PROCESS AUTOMATION

Instruction Manual/ Manual

Segment Coupler

SK1 and SK2

by Pepperl+Fuchs

process automation

CE

PEPPERL+FUCHS

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this publication is, therefore, printed on paper bleached without the use of chlorine.

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1 Validity of this instruction manual

Pepperl+Fuchs GmbH offers two different types of segment couplers, the SK1 and the SK2. For the difference between these two types, please refer to chapter 5.1. This manual applies to both types. In specific detail, this covers the following products of Pepperl+Fuchs GmbH:

Segment coupler SK1:

- KFD2-BR-1.PA.93, segment coupler for non-Ex applications with up to 32 PROFIBUS PA stations
- KFD2-BR-Ex1.3PA.93, segment coupler for Ex applications [EEx ia] IIC for up to 10 intrinsically safe PROFIBUS PA devices.

Segment coupler SK2:

- KLD2-GT-DP.xPA, the SK2 gateway with x = 1 or 2 channels.
- KLD2-GT-DPR.4PA, 4-channel SK2 gateway with a media-redundant PROFIBUS DP connection.
- KLD2-PL-1.PA, Power Link for SK2 without intrinsically safe interface.
- KLD2-PL-Ex1.PA, Power Link for SK2 with intrinsically safe interface [EEx ia] IIC.

All products have been developed and manufactured taking into account the applicable European standards and directives.

Note

A corresponding declaration of conformity may be requested from the manufacturer.

The manufacturer of the product, Pepperl+Fuchs GmbH in D-68301 Mannheim, has a certified quality assurance program in accordane with ISO 9001.

CE

ISO**9001**

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2 Symbols used

Warning

This symbol warns of a danger.
In the event the warning is ignored, the consequences may range from personal injury to death or from damage to equipment to destruction.

Attention

This symbol warns of a possible fault.
Failure to observe the instructions given in this warning may result in the device and any facilities or systems connected to it developing a fault or even failing completely.</i></F>

Note

This symbol draws your attention to important information.

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3 Instruction manual

This instruction manual is valid in combination with the corresponding data sheets. The data sheets can be retrieved under www.pepperl-fuchs.com.

The company who operates the plant, bears the responsibility regarding planning, mechanical installation, commissioning, operation and maintenance, specially in connection with applications in potentially explosive environments.

3.1 Intended use

Segment couplers are the interface between PROFIBUS DP and PROFIBUS PA and ensure among other things the galvanic separation between PROFIBUS DP and PROFIBUS PA. The PROFIBUS PA is the PROFIBUS DP with the addition of transmission elements in accordance with IEC 61158-2, which can be used in areas subject to the danger of explosions. For further information please see chapter 4.1.

Segment couplers with an intrinsically safe PROFIBUS PA interface are used to operate intrinsically safe PROFIBUS PA field devices within areas subject to the danger of explosions.

Data sheets for segment couplers contain the electrical data of the EC Declaration of conformity and are considered an integral part of the instruction manual. The data sheets can be retrieved under www.pepperl-fuchs.com.

Segment couplers that are operated in general electrical systems must not be operated in electrical systems that are connected with areas subject to the danger of explosions.

Laws and/or regulations governing the use or intended usage goal must be observed.

Segment couplers are only approved for proper professional usage in accordance with the intended purposes. Improper handling will void any claim made under the warrantee and any manufacturer's liability.

Protection of operating personnel and the system is not ensured if the module is not used in accordance with its intended purpose.

The device must be operated by authorised specialist personnel only in accordance with these operating instructions.

3.2 Commissioning and installation in connection with Ex areas

Commissioning and installation must only be performed by specialists who are trained specifically for this purpose.

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3.2.1 Installation of segment couplers outside the Ex area

Segment couplers are designed in the IP20 protection class in accordance with EN 60529 and must be appropriately protected against adverse environmental conditions such as splashed water or dirt beyond accumulation level 2.

Segment couplers must be installed outside of the area subject to the danger of explosion!

The intrinsically safe PROFIBUS PA may be introduced into the area subject to the danger of explosion with due consideration to the explosion group and category. Special care should be taken in this case to ensure a secure separation from all non-intrinsically safe circuits. The installation of the intrinsically safe circuits is to be conducted in accordance with the relevant installation regulations.

The intrinsically safe PROFIBUS PA should only be connected with the blue removable connection terminals of the segment couplers.

Warning

When interconnecting intrinsically safe field devices with the intrinsically safe PROFIBUS PA connection of the segment coupler, the respective maximum values of the field devices and segment coupler in accordance with the EC Declaration of conformity must be observed (Proof of Intrinsic Safety). EN 60079-14/IEC 60079-14 should be observed in this regard. For the Federal Republic of Germany, the "National Foreword" of DIN EN 60079-14/VDE 0165 Part 1 and the FISCO model (PTB Report W-53) must be observed in addition

When using intrinsically safe circuits in the dust Ex area "D", only field devices certified for this purpose may be connected.

If Power Links with an intrinsically safe interface are used for the SK2 segment coupler, care should be taken that there is a straight-line distance of 50 mm between the PROFIBUS DP connection of the gateway and the intrinsically safe terminals of the Power Link.

Warning

When segment couplers with intrinsically safe PROFIBUS PA are being installed and operated, the EC Declaration of conformity must be observed. Especially important is the obseration of the 'special conditions' that may be included.

3.2.2 Installation of segment couplers within Zone 2 of the Ex area

Segment couplers can only be installed in Zone 2 if corresponding conformity information of a named center or a declaration of conformity of the manufacturer is on file.

Currently:

- for the segment coupler SK1 the devices KFD2-BR-1.*PA93.
- for the segment coupler SK2 the devices
  - KLD2-GT-DP*.*PA
  - KLD2-PL-1.PA***

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The devices should be installed in a switch or junction box to IP54 or better, in accordance with EN 60529.

The intrinsically safe PROFIBUS PA may be introduced into the area subject to the danger of explosion with due consideration to the explosion group and category. Special care should be taken in this case to ensure a secure separation from all non-intrinsically safe circuits. The installation of the intrinsically safe circuits is to be conducted in accordance with the relevant installation regulations.

The connection of the intrinsically safe PROFIBUS PA is carried out exclusively via the blue, removable segment coupler connector terminals.

Warning

When interconnecting intrinsically safe field devices with the intrinsically safe PROFIBUS PA connection of the segment coupler, the respective maximum values of the field devices and segment coupler in accordance with the EC Declaration of conformity must be observed (Proof of Intrinsic Safety). EN 60079-14/IEC 60079-14 should be observed in this regard. For the Federal Republic of Germany, the "National Foreword" of DIN EN 60079-14/VDE 0165 Part 1 and the FISCO model (PTB Report W-53) must be observed in addition

When using intrinsically safe circuits in the dust Ex area "D", only field devices certified for this purpose may be connected.

If Power Links with an intrinsically safe interface are used for the SK2 segment coupler, care should be taken that there is a straight-line distance of 50 mm between the PROFIBUS DP connection of the gateway and the intrinsically safe terminals of the Power Link.

Warning

When segment couplers with intrinsically safe PROFIBUS PA are being installed and operated, the EC Prototype test certificates and EC Conformity information or Declaration of conformity must be observed. Especially important is the obseration of the 'special conditions' that may be included.

3.3 Grounding / shielding

If a screen is required and the latter has to be grounded due to EMC reasons, chapter 12.2.2.3 of the EN 60079-14 and chapter 3.3.3 of of the PNO guide PROFIBUS PA always have to be observed.

Preferably, the following possibilities should be used.

3.3.1 Hard grounding to both ends of the transmission line.

This procedure, which is optimal for electromagnetic compatibility and personal protection, can be used in accordance with EN 60079-14, Sect. 12.2.2.3 without restriction in systems with potential compensation that is "assured to a high level" throughout the entire course of the fieldbus installation.

3.3.2 Capacitive grounding in the non potentially explosive area

The following requirements are placed on the isolating capacitor:

- Fixed dielectric, for example ceramic

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- C ≤ 10nF
- Test voltage ≥1500V

3.4 Mounting and dismounting

Segment couplers are normally mounted on a 35-mm top hat section rail in accordance with DIN EN 50022 with an inserted Power Rail.

Recognized rules of the technology and setup requirements must be maintained during mounting and dismounting. Especially for tasks on electrical systems, special safety requirements must be observed. Mounting and dismounting must only be performed by specialists who are specially trained and authorized for the task.

3.5 Maintenance

The transmission behavior of the segment couplers is stable even over long periods of time. There is thus no need for regular adjustments or similar tasks. Maintenance is therefore not required.

3.6 Fault elimination

No changes must be made to segment couplers that are operated in connection with areas subject to the danger of explosion. Repairs made to segment couplers must only be performed by the manufacturer.

3.7 Marking

3.7.1 Marking of segment couplers with intrinsically safe interface

The segment couplers or power links with intrinsically safe interface are marked as follows:

Segment coupler SK1	**Segment coupler SK2**
Pepperl + Fuchs	Pepperl + Fuchs
D-68307 Mannheim	D-68307 Mannheim
KFD2-BR-Ex1.3PA.93	KLD2-PL-Ex1.PA
⟨Ex⟩ II (1) G D [EEx ia] IIC	⟨Ex⟩ II (1) G D [EEx ia] IIC
PTB 99 ATEX 2142	PTB 99 ATEX 2142
II 3 G EEx n A II T4	II 3 G EEx n A II T4
TÜV 00 ATEX 1531 X	TÜV 00 ATEX 1531 X

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3.7.2 Marking of segment couplers without intrinsically safe interface for installation in zone 2

The segment coupler SK1 or the gateways and power links of the segment coupler SK2, which are approved for the use in zone 2, are marked as follows:

Segment coupler SK1:

Pepperl + Fuchs

D-68307 Mannheim

KFD2-BR-1.*PA.93

Ex II 3 G EEx n A II T4

TÜV 01 ATEX 1788X

* = 1...n

Gateway for segment coupler SK2	**power link for Segment coupler SK2**
Pepperl + Fuchs	Pepperl + Fuchs
D-68307 Mannheim	D-68307 Mannheim
KLD2-GT-DP.*PA or	KLD2-PL-1.PA
KLD2-GT-DPR.*PA	
Ex II 3 G EEx n A II T4	Ex II 3 G EEx n A II T4
TÜV 02 ATEX 1819 X	TÜV 01 ATEX 1788X

* = 1...4

3.8 Ambient conditions

Ambient temperature -20 ...60 °C (253 ...333) K

Storage temperature -40 ...85 °C (233 ...358) K

Relative humidity max. 75 % rel. humidity without moisture condensation

3.8.1 Isolation coordinates for devices Ex certificate in accordance with EN 50020

Segment couplers are dimensioned for use in accumulation level 2, in accordance with EN 50178.

3.8.2 Isolation coordinates for information on galvanic separation in accordance with EN 50 178 and EN 61140

Segment couplers are built-in devices or electronic equipment for use in closed electrical operating locations to which only electrical specialists or persons trained in electro-technology are granted admission or access.

The devices are dimensioned for use in accumulation level 2, in accordance with EN 50 178..

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3.9 Disposal

Disposal of the packaging and segment couplers must only take place in accordance with the requirements of the country in which the segment coupler is installed.

The segment coupler does not contain any batteries that must be disposed of separately from the segment coupler.

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4 General

4.1 Range of application of segment couplers

Segment couplers are the interface between the PROFIBUS DP and the PROFIBUS PA.

Note

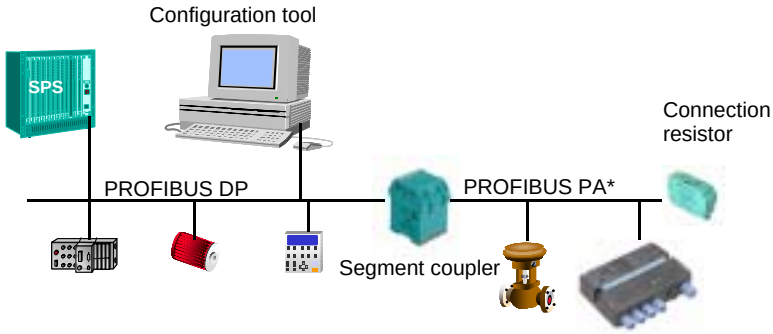
More recent documentation also refers to PROFIBUS MBP in connection with PROFIBUS PA. MBP stands for Manchester Bus Powered. PROFIBUS PA and PROFIBUS MBP are identical. The following section refers only to the term PROFIBUS PA that has been introduced. PROFIBUS MBP-IS is the intrinsically safe version of the PROFIBUS PA.

The PROFIBUS PA is the PROFIBUS DP with the addition of transmission elements in accordance with IEC 61158-2, which can be used in areas subject to the danger of explosions. Both systems are communication-compatible, so that a data exchange between both systems is possible without any problem.

The advantage of the physical transmission arrangement in accordance with IEC 61158-2 is that power can be supplied to field bus stations from the transmission line. The power supply current required for this is made available by the segment couplers.

If an intrinsically safe PROFIBUS PA segment is used, segment couplers with an intrinsically safe interface should be used. One task of the intrinsically safe segment coupler is then to ensure the intrinsic safety of the PROFIBUS PA segment. To this end, the maximum amount of power in the explosive area available in the event of an error is limited to an amount that is not suitable for bringing the surrounding atmosphere to the ignition point. This is achieved by limiting the voltage (in this case 12.6 V ... 13.4 V) and limiting the current (in this case I $\leq$ 100 mA). Everthing else is regulated by the FISCO model (chapter 4.2).

The following illustration shows a typical PROFIBUS structure::



*depending on the used segment coupler type the PROFIBUS PA segment can be intrinsically safe.

The segment couplers fulfill the following tasks:

- Potential separation between the PROFIBUS DP and the PROFIBUS PA
- Conversion of the RS 485 physical arrangement of the PROFIBUS DP to the phys-

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ical arrangement based on
IEC 61158-2 of the PROFIBUS PA.

- Adapting the PROFIBUS DP transfer rate to the PROFIBUS PA transfer rate of 31.25 kBd.
- Power supply of PROFIBUS PA stations over the bus line.
- Diagnostics via LEDs.
- Ensuring intrinsic safety if a segment coupler with an intrinsically safe interface is used.

As a general rule, the PROFIBUS PA is part of a PROFIBUS DP automation system. The control system (PLC) contains a PROFIBUS DP master (Class 1 master) that organizes the exchange of process data. Furthermore, a configuration tool, generally a PC, can be connected to the PROFIBUS DP as a Class 2 master. This configuration tool is generally used to set parameters and perform configuration for bus stations, even while they are still operating. The acyclic channel of the PROFIBUS DP V1 or PROFIBUS PA is used to do this.

Note

All segment couplers support both cyclic and acyclic communication of the PROFIBUS.

The way in which the SK1 and SK2 segment couplers of Pepperl+Fuchs work is essentially transparent. This means that PROFIBUS DP masters have direct access to PROFIBUS PA slaves. This offers the following advantages:

- No configuration of the segment couplers is required
- PROFIBUS PA slaves can be treated like PROFIBUS DP slaves
- There is no PROFIBUS DP address setting on the segment coupler
- Because of this, there is no restriction on the amount of data to 244 bytes of I/O data per PROFIBUS PA segment for the PROFIBUS PA.

Segment couplers can have an intrinsically safe interface on the PROFIBUS PA side. The difference between segment couplers with intrinsically safe and non-intrinsically safe interface is illustrated in the table below

	Intrinsically safe PROFIBUS PA	Non-intrinsically safe PROFIBUS PA
Measurement voltage	12.6 V ... 13.4 V	24 V ... 26 V
Measurement current	100 mA	400 mA
Max. PROFIBUS PA slaves[a]	10	32
Max. line length[b]	1000 m	1900 m

a. The actual number of stations on a PROFIBUS PA segment depends on the actual current consumption of the PROFIBUS PA slaves.

b. The actual length of the line depends on a number of factors including the type of cable used (see See also the section on4.3)

For additional information on the topic of explosion protection through intrinsic safety please refer to the Pepperl+Fuchs Ex protection manual Part. No. 21417 or the Video

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Explosion protection of electrical systems.

The actual number of stations that can be connected to a PROFIBUS PA segment depends on the current consumption of each station and the FDE (Fault Disconnection Electronics). This refers to an electronic current limit that restricts the maximum additional current I_{FDE} that can flow in the event of an error. I_{FDE} can be derived specifically for each device from the corresponding data sheet. In an extreme case, the I_{FDE} current is 9 mA, i. e. the maximum current consumption is the basic current (current consumption according to the data sheet) + I_{FDE}.

4.2 Introduction to intrinsic safety for field bus systems (FISCO model)

To render the proof of Intrinsic Safety as simple as possible, the so-called FISCO model was developed. FISCO stands for **F**ieldbus **I**ntrinsically **S**afe **CO**ncept.

The German Federal Physical Technical Institute (PTB) developed the FISCO model and has published it in Report PTB-W-53 "Examination of intrinsic safety for fieldbus systems". This model is based on the following prerequisites:

1. To transmit power and data, the bus system uses the physical configuration defined by IEC 61158-2. This is the case for PROFIBUS PA.
2. Only one active source is permitted on a bus segment (in this case the segment coupler). All other components work as passive current sinks.
3. The basic current consumption of a bus station is **at least** 10 mA.
4. It must be ensured for each bus station that
   $U_i \geq U_o$ of the segment coupler/Power Link
   $I_i \geq I_o$ of the segment coupler/Power Link
   $P_i \geq P_o$ of the segment coupler/Power Link.
5. Each bus station must fulfill the following requirement:
   $C_i \leq 5$ nF
   $L_i \leq 10$ µH
6. The permissible line length for EEx ia IIC applications is 1000 m.
7. The permissible stub line length for Ex applications is 30 m per stub line. The definition of the stub line must be observed in this connection.
8. The transmission line that is used must conform to the following cable parameters:
   resistor coating: 15 Ω/km < R' < 150 Ω/km
   inductance coating: 0.4 mH/Km ≤ L' ≤ 1 mH/km
   capacitance coating: 80 nF/km ≤ C' ≤ 200 nF/km (including the shield)
   Taking the shield into consideration, the capacitance coating is calculated as follows:
   $C' = C'_{conductor/conductor} + 0.5 * C'_{conductor/shield}$ if the bus line is potential free or
   $C' = C'_{conductor/conductor} + C'_{conductor/shield}$ if the shield is connected with a pole of the segment coupler/Power Link.
9. The bus segment must be terminated on both ends of the line with a fieldbus terminator. A fieldbus terminator is integrated into the SK1 segment coupler or Power Link of the SK2 so that an external bus termination is only required on the other end. According to the FISCO model the terminal bus resistance must conform to the following limits:

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$90\ \Omega \leq R \leq 100\ \Omega$
$0\ \mu F \leq C \leq 2{,}2\ \mu F$

On condition that the points 1 up to 9 are **all** satisfied, the proof of intrinsic safety has been provided by means of the FISCO model. Points 1, 3 and 5 are automatically satisfied if a product is certified in accordance with the FISCO model.

Warning

*The prerequisite for being allowed to bear the proof of intrinsic safety in accordance with the FISCO Model is, that the segment coupler **and** all fieldbus stations are certified according to FISCO.*
As a rule, a separate declaration of conformity is also required for the bus connection. Furthermore, the cable must meet the requirements of the FISCO model.

The following segment couplers SK1 or Power Links of the SK2 are approved in accordance with the FISCO model:

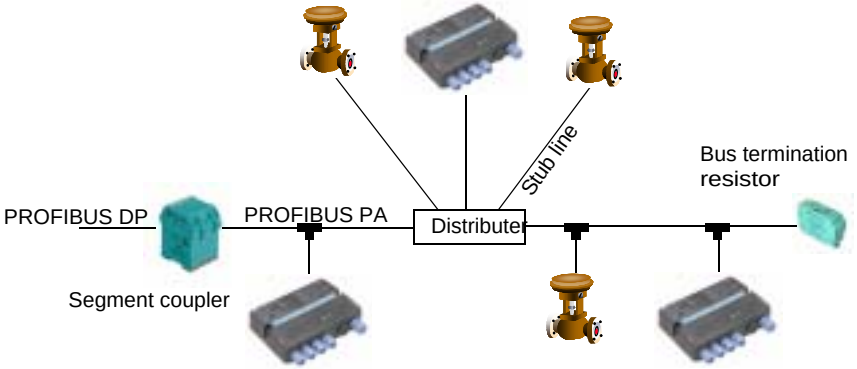
Segment coupler SK1:	Segment coupler SK2:
KFD2-BR-Ex1.3PA.93	KLD2-PL-Ex1.PA

For the characteristic Ex values, please refer to the EC Declaration of Conformity PTB 99 ATEX 2142.

Segment couplers or Power Links with an intrinsically safe interface provide a maximum basic current of 100 mA at a minimum output voltage of 12.6 V (SK1) or 12.8 V (SK2). Thus up to 10 bus stations can be supplied.

4.3 PROFIBUS PA topologies and lines

The PROFIBUS PA can be built up in the line or tree topology.



The PROFIBUS PA commissioning introduction recommends essentially two types of

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cables with the following characteristic cable values:

	Type A	Type B
Cable structure	Twisted wire pair, shielded	One or more twisted wire pairs, complete shielding
Conductor cross-section (nominal)	0.8 mm² (AWG 18)	0.32 mm² (AWG 22)
Loop resistor (direct current)	44 Ω/km	112 Ω/km
Wave resistance at 31.25 kHz	100 Ω ± 20%	100 Ω ± 30%
Wave attenuation at 39 kHz	3 dB/km	5 dB/km
Capacitive asymmetry	2 nF/km	2 nF/km
Group runtime distortion (7.9 ... 39) kHz	1.7 µs	a
Covering level of the shield	90%	a
Maximum extent of the network for non-intrinsically safe applications	1900 m	1200 m
Maximum extent of the network for intrinsically safe applications	1000 m	a

a. Not specified

The recommended extent of the network comprises the total of the main line and all stub lines.

A PROFIBUS PA station works from an input voltage of 9 V, i. e. this value corresponds to the minimum input voltage. With an unfavorable distribution of stations, i.e. if all PROFIBUS PA stations are widely removed from the segment coupler, it can happen that the voltage drop along the line is so great that the voltage level at the end is insufficient. This results in a shortening of the transmission line or the necessity of using cable with a larger cross-section. Under the most unfavorable conditions, you can reach the following lengths with cable type A (0.8 mm² or AWG 18):

- Application EEx ia IIC ==> 860 m
- Non-Ex application ==> 852 m

PROFIBUS PA allows for stub line. The length of each stub line is determined by the number of PROFIBUS PA stations and by the area of application. The following table offers an overview:

Number of stub lines	Maximum length of a stub line	
	Non-Ex	EEx ia
1 to 12	120 m	30 m
13 to 14	90 m	30 m
15 to 18	60 m	30 m
19 to 24	30 m	30 m

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Note

Please note that the permissible total line length (the total of the main line and all stub lines) must not be exceeded.

For cable type B, multiple PROFIBUS PA segments can be carried in one cable. If cable types other than those recommended are used, or if an intrinsically safe PROFIBUS PA segment is set up, the permissible line lengths are reduced.

4.4 Bus termination

Each PROFIBUS PA segment must be terminated at the end of the line(R = 100 Ω ± 2%; C = 1....2 µF ± 20%). The KMD0-FT-Ex1 represents a corresponding ready-manufactured solution for switch cabinet mounting. The F* -FT-Ex1.IEC can be used for field mounting. The terminating resistance required on the segment coupler is integrated into the KFD2-BR... segment coupler and KLD2-PL... Power Links.

4.5 Grounding

The PROFIBUS PA commissioning manual specifies 4 types of cable, of which cable types A and B have a shield. This shield must be grounded for EMC protection reasons. This is possible in 2 ways:

1. Hard grounding on both ends of the PROFIBUS PA transmission line. This requires laying a potential compensation line.
2. Hard grounding on all field devices, potential compensation in the field, capacitive grounding on the segment coupler. Different companies offer terminals an integrated capacitor (for example Phoenix Contact, Wago, ...). A sample wiring diagram is

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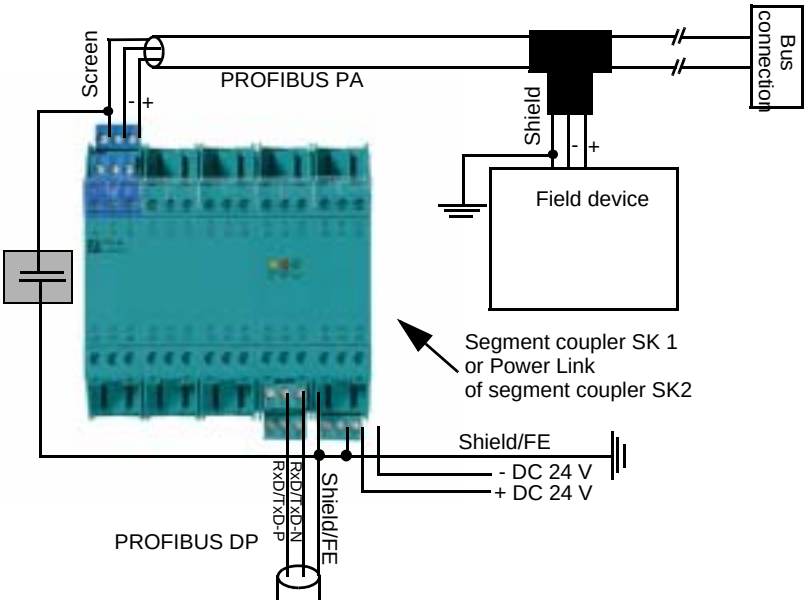
shown in the following illustration.



Attention

Please note in this regard the Instruction manual in chapter 3.3

Warning

Pepperl+Fuchs always recommends the use of shielded lines for the PROFIBUS PA. The shield should be hard grounded on the segment coupler/Power Link and on all field devices. Please refer to chapter 3.3.
For intrinsically secure applications, a potential compensation between the Ex and non-Ex areas is required. Note in this regard the respective relevant setup requirements.
If there is no potential compensation between the Ex and non-Ex area, there is a possibility of capacitive grounding on the segment coupler/ Power Link.
The capacitor used must have a fixed dielectric. The following applies to the capacitance of the capacitor: C ≤ 10 nF. In addition, the capacitor must be designed for a test voltage of ≥ 1500 V.

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5 Planning for a PROFIBUS PA application

Segment couplers are required for the conversion from PROFIBUS DP to PROFIBUS PA and back. Pepperl+Fuchs offers 2 types of segment couplers:

- Segment coupler SK1:
- Segment coupler SK2:

Planning can be performed in the following order:

1. Select the type of segment coupler
2. Determine the number of non-intrinsically safe and intrinsically safe PROFIBUS PA stations
3. Specify the necessary PROFIBUS PA segments and determining from that the required number of components (SK1 segment couplers the number of gateways and Power Links for the SK2 and in some cases the use of FieldBarriers).
4. Check functional capability.
5. Determine the required power feed modules and the amount of space required in the switch cabinet/junction box.
6. Determine the bus cycle time.

5.1 Selection of the segment coupler

What type of segment coupler will be used in the application must be determined in the first step, since this decision may in some circumstances have an effect on the system structure. The following table illustrates the differences between the SK1 segment coupler and the SK2 segment coupler:

	Segment coupler SK1:	**Segment coupler SK2:**
Number of components per segment coupler	*1*	*2 ... 21*
Number of PROFIBUS PA segments per segment coupler	*1*	*1 ... 20*
Intrinsically safe PROFIBUS PA	*Yes*	*Yes*
Non-intrinsically safe PROFIBUS PA	*Yes*	*Yes*
Number of stations per PA segment	*Max. 10 (Ex)* *Max. 32 (non-Ex)*	*Max. 10 (Ex)* *Max. 32 (non-Ex)*
Number of PROFIBUS PA slaves per segment coupler	*Max. 10 (Ex)* *Max. 32 (non-Ex)*	*Max.125 (Ex)* *Max. 125 (non-Ex)*
Data volume per PA slave	*Max. 244 Byte E + 244 Byte A per slave*	*Max. 244 Byte E + 244 Byte A per slave*
Data volume per segment coupler	*No limitation*	*No limitation*
PROFIBUS DP transfer rate	*93.75 kBd*	*45.45 kBd ... 12 MBd*
PROFIBUS DP media redundancy	*No*	*Yes (optional)*
Redundant power supply for segment couplers	*Yes*	*Yes*

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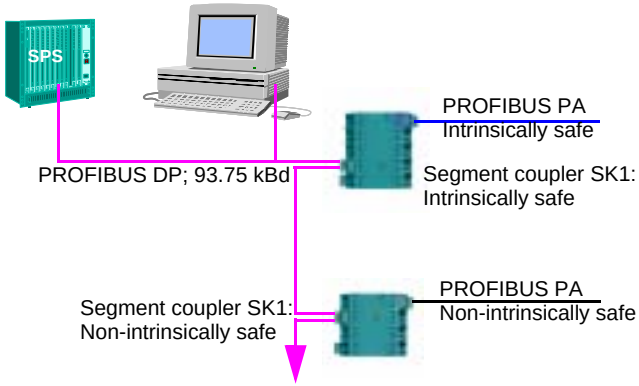
5.2 Operating principle of the SK1 segment coupler

The SK1 segment coupler brings together signal coupling between PROFIBUS DP and PROFIBUS PA and the power feed of the PROFIBUS PA segment in a single device. A PROFIBUS PA segment can be opened with an SK1 segment coupler.

SK1 segment couplers can be mounted in a switch cabinet or can be distributed through the system in local installation boxes, junction boxes, etc. In the second case, the topology appears as follows:



If the SK1 segment coupler is used, the transfer rate for the PROFIBUS DP is fixed at 93.75 kBd. In this case, if type A cable is used for the PROFIBUS DP the PROFIBUS DP segment can be up to a length of 1200 m. The length of the PROFIBUS PA segment depends on:

- whether the PROFIBUS PA segment in question is intrinsically safe or non-intrinsically safe.
- how many PROFIBUS PA stations are connected to the segment.
- how high the current consumption of the individual PA slaves is.
- how the PA slaves are distributed on the PROFIBUS PA segment.

For more detailed information, please refer to

The SK1 segment coupler works transparently. This means that PROFIBUS DP masters have direct access to every PROFIBUS PA slave. Addresses that have been assigned on a PROFIBUS PA segment are also occupied on the PROFIBUS DP.

The following types of SK1 segment coupler are available:

- KFD2-BR-1.PA.93, segment coupler for non-Ex applications with up to 32 PROFIBUS PA stations
- KFD2-BR-Ex1.3PA.93, segment coupler for Ex applications [EEx ia] IIC for up to 10 intrinsically safe PROFIBUS PA devices.

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5.2.1 Planning for a PROFIBUS PA application

Note

The following dimensioning is not valid, when FieldBarriers are used in the application.
If FieldBarriers are used, the dimensioning is described in the manual 'FieldBarriers'.

When planning for SK1 segment couplers proceed as follows.

1. Determine the number of intrinsically safe PROFIBUS PA slaves and the number of non-intrinsically safe PROFIBUS PA slaves.
2. Determine the number of needed segment couplers SK1 with intrinsically safe interface and without intrinsically safe interface.
   Add to this all power supply currents of non-intrinsically safe PROFIBUS PA slaves and divide the current by 400 mA. Round the result off to the nearest whole number. The result is the number of the segment couplers SK1 without intrinsically safe interface that is needed.
   Repeat the addition of power supply currents for the intrinsically safe PROFIBUS PA slaves, divide the total of the power supply currents by 100 mA and again round off to the next higher whole number. In general this calculation is represented as follows:

$$\text{Number non-Ex-segment couplers} = \text{Int}\left(\frac{\sum_{i=1}^{n} I_{\text{vers\_PA\_Slave i}}}{400\ \text{mA}}\right) + 1$$

$$\text{Number of Ex segment couplers} = \text{Int}\left(\frac{\sum_{i=1}^{n} I_{\text{vers\_PA\_Slave i}}}{100\ \text{mA}}\right) + 1$$

with $I_{\text{vers\_PA\_Slave i}}$ current consumption of slave i

3. Determine a preliminary structure for the non-intrinsically safe PROFIBUS PA slaves (which slave is operated on which SK1 segment coupler). When making this determination, make certain that a maximum 400 mA power supply current is available on a non-intrinsically safe PROFIBUS PA segment. The total of all required power supply currents must thus be less than 400 mA. For more details refer to .
4. Determine a preliminary structure for the intrinsically safe PROFIBUS PA slaves. When making this determination, make certain that a maximum 100 mA power supply current is available on an intrinsically safe PROFIBUS PA segment. The total of all required power supply currents must thus be less than 100 mA. For more detailed information, please refer to .
5. Check whether the input voltage on the last PROFIBUS PA slave is > 9 V. For additional information on this subject, please refer to .
6. Specify the addresses of the PROFIBUS PA slaves.

If you want to supply power to the SK1 segment coupler through the Power Rail, you must include power feed modules in the planning. Determine the number of power

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feed modules required (See section5.6) and the amount of space required (See section5.5) in the switch cabinet/junction box.

5.2.2 Determining the bus cycle time for use of the SK1 segment coupler

You must be familiar with the individual delay times to determine the response time. One of the delay times that occurs is the bus cycle time. This can be approximated for a **monomaster system** as follows:

$$T_{cycle} = T_{G+T} + \sum_{i=1}^{n} T_{MC(i)}$$

where: T_{G+T} = GAP Update Time + Token Time
T_{MC} = Message cycle, the time required for data exchange.

The time TMC can be calculated approximately as follows:

$$T_{MC} = 11\ ms + 0.56\ ms\ (L_S + L_R)$$

where
L_S = length of the output data in bytes
L_R = length of the input data in bytes

Note

This calculation is based on the following boundary conditions:
- Calling a telegram of variable length
- Idle Time 1 T_{id1} = 145 PROFIBUS DP bit times
- Station Delay Time T_{SDR} = 180 PROFIBUS DP bit times

The time T_{G+T} is a maximum of 47 ms given the following conditions:

- GAP factor = 1
- Slot Time T_{SL} = 4095 PROFIBUS DP bit times
- Idle Time 1 T_{id1} = 145 PROFIBUS DP bit times

Note

For additional information, please refer to EN 50170/-2 or get in touch with Pepperl+Fuchs.

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5.3 Operating principle of SK2 segment couplers

5.3.1 Concept of the SK2 segment coupler

Modern segment couplers must meet the following demands:

- No restriction on PROFIBUS PA data volume
- Support of PROFIBUS DP transfer rates (45.45 kBd, ..., 12 MBd)
- No affect on PROFIBUS DP speed due to the segment coupler
- No addressing of the segment coupler, either on the PROFIBUS DP side or on the PROFIBUS PA side
- Use without any additional configuration overhead (Plug'n Play)
- Possibility of direct access for the PROFIBUS DP master to the PROFIBUS PA slave (transparency)
- Independence from the manufacturer of the PROFIBUS DP master
- Connection of as many PROFIBUS PA stations as possible

All these requirements must be met by the SK2 segment coupler.

The structure of the SK2 segment coupler is modular. It consists of a gateway and at least one, no more than 20 Power Links.

Note

Whenever 'segment coupler SK2' or 'SK2' appears in the following text, it stands for the system, existing of a gateway and one or several power links.

Depending on the type, a gateway can operate 1, 2 or 4 channels that are independent of each other. Up to 5 Power Links can be connected on each channel. This results in the following maximum structure:

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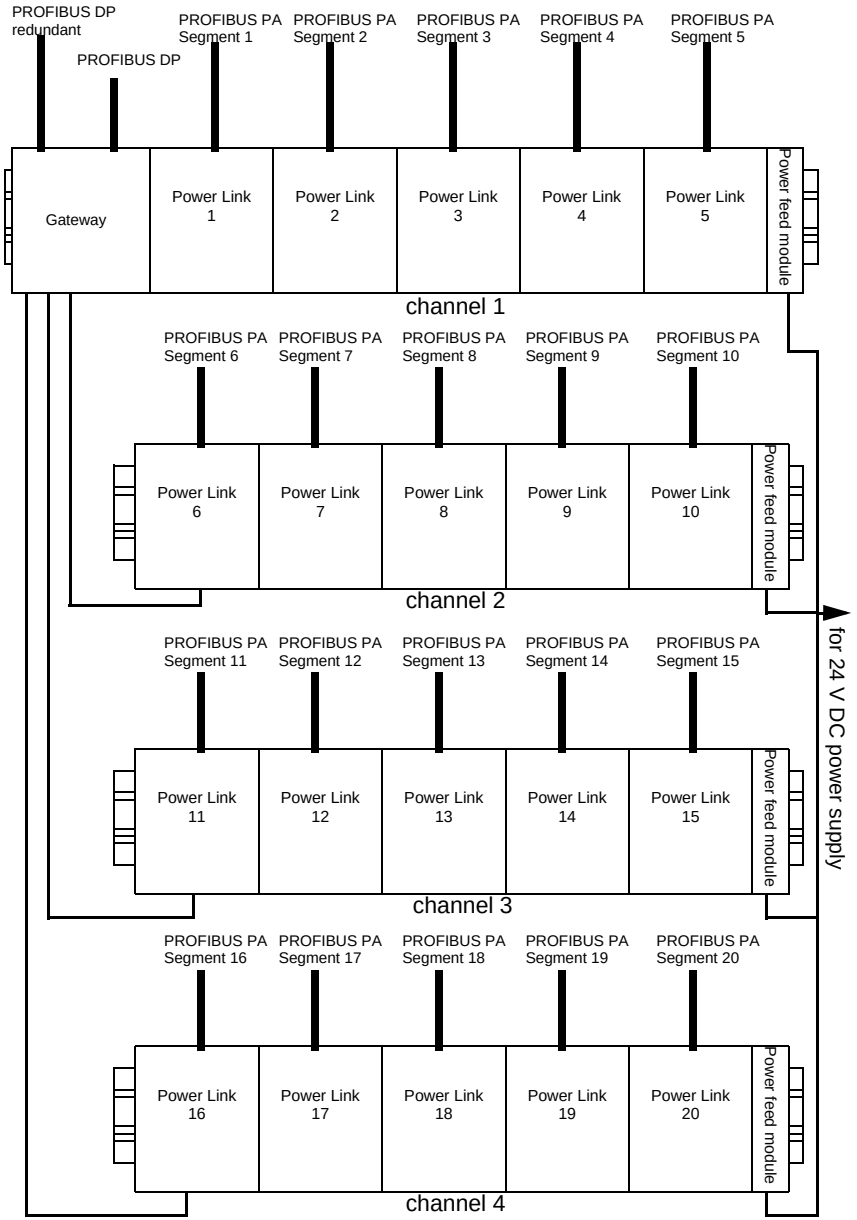

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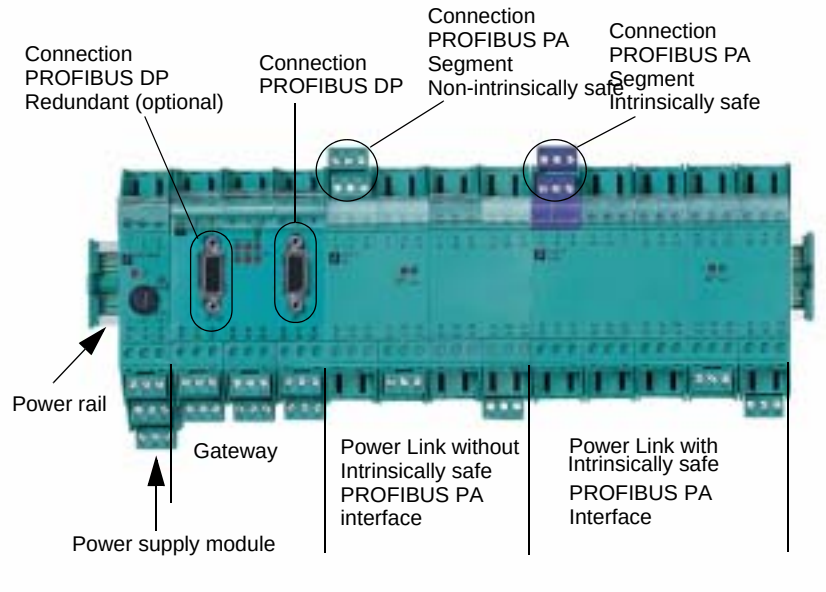
The illustration below shows a realistic example of an SK2 segment coupler with 2 Power Links



The gateway is used to convert the PROFIBUS DP protocol to the PROFIBUS PA protocol and back.

The Power Links switch the power supply to the PROFIBUS PA line. This makes the physical arrangement corresponding to IEC 61158-2 available on the output of a Power Link and opens up a PROFIBUS PA segment.

It is especially advantageous if power is supplied to the gateway and the Power Links from the Power Rail (See also the section on5.6). A power feed module is required to apply the power supply to the Power Rail.

In addition, communication between the gateway and the Power Links can take place over the Power Rail. No additional wiring is require for this. The gateway automatically applies the signals of channel 1 to the Power Rail.

In the case of multi-channel gateways, the terminals of the respective channel must be connected by the gateway with a Power Link of this channel. The connected Power Link applies the signal to the Power Rail again (see graphic on the preceding page).

As many as 5 Power Links can be connected to a PROFIBUS PA channel. Each Power Link opens up a PROFIBUS PA segment. This means that when the system is fully expanded, 20 PROFIBUS PA segments can be operated.

Up to 32 stations can be connected to each PROFIBUS PA segment with non-intrinsically safe Power Links, and for Power Links with an intrinsically safe PROFIBUS PA interface up to 10 station can be connected.

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Altogether not more than 125 PROFIBUS addresses can be managed by a PROFIBUS DP Master one PROFIBUS DP line. Due to this PROFIBUS DP restriction the maximum possible number of PROFIBUS PA slaves, which can be operated at one segment coupler SK2 is limited to 125.

Each PROFIBUS PA station is addressed directly by the PROFIBUS DP master of Class 1 or Class 2. This makes it possible among other things to plan for and configure PROFIBUS PA stations in the hazardous area from outside in the safe area.

Note

The segment coupler represents a physical load of one station on the PROFIBUS DP side. This must be taken into consideration if the PROFIBUS DP segment to which the KLD2-GT-DP.xPA gateway is connected is fully set up with 32 stations.

Note

Note that because of transparency, the addresses of PROFIBUS PA stations do not occur on the PROFIBUS DP line and vice-versa.

Because of the independence of PA channels cycle times of individual PROFIBUS channels are generally different. The cycle time of one PROFIBUS PA channel depends on the number of the connected stations and the data volume that is supposed to be transferred.

This independence makes it possible to adjust cycle times within certain limits. A multi-channel gateway must be used for this adjustment.

Stations with time-critical data are connected to a PROFIBUS PA channel on which only a few stations with a low data volume are present (in the extreme case 1 PROFIBUS PA station per channel).

Stations with time-non-critical data are connected to a PROFIBUS PA channel with more stations and a higher data volume. This PROFIBUS PA channel may consist of a m\number of PROFIBUS PA segments, i.e. a number of Power Links can be connected.

Because PROFIBUS PA channels work independently of each other, the result is a shorter cycle time in the upper case and a longer cycle time in the lower case.

PROFIBUS is able to address up to 125 stations. There is a possibility in this case of connecting up to 125 stations with the PROFIBUS DP through a gateway by using Power Links appropriately.

The SK2 segment coupler supports all transmission rates on the PROFIBUS DP side in accordance with EN 50170 Part 2 starting at 45.45 kBd.

Note

The SK2 segment coupler supports all PROFIBUS DP and PROFIBUS DP V1 services (cyclic and acyclic) of EN 50170 Part 2 with the exception of PROFIBUS PA master-master communication (MMAC1 and MMAC2).
Note in this regard also the information on *Page 53**.*

The gateway can occupy a second PROFIBUS DP connection. This allows for the possibility of implementing media redundancy on the PROFIBUS DP side.

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The use of a redundant transfer line increases the availability of the system.

Note

Media redundancy refers exclusively to the transmission medium (in this case the PROFIBUS DP line).

5.3.2 Planning of a PROFIBUS PA application with a segment coupler SK2

Note

The following dimensioning is not valid, when FieldBarriers are used in the application.
If FieldBarriers are used, the dimensioning is described in the manual 'FieldBarriers'.

1. Determine the number of intrinsically safe PROFIBUS PA slaves and the number of non-intrinsically safe PROFIBUS PA slaves.
2. Determine the number of the required Power Links with intrinsically safe and without intrinsically safe interface.
   Add to this all power supply currents of non-intrinsically safe PROFIBUS PA slaves and divide the current by 400 mA. Round the result off to the nearest whole number. The result is the number of power links without intrinsically safe interface, that is needed.
   Repeat the addition of power supply currents for the intrinsically safe PROFIBUS PA slaves, divide the total of the power supply currents by 100 mA and again round off to the next higher whole number. In general this calculation is represented as follows:

$$\text{Number non-Ex Power Links} = \text{Int}\left(\frac{\sum_{i=1}^{n} I_{vers\_PA\_Slave\ i}}{400\ mA}\right) + 1$$

$$\text{Number of Ex Power Links} = \text{Int}\left(\frac{\sum_{i=1}^{n} I_{vers\_PA\_Slave\ i}}{100\ mA}\right) + 1$$

   with $I_{vers\_PA\_Slave\ i}$ current consumption of slave i

3. Determine a preliminary structure for the non-intrinsically safe PROFIBUS PA slaves (which slave is operated on which Power Link). When making this determination, make certain that a maximum 400 mA power supply current is available on a non-intrinsically safe PROFIBUS PA segment. Thus the sum of all needed supply current has to be $\leq$ 400 mA. For more detailed information, please refer to .
4. Determine a preliminary structure for the intrinsically safe PROFIBUS PA slaves. When making this determination, make certain that a maximum 100 mA power supply current is available on an intrinsically safe PROFIBUS PA segment. The total of all required power supply currents must thus be less than 100 mA. For more de-

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tailed information, please refer to .

5. Check whether the input voltage on the last PROFIBUS PA slave is > 9 V. For additional information on this subject, please refer to .
6. Each PROFIBUS PA segment must be provided with a fieldbus terminator in the field. Include a fieldbus terminator of this type in the planning for each PROFIBUS PA segment. For example, for switch cabinet applications, the KMD0-FT-Ex1 from Pepperl+Fuchs can be used, or for applications in the field the F*-FT-Ex1.IEC.
7. Determine the least number of channels your gateway must have. To do this, add the number of Ex Power Links and non-Ex Power Links determined and divide the result by 5. This yields the minimum number of channels required.
8. Specify which Power Links you want to operate on which channel. Check whether the PROFIBUS PA cycle times resulting from these calculations are sufficient for your requirements. An approximate calculation of cycle times that occur on each channel is described in Section5.3.3.
   If the cycle times that occur are too high, use a gateway that has more channels than what you previously planned and determine the distribution of Power Links again. Check the cycle times that occur again.


Note

The following rule applies in general: The smaller the volume of data to be transferred, the smaller will be the cycle times that occur. Especially time-critical data should be transferred over a channel on which the smallest possible number of PROFIBUS PA stations are connected.

9. Plan the layout of your switch cabinet. For information regarding the mechanical dimensions, please refer to
   Each PROFIBUS PA channel must have its own Power Rail segment provided for it. channel 1 is automatically transferred on the Power Rail segment on which the gateway is mounted. The corresponding terminals of the gateway for channels 2 through 4 (if they are present) must be connected with **one** Power Link of the corresponding channel. The Power Link in turn transmits the signal to the Power Rail so that additional Power Links of this channel communicate with the gateway over the Power Rail.
   It is a good idea to provide each Power Rail segment (and thus each channel) with its own power feed module for the voltage supply. For more information on calculating cycle time, please refer to
10. Specify the addresses of the PROFIBUS PA slaves.


Note

*Observe, that the addresses, which are assigned at a PROFIBUS PA segment, are assigned for all other PROFIBUS PA segments **and** for the PROFIBUS DP segment.*
*Address 1 must not be assigned to **any** PROFIBUS PA slave or PROFIBUS DP slave.*

If you want to feed the segment couplers SK 2 via Power Rail, you have to plan power feed modules. Determine the number of power feed modules required (See section5.6) and the amount of space required (See section5.5) in the switch cabinet/ junction box.

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5.3.3 PROFIBUS DP time behaviour

The Segment coupler supports both cyclic and acyclic data exchange of the PROFIBUS DP V1. Cyclic communication services are performed based on a specific time grid, which is referred to as the bus cycle time.

A bus cycle time (or cycle time for short) means the time lapse that goes by under "worst case“ conditions to transfer the input data change of a PROFIBUS slave to the PROFIBUS master or the output data from the PROFIBUS master to the slave.

All data that is to be updated cyclically is automatically updated in the common data area by the PROFIBUS PA master.

The cycle time, this actualisation needs, depends on the data volume, that is transferred via the PROFIBUS PA channel.

From the point of view of the PROFIBUS DP, the segment coupler represents a multislave. If the PROFIBUS DP Master sends a request to a slave address existing at the segment coupler, the gateway answers directly on the request with the data, that are stored in the common data range. Because of this behavior, the PROFIBUS DP master does not need to wait for the PROFIBUS PA slave to respond. The result of this is that the cycle time of the entire system is composed as follows:

$$t_{Cycle} = t_{Cycle\_PA\text{-}channel} + t_{Cycle\_DP}$$

The time $t_{Cycle\_PA\text{-}channel}$ can be estimated as follows:

$$t_{Cycle\_PA\text{-}channel} = 10\ ms + n*10.5\ ms + 0.256\ ms*(L_E + L_A)$$

where n = the number of PROFIBUS PA slaves

L_E = total number of input bytes of **all** PROFIBUS PA slaves on the channel.

L_A = total number of all output bytes of **all** PROFIBUS PA slaves on the channel.

The time t_{Cycle_DP} can be estimated as follows

$$t_{cycle\_DP} = T_{Bit} * n * 500 + 11*T_{Bit}*(L_E + L_A)$$

where n = the number of PROFIBUS DP slaves
L_E = total number of input bytes of **all** PROFIBUS slaves
L_A = total number of output bytes of **all** PROFIBUS slaves
T_{Bit} = bit time = 1/transfer rate

For the time t_{Cycle_DP} a safety add-on of 10% should be included in the calculation in accordance with the Profibus User Organization.

The equation above applies given the following pre-conditions:

- The PROFIBUS DP is operated as a monomaster system, i. e. there is only one master on the PROFIBUS DP. If you want to use a multimaster system, the token hold time and the corresponding pause times of the additional masters must be added to the total.
- Only acyclic data exchange takes place. If the master is also supposed to transfer acyclic telegrams, the time required for acyclic communication must be

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added in total.

Note

For additional information, please refer to EN 50170/-2 or get in touch with Pepperl+Fuchs.

5.4 Dimensioning of a PROFIBUS PA segment

An SK1 segment coupler or a Power Link of the SK2 segment coupler opens up a PROFIBUS PA segment. The following section will illustrate how to dimension a PROFIBUS PA segment.

The following section is based on the assumption that type A cable is being used. For the cable parameters, please refer to the table on Page 15

Current calculation

Power is supplied to PROFIBUS PA stations from the bus. They represent a current sink. The current consumption of each station from the bus line must be at least 10 mA for Ex applications. There are no restrictions for non-Ex applications. Independently of whether they are SK1 or SK2 segment coupler, segment couplers limit the power supply current in the PROFIBUS PA segment to 100 mA for Ex applications and 400 mA for non-Ex applications. You must ensure that the current consumption of all stations is less than the current the segment coupler is capable of providing. The following applies:

$$I_{off\_SegmentCouplers} \geq \sum I_{on\_FieldDevices}$$

The current consumption if field devices determines the maximum number of stations per segment. For example, if field devices with a current consumption of 22.8 mA are used, 4 stations can be connected to a segment for Ex applications. If the current consumption per station falls to 10 mA, 10 stations can be connected.

Especially the dimensioning with 10 stations can be critical since it can happen in the event of an error (defect in a PROFIBUS PA slave) that this slave draws a higher current than the specified power supply current from the bus line. Under worst case conditions it may happen that the entire PROFIBUS PA segment can malfunction because of one defective slave.

To avoid this situation, a few devices offer what is referred to as a Fault Disconnect Electronic (FDE). This is an electronic current limit that limits additional current consumption of a defective slave in a failure case. This I_{FDE} can also vary between PROFIBUS PA slaves and must be obtained from the data sheet. If an error case is included in the current calculation, the situation described above changes as follows:

$$I_{off\_SegmentCouplers} \geq I_{FDE} + \sum I_{on\_FieldDevices}$$

This means that taking into consideration an error and a current consumption of 10 mA per slave, another 9 stations can still be operated on a segment.

Voltage calculation and line length

The distribution of stations on the PROFIBUS PA segment can have a negative effects on the maximum possible line length in certain circumstances. The following ex-

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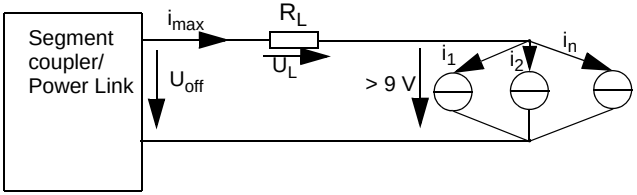
ample is intended to clarify this point:



R_L = Line resistance of line segment x
I_x = Current consumption of PA station x

The case in question is an Ex application. The result of the current calculation is that a maximum direct current including I_{FDE} of 100 mA is flowing. Type A cable is being used with a resistance coating of 44 Ω/km.

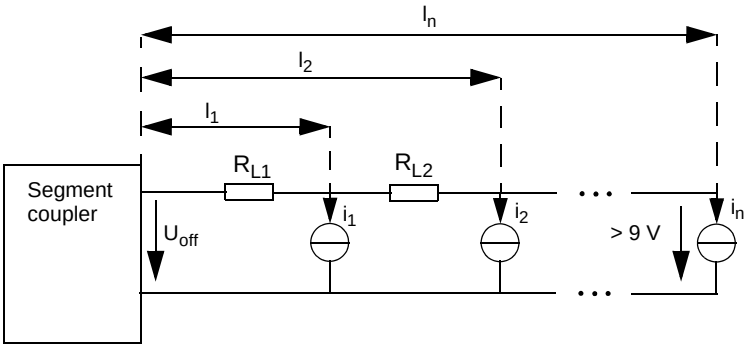
A requirement for a PROFIBUS PA slave to be able to function properly is that the input voltage on the bus line must be at least 9 V. The following therefore applies to the maximum voltage drop over the lead:

$$U_{Lmax} = U_{off} - 9\ V$$

Currently U_{off} for a modular segment coupler with an Ex interface is at least 12.8 V (12.8 V ... 13.4). For the worst case consideration, U_{off} should be set to 12.8 V. This results in a U_{Lmax} of 3.8 V.

Since all stations are connected at the end of the line, the maximum line resistance must be 38 Ω (U_L/i_{max}). This corresponds to a resistance coating of 44 Ω/km for a line length of 863 m.

Since in practice the stations are not all connected compactly at the end of the transmission line, the resulting structure is as follows:



R_{Lx} = Line resistance of line segment x
I_x = Current consumption of PA station x

Each station causes a voltage drop on the length segment through which its power supply current flows. For the first station, this would be:

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$U_{RL1} = i_1 * R_{L1}$ or $U_{RL1} = i_1 * l_1 * r$; where r = the resistance coating of the line

For the second station, this appears as follows:

$$U_{RL2} = i_2 * (R_{L1} + R_{L2}) \text{ or } U_{RL2} = i_2 * l_2 * r$$

In general, the equation for Ex applications is then as follows:

$$U_{RL} = r * \sum_{x=1}^{n} (i_x * l_x) \overset{!}{<} U_{off} - 9\ V$$

If the condition described above is not fulfilled,

a) the lead has be shortened or

b) a lead with reduced resistance coating has to be used.

Warning

When selecting the type of line, make certain that for Ex applications the requirements in terms of insulation voltage and single conductor insulation of EN 60079-14 Section 12 and the characteristic values in accordance with the FISCO model are maintained.

Note

Note that the length to be specified represents the length of the line between the terminals of the segment coupler and the respective station.

5.5 Mechanical dimensions of segment couplers

SK1 and SK2 segment couplers are based in terms of their housing on the well-tried and tested KF system of Pepperl+Fuchs.

A special characteristic of the KF system are the removable terminal blocks. Screw-in self-opening apparatus terminals suitable for a conductor cross-section of up to 2.5 mm² are integrated.

The advantage of the power rail is that power can be supplied to the modules through it. The illustration below shows the power rail versions that are used. The connection between the current-conducting leads of the power rail and the power pack of

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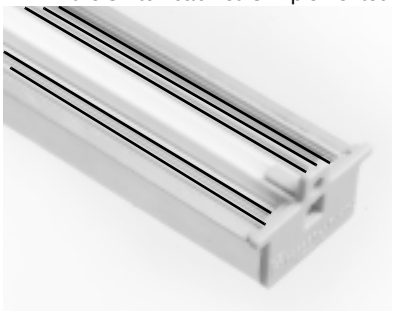
the switch cabinet is implemented by a power feed module.



Power Rail UPR-05

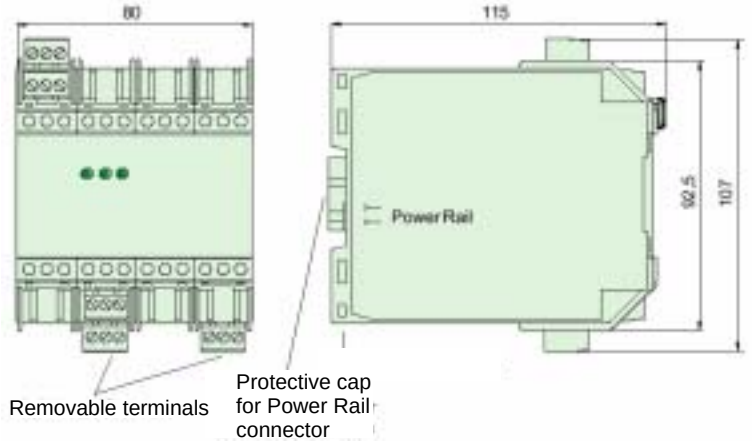
Power rail PR-05

The UPR-05 Power Rail does not have a grid and is delivered together with a carrier rail 2 meters in length. The UPR-05 can be shortened at any spot. The PR-05 has a 20 mm grid and is a inset component for the DIN rail to EN 50022. It is supplied with a length of 50 cm and can be reduced in size at any of the marks spaced at intervals of 40 mm.

In principle housings come in three shapes. For the dimensions of these housings, please refer to the following diagrams:

The following illustration applies in regard to the mechanical dimensions for products

- KFD2-BR-1.PA.93
- KLD2-PL-1.PA



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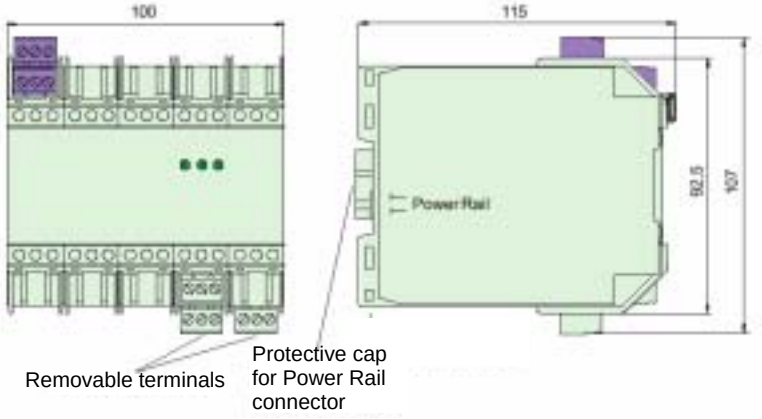
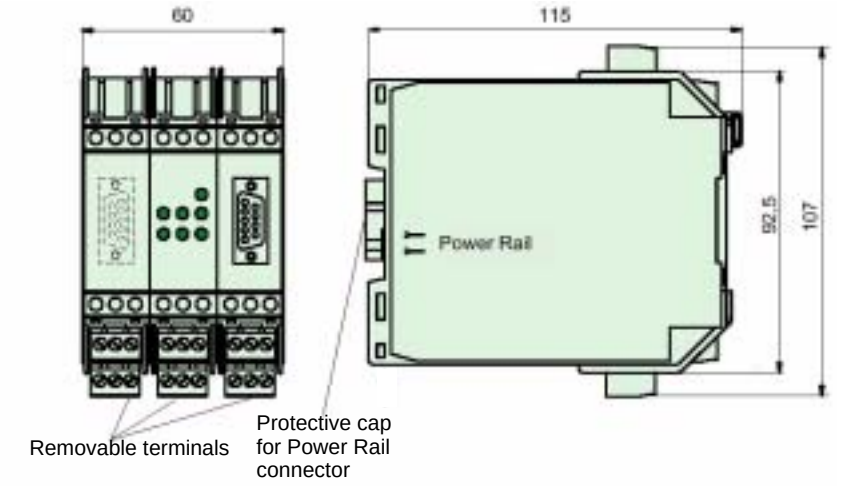
The following illustration applies in regard to the mechanical dimensions for products

- KFD2-BR-Ex1.3PA.93
- KLD2-PL-Ex1.PA



The following illustration applies in regard to the mechanical dimensions for products

- KLD2-GT-DP.xPA (x = 1 or 2)
- KLD2-GT-DPR.4PA



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5.6 Voltage supply

5.6.1 Voltage supply without redundancy

Pepperl+Fuchs offers power feed modules with different functionalities or connections. For the segment couplers Pepperl+Fuchs recommends the power feed module KFD2-EB.RPI, which is designed for a maximum rated operational current of 4 A. The total current, which is obtained from a power feed module must not exceed 4 A.

If a too high current is drawn, a fuse built into the power feed modules is triggered and interrupts the power supply of the entire Power Rail segment. A fuse being tripped is indicated through a relay output on terminals 7 and 10 of the power feed module.

The non-Ex versions of segment couplers are able to supply the PROFIBUS PA with a maximum of 400 mA. If only components of this type are used, it can happen that the 4 A supplied by a power feed module is not sufficient. In this case a new power supply segment must be formed with a new power feed module.

The supply current-conductors 1 and 2 of two supply segments must not be connected with each other.

Power can be supplied to the SK2 segment coupler, consisting of a gateway and a maximum of 5 Power Links per PROFIBUS PA channel through the terminals or the Power Rail. If power supply via the Power Rail is selected, it is possible to work with or without a redundant power supply. Both variants are described in chapter 5.6

For the total amount of current, note that Power Links KLD2-PL-... draw both the intrinsic current requirement as well as the current requirement of all PROFIBUS PA stations connected to the Power Link from the Power Rail. The total current that can be transmitted through the Power Rail must not exceed 2 A or 4 A, depending on the type of power feed module.

Please note that a separate Power Rail segment must be provided for each channel of a gateway. If you intend to mount all Power Links on the same top hat section rail or to supply power to all of them from the same power feed module, the communication line of the Power Rail (conductors 3 and 5) must be interrupted.

Example: A segment coupler consists of a gateway KLD2-GT-DP.1PA with 5 KLD2-PL-Ex1.PA Power Links connected. Under "worst case“ conditions, i. e. the external voltage supply is DC 20 V and PROFIBUS PA stations are drawing the maximum current from the PROFIBUS PA segment, the total power is calculated as follows:

Number	Product	Current consumption [mA]	Total [mA]
1	1 channel gateway KLD2-GT-DP.1PA	200	200

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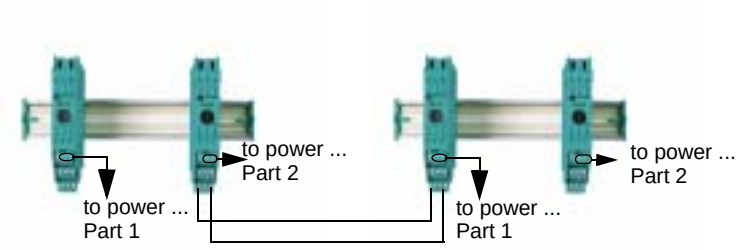
Number	Product	Current consumption [mA]	Total [mA]
5	Power Link KLD2-PL-Ex1.PA	430	2150
	Total current		2350

In this example the modular segment coupler can be operated with a power feed module that has a maximum output current of 4 A.

The non-Ex version of the KLD2-PL-1.PA Power Link has a maximum current consumption of 790 mA. If only components like this are used, the maximum current of 4 A will be exceeded. In this case a 2. supply segment with a separate power feed module has to be installed.

This also applies if power feed modules with a maximum current of 2 A are used in the example above. If this case occurs, the user must make certain that the Power Links that are assigned to channel 1 of the gateway, have an **uninterrupted** Power Rail connection to the gateway, since data exchange of channel 1 takes place over current rails 3 and 5 of the Power Rail.

If this cannot be accomplished for reasons related to the installation the KFD2-EB.RPI power feed module should be used with a pick-up directed to terminals 13 and 15. The following illustration shows the installation to be used in this case for a redundant power supply.



Power Links that are assigned to PROFIBUS PA channels 2 through 4 must not be located on the same Power Rail segment as Power Links of the PROFIBUS PA channel 1. This automatically separates power supply segments from each other and provides separate power feed modules for these PROFIBUS PA channels to use.

Note

Standard components of the KF system of Pepperl+Fuchs can be operated on the same Power Rail segment like modular segment couplers as long as the total power consumption does not exceed the maximum current of the power feed module. Combined fault indication, which is supported by many standard components of Pepperl+Fuchs, is not affected by the modular segment coupler and can also be transferred by the same Power Rail segment.

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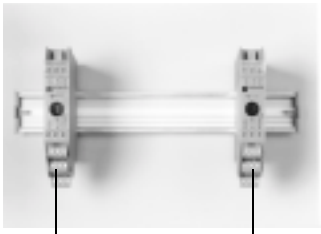
5.6.2 Voltage supply with redundancy

The power feed module KFD2-EB-R2A.RPI allows a redundant supply. The difference between the power feed modules described above and these ones is that no decoupling diodes are integrated that prevent the
flow of energy from the Power Rail via the power feed module to the power supply unit. The power feed module. The figure below shows the structure of a redundant power supply.

KFD2-EB-R2A.RPI



The power feed module KFD2-EB.R2A.RPI is designed for a maximum current flow of 2 A. If the current consumption of the application is higher than 2 A segmentation has to be performed. For further information please refer to chapter 8.

Note

If you are working with redundant supply for use with KFD2-EB-R2A.RPI *the current consumption of each Power Rail segment is to be dimensioned so that in the case of redundancy the segment can be supplied by a power feed module.*

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6 Quick commissioning

This chapter describes in brief outlines how to put into operation the segment couplers SK1 and SK2. It is intended for employees who have experience in commissioning PROFIBUSs and devices of Pepperl+Fuchs.

For detailed information please refer to chapter 7 for the segment coupler SK1 or to chapter 8 for the segment coupler SK2.

6.1 Quick commissioning of segment coupler SK1

1. If you have not done so already, mount the top hat section rail at the installation location on the segment coupler.
2. Mount the Power Rail PR03 or UPR03, if one of them is being used and snap the segment coupler and the power feed module /the power supply unit onto the Power Rail.
3. Connect the PROFIBUS DP and the PROFIBUS PA transfer line to the SK1 segment coupler SK1.

Function	KFD2-BR-Ex1.3PA.93	KFD2-BR-1.PA.93
PROFIBUS DP RxD/TxD-P	Terminal 40	Terminal 28
PROFIBUS DP RxD/TxD-N	Terminal 41	Terminal 29
PROFIBUS DP shield/FE	Terminal 42	Terminal 30
PROFIBUS DP DGND	Terminal 55	Terminal 40
PROFIBUS DP CNTR-P	Terminal 56	Terminal 41
PROFIBUS DP VP	Terminal 57	Terminal 42
PROFIBUS PA +	Terminals 3 and 18	Terminals 3 and 15
PROFIBUS PA -	Terminals 2 and 17	Terminals 2 and 14
PROFIBUS PA shield	Terminals 1 and 16	Terminals 1 and 13

4. Ground the shield of the PROFIBUS transmission lines in accordance with your shielding concept. For additional information, please refer to the possible grounding concepts in chapter 4.5.
5. If you do **not** work with Power Rail, connect the voltage supply 24 V DC to the corresponding terminals.

	KFD2-BR-Ex1.3PA93	KFD2-BR-1.PA.93
+	Terminal 59	Terminal 47
-	Terminal 60	Terminal 48
FE	Terminal 58	Terminal 46

If you are working with Power Rail, connect the power feed module in accordance with the instruction manual/data sheet to the 24 V DC power supply.
If you are using a KFA6-STR-1.24.4 or KFA6-STR-1.24.500 power pack to supply electrical power through the Power Rail, connect the power pack in accordance with the instruction manual/data sheet.

6. Add the bus termination, if the segment coupler SK1 is the last station at the PROFIBUS DP segment (see chapter 7.2). The fieldbus terminator for the PROFIBUS PA segment is integrated.

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7. Set the following PROFIBUS DP communication parameter via the configuration tool of the PROFIBUS DP Master:

Parameter	Value	Description
Baudrate [kBit/s]	93.75	PROFIBUS DP transfer rate
T_{SL} [$t_{bit\ DP}$]	4095	Slot-Time
Min T_{SDR} [$t_{bit\ DP}$]	22	Min. Station-Delay-Time
T_{ID2} [$t_{bit\ DP}$]	1000	Idle2-Time
Max T_{SDR}	1000	Max. Station-Delay-Time
T_{ID1} [$t_{bit\ DP}$]	145	Idle1-Time
T_{SET} [$t_{bit\ DP}$]	55	Setup-Time
T_{QUI} [$t_{bit\ DP}$]	0	Quiet-Time
G	10	Gap-Factor
HSA	126	Highest-Station-Address
max_retry_limit	1	Repetitions in event of failure

Since the parameter values listed above are default values, you may want to optimize them if necessary. For the necessary information please refer to chapter 8.5.

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6.2 Quick commissioning of segment coupler SK2

1. If you have not done so already, mount the top hat section rails at the installation location on the segment coupler.
2. Mount the Power Rail PR05 or UPR05. Note that a separate Power Rail segment is required for each PROFIBUS PA channel.
3. Snap the gateway and the Power Links of the channel 1 as well as the power feed module or the power supply unit onto the corresponding Power Rail segment. Please note that the distance between the PROFIBUS DP socket of the gateway and an intrinsically safe PROFIBUS PA connection of the Power Link must be at least 50 mm measured straight.
4. If a 2- or 4-channel gateway is being used snap the Power Links of the channels 2 to 4 as well as the power feed module or the power supply units onto the corresponding Power Rail segments.
5. Connect the PROFIBUS DP transfer line to the gateway.
6. If it is being used, connect the redundant PROFIBUS DP transfer line to the gateway.
7. Add the external bus termination if the gateway is the last station on the PROFIBUS DP segment (see chapter 8.2).
8. Connect the PROFIBUS PA transfer lines with the Power Links provided for this purpose. The terminal resistances for the PROFIBUS PA segments are integrated into the Power Links.

Function	Power Link Non-Ex version	Power Link Ex version
PROFIBUS PA +	3+ and 15+	3+ and 18+
PROFIBUS PA -	2- and 14-	2- and 17-
Shield PROFIBUS PA	1S and 13S	1S and 16S
Connection to the gateway CH +	28+	40+
Connection to the gateway CH -	29-	41-
Screen common connection gateway/Power Link	30S	42S
Functional ground FE	46FE	58FE
Measurement voltage +	47+	59+
Measurement voltage -	48-	60-

Note

The terminals „connection to the gateway +“ and „connection to the gateway -“ have to be connected with the terminals „PROFIBUS PA channel CHx +“ or „PROFIBUS PA channel CHx -“. The "x" designates the respective channel number 1 through 4.
If the Power Link is connected with PROFIBUS PA channel CH1 of the gateway, no connection between "Connection to the gateway +“ *and "Connection* to the gateway -“ *is necessary when the Power Rail is used.*

9. Connect the outputs for channels 2 through 4 of the gateway with the terminals

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"Connection to the gateway" **of one** Power Link of the corresponding channel.

Function	Termi-nal
Connection to Power Link channel 1, +	CH1 +
Connection to Power Link channel 1, -	CH1 -
Connection to Power Link channel 2, +	CH2 +
Connection to Power Link channel 2, -	CH2 -
Connection to Power Link channel 3, +	CH3 +
Connection to Power Link channel 3, -	CH3 -
Connection to Power Link channel 4, +	CH4 +
Connection to Power Link channel , -	CH4 -

10. Connect the power feed module according to the instruction manual/data sheet to the 24 V DC power supply.
    If you are using a KFA6-STR-1.24.4 power pack to supply electrical power through the Power Rail, connect the power pack in accordance with the instruction manual/ data sheet.
11. During configuration and when setting parameters for the PROFIBUS, make sure that DP-GSD files are used. For further information please refer to chapter 8.5.2.
12. Use your PROFIBUS configuration tool to set the watchdog time T_{WD}) to 5 s. For further information concerning the subject watchdog time and possible optimations please refer to
    chapter 8.5.2.

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7 Commissioning segment coupler SK1

7.1 Mounting the SK1 segment coupler

Devices of the KF system, such as the SK1 segment coupler, are normally mounted on a 35-mm top hat section rail in accordance with DIN EN 50022 with an inserted Power Rail. The devices can simply be snapped vertically onto the top hat section rail. In no case should the module be mounted from the side so that it is slanted or tipped.

Correct

Incorrect

The power feed modules are mounted the same way.

7.2 Connections and operating components

Usually the SK1 segment coupler receives electrical power through the Power Rail. At least one power feed module must be mounted on the Power Rail for this purpose.

If the SK1 segment coupler is **not** receiving electrical power through the Power Rail, the following terminals are available for this purpose:

	KFD2-BR-Ex1.3PA93	KFD2-BR-1.PA.93
+	Terminal 59	Terminal 47
-	Terminal 60	Terminal 48
FE	Terminal 58	Terminal 46

The following image shows the connection and operating components of all SK1 seg-

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ment couplers with an intrinsically safe interface:

1 = activated
0 = deactivated

The following image shows the terminal assignment of the SK1 segment coupler without an intrinsically safe interface

1 = activated
0 = deactivated

The fieldbus terminator should be switched into the circuit if the segment coupler represents the last device in the PROFIBUS DP segment.

The following table shows the pin assignment of the segment couplers:

Function	KFD2-BR-Ex1.3PA.93	KFD2-BR-1.PA.93
PROFIBUS DP RxD/TxD-P	Terminal 40	Terminal 28

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Function	KFD2-BR-Ex1.3PA.93	KFD2-BR-1.PA.93
PROFIBUS DP RxD/TxD-N	Terminal 41	Terminal 29
PROFIBUS DP shield/FE	Terminal 42	Terminal 30
PROFIBUS DP DGND	Terminal 55	Terminal 40
PROFIBUS DP CNTR-P	Terminal 56	Terminal 41
PROFIBUS DP VP	Terminal 57	Terminal 42
Measurement voltage +	Terminal 59	Terminal 47
Measurement voltage -	Terminal 60	Terminal 48
FE	Terminal 58	Terminal 46
PROFIBUS PA +	Terminals 3 and 18	Terminals 3 and 15
PROFIBUS PA -	Terminals 2 and 17	Terminals 2 and 14
PROFIBUS PA shield	Terminals 1 and 16	Terminals 1 and 13

7.3 Grounding

For information on grounding, please refer to chapter 4.5.

7.4 Commissioning of communication with the SK1 segment coupler

Since the SK1 segment coupler works transparently, PROFIBUS PA stations are treated by the control system like PROFIBUS DP stations. This also applies to commissioning.

To make it possible for the control system to exchange station data with a PROFIBUS, the GSD file of the station must be integrated into the configuration tool of the control system.

The SK1 segment couplers receive the PROFIBUS DP telegram, convert it simultaneously and transmit it on the PROFIBUS PA side. The PROFIBUS PA slave responds immediately to this telegram. The response telegram is received by the segment coupler, is again converted simultaneously and is transmitted on the PROFIBUS DP side as a slave response.

Hinweis

To make it possible for data exchange between the PROFIBUS DP and PROFIBUS PA to work correctly, it is essential for the PROFIBUS DP transfer rate to be set to 93.75 kBd.

The time lapse between the master call and the slave response is limited. Since the PROFIBUS PA is working at a lower transfer rate than the PROFIBUS DP, the standard settings of the bus parameters of the PROFIBUS DP Class 1 master must be changed.

Hinweis

If the bus parameters are not changed, no data exchange is possible between the PROFIBUS DP master and the PROFIBUS PA slave.

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PROFIBUS DP configuration tools do not always make it possible to set parameters for all bus parameters that are indicated in the following table. There are, however, dependencies that the configuration tool uses to calculate the dependant variable from the adjustable parameter value.

The following graph shows the standard settings of these parameter values for operation with the non-modular segment coupler:

Parameter	Value	Description
Baudrate [kBit/s]	93.75	PROFIBUS DP transfer rate
T_{SL} [$t_{bit\ DP}$]	4095	Slot-Time
Min T_{SDR} [$t_{bit\ DP}$]	22	Min. Station-Delay-Time
T_{ID2} [$t_{bit\ DP}$]	1000	Idle2-Time
Max T_{SDR}	1000	Max. Station-Delay-Time
T_{ID1} [$t_{bit\ DP}$]	145	Idle1-Time
T_{SET} [$t_{bit\ DP}$]	55	Setup-Time
T_{QUI} [$t_{bit\ DP}$]	0	Quiet-Time
G	10	Gap-Factor
HSA	126	Highest-Station-Address
max_retry_limit	1	Repetitions in event of failure

The PROFIBUS DP transfer rate is fixed at 93.75 kbit/s for non-modular segment couplers. The bit time is thus $t_{bit\ DP}$ = 10.67 µs. The PROFIBUS PA transfer rate is fixed at 31.25 kBit/s; while the bit time is $t_{bit\ PA}$ = 32 µs.

The slot-time setting of the table above works if the total of input data bytes plus output data bytes ≤ 253 bytes. If the data volume of a PROFIBUS PA slave exceeds this value, the slot-time should be set to 7192 [$t_{bit\ DP}$]. For purposes of optimization, the ideal setting can be calculated as follows:

$$T_{SL} > 13*(L_S + L_R) + 3*T_{SDR} + 630$$

where L_S is the number of data bytes in the Master_Request telegram and L_R is the number of data bytes in the Slave_Response telegram. Time T_{SDR} refers to the actual time lapse that is counted between the Master_Request and the Slave_Response. This is typically 75 $t_{bit\ DP}$.

Other possibilities for optimization in terms of cycle times are available through the Idle1-Time, Idle2-Time and the HSA setting.

The **Idle1-Time** T_{ID1} is an idle time to be observed by the master between a response telegram and the prompt telegram following it. Parameters cannot not set directly for T_{ID1} in many tools. To optimize the Idle-Time in spite of this, the Setup-Time T_{SET} parameter or, if it cannot be adjusted either, the Quiet-Time T_{QUI} parameter must be adjusted. The Idle-Time is calculated as follows:

$$T_{ID1} = 2*T_{SET} + T_{QUI} + 35*t_{bit\ DP}$$

The Idle1-Time T_{ID1} depends on the maximum response time (not to be confused with the Station-Delay-Time T_{SDR}) of all PA bus stations. In the table above, values are indicated for T_{ID1} and T_{SET} corresponding to the current PROFIBUS guidelines. In some circumstances, older PROFIBUS devices that do not yet work with response

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times in accordance with "PROFIBUS DP Expansion for EN 50170 (DPV1)", may provoke telegram repetitions. If this behavior occurs, you can increase Idle1-Time as an emergency measure. This will, however, increase the bus cycle time.

The **Idle2-Time** T_{ID2} is the idle time between an SDN telegram (send data with no acknowledge) and the following call telegram. These SDN telegrams are used for global control services (SYNC, UNSYNC, FREEZE, UNFREEZE, etc.). This value should be set to 1000 $t_{bit\ DP}$. If T_{ID2} cannot be set directly, you can use the parameter max T_{SDR}. If max T_{SDR} is greater than T_{ID1}, as is shown in the table, the value of max T_{SDR} is automatically used for T_{ID2}.

Highest-Station-Address HSA: A PROFIBUS master queries the status of all stations cyclically up to the address value HSA (1 telegram per cycle). As soon as one station at an address lower than HSA does not respond, (for example because it is not connected) the relatively long Slot-Time T_{SL} expires until the next call telegram is transferred. If it can be ensured that a station is present at every address including the HSA, this Slot-Time can be avoided.

7.5 Diagnostics

3 LEDs are available on the front side of the segment couplers for diagnostics. LED functionality is illustrated by the following table:

LED display	Meaning	Comments
Yellow, on continuously	Communication OK	Light off for Time Out
Yellow, on continuously	Hardware error	
Yellow flashing	DP reception error	Flashes 3 times when telegram error is detected
Flashes yellow and red simultaneously	PA reception error	Flashes 3 times when telegram error is detected
Yellow and red flashing alternately	Collision error	The Slot-Time T_{SL} is set too low
Green on	Power on	

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8 Commissioning the SK2 segment coupler

8.1 Mounting the SK2 segment coupler

Devices of the KF system, such as the gateway and the Power Links of the SK2 segment coupler, are normally mounted on a 35-mm top hat section rail in accordance with DIN EN 50022 with an inserted Power Rail. The devices can simply be snapped vertically onto the top hat section rail. In no case should the module be mounted from the side so that it is slanted or tipped.

Correct

Incorrect

The power feed modules are mounted in the same way.

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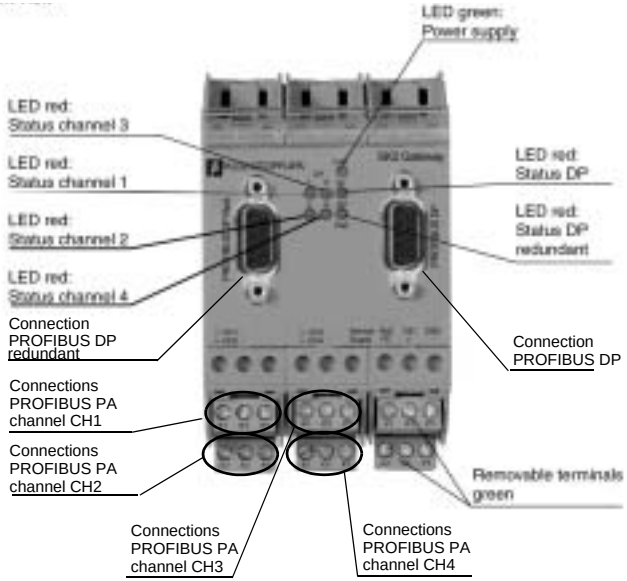
8.2 Connections

For the pin assignment of the gateway or Power Links, please refer to the following images:.



Terminal	Function
CH1 +	Connection to Power Link channel 1, +
CH1 -	Connection to Power Link channel 1, -
CH2 +	Connection to Power Link channel 2, +
CH2 -	Connection to Power Link channel 2, -
CH3 +	Connection to Power Link channel 3, +
CH3 -	Connection to Power Link channel 3, -
CH4 +	Connection to Power Link channel 4, +
CH4 -	Connection to Power Link channel , -
FE	Function ground
+	Measurement voltage +
-	Measurement voltage -
TxD	Service interface
RxD	Service interface
GND	Service interface

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Note

Terminals CH1 + and CH1 - (connection to the Power Link channel *1) or + and - (measurement voltage) are only wired if no Power Rail is being used.*
If the PROFIBUS PA channel 1 is transferred via the Power Rail, it is not possible to operate Power Links of other channels on the same Power Rail Segment as the Power Links of channel 1.

Warning

The service interface must only be used by authorized service personel by Pepperl+Fuchs.

The connection layout for the Power Links looks like this:

Non-Ex version

Ex version

Function	Non-Ex version	Ex version
PROFIBUS PA +	3+ and 15+	3+ and 18+
PROFIBUS PA -	2- and 14-	2- and 17-
Shield PROFIBUS PA	1S and 13S	1S and 16S
Connection to the gateway CH +	28+	40+
Connection to the gateway CH -	29-	41-
screen common connection gateway/power link	30S	42S
Functional ground FE	46FE	58FE
Measurement voltage +	47+	59+
Measurement voltage -	48-	60-

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Note

The terminals „connection to the gateway CH +“ and „connection to the gateway CH -“ are to be connected with the connections „PROFIBUS PA channel CHx +“ or „PROFIBUS PA channel CHx -“. The „x“ marks the respective channel number 1 to 4.
If the Power Link is connected with PROFIBUS PA channel CH1 of the gateway, no connection between "Connection to the gateway +“ *and "Connection* to the gateway -“ *is necessary when the Power Rail is used.*

As a transmission line between gateway and Power links a standard PROFIBUS DP lable type A is recommended. The screen of this cable is connected at the terminal 30S of the non- Ex power links or 42S of the Ex-power links.

8.3 Grounding

For information on grounding, please refer to chapter 4.5. The options described there for non-modular segment couplers apply correspondingly to modular segment couplers.

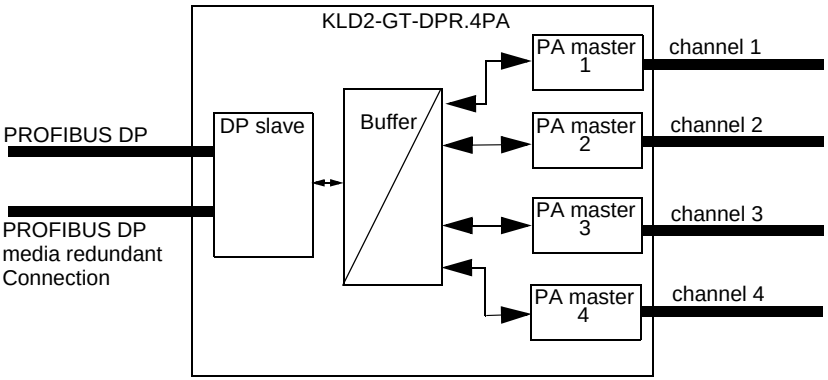
8.4 Mounting in Zone 2

For information on mounting the SK2 segment coupler in Zone 2 of an area subject to the danger of explosion, please refer to chapter 3.2.2 of this manual.

8.5 Commissioning of communication

The SK2 segment coupler works transparently. This means that the segment coupler is not perceived either from the point of view of PROFIBUS DP or PROFIBUS PA as a station (no addressing, configuration or parameter setting of the segment coupler required).

The following image shows the highly simplified structure of a gateway using the KLD2-GT-DPR.4PA as an example.



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PROFIBUS PA masters work independently of each other. The result of this is that individual PROFIBUS PA channels generally have differing bus cycle times.

PROFIBUS PA masters store all data of the corresponding channel in a common data area (buffer) of the gateway.

8.5.1 The startup phase of the modular segment coupler

The common data area serves as a buffer between the PROFIBUS DP and the PROFIBUS PA. Data is stored temporarily in reference to the PROFIBUS PA address.

If the power supply voltage of the segment coupler is turned on, the PA masters check which addresses are available on the respective channels and generate a reference list with all existing PROFIBUS PA slave addresses.

Note

*During the startup phase, the segment coupler will not answer **any** PROFIBUS DP telegrams.*

If the check reveals that the same addresses are present on different channels, LEDs CH x (x = 1, 2, 3 or 4) of the channels in question will flash red (see Page 57).

Master requests from the PROFIBUS DP master to these doubled addresses will **not** be answered by the segment coupler. This will also result in an error message in the higher level control system. As soon as the error has been eliminated, the LEDs go out automatically and the corresponding master requests are answered. This requires the slave that is still present to have been previously configured correctly in the control system.

8.5.2 Configuration of PROFIBUS PA slaves

Since the SK2 segment coupler works transparently, PROFIBUS PA stations are treated by the PROFIBUS DP master like PROFIBUS DP slaves. This also applies to commissioning and configuration.

To make it possible for a PROFIBUS PA slave to be placed in operation and be configured by a configuration tool, the GSD file of the slave must have been integrated into the configuration tool.

In principle, the following distinctions must be made with GSD files for PROFIBUS PA slaves:

1. Is the GSD a profile GSD or a manufacturer-specific GSD?
2. Is the GSD designed for communication over the RS 485 interface (DP-GSD) or over the interface based on IEC 61158-2 (PA-GSD)?

Note

If a SK2 segment coupler is used, independently of whether or not it is a manufacturer-specific or profile GSD, always use the DP-GSD.

If a profile GSD is used, you can tell by the filename whether the file is a DP-GSD file or a PA-GSD file. As a rule, profile GSDs are integrated into the configuration tool.

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For example, the file PA039733.gsd is a profile GSD FOR 4 binary outputs. The "PA" in the filename means that the device in question is a PROFIBUS PA slave. The "0" after the PA indicates that it is a DP-GSD. The filename of the PA-GSD for the same profile is PA139733. The "1“ after the abbreviation PA indicates that it is a PA-GSD.

If manufacturer-specific GSDs are used, for example to use functionality that falls outside the profile, you can tell whether it is a DP-GSD or a PA-GSD in the following manner:

- If you have not done so already, integrate the GSD into your configuration tool.
- Check the baud rates that are supported in your configuration tool.

If the baud rate 31.25 kBd is supported, it is a PA-GSD. Normally, only baud rates of 31.25 kBd, 45.45 kBd and 93.75 kBd are supported by the PA-GSD.

If the transfer rates based on PROFIBUS specification (EN 50170/-2) are supported, i. e. baud rates of 9.6 kBd to 1.5 MBd or 12 MBd, it is a DP-GSD.

Some PROFIBUS PA field device manufacturers do not offer **any** PROFIBUS DP-GSDs. In this case, the existing PROFIBUS PA-GSD must be converted. An appropriate conversion software package (GSD converter) is available at no cost at www.pepperl-fuchs.com. The task of this conversion software is exclusively to enter the missing transfer rate and set specific bus parameters to values that allow for problem-free operation of the PROFIBUS DP.

Important notes on the 'GSD Converter' conversion software:

Note

The advisory committee of the PROFIBUS user organization has agreed that certified GSD files that have been modified by the Pepperl+Fuchs GSD converter software do not lose their certificate.

Effect of the GSD converter software on field device functionality

The conversion of the GSD file imposes the following restrictions if it was previously supported by the original GSD file:

- FREEZE and SYNC functionality is deactivated. These functions are used in PROFIBUS DP for synchronizing sensors/actuators. Since the system is working with transfer rates of up to 12 MBd on the PROFIBUS DP side (host side) and with a transfer rate of 31.25 kBd on the PROFIBUS PA side (field side) it is not possible to ensure that this synchronization will work with no problems.
- A maximum of 4 master Class 2 connections (C2 connections) are supported for each slave.

Some PROFIBUS functions are currently not supported. If the field device is supposed to support one or more of the following functions, a warning will inform the user that this is no longer the case after the conversion. This affects the following functions:

- Alarms based on PROFIBUS DP V1
- The following functions of the PROFIBUS DP V2
  - Data Exchange Broadcast (Publisher/Subscriber)
  - Time synchronization
  - Isochronous mode, i. e. cycle-synchronous transfer

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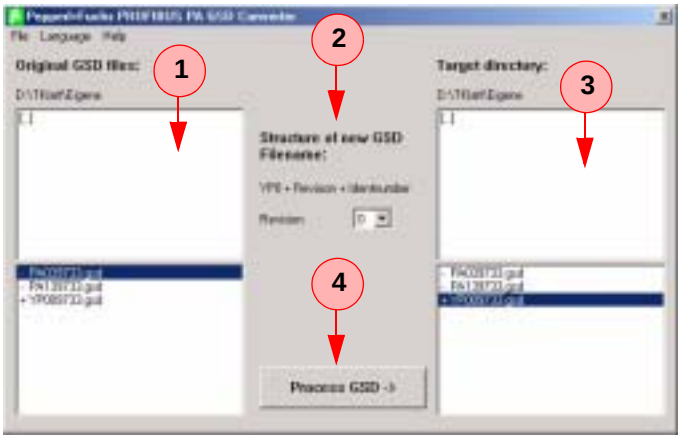
Use of the "GSD Converter“ software

After the program is started (pfgsdcv.exe) the following dialog appears:



To convert a GSD file, proceed as follows:

1. Switch to the directory in which the GSD files to be converted are located.
2. Select the GSD files to be converted:
   You can select one or more files (using Ctrl or Shift) for conversion. Files with '+' before the file name are the result of a former conversion and generate an error message if you attempt to convert them again. Files with a '-' are **not** the result of a conversion and can be converted.
   You can open a file to view it and edit it by double clicking on it.
3. Determine the version number of the GSD file to be converted:
The name of a PROFIBUS GSD file always consists of 3 parts:
   - The manufacturer-specific part (1- 4 characters).
   - An identification of the manufacturer, for example "PF_“ for Pepperl + Fuchs GmbH
   - The ID number (4 characters)
   - The file extension

For GSD files of PROFIBUS PA devices that were converted for transparent segment couplers up to 12 Mbit, the Profibus User Organization (PNO) has determined the manufacturer-specific part of the name. It is composed of the character sequence "YP0“ and a version number. You can select the version number using a drop-down box (revision) and thus generate different versions of GSD files for a field device (with the same ID number).

3. Switch to the directory in which the converted GSD files will be stored.
4. Convert the GSD files by clicking on the "Process GSD -->“ button.
   You can start the conversion process with this button. Another window appears in which you are informed of the results of the conversion process.

Information for determining the Watch Dog Time T_{WD}

Date of issue 08.11.2002

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PROFIBUS devices are able to activate a watchdog mechanism that monitors at each time interval of cyclic calls (data exchange) to make certain the PROFIBUS master is still active. The time measurement takes place in the PROFIBUS slave.

If the watchdog is activated and the time T_{WD} (Watch Dog Time) since the last cyclic call expires, the device leaves cyclic data exchange, goes into the original state (Wait_prm) and sets the outputs to the secure state.

The value of the time T_{WD} and the activation of the watch dog are transferred in the parameterizing telegram from the PROFIBUS Master to the PROFIBUS slave at start-up (transition to the data exchange). In general, dimensioning of the time T_{WD} is used-specific (not device-specific, not in the GSD). The value is bounded below by cycle times.

As a rule, the configuration tool is used to enter the time T_{WD}. There are configuration tools for which the watchdog time is set 1x per PROFIBUS master and other for which the watchdog time is set individually for each PROFIBUS PA station. This does not change with the value of the watchdog time.

For many tools, the time T_{WD} is automatically calculated based on the cycle time of the master with a corresponding baudrate.

At higher baud rates on the PROFIBUS DP side (for example 12 MBd) cycle times on the PA side may be longer by a factor of 300. If parameters were set directly for a PROFIBUS PA device at a baud rate (DP) for a time calculated for a higher master T_{WD}, it would generally be less than the PA cycle and the device would not enter into the data exchange.

Behavior of segment coupler 2

To ensure reliable operation of the PROFIBUS the following bus parameters should be used:

- Transfer rate 45.45 kBd ... 12 MBd
- Watchdog time T_{WD} = 5 s
- PROFIBUS DP Standard

Note

If there are a large number of PROFIBUS PA stations per channel of the SK2 segment coupler, the watchdog time T_{WD} should be verified. The limit value is about 32 stations, but depends on the volume of data to be transferred.

Determining the parameter T_{WD}

The watchdog time for the value above is a number based on experience, in other words one that usually works. If it turns out that the watchdog time is too long (slaves are not switching into the secure state quickly enough) or too short (slaves are switching into the secure state without the master ever having failed) this must be factored into the calculation. Depending on the configuration tool you are using, you can

- set parameters for only one watchdog time T_{WD} for the entire PROFIBUS system. In this case, the greatest delay time must be used as the basis for determining T_{WD}.
- set parameters for a watchdog time T_{WD} for each individual slave.

The time T_{WD} that is set (parameter) must be greater than the longest delay time

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T_{V_max} that will occur. This is composed of a number of elements as follows:

$$T_{V\_max} = T_{Cycle\_DP} + T_{Cycle\_PA\_channel}$$

where $T_{Cycle\_PA\_channel}$ = the cycle time of the PROFIBUS PA channel
T_{Cycle_DP} = Cycle time of the PROFIBUS DP

Pepperl+Fuchs recommends three times the PROFIBUS PA cycle time.

Details for calculating the T_{WD} parameter

The PA cycle time $T_{Cycle\_PA\_channel}$ depends on

1. the number n of stations on a channel
2. the effective data length L_{Σ} (average of the total of input and output data of all devices [number of bytes (unitless)]):

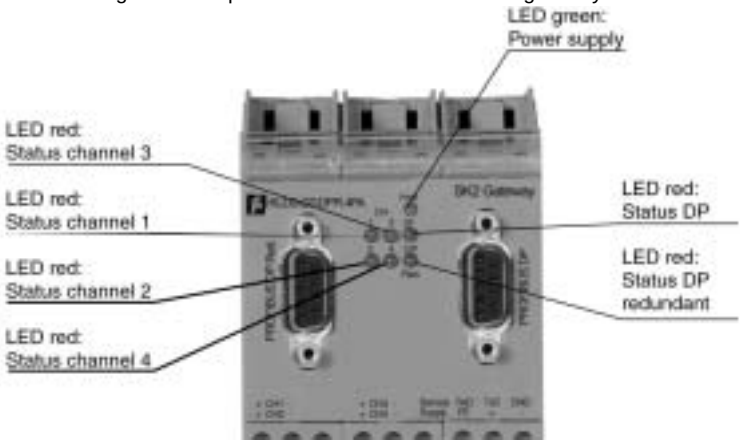
Cycle time can be calculated in an approximate manner as

$$T_{Cycle\_PA\_channel} = n * (0.256 \text{ ms} * L_{\Sigma} + 12 \text{ ms}) + 40 \text{ ms}$$

For more information on calculating cycle time, please refer to chapter 5.3.3

8.6 Displays and error messages

The following LEDs are present on the front side of the gateway:



In normal operation, the LEDs should display the following state if there are no errors:

LED display	Meaning
Green on	Power supply OK
Red CH_x; off	PA communication OK
Red_DP/Red_DP red; off	PROFIBUS DP communication OK

If errors occur on the PROFIBUS PA side, this will be indicated with flashing sequences. These sequences indicate and specify the error. The flashing sequences consist

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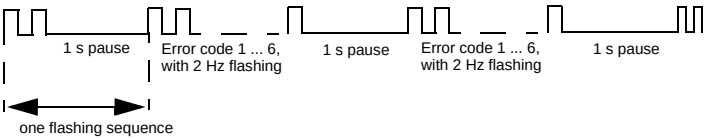
of an error code and a pause. The structure is shown in the following illustration.



Only the LEDs of the channel that has an error will flash.

The error code is indicated by the frequency of the flashing on the LED. The following example is intended to clarify this point:

The CH2 LED flashes 3 times, followed by a pause of about 1 s. Then the CH2 LED flashes again 3 times, etc. This indicates that one of the errors that are described under error code 3 has occurred on PROFIBUS PA channel 2.

For the meaning of the individual flashing sequences, please refer to the following table:

LED	Error code	Error description
Red CH_x	1	At least one slave in the channel is not responding to the master request in good time. Possible reasons: - Defective slave - Slave physically separated from the transfer medium - Problems with the quality of the signal transmission
Red CH_x	2	One or more slaves have exited data exchange mode. Possible reasons: - Slave physically separated from the transmission medium - Watch Dog Time T_{WD} too short - Defective slave
Red CH_x	3	One or more slaves is not switching into data exchange mode. Possible reasons: - Incorrect slave parameter values - Watch Dog Time T_{WD} too short
Red CH_x	4	NO data exchange on the PA channel. Possible reasons: - lead breakage or short-circuit - all slaves have been removed physically
Red CH_x and Red_DP / Red_DP red	5	2 identical addresses for different PA channels. Change one of the addresses that was assigned twice (note that no PROFIBUS PA slave must have the address 1).

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LED	Error code	Error description
Red PA_x	6	The PA cycle time is close to or greater than the Watch Dog Time T_{WD}. Increase the Watch Dog Time (see Page 54

If the red LED DP or DP_red flashes continuously at a frequency of about 1.4 Hz (1.4 times per second), this indicates that there is no data exchange on the PROFIBUS DP line or that the PROFIBUS DP cable is not connected.

At present there is no assignment of the LEDs to the redundant connections, i.e. if only one lead fails, the LEDs do not flash, if both leads fail, both LEDs are flashing.

If one or more LEDs are flashing at a frequency of 5 Hz, it is essential to send the device in to Pepperl+Fuchs.

Power Link LEDs

The meanings of the LEDs for the Power Link are as follow:

LED display	Meaning
Red CHK/ERR on	Hardware error
Red COM/ERR; 2 Hz flashing	No activity on the PROFIBUS PA Segment
Green PWR on	Power supply OK

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this publication is, therefore, printed on paper bleached without the use of chlorine.

One Company, Two Divisions.

Factory Automation Division

Product Range

- Digital and analogue sensors
- in different technologies
  - Inductive and capacitive sensors
  - Magnetic sensors
  - Ultrasonic sensors
  - Photoelectric sensors
- Incremental and absolute rotary encoders
- Counters and control equipment
- Identification Systems
- AS-Interface

Areas of Application

- Machine engineering
- Conveyor or transport
- Packaging and bottling
- Automotive industry

Process Automation Division

Product Range

- Signal conditioners
- Intrinsically safe interface modules
- Remote Process Interface (RPI)
- Intrinsically safe field bus solutions
- Level control sensors
- Process measuring and control systems engineering at the interface level
- Intrinsic safety training

Areas of Application

- Chemical industry
- Industrial and community sewage
- Oil, gas and petrochemical industry
- PLC and process control systems
- Engineering companies for process systems

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http://www.pepperl-fuchs.com

USA Headquarters
Pepperl+Fuchs Inc. 1600 Enterprise Parkway
Twinsburg, Ohio 44087 Cleveland-USA
Tel. (330) 4 25 35 55 Fax (330) 4 25 4607
e-mail: sales@us.pepperl-fuchs.com

Asia Pacific Headquarters
Pepperl+Fuchs Pte Ltd. P+F Building
18 Ayer Rajah Crescent Singapore 139942
Tel. 67 79 90 91 Fax 68 73 16 37
e-mail: sales@sg.pepperl-fuchs.com

Worldwide Headquarters
Pepperl+Fuchs GmbH K nigsberger Allee 87
68307 Mannheim Germany
Tel. +49 621 7 76-0 Fax +49 621 7 76-10 00
e-mail: pa-info@de.pepperl-fuchs.com

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Part. No. 105086 11/02 02