

INTERNATIONAL STANDARD

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**Industrial communication networks – Profiles –
Part 5-2: Installation of fieldbuses – Installation profiles for CPF 2**

**Réseaux de communication industriels – Profils –
Partie 5-2: Installation des bus de terrain – Profils d'installation pour CPF 2**

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**INDUSTRIAL COMMUNICATION NETWORKS –
PROFILES –****Part 5-2: Installation of fieldbuses –
Installation profiles for CPF 2**

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International Standard IEC 61784-5-2 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This third edition cancels and replaces the second edition published in 2010. This edition constitutes a technical revision.

This edition includes the following technical changes with respect to the previous edition:

- updates pertaining to current installation practices;
- addition of new technology that has become recently available;
- errors have been corrected;
- improved alignment with IEC 61918.

This standard is to be used in conjunction with IEC 61918:2013.

The text of this standard is based on the following documents:

FDIS	Report on voting
65C/738/FDIS	65C/743/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 61784-5 series, under the general title *Industrial communication networks – Profiles – Installation of fieldbuses*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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- replaced by a revised edition, or
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INTRODUCTION

This International Standard is one of a series produced to facilitate the use of communication networks in industrial control systems.

IEC 61918:2013 provides the common requirements for the installation of communication networks in industrial control systems. This installation profile standard provides the installation profiles of the communication profiles (CP) of a specific communication profile family (CPF) by stating which requirements of IEC 61918 fully apply and, where necessary, by supplementing, modifying, or replacing the other requirements (see Figure 1).

For general background on fieldbuses, their profiles, and relationship between the installation profiles specified in this standard, see IEC 61158-1.

Each CP installation profile is specified in a separate annex of this standard. Each annex is structured exactly as the reference standard IEC 61918 for the benefit of the persons representing the roles in the fieldbus installation process as defined in IEC 61918 (planner, installer, verification personnel, validation personnel, maintenance personnel, administration personnel). By reading the installation profile in conjunction with IEC 61918, these persons immediately know which requirements are common for the installation of all CPs and which are modified or replaced. The conventions used to draft this standard are defined in Clause 5.

The provision of the installation profiles in one standard for each CPF (for example IEC 61784-5-2 for CPF 2), allows readers to work with standards of a convenient size.

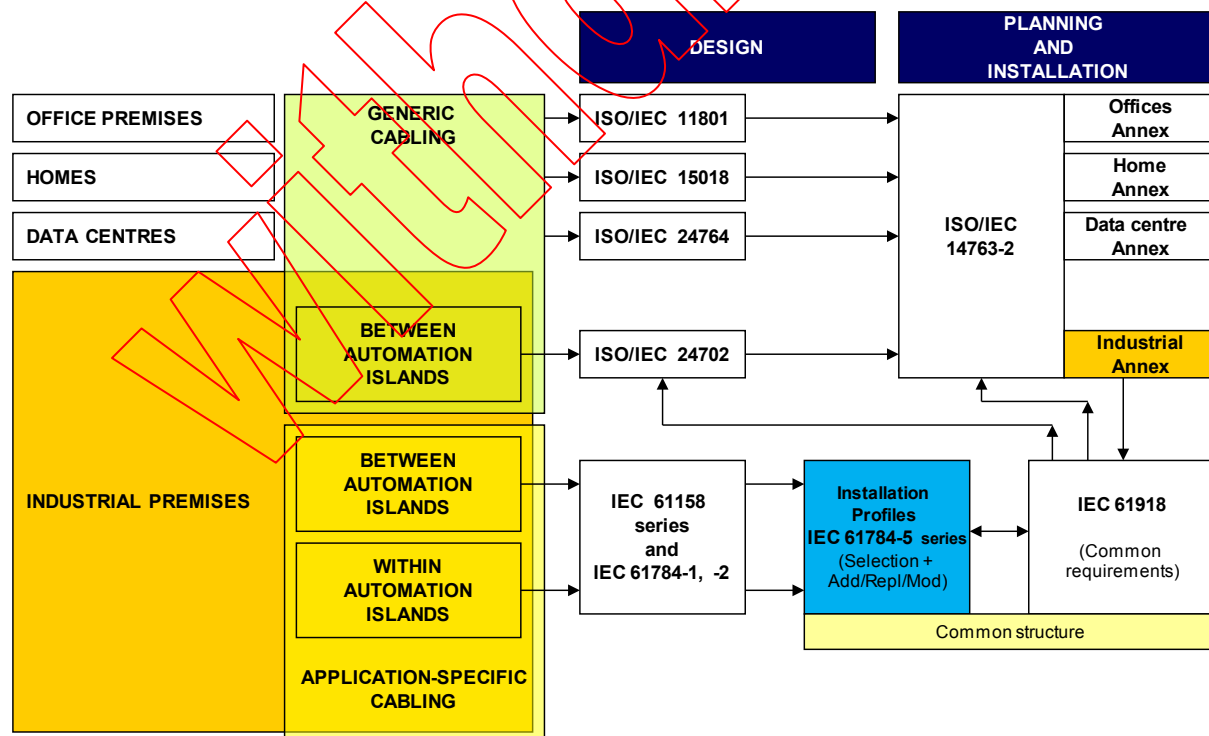


Figure 1 – Standards relationships

INDUSTRIAL COMMUNICATION NETWORKS – PROFILES –

Part 5-2: Installation of fieldbuses – Installation profiles for CPF 2

1 Scope

This part of IEC 61784-5 specifies the installation profiles for CPF 2 (CIP™¹).

The installation profiles are specified in the annexes. These annexes are read in conjunction with IEC 61918:2013.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61918:2013, *Industrial communication networks – Installation of communication networks in industrial premises*

The normative references of IEC 61918:2013, Clause 2, apply. For profile specific normative references, see Clauses A.2, B.2, C.2.

3 Terms, definitions and abbreviated terms

IEC 61918:2013, Clause 3, applies. For profile specific terms, definitions and abbreviated terms, see Clauses A.3, B.3, C.3.

4 CPF 2: Overview of installation profiles

CPF 2 consists of three basic communication profiles as specified in IEC 61784-1 and IEC 61784-2. These profiles share a common upper layers protocol named CIP™ (Common Industrial Protocol).

¹ CIP™ (Common Industrial Protocol) is a trade name of ODVA, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this standard does not require use of the trade name CIP™. Use of the trade name CIP™ requires permission of ODVA, Inc.

The installation requirements for CP 2/1 (ControlNet™²) are specified in Annex A.

The installation requirements for CP 2/2 (EtherNet/IP™³) are specified in Annex B.

The installation requirements for CP 2/3 (DeviceNet™⁴) are specified in Annex C.

5 Installation profile conventions

The numbering of the clauses and subclauses in the annexes of this standard corresponds to the numbering of IEC 61918 main clauses and subclauses.

The annex clauses and subclauses of this standard supplement, modify, or replace the respective clauses and subclauses in IEC 61918.

Where there is no corresponding subclause of IEC 61918 in the normative annexes in this standard, the subclause of IEC 61918 applies without modification.

The annex heading letter represents the installation profile assigned in Clause 4. The annex (sub)clause numbering following the annex letter shall represent the corresponding (sub)clause numbering of IEC 61918.

EXAMPLE “Subclause B.4.4” in IEC 61784-5-2 means that CP 2/2 specifies the subclause 4.4 of IEC 61918.

All main clauses of IEC 61918 are cited and apply in full unless otherwise stated in each normative installation profile annex.

If all subclauses of a (sub)clause are omitted, then the corresponding IEC 61918 (sub)clause applies.

If in a (sub)clause it is written “Not applicable.”, then the corresponding IEC 61918 (sub)clause does not apply.

If in a (sub)clause it is written “*Addition*.”, then the corresponding IEC 61918 (sub)clause applies with the additions written in the profile.

If in a (sub)clause it is written “*Replacement*.”, then the text provided in the profile replaces the text of the corresponding IEC 61918 (sub)clause.

NOTE A replacement can also comprise additions.

If in a (sub)clause it is written “*Modification*.”, then the corresponding IEC 61918 (sub)clause applies with the modifications written in the profile.

² ControlNet™ is a trade name of ODVA, Inc. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this profile does not require use of the trade name ControlNet™. Use of the trade name ControlNet™ requires permission of ODVA, Inc.

³ EtherNet/IP™ is a trade name of ODVA, Inc. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this profile does not require use of the trade name EtherNet/IP™. Use of the trade name EtherNet/IP™ requires permission of ODVA, Inc.

⁴ DeviceNet™ is a trade name of ODVA, Inc. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this standard does not require use of the trade name DeviceNet™. Use of the trade name DeviceNet™ requires permission of ODVA, Inc.

If all (sub)clauses of a (sub)clause are omitted but in this (sub)clause it is written “(Sub)clause $\times$ has “*addition:*” (or “*replacement:*”) or “(Sub)clause $\times$ is not applicable.”, then (Sub)clause $\times$ becomes valid as declared and all the other corresponding IEC 61918 (sub)clauses apply.

6 Conformance to installation profiles

Each installation profile within this standard includes part of IEC 61918:2013. It may also include defined additional specifications.

A statement of compliance to an installation profile of this standard shall be stated⁵ as either

Compliance to IEC 61784-5-2:2013⁶ for CP 2/m <name> or

Compliance to IEC 61784-5-2 (Ed.3.0) for CP 2/m <name>

where the name within the angle brackets < > is optional and the angle brackets are not to be included. The m within CP 2/m shall be replaced by the profile number 1 to 3.

NOTE The name can be the name of the profile, e.g. ControlNet, EtherNet/IP or DeviceNet.

If the name is a trade name then the permission of the trade name holder shall be required.

Product standards shall not include any conformity assessment aspects (including quality management provisions), neither normative nor informative, other than provisions for product testing (evaluation and examination).

⁵ In accordance with ISO/IEC Directives.

⁶ The date should not be used when the edition number is used.

Annex A (normative)

CP 2/1 (ControlNet™) specific installation profile

A.1 Installation profile scope

Addition:

This standard specifies the installation profile for Communication Profile CP 2/1 (ControlNet). The CP 2/1 is specified in IEC 61784-1.

The installation profiles are specified in the annexes. These annexes are read in conjunction with IEC 61918:2013.

A.2 Normative references

Addition:

IEC 60096-2:19617, *Radio-frequency cables – Part 2: Relevant cable specifications*

A.3 Installation profile terms, definitions, and abbreviated terms

A.3.1 Terms and definitions

A.3.2 Abbreviated terms

Addition:

DVM	Digital voltmeter
HMI	Human machine interface
I/O	Input/Output
IS	Intrinsic safety
MM	Multi mode
NAP	Network access port (local access to a device, i.e. not via the bus)
OTDR	Optical time domain reflectometer
PLC	Programmable logic controller
PVC	Polyvinyl chloride
RG6	Coaxial cable
SM	Single mode
TDR	Time domain reflectometer

A.3.3 Conventions for installation profiles

Not applicable.

⁷ This publication has been withdrawn but for the purposes of this standard, the edition cited is applicable.

A.4 Installation planning

A.4.1 General

A.4.1.1 Objective

A.4.1.2 Cabling in industrial premises

Addition:

CP 2/1 networks can be connected to generic cabling via a converter/adaptor as mentioned in IEC 61918:2013, 4.1. Connection to the generic cabling system can also be facilitated through EtherNet/IP and the AO as shown in Figure A.1.

CP 2/1 is designed to be deployed within the automation island and between automation islands as detailed in IEC 61918:2013, 4.1.2, Figure 5. The network is constructed of passive Taps $\boxed{T}$ and Repeaters $\boxed{R}$ interconnected by coaxial cable. Links are connected by Bridges $\boxed{B}$. The network can span an entire factory floor.

The interconnection of CP 2/1 with CP 2/2 and CP 2/3 can be accomplished through an appropriate converter/adaptor (linking device) as shown in Figure A.1.

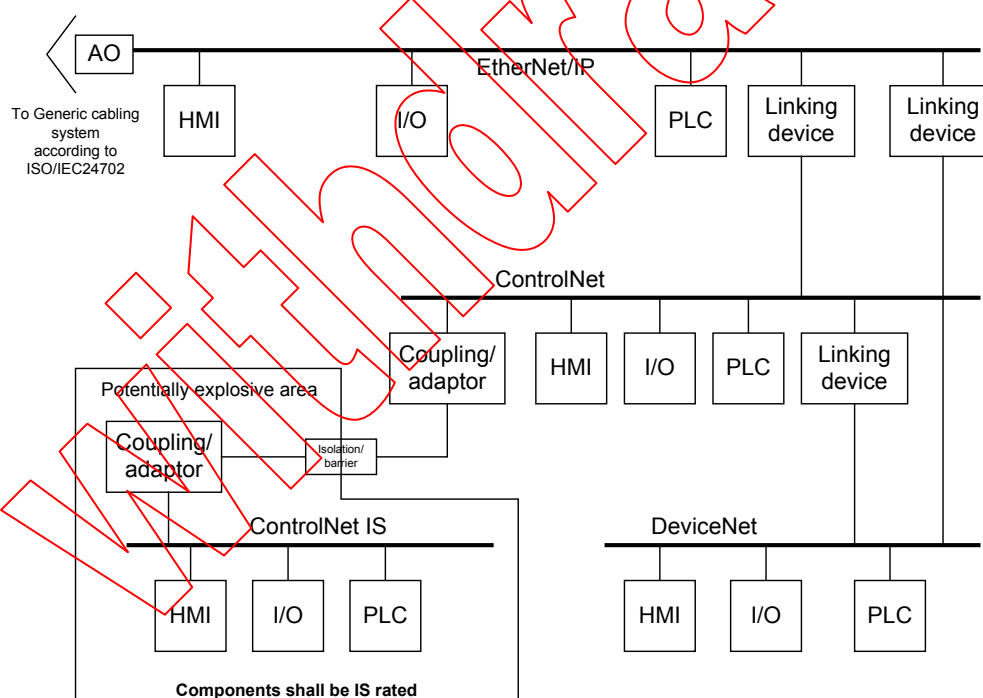


Figure A.1 – Interconnection of CPF 2 networks

The CP 2/1 coaxial media system is made up of the components found in Figure A.2. These parts are as follows:

- coaxial cable and associated connectors (BNC/TNC);
- passive taps (non-sealed and sealed) with fixed 1 m drop cable BNC/TNC connector on the end of the drop cable, which shall not be extended under any circumstances;
- trunk line terminators BNC/TNC;
- repeaters (linear, ring and star) fibre and copper;
- various coaxial couplers, bulkhead, jack-to-jack and plug-to-plug (BNC/TNC).

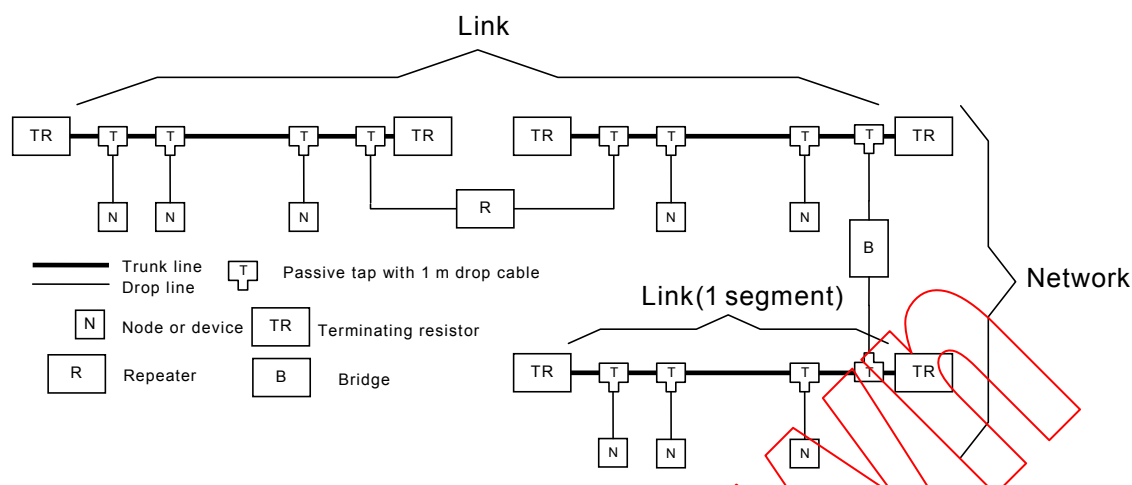


Figure A.2 – Overview of CPF 2/1 networks

A.4.2 Planning requirements

A.4.2.1 Safety

A.4.2.1.1 General

A.4.2.1.2 Electrical safety

A.4.2.1.3 Functional safety

Not applicable.

A.4.2.1.4 Intrinsic safety

Not applicable.

A.4.2.1.5 Safety of optical fibre communication systems

A.4.2.2 Security

A.4.2.3 Environmental considerations and EMC

A.4.2.3.1 Description methodology

Addition:

The configuration of the low-voltage power distribution system shall comply with local regulations. In some cases and geographical areas, additional earthing and bonding is necessary to control noise currents and provide a low noise functional earth for the low signal communications devices. This may be achieved through methods described in IEC 61918:2013, 4.4.7 and A.4.4.7.3 of this standard.

This network uses a parallel RC between earth and the shield of the coaxial cable. The shields shall not directly reference to earth at any point in the system, as doing so will allow noise currents to flow in the shields causing high error rates in the network.

A.4.2.3.2 Use of the described environment to produce a bill of material

A.4.2.4 Specific requirements for generic cabling in accordance with ISO/IEC 24702

A.4.3 Network capabilities

A.4.3.1 Network topology

A.4.3.1.1 Common description

A.4.3.1.2 Basic physical topologies for passive networks

Modification:

ControlNet supports passive bus topologies. Passive star topologies are not supported.

A.4.3.1.3 Basic physical topologies for active networks

Modification:

ControlNet supports active linear, star and ring topologies.

A.4.3.1.4 Combination of basic topologies

Addition:

ControlNet supports both series connected and parallel connected linear passive bus topologies. In addition ControlNet supports network redundancy using both series connected and parallel connected linear passive bus topologies. Both networks shall have the same number of active nodes in the same order on the network.

A.4.3.1.5 Specific requirements for CPs

Addition:

A.4.3.1.5.1 General

CP 2/1 supports both coaxial and fibre media in the trunk segments. Drop cables shall be coaxial. The network is an amplitude and delay limited network. In general, for the coaxial variant, amplitude is the limiting factor. Fibre trunk segments have much less loss so delay limits can be readily exceeded. In either case the amplitude and delay limits shall be observed. The maximum delay for any network construction (cabling and repeaters) shall be limited to 242 μ s round trip or 121 μ s each way.

ControlNet can be configured as a redundant network for both active star and active linear topologies in copper and fibre. See A.4.4.9.6 for specific design consideration. When configured as a redundant network, the number of nodes and addressing shall be the same for both networks.

The following subclauses A.4.3.1.5.2 to A.4.3.1.5.8 describe the various components and topology constructions possible.

A.4.3.1.5.2 Taps (coaxial media)

Taps connect each node on a network to the coax media system via a fixed 1 m drop cable as shown in Figure A.3.

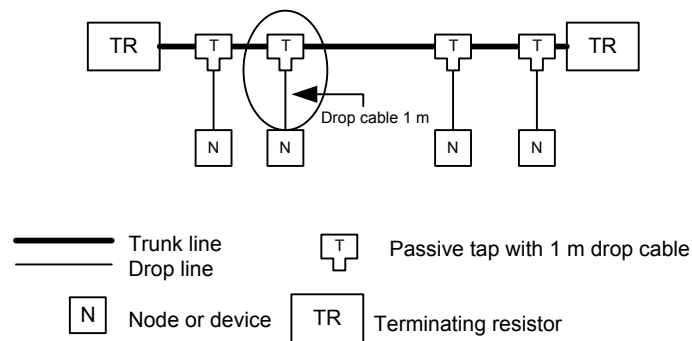


Figure A.3 – Drop cable requirements

A.4.3.1.5.3 Trunk cable

The trunk cable is the bus or central part of the CP 2/1 coax media system. The trunk cable is composed of multiple sections of cable. The standard cable that can be used to construct trunk cable sections is defined in A.4.4.1.2.1.

A.4.3.1.5.4 Trunk line connectors

BNC/TNC plugs are used to connect the coaxial cables to the taps. Devices are connected to the tap through a 1 m cable attached to the tap with the appropriate BNC/TNC plug. Each trunk cable section shall have a BNC or TNC plug installed on each end as shown in Figure A.4.

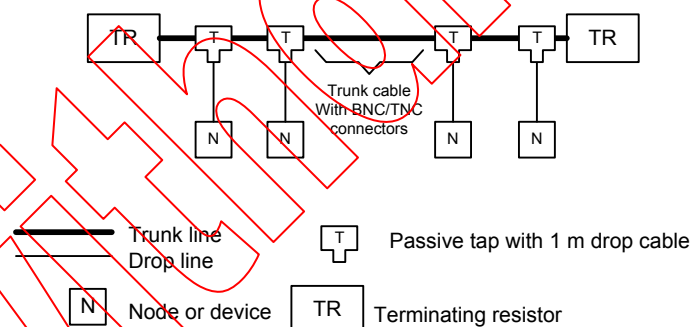


Figure A.4 – Placement of BNC/TNC plugs

A.4.3.1.5.5 Terminators

To minimize reflections, the network segment(s) shall be terminated with the appropriate $75\ \Omega$ coaxial terminators (see A.4.4.4.2).

Figure A.5 details the location of the $75\ \Omega$ coaxial terminators. The designer shall specify the placement of the $75\ \Omega$ coaxial terminators in the design documentation. The terminators are generally installed on the outside port of the tap located at each end of a segment. The terminator is fully described in A.4.4.4.

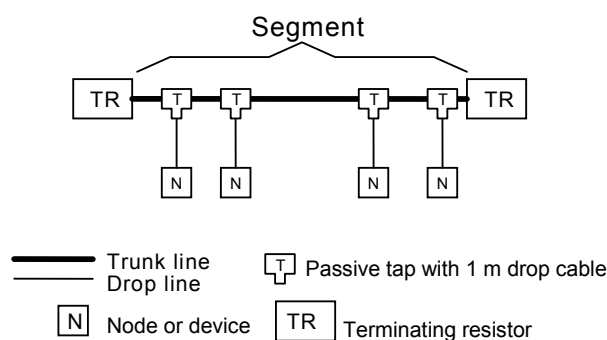


Figure A.5 – Placement of terminators

A.4.3.1.5.6 Repeaters

Repeater adapters shall be used to increase the number of taps, extend the total length of the network (see Figure A.6), or create an active star configuration as shown in Figure A.7. The number of repeaters and cable length total is limited depending on the network topology. See A.4.4.3.3.2 for information on limitations of length and number of nodes per segment. A repeater creates a new segment allowing additional cable or taps or both.

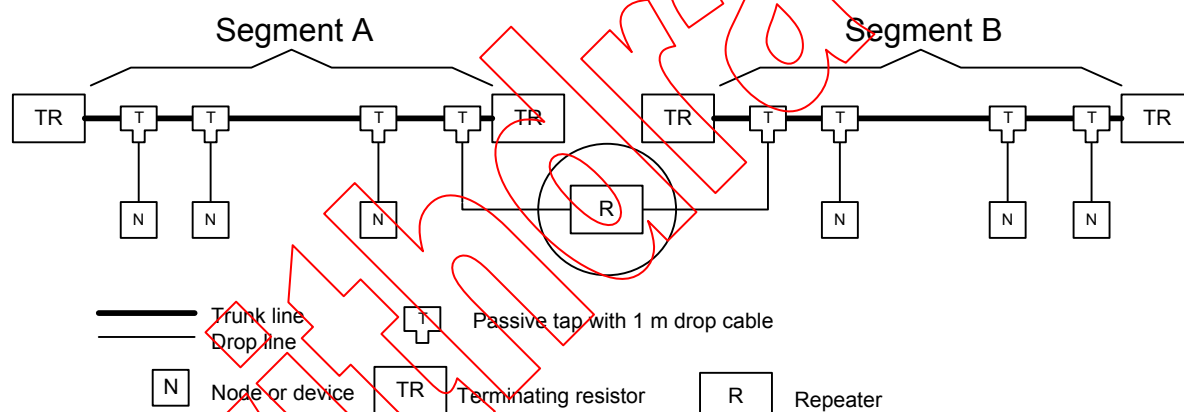


Figure A.6 – Extending a network using repeaters

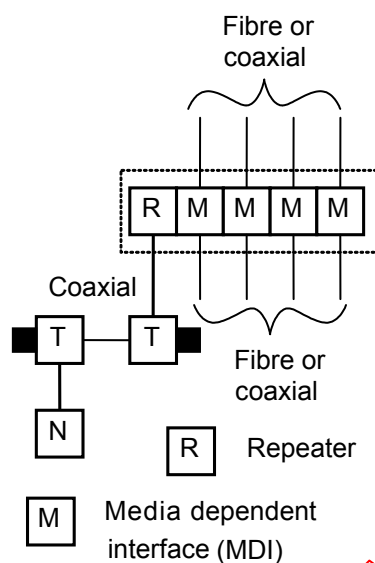


Figure A.7 – Extending a network using active star topology

A.4.3.1.5.7 Links

A link is formed by connecting multiple segments together through repeaters (see Figure A.8). A link may consist of only one segment. Each node in a link shall have a unique address in the range of 0 to 99. Node address 0 shall be reserved for devices that are auto address nodes or nodes without address switches.

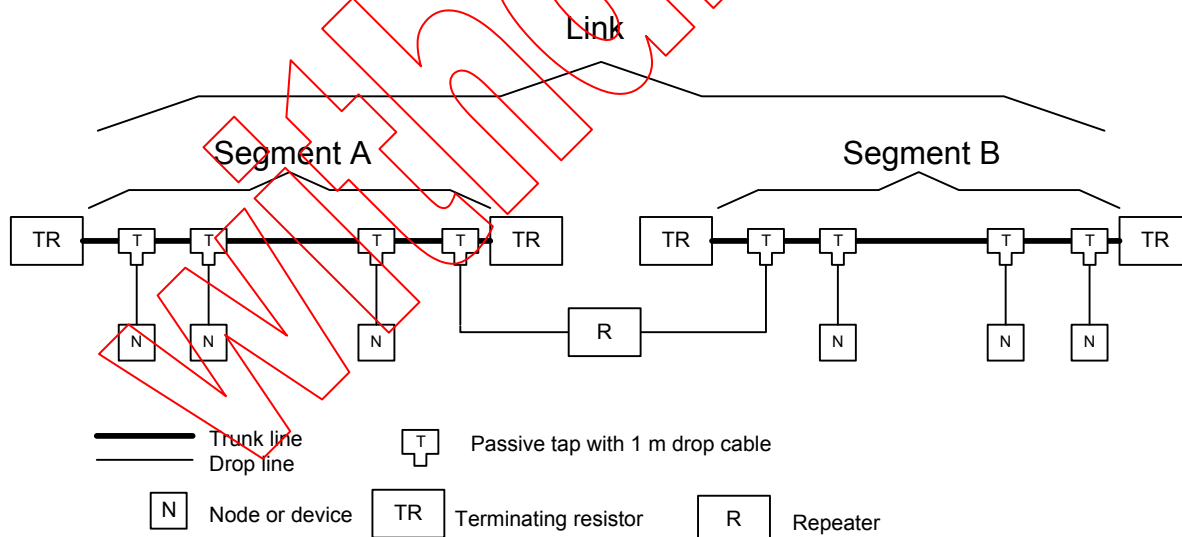


Figure A.8 – Links

A.4.3.1.5.8 Bridges

Bridges may be used to connect links together and to extend the network addressing beyond 99 nodes. A bridge connects links together as shown in Figure A.9.

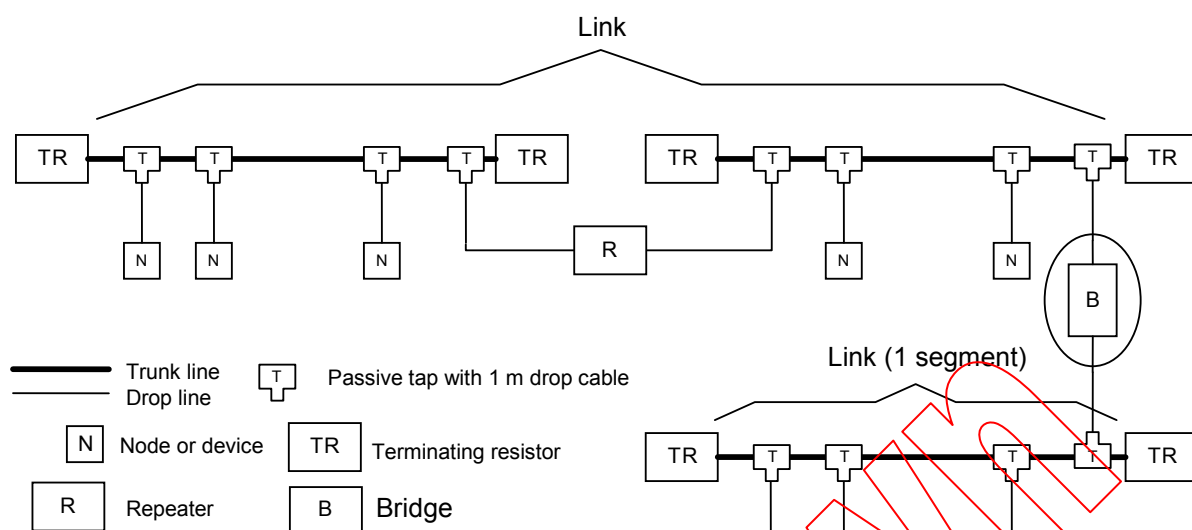


Figure A.9 – Extending the network beyond 99 nodes

A.4.3.1.6 Specific requirements for generic cabling in accordance with ISO/IEC 24702

A.4.3.2 Network characteristics

A.4.3.2.1 General

A.4.3.2.2 Network characteristics for balanced cabling not based on Ethernet

Replacement:

ControlNet is a coaxial based system, balanced cabling is not supported.

Table A.1 provides values based on the template given in IEC 61918:2013, Table 1.

Table A.1 – Basic network characteristics for copper cabling not based on Ethernet

Characteristics	CP 2/1
Basic transmission technology	Linear bus
Length / transmission speed	
Transmission speed	Segment length m
5 Mbit/s	Segment: 1 000 m maximum (see Figure A.10) Link: 20 km maximum ^a
Maximum capacity	Max. no.
Devices / segment	48
Devices / link	99
Devices / network	Unlimited
^a The total link length is limited to 20 km due to delay limitations of 121 µs each way (242 µs round trip).	

A.4.3.2.3 Network characteristics for balanced cabling based on Ethernet

Not applicable.

A.4.3.2.4 Network characteristics for optical fibre cabling

Replacement:

The allowable fibre segment lengths and wavelengths are detailed in Table A.2 for CP 2/1 based on the template given in IEC 61918:2013, Table 3.

Table A.2 – Allowable fibre lengths

CP 2/1		
Optical fibre type	Description	
Single mode silica	Bandwidth (MHz) or equivalent at λ (nm)	20 MHz 1 310 nm
	Minimum length (m)	0
	Maximum length ^a (m)	20 000 ^b
	Maximum channel Insertion loss/optical power budget (dB)	10,5
	Connecting hardware	See A.4.4.2.5
Multimode silica	Modal bandwidth (MHz × km) at λ (nm)	20MHz 1 300 nm
	Minimum length (m)	0
	Maximum length ^a (m)	M = 3 000 ^c L = 10 000 ^c XL = 10 000 ^c
	Maximum channel Insertion loss/optical power budget (dB)	M = 13,3 L = 15 XL = 10,5
	Connecting HW	See A.4.4.2.5
POF	Modal bandwidth (MHz × km) at λ (nm)	–
	Minimum length (m)	–
	Maximum length ^a (m)	–
	Maximum channel Insertion loss/optical power budget (dB)	–
	Connecting HW	–
Hard clad silica	Modal bandwidth (MHz × km) at λ (nm)	20 MHz 650 nm
	Minimum length (m)	0
	Maximum length ^a (m)	300
	Maximum channel Insertion loss/optical power budget (dB)	4,2 ^d
	Connecting HW	See A.4.4.2.5
^a This value is reduced by connections, splices and bends in accordance with formula (1) in 4.4.3.4.1 of IEC 61918:2013. ^b Extra Long Repeaters Only. ^c M = Medium distance capable modules, L = Long distance capable modules and XL = Extra long distance capable modules. ^d Short distance modules only.		

A.4.3.2.5 Specific network characteristics

Addition:

CP 2/1 supports active fibre rings, active line and active star topologies.

Fibre redundancy is only available for active line and active star topologies, see A.4.4.9.6 for the design and limitations of redundant networks.

Fibre ring is inherently redundant and does not require duplicate hardware.

A.4.3.2.6 Specific requirements for generic cabling in accordance with ISO/IEC 24702

A.4.4 Selection and use of cabling components

A.4.4.1 Cable selection

A.4.4.1.1 Common description

A.4.4.1.2 Copper cables

A.4.4.1.2.1 Balanced cables for Ethernet-based CPs

Not applicable.

A.4.4.1.2.2 Copper cables for non-Ethernet-based CPs

Replacement:

The selection of connector and installation tools shall be compatible with coaxial cable (referred to as RG6). If these are not properly matched, network failures may result.

The coaxial cable electrical requirements, on which the standard topology is based, can be found in Table A.3. The mechanical properties for the standard coaxial cable are described in Table A.4. These parameters (electrical and mechanical) can be used to procure the proper cable for standard installations. Speciality cables as described in Table A.5 may require different mechanical and/or electrical properties and therefore shall be accounted for in the network length limits and tools used for connector installation. Since the network is designed to be a 75 Ω system, substitution of the cable impedance is not allowed.

The electrical parameters detailed in Table A.3 shall be met in order to maintain standard network configurations as described in this installation profile.

Table A.3 – RG6 coaxial electrical properties

Specification	Limits/Characteristics
Shielding	Quad shield
Impedance	$(75 \pm 3) \Omega$
Delay	$(4,1 \pm 0,1) \text{ ns/m}$
Frequency	Attenuation (dB/100 m)
1 MHz	1,15
2 MHz	1,25
5 MHz	1,48
10 MHz	1,94
20 MHz	2,82
50 MHz	4,49
Structural return loss	23 dB minimum from 5 MHz to 50 MHz
Conductor d.c. resistance	92 Ω/km nominal
Shield d.c. resistance	24 Ω/km nominal
Capacitance	53,2 pF/m

The physical parameters listed in Table A.4 shall be met in order to maintain noise immunity and connector compatibility.

Table A.4 – RG6 coaxial physical parameters

Specification	Characteristics
Centre conductor material and diameter	18 AWG solid bare copper covered steel $0,823 \text{ mm}^2 \pm 0,020 \text{ mm}^2$
Dielectric material and diameter	$4,65 \text{ mm} \pm 0,13 \text{ mm}$
Shield construction 4 layers	Layer 1: foil Layer 2: 60 % braid Layer 3: foil Layer 4: 40 % braid
Jacket diameter	$7,67 \text{ mm} \pm 0,13 \text{ mm}$

Addition:

CP 2/1 uses 75 Ω RG6 quad shield coaxial cables compliant with IEC 60096-2.

Specific cable designs shall be selected based on the application and the environment. The MICE concept can be used to help determine the environmental conditions and to select components and/or appropriate mitigation. Table A.5 provides guidance for application specific cables.

Table A.5 – Cable type selection

Application type	Example cable type ^a
Light industrial applications	Standard – PVC CM-CL2
Industrial applications	Lay-on armoured and interlocking armour
High and low temperature application, as well as corrosive area (harsh chemicals – see manufacturing data sheets for chemical resistivity)	Plenum-FEP CMP-CL2P
Festooning or flexing applications (rolling “C” track and robotic tic-toc)	High flex
Moisture resistant applications; direct burial, with flooding compound, fungus resistant	Flood burial
^a See the local cable distributor for cable availability.	

All coaxial cables used in the ControlNet system shall meet the electrical requirements of this Clause A.4. In addition, they shall be constructed with quad shields (single, dual and tri shields are not allowed). It is important that the attenuation be met over the frequencies listed in this Clause A.4. If the attenuation is greater than listed in this Clause A.4, additional length derating shall be determined by using the equations in this Clause A.4. If the segment attenuation is too high the segment shall be divided using repeaters.

The cabling components shall be selected based on the environmental and application requirements. Highflex applications shall use cables designed to meet high flex. Cables expected to be subjected to weld splatter shall have the appropriate protection or jacket designs. Cables used in outdoor applications, shall have the appropriate UV protection or jacketing design.

A.4.4.1.3 Cables for wireless installation

A.4.4.1.4 Optical fibre cables

Addition:

For optical fibre, cabling shall conform to the requirements given in Table A.2. In addition the planner shall consider the following.

The planner shall define the maximum cable length allowed between any two devices. When installing optical fibre cables, this maximum cable length shall not exceed the lengths as defined in Table A.2. Using special cables or optical fibre splices can further reduce cable lengths. Reliable data transmission may be ensured up to this certified length if the cables and the connections have been installed correctly.

The properties of an optical fibre transmission system are mainly characterized by:

- the output power of the optical interface;
- the type of cable used;
- the quality of installation and the plug configuration.

Planner and installer shall observe the insertion loss requirements (cables and connectors) to insure proper functioning segment. In addition, the instructions of the cable, plug connector and device manufacturer shall be observed. For optical fibre cables of an industrial network the planner shall use the data defined in Table A.6.

Some additional information that shall be considered by the installer and maintenance personnel are given in the relevant clauses of this standard.

Table A.6 provides values based on the template given in IEC 61918:2013, Table 6.

Table A.6 – Information relevant to optical fibre cables

Characteristic	9..10/125 µm single mode silica	50/125 µm multimode silica	62,5/125 µm multimode silica	980/1 000 µm step index POF	200/230 µm step index hard clad silica
Standard	OS1	OM1, OM2 or OM3 1 300 nm	OM1, OM2 or OM3 1 300 nm	–	–
Attenuation per km (650 nm)	–	–	–	–	≤ 6,0 dB
Attenuation per km (820 nm)	–	–	–	–	–
Attenuation per km (1 310 nm)	≤ 1,0 dB or OS1	≤ 2,5 dB or OM1	≤ 3,5 dB or OM1	–	–
Number of optical fibres	2	2	2	–	2
Connector type (e.g. duplex or simplex)	BFOC 2,5	BFOC 2,5	BFOC 2,5	–	V-Pin
Jacket colour requirements	User defined	User defined	User defined	–	User defined
Jacket material	Application specific	Application specific	Application specific	–	Application specific
Resistance to harsh environment (e.g. UV, oil resist, LS0H)	Yes ^a	Yes ^a	Yes ^a	–	Yes ^a
NOTE Duplex and simplex cords/cables are supported.					
^a If application requires.					

A.4.4.1.5 Special purpose balanced and optical fibre cables**A.4.4.1.6 Specific requirements for CPs**

Not applicable.

A.4.4.1.7 Specific requirements for generic cabling in accordance with ISO/IEC 24702**A.4.4.2 Connecting hardware selection****A.4.4.2.1 Common description****A.4.4.2.2 Connecting hardware for balanced cabling CPs based on Ethernet**

Not applicable.

A.4.4.2.3 Connecting hardware for copper cabling CPs not based on Ethernet*Replacement:*

The connectors used in this network are limited to those shown in Table A.7.

Table A.7 – Copper connectors for ControlNet

CP 2/1	Coaxial IEC 61169-8	Others
Characteristics for CP 2/1 (ControlNet)	BNC	TNC RJ45 (NAP)

Addition:

The centre conductor contact shall be plated in conformance with one of the following specifications:

- 0,75 μm gold minimum over 1,25 μm nickel minimum over base metal;
- 0,05 μm to 0,2 μm gold flash over 1,25 μm palladium nickel minimum over 1,25 μm nickel minimum over base metal.

The connector characteristic impedance shall be 75 Ω nominal, 45 Ω minimum and 80 Ω maximum, from d.c. to 50 MHz.

For network reliability, the cables, connectors and installation tools shall be mechanically compatible. The cable and connector manufacturer's data sheets shall be consulted for compatibility and installation tool requirements.

Passive taps are used to connect the trunk sections together and provide a connection point for each node. A tap is required for each active device connected to the network. There are two variants of the taps available:

- sealed meeting IP67 minimum, using TNC connectors;
- non-sealed meeting IP65 maximum, using BNC connectors.

For reliability reasons the number of connections in a segment shall be minimized.

The cabling components shall be selected based on the environmental and application requirements.

A.4.4.2.4 Connecting hardware for wireless installation

A.4.4.2.5 Connecting hardware for optical fibre cabling

Replacement:

Table A.8 provides values based on the template given in IEC 61918:2013, Table 9.

Table A.8 – Fibre connectors for fieldbus systems

	IEC 61754-2	IEC 61754-4	IEC 61754-24	IEC 61754-20	IEC 61754-22	Others
	BFOC/2,5	SC	SC-RJ	LC	F-SMA	VPIN
CP 2/1 (ControlNet)	Yes	No	No	No	No	Yes
NOTE IEC 61754 series defines the optical fibre connector mechanical interfaces; performance specifications for optical fibre connectors terminated to specific fibre types are standardised in the IEC 61753 series.						

To minimize noise coupling into the sensitive receiver, connectors with plastic or ceramic ferrules are recommended.

Table A.9 provides values based on the template given in IEC 61918:2013, Table 10.

Table A.9 – Relationship between FOC and fibre types (CP 2/1)

FOC	Fibre type					
	9..10/125 μm single mode silica	50/125 μm multimode silica	62,5/125 μm multimode silica	980/1 000 μm step index POF	200/230 μm step index hard clad silica	Others
BFOC/2,5	No	Yes	Yes	No	No	No
SC	No	No	No	No	No	No
SC-RJ	No	No	No	No	No	No
LC	No	No	No	No	No	No
F-SMA	No	No	No	No	No	No
V-PIN	No	No	No	No	Yes	No
Insertion loss correction factors shall be used when using MMF fibres smaller than 62,5/125 μm .						

A.4.4.2.6 Specific requirements for CPs

Not applicable.

A.4.4.2.7 Specific requirements for generic cabling in accordance with ISO/IEC 24702**A.4.4.3 Connections within a channel/permanent link****A.4.4.3.1 Common description**

Not applicable.

A.4.4.3.2 Balanced cabling connections and splices for CPs based on Ethernet

Not applicable.

A.4.4.3.3 Copper cabling connections and splices for CPs not based on Ethernet**A.4.4.3.3.1 Common description****A.4.4.3.3.2 Connections minimum distance**

Replacement:

a) General

The shortest path for routing the cable shall be selected to minimize the amount of cable needed. The specific details of planning cabling route depend upon the needs of the network.

When determining the cable length of trunk-cable sections, it is important to measure the actual cable path as it is routed in the network. Vertical dimensions as well as horizontal dimensions shall be considered. The three-dimensional routing path distance shall always be calculated when determining cable lengths.

The total allowable length of a segment containing standard RG6 quad shield depends on the requirements of Table A.1 and Table A.3, and of the number of taps in the segment. There is no minimum trunk-cable section or segment length requirement. The maximum allowable total length of a segment is 1 000 m with two taps installed. Each additional tap decreases the maximum length of the segment by 16,3 m. The maximum number of taps allowed on a segment is 48. With 48 taps the maximum segment length is limited to 250 m. Figure A.10

details the relationship between the number of taps allowed in a segment and the segment length. If the network design falls in the grey area then a repeater is required.

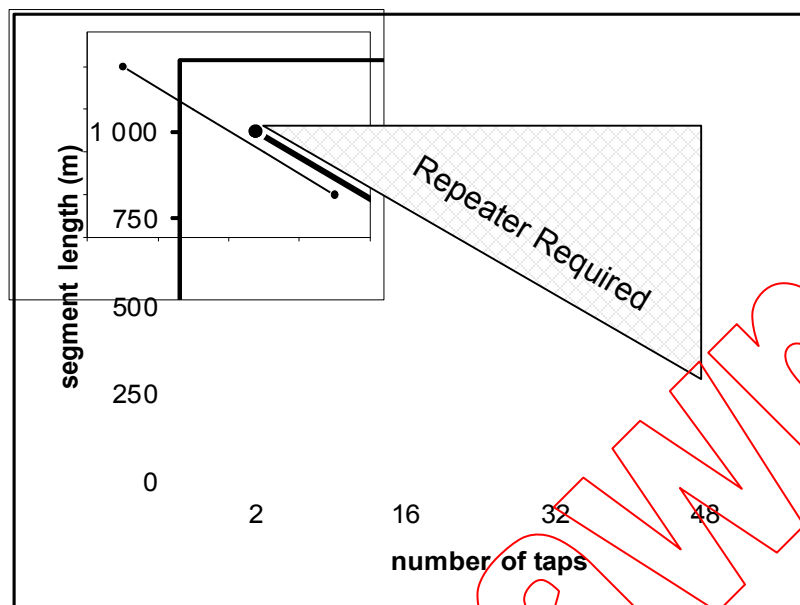


Figure A.10 – Maximum allowable taps per segment

Maximum allowable segment length = $1\,000\text{ m} - 16,3\text{ m} \times [\text{number of taps} - 2]$

EXAMPLE 1

The following is an example of how to calculate the number of taps allowed for different segment lengths.

If the segment requires 10 taps, then the maximum segment length is:

$$1\,000\text{ m} - 16,3\text{ m} \times [10 - 2]$$

$$1\,000\text{ m} - 130,4\text{ m} = 869,6\text{ m}$$

The amount of high flex RG6 cable that can be used in a system is less than the amount of standard RG6 cable. The designer is encouraged to keep the length of high flex cable use to a minimum. BNC bullet connectors or isolated bulkhead connectors shall be used to isolate areas that require high flex RG6 cable from areas that require standard RG6 cable; this allows the high flex RG6 section to be replaced before flex life is exhausted. An allowable total length of RG6 flex cable segment in the application can be determined using the equation below. Each additional tap decreases the maximum length of the segment. The maximum segment length depends on the attenuation of the high flex cable used. The maximum allowable segment length is then as follows:

$$\text{Segment_Length} = \frac{[20,29\text{ dB} - (\text{Number_taps} \times 0,32\text{ dB})]}{\text{cable_atten@10 MHz}}$$

Important: The cable attenuation at 10 MHz per unit length is defined as the signal loss measured at 10 MHz per 100 m of cable.

Cable attenuation for ControlNet cables are listed in the manufacturers' data sheets.

EXAMPLE 2

The cable selected for this example is high flex cable. The attenuation for this high flex coaxial cable is 2,30 dB per 100 m at 10 MHz. For a segment that requires 3 taps using high flex cable, the maximum segment length is:

$$\text{Segment_Length} = \left[\frac{[20,29 \text{ dB} - (3 \times 0,32 \text{ dB})]}{2,36 \text{ dB}} \right] \times 100 \text{ m}$$

or

$$\left[\frac{19,33 \text{ dB}}{2,36 \text{ dB}} \right] \times 100 = 820 \text{ m}$$

The total trunk-cable length or number of taps (connections) can be increased by breaking up the segment into smaller segments.

b) Repeaters

ControlNet supports copper and fibre repeaters. Regardless of the media, the repeaters can be configured in the following topologies.

A link may be configured one of five ways:

- series up to 20 repeaters;
- parallel up to 48 repeaters (see Figure A.12);
- a combination of series and parallel;
- star topology (see Figure A.11);
- ring up to 20 repeaters (see Figure A.14).

The total link length is limited to 20 km due to delay limitations of 121 µs each way (242 µs round trip).

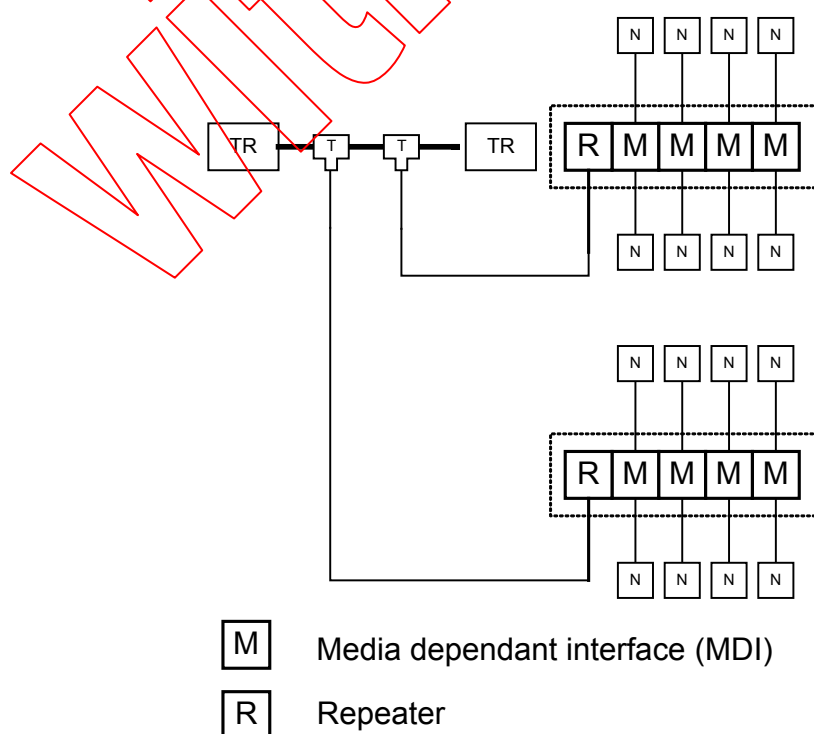


Figure A.11 – Example of repeaters in star configuration

The appropriate repeater module is required for the specific repeater topology needed. For example ring capable repeaters are required for fibre ring topologies.

A repeater can be connected to a segment at any tap location along the trunk. Fibre repeaters may be connected in series through the fibre ports.

The maximum link length is based on the distance between any two nodes. The maximum distance between any two nodes in a link is limited by the delay between the nodes. The maximum delay is limited to 121 μ s end-to-end or 242 μ s round trip.

c) Series connected repeaters

When installing repeaters in series, ControlNet network management software should be used to verify that the system is an allowable configuration. The system size is based on the maximum number of repeaters (20) in series and length of the media used between any two nodes. The total network delay described above in b) shall not be exceeded. See the installation instructions that were shipped with the repeater for an example series topology drawing and configuration instructions.

d) Parallel connected repeaters

When installing repeaters in parallel, a maximum of 48 repeaters (the maximum number of taps per 250 m segment) on any one segment is allowed. If the link is configured using repeaters in parallel, one shall count one of the repeater taps for one segment and the other repeater tap for the parallel segment that the repeater is connecting to the backbone network. See Figure A.12 for an example of repeaters in parallel. For further instructions on repeaters in series and parallel, see the instructions that were shipped with the repeater.

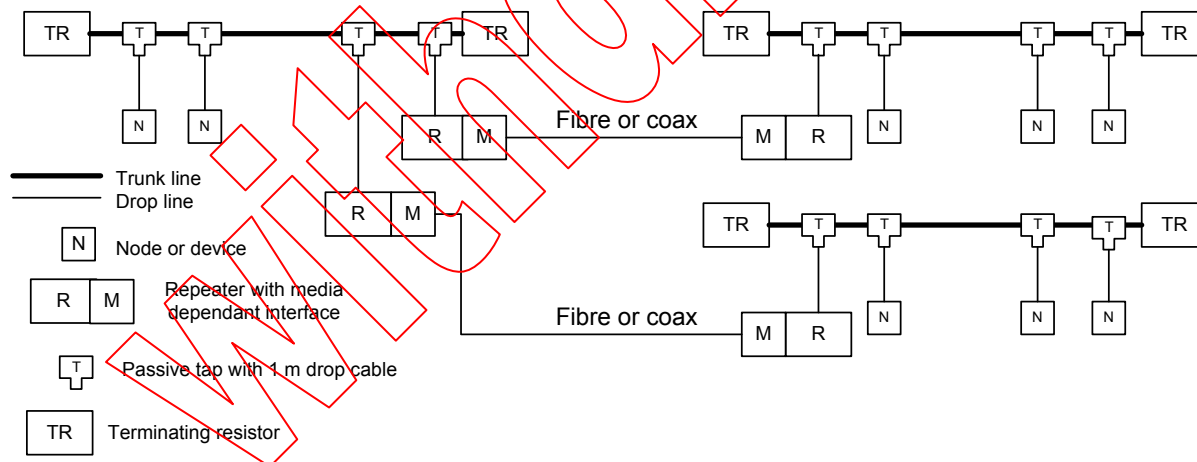


Figure A.12 – Repeaters in parallel

e) Repeaters in a combination of series and parallel

Repeaters can be installed in a combination of series and parallel connections to form a link. The guidelines listed for each type shall be followed. For mixed topologies (series and parallel), the maximum number of repeaters and media should be verified by using the appropriate network configuration software. See the installation instructions that were shipped with the repeater for an example combination series/parallel topology drawing. There shall not be more than one communication path to a node on a network. Ring repeaters have two paths by definition.

When the network is configured using repeaters in combination of series and parallel as shown in Figure A.13, it is important to count the taps and repeaters in all segments.

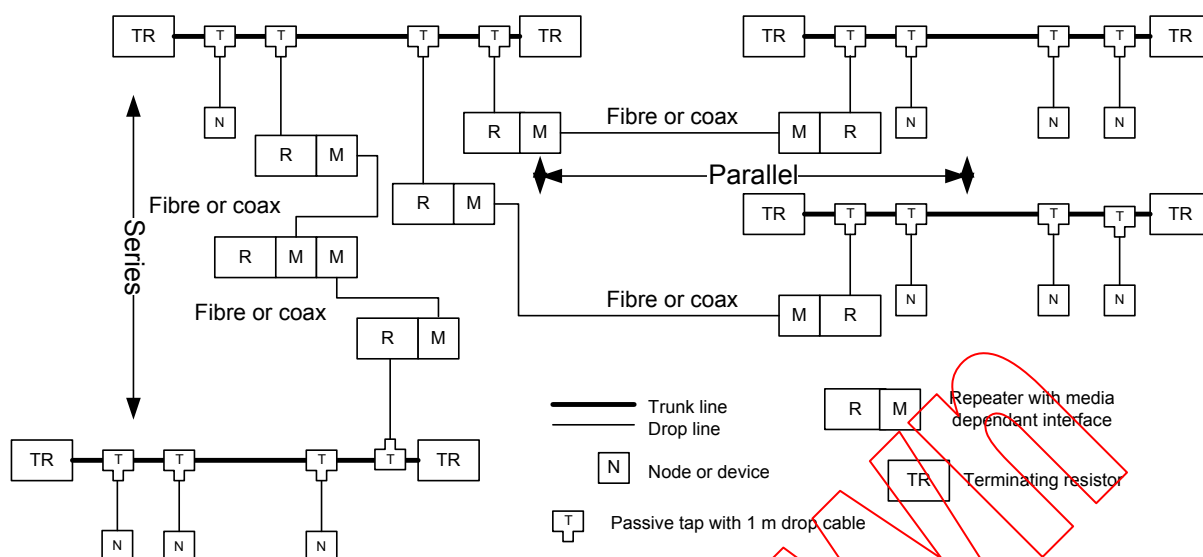


Figure A.13 – Repeaters in combination series and parallel

f) Ring repeaters

For a ring topology, the network designer shall use the appropriate ControlNet fibre ring repeaters. See Figure A.14 for an example of a fibre ring. See the installation instructions that were shipped with the repeater for instructions on setting up the ring. ControlNet supports both linear redundancy and ring topologies.

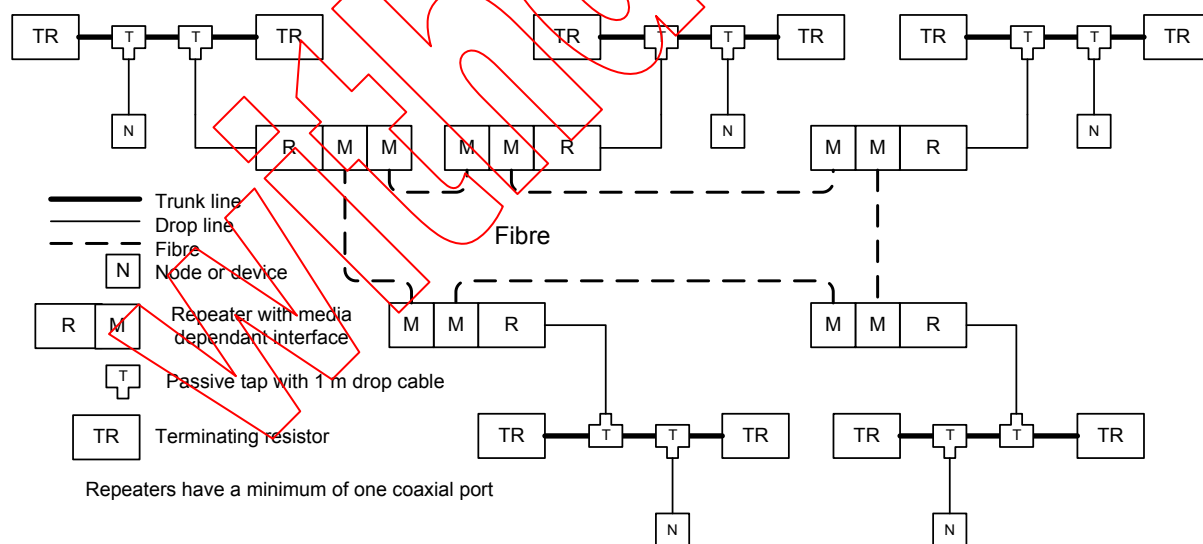


Figure A.14 – Ring repeater

A.4.4.3.3.3 Copper cabling splices

Addition:

The planner shall specify J-J BNC or TNC adaptors when splices are necessary.

A.4.4.3.3.4 Copper cabling bulkhead connections

Replacement:

Copper bulkheads shall be isolated from earth. Copper bulkheads shall be constructed of back-to-back BNC jacks, TNC jacks or a combination of BNC and TNC jacks. They shall provide environmental isolation. Examples of how bulkheads are used in this profile are shown in Figure A.15.

When copper adaptors are used they shall have a nominal characteristic impedance of 75 Ω , 45 Ω minimum and 80 Ω maximum, from d.c. to 50 MHz.

In this example, ControlNet cable:

- enters and exits the panel enclosure from the side using isolated-bulkhead connectors;
- contains two adjacent taps connected by a barrel connector;
- reserves one future tap location with a bullet.

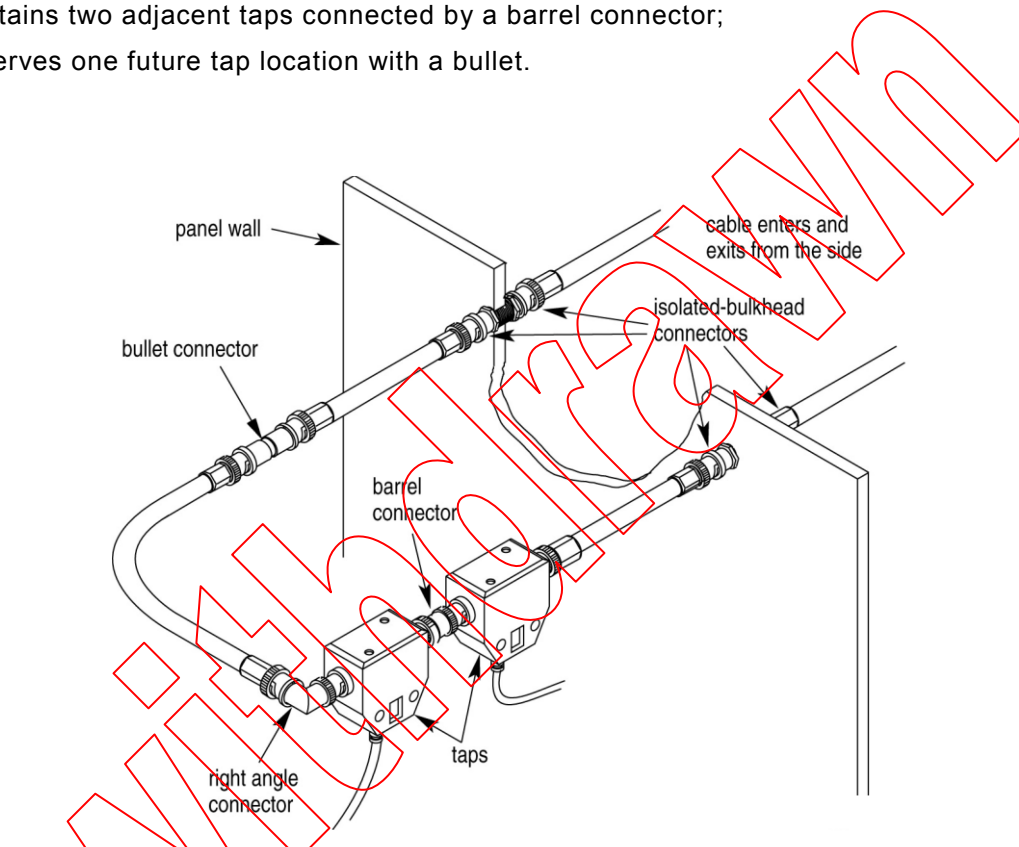


Figure A.15 – Installing bulkheads

A.4.4.3.3.5 Copper cabling J-J adaptors

Replacement:

When extending a trunk section, the appropriate BNC or TNC J-J (bullet) connector shall be used (see Figure A.15).

Copper adaptors shall have a nominal characteristic impedance of 75 Ω , 45 Ω minimum and 80 Ω maximum, from d.c. to 50 MHz

A.4.4.3.4 Optical fibre cabling connections and splices for CPs based on Ethernet

Not applicable.

A.4.4.3.5 Optical fibre cabling connections and splices for CPs not based on Ethernet

Addition:

The designer is encouraged to minimize the number of mechanical connections to minimize the risk of failure.

Each connection adds losses that shall be accounted for in the power budget found in Table A.2.

A.4.4.3.6 Specific requirements for generic cabling in accordance with ISO/IEC 24702

A.4.4.4 Terminators

A.4.4.4.1 Common description

A.4.4.4.2 Specific requirements for CPs

Addition:

Terminators are required for ControlNet in order to minimize reflections in the trunk system. Figure A.16 shows examples of BNC and TNC coaxial terminators. A $75\ \Omega$ terminator shall be placed at the end of each segment for the ControlNet cable system (see Figure A.17 for placement).

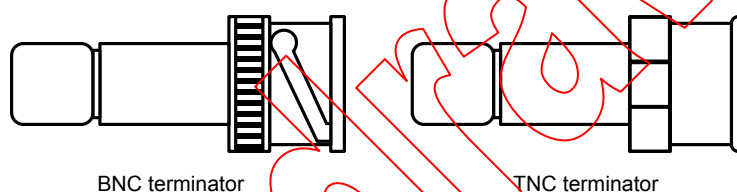


Figure A.16 – Coaxial BNC and TNC terminators

The number of required terminators is determined by multiplying the number of segments by two.

The terminators shall be coaxial $75\ \Omega$ 1 %, 0,5 W low inductance BNC or TNC.

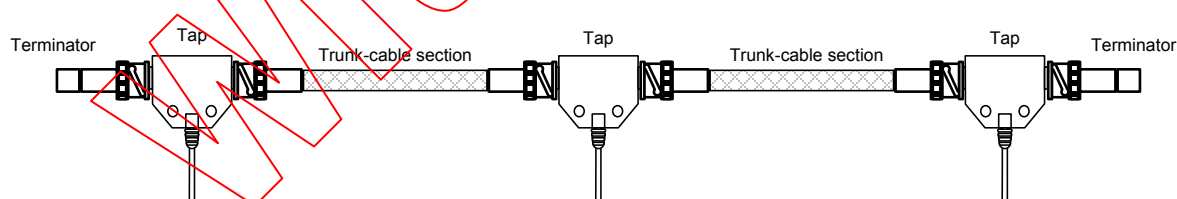


Figure A.17 – Terminator placement in a segment

A.4.4.4.3 Specific requirements for generic cabling in accordance with ISO/IEC 24702

A.4.4.5 Device location and connection

A.4.4.5.1 Common description

A.4.4.5.2 Specific requirements for CPs

Addition:

Devices shall be installed in accordance with the following:

- manufacturer's documentation;

- planner's documentation;
- cable routing;
- location of the taps.

A.4.4.5.3 Specific requirements for wireless installation

Not applicable.

A.4.4.5.4 Specific requirements for generic cabling in accordance with ISO/IEC 24702

A.4.4.6 Coding and labelling

A.4.4.7 Earthing and bonding of equipment and devices and shielded cabling

A.4.4.7.1 Common description

A.4.4.7.2 Bonding and earthing of enclosures and pathways

A.4.4.7.2.1 Equalization and earthing conductor sizing and length

Addition:

If the building does not have an adequate equipotential earthing system, then the star earthing method shall be used to mitigate earth potential offsets within the communications coverage area. Equipotential earthing can be installed in accordance with IEC 61918:2013.

A.4.4.7.2.2 Bonding straps and sizing

A.4.4.7.3 Earthing methods

A.4.4.7.3.1 Equipotential

A.4.4.7.3.2 Star

A.4.4.7.3.3 Earthing of equipment (devices)

Addition:

Equipment shall be earthed in accordance with the manufacturer's installation instructions.

A.4.4.7.3.4 Copper bus bars

A.4.4.7.4 Shield earthing

A.4.4.7.4.1 Non-earthing or parallel RC

Addition:

ControlNet coaxial shields are connected to earth via a parallel RC circuit that is integral to the active devices as modelled in Figure 32 of IEC 61918:2013. The coaxial shields shall not be directly bonded to earth as this will introduce noise in the network.

A.4.4.7.4.2 Direct

Not applicable.

A.4.4.7.4.3 Derivatives of direct and parallel RC

Not applicable.

A.4.4.7.5 Specific requirements for CPs

Not applicable.

A.4.4.7.6 Specific requirements for generic cabling in accordance with ISO/IEC 24702**A.4.4.8 Storage and transportation of cables****A.4.4.9 Routing of cables****A.4.4.9.1 Common description****A.4.4.9.2 Cable routing of assemblies****A.4.4.9.3 Detailed requirements for cable routing inside enclosures**

Addition:

Cable sections that run inside protective equipment enclosures are relatively short. For wiring external to enclosures, the maximum separation shall be maintained between ControlNet cable and Category-1 conductors. The minimum separation from other circuits is defined in Table 17 of IEC 61918:2013. When running cable inside an enclosure, the installer shall route the conductors external to all pathways in the same enclosure, or in a pathway separate from Category-1 conductors.

A.4.4.9.4 Cable routing inside buildings**A.4.4.9.5 Cable routing outside and between buildings****A.4.4.9.6 Installing redundant communication cables**

Addition:

A second trunk cable is used between ControlNet nodes for redundant media. With redundant media, nodes send signals on two separate segments. The receiving node compares the quality of the two signals and accepts the better signal to permit use of the best signal. This also provides a backup cable if one cable fails. Trunk cables on a redundant cable link are defined by the segment number and the redundant trunk-cable letter.

ControlNet products are labelled with the icons in Figure A.18. The light colored icon should be placed on drop cables connected to port A of the devices. The dark colored icon should then be placed on redundant node ports marked B. See Figure A.19 for redundant coaxial media example. Figure A.20 is an example of a redundant network using repeaters to extend the network. The difference in length of redundant network A and network B shall not exceed the limits in Figure A.21 for coax repeaters and Figure A.22 for fibre repeaters.



Figure A.18 – Redundant network icons

In Figure A.19, trunk cable A is denoted by the light icon and trunk cable B is denoted by the dark icon. The cabling system should be marked accordingly with the proper icon or letter.

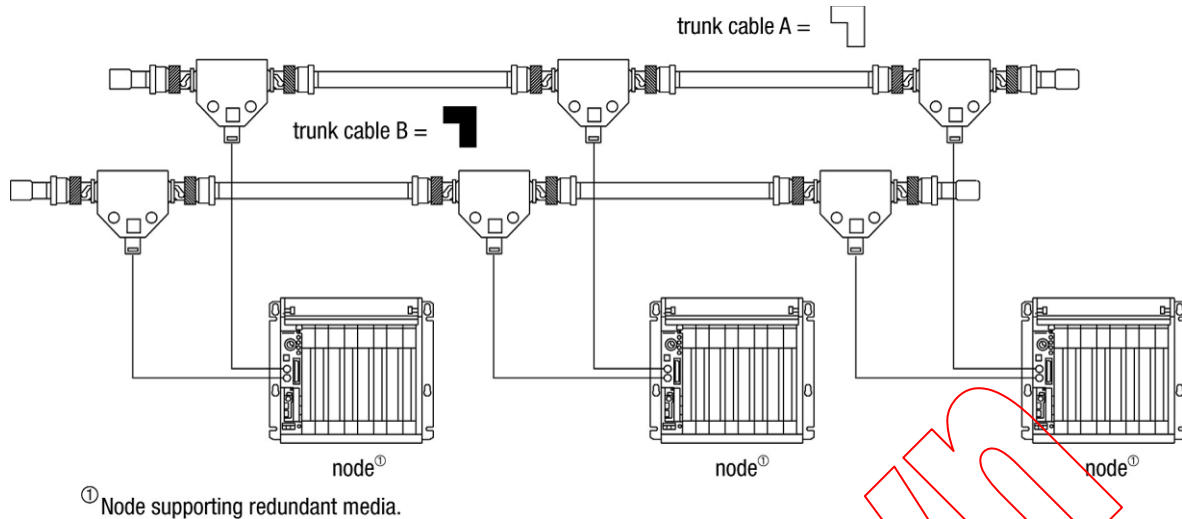


Figure A.19 – Redundant coax media

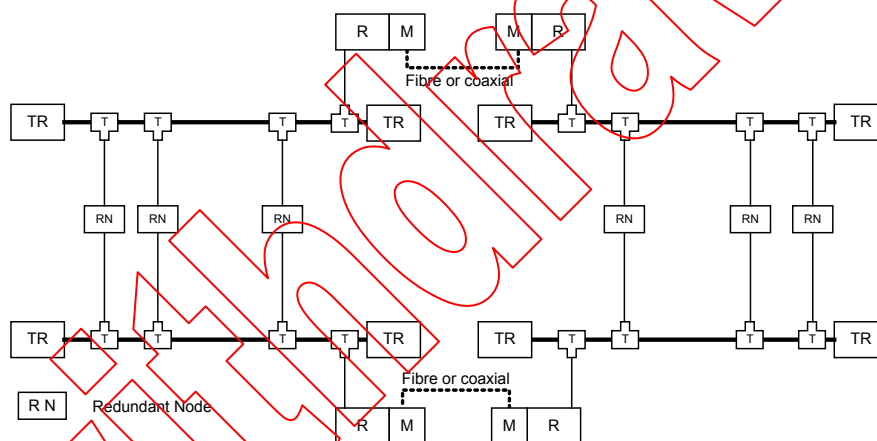


Figure A.20 – Redundant fibre media

The following guidelines shall be observed when planning a redundant media system.

- The two trunk cables (trunk cable A and trunk cable B) shall be routed differently to reduce the chance of both cables being damaged at the same time.
- Each node on a redundant-cable link shall support redundant coax connections and be connected to both trunk cables at all times. Any nodes connected to only one side of a redundant-cable link will result in media errors on the unconnected trunk cable.
- The cabling system shall be installed so that the trunk cables at any physical device location can be easily identified and labelled with the appropriate icon or letter. Each redundant ControlNet device is labelled so that it can be connected to the corresponding trunk cable.
- Both trunk cables (trunk cable A and trunk cable B) of a redundant-cable link shall have the same configurations. Each segment shall contain the same number of taps, nodes and repeaters. Nodes and repeaters shall be connected in the same relative sequence on both trunk cables.
- Cable shall be installed on each side of a redundant cable system so that each cable is about the same length. As the number of repeaters in a network increases, the allowable difference in length of the two redundant cabling systems is decreased as shown in Figure A.21.

- The difference in length between the two paths (trunk cable A and trunk cable B) shall not exceed the worst case limit line as detailed in Figure A.21 for coax media when using repeaters.
- The difference in length between the two paths (trunk cable A and trunk cable B) shall not exceed the worst case limit line as detailed in Figure A.22 for fibre media when using repeaters.
- When there are no repeaters in a redundant network the difference between the redundant paths (trunk cable A and trunk cable B) shall not exceed that detailed for zero repeaters in Figure A.21 or Figure A.22.
- Both redundant connections of a node shall not be connected to the same network; doing so will cause erratic operation. In addition all nodes with redundant ports shall be connected to a redundant network at the same physical location within the network. See Figure A.23 and Figure A.24 for both proper and improper connection of redundant nodes.
- The two networks shall not be connected together.
- ControlNet supports linear redundancy and ring topology. Dual redundant rings are not supported and will result in multiple communications paths and lead to network instabilities.

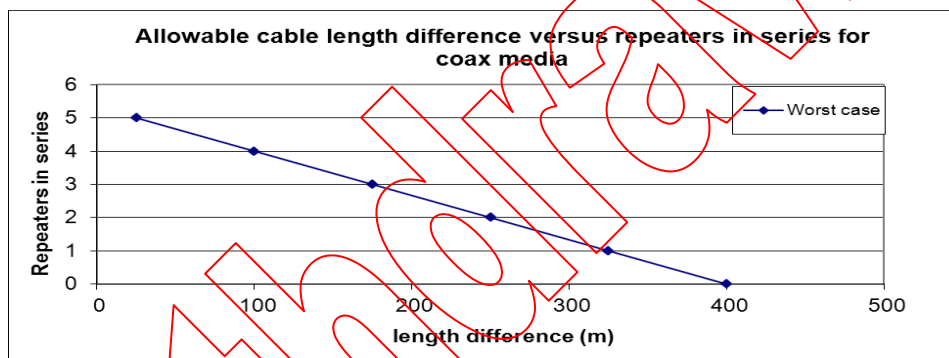


Figure A.21 – Repeaters in series versus length difference for coax media

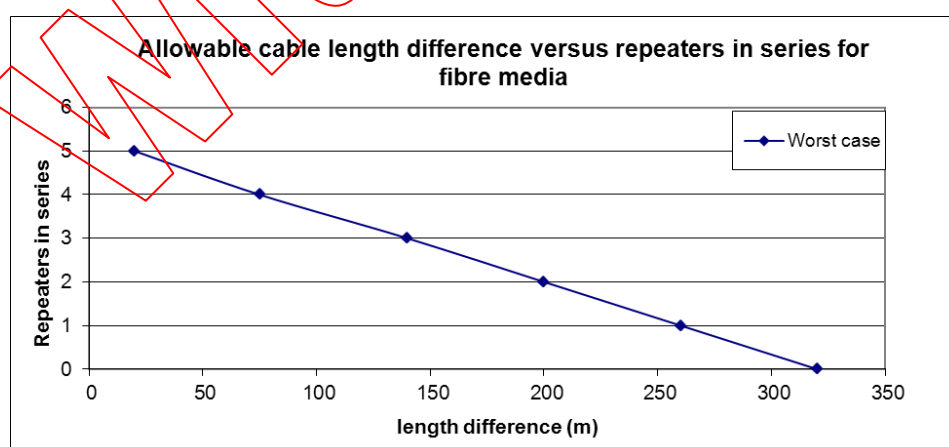


Figure A.22 – Repeaters in series versus length difference for fibre media

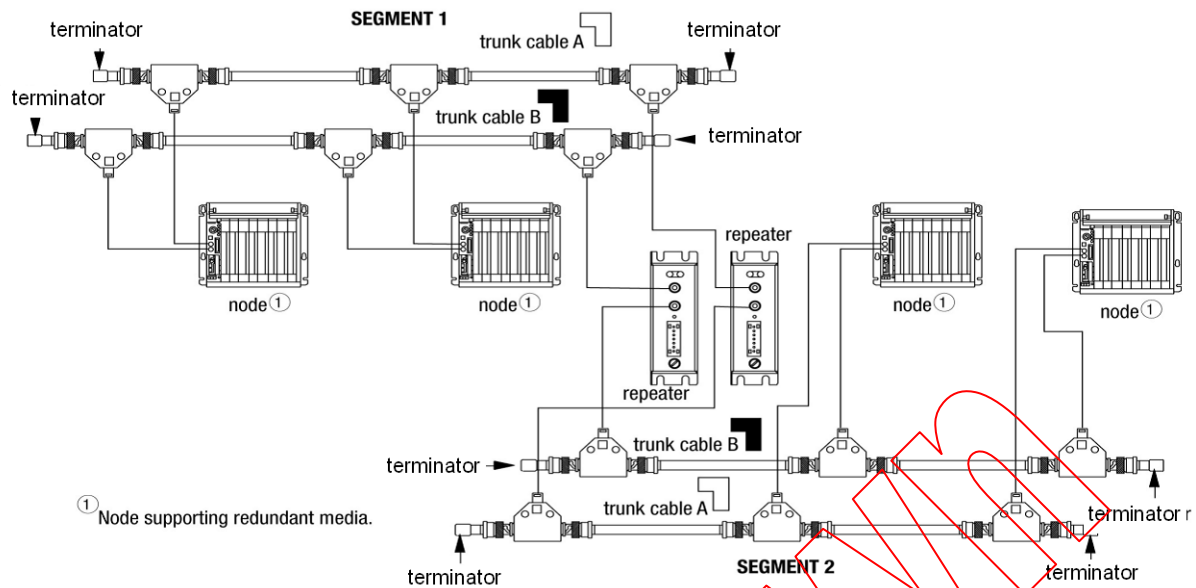


Figure A.23 – Example of redundant coax network with repeaters

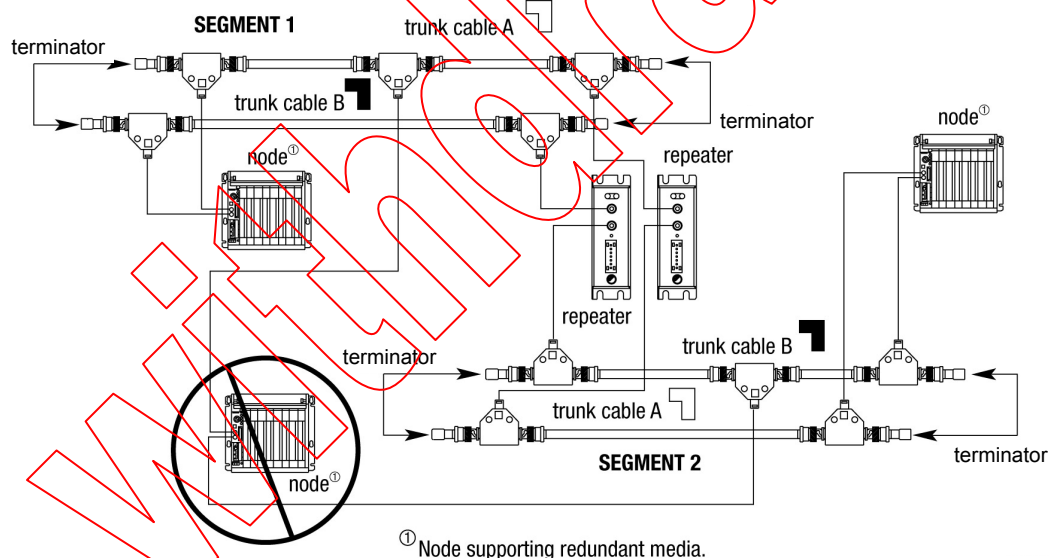


Figure A.24 – Example of improper redundant node connection

The allowable difference in length of trunk cable A and B can be found by counting the number of repeaters needed for the network and looking in the graph for coax repeaters above. When one repeater is used the allowable difference in length between network cable A and B is limited to 325 m (see Figure A.21 and Figure A.23).

A node supporting redundant trunk-cable connections will function even if trunk cable A is connected to the B connector on the node and vice-versa. However, doing so is not recommended because this makes cable fault indications (on the hardware or in the software) difficult to interpret and this makes locating a bad cable segment very difficult.

A.4.4.10 Separation of circuits

Addition:

These additional guidelines shall be followed for wiring all ControlNet cables:

- if cables are required to cross power lines, they should do so at right angles;
- cable shall be routed at least 1,5 m (5 ft.) from high-voltage enclosures, or sources of rf/microwave radiation.

If the conductor is in a metal wireway or conduit, each section of the wireway or conduit shall be bonded to each adjacent section so that it has electrical continuity along its entire length, and shall be bonded to the enclosure at the entry point.

A.4.4.11 Mechanical protection of cabling components

A.4.4.11.1 Common description

A.4.4.11.2 Specific requirements for CPs

Not applicable.

A.4.4.11.3 Specific requirements for generic cabling in accordance with ISO/IEC 24702

A.4.4.12 Installation in special areas

A.4.4.12.1 Common description

A.4.4.12.2 Specific requirements for CPs

Addition:

The cabling components shall be selected based on the environmental and application requirements. Highflex applications shall use cables designed to meet high flex. Cables expected to be subjected to weld splatter shall have the appropriate protection or jacket designs. Cables used in outdoor applications shall have the appropriate UV protection or jacketing design.

A.4.5 Cabling planning documentation

A.4.6 Verification of planning specification

A.5 Installation implementation

A.5.1 General requirements

A.5.1.1 Common description

A.5.1.2 Installation of CPs

A.5.1.3 Installation of generic cabling in industrial premises

Not applicable.

A.5.2 Cable installation

A.5.2.1 General requirements for all cabling types

Subclause 5.2.1.2 has replacement:

When pulling the RG6 type coax cable through multiple conduit bends, the specifications detailed in Table A.10 shall be followed.

Table A.10 – Parameters for coaxial RG6 cables

Characteristic		Value	
		PVC	FEP
Mechanical force	Minimum bending radius, single bending (mm)	77	70
	Bending radius, multiple bending (mm)	See manufacturer's data sheet	See manufacturer's data sheet
	Pull forces (N)	400	600
	Permanent tensile forces (N)	See manufacturer's data sheet	See manufacturer's data sheet
	Maximum lateral forces (N/cm)	See manufacturer's data sheet	See manufacturer's data sheet
	Temperature range during installation (°C)	See manufacturer's data sheet	See manufacturer's data sheet

Subclause 5.2.1.2 has addition:

When pulling the RG6 type coax cable outside of the conduit, the specifications detailed in Table A.11 shall be followed. Table A.12 and Table A.13 provide values based on the template given in IEC 61918:2013, Table 19 and Table 21.

Table A.11 – Bend radius for coaxial cables outside conduit

For this coax cable	The bend radius shall not exceed
PVC	38 mm
FEP	36 mm
Tap drop cable	26 mm

Table A.12 – Parameters for silica optical fibre cables

Characteristic		Value	
		GI Single mode	GI Multi mode
Mechanical force	Minimum bending radius, single bending (mm)	See manufacturer's data sheet	See manufacturer's data sheet
	Bending radius, multiple bending (mm)	See manufacturer's data sheet	See manufacturer's data sheet
	Pull forces (N)	See manufacturer's data sheet	See manufacturer's data sheet
	Permanent tensile forces (N)	See manufacturer's data sheet	See manufacturer's data sheet
	Maximum lateral forces (N/cm)	See manufacturer's data sheet	See manufacturer's data sheet
	Temperature range during installation (°C)	See manufacturer's data sheet	See manufacturer's data sheet

Table A.13 – Parameters for hard clad silica optical fibre

Characteristic		Value
		200 µm SI MM Fibre
Mechanical force	Minimum bending radius, single bending (mm)	See manufacturer's data sheet
	Bending radius, multiple bending (mm)	See manufacturer's data sheet
	Pull forces (N)	See manufacturer's data sheet
	Permanent tensile forces (N)	See manufacturer's data sheet
	Maximum lateral forces (N/cm)	See manufacturer's data sheet
	Temperature range during installation (°C)	See manufacturer's data sheet

A.5.2.2 Installation and routing**A.5.2.3 Specific requirements for CPs**

Not applicable.

A.5.2.4 Specific requirements for wireless installation

Not applicable.

A.5.2.5 Specific requirements for generic cabling in accordance with ISO/IEC 24702**A.5.3 Connector installation****A.5.3.1 Common description****A.5.3.2 Shielded connectors****A.5.3.3 Unshielded connectors**

Not applicable.

A.5.3.4 Specific requirements for CPs

Addition:

a) Tools

To install the cable connector, it is recommended that the proper tools be used that match the cable and the connectors. An example toolkit is provided in Figure A.25.

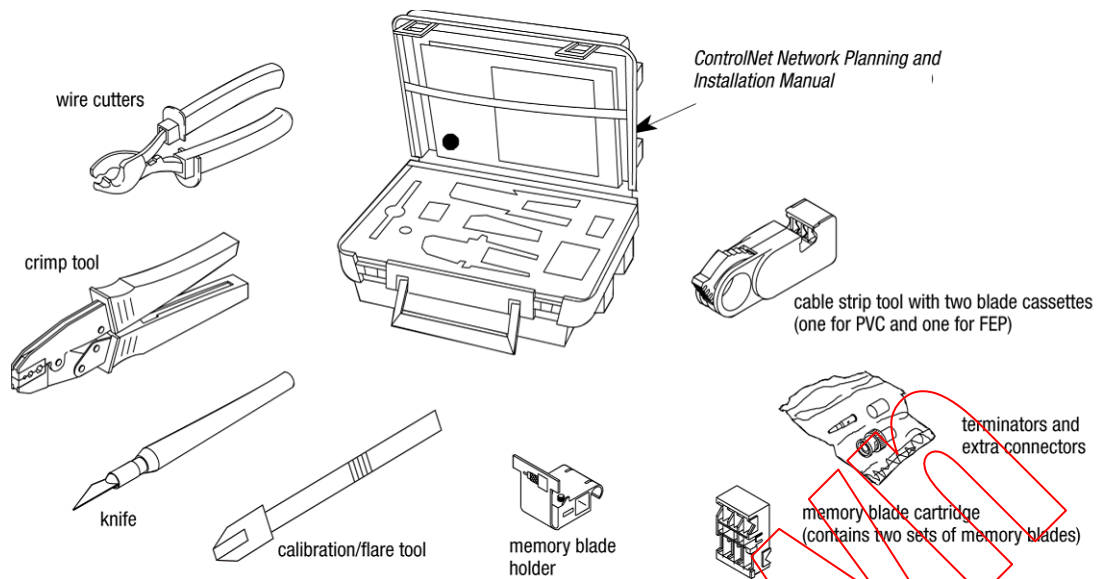


Figure A.25 – Example tool kit for installing BNC connectors

Additional tools:

- Heat gun (for IP67 sealed connectors)

If using a coaxial stripping tool, calibration is required.

b) Tool calibration

The following procedure shall be used to calibrate the cable strip tool to cut FEP or PVC cable.

- 1) Turn the three screws outward to back the blades out. This prevents the calibration tool from bottoming out
- 2) Place the calibration tool into the cable strip tool with the narrow end installed and facing forward for FEP cable (use the wider end for PVC) as shown in Figure A.26.

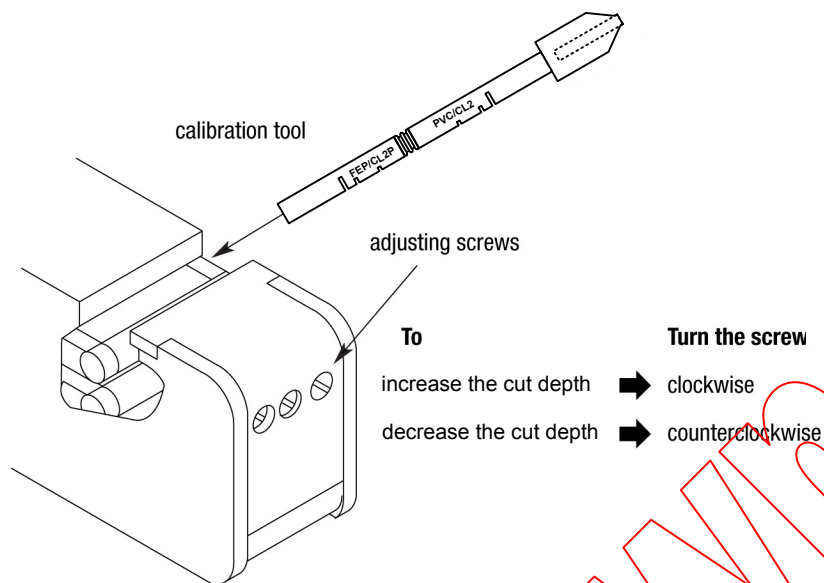


Figure A.26 – Calibration of coaxial stripper

- 3) Tighten the chamber gauge ring until the calibration tool is locked in place. Close all the way to the chamber gauge stop.

NOTE When aligned properly, the grooves of the calibration tool will be aligned with the blades.

- 4) Adjust the three screws clockwise until the blades just contact the bottom of the calibration grooves.
- 5) Retract the handle of the cable strip tool.
- 6) Remove the calibration tools from the cable strip tool.

When finished, the blade shall make a cut of the following dimensions in the cable as shown in Figure A.27.

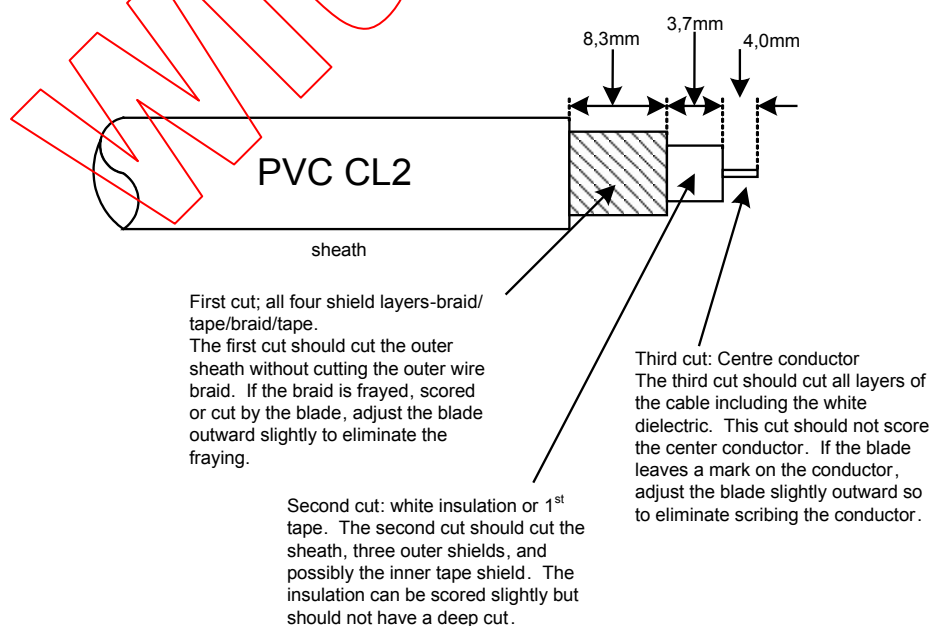


Figure A.27 – Coax PVC strip length detail (informative)

c) Stripping the cable

Important: The first and second cut adjustments need to be precise. Adjustments of 1/12 to 1/8 of a turn can make the difference between a correct and incorrect cut.

The calibration procedure shall be performed the first time the tool is used and every time the blade is changed. In addition, the calibration procedure shall be performed for each different coaxial cable that will be used.

Check the outer braid of the cable for cut or scored braid wire after stripping the cable. If the braid is damaged, cut the damaged end off and strip the cable again. If needed, adjust the appropriate cutting blade by backing the set screw out 1/8 of a turn. Do not crimp the BNC to a damaged braid. This type of mistake accounts for the majority of the connectivity problems that occur. Precise, clean connections will reduce network errors.

When cutting cable sections, make them long enough to route from one tap to the next with sufficient length so that the bend radius is not less than:

- 77 mm for wiring external to enclosures;
- 38 mm for wiring inside enclosures.

Proceed as follows.

- 1) Verify that the proper memory blade holder is installed for the type of cable to be stripped (PVC-CL2 or FEP-CL2P), see Figure A.28. The blades shall be recalibrated if the memory cartridge is replaced, see the calibration procedure above.

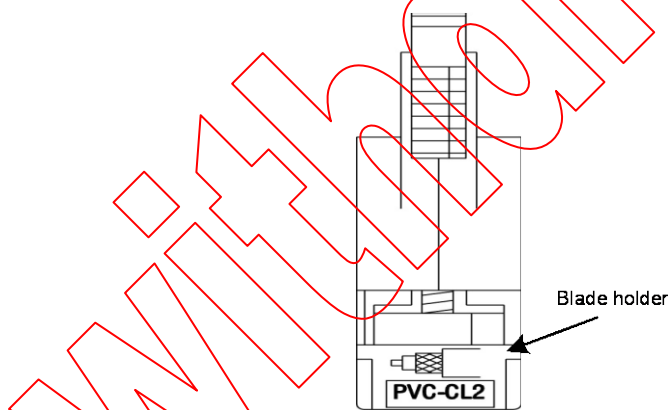


Figure A.28 – Memory cartridge and blade

- 2) Straighten out the end of the cable.
- 3) Insert the cable into the cable strip tool's cutting chamber so that approximately 26 mm (1 in) of extra cable extends beyond the edge of the tool as shown in Figure A.29.

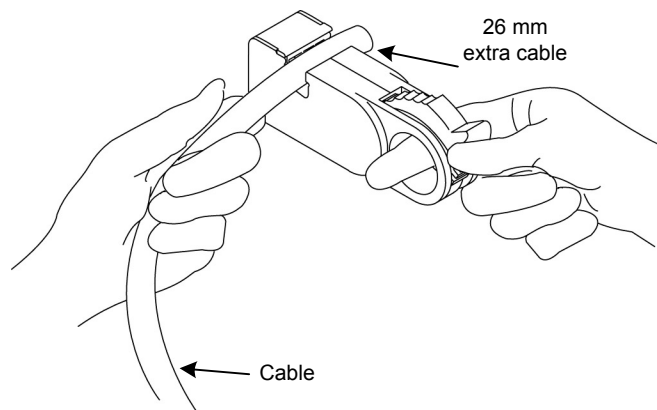


Figure A.29 – Cable position

- 4) Lock the cable into place by moving the chamber-gauge ring forward (see Figure A.30) until it meets the cable with slight resistance.

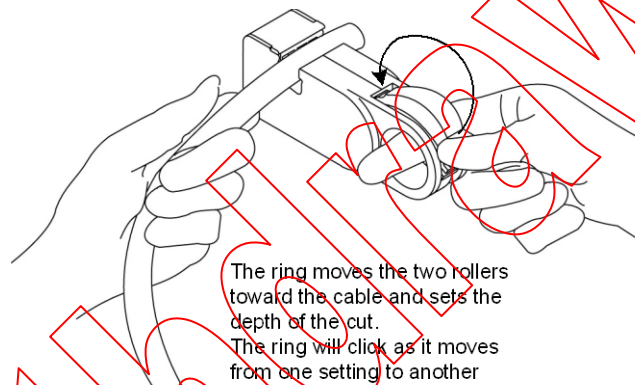


Figure A.30 – Locking the cable

- 5) Holding the cable in one hand, place the index finger of the other hand inside the chamber-gauge ring and turn the strip tool 360° around the cable. Turn four or five full rotations until the strip tool glides easily around the cable as indicated in Figure A.31.

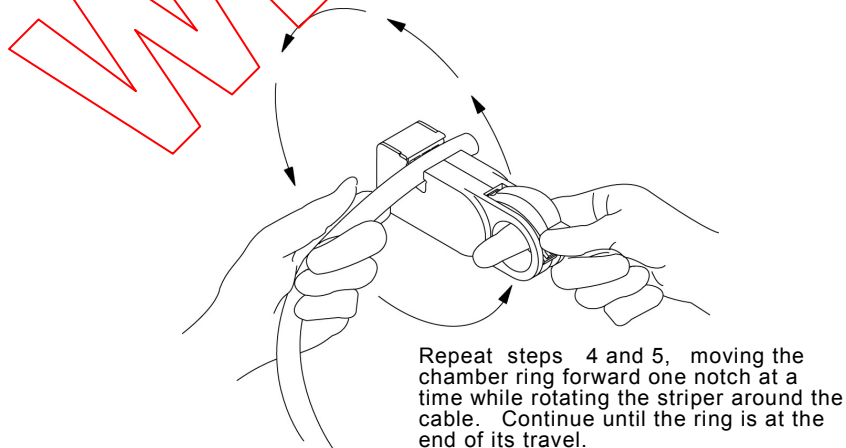


Figure A.31 – Stripping the cable

On the last repetition of steps 4) and 5), it is important to apply sufficient pressure on the chamber gauge ring to make sure the ring has reached the last stage. The chamber gauge should read “stop” for the last repetition.

- 6) After the chamber ring has been moved to the last position and turned a final time around the cable:
 - i) Move the chamber ring backward to release the strip tool and remove it from the cable.
 - ii) If using IP65/67, corrosion-resistant connectors, slide the heat shrink tubing over the cable.
 - iii) Slip the crimp ferrule onto the cable as shown in Figure A.32. Push it back to the sheath area of the cable to keep it out of the way for the moment.

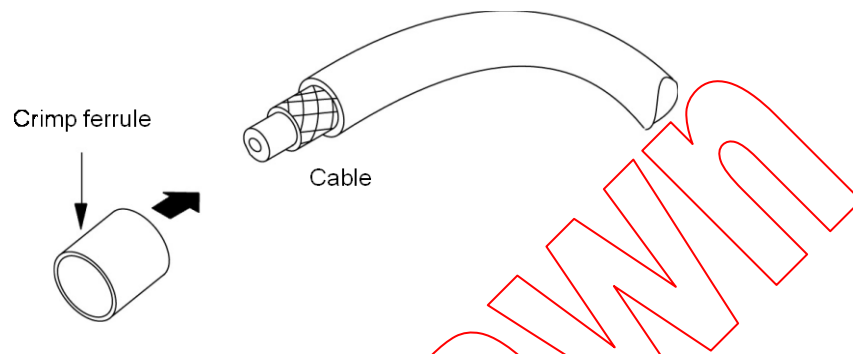


Figure A.32 – Install the crimp ferrule

- iv) Strip away the appropriate portion of the cable without using the strip tool.
- v) Clean the remaining cable parts from the strip chamber after each use.

This procedure should appropriately strip the cable, exposing these layers of the cable as detailed in Figure A.33.

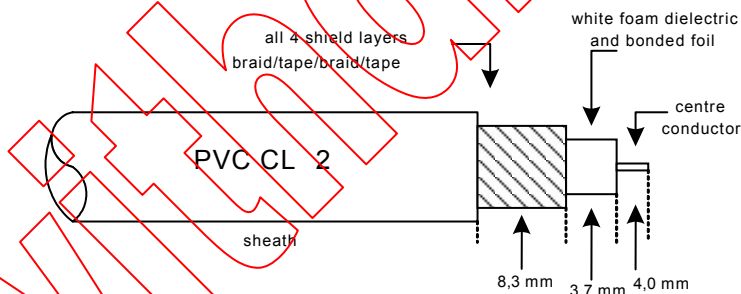


Figure A.33 – Cable preparation for PVC type cables (informative)

If there are not three distinct layers of cable or if the outer braid has been scored or cut, snip off the exposed end with the wire cutters and repeat the entire cable-stripping process. It is very important that the outer braid be intact before crimping the connector.

If stripping problems persist, the strip tool may need adjustment. See the calibration section for instructions on calibration.

- 7) For FEP cable cut off an additional 3,1 mm of the outer sheath with a knife as shown in Figure A.34.