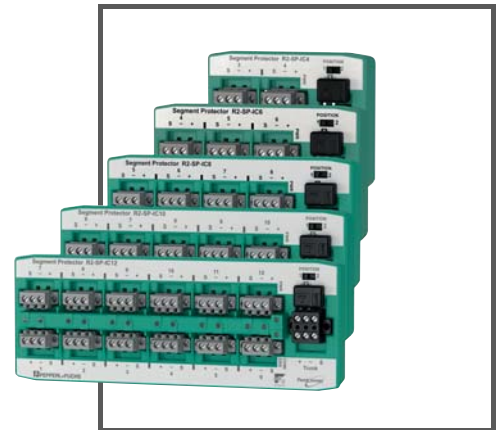


MANUAL

# Segment Protector R2-SP-IC\*



With regard to the supply of products, the current issue of the following document is applicable: The General Terms of Delivery for Products and Services of the Electrical Industry, published by the Central Association of the Electrical Industry (Zentralverband Elektrotechnik und Elektroindustrie (ZVEI) e.V.) in its most recent version as well as the supplementary clause: "Expanded reservation of proprietorship"

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# 1 Introduction

## 1.1 Contents

This document contains information that you need in order to use your product throughout the applicable stages of the product life cycle. These can include the following:

- Product identification
- Delivery, transport, and storage
- Mounting and installation
- Commissioning and operation
- Maintenance and repair
- Troubleshooting
- Dismounting
- Disposal



**Note!**

This document does not substitute the instruction manual.



**Note!**

For full information on the product, refer to the instruction manual and further documentation on the Internet at [www.pepperl-fuchs.com](http://www.pepperl-fuchs.com).

The documentation consists of the following parts:

- Present document
- Instruction manual
- Datasheet

Additionally, the following parts may belong to the documentation, if applicable:

- EC-type of examination
- EU declaration of conformity
- Attestation of conformity
- Certificates
- Control drawings
- Additional documents

## 1.2 Target Group, Personnel

Responsibility for planning, assembly, commissioning, operation, maintenance, and dismounting lies with the plant operator.

Only appropriately trained and qualified personnel may carry out mounting, installation, commissioning, operation, maintenance, and dismounting of the product. The personnel must have read and understood the instruction manual and the further documentation.

Prior to using the product make yourself familiar with it. Read the document carefully.

## 1.3 Symbols Used

This document contains symbols for the identification of warning messages and of informative messages.



## Warning Messages

You will find warning messages in instances, whenever dangers may arise from your actions. It is mandatory that you observe these warning messages for your personal safety and in order to avoid property damages.

Depending on the risk level, the warning messages are displayed in descending order as follows:



### ***Danger!***

This symbol indicates an imminent danger.

Non-observance will result in personal injury or death.



### ***Warning!***

This symbol indicates a possible fault or danger.

Non-observance may cause personal injury or serious property damage.



### ***Caution!***

This symbol indicates a possible fault.

Non-observance could interrupt the device and any connected systems and plants, or result in their complete failure.

## Informative Symbols



### ***Note!***

This symbol brings important information to your attention.



### **Action**

This symbol indicates a paragraph with instructions. You are prompted to perform an action or a sequence of actions.

## 2 Product Specifications

### 2.1 Overview and Application

The R2-SP-IC\* Segment Protectors are part of a new family of bus powered, fault-tolerant device couplers used for the connection of field devices to segments.

The Segment Protectors contain LED indicators for easy communication monitoring and diagnostics. The LEDs indicate:

- Bus communication activity
- Physical layer diagnostic status
- Power on the trunk
- A short circuit condition or fault at any connected spur (each spur is equipped with an individual LED)

The Segment Protectors are designed for fieldbus systems in accordance with IEC 61158-2 (FOUNDATION H1 or PROFIBUS PA) and in accordance with the FOUNDATION Fieldbus device coupler test specification FF-846.

Communication and power distribution share the same 2-wire cable using Manchester Bus Powered (MBP) coding.

#### **Mounting and enclosure of R2-SP-IC\* Segment Protectors**

The Segment Protector is designed for DIN mounting rail installation with simple snap-on hooks included. It can be installed in a fieldbus junction box or a control cabinet. Various choices or tailored enclosure solutions are offered by Pepperl+Fuchs.

#### **Connection layout**

**Spurs:** Each field device is connected to 1 output or spur, and 1 or more Segment Protector(s) are connected to the segment or trunk. R2-SP-IC\* offers the choice from 4...12 spur connections.

**Trunk:** The Segment Protector is connected to the trunk via a T-connector. Exchange and modification of one Segment Protector is possible while the segment is still in operation without affecting other parts of the same segment.

All connectors are available as screw or spring terminals. The terminals feature plugs with retaining screws, giving fieldbus-in-process-automation the necessary durability and availability.

#### **Type of protection**

The Segment Protector is certified for installation in Zone 2. Using Pepperl+Fuchs Segment Protectors in combination with Pepperl+Fuchs fieldbus power supplies allows you to perform live maintenance at the field device level in Zone 2 because the outputs are either classified Entity Ex ic or FISCO ic.

#### **Monitoring and diagnostic options**

The R2-SP-IC\* Segment Protector series are the first to offer device-level integrated physical layer diagnostics as a standard. Most important physical layer parameters, such as communication signal levels and signal jitter for each participating field device are monitored and compared to limit values that are mainly derived from the IEC 61158-2 physical layer specification or from empirical data.

A fault summary status alarm is shown on the Segment Protector through an LED indicator and can be issued in detail, i.e., via specific field device diagnostics using an advanced diagnostic module, positioned in the specific working environment of a process control system.

### **Receptacles for the mobile advanced diagnostic module or similar**

By default, receptacles for measuring tools such as the mobile advanced diagnostic module are included. This way, maintenance and commissioning personnel can conduct measurements in the field without the need for wiring tools and the wiring is never disturbed.

### **Failure condition handling (short circuit limitation and beyond)**

The design of the R2-SP-IC\* Segment Protector series focuses on fault tolerance towards failure conditions on the spur/field device level threatening the entire segment to fail.

Each spur is equipped with short circuit current limitation with unique features:

- **Spur contact bounce protection:** Protects the segment from continuous or intermittent current changes due to poorly attached, fractured, or loose fieldbus wires at a spur. When under vibration, wires can keep connecting and disconnecting to the attached field device load. The Pepperl+Fuchs spur contact bounce protection protects the fieldbus communication from permanent disturbances, and safeguards the segment against failure.
- **Progressive spur short circuit current limitation:** Avoids segment failure in situations where the spur current progressively rises, e.g., if water ingresses in the terminal arrangement, leading to increasing conductivity between the fieldbus wires and causing the current limiting electronics to dampen the communication signals due to increasing impedance. The Pepperl+Fuchs Segment Protector safely isolates any affected spur in order to prevent a total segment failure.
- **Device jabber protection:** Specific software or hardware failures can cause the field device to communicate continuously (jabber). The Pepperl+Fuchs Segment Protector has an integrated device jabber inhibitor that first detects faults caused by device jabber, and then immediately isolates the faulty device from the segment.

If a spur has a short circuit or failure, the fieldbus trunk and all other field devices remain in operation. When the fault is repaired, the Segment Protector automatically resumes normal operation of the spur.

These features, combined with overvoltage protection at 39 V, make segments reliable.

### **Surge protection for R2-SP-IC\* Segment Protectors**

Optional pluggable surge protection modules for the trunk and spur cables are available. The modules are designed to replace the individual connectors at the trunk and the spurs. This way, surge protection components can be installed in existing cabinets without the need for additional space or fixings.

Specific versions of surge protectors include a unique diagnostic function for predictive maintenance of the surge protectors themselves. Predictive failures are communicated through Pepperl+Fuchs advanced physical layer Infrastructure, enabling the maintenance engineer to change defective units before they start to adversely influence fieldbus communication. Being an integral part of the segment, the Pepperl+Fuchs advanced physical layer infrastructure does not require any scheduled manual maintenance activity.

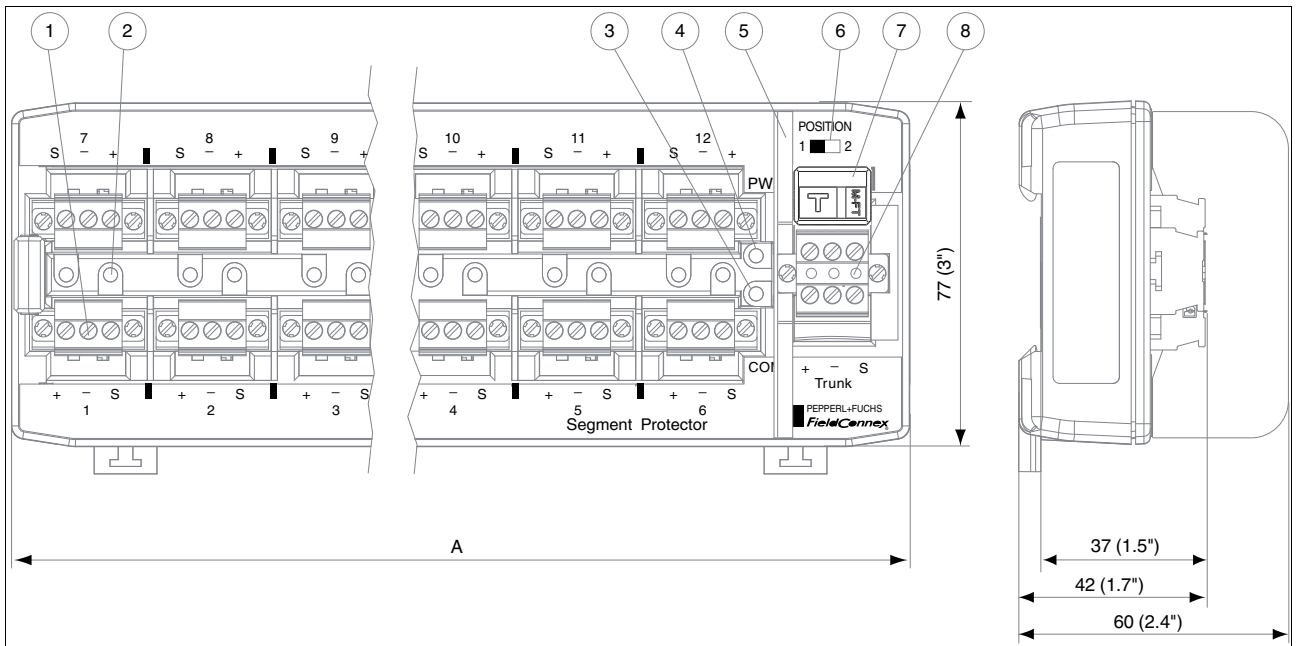
### **Fieldbus termination for R2-SP-IC\* Segment Protectors**

By default, a terminator with a high-availability design is included. A terminator is mounted at the very end of the segment or trunk. The last Segment Protector on the segment has open terminals at the T-connector where the terminator is installed. This design increases fieldbus availability in 2 ways:

1. The connection is secured by screws
2. Overtermination resulting in reduced signal levels is avoided: the termination is clearly visible for installation personnel and can only be connected at the end of the trunk line



## 2.2 Component Identity



- A** Height see table "Technical Data Depending on Model" on page 11
- 1** Spur 1 connector
- 2** LED ERR Spur 1 (red, short circuit)
- 3** LED COM/ERR (communication/diagnostics)
- 4** LED PWR (power)
- 5** Separation wall ACC-R2-SW.3
- 6** Switch, short circuit current selection
- 7** Terminator M-FT, removable
- 8** Trunk connection (T-connector T-CON.3)

All dimensions in millimeters (mm) and inch (") without tolerance indication




**Note!**


For characteristic values regarding hazardous areas, refer to the Statement of Conformity.

## 2.3 Technical Data R2-SP-IC\*

Technical Data	
<b>Fieldbus interface</b>	
Main cable (Trunk)	
Rated voltage	9 ... 31 V DC 10.5 V DC minimum input voltage acc. to FF-846
Rated current	max. 4.5 A
<b>Outputs</b>	
Rated voltage	max. 31 V
Rated current	max. 32 mA switch 1, position 1 max. 43 mA switch 1, position 2
Short-circuit current	46 mA switch 1, position 1 65 mA switch 1, position 2

<b>Technical Data</b>	
Voltage drop main cable/outputs	max. 1.2 V
Voltage drop trunk In/Out	0 V
Terminating resistor	external type M-FT 100 $\Omega$ +/- 10 %
Surge protection	Trunk overvoltage protection if voltage exceeds typ. 39 V, max. 41 V
<b>Indicators/operating means</b>	
Switch	configuration of short-circuit current/rated current
LED PWR	green: Fieldbus voltage > 10 V and fieldbus terminator is deactivated
LED COM/ERR	yellow: flashing: fieldbus communication status and physical layer diagnostic status
LED SPURS	red: 2 Hz flashing in short-circuit condition
<b>Directive conformity</b>	
Electromagnetic compatibility	
Directive 2004/108/EC	EN 61326-1:2013
<b>Standard conformity</b>	
Electromagnetic compatibility	NE 21:2011
Degree of protection	IEC 60529
Fieldbus standard	IEC 61158-2
Climatic conditions	IEC 60721
Shock resistance	EN 60068-2-27
Vibration resistance	EN 60068-2-6
<b>Ambient conditions</b>	
Ambient temperature	-50 ... 70 °C (-58 ... 158 °F)
Storage temperature	-50 ... 85 °C (-58 ... 185 °F)
Relative humidity	< 95 % non-condensing
Shock resistance	15 g 11 ms
Vibration resistance	1 g , 10 ... 150 Hz
Corrosion resistance	acc. to ISA-S71.04-1985, severity level G3
<b>Mechanical specifications</b>	
Connection type	pluggable , screw terminal or spring terminal
Housing material	Polycarbonate
Degree of protection	IP20
Mounting	DIN rail mounting
<b>Data for application in connection with Ex-areas</b>	
EC-Type Examination Certificate	TÜV 12 ATEX 098651 X
Group, category, type of protection, temperature class	 II 3 G Ex nAc [ic] IIC T4
<b>Supply</b>	
Maximum safe voltage	35 V
<b>Outputs</b>	
Voltage	32 V

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Technical Data	
Current	46 mA switch 1, position 1 65 mA switch 1, position 2
Inductance	0.125 mH switch 1, position 1 0.25 mH switch 1, position 2
Capacitance	60 nF
Directive conformity	
Directive 94/9/EC	EN 60079-0:2009 , EN 60079-11:2012 , EN 60079-15:2010
International approvals	
UL approval	E326119
Control drawing	116-0406
Approved for	Class I, Division 2, Groups A, B, C, D
IECEX approval	IECEX TUN 12.0015X
Approved for	 Ex nAc [ic] IIC T4
Certificates and approvals	
Marine approval	DNV A-14038

#### Technical Data Depending on Model

	R2-SP-IC4*	R2-SP-IC6*	R2-SP-IC8*	R2-SP-IC10*	R2-SP-IC12*
Number of outputs	4	6	8	10	12
Height	93 mm (3.7")	121 mm (4.7")	148 mm (5.8")	177 mm (7")	205 mm (8")
Mass	130 g	180 g	230 g	280 g	330 g
Quiescent current	max. 15 mA	max. 17 mA	max. 17 mA	max. 19 mA	max 19 mA
Power loss at 31 V input	470 mW **	530 mW **	530 mW **	590 mW **	590 mW **
** + 10 mW per spur at 20 mA load					

Table 2.1 Technical data depending on model

### 3 Hazardous Area Installation and Use



**Danger!**

Risk of explosion through damaged electronic components

Premature wear of electronic components in a device that was previously used in a general electrical system can cause sparks that can ignite the surrounding atmosphere.

Never install devices that have already been operated in general electrical systems in electrical systems used in combination with hazardous areas!

#### 3.1 Installation in Zone 2, no Live Maintenance at Trunk and Spurs (Ex nAc)

For non-intrinsically safe Zone 2 circuits, live maintenance on the trunk or spurs must only be carried out with hot work permit.

No special safety requirements exist for the host interface provided the host itself is installed in the safe area. If the host interface is installed in Zone 2, a declaration of conformity must be provided.

Field devices and Segment Protectors are located in Zone 2 and therefore need to be certified for non-sparking protection (Ex nAc). If the fieldbus power supplies are also located in hazardous area Zone 2, the same requirements apply.

The evaluation of a non-sparking circuit is limited to the maximum voltage of the fieldbus power supply ( $U_o$ ) which has to be less than or equal to the maximum rated input voltage  $U_i$  of the Segment Protector and field devices. Field devices and Segment Protectors following this requirement could be either certified for non-sparking apparatus equipment or intrinsically safe apparatus according to Entity or FISCO.

For the requirements for typical fieldbus products for use in Zone 2 installations refer to the manual: 'Using Pepperl+Fuchs fieldbus equipment in Zone 2 hazardous area environment'. This document is supplied separately and can be obtained from the Pepperl+Fuchs Internet product database.

#### 3.2 Installation in Zone 2 with Live Maintenance at the Spurs (Ex ic, FISCO ic)



**Danger!**

Risk of explosion through exposed conductors

Exposed conductors of inadequately fixed cables can cause sparks that can ignite the surrounding atmosphere.

When installing the device ensure that the cables are securely fixed.

For applications requiring certified output voltages at the spurs in accordance with IEC 60079-25 (rated as Ex ic or FISCO ic), two solutions are available:

1. The use of dedicated fieldbus power supply modules which safely limit the output voltage in accordance with IEC 60079-25, using a maximum output voltage level of  $U_o \leq 24$  V. The current is limited by the Segment Protector.
2. To take into account the Segment Protector internal voltage limitation, in accordance with IEC 60079-25, using a maximum output voltage level of  $U_o \leq 32$  V. The current is limited by the Segment Protector.

### 3.2.1 Spur Voltage Limited by the External Fieldbus Power Supply $U_o \leq 24V$ , Entity Examination

When using intrinsically safe fieldbus power supplies to directly limit the spur output safety voltage, it is necessary to pay particular attention to the type of fieldbus power supply selected for use with the Segment Protector. This determines the type of Zone 2 or Div. 2 installations and the certified field devices that can be connected, in the Zone 2 or Div. 2 area, to the spurs of the Segment Protector.

A check must be performed to ensure that the correct type of power supply module is used for the required safety output parameters. For example, the output voltage must be equal to, or less than the maximum voltage of the connected field devices.

When a power supply with  $U_o \leq 24 V$  is used, the resulting allowed safety output values for gas groups IIC, IIB, IIA at the spurs are:

#### **R2-SP-IC\* allowed safety output values:**

- $U_o = 24 V$ ,  $I_o = 65 mA$ ,  $L_o = 0.25 mH$ ,  $C_o = 60 nF$  (switch 1 in position 2).

The safety evaluation follows the Entity model defined in EN 60079–11.

Requirements for typical fieldbus products for use in Zone 2 installations are summarized in the manual: 'Using Pepperl+Fuchs fieldbus equipment in Zone 2 hazardous area environment. This document is supplied separately and can be obtained from Pepperl+Fuchs Internet product database.

### 3.2.2 Spur Voltage Limited by the Segment Protector

The fieldbus trunk is rated as non-sparking Ex nAc. Live maintenance at the trunk is only permitted with a hot work permit. The Segment Protector includes an internal voltage limitation in accordance with IEC 60079–25, using a maximum output voltage level of  $U_o \leq 32 V$ . If the internal voltage limitation of  $U_o \leq 32 V$  is used, it is required to determine the hazardous location related to the gas group in which the Segment Protector will be installed.

A switch determines the setting of two different maximum short circuit currents, one for gas group IIC, and one for gas group IIB. The spur outputs are rated as intrinsically safe Ex ic.



#### ***Danger!***

Risk of explosion through sparking

Using operating elements in a potentially explosive atmosphere can cause sparks that can ignite the surrounding atmosphere.

Only use operating elements (e.g., switch, slider, button, etc.) in the absence of a potentially explosive atmosphere.



#### ***Danger!***

Risk of explosion through material damage of an operating element

Using operating elements outside of the specified ambient temperature range can lead to material damage, e.g., increased porosity, etc. resulting in an unwanted failure of the functionality of the element. This can result in an increased explosion hazard in potentially explosive atmospheres.

Only use operating elements in the specified ambient temperature range.  
Temperature range:  $-5\text{ C}^\circ \dots +70\text{ C}^\circ$

Max. voltage $U_o$	Gas groups	Short circuit current $I_o$	Capacitance $C_o$	Inductance $L_o$	Switch 1 position
32 V, internal limitation	IIC	46 mA	60 nF	0.125 mH	Position 1
32 V, internal limitation	IIB/IIA	65 mA	60 nF	0.25 mH	Position 2
$\leq 24V$ , trunk voltage limitation	IIC/IIB/IIA	65 mA	60 nF	0.25 mH	Position 2

The requirements for typical fieldbus products for use in Zone 2 installations are summarized in the manual: 'Using Pepperl+Fuchs fieldbus equipment in Zone 2 hazardous area environment'. This document is supplied separately and can be obtained from Pepperl+Fuchs Internet product data base.

### 3.2.3 Spur Voltage Limited by the External Fieldbus Power Supply, FISCO Examination

When using intrinsically safe fieldbus power supplies to directly limit the spur output safety voltage, it is necessary to choose a suitable fieldbus power supply for use with the Segment Protector. The power supply used determines the type of Zone 2 or Division 2 installations and the certified field devices that can be connected to the spurs of the Segment Protector in the Zone 2 or Division 2 area.

A check must be performed to ensure that the correct type of power supply module is used for the required safety output parameters. For example, the output voltage must be equal to or less than the maximum voltage of the connected field devices.

In case a power supply with  $U_o \leq 17.5 V$  is used, the resulting safety output values for gas groups IIC, IIB, IIA at the spurs that are permitted, are:

- $U_o = 17.5 V$ ,  $I_o = 65 mA$ ,  $L_o = 0.25 mH$ ,  $C_o = 60 nF$  (switch 1 in position 2)

The safety evaluation follows the FISCO concept defined in EN60079-11.

The parameters of the cable used must be within the following ranges:

- $R' = 15...150 \text{ Ohm/km}$  (loop resistance)
- $L' = 0.4...1 \text{ mH/km}$
- $C' = 45...200 \text{ nF/km}$  (incl. a possibly existing shield)
- $C' = C'_{\text{wire/wire}} + 0.5 * C'_{\text{wire/shield}}$  (with floating field apparatus)
- $C' = C'_{\text{wire/wire}} + C'_{\text{wire/shield}}$  (if the shield is connected to one pole of the fieldbus devices supply circuit)

From the safety point of view, the maximum length of the Segment Protector spur cable is 1000 m for IIC and 5000 m for IIB, as each spur output is specified as an independent FISCO source.

Requirements for typical fieldbus products for use in Zone 2 installations are summarized in the manual: 'Using Pepperl+Fuchs fieldbus equipment in Zone 2 hazardous area environment'. This document is supplied separately and can be obtained from Pepperl+Fuchs Internet product data base.

## 4 Installation and Commissioning

In the following section you find information on how to install and commission the device in your fieldbus topology.



**Danger!**

Risk of explosion through exposition to gas atmosphere

If the device is installed in Zone 2 without mounting it in a sufficiently suitable enclosure, dust, water or other external interferences can cause the live device to spark. The sparks can ignite the surrounding atmosphere.

Only mount the device in an enclosure with degree of protection IP54 according to IEC/EN 60529. The enclosure must have a declaration of conformity according to 94/9/EC for at least category 3G.



**Danger!**

Risk of explosion through exposition to dust atmosphere

If the device is installed in Zone 22 without mounting it in a sufficiently suitable enclosure, dust, water or other external interferences can cause the live device to spark. The sparks can ignite the surrounding atmosphere.

Only mount the device in a suitable enclosure. The enclosure must have a declaration of conformity according to 94/9/EC for at least category 3D.



**Danger!**

Risk of explosion through live wiring

If you connect or disconnect energized non-intrinsically safe circuits in a hazardous atmosphere, sparks can ignite the surrounding atmosphere.

Only connect or disconnect energized non-intrinsically safe circuits in the absence of a hazardous atmosphere.



**Note!**

**Read the instruction manual first!**

Before you install and commission this product: Read the instruction manual for this product carefully. Make sure you understand all contents that are relevant for your application.

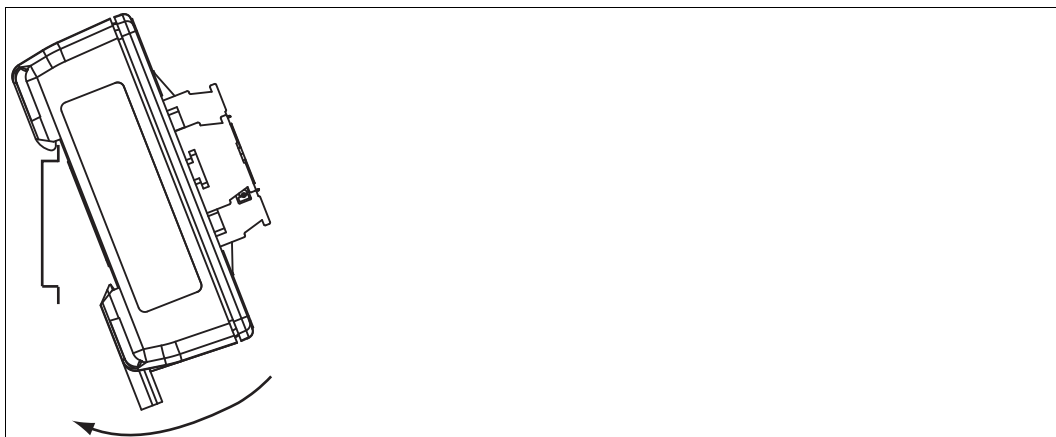
### 4.1 Mounting and Dismounting

The following chapter describes how to mount or dismount the device and how to attach a separation wall if required.

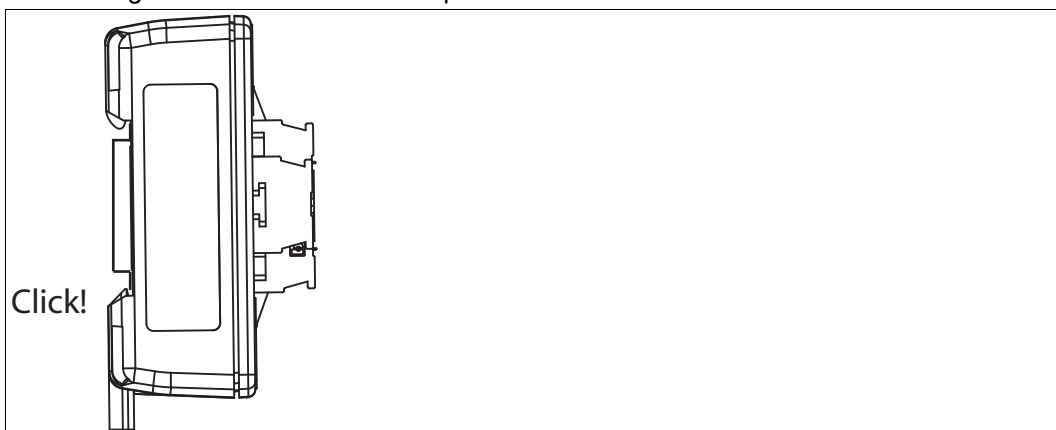


### Mounting the Segment Protector on a DIN Mounting Rail

1. Place the Segment Protector on the DIN mounting rail.
2. Gently press the Segment Protector to the DIN mounting rail until it is locked in place.



↳ The Segment Protector clicks into place.



### DIN Rail Mounting

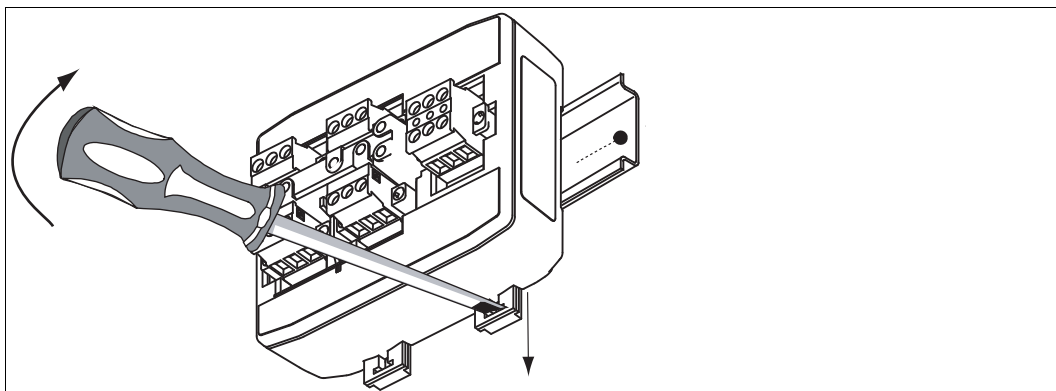
Ensure that the device coupler is fixed firmly on the DIN mounting rail.

The device coupler must mesh firmly with the DIN mounting rail.



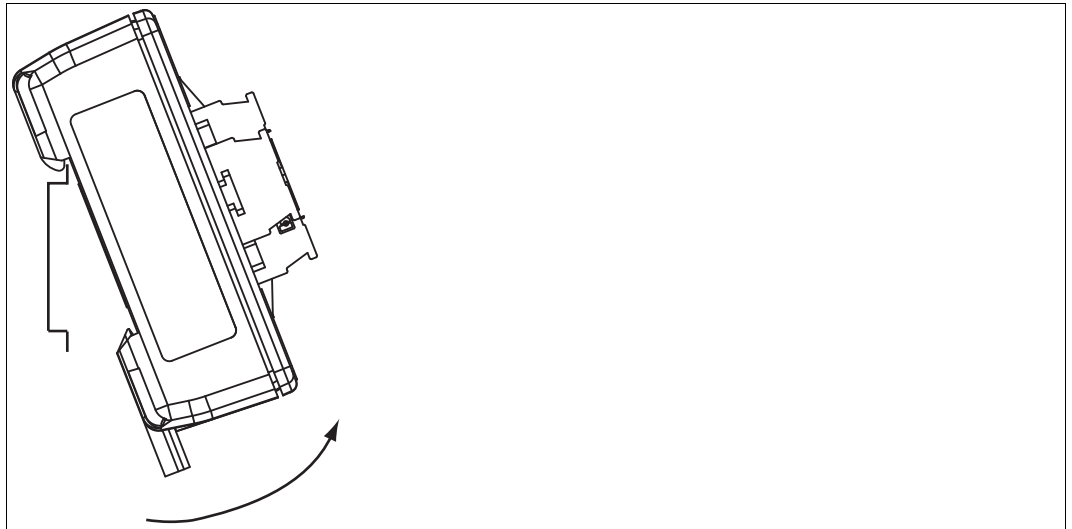
### Dismounting the Segment Protector

1. Use a slotted screwdriver to open both latches.





2. Then lift up the device in a semicircular motion.



#### 4.1.1 Separation Wall to Provide Intrinsic Safety (Ex ic)

To generate Ex ic rated spur outputs for Pepperl+Fuchs Segment Protectors in combination with Fieldbus Power Supplies, a separation wall must be positioned inside the Segment Protector. The separation wall is available as accessory. The separation wall is a mandatory prerequisite to ensure the required clearance of 50 mm between the trunk terminals and the spur terminals.



#### **Danger!**

Risk of explosion through insufficient type of protection

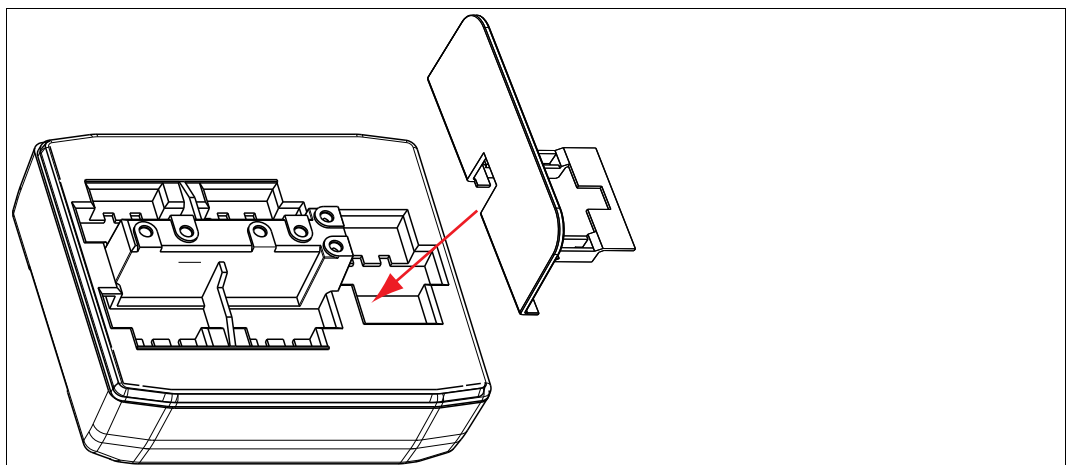
Using outputs with the insufficient type of protection can cause sparks or other hazards for potentially explosive atmospheres that can ignite the surrounding atmosphere.

For the Segment Protector to generate intrinsically safe (Ex ic) outputs according to IEC/EN 60079-11, use the specified accessories.  
Accessory: ACC-R2-SW.3

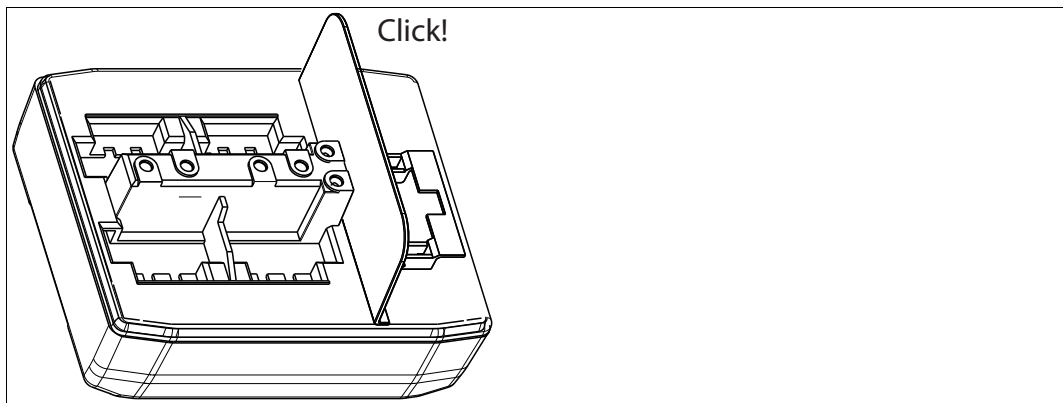


#### Mounting the Separation Wall

1. Remove the T-connector.
2. Press the separation wall (ACC-R2-SW.3) into the gap of the T-connector.



3. Make sure that it is locked in place.

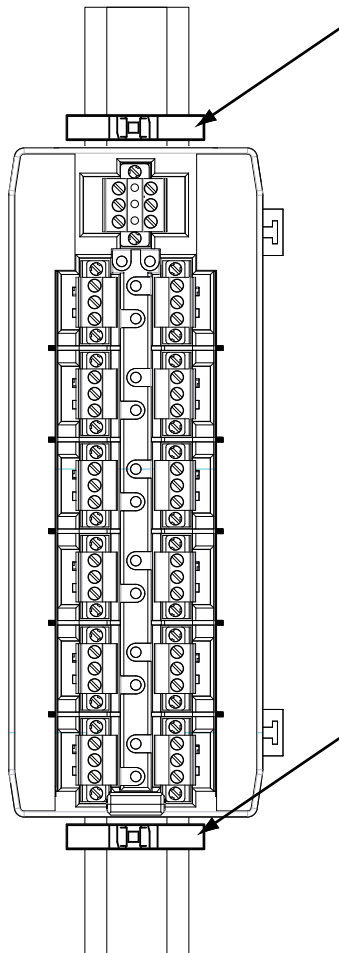


4. Remount the T-connector and fasten the retaining screws.

#### 4.1.2

### Additional Information on Vertical Mounting

If a Segment Protector is mounted vertically, use end brackets / end clamps on both sides of the Segment Protector to prevent shifting of the device.



Pepperl+Fuchs recommends using the following Phoenix Contact parts:

- Clipfix 35, snap-on end bracket, PHOENIX CONTACT part no: 3022218
- E/UK, screw-fastening end bracket, PHOENIX CONTACT part no: 1201442

For further information please refer to [www.phoenixcontact.com](http://www.phoenixcontact.com).

## 4.2 Segment Protector Connection Layout of the Trunk



### **Danger!**

Risk of explosion through exposed conductors

Exposed conductors of inadequately fixed cables can cause sparks that can ignite the surrounding atmosphere.

When installing the device ensure that the cables are securely fixed.



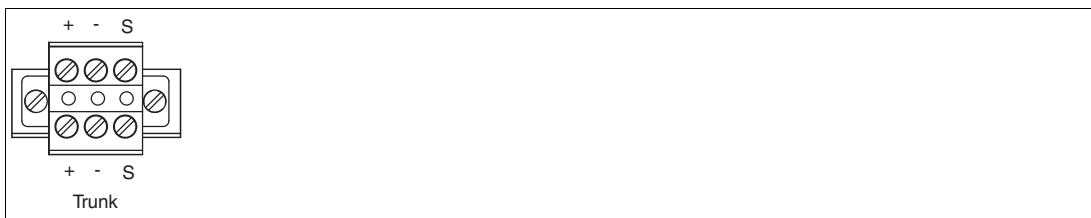
### **Danger!**

Risk of connection damage and resulting increased explosion hazard

Manipulating connections outside of the specified ambient temperature range can lead to material damage, resulting in an unwanted failure of the functionality of the connection. This could result in an increased explosion hazard in potentially explosive atmospheres.

Only manipulate connections in the specified ambient temperature range.  
Temperature range: -5 C° ... +70 C°

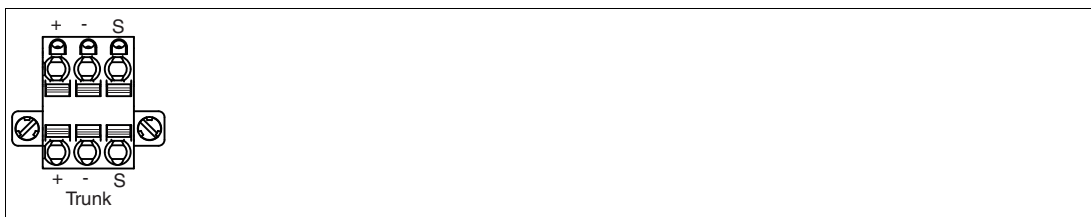
### Trunk Connection with Screw Terminal



Screw terminal trunk connection

- + Segment +
- Segment -
- S Shield connection

### Trunk Connection with Spring Terminal



Spring terminal trunk connection

- + Segment +
- Segment -
- S Shield connection

Important: Fix the trunk terminals with screws to protect the terminals from loosening.

### Screw Terminals: Cable and Connection Information

- Permissible wire core section:
  - Screw terminals with flexible or rigid wires: 0.2-2.5 mm<sup>2</sup>
- Insulation stripping length: 7 mm
- If you use stranded connectors: Crimp on wire end ferrules

- Ensure that connectors are mechanically locked
- Torque required for tightening terminal screws: 0.4-0.5 Nm

### Spring Terminals: Cable and Connection Information

- Permissible wire core section:  
- Spring terminals with flexible or rigid wires: 0.5-2.5 mm<sup>2</sup>
- Insulation stripping length: 10 mm
- Ensure that connectors are mechanically locked
- Torque required for tightening terminal screws: 0.4-0.5 Nm

## 4.3 Segment Protector Connection Layout of the Spurs



### **Danger!**

Risk of explosion through exposed conductors

Exposed conductors of inadequately fixed cables can cause sparks that can ignite the surrounding atmosphere.

When installing the device ensure that the cables are securely fixed.



### **Danger!**

Risk of connection damage and resulting increased explosion hazard

Manipulating connections outside of the specified ambient temperature range can lead to material damage, resulting in an unwanted failure of the functionality of the connection. This could result in an increased explosion hazard in potentially explosive atmospheres.

Only manipulate connections in the specified ambient temperature range.  
Temperature range: -5 C° ... +70 C°

### Spur Connection with Screw Terminal



Spur connectors

- + Spur +
- Spur -
- S Shield connection

### Spur Connection with Spring Terminal



- + Segment +
- Segment -
- S Shield connection

### Screw Terminals: Cable and Connection Information

- Permissible wire core section:
  - Screw terminals with flexible or rigid wires: 0.2-2.5 mm<sup>2</sup>
- Insulation stripping length: 7 mm
- If you use stranded connectors: Crimp on wire end ferrules
- Ensure that connectors are mechanically locked
- Torque required for tightening terminal screws: 0.4-0.5 Nm

### Spring Terminals: Cable and Connection Information

- Permissible wire core section:
  - Spring terminals with flexible or rigid wires: 0.5-2.5 mm<sup>2</sup>
- Insulation stripping length: 10 mm
- Ensure that connectors are mechanically locked
- Torque required for tightening terminal screws: 0.4-0.5 Nm

## 4.4 Grounding / Shielding of Fieldbus Transmission Lines

All shields of the fieldbus transmission lines (trunks and spurs) are connected together inside the Segment Protector, they have no connection to ground or DIN mounting rail.



#### **Danger!**

Risk of explosion through invalidation of type of protection

Grounding or shielding of signal lines of spurs can apply excessive amounts of energy to intrinsically safe circuits. As a result, intrinsically safe circuits can overload connected field devices that can produce sparks, or the circuits themselves can produce sparks. In both cases, this can lead to the ignition of the surrounding atmosphere.

Never connect signal lines to cable shield or earth.

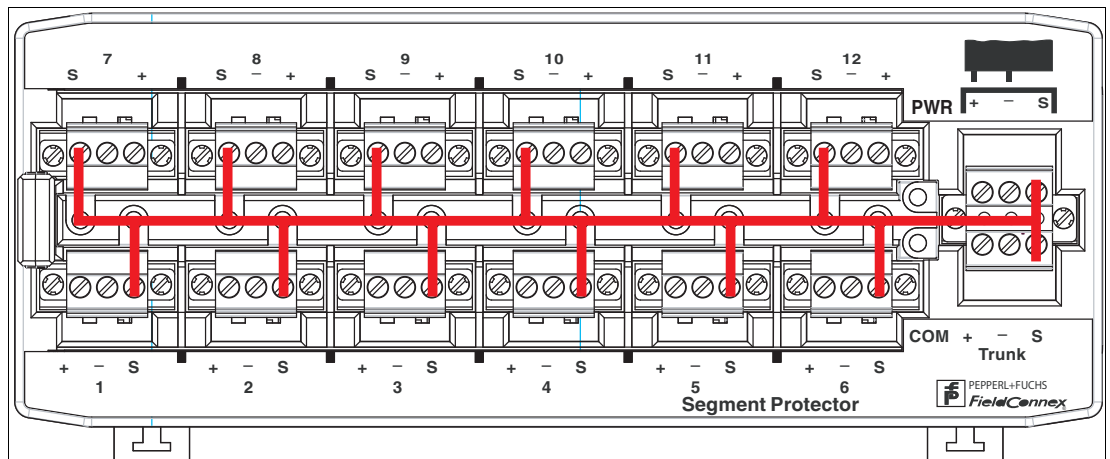


Figure 4.1 Stylized composition of the shield lines inside the Segment Protector

If EMC requires you to ground the shield of the trunk or of the spurs of a fieldbus transmission line, closely adhere to the information valid for this situation. For details refer to EN 60079-14 and to the corresponding information of the respective fieldbus type in use. Information on the fieldbus type is found in the PROFIBUS PA User and Installation Guideline or FOUNDATION Fieldbus H1 Application Guides.

## 4.5 Series Connection and Termination

In order to connect several Segment Protectors in series, loop the trunk line through the T-connector.

For exchange or maintenance of a Segment Protector within a series connection, pull off the respective T-connector without loosening the trunk lines. This way, the power supply of the other Segment Protectors will remain unaffected.

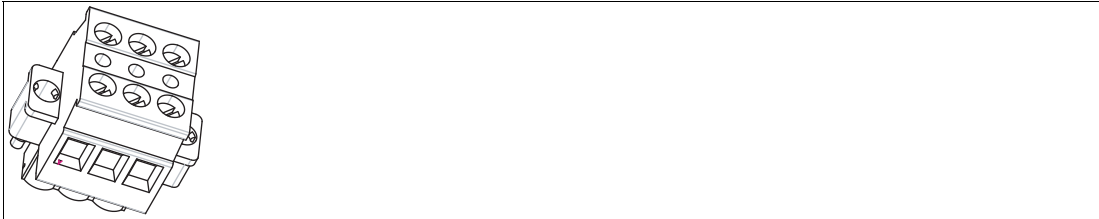


Figure 4.2 T-connector screw terminal for trunk and terminator connection



Figure 4.3 T-connector spring terminal for trunk and terminator connection

To provide segment termination: Plug in the terminator (included in delivery) at the last T-connector of the segment.

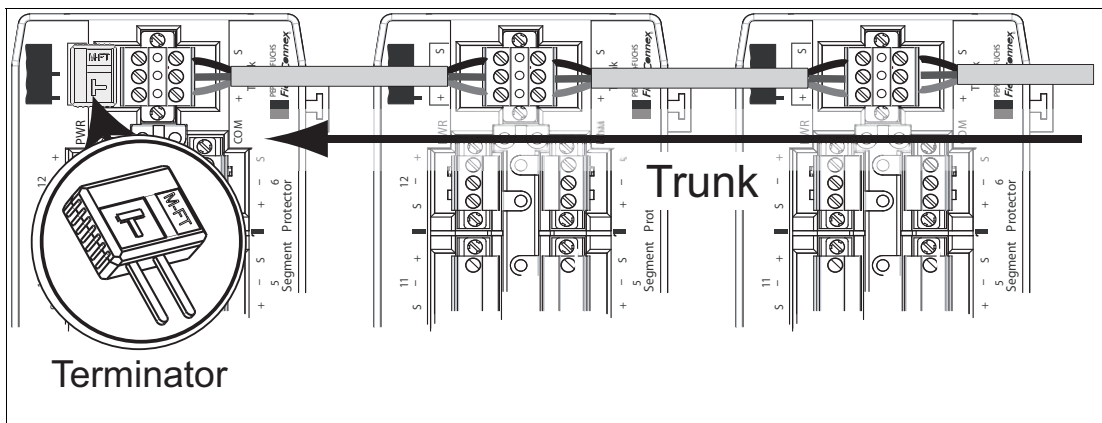


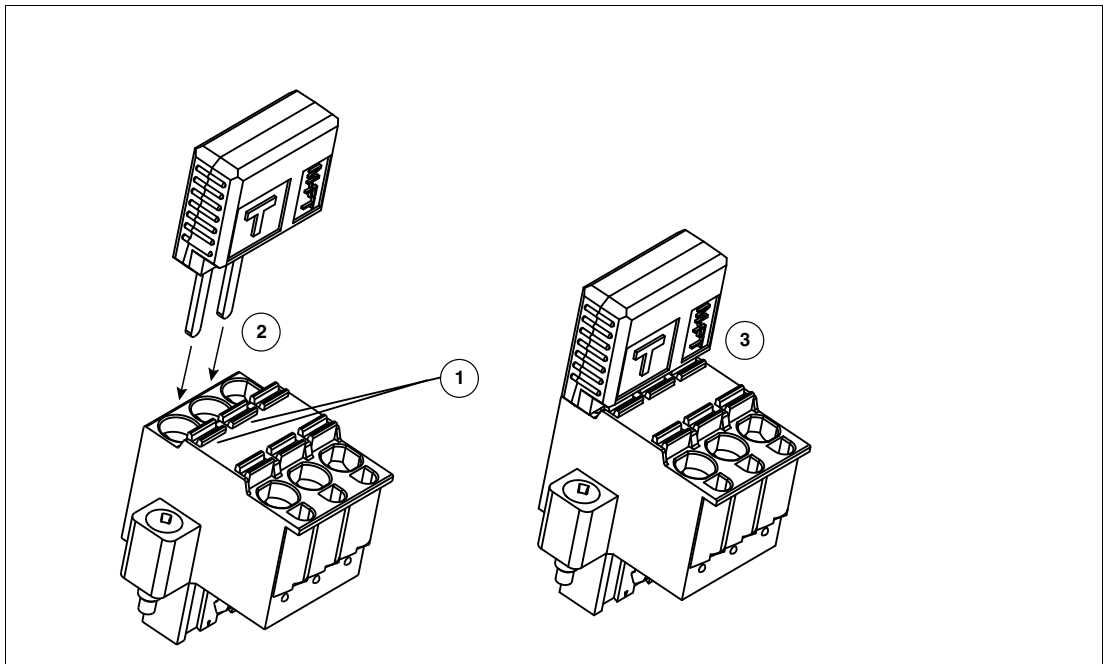
Figure 4.4 Stylized series connection and termination



**Note!**

As wrong termination may cause communication problems, make sure that each trunk is terminated with a terminator at each end of the trunk line (i.e., 2 terminators in total).

### Terminating a Spring Trunk Terminal



1. Plug in the M-FT terminator using the 2 entries shown in the picture.
2. Push down the M-FT.
3. Ensure that the M-FT is fully plugged in as shown.

In order to remove the M-FT, proceed as follows: Use a tool, e.g., a screw driver, to press down the 2 springs of the terminal shown in the picture. Press down both springs simultaneously and pull out the M-FT.

Note that the M-FT is included in the delivery.

## 5 Operation

### 5.1 Indicators

The Segment Protectors include the following LEDs:






- 1 LED as indicator for power on the trunk
- 1 LED as indicator for bus communication activity and the physical layer diagnostic status
- Up to 12 LEDs for up to 12 spurs as short circuit condition or fault indicator for each output (spur)

#### Trunk power LED PWR:

If the fieldbus trunk voltage exceeds 10 V, the LED is ON.

#### Diagnostic State LED COM:

Depending on the diagnostic state, the diagnostic LED is either ON or flashing. For further information, see chapter 5.2.

Diagnostic State	Diagnostic LED Enunciation	LED Sequence
No communication	LED: OFF	
Communication active	LED: ON	
Maintenance required	LED: 1 pulse per second	
Out of Specification	LED: 2 close pulses per second	
Auxiliary alarms: ■ ELS-1 water sensor alarm ■ *LBF-IA1*, Surge Protector alarm	LED: 3 close pulses per second	

#### Spur fault LED:

If the spur current exceeds its maximum short circuit current, the spur fault LED is switched ON.

### 5.2 Fault Detection, Physical Layer Diagnostics

The device coupler can monitor the important physical layer parameters for each participating field device, e. g., communication signal levels and signal jitter. The monitored values are compared to fixed-limit values derived from the IEC 61158-2 physical layer specification or from empirical data.

After a fault or deviation has been detected, a single yellow LED serves as fault indicator at the respective device coupler. For more information see chapter 5.1

Using Pepperl+Fuchs "Advanced Physical Layer" solutions, e. g., the diagnostic module HD2-DM-A, show the diagnostic state of the individual device in the specific working environment of the process control system. For more information, consult the documentation of the respective diagnostic product.

#### 5.2.1 Device Signal Level

In order to detect the following kind of faults or problems, device signal level monitoring and diagnostics are important:

- Incorrect segment termination
- Improper trunk or spur wiring
- Loose wires
- Water ingress in the device coupler or field device housing



The monitoring alarm setpoints are:

Signal level 'Maintenance required':	$U_{pp} \leq 300 \text{ mV}$ or $U_{pp} \geq 1200 \text{ mV}$
Signal level 'Out of Specification':	$U_{pp} \leq 200 \text{ mV}$ or $U_{pp} \geq 1300 \text{ mV}$

Where **U<sub>pp</sub>** is the peak-to-peak signal level

## 5.2.2 Device Signal Jitter

The device signal jitter is the deviation from the ideal timing of the communication signal. In fieldbus technology, jitter is the deviation of the ideal zero crossing point of the transmitted signal curve during the nominal bit duration. This deviation is measured in relation to the previous zero crossing, i. e., the reference event.

The device signal jitter is the most important parameter to monitor where the noise can influence the signal.

The monitoring alarm setpoints are:

Jitter level "Maintenance required":	$t \geq 3.5 \mu\text{sec}$ and $t \leq 5 \mu\text{sec}$
Jitter level "Out of Specification":	$t \geq 5 \mu\text{sec}$

Where **t** is the jitter error in time

## 5.3 Fault Isolation

### 5.3.1 Short Circuit Current Limitation (Static Fault Protection)

The spur short circuit current limitation is designed to protect the entire segment from failing by limiting the spur current from a direct short circuit (static protection). If the short circuit current condition exceeds a specified period, the spur is automatically isolated from the trunk, i. e., it does no longer receive any current.

### 5.3.2 Spur Contact Bounce Protection (Dynamic Fault Protection)

Periodic or intermittent changes in the current drawn throughout a segment can cause continuous communication failures up to a point where the segment fails. Changes in the spur current can occur during connection and disconnection of the spur wires or due to fractured or loose wires under vibration.

Conventional spur protection is only designed to protect the segment by limiting the spur current from a direct short circuit (static protection). It does not protect the segment from periodic or intermittent low-level changes in the segment current (dynamic protection).

Under vibration, insufficiently attached, fractured, or loose fieldbus wires keep connecting and disconnecting to the attached field device load. Because the spur is connected to one field device, the current does normally not increase to a value that exceeds the short circuit current. Such intermittent current disturbances are converted into corresponding voltage effects on the trunk. This could cause a temporary or total loss of communication, even leading to the loss of the segment.

The Pepperl+Fuchs Spur Contact Bounce Protection isolates a faulty spur from the segment to prevent segment failures caused by intermittent faults that are not detected by conventional spur protection device couplers.

### 5.3.3 Progressive Spur Short Circuit Current Limitation (Creeping Fault Protection)

Conventional spur protection circuits are designed to prevent segment failures during fast current changes above the rated short circuit current (direct short circuits).

Failure situations, where the spur current progressively increases, cause the current limiting electronics to dampen the communication signals due to its increasing impedance. A typical failure situation is water in the terminal arrangement with increasing conductivity between the fieldbus wires.

Oscillation sometimes occurs when a fault current is marginally above the current limiting setpoint and the electronic circuit is just operating. At this point, the voltage to the fault decreases with a resulting decrease in current that turns off the current limiting circuit. This cycle continues quite rapidly and can be amplified when a device is transmitting at the same time. The reaction during this narrow transition point is unpredictable because not every fault behaves in a repeatable way. For example, the impedance of water vs. voltage or current can be very non-linear, with the impedance further varying due to the possible impact of temperature and conductivity.

The following example shows the criticality of such a fault scenario:

A field device with an active backup – a link active scheduler (LAS) – loses communication to a host in the control room. This situation is due to the low communication signal during a progressing fault condition. The backup LAS now activates while the host LAS remains active. At this point, field devices at normally operating spurs still ‘see’ the backup LAS which is nearby, as well as the host.

With 2 active LAS on the segment, communication clashes and the segment fails.

Pepperl+Fuchs offers the progressive spur short circuit current limitation that detects slowly increasing spur current and isolates the faulty spur from the segment to prevent segment failures.

#### 5.3.4 Device Jabber Protection

Specific software or hardware failures can cause a field device to communicate continuously (jabber). In this event, the device should disconnect itself from the segment immediately.

The international fieldbus standard IEC 61158-2 requires that a field device contains a ‘jabber Inhibit’ circuit or ‘watchdog’. Up to this point, not all currently available devices support or contain the ‘jabber inhibit’ ‘watchdog’.

The Pepperl+Fuchs device couplers have a spur dependent ‘jabber inhibit’ feature to isolate a faulty field device from the segment in such events.

#### 5.4 Surge Protection

Optional surge protection modules for the trunk and spur cable are available. They are used for safeguarding the device coupler electronics against excessive surges and overvoltages.

The SCP-LBF-IA.36.IE\* spur modules replace the spur connectors where surge protection at the spur level is required.

The TCP-LBF-IA1.36.IE\* is the trunk module which replaces the T-trunk connector where surge protection on the trunk is required.



#### **Danger!**

Risk of explosion through insufficient type of protection

Using outputs with the insufficient type of protection can cause sparks or other hazards for potentially explosive atmospheres that can ignite the surrounding atmosphere.

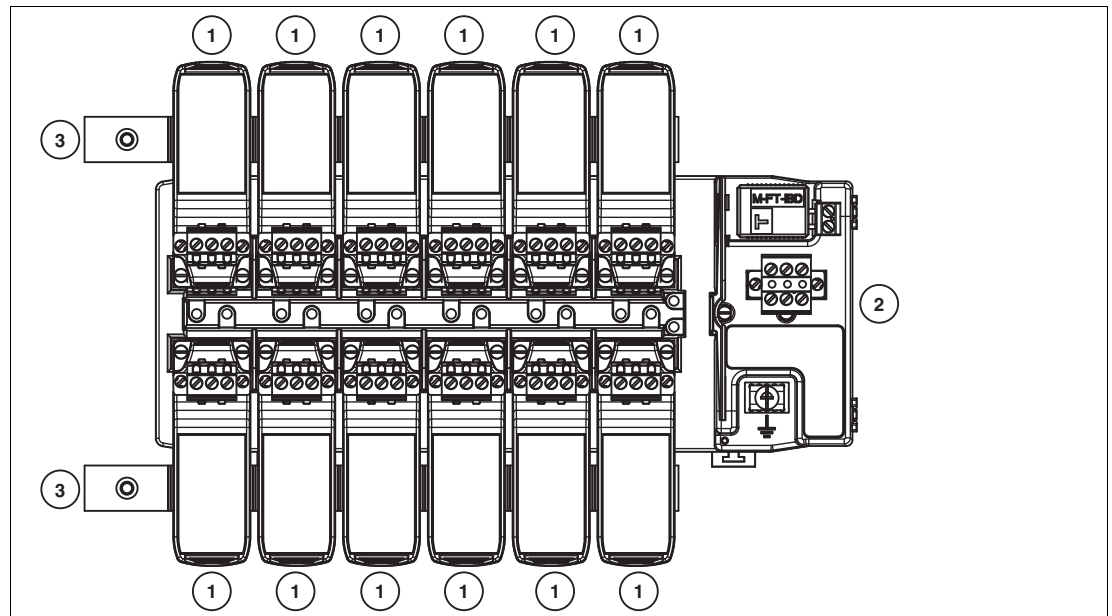
In order to generate intrinsically safe (Ex ic) outputs according to IEC/EN 60079-11 at the Segment Protector with SCP-LBF\* surge protectors on intrinsically safe spur outputs, use the specified accessories. Accessory: Surge protector TCP-LBF\* with an integrated separation wall at the trunk.

Solid ground rails, ACC-LBF-EB6, are used for routing the ground connections from the individual surge modules together.

Surge Protectors contain a diagnostic function that predicts their failure, before fieldbus communication or the segment voltages are adversely affected.

Surge protection electronics tolerate a number or frequency of activations at given voltage levels until they eventually fail. During this time, the surge protection electronics gradually degrade. The integral diagnostic function compares the overvoltage events to a given algorithm. This way, the function can predict how many more overvoltage events are tolerable until the surge protection electronics has reached the 'end of effective life'. Once this point has been reached, the diagnostic function issues an alarm to the Pepperl+Fuchs Advanced Diagnostics infrastructure. The alarm is transmitted to the Pepperl+Fuchs 'Advanced Diagnostic Manager' software running on the system maintenance or operator workstation. Additionally, the Surge Protector issues a visual alarm to help identify the failing unit or units quickly.

For detailed information, refer to the respective Surge Protector(s) manual(s).



- 1 Surge Protector SCP-LBF-IA1.36.IE\*
- 2 Surge Protector TCP-LBF-IA1.36.IE\*
- 3 Earth bar ACC-LBF-EB.6

## 5.5 Accessory: Enclosure Leakage Sensor ELS-1

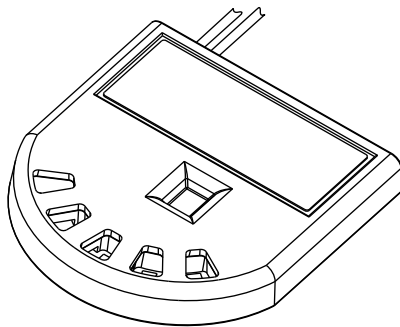
The FieldConnex<sup>®</sup> enclosure leakage sensor ELS-1 contains a diagnostic function to detect water ingress breaches inside housings early. ELS-1 warns of water ingress before it can adversely affect fieldbus communication, demand high current levels or cause galvanic corrosion damage to electronics. Compactly designed ELS-1 fits into most of today's existing field device housings.

The sensor is designed for use in fieldbus communication topologies according to IEC 61158-2. ELS-1 conforms to the intrinsically safe FISCO and Entity concepts and to IEC 60079-11. As an associated apparatus, ELS-1 can be attached to any fieldbus trunk or spur that is intrinsically safe certified.

ELS-1 can be connected in parallel to the spur output cables of Pepperl+Fuchs device couplers types R2-SP-IC\*, F2-SP-IC\*, and R4D0-FB-\*. Powered by the spur, ELS-1 requires less than 6 mA for operation.

Once water is detected, the diagnostic function inside ELS-1 issues an alarm to the Pepperl+Fuchs Advanced Diagnostics infrastructure. The alarm is transmitted to the Pepperl+Fuchs 'Advanced Diagnostic Manager' software running on the systems maintenance or operator workstation.

Additionally, ELS-1 issues a visual alarm to help identify the affected device/housing or validate the error.



## 5.6 Using Device Couplers in PROFIBUS PA Installations

You need to take special precautions for installations operating under the following conditions:

- With a high level of environmental impact
- With vibration or shock
- With field devices connecting or disconnecting regularly during operational conditions

The following precautions are necessary to decrease consecutive failures that cause a PROFIBUS PA segment to fail:

- Regularly check that the terminal connections of the device coupler are tightened correctly
- Increase the RETRY LIMIT parameter of the PROFIBUS master to a minimum of 4

Note: When using the Pepperl+Fuchs Segment Coupler HD2-GT\* series, the default value of the RETRY LIMIT is already set to 4.

- In order to disconnect a field device, ensure to adhere to the following sequence:
  1. Unplug the corresponding connector at the device coupler
  2. Unscrew the fieldbus wires at the field device

## 5.7 Using Device Couplers in FOUNDATION Fieldbus H1 Installations

You need to take special precautions for installations operating under the following conditions:

- With a high level of environmental impact
- With vibration or shock
- With field devices connecting or disconnecting regularly during operational conditions

The following precautions are necessary to decrease consecutive failures that cause a FOUNDATION Fieldbus H1 segment to fail:

- Regularly check that the terminal connections of the device coupler are tightened correctly
- Increase the STALE\_COUNT\_LIMIT parameter of the FOUNDATION Fieldbus LAS or host used to a minimum of 2

- In order to disconnect a field device, ensure to adhere to the following sequence:
  1. Unplug the corresponding connector at the device coupler
  2. Unscrew the fieldbus wires at the field device

## 6 Appendix

### 6.1 Ordering Information

Product name	Description
R2-SP-IC-4	Segment Protector with 4 outputs (spurs). Trunk and spur connections with screw terminals.
R2-SP-IC-6	Segment Protector with 6 outputs (spurs). Trunk and spur connections with screw terminals.
R2-SP-IC-8	Segment Protector with 8 outputs (spurs). Trunk and spur connections with screw terminals.
R2-SP-IC-10	Segment Protector with 10 outputs (spurs). Trunk and spur connections with screw terminals.
R2-SP-IC-12	Segment Protector with 12 outputs (spurs). Trunk and spur connections with screw terminals.
R2-SP-IC-4.1	Segment Protector with 4 outputs (spurs). Trunk and spur connections with spring terminals.
R2-SP-IC-6.1	Segment Protector with 6 outputs (spurs). Trunk and spur connections with spring terminals.
R2-SP-IC-8.1	Segment Protector with 8 outputs (spurs). Trunk and spur connections with spring terminals.
R2-SP-IC-10.1	Segment Protector with 10 outputs (spurs). Trunk and spur connections with spring terminals.
R2-SP-IC-12.1	Segment Protector with 12 outputs (spurs). Trunk and spur connections with spring terminals.
M-FT	Terminator M-FT, (packaging unit = 3 pieces). 1 terminator comes with each Segment Protector R2-SP*.
T-CON.3	T-connector screw terminal, T-CON.3, (packaging unit = 4 pieces). 1 T-connector comes with each Segment Protector R2-SP*.
T-CON.3.1	T-connector spring terminal, T-CON.3.1, (packaging unit = 4 pieces). 1 T-connector comes with each Segment Protector R2-SP*.
TP-CON.3	Fieldbus test plug sockets screw terminals, TP-CON.3, (packaging unit = 4 pieces).
TP-CON.3.1	Fieldbus test plug sockets spring terminals, TP-CON.3.1, (packaging unit = 4 pieces).
ACC-R2-SW.3	Separation wall ACC-R2-SW.3, (packaging unit = 3 pieces).
TCP-LBF-IA1.36.IE.0	Surge Protector for trunk connection, shield/screen grounded via gas discharge tube.
TCP-LBF-IA1.36.IE.1	Surge Protector for trunk connection, diagnostics included, shield/screen grounded via gas discharge tube.
SCP-LBF-IA1.36.IE.0	Surge Protector for spur connection, shield/screen grounded via gas discharge tube.
SCP-LBF-IA1.36.IE.1	Surge Protector for spur connection, diagnostics included, shield/screen grounded via gas discharge tube.
ACC-LBF-EB.6	Grounding rail to provide a common earth point and mechanical support for up to 6 SCP-LBF-1.36* modules.
ELS-1	Enclosure leakage sensor for water ingress detection.

## 6.2 Electromagnetic Compatibility Verification in Accordance with EC Council Legislation Directive 2004/108/EC

### Compatibility in Accordance with EN 61326-1 and NAMUR NE 21 Recommendation

The electromagnetic compatibility (EMC) requirements, applicable for electrical equipment for measurement, control, and laboratory use in general are anchored in the international standard EN 61326. 3 different performance criteria are distinguished in this standard:

A class **A** device operates as intended during the test. This device can withstand the immunity tests without any noticeable performance degradations within the specification limits of the manufacturer.

A class **B** device operates as intended after the test. The device shows temporary degradation or loss of function of performance during the test but self-recovers from that state when the exposures are ceased.

A class **C** device has loss of function. The device may need manual restoration. During the test a temporary loss of function is allowed, as long as an operator can restore the device back to operation.

The requirements of the association for standard and control and regulations of the German chemical industries, defined in the NE 21 recommendation, are partly higher compared to the test levels and failure criteria defined in EN 61326-1. For the product qualification, the failure criteria and test levels selected always represent the worst case conditions.

EN 61000-4, as a generic standard, defines the test setups for the specific required test for EN 61326-1 and NE 21.

See declaration of conformity for standards and editions applied.

### Conducted EMC Tests

#### Immunity

Standard	Type	Test Level	Category
EN 61000-4-2	Electrostatic discharge, direct contact	6 kV	A
	Electrostatic discharge, indirect, air	8 kV	A
EN 61000-4-3	Electromagnetic field radiated, radio frequency	10 V/m	A
EN 61000-4-4	Fast transients burst on signal lines	1 kV	A
	Fast transients burst on power lines	2 kV	A
EN 61000-4-5	Slow transient surge on signal lines	1 kV	B
	Slow transient surge on shielded lines	2 kV	B
EN 61000-4-6	Conducted immunity, radio frequency	10 V	A
EN 55011	Reduction factor conducted emission	Class A	–
	Reduction factor radiated emission	Class A	–

## 6.3 Referenced Documents

- Manual: "Using Pepperl+Fuchs fieldbus equipment in Zone 2 hazardous area environment"
- Selection table: Conformity of FieldConnex<sup>®</sup> Power Hub modules and motherboards to Ex ic



# PROCESS AUTOMATION – PROTECTING YOUR PROCESS



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