MANUFACTURER DOCUMENT PACKAGE

Manufacturer's Manual

Reference package for procurement and maintenance review

SIEMENS

6ES7972-4AA01-0XA0

PROFIBUS POWER RAIL BOOSTER

Used with the applicable SIMATIC NET Power Rail Booster V2.0 configuration.

REFERENCE PACKAGE

OFFICIAL DOCUMENT

Selected official manufacturer pages follow this cover.

Source: Siemens Power Rail Booster User Guide V2.0 G34924-R2100-U2-A1, September 2003

Power Rail Booster

User's Guide

Version V2.0

09/2003



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Exclusion of liability

We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are welcomed.

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Technical specifications subject to change without prior notice.

Foreword

Purpose of this manual

This manual provides an overview of the Power Rail Booster for PROFIBUS DP and supports users in configuration, installation and commissioning.

It is directed at persons, whose work involves the configuration, commissioning and/or servicing of automation systems.

Basic knowledge requirements

General knowledge in the field of automation is required to use this manual.

Validity

The manual is designed for use with the Power Rail Booster for PROFIBUS DP with the Order No. 6ES7 972-4AA01-0XA0.

Comparison with the previous version

Each section in the previous version of the "Power Rail Booster for PROFIBUS DP" User's Guide was revised and supplemented to create this latest version.

Note:

The previous version of this manual is recognizable by the number G34924-M2100-U2-A0 in the header line.

That number is now G34924-R2100-U2-A1.

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2 Introduction

The PRB (Power Rail Booster) is intended for use as a network component in electrical PROFIBUS networks. It's purpose is the amplification and safe, reliable transmission of PROFIBUS signals. The PRB enables the transmission of PROFIBUS signals over contact rails, loops and other cable types (such as telephone cables) not compliant with the PROFIBUS Specification. The PRB also enables data transmission in the face of an excessive EMC load.

The PRB can be easily integrated in existing PROFIBUS fieldbus networks. It is also possible to configure a complete PROFIBUS fieldbus network in line and/or star topology. Except for the Power Booster itself, no other filters or terminating elements are required for safe, reliable data transmission.

Every PRB has two independent, isolated interfaces, each in turn consisting of a transmitter component and a receiver component.

The primary channel is designed as 9-pin D subminiature (female) socket connector. An RS 485 bus segment to PROFIBUS Standard EN 50170 can be connected to this channel.

The secondary channel is run to a terminal strip. There are two pins for each signal (A1, A2 and B1, B2). A power rail segment can be connected to this channel. The nominal cross-sectional area measures 2.5mm².

7 LEDs signal the current status as well as any malfunctions.

The operating voltage supply comes from 24 V direct voltage.

At least two Power Rail Boosters are required for a transmission link.

2.1 Applications

Primary applications for the Power Rail Booster include:

- Motor-driven overhead trolley conveyors,
- Storage/retrieval devices,
- Crane installations,
- Rotary feed through units and rotary tables,
- Lifts and hoisting apparatus,
- Traversing tracks

It is also generally recommended that the Power Booster be used for cost-efficient, safe and reliable PROFIBUS transmissions via contact rails or cables.

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The following illustration shows a sample application.

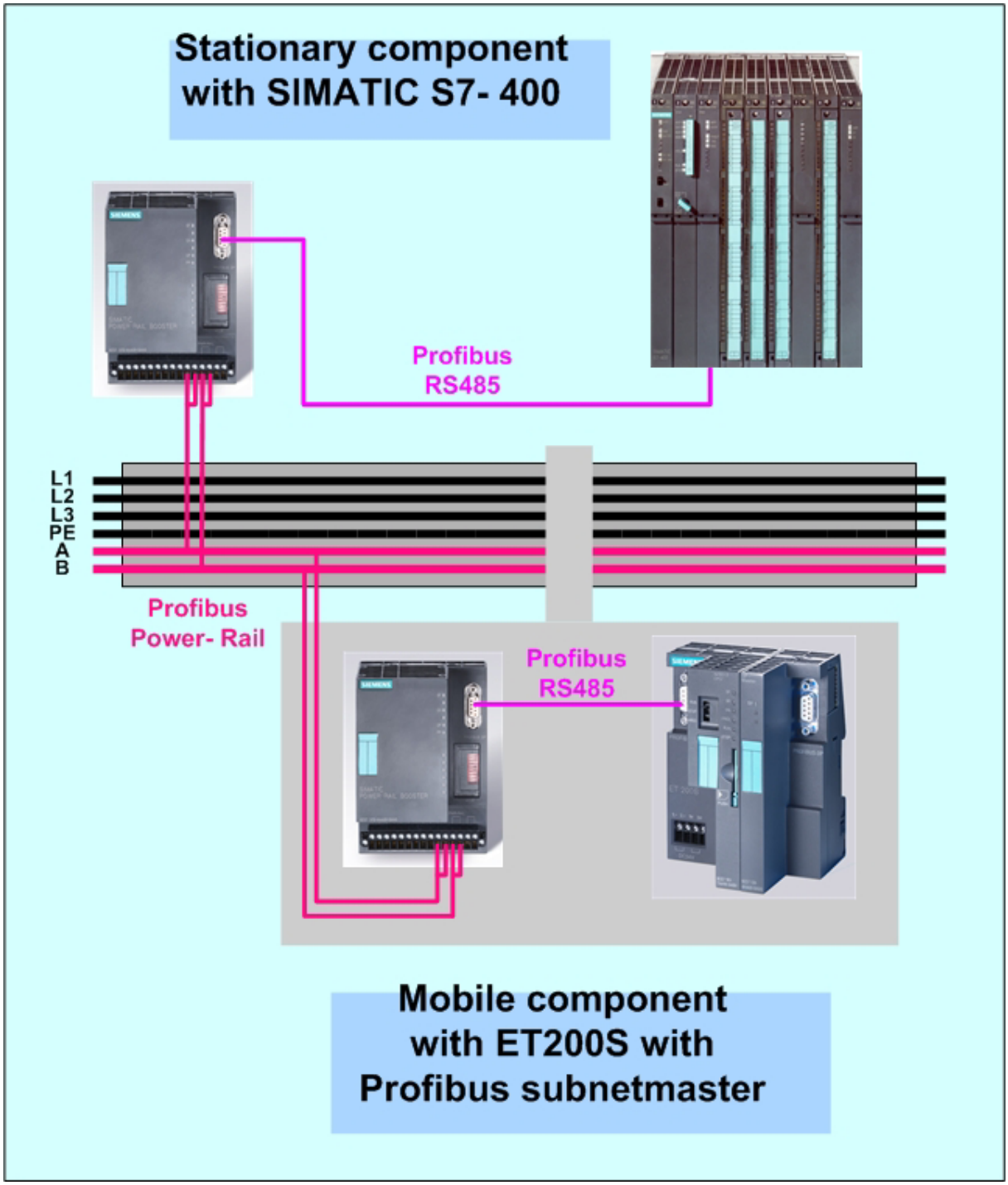


Fig. 1: Sample application for the Power Rail Booster

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3.2.3 Signal regeneration

The PRB regenerates the signal waveshape of the data received, making it possible to cascade as many as 10 PRBs. The signal throughput time is 6 tbits per PRB.

3.2.4 Short-circuit detection

The two interfaces on the PRB are monitored for short circuits. If a short circuit is detected, the transmitter components are shut down. When the problem has been rectified, they are automatically put back into operation as described in Section 3.1, "Basic function". Critical states are signalled as described in Section 7, "LED display and troubleshooting".

3.2.5 Monitoring of the output temperature

The output element is protected against overload by a temperature monitor. The monitor shuts the output element down when a critical temperature is exceeded. When the output has cooled down, the PRB automatically restarts data transmission. Critical states are signalled as described in Chapter 7, "LED display and troubleshooting".

3.2.6 Commissioning aids

At least one active station is required to test the Power Rail connection during installation. That station is usually the PROFIBUS master on the stationary side of the Power Rail. This station serves as message source. On power-up, the Power Rail Boosters are passive. They recognize the transmission speed based on the messages sent by the station. The diagnostic LEDs on the front of the Power Rail Booster provide a visual aid.

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4 Network topologies for contact rail systems

4.1 Term definitions

Contact rail system

Communication between stationary plant control system and mobile vehicles takes place over PROFIBUS DP. Signals from the master are amplified by the PRB and fed into the contact rails. The vehicle picks off the amplified signals with the collector. The moving PRB then transforms the signals back to the Standard PROFIBUS signal level.

DP master segment

A contact rail system can be connected to the PROFIBUS via one or more than one PROFIBUS master. The segment of a contact rail system in which data interchange takes place via a PROFIBUS master is referred to as a "DP master segment". Normally, a contact rail system consists of only one DP master segment. If there are multiple DP master segments, care must be taken to see that no electrical connection (short circuit) can be established between DP master segments via the double collector. This can be done using rail sections (see Section 4.4).

PRB segment

As a rule, more than one stationary Power Rail Booster is required to supply a contact rail system with PROFIBUS signals. The subsegment of a contact rail system in which data interchange takes place via a PRB is referred to as "PRB segment". A PRB segment is thus a subsegment of a DP master segment. It must be ensured that no electrical connection (short circuit) can be established between two PRB segments via the double collector. This can be done using rail sections (see Section 4.4).

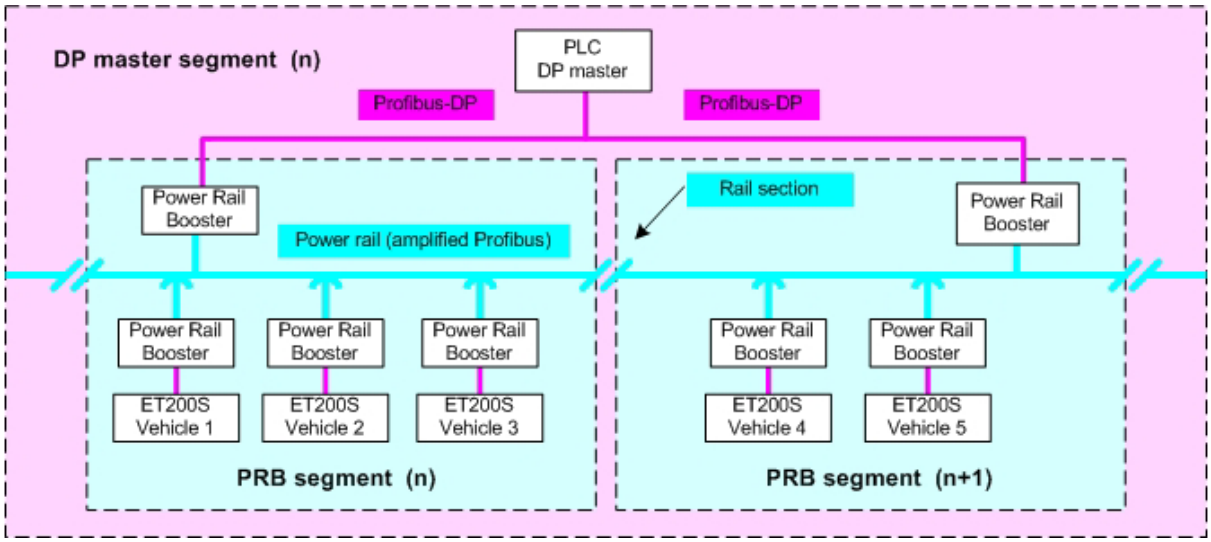


Fig. 2: Block diagram of a DP master segment with two PRB segments

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5.2 Configuration with the "PRB Checker"

The Table below provides an overview of the maximum permissible lengths of PRB segments depending on the transmission speed.

Baud rate	Maximal permissible length
9,600 bit/s	1,250 m
19,200 bit/s	625 m
45,450 bit/s	264 m
93,750 bit/s	128 m
187,500 bit/s	81 m
500,000 bit/s	25 m

Fig. 10: Maximum rail length depending on the selected transmission speed

In addition to the transmission speed, other parameters such as total capacitance and contact resistance must also be taken into account. The applications engineer has at his/her disposal, free of cost, the "PRB Checker" software tool for easy, fast and reliable calculation of the lengths of the individual PRB segments. This tool can be obtained through Siemens Customer Support under the ID 13884116 for downloading over the Internet.

Installation is not necessary following downloading. All files must be copied into one directory. After calling "PRB-Checker.exe", you can select the relevant PRB from the start screen based on Order No. and the language you wish to use.

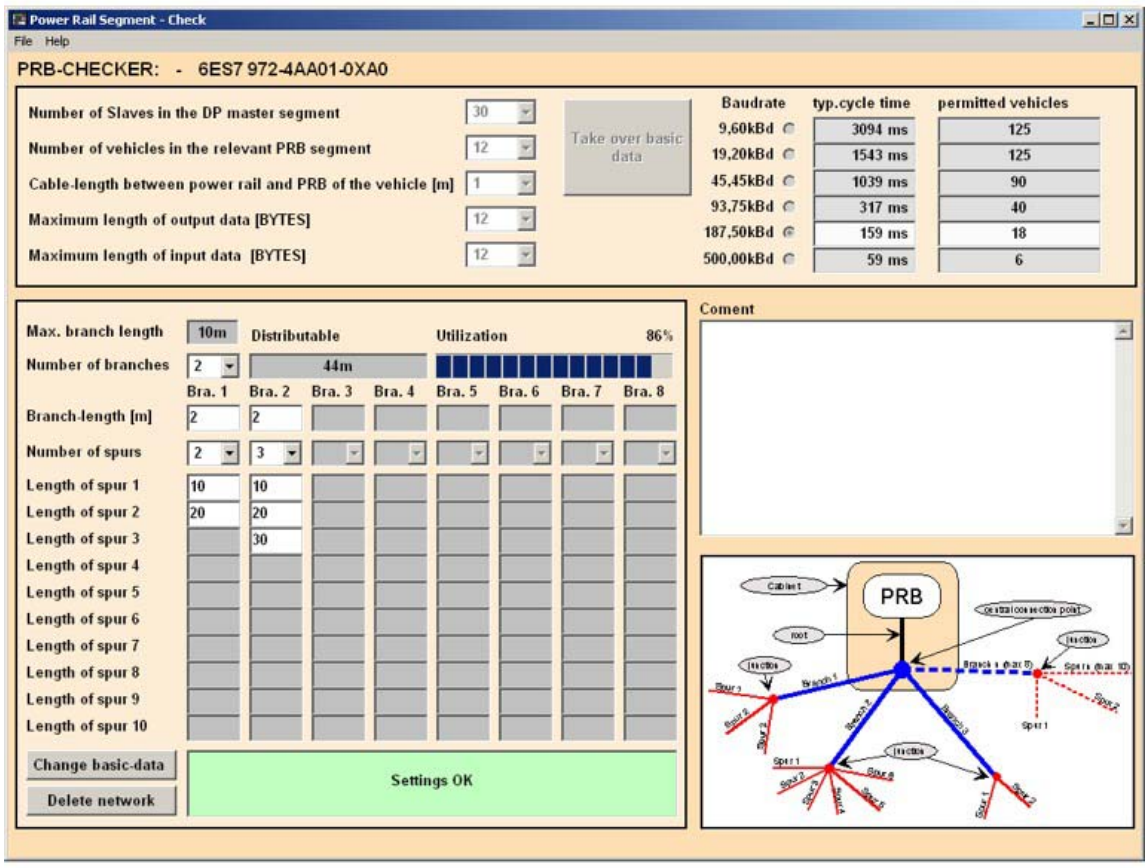


Fig. 11: The PRB Checker configuring tool – input screen form.

All application data relevant to the configuration of the segments must be entered in their entirety in the PRB Checker's input screen form.

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The program checks the input data immediately after each modification. If the result for the data entered is positive (green field), the relevant segment may be regarded as operational. If the result is negative (red field), there are two possibilities:

- the permissible line length (reflection limit) has been exceeded

or

- the permissible load (capacitance) has been exceeded.

If the permissible line length has been exceeded, you must reduce the length of the PRB segment until the Checker gives you the green light for your configuration.

If the load has been exceeded, you can reduce the length of the line, the number of vehicles in the PRB segment or the number of vehicles in the DP master segment.

In this way, you configure segment by segment as described in Section 5.1, "Procedure", until you have structured the entire length of your contact rail, including cabling, in the DP master and PRB segments.

You can also add comments and store your configuration segment by segment. The files can then be sent by e-mail and downloaded at another location. In the past, this has proven very successful as installation, documentation and quality control support.

5.3 Configuration of the bus parameters

Because of the way the PRB functions (see Section 3.2.3), the network parameters for the DP master segment must be configured depending on topology. This is done using Hardwareconfig in STEP-7 or COM PROFIBUS in STEP-5.

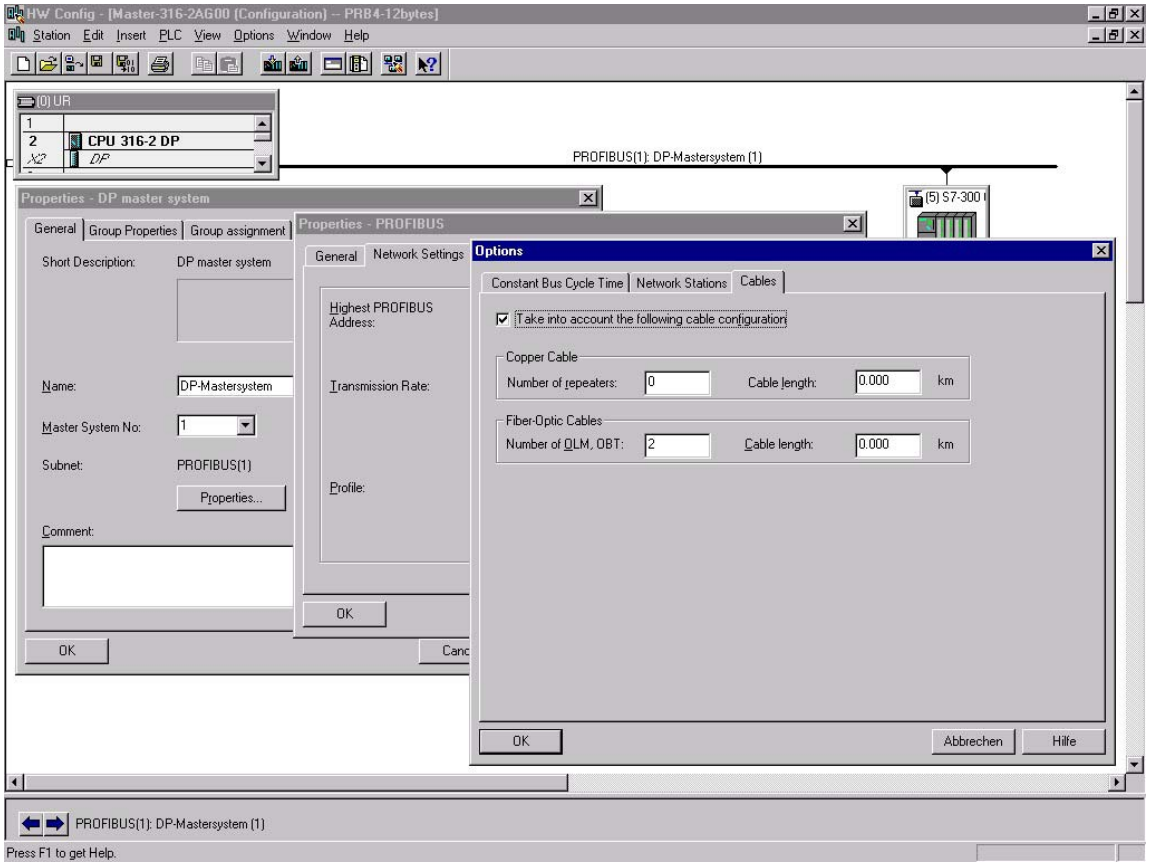


Fig. 12: Configuring the network parameters in Step 7's Hardware Configuration

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6.2 General information regarding commissioning

When configuration has been completed, the following steps must be taken to put the PRB into operation:

→ Set all DIL switches to the OFF position

→ Install the PRB

→ Connect the supply voltage and signalling contacts

→ Connect the Power Rail

→ Connect the RS485 bus cable with preassembled bus connector

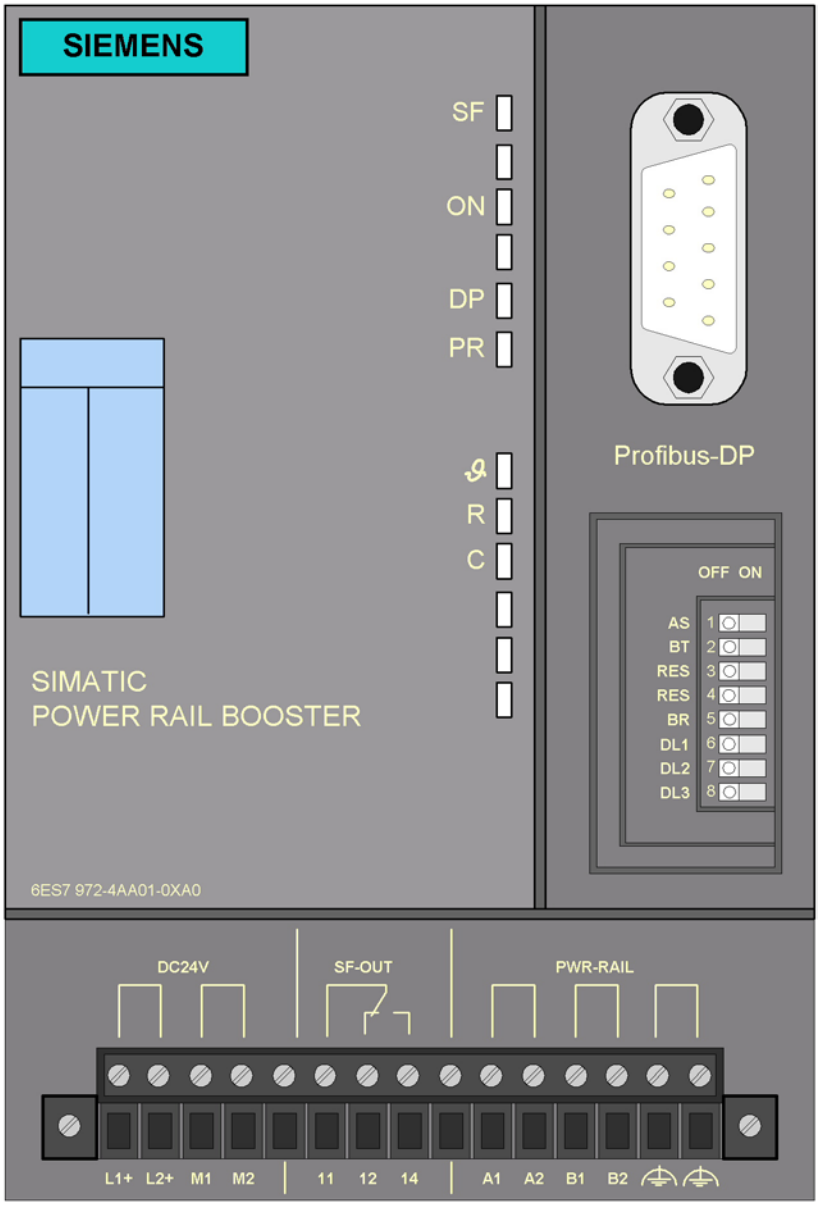


Fig. 13: Front view of the Power Rail Booster. Location of the DIL switches and of the terminal block for the operating voltage, group fault relay and Power Rail connection.

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6.3 Installation

6.3.1 Installing a PRB

A PRB can be mounted on a DIN EN 50022-compliant standard mounting rail with the dimensions 35x15mm or 7.5x15mm. A PRB must be installed or removed only when the supply voltage is switched off.

- → The PRB must be installed horizontally on a vertical wall as shown in Fig. 14.
- → The location must be selected to suit the ambient conditions and mechanical limit values shown in the technical specifications.
- → Sufficient space to connect all lines and cables must be available at the chosen location. In order to ensure sufficient heat dissipation, a space of at least 15mm must separate the upper corner of the PRB from the housing.
- → Install the PRB only on a low-resistance and low reactance-grounded mounting rail or mounting plate.

Installing a PRB on/removing a PRB from a mounting rail

- → Insert the upper locking hook on the PRB into the DIN rail and press the bottom surface, as shown in Fig.14, against the rail until the PRB clicks into place.
- → The PRB is removed by pulling the locking lever downward. With the lever held down, the PRB can be simply lifted off the mounting rail.

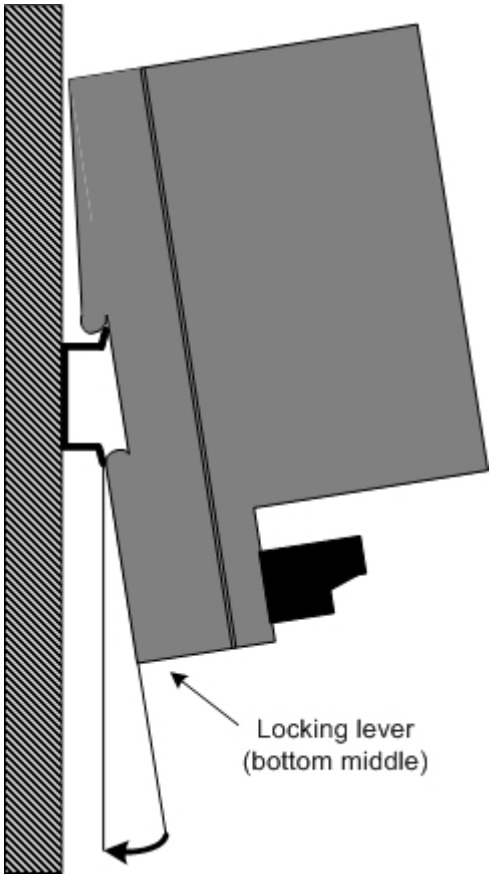


Fig. 14: Installing a PRB on a standard mounting rail

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6.3.2 Interfaces and connector pin assignment

6.3.2.1 Graphical interface diagram, galvanic isolation

The Power Rail Booster is equipped with a number of interfaces, which are shown in the diagram below.

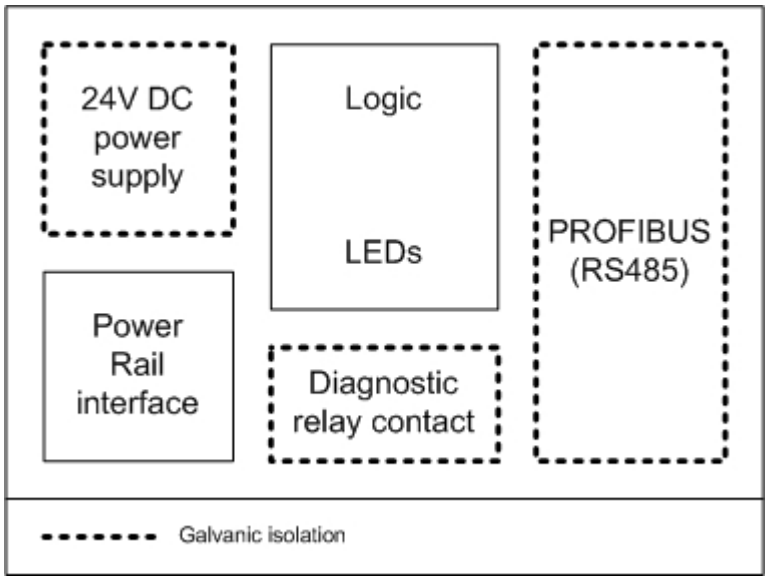


Fig. 15: Overview of interfaces on the Power Rail Booster

6.3.2.2 Wiring guidelines for interfaces

The following figure gives a overview, about the wiring of the PRB interfaces.

Wiring guidelines for ...		Power 24 V DC	Power Rail A / B	SF OUT
Usable wires / cables		Unshielded / shielded solid / flexible	Unshielded / shielded solid / flexible	
Shield		not necessary	not necessary	
Wire routing		no special requirement	Carry funktionground parallel (for example: additional wire, connected on both sides) Preferably use of 3-/ 5-wired cables	no special requirement
Connectable cross sections for solid wires		0,2 bis 2,5 mm²		
Connectable cross sections for flexible wires	without sleeve	0,2 bis 2,5 mm²		
	with sleeve	0,25 bis 2,5 mm²		
Skinning length		10 mm		
Sleeves		see DIN 46228		

Fig. 16: Wiring guidelines for the interfaces of the PRB

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6.3.2.3 Connecting the Power Rail interface

The connection is established via the 15-pin terminal block on the front of the PRB.

→ Because of their low capacitance, all cables to the contact rail on the Power Rail side, such as incoming cables and connecting cables, should be PROFIBUS cables. In principle, however, it is also possible to use other cable types, in which case the maximum cable length must match the cable capacitance.

→ Outputs A1/A2 as well as B1/B2 must be jumpered. This can be implemented by individually feeding the sliding contacts from the double collector or via an external jumper.

Pin No.	Name	Function
10	A1	Contact rail A, first sliding contact
11	A2	Contact rail A, second sliding contact
12	B1	Contact rail B, first sliding contact
13	B2	Contact rail B, second sliding contact
14	ε	Functional ground
15	ε	Functional ground

Fig. 17: Terminal assignment for the Power Rail interface

6.3.2.4 Connecting the PROFIBUS interface

PRBs are equipped with an electrical port with RS 485 level. This port takes the form of a 9-pin D Subminiature socket with screw-type locking mechanism. Bus lines A and B are galvanically isolated from the 24 V supply voltage and the Power Rail voltage. The port is located on the front of the PRB.

→ For the PROFIBUS DP side, the installation guidelines contained in the "SIMATIC NET PROFIBUS Networks" manual apply.

→ Connect the RS 485 bus segment using a PROFIBUS bus connector. If the PRB is located at the beginning or end of a bus segment, the bus terminator on this interface must be switched on.

→ All PROFIBUS bus connectors in the network must be screwed tightly into the RS 485 interface.

→ Make sure that the bus segment connected to the RS485 interface is terminated at both ends.

Pin No.	Name	Function
1	n.c.	Reserved
2	n.c.	Reserved
3	RxD/TxD-P	Data line B
4	RTS	Request to Send
5	GND	Ground
6	VCC	Supply voltage
7	n.c.	Reserved
8	RxD/TxD-N	Data line A
9	n.c.	Reserved

Fig. 18: Terminal assignment for the PROFIBUS RS485 interface

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6.3.2.5 Connecting the operating voltage

The operating voltage is connected via the 15-pin terminal block on the front of the PRB. The connection is protected against polarity reversal. Pins 1-2 and pins 3-4 are jumpered internally.

→ Supply the PRB only with safety extra-low voltage to IEC 60634-4-41 "Generation as Functional Extra-low Voltage with Safe Electrical Isolation", 20.4 V DC 20 to 28.8 V DC (+24 V typical).

→ The PRB must be operated with a grounded incoming supply. The reference potential (ground) of the 24 V DC supply voltage must be connected to PE.

→ Be sure there is sufficient tensile load and observe the cable's minimum bending radii.

Pin No.	Name	Function
1	L1+	24 V DC
2	L2+	24 V DC
3	M1	Ground
4	M2	Ground

Fig. 19: Terminal assignment for the supply voltage interface

6.3.2.6 Connecting the signalling contacts

A relay with potential-free contacts is provided for signalling faults or the failure of the operating voltage. The signalling contact can be connected to a controller's digital I/O via the 15-pin terminal block on the front of the PRB.

→ Be sure there is a sufficient tensile load and observe the cable's minimum bending radii.

Pin No.	Name	Function
6	11	Shared connector pin
7	12	NC contact, opens in the event of a group fault or missing VCC
8	14	NO contact, closes in the event of a group fault or missing VCC

Fig. 20: Terminal assignment for the signalling contact interface

6.3.2.7 Connection scheme for wiring PRB

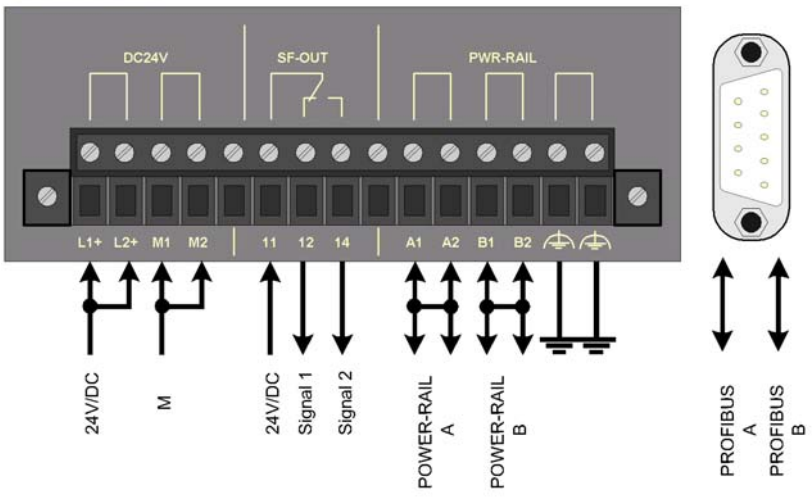


Fig. 21: Connection scheme PRB

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6.4 Determining the transfer resistance of collectors

The transfer resistors for the collectors, a major factor in total resistance, can be determined in the following ways.

6.4.1.1 Measuring individual resistances

Individual resistances can be measured by determining the resistance between sliding contacts and contact rail on a vehicle which is stationary and has been switched off using a hand-held multimeter. If necessary, sliding contacts and/or contact rail must be disconnected from the Power Rail Boosters.

The following applies to the resistors measured:

→ R measurement ≤ 100 ohms

6.4.1.2 Measuring the series resistances on individual double sliding contacts

In order to measure the transfer resistances on a moving vehicle, a pair of double sliding contacts can be used as substitute:

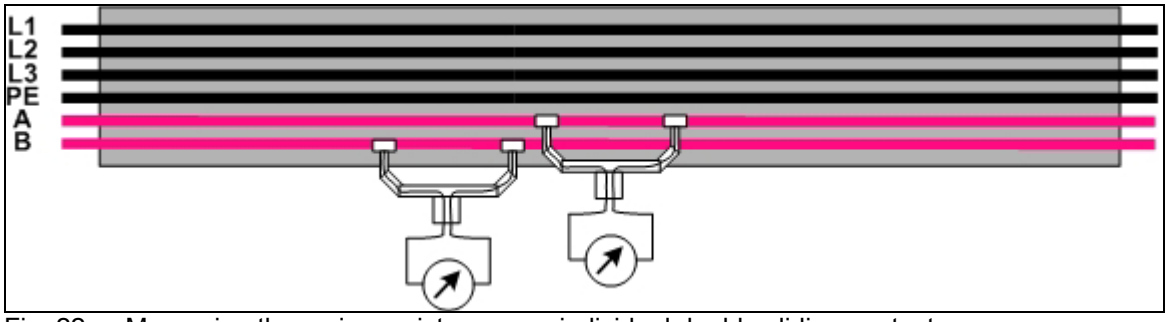


Fig. 22: Measuring the series resistances on individual double sliding contacts

The following applies to resistors (R1+R2) measured via the two double sliding contacts:

→ (R1+R2)/4 ≤ 100 ohms

6.4.1.3 Measuring the serial resistances on both double sliding contacts

In order to measure the transfer resistances on a moving vehicle, measure the resistance over the entire series connection of double sliding contacts. Before doing so, all Power Rail Boosters on the segment to be measured must be disconnected.

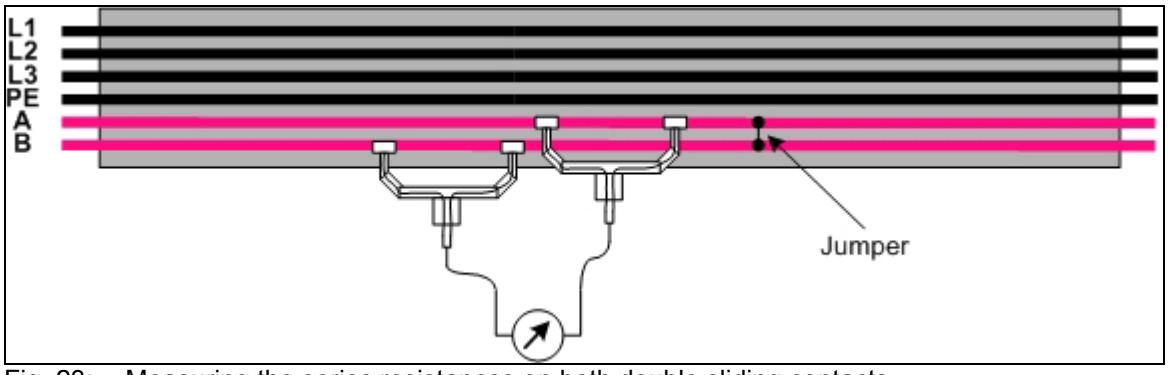


Fig. 23: Measuring the series resistances on both double sliding contacts

The following applies to the resistance (R) measured via both double sliding contacts:

→ R ≤ 100 ohms

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7 LED display and troubleshooting

7.1 Diagnostic displays for the Power Rail Booster

The front of the Power Rail Booster features seven LEDs for quick diagnosis of faults and operating states. The Table below describes the faults and operating states indicated by the LEDs and their causes.

LED	Meaning	Display	State	Cause/Remarks
SF	PRB System fault	Off	No fault	
		Red	System fault	- Short circuit on PROFIBUS. - Short circuit on POWER RAIL. - Line interruption on PROFIBUS (feed booster only). - Line interruption on Power Rail (moving booster only). - Baud rate not found or invalid baud rate. - Baud rate lost following invalid message frames (frame collision on the bus) - Shutdown due to excessively high capacitance, excessively high temperature or, when resistance measurement is active, due to excessively high sliding contact resistance.
ON	PRB ready	Off	No supply voltage.	24 V DC supply voltage not connected.
			Internal logic not ready.	PRB defective.
		Green	Supply voltage OK	
DP	Bus activity PROFIBUS	Off		- No message frames received on PROFIBUS side.
		Flickers		- Message frames received on PROFIBUS side.
PR	Bus activity Power Rail	Off		- No message frames received on Power Rail side.
		Flickers		- Message frames received on Power Rail side.
ϑ	Temp.	Off	Temperature within permissible range	Safe, reliable communication ensured for this parameter.
		Red	Shutdown due to overtemp.	- Output temperature too high. Reliable, safe communication no longer ensured. Power section shut down following termination of last message frame.
R	Resistance measurement	Yellow	N/A	Resistance measurement not activated.

Fig. 24: Possible LED displays and their causes

The relay for the group fault output permanently disables pins 11 and 14 when the "SF" LED shows red light.

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8 Technical specifications

Power Rail Booster	
Voltage and current supply	
Operating voltage	2.4 V to 28.8V DC, 24 V typ., SELV, galv. isolated
Power consumption (rated current)	Max. 1.2 A
Inrush current	max. 20 A
Fusing for supply voltage	6 A Category C circuit-breaker
Power dissipation	Max. 20W
Signal transmission	
Transmission speed	9.6; 19.2; 45.45; 93.75; 187.5; 500kbit/s
Setting of transmission speed	Automatic
Signal propagation time	$\leq 6\ t_{Bit}$
Retimer	
Timing accuracy	$\pm$ 0.1%
Compatibility to	
6ES7 972 4AA00 0XA0	not compatible (no mixed configuration possible)
6ES7 972 4AA00 0XA0 with fan	not compatible (no mixed configuration possible)
Safety	
VDE / EN Specifications	EN61010
PROFIBUS interface	
Input / Output signal	RS485 level
Input voltage ensurance	-7V to +12V
Characteristic PIN6 (Vcc)	5V ± 10%, 50mA
PIN assignments	See Documentation, Section 6.3.2.4
Galvanic isolation	Yes
POWER RAIL interface	
Input / Output signal	Differential signal up to 40V
Input voltage endurance	Differential signal up to 60V, against ground 2,5kV
PIN assignments	See Documentation, Section 6.3.2.3
Permitted switch for the power rail signal	Sirius-3R 3RH11 22-2AB00 (AC-operation) 3RH11 22-2BB40 (DC-operation)
Shock-proof	Yes, to EN 61131-2
Galvanic isolation	Yes (not to internal logic)
Supply voltage interface	
PIN assignments	See Documentation, Section 6.3.2.5
Galvanic isolation	Yes
Signalling contact interface	
Maximum switching voltage	30 V DC; 250 V AC
Maximum switching current	2.0 A
Maximum make-break capacity	60 W / 62.5 VA (resistive load)
PIN assignments	See Documentation, Section 6.3.2.6
Galvanic isolation	Yes
Electromagnetic compatibility (EMC)	
Emitted interference	Limit value class B (EN55022)
Immunity to static discharge	Shield connection and housing components: ± 6 kV Contact discharge (EN61000-4-2)

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Power Rail Booster	
Immunity to high-frequency discharge	Frequency range: 80 MHz to 1 GHz, test field intensity: 10 V/m at 80% amplitude modulation with 1 kHz. Range 87 MHz to 108 MHz, 174 MHz to 230 MHz and 470 MHz to 790 MHz: 3V/m
Immunity to conducted interference	Power and bus cables ± 2 kV (Burst)(EN61000-4-4)
Immunity to conducted interference (surge)	Power cables ± 1 kV symmetrical (Surge) Bus cables ± 2kV unsymmetrical (EN61000-4-5)
Climatic service environment	
Ambient temperature	0 °C to +60 °C (IEC 68-2-1, IEC 68-2-2)
Storage temperature	–40 °C to +70 °C (IEC 68-2-14)
Relative humidity	<95 %, no condensation (IEC 68-2-30)
Mechanical service environment	
Vibration during operation	10 to 58 Hz, 0.075 mm displacement; 58 to 150 Hz, 9.8 m/s 2 (1 g) acceleration (IEC 68–2–6)
Vibration during transport	5 to 9 Hz, 3.5 mm displacement; 9 to 500 Hz, 9.8 m/s 2 (1 g) acceleration
Type of protection	IP20
Dimensions	90.1x132x74 (WxHxD)
Mounting position	Horizontal installation on vertical wall
Weight	360g

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