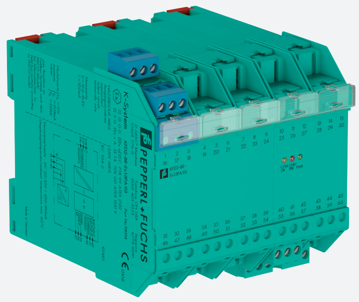
Gateway

FieldConnex® Fieldbus

KFD2-BR-Ex1.3PA.93



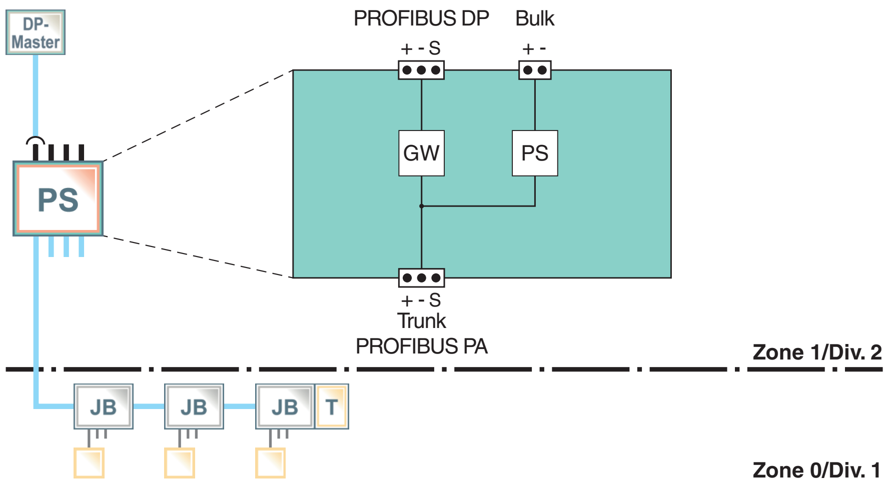
- Output: 12.6 ... 13.4 V/100 mA
- Couples PROFIBUS PA devices transparently to PROFIBUS DP
- Intrinsically safe, Ex ia (FISCO or Entity)
- Installation in Zone 2/Class I, Div. 2
- Fixed, high-availability terminator
- For all non-redundant masters
- Cyclic/acyclic data exchange

Segment Coupler 1, intrinsically safe power supply and gateway for coupling PROFIBUS PA devices to PROFIBUS DP

Function

The Segment Coupler 1 (SK1) is an all-in-one gateway and fieldbus power supply for connecting PROFIBUS PA to PROFIBUS DP transparently.
The Segment Coupler powers a single PROFIBUS PA segment adapting current and voltage.
The output is rated intrinsically safe Ex ia IIC according to FISCO and Entity. The complete segment can be installed intrinsically safe.
Communication is transparent between DP and PA. The gateway of the Segment Coupler makes each PA device appear as if it was connected to DP: This relates to addressing, cyclic/acyclic data exchange, and the transfer rate. Segment design is clear and easy to understand without subnetworks. The gateway itself is confguration-free. All in all, these features significantly reduce engineering work.
SK1 supports any PROFIBUS DP master at a fixed transfer rate of 93.75 kbps.

Connection



Technical Data

General specifications		
Installation in hazardous area		Zone 2 / Div. 2
Supply		
Connection		Power Rail or terminals 59+, 60-, 58 FE
Rated voltage	U_r	20 ... 35 V DC
Ripple		≤ 10 %
Rated current	I_r	190 mA ... 430 mA
Fieldbus connection		
Number of segments		1

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Technical Data

Rated voltage	U_N	24 ... 26 V
PROFIBUS PA		
Connection		terminals 3, 18+; 2, 17-
Rated voltage		12.6 ... 13.4 V
Rated current		max. 100 mA
Terminating impedance		100 Ω , integrated
PROFIBUS DP		PROFIBUS with RS-485 transmission technology
Connection		Terminals 40 RxD/TxD-P, 41 RxD/TxD-N, 42 screen/FE, 55 DGND, 56 CNTR-P, 57 VP
Baud rate		93.75 kBit/s
Terminating impedance		with rotary switch (S1) switchable: 1 = on; 0 = off
Galvanic isolation		
PROFIBUS DP/PROFIBUS PA		safe galvanic isolation acc. to EN 50020, voltage peak value 375 V
PROFIBUS DP/Supply		functional insulation acc. to DIN EN 50178, rated insulation voltage 50 V_{eff}
PROFIBUS PA/Supply		safe galvanic isolation acc. to EN 50020, voltage peak value 375 V
Directive conformity		
Electromagnetic compatibility		
Directive 2014/30/EU		EN 61326-1:2013
Standard conformity		
Galvanic isolation		EN 50178
Electromagnetic compatibility		NE 21:2006
Degree of protection		IEC 60529
Fieldbus standard		EN 50170/2
Climatic conditions		IEC 60721
Ambient conditions		
Classification		3K3
Ambient temperature		-20 ... 60 °C (-4 ... 140 °F)
Storage temperature		-40 ... 85 °C (-40 ... 185 °F)
Relative humidity		< 75 %
Pollution degree		max. 2, according to IEC 60664
Mechanical specifications		
Connection type		screw terminal , pluggable
Core cross section		up to 2.5 mm^2
Housing		100 mm x 115 mm x 107 mm
Housing material		Polycarbonate
Degree of protection		IP20
Mass		650 g
Mounting		DIN rail mounting
Data for application in connection with hazardous areas		
EU-type examination certificate		PTB 99 ATEX 2142 , for additional certificates see www.pepperl-fuchs.com
Marking		⟨Ex⟩ II (1) G [Ex ia] IIC Ga , ⟨Ex⟩ II (1) D [Ex ia] IIIC Da
Supply		
Maximum safe voltage	U_m	253 V AC / 125 V DC (Attention! U_m is no rated voltage.)
PROFIBUS PA		
Voltage	U_o	15 V
Current	I_o	207.2 mA
Power	P_o	1.93 W
Maximum safe voltage	U_m	60 V
Certificate		PF 15 CERT 3527 X
Marking		⟨Ex⟩ II 3G Ex ec II T4 Gc
Directive conformity		
Directive 2014/34/EU		EN 60079-0:2012 , EN 60079-7:2015 , EN 60079-11:2012
General information		

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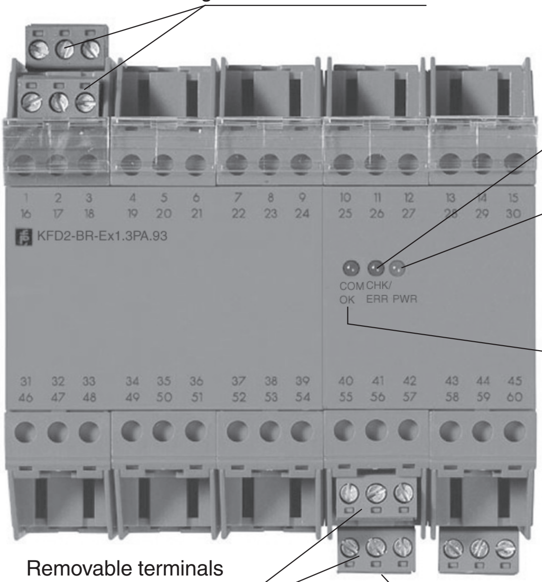
Technical Data

Supplementary information	Observe the certificates, declarations of conformity, instruction manuals, and manuals where applicable. For information see www.pepperl-fuchs.com.

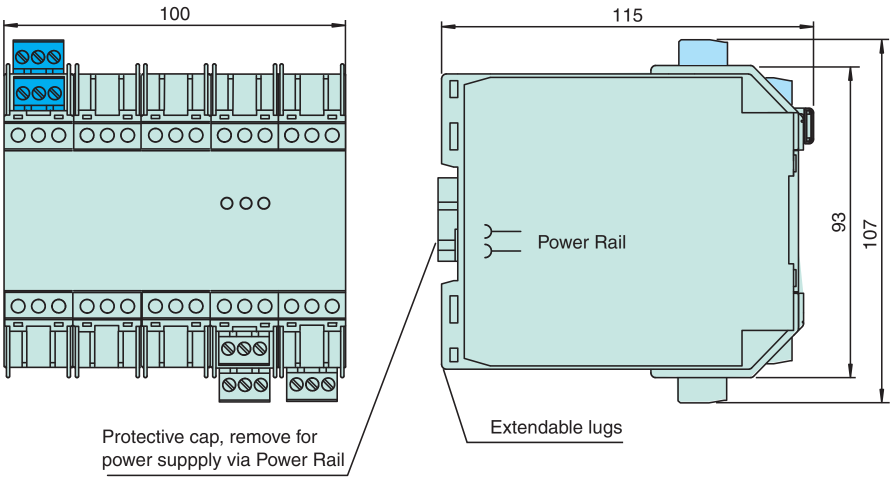
Assembly

Front View



Additional Information

Dimensions



Accessories

Power Rail	UPR-03	Inset component for DIN rail in accordance with DIN EN 50022, standard length 500 mm
Power supply modules	KFD2-EB2	Supplies power to the power rail at a voltage of 24 V DC and a max. current of 4 A
Terminator	KMD0-FT-Ex F*-FT-Ex1.I.IEC F*-FT-Ex1.D.IEC	Terminates the PROFIBUS PA branch in the field. The KMD0-FT-Ex is connected to the last PROFIBUS PA station.

Installation

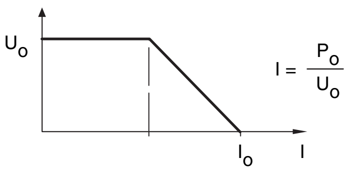
Connection

Please note!

On the segment coupler no supply voltage or other external voltage must be applied to the PROFIBUS terminals.

For additional information see the PNO manual for PROFIBUS PA.

Output characteristic



***) FISCO:**
Fieldbus **I**ntrinsically **S**afe **Co**ncept

Number of stations, current consumption of stations:

The total of the max. current consumption of connected bus stations must be less than the rated current I_S of the segment coupler. The modulation current with which a bus station sends data does not need to be taken into consideration.

Ground, shield:

For reasons of interference immunity, the shield/FE, the FE and especially the shield/PA should be connected to a functional ground (or Ex-ground) on the segment coupler.

Commissioning and Operation

Configuration

Bus parameters: Bus parameters of the PROFIBUS Master

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Operation is ensured with the following bus parameters:

Parameter	Value	For description see section	Description
Baudrate (kBit/s)	93.75		
T_{SL} (t_{Bit})	4095	Slot time	
min T_{SDR} (t_{Bit})	22		Station delay time
T_{ID2} (t_{Bit})	1000	Idle2 time	
max T_{SDR} (t_{Bit})	1000	in Idle2 time	
T_{ID1} (t_{Bit})	145/335*)	Idle1 time	
T_{SET} (t_{Bit})	55/150*)	in Idle1 time	
T_{QUI} (t_{Bit})	0		Quiet time
G	10		Gap factor
HSA	126	Highest Station Address	
max_retry_limit	1		Repetitions in event of failure

*) There are no response errors for these values, even with older devices.
All time units that are specified in bits (without index [1])) refer to 93.75 kBit/s. 1 Bit = 10.66 µs.

Idle1 time:

The Idle1 time T_{ID1} is the idle time that must be observed by the Master between a response telegram and the following call-up telegram.The Idle time T_{ID1} should not be set directly by parameter for many control tools. To adjust the Idle time in spite of this, the Setup time parameter T_{SET} must be changed or, if T_{SET} is also inaccessible, T_{QUI} :

T_{ID1} is calculated from: $T_{ID1} = 2 \times T_{SET} + T_{QUI} + 35$ Bit

The Idle time T_{ID1} depends on the maximum response time [2)] of all PA bus stations. For T_{ID1} and T_{SET}, values are specified in the left column corresponding to the current PROFIBUS regulations. Under certain circumstances, older PROFIBUS devices that do not work with the response times in accordance with Standard PROFIBUS DP-E could cause telegrams to be repeated. If this behaviour occurs, you can increase the Idle 1 time as an emergency measure. However, this also increases system response time (see Diagram 1).

Slot time:

The Slot time T_{SL} should be set to 4 095[3)] Bit. The Slot time depends on the following parameters:

- Data field length L_S of the call-up telegram [byte][4)]
- Data field length L_R of the response telegram [byte]
- Station delay time T_{SDR} of the PA bus station[5)] [Bit_{PA}][6)]

If the maximum total of data field length L_S and data field length L_R of all bus stations is known, the Slot time can be optimised (minimised):

$$T_{SL} > 13 \text{ Bit} \times (L_S + L_R) + 3 \text{ Bit} \times T_{SDR}/Bit_{PA} + 630 \text{ Bit [Bit]}$$

In contrast to the Idle1 time, the Slot time has only a minor effect on the system response time. Because of this, no minimisation is required. If the value of T_{SL} is too small, data exchange with long data field lengths cannot take place and the telegram packets will collide (see LED display, collision). For these reasons, the Slot time should not be set too low.

Idle2 time:

The Idle2 time T_{ID2} is the idle time between an SDN (**S**end **D**ata with **n**o Acknowledge)[7)] and the subsequent call-up telegram. It should be set to 1000 Bit. If T_{ID2} will not be set directly, the parameter max. T_{SDR} is used. If max. T_{SDR} is greater than T_{ID1} (as in the table), the value of max. T_{SDR} is accepted for T_{ID2} [8)].

Highest Station Address HSA:

A PROFIBUS master queries the status of all stations cyclically up to the address value HSA. 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 expires. The effect on the system response time is illustrated in Diagram 1. If it is ensured that a station is present for each address up to and including HSA, this Slot time can be avoided --> Diagram 1, broken line.

Comments for projecting, time response:

Within the bus-specific communication interfaces, the time interval from the transfer of a piece of information to the next transfer of this information, or when it is updated, is referred to as the **system response time**, access time or total cycle time. The actual system response time is the total of all message cycles[9)] (the message cycle time) within a token cycle[10)]. Not all messages are processed cyclically (in every token cycle). These acyclic telegrams can be ignored at first, since they are used only sporadically.

Starting with single-master operation, the system response time is the total of message cycles T_{MCi} to the passive bus stations. "n" is the number of these stations. A good approximation of the actual system response time T_{SYS} can be obtained by adding up one message cycle for effective data (cyclic data exchange) for each bus station "i" (i = {1…n}). In addition, the duration of the Gap Update and Token T_{G+T} are added.

$$T_{SYS} = \sum_{0=1}^{n} T_{MC(i)} + T_{G+T}$$

The value of T_{G+T} is a maximum (worst case) of 47 ms (boundary conditions[11)]). With a smaller number of stations, the duration of T_{T+G} is noticeable (see Diagram 1). T_{T+G} can be reduced to 11.36 ms (boundary conditions[12)]) by adjusting the Highest Station Address HSA --> Diagram 1, broken line. See Highest Station Address.

The duration of a message cycle depends on the effective data length L_S of the call (Output_Length) and L_R of the response (Input_Length). [in Bytes]

Equation 1

$$T_{MC} = 11\ \text{ms} + 0.256\ \text{ms} \times (L_S + L_R)$$

Boundary conditions[13)] --> Diagram 2 (T_{ID1} = 145 Bit)

To enhance clarity, for the effective data lengths L_S and L_R, their sum L_Σ is used: $L_\Sigma = L_S + L_R$

The response time T_{SYS} can be calculated by adding up the effective data lengths $L_{\Sigma(i)}$ of stations i = {1 … n}.

Equation 2

$$T_{SYS} = n \times 11\ \text{ms} + 0.256\ \text{ms} \times \sum_{0=1}^{n} T_{\Sigma(i)} + 47\ \text{ms}$$

If an average effective data length $\overline{L}_\Sigma$ is used, Equation 1 with n stations is simplified to:

Equation 3

$$T_{SYS} = n \times \overline{T}_{MC} + T_{G+T} = n \times (11\ \text{ms} + \overline{L}_\Sigma \times 0.256\ \text{ms}) + 47\ \text{ms}$$

Many devices work at an effective input **or** output data length of 5 ... 10 Bytes. Thus, the calculation example is close to practical requirements at $\overline{L}_\Sigma$ = 10 Bytes:

Equation 4

$$T_{SYS} = n \times 11\ \text{ms} + 10 \times 0.256\ \text{ms} + 47\ \text{ms}$$
$$T_{SYS} = n \times 13.56\ \text{ms} + 47\ \text{ms} \text{ --> Diagram 1 } (T_{ID} = 145\ \text{Bit})$$

Characteristic Curves

Diagram 1

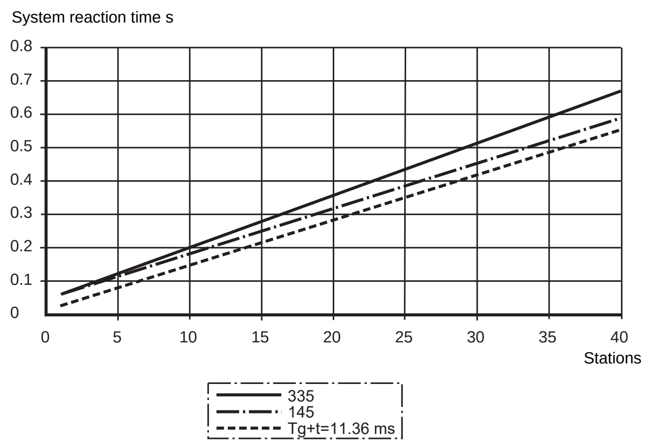
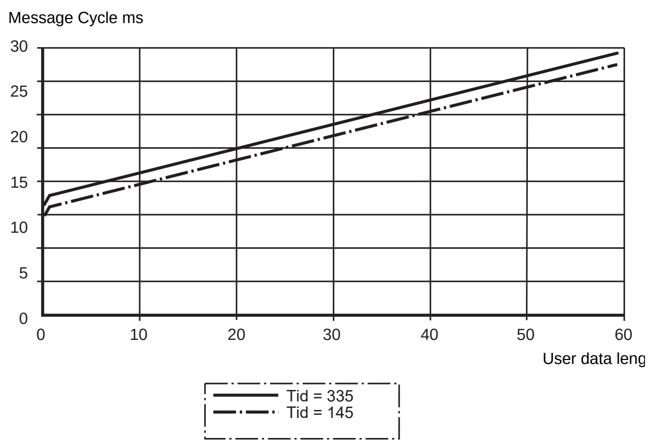


Diagram 2



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The previous formulas applied for operation at an Idle1 time of 145 Bit. If you are forced to increase the Idle time-1 (see the section entitled Idle1 time), the message cycle will also increase. The calculated times are shown in the diagrams with the T_{ID1} values of 335 Bit (thin line) recommended in older data sheets.

The following formulas contain the additional parameter T_{ID1}. The equations are numbered according to the previous equations with an additional index i.

Equation 1i

$$T_{MC} = 9.456 \text{ ms} + 0.256 \text{ ms} \times L_{\Sigma} + L_{ID} / 93.75 \text{ kBit/s}$$

Equation 2i

$$T_{SYS} = n \times (9.456 \text{ ms} + T_{ID} / 93.75 \text{ kBit/s}) + 0.256 \text{ ms} \times \sum_{i=0}^{n} T_{\Sigma(i)} + 48 \text{ ms}$$

Equation 3i

$$T_{SYS} = n \times (9.456 \text{ ms} + T_{ID} / 93.75 \text{ kBit/s} + \bar{L}_{\Sigma} \times 0.256) + 48 \text{ ms}$$

Equation 4i

$$T_{SYS} = n \times (11 \text{ ms} + 10 \times 0.256 \text{ ms}) + 48 \text{ ms}$$
$$T_{SYS} = n \times 13.56 + 47 \text{ ms} \text{ --> Diagram 1 } (T_{ID}) = 145 \text{ Bit)}$$

Indication

LED display	Meaning	Comments
Yellow On continuously	Communication OK	Light off for time out (of DP line approx. 0.3 s light off with time out of PA line approx. 3 s)
Red On continuously	Hardware error	
Yellow flashing	DP reception error	flashes 3 times when telegram error is detected
Yellow and **Red** flashing in sync	PA reception error	flashes 3 times when telegram error is detected
Yellow and **Red** flashing alternately	Collision error sh. Slot time	flashes 3 times when collision error is detected
Green On	Power on	

Footnotes

1) Index PA applies to 31.25 kBit/s: 1 Bit_{PA} = 3 Bit_{DP} = 32 µs.
2) This special reaction time is not the so-called station delay time T_{SDR}.
3) The value 4095 Bit applies to the following parameters: $L_S + L_R < 253$ Bytes; T_{SDR} = 60 Bit_{PA} (1.92 ms). If you would like to allow for data exchange with call-up and response telegram, each with a theoretical maximum length of 246 Bytes ($L_S + L_R$ = 492 Bytes), T_{SL} should be set to 7192 Bit.
4) The unit, byte, is the number of telegram characters (UART characters).
5) Most PA bus stations have a T_{SDR} of 60 Bit_{PA}.
6) The time unit bit_{PA} applies for the PROFIBUS PA side as 31.25 kBit/s. 1 Bit_{PA} = 32 µs .
7) SDN telegrams are used for example by the “Global Control” service.
8) T_{ID2} is calculated from: T_{ID2} = max (T_{SYN} +T_{SM}, max T_{SDR}). The greater value should be placed in parentheses. The relationships between these monitoring times are described in DIN 19 245-1 Section 4.1.7.
9) A message cycle includes a call-up telegram, response telegram, reaction time (between call and response) and the pause time until the beginning of the next call (Idle time-1).
10) The duration of a token cycle and the system response time are practically identical.
11) T_{T+G} = 47 ms applies with the following boundary conditions: GAP Update in Worst Case (station address not present. Slot time T_{SL} = 4059 Bit; Idle time-1 T_{ID1} @ 150 Bit.
12) T_{T+G} = 47 ms applies with the following boundary conditions: GAP Update with response; Idle time-1 T_{ID1} = 145 Bit
13) Equation 1 has the following conditions: Idle time-1 =145 Bit; station delay time of station T_{SDR} = 60 Bit_{PA} = 180 Bit; call and response have the same telegram format with a variable data field length (SD2).
    The time unit bit_{PA} applies for the PROFIBUS PA side as 31.25 kBit/s. 1 Bit_{PA} = 32 µs.

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