PROFINET Cabling and Interconnection Technology

Guideline for PROFINET

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Prepared by PI Working Group 1 “Passive Network Components” in Committee B “Technologies”.

In this specification the following key words (in **bold** text) will be used:

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	May 2021	Completely reworked, new content

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 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 11801-1: Information technology - Generic cabling for customer premises - Part 1: General requirements

ISO/IEC 11801-3: Information technology - Generic cabling for customer premises - Part 3: Industrial premises

ISO/IEC 14763-2: Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation.

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: Non electrical 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 60079-11: Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "

IEC 60079-14: Explosive atmospheres – Part 14: Electrical installations design, selection and erection

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 60332–1-2: Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame

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 60352-3: Solderless connections - Part 3: Accessible insulation displacement (ID) connections - General requirements, test methods and practical guidance

IEC 60352-4: Solderless connections - Part 4: Solderless non-accessible insulation displacement connections - General requirements, test methods and practical guidance

IEC 60352-6: Solderless connections - Part 6: Insulation piercing connections - General requirements, test methods and practical guidance

IEC 60364-1: Low-voltage electrical installations - Part 1: Fundamental principles, assessment of general characteristics, definitions

IEC 60364-4-41: Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock

IEC 60364-4-42: Low-voltage electrical installations - Part 4-42: Protection for safety - Protection against thermal effects

IEC 60364-4-44: Low-voltage electrical installations - Part 4-44: Protection for safety - Protection against voltage disturbances and electromagnetic disturbances

IEC 60364-5-54: Electrical installations of buildings - Part 5-54: Selection and erection of electrical equipment – Earthing arrangements, protective conductors and protective bonding conductors.

IEC 60512-6-2: Connectors for electronic equipment - Tests and measurements - Part 6-2: Dynamic stress tests - Test 6b: Bump

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 60512-9-1: Connectors for electronic equipment - Tests and measurements - Part 9-1: Endurance tests - Test 9a: Mechanical operation

IEC 60529: Degrees of protection provided by enclosures (IP Code)

IEC 60603-7-series: Connectors for electronic equipment - Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions

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 60793-2-50: Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single–mode fibres

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 60811-100: Electric and optical fibre cables - Test methods for non-metallic materials - Part 100: General

IEC 60811-201: Electric and optical fibre cables - Test methods for non-metallic materials - Part 201: General tests - Measurement of insulation

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 60874-14series: 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 mm2 up to 35 mm2 (included)

IEC 61000-4 series: Electromagnetic compatibility: EMC, Testing and measurement techniques Parts 4-x ISO 23570-3: Industrial automation systems and integration — Distributed installation

IEC 61000-6-2: Electromagnetic compatibility: EMC) -Part 6-2: Generic Standards -Immunity for industrial environments

IEC 61000-6-4 am1: Electromagnetic compatibility: EMC) - Part 6-4: Generic standards - Emission standard for industrial environments

IEC 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

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 61076-2-107: Connectors for electronic equipment – Product requirements – Part 2 107: Detail specification for circular hybrid connectors M12 with electrical and fibre-optical contacts with screw-locking

IEC 61076-2-109: Connectors for electronic equipment - Product requirements - Part 2-109: Circular connectors - Detail specification for connectors with M 12 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 61076-2-114: Circular connectors – Detail specification for data and power connectors with M8 screw-locking

IEC 61076-3-101: Connectors with assessed quality, for use in d.c., low-frequency analogue and in digital high-speed data applications - Part 3: Rectangular connectors

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 61076-3-123: 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 connector for industrial environments with push-pull locking

IEC 61131-2: Programmable controllers - Part 2: Equipment requirements and tests

IEC 61156-1: Multicore and symmetrical pair/quad cables for digital communications - Part 1: Generic specification

IEC 61156-2: Multicore and symmetrical pair/quad cables for digital communications - Part 2: Symmetrical pair/quad cables with transmission characteristics up to 100 MHz - Horizontal floor wiring - Sectional specification

IEC 61156-3: Multicore and symmetrical pair/quad cables for digital communications – Part 3: Work area wiring; Sectional 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 61158-2: Digital data communications for measurement and control - Fieldbus for use in

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 61326-1: Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements

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 61784-1: Industrial communication networks - Profiles - Part 1: Fieldbus profiles industrial control systems physical layer.

IEC 61784-2: Industrial communication networks - Profiles - Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC

IEC 61784-3: Industrial communication networks - Profiles - Part 3: Functional safety fieldbuses - General rules and profile definitions

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 61935-1: Specification for the testing of balanced and coaxial information technology cabling - Part 1: Installed balanced cabling as specified in ISO/IEC 11801-1 and related standards

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

ISO/IEC/IEEE 8802-3:2021 Telecommunications and exchange between information technology systems - Requirements for local and metropolitan area networks - Part 3: Standard for Ethernet

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 clause 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 represent 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 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)

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.

Supported physical Layers:

- 2/4-Pair balanced Cabling
- Fibre Optical Cabling

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 1: Environments Inside Enclosure and Outside Enclosure

	Inside enclosure	Outside enclosure
Mechanical		
Shock/bump [a)] 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 b)	-20°C to +70°C b)
Electromagnetic		
Transfer Impedance	See components selection	

a) Bump: the repetitive nature of the shock experienced by the channel shall be taken into account.

b) An additional heating by POE has to be considered by the user.

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 1: Cabling Landscape with allocation of application areas

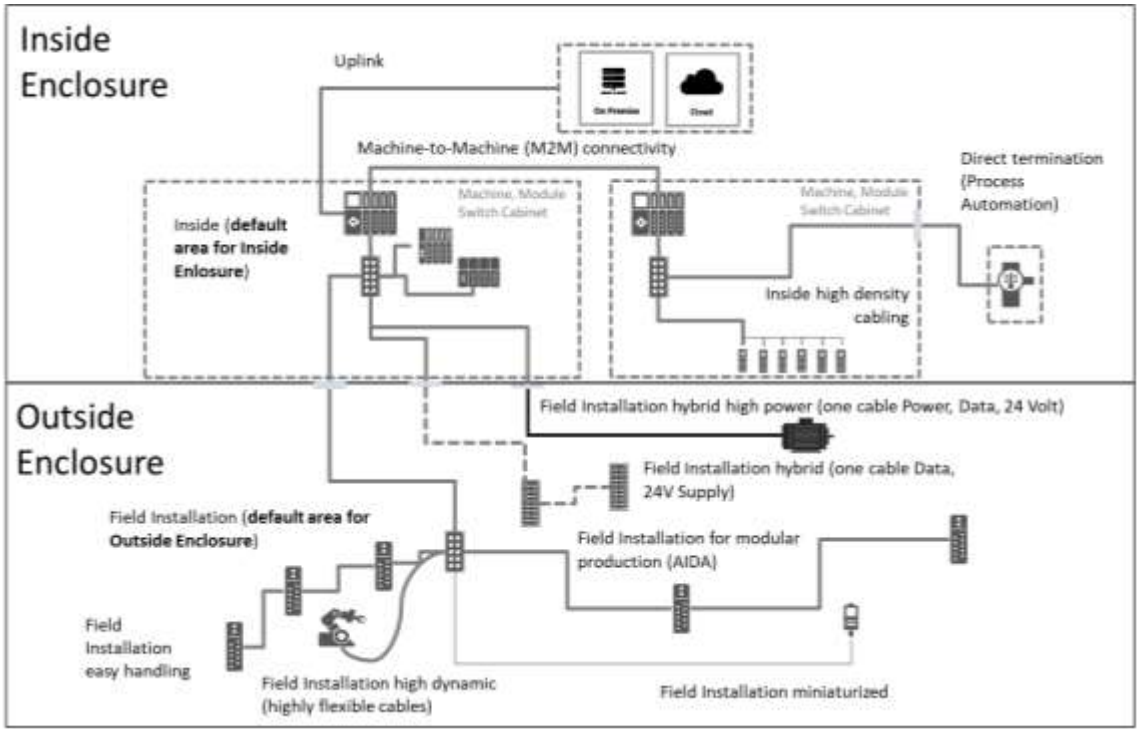


Table 2: Supported Application Areas

Environment:	**Application Area:**
Inside Enclosure	Uplink
	Machine-to-Machine (M2M) connectivity
	Inside cabling (**default area for Inside Enclosure**)
	Inside high-density cabling
	Direct termination (Process Automation)
Outside Enclosure	Field Installation (**default area for Outside Enclosure**)
	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** 2 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 at the Table 3 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 1: 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

Machine-to-Machine (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 to provide 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 represent 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 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 3: 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 amount 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 cabling, today with 2-pair cabling, and in the future also 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 3: Component Classification (PROFINET Data Connectors) supported Application Areas

	Connector				Application Area											
Physical Layer	**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)**
2/4-Pair-Ethernet	**4 pair PushPull**	IEC 61076-3-117		SPC						X		X		X		
	M12 X	IEC 61076-2-109		**GPC**			X		X	X				X		
	RJ 45	IEC 60603-7-3		**GPC**		X	X									
		IEC 61076-3-124		SPC		X		X								
		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									
Fibre Optic	**LC**	IEC 61754-20		**GPC**	X	X	X									
	Push Pull SCRJ	IEC 61076-3-123		SPC						X						

X: dedicated soluion

Table 4: Component Classification (PROFINET 24 Volt Connectors)

	Connector				Application Area											
Physical Layer	**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)**
24 Volt Supply	**M12 L Coded**	IEC 61076-2-111		**GPC**		**X**	**X**	**X**	**X**	**X**				**X**		
	Push Pull	IEC 61076-3-123		SPC						**X**		**X**		**X**		

X: dedicated solution

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.

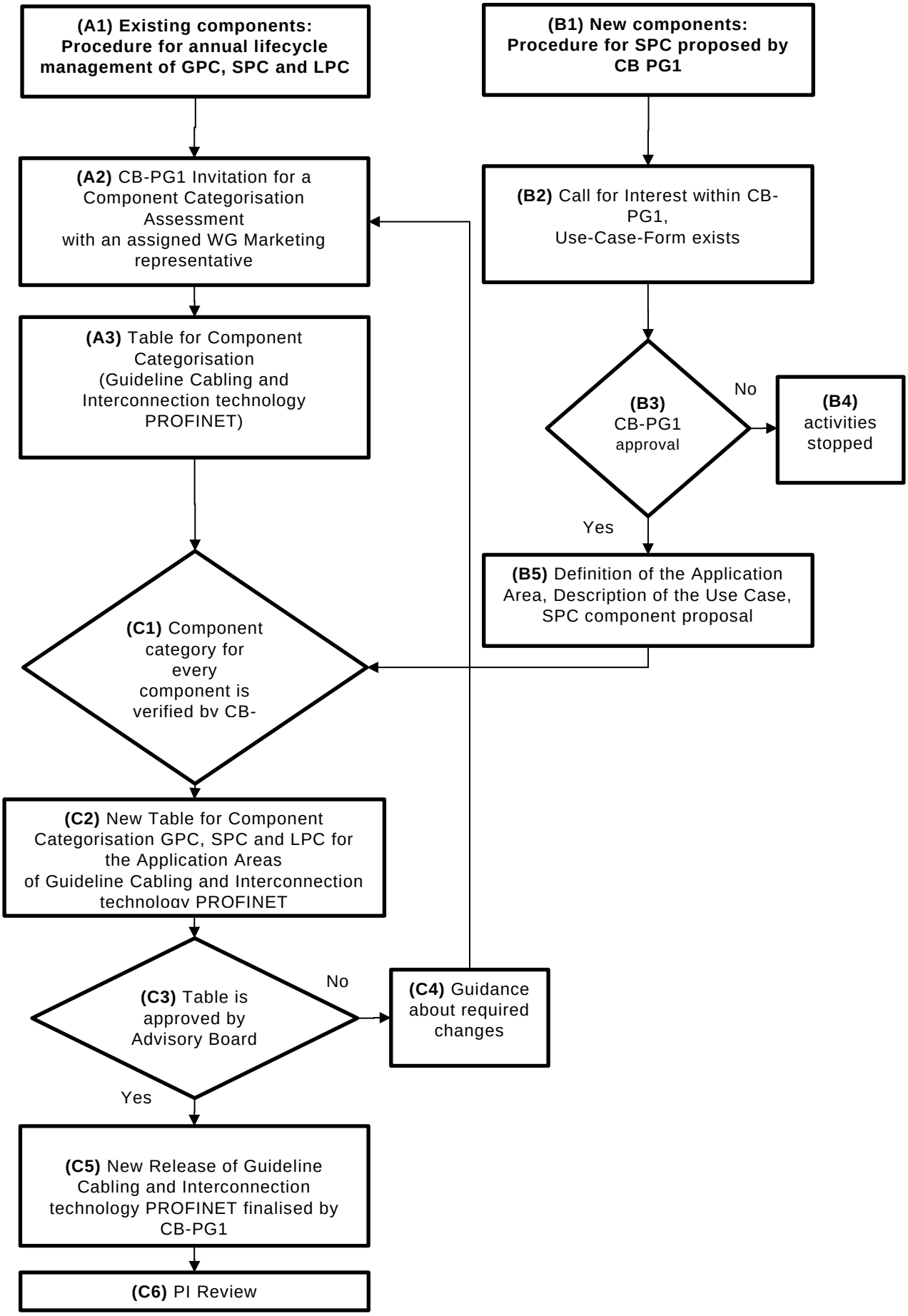
2. A call for interest would be initiated in CB-PG1 in order to describe the Use-Case/Application Are in the respective form (B2)

    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 2: 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 3: Procedure for connectors

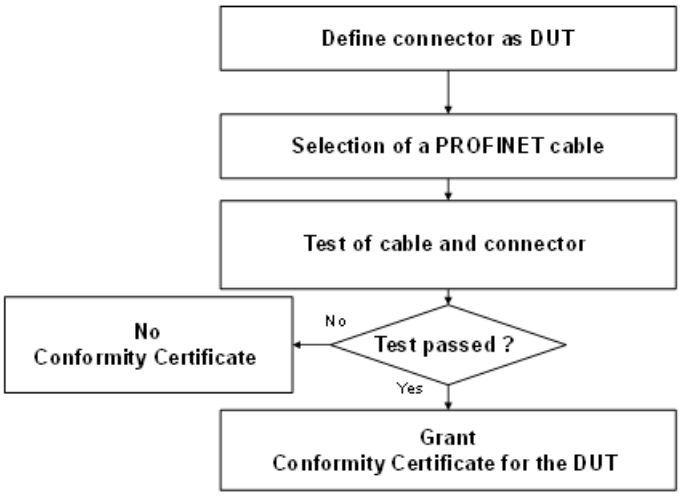
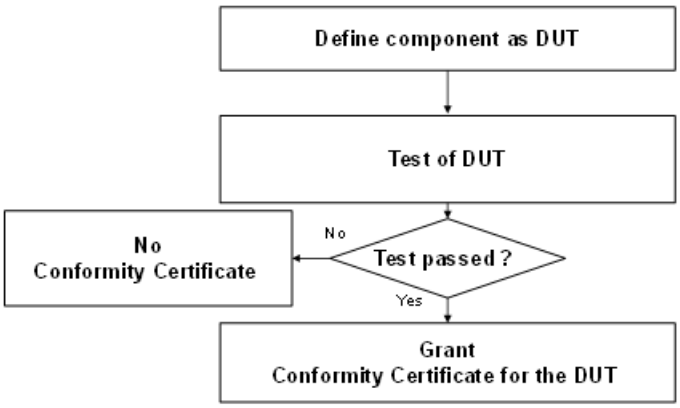


Figure 4: Procedure for PROFINET components, except connectors



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 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 2 pair Cables (Type A, B, C, R)

Table 5: 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 A)	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 ± 0,2 mm		Application specific	1,4 ± 0,2 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 - 8,0 mm			5,5 - 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) B)
Delay Skew IEC 61156	≤ 20 ns/100 m		
Coupling attenuation EN 50289-1-6	≥ 80 dB at 30 MHz to 100 MHz		

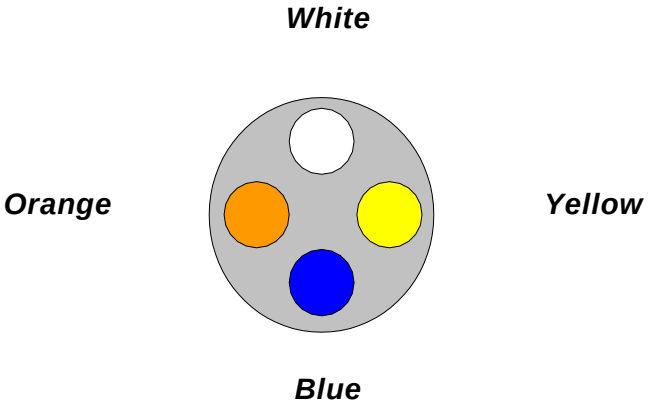
Ambient Conditions Requirement:	
Operating temperature	-20°C ...+70°C

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	≥ 1.20 mm ≤ 1,60 mm
	Outer cable diameter	IEC 60811-203	≥ 5,5 mm, ≤ 8,0mm
	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/s² 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_{DC} ≤14 mOhm/m (measured cable length 30 m) IEC 60189-1	R_{DC} ≤ 14 mOhm/m after mechanical test according trailing chain /torsion /bending test and after 10A DC (30 s)
Type C	Application specific		

Note A) 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.



11.2 Balanced 4 pair Cables (Type A, B, C)

Table 6: 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[A)]	≤ 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) [B)]
Delay skew	≤ 20 ns/100 m between pair Orange and pair Green		

IEC 61156	
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 A) 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).

11.3 Balanced 2 pair Hybrid Cables (Type B, C)

Hybrid cables contain cores for signals transmission and power supply.

Table 7: 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 A)	AWG 22/7, ≥ 0,318 mm²	AWG 22/.., ≥ 0,318 mm²
Conductor Cross Section power wire	1,5 mm^2	
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 ± 0,2 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) B)	IEC 61156-6 (≥ Category 5) B)
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 A) AWG dimensions are given for information only.

Note B) The possible channel length of the hybrid cable depends on the power consumption of the connected devices.

12 Optical Fibre Cables

12.1 POF and PCF cables

Table 8: POF and PCF Cable Specification

General Requirement:	**Application Type B**	**Application Type C**
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, Methode 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 9: 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 10: All-silica multi mode optical fibre cables Specification

General Requirement:	**Application Type B**	**Application Type C**
Cable Design	2 All-silica multi 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 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 IEC 60811-203	50/125 µm 62,5/125 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	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, Methode 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.

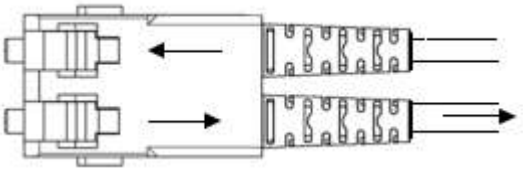
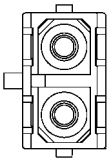
13.2 Connectors of Fibre Optic

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 11: 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 Table 1
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 12: 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 Inside enclosure of Table 1
Shock, half-sine pulses	

Table 13: Key characteristic according to IEC 61754-24

Area	Key characteristic		
Robustness	Values according Inside enclosure of Table 1		
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^2)	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 900µm	
Wire Diameter	subcable diameter	POF/PCF 2,2mm	

Figure 5: Contact Assignment IP 20 SC-RJ Fibre optic Connector (if applicable)

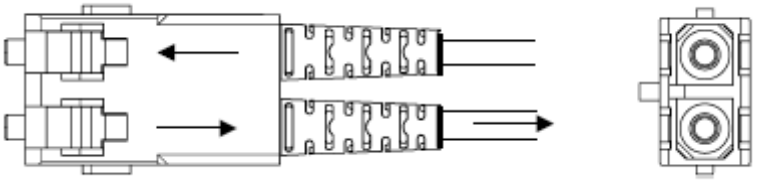
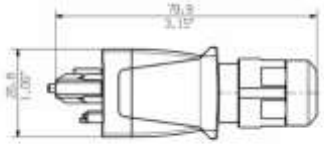


Table 14: Additional Requirements

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 15: 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 Table 1
Standard:	IEC 61754-24-21
Figures (technical drawings):	
Interface:	Connector front and side view
Product Example (picture):	

Particular 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.

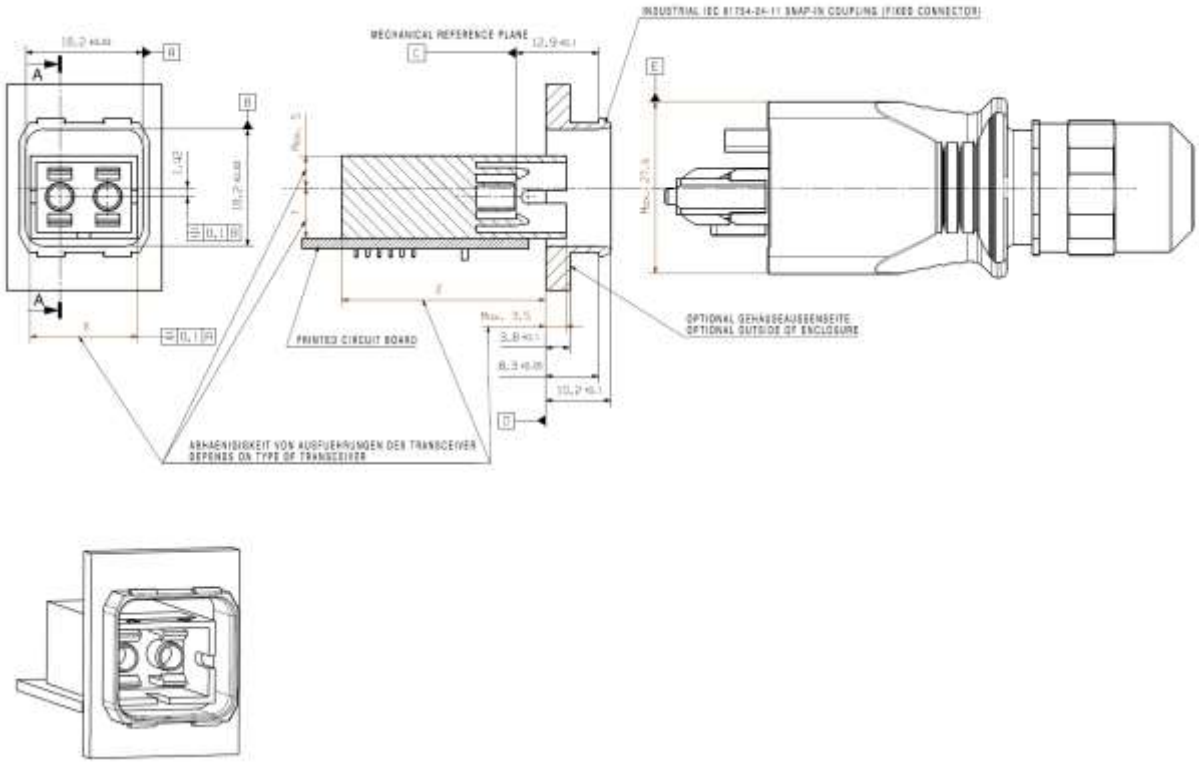
Table 16: Standard requirements of connectors according to IEC 61754-24-21

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-20°C – 70°C
Degree of protection (IEC 60529)	According to outside enclosure of Table 1
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 1
Shock, half-sine pulses	

Design integration:

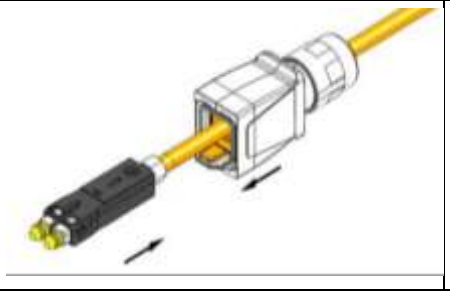
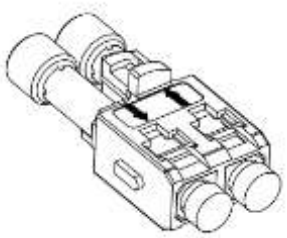
SC- RJ Push Pull connector: Only a SCRJ connector or a transceiver with mating face in accordance with IEC 61754-24-21 shall be used. The data required for mating compatibility to the Push Pull housing is specified in IEC 61076-3-107. The compliance to this standard is ensured by the device manufacturer.

Figure 6: Design Integration Requirements



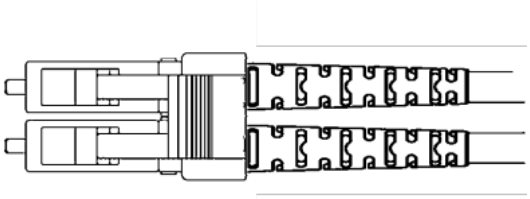
The integration into the Push Pull Housing of the SC-RJ Data insert is vendor specific.

Table 17: Key characteristics of connectors according to IEC 61754-24-21

Area	Key characteristic		
Robustness	Values of outside enclosure according to Table 1		
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^2)	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 18: 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):	

Particular Description:

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

Table 19: Standard requirements of connectors according to IEC 61754-20

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	according "Inside enclosure"
Degree of protection (IEC 60529)	according "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 1
Shock, half-sine pulses	

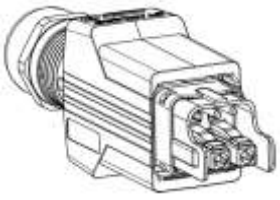
Table 20: Key characteristics of connectors according to IEC 61754-20

Area		Key characteristic	
Robustness		Values of inside enclosure according to Table 1	
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^2)	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 21: Connector according to IEC 61076-3-123

PROFINET Connector Type:	Fibre optic connector LC Push-Pull according 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.

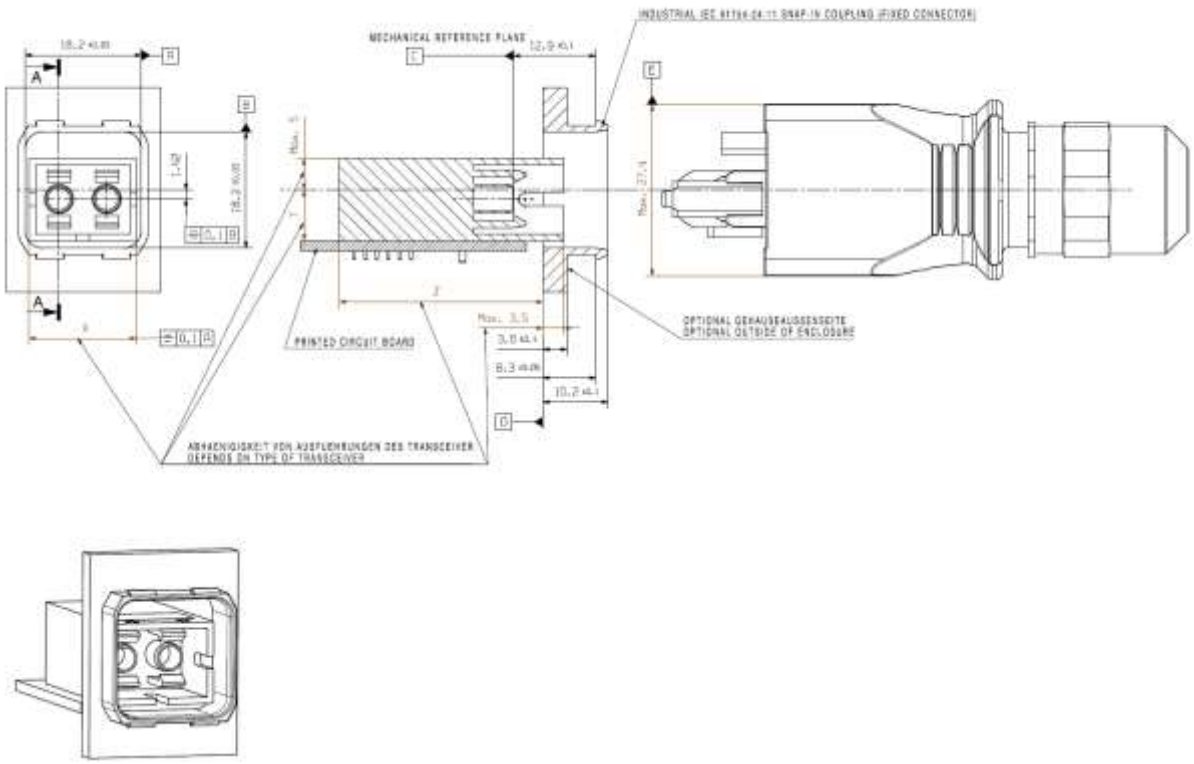
Table 22: Standard requirements of connectors according to IEC 61076-3-123

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature and Degree of protection (IEC 60529)	Values of outside enclosure according to Table 1
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 1
Shock, half-sine pulses	Values of outside enclosure according to Table 1

Table 23: Key characteristics of connectors according to IEC 61076-3-123

Robustness (housing, ….)		Values of outside enclosure according to Table 1	
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^2)	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 7: Design Integration Requirements



13.2.5 BFOC-FO-Connector

Table 24: 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 25: Standard requirements of connectors according to IEC 61754-2

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	according "Inside enclosure"
Degree of protection (IEC 60529)	according "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 1
Shock, half-sine pulses	Values of outside enclosure according to Table 1

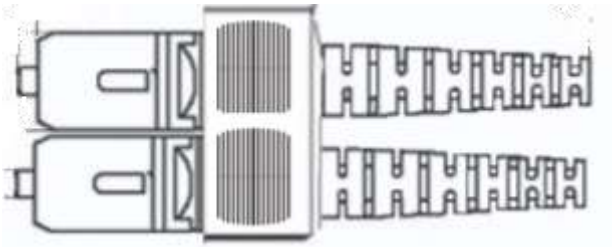
Table 26: Key characteristics of connectors according to IEC 61754-2

Robustness (housing, ….)		Values of outside enclosure according to Table 1	
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^2)	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 27: 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 28: Standard requirements of connectors according to IEC 61754-4

Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	Values of inside enclosure according to Table 1
Degree of protection (IEC 60529)	Values of inside enclosure according to Table 1
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 1
Shock, half-sine pulses	Values of inside enclosure according to Table 1

Table 29: Key characteristics of connectors according to IEC 61754-4

Robustness (housing, ….)		Values of inside enclosure according to Table 1	
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^2)	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 30: 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 rewireable or no-rewireable, with M12x1 screw-locking. Suitable for inside & outside, typical applications are outside environmental with degree of protection IP65/IP67.

Table 31: 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 acc. 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)	100 MHz, Class D (Cat. 5) acc. ISO/IEC 11801-1
Mechanical	
Mating cycles (mating & unmating)	100 min. acc. IEC 60512 test 9a
Cable Strain Relief	80 N min. acc. IEC 61984, cable outer diameter 4…9 mm
Vibration, sinusoidal	10 Hz to 500 Hz and 0,35 mm or 50 m/s^2 acc. IEC 60512 test 6d
Shock, half-sine pulses	50g, 11ms acc. IEC 60512 test 6c

Table 32: Key Characteristics according to IEC 61076-2-101 M12-D coded

Robustness (housing, ….)	Values of outside enclosure according to Table 1
Number of contacts	4
Shielding	360° shielding suitable for Cat. 5
Contacts (contact details, …)	acc. 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 33: 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 rewireable or no-rewireable 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 34: Standard requirements of connectors according to IEC 61076-02-114 M8-D coded

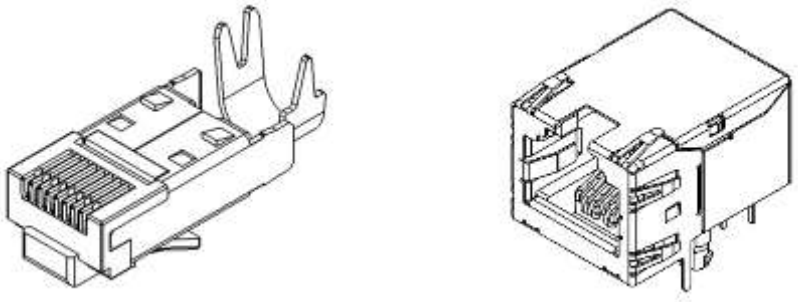
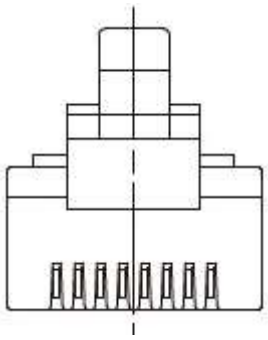
Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-25 °C … + 85 °C
Degree of protection	IP65, IP67 acc. IEC 60529
Electrical	
Operating Voltage	50 V a.c. / 60 V d.c.
Current Rating	4 A
Voltage proof signal-shield	0,84 kV r.m.s.
Transmission performance (category)	100 MHz, Class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

Table 35: 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 1
Number of contacts	4
Shielding	360° shielding suitable for Cat. 5
Contacts (contact details, …)	acc. 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 36: 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 37: Standard requirements of connectors according to IEC 60603-7-3

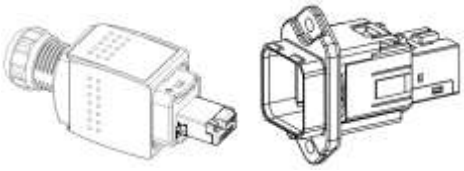
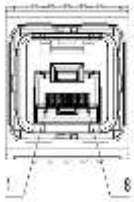
Standard/Requirement	Value
Climate / Environmental	
Ambient Temperature Operating Temperature	-20 °C to 70 °C -40 °C to 85 °C
Degree of protection (IEC 60529)	IP20
Electrical	
Operating Voltage	57 V d.c. (as defined by IEC 61984, clause 3.22)
Current Rating	600 mA per contact @ 70 °C
Voltage proof signal-shield	1500 V a.c. r.m.s.
Transmission performance (category)	Cat. 5
Mechanical	
Mating cycles (mating & unmating)	50 min.
Cable Strain Relief	Acc. 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 38: Key characteristics of connectors according to IEC 60603-7-3

Area	Key characteristic
Robustness	Values of inside enclosure according to Table 1
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^2)	AWG 22 0,34 mm^2
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 39: 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 40: 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 Operating Temperature	-20 °C … 70 °C -40 °C … 85 °C Values of inside and outside enclosure according to Table 1
Degree of protection (IEC 60529)	IP 65/67
Electrical	
Operating Voltage	57 V d.c. [2)]
Current Rating	600 mA per contact @ 70°C
Voltage proof signal-shield	1.500 V a.c. r.m.s.
Transmission performance (category)	Minimum Cat. 5
Mechanical	
Mating cycles (mating & unmating)	50 min.
Cable strain relief	acc. 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)

[1)] 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.

[2)] As defined by IEC 61984, clause 3.22

Table 41: 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 1
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^2)	Data: AWG 22 – AWG 24 (0,34 mm^2 – 0,2 mm^2)
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 42: RJ45 pin and pair assignment for 4-pair cabling (10/100 Mbps and 1/10 Gbps)

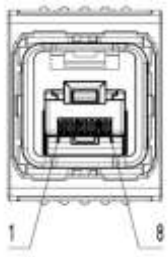
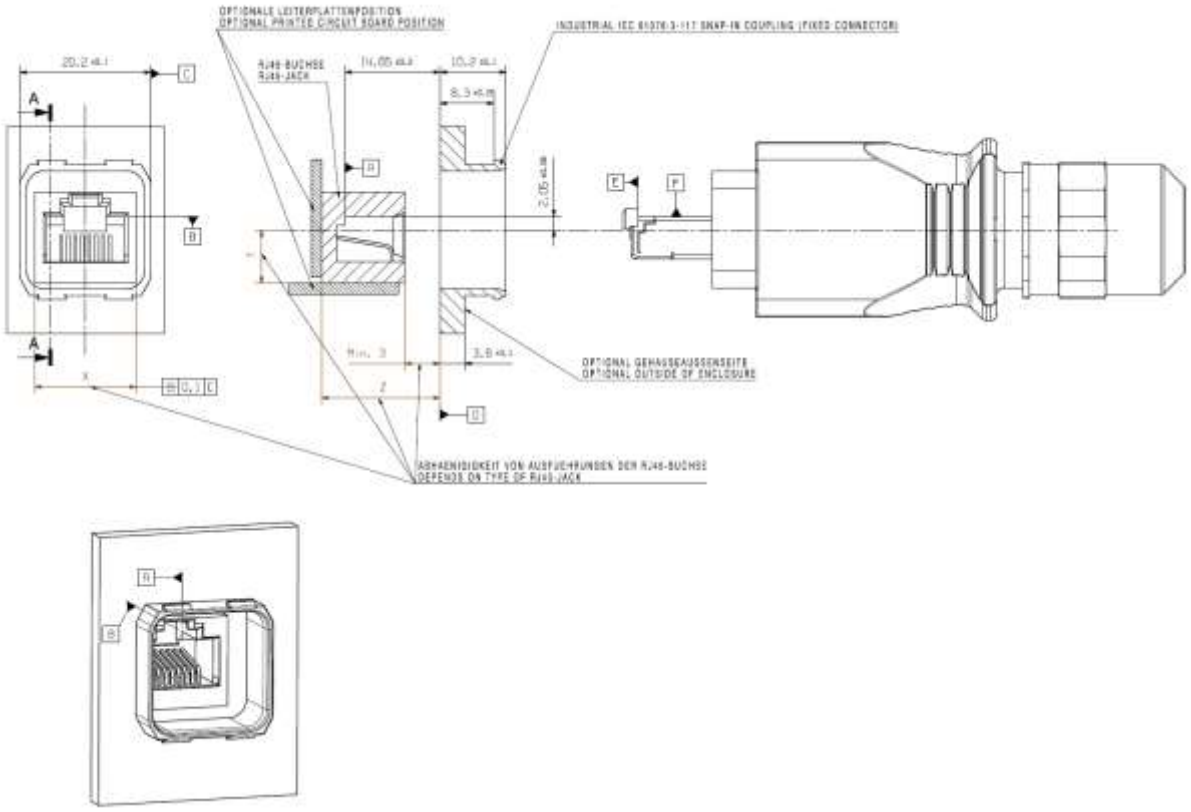
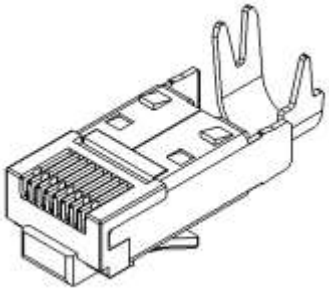
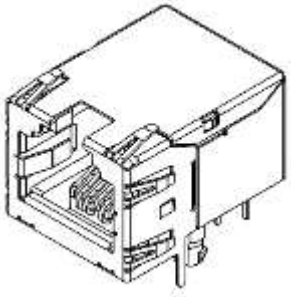
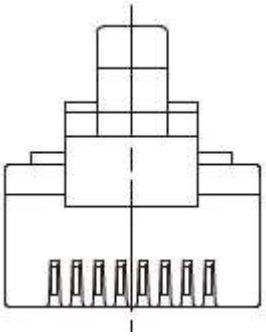
Connector				Cable		
 Figure, IP65/67 RJ45 Interface	Function	Signal	Contact	Function	Colour TIA-568A	Colour TIA-568B
	Bi-directional pair A+	BI_DA+	1	TD/RD 1	White/Green	White/Orange
	Bi-directional pair A-	BI_DA-	2		Green	Orange
	Bi-directional pair B+	BI_DB+	3	TD/RD 2	White/Orange	White/Green
	Bi-directional 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 8: Design Integration Requirements



13.3.5 RJ45-4-pair connector of balanced cable

Table 43: 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 44: Standard requirements of connectors according to IEC 60603-7-5

Standard/Requirement	Value
Climate / Environmental	
Ambient Temperature Operating Temperature	-20 °C to 70 °C -40 °C to 85 °C Values of inside enclosure according to Table 1
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. r.m.s.
Transmission performance (category)	Cat 5 / Cat.6 / Cat 6_A
Mechanical	
Mating cycles (mating & unmating)	50 min.
Cable Strain Relief	Acc. 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 45: 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^2)	AWG 24 – AWG 22 0,2 mm^2 – 0,34 mm^2
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 46: 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 rewireable or no-rewireable, with M12x1 screw-locking. Suitable for inside & outside, typical applications are outside environmental with degree of protection IP65, IP67.

Table 47: 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 acc. 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^2 wire gauge)
Voltage proof signal-shield	0,5 kV r.m.s.
Transmission performance (category)	100 MHz, Class D (CAT 5…..CAT 6A) acc. ISO/IEC 11801-1
Mechanical	
Mating cycles (mating & unmating)	100 min. acc. IEC 60512 test 9a for Gold contacts
Cable Strain Relief	80 N min. acc. IEC 61984, cable outer diameter 4…9 mm
Vibration, sinusoidal	10 Hz to 500 Hz and 0,35 mm or 50 m/s^2 acc. IEC 60512 test 6d
Shock, half-sine pulses	50 g, 11 ms acc. IEC 60512 test 6c

Table 48 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 1
Number of contacts	8
Shielding	360° shielding suitable for min. Cat. 5
Contacts (contact details, …)	acc. 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 49: Connector according to IEC 61076-3-122

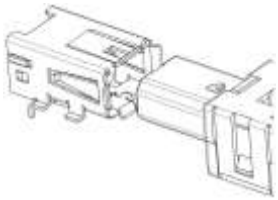
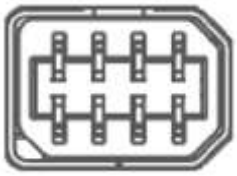
PROFINET Connector Type:	PROFINET Specific Passive Components (SPC) M2M connectivity miniaturized and peripheral cabinet connectivity miniaturized
Standard:	IEC 61076-3-122
Figures (technical drawings):	
Interface: Type 1 - Male connector (front view)	
Product Example (picture):	

Table 50: 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 1
Degree of protection (IEC 60529)	IP20
Electrical	
Operating Voltage	50 V a.c. r.m.s. / 60 V d.c.
Current Rating	1 A *
Voltage proof signal-shield	1.500 V a.c. r.m.s.
Transmission performance (category)	Cat. 5 / Cat. 6_A
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	

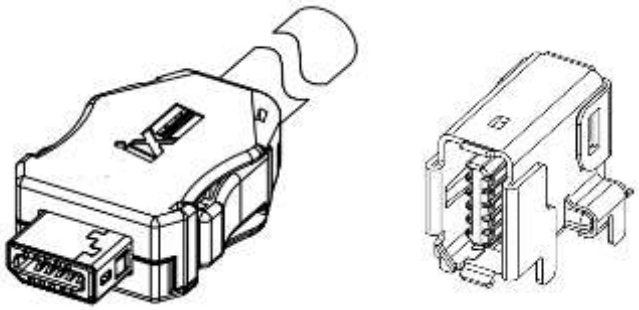
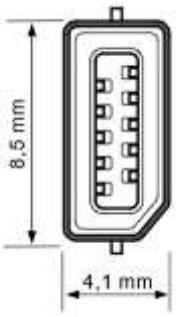
Table 51: Key characteristics of connectors according to IEC 61076-3-122

Area	Key characteristic
Robustness (housing, ….)	Inside enclosure according to Table 1
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	• SMT solder pads at >2 positions • THT/wave soldering with >2 through-hole anchors • 2 board positioning pins
Locking mechanism	• Metal latching mechanism • Dimension and shape of latch optimized for high packaging density • Operation without tool or with standard tool (e.g. screwdriver)
Wire Termination	• Field install-ability • IEC 60352-3, -4 and -6 • High transmission performance up to Cat. 6_A by controlled wire positioning
Outer Cable Diameters (range)	4,7 mm – 8,2 mm
Wire-Cross Section (AWG and mm^2)	AGW 22 – AWG 26 0,14 mm^2 – 0,34 mm^2

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 52: Connector according 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 53: Standard requirements of connectors according to IEC 61076-3-124

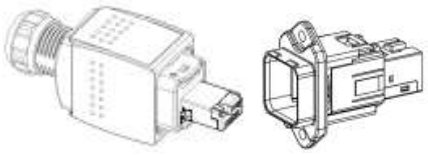
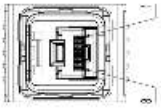
Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	-40 °C to 85 °C
Degree of protection (IEC 60529)	IP20
Electrical	
Operating Voltage	50 V a.c. r.m.s. / 60 V d.c.
Current Rating	1,5 A *
Voltage proof signal-shield	2.250 V d.c.
Transmission performance (category)	Cat. 5 / Cat. 6_A
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^2 max.
Shock, half-sine pulses	300 m/s^2 max., 11 milliseconds, 18 shocks
* all pins used simultaneously and $T_{amb.}$ = 40 °C	

Table 54: Key characteristics of connectors according to IEC 61076-3-124

Area	Key characteristic
Robustness	Inside enclosure according to Table 1
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^2)	AWG 28 – AWG 22 0,08 mm^2 – 0,33 mm^2
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 Push Pull 4-pair Connector for Balanced Cable

Table 55: 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 56: 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 Table 1
Degree of protection (IEC 60529)	IP 65/67
Electrical	
Operating Voltage	57 V d.c. 2)
Current Rating	600 mA per contact @ 70°C
Voltage proof signal-shield	1.500 V a.c. r.m.s.
Transmission performance (category)	Minimum Cat. 5
Mechanical	
Mating cycles (mating & unmating)	50 min.
Cable strain relief	acc. 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 1

1) 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.

2) As defined by IEC 61984, clause 3.22

13.4 PROFINET Connectors for 24V Power Supply

13.4.1 M12-A-coded Connector for 24V Power Supply

Table 57: 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).

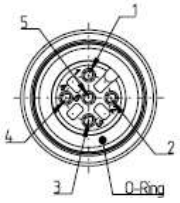
Table 58: Standard requirements of connectors according to IEC 61076-2-101

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. acc. 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 59: Key characteristics of connectors according to IEC 61076-2-101

Area	Key characteristic
Robustness (housing, ….)	Outside enclosure according Table 1
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 60: 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

13.4.2 7/8”- Power Connector for 24V Power Supply

Table 61: Key characteristics of connectors according to ANSI / B93 55M-1981 or NFPA/T3.5.29 R1-2007

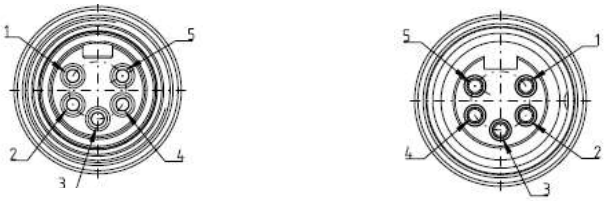
PROFINET connector Type:	PROFINET Legacy Passive Components (LPC)
Standard:	ANSI / B93 55M-1981 or NFPA/T3.5.29 R1-2007
Figures (technical drawings):	
Interface (male/female)	
Product Example (picture):	

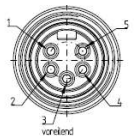
Table 62: Standard Requirements

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. acc. IEC 61984, cable outer diameter 6 … 9,0 mm 100 N min. acc. IEC 61984, cable outer diameter 9 … 10,0 mm

Table 63: Key characteristics of connectors 7/8” 5-way

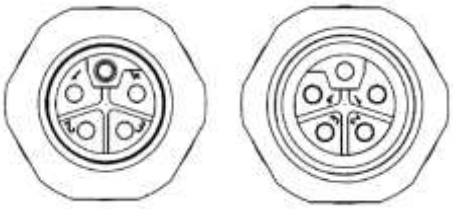
Area	Key characteristic
Robustness	Outside enclosure according to Table 1
Number of contacts	4+FE
Shielding	no
Locking mechanism	7/8” Thread
Outer Cable Diameters (range)	6.0 mm – 10 mm
Wire-Cross Sectior (AWG and mm²)	1,5 mm², 2,5 mm²
Wire Construction (solid/stranded)	stranded

Table 64: 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

13.4.3 M12-L Power Connector for 24V Power Supply

Table 65: M12 power connector according 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 66: Standard requirements M12 power L coded connector according IEC 61076-02-111

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

Table 67: Key characteristics M12 power L coded connector acc. IEC 61076-2-111 L coded

Area	Key characteristic
Robustness	Outside enclosure according to Table 1
Number of contacts	4, optional 4+FE
Shielding	optional
Contacts (contact details, …)	acc. 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^2 … 2,5 mm^2
Wire Construction (solid/stranded)	Solid, stranded

Table 68: Pin assignment M12 power L coded 4 way acc. IEC 61076-2-111

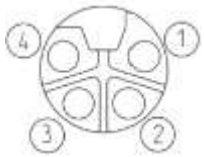
Connector acc to IEC61076-2-111 – L-coded 4 way				Cable Colour outer sheet black	
	Function	Signal	Contact	Function	Colour
	24V (1L+ Non-switched)	L1	1	L1	BN
	Masse 2M (Switched)	N2	2	N2	WH
	Masse 1M (Non-Switched)	N1	3	N1	BU
	24V (2L+ Switched)	L2	4	L2	BK
	Colour (insulation body):	black			

Table 69: Pin assignment M12 power L coded 5 way acc. IEC 61076-2-111

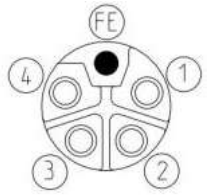
Connector acc to IEC61076-2-111 – L-coded 5 way				Cable Colour outer sheet grey	
	Function	Signal	Contact	Function	Colour
	24V (1L+ Non-switched)	L1	1	L1	BN
	Masse 2M (Switched)	N2	2	N2	WH
	Masse 1M (Non-Switched)	N1	3	N1	BU
	24V (2L+ Switched)	L2	4	L2	BK
	Functional Earth	FE	FE	FE	GY or PK
	Colour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

Table 70: Pin assignment M12 power L coded 5 way acc. 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

13.4.4 Push-Pull 4-way Power Connector for 24V

Table 71: Key Characteristics Push-Pull, Power 5-way M12 power IEC 61076-3-126

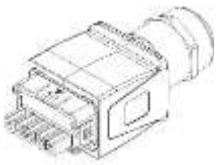
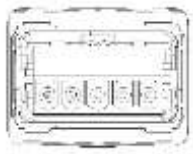
PROFINET connector Type:	PROFINET Legacy Passive Components (LPC)
Standard:	IEC 61076-3-126
Figures (technical drawings):	
Interface:	
Product Example (picture):	

Table 72: 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. acc. IEC 61984 of cable outer diameter 6 … 9,0 mm 100 N min. acc. IEC 61984 of cable outer diameter 9 … 10,0 mm

Table 73: Key characteristics of connectors according to IEC 61076-3-126

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

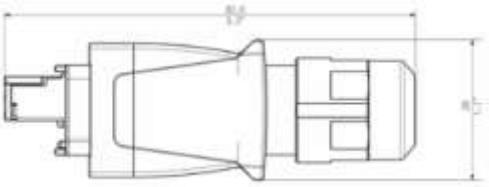
Table 74: Connector acc to IEC 61076-3-126 –Push Pull Power 5 way

Connector				Cable	
	Function	Signal	Contact	Function	Colour
		L1	1	L1	BK1
		N1	2	N1	BK2
		L2	3	L2	BK3
		N2	4	N2	BK4
		FE	FE	FE	GNGE

13.5 Signal Connectors of PROFINET

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

Table 75: 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 76: Standard requirements of connectors according to IEC 61076-3-119

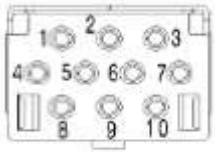
Standard/Requirement	Value
Climate / Environmental	
Operating Temperature	Values according to Table 1 of outside enclosure"
Degree of protection (IEC 60529)	
Electrical	
Operating Voltage	24 Volt
Current Rating	max. 3 A per contact
Voltage proof signal-shield	1,5 kV
Transmission performance (category)	Cat. 5 (ISO/IEC 11801-1)
Mechanical	
Mating cycles (mating & non mating)	500
Cable Strain Relief	According IEC 61754-24
Vibration, sinusoidal	Values according to Table 1 of outside enclosure"
Shock, half-sine pulses	

Table 77: Key characteristics of connectors according to IEC 61076-3-119

Area	Key characteristic
Robustness	Outside enclosure according to Table 1
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 mm²)	Wire connection cross section, finely stranded, max. 0.75 mm² / AWG 20 Wire connection cross-section, finely stranded, min. 0.08 mm² / AWG 27

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

Table 78: Example of contact Assignment IP 67 Signal connector

Pin-Assignment	

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

13.6 Bulkhead for PROFINET

Table 79: Bulkhead according IEC 61918 & ISO/IEC 11801-1

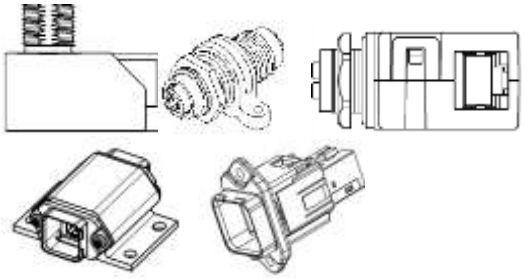
Connector Type:	Bulkhead for PROFINET
Definition (IEC 61918)	Bulkhead: wall or barrier which maintains the ingress and climatic environmental classifications applicable on either side
Standard:	IEC 61918 ISO/IEC 11801-1
Figures (technical drawings):	
Type of Interfaces	RJ 45 – RJ 45 RJ 45 – M12-x-Code 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 80: 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 1)
Degree of protection (IEC 60529)	IP 20 and IP6x 3)
Electrical	
Operating Voltage	Max. 57V d.c 1)
Current Rating	Max. 400 mA 1)
Transmission performance (category) 4)	Cat. 5 up to Cat. 6_A 2), used as s one single connection
Mechanical	
Pull force	Depending on application of Inside and/or Outside Cabinet of Table 1
Vibration, sinusoidal	Depending on application of Inside and/or Outside Cabinet of Table 1
Shock, half-sine pulses	Depending on application of Inside and/or Outside Cabinet of Table 1
1) depending on support of PoE-Standards 2) depending of required performance 3) depending on application 4)Described as Cross-Connection in ISO/IEC 11801-1	

13.6.1 Implementation of Bulkheads

PROFINET bulkheads are implemented in different versions:

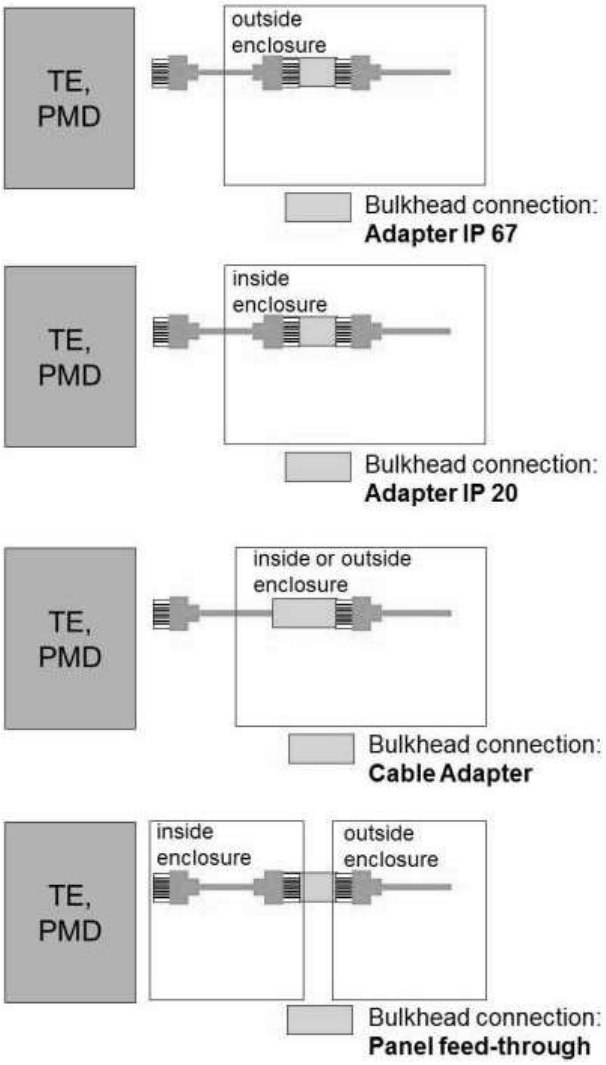
1. Adapter
   a. Adapter IP 6x for the Push Pull connector, M12 connector, Hybrid connector on both side of the adapter
   b. Adapter IP 20 for RJ 45 connector on one or both side of the adapter

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 81: Bulkhead according IEC 61918 & ISO/IEC 11801-1

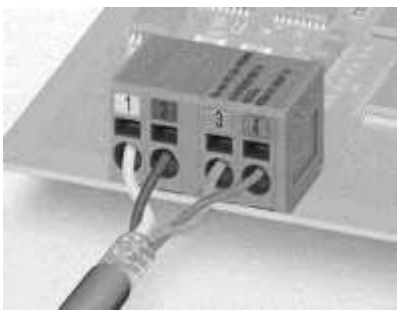
Ingress-	Outside IP6x, Inside IP20 and Inside IP20 to Outside IP6x
Count of Connection	1 x Connection
Shielding	Optimal 360° shielding vs. EMI noise

Figure 9: Definition of the different Bulkhead connections



13.7 Connection Terminal for PROFINET

Table 82: Cabling Landscape with allocation of application areas

Product Example (picture):	

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

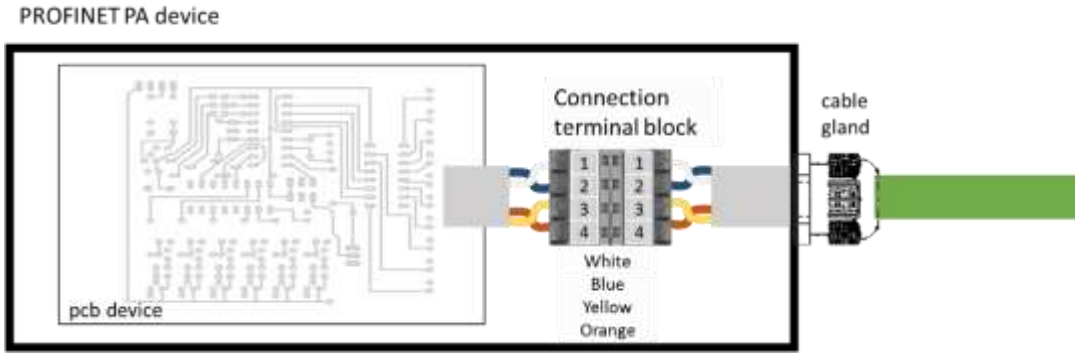


Table 83: Shielding / EMC and mechanical design (properties of PROFINET-compliant device connection

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 84: Ethernet transfer (property of PROFINET-compliant terminal)

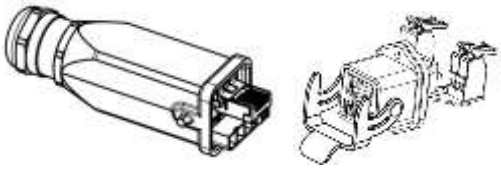
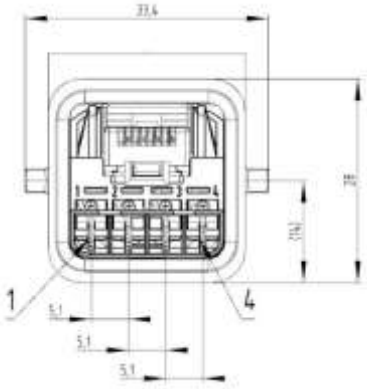
Requirement	Comment:
Component requirement as per Category 5 in accordance with ISO/IEC 11801-series (Connecting hardware)	The electrical approval of the transfer parameters is in analogy as a "mated pair". (Plug-in connector)
PROFINET cable with 2/4 pair is implemented in line with PROFINET Cabling 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 rms, contact-to-contact. 1 500 V rms, 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 85: 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	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.	

13.7.1 PROFINET Hybrid Connector Variant 5 / 48V for PROFINET

Table 86: Connector according to IEC 61076-3-106 (V5)

PROFINET connector Type:	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 date 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 87: 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. [2)] 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. r.m.s.
Transmission performance (category)	Minimum Cat. 5
Mechanical	
Mating cycles (mating & unmating)	50 min.
Cable strain relief	acc. 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)

[1)] 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.

[2)] As defined by IEC 61984, clause 3.22

Table 88: 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 1
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^2)	Data: AGW 22 – AWG 24 (0,34 mm^2 – 0,2 mm^2) Power: 1,5 mm^2
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 Clause 13.2.

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

Table 89: PROFINET FO cabinet cord set specification

Comment	only harnessed cord sets are defined
Application	Inside enclosure according to Table 1
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 90: 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	lEC 60794-1-2 E3
Impact	lEC 60794-1-2 E4
Tensile performance	lEC 60794-1-2 E1
Bending Radius	IEC 60794-1-2-E11A.
Repeated bending	lEC 60794-1-2 E6
Torsion	lEC 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

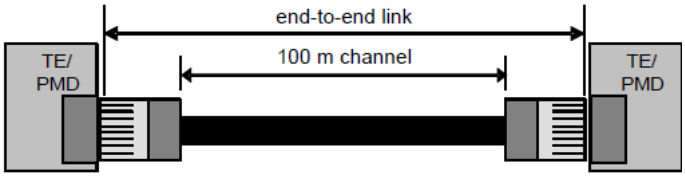
Cabinet cord sets for balanced cabling

B.1 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.

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 11: 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 91: Parameters of cord sets for balanced cabling

Type	PROFINET cord set
Number of wires	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.2 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* L / 100 + 2 * IL con

IL cab= 22,0 dB / 100m @ 100 MHz, IL con = 0,4 dB

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

B.3 Requirements of IL, RL and NEXT of Type C Cabling

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* L / 100 + 2 * IL con

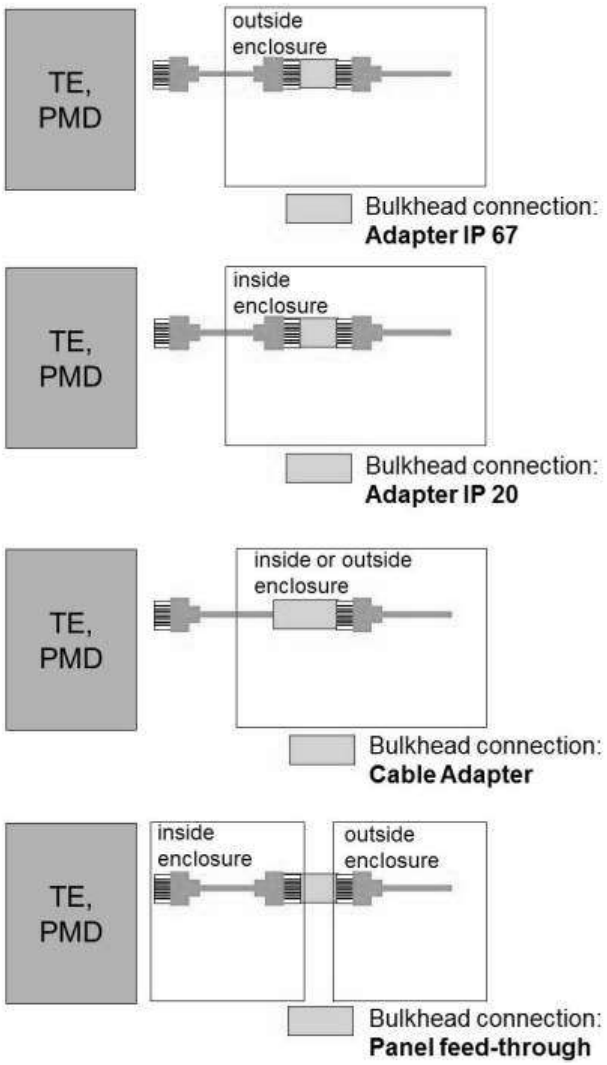
IL cab= 33,0 dB / 100m @ 100 MHz, IL con = 0,4 dB

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

B.4 Conformity and Configuration

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 E.

Figure 12: Configuration End-to-End link build up with PROFINET cabinet cord sets



B.5 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 clause specifies the minimum requirements for cords. The test methods and mechanical stresses are specified in IEC 61935-2. All requirements of this clause 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 to 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 clause 13.

B.5.1 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:

Requirement of PROFINET cabinet cord sets

Table 92: Requirements of PROFINET cabinet cord sets

Type	PROFINET Cabinet cord set
Comment	only harnessed cord sets are defined
Application	Inside enclosure
Number of wires	4,8
Channel performance	Class D (IEC 11801-1)
Cable performance	at least Cat. 5 IEC 61156-6
Cable Colour (outer sheath)	RAL 6018
Cabinet cord set marking 2 pair	“PROFINET cabinet cord 2 pair”
Cabinet cord set marking 4 pair	“PROFINET cabinet cord 4 pair”
PROFINET Component	X
Ambient temperature	-20°C... 70°C
Wire diameter	2 pair: AWG 22 - 24 4 pair: AWG22 - 26
Type of wire	stranded

*1Cable Coupling Attenuation 80dB (Measurement of the coupling attenuation according to EN 50289-1-6)

*2 Connector Coupling 45 dB (Measurement of the coupling attenuation according to IEC 62153-4-12)

B.5.2 PROFINET Cabinet cord set specification 12.2.2

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 93: Requirements of PROFINET cabinet cord sets

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	<= 145 Ohm/km
Elongation at break of the insulation		IEC 60811-501	IEC 61156-6
Elongation at break of		IEC 60811-501	IEC 61156-6
the sheath			
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	≥ 80 dB at 30 MHz to 100 MHz	EN50289-1-6	≥ 80 dB at 30 MHz to 100 MHz
Operating temperature	-20°C ...+70°C		All cable materials have to be designed for - 20°C ...+70°C
Differential delay / Delay skew between Pair 1 (orange) and Pair 2 (green)		IEC 61156-6	<=20ns/100m

The connectors used to build up a cabinet cord shall be in accordance to the specification of the inside connector in clause 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).

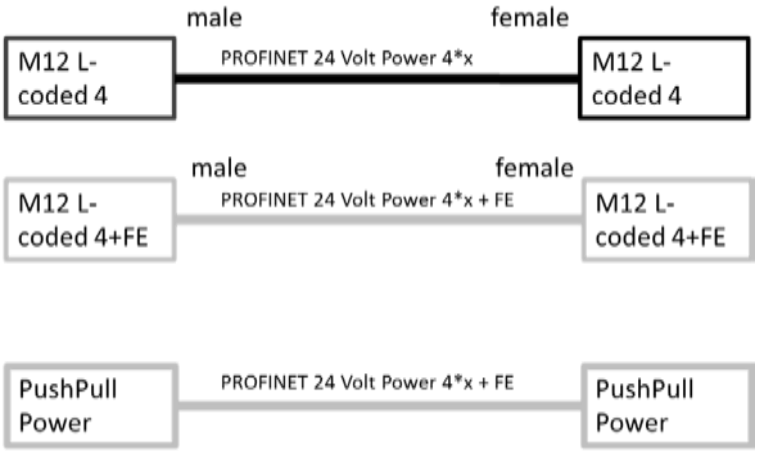
Annex C

Cordsets for 24V-Cabling

C.1 General

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

Figure 13: PROFINET 24 V Power cord sets



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

C.2 Qualification test for PROFINET 24 V cord sets

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

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

Table 94: 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 mm²
Outer cable diameter:	5 -10 mm

Annex D

PROFINET 24 V Cabling

D.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 95: 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 E

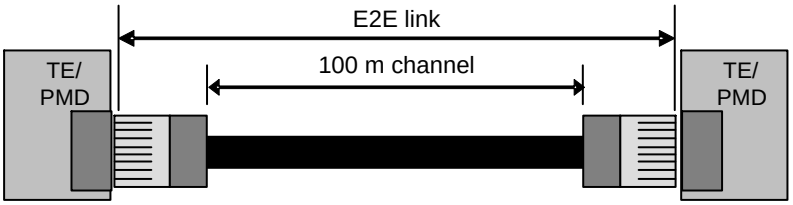
End-to-End (E2E) link assemblies for balanced cabling

E.1 E2E Configurations

E.1.1 E2E link without interconnections

Figure 14 shows an E2E link without interconnections of 100 m length with connectors installed directly at both ends of the cable.

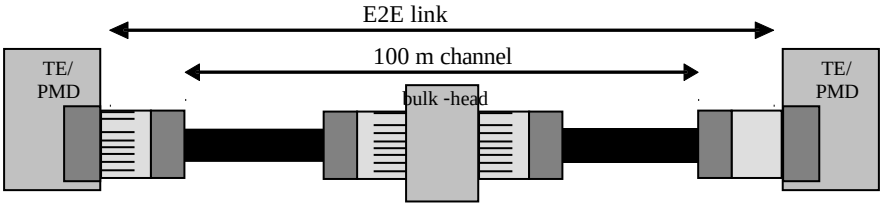
Figure 14: E2E link without interconnections



E.1.2 E2E link interconnections

Figure 15 shows an assembled End-to-End link of 100 m length, containing an intermediate plug connection established with a bulkhead.

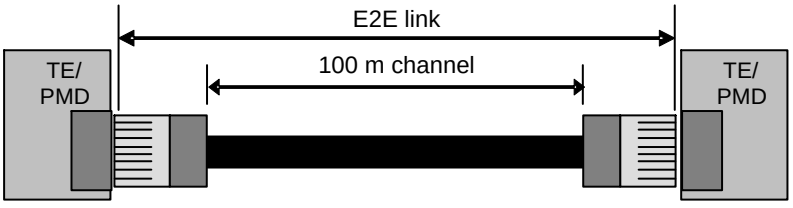
Figure 15: E2E link with interconnections



E.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 16: Definition of the reference plain



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

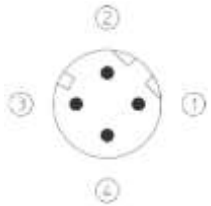
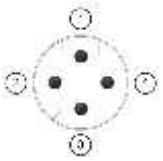
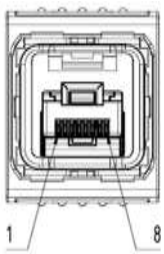
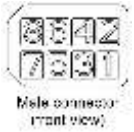
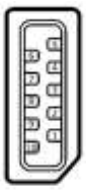
Annex F
Tables of Contact and Wire Arrangement

F.1 Contact arrangement

Table 96: 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	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+	White/ Green	Pair 3	White/ Orange	Pair 2	Yellow	TX +	1	1
2	2	2	2	BI_DA-	Green		Orange		Orange	TX -	3	2
3	6	3	3	BI_DB+	White/ Orange	Pair 2	White/ Green	Pair 3	White	RX +	2	3
4	4	4	8	BI_DC+	Blue	Pair 1	Blue	Pair 1				
5	5	5	7	BI_DC-	White/ Blue		White/ Blue					
6	7	6	4	BI_DB-	Orange	Pair2	Green	Pair3	Blue	RX -	4	6
7	9	7	5	BI_DD+	White/ Brown	Pair 4	White/ Brown	Pair 4				
8	10	8	6	BI_DD-	Brown		Brown					

Table 97: Pin and Pair assignment Connectors for balanced cabling (Summary)

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

Shielding / EMC and mechanical design

G.1 Requirements

G.1.1 Shielding and EMC Requirements

Table 98: 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.	

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

Table 99: 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/Os 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 rms, contact-to-contact. 1 500 V rms, 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	

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

Table 100: 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.	

Bibliography

ISO/IEC 11801-2, *Information technology – Generic cabling for customer premises – Part 2: Office premises*

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