

# ***PROFINET Cabling and Interconnection Technology***

## ***Guideline for PROFINET***

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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.

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## Revision Log

Version		Date	Changes/History
1.8	TC2WG6	12-Dec-2002	First draft in PI review
1.96	TC2WG6	31-Aug-2006	Second draft; structure changed, new content
1.99	TC2WG6	05-Oct-2006	WG
2.00	TC2WG6	12-Mar-2007	PI Review finished / Change Requests included
2.01	TC2WG6	03-Mar-2011	First WG Draft (2 and 4 pair Cabling)
2.02	TC2WG6	14-Apr-11	WG
2.03	TC2WG6	14-Apr-11	WG Draft
2.04	TC2WG6	27-Apr-11	Type A,B cable (outer diameter: 9 mm)
2.05	TC2WG6		Editorial revision
2.06	TC2WG6	23-Mai-11	Version for WG meeting 2011-05-26
2.1	TC2WG6	26-Mai-11	WG Draft
2.9	TC2WG6	14-Jun-11	PI Review
3.00	TC2WG6		PI Review finished / Change Requests included
3.01	CB/PG1	15-Nov-11	Final for publishing
3.02	CB/PG1	20-Nov-13	Cabinet cord set specification; M 12 x-coded contact arrangement
3.1	CB/PG1	06-Mar-14	Push Pull Signal, LC Fibre Optic
4.00	CB/PG1	02-Feb-17	M12 L-coded +cable, M8 D-coded, Push Pull LC
4.10	CB/PG1	May 2018	Colour Coding of M12 L and PushPull R cable for robotics applications added
5.0	CB/PG1	November 2020	Completely reworked, new content
5.2	CB/PG 1	November 2022	Additions for One Cable and SPE
5.3	CB/PG 1	May 2023	Final for release

## 1 Management Summary – Purpose and Scope of the Document

PROFINET ensures the integrity of horizontal communication between automation, devices and M2M (Machine to Machine) as well as the vertical communication throughout the business processes and value chains.

The high quality of PROFINET communication, especially in industrial environments, is ensured through the rigorous use of compatible components specified in this document.

This document:

- describes the connectors for PROFINET devices and the PROFINET cabling system and its components.
- complements the fundamental provisions for the passive infrastructure of PROFINET networks inside and between the automation islands as specified in IEC 61918 and IEC 61784-5-3.
- is mandatory for manufacturers of PROFINET devices, cables and connectors, system integrators, manufacturers of test equipment for PROFINET cabling and test labs.

The provisions in this document provide the basis for a PROFINET conformity assessment and certification. Products matching the requirements defined in this PROFINET guideline may be declared as PROFINET-conform, following the procedures as outlined in this document.

In detail, this document specifies the following components:

- Connectors, cables, cordsets and other passive network components (e.g., bulkheads and connection terminals) for PROFINET communication (via optical fibre or balanced cabling)
- Connectors, cables and other passive network components for the PROFINET 24 V power supply

The passive components specified in chapter 4.1 of this document are categorized into the following three groups:

1. PROFINET General Passive Components (GPC)
2. PROFINET Specific Passive Components (SPC)
3. PROFINET Legacy Passive Components (LPC)

This document specifies additional requirements and tests for:

- The End-to-End link
- Connectors, cables, cordsets and other passive network components (e.g., bulkheads) for PROFINET communication (via optical fibre or balanced cabling) and 24 V power supply.

Furthermore, this document provides the requirements of the integration of PROFINET connectors into devices.

## 2 List of Affected Patents / Certification

Attention is drawn to the possibility that some of the elements of this guideline may be the subject of patent rights as listed below.

The PROFIBUS Nutzerorganisation e. V. (PNO) shall not be held responsible for identifying any or all such patent rights.

Relevant patents are only those which have an impact on mating compatibility.

Affected Patents:

This guideline applies to internationally standardized interfaces. All patents are listed in the standard patent declaration.

In this guideline only interfaces are taken into account, which have no patents or whose patents can either be used freely or for which are granted under normal market conditions (see related international standards).

Patents that exist within the standard that must be taken into account in accordance with the applicable regulations of standardization are not listed here.

The passive components based on the interfaces can in turn be protected by patent.

PROFIBUS & PROFINET International (PI) does not guarantee the completeness of the affected patents.

Passive components are not certified by PROFIBUS & PROFINET International (PI), but the vendor shall give a PI manufacturers declaration for PROFINET cabling of conformity to this Guideline.

<https://www.profibus.com/download/manufacturers-declaration-for-profinet-cabling/>

### 3 Related Documents and References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 11801-series: Information technology – Generic cabling for customer premises

ISO/IEC 14763-4 Information technology - Implementation and operation of customer premises cabling - Part 4: Measurement of end-to-end (E2E)-Links

ISO 23570-3: Industrial automation systems and integration — Distributed installation in industrial applications — Part 3: Power distribution bus

EN 50289-1-6: Communication cables - Specifications for test methods - Part 1-6: Electrical test methods Electromagnetic performance

EN 50289-3-10: Communication cables - Specifications for tests methods - Part 3-10: Mechanical test methods - Torsion and twisting

EN 50289-3-16 Part 3-16: Mechanical test methods - Cable tensile performance

EN 50396: Nonelectrical test methods for low voltage energy cables

IEC 60050-series: International Electrotechnical Vocabulary

IEC 60060–1: High-voltage test techniques. Part 1: General definitions and test requirements

IEC 60189-1: Low-frequency cables and wires with PVC insulation and PVC sheath. Part 1: General test and measuring methods

IEC 60227-2: Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V Part 2: Test methods

IEC 60228: Conductors of insulated cables

IEC 60332-1-series: Tests on electrical and optical fibre cables under fire conditions

IEC 60332-3-24: Tests on electric and optical fibre cables under fire conditions - Part 3-24: Test for vertical flame spread of vertically mounted bunched wires or cables - Category C

IEC 60512-6-3-series: Connectors for electronic equipment - Tests and measurements - Part 6-3: Dynamic stress tests - Test 6c: Shock

- IEC 60512-6-4: Connectors for electronic equipment - Tests and measurements - Part 6-4: Dynamic stress tests - Test 6d: Vibration: sinusoidal
- IEC 60529: Degrees of protection provided by enclosures (IP Code)
- IEC 60603-7: Connectors for electronic equipment - Part 7: Detail specification for 8-way, unshielded, free and fixed connectors
- IEC 60603-7-3: Connectors for electronic equipment - Part 7-3: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 100 MHz
- IEC 60603-7-5: Connectors for electronic equipment - Part 7-5: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz
- IEC 60664-1: Insulation coordination for equipment within low-voltage supply systems - Part 1: Principles, requirements and tests
- IEC 60793-1-20: Optical fibres - Part 1-20: Measurement methods and test procedures - Fibre geometry
- IEC 60793-1-40: Optical fibres - Part 1-40: Attenuation measurement methods
- IEC 60793-1-41: Optical fibres - Part 1-41: Measurement methods and test procedures - Bandwidth
- IEC 60793-1-44: Optical fibres - Part 1-44: Measurement methods and test procedures - Cut-off wavelength
- IEC 60793-2-series: Optical fibres - Part 2, specification of A1-OM2,3,4,5 and A1-OM1 multimode fibre
- IEC 60794-1-series: Optical fibre cables – Generic specification – General
- IEC 60794-1-2: Optical fibre cables - Part 1-2: Generic specification - Basic optical cable test procedures - General guidance
- IEC 60811-203 Part 203: General tests - Measurement of overall dimension
- IEC 60811-401: Electric and optical fibre cables - Test methods for non-metallic materials - Part 401: Miscellaneous tests - Thermal ageing methods - Ageing in an air oven
- IEC 60811-501 Part 501: Mechanical tests - Tests for determining the mechanical properties of insulating and sheathing compounds
- IEC 60811-508: Electric and optical fibre cables - Test methods for non-metallic materials - Part 508: Mechanical tests - Pressure test at high temperature for insulation and sheaths
- IEC 60811-509 Part 509: Mechanical tests - Test for resistance of insulations and sheaths to cracking (heat shock test)
- IEC 60874-14-series: Connectors for optical fibres and cables – all parts 14-x: Detail specification for fibre optic connector type SC
- IEC 60999-1: Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm<sup>2</sup> up to 35 mm<sup>2</sup> (included)
- IEC 61034-2: Measurement of smoke density of cables burning under defined conditions - Part 2: Test procedure and requirements
- IEC 61076-2-101: Connectors for electronic equipment - Product requirements - Part 2-101: Circular connectors - Detail specification for M12 connectors with screw-locking
- IEC 61076-2-109: Connectors for electronic equipment - Product requirements - Part 2-109: Circular connectors - Detail specification for connectors with M12 x 1 screw-locking, for data transmission frequencies up to 500 MHz

- IEC 61076-2-111: Connectors for electronic equipment - Product requirements - Part 2-111: Circular connectors - Detail specification for power connectors with M12 screw
- IEC 61076-2-113: Connectors for electronic equipment - Product requirements - Part 2-113: Circular connectors - Detail specification for connectors with M12 screw locking with power and signal contacts for data transmission with frequency up to 100 MHz
- IEC 61076-2-114: Circular connectors – Detail specification for data and power connectors with M8 screw-locking
- IEC 61076-2-117: Connectors for electronic equipment - Product requirements - Part 2-117: M17 Hybrid SPE connectors according
- IEC 61076-3-106: Connectors for electronic equipment - Product requirements - Part 3-106: Rectangular connectors - Detail specification for protective housings for use with 8-way shielded and unshielded connectors for industrial environments incorporating the IEC
- IEC 61076-3-117: Connectors for electronic equipment – Product requirements – Part 3 117: Rectangular connectors – Detail specification for protective housings for use with 8-way shielded and unshielded connectors for industrial environments incorporating IEC 60603-7 series interface – Variant 14 related to IEC 61076-3-106 – Push-pull coupling
- IEC 61076-3-119 Connectors for electrical and electronic equipment - Product requirements - Part 3-119: Rectangular connectors - Detail specification for shielded and unshielded, free and fixed 10-way connectors with push-pull coupling for industrial environments for data transmission with frequencies up to 100 MHz
- IEC 61076-3-122: Connectors for electrical and electronic equipment - Product requirements - Part 3-122: Detail specification for 8-way, shielded, free and fixed connectors for I/O and data transmission with frequencies up to 500 MHz and current-carrying capacity in industrial environments
- IEC 61076-3-123: Rectangular connector. Detail specification for hybrid connectors for industrial environments, for power supply and fibre optic data transmission, with push-pull locking
- IEC 61076-3-124: Connectors for electrical and electronic equipment - Product requirements – Part 3-124: Rectangular connectors – Detail specification for 10-way, shielded, free and fixed connectors for I/O and data transmission with frequencies up to 500 MHz
- IEC 61076-3-126: Connectors for electrical and electronic equipment - Product requirements - Part 3-126: Rectangular connectors - Detail specification for 5 pole power connectors for industrial environments with push-pull locking
- IEC 61156-1: Multicore and symmetrical pair/quad cables for digital communications - Part 1: Generic specification
- IEC 61156-5: Multicore and symmetrical pair/quad cables for digital communications – Part 5: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Horizontal floor wiring – Sectional specification
- IEC 61156-6: Multicore and symmetrical pair/quad cables for digital communications - Part 6: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz - Work area wiring - Sectional specific
- IEC 61156-11: Multicore and symmetrical pair/quad cables for digital communications – Part 11: Symmetrical single pair cables with transmission characteristics up to 600 MHz – Horizontal floor wiring – Sectional specification
- IEC 61156-12: Multicore and symmetrical pair/quad cables for digital communications – Part 12: Symmetrical single pair cables with transmission characteristics up to 600 MHz – Work area wiring – Sectional specification
- IEC 61300-series Fibre optic interconnecting devices and passive components - Basic test and measurement procedures

IEC 61300-2-2: Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-2: Tests - Mating durability

IEC 61300-2-4: Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-4: Tests - Fibre or cable retention

IEC 61300-3-4: Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-4: Examinations and measurements - Attenuation

IEC 61300-3-34: Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-34: Examinations and measurements - Attenuation of random mated connectors

IEC 61326-3-1-series: Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions: functional safety - General industrial applications

IEC 61753-series: Fibre optic interconnecting devices and passive components performance standard

IEC 61754-2: Fibre optic connector interfaces - Part 2: Type BFOC/2,5 connector family

IEC 61754-4: Fibre optic interconnecting devices and passive components - Fibre optic connector interfaces - Part 4: Type SC connector family

IEC 61754-20: Fibre optic connector interfaces – Part 20: Type LC connector family

IEC 61754-24: Fibre optic connector interfaces, - Part 24: Type SC-RJ connector family

IEC 61754-24-11: Fibre optic interconnecting devices and passive components - Fibre optic connector interfaces - Part 24-11: Type SC-RJ connectors with protective housings based on IEC 61076-3-117

IEC 61754-24-21: "Fibre optic interconnecting devices and passive components - Fibre optic connector interfaces - Part 24-21: Type SC-RJ connectors with protective housings based on IEC 61076-3-106, variant 06"

IEC 61784-5-3: Industrial communication networks - Profiles - Part 5-3: Installation of fieldbuses - Installation profiles for CPF 3

IEC 61918: Industrial communication networks - Installation of communication networks in industrial premises

IEC 61935-2: Specification for the testing of balanced and coaxial information technology cabling - Part 2: Cords as specified in ISO/IEC 11801 and related standards

IEC 61984: Connectors - Safety requirements and tests

IEC 62012-1: Multicore and symmetrical pair/quad cables for digital communications to be used in harsh environments - Part 1: Generic specification

IEC 62153-4-12: Metallic communication cable test methods - Part 4-12: Electromagnetic compatibility (EMC) - Coupling attenuation or screening attenuation of connecting hardware - Absorbing clamp method

IEC 63171-6: Connectors for electrical and electronic equipment – Part 6: Detail specification for 2-way and 4-way (data/power), shielded, free and fixed connectors for power and data transmission with frequencies up to 600 MHz

IEC 63171-7: Connectors for electrical and electronic equipment - Part 7: Detail specification for 4-way to 6-ways plus PE or FE (data/power) shielded, free and fixed circular connectors for balanced single-pair data transmission current-carrying capacity: mechanical mating information, pin assignment and additional requirements for type 7

## 4 Definitions and Abbreviations

### 4.1 Terms and definitions

For definitions and abbreviations see IEC 61918 and IEC 61784-5-3.

For the purposes of this document, the following terms and definitions apply:

**GPC : PROFINET General Passive Components**

**SPC : PROFINET Specific Passive Components**

**LPC : PROFINET Legacy Passive Components**

## 5 PROFINET Component Applications

For the purposes of this guideline, PROFINET components are selected components for device integration and cabling that shall be used in the context of a PROFINET network.

The PROFINET philosophy is to unify the connectors supplied by different vendors for a safe and easy installation. In order to reach this target, only the listed connectors shall be used for PROFINET networks.

A main aspect is to specify suitable components for all relevant application environments.

The components shall be seen as a coordinated and interoperability system that ensures particularly easy planning and installation.

The selection of components is also based on the applicable standards of chapter 3 and application-independent cabling systems and offers sufficient performance for a reliable and safe cabling. Additional requirements resulting from the PROFINET specification and the application environment have included the specification of the components of this guideline.

The use of these cables and connectors represents a matched system that ensures a high interoperability.

Passive components are not certified by PROFIBUS & PROFINET International (PI), but the vendor shall give a PI manufacturers declaration for PROFINET cabling of conformity to this Guideline.

<https://www.profibus.com/download/manufacturers-declaration-for-profinet-cabling>

The connectors can be e.g., part of

- Switch cabinet
- Device
- Cabling between devices
- Connections within a channel
- Controller
- Industrial outlet
- Network component
- Sensor, actuator
- Drive, motor
- Coupling

The PROFINET Data cabling is referred to as:

- **PROFINET Data connectors and cabling**
- **PROFINET Hybrid connectors and cabling**

The 24 V power supply cabling is referred to as:

- **PROFINET 24 V connectors and cabling**

The integration of the signals is referred as:

- **PROFINET Signal connectors**



## 6 Guide to Use

For all cables and connectors used in certified PROFINET installations or as part of a PROFINET device, the following rules apply.

Cables and connectors are categorized according to their priority of use:

1. **PROFINET General Passive Component (GPC)** are components which represent the default solution for all PROFINET installations and PROFINET devices. Interoperability, convenience of use for all implementations and conformance with all technical aspects of this guideline are provided. Deviations shall only be accepted in a few unavoidable cases (specific application areas).
2. **PROFINET Specific Passive Component (SPC)** are solution for a designated application area or several application areas that cannot be covered by the GPC in a technically and economically reasonable way. Adaptors with specific cables and connectors to General cables and connectors (GPC) shall be provided in order to deploy implementations which are in conformance with all technical aspects of this guideline.
3. **PROFINET Legacy Passive Component (LPC)** Solution are only supported for legacy PROFINET installations and PROFINET devices that are not covered by the preferred cables and connectors (GPC). These connectors and cables will be discontinued in the near future and are not General for new developments. In order to ensure a high interoperability of PROFINET installations, adaptors shall be used to interconnect devices with legacy connectors to the GPC infrastructure. The implementations shall be in conformance with all technical aspects of this guideline to be in conformance with PI rules and regulations.

GPC and SPC do not represent an evaluation of the connectors, but rather describe their different characters. SPC can be seen as components that are very well adapted to special applications. GPCs are broader in their area of application but can be inferior to an SPC in special applications.

### 6.1 Classification of passive components (connectors and cabling)

Passive components for PROFINET installations are classified by a system to ensure the use of suitable components. This classification primarily serves the device manufacturer to equip their devices with the appropriate interfaces. In addition, this guideline is the basis for the general selection of components, done by component manufacturers (passive network components) as well as the end users.

This classification builds the basis for installation and planning guidelines for PROFINET infrastructures.

The physical Layer is the fundament for the next steps in the selection of the appropriate connectivity component. There are different physical layers available for PROFINET.

In the next step, the installation environment is selected. This is divided into "Inside Enclosure" and "Outside Enclosure".

There is no further specification for the PROFINET GPC, since these components can be used for a wide range of application environments.

The last step takes the specific application environments into account. It is relevant for the SPC.

There is no classification for LPC, as these components shall only be used in existing device families.

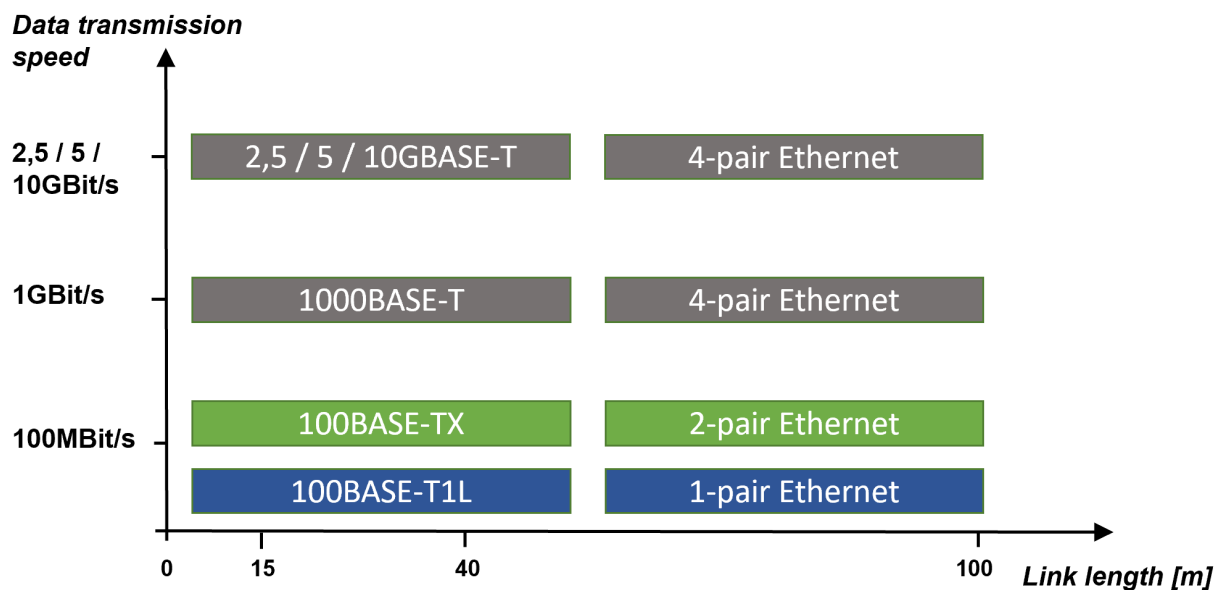
## 6.2 Physical Layers (PROFINET Data connectors and cabling)

The physical layers for PROFINET in factory automation application areas are based on 4/2/1-pair Ethernet infrastructure. All physical layers allow a maximum distance of 100 m.

**Figure 1: Copper based communication for PROFINET**

Certain physical layers are possible in order to realize a PROFINET communication. Users can also deploy different types of PROFINET cabling. Planers should consider the different characteristics, advantages, and disadvantages for their project.

The 100BASE-T1L is currently under development in IEEE 802.3. The 1000BASE-T1L protocol is for further study.



**Table 1: PROFINET supported physical Layers**

Datarate	Copper Based			Fibre Based		
	4-Pair-Ethernet	2-Pair-Ethernet	1-Pair-Ethernet	POF	Single-mode	Multi-mode
100 MBit/s	max. 100m	max. 100m	max. 100 m <sup>a)</sup> (T1-C)	max. 50 m		
1000 MBit/s	max. 100m		40 m (T1-C ffs.))		max. 10 KM	max. 1 KM
10 GBit/s	max. 100m				max. 10 KM	max. 1 KM

a) T1-C limited to 600 MHz bandwidth in accordance with ISO/IEC 11801-1 AMD 1 (ffs. because this standard is in work)  
 Note: Screened cables meeting the requirements of 6.2.7 and 6.2.8 (minimum Type Ib); ANEXT is proven by design according to IEC 61156-11

### 6.3 Environment Inside Enclosure and Outside Enclosure

The environmental conditions and the PROFINET installation classes are defined in IEC 61784-5-3.

High reliability of industrial installations in production industry and field areas require reliable, save, robust and EMC-resistant components.

Meeting the high demands in all areas of the industrial sector, a differentiation between "inside" and "outside" protected areas needs to be made:

- **Inside enclosure** refers to the environment found in control stations, electronic rooms and inside cabinets.
- **Outside enclosure** refers to higher demands with regard to dust, moisture, vibration, EMC etc. that exist in the industrial area when used outside an enclosure.

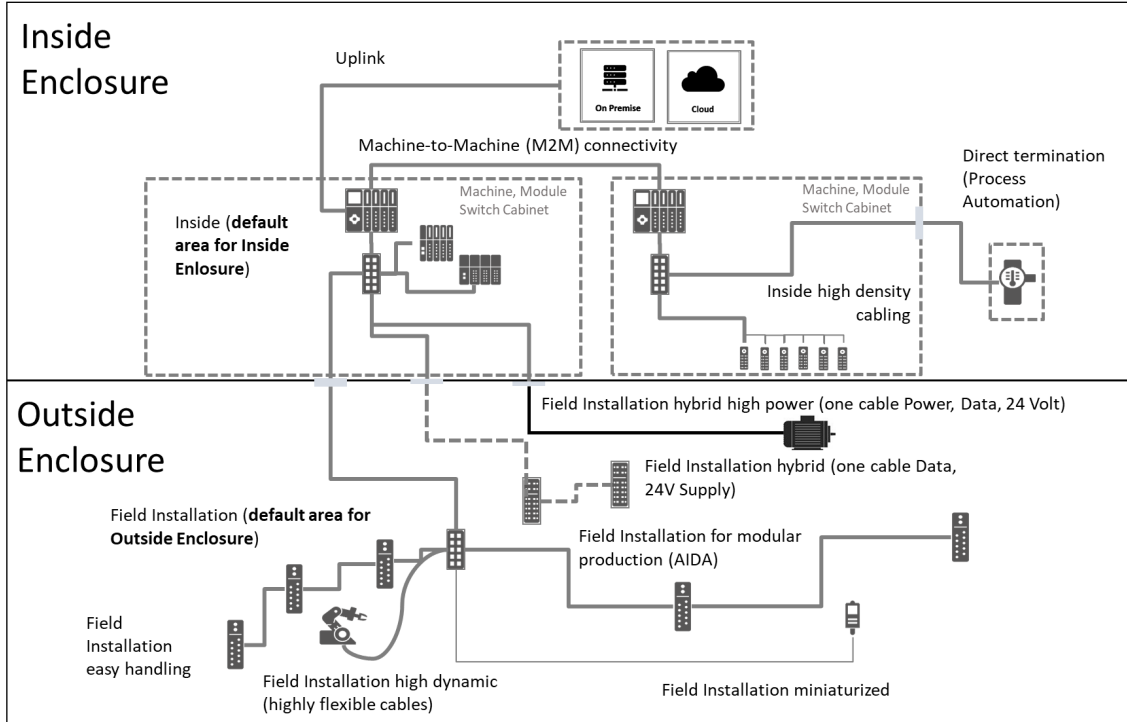
**Table 2: Environments Inside Enclosure and Outside Enclosure**

	Inside enclosure	Outside enclosure
Mechanical		
Shock/bump <sup>a)</sup> Peak acceleration	IEC 60512-6-3, test 6c 20 g / 11 ms 3 per axis in both directions	IEC 60512-6-3, test 6c 50 g / 11 ms 3 per axis in both directions
Vibration 10-500 Hz	IEC 60512-6-4, test 6d 0.35 mm or 5g	IEC 60512-6-4, test 6d 0.35 mm or 5g
Ingress Protection		
Class	IEC 60529:1989 + A1:1999 + A2:2013 IP20	IEC 60529:1989 + A1:1999 + A2:2013 IP65 and IP67
Climatic		
Ambient temperature	0°C to +70°C <sup>b)</sup>	-20°C to +70°C <sup>b)</sup>
Electromagnetic		
Transfer Impedance	See components selection	
<div><div>a)</div><div>Bump: the repetitive nature of the shock experienced by the channel shall be taken into account.</div></div> <div><div>b)</div><div>An additional heating by POE has to be considered by the user.</div></div>		

## 6.4 Application Areas (Data connectors and cabling/ 24 V connectors and cabling)

PROFINET Passive Components are designed for the PROFINET application areas. Following application areas are defined for PROFINET. These application areas are relevant for PROFINET General Passive Component (GPC) Components as well as PROFINET Specific Passive Component (SPC) Solution.

**Figure 2: Cabling Landscape with allocation of application areas**



**Table 3: Supported Application Areas**

Environment:	Application Area:
<b>Inside Enclosure</b>	Uplink
	Machine-to-Machine (M2M) connectivity
	Inside cabling ( <b>default area for Inside Enclosure</b> )
	Inside high-density cabling
	Direct termination (Process Automation)
<b>Outside Enclosure</b>	Field Installation ( <b>default area for Outside Enclosure</b> )
	Field Installation for modular production
	Field Installation hybrid (one cable Data, 24V Supply)
	Field Installation easy handling
	Field Installation hybrid high power (one cable Power, Data, 24 V)
	Field Installation high dynamic (highly flexible cables)
	Field Installation miniaturized

In **Table 3** are the different supported Application Areas listed. Future Applications will be added in new versions of the guideline.

PROFINET devices and uplink cabling shall be compatible and according to the connector definition, which are listed in the Table 4 below.

The default application areas are Inside Cabling and Field Installation, which correspond directly to the inside enclosure and outside enclosure environment.

All components of the application area inside enclosure and outside enclosure shall fulfil at least the environmental requirements of Table 2 Table 2: Environments **Inside Enclosure** and **Outside Enclosure**.

## 7 Application Areas

### 7.1 Inside Enclosure

#### 7.1.1 Uplink

The Uplink provides data from the field level to the level IT systems such as the Manufacturing Execution System (MES). Uplinks are essential parts of industrial premises and as such they have to be compatible to structured premises cabling. This communication typically requires data to be transmitted at a very high data rate over a large distance up to 1000 m and thus, it predominantly uses fibre optical (FO) cabling. The long uplink cables can also be exposed to various EM noise sources such as wireless transceivers or machinery which shall not deteriorate negatively the data transmission over copper and FO cable.

#### 7.1.2 Machine-to-machine (M2M) connectivity

M2M connectivity enables machinery, robots and devices to exchange information and perform actions without the need for human interaction or intervention. M2M communications help enterprises to reduce the equipment downtime, thus minimizing the costs for maintenance. Moreover, production duration can be shortened with M2M deployment as it automates the operational alteration and maximizes efficiency.

M2M communication utilizes an End-to-End link with high bandwidth up to 10 Gbit/s preferable over 4-pair balanced copper cabling. Main purposes of M2M communication is providing sensor data to the governing control unit and to exchange data at a high data rate between control units of a machine (Cabinet) or an automation island (Field Outside) with the objective to stimulate an appropriate response. The sensors can be attached to or are integrated in field equipment with moving or rotating elements causing a high level of vibration, physical shock and EM noise. Furthermore, sensors and other field equipment are designed as small as possible to allow their integration into machines or automation cells with limited space.

M2M connectivity covers a wide range of cabling options, depending on the environmental conditions and dimensional constraints as explained above. Miniaturized M2M connectivity uses specialized small connectors with high mechanical and EMI robustness.

#### 7.1.3 Inside cabling

The Application Area Inside Cabling is the default environment for any cabling that starts on a device within a protected atmosphere of a control cabinet or other housing (Inside enclosure) and also ends on a device within an Application Area Inside Cabling. It includes a part of an End-to-End that is located in the Outside Enclosure. When specifying the components for inside cabling, that part of the End-to-End link is considered in which all of the permitted connector pairs are located within this protected atmosphere. If connectors are also used in the application area class Field Outside in the end-to-end link, or if one of the devices is located there, they must be assigned to one of the application area class Field Outside. The components that are used in the Inside Area are the PROFINET General Passive Components (GPC) for the Application Area Class Cabinet Inside.

It is assumed that part of the end-to-end link can also be in the field outside class. Therefore, for example, the cables are also suitable for application area field installation due to their universal applicability.

Inside Cabling supports the balanced cabling in 2 and 4 pairs as well as the FO cabling.

#### 7.1.4 Inside high-density cabling

Peripheral equipment typically incorporates cabinets accommodating devices such as a local control unit and I/O systems. The dimensions of peripheral cabinet device modules are getting smaller and smaller to enable high packaging densities in the equipment's racks. Distributed peripheral equipment with inside high-density Cabling communication utilizes an End-to-End link with High Bandwidth up to 10 Gbit/s preferable over 4pair balanced copper cabling.

Peripheral cabinet connectivity connects a device incorporated in the cabinet of peripheral equipment to other devices inside. This represents an End-to-End connection inside a protected area. Exceptionally it may connect equipment outside the cabinet, including the control unit governing the automation cell or higher-level IT systems.

Flexible and wide range of plug variations are welcome, e.g. straight and angled versions to achieve compact arrangement and density in cabinet. Furthermore, small footprint receptacles are needed to provide more layout space for electronic components on PCB.

## **7.2 Outside Enclosure**

### **7.2.1 Field Installation**

The application area field installation is the default environment for any cabling that starts on a device outside the protected atmosphere of a control cabinet or other housing (Outside Enclosure) and ends at a such a device. It includes an End-to-End link that starts on a device in the Outside Enclosure and ends at a device in a cabinet (Inside Enclosure).

When specifying the components for field installation, that part of the End-to-End link is considered in which all of the permitted connections are located within the Outside Enclosure Area. If connectors are also used in the Field Application Area Class Inside Cabinet or if one of the devices is located there, then these shall be assigned to the corresponding application area. The components to be used in the Field Installation Area are the PROFINET General Passive Components (GPC) for the Application Area Class Cabinet Field Outside.

The field installation supports the 1, 2 and 4 pair balanced cabling as well as the optical cabling.

### **7.2.2 Field Installation for modular production**

Modular production systems, such as those used in automobile production, have extended requirements for field installation. In addition to simple installation and commissioning, this application area primarily requires a very quick and easy exchange of automation components.

The passive network components are optimized for an extensive line topology. On site termination and pre harnessed cables are both supported.

### **7.2.3 Field Installation of hybrid cable and connector (one data cable and one 24V Supply)**

For control units and devices in the outside field, a space-saving and easy connection option is required. This can be realized by using a single cable solution such as the PROFINET Type B Hybrid. Instead of two separate cables, the device is connected via a hybrid cable and a hybrid plug, which provides elements for transmitting power with 24 V as well as data. The hybrid cabling is either the full End-to-End link or just a part of the outside cable installation. Defined SPCs shall be used in this application area.

SPC Connectors with those properties and suitable for Field Installation hybrid are listed at the Table 4: Component Classification (PROFINET Data Connectors) supported Application Areas below.

### **7.2.4 Field Installation easy handling**

In applications where an easy exchange of components is required, additional requirements are placed on the Field Installation. One of the applications is the highly efficient assembly e.g. in automotive manufacturing. Here the easy, reliable and fast exchange of automation components without special tools is required. The requirements of these applications can be supported by the design of the PROFINET cabling components.

Connectors with push-pull locking mechanism give special advantage to all applications that require quick and simple handling. Exchange, repair and maintenance is significantly simpler and faster due to the blind and tool-free mating. In applications that require a high number of connections these advantages multiply in particular. All applications that are difficult to access and/or where space is limited benefit from the easy-to-use push-pull locking.

### **7.2.5 Field Installation hybrid high power (Data & 24 V)**

In the field, it may be necessary to supply devices and motors with a high power, for example provided by an inverter. To avoid high cabling effort by using several separate cables for the encoder system, for data transmission and for the power transfer, space-saving solutions are favoured. In the field, this can be a

single cable solution, especially from the inverter to the corresponding device requiring high power. The single cable solution combines all necessary elements and provides an easy cable installation. For different power levels different SPCs are defined.

### **7.2.6 Field Installation high dynamic (highly flexible cables)**

In several applications like robotics or assembly lines cables are moved during operation. Machines parts or even the full machine might do permanent repeated movements in operation. For example, cables in robots are experiencing dynamic stress all the time. Similar happens to cables installed in energy chains (C-track). For this demanding application selected PROFINET components are specified. Special cables are designed for robot applications.

### **7.2.7 Field Installation miniaturized**

The size of the automation devices for example in IIoT (Industrial Internet of Things) applications is significantly reduced. This small automation devices will also be connected to a PROFINET network. To achieve this, a dedicated miniaturized connectivity is necessary for this specific application area. The PROFINET component approach for the E2E link also applies to miniaturized field Installation. A preferred physical layer here is balanced 2-pair cabling and 1-pair cabling (single pair Ethernet).

## **7.3 Direct termination (Process Automation)**

The Field Devices Installation with direct termination is defined by the fact that the PROFINET cable is led directly to the connection terminal of a device. A connection without a connector is not permitted in standard manufacturing applications. However, there are exceptions in special industrial segments in which the connection without connector is required. A typical segment for Field Devices Installation with direct termination is the industrial segment of the process automation, in which the devices are often connected directly, without connectors. The cables are usually led into the device via a cable gland.

# **8 Component Classification**

## **8.1 Connectors**

The connectors currently specified for PROFINET can be assigned to the priority of use and the individual applications.

The SPC are only to be used for dedicated applications that have specific requirements. Therefore, the SPC are assigned to individual applications. See the following table for details.

In the default application areas (Inside Cabling and Field Installation) only GPC shall be used.

**Table 4: Component Classification (PROFINET Data Connectors) supported Application Areas**

	Connector			Application Area											
Physical Layer	Connector Type	IEC Standard	priority of use category (GPC, SPC)	Uplink	M2M	Inside (default area for Inside Enclosure)	Inside high density	Field Installation (default area for Outside Enclosure)	Modular Production	Field Installation hybrid (one cable Data, 24V Supply)	Field Installation easy handling	Field Installation hybrid high power (one cable Power, Data, 24 V)	Field Installation high dynamic (highly flexible cables)	Field Installation miniaturized	Direct termination (Process Automation)
2/4-Pair-Ethernet	PushPull RJ45	IEC 61076-3-117	SPC						X		X		X		
	M12 X	IEC 61076-2-109	GPC			X		X	X				X		
	RJ45	IEC 60603-7-3	GPC		X	X									
	ix Industrial	IEC 61076-3-124	SPC		X		X								
	Mini-IO	IEC 61076-3-122	SPC		X		X								
2-Pair-Ethernet	M12-D	IEC 61076-2-101	GPC			X		X	X				X		
	M8-D	IEC 61076-2-114	SPC											X	
	RJ45	IEC 60603-7-3	GPC		X	X									
2-Pair Hybrid	M12-Y	IEC 61076-2-113	SPC							X					
	M23	IEC 61076-2-117	SPC							X					
1-Pair Hybrid	M8	IEC 63171-6	SPC											X	
	M12	IEC 63171-7 Type II	SPC							X	X				
	M12	IEC 63171-7 Type VI	SPC							X	X				
Fibre Optic	LC	IEC 61754-20	GPC	X	X	X									
	PushPull SCRJ	IEC 61076-3-123	SPC						X						
X: dedicated solution															



**Table 5: Component Classification (PROFINET 24 Volt Connectors)**

		Connector				Application Area											
		Connector Type	IEC Standard	Clause in this document	priority of use category (GPC, SPC)	Uplink	M2M	Inside (default area for Inside Enclosure)	Inside high density	Field Installation (default area for Outside Enclosure)	Modular Production	Field Installation hybrid (one cable Data, 24V Supply)	Field Installation easy handling	Field Installation hybrid high power (one cable Power, Data, 24 V)	Field Installation high dynamic (highly flexible cables)	Field Installation miniaturized	Direct termination (Process Automation)
Physical Layer	24 Volt Supply	M12 L Coded	IEC 61076-2-111		GPC		X	X	X	X	X				X		
		PushPull Power	IEC 61076-3-123		SPC						X		X		X		
X: dedicated soluion																	

## 9 Lifecycle management

The lifecycle management follows the scheme in **Figure 3** – Procedure for annual Lifecycle management and new components with the mentioned steps.

Passive components can be classified according to the following scheme:

1. GPC shall be adopted from the previous version of this guideline.
2. New GPC shall be selected from SPC.
3. New SPC shall be selected following the “Procedure for proposed SPC”
4. New LPC shall be selected by CB-PG1 following the “Procedure for annual Lifecycle management of GPC, SPC and LPC”
5. The announcement of lifecycle changes shall be performed by a new edition of this guideline.

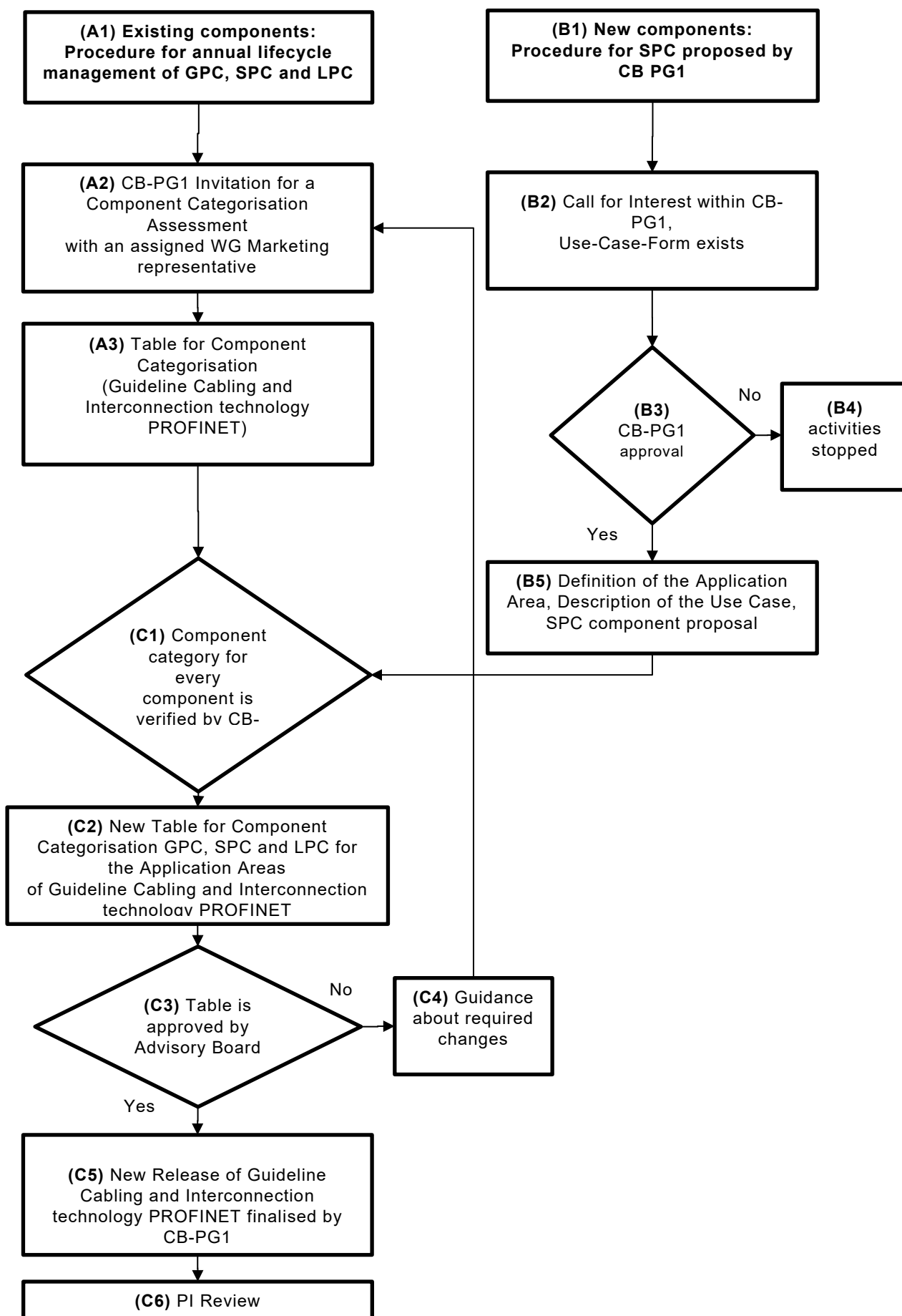
### 9.1 Procedure for annual Lifecycle management of GPC, SPC

1. Every year CB-PG1 initiates an assessment with an assigned WG Marketing representative (A1), (A2)
2. It would be proposed by CB-PG1, whether the existing content will remain or moved to another category based on the previous table. (C1), (C2)
3. New components for SPC will be included based on the outcome from (B5)
4. The new proposed table has to be confirmed or rejected by the Advisory Board. (C3)
5. In the positive case, a new edition of the guideline would be created, following the procedure of the PI-Review (C5) (C6)
6. In the negative case, the procedure starts again including guidance from the Advisory Board or their agents. (C4)

### 9.2 Procedure for proposed SPC

1. A new SPC can be proposed by WG's, users or vendors (B1) for a specific application area.
2. A call for interest would be initiated in CB-PG1 in order to describe the Use-Case/Application Area in the respective form (B2)
  - a. The proposal has to be presented to CB-PG1. The proposer can be supported by a cable or connector manufacturer.
  - b. The proposer has to declare why existing cables or connectors cannot fulfil the economic and technical requirements. A maximum of two cable or connector solutions may exist in the same application area.
3. If CB-PG1 supports the inclusion of the new application area, a detailed description of the use case, the proposed component and technical and economic feasibility would be prepared. Otherwise, the activities are stopped. (B2), (B3), (B4), (B5)

Figure 3: Procedure for annual Lifecycle management and new components



## 10 Manufacturer Declaration for PROFINET cabling Conformity

The test procedure for passive components (connectors, cables and cords) shall conform to the Procedure for a PROFINET Conformity.

<https://www.profibus.com/download/manufacturers-declaration-for-profinet-cabling/>

All passive components shall conform to the specification in this guideline.

### 10.1 Procedure for a PROFINET Conformity

The conformance testing is only relevant for the PROFINET GPC, SPC data connectors and cabling and 24 V connectors and cabling.

Connectors and cables shall fulfil the requirements and standards described in this guideline. To ensure the compatibility of cables and connectors under the PROFINET system, the cables and connectors shall be tested.

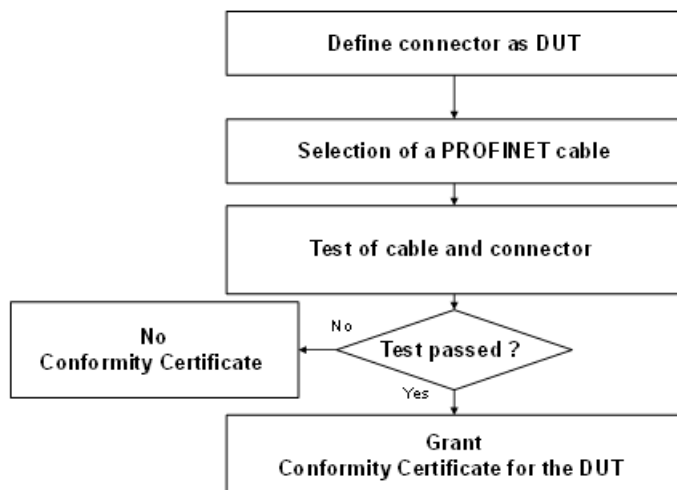
The Certificate of Conformance (CoC) ensures that the components shall be tested as specified. All tests refer to the inside and outside requirements specified in this guideline.

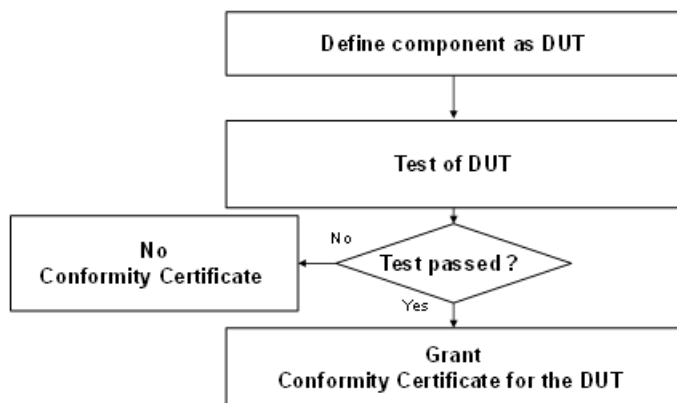
The use of the listed PROFINET connectors is necessary for PROFINET devices to be certified in a test lab.

Vendors only can declare for the listed connectors that fulfil the PROFINET specification a PROFINET vendor conformity declaration.

The product vendors shall issue a conformity certificate through the following procedure.

**Figure 4: Procedure for connectors**



**Figure 5: Procedure for PROFINET components, except connectors**

The vendor who issues the CoC takes responsibility for the:

- listed cables and connectors or harnessed cables
- performing the test as specified in this guideline
- granting of the conformity certificate

The CoC can be issued unilaterally or bilaterally (e.g. from the cable and/or the connector vendor or the harness maker). Conformity testing is a requirement of PROFINET labelling of the products described in this guideline.

Conformity testing is required for the following components:

- Connectors, cables and cordsets for PROFINET Data Cabling
- Connectors, cables and cordsets for PROFINET Hybrid Cabling
- Connectors, cables for PROFINET 24 V Cabling

The procedure for the declaration is a separate PI document.

The CoC of the listed components is mandatory for PROFINET.

This document describes the permitted cabling and connectors which can be used as in certified PROFINET application or in combination with a PROFINET device.

## 10.2 Certification of PROFINET-Devices

For the release of a certificate as PROFINET-device the following prerequisites shall be fulfilled:

1. The device is equipped with an GPC, SPC connector interface as described in this guideline.
2. The devices shall be tested with GPC, SPC connectors and cables in conformance with this guideline.
3. New device developments shall be started either with a GPC or an SPC connector based on the current version of this guideline.
4. Extensions of an existing device family with an LPC connector can use the same LPC connector.

## 11 Balanced Cables

### 11.1 Balanced 1 pair Cables (Type A, B, C)

**Table 6: Balanced 1 pair Cable Specification**

General Requirement:	Application Type A	Application Type B	Application Type C
Design	1 pair Data Cable		
Cable Installation Type	Stationary, no movement after installation	Flexible, occasional movement or vibration	Special applications
Cable Marking (at least)	“PROFINET Type A 1 Pair”	“PROFINET Type B 1 Pair”	“PROFINET Type C 1 Pair”
Conductor Diameter or Cross Section <sup>A)</sup>	AWG 22/1 ≥ 0,610 mm	AWG 22/7 ≥ 0,318 mm²	AWG 22/... ≥ 0,318 mm²
Core identification (colour)	Pair 1: white, blue		
Core Diameter IEC 60811-203	1,5 to 1,7 mm		Application specific
Cable Design	2 cores as 1 twisted pair		
Shielding Design	Aluminium Foil + Copper Braiding		Application specific
Outer Cable Diameter	5,5 to 6,2 mm <sup>A)</sup>		
Colour (Outer Sheath)	Green RAL6018		Green RAL6018 (preferred)
<sup>A)</sup> cabinet cabling with reduced outer diameter and length see Table 111: Requirements of PROFINET cabinet cord sets.			
Electrical and Transmission Requirements:			
Conductor resistance IEC 60189-1	≤ 62 Ω/ km	≤ 60 Ω/ km	≤ 62 Ω/ km
Data transmission ISO/IEC 11801-1 IEC 61156-1	IEC 61156-11	IEC 61156-11	IEC 61156-12
Coupling attenuation EN 50289-1-6	≥ 80 dB at 30 MHz to 1000 MHz		
Ambient Conditions Requirement:			
Operating temperature	-20°C ...+70°C		
Mechanical Requirement:			
Type of cable	Test-Description	Measurement to be performed	Requirements
Type A, B	Crush test of the cable	IEC 62012-1	3000 N
	Flame retardancy	IEC 60332–1-2	Must pass the test
	Pressure test at high temperature for insulation and sheaths	IEC 60811-508	Max. 50 %
	Heat shock test	IEC 60811-509	No cracks

	Core diameter	IEC 60811-203	$\geq 1,50 \text{ mm}$ $\leq 1,70 \text{ mm}$
	Outer cable diameter	IEC 60811-203	$\geq 5,50 \text{ mm},$ $\leq 6,20 \text{ mm}$
	Tensile performance of the cable	EN 50289-3-16	50 N
Type C	Application specific		
Note 1: AWG dimensions are given for information only.			
Note 2: Restriction of the component approach is possible according to the specification of the cable manufacturer (reduction of the E2E link length shall be defined by the vendor in the cable specification).			

## 11.2 Balanced 2 pair Cables (Type A, B, C, R)

**Table 7: Balanced 2 pair Cable Specification**

General Requirement:	Application Type A	Application Type B	Application Type C	Application Type R
Design	2 pair Data Cable			
Cable Installation Type	Stationary, no movement after installation	Flexible, occasional movement or vibration	Special applications	Cable for robot applications
Cable Marking (at least)	“PROFINET Type A”	“PROFINET Type B”	“PROFINET Type C”	“PROFINET Type R”
Conductor Diameter or Cross Section <sup>A)</sup>	AWG 22/1 ≥ 0,610 mm	AWG 22/7 ≥ 0,318 mm²	AWG 22/... ≥ 0,318 mm²	
Core identification (colour)	Cable design star quad: white, yellow, blue, orange Cable design 2 twisted pair: Pair 1: white, blue; Pair 2: yellow, orange			
Core Diameter IEC 60811-203	1,4 to 1,6 mm		Application specific	1,4 to 1,6 mm
Cable Design	4 cores as 2 twisted pairs or star quad			
Shielding Design	Aluminium Foil + Copper Braiding		Application specific	Suitable for robot applications metal tape with 100% coverage screen of copper wires: optical coverage minimum 85% for braid and minimum 90% for spiralized (preferred braided screen)
Outer Cable Diameter				5,5 to 8,0 mm
Colour (Outer Sheath)	Green RAL6018		Green RAL6018 (preferred)	

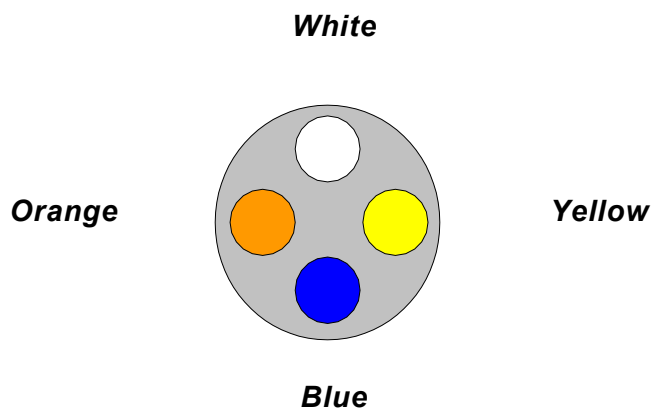
Electrical and Transmission Requirements:			
Conductor resistance IEC 60189-1	≤ 62 Ω/ km	≤ 60 Ω/ km	≤ 62 Ω/ km
Data transmission ISO/IEC 11801-1 IEC 61156-1	IEC 61156-5 (≥ Category 5)	IEC 61156-5 (≥ Category 5)	IEC 61156-6 (≥ Category 5) <sup>B)</sup>
Delay Skew IEC 61156-1	≤ 20 ns/100 m		
Coupling attenuation EN 50289-1-6	≥ 80 dB at 30 MHz to 100 MHz		
Ambient Conditions Requirement:			
Operating temperature	-20°C ...+70°C		
Mechanical Requirement:			
Type of cable	Test-Description	Measurement to be performed	Requirements
Type A, B	Crush test of the cable	IEC 62012-1	3000 N
	Flame retardancy	IEC 60332–1-2	Must pass the test
	Pressure test at high temperature for insulation and sheaths	IEC 60811-508	Max. 50 %
	Heat shock test	IEC 60811-509	No cracks
	Core diameter	IEC 60811-203	≥ 1,40 mm ≤ 1,60 mm
	Outer cable diameter	IEC 60811-203	≥ 5,5 mm, ≤ 8,0 mm
	Tensile performance of the cable	EN 50289-3-16	50 N
Type R	Trailing chain test (horizontal)	Bending radius: max. 15xD acceleration: min. 10 m/s <sup>2</sup> speed: min. 180 m/min chain length: min. 5 m cycles: min. 5 million	After 5 million cycles: Pass test of IEC 61156-6 (≥ Category 5) and no crack of jacket
	Torsion test (vertical)	Torsion stress: ± 180°/m Cycles: min. 5 million Weight: 300 g  EN 50289-3-10	After 5 million cycles: Pass test of IEC 61156-6 (≥ Category 5) and no crack of jacket
	Reverse bending test	Bending radius: max. 7xD Weight: 300 g, cycles: min. 1 million Similar to EN 50396 paragraph 6.4	After 1 million cycles: Pass test of IEC 61156-6 (≥ Category 5) and no crack of jacket



	DC resistance screen	R <sub>DC</sub> ≤ 14 mOhm/m (measured cable length 30 m) IEC 60189-1	R <sub>DC</sub> ≤ 14 mOhm/m after mechanical test according to trailing chain /torsion /bending test and after 10A DC (30 s)
Type C	Application specific		
Note 1) AWG dimensions are given for information only.			

Note B) Restriction of the component approach is possible according to the specification of the cable manufacturer (reduction of the E2E link length shall be defined by the vendor in the cable specification).

The core assignment of the star-quad cable is indicated by the following colour coding.



### 11.3 Balanced 4 pair Cables (Type A, B, C)

Table 8: Balanced 4 pair Cable Specification

General Requirement:	Application Type A	Application Type B	Application Type C
Design	4 pair Data Cable		
Cable Installation Type	Stationary, no movement after installation	Flexible, occasional movement or vibration	Special Applications (e.g. highly flexible, permanent movement, vibration or torsion)
Cable Marking	PROFINET Type A 4 pair CATx, (x ≥5)	PROFINET Type B 4 pair CATx, (x ≥ 5)	PROFINET Type C 4 pair CATx, (x ≥ 5)
Minimum Conductor Diameter or Cross Section <sup>A)</sup>	≤ AWG 23/1, ≥ 0,546 mm	≤ AWG 23/7, ≥ 0,254 mm²	≤ AWG 24, ≥ 0,485 mm for solid conductors, ≥0,201 mm² for stranded conductors
Core Diameter IEC 60811-203	1,0 - 1,6 mm		Application specific
Core Identification (Colour)	White/Orange, Orange White/Green, Green White/Blue, Blue White/Brown, Brown Ring or stripe marking on the white core is optional		
Shielding Design Type	Aluminium Foil + Copper Braiding		Application specific
Outer Cable Diameter IEC 60811-203	5,5 - 9,0 mm		
Colour (Outer Sheath)	Green RAL6018		

Electrical and Transmission Requirement:			
Conductor resistance IEC 60189-1	≤ 85 Ω/km		≤ 95 Ω/km
Data transmission ISO/IEC 11801-1 IEC 61156-1	IEC 61156-5 (≥ Category 5)	IEC 61156-5 (≥ Category 5)	IEC 61156-6 (≥ Category 5)
Delay skew IEC 61156	≤ 20 ns/100 m between pair Orange and pair Green		
Coupling attenuation EN 50289-1-6	≥ 80 dB at 30 MHz to 100 MHz		
Ambient Condition Requirement:			
Operating temperature	-20°C ...+70°C		
Mechanical Requirement:			
Type of cable	Test-Description	Measurement to be performed	Requirements
Type A, B	Flame retardancy	IEC 60332–1-2	Has to pass the test
	Pressure test at high temperature for insulation and sheaths	IEC 60811-508	Max. 50 %
	Heat shock test	IEC 60811-509	No cracks
	Core diameter	IEC 60811-203	≥ 1,0 mm, ≤ 1,6 mm
	Outer cable diameter	IEC 60811-203	≥ 5,5 mm, ≤ 9,0 mm
	Tensile performance of the cable	EN 50289-3-16	50 N
	Crush test of the cable	IEC 62012-1	2000 N
Type C	Application specific		
Note 1: AWG dimensions are given for information only. Note 2: Restriction of the component approach is possible according to the specification of the cable manufacturer (reduction of the E2E link length shall be defined by the vendor in the cable specification).			

### 11.4 Balanced 2 pair Hybrid Cables (Type B, C)

Hybrid cables contain cores for signals transmission and power supply.

**Table 9: Balanced 2 pair Hybrid Cable Specification**

General Requirement:	Application Type B	Application Type C
Design	2 pair Hybrid Cable	
Cable Installation Type	Flexible, occasional movement or vibration	Special Applications (e.g. highly flexible, permanent movement, vibration or torsion)
Cable Marking (at least)	“PROFINET Hybrid Type B”	“PROFINET Hybrid Type C”
Conductor Cross Section data wire <sup>A)</sup>	AWG 22/7, ≥ 0,318 mm²	AWG 22/..., ≥ 0,318 mm²
Conductor Cross Section power wire	1,5 mm²	
Core Identification (Colour)	Cable design star quad: white, yellow, blue, orange Cable design 2 twisted pair: Pair 1: white, blue; Pair 2: yellow, orange Power cores black with numbers 1,2,3,4	
Data Core Diameter IEC 60811-203	1,4 to 1,6 mm	Application specific
Power Core Diameter IEC 60811-203	2,4 ± 0,2 mm	
Cable Design	2 twisted pairs or 1 star quad + 4 power cores	
Shielding Design Type Data element	Aluminium Foil + Copper Braiding	Application specific
Outer Cable Diameter IEC 60811-203	8,0 - 12,0 mm	
Colour (Outer Sheath)	Green RAL6018	Application Specific
Electrical and Transmission Requirement:		
Conductor resistance data core IEC 60189-1	≤ 60 Ω/km	≤ 62 Ω/km
Conductor resistance power core IEC 60189-1	≤ 14 Ω/km	
Data transmission ISO/IEC 11801-1 IEC 61156-1	IEC 61156-5 (≥ Category 5) <sup>B)</sup>	IEC 61156-6 (≥ Category 5) <sup>B)</sup>
Delay skew IEC 61156	≤ 20 ns/100 m	
Coupling attenuation EN 50289-1-6	≥ 80 dB at 30 MHz to 100 MHz	
Maximal current in each power wire:	For T ≤ 55°C: 16 A For T > 55°C the current is not specified but may be indicated in the relevant detailed specification of the cable manufacturer (derating diagram)	
Ambient Condition Requirement:		
Operating temperature	-20°C ...+70°C	

Mechanical Requirement:			
Type of cable	Test-Description	Measurement to be performed	Requirements
Hybrid Type B	Flame retardancy	IEC 60332–1-2	Has to pass the test
	Pressure test at high temperature for insulation and sheaths	IEC 60811-508	Max. 50 %
	Heat shock test	IEC 60811-509	No cracks
	Tensile performance of the cable	EN 50289-3-16	50 N
	Crush test of the cable	IEC 62012-1	3000 N
Hybrid Type C	Application specific		
Note 1: AWG dimensions are given for information only.			
Note 2: The possible channel length of the hybrid cable depends on the power consumption of the connected devices.			

### 11.5 Connector specific Hybrid Cable (Type B, C)

Hybrid cables contain additional cores for signals transmission and power supply. The possible channel length of the hybrid cable depends on the power/signal/data requirement of the connected devices and topology of the PROFINET Network.

**Table 10: Connector specific Hybrid Cable Specification**

<b>General Requirement:</b>	<b>Application Type B</b>	<b>Application Type C</b>
Design	1 data element Hybrid Cable	
Cable Installation Type	Flexible, occasional movement or vibration	Special Applications (e.g. highly flexible, permanent movement, vibration or torsion)
Cable Marking (at least)	<p>“PROFINET Hybrid Type {B / C} {connector type standard} / {1 / 2 / 4}-Pair-Data-{dimension}mm<sup>2</sup> + {no.of pairs}x{no. of cores}x{dimension}mm<sup>2</sup> + ... (repeat content if needed)  Text between { } defines content to be selected { } are not to be printed on the cable.  If signal/power cores are not implemented as pairs, "{no. of pairs}x" must not be applied.  Order: all Data content &gt; all Signal content &gt; all Power content  AWG values instead of mm<sup>2</sup> are allowed.</p> <p>e.g. PROFINET Hybrid Type B IEC 61076-2-117 Type 3 / 1-Pair-Data-0,34mm<sup>2</sup> + 2x2x1,0mm<sup>2</sup>+ 5x4,0 mm<sup>2</sup></p> <p>PROFINET Hybrid Type B IEC 63171-7 Type 6 / 1-Pair-Data-AWG22 + 3xAWG14</p>	

Data element	<p>1x data element according to chapter 11.1 to 11.3</p> <p>Deviations:</p> <p>If the chosen connector defines a smaller conductor cross section for the data element, the cross section has to be adjusted according to the connector definition.</p> <p>All values according to chapter 11.1 to 11.3 are applicable.</p> <p>Exception: conductor diameter/cross section, core diameter, conductor resistance.</p> <p>A sheath for the data element is optional. If a sheath is applied, the defined sheath values according to chapter 11.1to 11.3 are not applicable.</p> <p>Hybrid specification overrules the content of chapter 11.1to 11.3 for data elements used within hybrid cables.</p>											
Conductor Cross Section power/signal conductor <sup>A)</sup>	conductor dimensions ≤ 1,0 mm² (AWG18) stranded conductor min. 7-wire	Application specific										
	conductor dimensions > 1,0 mm² (AWG18) min. IEC 60228 class 5 has to be applied.	Application specific										
Power/Signal Core Outer diameter IEC 60811-203	<p>maximum outer diameter of power/signal is given by connector size</p> <p>For any power or signal core with rated voltage &gt; 50 V and ≤ 1000 V AC following minimum average insulation wall thickness need to be applied:</p> <table><tr><td>nominal wire cross section [mm²] minimum average [mm]</td><td>insulation wall thickness,</td></tr><tr><td>0,5-1,0</td><td>0,3</td></tr><tr><td>1,5-2,5</td><td>0,4</td></tr><tr><td>4,0-6,0</td><td>0,5</td></tr><tr><td>10,0</td><td>0,6</td></tr></table> <p>insulation resistance: min. 1000 MOhm/m</p>		nominal wire cross section [mm²] minimum average [mm]	insulation wall thickness,	0,5-1,0	0,3	1,5-2,5	0,4	4,0-6,0	0,5	10,0	0,6
nominal wire cross section [mm²] minimum average [mm]	insulation wall thickness,											
0,5-1,0	0,3											
1,5-2,5	0,4											
4,0-6,0	0,5											
10,0	0,6											
Power/Signal Core Identification	Identification of cores according to chapter 13.4 has to be applied.											
Cable Design	<sup>A)</sup> data element + further components according to chapter 13.4 have to be applied											

Further shielding	<p>Necessity of further shielding is defined by the chosen connector according to chapter 13.4. If further shielding is applied:</p> <p><u>min. shielding over the overall assembly:</u> screen of copper wires optical coverage min. 80 % braid over defined assembly</p> <p><u>min. shielding over signal/power pairs:</u> application specific e.g. foil screen, braid, ...</p>	<p>Necessity of further shielding is defined by the chosen connector according to chapter 13.4. If further shielding is applied:</p> <p><u>min. shielding over the overall assembly:</u> Screen of copper wires optical coverage min. 80 % braid or min. 85 % for spiralized preferred braided screen</p> <p><u>min. shielding over signal/power pairs:</u> application specific e.g. foil screen, braid, ...</p>
Outer Cable Diameter IEC 60811-203	Outer diameter of the completed cable has to be within the limit according to the chosen connector according to chapter 13.4	
Colour (Outer Sheath)	Application Specific	Application Specific
<b>Electrical and Transmission Requirement:</b>		
Conductor resistance data core <sup>A)</sup> IEC 60189-1	$\geq 0,324 \text{ mm}^2 \text{ (AWG22/7)} \leq 63 \text{ } \Omega/\text{km}$	$\geq 0,324 \text{ mm}^2 \text{ (AWG22/...)} \leq 65 \text{ } \Omega/\text{km}$
	$\geq 0,254 \text{ mm}^2 \text{ (AWG23/7)} \leq 88,4 \text{ } \Omega/\text{km}$	$\geq 0,254 \text{ mm}^2 \text{ (AWG23/...)} \leq 91 \text{ } \Omega/\text{km}$
	$\geq 0,205 \text{ mm}^2 \text{ (AWG24/7)} \leq 99 \text{ } \Omega/\text{km}$	$> 0,205 \text{ mm}^2 \text{ AWG24/...} \leq 102 \text{ } \Omega/\text{km}$
	$\geq 0,128 \text{ mm}^2 \text{ (AWG26/7)} \leq 159 \text{ } \Omega/\text{km}$	$\geq 0,128 \text{ mm}^2 \text{ AWG26/...} \leq 164 \text{ } \Omega/\text{km}$
Conductor resistance power/signal core IEC 60189-1	value according to chosen conductor standard + 4% caused by the extension of the multiple stranding production steps	
Data transmission data element <sup>A)</sup> ISO/IEC 11801-1 IEC 61156-1	according to chosen data element according to clause 11.1 to 11.3 dimensions 0,14 to 0,25 mm <sup>2</sup> (AWG26 to AWG24) are to be measured by IEC 61156-6 or IEC 61156-12 depended on the chosen data element	
Delay skew data element IEC 61156	according to chosen data element according to clause 11.1 to 11.3	
Coupling attenuation data element EN 50289-1-6	according to chosen data element according to clause 11.1 to 11.3 to be measured on the data element screen	

Ambient Condition Requirement:		
Operating temperature	-20°C ...+70°C	
a) AWG dimensions are given for information only.		

General Requirement:	Application Type B	Application Type C										
Design	1 data element Hybrid Cable											
Cable Installation Type	Flexible, occasional movement or vibration	Special Applications (e.g. highly flexible, permanent movement, vibration or torsion)										
Cable Marking (at least)	"PROFINET Hybrid Type {B / C} {connector type standard} / {1 / 2 / 4}-Pair-Data-{dimension}mm² + {no.of pairs}x{no. of cores}x{dimension}mm² + ... (repeat content if needed) Text between { } defines content to be selected { } are not to be printed on the cable If signal/power cores are not implemented as pairs, "{no. of pairs}x" must not be applied. Order: all Data content > all Signal content > all Power content AWG values instead of mm² are allowed.  e.g. PROFINET Hybrid Type B IEC 61076-2-117 Type 3 / 1-Pair-Data-0,34mm² + 2x2x1,0mm²+ 5x4,0mm² PROFINET Hybrid Type B IEC 63171-7 Type 6 / 1-Pair-Data-AWG22 + 3xAWG14											
Data element	1x data element acc. to chapter 11.1 to 11.3 Deviations: If the chosen connector defines a smaller conductor cross section for the data element, the cross section has to be adjusted acc. to the connector definition. All values acc. to chapter 11.1 to 11.3 are applicable. Exception: conductor diameter/cross section, core diameter, conductor resistance  A sheath for the data element is optional. If a sheath is applied, the defined sheath values acc. to chapter 11.1 to 11.3 are not applicable.  Hybrid specification overrules the content of chapter 11.1 to 11.3 for data elements used within hybrid cables.											
Conductor Cross Section power/signal conductor <sup>A)</sup>	conductor dimensions ≤ 1,0 mm² (AWG18) stranded conductor min. 7-wire	Application specific										
	conductor dimensions > 1,0 mm² (AWG18) min. IEC 60228 class 5 has to be applied.	Application specific										
Power/Signal Core Outer diameter IEC 60811-203	maximum outer diameter of power/signal is acc. to the chosen connector acc. to chap. 15.4  For any power or signal core with rated voltage > 50 V and ≤ 1000 V AC following minimum average insulation wall thickness need to be applied: <table><tr><td>nominal wire cross section [mm²]</td><td>insulation wall thickness, minimum average [mm]</td></tr><tr><td>0,5-1,0</td><td>0,3</td></tr><tr><td>1,5-2,5</td><td>0,4</td></tr><tr><td>4,0-6,0</td><td>0,5</td></tr><tr><td>10,0</td><td>0,6</td></tr></table> insulation resistance: min. 1000 MOhm/m		nominal wire cross section [mm²]	insulation wall thickness, minimum average [mm]	0,5-1,0	0,3	1,5-2,5	0,4	4,0-6,0	0,5	10,0	0,6
nominal wire cross section [mm²]	insulation wall thickness, minimum average [mm]											
0,5-1,0	0,3											
1,5-2,5	0,4											
4,0-6,0	0,5											
10,0	0,6											
Power/Signal Core Identification	Identification of cores acc. to chap. 15.4 have to be applied.											
Cable Design	1 data element + further components acc. to chap. 15.4 have to be applied											
Further shielding	Necessity of further shielding is defined by the chosen connector acc. to chap. 15.4. If further shielding is applied:  <u>min. shielding over the overall assembly:</u> screen of copper wires optical coverage min. 80 % braid over defined assembly  <u>min. shielding over signal/power pairs:</u> application specific e.g. foil screen, braid, ...	Necessity of further shielding is defined by the chosen connector acc. to chap. 15.4. If further shielding is applied:  <u>min. shielding over the overall assembly:</u> Screen of copper wires optical coverage min. 80 % braid or min. 85 % for spiralized preferred braided screen  <u>min. shielding over signal/power pairs:</u> application specific e.g. foil screen, braid, ...										
Outer Cable Diameter IEC 60811-203	Outer diameter of the completed cable has to be within the limit acc. to the chosen connector acc. to chap. 15.4											
Colour (Outer Sheath)	Application Specific	Application Specific										
Electrical and Transmission Requirement:												
Conductor resistance data core <sup>A)</sup> IEC 60189-1	≥ 0,324 mm² (AWG22/7) ≤ 63 Ω/km	≥ 0,324 mm² (AWG22/...) ≤ 65 Ω/km										
	≥ 0,254 mm² (AWG23/7) ≤ 88,4 Ω/km	≥ 0,254 mm² (AWG23/...) ≤ 91 Ω/km										
	≥ 0,205 mm² (AWG24/7) ≤ 99 Ω/km	> 0,205 mm² AWG24/... ≤ 102 Ω/km										
	≥ 0,128 mm² (AWG26/7) ≤ 159 Ω/km	≥ 0,128 mm² AWG26/... ≤ 164 Ω/km										
Conductor resistance power/signal core IEC 60189-1	value acc. to chosen conductor standard + 4% caused by the extension of the multiple stranding production steps											
Data transmission data element <sup>A)</sup> ISO/IEC 11801-1 IEC 61156-1	acc. to chosen data element acc. to chap. 11.1 to 11.3 dimensions 0,14 to 0,25 mm² (AWG26 to AWG24) are to be measured by IEC 61156-6 or IEC 61156-12 dependend on the chosen data element											
Delay skew data element IEC 61156	acc. to chosen data element acc. to chap. 11.1 to 11.3											
Coupling attenuation data element EN 50289-1-6	acc. to chosen data element acc. to chap. 11.1 to 11.3 to be measured on the data element screen											
Ambient Condition Requirement:												
Operating temperature	-20°C ...+70°C											



<b>Mechanical Requirement:</b>			
<b>Type of cable</b>	<b>Test-Description</b>	<b>Measurement to be performed</b>	<b>Requirements</b>
Hybrid Type B	Flame retardancy	IEC 60332-1-2	Has to pass the test
	Pressure test at high temperature for insulation and sheaths	IEC 60811-508	Max. 50 %
	Heat shock test	IEC 60811-509	No cracks
	Tensile performance of the cable	EN 50289-3-16	50 N
	Crush test of the cable	IEC 62012-1	3000 N
Hybrid Type C	Application specific		

<b>Mechanical Requirement:</b>			
<b>Type of cable</b>	<b>Test-Description</b>	<b>Measurement to be performed</b>	<b>Requirements</b>
Hybrid Type B	Flame retardancy	IEC 60332-1-2	Has to pass the test
	Pressure test at high temperature for insulation and sheaths	IEC 60811-508	Max. 50 %
	Heat shock test	IEC 60811-509	No cracks
	Tensile performance of the cable	EN 50289-3-16	50 N
	Crush test of the cable	IEC 62012-1	3000 N
Hybrid Type C	Application specific		

Note A) AWG dimensions are given for information only.

## 12 Optical Fibre Cables

### 12.1 POF and PCF cables

**Table 11: POF and PCF Cable Specification**

<b>General Requirement:</b>	<b>Application Type B</b>	<b>Application Type C</b>
Cable Design	2 Plastic optical fibre or 2 polymer clad fibre data cables	
Cable Installation Type	stationary, flexible, depending on cable construction	Special Applications (e.g. highly flexible, permanent movement, vibration or torsion)
Cable Marking (at least)	PROFINET Type B + fibre type i.e.: PROFINET Type B 2P980/1000 PROFINET Type B 2K200/230	PROFINET Type C + fibre type i.e.: PROFINET Type C 2P980/1000 PROFINET Type C 2K200/230
Core/cladding diameter IEC 60811-203	POF: 980/1000 µm PCF: 200/230 µm	
Diameter secondary coating IEC 60811-203	POF: n. a. PCF: 0,5 mm ± 0,05 mm	

Colour (subcable)	orange + black orange with arrow (pointing direction of data stream)		
Diameter subcable IEC 60811-203	2,2 mm ± 0,1 mm		
Outer cable diameter IEC 60811-203	9,5 mm	Application Specific	
Colour (Outer Sheath)	Green RAL6018		
Transmission Requirement:			
Data Transmission IEC 60793-2	POF: A4a PCF: A3c		
Nominal wavelength	650 nm		
Bandwidth MHz referred to 100 m IEC 60793-1-41	POF: >=35 MHz PCF: >=70 MHz		
Maximum attenuation @650 nm; FWHM < 4 nm IEC 60793-1-40	POF: max. 160 dB/km PCF: max. 10 dB/km	POF: Application Specific PCF: Application Specific	
Numerical aperture IEC 60793-1-20	POF: 0,50 ± 0,05 PCF: 0,37 ± 0,04		
Ambient Condition Requirement:			
Operating temperature IEC 60794-1-2, Method F1	-20°C ...+70°C PCF: t1=24h; max. 1,5 dB/100 m (@650nm) POF: t1=24h; max. 2,5 dB/50 m (@650nm)		
Mechanical Requirement:			
Type of cable	Test-Description	Measurement to be performed	Requirements
Type B	Tensile performance long term of the cable	IEC 60794-1-2, Method E1	POF: 100 N; 45 m length; max. 1 dB ΔA (@ 650 nm)  PCF: 400 N; 100 m length; max. 1 dB ΔA (@ 650 nm)
	Bending radius	IEC 60794-1-2, Method E11A	>15 times cable diameter; 5 turns, 1 cycle, max. 1,0 dB (@ 650 nm)
Type C	Application specific		

## 12.2 All-silica single mode optical fibre cables

**Table 12: All-silica single mode optical fibre Cables Specification**

General Requirement:	Application Type B	Application Type C
Cable Design	2 All-silica single mode optical fibre data cable	
Cable Installation Type	stationary, flexible, depending on cable construction	Special Applications (e.g. highly flexible, permanent movement, vibration or torsion)
Cable Marking (at least)	PROFINET Type B + fibre type i.e.: PROFINET Type B 2E9/125	PROFINET Type C + fibre type i.e.: PROFINET Type C 2E9/125

Core/cladding diameter IEC 60811-203	9/125 μm		
Diameter secondary coating IEC 60811-203	1,4 mm ± 0,1 mm		
Colour (subcable)	orange + black orange with arrow (pointing direction of data stream)		
Diameter subcable IEC 60811-203	2,9 mm ± 0,1 mm		
Outer cable diameter IEC 60811-203	max. 9,5 mm	Application Specific	
Colour (Outer Sheath)	Green RAL6018		
Transmission Requirement:			
Data Transmission IEC 60793-2	B1		
Nominal wavelength	1310 nm		
Cut-off wavelength IEC 60793-1-44	< 1260 nm		
Maximum attenuation @1310 nm IEC 60793-1-40	0,5 dB/km	Application Specific	
Ambient Condition Requirement:			
Operating temperature IEC 60794-1-2, Method F1	-20°C ...+70°C 2 cycles; t1=24h; max. 1,0 dB/km (@ 1300 nm)		
Mechanical Requirement:			
Type of cable	Test-Description	Measurement to be performed	Requirements
Type B	Tensile performance long term of the cable	IEC 60794-1-2, Method E1	600 N; 100 m length; max. 1,0 dB ΔA (@ 1300 nm)
	Bending radius	IEC 60794-1-2, Method E11A	>15 times cable diameter 5 turns, 1 cycle, max. 0,1 dB (@ 1300 nm)
Type C	Application specific		

### 12.3 All-silica multimode optical fibre cables

**Table 13: All-silica multimode optical fibre cables Specification**

General Requirement:	Application Type B	Application Type C
Cable Design	2 All-silica multimode optical fibre data cable	
Cable Installation Type	stationary, flexible, depending on cable construction	Special Applications (e.g. highly flexible, permanent movement, vibration or torsion)
Cable Marking (at least)	PROFINET Type B + fibre type i.e.: PROFINET Type B 2G50/125 PROFINET Type B 2G62,5/125	PROFINET Type C + fibre type i.e.: PROFINET Type C 2G50/125 PROFINET Type C 2G62,5/125
Core/cladding diameter	50/125 µm 62,5/125 µm	

IEC 60811-203			
Diameter secondary coating IEC 60811-203	1,4 mm ± 0,1 mm		
Colour (subcable)	orange + black orange with arrow (pointing direction of data stream)		
Diameter subcable IEC 60811-203	2,9 mm ± 0,1 mm		
Outer cable diameter IEC 60811-203	max. 9,5 mm	Application Specific	
Colour (Outer Sheath)	Green RAL6018	Application Specific	
Transmission Requirement:			
Data Transmission IEC 60793-2	A1-OMx, A1-OM1		
Maximum link length	2000 m		
Nominal wavelength	1300 nm		
Bandwidth MHz referred to 1 km IEC 60793-1-41	>=500 MHz		
Maximum attenuation @1300 nm IEC 60793-1-40	1,5 dB/km	Application Specific	
Ambient Condition Requirement:			
Operating temperature IEC 60794-1-2, Method F1	-20°C ...+70°C 2 cycles; t1=24h; max. 1,0 dB/km (@ 1300 nm)		
Mechanical Requirement:			
Type of cable	Test-Description	Measurement to be performed	Requirements
Type B	Tensile performance long term of the cable	IEC 60794-1-2, Method E1	600 N; 100 m length; max. 1,0 dB ΔA (@ 1300 nm)
	Bending radius	IEC 60794-1-2, Method E11A	>15 times cable diameter 5 turns, 1 cycle, max. 0,1 dB (@ 1300 nm)
Type C	Application specific		

## 13 Connectors of PROFINET

### 13.1 Connectors of Type C

Connectors, which are optimized for the use of type C cable are permitted. These connectors can be matched to the cable in the following parameters. For type C cables the component approach is not supported. Connectors of Type C, which are harnessed in cabinet cords, can be matched. There is no vendor declaration for connectors harnessed in the cabinet cord set.

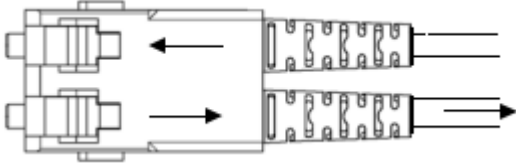
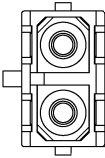

### 13.2 Connectors of Fibre Optic

A full set of tests as specified in ISO/IEC 61753-series shall be carried out for all fibre types for which PROFINET compliance is claimed. The test load of each test shall meet ISO/IEC 61753-series.

All test methods shall be in accordance with the standards of IEC 61300-series.

#### 13.2.1 SC-RJ-FO-Connector

**Table 14: Physical Layer of Connector according to IEC 61754-24**

PROFINET Connector Type:	PROFINET General Passive Component (GPC)  Fibre optic connector SC-RJ of inside enclosure according to Table 2
Standard:	IEC 61754-24
Figures (technical drawings):	
Interface:	 Connector front view
Product Example (picture):	

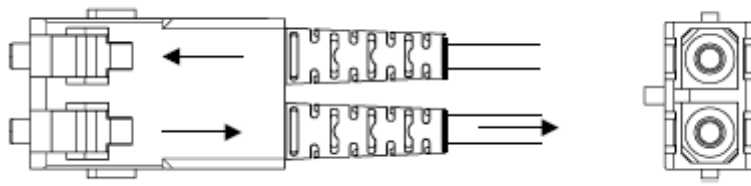
The SC-RJ Connector is the main connector for PROFINET fibre optic connections (POF and PCF)

**Table 15: Standard requirements of connector according to IEC 61754-24**

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-20°C – 70°C
Degree of protection (IEC 60529)	IP20;
Mechanical	
Mating cycles (mating & unmating)	750, according to IEC 61300-2-2
Cable Strain Relief	According to IEC 61300-2-4
Vibration, sinusoidal	Values according to Inside enclosure of Table 2
Shock, half-sine pulses	

**Table 16: Key characteristic according to IEC 61754-24**

Area	Key characteristic		
Robustness	Values according to Inside enclosure of Table 2		
Number of contacts	2 fibre ferrules		
Contacts (contact details, ...)	POF, PCF		
Locking mechanism	Push-Pull		
Wire Termination	Fibre termination: field assembled and pre-assembled Versions		
Outer Cable Diameters (range)	The connector shall be terminated onto PROFINET optical fibre cable		
Wire-Cross Section (AWG and mm <sup>2</sup> )	Nominal diameter cladding	POF 1000 µm PCF 230 µm	IEC 60793-2  A4a A3c
	Nominal diameter secondary coating	POF n. a. PCF 0,5 mm  Glass 900 µm	
Wire Diameter	subcable diameter	POF/PCF 2,2 mm	

**Figure 6: Contact Assignment IP 20 SC-RJ Fibre optic Connector (if applicable)****Table 17: Additional Requirements**

Mated pair transmission performance		
Maximum insertion loss	POF/PCF 1,5 dB Glass Multimode 0,75dB	IEC 61300-3-34

**13.2.2 SCRJ-FO-Push-Pull Connector****Table 18: Physical Layer of Connector according to IEC 61754-24-21**

PROFINET Connector Type:	PROFINET General Passive Component (GPC)  Fibre optic connector SC-RJ Push-Pull for outside enclosure according to Table 2
Standard:	IEC 61754-24-21
Figures (technical drawings):	
Interface:	Connector front and side view
Product Example (picture):	

**Description:**

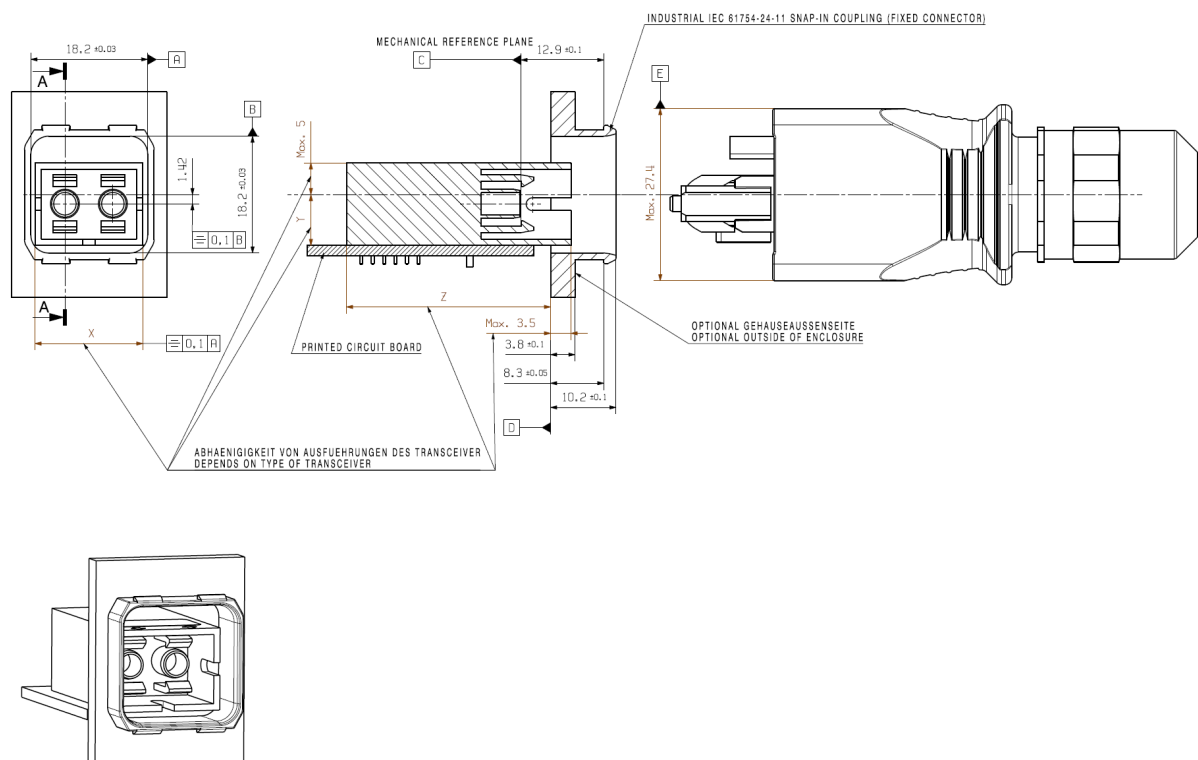
The SC-RJ connector with push pull housing is the main connector in harsh environments for PROFINET optical fibre connections and offers a universal system in conjunction with the IP20 environment. The connector is described IEC 61754-24-21.

**Table 19: Standard requirements of connectors according to IEC 61754-24-21**

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-20°C – 70°C
Degree of protection (IEC 60529)	According to outside enclosure of Table 2
Mechanical	
Mating cycles (mating & unmating)	According to IEC 61300-2-2
Cable Strain Relief	According to IEC 61300-2-4
Vibration, sinusoidal	Values of outside enclosure according to Table 2
Shock, half-sine pulses	

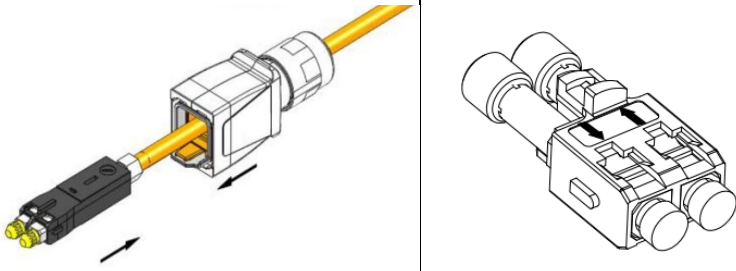
**Design integration:**

SC- RJ Push Pull connector: Only a SCRJ connector or a transceiver with mating face in accordance with IEC 61754-24-21 shall be used. The data required for mating compatibility to the Push Pull housing is specified in IEC 61076-3-107. The compliance to this standard is ensured by the device manufacturer.

**Figure 7: Design Integration Requirements**

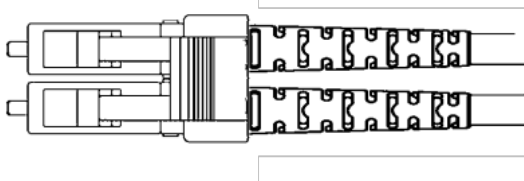



**Table 20: Key characteristics of connectors according to IEC 61754-24-21**

Area	Key characteristic		
Robustness	Values of outside enclosure according to Table 2		
Number of contacts	2 fibre ferrules		
Contacts (contact details, ...)	POF, PCF		
Locking mechanism	Push-Pull		
Wire Termination	Fibre termination: field assembled and pre-assembled Versions		
Outer Cable Diameters (range)	The connector shall be terminated onto PROFINET optical fibre cable		
Wire-Cross Section (AWG and mm <sup>2</sup> )	Nominal diameter cladding	POF 1000 µm PCF 230 µm Glass 125 µm	IEC 60793-2  A4a A3c A1-OMx, A1-OM1 and B.652, B654
	Nominal diameter secondary coating	POF n. a. PCF 0,5 mm Multimode 1,4 mm Singlemode 1,4 mm	
Wire Diameter	subcable diameter	POF/PCF 2,2 mm Multimode 2,9 mm Singlemode 2,9 mm	
contact assignment			

### 13.2.3 LC-FO-Connector

**Table 21: Connector according to IEC 61754-20**

PROFINET Connector Type:	PROFINET General Passive Component (GPC)  Fibre optic connector LC cabinet for single- and multi-mode fibre types
Standard:	IEC 61754-20
Figures (technical drawings):	 Transmit: Red boot Receive: Black boot
Product Example (picture):	

**Description:**

The LC Connector is the main connector for PROFINET multi and single mode glass fibre connections.

**Table 22: Standard requirements of connectors according to IEC 61754-20**

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	according to "Inside enclosure"
Degree of protection (IEC 60529)	according to "Inside enclosure"
Mechanical	
Mating cycles (mating & unmating)	750 According to IEC 61300-2-2
Cable Strain Relief	According to IEC 61300-2-4
Vibration, sinusoidal	According to inside enclosure of Table 2
Shock, half-sine pulses	

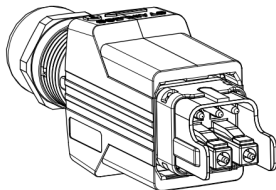
**Table 23: Key characteristics of connectors according to IEC 61754-20**

Area		Key characteristic	
Robustness		Values of inside enclosure according to Table 2	
Number of contacts		2 fibre ferrules	
Shielding		Not applicable	
Contacts (contact details, ...)		Different ferrule types for Multimode, Singlemode	
Board retention (SMT receptacle)		Not applicable	
Locking mechanism		Latch	
Wire Termination		Fibre termination field and pre-manufactured available	
Outer Cable Diameters (range)		The connector shall be terminated onto PROFINET optical fibre cable	
Wire-Cross Section (AWG and mm <sup>2</sup> )	Nominal diameter cladding	Glass 125 µm	IEC 60793-2 A1-OMx, A1-OM1 and B.652, B654
	Nominal diameter secondary coating	Multimode 1,4 mm Singlemode 1,4 mm	
Wire Diameter	subcable diameter	Multimode 2,9 mm Singlemode 2,9 mm	

Assignments of Connector Pins to Cable Pairs and Colours (if applicable)

#### 13.2.4 LC-FO-Connector Push Pull

**Table 24: Connector according to IEC 61076-3-123**

PROFINET Connector Type:	Fibre optic connector LC Push-Pull according to 61076-3-123
Standard:	IEC 61076-3-123
Figures (technical drawings):	

#### Particular Description:

The LC connector with push pull housing is an additional connector in harsh environments for PROFINET optical fibre connections and offers a universal system in conjunction with the IP20 environment.

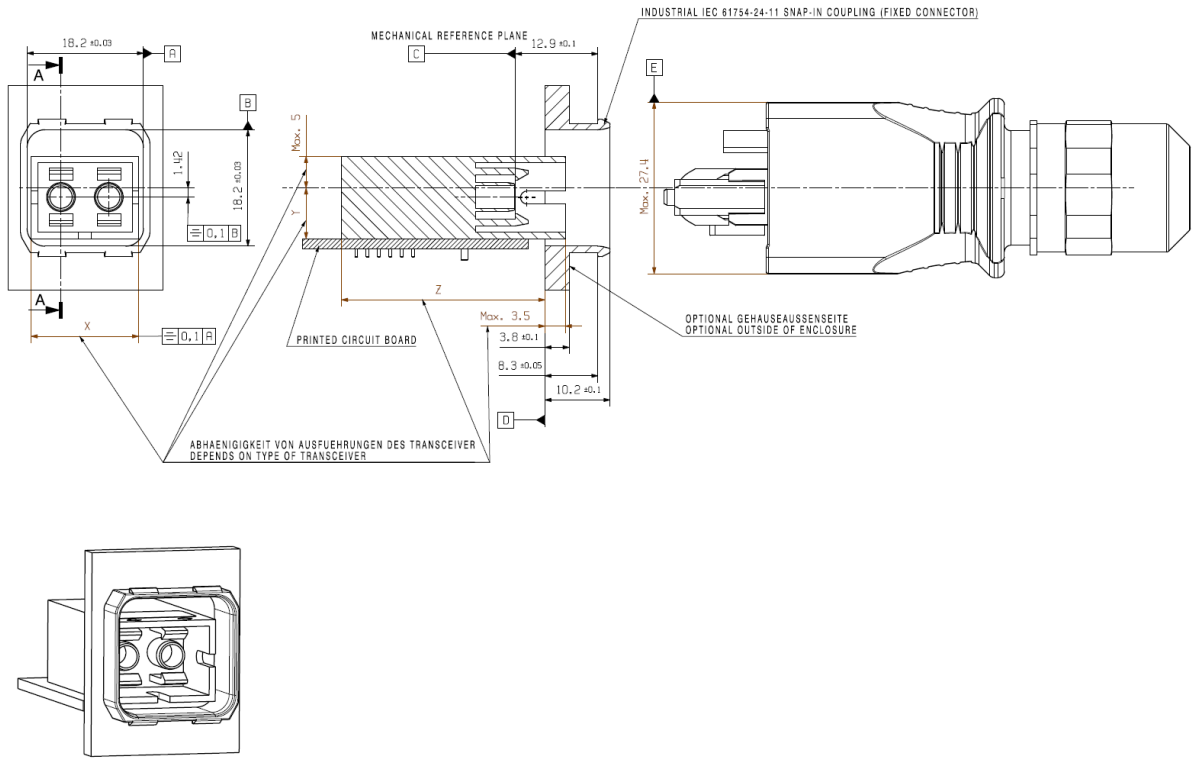
**Table 25: Standard requirements of connectors according to IEC 61076-3-123**

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature and Degree of protection (IEC 60529)	Values of outside enclosure according to Table 2
Mechanical	
Mating cycles (mating & unmating)	50, according to IEC 61300-2-2
Cable Strain Relief	According to IEC 61300-2-4
Vibration, sinusoidal	Values of outside enclosure according to Table 2
Shock, half-sine pulses	Values of outside enclosure according to Table 2

**Table 26: Key characteristics of connectors according to IEC 61076-3-123**

Robustness (housing, ....)		Values of outside enclosure according to Table 2	
Number of contacts		2 fibre ferrules	
Shielding		Not applicable	
Contacts (contact details, ...)		Different ferrule types for Multimode, Singlemode	
Board retention (SMT receptacle)		Not applicable	
Locking mechanism		Push-Pull	
Wire Termination		Fibre termination field and pre-manufactured available	
Outer Cable Diameters (range)		The connector shall be terminated onto PROFINET optical fibre cable	
Wire-Cross Section (AWG and mm <sup>2</sup> )	Nominal diameter cladding	Glass 125 µm	IEC 60793-2 A1-OMx, A1-OM1 and B.652, B654
	Nominal diameter secondary coating	Multimode 1,4 mm Singlemode 1,4 mm	
Wire Diameter	subcable diameter	Multimode 2,9 mm Singlemode 2,9 mm	

Figure 8: Design Integration Requirements



13.2.5 BFOC-FO-Connector

Table 27: Connector according to IEC 61754-2

PROFINET Connector Type:	PROFINET Legacy Passive Component (LPC) Fibre optic connector BFOC inside cabinet for all fibre types
Standard:	IEC 61754-2
Figures (technical drawings):	
Product Example (picture):	

Particular Description:

The ST™ connector (straight tip) is the standard connector type for installations. It is frequently used in local networks. A typical feature of the ST™ connector is the bayonet connection, also known as the BFOC connector (bayonet FO connector).

**Table 28: Standard requirements of connectors according to IEC 61754-2**

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	according to "Inside enclosure"
Degree of protection (IEC 60529)	according to "Inside enclosure"
Mechanical	
Mating cycles (mating & unmating)	50 According to IEC 61300-2-2
Cable Strain Relief	According to IEC 61300-2-4
Vibration, sinusoidal	Values of outside enclosure according to Table 2
Shock, half-sine pulses	Values of outside enclosure according to Table 2

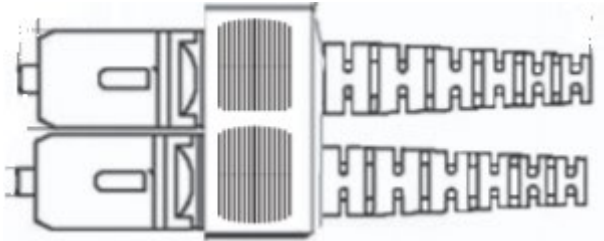


**Table 29: Key characteristics of connectors according to IEC 61754-2**

Robustness (housing, ....)		Values of outside enclosure according to Table 2	
Number of contacts		2 fibre ferrules	
Contacts (contact details, ...)		Different ferrule types for POF, PCF, Multimode, Singlemode	
Board retention (SMT receptacle)		Not applicable	
Locking mechanism		Bayonet	
Wire Termination		Fibre termination field and pre-manufactured available	
Outer Cable Diameters (range)		The connector shall be terminated onto PROFINET optical fibre cable	
Wire-Cross Section (AWG and mm <sup>2</sup> )	Nominal diameter cladding	POF 1000 µm PCF 230 µm Glass 125 µm	IEC 60793-2  A4a A3c A1-OMx, A1-OM1 and B.652, B654
	Nominal diameter secondary coating	POF n. a. PCF 0,5 mm Multimode 1,4 mm Singlemode 1,4 mm	
Wire Diameter	subcable diameter	POF/PCF 2,2 mm Multimode 2,9 mm Singlemode 2,9 mm	

Assignments of Connector Pins to Cable Pairs and Colours (if applicable)

### 13.2.6 SC-Duplex-FO-Connector

**Table 30: Connector according to IEC 61754-4**

PROFINET Connector Type:	PROFINET Legacy Passive Component (LPC)  Fibre optic connector SC-Duplex inside cabinet for all fibre types.
Standard:	IEC 61754-4
Figures (technical drawings):	
Interface:	
Product Example (picture):	

#### Particular Description

SC connectors are among the most popular optical connector systems worldwide.

Due to their good mechanical properties they achieve excellent optical measurement values.

**Table 31: Standard requirements of connectors according to IEC 61754-4**

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	Values of inside enclosure according to Table 2
Degree of protection (IEC 60529)	Values of inside enclosure according to Table 2
Mechanical	
Mating cycles (mating & unmating)	750, according to IEC 61300-2-2
Cable Strain Relief	According to IEC 61300-2-4
Vibration, sinusoidal	Values of inside enclosure according to Table 2
Shock, half-sine pulses	Values of inside enclosure according to Table 2

**Table 32: Key characteristics of connectors according to IEC 61754-4**

Robustness (housing, ....)		Values of inside enclosure according to Table 2	
Number of contacts		2 fibre ferrules	
Contacts (contact details, ...)		Different ferrule types for POF, PCF, Multimode, Singlemode	
Locking mechanism		Snap-in	
Wire Termination		Fibre termination field and pre-manufactured available	
Outer Cable Diameters (range)		The connector shall be terminated onto PROFINET optical fibre cable	
Wire-Cross Section (AWG and mm <sup>2</sup> )	Nominal diameter cladding	POF 1000 µm PCF 230 µm Glass 125 µm	IEC 60793-2  A4a A3c A1-OMx, A1-OM1 and B.652, B654
	Nominal diameter secondary coating	POF n. a. PCF 0,5 mm Multimode 1,4 mm Singlemode 1,4 mm	
Wire Diameter	subcable diameter	POF/PCF 2,2 mm Multimode 2,9 mm Singlemode 2,9 mm	

Assignments of Connector Pins to Cable Pairs and Colours (if applicable)

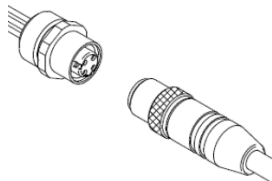
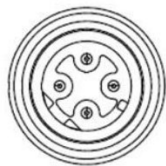



### 13.3 Connectors for Balanced Cable

#### 13.3.1 M12-2-Pair Connector for Balanced Cable

##### 13.3.1.1 M12-D 2-Pair Connector for Balanced Cable

**Table 33: Connectors according to IEC 61076-2-101 D code**

PROFINET Connector Type:	PROFINET General Passive Component (GPC) M12-D coded PROFINET Cat. 5 4way data connector for outside environment
Standard:	IEC 61076-2-101 M12-D coded
Figures (technical drawings):	
Interface:	
Product Example (picture):	

#### Particular Description:

M12-D 4-way data rugged circular connectors typically used for industrial process measurement and control. These connectors consist of fixed and free connectors either rewirable or no-rewirable, with M12x1 screw-locking. Suitable for inside & outside, typical applications are outside environmental with degree of protection IP65/IP67.

**Table 34: Standard requirements of connectors according to IEC 61076-2-101 M12-D coded**

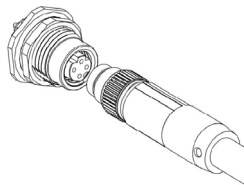
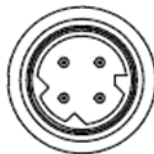

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-25 °C ... + 85 °C
Degree of protection	IP65, IP67 according to IEC 60529
Electrical	
Operating Voltage	50 V a.c. / 60 V d.c.
Current Rating	4 A
Voltage proof signal-shield	1,4 kV r.m.s
Transmission performance (category)	Cat. 5 according to ISO/IEC 11801-1
Mechanical	
Mating cycles (mating & unmating)	100 min. according to IEC 60512 test 9a
Cable Strain Relief	80 N min. according to IEC 61984, cable outer diameter 4...9 mm
Vibration, sinusoidal	10 Hz to 500 Hz and 0,35 mm or 50 m/s <sup>2</sup> according to IEC 60512 test 6d
Shock, half-sine pulses	50g, 11ms according to IEC 60512 test 6c

**Table 35: Key Characteristics according to IEC 61076-2-101 M12-D coded**

Robustness (housing, ....)	Values of outside enclosure according to Table 2
Number of contacts	4
Shielding	360° shielding suitable for Cat 5
Contacts (contact details, ...)	according to IEC 61076-2-101
Locking mechanism	Screw-Locking M12x1
Wire Termination	Screw, IDC, spring-type terminal; Crimp,
Outer Cable Diameters (range)	5,5...8,0 mm
Wire-Cross Section (AWG)	AWG 22
Wire Diameter	1,4...1,6 mm
Wire Construction (solid/stranded)	Solid, stranded
Colour Code, Signal, Pin and Pair assignment	see Annex F

### 13.3.2 M8-D 2-pair Connector for Balanced Cable

**Table 36: Connector according to IEC 61076-2-114 M8-D coded**

PROFINET Connector Type:	PROFINET Specific Passive Component (SPC) M8-D coded PROFINET Cat 5 4way data connector for outside environment
Standard:	IEC 61076-2-114 M8-D coded
Figures (technical drawings):	
Interface:	
Product Example (picture):	

#### Particular Description:

M8-D 4-way miniaturized data rugged circular connector typically used in industrial applications. These connectors consist of fixed and free connectors either rewirable or no-rewirable with M8x1 screw-locking. Suitable for inside & outside, typical applications are outside environmental with degree of protection IP65, IP67 and data transmission up to 100 MHz.

**Table 37: Standard requirements of connectors according to IEC 61076-02-114 M8-D coded**

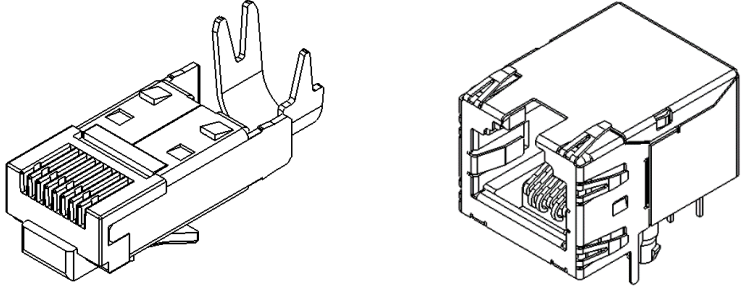
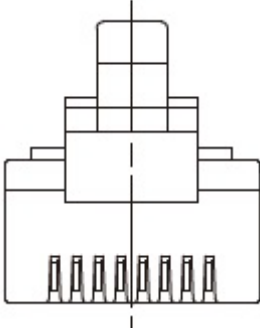
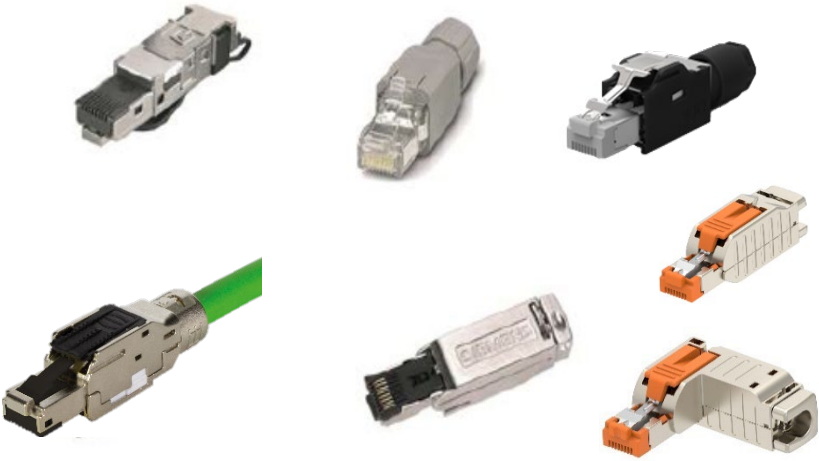
Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-25 °C ... + 85 °C
Degree of protection	IP65, IP67 according to IEC 60529
Electrical	
Operating Voltage	50 V a.c. / 60 V d.c.
Current Rating	4 A
Voltage proof signal-shield	0,84 kV rms
Transmission performance (category)	Cat. 5 according to ISO/IEC 11801-1
Mechanical	
Mating cycles (mating & unmating)	100 min. according to IEC 60512 test 9a
Cable Strain Relief	80 N min. according to IEC 61984, cable outer diameter 4...9 mm
Vibration, sinusoidal	10 Hz to 500 Hz and 0,35 mm or 50 m/s <sup>2</sup> according to IEC 60512 test 6d
Shock, half-sine pulses	50g, 11ms according to IEC 60512 test 6c

**Table 38: Key characteristics of connectors according to IEC 61076-2-114 M8-D coded**

Area	Key characteristic
Robustness (housing, ....)	Values of outside enclosure according to Table 2
Number of contacts	4
Shielding	360° shielding suitable for Cat 5
Contacts (contact details, ...)	according to IEC 61076-2-114 M8-D coded
Locking mechanism	Screw-Locking M8x1
Wire Termination	Screw, IDC, spring-type terminal; crimp,
Outer Cable Diameters (range)	5,5....8,0 mm
Wire-Cross Section (AWG)	AWG 22
Wire Diameter	1,4....1,6 mm
Wire Construction (solid/stranded)	Solid, stranded
Colour Code, Signal, Pin and Pair assignment	see Annex F

### 13.3.3 RJ45 2-pair Connector for Balanced Cable

**Table 39: Connector according to IEC 60603-7-3**

PROFINET Connector Type:	PROFINET General Passive Components (GPC) RJ45 IP20 Connector for Cabinet Connectivity (intern/intern and intern/extern), 2-Pair Balanced Cabling
Standard:	IEC 60603-7-3
Figures (technical drawings):	
Interface:	 Male connector (front view)
Product Example (picture):	

**Particular Description:**

RJ45 is to be considered as the standard interface to support cabling for PROFINET in inside environment.

**Table 40: Standard requirements of connectors according to IEC 60603-7-3**

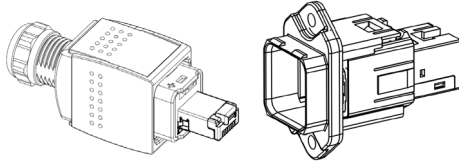
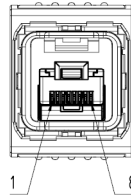

Standard/Requirement	Value
Climate / Environmental	
Ambient Temperature	-20 °C to 70 °C
Operating Temperature	-40 °C to 85 °C
Degree of protection (IEC 60529)	IP20
Electrical	
Operating Voltage	57 V d.c. (as defined by IEC 61984, clause 3.22)
Current Rating	600 mA per contact @ 70 °C
Voltage proof signal-shield	1500 V a.c. rms
Transmission performance (category)	Cat. 5
Mechanical	
Mating cycles (mating & unmating)	50 min.
Cable Strain Relief	According to IEC 61984
Vibration, sinusoidal	IEC 60512-6-4, test 6d: 10 Hz ... 500 Hz, 0,35 mm, 5 g max.
Shock, half-sine pulses	IEC 60512-6-3, test 6c: 50 g, 11 milliseconds (suitable for inside & outside)

**Table 41: Key characteristics of connectors according to IEC 60603-7-3**

Area	Key characteristic
Robustness	Values of inside enclosure according to Table 2
Number of contacts	4 pins in 8-pin housing, as defined in IEC 60603-7-3
Shielding	Yes, 360° shielding for EMI
Outer Cable Diameters (range)	5,5 mm – 9,0 mm
Wire Termination	Piercing or Insulation Displacement Connection (IDC)
Wire-Cross Section (AWG and mm <sup>2</sup> )	AWG 22 0,34 mm <sup>2</sup>
Wire Diameter	1,0 mm – 1,6 mm
Wire Construction (solid/stranded)	Solid and stranded
Colour Code, Signal, Pin and Pair assignment	see Annex F

### 13.3.4 RJ45 2-pair Push Pull Connector for Balanced Cable

**Table 42: Connector according to IEC 61076-3-117 (V14)**

PROFINET Connector Type:	PROFINET Specific Passive Components (SPC) RJ45 IP65/67 Connector (Connectors for Outside Environment (Balanced cabling))
Standard:	IEC 61076-3-117 Variant 14
Figures (technical drawings):	
Interface:	
Product Example (picture):	

**Particular Description:**

Very robust IP65/67 sealed RJ45 interface to support cabling for PROFINET.

This series represents the standard PROFINET device interface for the IP 65/67 environment of the German automobile manufacturing industry. This interface is dedicated for PROFINET connections between switch cabinets and outside machine parts or production equipment.

**Table 43: Standard requirements of connectors according to IEC 61076-3-117 Variant 14 with IEC 60603-7-3 or IEC 60603-7-5 (RJ45 interface 1)**

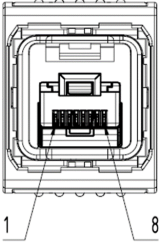
Standard/Requirement	Value
Climate / Environmental	
Ambient Temperature	-20 °C ... 70 °C
Operating Temperature	-40 °C ... 85 °C Values of inside and outside enclosure according to Table 2
Degree of protection (IEC 60529)	IP 65/67
Electrical	
Operating Voltage	57 V d.c. <sup>2)</sup>
Current Rating	600 mA per contact @ 70°C
Voltage proof signal-shield	1.500 V a.c. rms
Transmission performance (category)	Minimum Cat. 5
Mechanical	
Mating cycles (mating & unmating)	50 min.
Cable strain relief	according to IEC 61984
Vibration, sinusoidal	IEC 60512-6-4, test 6d: 10 Hz ... 500 Hz, 0,35 mm, 5 g max.
Shock, half-sine pulses	IEC 60512-6-3, test 6c: 50 g, 11 milliseconds (suitable for inside & outside)
<sup>1)</sup> RJ45 pinning compatibility applies only to the pins themselves. For full plug-in compatibility, the shape of the casing of industrial connectors shall also be taken into account. The specified RJ 45 receptacle (Jack) for "Outside" applications has to be mating compatible with the RJ 45 Plug, in accordance with IEC 60603-7.  <sup>2)</sup> As defined by IEC 61984, clause 3.22	

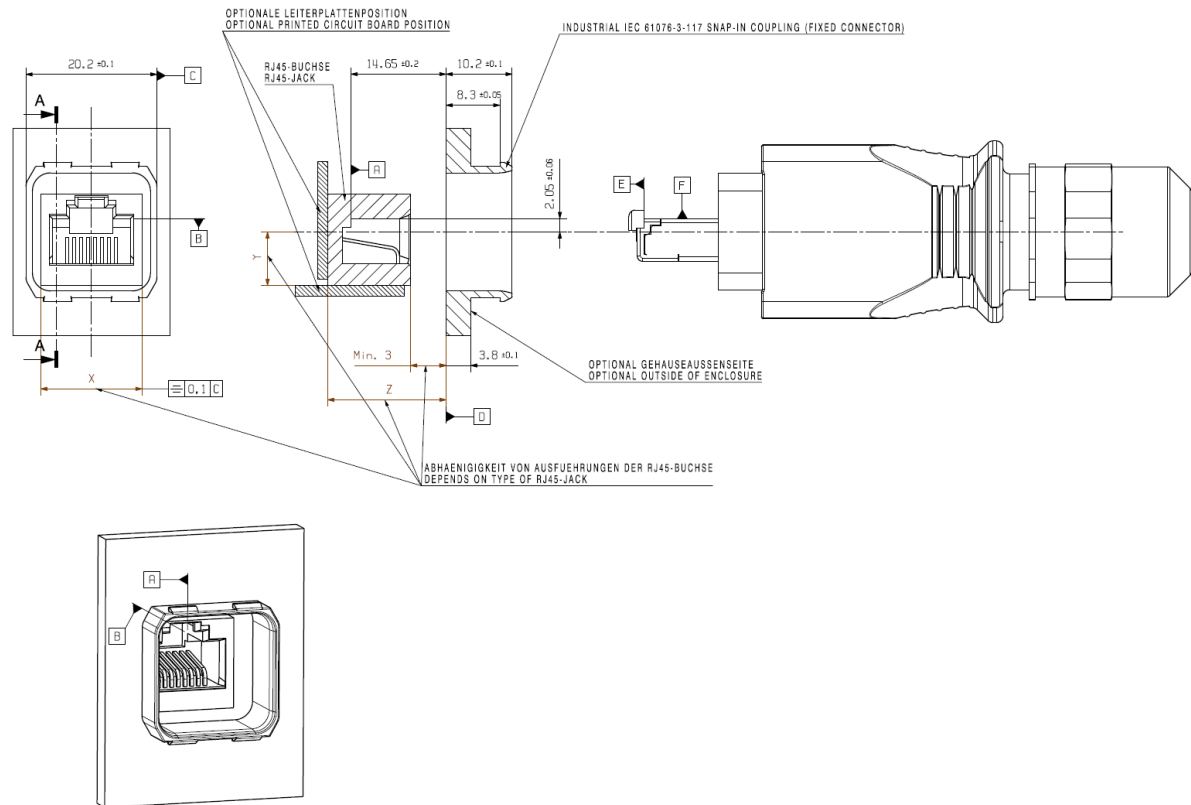


**Table 44: Standard requirements of connectors according to IEC 61076-3-117 Variant 14 and IEC 60603-7-3 or IEC 60603-7-5 (RJ45 interface 1))**

Area	Key characteristic
Robustness (housing, ....)	Values of inside enclosure according to Table 2
Number of contacts	RJ45 with 4 or 8 pins as defined in IEC 60603-7-3 or IEC 60603-7-5
Shielding	360° shielding vs. EMI noise, e.g. from rotating machines
Contacts (contact details)	RJ45 contact with 4 or 8 pins as defined in IEC 60603-7-3 or IEC 60603-7-5
Locking mechanism	Depending on the housing material with metal or plastic locking latch
Wire Termination	Insulation Displacement Connection (IDC) preferred to support field installation without special tooling
Outer Cable Diameters (range)	5,5 mm to 9,0 mm
Wire-Cross Section (AWG and mm <sup>2</sup> )	Data: AWG 22 – AWG 24 (0,34 mm <sup>2</sup> – 0,2 mm <sup>2</sup> )
Wire Diameter	1,0 mm – 1,6 mm
Wire Construction (solid/stranded)	Solid and stranded
Colour Code, Signal, Pin and Pair assignment	see Annex F

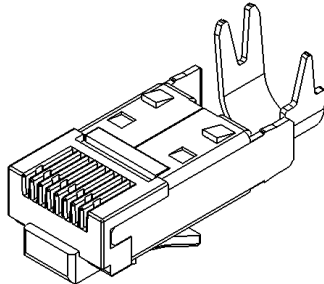
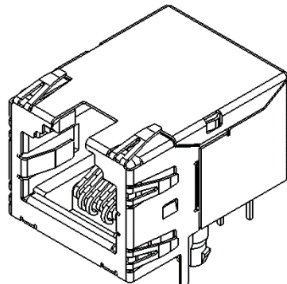
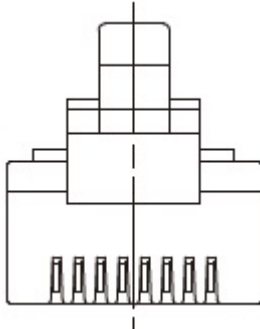

**Table 45: RJ45 pin and pair assignment for 4-pair cabling (10/100 Mbps and 1/10 Gbps)**

Connector				Cable		
 <p>Figure, IP65/67 RJ45 Interface</p>	Function	Signal	Contact	Function	Colour TIA-568A	Colour TIA-568B
	Bi-directional pair A+	BI_DA+	1	TD/RD 1	White/Green	White/Orange
	Bi-directional pair A-	BI_DA-	2		Green	Orange
	Bi-directional pair B+	BI_DB+	3	TD/RD 2	White/Orange	White/Green
	Bi-directional pair B-	BI_DB-	6		Orange	Green
	Bi-directional pair C+	BI_DC+	5	TD/RD 3	White/Blue	White/Blue
	Bi-directional pair C-	BI_DC-	4		Blue	Blue
	Bi-directional pair D+	BI_DD+	7	TD/RD 4	White/Brown	White/Brown
	Bi-directional pair D-	BI_DD-	8		Brown	Brown

**Figure 9: Design Integration Requirements**

### 13.3.5 RJ45-4-pair connector of balanced cable

**Table 46: RJ45 4-pair Connector according to IEC 60603-7-5**

PROFINET Connector Type:	PROFINET General Passive Components (GPC)  RJ45 IP20 Connector for Cabinet Connectivity (intern/intern and intern/extern), 4-Pair Balanced Cabling	
Standard:	IEC 60603-7-5	
Figures (technical drawings):		
Interface:	 Male connector (front view)	
Product Example (picture):		

**Particular Description:**

RJ45 is to be considered as the standard interface to support cabling for PROFINET in inside environment.

**Table 47: Standard requirements of connectors according to IEC 60603-7-5**

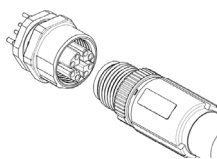


Standard/Requirement	Value
Climate / Environmental	
Ambient Temperature	-20 °C to 70 °C
Operating Temperature	-40 °C to 85 °C Values of inside enclosure according to Table 2
Degree of protection (IEC 60529)	IP20
Electrical	
Operating Voltage	57 V d.c. (as defined by IEC 61984, clause 3.22)
Current Rating	600 mA per contact @ 70 °C
Voltage proof signal-shield	1500 V a.c. rms
Transmission performance (category)	Cat. 5 / Cat. 6 / Cat. 6A
Mechanical	
Mating cycles (mating & unmating)	50 min.
Cable Strain Relief	According to IEC 61984
Vibration, sinusoidal	IEC 60512-6-4, test 6d: 10 Hz ... 500 Hz, 0,35 mm, 5 g max.
Shock, half-sine pulses	IEC 60512-6-3, test 6c: 50 g, 11 milliseconds (suitable for inside & outside)

**Table 48: Key characteristics of connectors according to IEC 60603-7-5**

Area	Key characteristic
Number of contacts	8 pins, as defined in IEC 60603-7
Shielding	Yes, 360° shielding for EMI
Outer Cable Diameters (range)	5,5 mm – 9,0 mm
Wire Termination	Piercing or Insulation Displacement Connection (IDC)
Wire-Cross Section (AWG and mm <sup>2</sup> )	AWG 24 – AWG 22 0,2 mm <sup>2</sup> – 0,34 mm <sup>2</sup>
Wire Diameter	1,0 mm – 1,6 mm
Wire Construction (solid/stranded)	Solid and stranded
Colour Code, Signal, Pin and Pair assignment	see Annex F

### 13.3.6 M12-X-coded 4-pair Connector for Balanced Cable

**Table 49: Connector according to IEC 61076-2-109 M12-X coded**

PROFINET Connector Type:	PROFINET General Passive Component (GPC) M12-X coded PROFINET Cat 5 8-way data connector for outside environment
Standard:	IEC 61076-2-109 M12-X coded
Figures (technical drawings):	
Interface:	
Product Example (picture):	

#### Particular Description:

M12-X 8 way (4 pair) rugged circular connector for data transmission frequencies up to 500 MHz typically used for industrial process measurement and data acquisition. These connectors consist of fixed and free connectors either rewirable or no-rewirable, with M12x1 screw-locking. Suitable for inside & outside, typical applications are outside environmental with degree of protection IP65, IP67.

**Table 50: Standard requirements of connectors according to IEC 61076-02-109 M12-X- coded**

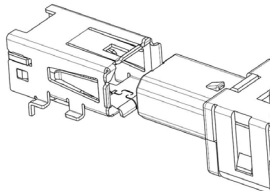
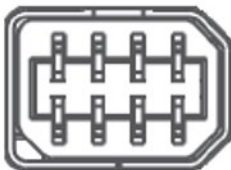

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-25 °C ... + 85 °C
Degree of protection	IP65, IP67 according to IEC 60529
Electrical	
Operating Voltage	50 V a.c. / 60 V d.c.
Current Rating	0,5 A (single contact 1 A; 0,25 mm <sup>2</sup> wire gauge)
Voltage proof signal-shield	0,5 kV rms
Transmission performance (category)	Cat. 5 – Cat. 6 <sub>A</sub> according to ISO/IEC 11801-1
Mechanical	
Mating cycles (mating & unmating)	100 min. according to IEC 60512 test 9a for Gold contacts
Cable Strain Relief	80 N min. according to IEC 61984, cable outer diameter 4...9 mm
Vibration, sinusoidal	10 Hz to 500 Hz and 0,35 mm or 50 m/s <sup>2</sup> according to IEC 60512 test 6d
Shock, half-sine pulses	50 g, 11 ms according to IEC 60512 test 6c

**Table 51 Key characteristics of connectors according to IEC 61076-2-109 M12-X coded**

Area	Key characteristic
Robustness (housing, ....)	Values of outside enclosure according to Table 2
Number of contacts	8
Shielding	360° shielding suitable for min. Cat. 5
Contacts (contact details, ...)	according to IEC 61076-2-109
Locking mechanism	Screw-Locking M12x1
Wire Termination	Screw, IDC, spring-type terminal; Crimp,
Outer Cable Diameters (range)	5,5....9,0 mm
Wire-Cross Section (AWG)	AWG 22, AWG 24
Wire Diameter	1,0....1,6 mm
Wire Construction (solid/stranded)	Solid, stranded
Colour Code, Signal, Pin and Pair assignment	see Annex F

### 13.3.7 IEC 61076-3-122 miniaturized 4-pair Connector for Balanced Cable

**Table 52: Connector according to IEC 61076-3-122**

PROFINET Connector Type:	PROFINET Specific Passive Components (SPC) M2M connectivity miniaturized and peripheral cabinet connectivity miniaturized	
Standard:	IEC 61076-3-122	
Figures (technical drawings):		
Interface: Type 1 - Male connector (front view)		
Product Example (picture):		



**Table 53: Standard requirements of connectors according to IEC 61076-3-122**

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-55 °C ... 85 °C, values of inside and outside enclosure according to Table 2
Degree of protection (IEC 60529)	IP20
Electrical	
Operating Voltage	50 V a.c. rms / 60 V d.c.
Current Rating	1 A *
Voltage proof signal-shield	1.500 V a.c. rms
Transmission performance (category)	Cat. 5 / Cat. 6A
Mechanical	
Mating cycles (mating & unmating)	750 min.
Cable Strain Relief	50 N min.
Vibration, sinusoidal	10 Hz ... 55 Hz, 1,55 mm, 10g max. 10 Hz ... 500 Hz, 0,35 mm, 5g max.
Shock, half-sine pulses	50 g, 11 milliseconds (suitable for inside & outside)
* As given by the current-temperature derating in IEC 61076-3-122 Ed.2 for T=60 °C	

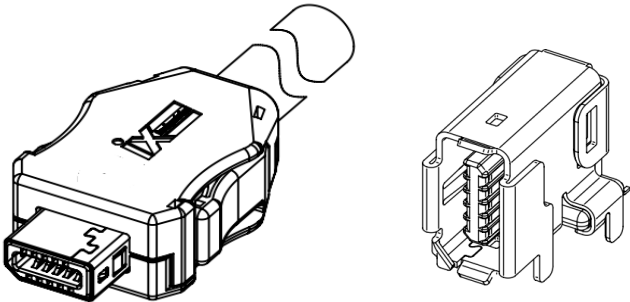
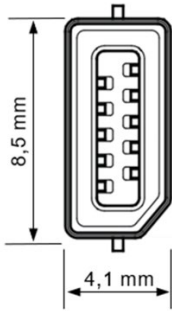

**Table 54: Key characteristics of connectors according to IEC 61076-3-122**

Area	Key characteristic
Robustness (housing, ....)	Inside enclosure according to Table 2
Number of contacts	8
Shielding	High performance 360° shielding, through die-cast housing or by stamped and formed shielding
Contacts (contact details, ...)	Two redundant contact points per contact (16 contact points per 8 contacts), increasing resilience to physical shock and vibration
Receptacle board retention & positioning	<ul style="list-style-type: none"> <li>SMT solder pads at &gt;2 positions</li> <li>THT/wave soldering with &gt;2 through-hole anchors</li> <li>2 board positioning pins</li> </ul>
Locking mechanism	<ul style="list-style-type: none"> <li>Metal latching mechanism</li> <li>Dimension and shape of latch optimized for high packaging density</li> <li>Operation without tool or with standard tool (e.g. screwdriver)</li> </ul>
Wire Termination	<ul style="list-style-type: none"> <li>Field install-ability</li> <li>IEC 60352-3, -4 and -6</li> <li>High transmission performance up to Cat. 6A by controlled wire positioning</li> </ul>
Outer Cable Diameters (range)	4,7 mm – 8,2 mm
Wire-Cross Section (AWG and mm <sup>2</sup> )	AGW 22 – AWG 26 0,14 mm <sup>2</sup> – 0,34 mm <sup>2</sup>

Wire Diameter	0,9 mm – 1,6 mm
Wire Construction (solid/stranded)	Solid and stranded
Colour Code, Signal, Pin and Pair assignment	see Annex F

13.3.8 IEC 61076-3-124 miniaturized 4-pair Connector for Balanced Cable

Table 55: Connector according to IEC 61076-3-124

PROFINET Connector Type:	PROFINET Specific Passive Components (SPC)  Cabinet connectivity (intern/intern and intern/extern) miniaturized
Standard:	IEC 61076-3-124
Figures (technical drawings):	
Interface Type A Male connector (front view):	
Product Example (picture):	
* Device manufacturers are General to integrate a socket with Type A.	

**Particular Description:**

Specific miniaturized PROFINET 2/4-pair connector, particularly suited for Cabinet connectivity (intern/intern and intern/extern) miniaturized.

**Table 56: Standard requirements of connectors according to IEC 61076-3-124**

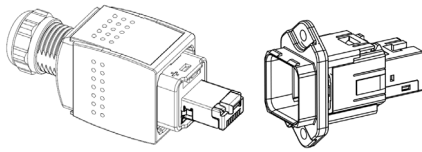
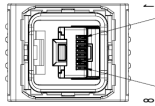

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-40 °C to 85 °C
Degree of protection (IEC 60529)	IP20
Electrical	
Operating Voltage	50 V a.c. rms / 60 V d.c.
Current Rating	1,5 A *
Voltage proof signal-shield	2.250 V d.c.
Transmission performance (category)	Cat. 5 / Cat. 6A
Mechanical	
Mating cycles (mating & unmating)	2.500 min.
Cable Strain Relief	80 N min.
Vibration, sinusoidal	10 Hz ... 500 Hz, 0,35 mm, 50 m/s <sup>2</sup> max.
Shock, half-sine pulses	300 m/s <sup>2</sup> max., 11 milliseconds, 18 shocks
* all pins used simultaneously and T <sub>amb.</sub> = 40 °C	

**Table 57: Key characteristics of connectors according to IEC 61076-3-124**

Area	Key characteristic
Robustness	Inside enclosure according to Table 2
Number of contacts	10
Shielding	Yes, 360° shielding for EMI
Outer Cable Diameters (range)	6,3 mm – 7,2 mm
Wire-Cross Section (AWG and mm <sup>2</sup> )	AWG 28 – AWG 22 0,08 mm <sup>2</sup> – 0,33 mm <sup>2</sup>
Wire Diameter	0,95 mm – 1,60 mm
Wire Construction (solid/stranded)	Solid and stranded
Colour Code, Signal, Pin and Pair assignment	see Annex F

### 13.3.9 RJ45 PushPull 4-pair Connector for Balanced Cable

**Table 58: Connector according to IEC 61076-3-117 (V14)**

PROFINET Connector Type:	PROFINET Specific Passive Components (SPC) RJ45 IP65/67 Connector (Connectors for Outside Environment (Balanced cabling))
Standard:	IEC 61076-3-117 Variant 14
Figures (technical drawings):	
Interface:	 IP 65/67 covered RJ45 interface with Push Pull locking
Product Example (picture):	

#### Particular Description:

Very robust IP65/67 sealed RJ45 interface to support cabling for PROFINET.

This series represents the standard PROFINET device interface for the IP 65/67 environment of the German automobile manufacturing industry. This interface is dedicated for PROFINET connections between switch cabinets and outside machine parts or production equipment.

**Table 59: Standard requirements of connectors according to IEC 61076-3-117 Variant 14 and IEC 60603-7-3 (RJ45 interface 1))**

Standard/Requirement	Value
Climate / Environmental	
Ambient Temperature Operating Temperature	-20 °C ... 70 °C -40 °C ... 85 °C Suitable for inside & outside enclosure according to Table 2
Degree of protection (IEC 60529)	IP 65/67
Electrical	
Operating Voltage	57 V d.c. <sup>2)</sup>
Current Rating	600 mA per contact @ 70°C
Voltage proof signal-shield	1.500 V a.c. rms
Transmission performance (category)	Minimum Cat. 5
Mechanical	
Mating cycles (mating & unmating)	50 min.
Cable strain relief	according to IEC 61984
Vibration, sinusoidal	IEC 60512-6-4, test 6d: 10 Hz ... 500 Hz, 0,35 mm, 5 g max.
Shock, half-sine pulses	IEC 60512-6-3, test 6c: 50 g, 11 milliseconds Suitable for inside & outside enclosure according to Table 2
<sup>1)</sup> RJ45 pinning compatibility applies only to the pins themselves. For full plug-in compatibility, the shape of the casing of industrial connectors shall also be taken into account. The specified RJ 45 receptacle (Jack) for "Outside" applications has to be mating compatible with the RJ 45 Plug, in accordance with IEC 60603-7.  <sup>2)</sup> As defined by IEC 61984, clause 3.22	

### 13.4 PROFINET Connector for hybrid Cabling

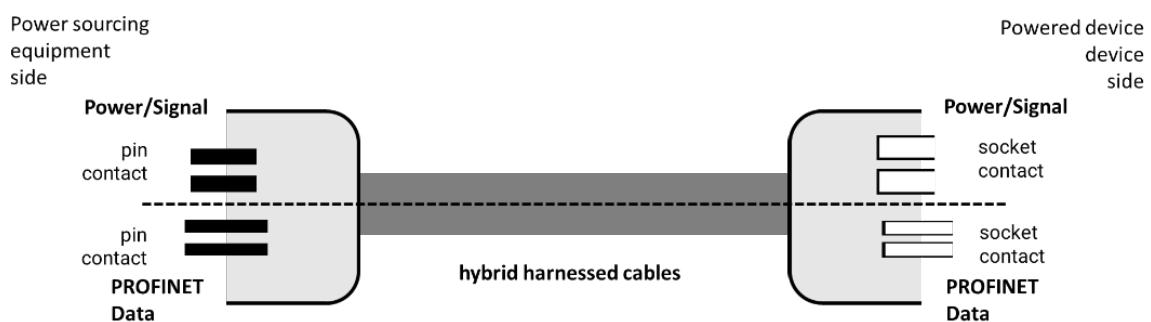
Generally, PROFINET hybrid harnesses have pins on one side and socket on the other side

Active devices with the Hybrid interface can deliver power to other devices or will be powered via this hybrid interface. For this point it is very important also define the type of interface for power sourcing equipment (PSE) or powered devices (PD).

Power delivering ports shall use the female Hybrid interface.

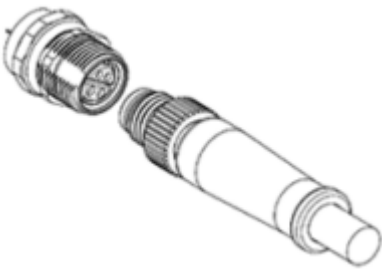
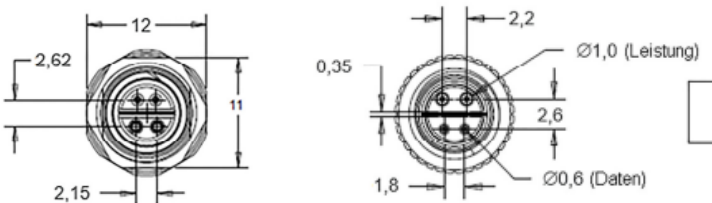

Powered ports shall use the male Hybrid interface.

**Figure 10: Hybrid Cabling**



### 13.4.1 M8 Hybrid SPE connectors according to IEC 63171-6 T1 Industrial Style

**Table 60: SPE connectors according to IEC 63171-6 T1 Industrial Style – Type M8 Hybrid**

PROFINET Connector Type:	PROFINET Specific Passive Components (SPC)
Standard:	IEC 63171-6
Figures (technical drawings):	
Interface Type (front view):	
Product Example (picture):	

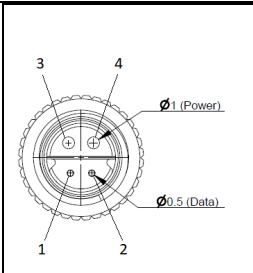
#### Particular Description:

M8 Hybrid SPE 2-way data + 2-way power miniaturized data rugged circular connector typically used in industrial applications to deliver SPE and power to small devices. These connectors consist of fixed and free connectors either rewirable or no-rewirable with M8x1 screw-locking. Suitable for inside & outside, typical applications are outside environmental with degree of protection IP65/IP67 and data transmission up to 600 MHz.

**Table 61: Standard requirements of connectors according to IEC 63171-6**

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-40 ... +85 °C
Degree of protection (IEC 60529)	IP65 / IP67
Electrical	
Operating Voltage based on: Rated Voltage Power Rated Voltage Data	50V AC / 60V DC 50V AC / 60V DC
Current Rating Power Current Rating Data	8A 1,5A
Voltage proof contact-contact Voltage proof contact-shield	1000V DC 1500V DC
Transmission performance (category)	Cat. B according to IEC 63171
Mechanical	
Mating cycles (mating & unmating)	100 min.
Cable Strain Relief	according to IEC 61984
Vibration, sinusoidal	10 Hz to 500 Hz and 0,35 mm or 50 m/s <sup>2</sup> according to IEC 60512 test 6d
Shock, half-sine pulses	50 g, 11 ms according to IEC 60512 test 6c

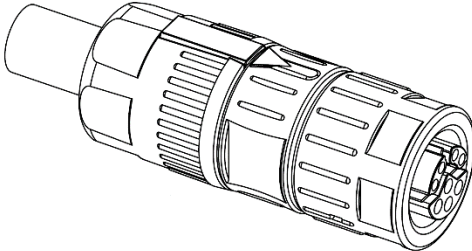
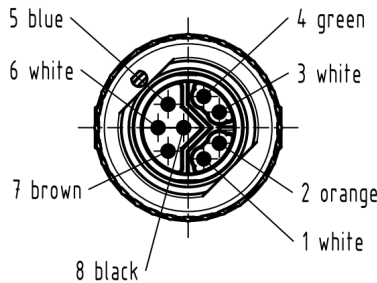

**Table 62: Key characteristics of connectors according to IEC 63171-6**

Area	Key characteristic			
Robustness	Outside enclosure			
Number of contacts	4			
Shielding	Data element mandatory, overall assembly optional			
Outer Cable Diameters (range)	7,5 mm max.			
Wire-Cross Section (AWG and mm²)	Power: 0,82mm² / (AWG 18) Data: 0,14mm² ... 0,25mm² / (AWG 26 ... 24) only in combination data & power			
Core Diameter	Power: 1,80 mm max. Data: 1,7 mm max.			
Wire Construction (solid/stranded)	stranded			
Colour Code, Signal, Pin and Pair assignment		Contact No.	Signal	Wire colour
		1	BI_DA+	Blue
		2	BI_DA-	White
		3	U	Red
		4	GND	Black



### 13.4.2 M12 Type Y

**Table 63: M12-Y Hybrid Connector according to IEC 61076-2-113**

PROFINET Connector Type:	PROFINET Specific Passive Components (SPC)
Standard:	IEC 61076-2-113 Type 4
Figures (technical drawings):	
Interface Type (front view):	
Product Example (picture):	

#### Particular Description:

M12-Y 4-way data + 4-way power rugged circular connectors typically used for industrial process measurement and control. These connectors consist of fixed and free connectors either rewirable or no-rewirable, with M12x1 screw-locking. Suitable for inside & outside, typical applications are outside environmental with degree of protection IP65/IP67 and data transmission up to 100 MHz.

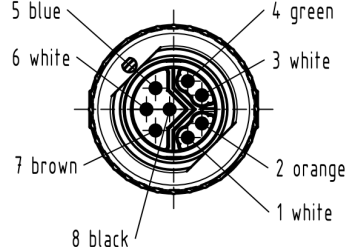
**Table 64: Standard requirements of M12-Y connector according to IEC 61076-2-113**

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-40 ... +85 °C
Degree of protection (IEC 60529)	IP65 / IP67
Electrical	
Operating Voltage based on: Rated Voltage Power Rated Voltage Data	50 V AC / 60 V DC 50 V AC / 60 V DC
Current Rating Power Current Rating Data	6 A 0,5 A
Voltage proof contact-shield Power Voltage proof contact-shield Data	0,65 kV AC rms 0,65 kV AC rms
Transmission performance (category)	Cat. 5, according to ISO/IEC 11801-1
Mechanical	
Mating cycles (mating & unmating)	100 min.
Cable Strain Relief	according to IEC 61984
Vibration, sinusoidal	10 Hz to 500 Hz and 0,35 mm or 50 m/s <sup>2</sup> according to IEC 60512 test 6d
Shock, half-sine pulses	50 g, 11 ms according to IEC 60512 test 6c

**Table 65: Key characteristics of M12-Y connector according to IEC 61076-2-113**

Area	Key characteristic
Robustness	Outside enclosure
Number of contacts	4 data contact + 4 power contacts
Shielding	Data element mandatory, overall assembly optional
Outer Cable Diameters (range)	8.8 mm max.
Wire-Cross Section (AWG and mm <sup>2</sup> )	Power: 0,5 ... 0,85mm <sup>2</sup> (AWG 20 ... 18) Data: 0,14mm <sup>2</sup> ... 0,25mm <sup>2</sup> (AWG 26 ... 24)
Core Diameter	Power: 1,8 mm max. Data: 1,6 mm max.
Wire Construction (solid/stranded)	stranded

**Table 66: Pin assignment M12-Y connector according IEC 61076-2-113**

Connector according to IEC61076-2-113 – Y-coded 8 way				Wire Colour	
	Function	Power / Signal	Contact	Colour ANSI/TIA	Colour PROFINET
	Transmit +	TX +	1	WHITE/ORANGE	YELLOW
	Transmit -	TX -	2	ORANGE	ORANGE
	Receive +	RX +	3	WHITE/GREEN	WHITE
	Receive -	RX -	4	GREEN	BLUE
	Masse 1M (Non-Switched)	N1	5		BLUE
	Masse 2M (Switched)	N2	6		WHITE
	24V (1L+ Non-switched)	L1	7		BROWN
	24V (2L+ Switched)	L2	8		BLACK
	Colour (insulation body):	BLACK			

13.4.3 M12 Hybrid SPE connectors according to IEC 63171-7 Type II

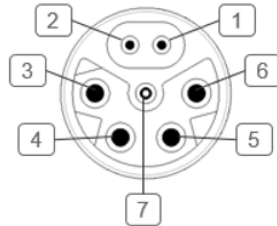
Table 67: M12 Hybrid SPE connectors according to IEC 63171-7 Type II

PROFINET Connector Type:	PROFINET Specific Passive Components (SPC)
Standard:	IEC 63171-7
Figures (technical drawings):	
Interface Type (front view):	
Product Example (picture):	

**Table 68: Standard requirements of M12 Hybrid SPE connectors according to IEC 63171-7 Type II**

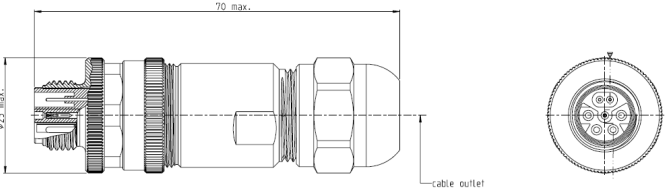
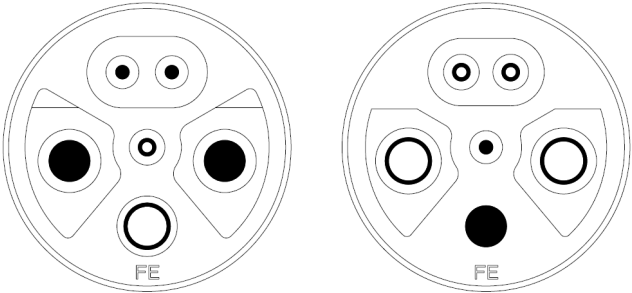

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-40 ... +90 °C
Degree of protection (IEC 60529)	IP65 / IP67
Electrical	
Operating Voltage based on: Rated Voltage Power Rated Voltage Data	50V 50V
Current Rating Power Current Rating Data	2 x 8A (16A) 2A
Voltage proof contact-shield Data	1.500 V a.c. rms
Transmission performance (category)	Cat. B according to IEC 63171
Mechanical	
Mating cycles (mating & unmating)	100 min.
Cable Strain Relief	according to IEC 61984
Vibration, sinusoidal	10 Hz to 500 Hz and 0,35 mm or 50 m/s <sup>2</sup> according to IEC 60512 test 6d
Shock, half-sine pulses	50 g, 11 ms according to IEC 60512 test 6c

**Table 69: Key characteristics of M12 Hybrid SPE connectors according to IEC 63171-7 Type II**

Area	Key characteristic			
Robustness	Outside enclosure			
Number of contacts	Up to 7			
Shielding	Data element mandatory, overall assembly optional			
Outer Cable Diameters (range)	11,5 mm max			
Wire-Cross Section (AWG and mm <sup>2</sup> )	Power: 1,5 mm <sup>2</sup> (AWG 16) Data: 0,14 mm <sup>2</sup> – 0,38 mm <sup>2</sup> ( AWG 26 .. 22)			
Core Diameter	Power: 2,10 mm max. Data: 1,6 mm max.			
Wire Construction (solid/stranded)	stranded			
Colour Code, Signal, Pin and Pair assignment		Contact No.	Signal/Power	Wire colour
		1	BI_DA+	Blue
		2	BI_DA-	White
		3	L1	BN
		4	N2	WH
		5	N1	BU
		6	L2	BK
		7	Shield	

13.4.4 M12 Hybrid SPE connectors according to IEC 63171-7 Type VI

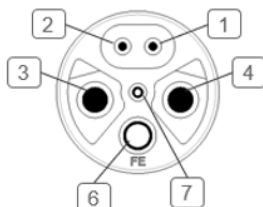
Table 70: M12 Hybrid SPE connectors according to IEC 63171-7 Type VI

PROFINET Connector Type:	PROFINET Specific Passive Components (SPC)
Standard:	IEC 63171-7
Figures (technical drawings):	
Interface Type (front view):	
Product Example (picture):	

**Table 71: Standard requirements of M12 Hybrid SPE connectors according to IEC 63171-7 Type VI**

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-40 ... +90
Degree of protection (IEC 60529)	IP65 / IP67
Electrical	
Operating Voltage based on: Rated Voltage Power Rated Voltage Data	50V 50V
Current Rating Power Current Rating Data	16A 2A
Voltage proof contact-shield Data	1.500 V a.c. rms
Transmission performance (category)	Cat. B according to 63171
Mechanical	
Mating cycles (mating & unmating)	100 min.
Cable Strain Relief	according to IEC 61984
Vibration, sinusoidal	10 Hz to 500 Hz and 0,35 mm or 50 m/s <sup>2</sup> according to IEC 60512 test 6d
Shock, half-sine pulses	50 g, 11 ms according to IEC 60512 test 6c


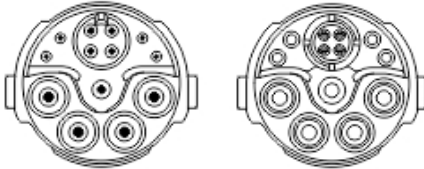

**Table 72: Key characteristics of M12 Hybrid SPE connectors according to IEC 63171-7 Type VI**

Area	Key characteristic			
Robustness	Outside enclosure			
Number of contacts	VI			
Shielding	Data element mandatory, overall assembly optional			
Outer Cable Diameters (range)	11,5 mm max.			
Wire-Cross Section (AWG and mm <sup>2</sup> )	Power: 2,5mm <sup>2</sup> (AWG 14) Data: 0,14 mm <sup>2</sup> .. 0,38 mm <sup>2</sup> (AWG26 .. 29)			
Core Diameter	Power: 2,4 mm max. Data: 1,6 mm max.			
Wire Construction	stranded			
Pin and Pair assignment		Contact No.	Signal	Wire colour
		1	BI_DA+	Blue
		2	BI_DA-	White
		3	L1	BN
		4	N1	BU
		6	FE	PK
		7	Shield	



### 13.4.5 M23 Hybrid connectors according to IEC 61076-2-117 Type 3

**Table 73: M23 Hybrid connectors according to IEC 61076-2-117 Type 3**

PROFINET connector Type:	PROFINET Specific Passive Components (SPC)  Hybrid connectivity (Ethernet-, signal- and power contacts) for cabling outside cabinet environment
Standard:	IEC 61076-2-117 M23 Type 3 (under preparation)
Figures (technical drawings):	
Interface:  IP 65/67 covered data insert with 4 contacts, 4 signal contacts and 4 power contacts with PE	
Product Example (picture):	

#### Particular Description:

Very robust IP65/67 circular connector interface with 4 signal- and power contacts to support hybrid cabling for PROFINET and separate powering. This interface is dedicated for heavy duty connections between switch cabinets and field devices as intelligent machine parts or production equipment.

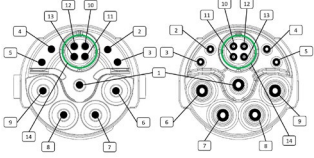
The hybrid plug connector is to be used where decentralized field devices are to be connected via combined plug connector for data and power supply. A complete contact-protected plug connector enables the use of the same plug connectors at both ends because no pin-socket change is necessary. The data interface is based on a 2 pair data insert. The signal interface consists of 4 contacts for 50V / 8A intended for emergency stop control voltage. The power interface consists of 4 contacts for 600 V / 30 A and is intended for the permanent control voltage.

The power interface offers 4 power contacts for 30 A, for 600 V AC or 800V DC applications.

**Table 74: Standard requirements of M23 Hybrid connectors according to IEC 61076-2-117 Type 3**

Standard/Requirement	Value
Climate / Environmental	
Climatic category A	-40 °C ... 115 °C
Climatic category B	-25 °C ... 85 °C (suitable for inside & outside)
Degree of protection (IEC 60529)	IP 65/67
Electrical	
Operating Voltage based on:	
Rated Voltage Power	600 V
Rated Voltage Signal	50 V
Rated Voltage Data	50 V
Current Rating Power	30 A
Current Rating Signal	8 A
Current Rating Data	2 A
Voltage proof Data-shield	1.500 V a.c. rms
Transmission performance (category)	Cat. 5 IEC 11801
Mechanical	
Mating cycles (mating & unmating)	PL1 ; PL2 ; PL3 according to IEC 61076-2-117 table 55
Cable strain relief	according to IEC 61984
Vibration, sinusoidal	10 Hz to 500 Hz and 0,35 mm or 50 m/s <sup>2</sup> according to IEC 60512 test 6d
Shock, half-sine pulses	50 g, 11 ms according to IEC 60512 test 6c

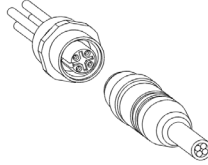
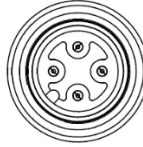

**Table 75: Key characteristics of M23 Hybrid connectors according to IEC 61076-2-117 Type 3**

Area	Key characteristic			
Robustness	Outside enclosure			
Number of contacts	Up to 13			
Shielding	Data element mandatory, signal pair optional, overall assembly optional			
Outer Cable Diameters (range)	5,5 mm to 17,0 mm			
Wire-Cross Section (AWG and mm <sup>2</sup> )	Power: max. 4 mm <sup>2</sup> (AWG 12) Signal: max. 1 mm <sup>2</sup> (AWG 18) Data: 0,32-0,38 mm <sup>2</sup> (AWG 22)			
Core Diameter	Power: max. 4,1 mm Signal: max. 2,1 mm Data: max. 1,6 mm			
Wire Construction	stranded			
		Contact No.	Signal	Wire colour
		1	PE	GNYE
		2	Signal	Application specific
		3	Signal	Application specific
		4	Signal	Application specific
		5	Signal	Application specific
		6	Power	Application specific
		7	Power	Application specific
		8	Power	Application specific
		9	Power	Application specific
		10	data pair 1	BU
		11	data pair 1	WH
		12	data pair 2	YE
		13	data pair 2	OG

### 13.5 PROFINET Connectors for 24V Power Supply

#### 13.5.1 M12-A-coded Connector for 24V Power Supply

**Table 76: M12 5 pole A-coded connector according to IEC 61076-2-101**

PROFINET Connector Type:	PROFINET Legacy Passive Components (LPC)
Standard:	IEC 61076-2-101
Figures (technical drawings):	
Interface (male/female)	
Product Example (picture):	

#### Particular Description (if applicable)

M12 power connector with screw-locking.

PROFINET 24 V Cabling is intended to be used either with an integrated functional earth (FE) or without a functional earth. There are dedicated connectors and cable designs. PROFINET recommends the termination to the functional earth (FE) by an external termination point on the device. In this case the 4-way power cabling without functional earth (FE) should be used.

All PROFINET devices shall be equipped with an external functional earth (FE) termination point. For further information see guideline Order Number 8.101 (Recommendations for functional grounding and bonding).

**Table 77: Standard requirements of connectors according to IEC 61076-2-101**

Standard / Requirements	Value
Climate / Environmental	
Operating Temperature, (inside/outside)	-25°C - +85°C
Degree of protection (IEC 60529), (inside/outside)	IP65 or IP65/IP67
Electrical	
Operating Voltage within PROFINET	Typical 24 V
Current Rating	4 A
Mechanical	
Mating cycle (mating & un mating)	≥100
Cable Strain Relief	80 N min. according to IEC 61984, cable outer diameter 4,0... 9,0 mm
Vibration, sinusoidal	10Hz...500Hz, 0,35mm, 5g max.
Shock, half-sine pulses, (inside/outside)	50 g, 11 milliseconds

**Table 78: Key characteristics of connectors according to IEC 61076-2-101**


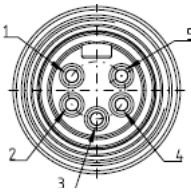
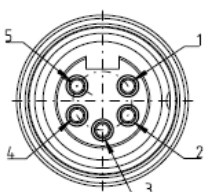

Area	Key characteristic
Robustness (housing, ....)	Outside enclosure according to Table 2
Number of contacts	4; optional 5 (4+FE)
Shielding	optional
Locking mechanism	M12x1 Thread
Outer Cable Diameters (range)	4,0 mm – 6,0 mm
Wire Construction (solid/stranded)	stranded

**Table 79: Pin assignment for M12 A-coded 5 pole**

	Function	Signal	Contact
	24V (1L+ Non-switched)	L1	1
	Masse 2M (Switched)	N2	2
	Masse 1M (Non-Switched)	N1	3
	24V (2L+ Switched)	L2	4
	Functional Earth	FE	5

### 13.5.2 7/8"- Power Connector for 24V Power Supply

**Table 80: Key characteristics of connectors according to ANSI / B93 55M-1981 or NFPA/T3.5.29 R1-2007**

PROFINET connector Type:	PROFINET Legacy Passive Components (LPC)
Standard:	ANSI / B93 55M-1981 or NFPA/T3.5.29 R1-2007
Figures (technical drawings):	
Interface (male/female)	 
Product Example (picture):	

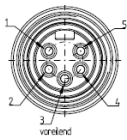
**Table 81: Standard Requirements**

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature, (inside/outside)	-25°C - +85°C
Degree of protection (IEC 60529), (inside/outside)	IP65/IP67
Electrical	
Operating Voltage	Typical 24V
Current Rating	Max 16 A
Mechanical	
Mating cycle (mating & unmating)	≥ 100
Cable Strain Relief	80 N min. according to IEC 61984, cable outer diameter 6 ... 9,0 mm 100 N min. according to IEC 61984, cable outer diameter 9 ... 10,0 mm

**Table 82: Key characteristics of connectors 7/8" 5-way**

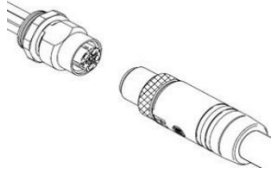
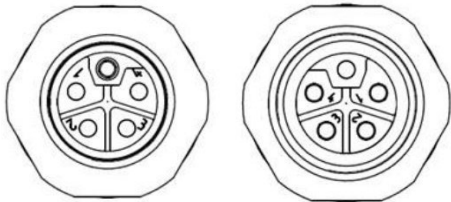
Area	Key characteristic
Robustness	Outside enclosure according to Table 2
Number of contacts	4+FE
Shielding	no
Locking mechanism	7/8" Thread
Outer Cable Diameters (range)	6.0 mm – 10 mm
Wire-Cross Section (AWG and mm <sup>2</sup> )	1,5 mm <sup>2</sup> , 2,5 mm <sup>2</sup>
Wire Construction (solid/stranded)	stranded

**Table 83: Pin assignment for 7/8" 5-way**

Connector 7/8" 5-way			
	Function	Signal	Contact
	GND Actuator Power	N2 optional	1
	GND Sensor/System Power	N1	2
	FE	FE	3/FE
	Sensor/System Power	L1	4
	Actuator Power	L2 optional	5

### 13.5.3 M12-L Power Connector for 24V Power Supply

**Table 84: M12 power connector according to IEC 61076-2-111 M12-L coded**

PROFINET connector Type:	PROFINET General Passive Component (GPC) M12-L coded 4 way optional 5-way PROFINET 24 V power supply connector for outside environment
Standard:	IEC 61076-2-111 M12-L-coded
Figures (technical drawings):	
Interface:	
Product Example (picture):	

**Particular Description** (if applicable):

M12 power connector with current rating 16 A and voltage ratings of 63 V with screw-locking, in PROFINET typically used for 24 V power supply and power applications in industrial premises.

PROFINET 24 V Cabling is intended to be used either with an integrated functional earth (FE) or without a functional earth. There are dedicated connectors and cable designs.

PROFINET recommends the termination to the functional earth (FE) by an external termination point on the device. In this case the 4-way power cabling without functional earth (FE) should be used.

All PROFINET devices shall be equipped with an external functional earth (FE) termination point. For further information see guideline Order Number 8.101 (Recommendations for functional grounding and bonding).



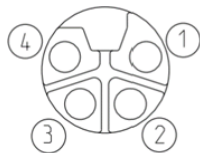
**Table 85: Standard requirements M12 power L coded connector according to IEC 61076-02-111**

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-25 °C ... + 85 °C
Degree of protection	IP65 or IP 65/67 according to IEC 60529
Electrical	
Operating Voltage within PROFINET	typically 24 V
Current Rating	16 A
Voltage proof signal-shield	0,84 kV rms
Transmission performance (category)	n. a.
Mechanical	
Mating cycles (mating & unmating)	100 min. according to IEC 60512 test 9a
Cable Strain Relief	80 N min. according to IEC 61984, cable outer diameter 6 ... 9,0 mm 100 N min. according to IEC 61984, cable outer diameter 9 ... 12,5 mm
Vibration, sinusoidal	10 Hz to 500 Hz and 0,35 mm or 50 m/s <sup>2</sup> according to IEC 60512 test 6d
Shock, half-sine pulses	50 g, 11 milliseconds according to IEC 60512 test 6c

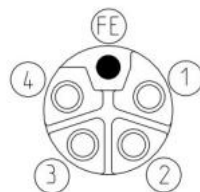
**Table 86: Key characteristics M12 power L coded connector according to IEC 61076-2-111 L coded**

Area	Key characteristic
Robustness	Outside enclosure according to Table 2
Number of contacts	4, optional 4+FE
Shielding	optional
Contacts (contact details, ...)	according to IEC 61076-2-111 L coded
Locking mechanism	Screw-Locking M12x1
Wire Termination	Screw, IDC, spring-type terminal; crimp,
Outer Cable Diameters (range)	6,0 ... 12,5 mm
Wire-Cross Section (AWG)	0,75 mm <sup>2</sup> ... 2,5 mm <sup>2</sup>
Wire Construction (solid/stranded)	Solid, stranded

**Table 87: Pin assignment M12 power L coded 4 way according to IEC 61076-2-111**

Connector according to IEC61076-2-111 – L-coded 4 way				Cable Colour outer sheet black	
	Function	Signal	Contact	Function	Colour
	24V (1L+ Non-switched)	L1	1	L1	BN
	Masse 2M (Switched)	N2	2	N2	WH
	Masse 1M (Non-Switched)	N1	3	N1	BU
	24V (2L+ Switched)	L2	4	L2	BK
	Colour (insulation body):	black			

**Table 88: Pin assignment M12 power L coded 5 way according to IEC 61076-2-111**

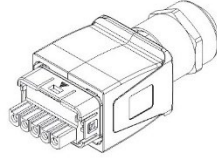
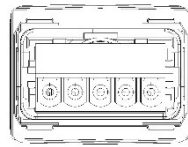

Connector according to IEC61076-2-111 – L-coded 5 way				Cable Colour outer sheet grey	
	Function	Signal	Contact	Function	Colour
	24V (1L+ Non-switched)	L1	1	L1	BN
	Masse 2M (Switched)	N2	2	N2	WH
	Masse 1M (Non-Switched)	N1	3	N1	BU
	24V (2L+ Switched)	L2	4	L2	BK
	Functional Earth	FE	FE	FE	PK or GY
	Colour (insulation body):	grey			

**Table 89: Pin assignment M12 power L coded 5 way according to IEC 61076-2-111**

Potential	Contact Number Push Pull Power	Push Pull Colour Coding	Contact Number M12-L- coded	Additional M12-L Colour Coding
L1	1	Brown	1	Brown
N1	2	Blue	3	Blue
L2	3	Black	4	Black
N2	4	White	2	White
FE	FE	Pink or Grey	FE	Pink or Grey

### 13.5.4 Push-Pull 4-way Power Connector for 24V

**Table 90: Key Characteristics Push-Pull, Power 5-way M12 power IEC 61076-3-126**

PROFINET connector Type:	PROFINET Legacy Passive Components (LPC)
Standard:	IEC 61076-3-126
Figures (technical drawings):	
Interface:	
Product Example (picture):	


**Table 91: Standard requirements of connectors according to IEC 61076-3-126**

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature, (inside/outside)	-25°C - +70°C
Degree of protection (IEC 60529), (inside/outside)	IP65/IP67
Electrical	
Operating Voltage	24V
Current Rating	16A
Mating cycle (mating & un mating)	≥100
Cable Strain Relief	80 N min. according to IEC 61984 of cable outer diameter 6 ... 9,0 mm 100 N min. according to IEC 61984 of cable outer diameter 9 ... 10,0 mm

**Table 92: Key characteristics of connectors according to IEC 61076-3-126**

Area	Key characteristic
Robustness	Outside enclosure according to Table 2
Number of contacts	4+FE
Shielding	no
Locking mechanism	Push Pull
Outer Cable Diameters (range)	max. 10 mm
Wire-Cross Section (AWG and mm <sup>2</sup> )	1,5mm <sup>2</sup> , 2,5mm <sup>2</sup>
Wire Construction (solid/stranded)	stranded

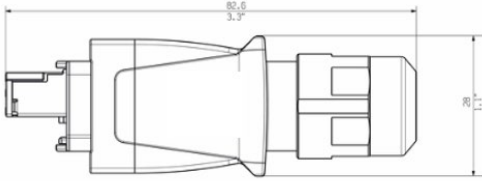
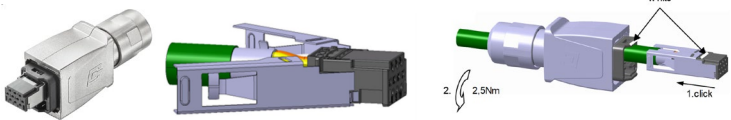
**Table 93: Connector according to IEC 61076-3-126 –Push Pull Power 5 way**

Connector				Cable	
	Function	Signal	Contact	Function	Colour
		L1	1	L1	Brown
		N1	2	N1	Blue
		L2	3	L2	Black
		N2	4	N2	White
		FE	FE	FE	Pink or Grey

## 13.6 Signal Connectors of PROFINET

### 13.6.1 Push Pull 10 pole Signal Connectors of PROFINET (IEC 61076-3-119)

**Table 94: Connector according to IEC 61076-3-119**

PROFINET connector Type:	PROFINET Push Pull Signal connector
Standard:	IEC 61076-3-119
Figures (technical drawings):	
Interface:	Connector front and side view
Product Example (picture):	

#### Particular Description (if applicable):

For Signal applications the standardized shielded 10 pole Push Pull Variant 14 free and fixed connector should be used. If the Push Pull interface is used for Data applications in the same device, the standardized shielded 10 pole Push Pull Variant 14 free and fixed connector shall be used for Signal applications.

**Table 95: Standard requirements of connectors according to IEC 61076-3-119**

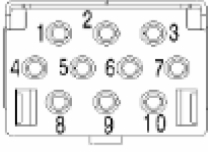
Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	Values according to Table 2 of outside enclosure"
Degree of protection (IEC 60529)	
Electrical	
Operating Voltage	24 Volt
Current Rating	max. 3 A per contact
Voltage proof signal-shield	1,5 kV
Mechanical	
Mating cycles (mating & non mating)	500
Cable Strain Relief	According to IEC 61754-24
Vibration, sinusoidal	Values according to Table 2 of outside enclosure"
Shock, half-sine pulses	

**Table 96: Key characteristics of connectors according to IEC 61076-3-119**

Area	Key characteristic
Robustness	Outside enclosure according to Table 2
Number of contacts	10
Shielding	360° all-round enclosure
Contacts (contact details, ...)	Insulation cross-section, max. 1.05 mm Insulation cross-section, min. 0.85 mm Contact surface Gold over nickel
Locking mechanism	Push-Pull
Wire Termination	field assembled and pre-assembled Versions
Outer Cable Diameters (range)	Sheath diameter, max. 10 mm Sheath diameter, min. 5 mm
Wire-Cross Section (AWG and mm <sup>2</sup> )	Wire connection cross section, finely stranded, max. 0.75 mm <sup>2</sup> / AWG 20 Wire connection cross-section, finely stranded, min. 0.08 mm <sup>2</sup> / AWG 27

The integration into the Push Pull Housing of the SC-RJ Data insert is vendor specific.

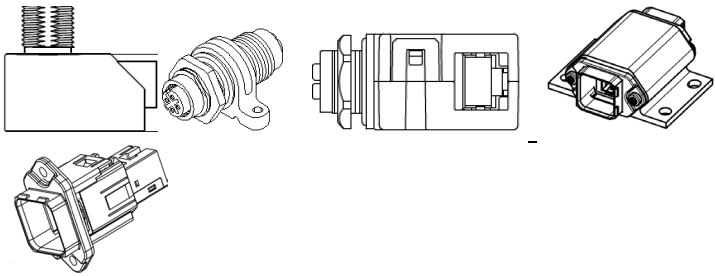

**Table 97: Example of contact Assignment IP 67 Signal connector**

Pin-Assignment	
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**Qualification Test for PROFINET Signal Cabling**

The qualification test shall be performed for outside enclosures in accordance with the following standard:  
IEC 61076-3-119

**13.7 Bulkhead for PROFINET****Table 98: Bulkhead according to IEC 61918 & ISO/IEC 11801-1**

Connector Type:	Bulkhead for PROFINET
Definition (IEC 61918)	Bulkhead: wall or barrier which maintains the ingress and climatic environmental classifications applicable on either side
Standard:	IEC 61918 ISO/IEC 11801-1
Figures (technical drawings):	
Type of Interfaces	RJ 45 – RJ 45 RJ 45 – M12-x-Code RJ45 – M12-D-Code RJ45 (Var.14) – RJ45 M12-D-Code – M12-D-Code RJ45 – M12-D-Code M12-x-Code - M12-x-Code
Product Example (picture):	

**Table 99: Standard requirements of connectors according to IEC 61076-3-122**

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-55 °C ... 85 °C (suitable for inside & outside of Table 2)
Degree of protection (IEC 60529)	IP 20 and IP6x <sup>3)</sup>
Electrical	
Operating Voltage	Max. 57V d.c <sup>1)</sup>
Current Rating	Max. 400 mA <sup>1)</sup>
Transmission performance (category) <sup>4)</sup>	Cat. 5 up to Cat. 6A <sup>2)</sup> , used as s one single connection
Mechanical	
Pull force	Depending on application of Inside and/or Outside Cabinet of Table 2
Vibration, sinusoidal	Depending on application of Inside and/or Outside Cabinet of Table 2
Shock, half-sine pulses	Depending on application of Inside and/or Outside Cabinet of Table 2
1) depending on support of PoE-Standards 2) depending on required performance 3) depending on application 4) Described as Cross-Connection in ISO/IEC 11801-1	

### 13.7.1 Implementation of Bulkheads

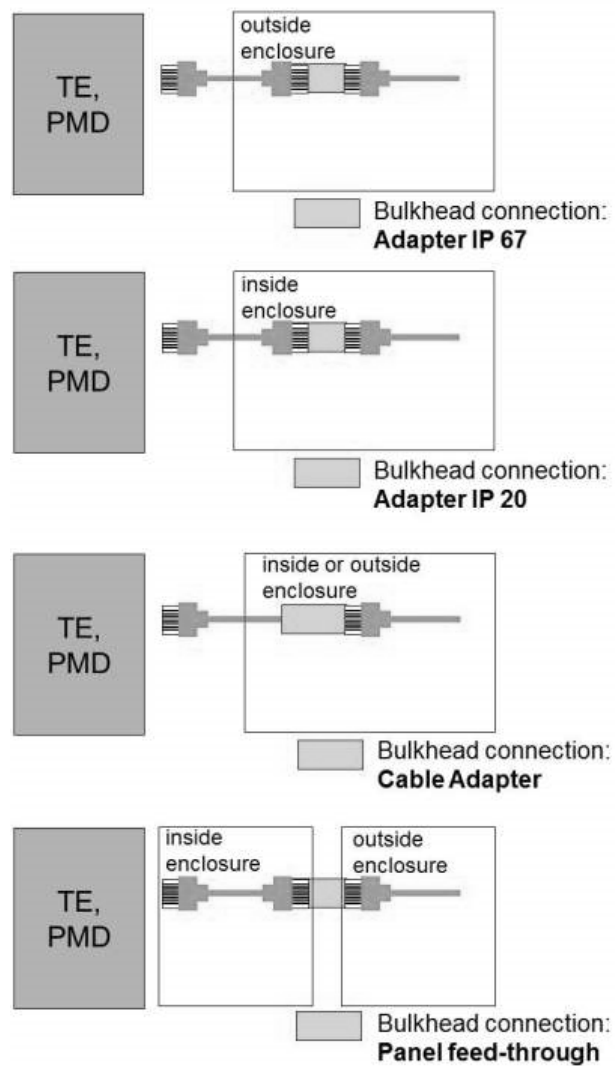
PROFINET bulkheads are implemented in different versions:

1. Adapter
  - a. Adapter IP 6x for the Push Pull connector, M12 connector, Hybrid connector on both side of the adapter
  - b. Adapter IP 20 for RJ 45 connector on one or both side of the adapter
2. Cable Adapter for the Push Pull connector, M12 connector, Hybrid connector or RJ45 connector directly terminated to the PROFINET cable
3. Panel feed-through for the Push Pull connector, M12 connector or Hybrid connector on one side and the RJ 45 connector on the other side

**Table 100: Bulkhead according to IEC 61918 & ISO/IEC 11801-1**

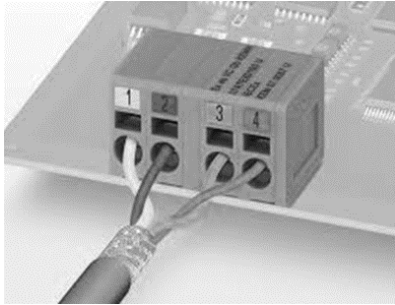
Ingress-	Outside IP6x, Inside IP20 and Inside IP20 to Outside IP6x
Count of Connection	1 x Connection
Shielding	Optimal 360° shielding vs. EMI noise



**Figure 11: Definition of the different Bulkhead connections**

### 13.8 Connection Terminal for PROFINET

**Table 101: Cabling Landscape with allocation of application areas**

Product Example (picture):	
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#### Particular Description:

The interface of PROFINET Process devices must meet the requirements for PROFINET. These include the properties defined by PROFINET for a connection terminal.

In addition to the PROFINET requirements, there are the requirements for the specific application in the process automation environment. If the requirements (e.g. ATEX) are stricter than the PROFINET requirements, they should take priority. These Process Automation specific requirements are not defined in the PROFINET guidelines.

The fixed connection is used for device connectivity inside field devices in process automation. This PROFINET connection consists of the terminal used in the device in combination with the areas of the device designed for the cable connection, plus the shield termination and a suitable strain relief mechanism (e.g. cable gland). The terminal is described as a PROFINET-compliant component and PROFINET compliance is guaranteed by means of a manufacturer declaration. Guidelines are defined for the device connection.

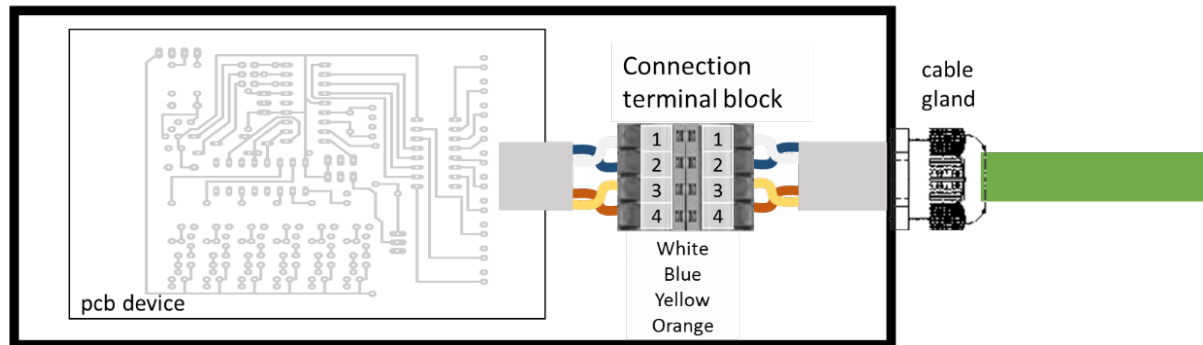
Only the combination of a PROFINET-compliant terminal and a shield connection designed in accordance with the guidelines guarantees a PROFINET-compliant connection for which the manufacturer of the device takes responsibility.

There are two variants of the PROFINET connection terminal:

- PCB terminal block inside the device with direct connection to the PROFINET cable (example 2 pair).
- Connection terminal block inside a device for connection of internal and external PROFINET cables (example 2 pair).

**Figure 12: Connection terminal block inside a device for connection of internal and external PROFINET cables (example 2 pair)**

PROFINET PA device



**Table 102: Shielding / EMC and mechanical design (properties of PROFINET-compliant device connection)**

Requirement	Comment:
The position and execution of the shield connection is defined in the device design. The electric parameters of the shield connection must comply with ISO/IEC 11801-1.	The device manufacturer is responsible for a clean shield connection. It defines "Met by Design"
The device must be fitted with a strain relief appropriate to the application.	The strain relief must be designed such that the requirements of the shield connection are complied with
The shield connection must be tailored to the balanced PROFINET 2/4 pair cable specified.	

**Table 103: Ethernet transfer (property of PROFINET-compliant terminal)**

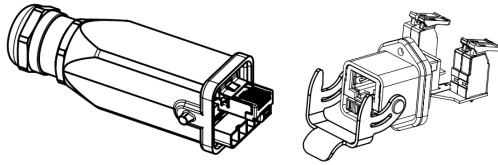
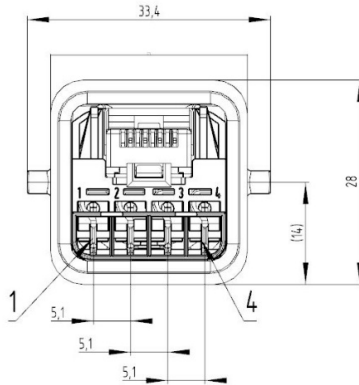

Requirement	Comment:
Component requirement as per Category 5 in accordance with ISO/IEC 11801-series (Connecting hardware)	The electrical approval of the transfer parameters is in analogy as a "mated pair". (Plug-in connector)
PROFINET cable with 2/4 pair is implemented in line with PROFINET Cabling and Interconnection Technology Guideline Balanced 2/4 pair Cables (Type A,B,C).	Additional contacts for further I/O's and power supply are not defined
Identification of contact points with known PROFINET cable Colour assignment	See PROFINET Cabling and Interconnection Technology Guideline Chapter: Balanced 2/4 pair Cables (Type A,B,C)
A transfer of POE plus in accordance with IEEE 802.3at-2009 is required.	Additional heating as a result of POE plus me considered by the user
Voltage proof Conditions: IEC 60512, Test 4a, Method A. Standard atmospheric conditions. 1 000 V r.m.s, contact-to-contact. 1 500 V r.m.s, contact to shield.	The contact-to-contact test must be evidenced by the terminal manufacturer If applicable, the contact to shield test must be evidenced by the device manufacturer.
The requirements of IEC 60664-1 (insulation coordination) must be taken into consideration	

**Table 104: Mechanical, electrical and climatic requirements (property of PROFINET-compliant terminal)**

Requirement	Comment:
Shock and vibration Requirements for contact point in accordance with IEC 60512-6-3, Test 6c / 50 g / 11 ms / 3 per axis in both directions  Vibration: IEC 60512-6-4, test 6d 0.35 mm or 5 g Temperature range -20 °C to +70 °C	Referenced from PROFINET Interconnection Guideline Table 6. 1: General Environmental Requirements of passive PROFINET Connection Systems (informative chart from IEC 61784-5-3)
The contact point must be designed in accordance with IEC 60999-1.	

### 13.8.1 PROFINET Hybrid Connector Variant 5 / 48V for PROFINET

**Table 105: Connector according to IEC 61076-3-106 (V5)**

PROFINET connector Type:	PROFINET Legacy Passive Component (LPC)  Hybrid connectivity (Ethernet and optional power contacts) for cabling outside cabinet environment
Standard:	IEC 61076-3-106 Variant 5
Figures (technical drawings):	
Interface:  IP 65/67 covered RJ45 interface and optional power interface with 4 power contacts	
Product Example (picture):	

#### Particular Description:

Very robust IP65/67 sealed RJ45 interface with an optional “Multipurpose area” used for 4 power contacts to support hybrid cabling for PROFINET and separate powering. This interface is dedicated for heavy duty connections between switch cabinets and outside machine parts or production equipment.

The hybrid plug connector is to be used where decentralized field devices are to be connected via combined plug connector for data and power supply. A complete contact-protected plug connector enables the use of the same plug connectors at both ends because no pin-socket change is necessary. The data interface based on the standard RJ45 interface and the power interface consist of 4 contacts for 24 V / 16 A d.c. The power interface is intended for the permanent control voltage and the emergency stop control voltage.

**Table 106: Standard requirements of connectors according to IEC 61076-3-106 Variant 05 and IEC 60603-7-3 (RJ45 interface 1)**

Standard/Requirement	Value
Climate / Environmental	
Ambient Temperature Operating Temperature	-20 °C ... 70 °C -40 °C ... 85 °C (suitable for inside & outside)
Degree of protection (IEC 60529)	IP 65/67
Electrical	
Operating Voltage	Data: 57 V d.c. <sup>2)</sup> Power: 24 V d.c. (20,4 ... 28,8 V)
Current Rating	Data: 600 mA per contact @ 70°C Power: 16 A
Voltage proof signal-shield	1.500 V a.c. rms
Transmission performance (category)	Minimum Cat. 5
Mechanical	
Mating cycles (mating & unmating)	50 min.
Cable strain relief	according to IEC 61984
Vibration, sinusoidal	IEC 60512-6-4, test 6d: 10 Hz ... 500 Hz, 0,35 mm, 5 g max.
Shock, half-sine pulses	IEC 60512-6-3, test 6c: 50 g, 11 milliseconds (suitable for inside & outside)
<sup>1)</sup> RJ45 pinning compatibility applies only to the pins themselves. For full plug-in compatibility, the shape of the casing of industrial connectors shall also be taken into account. The specified RJ 45 receptacle (Jack) for "Outside" applications has to be mating compatible with the RJ 45 Plug, in accordance with IEC 60603-7.  <sup>2)</sup> As defined by IEC 61984, clause 3.22	

**Table 107: Key characteristics of connectors according to IEC 61076-3-106 Variant 05 and IEC 60603-7-3 (RJ45 interface)**

Area	Key characteristic
Robustness	Outside enclosure according to Table 2
Number of contacts	Data: RJ45 with 4 or 8 pins as defined in IEC 60603-7-3 Power: 4 pins
Shielding	Data: 360° shielding vs. EMI noise, e.g. from rotating machines Power: n. a.
Contacts (contact details, ...)	Data: RJ45 contact with 4 or 8 pins as defined in IEC 60603-7-3 Power: Contact with 4 contact points at each contact
Locking mechanism	Depending on the hosing material with metal or plastic locking latch
Wire Termination	Insulation Displacement Connection (IDC) preferred to support field installation without special tooling
Outer Cable Diameters (range)	6,0 mm to 12,0 mm
Wire-Cross Section (AWG and mm <sup>2</sup> )	Data: AGW 22 – AWG 24 (0,34 mm <sup>2</sup> – 0,2 mm <sup>2</sup> ) Power: 1,5 mm <sup>2</sup>
Wire Diameter	Data: 1,0 mm – 1,6 mm Power: 2,7 mm max.
Wire Construction (solid/stranded)	Solid and stranded
Colour Code, Signal, Pin and Pair assignment	see Annex F

## Annex A

### Cabinet cord sets for optical cable

#### A.1 General

PROFINET Cabinet cord sets are cord sets for cabinet applications. PROFINET Cabinet cord sets fulfil the PROFINET component specification and can be used concerning the PROFINET component model. The conformity of the PROFINET cabinet cord set to this specification shall be declared by the vendor.

Connecting hardware performance is influenced by the properties of the plug termination and therefore cords should be tested to determine the quality of the assembly.

PROFINET cabinet cord sets shall be labelled as PROFINET cabinet cord sets.

Connectors used to build up a cabinet cord shall be based on the mating face as defined in chapter 13.2.

The conformity shall be declared for the PROFINET cabinet cord set.

**Table 108: PROFINET FO cabinet cord set specification**

Comment	only harnessed cord sets are defined
Application	Inside enclosure according to Table 2
Cable colour (outer sheath)	RAL 6018
Cabinet cord set marking 2 pair	PROFINET FO Cabinet Cord Set
Cable diameter, nominal	2.8 mm ( +/- 0.1)
Diameter secondary coating	0,9 / 1,4 mm
Cable type	Duplex-Cable
Connector	SCRJ (IEC 61754-24-11) SC-Duplex (IEC 60874-14-x) LC (IEC 61754-20)
Cable performance SM min.	OS 2
Cable performance MM min.	OM 2
Insertion Loss SM, max.	0.4 dB
Insertion Loss MM, max.	0.7 dB
Temperature (Transport & storage)	- 25 - +70 °C
Temperature (Installation)	-10°C... 70°C
Temperature (in operation)	- 20 - +70 °C
Crush	500N / 1 Minute
Impact	20 (Wp=0,74J, r=25mm)
Tensile performance	200 N / 5 Minutes,
Bending Radius	r=30 mm (6 times, 3 cycles)
Repeated bending	5000 Cycles of r=60 mm
Torsion	10 (±360°, Length = 1000 mm, F =20 N)
Kink	5 × the cable diameter
Sheath pull-off force for optical fibre cable for use in patch cords	fulfilled
Sheath shrinkage for optical fibre cable for use in patch cords	Fulfilled
Buffered fibre movement under compression in optical fibre cables for use in patch cords	fulfilled



Test for vertical flame spread test for vertical flame propagation	fulfilled
Measurement of smoke density of cables burning	fulfilled
max. length	20 m

The following parameters shall preferably adhere to:

- Sheathing materials suitable for the intended application
- Flame retardance in accordance with IEC 60332-1
- Materials for special applications materials free of substances destructive to lacquer-coatings (e.g. silicone)

**Table 109: Standards of cabinet FO cord set**

Test-Title	Measurement to be performed by
Cable performance SM	ISO/IEC 11801-1
Cable performance MM	ISO/IEC 11801-1
Insertion Loss SM	IEC 61300-3-4, method B
Insertion Loss MM	IEC 61300-3-4, method C
Temperature (transport & storage)	IEC 60794-2-50 Method F12
Temperature (in operation)	IEC 60794-2-50 Method F12
Crush	IEC 60794-1-2 E3
Impact	IEC 60794-1-2 E4
Tensile performance	IEC 60794-1-2 E1
Bending Radius	IEC 60794-1-2-E11A.
Repeated bending	IEC 60794-1-2 E6
Torsion	IEC 60794-1-2 E7
Kink	IEC 60794-1-2-E10.
Sheath pull-off force	IEC 60794-2-50 Method E21
Sheath shrinkage	IEC 60794-2-50 Method F11
Buffered fibre movement under compression	IEC 60794-2-50 Method E22
Test for vertical flame spread test for vertical flame propagation	IEC 60332-3-24 Cat C IEC 60332-1-2 Annex A
Measurement of smoke density of cables burning	IEC 61034-2

## Annex B

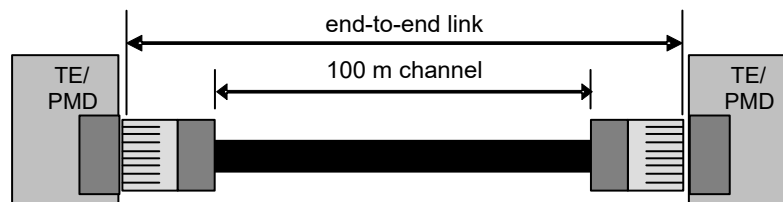
### Cord Sets for PROFINET Data Cabling

#### B.1 Cord sets for balanced cabling

PROFINET cord sets fulfil the PROFINET component specification and can be used concerning the PROFINET component model. The conformity of the PROFINET cabinet cord set to this specification shall be declared by the vendor.

PROFINET cabling is based on the End-to-End link. The End-to-End link extends the ISO/IEC 11801-3 channel about the plug connectors, which are mated to the PROFINET device (TE/PMD). End-to-End link is specified in IEC 61918.

**Figure 13: End-to-End link**



The conformity shall be declared for the PROFINET cord set.

PROFINET cord set used shall comply with the following parameters:

**Table 110: Parameters of cord sets for balanced cabling**

Type	PROFINET cord set
Number of wires	2, 4, 8
Cable Type	A, B
Connector type	PROFINET connector for type A, B cable
Cord set marking (additional to cable marking)	"PROFINET cord set"

End-to-End link build up with PROFINET cabinet cord sets meet the requirement.

##### B.1.1 Cord Sets for Balanced Type A/B Cabling – Requirements of NEXT, Insertion loss (IL) and Return Loss (RL)

Cords shall meet RL and Next requirements specified in ISO/IEC 11801-1.

IL of cord sets shall not exceed the value stated for the given length:

$$IL = IL_{cab} \cdot L / 100 + 2 \cdot IL_{con}$$

$$IL_{cab} = 22,0 \text{ dB} / 100\text{m} @ 100 \text{ MHz}, IL_{con} = 0,4 \text{ dB}$$

(Informative values of  $IL_{cab}$  at 100 MHz for PROFINET cord sets from ISO/IEC 11801-1)

##### B.1.2 Cord Sets for Balanced Type C Cabling – Requirements of IL, RL and NEXT

Cords shall meet return loss (RL) and Next requirements specified in ISO/IEC 11801-1.

Insertion loss (IL) of cord sets shall not exceed the value stated for the given length:

$$IL = IL_{cab} \cdot L / 100 + 2 \cdot IL_{con}$$

$$IL_{cab} = 33,0 \text{ dB} / 100\text{m} @ 100 \text{ MHz}, IL_{con} = 0,4 \text{ dB}$$

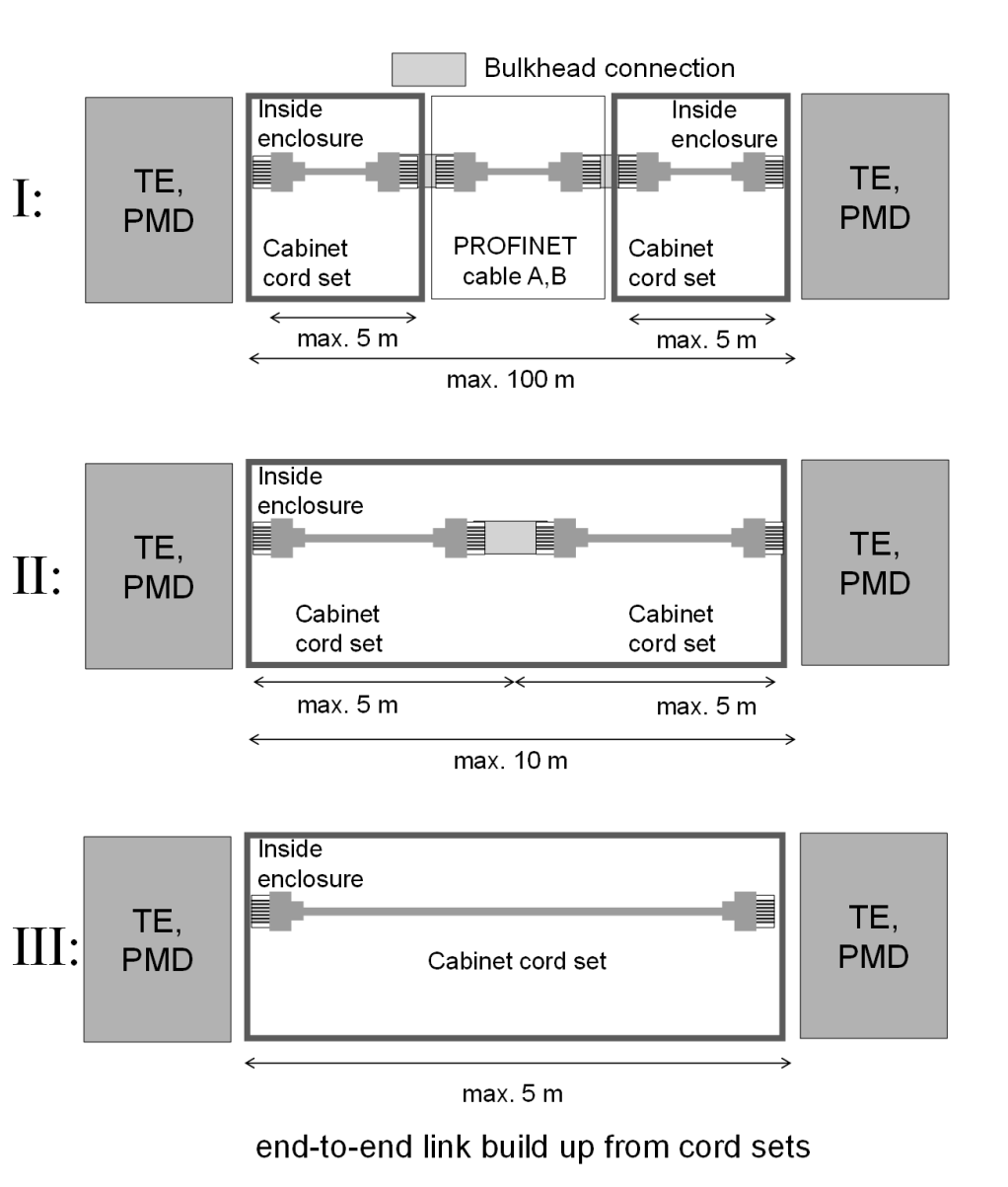
(Informative values of  $IL_{cab}$  @ 100 MHz for PROFINET cord sets from ISO/IEC 11801-1)

## B.2 Cabinet cord sets for balanced cabling

PROFINET Cabinet cord sets are cord sets for cabinet applications. PROFINET Cabinet cord sets fulfil the PROFINET component specification and can be used concerning the PROFINET component model. The conformity of the PROFINET cabinet cord set to this specification shall be declared by the vendor.

End-to-End link build up with PROFINET cabinet cord sets meet the requirement described in Annex F.

**Figure 14: Configuration End-to-End link build up with PROFINET cabinet cord sets**



### B.2.1 Conformity and Configuration

Connecting hardware performance is influenced by the properties of the plug termination and therefore cords should be tested to determine the quality of the assembly.

This chapter specifies the minimum requirements for cords. The test methods and mechanical stresses are specified in IEC 61935-2. All requirements of this chapter have to be met after first exposing the device under test to mechanical stress.

Cords shall meet the electrical and mechanical requirements of IEC 61935-2.

The cabinet cord sets shall meet a tightened flexures test in accordance with IEC 61935-2 7.3. The cabinet cord shall fulfil after the specified flexures at least the category 5 patch cord test according to ISO/IEC 11801-1.

PROFINET cabinet cord sets shall be labelled as PROFINET cabinet cord sets.

Cable used to build up a cabinet cord are based electrically on at least category 5 balanced LAN cables according to ISO/IEC 11801-1 Class D.

Connectors used to build up a cabinet cord shall be based on the mating face as defined in chapter 13.

### B.2.2 Qualification test for PROFINET cabinet cord sets

The conformity shall be declared for the PROFINET cabinet cord set.

PROFINET Cabinet cord set used shall comply with the following parameters:

**Table 111: Requirements of PROFINET cabinet cord sets**

Type	PROFINET Cabinet cord set for 1 pair	PROFINET Cabinet cord set for 2 / 4 pair
Comment	only harnessed cord sets are defined	
PROFINET Component	X	
Application	Inside enclosure	
Ambient temperature	-20 °C... 70 °C	
Number of wires	2	4,8
Wire diameter	1 pair: AWG 22 - 26	2 pair: AWG 22 - 24 4 pair: AWG 22 - 26
Type of wire	stranded	
Cable Colour (outer sheath)	RAL 6018	
Cabinet cord set marking 1 pair	“PROFINET cabinet cord 1 pair”	Not applicable
Cabinet cord set marking 2 pair	Not applicable	“PROFINET cabinet cord 2 pair”
Cabinet cord set marking 4 pair	Not applicable	“PROFINET cabinet cord 4 pair”
Channel performance	T1-C	Class D (IEC 11801-1)
Cable performance	IEC 61156-12	at least Cat 5 IEC 61156-6
Cable Coupling Attenuation	80 dB (Measurement according to EN 50289-1-6)	
Connector Coupling	45 dB (Measurement according to IEC 62153-4-12)	
Note 1: AWG dimensions are given for information only		

### B.2.3 PROFINET Cabinet cord set specification

The following parameters shall preferably adhere to:

- Sheathing materials suitable for the intended application
- Materials for special applications materials free of substances destructive to lacquer-coatings (e.g. silicone)

Additional test parameters are described in the Draft IEC 61784-5-3.

The cable used to build up a cabinet cord shall comply with the following standards:

**Table 112: PROFINET Cabinet cord set specification**

Test-Title	Severity or condition of test	Measurement to be performed	Requirements
IEC 11801-1 Cat. 5 component	Category 5	IEC 61156-6	Electrical requirement category 5
Conductor resistance	AWG 26 stranded	IEC 60189-1	$\leq 145 \text{ Ohm/km}$
Elongation at break of the insulation		IEC 60811-501	IEC 61156-6
Elongation at break of the sheath		IEC 60811-501	IEC 61156-6
Elongation at break of the sheath after ageing		IEC 60811-401	IEC 61156-6
Tensile strength of the sheath		IEC 60811-501	IEC 61156-6
Tensile strength of the sheath after ageing		IEC 60811-401	IEC 61156-6
Crush test of the cable		IEC 61156-1	1000N
Flame retardancy		IEC 60332-1-2	Has to pass the test
Sheath pressure test at high temperature		IEC 60811-508	Max. 50 %
Heat shock test		IEC 60811-509	No cracks
Tensile performance of the cable	50N	EN 50289-3-16	IEC 61156-6
Colour (Outer Jacket)	green	Visual inspection	RAL 6018
Coupling attenuation	$\geq 80 \text{ dB}$ at 30 MHz to 100 MHz	EN50289-1-6	$\geq 80 \text{ dB}$ at 30 MHz to 100 MHz
Operating temperature	$-20^{\circ}\text{C} \dots +70^{\circ}\text{C}$		All cable materials have to be designed for $-20^{\circ}\text{C} \dots +70^{\circ}\text{C}$
Differential delay / Delay skew between Pair 1 (orange) and Pair 2 (green)		IEC 61156-6	$\leq 20\text{ns}/100\text{m}$

The connectors used to build up a cabinet cord shall be in accordance with the specification of the inside connector in chapter 13.

The Qualification Test for the cabinet cord sets shall meet return loss (RL) and Next requirements specified in ISO/IEC 11801-1 for balanced cords (at least category 5).

## Annex C

## Cables for 24V Cabling

## C.1 PROFINET 24 V Power Supply Cable Specification

Table 113 24 V Power Supply Cable Specification

PROFINET 24V DC Power Cable Types	PROFINET 24V Power Cable 0,75 mm²	PROFINET 24V Power Cable 1,5 mm²	PROFINET 24V Power Cable 2,5 mm²
Cable Installation Type	Fixed and flexible installation, occasional movement or vibration		
Design	4 x 0,75 mm² or 5 x 0,75 mm²	4 x 1,5 mm² or 5 x 1,5 mm²	4 x 2,5 mm² or 5 x 2,5 mm²
Number of Wires	4 or 5		
Rated Voltage	300 V		
Current-carrying capacity per conductor at 40°C ambient temperature <sup>1)</sup>	8 A	16 A	
nominal conductor cross section	0,75 mm²	1,5 mm²	2,5 mm²
Wire Construction	flexible conductor		
Wire Identification	5 wires with colours: Brown (L1), Blue (N1), Black (L2), White (N2), Optional: 1 wire Pink or Grey (Functional Earth)		
Colour (Outer Sheath)	Black (without Functional Earth) or Grey (with Functional Earth)		
Cable Marking (at least)	“PROFINET 24V Power 4x0,75” (without Functional Earth) or “PROFINET 24V Power 4x0,75 + FE “ (with Functional Earth)	“PROFINET 24V Power 4x1,5” (without Functional Earth) or “PROFINET 24V Power 4x1,5 + FE “ (with Functional Earth)	“PROFINET 24V Power 4x2,5” (without Functional Earth) or “PROFINET 24V Power 4x2,5 + FE “ (with Functional Earth)
Operating Temperature Range	see Table 1 "Outside enclosure"		
1) Derating in accordance with IEC 60204-1 und IEC 60364-5-52			

## C.2 Qualification test for PROFINET 24 Volt cables

Table 114 Test requirement 24 V Power Cable

Cable Type to be tested	Test-Description	Severity or condition of test	Measurement to be performed	Requirements
all	Conductor class	Min. class 5	IEC 60228	class 5 or class 6 of IEC 60228
24V Power Cable 0,75 mm <sup>2</sup>	Conductor resistance	0,75 mm <sup>2</sup>	IEC 60227-2 clause 2.1	<= 27 Ω/km
24V Power Cable 1,5 mm <sup>2</sup>	Conductor resistance	1,5 mm <sup>2</sup>	IEC 60227-2 clause 2.1	<= 14 Ω/km
24V Power Cable 2,5 mm <sup>2</sup>	Conductor resistance	2,5 mm <sup>2</sup>	IEC 60227-2 clause 2.1	<= 8 Ω/km
All	Flame retardancy		IEC 60332-1-2	Has to pass the test
All	Outer cable diameter	6,0 mm – 12,5 mm	IEC 60811-203	>=6,0 mm, <=12,5 mm

All	Wall thickness sheath	min. 0,8 mm	IEC 60811-203	$\geq 0,8$ mm
24V Power Cable with 4 wires	Colour outer Jacket	PROFINET Guideline	Visual inspection	black
24V Power Cable with 5 wires	Colour outer Jacket	PROFINET Guideline	Visual inspection	grey
All	Colour wire	PROFINET Guideline	Visual inspection	brown, blue, black, white, opt. grey
24V Power Cables with 4 wires	Cable Marking	PROFINET Guideline	Visual inspection	"PROFINET 24V Power 4x0,75"/ "PROFINET 24V Power 4x1,5"/ "PROFINET 24V Power 4x2,5"
24V Power Cables with 5 wires	Cable Marking	PROFINET Guideline	Visual inspection	"PROFINET 24V Power 4x0,75 + FE"/ "PROFINET 24V Power 4x1,5 + FE"/ "PROFINET 24V Power 4x2,5 + FE"
All	Operating temperature	-20°C... 90°C		All cable material have to be designed for -20°C up to 90°C
All	Voltage test on completed cable	test voltage 1500 V	see IEC 60227-2	IEC 60227-1 table 3
All	Trailing chain test	bending test in trailing chain	bending radius: 12xD; acceleration: 3 m/s <sup>2</sup> ; speed: 3 m/s cycles. 2 mio	no conductor break or breakdown
All	Elongation at break of the insulation		IEC 60811-501	IEC 61156-5
All	Elongation at break of the sheath		IEC 60811-501	IEC 61156-5
All	Elongation at break of the sheath after ageing		IEC 60811-401	IEC 61156-5
All	Tensile strength of the sheath		IEC 60811-501	IEC 61156-5
All	Tensile strength of the sheath after ageing		IEC 60811-401	IEC 61156-5
All	Sheath pressure test at high temperature		IEC 60811-508	Max. 50 %
All	Heat shock test		IEC 60811-509	No cracks

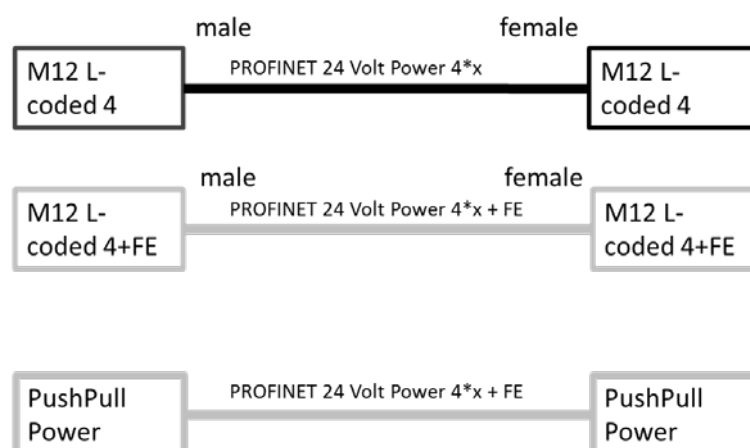
## Annex D

### Cordsets for 24V-Cabling

#### D.1 General

PROFINET cord sets for 24 Volt cabling is a combination of a PROFINET connector and a PROFINET 24 V cable.

**Figure 15: PROFINET 24 V Power cord sets**



The conformity of the PROFINET cord set to this specification shall be declared by the vendor.

#### D.2 Qualification test for PROFINET 24 V cord sets

The Qualification Test shall be performed in accordance with the cable and connector specification.

The single contacts of the connector shall be used in accordance with the table below:

**Table 115: Basic parameters for shielded 10 pole Push Pull free and fixed connector.**

Push Pull Signal connector:	Properties
Rated Current:	max. 3 A per contact
Rated voltage	24 Volt
Number of contacts	10
locking mechanism	Push Pull
Conductor cross-section:	0,08 - 0,75 mm <sup>2</sup>
Outer cable diameter:	5 -10 mm



## Annex E

### PROFINET 24 V Cabling

#### E.1 Power Classes of 24 V Cabling

PROFINET 24 V Cabling is intended to be used either with an integrated functional earth (FE) or without a functional earth. There are dedicated connectors and cable designs.

PROFINET recommends the termination to the functional earth (FE) by an external termination point on the device. In this case the 4-way power cabling without functional earth (FE) should be used.

All PROFINET devices shall be equipped with an external functional earth (FE) termination point.

For further information see guideline Order Number 8.101 (Recommendations for functional grounding and bonding).

The PROFINET 24 V power supply of PROFINET devices is divided in two different power classes:

1. The supply is in star topology (current is limited to the demand of one device)
2. The supply is in line topology (higher current)

**Table 116: Power Classes for the 24 V installation**

Power Class:	1	2
Application:	24 V Power Supply in star topology	24 V Power Supply in line or star topology
Operating current:	max. 4 A	max. 16 A (including power class 1)
Operating voltage	24 Volt	24 Volt
Number of circuits:	1 (optional 2)	1 (optional 2)
Functional earth (FE):	optional	optional

## Annex F

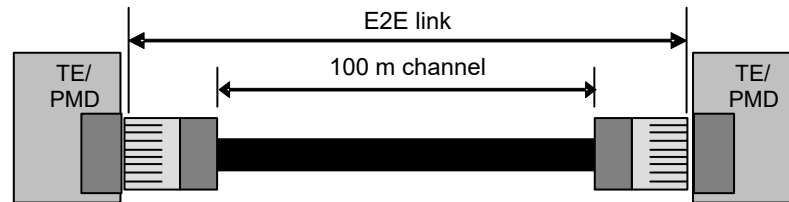
### End-to-End (E2E) link assemblies for balanced cabling

#### F.1 E2E Configurations

##### F.1.1 E2E link without interconnections

Figure 16 shows an E2E link without interconnections of 100 m length with connectors installed directly at both ends of the cable.

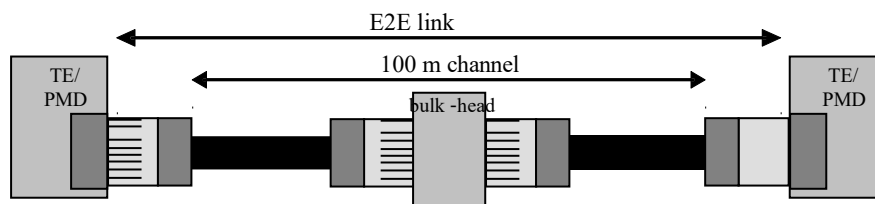
**Figure 16: E2E link without interconnections**



##### F.1.2 E2E link interconnections

Figure 17 shows an assembled End-to-End link of 100 m length, containing an intermediate plug connection established with a bulkhead.

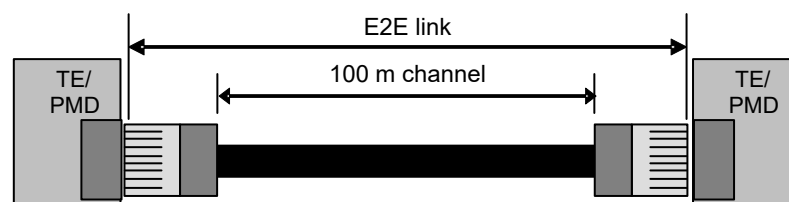
**Figure 17: End-to-End link with interconnections**



#### F.2 Procedures for measurement of the End-to-End link

The traditional definition of the channels excludes the contribution of the end connections (connections to the application or the field tester) to the overall NEXT. In order to allow for two alternative but functional equivalent test method values for the End-to-End Link need to be defined in order to support the different test scenario.

**Figure 18: Definition of the reference plain**



The procedures of the E2E link measurement are specified in ISO/IEC 14763-4.

## Annex G

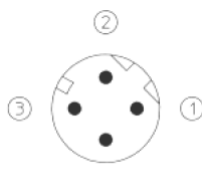
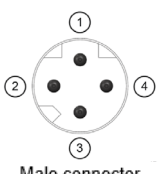
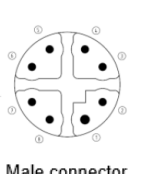
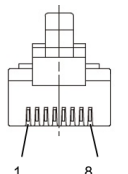
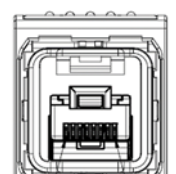
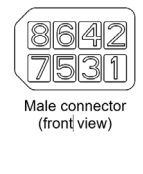
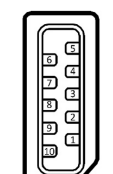
## Tables of Contact and Wire Arrangement

## G.1 Contact arrangement

Table 117: Colour Code and Signal assignment Connectors for balanced cabling

IEC 61076-3-122 - (Mini-IO)	IEC 61076-3-124 - (ix)	IEC 60603-7 - RJ45 8(8) - pole	IEC 61073-2-109 M12 X-coded	IEEE 802.3 Signal Gigabit Ethernet MDI	IEEE 802.3 Signal Gigabit Ethernet MDI-X	ANSI /TIA 568 Series				PNO PROFINET 2 pair Colour-Code	IEEE 802.3 Signal Fast Ethernet	IEC 61076-2-114 M8 (D-coded), IEC 61076-2-101 M12 (D-coded)	IEC 60603-7 - RJ45 8(4) - pole
						T568A Colour- code	T568A Cable Pair	T568B Colour- Code	T568B Cable Pair				
1	1	1	1	BI_DA+	BI_DB+	White/ Green	Pair 3	White/ Orange	Pair 2	Yellow	TX +	1	1
2	2	2	2	BI_DA-	BI_DB-	Green		Orange		Orange	TX -	3	2
3	6	3	3	BI_DB+	BI_DA+	White/ Orange	Pair 2	White/ Green	Pair 3	White	RX +	2	3
4	4	4	8	BI_DC+	BI_DD+	Blue	Pair 1	Blue	Pair 1				
5	5	5	7	BI_DC-	BI_DD-	White/ Blue		White/ Blue					
6	7	6	4	BI_DB-	BI_DA-	Orange	Pair2	Green	Pair3	Blue	RX -	4	6
7	9	7	5	BI_DD+	BI_DC+	White/ Brown	Pair 4	White/ Brown	Pair 4				
8	10	8	6	BI_DD-	BI_DC-	Brown		Brown					

Table 118: Pin and Pair assignment Connectors for balanced cabling (Summary)

IEC 61076-2-101	IEC 61076-2- 114	IEC 61073-2- 109	IEC 60603-7	IEC 60603-7	IEC 61076-3- 122	IEC 61076-3- 124
M12 D-coded	M8 D-coded	M12 X-coded	RJ45	RJ45 / IP67	Mini-IO	ix Industrial
 Male connector (front view)	 Male connector (front view)	 Male connector (front view)	 Male connector (front view)	 Male connector (front view)	 Male connector (front view)	 Male connector (front view)

## Annex H

## Shielding / EMC and mechanical design

## H.1 Requirements

## H.1.1 Shielding and EMC Requirements

Table 119: Shielding / EMC

Requirement	Comment:
The position and execution of the shield connection is defined in the device design. The electric parameters of the shield connection must comply with ISO/IEC 11801-1.	The device manufacturer is responsible for a clean shield connection. It defines "Met by Design"
The device must be fitted with a strain relief appropriate to the application.	The strain relief must be designed such that the requirements of the shield connection are complied with
The shield connection must be tailored to the balanced PROFINET 2/4 pair cable specified.	

## H.1.2 Ethernet transfer (property of PROFINET-compliant terminal)

Table 120: Ethernet transfer

Requirement	Comment:
Component requirement as per Category 5 in accordance with ISO/IEC 11801-series (Connecting hardware)	The electrical approval of the transfer parameters is in analogy as a "mated pair". (Plug-in connector)
PROFINET cable with 2/4 pair is implemented in line with PROFINET Cabling and Interconnection Technology Guideline Balanced 2/4 pair Cables (Type A,B,C).	Additional contacts for further I/O's and power supply are not defined
Identification of contact points with known PROFINET cable colour assignment	See PROFINET Cabling and Interconnection Technology Guideline Chapter: Balanced 2/4 pair Cables (Type A,B,C)
A transfer of PoE plus in accordance with IEEE 802.3at-2009 is required.	Additional heating as a result of POE plus may be considered by the user
Voltage proof Conditions: IEC 60512, Test 4a, Method A. Standard atmospheric conditions. 1 000 V r.m.s, contact-to-contact. 1 500 V r.m.s, contact to shield.	The contact-to-contact test must be evidenced by the terminal manufacturer If applicable, the contact to shield test must be evidenced by the device manufacturer.
The requirements of IEC 60664-1 (insulation coordination) must be taken into consideration	

### H.1.3 Mechanical, electrical and climatic requirements (property of PROFINET-compliant terminal)

**Table 121: Ethernet transfer Mechanical, electrical and climatic requirements**

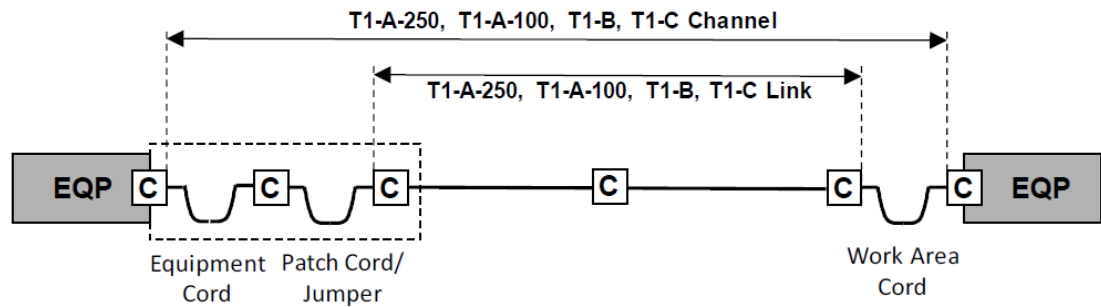
Requirement	Comment:
Shock and vibration Requirements for contact point in accordance with IEC 60512-6-3, Test 6c / 50 g / 11 ms / 3 per axis in both directions  Vibration: IEC 60512-6-4, test 6d 0.35 mm or 5g	Referenced from PROFINET Interconnection Guideline Table 6. 1: General Environmental Requirements of passive PROFINET Connection Systems (informative chart from IEC 61784-5-3)
Temperature range -20 °C to +70 °C	
The contact point must be designed in accordance with IEC 60999-1.	

## Annex I

### I.1 1 pair Ethernet channel requirements

The Channel model according to IEC CD 11801-1 AMD1 ISO/IEC 2022 allows maximum 4 couplers in a 100 m channel. This is standard in many PROFINET Applications.

**Figure 19: Single Pair Cabling Model**



#### Key

EQP	Equipment
C	Connection (mated pair)

(source ISO/IEC CD 11801-1 AMD 1© ISO/IEC 2022, Figure 9, page 45)

PoDL is out of scope for this guideline for the time being. For additional power supply at the device a one cable hybrid solution is recommended.

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