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TURCK

FOC1...
Media Converters FO

Instructions for Use

Contents

Contents

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1 About these instructions

These instructions for use describe the structure, functions and the use of the product and will help you to operate the product as intended. Read these instructions carefully before using the product. This is to avoid possible damage to persons, property or the device. Retain the instructions for future use during the service life of the product. If the product is passed on, pass on these instructions as well.

1.1 Target groups

These instructions are aimed at qualified personnel with knowledge of explosion protection (e.g. EN 60079-14 etc.) and must be carefully read by anyone mounting, commissioning, operating, maintaining, dismantling or disposing of the device.

1.2 Explanation of symbols used

The following symbols are used in these instructions:

	**DANGER** DANGER indicates a dangerous situation with high risk of death or severe injury if not avoided.
	**WARNING** WARNING indicates a dangerous situation with medium risk of death or severe injury if not avoided.
	**CAUTION** CAUTION indicates a dangerous situation of medium risk which may result in minor or moderate injury if not avoided.
	**NOTICE** NOTICE indicates a situation which may lead to property damage if not avoided.
	**NOTE** NOTE indicates tips, recommendations and useful information on specific actions and facts. The notes simplify your work and help you to avoid additional work.
▶	**CALL TO ACTION** This symbol denotes actions that the user must carry out.
⇨	**RESULTS OF ACTION** This symbol denotes relevant results of actions.

1.3 Other documents

Besides this document the following material can be found on the Internet at **www.turck.com**:

- Data sheet
- Quick Start Guide
- Declarations of conformity (current versions)
- Approvals

1.4 Feedback about these instructions

We make every effort to ensure that these instructions are as informative and as clear as possible. If you have any suggestions for improving the design or if some information is missing in the document, please send your suggestions to **techdoc@turck.com**.

2 Notes on the product

2.1 Product identification

These instructions apply to the following devices:

- FOC11-3G
- FOC11EX-2G
- FOC12-3G
- FOC12Ex-2G

2.2 Scope of delivery

The delivery consists of the following:

- FOC media converter
- Terminal block, 2-pin
- Quick Start Guide

2.3 Turck service

Turck supports you with your projects, from initial analysis to the commissioning of your application. The Turck product database under **www.turck.com** contains software tools for programming, configuration or commissioning, data sheets and CAD files in numerous export formats.

The contact details of Turck subsidiaries worldwide can be found on p. [▶ 40].

3 For your safety

The product is designed according to state-of-the-art technology. However, residual risks still exist. Observe the following warnings and safety notices to prevent damage to persons and property. Turck accepts no liability for damage caused by failure to observe these warning and safety notices.

3.1 Intended use

The FOC media converters of the FOC1… series convert electrical RS485 and RS485-IS signals into optical signals and visa versa. The PROFIBUS-DP and Modbus bus signals (as well as other serial data streams) can be transferred via the FO segments as isolated and interference-free signals over distances of at least 2500 m. The FOC1…-2G media converters are provided with an RS485-IS interface and are suitable for use in Zone 1. The FOC1…-3G media converters are provided with a standard RS485 interface and are suitable for use in Zone 2. The intrinsically safe FO interfaces (Ex op is) enable all media converters of the FOC series to be connected and different FO network structures (point-to-point connections, ring topologies) to be set up.

The devices may only be used as described in these instructions. Any other use is not in accordance with the intended use. Turck accepts no liability for any resulting damage.

3.2 General safety instructions

- The device may only be assembled, installed, operated, parameterized and maintained by professionally-trained personnel.
- The device may only be used in accordance with applicable national and international regulations, standards and laws.
- The device meets the EMC requirements for industrial areas. When used in residential areas, take measures to avoid radio interference.
- Only combine devices for which the technical data is suitable for joint use.

3.3 Notes on Ex protection

- When using the device in Ex circuits, the user must also have an additional knowledge of explosion protection (IEC/ EN 60079-14 etc.).
- Observe national and international regulations for explosion protection.
- Only use the device within the permitted operating and ambient conditions (see Certification data and conditions resulting from the Ex-approval).
- Only operate the device with an enclosed IP30 cover via the connection terminals.
- Never connect equipment to intrinsically safe circuits if this equipment was previously used once in non-intrinsically safe circuits.
- Cables and terminals with intrinsically safe circuits must be indicated (use light blue for color-coding) and must be separated from non-intrinsically safe circuits or isolated accordingly (IEC/EN 60079-14).
- Carry out a “Proof of intrinsic safety” (IEC/EN 60079-14).
- Combinations of FOC1…-2G and FOC1…-3G: Maintain a distance of 50 mm (thread distance) between the connection circuits of intrinsically safe and non-intrinsically safe circuits.

3.4 Requirements for ATEX and IECEx approval

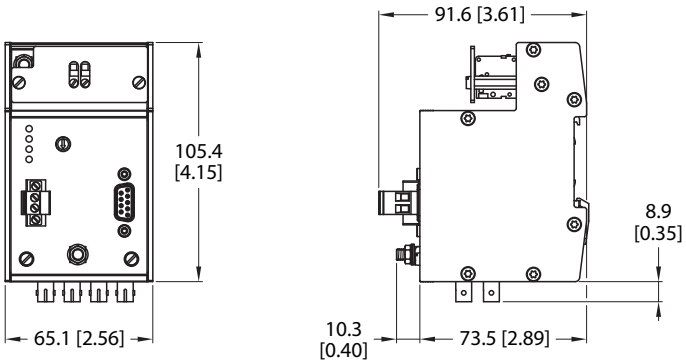
- Use in Zones 1 and Zone 2: Install the device in a separately approved housing in accordance with EN IEC 60079-0 with a protection type of at least IP54 in accordance with IEC/EN 60529 and, if necessary, in compliance with IEC/EN 60079-7.
- Use in Zones 21 and Zone 22: Install the device in a separate housing in accordance with EN IEC 60079-31.

4 Product description

The FOC series consists of four FO media converters that differ in the RS485 interfaces, number of FO ports provided and application areas:

- FOC11-3G: 1 × RS485 and 1 × FO op is, suitable for use in Zone 2
- FOC12-3G: 1 × RS485 and 2 × FO op is, suitable for use in Zone 2
- FOC11EX-2G: 1 × RS485-IS and 1 × FO op is, suitable for use in Zone 1
- FOC12EX- 2G: 1 × RS485-IS and 2 × FO op is, suitable for use in Zone 2

4.1 Device overview



mm [Inch]

Fig. 1: FOC1… – Dimensions

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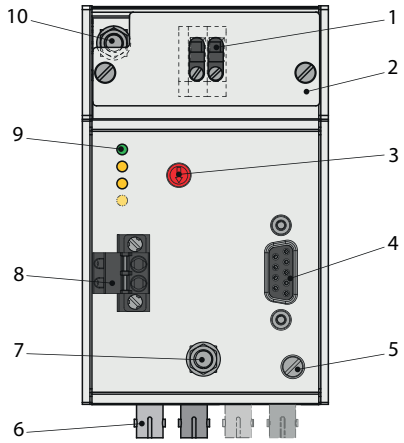

Fig. 2: FOC1… – Connections and operating elements

Position	Description
1	Power supply connection
2	IP30 cover
3	Rotary switch: Baud rate/operating mode
4	FOC1…-3G: RS485 interface
	FOC1…-2G: RS485-IS interface
5	RS485 shield: Screw head connected to M5 × 1 bolt (shield) – capacitively with insulating washer, directly without insulating washer
6	FO interface, BFOC/2,5 (ST) connector
7	RS485 shield: M5 × 1-bolt (shield)
8	Alarm output
9	LED indicators
10	Housing potential: M5 × 1 bolt (case ground)

4.2 Properties and features

General features

- Media converters for converting electrical RS485 and RS485-IS signals into intrinsically safe optical signals and visa versa
- Transfer of PROFIBUS-DP telegrams, Modbus-RTU and other byte-oriented serial data telegrams
- Full galvanic isolation
- Transfer rates from 9.6 kbps…1.5 Mbps
- Transfer range of the FO segment: at least 2500 m with Multimodefiber OM1, at least 1500 m with Multimodefiber OM2
- Connection of up to 31 bus stations (e.g. excom I/O systems) per segment
- Routing of the FO segment into Zone 1
- Optical interface with ST connectors for transmitter and receiver terminals
- Automatic baud rate detection with PROFIBUS-DP
- Rotary coding switches for setting the device functions
- Alarm output, connectable in series
- Status LEDs (power supply, FO segment(s), RS485 and RS485-IS segment)
- Any combination possible with other FOC device variants

FOC11-3G – Properties

- Installation in the safe area in Zone 2
- 1 × RS485 interface
- 1 × intrinsically safe FO interface (Ex op is)
- 1 × electronic 24 V alarm contact
- Applications: FO point-to-point connection

FOC12-3G – Properties

- Installation in the safe area in Zone 2
- 1 × RS485 interface
- 2 × intrinsically safe FO interface (Ex op is)
- 1 × electronic 24 V alarm contact
- Applications: FO point-to-point connection, FO ring

FOC11EX-2G – Properties

- Installation in the safe area as well as in Zone 1 and Zone 2
- 1 × intrinsically safe RS485-IS interface
- 1 × intrinsically safe FO interface (Ex op is)
- 1 × NAMUR alarm output
- Applications: FO point-to-point connection

FOC12EX-2G – Properties

- Installation in the safe area as well Zone 1 and Zone 2
- 1 × intrinsically safe RS485-IS interface
- 2 × intrinsically safe FO interface (Ex op is)
- 1 × NAMUR alarm output
- Applications: FO point-to-point connection, FO ring

4.3 Functions and operating modes

Media converter

The media converter is supplied with 24 VDC in accordance with explosion protection type Ex e.

The RS485 interface enables up to 31 nodes (e.g. excom stations) to be connected. The FO media converter is a physical station and must be included as a bus device within a PROFIBUS segment.

The media converter regenerates the signal amplitude, edge steepness and bit width of PROFIBUS telegrams. PROFIBUS-DP telegrams with a valid start delimiter are forwarded, and faulty telegrams are discarded. The bit length and signal amplitude are conditioned (byte refresh) with Modbus RTU and other byte-oriented serial data streams. Line faults (wire-break/short-circuit) are not transmitted between segments. This ensures interference-free and independent operation of all segments.

The RS485 connection is designed as a 9-pin SUB-D female connector. BFOC/2,5 (ST) male connectors are available for connecting the FO cables. When using an OM1 62.5/125 µm multimodefiber cable the transfer range is at least 2500 m, with a 50/125 µm multimodefiber cable the transfer range is at least 1500 m.

Transfer rates from 9.6 kbps to 1.5 Mbps are possible and are detected automatically in PROFIBUS-DP mode. When using the Modus-RTU protocol, the transfer rate is set via a rotary coding switch.

Diagnostic functions

Status LEDs (power supply, FO segment, RS485 segment and transfer rate detection in the RS485 segment) and an alarm output are provided for diagnostic tasks. The alarm output is connected via a two-pin male connector.

The FOC1…Ex-2G device variants are provided with a NAMUR alarm output. The alarm output switches through during fault-free operation and switches off when a fault occurs. The alarm output can be connected in series with the alarm output of another FOC…-2G and evaluated via a NAMUR input module in accordance with IEC/EN 60947-5-6 (e.g. DM80Ex).

The FOC1…-3G device variants are provided with an electronic alarm contact. The alarm output switches through during fault-free operation and switches off when a fault occurs. The alarm contact can be connected in series with the alarm contact of another FOC…-3G and evaluated via a digital input module (e.g. DI80) or a NAMUR input (e.g. DM80). If installed in Zone 2, the alarm contact must not be plugged in or unplugged under live conditions. The plug connector is provided with locking screws.

The alarm output indicates the following faults:

- Fault/malfunction inside the device (self diagnostic)
- Operating voltage too low/missing
- RS485: Communication error
- No Idle signal/FO segment interrupted
- FO communication error

Setup of FO network structures

The FO media converters enable simple and complex FO network structures to be created. Both individual stations as well as new segments with up to 31 stations can be connected to the RS485 interface of the FOC media converters. The FO media converters are connected via the

RS485 interface with the field devices and via the FO interface with additional media converters. This makes it possible to change between RS485 and FO transmission within a system as required. The following applications can be implemented:

- FO point-to-point connection
- FO ring
- Combinations of FO ring and FO point-to-point connection

Single FO point-to-point connections

Depending on the application, a single point-to-point is implemented with the following FOC11 media converters:

- The FOC11-3G media converters are used to connect to the non-intrinsically safe RS485 interface.
- The FOC11EX-2G media converters are used to connect to the intrinsically safe RS485-IS interface.
- The FOC11 media converters are provided with an FO interface.
- For the point-to-point connection: Set the coding switch of the devices to position 0 (only applies to PROFIBUS-DP).

The following figure shows a single point-to-point connection in a PROFIBUS-DP network. Equivalent Modbus-RTU networks can be created. With Modbus RTU, the baud rate must be set with the rotary coding switch (see chapter Setting/rotary coding switch):

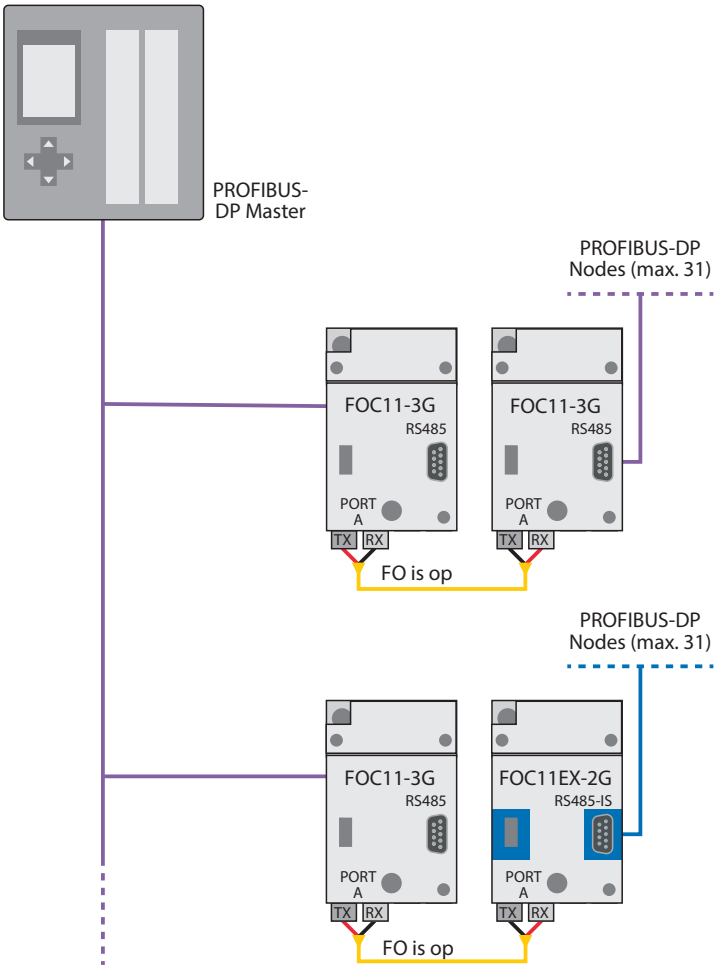

Fig. 3: FOC media converters – single point-to-point connection

FO point-to-point connections – cascaded

Several FO media converters can be connected in series (cascaded) in order to lengthen FO segments. Depending on the application, a cascaded point-to-point connection is implemented with the following FOC11 and FOC12 media converters:

- The FOC11-3G and FOC12-3G media converters are used to connect to the non-intrinsically safe RS485 interface.
- The FOC11EX-2G and FOC12EX-2G media converters are used to connect to the intrinsically safe RS485-IS interface.
- The FOC11 media converters are provided with one FO interface and the FOC12 media converters with two FO interfaces.
- For the point-to-point connection: Set the coding switch of the devices to position 0 (only applies to PROFIBUS-DP).

The following figures show two examples of cascaded point-to-point connections in a PROFIBUS-DP network. Equivalent Modbus-RTU networks can be created. With Modbus RTU, the baud rate must be set with the rotary coding switch (see chapter Setting/rotary coding switch):

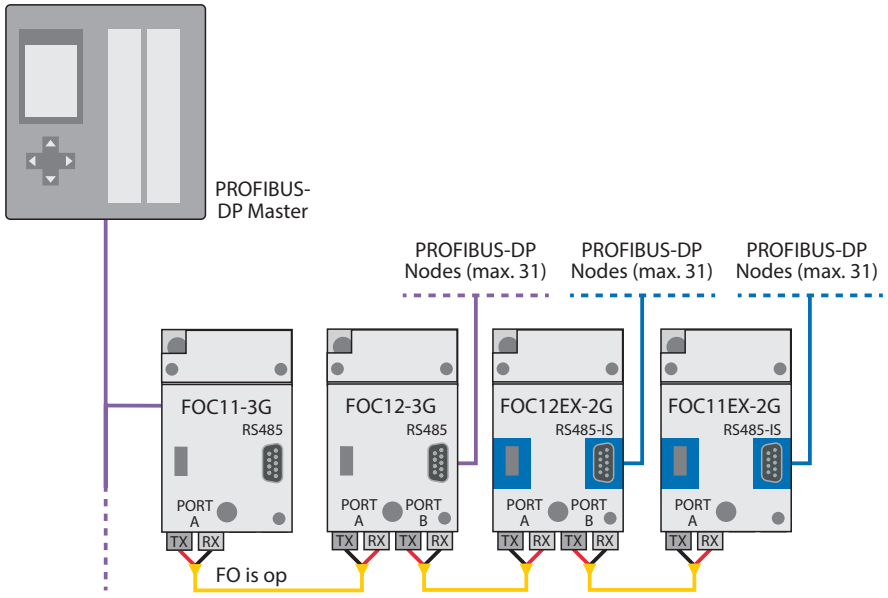

Fig. 4: FOC media converters – cascaded point-to-point connection

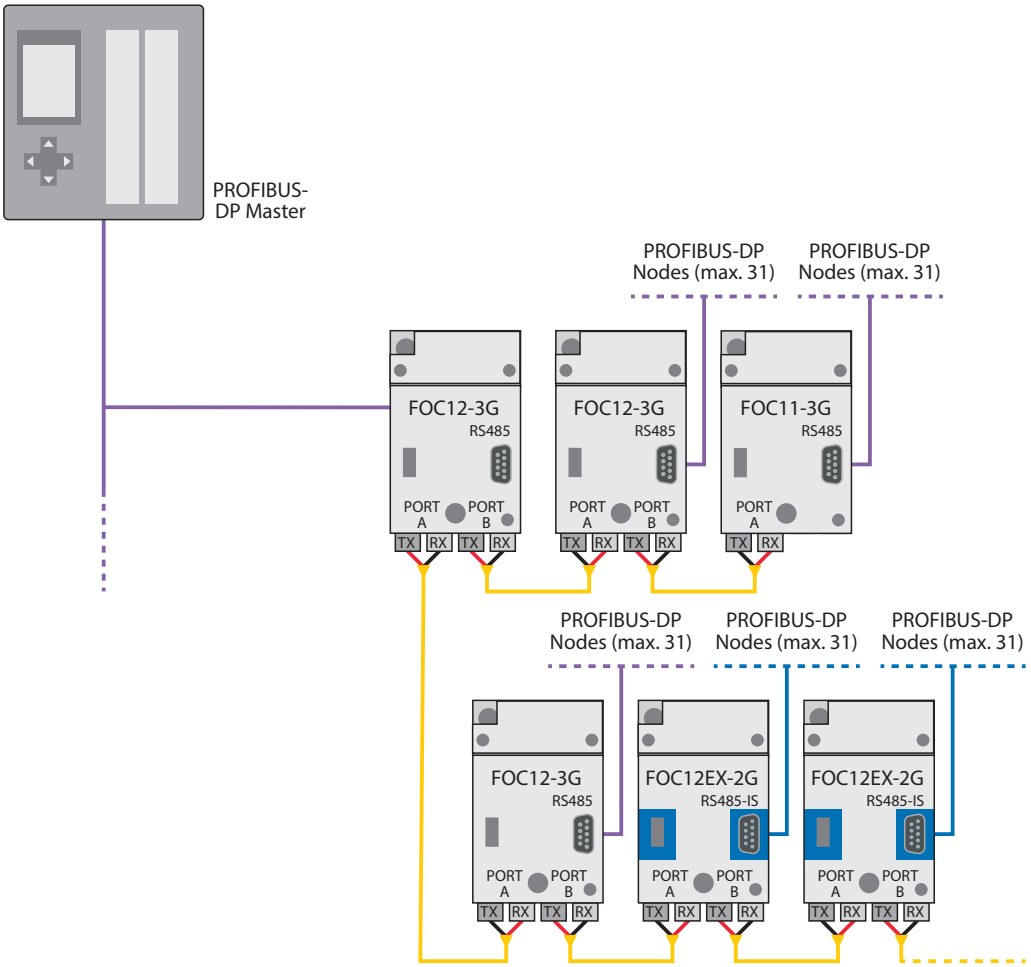

Fig. 5: FOC media converters – cascaded point-to-point connection

FO ring – with PROFIBUS-DP

Depending on the application, an optical ring can be implemented in an FO network with PROFIBUS-DP – using the following FOC12 media converters:

- The FOC12-3G media converters are used to connect to the non-intrinsically safe RS485 interface.
- The FOC12EX-2G media converters are used to connect to the intrinsically safe RS485-IS interface.
- The FOC12 media converters are provided with two FO interfaces.
- Up to ten FOC media converters can be used for each FO ring.
- Setting the coding switch: first FOC12 media converter (ring master) to position 1, all other media converters (ring devices) to position 2.

The following figure shows a single FO ring with FOC12 media converters in a PROFIBUS-DP network:

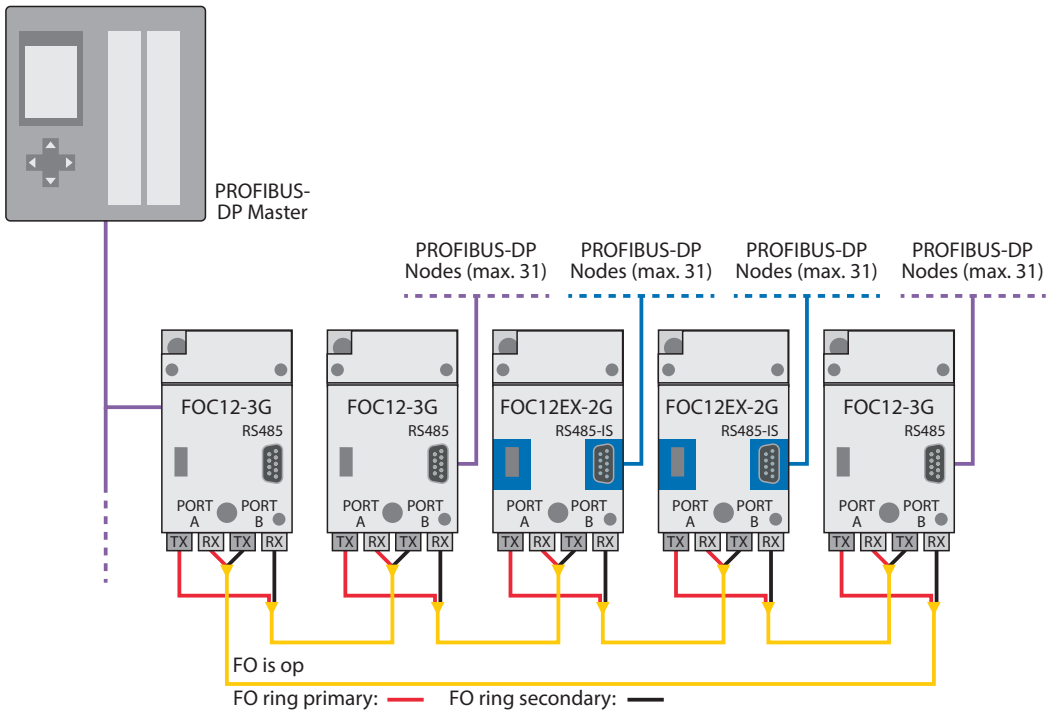

Fig. 6: FOC media converters – FO ring with PROFIBUS-DP

Extended FO ring – with PROFIBUS-DP

The FOC12 FO media converters make it possible to create an optical ring in an FO network and extend it via the RS485 interface using FOC11 and FOC12 media converters. The following figure shows an FO ring with a point-to-point connection in a PROFIBUS-DP network:

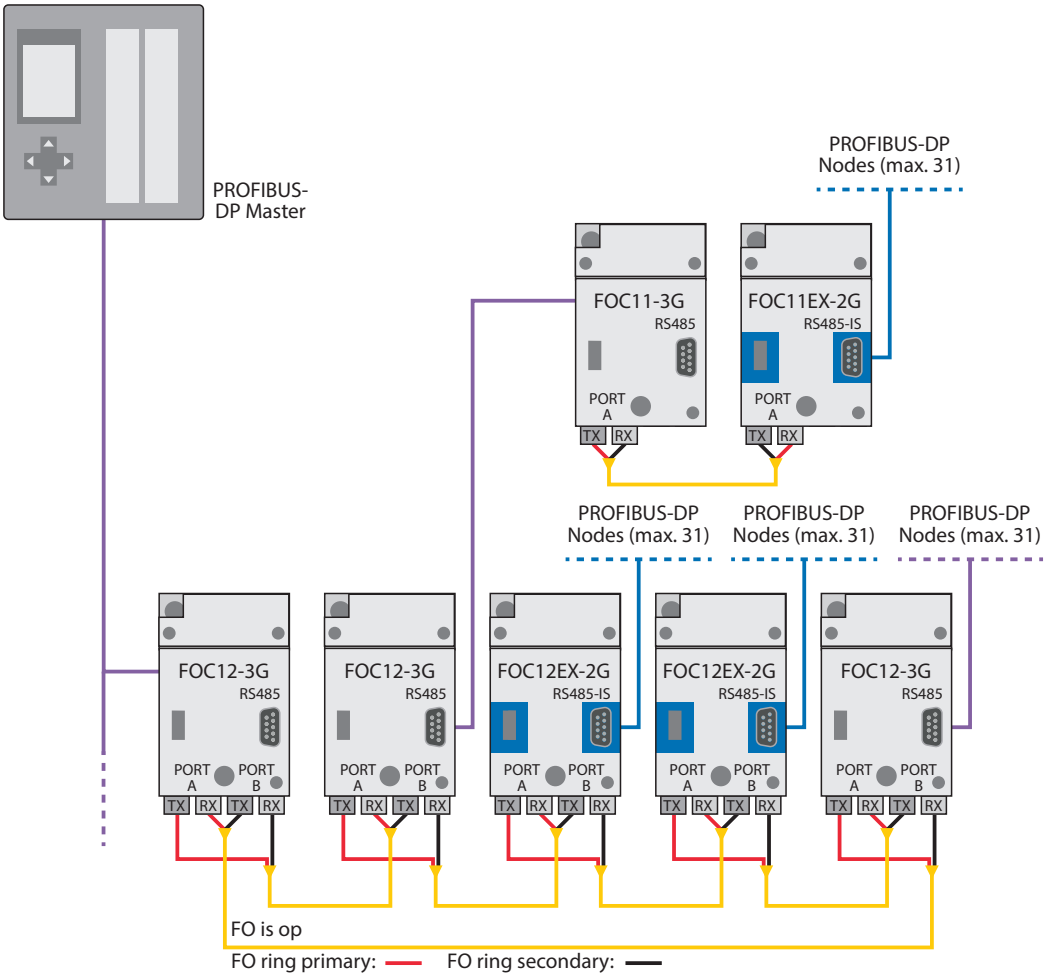

Fig. 7: FOC media converters – extended FO ring with PROFIBUS-DP

FO ring – with PROFIBUS-DP – operating principle

In normal operation all FOC12 media converters are connected via the FO ring. The physical layer here consists of two optical rings: one primary ring and one secondary. Only the primary optical ring is used for the data transfer, the secondary optical ring is only monitored (Idle signal). Up to ten FOC12 media converters can be used for each FO ring.

The FOC12 media converters detect the failure of an FO segment or another FOC12 media converter in the FO ring and are able to compensate for the failure internally via the FO ring in order to maintain communication. The FOC12 media converters can be replaced during operation without interrupting communication or added in order to extend the FO ring.

5 Installing

The FOC11-3G and FOC12-3G media converters can be installed as equipment in the safe area and in Zones 2/22. For operation in Zone 2, install the devices in an approved Ex e housing in accordance with EN 60079-0 with a protection type of at least IP54. Operation in Zone 22 requires installation in a housing in accordance with EN 60079-31. The intrinsically safe optical outputs can be routed into Zone 1/21.

DANGER
Potentially explosive atmosphere
Risk of explosion through spark ignition
Operation in FOC…-3G in Zone 2:

- ▶ Only connect the device when it is in a de-energized state.
- ▶ Installation in Zone 2: Do not connect or disconnect the alarm output under live conditions.
- ▶ Install the device in an Ex e housing in accordance with EN 60079-0 with a protection type of at least IP54.
- ▶ When mounting the device, ensure that its permissible operating temperature is not exceeded even in unfavorable ambient conditions.
- ▶ When connecting different areas via the FO cable: Only use additional lens systems or light amplifiers if they have been approved for this purpose.

The FOC11EX- 2G and FOC12EX- FOC12Ex media converters can be installed as equipment in the safe area and in Zones 1/21 or 2/22. For operation in Zone 1 or 2, install the devices in an approved Ex e housing in accordance with EN 60079-0 with a protection type of at least IP54. Operation in Zone 21 or 22 requires installation in a housing in accordance with EN 60079-31. The intrinsically safe optical outputs can be routed into Zone 1/21.

DANGER
Potentially explosive atmosphere
Risk of explosion through spark ignition
Operation of FOC…-2G in Zone 1 or 2:

- ▶ Only connect the device when it is in a de-energized state.
- ▶ Install the device in an Ex e housing in accordance with EN 60079-0 with a protection type of at least IP54.
- ▶ When mounting the device, ensure that its permissible operating temperature is not exceeded even in unfavorable ambient conditions.
- ▶ When connecting different areas via the FO cable: Only use additional lens systems or light amplifiers if they have been approved for this purpose.

- ▶ Protect the mounting location from radiated heat, sudden temperature fluctuations, dust, dirt, humidity and other ambient influences.
- ▶ Install the device on a DIN rail (TH35).
- ▶ Maintain a clearance of ≥ 5 mm from the side of the adjacent device.
- ▶ Combinations of FOC1…-2G and FOC1…-3G: Maintain a distance of 50 mm (thread distance) between the connection circuits of intrinsically safe and non-intrinsically safe circuits.

6 Connection

Connections and operating elements

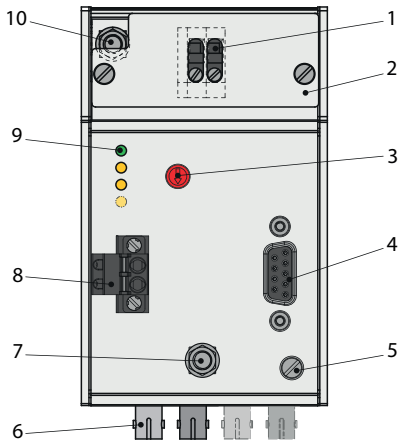

Fig. 8: FOC1… – Connections and operating elements

Position	Description
1	Power supply connection
2	IP30 cover
3	Rotary switch: Baud rate/operating mode
4	FOC1…-3G: RS485 interface
	FOC1…-2G: RS485-IS interface
5	RS485 shield: Screw head connected to M5 × 1 bolt (shield) – capacitively with insulating washer, directly without insulating washer
6	FO interface, BFOC/2,5 (ST) connector
7	RS485 shield: M5 × 1-bolt (shield)
8	Alarm output
9	LED indicators
10	Housing potential: M5 × 1 bolt (case ground)

Wiring diagrams

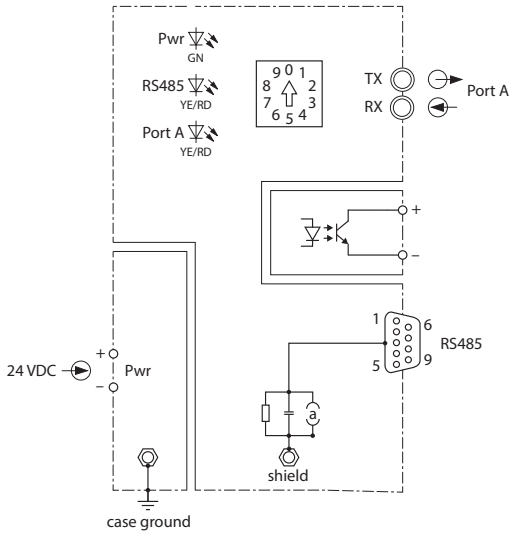

Fig. 9: FOC11-3G – wiring diagram

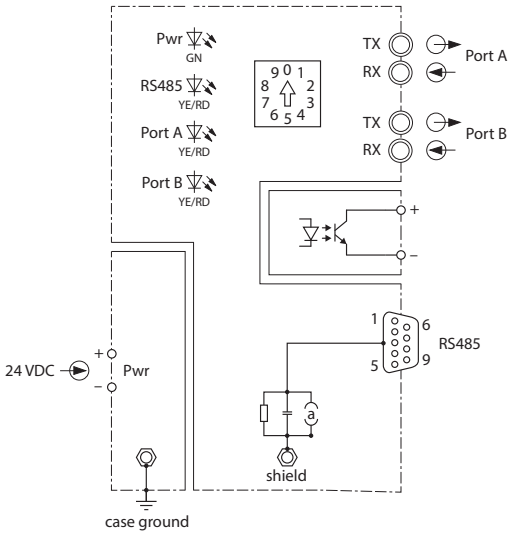

Fig. 10: FOC12-3G – wiring diagram

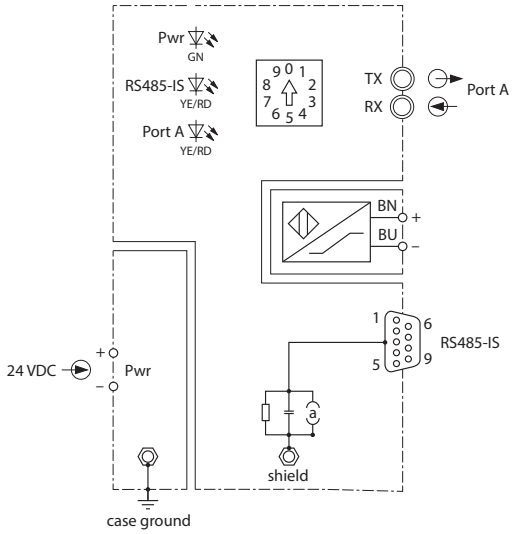

Fig. 11: FOC11EX-2G – wiring diagram

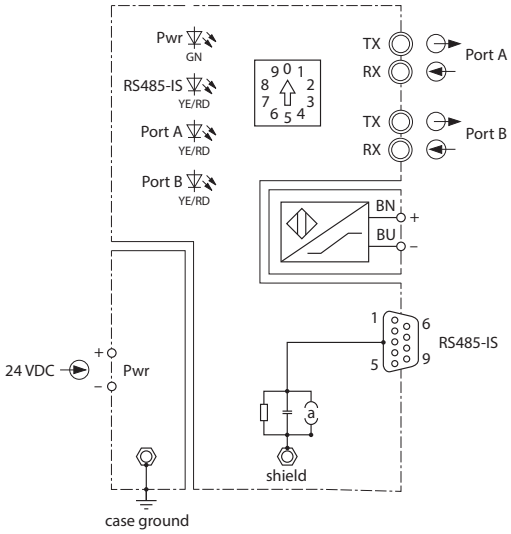

Fig. 12: FOC12EX-2G – wiring diagram

Connecting the power supply

DANGER
Potentially explosive atmosphere
Risk of explosion through spark ignition

- Operation in Zone 1 or Zone 2: Only connect the device in a de-energized state or if there is no potentially explosive atmosphere present.

The device is provided with a 2-pin Ex e terminal for connecting the power supply. The maximum terminal cross section is:

	Single connection	Multi-wire connection
Rigid	4 mm^2	0.2…2.5 mm^2
Flexible	2.5 mm^2	0.2…1 mm^2

- Strip the connection cables for the power supply (9 mm).
- Stranded wire cables: use ferrules.
- Slightly undo the fixing screws of the IP30 cover and push the cover back.
- Connect the power supply to terminal 1 (+) and terminal 2 (-).
- Tighten the terminals. The tightening torque is 0.4…0.5 Nm.
- Pull the IP30 cover back to the front and fasten the fixing screws.

Connecting the equipotential bonding

- Connect the M5 × 1 bolt (case ground) on the device to the equipotential bonding.

Connecting the RS485 shield

Depending on the expected interference and the installation, the user may choose between capacitive and direct grounding. T The shield is factory fitted with a capacitive connection to the cable shield. his requires the insertion of an insulating washer between the screw head and the cable shield.

- Choosing direct grounding: unscrew the screw, remove the insulating washer and retighten the screw.
- If the shield is to be connected to the case ground housing potential: Connect the M5 × 1 bolt (shield) with the M5 × 1 bolt (case ground).

FOC11…- 3G and FOC12…- 3G: Connecting media converters to the fieldbus

The fieldbus interface is provided with a 9-pin SUB-D female connector.

- ▶ Connect the device as per the wiring diagram via a standard PROFIBUS SUB-D male connector (e.g. D9T-RS485, ID 6890942) to the fieldbus master or fieldbus station.

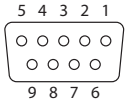

Fig. 13: SUB-D female connector

Assignment of SUB-D pins

Pin No.	RS485	Meaning
1	n. c.	Not connected
2	n. c.	Not connected
3	RxD/TxD-P	Receive data/send data B line (red)
4	n. c.	Not connected
5	DGND	Chassis ground for data signals and bus termination
6	VP	Bus termination power supply
7	n. c.	Not connected
8	RxD/TxD-N	Receive data/send data of A line (green)
9	n. c.	Not connected
Housing	PE/FE	Capacitive and direct grounding possible.

FOC11EX…- 2G and FOC12EX…- 2G: Connecting media converters to the fieldbus

The PROFIBUS interface is provided with a 9-pin SUB-D female connector.

- ▶ Connect the device to the fieldbus as per the wiring diagram with a PROFIBUS-SUB-D connector approved for Ex applications (e.g. D9T-RS485IS, ID 6890944).

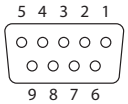

Fig. 14: SUB-D female connector

Assignment of SUB-D male connectors

Pin No.	RS485-IS	Meaning
1	n. c.	Not connected
2	n. c.	Not connected
3	RxD/TxD-P	Receive data/send data B line (red)
4	n. c.	Not connected
5	ISGND	Chassis ground for bus termination
6	ISP	Bus termination power supply
7	n. c.	Not connected
8	RxD/TxD-N	Receive data/send data of A line (green)
9	n. c.	Not connected
Housing	PE/FE	Capacitive and direct grounding possible.

Connecting FO cables to the optical interface

CAUTION
Laser class 1 device in accordance with IEC/EN 60825-1
Risk of eye injury from laser beams

- ▶ During operation never look directly into the transmitter diodes or with optical aids into the fiber optic cables. The infra-red light is not visible.

FO cables are connected to the FO media converters with an ST(BFOC) male connector.

- ▶ Remove protective caps.
- ▶ Fit the ST male connectors of the fiber optic cables on the ST female connector of the transmit and receive channel.
- ▶ Push down the spring mechanism of the ST male connector.
- ▶ Rotate the ST male connector clockwise a quarter turn until the connector locks securely into position.
- ⇨ The FO connection is secured

Connecting FO media converters in point-to-point applications

NOTICE
Connecting FO media converters in point-to-point applications
Malfunction in the FO network

- ▶ When coupling FO media converters: Note the signal direction

- ▶ Connect the TxD terminal (transmitter) of device 1 to the RxD terminal (receiver) of device 2.
- ▶ Connect the RxD terminal (receiver) of device 1 to the TxD terminal (transmitter) of device 2.

Connecting FOC12 media converters in the ring (PROFIBUS-DP)

Two independent optical rings are set up via port A and port B.

- ▶ Connect the TxD terminal of one device with the RxD terminal of the other device so that a closed ring is produced.

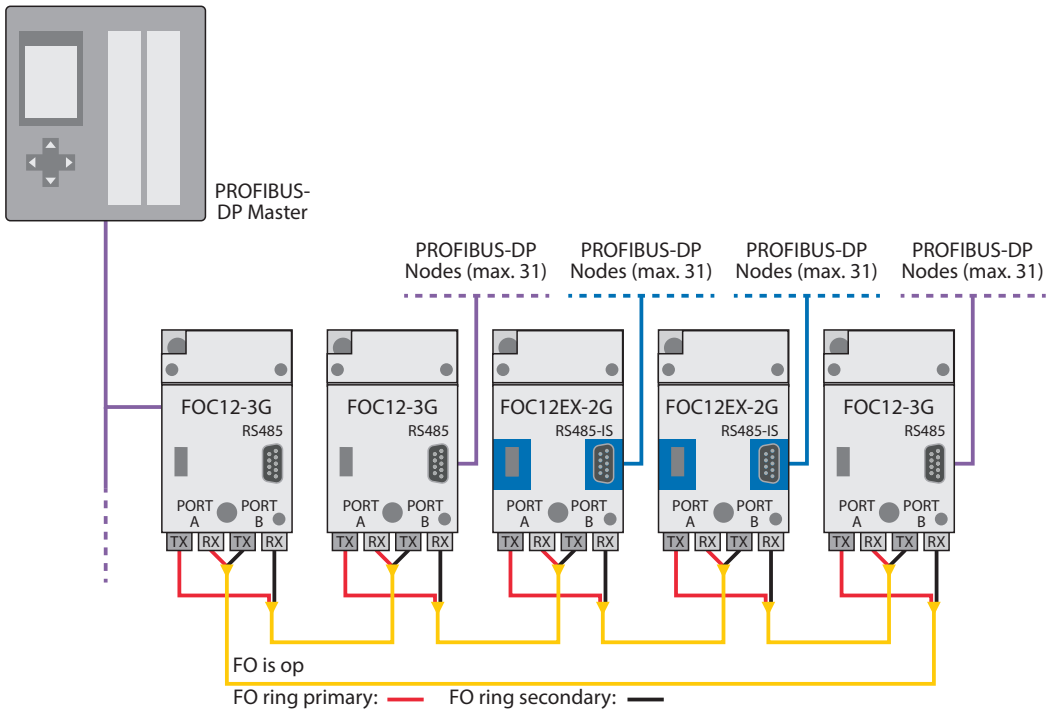

Fig. 15: FOC media converters – connecting in the FO ring

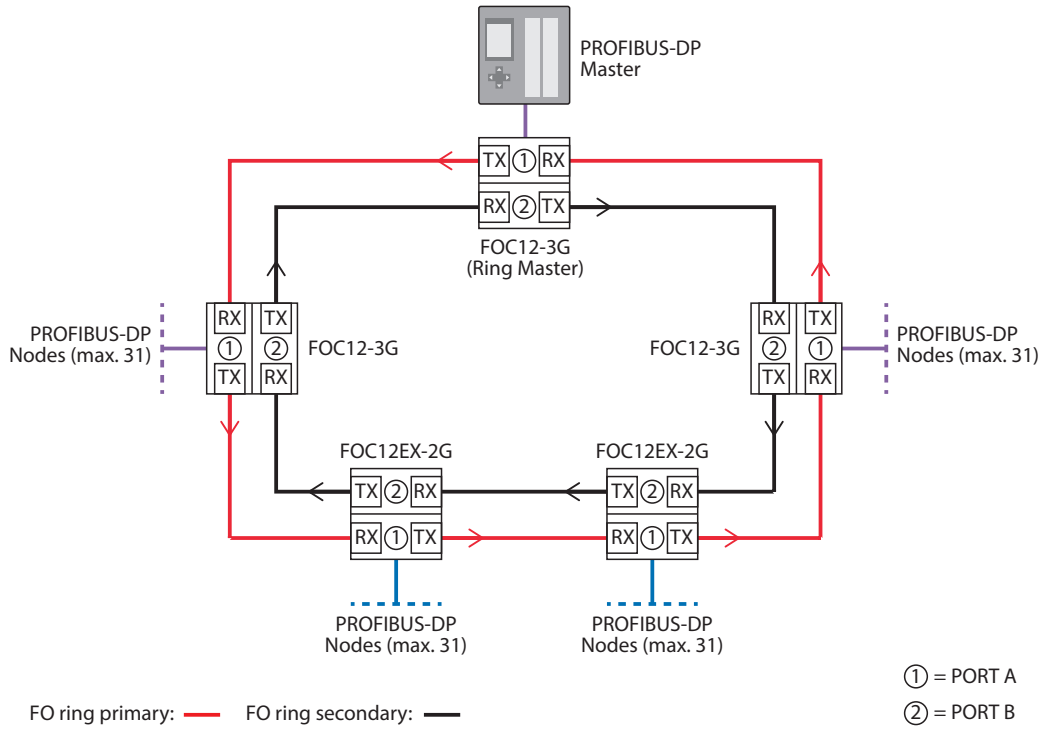

Fig. 16: FO ring with FOC12 media converters – simplified diagram

Connecting the alarm output

DANGER
Potentially explosive atmosphere
Risk of explosion through spark ignition

- FOC…3G: Operation in Zone 2: Do not connect or disconnect the terminal (alarm contact) under live conditions.Risk of explosion through spark ignition

The FOC1…EX-2G device variants are provided with a NAMUR alarm output. The alarm output can be connected in series with the alarm output of another FOC…-2G and evaluated via a NAMUR input module in accordance with IEC/EN 60947-5-6 (e.g. DM80Ex).

The FOC1…-3G device variants are provided with an electronic alarm contact. The alarm contact can be connected in series with the alarm contact of another FOC…-3G and evaluated via a digital input module in accordance with IEC/EN 61131-2 Type 3 (e.g. DI80) or a NAMUR input.

- Connect the alarm output via a two-pin male connector.

Terminal	FOC1…Ex-2G	FOC1…-3G
1	+	+
2	-	-

Activating terminating resistors

- Terminating resistors must be activated at the start and end of each segment.

FOC1…EX-2G: Bus termination on the intrinsically safe side is in accordance with the RS485-IS guidelines (Doc. no. 2.262) of the PROFIBUS User Organisation (PNO).

7 Commissioning

DANGER
Potentially explosive atmosphere
Risk of explosion through spark ignition

- ▶ Use in Zones 1 and Zone 2: Only operate the device with an enclosed IP30 cover via the connection terminals

The device is operational automatically once the cables are connected and the power supply is switched on.

8 Operation

FOC1… – LED functions

Status LEDs on the front of the device indicate the following operating states:

LED	Color	Meaning
Power	Off	Operating voltage too low/ missing
	Green	Operating voltage OK
	Red	Fault/malfunction inside the device
RS485 and RS485-IS	Off	No bus communication
	Yellow	Bus communication active
	Yellow flashing	Baud rate detection active
	Red	Communication error
Port A	Off	No bus communication
	Yellow	Bus communication active
	Red flashing	Telegrams partly faulty
	Red	Communication error
Port B (only FOC12)	Off	No bus communication
	Yellow	Bus communication active
	Red flashing	Telegrams currently faulty
	Red	Communication error

9 Setting

9.1 Transfer rate (rotary switch)

The transfer rate with PROFIBUS-DP is detected automatically by the device. For other byte-oriented serial data streams, the transfer rate must be permanently set via a rotary switch (position 3…9). The data bytes have the following structure:
1 start bit/8 data bits/even parity/1 stop bit.

FOC11 – setting the transfer rate

▶ Permanently set the transfer rate and topology with the rotary switch according to the following table:

Rotary switch position	Transfer rate/topology network structure
0	PROFIBUS-DP: automatic baud rate detection | point-to-point connection
1	–
2	–
3	Modbus RTU: 9.6 kbps | point-to-point connection
4	Modbus RTU: 19.2 kbps | point-to-point connection
5	Modbus RTU: 38.4 kbps | point-to-point connection
6	Modbus RTU: 57.6 kbps | point-to-point connection
7	Modbus RTU: 115.2 kbps | point-to-point connection
8	Modbus RTU: 500 kbps | point-to-point connection
9	Modbus RTU: 1.5 Mbps | point-to-point connection

FOC12 – setting the transfer rate

▶ Permanently set the transfer rate and topology with the rotary switch according to the following table:

Rotary switch position	Transfer rate/topology network structure
0	PROFIBUS-DP: automatic baud rate detection | point-to-point connection
1	PROFIBUS-DP: automatic baud rate detection | ring master
2	PROFIBUS-DP: automatic baud rate detection | ring device
3	Modbus RTU: 9.6 kbps | point-to-point connection
4	Modbus RTU: 19.2 kbps | point-to-point connection
5	Modbus RTU: 38.4 kbps | point-to-point connection
6	Modbus RTU: 57.6 kbps | point-to-point connection
7	Modbus RTU: 500 kbps | point-to-point connection
8	Modbus RTU: 1.5 Mbps | point-to-point connection
9	PROFIBUS-DP: automatic baud rate detection | without fault signal for Port B | point-to-point connection

9.2 Bus parameters

Depending on the network components and the length of the lines, the transfer of telegrams in a network involves delays. These delay times must be taken into account when configuring the T_{slot} network parameter in the masters.

The calculation of the T_{slot} network parameter depends on two different possible applications:

- FO point-to-point connection
- FO ring

FO point-to-point connection – calculating bus parameters

The definition of bus parameters on the master for the point-to-point connection must take into account the maximum number of cascaded media converters between the master and field device(s). The FOC… media converters have a telegram delay of 33 t_{bit}. Use the following formula with the relevant values to calculate the T_{slot}.

Calculation of the bus parameters	
min T_{SDR}	≥ 11 t_{bit}
max T_{SDR}	≥ 33 × N + max $T_{SDR\ default}$ in t_{bit}
T_{slot}	≥ max T_{SDR} + 15 t_{bit}
N	Max. number of cascaded FO media converters

The value "max $T_{SDR\ default}$" depends on the baud rate.

Baud rate	**max $T_{SDR\ default}$ in t_{bit}**
Baud rate ≤ 187.5 k	60
Baud rate 500 k	100
Baud rate 1.5 M	150

FO point-to-point connection – calculation of T_{slot} (examples)

Example 1:

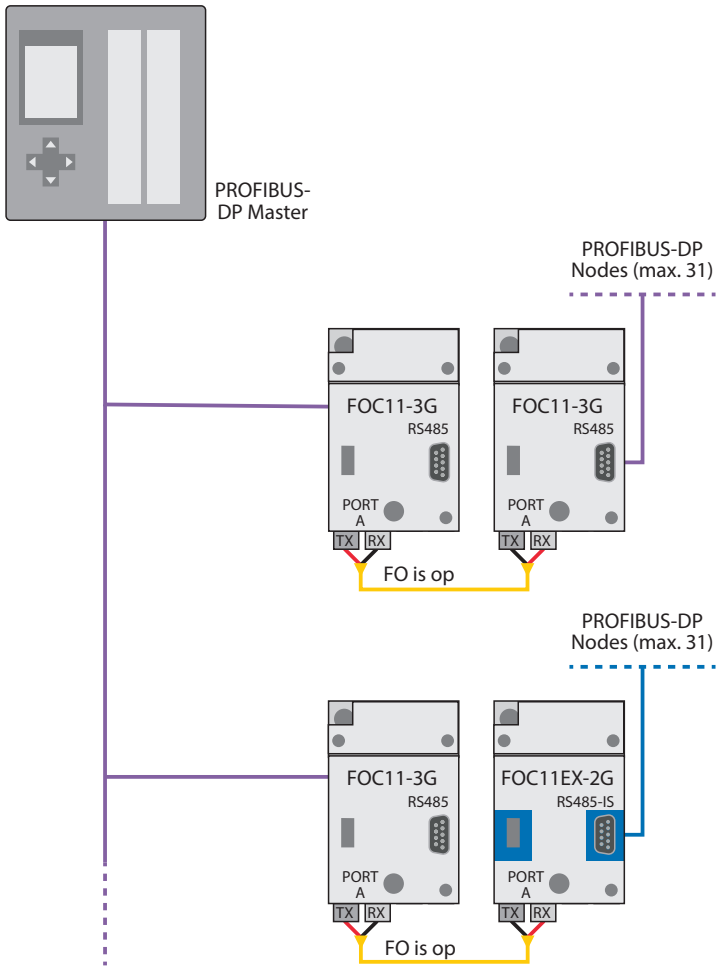

Fig. 17: FOC media converters – single point-to-point connection (example 1)

Example 1 shows four FOC media converters in use, but only two cascaded media converters. Only the bit times of two media converters (N=2) therefore need to be taken into account in the calculation of the bus parameters.

Baud rate selected = 1.5 Mbit

min $T_{SDR} \geq 11\ t_{bit}$

max $T_{SDR} \geq 33 \times N + 150\ t_{bit} = 216\ t_{bit}$

$T_{slot} \geq \max T_{SDR} + 15\ t_{bit} = 231\ t_{bit}$

Example 2:

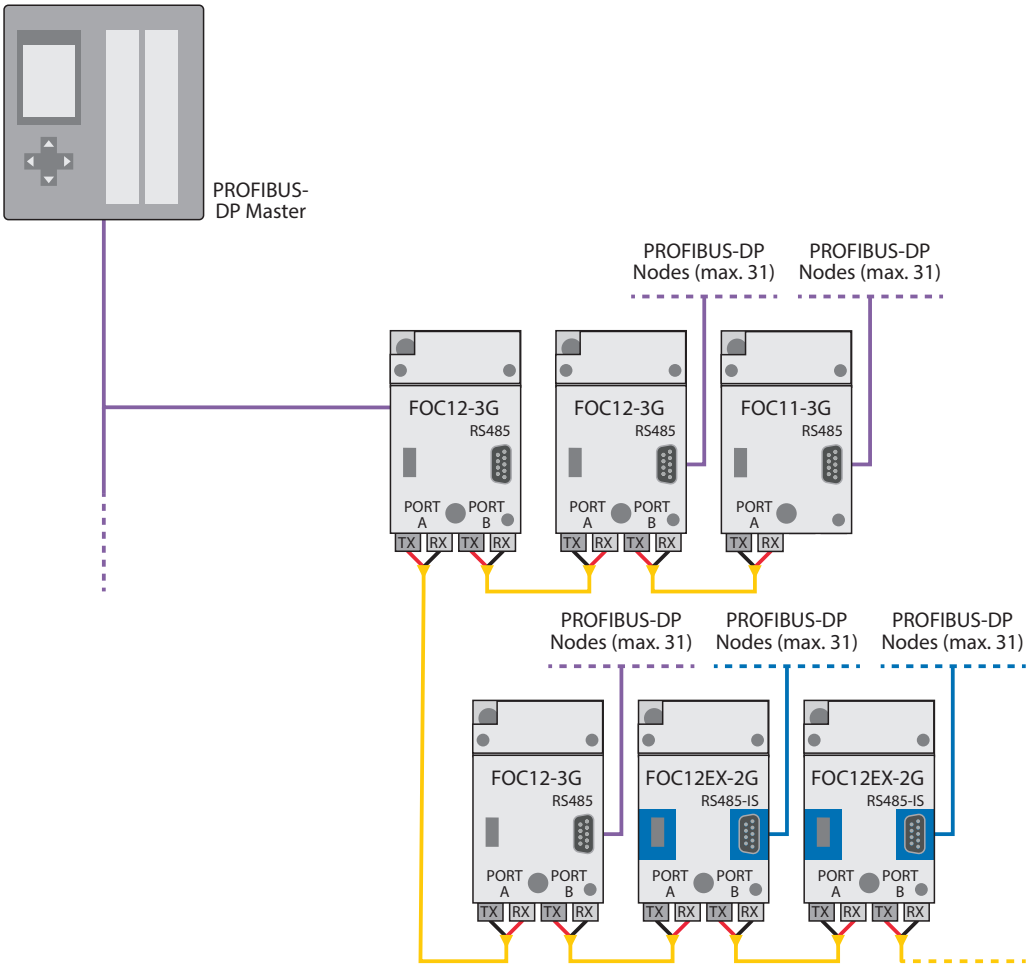

Fig. 18: FOC media converters – single point-to-point connection (example 2)

Example 2 shows six FOC media converters in use, but only four cascaded media converters. Only the bit times of four media converters (N=4) therefore need to be taken into account in the calculation of the bus parameters.

Baud rate selected = 1.5 Mbit

min $T_{SDR} \geq 11\ t_{bit}$

max $T_{SDR} \geq 33 \times N + 150\ t_{bit} = 282\ t_{bit}$

$T_{slot} \geq \max T_{SDR} + 15\ t_{bit} = 297\ t_{bit}$

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FO ring – calculation of bus parameters

A bit time of 44 t_{bit} must be taken into account for the transfer between two FOC media converters in an FO ring. Added to this is a one-off value of 33 t_{bit}. Any interruption in an FO segment must also be taken into account.

The value for min T_{SDR} is normally ≥ 11 t_{bit}. If one or several field devices are located directly in the master segment, min T_{SDR} must be set at a value of ≥ 22 t_{bit}

Calculation of the bus parameters	
min T_{SDR}	≥ 11 t_{bit} (with field device master segment: ≥ 22 t_{bit})
max T_{SDR}	≥ (44 × (N - 1) + 33) × 2 + T_{seg} in t_{bit} + max $T_{SDR\ default}$ in t_{bit}
T_{slot}	≥ max T_{SDR} + 15 t_{bit}
T_{seg}	Additional signal delays that may occur outside of the FO ring (see example 2).
N	Max. number of cascaded FO media converters

The value "max $T_{SDR\ default}$" depends on the baud rate:

Baud rate	**max $T_{SDR\ default}$ in t_{bit}**
Baud rate ≤ 187.5 k	60
Baud rate 500 k	100
Baud rate 1.5 M	150

FO point-to-point connection – calculation of T_{slot} (examples)

Example 1

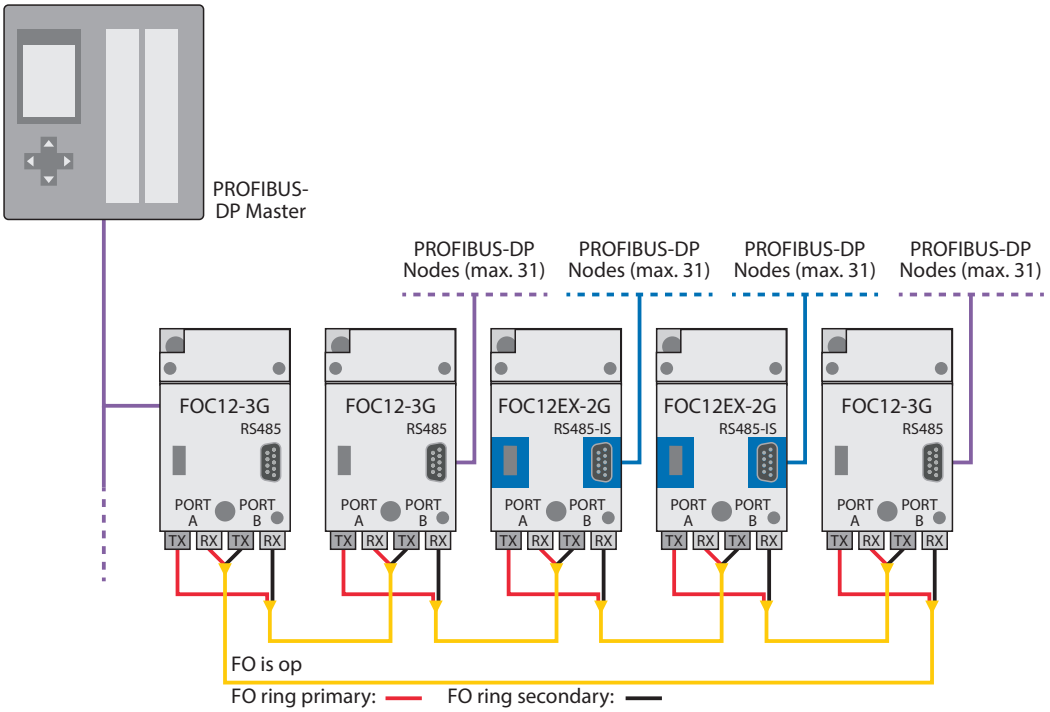

Fig. 19: FOC media converters – FO ring with PROFIBUS-DP (example 1)

Example 1 shows a single FO ring with five FOC12 media converters (N = 5).

Baud rate selected = 1.5 Mbit

min $T_{SDR} \geq 11\ t_{bit}$

max $T_{SDR} \geq (44 \times (N - 1) + 33) \times 2 + 150\ t_{bit} = 568\ t_{bit}$

$T_{slot} \geq \max T_{SDR} + 15\ t_{bit} = 583\ t_{bit}$

Example 2

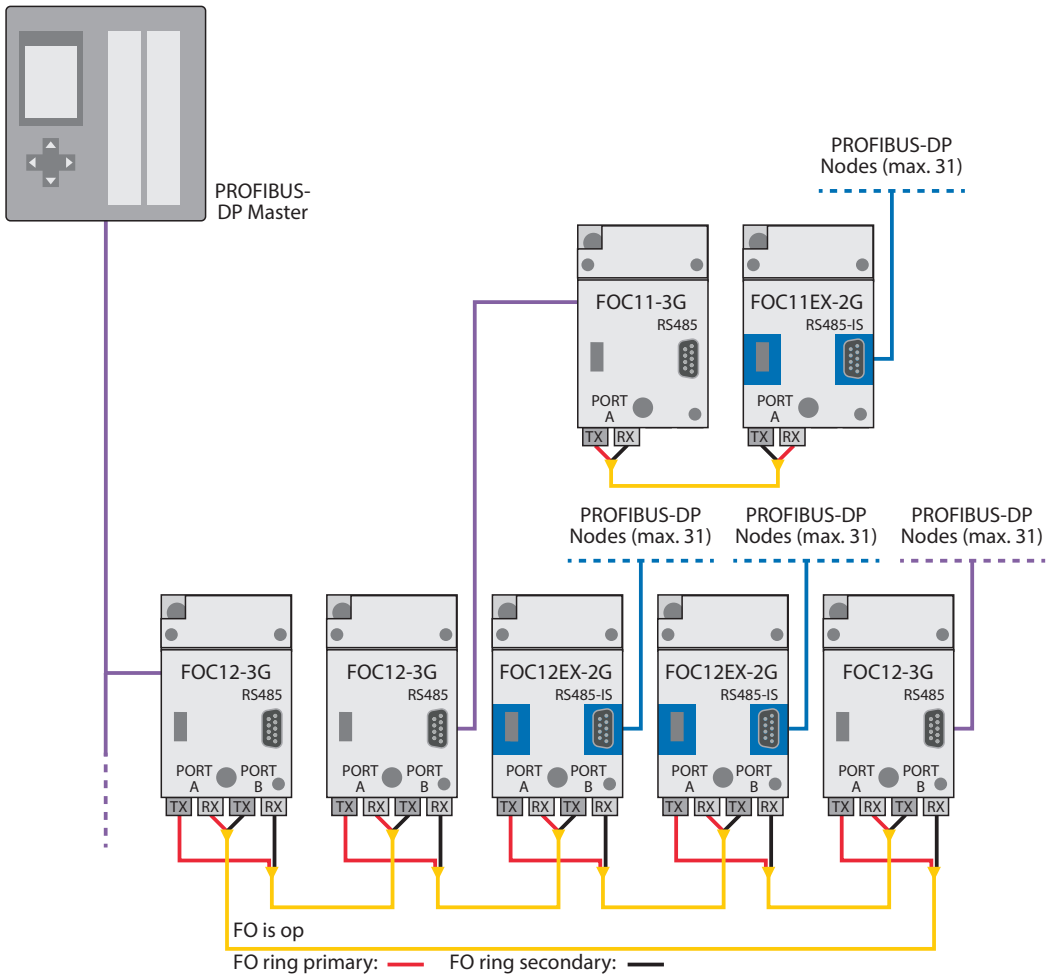

Fig. 20: FOC media converters – extended FO ring with PROFIBUS-DP (example 2)

Example 2 shows a single FO ring with cascaded five FOC12 media converters (N = 5). This FO ring has been extended with a point-to-point connection with two cascaded FOC11 media converters. This point-to-point connection results in an additional signal delay (T_{seg}) of 33 t_{bit} per media converter, which must be included in the calculation of T_{slot}. The additional signal delay time T_{seg} is thus $2 \times 33\ t_{bit} = 66\ t_{bit}$ for a point-to-point connection with two cascaded FOC11 media converters.

Baud rate selected = 1.5 Mbit

$\min T_{SDR} \geq 11\ t_{bit}$

$\max T_{SDR} \geq (44 \times (N - 1) + 33) \times 2 + T_{seg} + 150\ t_{bit} = 634\ t_{bit}$

$T_{slot} \geq \max T_{SDR} + 15\ t_{bit} = 649\ t_{bit}$

10 Troubleshooting

If the device does not function as expected, first check whether ambient interference is present. If there is no ambient interference present, check the connections of the device for faults.

If there are no faults, there is a device malfunction. In this case, decommission the device and replace it with a new device of the same type.

11 Maintenance

The maintenance requirements of the particular system apply to the devices.
No other device specific maintenance measures are required.

12 Repair

The device must not be repaired by the user. Take defective devices out of operation and return them to Turck for an error analysis. Observe our return acceptance conditions when returning the device to Turck.

12.1 Returning devices

Returns to Turck can only be accepted if the device has been equipped with a Decontamination declaration enclosed. The decontamination declaration can be downloaded from
https://www.turck.de/en/retoure-service-6079.php
and must be completely filled in, and affixed securely and weather-proof to the outside of the packaging.

13 Disposal

The devices must be disposed of correctly and must not be included in general household garbage.

14 Technical data

14.1 Technical data – FOC1-…-2G

Type code	FOC11EX-2G	FOC12EX-2G
ID	100000551	100000552
Rated voltage	24 VDC	
Supply voltage range	18…32 VDC	
Inrush current	≤ 100 mA	
Power consumption	Typically 2.4 W	
Heat dissipation	Max. 3.2 W	
Galvanic isolation	Complete galvanic isolation in accordance with IEC/EN 60079-11 (bus to bus and bus to power supply), rated voltage 250 V, test voltage 600 V	
Number of channels	1-channel	2-channel
Diagnostics	Fault signal output , 1 × NAMUR sensor (Ex i)	
Transfer rate	9.6 is kbps to 1.5 Mbps	
Signal level (RS485-IS)	3.3 V (in accordance with RS485-IS standard, PNO)	
Electrical connections		
Power supply	Ex e terminal, 2-pin, screw connection	
Fault signal output	Removable male connector, 2-pin, spring-loaded connection	
RS485-IS (Ex)	1 × SUB-D connector, 9-pin	
Equipotential bonding	M5 × 1 bolt (case ground)	
RS485 shield	M5 × 1 bolt (shield)	
Fiber optic cable (FOC)	BFOC/2,5 (ST) connector	
Optical channel		
– Wave length	820 nm	
Injected optical power		
– Multimode fiber 50/125 µm	- 20.5 dBm	
– Multimode fiber 62.5/125 µm	- 16 dBm	
– Multimode fiber 200 µm	- 10 dBm	
Receiver sensitivity	- 24 dBm	
LEDs		
Operational readiness	1 × green	
Status/error	2 × yellow/red	3 × yellow/red
Housing material	Anodized aluminum	
Fixing type	Snap-fit on DIN rail (EN 60715)	
Protection type	IP20	
Ambient temperature	-40…+70 °C	
Relative air humidity	≤ 93 % at 40 °C acc. to IEC/EN 60068-2-78	
Vibration test	Acc. to IEC/EN 60068-2-6	
Shock testing	Acc. to IEC/EN 60068-2-27	
EMC	Acc. to IEC/EN 61326-1 Acc. to NAMUR NE21	
MTTF	77 years acc. to SN 29500 (Ed. 99) 40 °C	71 years acc. to SN 29500 (Ed. 99) 40 °C
Dimensions (W × H × D)	65 × 105 x 73.5 mm	

14.2 Technical data – FOC1-…-3G

Type code	FOC11-3G	FOC12-3G
Ident No.	100000549	100000553
Rated voltage	24 VDC	
Supply voltage range	18…32 VDC	
Inrush current	< 100 mA	
Power consumption	Typically 2.4 W	
Heat dissipation	max. 3.2 W	
Galvanic isolation	Complete galvanic isolation in accordance with IEC/EN 60079-11 (bus to bus and bus to power supply), rated voltage 250 V, test voltage 600 V	
Number of channels	1-channel	2-channel
Diagnostics	Fault signal output, < 30 V acc. to Type 3 in accordance with IEC 61131-2	
Transfer rate		
Signal level (RS485)	5 V	
Electrical connections		
Power supply	Ex e terminal, 2-pin, screw connection	
Fault signal output	Removable male connector, 2-pin, spring-loaded connection	
RS485	1 × SUB-D connector, 9-pin	
Equipotential bonding	M5 × 1 bolt (case ground)	
RS485 shield	M5 × 1-bolt (shield)	
Fiber optic cable (FOC)	BFOC/2,5 (ST) connector	
Optical channel		
– Wave length	820 nm	
Injected optical power		
– Multimode fiber 50/125 µm	- 20.5 dBm	
– Multimode fiber 62.5/125 µm	- 16 dBm	
– Multimode fiber 200 µm	- 10 dBm	
Receiver sensitivity	- 24 dBm	
LEDs		
Operational readiness	1 × green	
Status/error	2 × yellow/red	3 × yellow/red
Housing material	Anodized aluminum	
Fixing type	Snap-fit on DIN rail (IEC/EN 60715) or wall mounting	
Protection type	IP20	
Ambient temperature	-40…+70 °C	
Relative air humidity	≤ 93 % at 40 °C acc. to IEC/EN 60068-2-78	
Vibration test	Acc. to IEC/EN 60068-2-6	
Shock testing	Acc. to IEC/EN 60068-2-27	
EMC	Acc. to EC/EN 61326-1 Acc. to NAMUR NE21	
MTTF	69 years acc. to SN 29500 (Ed. 99) 40 °C	63 years acc. to SN 29500 (Ed. 99) 40 °C
Dimensions (W × H × D)	65 × 105 x 73.5 mm	

15 Approvals and device markings

15.1 FOC1…-2G – approvals and device markings

Approvals	Marking as per ATEX directive	EN 60079-0/-7 /-11 /-18 / -28
ATEX approval no.: EPS 21 ATEX 1 058 X	Ex II 2 (1) G Ex II (2) (1) D	Ex eb mb ib [op is Ga] IIC T4 Gb [Ex ib Db] [Ex op is Da] IIIC
CE 0102		
IECEx approval no.: IECEx EPS 21.0017 X		Ex eb mb ib [op is Ga] IIC T4 Gb [Ex ib Db] [Ex op is Da] IIIC

Ambient temperature T_{amb}: -40…+70 °C

Approval data

Max. rated voltage U_m	40 VDC
Max. heat dissipation	≤ 3.2 W
RS485-IS Ex ib IIC/Ex ib IIIC	U_0 ≤ 4.2 V I_0 ≤ 131 mA P_0 ≤ 124 mW Characteristic: linear U_i ≤ 4.2 V C_i = 35.7 µF L_i negligible
Optical interface	Ex op is
Alarm output	U_i ≤ 10 V C_i = 30 nF L_i negligible

15.2 FOC1…-3G – approvals and device markings

Approvals	Marking as per ATEX directive	EN 60079-0/-7 /-11 /-18 / -28
ATEX approval no.: EPS 21 ATEX 1 058 X	⟨Ex⟩ II 3 (1) G ⟨Ex⟩ II (1) D	Ex ec mc ic [op is Ga] IIC T4 Gc [Ex op is Da] IIIC
CE 0102		
IECEx approval no.: IECEx EPS 21.0017 X		Ex ec mc ic [op is Ga] IIC T4 Gc [Ex op is Da] IIIC

Ambient temperature T_{amb}: -40…+70 °C

Approval data

Max. rated voltage U_m	40 VDC
Max. heat dissipation	≤ 3.2 W
RS485	U_m = 40 V
Optical interface	Ex op is
Alarm output	U_m = 40 V

16 Turck subsidiaries — contact information

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Australia	Turck Australia Pty Ltd Building 4, 19-25 Duerdin Street, Notting Hill, 3168 Victoria **www.turck.com.au**
Austria	Turck GmbH Graumanngasse 7/A5-1, A-1150 Wien **www.turck.at**
Belgium	TURCK MULTIPROX Lion d'Orweg 12, B-9300 Aalst **www.multiprox.be**
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China	Turck (Tianjin) Sensor Co. Ltd. 18,4th Xinghuazhi Road, Xiqing Economic Development Area, 300381 Tianjin **www.turck.com.cn**
Czech Republic	TURCK s.r.o. Na Brne 2065, CZ-500 06 Hradec Králové **www.turck.cz**
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Mexico	Turck Comercial, S. de RL de CV Blvd. Campestre No. 100, Parque Industrial SERVER, C.P. 25350 Arteaga, Coahuila **www.turck.com.mx**
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