SIEMENS

Power Line Booster

Operating Instructions

Version 1.07

08/2018

A5E36203125A-AE

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

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indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠ 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.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

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⚠ WARNING

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We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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℗ 08/2018 Subject to change

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Preface

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Purpose of the manual

This manual describes the hardware and software components of the Power Line Booster 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.

System overview and introduction

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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 (graphite/copper on copper) 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 (e.g. field devices).
- It prioritizes cyclic PROFINET telegrams to ensure real-time conditions.
- 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 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 offers a PN-IO interface through which status information can be retrieved.
- It can even be used as PROFINET terminal (diagnostics).
- 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 (email address (mailto:PLB-Support.industry@siemens.com)) or your local Siemens representative.

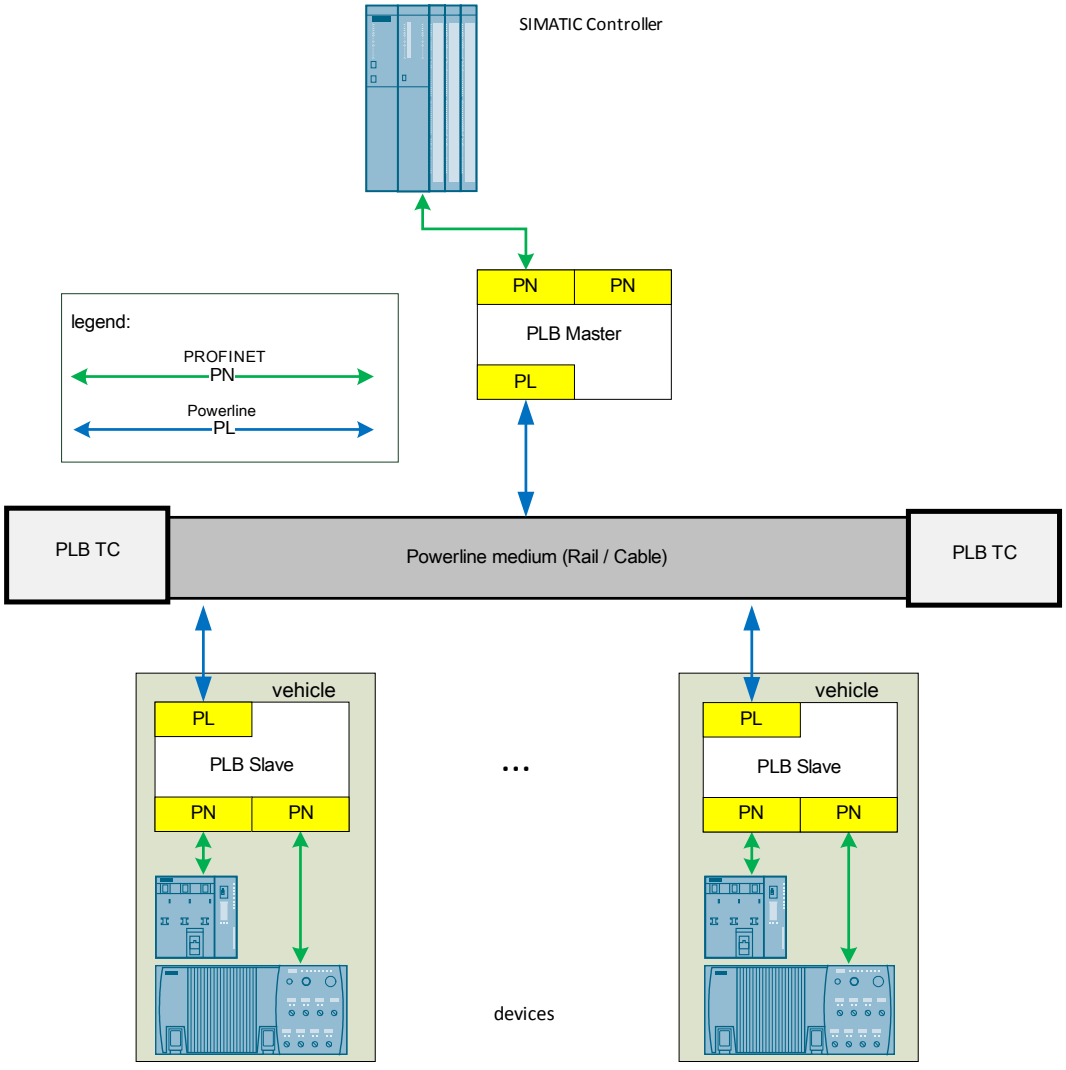

Figure 2-1 Design example of a Power Line Booster system

The Power Line Booster ensures that all devices communicate cyclically and that high-priority PROFINET telegrams are transmitted first.

Technology

The Power Line Booster uses a communication technology that can be used to implement the transmission of Ethernet-based telegrams, especially PROFINET, over power lines and/or control lines. 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 telegrams 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 between about 2 MHz up to about 70MHz. By the same token, the device demodulates the data telegrams it receives from the other end.

Functional description

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3.1 System limits

3.1.1 Insolation

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

- Low voltage: max. 500 V AC +15% line-to-line voltage with balanced earth
  This high limit applies to the **system support lines**, e.g. L1, L2, L3 (not for the communication lines) and refers to the isolation system of the PLB system
- Extra-low voltage: max. 42 V AC +15%
  This restriction applies to the **communication lines**. Operation of the system is also possible when these rails or lines are deenegized. Operation is not possible when both communication lines are short-circuited.
- PLB supply voltage: 24 V DC ± 20 %
  The power supply unit for the **supply voltage** of the Power Line Booster must meet the "National Electrical Code (NEC) Class 2" specification. The device cannot be operated without supply voltage.

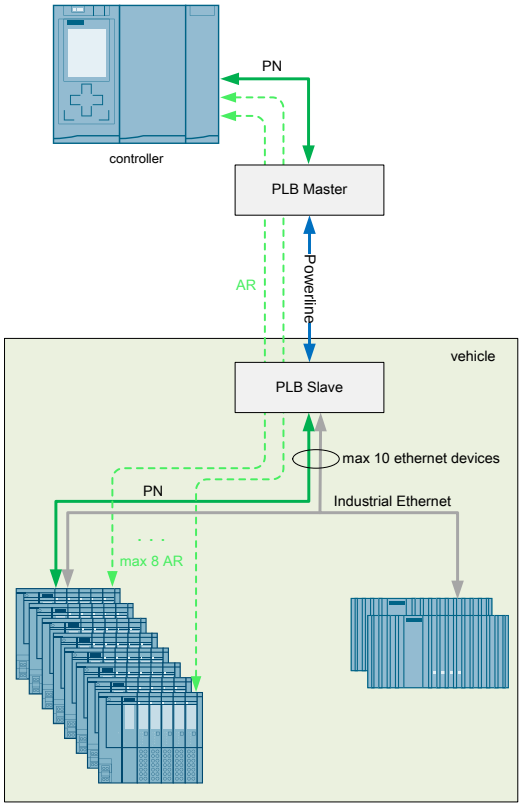
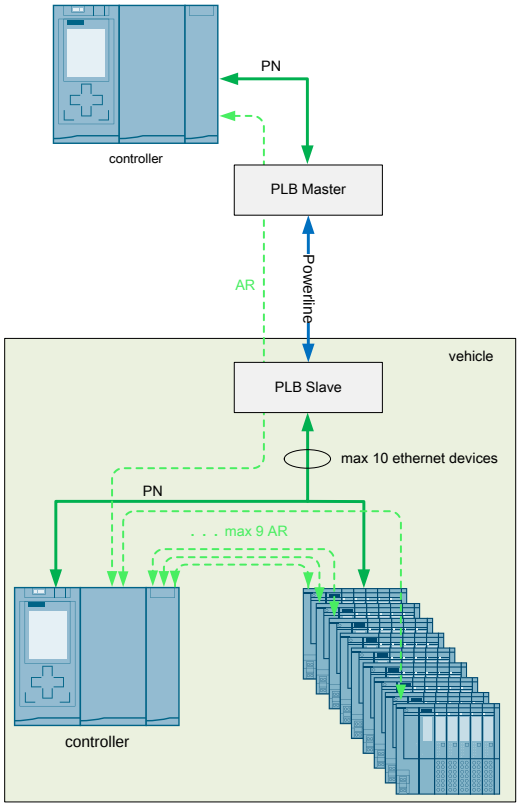
3.1.2 Configuration limits

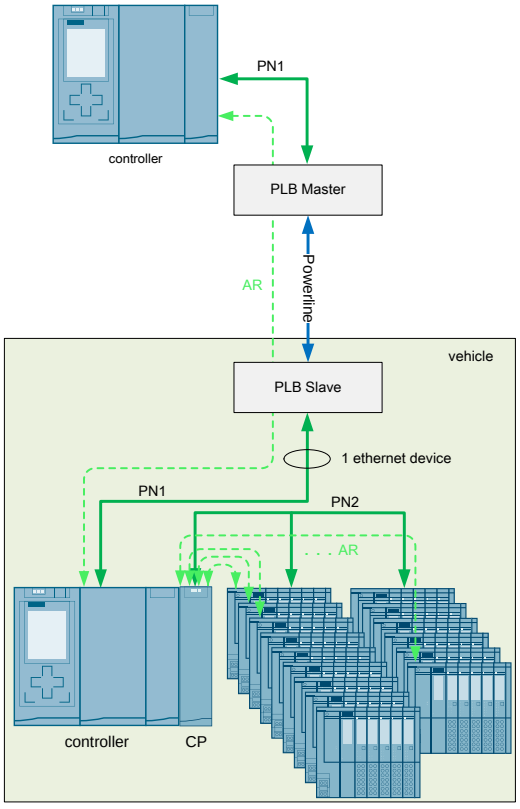
Product properties:

All rules below must be observed.

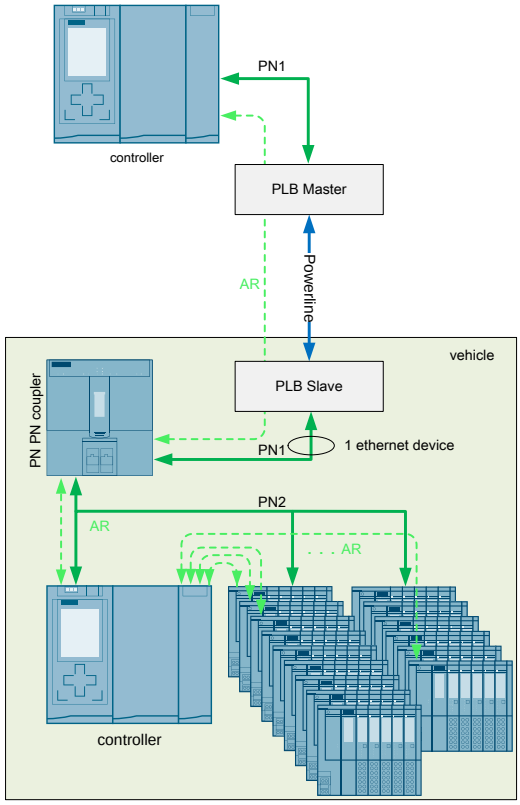
- max. 50 PLB slaves per PLB master
- max. 50 PROFINET (PN) connections (PN Application Relation) per PLB master
- Max. 250 m segment length
- Max. 8 PN connections via the PL connection per PLB slave
- Max. 10 Ethernet nodes in local PLB slave network
- Max. 64 bytes IO data per PN connection in each direction of communication
- At least 128 ms PN cycle time with 50 PLB slaves
- At least 64 ms PN cycle time with 20 PLB slaves

Table 3- 1 Examples for the configuration limits

	
Maximum of 8 application relations (AR) via PL and maximum 10 Ethernet nodes on one PLB slave	Maximal 10 Ethernet connections per PLB slave. The PROFINET stations on the carrier are connected to the PN controller on the carrier. The carrier controller is connected to the stationary controller via powerline using a single AR as I-device.



Second PROFINET (PN2) has no effect on the powerline connection.
Supply disconnection by CP.



Supply disconnection by a PN PN coupler.
The second PROFINET does not have an effect on the powerline connection.

3.1.3 Rated conditions

- The operation of Power Line Booster devices in public supply networks is not permitted.
- The operation of standard powerline components in the system environment is not permitted.
- Stations connected to the PLB master can only communicate with stations connected to a PLB slave. Inter-station communication, i.e. direct data exchange between stations connected to different PLB slaves, is not possible.

3.2 Components

3.2.1 Introduction

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

- Power Line Booster (PLB BM) as master and slave with modem module (PLB MM) and BusAdapter,
- Termination and coupling modules (PLB TC),
- Carrier power supply
  see also "Carrier power supply (infeed system) (Page 22),
- and other system-dependent components
  see also "The components of a PLB system (Page 27)

3.2.2 Power Line Booster (device)

3.2.2.1 Overview

Figure 3-1 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 enclosure) 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 a carrier. You can use several slaves in one segment.

NOTICE
Plug or remove the modules only in the de-energized state. **Use the DIP switches for configuration only in the de-energized state.**

3.2.2.2 PLB Basic module

Figure 3-2 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 module.

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

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

3.2.2.3 ET200SP BA (BusAdapter)

Figure 3-3 BA 2xRJ45 (BusAdapter RJ-45)

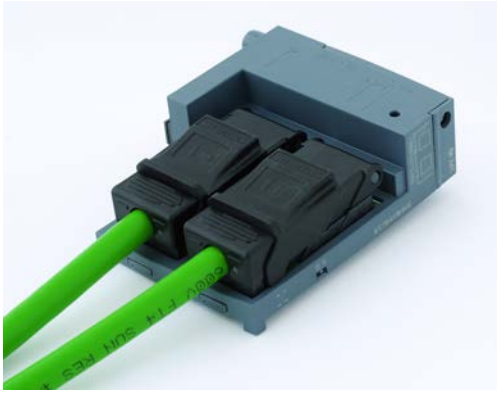


Figure 3-4 BA 2xFC (BusAdapter Fast Connect)

Figure 3-5 Slot for the 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).

3.2.2.4 PLB MM (Modem Module)

Figure 3-6 PLB MM

Figure 3-7 Slot for the PLB MM

PLB device	MLFB
PLB Modem Module: PLB MM	6ES7972-5AA50-0AB0

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

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.

3.2.2.5 PLB MM [ST] (modem module)

Figure 3-8 PLB MM

Figure 3-9 Slot for the PLB MM

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

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

NOTICE
You cannot operate the PLB modem module together with its predecessor (6ES7972-5AA50-0AB0). All PLB MMs involved in the communication must have the same MLFB 6ES7972-5AA51-0AB0!

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.

3.2.2.6 PLB EM (Empty Module)

Figure 3-10 PLB EM

Figure 3-11 Slot for the PLB EM

PLB device	MLFB
PLB Empty Module: PLB EM	6ES7972-5AA80-0XA0

The empty enclosure 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 as cover and for expansions at a later time.

3.2.3 PLB TC (Termination and coupling module)

Figure 3-12 PLB TC

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

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

The PLB TC is used termination of segments. Both ends of the communication lines of the respective segment are terminated by the termination module.

CAUTION
Disconnect the system from the power supply prior to installation!

See also

PLB TC (Page 42)

3.2.4 Carrier power supply

3.2.4.1 Carrier power supply (infeed system)

The AC carrier power supply is only required in sliding contact systems. The infeed system consists of the circuit breaker, transformer and filter.

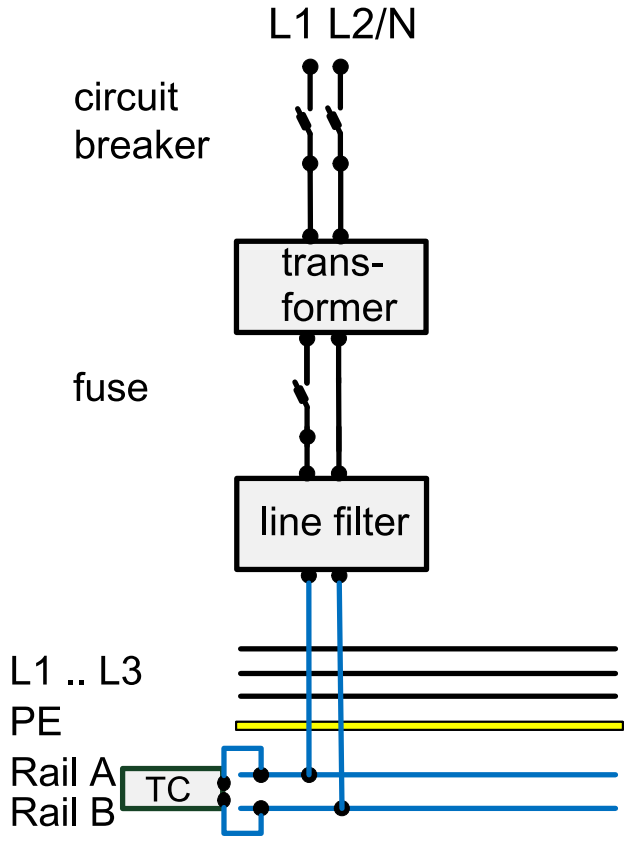


Figure 3-13 Segment infeed system

3.2.4.2 Circuit breaker for the carrier power supply

Select the circuit breaker so that the supply transformer, its supply line and all downstream components and lines are protected. For a more precise dimensioning, refer to section Connecting the carrier power supply (Page 39).

3.2.4.3 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 75)

- Rated current: min. 1.0 A

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 3- 2 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

3.2.4.4 Line filter

Prevents crosstalk of the communication signals to other lines 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.

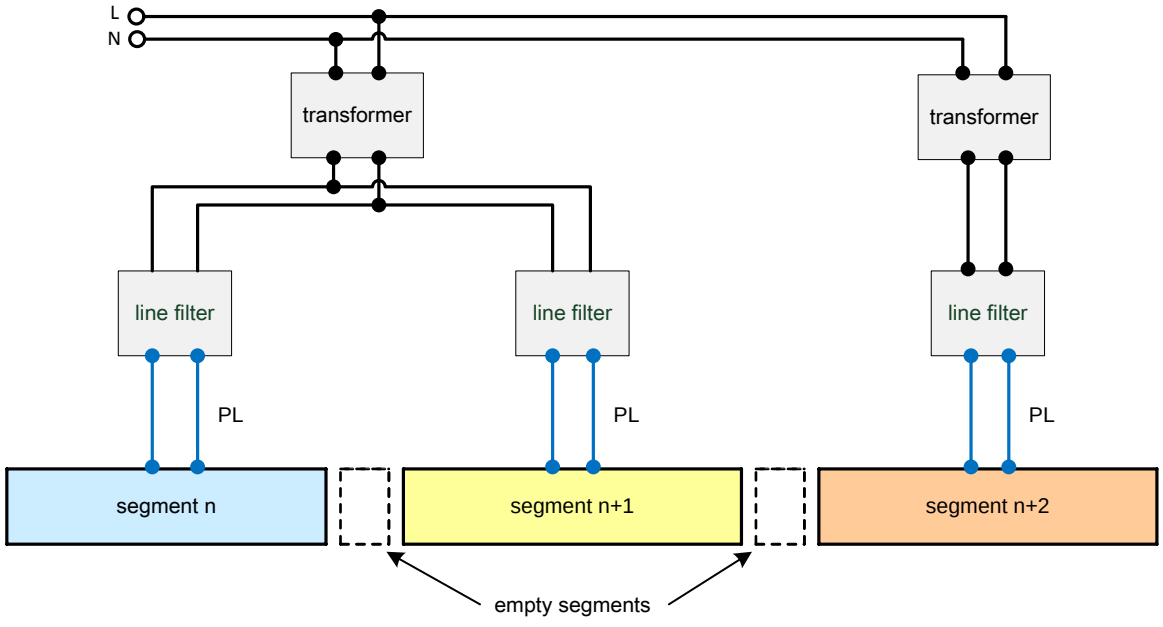


Figure 3-14 Application examples of the line filter

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

Table 3- 3 Requirements for the line filter

Attenuation for common mode signals and push-pull signals between 2 MHz and 70 MHz	≥ 50 dB
Output impedance (between 2 MHz and 70 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 lines. 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 lines (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 lines.

Table 3- 4 Example of a line filter

Manufacturer	Type	Order number
Schurter	Line filter (up to 16 A)	5500.2218.01

Figure 3-15 Line filter up to 16 A

See also "Connection of the line filter (Page 43)

3.2.4.5 Component example for a carrier power supply

Table 3- 5 Example

Supply network	230 V AC rated voltage, + 15%
Circuit breaker (for transformer and downstream lines)	Recommended 1.0 A, type B maximum 1.9 A (SIEMENS 3RV1011-1BA10 / 1.9 A.)
Lines between circuit breaker and transformer, transformer and line filter	at least 2x 0.5 mm², e.g.: Ölflex Classic 110, Lapp cable no. 1119752
Lines between line filter and rail (filter mounted directly on the mounting rail)	With lengths ≤ 1 m: Single cores, 2.5 mm² With lengths > 1 m: See Section Cable lengths (Page 40).
Supply transformer	mdexx: TAM3242-8JV00-0EA0
Lines between rail and PLB TC (terminal box)	Single core, 2.5 mm²
Line filter (LF)	Schurter: 5500.2218.01

Plant planning

4

4.1 The components of a PLB system

4.1.1 Overview

In addition to the previously described Power Line Booster (device), the TC module and the carrier power supply, additional components are used, for example, in an electric monorail system:

- Rails and sliding contact lines
- Elements for connection system
- Plant controller
- possibly Isolation monitor

4.1.2 Rails and sliding contact lines

Select such a combination for the rail/sliding contact 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.

Note

You must also connect the PE rail with the mounting rail at the positions at which a PLB TC is connected. Run this connection directly using a short line (max. 20 cm).

The grounding of this rail over the PE feeder alone is not sufficient.

PLB TC (Page 42)

Arrangement of the sliding contact lines

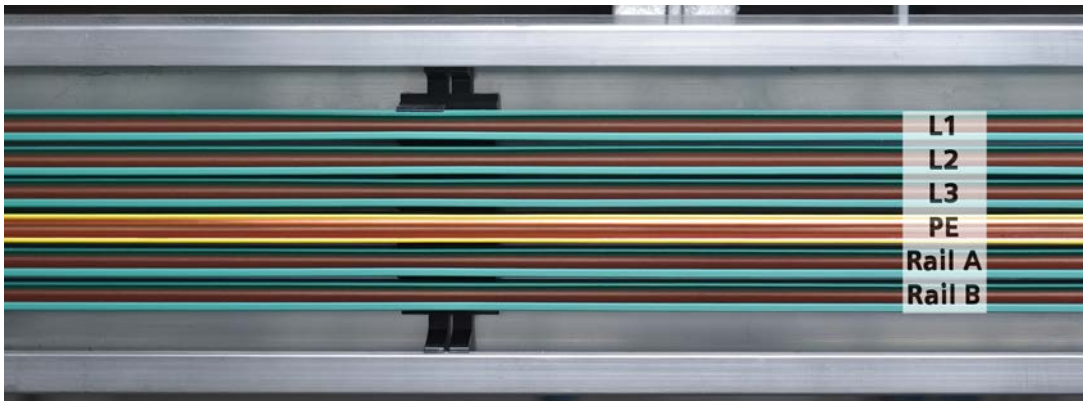


Figure 4-1 Arrangement of the rails

The following arrangement is required for reliable function of the PLB communication.

Rails: L1, L2, L3, PE, Rail A and Rail B. There may be no additional sliding contact line between PE, Rail A and Rail B in particular!

Due to the positioning of the PE, additional spacing between the live parts with dangerous contact voltage (L1..L3) and the communication rails Rail A/B is created. This additional spacing reduces the crosstalk of the communication signals and the risk of short-circuits.

If additional sliding contacts are required below the communication rails Rail A and Rail B, you must separate them with an additional PE rail or a shield plate as separator.

NOTICE
Use rails Rail A and Rail B for PL communication only!

Note

Rail quality

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

4.1.3 Connection system

If you are using shielded cables according to the specifications in this manual, you can use different contacting options for easy implementation of the shield connection at the transition to the power rails. You must apply the shield over a large area and connect it professionally to the suitable metal parts of the system.

To connect the carrier power supply to the rail or to connect a stationary PLB to the rail, we recommend the following alternatives:

1. Metal terminal box with EMC gland: e.g. Bopla, order number: 01118000 Link (http://www.bopla.de/en). In combination with an EMC cable gland Harting 19620005080 (for line diameters 6.5 .. 9.5 mm)
2. Plastic terminal box (Bopla, Rose, Vahle, …) in combination with a shield clamp (SK terminal, s. accessories Article numbers (Page 77)). You must apply the shield clamp over a large area and connect it to suitable metal parts of the system.

4.1.4 Isolation monitor

The operation of an isolation monitor may be necessary for safety reasons (see section Installation planning). This remains the responsibility of the plant constructor.

Figure 4-2 Example of an isolation monitor

CAUTION

The isolation monitor from Bender which we are using as an example here cannot be used in some commercial power supply networks (e.g. in the U.S.).

Note the maximum permitted operating voltage as specified in the manufacturer documentation!

See also

Installation planning (Page 33)

4.1.5 Plant controller

Connect the plant controller (e.g. a PROFINET IO controller) with all PLB masters in the plant.

4.2 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 in order 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.

Keep in mind that the communication takes place on carrier frequencies from 2 MHz – 70 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 current standards regarding electromagnetic compatibility. This means it is immune to interference tested according to current standards. Practical experience has shown, however, that plant-specific constellations, for example, due to accumulation of multiple interferences or even individual devices due to poor wiring can result in interferences that significantly exceed the range that is tested according to the current standards.

To deal with such interferences, it is possible to deactivate frequency bands on the Power Line Booster which exhibit an excessive amount of interference. Please contact Technical Support when performing system-specific configurations.

Note

If you would like to have technical support set up a system-specific configuration in your plant, you need to ensure that all installed devices in the plant include the proper configuration. Specifically, you must set this system-specific configuration up again when replacing a device.

If you are operating the Power Line Booster with the factory settings, interferences up to 73 dB µV (QPk, corresponds to 1 Vpp, see EN 6100-6-4:2007) do not result in communication errors.

If the incoming level of a device in the plant (e.g. of a master) is greater than the minimum receiving level of another device in the plant (e.g. slave), then both 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 (see also section Grounding bar (Page 43))
- Missing or incorrectly connected termination at the line ends
- Line sections of the communication lines (Rail A/B) and supply lines (L1, L2, L3) running parallel with very little distance. Compare Rails and sliding contact lines (Page 27)
- Connection elements between Rail A/B and L1, L2, L3 such as relays, short-circuits, etc.
- Lacking / insufficient filter elements in carrier power supply 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
- Quality of the rails, connecting pieces, sliding contacts and lines
- Rail elements such as switches, lifters, etc.
- Number of carriers in the segment (dynamic)

Because the number of carriers in the segment can change dynamically, keep in mind that the outcome can be two extreme cases. The extreme case for lateral attenuation is a segment without any carrier at all and for longitudinal attenuation it is a segment with the maximum number of carriers. In the first case, there must still be no crosstalk of the signal; in the second case, stable communication between the master and all carriers must still be possible. Hence the requirement for a specific placement of the PLB master (see sectionPLB master (Page 44)).

If there is crosstalk between two plant units, you may encounter communication failures (when the two masters can detect each other, for example, or when slaves log into the wrong segment). It may also be that only the cycle times get longer because both segments must now share the medium. This is also the case when a different channel is selected in a different plant (see settings).

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 e.g. welding equipment, large drives, 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 will be possible to operate a segment (without switches) with up to 30 carriers without crosstalk. If you use switches or lifts, place these system components in the communication-free plant area and contact technical support.

Note

For more complex plants, it may be best to involve Technical Support for the Power Line Booster as early as the planning phase.

If it is necessary to operate more than 30 carriers (up to 50 carriers) in a communication segment, additional attenuation measures are required. Please contact Technical Support (mailto:PLB-Support.industry@siemens.com).

Data rate

The maximum data rate that can be transmitted is proportional to the band width that is available, i.e. the larger the band width, the larger the attainable data rate. If the connections are poor, for example due to high contact resistances or unsuitable cables, this can have a negative effect.

Relevance of the data rate

Which data rate is actually necessary or sufficient for a specific application does not only depend on the quantity of user data – even if the connections are optimal. Depending on the protocol, an overhead that is more or less large results for processing the powerline communication. Intermediate devices, such as routers, etc., also lead to delays that occur when the signals are passed on. The achievable net data rate is thus influenced in multiple ways by the condition of the connection route and its surroundings.

4.3 Installation planning

Plan the installation based on a plant layout.

NOTICE
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 take this into consideration during maintenance. **If you are using an isolation monitor (such as Bender Isowächter, in Europe) for safety reasons, it must be connected between the supply transformer and the line filter.**

Note

The applications described in this manual, refer to a distance of rail (without branches) with up to 30 carriers. If you are planning a more complex plant, contact the Technical Support for the Power Line Booster (email address (mailto:PLB-Support.industry@siemens.com)).

4.4 Segment limits

4.4.1 Segment

Plant in one segment

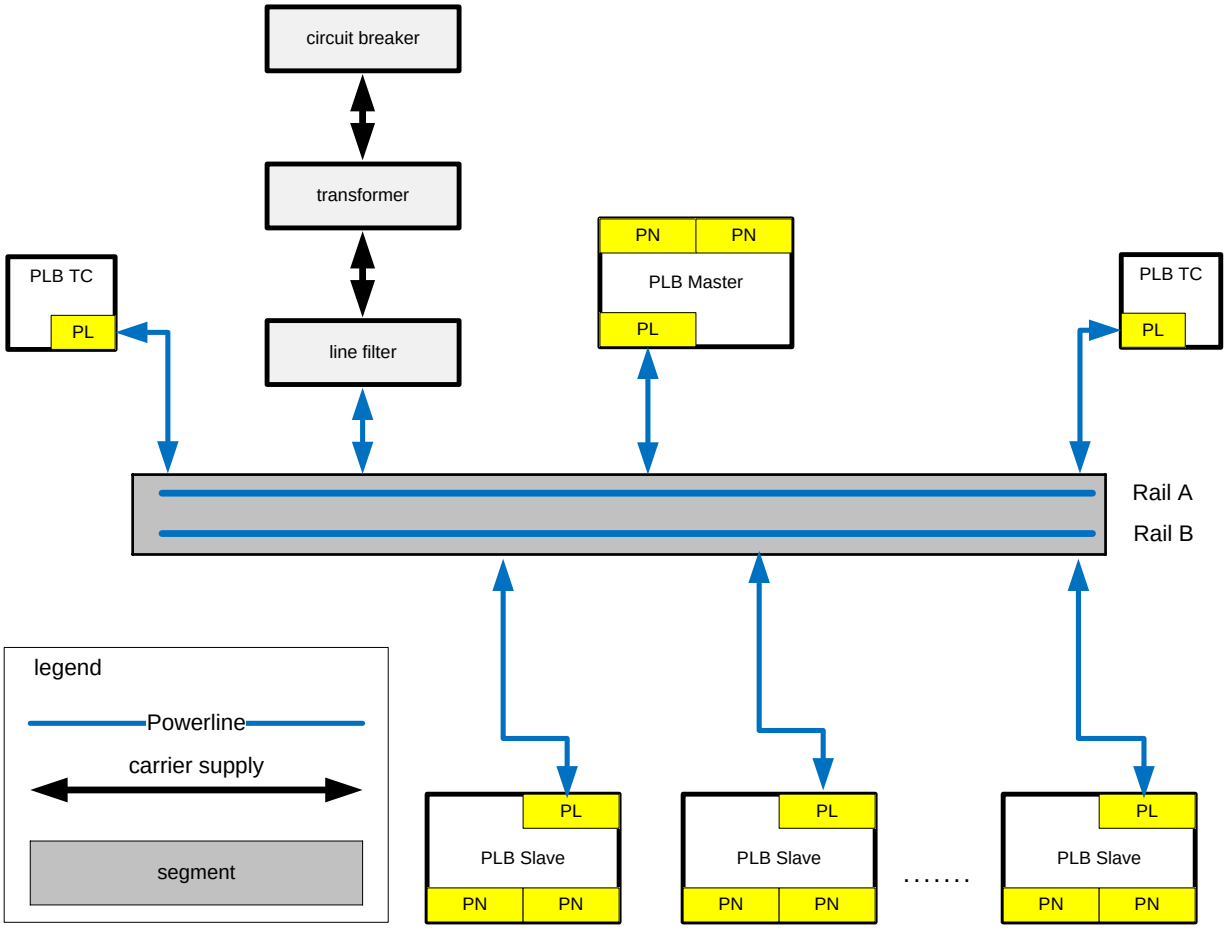


Figure 4-3 Linear plant

Segment breaks

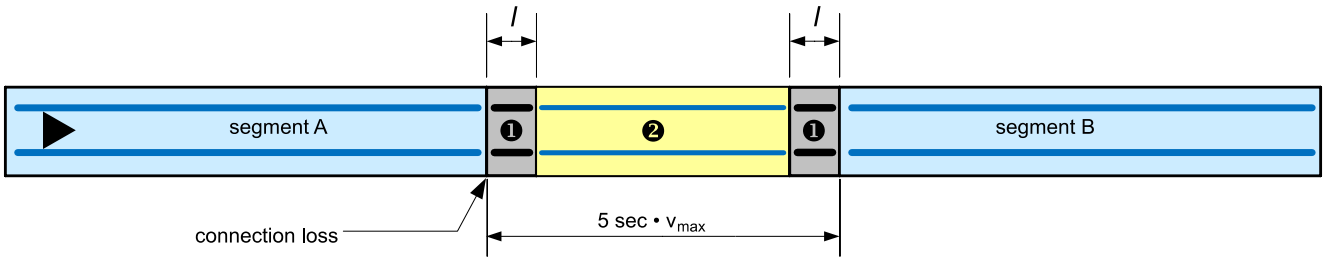


Figure 4-4 Segment transition

You usually have to create segments in electric monorail systems. (See picture above)

You must isolate the transition of a communication segment (in the example, Segment A) into the next (in the example: Segment B) with a separator ① in the rail pairs. The length "l" of this separator must be greater than the longest current collector (sliding contact) in the EMS. However, the separator should only be about 0.05 m longer than the current collector. Furthermore, an empty segment ② is required. The minimum dwell time in this area must be 5 seconds (see figure above). This ensures that the PLB slave on the vehicle checks in and out again at this time.

Cut the segments of the communication lines Rail A and Rail B at the same height (not offset).

Note

When you separate a plant into several segments, communication between controller and device is not possible in the empty segments.

Note

Keep in mind that all Power Line Booster devices in a plant or plant section must be configured to the same channel (see Settings (Page 55)). Otherwise, communication is not possible with all stations.

We recommend that you use different channels for each plant section in adjacent but separate plants (i.e. plant units).

Note

Special case

Closed rings in plants must be opened up, which means an empty segment must be inserted at one point in the ring, separated by two separators. Due to the Power Line technology, the empty segment must have a minimum length in accordance with the traveling time of at least 5 s so that the PLB slave can log out and in again.

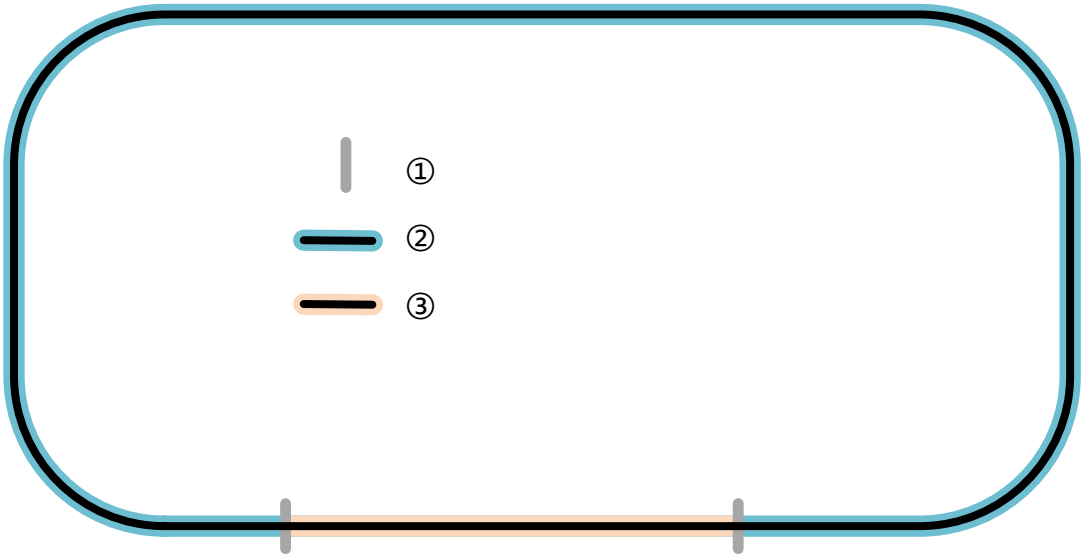


Figure 4-5 Basic ring

Legend	
①	Separator
②	Communication segment (e.g. segment A)
③	Empty segment (e.g. segment B)

The login time is defined in the section Startup and login time (Page 37).

4.4.2 Segment length

Plan the length of the communication segment so that it does not exceed the maximum permitted segment length (see Installation planning (Page 33)).

The maximum segment length of a communication segment is 250 m. You must ensure that the maximum number of permitted carriers in the segment is never exceeded during operation of the plant.

You can maintain this, for example, by selecting the segment length in such a way that no more than 50 carriers can actually fit into the communication segment.

4.5 Startup and login time

4.5.1 Plant startup

Cold restart of an entire electric monorail system with regard to the Power Line Booster, takes place in the following phases:

Table 4- 1 Phases of a cold restart

Phase	Description	Duration
Startup phase and establishing the Power Line Booster communication	Start begins with 24 V DC in. All PLB slaves of a segment establish a connection to their master. The master integrates the added devices into its cycle one after the other. The length of this phase depends on the number of PLB slaves in the system.	With 50 stations maximum 30 s
Establishing the plant communication	Here, the higher-level communication between the plant controller and the field devices on the carriers or the local PLC is established. In case of a PROFINET connection, an AR (Application Relation) must be established.	Depending on the type and communication protocol of the plant.

4.5.2 Login

An electric monorail system consists of plant units which offer communication (communication segments) and parts on which communication is not possible (empty segments).

When a carrier exits a communication segment, its PLB modem module loses the connection to the PLB master in this segment. This leads to a restart of the modem. After the reboot, the modem is once again ready to establish a connection to another master.

The following times have to be take into consideration in the process:

Table 4- 2 Phases of a check-in with a segment change without voltage loss

Phase	Description	Duration
Lost connection	The PLB modem detects a connection loss. This phase must take place in an empty segment.	typ. 5 s
Reboot	When the connection is lost, the PLB modem performs a reboot. This phase may take place in the empty segment if the carrier stays in it long enough.	typ. 7 s
Login phase	Establishment of the Power Line connection to its PLB master in the new communication segment. This phase starts as soon as the carrier arrives in the new communication segment and the reboot of the modem is complete.	typ. 4 s max. 10 s

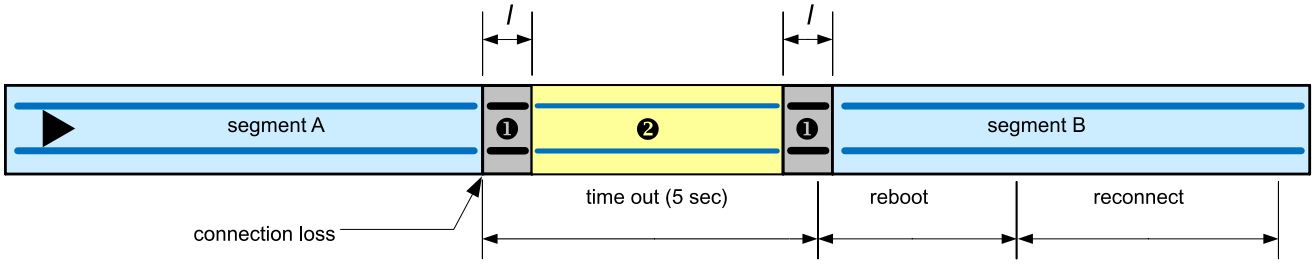


Figure 4-6 Transition from one communication segment to another

If the a PLB slave checks in from the de-energized state (for example, loading platform), please note the following times.

Table 4- 3 Phases of a check-in in the de-energized state

Phase	Description	Duration
Booting	The PLB basic module (slave) boots.	typ. 15 s
Login phase	Establishment of the Power Line connection to its PLB master. (provided that the PLB slave is in a communications segment)	typ. 4 s max. 10 s

When a modem starts the first time in a base module (BM PLB) (e.g. after a modem replacement or after changing the DIP switch), there is a configuration phase (about 8 s) between the startup and the check-in phase.

4.6 Installation

4.6.1 Line selection

4.6.1.1 Connection of the Power Line Booster

Please use the following lines for the connecting cables of the PLB devices (master and rail or slave and sliding contact):

Table 4- 4 Order numbers for connecting cables of the PLB devices

	8 m length
Without plug	6ES7903-1AH40-0AB0
With plug (male)	6ES7903-1AH401-0AB0
With two plugs (male + female)	6ES7903-1AH402-0AB0

Notes:

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

Use the following counterparts: 09620030301 or 09620030801 (add-on housing), HAN Q 5/0-F, 09120053101 (female contact insert) and HAN-E crimp contact socket, gold-plated, e.g. 09330006223 or 09330006216.

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

For short connecting lines (< 100 cm), you can use single-core wires (see section Cable lengths (Page 40)).

4.6.1.2 Connecting the carrier power supply

Ideally you install the line filter directly at the feeding point on the rail. In this case, use connecting cables with 2.5 mm² single cores.

NOTICE
If you cannot install the line filter directly at the feeding point on the rails, use the same line as for the connection of the Power Line Booster. Compare also Table 4-4 Order numbers for connecting cables of the PLB devices (Page 39). Note that the line must be protected with a 2 A circuit breaker, switch-off characteristic B. The circuit breaker must also be installed in the line protection of the transformer described in "Line protection for the carrier power supply (Page 22)".

See also

Connection of the Power Line Booster (Page 39)

4.6.1.3 Connection of the TC modules

The connecting cables between the PLB TC and the rails Rail A and Rail B should be 2.5 mm² single core.

4.6.2 Grounding

You must connect the Power Line Booster to the functional grounding via the top-hat rail. Keep the ground connection of the DIN rail relatively short and extensive.

4.7 Wiring

4.7.1 Cable lengths

To connect the PLB to the communication sliding contacts, we recommend cables according to Table 4-4 Order numbers for connecting cables of the PLB devices (Page 39). They have a length of 8 m and may not be shortened.

For lead lengths up to 1 m, you can use unshielded cables or twisted single cores of the same type and the same length (+/- 5%).

Example: All sliding contact cables on the vehicles are single core wires with a length of 0.5 m. The TC module is connected to the rail with 30 cm single cores. The master is connected to the rail with the 8 m special cable (MLFB 6ES7903-1AH40-0AB0). The carrier power is also connected to the rail with the 8 m special cable (MLFB 6ES7903-1AH40-0AB0).

Any deviations are only permitted for trailing cables for lifters at the beginning of the segment.

Permitted cable lengths

Connection between ..	shielded	unshielded
PLB master - rail	The following lengths are permitted 8.0 m.	Max. 1.0 m
42 V transformer – line filter (LF)	unlimited	unlimited
Line filter (LF) - rail	The following lengths are permitted 8.0 m.	Max. 1.0 m
Rail - PLB slave	The following lengths are permitted 8.0 m.	Max. 1.0 m

Connection between ..	shielded	unshielded
24 V power supply unit (e.g. SITOP) – 24 V-supply input of the PLB	unlimited (note voltage drop), as of a cable length of 30 m, a device for transient limitation (e.g., lightning protection unit) must be installed in front of the PLB	unlimited (note voltage drop), as of a cable length of 30 m, a device for transient limitation (e.g. lightning protection unit) must be installed in front of the PLB.
PLB TC (terminal box) - rail	n.a.	Max. 0.5 m
Trailing cable	30 m [1]	not permitted

[1] When connecting trailing cables to EMS rails, the permitted segment length, the number of permitted stations in the segment and the recommended master position can change. Contact Technical Support in this case.

See also

Connection of the Power Line Booster (Page 39)

4.7.2 Shield connection

For connections with shielded cable, you must connect a shield at both ends. In case of a metal rail terminal box, grounding is provided by the EMC cable gland. Otherwise, use a shield clamp in close proximity to the terminal box. You must apply the shield clamp over a large area and connect it to suitable metal parts of the system.

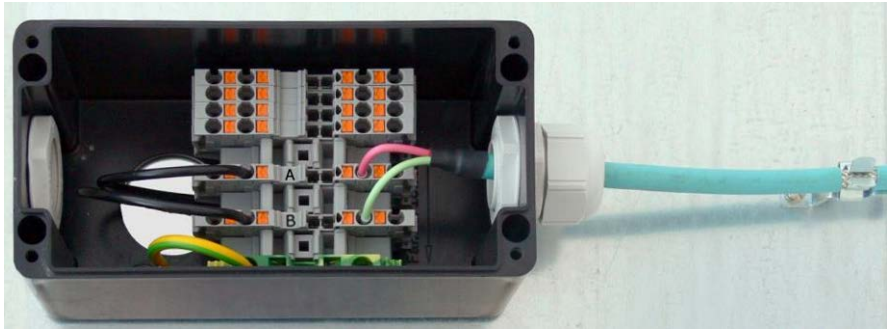


Figure 4-7 Connection via terminal box with shield clamp

4.7.3 Cable routing

4.7.3.1 PLB TC

Connect the end of the rail pair Rail A/ Rail B with the ports X1.1 and X1.2 of the PLB TC (see Figure 3-12 PLB TC (Page 21)).

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

Figure 4-8 PLB TC (TC module)

Note

The connections X2.1 (A') and X2.2 (B') are not currently in use and must be isolated.

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

See also

PLB TC (Termination and coupling module) (Page 21)

4.7.3.2 Connection of the line filter

Install the line filter between the transformer of the carrier power supply and the communication rails Rail A and Rail B (see Figure 3-13 Segment infeed system (Page 22)).

Terminal	Connection
L (LINE)	L from transformer
N (LINE)	N from transformer
PE (LINE)	PE
L' (LOAD)	Rail A
N' (LOAD)	Rail B

See also

Carrier power supply (infeed system) (Page 22)

4.7.3.3 Supply line of the carrier power supply

We recommend placing the line filter directly on the mounting rail and to implement the carrier voltage infeed at the same location as the connection of the master.

With a remote installation of the line filter, route the shielded supply line or communication lines close to the rails/sliding contacts (up to the rail terminal box). If you are using unshielded single cores to extend the connecting cable, these may only be 1.0 m long. Note that an additional 2A circuit breaker type B is required in this case (see (Page 39)).

You can route the shielded supply lines across cable racks, consoles or perforated cable trays or even "freely suspended" (reference routing type E, according to **DIN VDE 0298-4**). Routing in closed systems, such as pipes or through non-perforated cable channels, is not permitted.

4.7.4 Grounding bar

You need to build the Power Line communication rails in accordance with this manual. You need to pay particular attention to ensure that the Power Line rails are always separated from the other rails by PE rails.

In addition, the system is to be planned in such a way that the protective conductor rail is grounded at each connecting piece (about every 6 meters), exactly at the level of the segment ends in each case as well as at the rail ends (e.g. at rail switches) with a short cable (<= 10 cm) on the carrier rail or over the steel construction.

4.7.5 PLB master

In systems where the vehicles moves in both directions during regular operation, you need to install and connect the master in the middle of the segment (± 10 m).

In systems where the vehicles only move in one direction during regular operation, you must place the master away 1/3 of the segment length away as measured from check-in location.

Note

A maximum of twenty vehicles may be located between the beginning of the segment (entering vehicle) and the master. A maximum of 30 vehicles may be located between the end of the segment (exiting vehicle) and the master.

4.8 Installation

Installation of the Power Line Booster

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

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

If you plug the Power Line Booster onto a vertical DIN rail or one installed horizontally, 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.

Installation of modem and BusAdapter

Figure 4-10 Installation of the modules

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) screw driver 0.5x3 (0.5x3.5).

Installation sequence:

1. Modem, empty enclosure
2. BusAdapter

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

Installation of the connectors

The connectors to the ports X2 (Port X2 (Page 54)) and X80 (Port X80 (Page 54)) 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) screw driver to install the cables.

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

4.9 Commissioning

Make the settings and configuration as described in the section Settings (Page 55).

Operator controls, displays, ports, slots

5

5.1 Operator controls

5.1.1 FRES button

The Factory RESET (FRES) button is located on the bottom of the PLB.

Figure 5-1 FRES button

Figure 5-2 Position of the FRES button

Keeping the FRES button pressed for more than 5 seconds, results in a restart and the factory settings are restored on the device (see also PROFINET/Ethernet (Page 57)).

The factory settings are:

- IP address: 0.0.0.0
- PN name: deleted, i.e. empty

See also

Settings (Page 55)

5.1.2 DIP switches

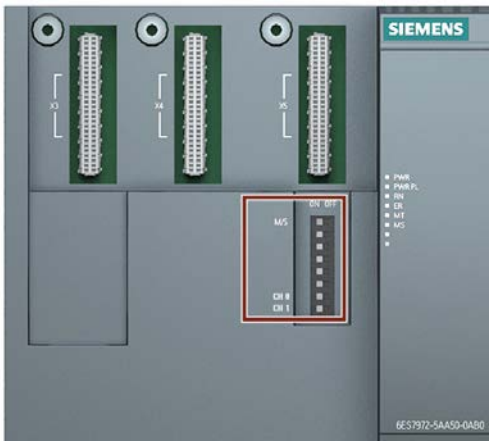


Figure 5-3 DIP switches

For details on setting of the DIP switches, see Table 6-1 Operator controls (Page 55)

See also

Settings (Page 55)

5.2 Displays

5.2.1 LED displays on the PLB basic module

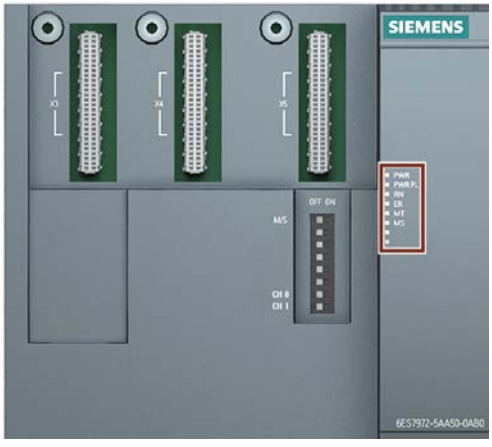


Figure 5-4 LED displays on the PLB basic module

Table 5- 1 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 to PE or to 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 • 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
Note: If all LEDs are flashing permanently at a frequency of 1 Hz, you are dealing with a configuration or device fault. a) Changing the DIP switch settings			

5.2.2 LED displays on the modem module / modem module [ST]

Figure 5-5 LED displays on the modem module / modem module [ST]

Table 5- 2 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 • 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 • Firmware update of the modem module a) is running • When restarting after a configuration change b)
		Flashes (approx. 8 Hz)	Powerline data traffic
		On	LED test for about 0.5 s during startup Modem active, PL connection exists

LED labeling Meaning	Color	State	Description
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
Firmware update: A firmware update can take up to two minutes. When updating the modem firmware, the power supply must not be switched off. A voltage interruption irreversibly deletes the modem firmware (repair necessary). You may only remove the modem module from the PLB module when the modem module is de-energized. This applies in particular during the firmware update process.

5.2.3 LED displays on the BusAdapter

Figure 5-6 LED displays on the BusAdapter

Table 5- 3 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 PLB basic module
		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.			

5.3 Ports and slots

5.3.1 Slot X3

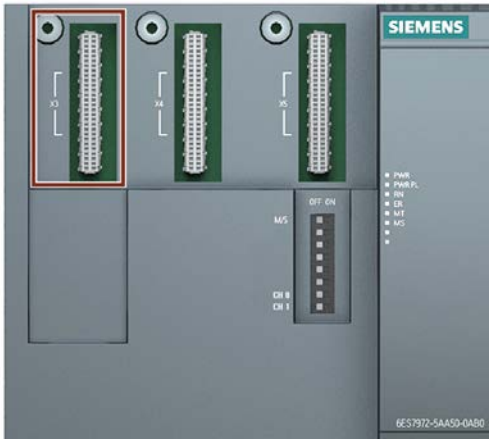


Figure 5-7 Slot X3 for the ET200SP BA (BusAdapter)

5.3.2 Ports X1

Figure 5-8 LAN ports X1

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

5.3.3 Slot X4

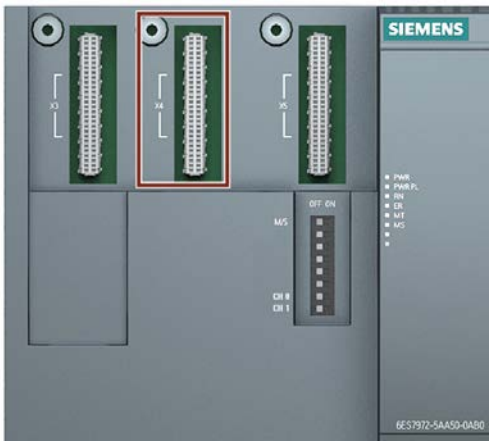


Figure 5-9 Slot for the PLB MM (Modem Module)

5.3.4 Slot X5

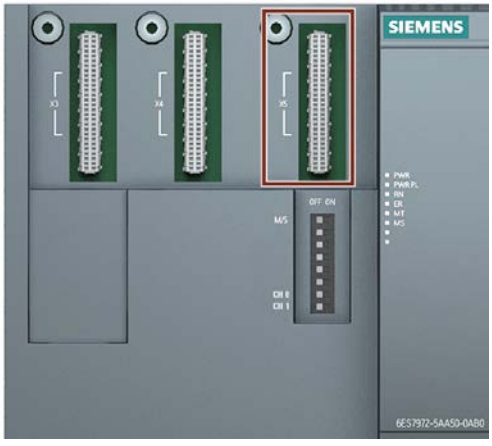


Figure 5-10 Slot for the PLB EM (Empty Module)

5.3.5 Port X2

Figure 5-11 Powerline port X2

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

5.3.6 Port X80

Figure 5-12 24 V DC power supply port X80

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

Settings

6

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 D0.0 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.

There are three DIP switches to configure the PLB (one 8x DIP switch). You may only operate these switches in the de-energized state. The switches are located below the PLB EM (Empty Module).

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

Table 6- 1 Operator controls

Operator control	Labeling	State			Function
Button	FRES	Off			see FRES button (Page 47)
		On ≥ 5s			
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	

You can prevent communication errors caused by crosstalk between different plants with the correct setting of the channel. In this case, all devices (master and slaves) in a plant must be set to the same channel.

Table 6- 2 Set master/slave operating mode

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

Table 6- 3 Channel setting (examples)

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

PROFINET/Ethernet 7

7.1 PROFINET IO

7.1.1 Definition

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. PROFINET IO IRT permits defined reaction times and high-precision system behavior.

A PROFINET IO system consists of the following PROFINET devices:

- IO controller
  Device used to address the connected IO devices.
- IO device (e.g. Power Line Booster)
  Distributed field device that is assigned to an IO controller.

The PROFINET IO controller operating mode enables direct access to IO devices over Industrial Ethernet, (e.g. from an S7-1500 CPU as IO controller to a PLB as IO device).

PROFINET IO has the following properties and functions:

- Real-time communication (RT)
- Isochronous real-time communication (IRT) *
- Media redundancy*
- Prioritized startup*
- Device replacement without swap medium
- I-device*
- IO controller*
- Shared device*
- Isochronous mode*

* does not apply to Power Line Booster

Note

For additional information on "PROFINET IO", refer to the STEP 7 online help and the PROFINET System Description Manual.

http://support.automation.siemens.com/WW/view/en/19292127

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. So that only one station at a time can send data in a given direction.

Topology recognition is not possible with a "shared medium", such as the one also used by the Power Line Booster.

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 65)".

See also

http://support.automation.siemens.com/WW/view/en/19292127
(http://support.automation.siemens.com/WW/view/en/19292127)

7.1.2 Startup parameters

The Power Line Booster does not require adjustable startup parameters.

7.1.3 IO address space

The figure below shows the IO address space of the Power Line Booster. A total of 10 bytes of data (input byte/input word - IB/IW) is transferred to the PROFINET CPU. The Power Line Booster does not have any output data.

Slot 0 (PLB BM):
No data

Slot 1 (PLB BM):

Status word master slave IB x (Unsigned8):
Bit 0: Operating mode master/slave 0=Slave; 1=Master
Bits 1-7: reserved (status not defined)

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

Status byte LED IB x+1 / IB x+2
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 (modem)

Status byte Link: IB y (unsigned 8):
Bit 0: PL-Link
Bits 1-7: reserved (status not defined)

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

Status word PLB cycle: IW y+1 (unsigned 16, master only):
16-bit value in ms
For PLB slave: 0

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

Status word number of active slaves: IWB y+2 (unsigned 16, master only)
With PLB slave: 0

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

Status word PL channel: IW y+3 (unsigned16):

word y+3															
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 (Page 55)

See also

DIP switches (Page 48)

Settings (Page 55)

7.1.4 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 BM 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 7- 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 7- 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	

7.1.5 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 in 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 (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 V13:

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 7-1 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.

7.1.6 Interrupts/diagnostic message

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

7.2 Ethernet

If you do not operate the Power Line Booster as 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 (STEP7, 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 Manual.

http://support.automation.siemens.com/WW/view/en/19292127 (http://support.automation.siemens.com/WW/view/en/19292127)

Note

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

7.3 Timing and runtimes

7.3.1 Overview

The Power Line Booster system implements a transparent transmission of Ethernet telegrams 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 at the same time, but only so many that a specified PLB cycle time across all accessible slaves is not exceeded.

Note

To ensure uninterrupted operation, we recommend you only use the Power Line Booster communication system for the PROFINET communication.

7.3.2 Configuration of the PN cycle time

The PN cycle time should not be less than the mean PLB cycle time.

Table 7- 3 The specified PLB cycle time is listed in the table below.

Number of accessible slaves	Recommended PN cycle time
Up to 20	64 ms
21 to 50	128 ms

Because synchronization of the IO data takes about 2 ms per PLB slave on average, we can assume that the average PLB cycle time recommended in the table above usually does not exceed recommended PN cycle time. A requirement is that no more than eight devices (e.g. local PLC, frequency converters, etc.) with up to 64 bytes of IO data each are connected to the PLB slave.

7.3.3 Configuration of the monitoring time

The following effects may still result in the mean PLB cycle time being exceeded:

1. Login of PLB slaves in a segment.
   Trimming of the carrier frequencies of the master and slave modem resulting during the login process, results in a media assignment that makes the media unavailable for the cycle.
2. Logout 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.
3. Impedance change due to plant elements such as switches and trailing cables. The trimming 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 sliding contacts.
5. Crosstalk of the powerline signals from other plants or plant units. (Should already be prevented by suitable isolation and attenuation during installation of the plant).

To determine the timeout period, you must expect a maximum PLB cycle time of about 300 ms in total (worst case value caused by latency of the PLB system) for a segment with 50 carriers. In addition to this latency, additional effects (e.g. response time of PLC and field devices, processing times as well as upstream/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.

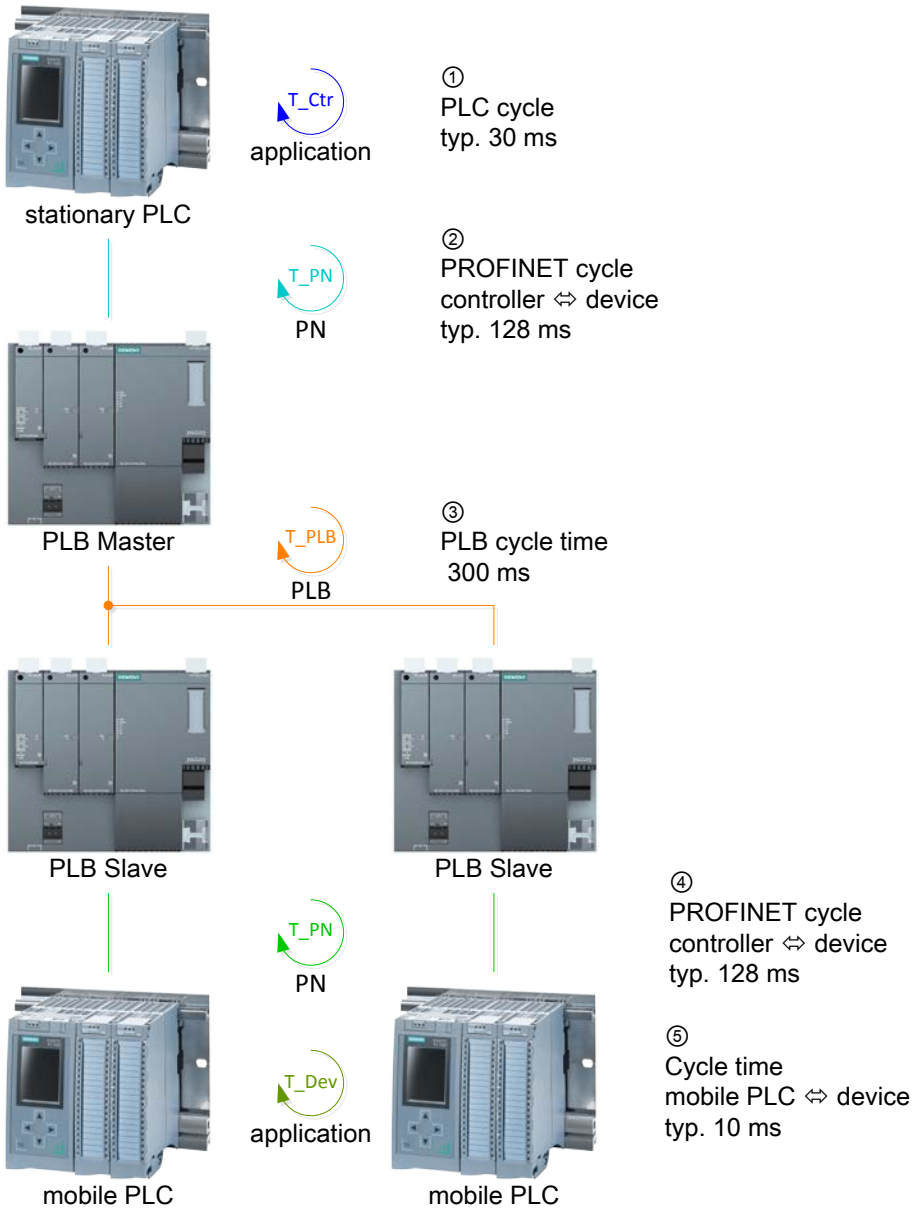


Figure 7-2 Exemplary consideration of cycles between plant and carrier controller

① Cycle of the controller at which it can process IO data.

② PROFINET cycle 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 300 ms for this cycle.

④ PROFINET cycle configured between controller and device.

⑤ Cycle between carrier controller and the devices.

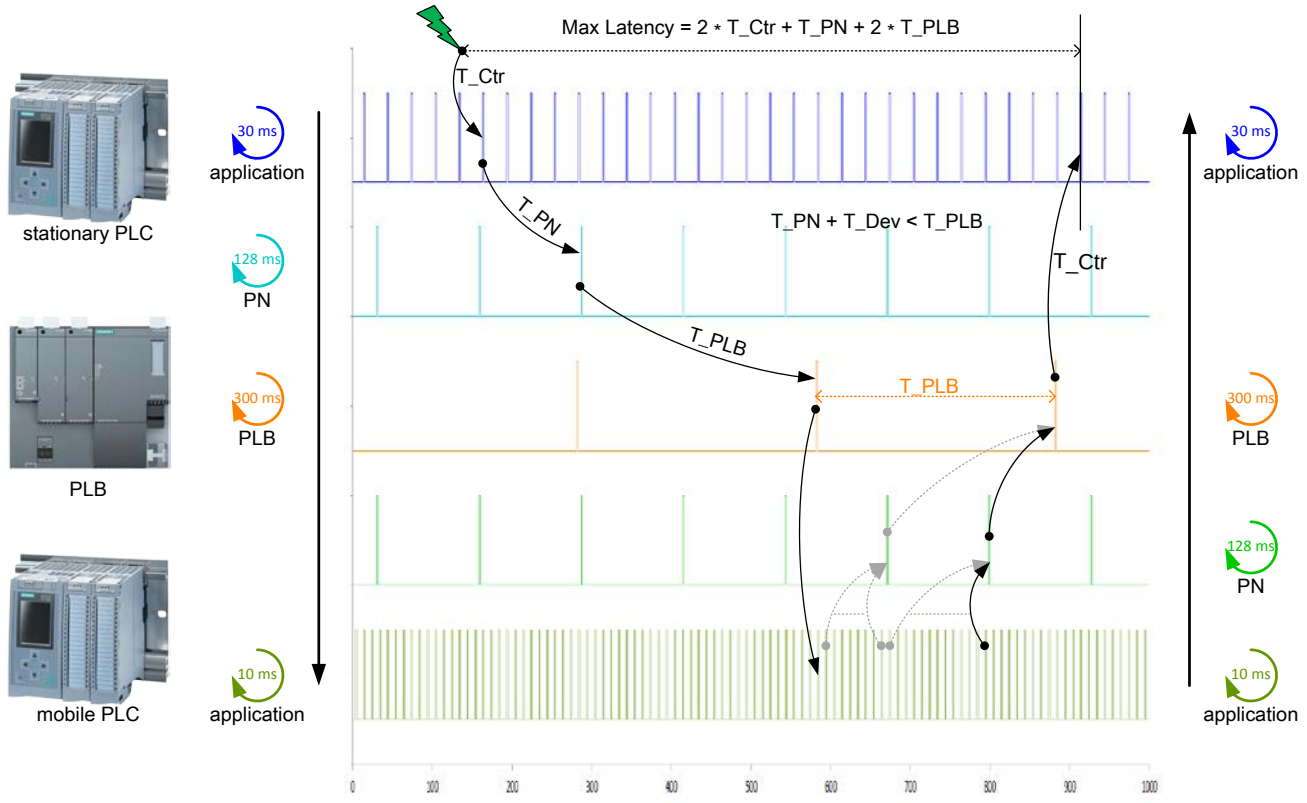


Figure 7-3 Maximum latency time for bidirectional communication

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 cycle time T_{PN} is significantly shorter than the latency time caused by the PLB system T_{PLB}.

The result is the time below:

$T_{Lat} = 2 * T_{Ctr} + T_{PN} + 2 * T_{PLB}$

When you substitute these with typical values (T_{Ctr} = 30ms, T_{PN} = 128ms, T_{PLB} =300ms, T_{Dev} = 10ms) you get:

T_{Lat} =2 * 30ms + 128ms + 2 * 300ms = 788ms.

Note

When using PROFINET

take into consideration a threshold monitoring time of

- 7 update cycles at 128 ms PN cycle time or

- 9 update cycles at 64 ms PN cycle time.

When using Ethernet

take into consideration a latency time of

- 800 ms, if there can be more than 20 carriers in the segment or

- 600 ms, if there can be fewer than 20 carriers in the segment.

Note

With typical PLB applications (e.g. electric monorail system), we can assume that several carriers do not leave the communication segments at the same time. This means we assume that no more than one carrier and therefore one PLB slave exit the communication segment within a time period of 2 s. If more PLB slaves were to exit the segment at the same time (e.g. due to an error), the maximum latency time calculated above may be exceeded.

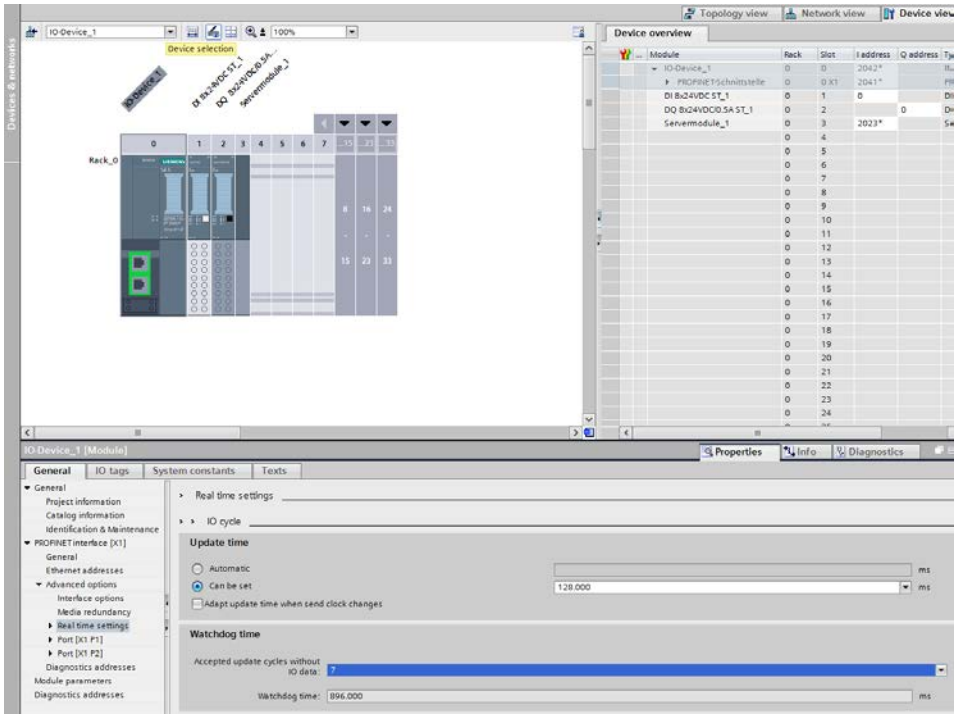


Figure 7-4 Example for configuring the threshold monitoring time in the TIA Portal

Maintenance and service 8

8.1 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 Article numbers (Page 77).

8.2 Firmware update and expanded start-up

Special authorizations are required for a firmware update or also the expanded start-up.

Update User

The firmware update is executed via SFTP. The special "Update User" authorization is required for this purpose. Please contact Technical Support.

Service user

The expanded start-up is for advanced users and requires the special "Service User" authorization. Please contact Technical Support.

8.3 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

9

9.1 Technical specifications

9.1.1 Mechanics

Dimensions and weight

Table 9- 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 9- 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 9- 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 9- 4 PLB TC

Degree of protection	IP20

When mounted

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. Note the distance to the adjacent devices in the section Climate (Page 75).

You must install the PLB TC into a separate enclosure due to its connecting cables (e.g. rail terminal boxFigure 4-7 Connection via terminal box with shield clamp (Page 41)).

See also

PLB TC (Termination and coupling module) (Page 21)

Shield connection (Page 41)

9.1.2 Electrical characteristic values

Device	Rated voltage		Current consumption		Power consumption	
	min.	max.	Typical	max.	Typical	max.
PLB BM LV M/S incl. Modules (MM, BM) • X80 • X2	19.2 V DC 0 V AC	28.8 V DC 48.3 V AC	0.29 A Reactive current	0.63 A -	7.0 W -	12.0 W
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 75)

9.1.3 MTBF

Mean Time Between Failures

	FIT	MTBF
PLB BM	2532	394,944 h or **45.1 years**
PLB MM	904	1,106,194 h or **126.3 years**
PLB MM [ST]	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**

9.1.4 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).

9.2 Approvals

9.2.1 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.

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)

9.3 Security information

Siemens offers products and solutions with industrial security functions which support the secure operation of plants, solutions, machines, devices and/or networks. They are important components in a comprehensive industrial security concept. The Siemens products and solutions continue to be developed under this aspect. Siemens recommends that you keep yourself regularly informed about product updates.

To enssure safe operation of Siemens products and solutions, it is necessary to take appropriate security measures (cell protection concept, for example) and to integrate each component in a comprehensive industrial security concept that is state-of-the-art. This should also cover the third-party products used. You can find more information about industrial security under http://www.siemens.com/industrialsecurity.

To stay informed about product updates as they occur, sign up for a product-specific newsletter. For more information, visit http://support.automation.siemens.com.

Article numbers

10

Table 10- 1 Components of the Power Line Booster device

Product name	Component	MLFB / order number
SIMATIC Power Line Booster Base Module Low Voltage Master/Slave	PLB BM LV M/S	6ES7972-5AA10-0AB0
SIMATIC PLB MM (Modem Module)	PLB MM	6ES7972-5AA50-0AB0
SIMATIC PLB MM [ST] (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)	PLB EM	6ES7972-5AA80-0XA0
ET200SP Bus Adapter RJ45	BA 2xRJ45	6ES7193-6AR00-0AA0
ET200SP Bus Adapter Fast Connect	BA 2xFC	6ES7193-6AF00-0AA0
Label	for PLB BM [PU = 500 pcs.]	6ES7193-6LR10-0AA0
optional: Reference identification label "flag"	for PLB MM, BA [PU = 10 pcs.]	6ES7193-6LF30-0AW0

Table 10- 2 Accessories

Product name	Component	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** (additional M4x 6 fixing screw required)	Phoenix Contact: Order no.:32.40.214 icotek: Order no.:36925
Carrier voltage transformer	TSV	mdexx: Order no.: TAM3242-8JV00-0EA0
Line filter	LF	(1): Schurter 5500.2349 (clip standard mounting 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)

PST

The Primary Setup Tool is available from Siemens on the Internet at the following entry ID: 19440762

Table 10- 3 Order numbers for connecting cables of the PLB devices

	8 m length
Without plug	6ES7903-1AH40-0AB0
With plug (male)	6ES7903-1AH401-0AB0
With two plugs (male + female)	6ES7903-1AH402-0AB0

Appendix 11

11.1 Glossary

Plant controller

Stationary PLC (programmable logic controller). For example, responsible for the drive commands and preventing collisions. Communicates with the → carrier controller.

Threshold monitoring time

If an IO Device is not supplied by the IO controller with input/output data (IO data) within the threshold monitoring time, it switches to the safe state.

Application Relation (AR)

Logical PROFINET connection between a PN IO controller and a PN IO device.

Rated voltage

Voltage for which the isolation must be designed (dependent on plant standard).

Dangerous contact voltage

→ Voltage, dangerous contact

Reactive current

Current whose phase length is offset by 90° to the voltage. In this case, we are referring to a capacitive reactive current that rushes ahead of the voltage by 90°.

Flash test, station

→ Station flash test

Boot system

Software which loads the operating system or prepares the start of the operating system.

DCP

Discovery and Configuration Protocol, see IEC 61158.

Expansion point

Constructive measure in the rail system to compensate for temperature expansion.

Device

→ Field device

Real-time capability

The real-time capability characterizes the property of a system to supply specific information reliably and within a specified time interval.

EMS

Automatically controlled electric monorail system (EMS) for internal transport - for example, a conveyor system.

EMS plant control system

Central control of an → EMS. The EMS controller addresses several → plant segment controllers to control the assigned → plant segments and, therefore, the → EMS carriers of these segments.

EMC

Electromagnetic compatibility (EMC) is the property of electrical devices which prevents that these devices interfere each other via fields or cables.

Vehicle

Mobile component of the EMS and carrier of the → carrier controller.

Carrier controller

Mobile PLC. Controls the carrier, reads product information and controls the motors. The carrier controller communicates with the → plant controller.

FE

Functional Earth.

Field device

Corresponds to the slave bus nodes for PROFINET (IO device) but also in other protocols.

Freeware

Software that is made available free of charge by the author and can be used for commercial and private purposes.

Frequency converter

A primary component of a three-phase motor to adapt the frequency and the amplitude of the alternating voltage for the motor.

Functional Earth (FE)

Earth required for the function of the system. FE: Functional Earth

I-device

An I-device is an "intelligent CPU as IO device“. With this function, PROFINET not only supports communication to lower-level devices, such as IO controllers, but also IO communication to other higher-level or central controllers connected as IO devices.

IO controller

Device used to address connected I/O devices (e.g. distributed I/O). This means, The IO controller exchanges input and output signals with assigned IO devices. The IO controller is often the SIMATIC CPU on which the user program runs.

IO data

Corresponds to the cyclical user data that are exchanged between an IO controller and an IO device.

IO device

→ Field device

Extra-low voltage

Extra-low voltage usually covers the area with voltages that are not dangerous to contact. The high limit varies depending on the referenced standard.

Communication segment

Rail section in which communication is always possible. All PLB slaves in this rail section communicate with a PLB master that has been assigned to this section.

Short-circuit

A short-circuit is an error state. It is usually a low resistance connection of two or more conductors due to a break-down of the isolation.

Empty segment

An empty segment is an autonomous mechanical section of the EMS (Electric Monorail System) in which **data traffic** between a → plant segment controller and the → EMS carriers located within it does not take place.

Circuit breaker

Protective device to prevent an overload by currents from cables.

Low voltage

The limits of the low voltage depend on the reference standard. It usually covers the area with dangerous contact voltages < 1 kV AC or < 1.5 kV DC.

PE

Protective Earth.

PELV

Protective extra-low voltage in accordance with the PELV standard for the protection against electrical shock. PELV is used whenever it is necessary for operational reasons to ground active conductor rails of the extra-low voltage or equipment chassis.

Powerline

The industrial powerline used here uses powerline technology to transmit Industrial Ethernet signals via conductive media that are originally not intended for broadband communication.

PST (Primary Setup Tool)

Free software for configuration of the communication settings of programmable controllers with network interface. Can be used for PROFINET devices and select SIEMENS automation components.

RAIL A/B

RAIL is derived from the English term Railing; in this document it relates to the EMS rail. In an EMS, we refer to the two sliding contacts of the EMS rail used for data communication as RAIL.

PROFINET

PROcess FIeld NETwork, open Industrial Ethernet Standard that continues the PROFIBUS and Industrial Ethernet. A cross-vendor communication, automation, and engineering model defined by the PROFIBUS International e. V. as automation standard.

Rail

Component of the carrying structure of the EMS. As a carrier rail, it serves to suspend and move the → carriers. The → sliding contacts installed on the EMS rail provide the means for the power supply and communication. The sliding contacts are made of an insulated standard U profile that is contacted on its inside by the current collectors.

The combination of UMC rails and bypass sections forms the rail system of the → EMS.

Rail system

The total of all → rails of an → EMS.

Rail intersection

The rail intersection separates the → RAIL A/B sliding contacts electrically.

Shield clamp

Equipment for electrical and mechanical connection of shielded cables to a conductive basis.

Sliding contact

Electrical part of the EMS rail. Up to 8 sliding contacts are mounted on the EMS rail. The sliding contacts are used for energy supply of the → carrier and data traffic. The two sliding contacts for data traffic are referred to as → RAIL A/B.

Protective Earth (PE)

Earth required for protection of persons and goods. PE: Protective Earth

Heavy duty EMS

The heavy duty EMS has been designed for transporting extremely heavy weights. It can be designed with two tracks and often has a scissor lifting system. When it is equipped like this, the carrier can change its speeds and positions independently in travel direction and stroke.

Segment

See → Communication segment, → -Empty segment → Separator

SELV

Safety extra-low voltage in accordance with the SELV standard for the protection against electrical shock.

SFTP

Refers to the SSH FTP (Secure File Transfer Protocol). SFTP is a protocol for encrypted exchange of data between communication devices. Encryption is provided by the HTTPS server.

Shared Medium

Medium shared by several communication devices. Only one device can send data over such a medium at a specific time. The medium is blocked for all other devices during the time.

Signature

Used to check the authenticity of a software component to identify modified or incorrect software.

Voltage, dangerous contact

Voltage which represents danger for persons. The absolute voltage value is defined in the applicable plant standard.

STEP7

SIEMENS S7 software for configuration of programmable controllers. It also covers especially the communication settings.

Station flash test

Process for locating a device in the plant. The flash test is triggered by the TIA Portal or STEP7, for example.

TIA Portal

Totally Integrated Automation Portal. Software for configuration of programmable controllers. It also covers especially the communication settings. The TIA Portal is the successor of → STEP7.

Timeout

Time interval after the expiration of which a feedback from the communication partner is no longer expected.

Topology recognition

Topology recognition can be used to determine the communication structure of an automation plant. Each device in the plant can be identified and it can be determined to which other devices (e.g. switches) it is connected. Topology recognition requires that all devices in the communication network support the so-called neighborhood detection with the help of the LLDP protocol (Link Layer Discovery Protocol). Topology recognition is not supported by the PLB system.

Carrier voltage

Voltage onto which the powerline signals are modulated. It is present, for example, at the sliding contacts Rail A/B.

Separator

A separator is a short mechanical section of the EMS (Electric Monorail System) in which **data traffic** between a → plant segment controller and the → EMS carriers located within it cannot take place. It is used to separate a → communication segment and an → empty segment or an additional → communication segment.

Crosstalk

Undesirable propagation of the communication signals into other communication segments and communication lines.

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