



# **PROFIBUS Interconnection Technology**

**Guideline**

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- may:** indicates flexibility of choice with no implied preference.
- should:** indicates flexibility of choice with a strongly preferred implementation.
- shall:** indicates a mandatory requirement. Designers **shall** implement such mandatory requirements to ensure interoperability and to claim conformance with this specification.

Publisher:  
PROFIBUS Nutzerorganisation e.V.  
Haid-und-Neu-Str. 7  
76131 Karlsruhe  
Germany  
Phone: +49 (0) 721 / 96 58 590  
Fax: +49 (0) 721 / 96 58 589  
E-mail: [info@profibus.com](mailto:info@profibus.com)  
Web site: [www.profibus.com](http://www.profibus.com)

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## 1 Management Summary - Scope of this document

This guideline is intended primarily for manufacturers of PROFIBUS field devices and manufacturers of connectors.

The objective of this guideline is to limit the variety of methods utilized in PROFIBUS connections. Connectors for the connection of PROFIBUS field devices are to be preferred to other connection methods because of the advantages for servicing, commissioning, and testing.

The guideline considers the different requirements for PROFIBUS connectors. Since one single connector type cannot meet these requirements and in some cases the types must be unambiguous, different connector variants are specified according to their requirements:

| Type of protection   |                | Data line |                | Load current supply     |      | Chapter |
|--|----------------|-----------|----------------|-------------------------|------|---------|
| IP 20  | IP65 or higher | Copper    | Optical fibers | Encoder and electronics | Load |         |
| for PROFIBUS with ANSI TIA/EIA-485-A transmission standard |                |           |                |                         |      |         |
| X  | (X)            | X         |                |                         |      | 3.1     |
| X  |                |           | X              |                         |      | 3.2     |
|  | X              | X         |                |                         |      | 4.1     |
|  | X              | X         |                | X                       | X    | 4.2.2.1 |
|  | X              |           | X              | X                       | X    | 4.2.2.2 |
|  | X              | X         |                | X                       |      | 4.3     |
| for PROFIBUS with IEC 61158-2 transmission technology      |                |           |                |                         |      |         |
|  | X              | X*        |                |                         |      | 4.4     |

\*) With IEC 61158-2 transmission technology, the field devices are supplied preferably via the data line

Table 1-1: Requirements to the various connection methods

The connectors specified in the guideline should be used for new designs of PROFIBUS field devices. If other suitable connection methods or connectors must be used for PROFIBUS field devices because of relevant electromagnetic requirements or user specifications, these can be used, provided that they meet the following requirements:

- Type of protection according to the application
- Operating safety
- Connector suitable for the cable cross-section
- Suitable for the selected baud rate

The following signals must be provided at the connecting point of the PROFIBUS field devices with ANSI TIA/EIA-485-A transmission standard in every case.

| Signal        | Meaning                                 |
|---------------|---|
| Shield        | Shield                                  |
| RxD / TxD – P | Receive / Transmit data – P, B – line   |
| RxD / TxD – N | Receive / Transmit data – N, A – line   |
| DGND*         | Data ground (reference potential to VP) |
| VP*           | Supply voltage – plus ( P 5 V)          |

\*) The signals VP and DGND inside the device are necessary for an external supply of the terminating resistors. (used only with 9-pin D-SUB connectors)

Table 1-2: PROFIBUS mandatory signals at the device interface

All cables used must meet the following parameters according to the PROFIBUS specification for copper signal cable data wires. The connectors must allow these connections.

| Parameter                       | DP, Cable type A                        |
|---------------------------------|---|
| Surge impedance in $\Omega$     | 135...165 for a frequency of 3...20 MHz |
| Effective capacitance (pF/m)    | $\leq 30$                               |
| Loop resistance ( $\Omega$ /km) | $\leq 110$                              |
| Core design (solid)             | AWG 22/1                                |
| Core design (flexible)          | $> 0,32 \text{ mm}^2$                   |

Table 1-3: Cable parameters for PROFIBUS copper signal cables with ANSI TIA/EIA-485-A transmission standard

For special uses (e.g. use in trailing chains or festoons) cables may be used which deviate mechanically or electrically from the specifications of the technical guideline or the specified data of the type A cable. The surge impedance must be retained.

| Parameter                       | PA                           |
|---------------------------------|------------------------------|
| Cable design                    | Twisted pair and shielded    |
| Core cross-section (nominal)    | 0.8 mm <sup>2</sup> (AWG 18) |
| Loop resistance ( $\Omega$ /km) | 44                           |
| Impedance at 31.25 kHz          | 100 $\Omega \pm 20\%$        |
| Wave attenuation at 39 kHz      | 3 dB/km                      |
| Asymmetrical capacitance        | 2 nF/km                      |

Table 1-4: Specification of the reference cable for IEC 61158-2 transmission standard

This guideline does not release manufacturers of field devices and connectors as well as users from having to observe the relevant standards and regulations. The valid version of the EMC directive and other PROFIBUS guidelines and the shield and grounding directives, particularly for PROFIBUS-PA, must be observed.

## 2 Reference to affected PROFIBUS Guidelines

The following PROFIBUS guidelines are also affected by the guideline “PROFIBUS Interconnection Technology” and may have to be considered when applying the connection techniques described here.

| Document                                    | Art. no.                          |
|---|-----------------------------------|
| PROFIBUS Specification (FMS, DP, PA)        | 0.032 (English)                   |
| Test Specifications for PROFIBUS-DP Slaves  | 2.032 (English)                   |
| Test Specifications for PROFIBUS-DP Masters | 2.071 (German)                    |
| Test Specifications for PROFIBUS-PA Devices | 2.061 (German)                    |
| Fiber Optical Data Transfer for PROFIBUS    | 2.021(German),<br>2022 (English)  |
| PROFIBUS-DP Extensions                      | 2.082 (English)                   |
| PROFIBUS-PA User + Installation Guideline   | 2.091(German),<br>2.092 (English) |
| GSD Specification for PROFIBUS-FMS          | 2.101(German),<br>2.102 (English) |
| GSD Specification for PROFIBUS-DP           | 2.122 (English)                   |
| Installation Guideline for PROFIBUS-DP/FMS  | 2.111(German),<br>2.112 (English) |
| Profile for Encoders                        | 3.062 (English)                   |

Table 2-1: Affected PROFIBUS guidelines

### List of affected patents

There is no affected patent known by the members of the Working Group. The list is empty. No patent search, neither external nor internal, has been done by the members of the Working Group up to now. PROFIBUS International does not guarantee the completeness of this list.

### 3 Interconnection technology for PROFIBUS in IP 20 or higher

#### 3.1 Interconnection technology for PROFIBUS standard cables

The connection methods described in the following chapters apply to PROFIBUS systems in IP 20 enclosure. The configuration must be carried out as specified in "Installation Guideline for PROFIBUS-DP/FMS", Order-No. 2.112. The transmission refers exclusively to the transmission using copper cables (RS-485) according to IEC 61158-2.

The use of a 9-pin D-SUB connector according to IEC 61158-2 Volume 2 is proposed. All other connectors which comply with the standard and provide mandatory signals are permitted.

The tee functionality is achieved in the connector.

The bus connector housing used must be selected according to the available space at the bus device.

Using a suitable housing, the 9-pin D-SUB connector can also be used for IP 65 enclosures.

The pin assignment for a 9-pin D-SUB connector is defined as per table 3.1-1.

| Pin   | Signal                 | Description |  | Specification         |
|---|------------------------|-------------|--|-----------------------|
|   |                        | Cable       | Device   |                       |
| 1   | not connected          |             |  |                       |
| 2   | M24                    |             | Ground of 24V power supply                         | Optional <sup>b</sup> |
| 3   | <b>RxD/TxD-P</b>       |             | <b>Receive/Transmit data; line B (red)</b>         | <b>Mandatory</b>      |
| 4   | CNTR-P                 |             | Control of repeater direction                      | Optional <sup>b</sup> |
| 5   | <b>DGND</b>            |             | <b>Data ground (reference voltage to VP)</b>       | <b>Mandatory</b>      |
| 6   | <b>VP <sup>a</sup></b> |             | <b>Power supply +5v (e.g. for bus termination)</b> | <b>Mandatory</b>      |
| 7   | P24                    |             | +24V power supply                                  | Optional <sup>b</sup> |
| 8   | <b>RxD/TxD-N</b>       |             | <b>Receive/Transmit data; line A (green)</b>       | <b>Mandatory</b>      |
| 9   | CNTR-N                 |             | Control of repeater direction                      | Optional <sup>b</sup> |
| <sup>a</sup> Minimum current capability is 10mA<br><sup>b</sup> These signals should be provided by the device if converters from RS485 to fibre optic transmission are to be supported |                        |             |  |                       |

Table 3.1-1: Assignment of a 9-pin D-SUB female/male connector

The shield potential shall be transmitted via the metal shroud of the D-SUB connector over a large surface.

Existing PROFIBUS devices with connected Pin 1 are still conform to the PROFIBUS Guideline. For new devices the Pin 1 shall not be used.

To minimize cable reflections and ensure a defined open-circuit level on the transmission line, the terminating resistor combination (described below) must be connected to both ends.

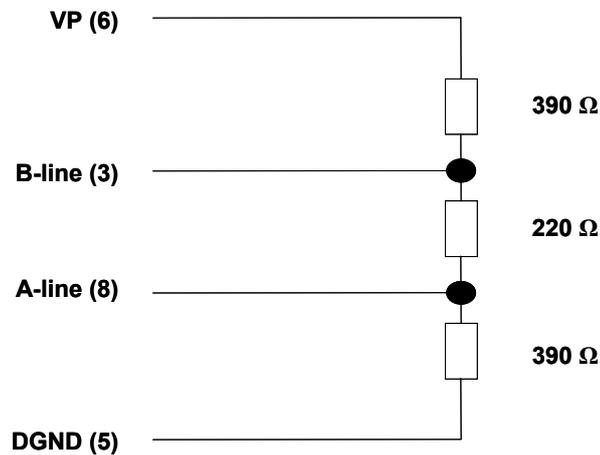


Figure 3.1-2: Cable termination, cable line A, of the PROFIBUS cable according to IEC 61158-2 (PIN numbers of a 9-pin D-SUB connector)

Connectors with integrated series inductances should be used because of the 15 to 25 pF assumed capacitive load of the device and the consequent cable reflections.

For cable type A 4 inductivities must be inserted into the bus cable. Each inductivity has 110 nH ± 20% in accordance with figure 3.1-3. The resistance (Terminal A to A') cannot exceed 0,35 Ω.

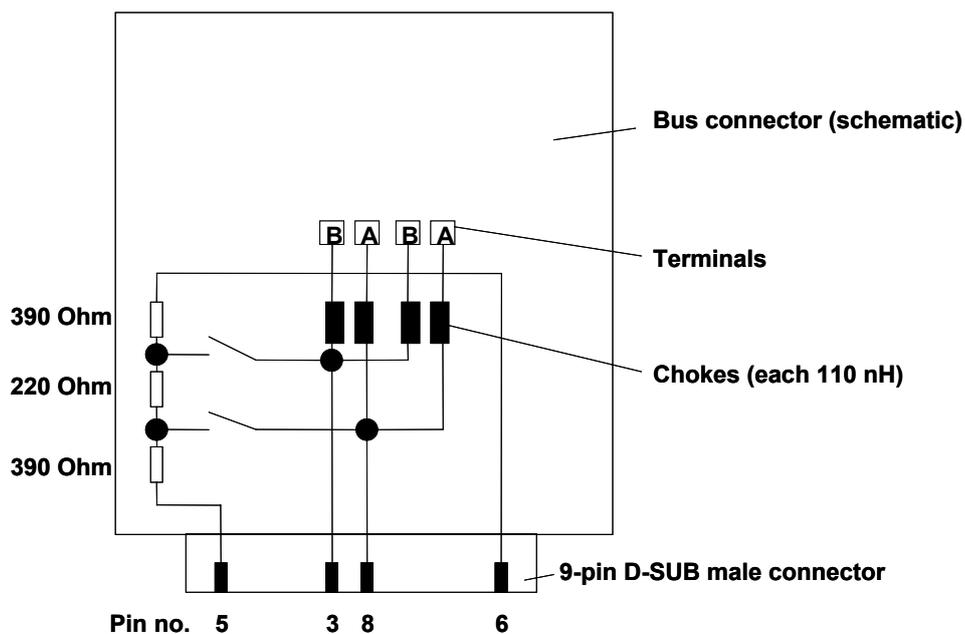


Figure 3.1-3: Connector with integrated terminating resistors, cable inductances and tee function

### 3.2 Interconnection technology for optical fibers

The following connectors are used for optical PROFIBUS networks according to the PROFIBUS guideline "Fiber Optical Data Transfer for PROFIBUS".

#### 3.2.1 Connectors for optical fibers (820 nm and 1300 nm)

Optical fibers (single-mode E 9/125 or E 10/125 and multi-mode G 50/125 or G 62.5/125) are to be connected using connectors of type BFOC/2.5 according to IEC 874-10 (brand name "ST<sup>®</sup>") (see figure 3.2.1-1). These connectors are available worldwide from many manufacturers. You can select among the following assembly methods:

- pre-assembled cables
- pre-assembled pigtails for splicing
- connectors which can be assembled at the site



Figure 3.2.1-1: BFOC (ST<sup>®</sup>) connectors for optical fibers

#### 3.2.2 Connectors for polymer fibers and HCS<sup>®</sup>/PCS fibers (660 nm)

Polymer fibers (POF) as well as HCS<sup>®</sup> and PCS fibers should preferably be connected using type BFOC/2.5 connectors.

Apart from the above mentioned connectors, other connector elements are permissible which are compatible with the reference fiber 980/1000 (polymer fiber) or 200/230 (HCS<sup>®</sup> and PCS respectively).

These are manufacturer-specific connections which are not compatible with one another. They are very simple connectors which can be assembled without any special tools and come supplied with the suitable diode sockets. These connectors are normally supplied with PROFIBUS devices so that the optical connectors can be replaced easily during installation.

The following manufacturer-specific solutions for polymer optical fibers and HCS<sup>®</sup>/PCS optical fibers are used for PROFIBUS, apart from the standardized BFOC (ST<sup>®</sup>) connectors:

- Hewlett Packard: Versatile Link
- Toshiba: Toslink
- Hirschmann: Opto-Quick

For PROFIBUS applications with optical fibers requiring at least an IP 65 enclosure, refer to chapter 4.

## 4 Interconnection technology for IP 65 or higher

### 4.1 Interconnection technology for PROFIBUS standard cables (RS-485)

This chapter describes the PROFIBUS Interconnection technology for applications with RS-485 transmission technology in IP 65 or higher, which provides a power supply and bus signal via separate cables and which should have compact connectors.

#### 4.1.1 M12 bus connector

The M12 connector system is used for field devices which have a separate power supply and have at least an IP 65 enclosure. To avoid confusing the bus and other slots, reverse key coding is used.

The PROFIBUS topology is a line structure. The tees connect the field devices to the bus cable. The branch length depends on the baud rate and should be as short as possible. When the baud rate is higher than 1.5 MB/s, branches shall be avoided. In the optimal case, the tee is directly mounted on the field device.

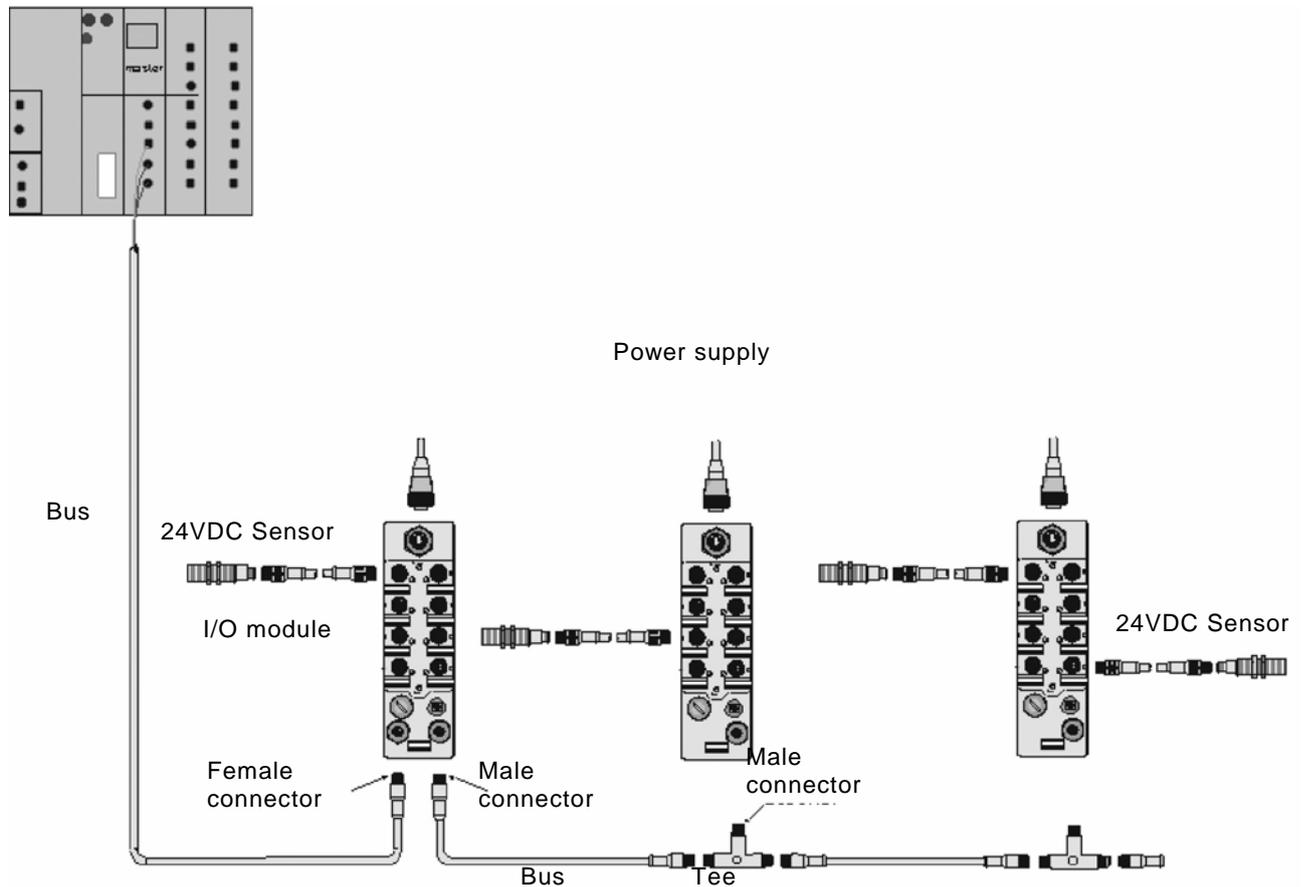


Figure 4.1.1-1: Connection of field device using M12 connectors and tees



Pin assignment of the female connector on the device side:

| Pin no. | Signal                                  |
|---------|---|
| 1       | Power supply plus, (P5V)                |
| 2       | RxD/TxD-N / A-line (green)              |
| 3       | Data ground (reference potential to VP) |
| 4       | RxD/TxD-P / B-line (red)                |
| 5       | not connected                           |
| Thread  | Shield                                  |

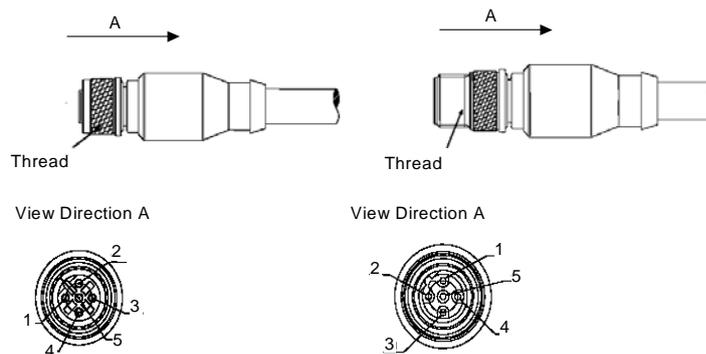
Pin assignment of the male connector on the device side:

| Pin no. | Signal                     |
|---------|----------------------------|
| 1       | not connected              |
| 2       | RxD/TxD-N / A-line (green) |
| 3       | not connected              |
| 4       | RxD/TxD-P / B-line (red)   |
| 5       | not connected              |
| Thread  | Shield                     |

Table 4.1.2-1: Pin assignment of male and female connectors

The contacts must be resistant to corrosion (e.g. gold plating).  
The shield shall be concentric around the thread.

**The shield potential shall be transmitted via the thread.** Existing PROFIBUS devices with connected Pin 5 are still conform to the PROFIBUS Guideline. For new devices the Pin 5 shall not be used.



| Pin no. | Signal                     |
|---------|----------------------------|
| 1       | not connected              |
| 2       | RxD/TxD-N / A-line (green) |
| 3       | not connected              |
| 4       | RxD/TxD-P / B-line (red)   |
| 5       | not connected              |
| Thread  | Shield                     |

Figure 4.1.2-2: Pin assignment of the cable connector

Existing pre harnessed PROFIBUS cable with connected Pin 5 are still conform to the PROFIBUS Guideline. **For new cables the Pin 5 shall not be connected.**

The tee has two male connectors and one female connector.

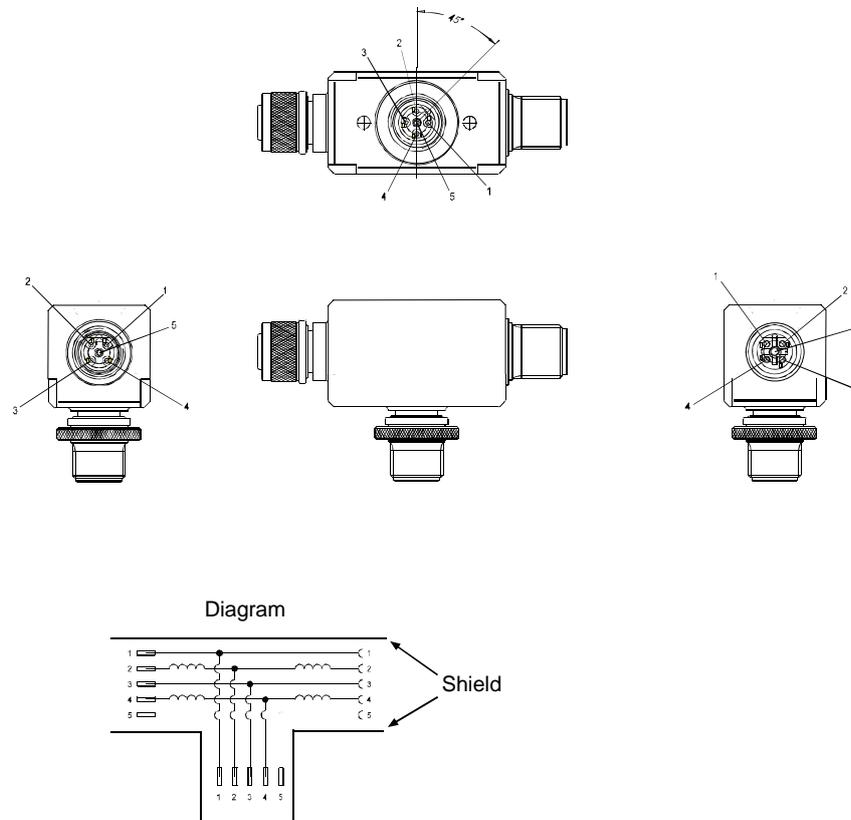


Figure 4.1.2-4: Tee

The tees must have an internal decoupling circuit (see figure 4.1.2-4) which allows an interference-free use at 3...12 MBaud.

Care must be taken to ensure that the shield in the tee is concentric up to the union nut (thread) and not interrupted (metalized connectors and others).

Existing PROFIBUS tees with connected Pin 5 are still conform to the PROFIBUS Guideline. For new tees the Pin 5 shall not be connected.

The tee passes on the voltage of 5 V supplied by the field device to operate the terminating resistor.

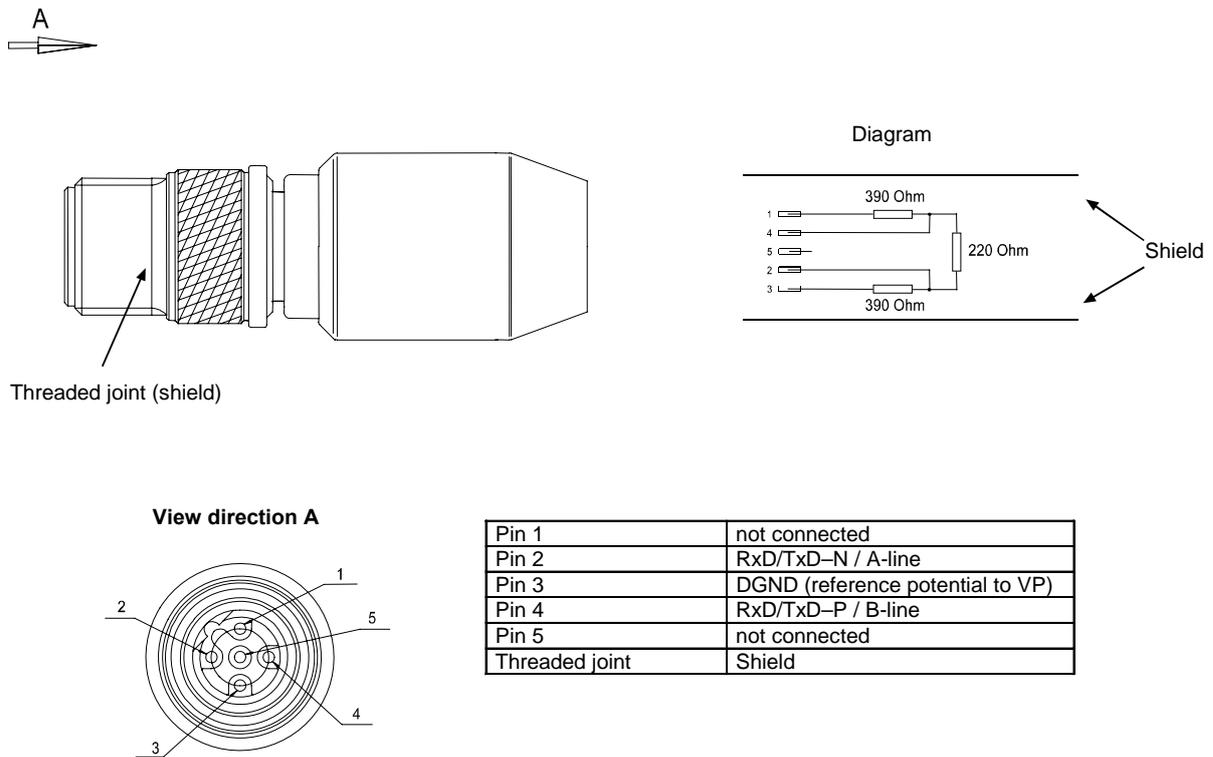


Figure 4.1.2-5: Terminating resistor (male connector)

**4.1.3 Installation**

Connect the bus cable shield according to the PROFIBUS grounding requirements. (For grounding and shielding see “Installation Guideline for PROFIBUS-DP/FMS“, chapter 3).

Depending on the baud rate, the tees are either directly connected to the field devices or via short branches. The length of the branches can be obtained from the PROFIBUS specification. Avoid branches, where possible.

The female connector of the device must be connected to the male connector at that tee at which all four decoupling reactors are connected. The other two connections are used to loop the bus cable through.

The tees are connected to one another using the recommended PROFIBUS cables and M12 connectors. When series inductances are implemented in the field device, this field device must not be connected via an external tee. In this case, the bus is directly connected via the M12 connectors (male/female) in the field device.

The bus cable can easily be extended by selecting the appropriate male and female connector.

**The IP 65 or higher enclosure is achieved only when connected. For open connectors, covers are available.**

## 4.2 Interconnection technology for standard PROFIBUS hybrid cable (RS-485)

Devices and modules for decentralized use in machines and systems are not only connected to PROFIBUS, but also to a 24-Volt power supply. Connectors require a rugged design which is suited for industrial ambient conditions. The installation system meeting these requirements consists of the following parts:

- Standard hybrid cable with copper wires and POF (Polymer Optical Fibers) or shielded two-wire cable for the power supply and data transmission of field bus signals
- Hybrid connectors for the above mentioned cable with IP 65 enclosure or higher
- PROFIBUS devices with active, hybrid interfaces.

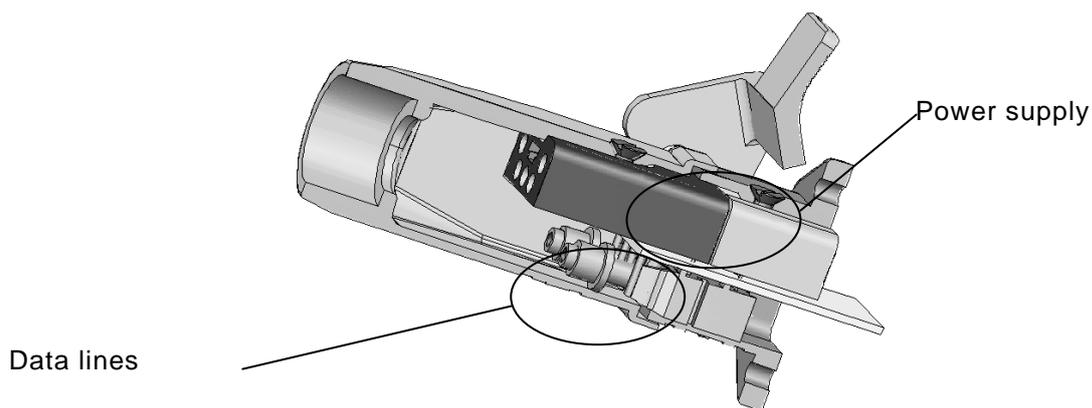


Figure 4.2-1: Illustration of the hybrid connector

### 4.2.1 Description of the hybrid connector family

#### Basic features:

- Connection of up to four copper wires for the power supply and
- one contact cavity for optionally fitting a PE conductor with a cross-section of 1.5 mm<sup>2</sup> max.
- Simple connection
- Tightness for the use in rugged industrial environment with IP 65 enclosure and higher
- Insensitivity to electromagnetic interference

For the data lines, two versions are available:

**Optical fibers for data transmission.** POF and HCS<sup>®</sup> can be used as copper – optical fiber hybrid cables. The optical data transmission ensures optimal electromagnetic compatibility. Large networks with a high baud rate can also be achieved.

**Two-wire cable for data transmission.** A shielded two-wire cable according to PROFIBUS specification can be used as copper – copper hybrid cable. A module for the electrical bus connection is available which includes the shield connection and the large-surface shield transmission as well as the required inductances. The screen is connected using a clip and must be installed according to the PROFIBUS shielding requirements (see Installation Guideline for PROFIBUS-FMS/DP”, chapter 3).

Independently of the data transmission medium used, the same connector housings are used so that a universal design for all cable types is possible.

**4.2.2 Description of the system configuration**

An installation system must offer solutions for all connectors which may be implemented. Transitions into other installation environments such as circular connectors or D-SUB connectors are supported.

We can differentiate between the purely electrical installation system (**copper – copper hybrid cable** or copper bus cable + 24 V power supply) and the optical/electrical solution (**copper – optical fiber hybrid cable** or optical fiber cable + 24 V power supply). Two versions of the hybrid connector are available.

**4.2.2.1 Description of the system configuration (copper – copper standard hybrid cable)**

When copper – copper hybrid cables are used, the bus signal is subject to the same technical specifications as for an individual two-wire cable (see "Installation Guideline for PROFIBUS-DP/FMS", chapter 3).

The last bus devices must be terminated with an electrical bus termination according to the PROFIBUS guidelines. A special terminating connector with integrated bus termination is used for a hybrid cable so the required bus termination is ensured by the connection of the terminating connector. Alternatively, the bus termination can also be implemented into the device.

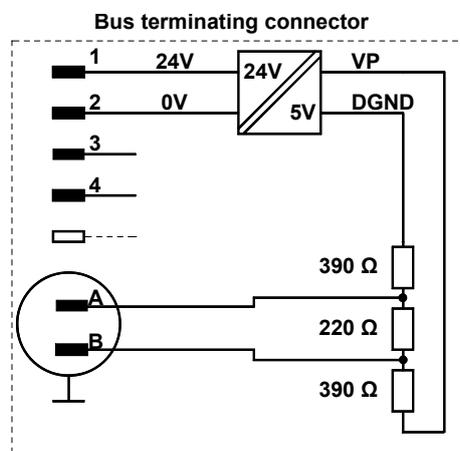


Figure 4.2.2.1-1: Terminating connector for cable termination

Media converters are used for the transition to copper – optical fiber hybrid cables. Apart from the additional 24 Volt supply, interfaces (converters) are available to separate 24 Volt and data from each other.

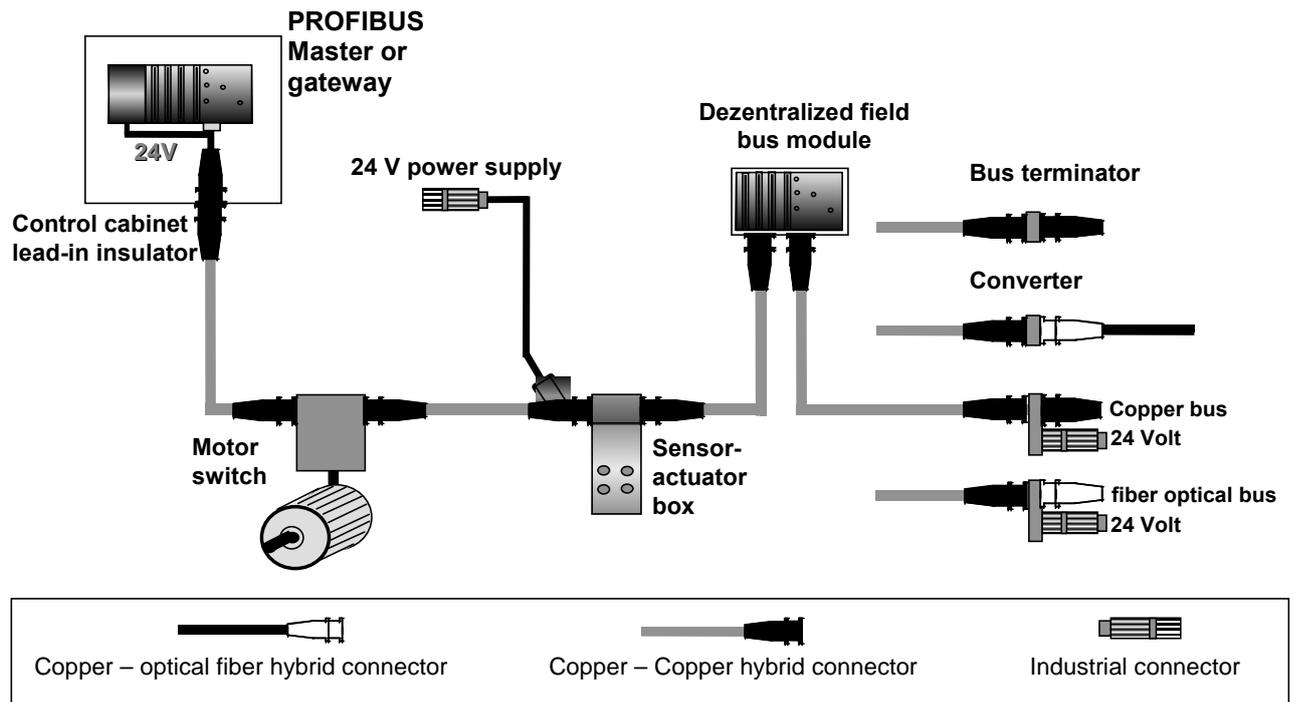


Figure 4.2.2.1-2: System configuration copper – copper

**4.2.2.2 Description of the system configuration (copper – optical fiber standard hybrid cable)**

For decentralized modules with an integrated optical fiber hybrid interface, the system configuration is identical with the electrical solution, apart from the missing bus terminating connector. The tee function is always active. When field devices communicate with the connected field bus system via an electrical interface, they can be connected to the copper – optical fiber hybrid cable by using media converters. They convert optical bus signals into electrical signals.

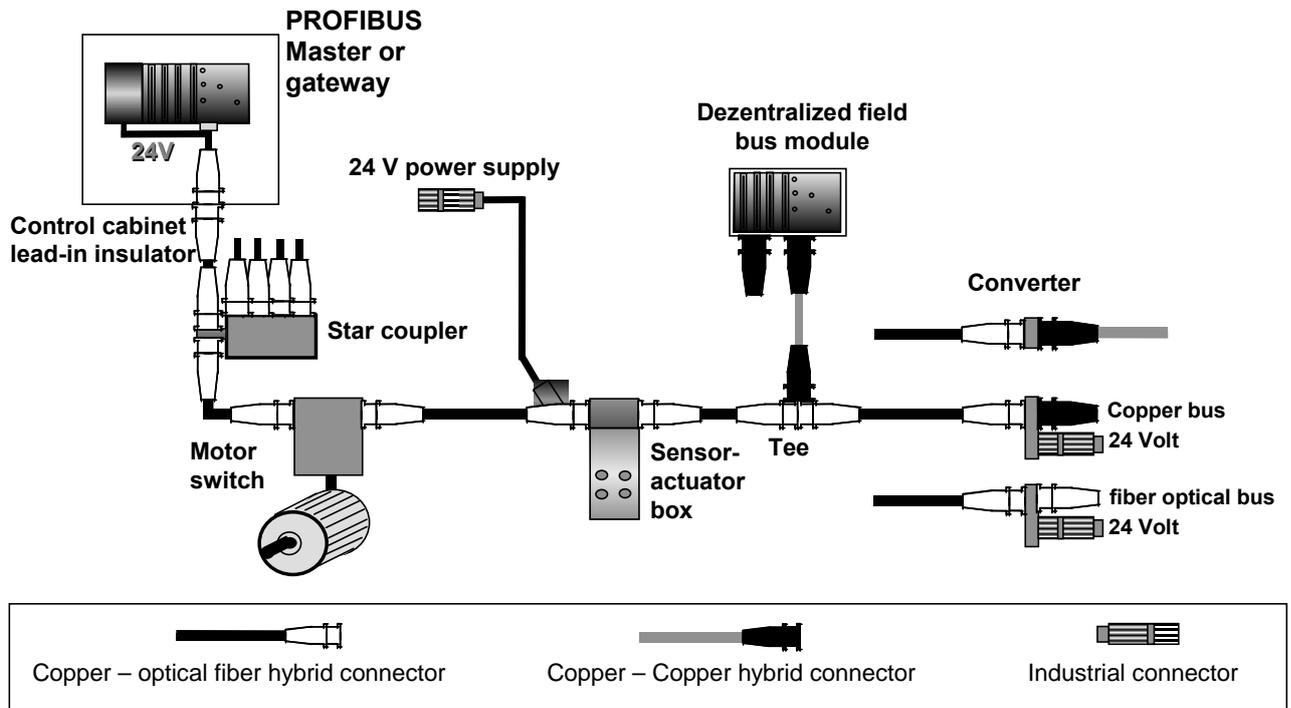


Figure 4.2.2.2-1: System configuration copper – optical fibers

### 4.2.3 Implementation and design of the devices

Mechanical and functional aspects must be considered when applying hybrid connectors. Data signals are supplied via a PCB in the device regardless of whether a copper – copper or a copper – optical fiber hybrid connector is used. The dimensions of the PCB must be maintained for an exact installation and the precise location of the relevant modules. The connectors are designed such that there is an individual PCB module for every connector or that the PCB is part of the entire device electronics.

Because of the 15 to 25 pF assumed capacitive load and the consequent cable reflections, series inductances should be integrated into the cables.

For cable type A 4 inductivities must be inserted into the bus cable. Each inductivity has 110 nH  $\pm$  20% in accordance with figure 4.2.3-1. The resistance (Terminal A to A') cannot exceed 0,35  $\Omega$ .

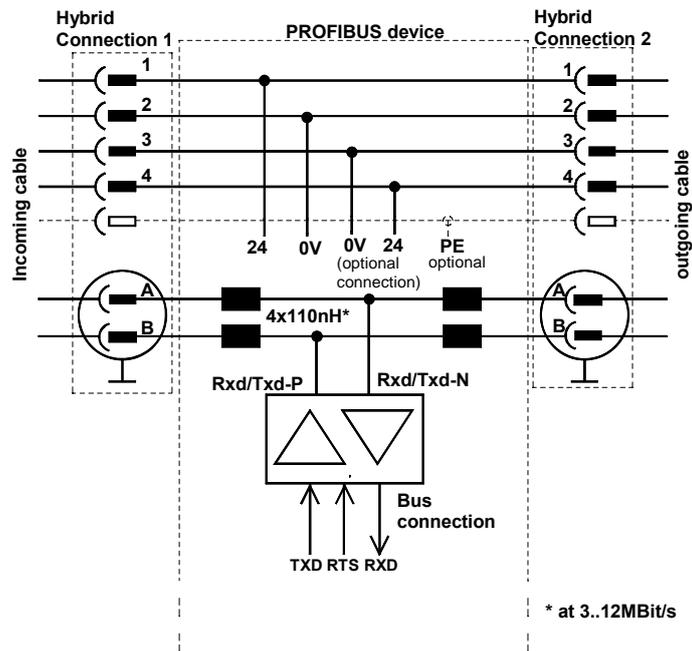


Figure 4.2.3-1: Hybrid connector with copper cable (twisted pair) as data line

For triggering the optical fiber modules, in addition to the driver circuit for the transmit and receive modules one must ensure that interface modules are used which compensate for signal distortions (bit retiming), thus allowing the cascability of several modules. These modules are responsible for the signal management such as transmit and receive selection. For more detailed information refer to the guideline "Fiber optical data transfer".

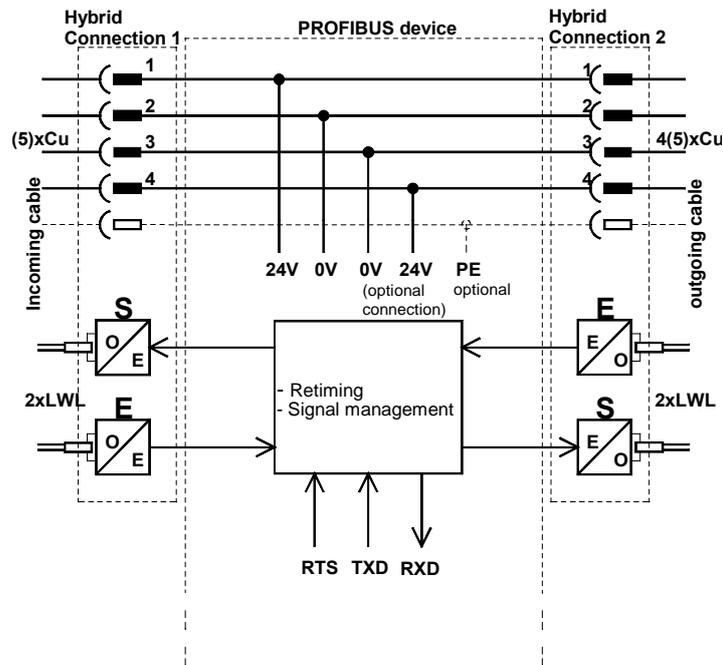


Figure 4.2.3-2: Hybrid connector with optical fibers as data line

A PROFIBUS module includes a connector for the incoming line (hybrid connection 1) and the outgoing line (hybrid connection 2). They are arranged such that the 24 V power supply from the incoming line ends in a female connector. This means that a bus cable has always a male and a female end. The center contact cavity of the 24 V power supply is reserved for the use of a PE conductor.

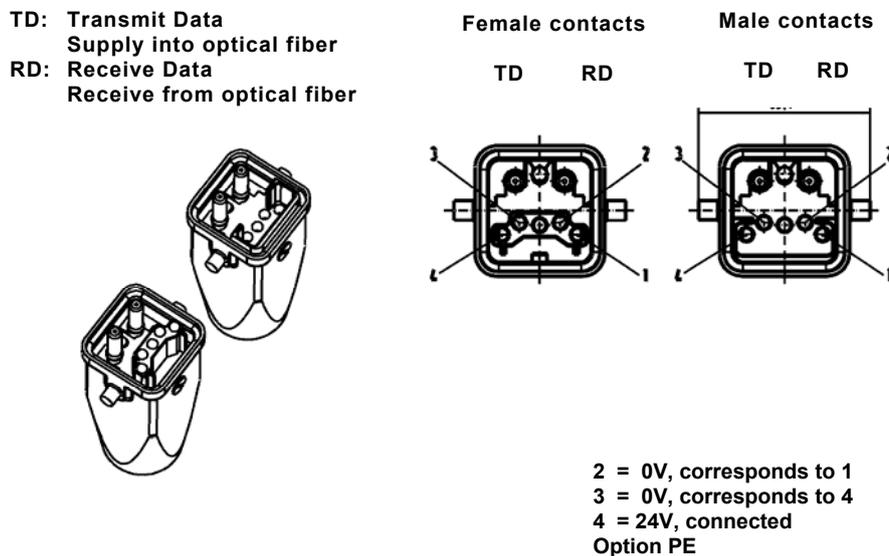


Figure 4.2.3-3: Hybrid connector copper – optical fiber / cable end

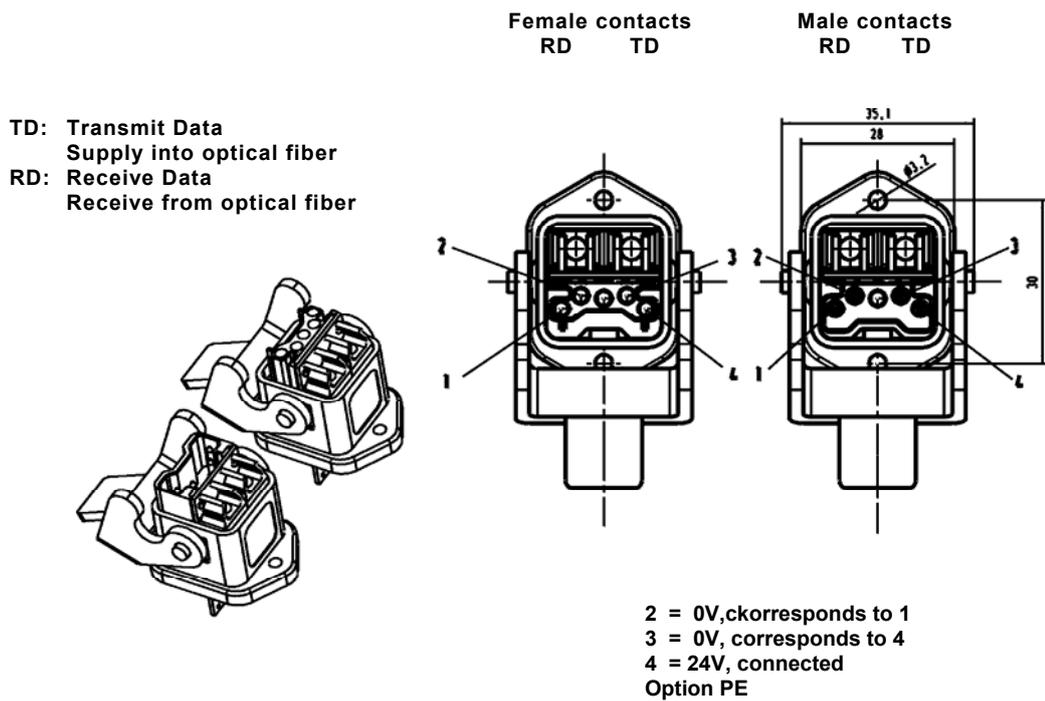


Figure 4.2.3-4: Hybrid connector copper – optical fiber / device end

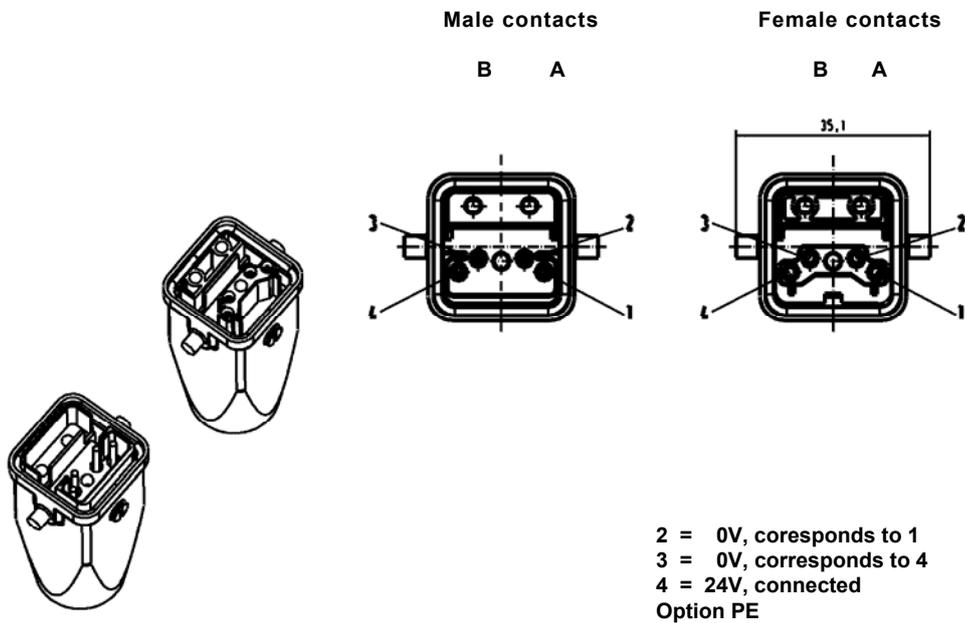


Figure 4.2.3-5: Hybrid connector copper – copper / cable end

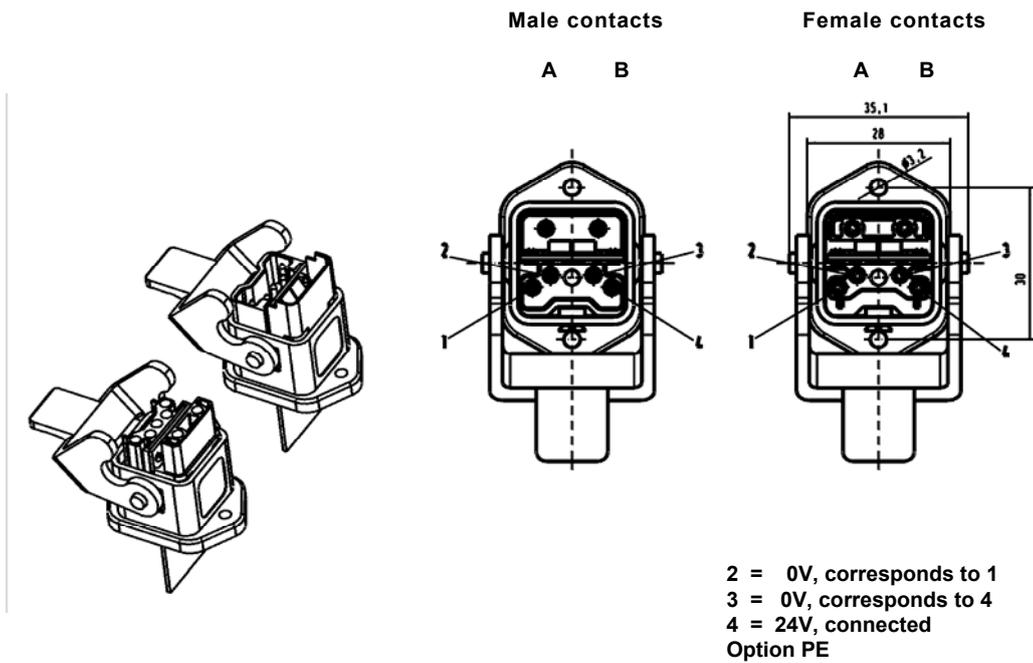


Figure 4.2.3-6: Hybrid connector copper – copper / device end

For the mechanical adaptation of the devices, the dimensions on the following figures are necessary:

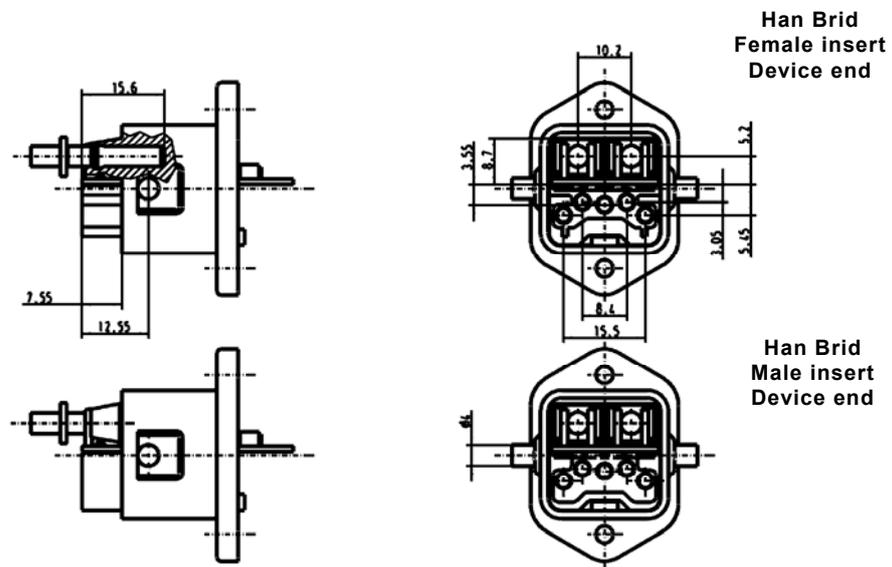


Figure 4.2.3-7: Device connection hybrid connector

### 4.3 Interconnection technology for standard and hybrid cables (RS-485)

The connection technologies described in the following chapters apply to PROFIBUS systems in IP 65 enclosure or higher, in which devices and modules receive data as well as the 24 V power

supply for electronics and encoder via a connector, and a hybrid cable or separate cables as option.

The transmission exclusively refers to the transmission via copper cable (RS-485) in accordance with IEC 61158-2 .

**4.3.1 Bus connector for ANSI TIA/EIA-485-A interface**

The bus connector is suitable for the connection of two separate cables (data and 24 V) as well as a 5-wire hybrid cable.

The tee functionality is implemented in the connector plate.

The 6-pin connector insert is connected according to table 4.3.1-1, independently of the supply (in one or two cables).

| Pin no. | Signal       | Meaning  |
|---------|--------------|--|
| 1       | RxD/TxD-P *) | Receive / Transmit data P; B-line              |
| 2       | Shield       |  |
| 3       | PE           |  |
| 4       | RxD/TxD-N *) | Receive / Transmit data- N; A-line             |
| 5       | P24          | Plus 24V electronics / encoder supply voltage  |
| 6       | M24          | Minus 24V electronics / encoder supply voltage |

Table 4.3.1-1: Assignment of the 6-pin connector insert

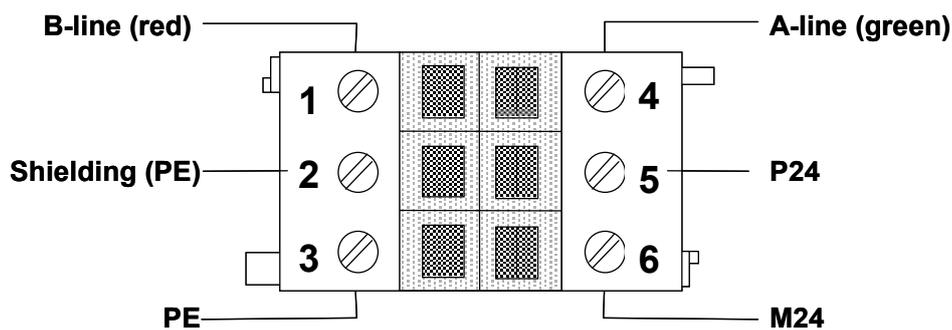


Figure 4.3.1-1: Pin assignment of the connector insert for the wiring of PROFIBUS data line and supply voltage for electronics/encoder

The following table shows specifications of the current carrying capacity and conductor size.

|                                  |                   |
|----------------------------------|-------------------|
| <b>Current carrying capacity</b> | 16 A max. at 40°C |
|                                  | 12 A max. at 55°C |

|                                 |                   |                             |
|---------------------------------|-------------------|-----------------------------|
| <b>possible conductor sizes</b> | flexible cables   |                             |
|                                 | • with ferrule    | 0.25 to 1.5 mm <sup>2</sup> |
|                                 | • without ferrule | 0.25 to 2.5 mm <sup>2</sup> |

Table 4.3.1-2: Current carrying capacity and conductor sizes for connector insert

To minimize cable reflections and ensure a defined idle level on the transmission line, connect the terminating resistor combination (described below) to both ends. Attach this terminating resistor combination to the relevant devices and modules or as a separate unit.

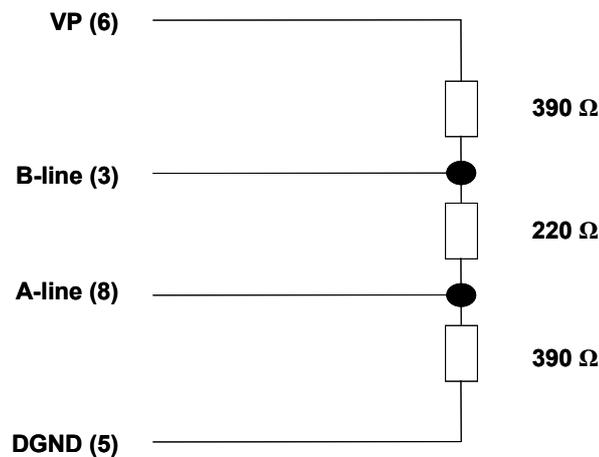


Figure 4.3.1-2: The cable termination of the PROFIBUS cable according to IEC 61158-2

Series inductances are integrated into the connector plate because of the 15 to 25 pF assumed capacitive load and the resulting cable reflections.

For cable type A 4 inductivities must be inserted into the bus cable. Each inductivity has 110 nH ± 20% in accordance with figure 4.3.1-3. The resistance (Terminal A to A') cannot exceed 0,35 Ω.

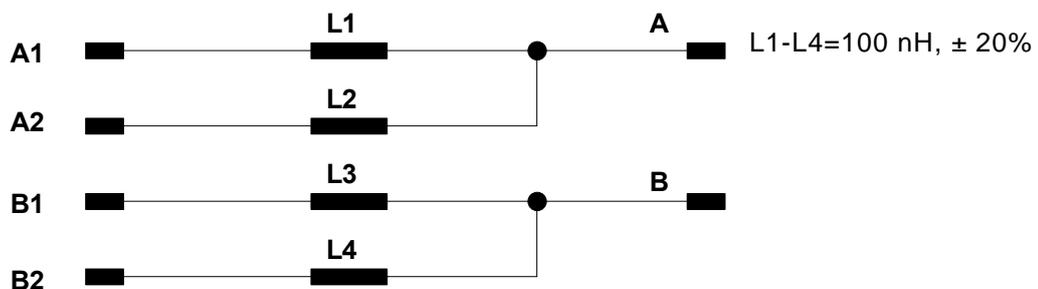


Figure 4.3.1-3: Cable inductances and tee function in the connector plate

### 4.3.2 System configuration

The following combinations are possible with the connection methods described here:

- Feed power supply for electronics / encoder and PROFIBUS in one cable and loop through. Figure 4.3.2-1
- Feed power supply for electronics / encoder and PROFIBUS in separate cables and loop through in one cable. Figure 4.3.2-2
- Feed power supply for electronics / encoder and PROFIBUS in separate cables and loop through. Figure 4.3.2-3
- Feed power supply for electronics / encoder to every DP slave and loop PROFIBUS through in a separate cable. Figure 4.3.2-4
- Separate slave from bus and loop power supply and PROFIBUS through. Figure 4.3.2-5

Each possible configuration is shown below as an example:

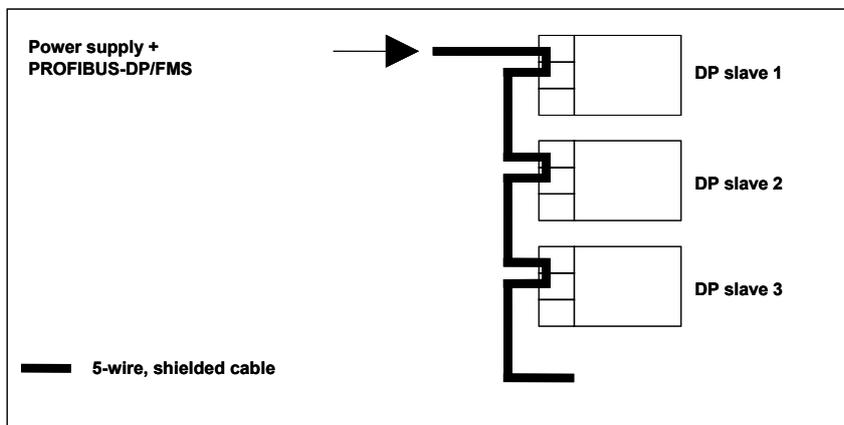


Figure 4.3.2-1: Power supply and PROFIBUS in one cable and loop through

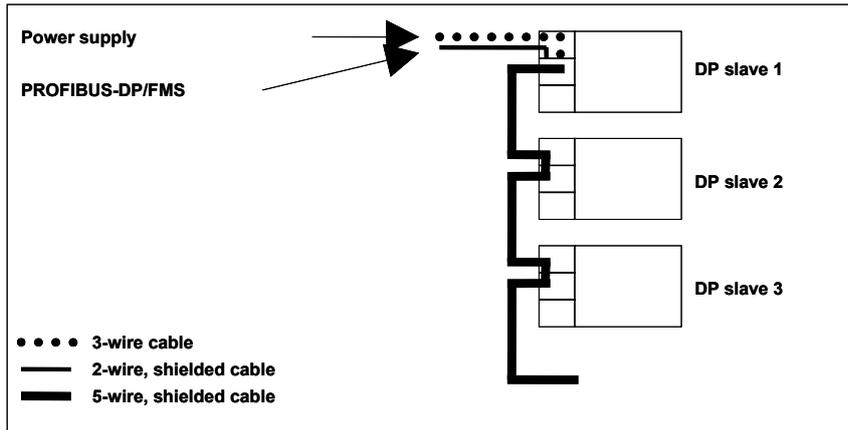


Figure 4.3.2-2: Power supply and PROFIBUS in separate cables and loop through in one cable

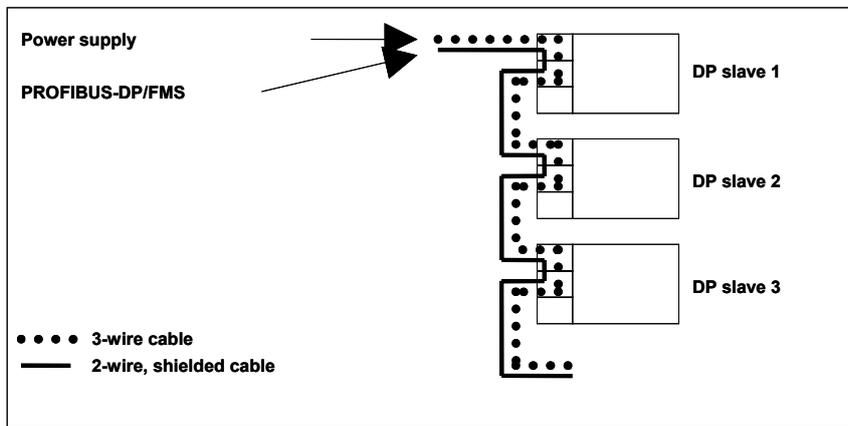


Figure 4.3.2-3: Power supply and PROFIBUS-DP/FMS in separate cables and loop through

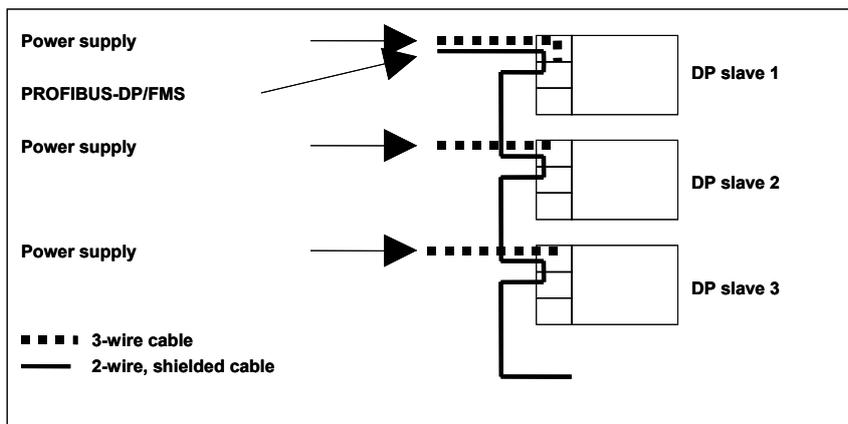


Figure 4.3.2-4: Power supply to every slave and feed PROFIBUS in a separate cable and loop through

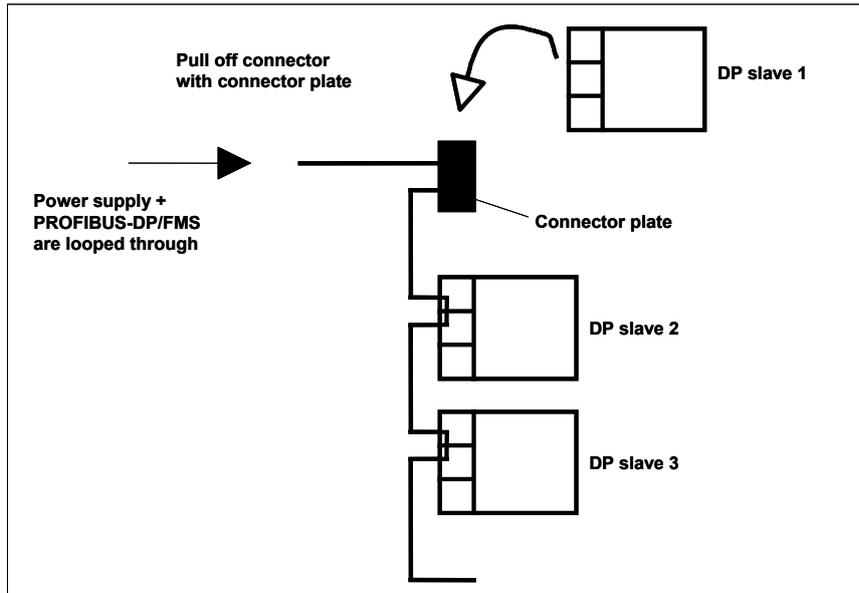


Figure 4.3.2-5: Separate slave from bus and loop power supply / PROFIBUS through

### 4.3.3 Implementation / Device design

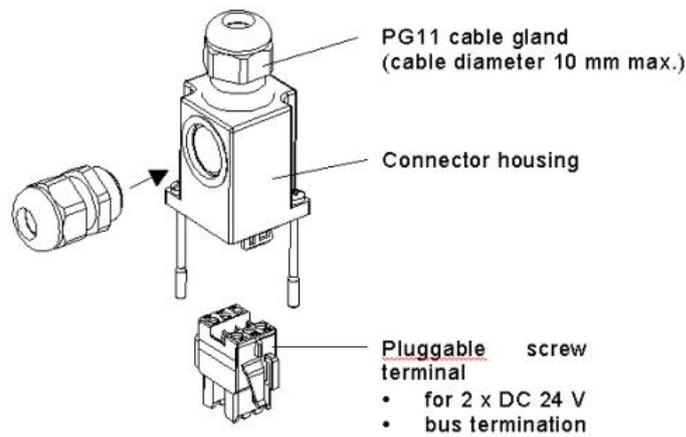


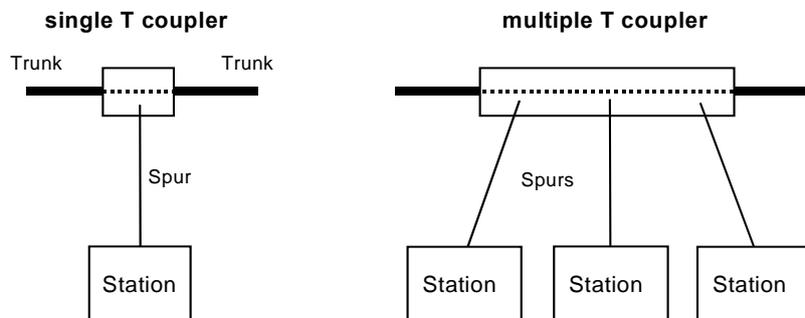
Figure 4.3.3-1: Connector assembly



#### 4.4 Interconnection technology for IEC 61158-2

##### General

The topology can be in the form of a tree, line or a combination of the two. The tees connect the stations (e.g. Field devices) to the bus cable and must be IP 65 or higher. The tee connect can be constructed in single T or multiple T, see Figure I.1. The tee function can also be integrated into the station.



**Figure I.1 – Schematic of the station coupler**

##### 4.4.1 Pin assignment of M12 circular connector

The contacts of the M12 circular connector shall be assigned to functions as shown in Table I.1 and Figure I.2.

**Table I.1– Contact assignments for the external connector for harsh industrial environments**

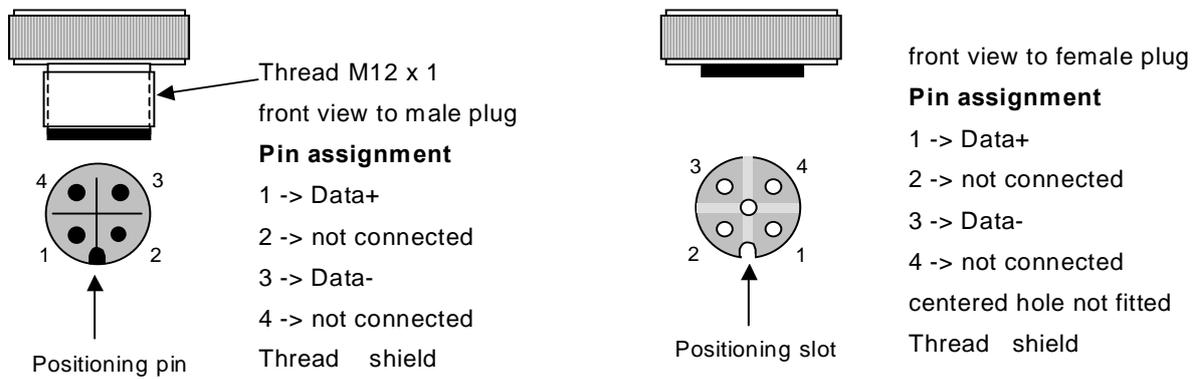
| Contact No. | Function                          |
|-------------|-----------------------------------|
| 1           | Data + with the option of power + |
| 2           | not connected                     |
| 3           | Data – with the option of power – |
| 4           | not connected                     |
| Thread      | Shield                            |

The shield shall be concentric around the thread. The shield potential shall be transmitted via the thread. Existing Type 3 devices with connected pin 4 are still conform to this Standard. For new devices the pin 4 shall not be used. Existing pre-harnessed Type 3 cables with connected pin 4 are still conform to this Standard. For new cables the pin 4 shall not be connected.

The M12 circular connector and the female connector shall be IP 65 or higher.

The male and female contacts shall be designed such that they maintain their transmission properties even in a corrosive atmosphere, e.g. chemical environment.

The centred hole of the female plug shall not be fitted because of the increased air and creepage distances in potentially explosive atmospheres, see Figure I.2.



**Figure I.2 – Pin assignment of the male and female connectors IEC 61076-2-101 (A coding)**

**Connection between a tee and a station**

The tees and the stations are connected using a shielded circular connector M12. The tee can be connected directly to the station or a branch using a shielded M12 connector.

Always make sure that the bus cable shield is applied over a large surface according to the grounding guidelines (for grounding and shielding see 21.8.6 and 21.8.7).

Field termination techniques such as screw or blade terminals and permanent termination may also be used.

**4.4.2 Connector for asynchronous transmission**

Each station is connected to the medium via a 9-pin sub-D connector. The female side of the connector is located in the station, while the male side is mounted to the bus cable.

The mechanical and electrical characteristics are specified in IEC 60807-3.

Preferably a metal connector housing should be used. When put together both parts of the connector should be fixed by conducting screws. The connection between the cable sections and the stations should be realized as T-connectors, containing three 9-pin sub-D connectors (two male connectors and one female connector). Such T-connectors allow disconnection or replacement of stations without cutting the cable and without interrupting operation (on line disconnection).

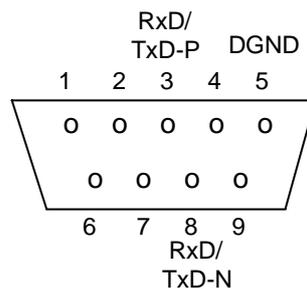
The pin assignments for the connectors are shown in Table 1.2 and Figure 1.3.

| Pin | Signal                 | Description                                  |  | Specification         |
|-----|------------------------|--|--|-----------------------|
|     |                        | Cable  | Device   |                       |
| 1   | not connected          |  |  |                       |
| 2   | M24                    |  | Ground of 24V power supply                         | Optional <sup>b</sup> |
| 3   | <b>RxD/TxD-P</b>       | <b>Receive/Transmit data; line B (red)</b>   |  | <b>Mandatory</b>      |
| 4   | CNTR-P                 |  | Control of repeater direction                      | Optional <sup>b</sup> |
| 5   | <b>DGND</b>            |  | <b>Data ground (reference voltage to VP)</b>       | <b>Mandatory</b>      |
| 6   | <b>VP <sup>a</sup></b> |  | <b>Power supply +5v (e.g. for bus termination)</b> | <b>Mandatory</b>      |
| 7   | P24                    |  | +24V power supply                                  | Optional <sup>b</sup> |
| 8   | <b>RxD/TxD-N</b>       | <b>Receive/Transmit data; line A (green)</b> |  | <b>Mandatory</b>      |
| 9   | CNTR-N                 |  | Control of repeater direction                      | Optional <sup>b</sup> |

<sup>a</sup> Minimum current capability is 10mA

<sup>b</sup> These signals should be provided by the device if converters from RS485 to fibre optic transmission are to be supported

**Table I.2 – Contact designations**



**Figure I.3 – Connector pinout, front view of male and back view of female respectively**

The Data Ground, connected to pin 5, and the Voltage-Plus, connected to pin 6, supply the Bus Terminator.

The control signals CNTR-P and CNTR-N, connected to pin 4 and pin 9, support direction control when repeaters without self control capability are used. ANSI TIA/EIA-485-A signalling is recommended. For simple devices the signal CNTR-P may be a TTL signal (1 TTL load) and the signal CNTR-N may be grounded (DGND). The definition of signalling is not a subject of this standard.

The 24 V output voltage, according to IEC 61131-2:1992, 3.2.1, allows the connection of operator panels or service devices without integrated power supply. If a device offers 24 V output voltage it shall allow for a current load up to 100 mA.

**4.4.3 Connectors for fibre optic cable**

**Connectors for glass fibre optic cable (850 nm and 1300 nm)**

Glass fibre optic cables are connected or interconnected using type BFOC/2.5 connectors according to IEC 60874-10-1.

NOTE Butt joint contact of the fibres, so-called Physical Contact (PC) minimizes the attenuation and reflection for fibre-fibre connections.

**Connectors for plastic and glass fibre optic cable (660 nm)**

Plastic fibre optic cables are preferentially connected or interconnected using type BFOC/2.5 connectors.

Other connector elements are admissible if they are compatible to reference fibre 980/1000 plastic fibre or 200/230 glass fibre.

**4.4.4 Implementation**

For process engineering, PROFIBUS with IEC 61158-2 transmission technology is used. It allows the implementation of several sensor and actuators into a bus system, even in a potentially hazardous atmosphere.

When PROFIBUS is used in a potentially hazardous atmosphere, it must be an intrinsically safe type of protection EEx i.

Using the IEC 61158-2 transmission technology, PROFIBUS devices are supplied by two-wire cables and the process data from the sensor is transmitted digitally.

**The intrinsic safety of the bus allows the connection and disconnection of field devices to and from the running PA network.**

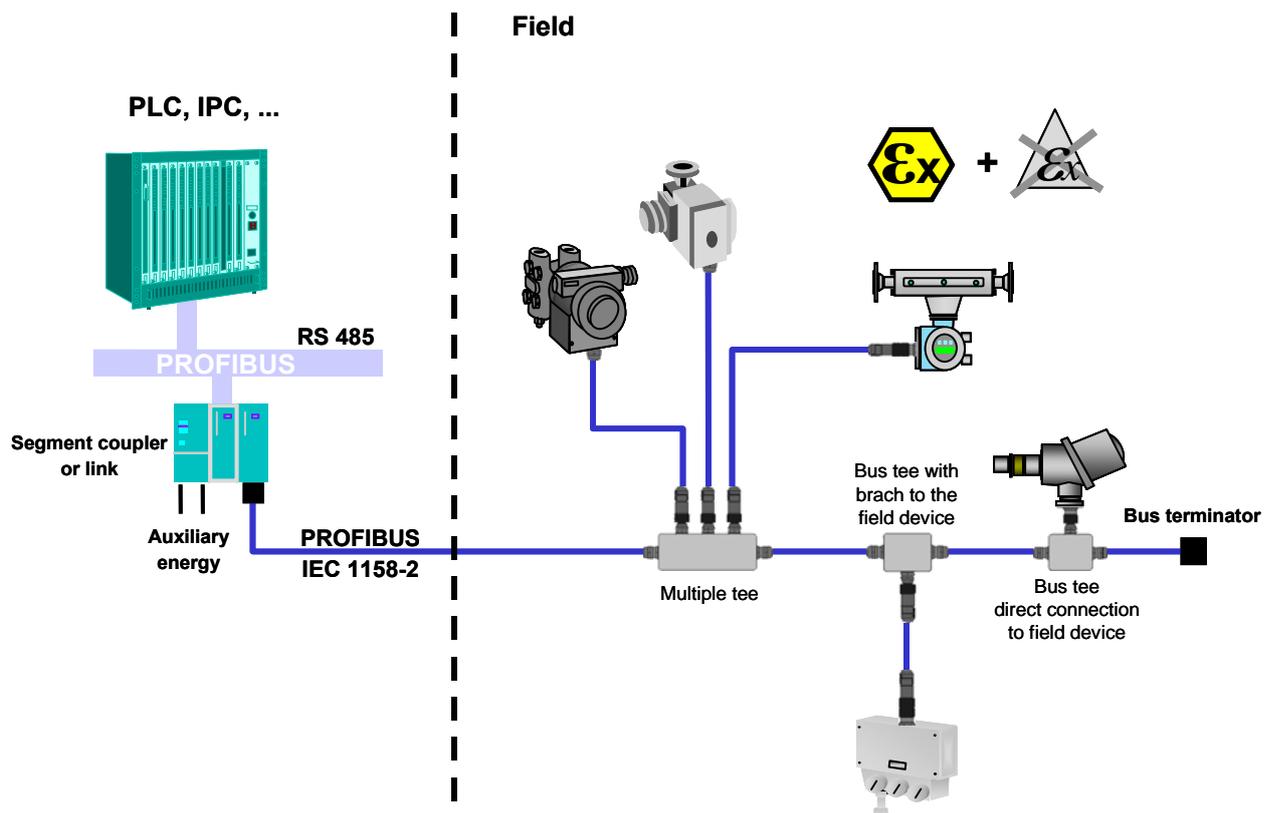


Figure 4.4.3-1: Typical PROFIBUS network in process automation

A typical PROFIBUS network in process automation consists of the following components:

- Segment coupler
- Simple or multiple tees
- Bus terminators
- Bus cable complying with IEC 61158-2

Operation in an atmosphere which is not potentially hazardous is restricted only by

- the maximum number of connected field devices
- the maximum length of the bus cable
- the maximum length of the branches (cables between tees and field devices)

The number of field devices, the length of the bus cable and the branches is even more restricted in a potentially hazardous atmosphere.

All components (segment couplers, tees, field devices and bus terminators) must comply with the intrinsically safe type of protection EEx i.

The bus termination must be visible.

(see "PROFIBUS-PA User and Installation Guideline", chapter 3)

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PROFIBUS Nutzerorganisation e.V.

Haid-und-Neu-Str. 7

76131 Karlsruhe

Germany

Phone: +49 (0) 721 / 96 58 590

Fax: +49 (0) 721 / 96 58 589

e-mail: [info@profibus.com](mailto:info@profibus.com)

<http://www.profibus.com>