



Project planning, installation and commissioning of a fibre optic cable system of R. STAHL for the safe and hazardous area

**Project planning, installation and commissioning of a fibre optic cable system of
R. STAHL for the safe and hazardous area**

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Operating Instructions

Project planning, installation and commissioning of a fibre optic cable system of R. STAHL for the safe and hazardous area



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1. Introduction

R. STAHL introduced an intrinsically safe fieldbus system based on an RS 485 interface on to the market in 1995. This fieldbus system offers the possibility of connecting several field stations together by means of a bus system and connect that in turn to a central control system.

The fieldbus system is certified by the examining body PTB for use in Zone 1 and 2 as well as Zone 21 and 22. As the fieldbus system is certified as intrinsically safe, the components connected to it can be connected to or disconnected from the bus without any further safety measures under Ex conditions.

With adverse ambient conditions such as EMC, potential differences, overvoltage protection or large bus coverage distances, fibre optic cables can be used as an alternative to the RS 485 interface.

This document describes the different possibilities available for the use of fibre optic cables in non-hazardous and hazardous areas.

2. Project planning

2.1. General

A wide range of products are available for non-hazardous areas. Please observe the following as selection criteria:

- ⇒ the bus protocol
- ⇒ ring or line structure topology
- ⇒ redundant or non redundant design
- ⇒ the distance between 2 fieldbus devices
- ⇒ the total extent of the fiber optic network
- ⇒ selection of fiber type, multi-mode 50/125 µm or 62.5/125 µm (single-mode 9/125 µm fibers and plastic fibers are not supported)
- ⇒ fiber optic connectors, glued or crimped
- ⇒ the design features of the fiber optic cable
 - loose tube cable, breakout cable
 - indoor or outdoor installation
 - rodent protection
 - metallic/non-metallic armouring
 - hybrid-cable with fiber optic and copper integrated into a single cable
- ⇒ reserve fibers with fiber optic connectors mounted

As fiber optic connections are point-to point connections due to their operating principle, a direct line-type bus structure similar to an RS 485 bus is not possible. Line-type topologies can only be implemented when multiple electro optical converters (repeaters) are cascaded. Cascading of multiple repeaters reduces the availability of the connected field bus devices as their count increases. A solution to this problem is offered by an optical ring which tolerates the failure of a repeater or a fiber breakage.



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2.2. Hazardous area

Approved assemblies must be used for fiber optic networks used in the hazardous areas. R. STAHL provides standard solutions for fiber optic technology for

- ⇒ the safe area
- ⇒ the hazardous area
- ⇒ laying indoor cables
- ⇒ laying outdoor cables.

2.3. Device selection

According to the operation area and usage 3 different devices are available.

	Operating area								
	Safe area			Zone 2			Zone 1		
	Device	RS485	Fiber optic	Device	RS485	Fiber optic	Device	RS485	Fiber optic
9186/12-11-11	✓	✓	✓	✓	✓	✓	✗	✗	✓
9186/15-12-11	✓	✓	✓	✓	✓	✓	✗	✗	✓
9186/25-12-11	✓	✓	✓	✓	✓	✓	✗	✗	✓

- Device: Installation of the device in the hazardous area (type of protection 9185/12 Ex e, m and 9186/x5 Ex nA)
- RS 485: Type of explosion protection for the RS 485 interface (Ex i), can be used in the hazardous area
- Fiber optic: Type of explosion protection for the optical interface (op is), can be used in the hazardous area

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2.4. Project planning examples Zone 1

2.4.1. Fiber optic point-to-point for zone 1 use with fiber optic field bus isolating repeater type 9186/....

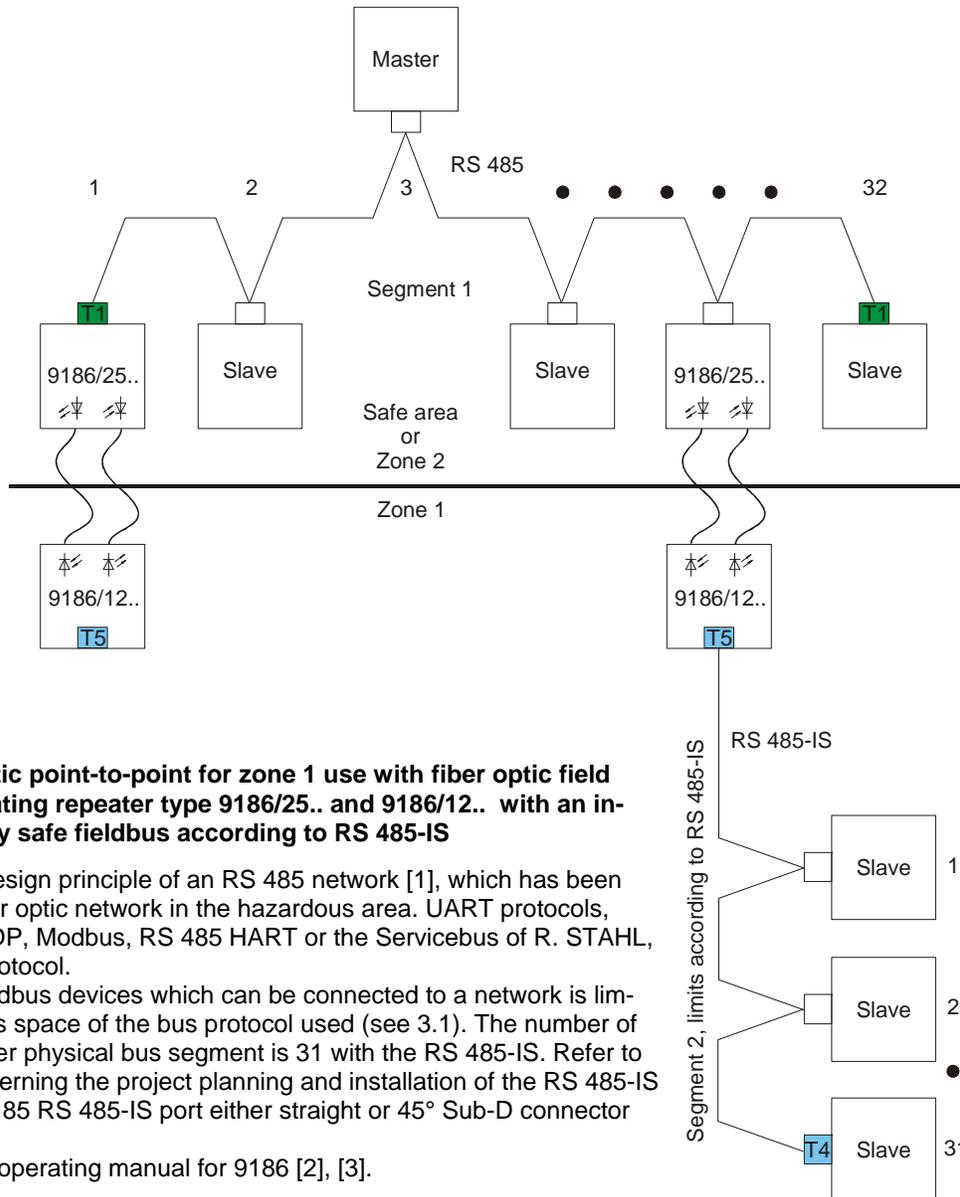


Fig 1 Fiber optic point-to-point for zone 1 use with fiber optic field bus isolating repeater type 9186/25.. and 9186/12.. with an intrinsically safe fieldbus according to RS 485-IS

Fig 1 shows the design principle of an RS 485 network [1], which has been extended by a fiber optic network in the hazardous area. UART protocols, such as Profibus DP, Modbus, RS 485 HART or the Servicebus of R. STAHL, are used as the protocol.

The number of fieldbus devices which can be connected to a network is limited by the address space of the bus protocol used (see 3.1). The number of fieldbus devices per physical bus segment is 31 with the RS 485-IS. Refer to [1] for details concerning the project planning and installation of the RS 485-IS fieldbus. At the 9185 RS 485-IS port either straight or 45° Sub-D connector may be used.

For the setup see operating manual for 9186 [2], [3].

	Description, bus terminating resistor	Ordering code
T1	Sub-D connector standard RS 485, non Ex and Zone 2	315 732 0
T4	Sub-D connector for Zone 1 CPM, in accordance with RS 485-IS	94 900 02 22 0
T5	Sub-D connector for Zone 1 CPM, straight version Sub-D connector for Zone 1 CPM, 45° version	94 900 02 22 0 201805

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2.4.2. Redundant fiber optic point-to-point for Zone 1 with fiber optic field bus isolating repeater type 9186/....

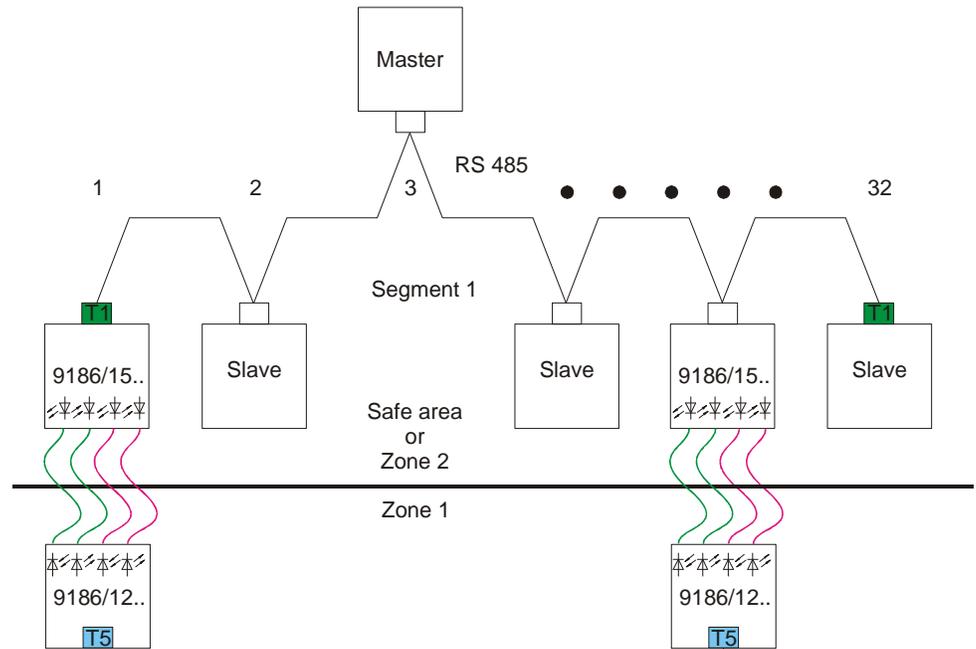


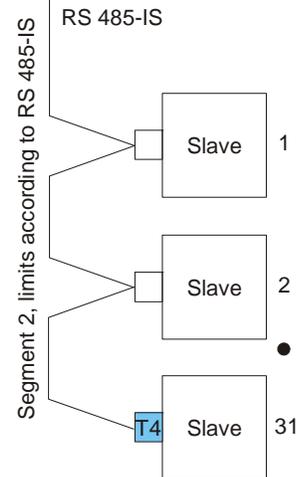
Fig 2 Redundant fiber optic point-to-point for Zone 1 with fiber optic field bus isolating repeater type 9186/15.. and 9186/12.. with an intrinsically safe fieldbus to RS 485-IS

Fig 2 shows the design principle of an RS 485 network [1], which has been extended by a fiber optic network in the hazardous area. UART protocols, such as Profibus DP, Modbus, RS 485 HART or the Servicebus of R. STAHL, are used as the protocol.

The number of fieldbus devices which can be connected to a network is limited by the address space of the bus protocol used (see 3.1). The number of fieldbus devices per physical bus segment is 31 with the RS 485-IS. Refer to [1] for details concerning the project planning and installation of the RS 485-IS fieldbus. At the 9185 RS 485-IS port either straight or 45° Sub-D connector may be used.

Here redundant fiber connection is used (red and green)

For the setup see operating manual for 9186 [2], [3].



	Description, bus terminating resistor	Ordering code
T1	Sub-D connector standard RS 485, non Ex and Zone 2	315 732 0
T4	Sub-D connector for Zone 1 CPM, in accordance with RS 485-IS	94 900 02 22 0
T5	Sub-D connector for Zone 1 CPM, straight version	94 900 02 22 0
	Sub-D connector for Zone 1 CPM, 45° version	201805

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2.4.3. Fiber optic line (daisy chain) for Zone 1 with fiber optic field bus isolating repeater type 9186/....

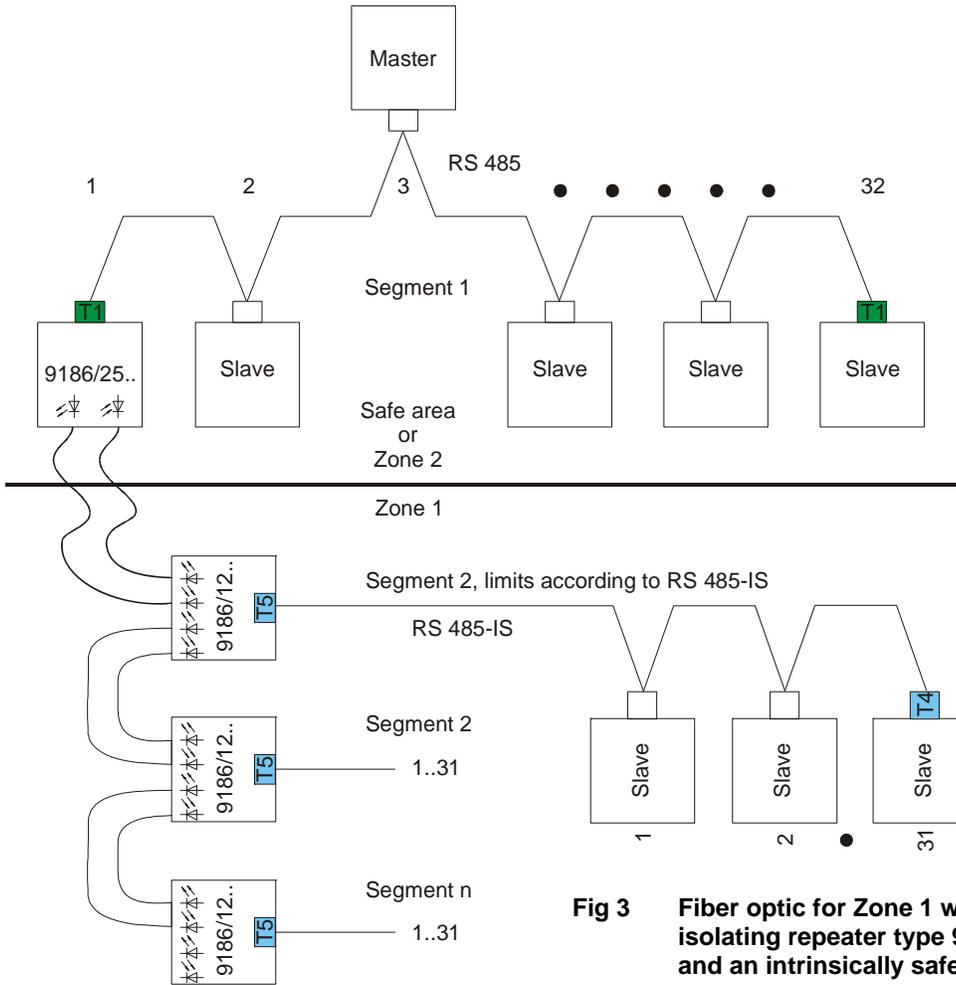


Fig 3 Fiber optic for Zone 1 with fiber optic field bus isolating repeater type 9186/25.. and 9186/12.. and an intrinsically safe fieldbus to RS 485-IS

Fig 3 shows the design principle of an RS 485 network [1], which has been extended by a fiber optic network in the hazardous area. UART protocols, such as Profibus DP, Modbus, RS 485 HART or the Servicebus of R. STAHL, are used as the protocol.

The number of fieldbus devices which can be connected to a network is limited by the address space of the bus protocol used (see 3.1). The number of fieldbus devices per physical bus segment is 31 with the RS 485-IS. Refer to [1] for details concerning the project planning and installation of the RS 485-IS fieldbus. At the 9185 RS 485-IS port either straight or 45° Sub-D connector may be used.

The fiber connection is carried out as line (daisy chain), which reduces the number of 9186/15 required in the control room. Care should be taken on the fact that each 9186/12 connected in daisy chain will reduce the availability of the slave devices connected afterwards.

For the setup see operating manual for 9186 [2], [3].

	Description, bus terminating resistor	Ordering code
T1	Sub-D connector standard RS 485, non Ex and Zone 2	315 732 0
T4	Sub-D connector for Zone 1 CPM, in accordance with RS 485-IS	94 900 02 22 0
T5	Sub-D connector for Zone 1 CPM, straight version	94 900 02 22 0
	Sub-D connector for Zone 1 CPM, 45° version	201805

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2.4.4. Fiber optic ring for Zone 1 with fiber optic field bus isolating repeater type 9186/....

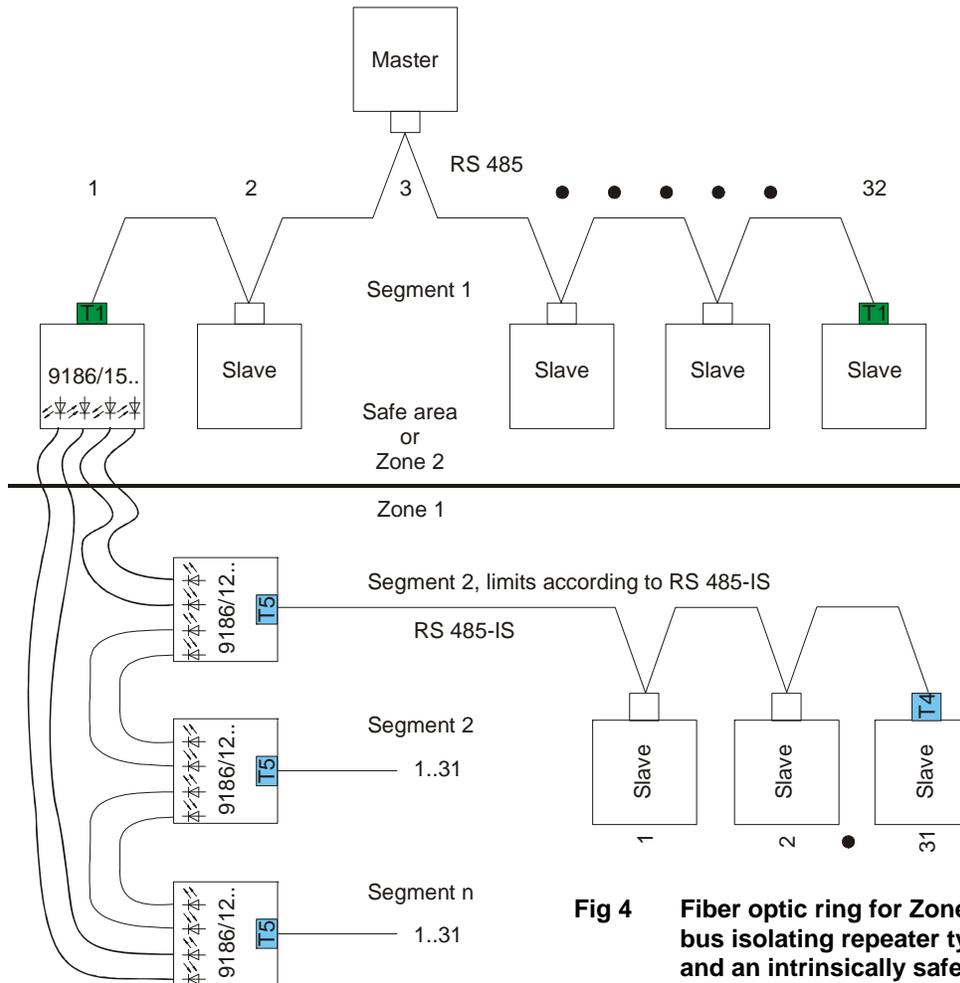


Fig 4 Fiber optic ring for Zone 1 with fiber optic field bus isolating repeater type 9186/15.. and 9186/12.. and an intrinsically safe fieldbus to RS 485-IS

Fig 4 shows the design principle of an RS 485 network [1], which has been extended by a fiber optic network in the hazardous area. UART protocols, such as Profibus DP, Modbus, RS 485 HART or the Servicebus of R. STAHL, are used as the protocol. The number of fieldbus devices which can be connected to a network is limited by the address space of the bus protocol used (see 3.1). The number of fieldbus devices per physical bus segment is 31 with the RS 485-IS. Refer to [1] for details concerning the project planning and installation of the RS 485-IS fieldbus. At the 9185 RS 485-IS port either straight or 45° Sub-D connector may be used.

Using a fiber ring combines the advantage of a line (daisy chain) interconnection without reducing the availability of the loop with a increased number of 9186.

For a proper function of a fiber ring some parameter shall be observed and set like: bus parameters, number of 9186 in a ring, distance between 9186 and the total length of a fiber ring. For the setup see operating manual for 9186 [2], [3].

	Description, bus terminating resistor	Ordering code
T1	Sub-D connector standard RS 485, non Ex and Zone 2	315 732 0
T4	Sub-D connector for Zone 1 CPM, in accordance with RS 485-IS	94 900 02 22 0
T5	Sub-D connector for Zone 1 CPM, straight version Sub-D connector for Zone 1 CPM, 45° version	94 900 02 22 0 201805

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2.4.5. Fiber optic point-to-point for zone 1 use with fiber optic field bus isolating repeater type 9186/15.. and 9186/12.. for the use with old CPMs tpye 9440/12.. (not for use in new installations)

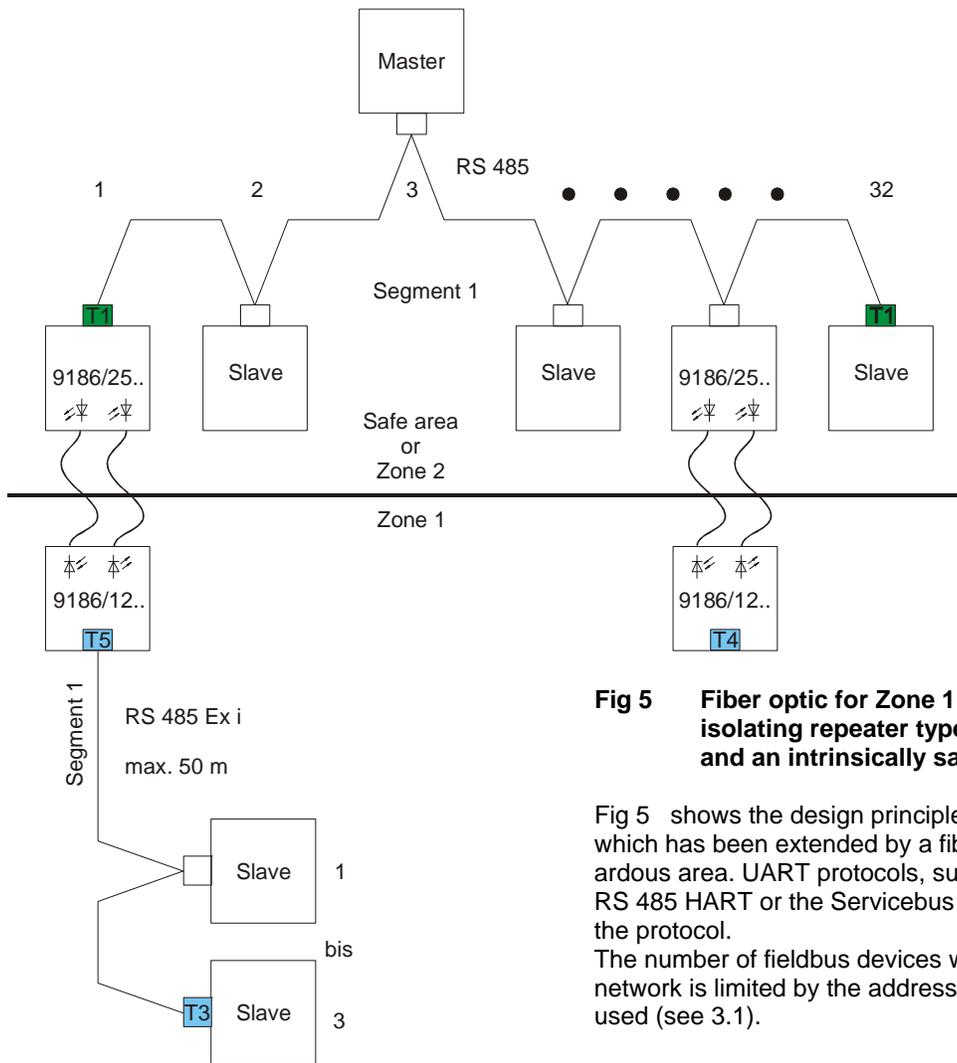


Fig 5 Fiber optic for Zone 1 with fiber optic field bus isolating repeater type 9186/25.. and 9186/12.. and an intrinsically safe fieldbus to RS 485 Exi

Fig 5 shows the design principle of an RS 485 network [1], which has been extended by a fiber optic network in the hazardous area. UART protocols, such as Profibus DP, Modbus, RS 485 HART or the Servicebus of R. STAHL, are used as the protocol.

The number of fieldbus devices which can be connected to a network is limited by the address space of the bus protocol used (see 3.1).

If a 9186 is used in an old installation according to RS 485 Ex i together with a CPM type 9440/12 the number of CPMs is limited to 3 and the segment limit will be 50 m.

Refer to [1] for details concerning the project planning and installation of the RS 485 Exi fieldbus.

	Description, bus terminating resistor	Ordering code
T1	Sub-D connector standard RS 485, non Ex and Zone 2	315 732 0
T3	Sub-D connector for Zone 1 CPM, in accordance with RS 485Ex i	94 900 03 22 0
T4	Sub-D connector for Zone 1 CPM, in accordance with RS 485-IS	94 900 02 22 0
T5	Sub-D connector for Zone 1 CPM, straight version Sub-D connector for Zone 1 CPM, 45° version	94 900 02 22 0 201805

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2.5. Project planning examples Zone 2

2.5.1. Fiber optic point-to-point for Zone 2 with fiber optic field bus isolating repeater type 9186/....

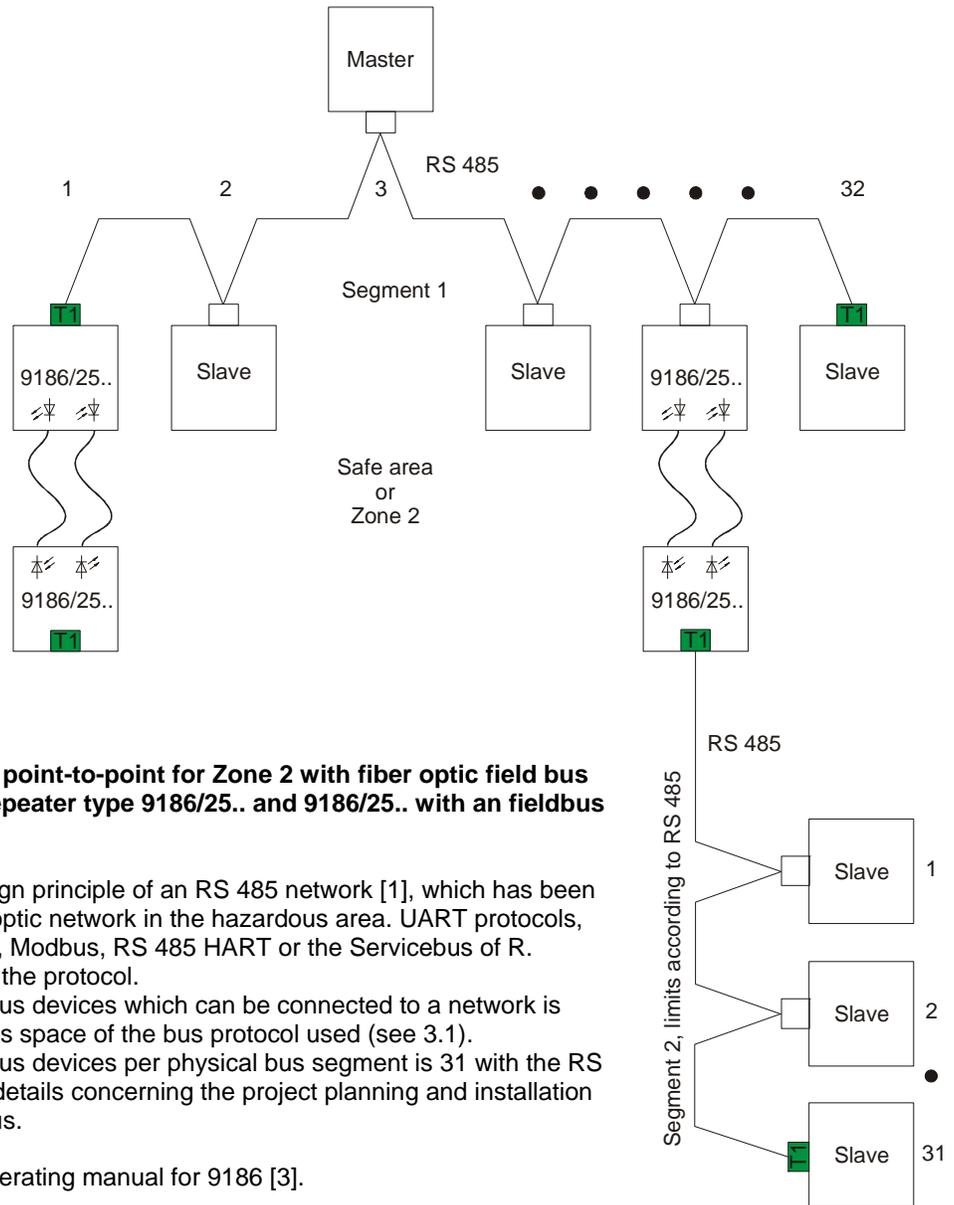


Fig 6 Fiber optic point-to-point for Zone 2 with fiber optic field bus isolating repeater type 9186/25.. and 9186/25.. with an fieldbus to RS 485

Fig 6 shows the design principle of an RS 485 network [1], which has been extended by a fiber optic network in the hazardous area. UART protocols, such as Profibus DP, Modbus, RS 485 HART or the Servicebus of R. STAHL, are used as the protocol.

The number of fieldbus devices which can be connected to a network is limited by the address space of the bus protocol used (see 3.1). The number of fieldbus devices per physical bus segment is 31 with the RS 485. Refer to [1] for details concerning the project planning and installation of the RS 485 fieldbus.

For the setup see operating manual for 9186 [3].

	Description, bus terminating resistor	Ordering code
T1	Sub-D connector standard RS 485, non Ex and Zone 2	315 732 0

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2.5.2. Redundant fiber optic point-to-point for Zone 2 with fiber optic field bus isolating repeater type 9186/....

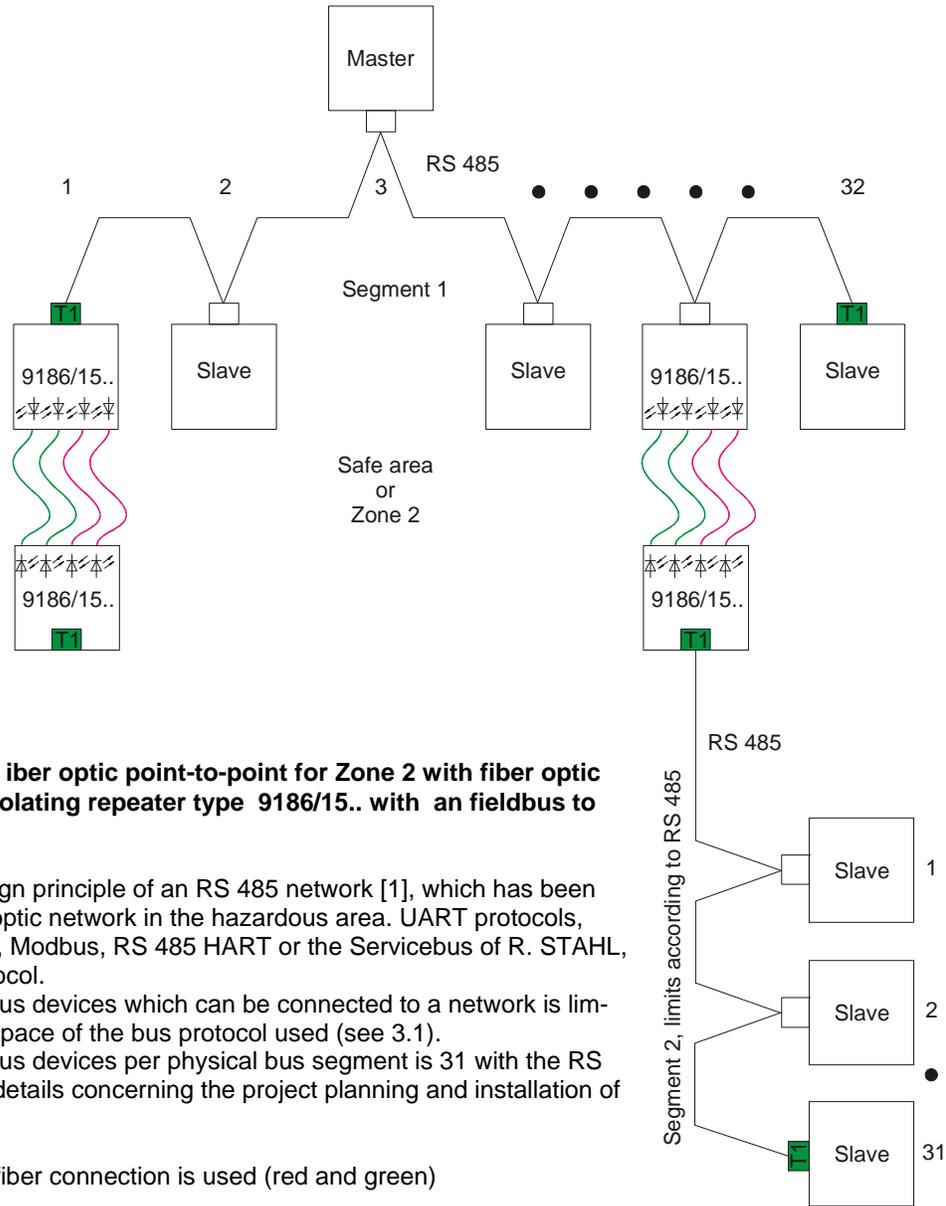


Fig 7 Redundant fiber optic point-to-point for Zone 2 with fiber optic field bus isolating repeater type 9186/15.. with an fieldbus to RS 485

Fig 7 shows the design principle of an RS 485 network [1], which has been extended by a fiber optic network in the hazardous area. UART protocols, such as Profibus DP, Modbus, RS 485 HART or the Servicebus of R. STAHL, are used as the protocol.

The number of fieldbus devices which can be connected to a network is limited by the address space of the bus protocol used (see 3.1).

The number of fieldbus devices per physical bus segment is 31 with the RS 485. Refer to [1] for details concerning the project planning and installation of the RS 485 fieldbus.

Here a redundant fiber connection is used (red and green)

For the setup see operating manual for 9186 [2], [3].

	Description, bus terminating resistor	Ordering code
T1	Sub-D connector standard RS 485, non Ex and Zone 2	315 732 0

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2.5.3. Fiber optic line (daisy chain) for Zone 2 with fiber optic field bus isolating repeater type 9186/....

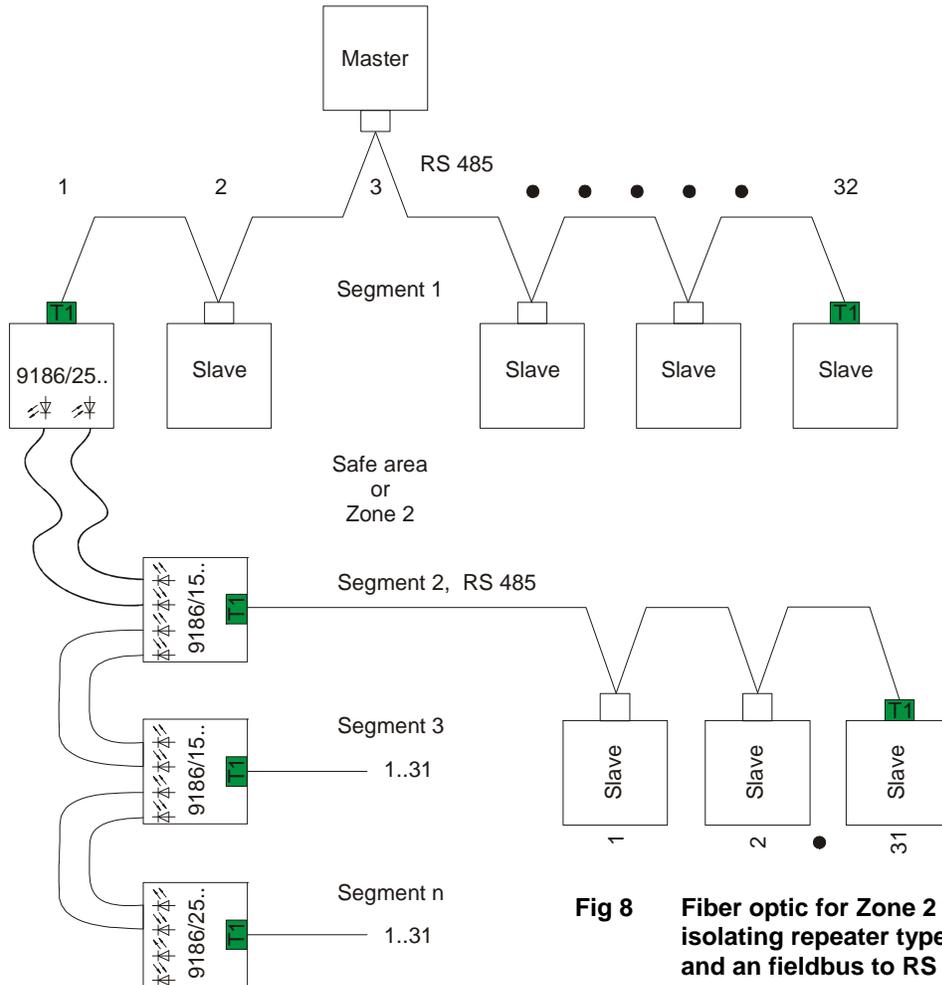


Fig 8 Fiber optic for Zone 2 with fiber optic field bus isolating repeater type 9186/15.. and 9186/25.. and an fieldbus to RS 485

Fig 8 shows the design principle of an RS 485 network [1], which has been extended by a fiber optic network in the hazardous area. UART protocols, such as Profibus DP, Modbus, RS 485 HART or the Servicebus of R. STAHL, are used as the protocol.

The number of fieldbus devices which can be connected to a network is limited by the address space of the bus protocol used (see 3.1).

The number of fieldbus devices per physical bus segment is 31 with the RS 485. Refer to [1] for details concerning the project planning and installation of the RS 485 fieldbus.

The fiber connection is carried out as line (daisy chain), which reduces the number of 9186/15 required in the control room. Care should be taken on the fact that each 9186/.. connected in daisy chain will reduce the availability of the slave devices connected afterwards.

For the setup see operating manual for 9186 [3].

	Description, bus terminating resistor	Ordering code
T1	Sub-D connector standard RS 485, non Ex and Zone 2	315 732 0

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2.5.4. Fiber optic ring for Zone 2 with fiber optic field bus isolating repeater type 9186/....

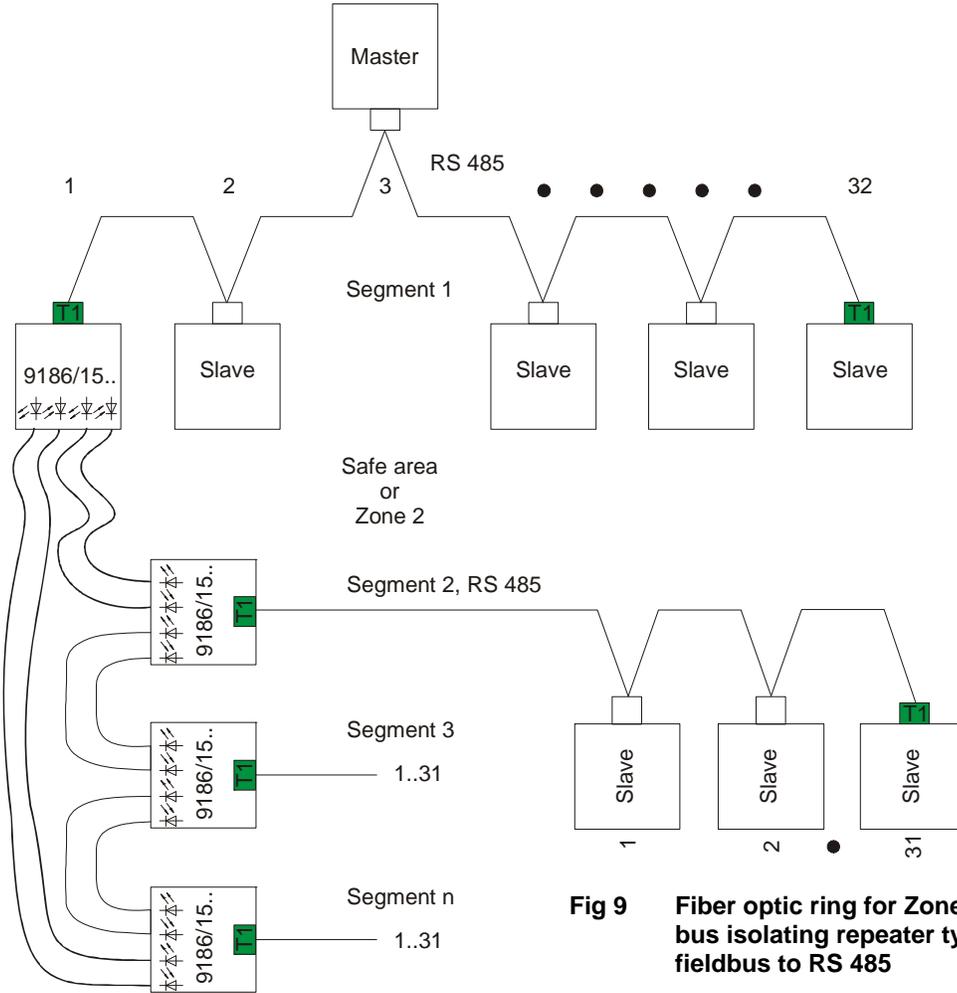


Fig 9 Fiber optic ring for Zone 2 with fiber optic field bus isolating repeater type 9186/15.. with an fieldbus to RS 485

Fig 9 shows the design principle of an RS 485 network [1], which has been extended by a fiber optic network in the hazardous area. UART protocols, such as Profibus DP, Modbus, RS 485 HART or the Servicebus of R. STAHL, are used as the protocol.

The number of fieldbus devices which can be connected to a network is limited by the address space of the bus protocol used (see 3.1).

The number of fieldbus devices per physical bus segment is 31 with the RS 485. Refer to [1] for details concerning the project planning and installation of the RS 485 fieldbus.

Using a fiber ring combines the advantage of a line (daisy chain) interconnection without reducing the availability of the loop with a increased number of 9186.

For a proper function of a fiber ring some parameter shall be observed and set like: bus parameters, number of 9186 in a ring, distance between 9186 and the total length of a fiber ring.

For the setup see operating manual for 9186 [3].

	Description, bus terminating resistor	Ordering code
T1	Sub-D connector standard RS 485, non Ex and Zone 2	315 732 0



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3. Project planning rules and limitations

Please refer to [1], [4] for the RS 485 project planning rules

3.1. Address space of the bus protocols

Protocol	Software	Address space
Profibus DP	----	0 to 124
Modbus RTU	----	0 to 127
Servicebus	I.S. Wizard	0 to 127
HART RS 485	AMS, Emerson	0 to 127
HART RS 485	HART Server, HCF	0 to 31
HART RS 485	PDM, Siemens	0 to 31
HART RS 485	H-FDCM, Honeywell	0 to 127
HART RS 485	PRM, Yokogawa	0 to 31

The bus protocols used must be taken into consideration when assigning addresses to the individual bus users. If a system is planned with, for instance, 20 Profibus networks and, in parallel with this, a Servicebus network for HART and diagnostic purposes, coordination between the two networks will be required for address assignment. If, for instance, 10 bus users (I.S. 1 Remote I/O) are present per Profibus network, the addresses should not be set from 1 to 10 per network since the same addresses will be used on the Profibus as are used on the Servicebus. The Servicebus will normally be installed beyond several Profibus segments and this means that several I.S. 1 stations with the same addresses occur on the Servicebus. In order to avoid this, the addresses should be assigned consecutively, e.g. 1 to 10, 11 to 20 and 21 to 30...

3.2. Project planning rules for 9186..

3.2.1. 9186/12-11-11

Project planning rules for

- Maximum length of a glass fiber between different devices
- Number of devices in a fiber optic ring
- Maximum length of a fiber optic ring
- Setting of a 9186
- Setting for the bus parameters

can be found in the operation manual [2].

3.2.2. 9186/15-12-11 for point-to-point or end of a line 9186/25-12-11 ring, redundant point-to-point, line

Project planning rules for

- Maximum length of a glass fiber between different devices
- Number of devices in a fiber optic ring
- Maximum length of a fiber optic ring
- Setting of a 9186
- Setting for the bus parameters

can be found in the operation manual [3].

Project planning, installation and commissioning of a fibre optic cable system of R. STAHL for the safe and hazardous area

3.3. Fiber Optic Cable

R. STAHL use a breakout cable with 3 mm sub-cable for direct connector installation as standard glass fiber cable. Glass fibers with 50/125 µm (multi-mode fibers) are normally used. Other fiber types may also be used such as 62.5/125 µm or HCS, however, they are not used by R. STAHL. Three types are available. Loose tube cables with 2 to 24 fibers are available as an alternative for longer distances(> 200-300m) . The disadvantage of a loose tube cable is the necessity for a splice box or splitter adapter which generates additional costs (price for the device and installation time).

Laying location	Fig. No.	Cable type ²⁾	Number of Fibers	Diameter [µm]	Sub-cable diam. [mm]	External diam.. [mm]	Rodent protection non-metallic	Jacket	Designation
Indoor	Fig 10	Br	4	50/125	2,7	10	-	PVC	04-G50/CWJSTNT-D27
Outdoor	Fig 11	Lt	2-24	50/125	-	10	X	PE	KL-A-DQ(ZNS)2Y 1x n ¹⁾ G50/125
Outdoor	Fig 12	Br	4	50/125	2,5	13,5	X	PE	KL-AT-V(ZN)HH(ZNS)2Y

1) n = number of Fibers

2) cable type: Br; breakout, Lt; Loose tube cable

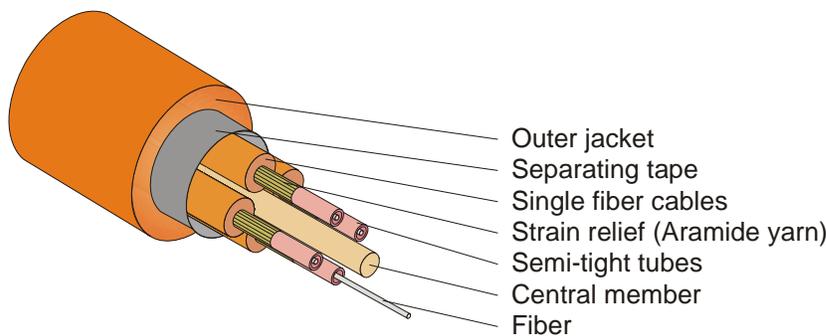


Fig 10 Breakout-cable for Indoor use

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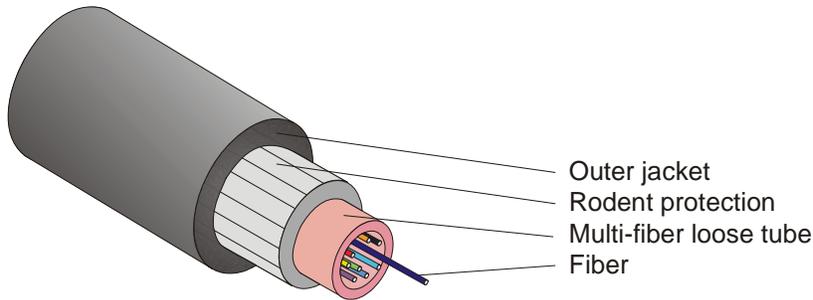


Fig 11 multi-fiber loose tube cables

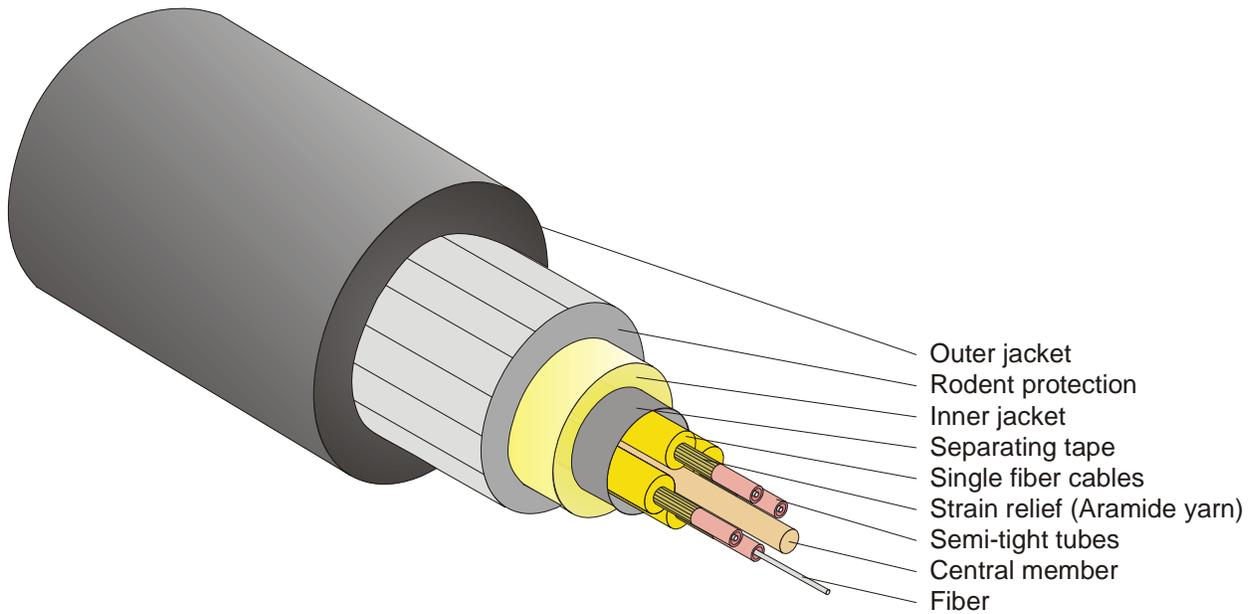


Fig 12 Breakout-cable for Outdoor use

3.1. Terminating resistors

An RS 485 bus must be provided with two terminating resistors. The Fiber optic couplers generally constitute the start of a bus segment. On a 9186/15 or ..25 fiber optic coupler the termination resistor is in the Sub-D connector. On 9186/12 fiber optic coupler the termination resistor is half in the Sub-D connector and half in the 9186 (A special approved connector shall be used).

3.2. Fiber optic connector

All devices use ST connectors. These are available in different versions on the market.

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3.3. RS 485, RS485-IS connectors

Description, Bus Terminator	Order number	
Sub D-connector standard RS 485, none Ex and Zone 2	315 732 0	
Sub D-connector for zone 1 CPM, according to RS 485 Ex i	94 900 03 22 0	
Sub D-connector for zone 1 CPM, according to RS 485-IS	94 900 02 22 0	
Sub D-connector for zone 1, 45° version according to RS 485-IS	201805	



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4. Installation

4.1. Important information on installation and project planning rules

The great majority of problems that occur during commissioning of a fiber optic cable installation are installation problems, such as:

- wrong cables
- badly connected connectors,
- Fiber breakage
- Mixing up send and receive fibers
- no spare fibers planned

These faults account for about 90 % of all commissioning problems. The remaining 10 % is split between configuration errors and equipment faults.

To counter this state of affairs, attention must be paid during installation to cable laying and joining of connectors.

4.2. Cable laying

- Keep a bending radius ($> 450 \text{ mm}$)¹⁾ => do not pull cables around sharp corners
- Stay below the allowed pulling force ($< 200 \text{ N}$)¹⁾ => do not try to pull excessively long stretches in one operation
- Allow enough spare cable at the ends for making connections
- Mark the cable clearly at both ends (start and end identification)

¹⁾ The specifications of the cable manufacturer shall be observed.

If these basic rules are not observed, it may end up with broken fibers. A broken fiber can occur even after a few weeks or years. It is often the case that stressed fibers degenerate with time leading to increased attenuation and a slowly developing fault.

4.3. Connection of the fiber optic cable connector

1. The specifications of the connector manufacture shall be observed
2. The special tools of the connector manufacture shall be used
3. The fiber shall not be subjected to stresses during connector mounting
4. The dust protection cap shall be fitted immediately after the connector is mounted
5. The attachment of the bus cable and individual fiber identification shall be of a permanent nature

Information: If the cable laying is awarded to a sub-contractor, then the following points should be included in the contract:

Cable identification by the subcontractor (how and where)
Excess cable at the ends
Measurement protocol of each individual fiber of fiber optic cable
Only cables meeting the specification should be accepted



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5. Commissioning

The most important step in commissioning a fiber optic cable network is the examination of the physical installation and measurement of the fiber optic circuits. If this has not been performed, it makes poor sense to continue with commissioning.

A differentiation must be made between the electrical and optical interface during commissioning. First of all the electrical interface between the master and Fiber optic cable coupler must be put into operation. The optical interface can be subsequently put into operation.

5.1. RS 485 bus segment in the safe area

For proper functioning of the bus segment, the bus must be terminated at both ends with active terminating resistors. These resistors can be integrated in the Sub-D connectors or in the devices themselves. Modern Sub-D connectors with switch-in terminating resistors isolate the bus cable leaving that point from the bus when the terminating resistors are switched in. The downstream stations can no longer be accessed. This means that troubleshooting for a bus fault is simplified. See [1]

5.2. RS 485 IS bus segment in the hazardous area

For a proper functioning of the bus segment, the bus must be terminated at the front end with the active terminating resistor in the fieldbus isolating repeater or Sub-D connector. Each CPM connected to the bus segment is to be terminated by a Sub-D connector with switch in terminating resistor supplied by R. STAHL. The terminating resistor is to be switched on at the end of a bus segment. If the terminating resistor is switched in before the last CPM on the bus segment, all downstream CPMs from this bus segment are disconnected. See [1]

5.3. Fiber optic bus segment

A proper made fiber optic cable run is essential for proper functioning of the bus segment (correctly fitted connectors, fibers in perfect condition). Problems which can still arise are mixed up fibers (TXD-1 must be connected to RXD-2 and RXD-1 must be connected to TXD-2). Settings of the fiber optic coupler such as baud rate, steady light to TXD for test, master ring redundancy, etc.

5.4. Examining the settings of the fieldbus devices

- Address
- Configuration
- Power supply
- Repeater, field bus isolating repeater, Fiber optic cable coupler => settings



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5.5. Commissioning the master

- Configuration of the bus master, special bus parameters for use with fiber optic lines and rings (see [2], [3]).
- Connection of the bus segment to the bus master
- Check whether the bus master can access all bus users
⇒ What quality is achieved, error, magnitude etc.?

A good bus should not indicate errors in the normal operating state. If errors occur, these must be eliminated since minor / rare errors become serious problems over the course of time.

6. Troubleshooting

Troubleshooting can be split into several groups:

1. The logical search using a bus analyzer that carries out an analysis of the protocol and data link levels. This records and plays back telegram traffic. See [1]
2. On the physical RS 485 level using an oscilloscope. This detects how good the construction of the bus segment is. This is necessary, if the logical examination shows that some telegrams have been destroyed. The oscilloscope can show bus faults such as open circuits, short circuits, impedance mismatch, cable junctions, quiescent voltage level and transmission voltage levels of individual bus users. See [1]
3. In fiber optic lines a direct measurement, as it can be done with an electrical interface, is only possible with special instruments which are normally not available on site.

Indirect measurement is used for this reason, such as,

- Attenuation measurement of both fibers,
- Measurement of the transmission level of the fiber optic couplers concerned,
- Verification that the receivers are operational.
- With very high attenuation, it is useful to use an ODTR (optical time domain reflectometer) measurement device to pinpoint the spot with increased attenuation. An ODTR measurement device is a reflection measurement device which measures the light energy reflected at the faulty point and which then localizes the point and magnitude of the fault
 - If the connector is poorly connected, an attenuation measurement cannot determine which of both connectors is faulty
 - in case of doubt both connectors must be exchanged successively. However, an ODTR measurement device can locate the fault location
 - Only one of the connectors must be exchanged
- The dynamic performance of a fiber optic network can only be tested using a fiber coupler and an optical probe for an oscilloscope. However, this is practically impossible in practice due to the effort involved



Operating Instructions

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7. Bibliography

[1]	Project planning, installation and commissioning of the RS 485 fieldbus system of R. STAHL for the safe and hazardous area from R. STAHL
[2]	R. STAHL operating instructions for the 9186/12
[3]	R. STAHL operating instructions for the 9186/15 and 9186/25
[4]	Installation Guideline for PROFIBUS-FMS/DP from Profibus User Organisation Installation and wiring recommendations for RS 485 Transmission Version: 1.0 Order No.: 2.111 - Language: German Order No.: 2.112 - Language: English