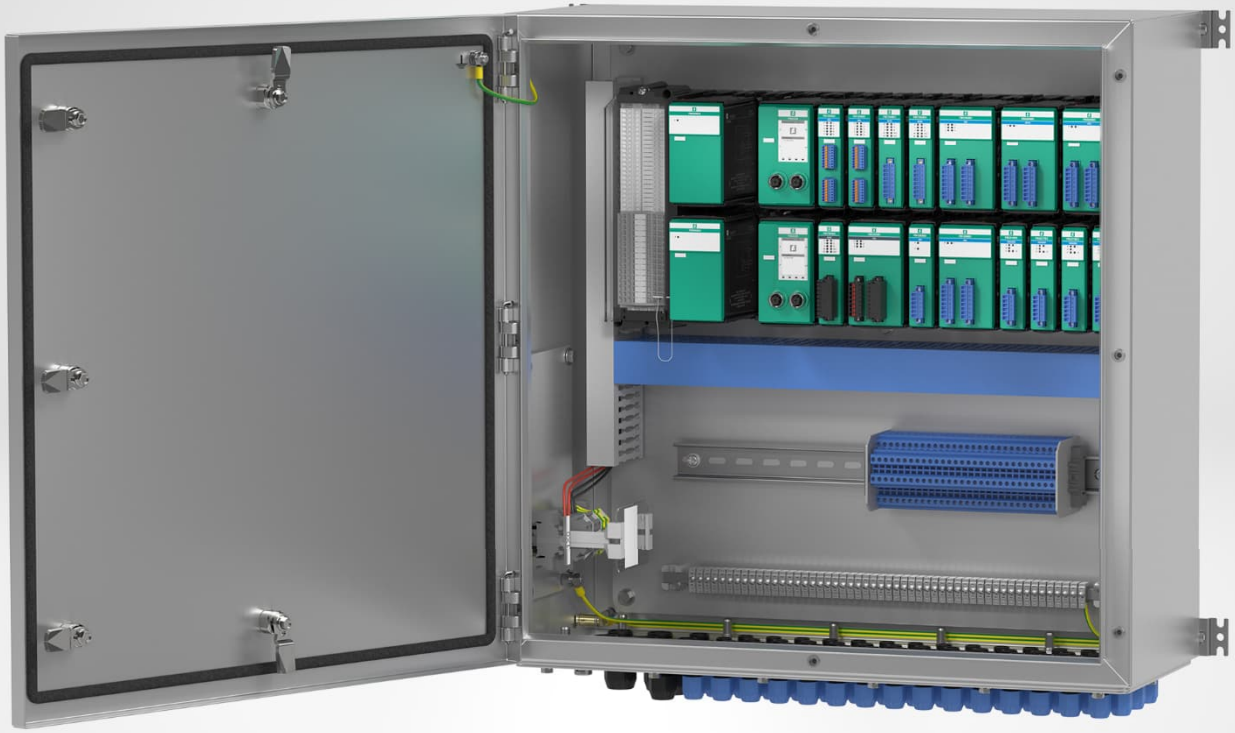
Engineering Guideline
03-2022

Grounding, Earthing and Shielding of FB Remote I/O Systems

Application in Hazardous Area Zone 1



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Abstract

This document provides guidelines to planers, end users and maintenance staff for proper application of shielding and grounding rules for installations of FB Remote I/O systems in hazardous area Zone 1. This document helps users solve grounding respectively earthing issues in respect to standards IEC 60079. We describe grounding and earthing connection points and provide how to apply the guidelines both with legacy and current FB backplanes.

Introduction

Grounding, earthing and shielding of FB Remote I/O stations mounted in hazardous areas classified as Zone 1 underlies the ATEX/IEC 60079-14 “Electrical installations design, selection and erection”. In addition, national or local rules may apply.

For installations in hazardous areas, ATEX/IEC 60079-14 describes requirements for earthing, grounding, and potential equalization, that is necessary prevent elevated potentials on equipotential bonding conductors, also called protective bonding (PB) The technical reason is to properly suppress vagabonding currents on the equipment, e.g. pipes or cable shield, divert them to proper ground and thus ensure functional and technical safety of the installation. Vagabonding currents can cause safety hazards as they can deliver ignition energy in potentially hazardous areas or can cause corrosion of pipes.

Protective Earth (PE) provides personal protection, in which it carries electrical currents in the event of a fault. The fault current is led back to the mains supply and is intended to be big enough to blow a fuse thus shutting down the circuit and protect personnel from electrical shock.

Process plants with hazardous areas require PE and PB networks. Both shall be led separately and only be connected at the central earth point (CEP). For functional reasons it can be necessary to mesh PE and PB. If meshed very closely it can be decided that PE can be utilized as PB in certain applications since it provides an implicit equipotential bonding.

This guideline describes the special cases for connecting wiring between differently classified areas such as safe and explosion hazardous with a focus on PE and PB interconnection.

While the authors of this engineering guideline took great care in preparing this engineering guideline, Pepperl+Fuchs provides this information as is without any express or implied warranty. Always follow applicable standards, rules and regulations for safety and explosion hazardous protection.

Table of Contents

Design Elements of an FB Remote I/O Station

This chapter describes the product designs and details relevant to grounding, earthing and shielding of FB Remote I/O Systems. For further product details refer to the datasheets online at www.pepperl-fuchs.com/rio.

Backplanes

The FB backplanes hold all other components of the FB Remote I/O system and provide the system connections for power and fieldbus. The type code of all backplanes starts with FB9262BP*. Two types of FB backplanes are available:

Legacy FB backplanes carry the suffix ".1" (FB9262BP*.1) and will be referred for readability of this document as *type 1*. They provide a PE terminal intended for the fieldbus shield and the PE connection for power. All terminals designated with PE are internally connected.

Newer generation FB backplanes carry the suffix ".2" (FB9262BP*.2) and will be referred as *type 2*. They provide a PE connection for power and a separate PB connection. PE and PB are insulated. The differences between type 1 and type 2 backplanes have implications on grounding and shielding, when utilizing both types within the same plant.

This document describes three preferred layouts:

1. For existing grounding structures using FB backplanes type 1
2. Grounding structure of systems based on type 2 backplanes only and
3. Extensions for installations based on type 1 backplanes with type 2.

Power Supplies

FB Remote I/O systems can be equipped with two different power supplies: 24 V DC or 230 V AC input.

In industrial installations, 24 V power is provided by power supplies with integrated protection from electrical shock. This is either in the grade of Safety Extra Low Power (SELV) or Protected Extra Low Power (PELV). In most cases, 24 V DC power supply is distributed via 2 wires only ("+" and "-") without PE carried along.

With 230 V AC power supply cord normally a PE lead is carried along. The internal FB AC power supplies are double insulated class II power supplies and do not require PE for protection. Nevertheless, in many installations, PE is connected to the terminal on the FB backplane labelled: PE.

System Earthing and Grounding Structures

Table 1 shows the usage for PE and PB for type 1 and type 2 FB backplanes in relation to power supply selections.

Table 1: Usage of PE and PB connections of type 1 and type 2 FB backplanes with different power supplies

Description	Type 1 FB backplane	Type 2 FB backplane
Type Code	FB9262BP*.1	FB9262BP*.2
Grounding Connectivity	One connection labelled PE, all PE terminals interconnected	Separate PB and PE, PE terminals isolated from each other
24 V DC	PE is utilized as PB	PE unused PB used as PB
230 V AC	PE is utilized as PB	PE functionally unused PB used as PB

Enclosure

Due to ATEXs and IECEx rules for installation in Zone 1 require that FB Remote I/O Systems must be installed in a suitable, certified enclosure e.g. with increased safety protection, "Ex e enclosure". This enclosure can be made of GRP or stainless steel and must be properly grounded. This means that the Remote I/O and the enclosure are connected to the PB-bar of the hazardous area. Apart from the FB backplane with its terminals, the enclosure contains an equipotential bonding rail for PB (PB bar in Figure 1), and separate grounding bars to hold the shield from fieldbus cables and the shields from field signals. Also, terminal blocks simplify on-site installation through easy connection to the mains power.

GRP enclosures: The insulating properties of the GRP enclosure isolate all elements from each other. Required connections between the elements must be made deliberately with proper wiring. The FB backplane itself is mounted on a metal mounting plate which must be connected to PB. A GRP enclosure setup is shown in Figure 1.

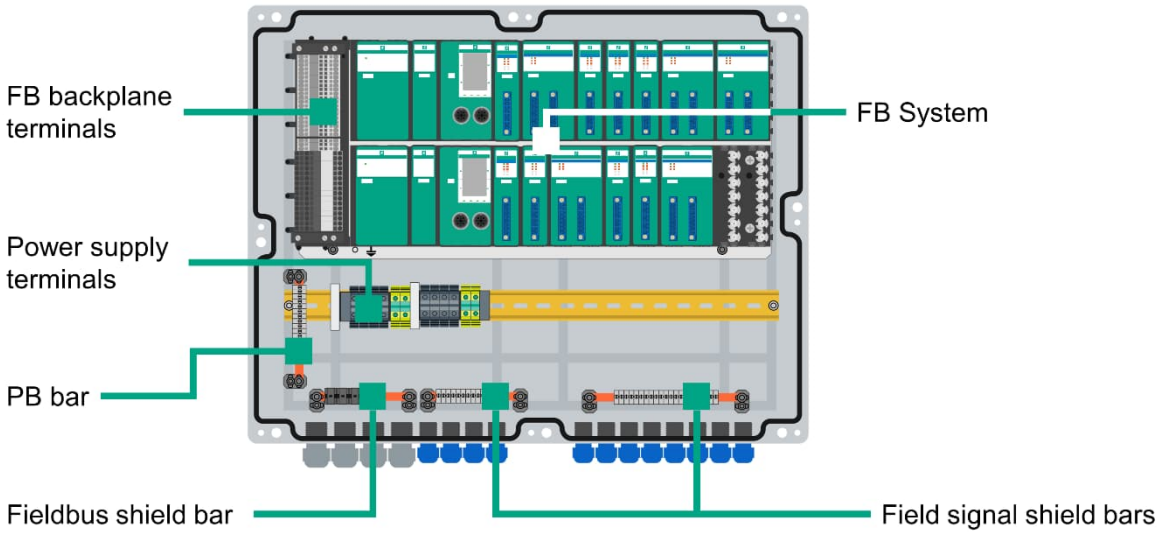


Figure 1: GRP enclosure. Note the separation of rails for grounding, shielding, and equipotential bonding.

Steel enclosures provide a similar setup, which is shown in Figure 2. The equipotential bonding PB is directly connected to the enclosure itself via an outside bolt – and therefore all metallic parts directly attached to the enclosure are connected to the PB system. This applies to the terminals for power connection which are normally mounted on a DIN rail on the left inner side of the enclosure (not visible from front view). Through this setup the PE terminals are connected directly to PB. The shield bars are isolated from the stainless steel enclosure and therefore require dedicated wiring as in the GRP setup.

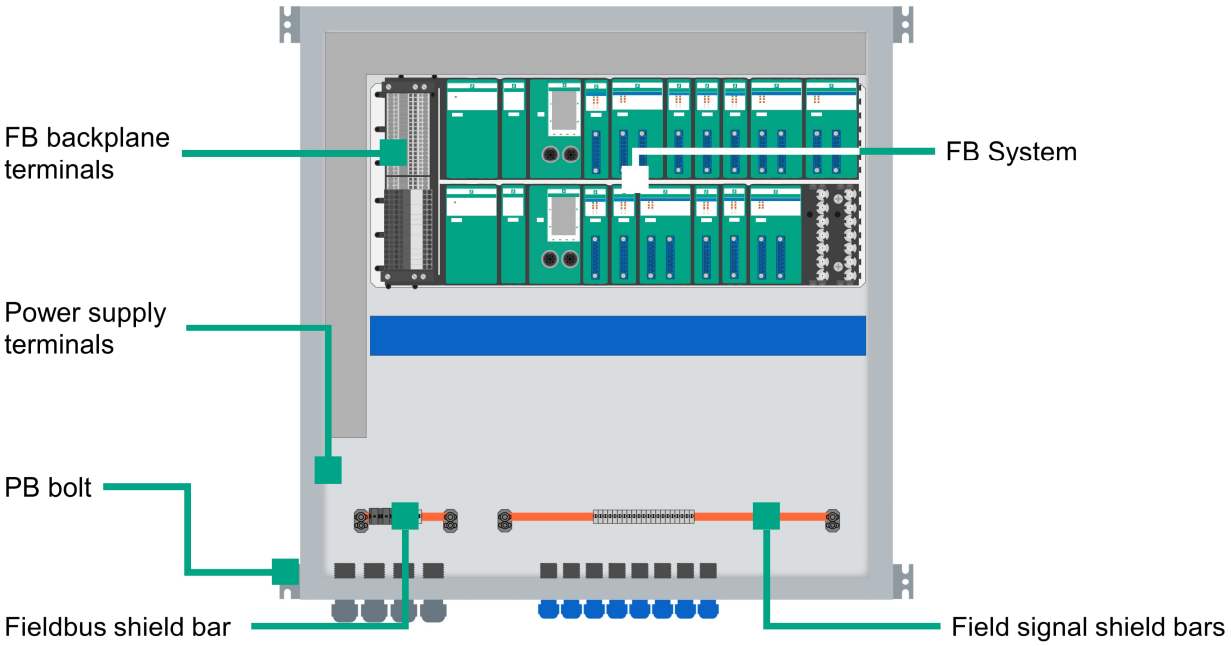


Figure 2:Stainless steel enclosure

Depending on the grounding structure in the plant and the mains power (24 V DC or 230 V AC), the elements can be used and interconnected in different combinations to provide the required protection.

Earthing and Grounding of the FB Remote I/O Station

This chapter describes the wiring and connections for proper earthing and grounding of FB Remote I/O stations. It covers combinations of

- backplane types 1 and 2,
- power supplies 24 V DC and 230 V AC
- for systems with central earthing point, i.e. equipotential bonding of PE and PB
- for systems without equipotential bonding of PE and PB

Table 2 shows the legend of drawing elements used in this chapter.

Table 2: Attributes and Definitions of Drawing Elements

Style	Attribute	Definition
	Yellow	Protective Earth (PE)
	Green	Protective Bonding (PB)
	Black	Power
	Dark Pink	Communication
	Grey	Instrument connection
	Dot	Connection
	Dash and dot	Shield (combined with color to indicate functionality)

Type 1 Backplane with 230 V AC Power Supply

Solution with proper equipotential bonding between safe and hazardous area:

1. Isolate the PE of the 230 V AC power supply on PE terminal blocks on the DIN-rail.
2. Connect the PE terminals of the FB backplanes to the PB bar.
3. Connect the field signal shield bar to the PB bar.
4. Option to protect fieldbus communication from EMI:
    a. Connect the fieldbus shield bar to PB.
    b. At the PLC, connect the shield in PB quality.

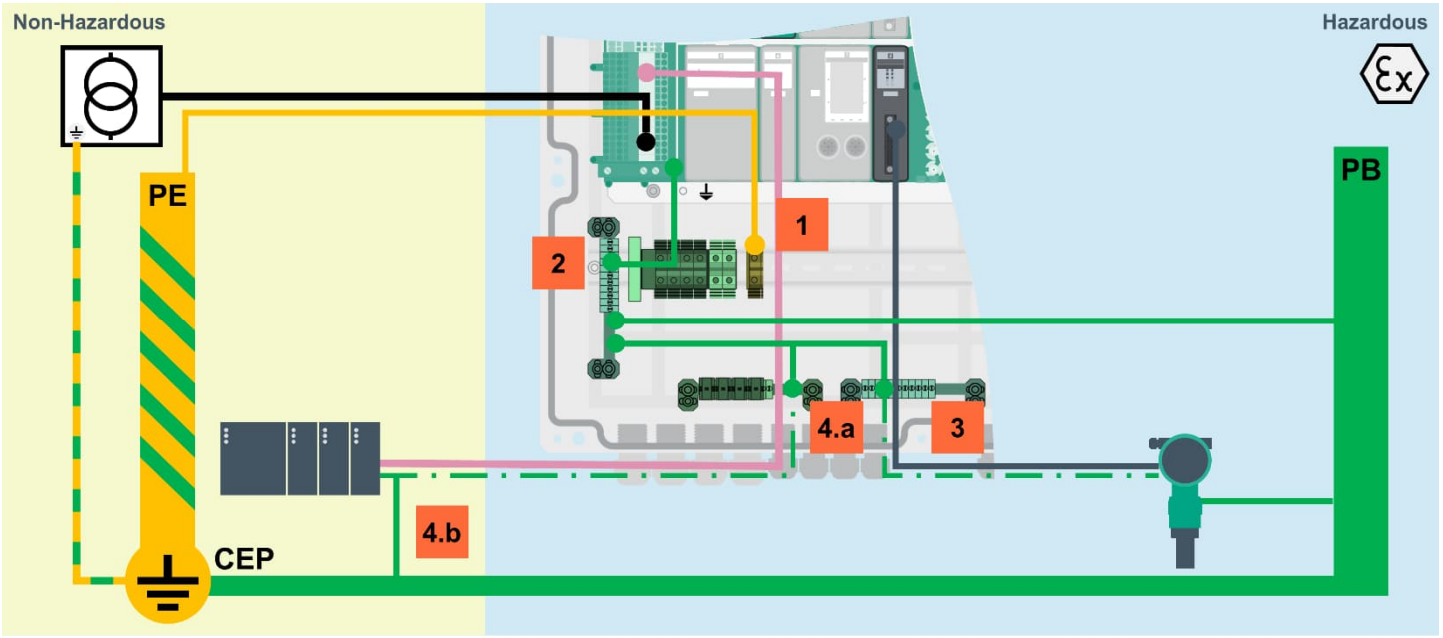


Figure 3: Type 1 backplane with 230 V AC power supply and connected PE and PB earth bars

Solution with insufficient or without equipotential bonding between safe and hazardous area

1. Isolate the PE of the 230 V AC power supply on PE terminal blocks on the DIN-rail.
2. Connect the PE Terminals of the FB backplanes to the PB bar.
3. Connect the field signal shield bar to PB bar.

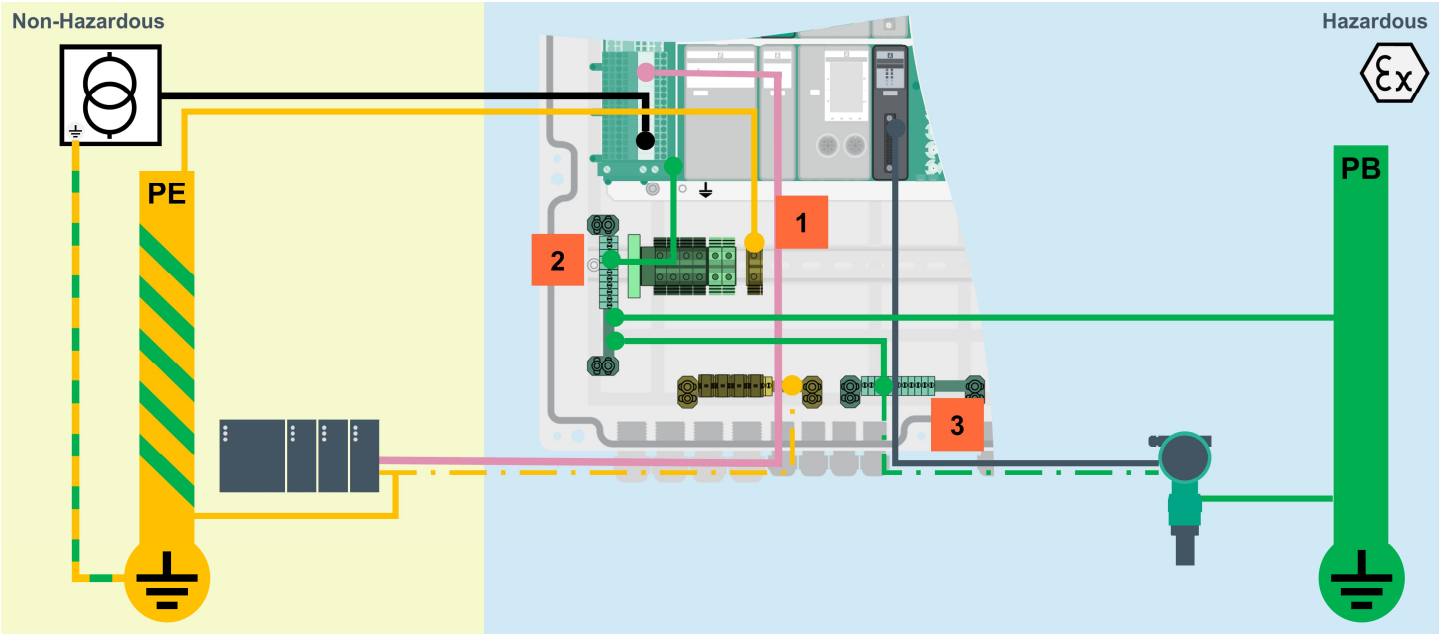


Figure 4: Type 1 backplane with 230 V AC power supply and PE and PB earth bars not connected

Type 1 Backplane with 24 V DC Power Supply

Solution with proper equipotential bonding between safe and hazardous area:

1. Connect the PE terminals of the FB backplanes to the PB bar.
2. Connect the field signal shield bar to PB bar.
3. Option to protect fieldbus communication from EMI:
    a. Connect the fieldbus shield bar to PB via the field signal shield bar.
    b. At the PLC, connect the shield in PB quality.

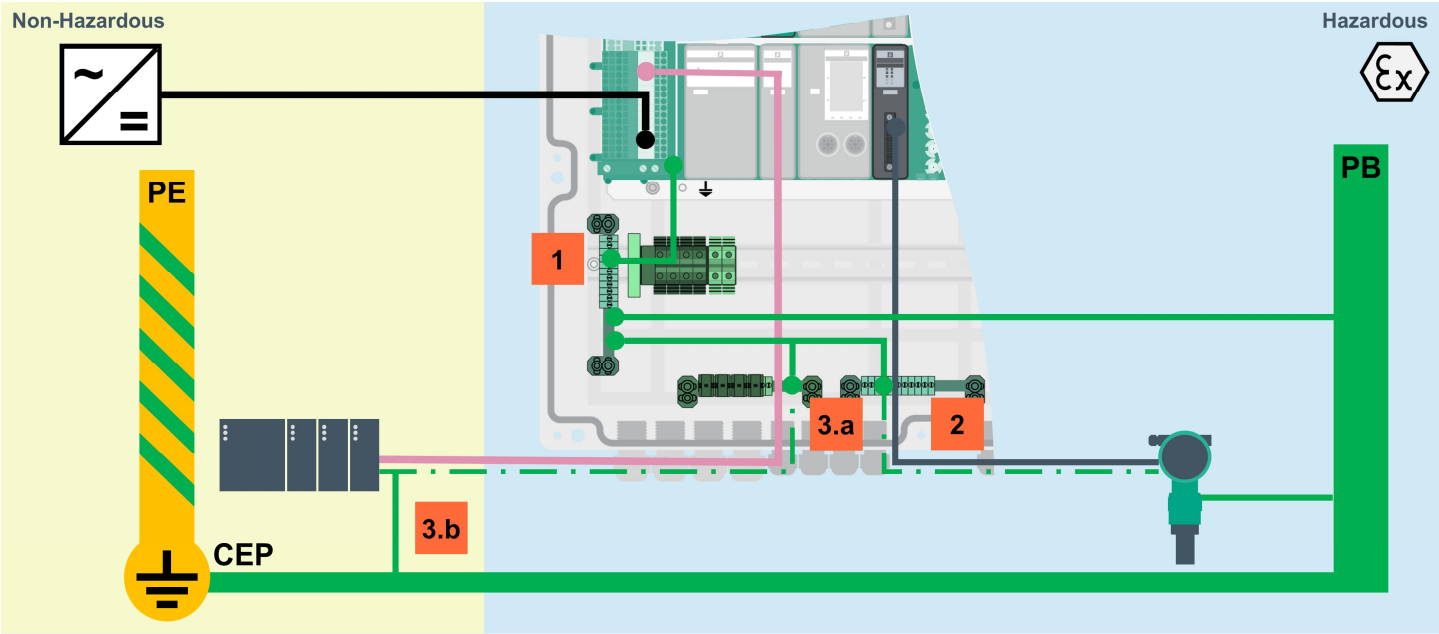


Figure 5: Type 1 backplane with 24 V DC power supply and connected PE and PB bus bars

Solution with insufficient or without equipotential bonding between safe and hazardous area:

1. Connect the PE terminals of the FB backplanes to the PB bar.
2. Connect the field signal shield bar to PB bar.

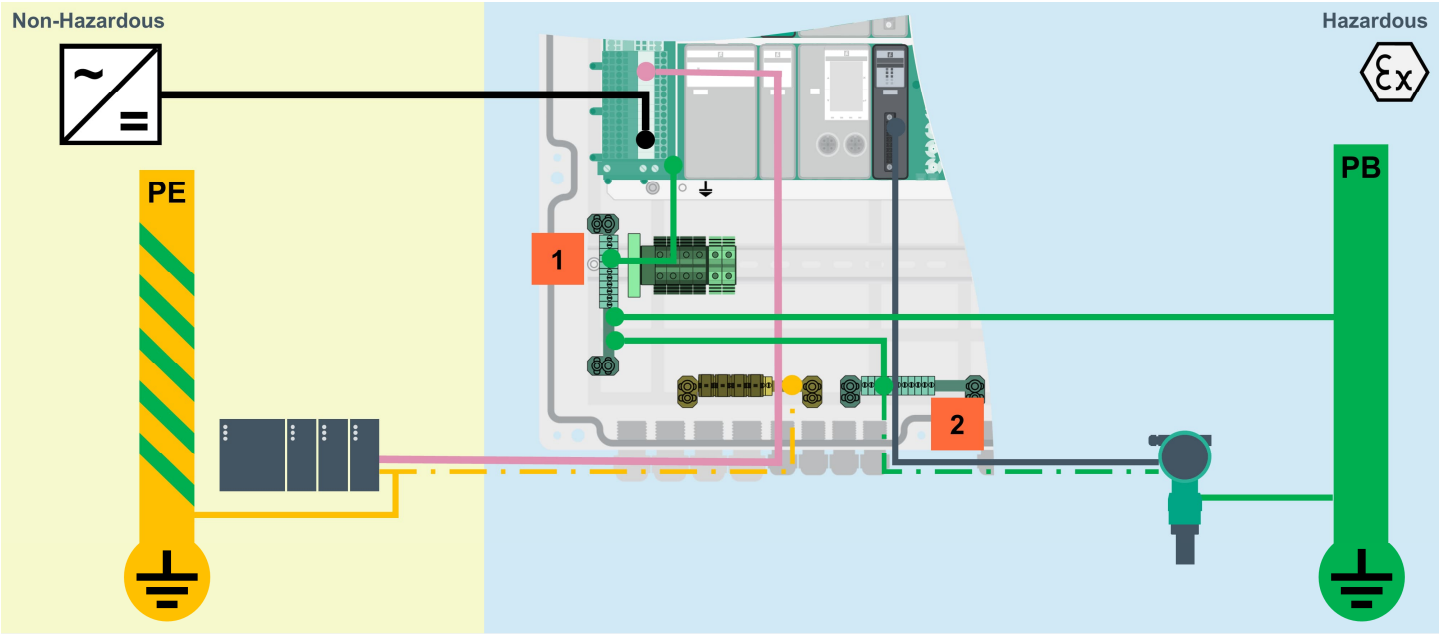


Figure 6:Type 1 backplane with 24 V DC power supply and PE and PB earth bars not connected

Type 2 Backplane with 230 V AC Power Supply

Solution with proper equipotential bonding between safe and hazardous area:

1. Connect the PE of the 230 V AC power supply on PE terminal blocks of the FB backplane. Ensure that the PE terminals on the DIN rail are isolated from PB.
2. Connect the PB Terminals of the FB backplanes to the PB bar.
3. Connect the field signal shield bar to PB bar.
4. Option to protect fieldbus communication from EMI:
    a. Connect the fieldbus shield bar to PB via the field signal shield bar.
    b. At the PLC, connect the shield in PB quality.

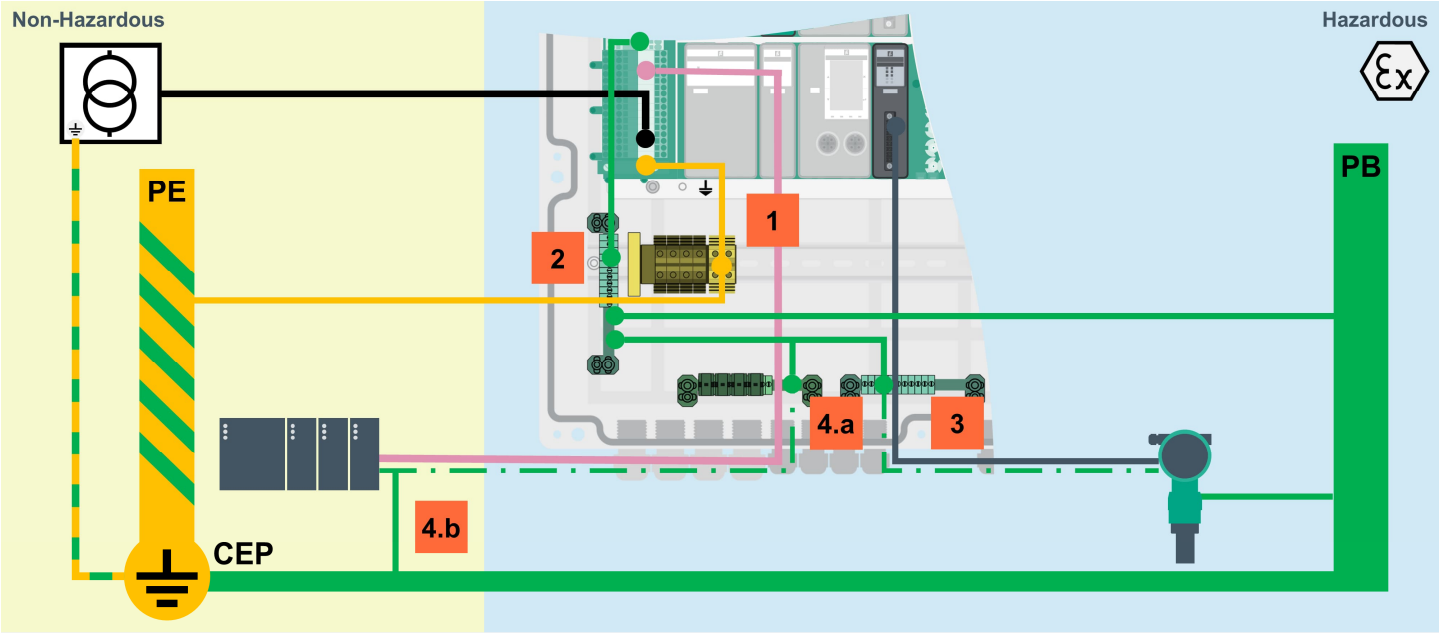


Figure 7: Type 2 backplane with 230 V AC power supply and PE and PB earth bars

Solution with insufficient or without equipotential bonding between safe and hazardous area

1. Connect the PE of the 230 V AC power supply on PE terminal blocks of the FB backplane. Ensure that the PE terminals on the DIN rail are isolated from PB.
2. Connect the PB Terminals of the FB backplanes to the PB bar.
3. Connect the field signal shield bar to PB bar.

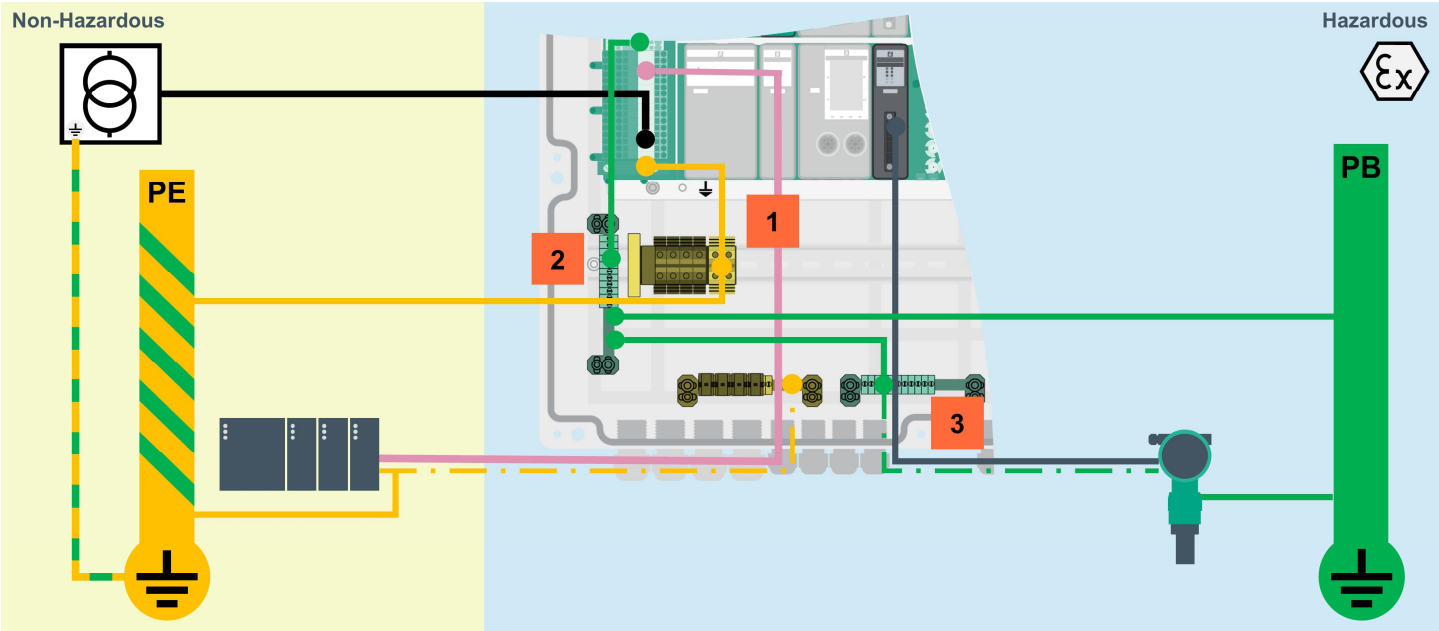


Figure 8: Type 2 backplane with 230 V AC power supply and not connected PE and PB earth bars

Type 2 Backplane with 24 V DC Power Supply

Solution with proper equipotential bonding between safe and hazardous area:

1. Connect the PB Terminals of the FB backplanes to the PB bar.
2. Connect the field signal shield bar to PB bar.
3. Option to protect fieldbus communication from EMI:
    a. Connect the fieldbus shield bar to PB via the field signal shield bar.
    b. At the PLC, connect the shield in PB quality.

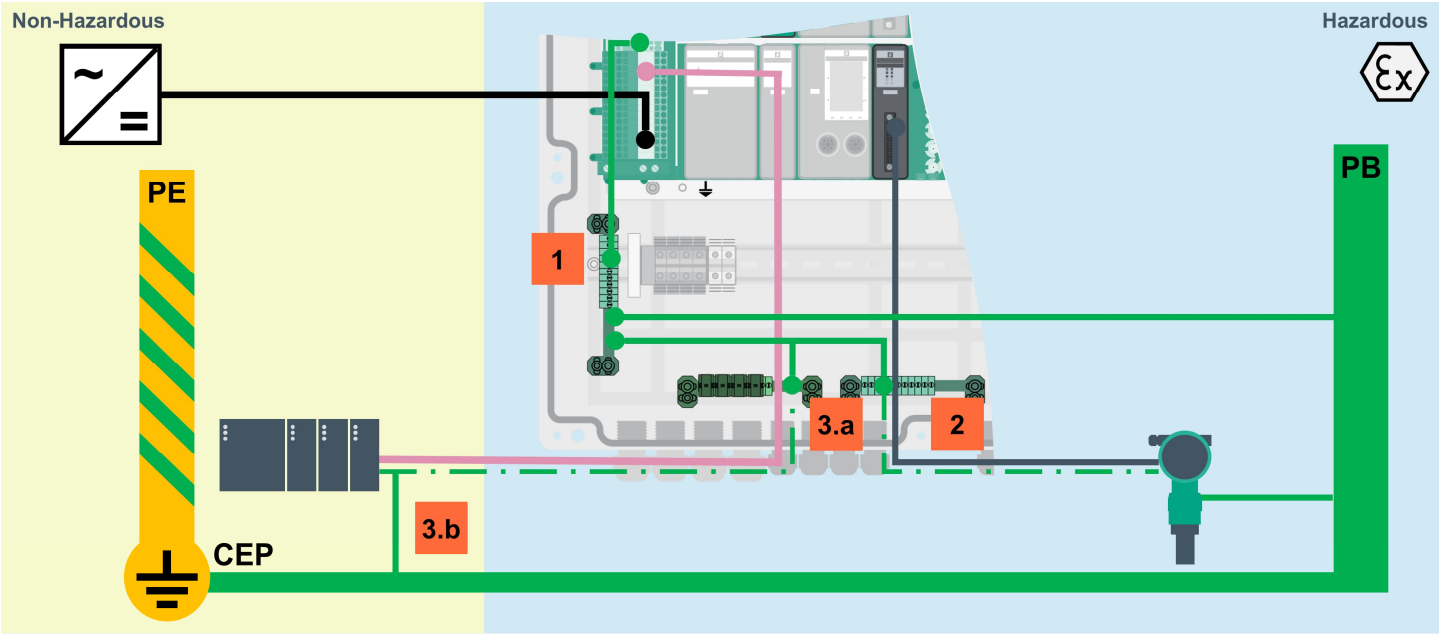


Figure 9: Type 2 backplane with 24 V DC power supply and connected PE and PB earth bars

Solution with insufficient or without equipotential bonding between safe and hazardous area

1. Connect the PB Terminals of the FB backplanes to the PB bar.
2. Connect the field signal shield bar to PB bar.

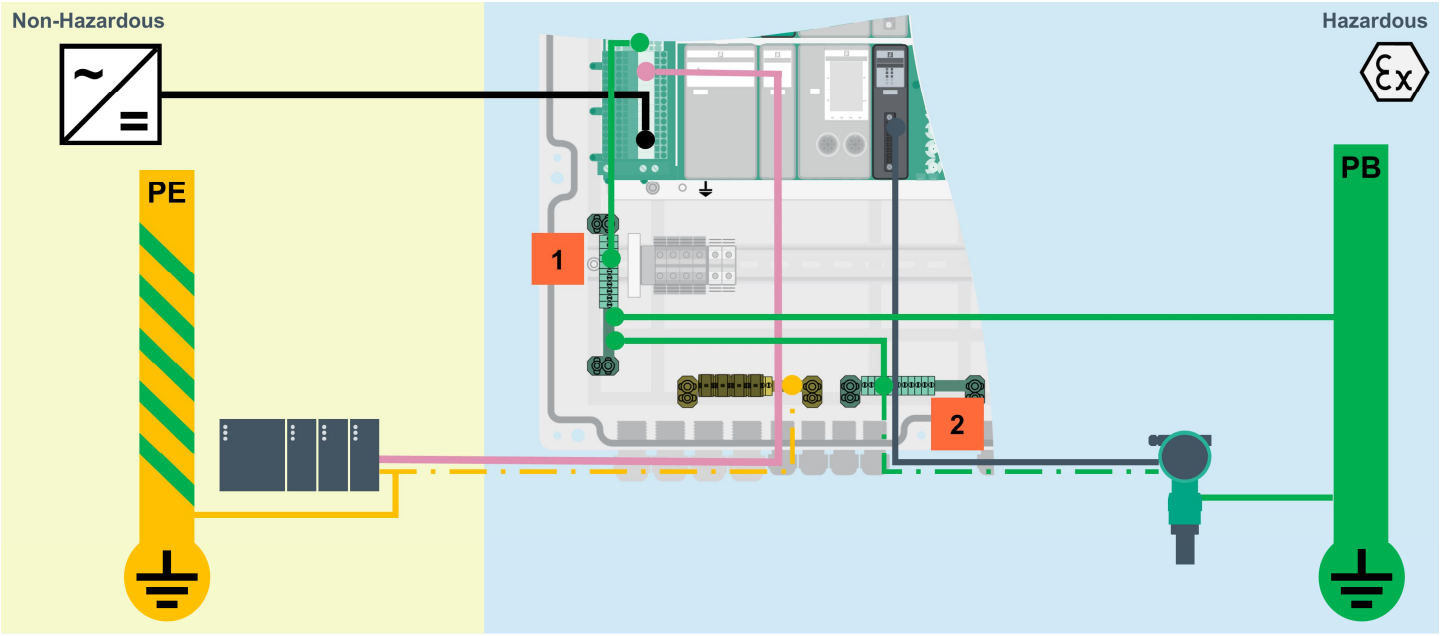


Figure 10: Type 2 backplane with 24 V DC power supply and unconnected PE and PB bus bars

Fieldbus Shield Connection

Single-sided shielding in safe area is required for explosion protection. Users often prefer grounding of the fieldbus or Ethernet shield on both ends, which provides improved protection from EMI to fieldbus communications. Also, while EMI disturbances can be considered rare, particularly inside a stainless steel enclosure, some users may wish to continue the shield to the Remote I/O station. This chapter shows direct and capacitive grounding techniques for the fieldbus shield for all relevant scenarios: with and without central earthing point for both, fieldbus and Ethernet-based systems.

Serial Bus Systems

Solution with proper equipotential bonding between safe and hazardous area:

If PB and PE are connected through equipotential bonding, the fieldbus shield can be continued to the FB backplane. On type 1 backplanes, the shield can be connected to PE terminals next to the fieldbus connections, on type 2 backplanes the PB terminals can be used.

1. Connect the PE terminals of the FB backplanes to the PB bar.
2. Connect the field signal shield bar to PB bar.
3. Fieldbus shield:
    a. Connect the fieldbus shield bar to PB via the field signal shield bar.
    b. At the PLC, connect the shield in PB quality.
    c. Continue the fieldbus shield to the FB backplane.

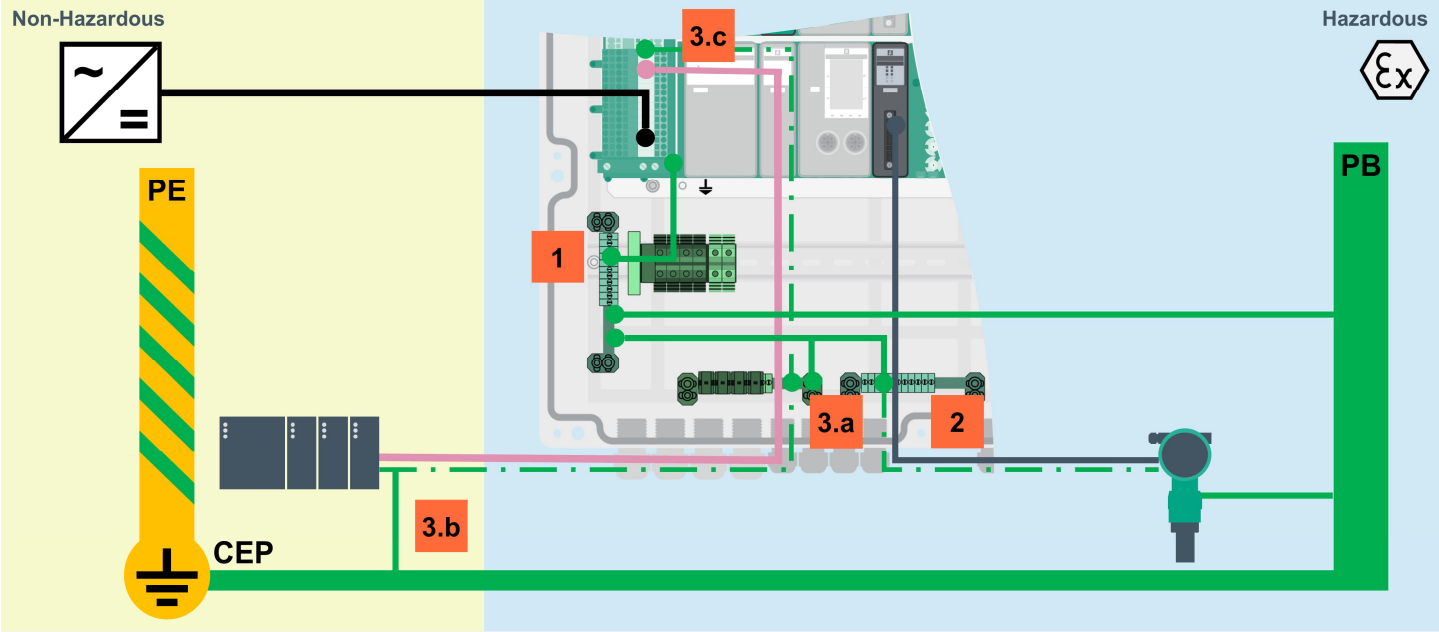


Figure 11: Type 1 backplane with serial bus communication and fieldbus shield continued to FB backplane.

Ethernet-based Bus Systems

Solution with proper equipotential bonding between safe and hazardous area

For usage of FB82xxB.1.EL gateways it is mandatory to connect the shield of the Ethernet cable to PB. The reason is that the shield is continued to the M12 connector, the shield shall be voltage free. If the equipotential bonding bus bars of the safe and hazardous area are connected, the shield can be also connected on both sides.

1. Connect the PE terminals of the FB backplanes to the PB bar.
2. Connect the field signal shield bar to PB bar.
3. Fieldbus shield:
    a. Connect the fieldbus shield bar to PB via the field signal shield bar.
    b. At the PLC, connect the shield in PB quality.
    c. Connect the communication cable with preconfigured M12 plug to the FB82xxB.1.EL Gateway. In addition, strip the isolation and connect the shield at 3.a

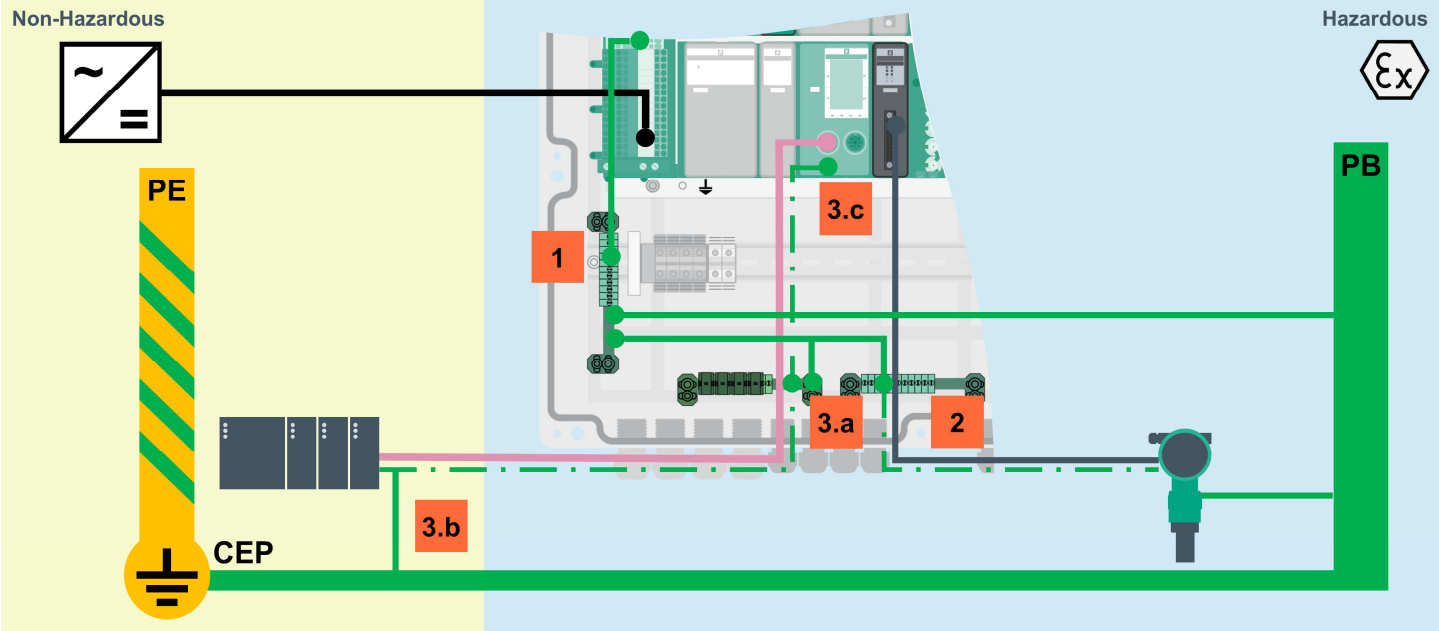


Figure 12: Type 1 backplane with Ethernet communication and fieldbus shield continued to gateway through preconfigured M12 cable

Capacitive Grounding of the Fieldbus Shield

Solution with insufficient or without equipotential bonding between safe and hazardous area

The shield of the fieldbus cable must be connected to PB in the FB enclosure and be isolated on the safe side. Capacitive grounding to PE can be considered. The capacitive connection must be of PB quality.

Note: a suitable capacitor (min. Y2 or Y1) type with sufficient rated voltage e.g. typical Y2 rated voltage value 250 V AC -> 5 kV test voltage may be used as capacitive grounding in the safe area. Application of this solution is subject of validation by hazardous area specialist.

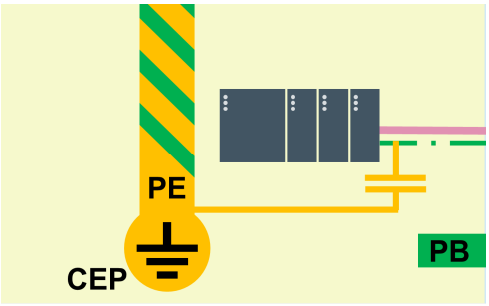


Figure 13: Capacitive grounding of fieldbus shield

Installations with Type 1 and Type 2 Backplanes

When mixing type 1 and type 2 backplanes in an existing installation due to extension or replacement, the grounding structure must be considered and may require modification. It is preferred to separate PE and PB, consequently the PE wiring should be disconnected form the type 1 backplane and terminated on a terminal block in the enclosure. The now available PE terminals at the type 1 FB backplane shall be used as PB.

The first example shows the replacement or supplement of extension backplanes. It details backplane interconnections of PB and PE shown in Figure 14.**Fehler! Verweisquelle konnte nicht gefunden werden.** Figure 15 shows all other variants in the form of connection tables.

An installation with type 1 backplane as base backplane is extended with a type 2 extension backplane.

1. PE wiring
    a. Disconnect the PE wiring from type 1 backplanes and terminate in the enclosure
    b. Optional: connect PE wiring to terminals 3 and / or 6 at type 2 backplane
2. PB wiring
    a. Connect PB wiring to terminal 3 and / or 6 at type 1 base backplane and terminal 16 at type 1 redundancy backplane
    b. Connect PB wiring to terminals 15 and 16 at type 2 extension backplane
    c. Optional: Connect the fieldbus shield to terminal 11 and / or 16
3. Interconnect PB wiring
    a. Connect terminal 16 of type 1 base backplane and terminal 16 of type 2 extension backplane
    b. If present: Connect terminal 15 of type 2 extension backplane with terminal 2 of type 1 redundancy backplane
    c. If present: Connect terminal 15 of type 1 base backplane with terminal 1 of type 1 redundancy backplane

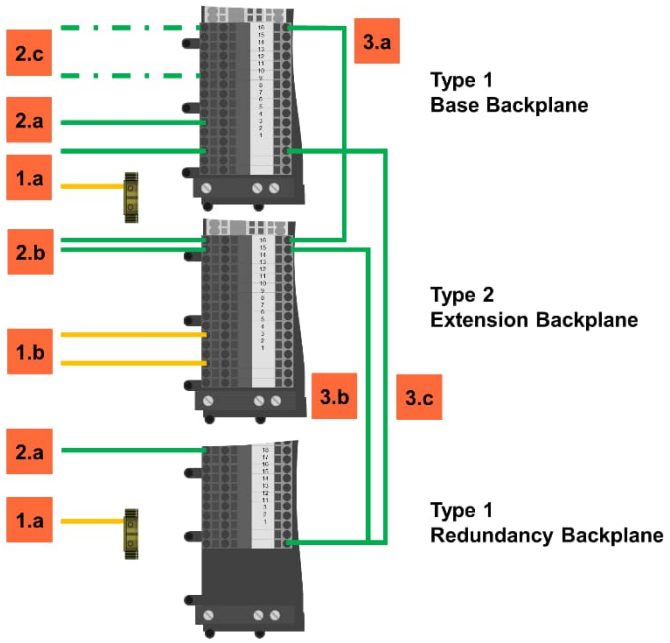
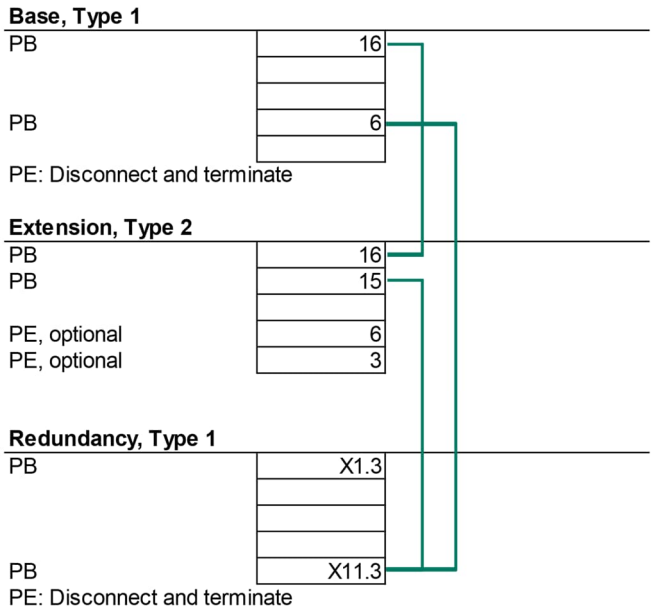
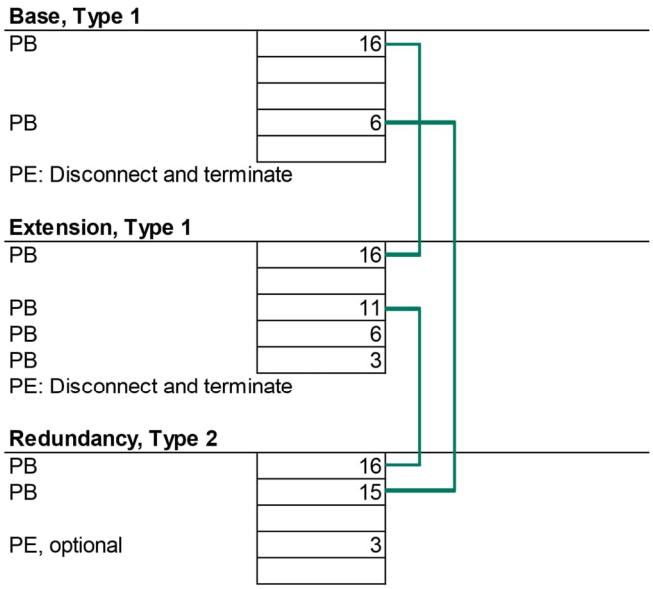


Figure 14: Connection combinations of FB backplanes FB9262BP.1 and FB9262BP*.2*

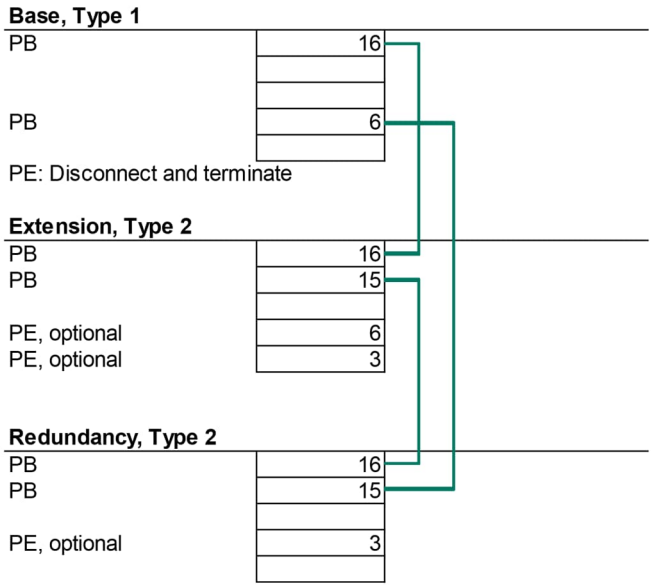
Replacement or Supplement of Extension Backplane



Replacement of Redundancy Backplane



Replacement of Extension and Redundancy Backplane



Replacement of Base Backplane

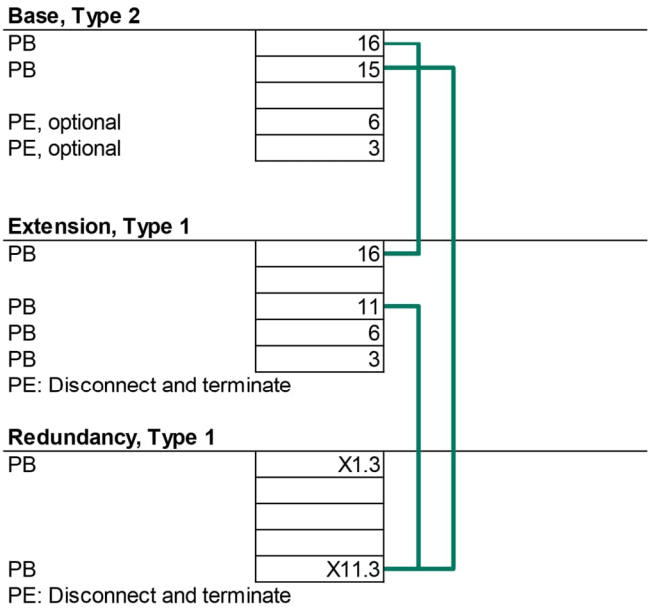


Figure 15: Connection tables for PB, PE, and shield

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