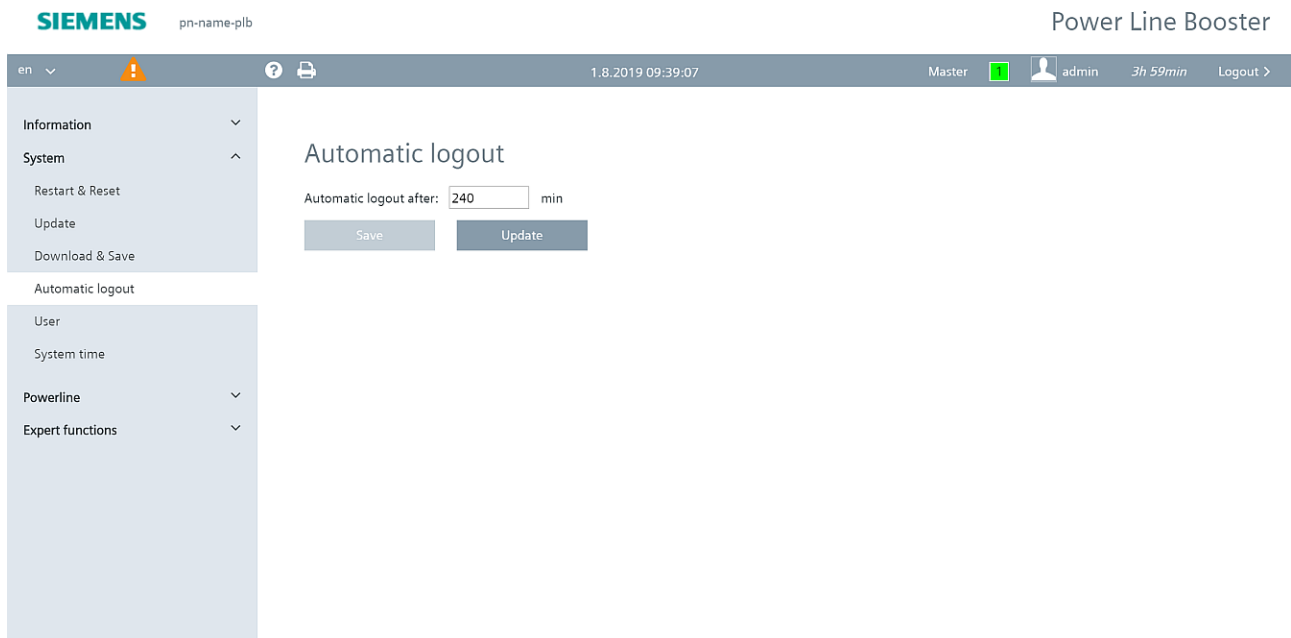


Figure 6-10 Automatic logout

For security reasons, a user is automatically logged off after a defined period of inactivity. You can configure this period on this page. As long as you are actively logged in on the device, the timer for automatic logout is reset with each interaction. The remaining time until automatic log off is shown in the status bar at the top right.

6.3.5 User

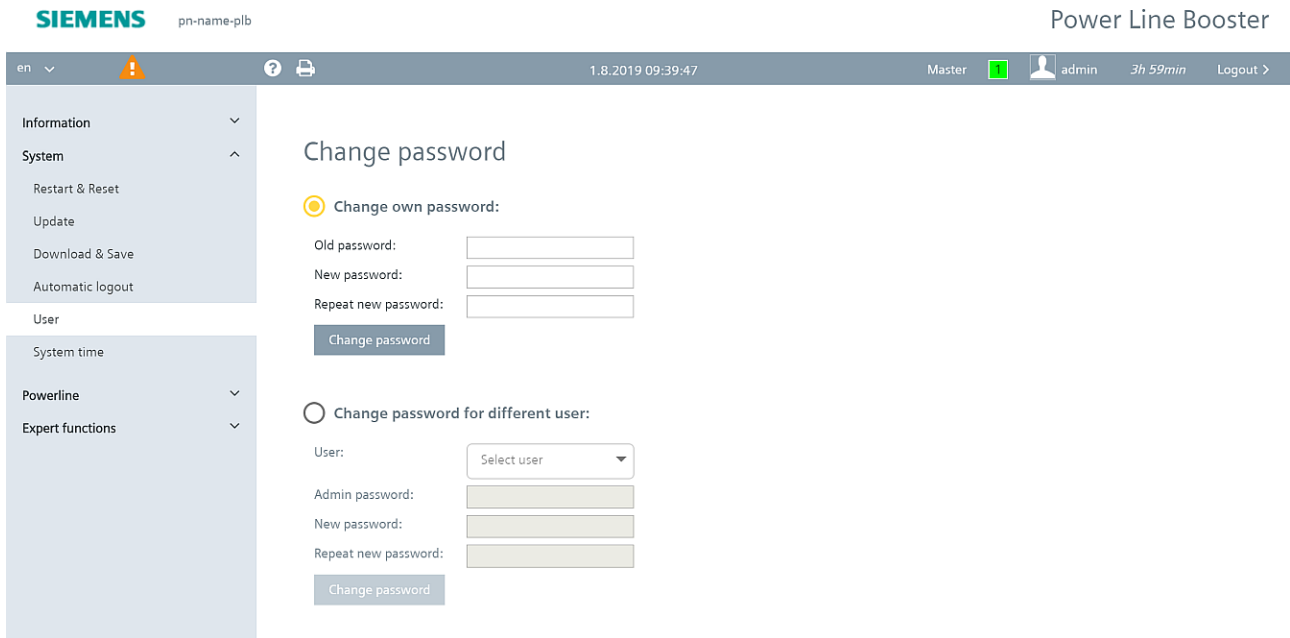


Figure 6-11 User functions

Change password

On this page, you can change the password as the logged in user. To assign a new password, you must first enter your old password. Then enter the new password into the respective field. For security reasons, you must enter the new password again in the associated field. You save the new password with the "Change password" button.

The new password must be at least 8 characters (max. 20) long. It must also contain the following:

- At least one upper case letter
- At least one lower case letter
- At least one number
- (optionally also) special characters (ASCII 0x20 - 0x7E)

If you are logged in as "admin" user type (with administrator rights), you can also change the password of another user. To do so, you first enter your admin password, then you assign the new password for the other user and enter it once again to confirm it. You save the new password with the "Change password" button.

6.3.6 System time

System time (master only)

You can synchronize the system time of the Power Line Booster either automatically via an NTP server or enter it manually. You make the setting in the two tabs on this page. You can set synchronization of the time only on the master. The slaves always get their time from the master to which they are currently connected.

Note that the PLB does not retain the time if the supply voltage is interrupted.

6.3.6.1 Setting the time manually

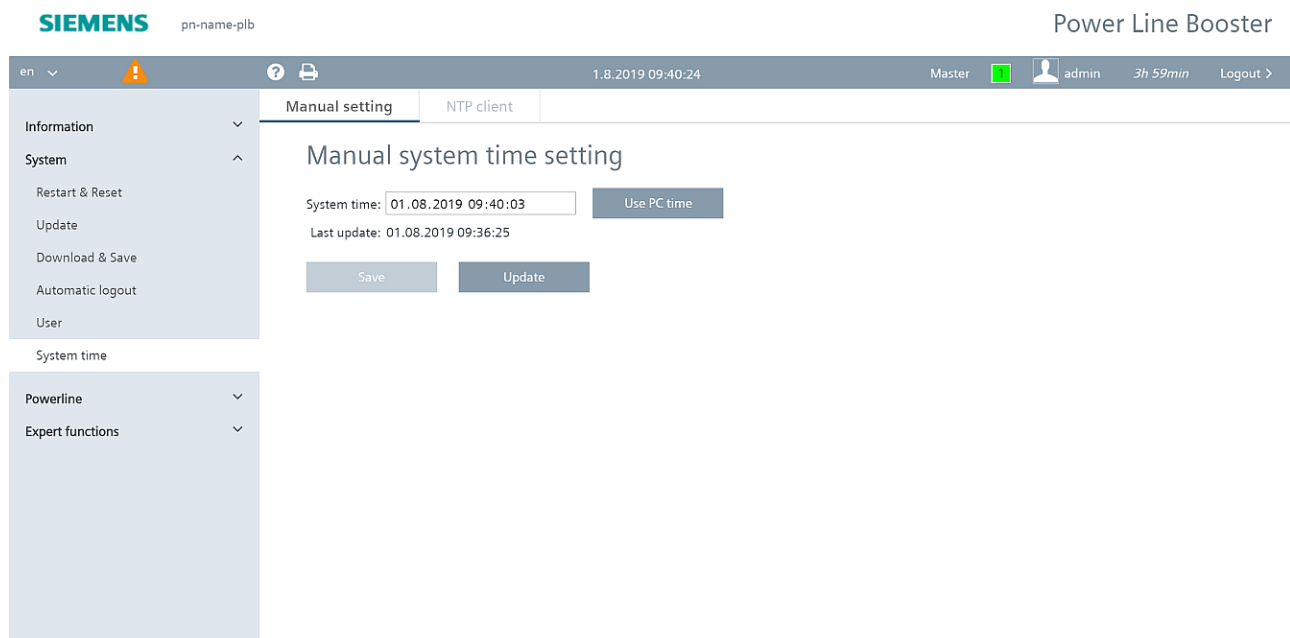


Figure 6-12 Setting the time manually

Setting the time manually

In addition to an automatic update of the time, you can also set the time manually on the master. To do so, you either enter the time manually in the entry field or you use the system time of your computer via the button. The Power Line Booster applies the time in the entry field as the new system time after pressing the button.

6.3.6.2 Setting the time-of-day of the NTP client

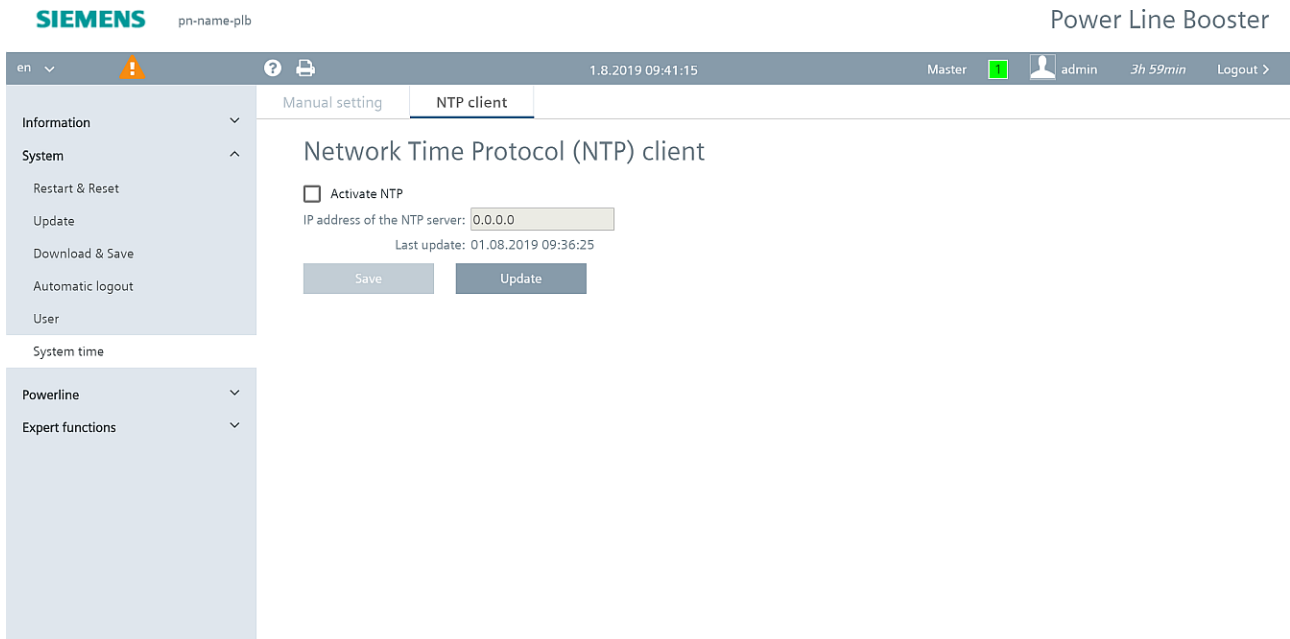


Figure 6-13 Setting the time-of-day of the NTP client

Setting the time-of-day of the NTP client

On this page you can activate the NTP client to synchronize the system time of the Power Line Booster.

Enter the IP address of the NTP server in the respective field and apply it by clicking "Save". The NTP server must be reachable over port 123 and be located in the same subnet as the PLB.

6.4 Powerline

6.4.1 Traffic Manager

Below you can change the system configuration. These parameters have already been optimized for standard applications and must not be changed. Please note that the stability of the system can be significantly reduced by just a minor change of the parameters.

6.4.1.1 Traffic Manager time configuration

The screenshot shows the Siemens Power Line Booster web interface. The top navigation bar includes the Siemens logo, the user name 'admin', and the session duration '3h 59min'. The main content area is titled 'Traffic Manager timer configuration' and contains the following fields:

Blacklist Timer:	<input type="text" value="1024"/>	ms
Hello Phase:	<input type="text" value="5"/>	ms
1st timeout:	<input type="text" value="30"/>	ms
2nd timeout:	<input type="text" value="20"/>	ms
3rd timeout:	<input type="text" value="15"/>	ms
> 4th timeout:	<input type="text" value="10"/>	ms

At the bottom of the configuration area, there are two buttons: 'Save' and 'Update'.

Figure 6-14 Traffic Manager time configuration

Time settings

To ensure the real-time requirements, the PLB master polls all PLB slaves to which it is connected in each cycle one after the other (polling) and waits for a response. When it is finished with one cycle, it starts all over again.

If a known slave does not respond in a cycle (PLB slave is faulty or has dropped out of the segment), the master waits for the time configured under "**1st timeout**" before it tries to contact the next connected station. If it does not receive a response in the second cycle, it only waits for the time defined under "**2nd timeout**". Because the likelihood that the station has dropped out of the segment gets greater with each attempt, the timeout times are also getting shorter. The time that is configured under "**(>) 4th timeout**" is applied until the "**Blacklist Timer**" has expired. Once the blacklist timer has expired, it is assumed that the station has dropped out of the segment and that the master will not poll it in future cycles. The time of the "**Blacklist Timer**" must also be configured on the slave so that it knows whether it is still potentially being polled by a master or whether it must respond to "Hello frames" to log in again on a master. The value of the "**Blacklist Timer**" must always be the same for all communication partners (master and slave).

6.4 Powerline

For a slave that has been newly introduced into a segment to be polled by the master in the future, the master sends a "Hello frame" at the beginning of each cycle. Communication is then paused according to the "Hello Phase" time so that slaves that are not connected to the master yet have time to respond.

If entering and leaving the communication segment is not an application (for example, in plants with only one segment), you can also set the "Hello Phase" to "0 ms". The cycle time is reduced by the duration of the "Hello Phase" in this case.

Visibility of the parameters

The "Hello-Phase" timer and the timeout values are parameters that can only be configured in the Master operating mode.

Dependencies

The "Hello Phase" and all timeout values must be shorter than the "Blacklist Timer". This is checked by the system and displayed as error, if necessary.

6.4.1.2 Traffic Manager buffer configuration

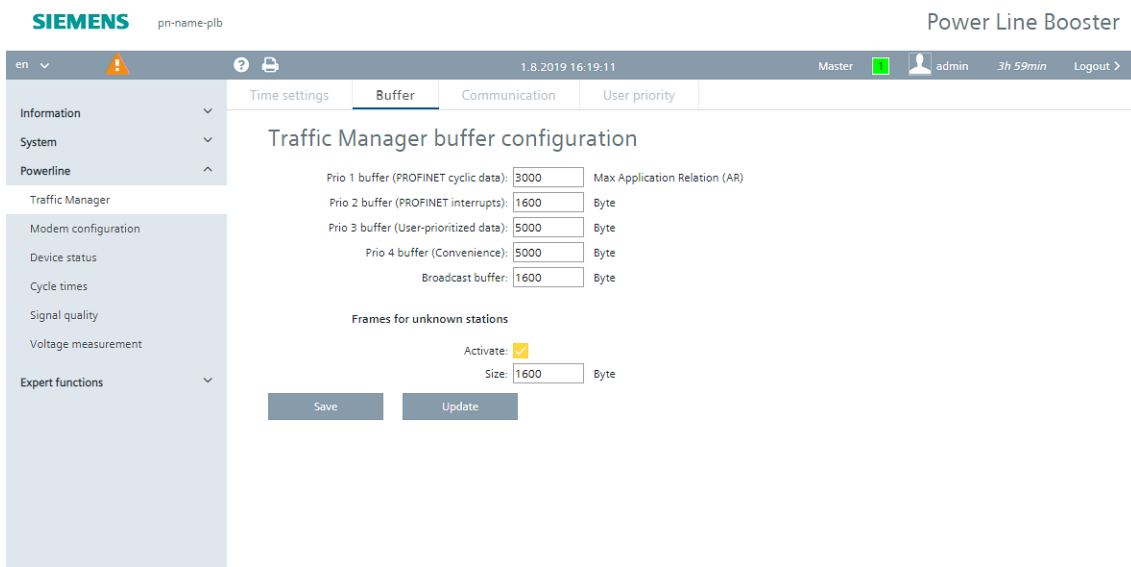


Figure 6-15 Traffic Manager buffer configuration

Buffer

The Traffic Manager has various buffers to cache the incoming Ethernet frames until they can be packaged and send in a container. Buffers that are not in use do not have an effect on the bandwidth of the PLB communication. That is why a parameter adaptation is not required in case of change.

The buffers differ in the priority with which they are emptied and sent.

The Traffic Manager can only transmit a specific number of bytes in each poll cycle (query of a master and a slave responding to it). The number of bytes is configured with the "**Container size**" (see Communication (Page 98)). If a buffer overflow occurs, this is shown in the log (Page 85).

- The data of the "**Prio 1 buffer**" are sent first. Here the cyclical data is buffered. The selected default is configured so that there is sufficient space for the cyclical data of the PROFINET devices connected to the PLB in typical applications. If more PROFINET data is to be transmitted via powerline than is set in the default configuration, the size of the Prio 1 buffer must be increased.
- The "**Prio 2 buffer**" is reserved for PROFINET alarms. The selected default is configured so that there is sufficient space for any alarms that may occur in the PROFINET devices connected to the PLB.
- The "**Prio 3 buffer**" is for "User-prioritized data". If this buffer is activated, the Unicast frames are buffered in the ports specified for TCP/UDP in User priority (Page 99). The saved frames are sent directly after the PROFINET data (Prio 1 and Prio 2) if there is still space in the container.
- All Unicast data that are not Prio 1 to Prio 3 are buffered in the "**Prio 4 buffer**" and sent (if there is still space in the container).
- The "**Broadcast buffer**" is the buffer for all broadcast and multicast data. Broadcast frames are not sent until the data of Prio 1 to Prio 4 class have been sent and when there is sufficient space in the container.
- All frames that cannot be assigned to an Ethernet station behind a slave are saved in the buffer "**Frames for unknown stations**" (only in the PLB master). For PDS applications, these are frames that are created due to the redundant transfer via PRP (Page 39), for example, and that can only be sent in the PRP section in which the vehicle is currently located. You can use the checkmarks to suppress this buffer and thus its transfer.

6.4.1.3 Traffic Manager communication

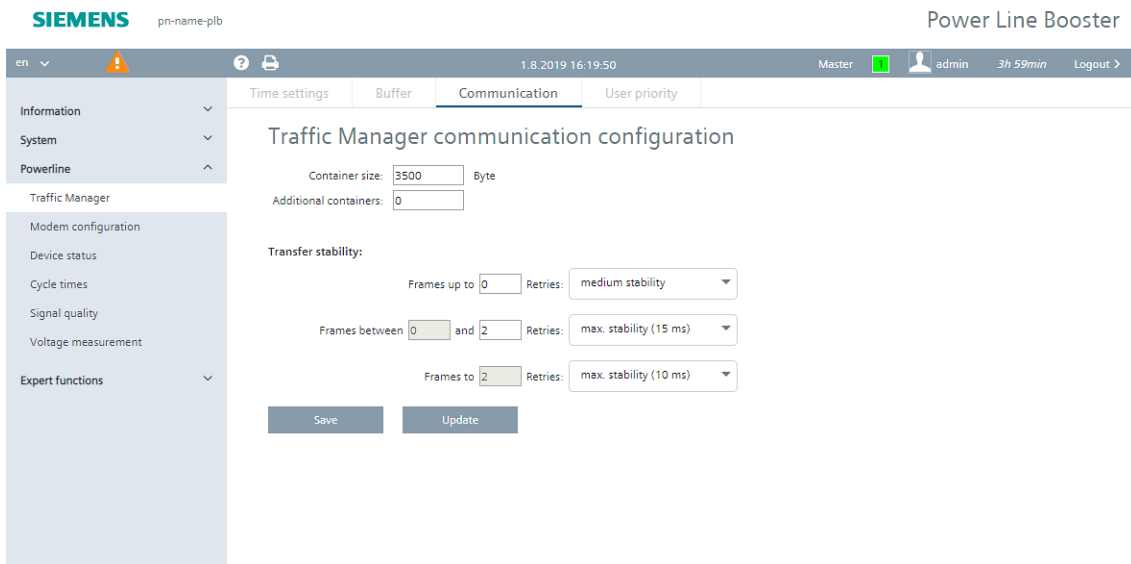


Figure 6-16 Communication configuration

Communication

The PLB packages all frames of a station into a container (according to prioritization). The container is filled until either all buffers were emptied for the container is full.

The transmission cycle of the container depends on its size. This means that a larger container results in a higher data transmission rate but also in longer cycle times.

To achieve short cycle times, only one container is transmitted for each station per cycle. The number of additional containers can be set with the "**Additional containers**" parameter. Additional containers are only created until either the buffers are empty or the maximum number of containers has been reached.

Note

With more than one container, the cycle time increases when large amounts of data are transmitted.

It may be useful to permit additional containers, for example, in the maintenance area of the plant. They can be used to increase the bandwidth for configuring the vehicles over Powerline. An increase of the cycle time due to low real-time requirements is also acceptable in this case.

Transmission stability (only in Master operating mode)

There are a total of four different transmission modes:

- **Medium stability:** High data transmission rate, medium interference sensitivity of the data transmission.
- **High stability:** Compromise between data transmission rate and interference sensitivity.
- **Maximum stability (15 ms):** Low data transmission rate and maximum interference sensitivity. The frame lifetime in the powerline system is 15 ms.
- **Maximum stability (10 ms):** Low data transmission rate and maximum interference sensitivity. The frame lifetime in the powerline system is 10 ms.

Here you can set when and which mode is used for the transmission. A detailed description of the topics "Timeout" and "Powerline cycle" can be found in Time configuration (Page 95).

For most applications, we recommend using the "medium stability" transfer mode for fault-free operation (without timeouts). In the case of retries, you should first configure the maximum stability with a frame lifetime of 15 ms. For the last frames until reaching the Blacklist Timer (Page 95), use the transfer mode "Maximum stability with 10 ms" frame lifetime.

6.4.1.4 Traffic Manager User priority

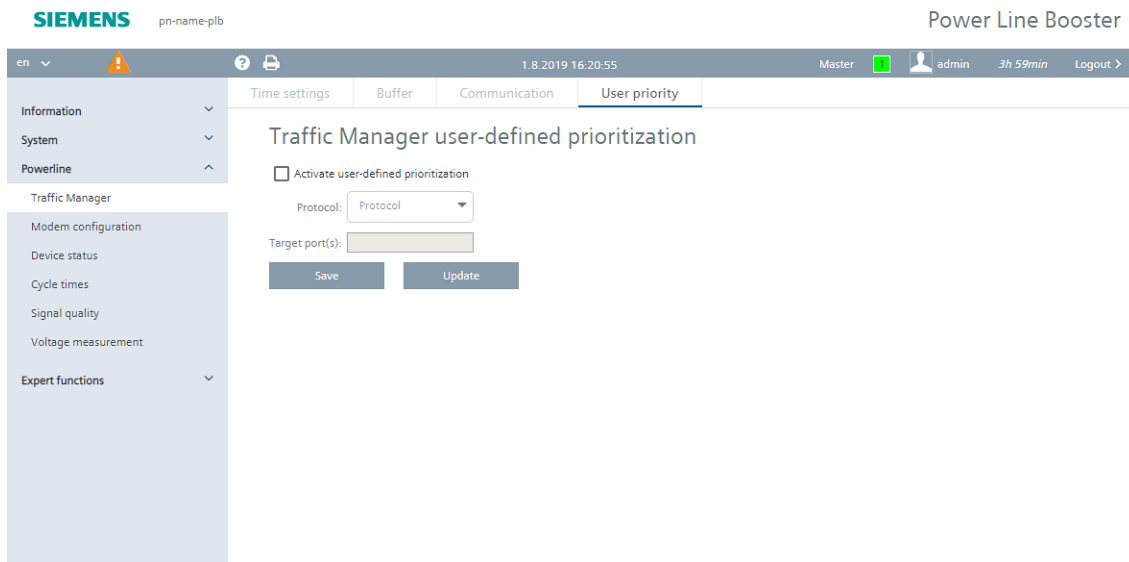


Figure 6-17 User priority

User priority

The frames are transmitted according to their priority to guarantee, for example, the transmission of PROFINET frames even in case of a very high network load. User prioritization enables prioritization of the frames. This ensures that these frames are transmitted immediately after the PROFINET frames.

6.4 Powerline

Use the check box to activate or deactivate the **user-defined prioritization**. You can select UDP or TCP as **protocol**. Valid target **ports** are 1 to 65535. You can select the port as follows:

- all ports with "*"
- individual ports, separated by ";" (e.g. 11; 15; 119)
- a port range connected by "-" (e.g. 456-789)

6.4.2 Modem configuration

6.4.2.1 Signal configuration

Powerline signal gain

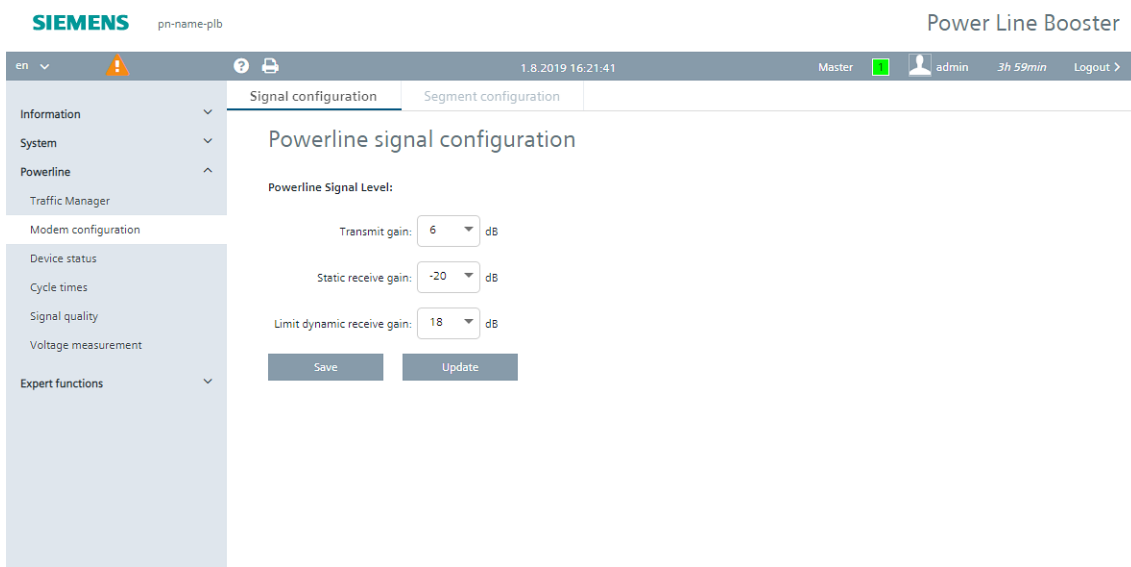


Figure 6-18 Powerline signal configuration

Stable powerline communication requires a signal level high enough that a stable communication connection is available at the most remote slave even in case of external interferences. On the other hand, there must be no crosstalk between two neighboring powerline segments. The crosstalk limit can be determined with the crosstalk measurement (Page 116). As soon as crosstalk occurs for the high-frequency powerline signal, the cycle time multiplies and data transmission in real time of PROFINET can no longer be guaranteed. To prevent this from happening, the powerline signal strength can be increased or dampened individually in send and receive direction over signal elements.

For an ideal signal-to-noise ratio (Page 111) on the rail, the **"transmit gain"** should always be set to a relatively high level. If the application is a point-to-point application without termination modules, there is no signal attenuation between sender and receiver. We

recommend lowering the signal level by about 4 dB for these types of applications so that there is no signal overmodulation in the receiver.

Two signal elements are installed in the receive path of the Power Line Booster. The "**Static receive gain**" can be set to a fixed value in this case. To compensate for different signal levels along the distance, the powerline signal can be dynamically readjusted by a second signal element. The maximum permissible gain can be defined with the "**Limit dynamic receive gain**" parameter. However, this value must not be selected too low to still provide the powerline unit with a sufficient working range.

If there is no additional powerline communication in the environment of the powerline application, the "**Static receive gain**" can be reduced because there is never any crosstalk into another segment.

6.4.2.2 Segment configuration (master only)

Segment configuration

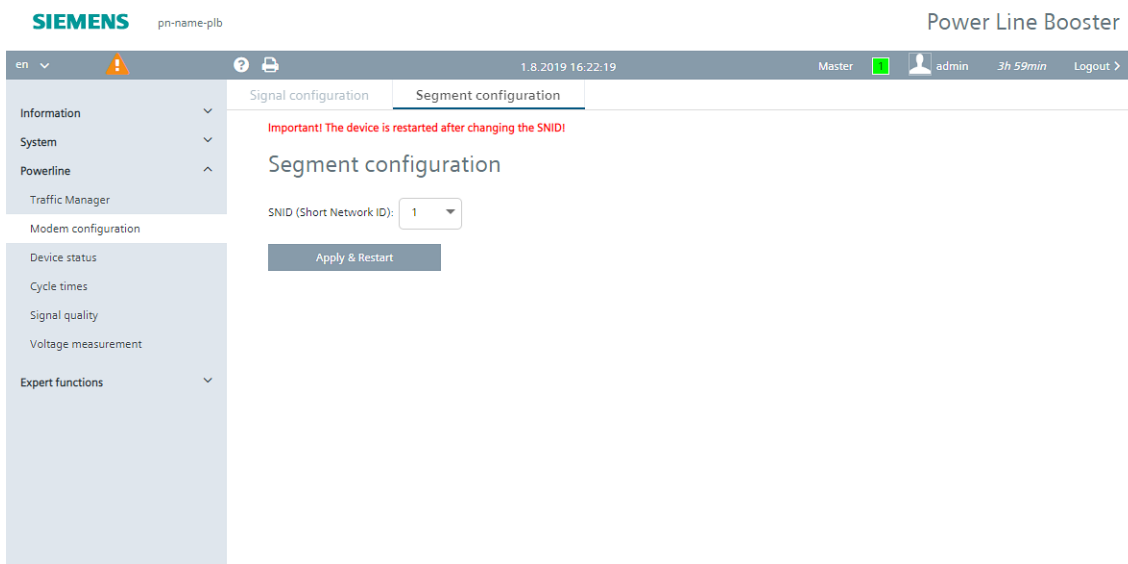


Figure 6-19 Segment configuration

The identification of segments in powerline networks takes place over the so-called "**Short Network ID**" (SNID). To achieve relatively short transfer times during the segment change, neighboring segments must have a different SNID. This means it is necessary to assign different SNIDs to masters of neighboring segments using the drop-down menu.

A change of the SNID requires a reboot of the Power Line Booster.

6.4.3 Status tables (master only)

The Power Line Booster system provides the user with a large number of current status parameters and measured values. The information on the slaves is listed on the following pages in two tables each. The top table always contains all slaves that are currently connected to the master. The number of slaves shows in the table is always visible in the parentheses behind "Connected devices". To show all slaves that have ever been connected to the master since the last reboot, activate the function "**Show devices that are not connected**" below the table. Depending on the number of devices in the system, it may take a few seconds for these values to load.

If measured values are displayed in the table, these are, by default, short-term measured values. This means that only the measured values of the last 60 seconds are taken into account. In addition, the short-term measured values are also reset during each successful connection to ensure that only the latest data is displayed. If you want to display long-term measured values, you can do so by pressing the selection button above the table. Long-term measured values are the measured values since the last restart of the device or since the last manual reset of the measured values. This measuring duration is always shown above the table on the respective page. By pressing the "**Reset long-term measured values**" button, you reset the long-term measured values of the entire system. However, you only have access to this function in your capacity as an administrator. Measured values are generally lost during a restart!

Tables with status parameters only show the current value and thus there is no distinction between short-term and long-term measured values.

Below the table you can automatically update the values in the table. If the function "**Update automatically**" is active, new values are queried cyclically about every 3 seconds. You can also load new values once by pressing the "**Update**" button.

All values in the tables can be sorted in ascending or descending order.

If two slaves are mounted on a vehicle (Powerline Double Slider application), this can be highlighted in color in the table by activating the function "**Group stations**". The connected slaves are treated as a unit during sorting.

To get a better overview, most pages let you show or hide columns that are grouped by topic.

A tooltip provides you with a detailed description of the individual columns when you move the mouse over the individual column headers.

To interpret the results, we generally recommend to compare the values with each other and to specifically look at vehicles with potential outliers.

6.4.3.1 Device status (master only)

You can view the current status of the slaves on this page. These are mainly static values that the slave only transmits to the master during the login process.

You can find a general description of the tables in Status tables (Page 102).

The following columns are always displayed:

- "Connected on": Time at which the connection to the slave was set up.
- "PN name": PROFINET name of the slave.
- "IP address": IP address of the slave.
- "FW version": The PLB FW version of the slave.

You can display the current position of the slaves via the "Position info" switch. However, this value is only available if the current position of the PLB slave is transmitted via the PROFINET IO interface.

- "Position": Shows the current position of the slave (only if this is transmitted via PN-IO (Page 64)).

By default, the active "Device errors" of the slaves are displayed as well. You can find a detailed description of the errors in Error status and warnings of the device (Page 81).

- "Rescue Mode": A slave restarted with the Rescue firmware after a fatal error.
- "Log backup": A slave has created a backup of the log files after restart in Rescue mode to determine the cause of the error.
- "Core Dump": The modem firmware of a slave has restarted after a fatal error and log files were created to determine the cause of the error.

The following columns are displayed in the table with the "Hardware information" switch:

- "Modem MAC": The MAC address of the PLB modem module of the slave is listed here.
- "Basic MAC": The MAC address of the PLB basic module of the slave is listed here.
- "HW Modem": The hardware version of the PLB modem module of the slave is listed here.
- "HW Basic": The hardware version of the PLB basic module of the slave is listed here.

The configuration of the signal gain (Page 100) of the individual slaves can be viewed using the "Signal configuration" switch:

- "TX": Configured static transmit gain of the powerline signal on the slave.
- "RX": Configured static receive gain of the powerline signal on the slave.
- "RX Limit": The configured limit value of the receive gain on the slave.

6.4.3.2 Cycle time

Cycle time

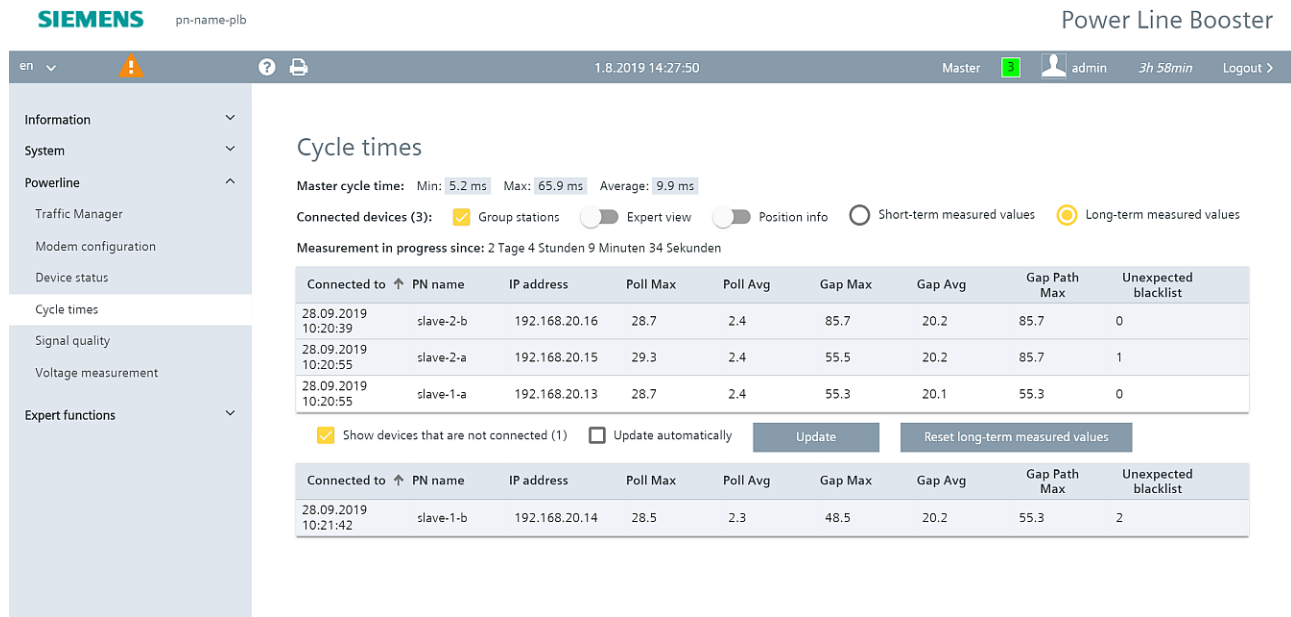


Figure 6-20 Cycle times (long-term measurement)

This page gives you an overview of the cycle times of the connected PLB master and its slaves. The cycle time is the time that the master needs to query all connected slaves one after the other.

You can find a general description of the tables in **Status tables** (Page 102).

The minimum, maximum and average cycle time of the master is displayed at the top of the page.

The following columns are displayed by default in the table of slaves:

- "Connected on": Time at which the connection to the slave was set up.
- "PN name": PROFINET name of the slave.
- "IP address": IP address of the slave.

You can display the current position of the slaves via the "Position info" switch. However, this value is only available if the current position of the PLB slave is transmitted via the PROFINET IO interface.

- "Position": Shows the current position of the slave (only if this is transmitted via PN-IO (Page 64)).

In addition, the following values are always displayed regardless of the switch position.

- "Poll Max": Maximum polling time (query time + response time) to a slave.
- "Poll Avg": Average polling time to a slave (typically < 2.5 ms).
- "Gap Max": Maximum time between two frames to one slave.

- "Gap Avg": Average time between two frames to one **slave**.
Typical: "Poll Avg" • times number of stations in the segment + "Hello Phase" (Page 72).
In a completely full segment, the "Gap Avg" should be shorter than the configured PROFINET update time.
- "Gap Path Max": Maximum time between two frames to one **vehicle** (Power Line Double Slider applications (PDS); for single slider applications (PSS) identical to "Gap Avg").
This value must always be less than the configured PROFINET/PROFIsafe monitoring time (Page 73).
- "Unexpected blacklist": Number of unexpected connection aborts to a slave. The master memorizes the order in which the slaves arrive. This means the master knows which slave is at the end of the line and will leave the segment next. If there is a connection abort to a slave that is not at the end of the line according to the arrival sequence, this is evaluated as an "Unexpected blacklist". This value is only plausible when all vehicles in the segment have changed completely once after a restart of the master and there is no switch in the segment.

You can also switch to the expert view which shows you these additional table columns:

- "Poll Sequence": Position in which the slave is polled by the master.
- "Poll Min": Minimum polling time to a slave.
- "Gap Min": Minimum time between two frames to one slave.
- "Gap Path Min": Minimum time between two frames to one vehicle (PDS applications).
- "Blacklist": Number of connection aborts to a slave.
- "Whitelist": Number of established connections to a slave.

The counters for the timeouts indicate how often a slave has not responded to a query from a master. When a vehicle leaves the segment, the timeouts are incremented until the defined "Blacklist Timer" has been reached. This behavior is normal and expected. An evaluation, therefore, is only meaningful for vehicles within a segment.

- "1 TO" Number of: 1st timeout: Slave has not responded to a poll frame once. First timeouts are normal during regular operation to a certain extent.
- "2 TO" Number of: 2nd timeout: Slave has not responded to a poll frame twice in a row. More than two timeouts should not occur during regular operation.
- "3 TO" Number of: 3rd timeout: Slave has not responded to a poll frame three times in a row.
- "4 TO" Number of: 4th timeout: Slave has not responded to a poll frame four times in a row.
- "5+ TO" Number of: 5th timeouts and following timeouts: Slave has not responded to a poll frame at least five times in a row.

See also

Configuring the PROFINET update time (Page 72)

6.4.4 Signal quality (master only)

6.4.4.1 Signal gain and transmission quality

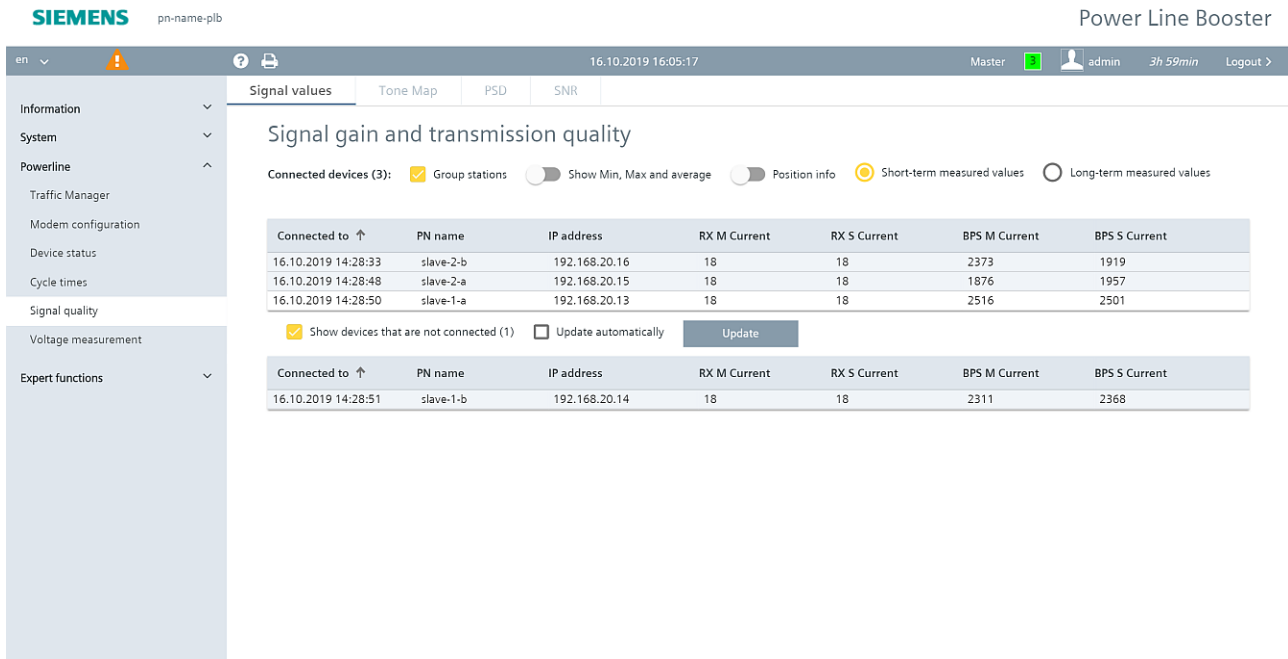


Figure 6-21 Signal gain and transmission quality (short-term measurement)

On this page you can view the signal quality and get information on the receive gain and modulation.

You can find a general description of the tables in Status tables (Page 102).

By default, the table shows the following values:

- "Connected on": Time at which the connection to the slave was set up.
- "PN name": PROFINET name of the slave.
- "IP address": IP address of the slave.

You can display the current position of the slaves via the "Position info" switch. However, this value is only available if the current position of the PLB slave is transmitted via the PROFINET IO interface.

- "Position": Shows the current position of the slave (only if this is transmitted via PN-IO (Page 64)).

In addition, the following values are always displayed regardless of the switch position.

The parameters "RX M" and "RX S" show the current dynamic receive gain. The maximum value is configured by means of "Limit dynamic receive gain" in Signal configuration (Page 100). The configured limit value should only be reached by a few vehicles in a full segment. This is necessary to provide the system with a sufficient control reserve. If required, the limit value can be adjusted taking into account the crosstalk limit (see Crosstalk measurement (Page 116)).

- "RX M": Current value of the dynamic receive gain of this connection on the master (in dB).
- "RX S": Current value of the dynamic receive gain of this connection on the slave (in dB).

The parameters "BPS M" and "BPS S" specify the number of bits that are actually used for modulation. The closer a vehicle is to the master, the higher this value. The most remote slave usually has the lowest modulation due to attenuation. If neighboring stations have very different values, this may indicate an error and the vehicle cabling should be checked, among other things, for EMC interferences, deviating cable material, incorrect cable lengths or cable break. A detailed evaluation of the modulation is possible using the Tone Map (Page 109).

- "BPS M": Current value of the modulation (bits per symbol) of this connection on the master.
- "BPS S": Current value of the modulation (bits per symbol) of this connection on the slave.

You can have the following columns shown in addition for these values with the switch "Show Min, Max and average":

- "RX M Min" and "RX S Min": Minimum value of the receive gain of this connection on master and slave (in dB).
- "RX M Max" and "RX S Max": Maximum value of the receive gain of this connection on master and slave (in dB).
- "RX M Avg" and "RX S Avg": Average value of the receive gain of this connection on master and slave (in dB).
- "BPS M Min" and "BPS S Min": Minimum value of the modulation (bits per symbol) of this connection on master and slave.
- "BPS M Max" and "BPS S Max": Maximum value of the modulation (bits per symbol) of this connection on master and slave.
- "BPS M Avg" and "BPS S Avg": Average value of the modulation (bits per symbol) of this connection on master and slave.

6.4.4.2 Signal graphs

The following tabs give you various options to show and evaluate the signal quality of the Power Line Booster system in form of a graph. First you must specify the communication partner of which you want to determine the graph using the "Connected devices" pull-down menu. You can reload the list of slaves that are currently connected to the master with the "**Updating the slaves**" button. Once you have selected a PLB slave, you can start the measurement with the button and stop it again. The data is updated cyclically as long as the measurement is in progress.

In the graphs, you can see the values that were received last in blue, while red and green indicate the minimum and maximum values for each frequency, respectively. You can reset extreme values with a button.

Some carriers are locked by the system for transmission. The reason for this is dictated by the standard as well as by the supply cables, which form poles in the frequency range. These deactivated carriers are shown in the grayed-out area in the graph.

You can save a measurement as PDF file with the "**Save**" button in the print dialog. You can add additional information on the respective measurement as free text in the comment field.

The measurements are stopped when you leave the page.

6.4.4.3 Tone Map

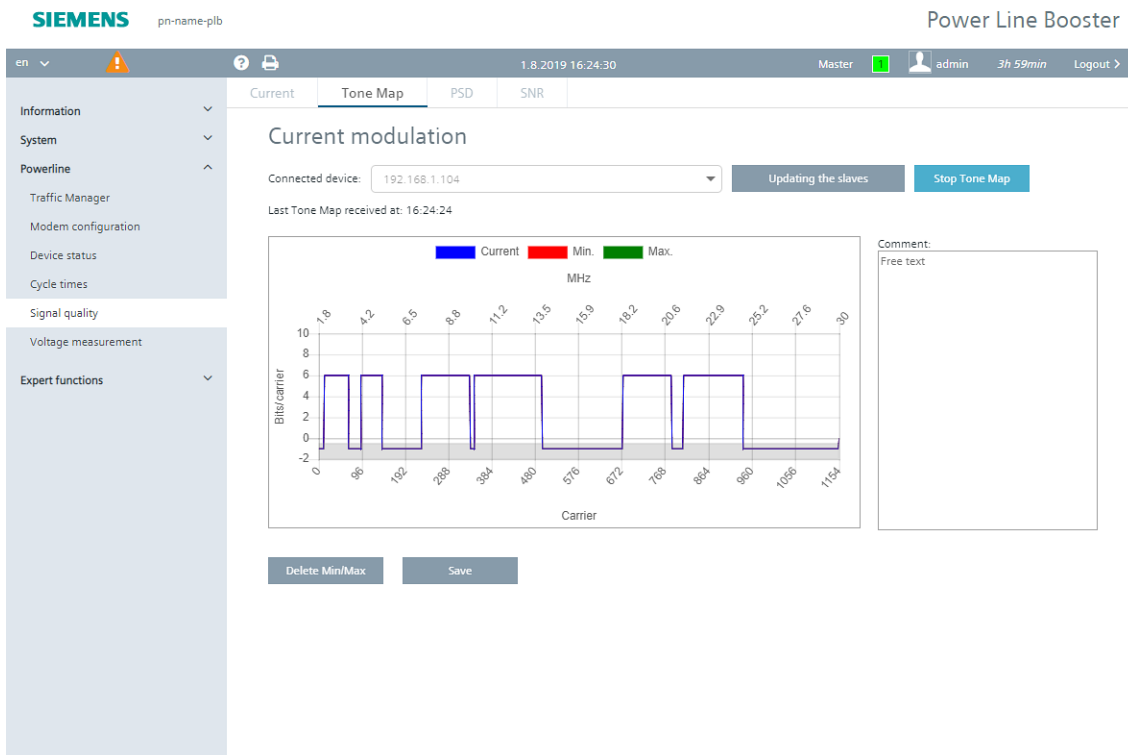


Figure 6-22 Tone Map of the current modulation

The Tone Map shows the current modulation between two connection partners in form of a graph.

You can find a general explanation of operating this metering function under Signal graphs (Page 108).

For communication over powerline, the data is distributed across up to 1155 carrier frequencies in the range from approx. 2 MHz to 28 MHz.

A different number of bits is modulated onto each carrier. The total of all carriers corresponds to the value "Bits per Symbol" (BPS) from the Transmission quality (Page 106) table.

This basically means that the more bits can be modulated onto a carrier, the better the connection and thus the transmission rate. Some carriers locked for modulation by the system are shown with "-1" in the grayed-out area of the graph.

The closer a PLB slave is to the master, the better the modulation. If the slave is located directly at the master, it should be possible to transmit 6 bits/carrier across all approved frequencies. The signal strength and thus the modulation decreases with the distance from the master, but mainly with each slave that is located between slave and master. Initially, this impacts only the higher frequencies but then it spreads to the lower frequencies. For communication to be stable, it must be possible to modulate data onto almost all approved carriers. If this should not be possible due to physical plant properties, these carriers, too, must be locked for communication. Please contact PLB Support for more information.

6.4.4.4 Signal strength



Figure 6-23 Signal strength (Power Spectral Density)

By measuring the PSD (power spectral density), you can display the signal strength trend of the powerline signal.

You can find a general explanation of operating this metering function under Signal graphs (Page 108).

The signal strength in the frequency range of the powerline signal can be determined during communication as well as during a communication break. Switchover takes place with the switch next to the button for starting the measurement. In the "PSD" mode, you can display the signal strength of the powerline signal and determine, for example, to what extent which frequencies are attenuated along the path. Due to laws of physics, higher frequencies are attenuated more strongly than lower frequencies along the path. By comparing the graphs of two neighboring slaves, you can draw conclusions about potential (wiring) faults in one of the stations.

In the "Noise" position, the measurement is made during a communication break and represents the background noise in the communication segment. The measurement should result in a relatively straight line here. Any deviation indicates interference in the powerline frequency range, for example, by a converter.

6.4.4.5 Signal-to-noise ratio



Figure 6-24 Signal-to-noise ratio

The signal-to-noise ratio (SNR) measures the quality of the powerline useful signal that is covered by noise.

You can find a general explanation of operating this metering function under Signal graphs (Page 108).

To extract the user data safely from the powerline signal, the useful signal must stand out from the background noise. This means the signal-to-noise ratio must be sufficiently large. If the SNR drops, the error rate increases and the modulation of the respective carrier is reduced which is then also reflected in the Tone Map (Page 109). For a relatively good signal-to-noise ratio, the transmit level set under Signal configuration (Page 110) should be as high as possible. If the SNR is poor, the background noise can be determined by a PSD measurement (Page 110) to identify potential interferences (e.g. by frequency converters or incorrectly applied shielding). The comparison of two neighboring vehicles can indicate whether the entire segment or only one station is affected.

6.4.5 Voltage measurement (master only)

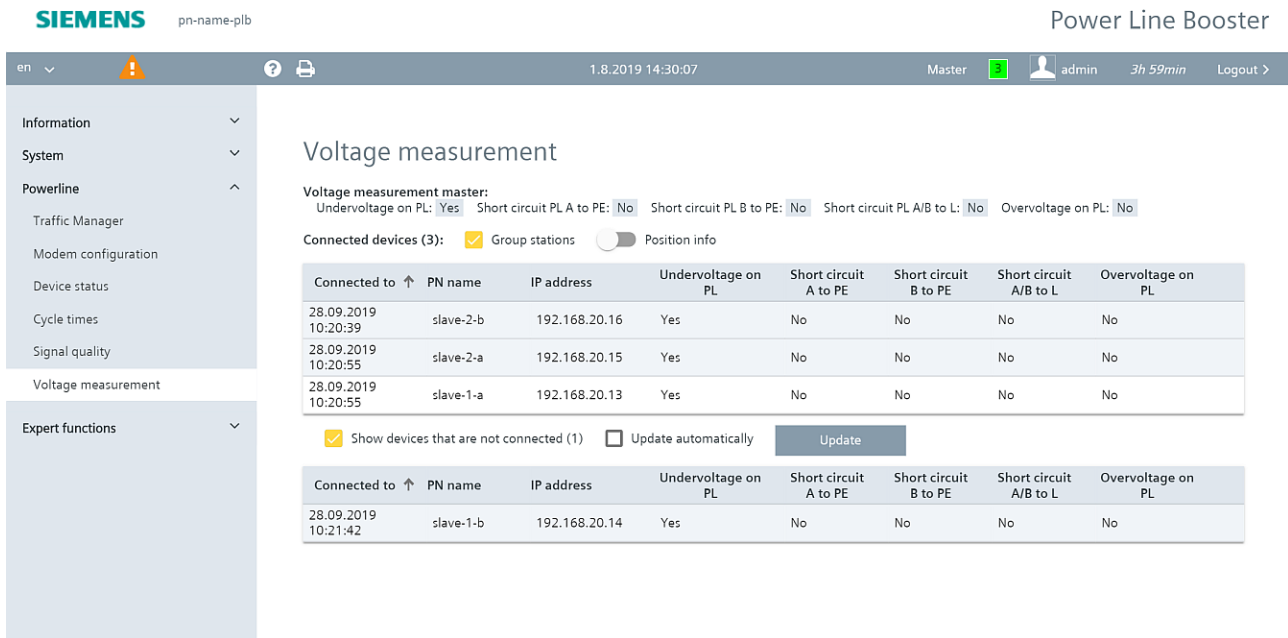


Figure 6-25 Voltage measurement

This page gives you an overview of the current voltage states of the connected master as well as the connected slaves. You can use the displayed states, for example, to determine whether there is a short circuit, overvoltage or undervoltage on the powerline rail.

You can find a general description of the tables in Status tables (Page 102).

The measured voltage states of the master are displayed above the table (identical display as in Errors and warnings (Page 81)).

Below this is the table that shows the following values by default:

- "Connected on": Time at which the connection to the slave was set up.
- "PN name": PROFINET name of the slave.
- "IP address": IP address of the slave.

You can display the current position of the slaves via the "Position info" switch. However, this value is only available if the current position of the PLB slave is transmitted via the PROFINET IO interface.

- "Position": Shows the current position of the slave (only if this is transmitted via PN-IO (Page 64)).

The following states are always displayed below, independent of the switch position.

- "Undervoltage on PL": The PLB measures a carrier voltage (Page 29) that is significantly lower than 42 V on the powerline rail. This is normal for sections or areas without communication. Possible causes of the errors may be the failure of the PLB supply voltage or that the PLB is only connected to one slider.
- "Short circuit PL A to PE": The PLB has detected a short circuit between the Powerline rail "A" and the earth.

- "Short circuit PL B to PE": The PLB has detected a short circuit between the Powerline rail "B" and the earth.
- "Short circuit A/B to L": The PLB has detected a short circuit between the Powerline rail "A" and/or "B" and a line conductor.

 **WARNING**

A voltage that is dangerous to the touch is present on all Powerline rails and all cables and plant units connected to them.

Measure: Shut down plant!

- "Overvoltage on PL": This value indicates whether an overvoltage was detected on the powerline rail instead of the 42 V carrier voltage (Page 29). If "Yes", this may be a cabling error.

 **WARNING**

A voltage that is dangerous to the touch is present on all Powerline rails and all cables and plant units connected to them.

Measure: Shut down plant!

Note that faulty voltages often affect the entire segment and that all slaves in the segment therefore show the same error.

6.5 Expert functions

Expert functions are available on the PLB for diagnostics and commissioning of a Power Line Booster system. The functions often engage deeply with the system and have a significant effect on communication. The functions described below may only be executed by trained personnel and outside of regular production.

Only one expert function can be executed at a time. The other web pages are grayed out.

As soon as an expert function is active on the master, this fact is displayed in the status bar of the web page with the note "Expert function activated".

All expert settings are not stored retentively in the system and the PLB always resumes its original configuration after a restart.

6.5.1 Changing NMK (channel) temporarily

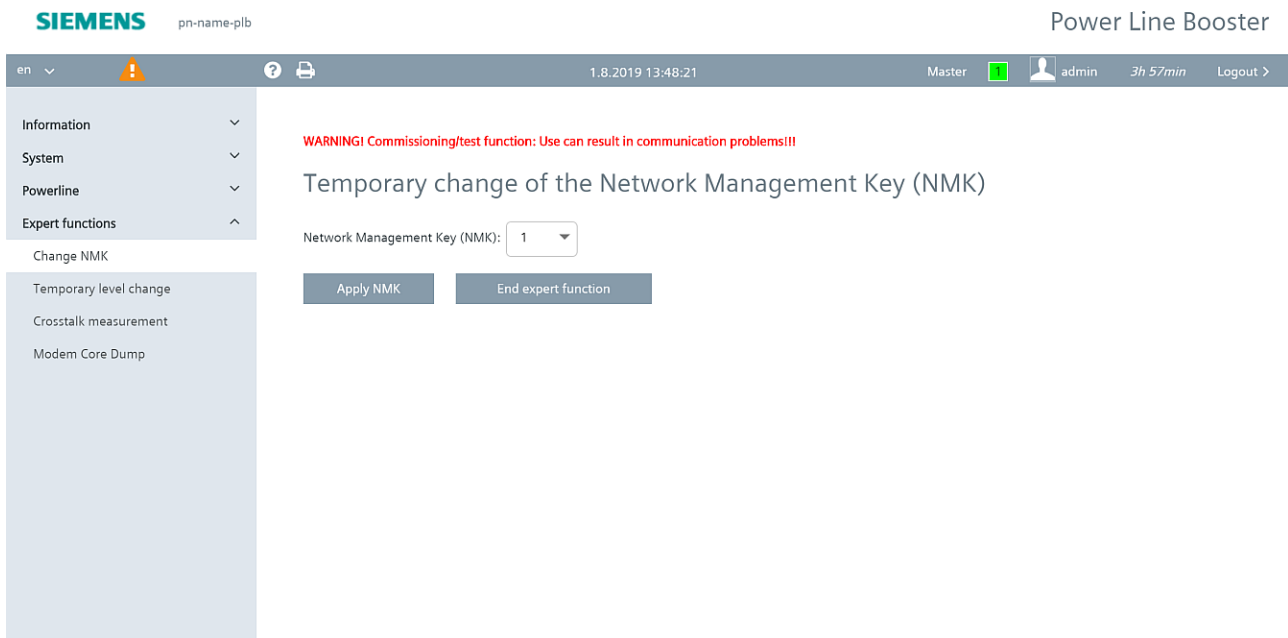


Figure 6-26 Changing NMK temporarily

The NMK (Network Management Key) of the Power Line Boosters is set with the DIP switches on the basic device for regular operation. This key ensures that only PLB devices with identical NMK can communicate with each other, which is why all devices must have the same NMK for regular operation. During commissioning, you can change the NMK temporarily using the Expert functions (Page 113), for example, to reach slaves in the segment with a different NMK. You can select the four possible NMKs in the pull-down menu and "apply" the key temporarily.

For plant installations with permanent communication and switchover of the sliders via relay (double slider solution in an application), the slaves on the vehicle have different NMKs. By changing the NMK on the master temporarily, you have a convenient option to reach all slaves for a firmware update, for example.

The NMK that is configured over the DIP switches becomes active again as soon as you "Restore the standard" or end the web session through logging off, automation logout or connection interruption.

6.5.2 Temporary level change

The screenshot shows the Siemens web interface for a Power Line Booster. The page title is "Temporary signal level change in the entire segment". A red warning message reads: "WARNING! Commissioning/test function: Use can result in communication problems!!!".

There are three sliders for configuration:

- Transmit gain:** Current: 6 dB (Configured: 6 dB). The slider range is from -24 to 6.
- Limit dynamic receive gain:** Current: 18 dB (Configured: 18 dB). The slider range is from -4 to 48.
- Static receive gain:** Current: -20 dB (Configured: -20 dB). The slider range is from -46 to 14.

Below the sliders is a checkbox labeled "Add additional -6dB static receive gain", which is currently unchecked. At the bottom of the configuration area is a button labeled "End expert function".

Figure 6-27 Temporary level change

To determine the system limits during commissioning, for example, you can temporarily change the sending and receiving levels on the master. The master transmits this temporary level configuration to all slaves in the segment that are connected to it. As soon as a slave loses the connection to the master, it resumes its normal level configuration. Unlike the other Expert functions (Page 113), level change remains active even when the web session is closed (log off, automatic logout or connection interruption) to make long-term measurements.

The levels can be set with three sliders, and the PLBs apply these levels directly without additional acknowledgment. If no measurement is active, the sliders are set to the levels configured under Signal configuration (Page 110).

The top slider is the "**static transmit gain**" of the powerline signal. To achieve a good signal-to-noise ratio, the transmit level should be set relatively high during regular operation.

The center slider sets the **Limit for the dynamic receive gain** of the PLB modem. The PLB communication partners need a relatively large range for stable communication in which they can control the receive gain up to the set limit value depending, for example, on the current distance.

The bottom slider sets the second gain element in the receive path. Compared to the previous receive gain, however, this "**static receive gain**" is always set to the same value. If this slider is already set to the maximum attenuation, you can activate an additional attenuator with 6 dB by selecting a check box.

If you want to change the values of the Signal configuration (Page 110) due to the measurement, you may have to conduct a Crosstalk measurement (Page 116).

6.5.3 Crosstalk measurement

SIEMENS pn-name-plb Power Line Booster

en 1.8.2019 14:19:33 Master admin 3h 59min Logout >

WARNING! Commissioning/test function: Use can result in communication problems!!!

Crosstalk measurement

IP address of neighboring masters:

Admin password of neighboring masters:

Static levels:
Transmit gain: dB Limit dynamic receive gain: dB

Variable level:
Static receive gain start: dB Static receive gain end: dB

Crosstalk limit at -10 dB -> set segment attenuation is sufficient, Configured: -20 dB , -20 dB , -20 dB , -28 dB

Rx attenuation in dB	Local master Cycle time in ms	Neighboring master Cycle time in ms
-32	4.2	4.2
-30	4.2	4.2
-28	4.2	4.2
-26	4.2	4.2
-24	4.2	4.2
-22	4.2	4.2
-20	4.2	4.2
-18	4.2	4.2
-16	4.2	4.2
-14	4.2	4.2
-12	4.2	4.2
-10	4.2	4.2
-8	4.5	4.3
-6	4.8	4.4
-4	5.2	4.5
-2	5.5	4.6
0	5.8	4.7
2	6.2	4.8
4	6.5	4.9
6	6.8	4.9
8	7.2	4.9
10	7.0	4.9
12	7.2	4.9
14	7.2	5.0

Comment:
Free text

Figure 6-28 Crosstalk measurement (positive example)

SIEMENS pn-name-plb Power Line Booster

en 1.8.2019 13:55:08 Master admin 3h 59min Logout >

Information
System
Powerline
Expert functions
Change NMK
Temporary level change
Crosstalk measurement
Modem Core Dump

WARNING! Commissioning/test function: Use can result in communication problems!!!

Crosstalk measurement

IP address of neighboring masters: 192.168.1.101
Admin password of neighboring masters:

Static levels:
Transmit gain: 6 dB Limit dynamic receive gain: 18 dB

Variable level:
Static receive gain start: -52 dB Static receive gain end: 14 dB

Start measurement Stop measurement

Crosstalk limit at -26 dB -> set segment attenuation is not sufficient, Configured: -20 dB, -20 dB, -20 dB, -20 dB

Comment:
Free text

Save

Figure 6-29 Crosstalk measurement (negative example)

Stable communication requires that the level of the powerline signal is relatively high to achieve an ideal signal-to-noise ratio. Because each vehicle dampens the signal level, this is especially important in a full segment. However, the level in the segment must not be too high because crosstalk of the high-frequency powerline signal between neighboring segments will significantly extend the cycle time.

To verify the plant cabling and thus the crosstalk limit, a crosstalk measurement is required during commissioning. The measurement is a functionality of the PLB Expert function (Page 113) can be run through this page. To determine the crosstalk limit, you must move exactly one vehicle with exactly one PLB slave in two directly neighboring segments close to the intersection you want to measure. With this configuration you can achieve the maximum signal level at the intersection because the signal is not dampened by additional vehicles. If the installation is the PDS application (Powerline Double Slider) with uninterrupted communication, you must disable one PLB on the two vehicles involved for the measurement. Afterward, you should run another measurement with a vehicle on the segment cut to exclude crosstalk over the vehicle cabling. One slider with a PLB slave must be located in the left segment, and the other slider with PLB slave must be located in the right segment.

6.5 Expert functions

To run the crosstalk measurement, you must first enter the IP address as well as the "admin" password of the PLB master of the neighboring segment (remote master). Note that the master on which you are logged in will set up a connection to the remote PLB master during the measurement. If a connection setup to the remote master is not possible, check whether a manual login has already permitted setup of a non-certified https connection. In addition, no "admin" user may be logged in on the remote master during the measurement.

In the second step, you must first define the static parameters for the measurement. We recommend using the values set for regular operation for "Transmit gain" as well as for "Limit of dynamic receive gain".

Using the entry fields for the variable level, you can define the start and end value of the measurement. In the first step, we recommend that you take full advantage of the full level range. For later measurements you can limit the level range to reduce the measurement time. We also recommend increasing the start value if no stable Powerline connection can be set up between master and slave at the lowest level value.

When you start the measurement, all PLBs involved in the measurement (both masters and both slaves) will run through the level values between defined start and end value synchronously step-by-step. The cycle time in the segments is determined for each level value and recorded in the graph. As soon as there is crosstalk, the cycle time in a segment increases significantly. This is the crosstalk limit at which the powerline signal becomes visible in the neighboring segment and thus prevents stable and deterministic communication. The Power Line Booster can also evaluate the graph in case of a correct measurement and displays the crosstalk limit for you as well as the currently configured "static receive gain" of the four PLBs involved in the measurement.

Once you have determined the crosstalk limit at all segment intersections in the plant, you must set the value with the highest/worst crosstalk limit as configuration for the "static receive gain" on all Power Line Boosters in the plant.

With the standard configuration, there should be no crosstalk in a typical system. If this is not the case, check the system installation (grounding of the PE rail, TC modules, shielding, etc.).

Note that all long-term measured values of the Log tables (Page 85) are reset after the crosstalk measurement.

6.5.4 Modem Core Dump

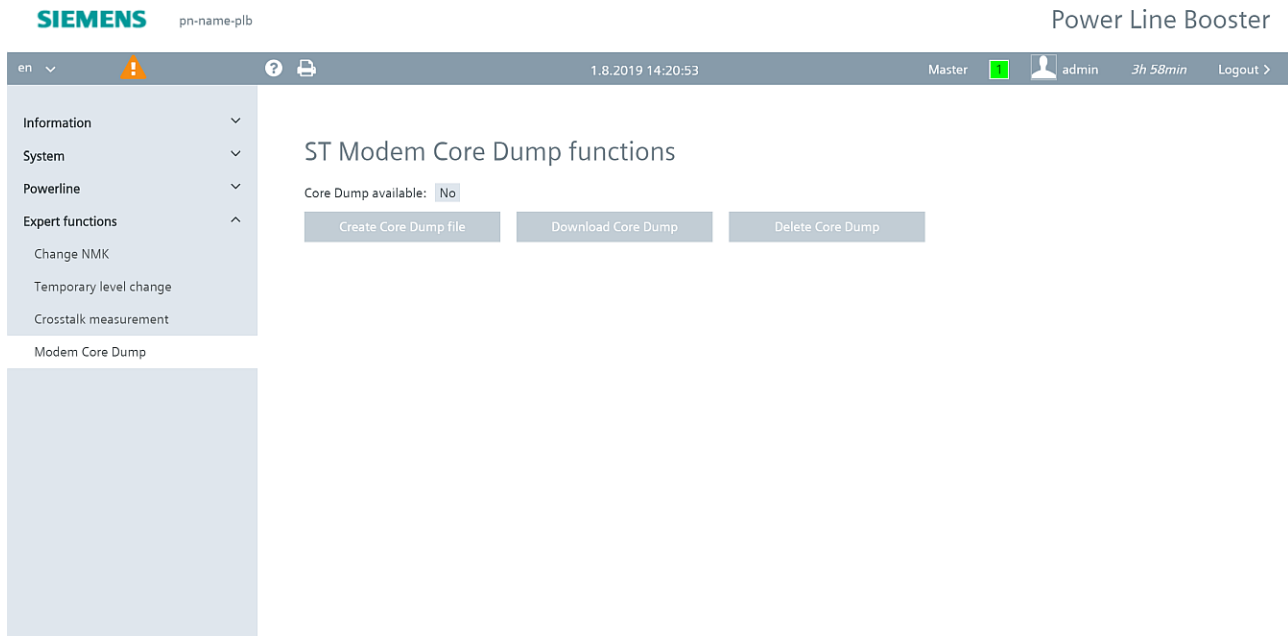


Figure 6-30 Modem Core Dump

In case of a fatal error of the modem firmware, the modem creates a complete copy of all relevant data (core dump) for error diagnostics by SIEMENS PLB Support (<mailto:PLB-support.industry@siemens.com>). The fact that a core dump is available is shown under Errors and warnings and in the header area of all web pages.

In the first step, the core dump must be imported from the modem and saved on the system to be downloaded later. While the file is being created, there may be communication problems; this is why this process should not take place during production hours. It can take up to 20 minutes for the download file to be created!

Only after this step is complete can you download the data. Because of its size, we recommend downloading the file over a direct Ethernet connection.

After the core dump has been deleted, the error message will no longer be shown on the web pages.

6.6 Commissioning sequence

The following section is intended to serve as a starting point for the commissioning of a new PLB system. The example refers to a PDS multi-segment system. However, for the most part you can also project it onto other systems.

6.6.1 Visual check

The following must be checked before the first measurements:

- Are the TC modules correctly installed at the end of the segment (e.g. with short cable, is there a connection between TC module and rail, etc.)?
- Is the PE rail grounded against the steel structure at the height of all PL segment ends with short cables?
- Is the PE rail grounded with short cables against the steel structure approximately every 6 meters?
- Are the separators correctly designed at the segment change (e.g. with short cable, no connecting cables of the respective segments via the center line of the segment cut, etc.)?
- Is the 42 V carrier voltage supply available in all segments, or have the circuit breakers tripped due to short-circuits, for example?
- Is the shielding of the powerline connection cables (> 1 meter) correctly executed?
- Is the DIP switch position of the devices correct (master/slave and network key)?
- Are all modules and the BusAdapter correctly inserted and fastened to the base?
- Is the SNID setting different on adjacent masters (see Segment configuration (Page 101))?
- Do all devices have the same firmware version (see Device status (Page 103))?
- Do all devices have the correct (level) configuration (see Device status (Page 103))?

6.6.2 Segment cabling

Next, please check the actual cabling of each individual segment and vehicle. Using the Voltage measurement (Page 112) table, you can check whether the master or any slave detects a short-circuit or if all devices measure the supply voltage 42 V, for example. If the supply voltage is not measurable, it indicates that this node is only connected single-phase.

6.6.3 Segment damping

The elementary requirement for a stable powerline connection is that there is no crosstalk between adjacent segments at any time. For this reason, you should now carry out Crosstalk measurement on all segments. For later documentation, it is advisable to save the measurement results. If crosstalk occurs between segments, check again the cabling of both segments involved in the measurement. In compliance with the cabling regulations, it should always be possible to prevent crosstalk in typical systems with standard configuration.

The only alternative way to minimize a crosstalk is to reduce the signal levels of the entire system, but this can lead to limitations of the maximum quantity structure.

6.6.4 Cycle times and level values

In the next step you should check the cycle times and level values. This can be done either at a standstill with as many slaves as possible in the segment or in travel operation.

Observe the values in the Cycle time (Page 104) and Signal amplification and transmission quality (Page 106) tables. The measured values of the cycle times should be similar in all segments as well as to all slaves. Only the slave at "Poll order" 1 can/should have slightly higher values depending on the system. If the measured values of one slave differ from those of the others (longer cycle time, more timeouts, etc.), please check this slave for faults, for example, its cabling.

In the signal quality table you will notice that the values of the slaves deteriorate with the distance to the master. However, if you sort the table via the "Connected to" column or via the "Position" column, if available, you can also identify outliers against the other slaves here.

6.6.5 Frequency spectrum used

Drive as many vehicles as possible in the segment to be measured. Perform a Tone Map (Page 109) measurement on the slaves that are close to the master. The majority of carriers (apart from the deactivated ones) should be 6 bits/carrier.

In the second step you perform the measurement on the slave that is furthest away from the master. Here the connection is clearly worse due to the damping by the vehicles and route. However, only 10-20% of all carriers may have 0 bits/carrier (apart from the deactivated ones).

If this is not the case and you cannot find any fault in the cabling, for example, you have to either increase the level in the system (then do another Crosstalk measurement (Page 116)) or reduce the number of vehicles for a stable operation.

In addition, you can also perform an SNR (Page 111) and PSD measurement (Page 110) on the slaves at the master and segment end.

6.7 Error diagnostics

6.6.6 Test mode with reduced levels

In the last step, we recommend temporarily reducing the signal levels (see Temporary level change). Reduce the level until the first communication disturbances occur or you notice a deterioration of the measured values in the Cycle time table. Start with the value of the "Static receive gain", as this has no influence on the signal-to-noise ratio compared to the transmission level.

The level reserve of the system is the difference between the original level and the level at which the first deterioration occurs. The higher the level reserve, the more tolerant the communication is to external influences. The level reserve should be at least 8 dB.

6.7 Error diagnostics

The following table shows typical error patterns and provides information on how to correct them.

Table 6- 2 Fault descriptions and causes

Fault description	Possible causes/remedy
No communication is possible between master and slave (PL LEDs on modem do not flash).	Is the configuration via the DIP switches correct? Is exactly one device configured as master? Do all PLBs have the same network key?
Transfer time for segment change takes too long.	Do the neighboring masters have a different SNID configuration (see Segment configuration (Page 101))?
One segment often suffers from communication problems.	Is there an electrical connection between slider and rail at all times? Do sliders lift off at curves, separators, switches or lifters? If Yes → Correct rail installation / slider mounting. Is there crosstalk to a neighboring segment? Test no. 1: Switch off neighboring master. If there is significant improvement afterwards, there is crosstalk. Test no. 2: Perform crosstalk measurement (Page 116). Dependent on the result: Check cabling and reduce the level, if necessary.
Communication problems occur in several segments.	Is there any regularity? For example, are there always faults as long as a certain vehicle is in the segment? Does the Cycle time (Page 104) or Signal quality (Page 106) table show any anomaly when comparing the measured values between the individual slaves? Checking Voltage measurements (Page 112). For example, does a vehicle cause a short-circuit that travels through the system?
All of the PLB's LEDs flash directly after switch on	Are the modem module and the BusAdapter inserted correctly? Are the pins of the connector bent? Is a wrong modem inserted (only this order number 6ES7972-5AA51-0AB0 is valid)?

Maintenance and service

7.1 Spare parts and repairs

Repairs

In case of repair, the HMI device must be shipped to the Return Center in Fürth. Repairs may only be carried out at the Return Center in Fürth.

Depending on the work necessary to repair the device, the Center may decide to give you a credit. A credit note is only granted if the sender orders a new device.

The address is:

Siemens AG
Retouren-Center
c/o Geis Industrie-Service GmbH Tor 1-4
Kraftwerkstr. 25A
D-9156 Erlangen
Germany

During longer operation environmental influences act on the device, for example, temperature, humidity and air pressure. Send the device to the Return Center for a verification of the function and measuring accuracy. Flat-rate charges are specified for the verification and, if necessary, for the repair.

Spare parts

Spare parts and accessories can be found in section Order numbers (Page 129).

7.2 Recycling and disposal

The devices described in this manual can be recycled due to their ecologically compatible components. Contact a certified disposal service company for environmentally sound recycling and disposal of your old devices.

Technical specifications and approvals

8.1 Technical specifications

8.1.1 Mechanics

Dimensions and weight

Table 8- 1 Power Line Booster BM with equipped BA, MM, EM

Width	Length	Depth	Weight
146 mm	130 mm	83 mm	0.90 kg

Note: Information without DIN rail mounting bracket

Table 8- 2 PLB TC

Width	Length	Depth	Weight
50 mm	50 mm	30 mm	0.20 kg

Note: Dimensions without connecting cables

Degree of protection

Table 8- 3 Power Line Booster

Degree of protection	IP20
----------------------	------

The degree of protection is only fulfilled for the fully equipped device. This means only including all plugged-in modules.

Table 8- 4 PLB TC

Degree of protection	IP20
----------------------	------

When installed.

Installation

You can clip the PLB onto a 35 mm DIN rail (TS 35, EN50022). You can use the DIN rail in the horizontal or vertical version. Observe the distance to the adjacent devices in the section Climate (Page 127).

You must install the PLB TC into a separate enclosure due to its connecting cables (e.g. rail terminal box (Page 48)).

8.1 Technical specifications

8.1.2 Shock values

Table 8- 5 Vibratory load

IEC 61131-2,	
IEC 60068-2-6, Test Fc frequency / deflection or acceleration:	5 – 8.4 Hz / 3.5 mm 8.4 – 150 Hz / 9.8 m/s ² 10 cycles per axis, all three axes, Throughflow time 1 min /octave

Table 8- 6 Shock load

IEC 61131-2,	
IEC 60068-2-27, Test Ea acceleration:	150 m/s ²
Duration:	11 ms
Pulse shape:	half-sine
Shocks in pos. and neg. direction to each axis	3 shocks (11 ms) with 15 G

8.1.3 Electrical characteristic values

Device	Rated voltage			Current consumption		Power consumption	
	min.	Typical	max.	Typical	max.	Typical	max.
PLB BM LV M/S incl. Modules (MM, BM) X80	19.2 V DC		28.8 V DC	0.29 A	0.63 A	7.0 W -	12.0 W
PLB BM LV M/S incl. modules (MM, BM) X2	0 V AC	42 V AC	48.3 V AC	4 mA (at 42 V AC)	-	180 mW	200 mW
PLB TC	31.1 V AC		48.3 V AC	Reactive current		-	

Overvoltage category	III
Degree of pollution	2
Protection class	II

The associated product standards are available in the section CE conformity (Page 127).

8.1.4 MTBF

Mean Time Between Failures

	FIT	MTBF
PLB BM	2532	394,944 h or 45.1 years
PLB MM	1185	843,881 h or 96.2 years
BA 2xRJ45 [BA 2xFC]		917.6 years [1,024 years]
Power Line Booster (PLB BM, PLB MM, BA 2xRJ45)	3319	301,296h or 34.4 years

8.1.5 Climate

You can operate all devices at ambient temperatures of **0 .. +60 °C in standard mounting position** (DIN rail mounting horizontal on a vertical mounting surface). If you want to install the Power Line Booster on a vertical DIN rail on a vertical mounting surface or on a horizontal mounting surface, the maximum ambient temperature is reduced to +50 °C.

Distance to adjacent devices: 60 mm above and below the PLB.

The storage temperature is -40 °C ... +70 °C.

Max. operation altitude: 2000 m above sea level

All components are designed for continuous operation (24 h/7 d).

8.2 Approvals

8.2.1 CE conformity



The PLB modules

- PLB BM,
- PLB MM and
- PLB TC

in the version sold by us conforms with the directives of the following European guidelines:

2014/30/EC Directive of the European Parliament and of the Council of 26 February 2014 on the approximation of the laws of the Member States relating to electromagnetic compatibility

2011/65/EC Directive of the European Parliament and Council of 8 June 2011 on the harmonization of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits.

8.2 Approvals

Compatibility with the directives is verified by compliance with the following standards:

EN 61000-6-2:2005 (PLB BM, PLB MM)

EN 61000-6-4:2007+A1:2011 (PLB BM, PLB MM)

EN 61010-1:2010 (PLB BM, PLB MM, PLB TC)

EN 61010-2-201:2013 (PLB BM, PLB MM, PLB TC)

8.2.2 cULus approval



Underwriters Laboratories Inc., to

- UL 61010-1, Ed. 3, Rev. 2018-11-21
and UL 61010-2-201, Ed. 2, Published 2018-05-14
- CSA C22.2 No. 61010-1, Ed. 3, Rev. 2018-11
and CSA C22.2 No. 61010-2-201, Ed. 2, Published 2018-02

The approval is for the PLB modules:

- PLB BM,
- PLB MM and
- PLB TC

Order numbers

Power Line Booster components

Table 9- 1 Order numbers of the components

PMD product name	Component	Order number
SIMATIC Power Line Booster Base Module Low Voltage Master/Slave	PLB BM LV M/S	6ES7972-5AA00-0AB0
SIMATIC Power Line Booster Base Module High Voltage Master/Slave	PLB BM HV M/S	6ES7972-5AA10-0AB0
SIMATIC Power Line Booster Base Module Low Voltage Slave	PLB BM LV S	6ES7972-5AA30-0AB0
SIMATIC Power Line Booster Base Module High Voltage Slave	PLB BM HV S	6ES7972-5AA40-0AB0
SIMATIC PLB MM (modem module)	PLB MM	6ES7972-5AA51-0AB0
SIMATIC PLB Termination and Coupling	PLB TC	6ES7972-5AB00-0XA0
SIMATIC PLB Empty Module (empty enclosure as cover) (5 pieces per packing unit)	PLB EM	6ES7972-5AA90-0XA0

Connecting cables

Table 9- 2 Order numbers for connecting cables of the PLB devices

Connecting cables	8 m length
Without plug	6ES7903-1AH40-0AB0
With plug (male)	6ES7903-1AH41-0AB0
With two plugs (male + female)	6ES7903-1AH42-0AB0

Table 9- 3 Use the following HAN® connectors from Harting

Product	Type	Harting order number
Add-on housing straight	HAN® 3 EMC	09 62 003 0301
Add-on housing angled	HAN® 3 EMC	09 62 003 0801
Socket insert (female)	HAN® Q 5/0-F	09 12 005 3101
Contact insert (male)	HAN® Q 5/0-F	09 12 005 3001
Crimp contact (female)	HAN E®, 2.5 mm ² , gold-plated	09 33 000 6223

Product	Type	Harting order number
Crimp contact (male)	HAN E®, 2.5 mm ² , gold-plated	09 33 000 6123
Crimp contact (female)	HAN E®, 1.5 mm ² , gold-plated	09 33 000 6216
Crimp contact (male)	HAN E®, 1.5 mm ² , gold-plated	09 33 000 6116

Accessories

Table 9- 4 Order numbers of the recommended accessories

Product name	Component	Manufacturer: Order number
Connectors	X2 (PLB BM) TKFC 2.5/2-ST-5.08 BK [PU = 50 pcs.] X80 (PLB BM) SPC 5/2-ST-7.62 BK [PU = 50 pcs.]	Phoenix Contact: Order no.:17.24.239 Phoenix Contact: Order no.:17.07.524
Shield clamp	for X2 (PLB BM) [PU = 10 pcs.] SKS 14-D for X2 (PLB BM) [PU = 10 pcs.] LF(Z) / SKL 8..11 (also requires M4x 6 fixing screw)	Phoenix Contact: Order no.:32.40.214 icotek: Order no.:36925
Carrier voltage transformer	TSV	mdexx: Order no.: TAM3242-8JV00-0EA0
Line filter		(1) Schurter: 5500.2349 (clip DIN rail) (2) Schurter: 5500.2218.01 (screw-type lugs)
Primary circuit breaker		SIEMENS: 3RV1011-1BA10
Secondary circuit breaker		(1) SIEMENS: 5SY4202-5 (2-pole, 2A, A characteristic) (2) SIEMENS: 5SY4202-6 (2-pole, 2A, B characteristic)
PLB cable	PLB cable with variable length	Lapp: Order no.: 2170322

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