Fieldbus-Cabling in Standards

IEEE 802.3

10 Mb/s Single Twisted Pair Ethernet Study Group

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Typical Topologies

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

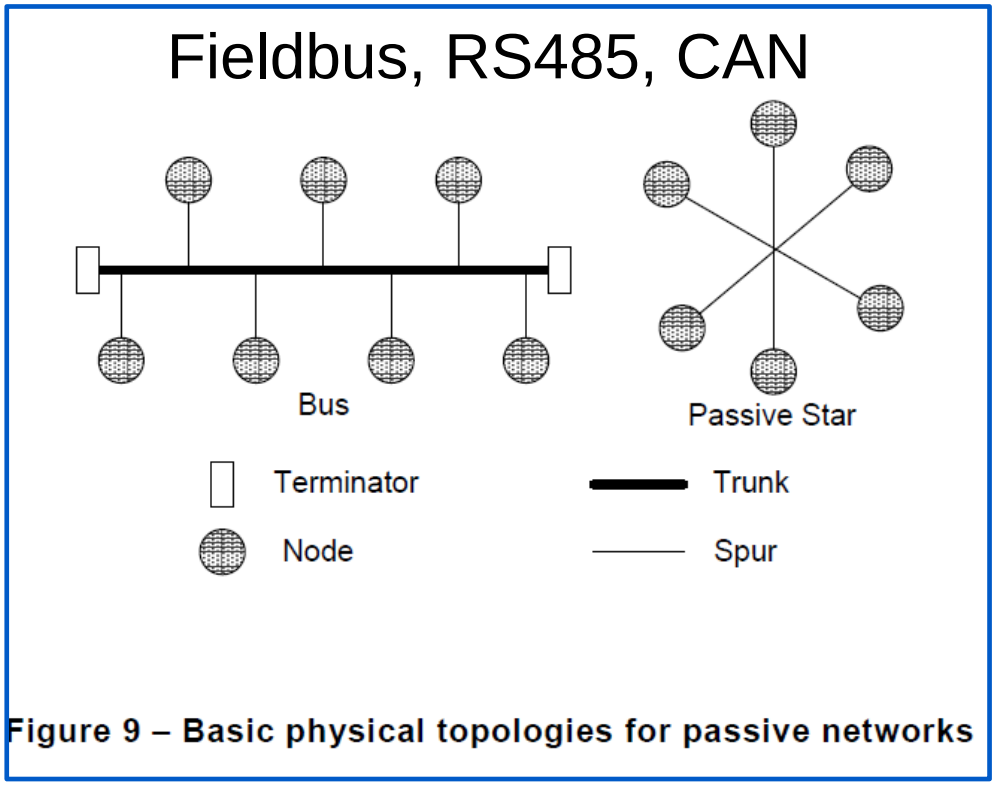


Figure 9 – Basic physical topologies for passive networks

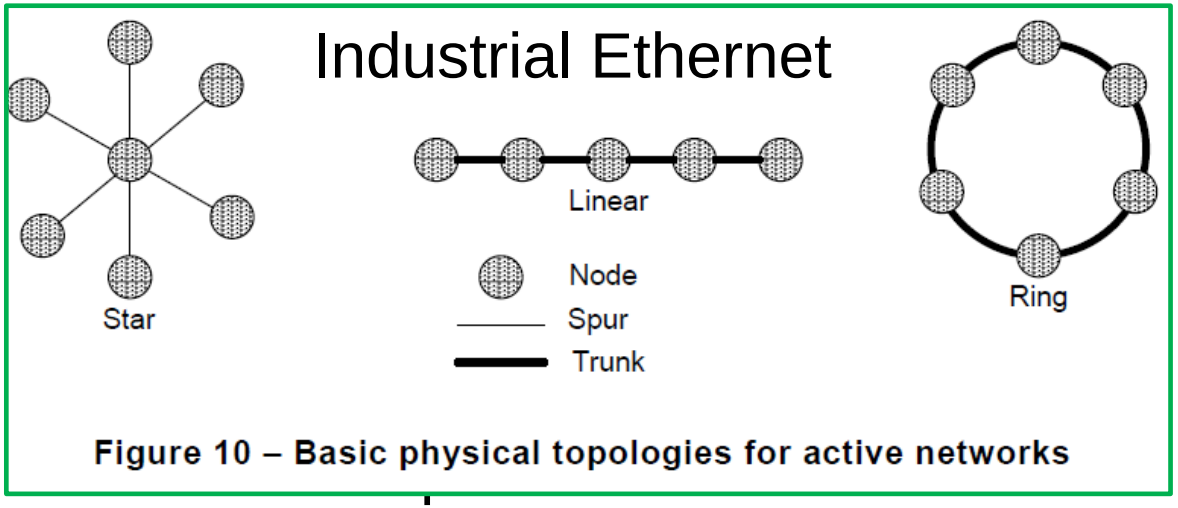


Figure 10 – Basic physical topologies for active networks

For further information see:
Horrmeyer 10SPE_00_0916

Where Standards come from

Guidelines from consortias

Generic industrial communication cabling standard IEC 61918

Profile specific cabling standard IEC 61784-5-x

x runs from 1 to 20 and represents the technologies from a consortia

Annexes A, B, .. In each x for different Fieldbus-PHY‘s from a consortia

Only twisted pairs considered in the following slides

65C/738/FDIS

FINAL DRAFT INTERNATIONAL STANDARD
PROJET FINAL DE NORME INTERNATIONALE

	Project number / Numéro de projet: IEC 61784-5-x Ed 3.0	
	IEC/TC or SC CEI/CE ou SC: SC65C	Secretariat / Secrétariat: FRANCE
☒ Submitted for parallel voting in CENELEC / Soumis au vote parallèle au CENELEC	Distributed on / Diffusé le: 2013-05-31	Voting terminates on / Vote clos le: 2013-08-02

IEC 61784-5-1, Annex A, CP 1/1 (FOUNDATION™ H1)

Table A.5 – Information relevant to copper cable: fixed cables

Characteristic	Type A (Reference)	Type B	Type C	Type D
Cable description	Twisted pair, shielded	One or more twisted pairs, total shielding	Several twisted pairs, not shielded	Several non-twisted pairs, not shielded
Nominal conductor cross sectional area	0,8 mm^2 (AWG 18)	0,32 mm^2 (AWG 22)	0,13 mm^2 (AWG 26)	1,25 mm^2 (AWG 16)
Maximum d.c. resistance (loop)	44 Ω/km	112 Ω/km	264 Ω/km	40 Ω/km
Characteristic impedance at 31,25 kHz	100 Ω ±20 %	100 Ω ±30 %	[a]	[a]
Maximum attenuation at 39 kHz	3 dB/km	5 dB/km	8 dB/km	8 dB/km
Maximum capacitive unbalance	2 nF/km	2 nF/km	[a]	[a]
Group delay distortion (7,9 to 39 kHz)	1,7 µs/km [b]	[a]	[a]	[a]
Surface covered by shield	90 %	[a]	–	–
Extent of network including spur cables	1 900 m	1 200 m	400 m	200 m
For maximum d.c. resistance (loop), the cross sectional area shall be the minimum value. All cable shall be annealed copper, tin coated.				

[a] Not specified.

[b] Using currently available

Table A.6 – Connectors for copper cabling CPs not based on Ethernet

	IEC 60807-2 or IEC 60807-3	IEC 61076-2-101			IEC 61169-8	ANSI/(NFPA) T3.5.29 R1-2007		Others		
	Sub-D	M12-5 with A-coding	M12-5 with B-coding	M12-n with X-coding	Coaxial (BNC)	M 18	7/8-16 UN-2B THD	Open style	Terminal block	Others
CP 1/1	9 pin	Yes	No	No	No	No	Yes	No	No	No
NOTE For M12-5 connectors, there are many applications using these connectors that are not compatible and when mixed can cause damage to the applications.										

IEC 61784-5-2, Annex C, CP 2/3 (DeviceNet™)

Table C.13 – DeviceNet cable profiles

	Cable profile		
	Thick	Thin	Flat
Data pair			
Physical characteristics	Specification		
Conductor pair size	18 AWG or 0,82 mm^2 copper minimum; 19 strands minimum (individually tinned)	24 AWG or 0,20 mm^2 copper minimum; 19 strands minimum (individually tinned)	16 AWG or 1,3 mm^2 copper minimum; 19 strands minimum (individually tinned)
Insulation diameter	3,8 mm (nominal)	1,96 mm (nominal)	2,8 mm (nominal)
Colours	LT BU/WH	LT BU/WH	LT BU/WH
Pair twist/m	9,8 (approximately)	16,5 (approximately)	

+ much more details

Table C.14 – Copper connectors for non-Ethernet based fieldbus

	IEC 60807-2 or IEC 60807-3	IEC 61076-2-101			IEC 611698	ANSI/(NFPA) T3.5.29 R1-2007		Others		
	Sub-D	M12-5 with A-coding	M12-5 with B-coding	M12-n with X-coding	Coaxial (BNC)	M 18	7/8-16 UN-2B THD	Open-style	Terminal block	Others
CP 2/3	No	Yes	No	No	No	Yes	Yes	Yes	Yes	See Table C.15

NOTE For M12-5 connectors, there are many applications using these connectors that are not compatible hen mixed can cause damage to the applications.

Table C.2 – Cable trunk and drop lengths for CP 2/3

Cable profile	Trunk length			Cumulative drop length [a]		
	Data rate			Data rate		
	125 kbit/s	250 kbit/s	500 kbit/s	125 kbit/s	250 kbit/s	500 kbit/s
	Trunk length at data rate m			Cumulative drop length at data rate [a] m		
Thick	500	250	100	156	78	39
Thin	100	100	100	156	78	39
Flat	420	200	75	156	78	39

n:

C.15 provides a list of available connectors for DeviceNet networks. This table is an on of Table C.14.

Table C.15 – Additional connectors for CP 2/3 (DeviceNet)

nnector	M12-5 A-coding	Mini 7/8-16 UN-2B THD / M18	Open	Flat
ard	IEC 60947-5-2:2007, Figure D.2	ANSI/(NFPA) T3.5.29 R1-2007	ODVA (see [6])	ODVA (see [6])
cts	5	5	5	4
nt (A)	3	8	8	8
d	Yes	Yes	No	Yes

IEC 61784-5-3, Annex A, CP 3/1 (PROFIBUS)

Table A.2 – Basic network characteristics for balanced cabling not based on Ethernet (ISO/IEC 8802-3)

Characteristic	CP 3/1 (PROFIBUS)	
Basic transmission technology	RS 485	RS 485-IS
Length / transmission speed	Segment leng m	
9,6 kbit/s – 93,75 kbit/s	1 200	1 20
187,5 kbit/s	1 000	1 00
500 kbit/s	400	400
1,5 Mbit/s	200	200
3 – 6 – 12 Mbit/s	100	Not
Maximum capacity	Maximum n	
Devices / segment	32	32
Number of devices / network [a]	125	125
[a] Limited by addressing scheme.		

Table A.4 – Information relevant to copper cable: fixed cables

Characteristic	CP 3/1 (PROFIBUS RS 485)	CP 3/1 (PROFIBUS RS 485-IS) [a]
Nominal impedance of cable (tolerance)	135 Ω to 165 Ω; f = 3 MHz to 20 MHz	
Balanced or unbalanced	Balanced	
DCR of conductors	< 55 Ω/km	
DCR of shield	Not defined	
Number of conductors	2	
Shielding	Mandatory	
Colour code for conductor	A = green; B = red	
Jacket colour requirements	Violet	Light blue [b]
Jacket material	Application dependent	
Resistance to harsh environment (e.g. UV, oil resist, LS0H)	Cable types for different applications available	
Agency ratings	Cable types with different ratings available	
Conductor cross-sectional area	≥ 0,34 mm²	≥ 0,34 mm² [c]
Capacitance	< 30 pF/m	
L/R ratio (µH / Ω)	Not specified	≤ 15
The L/R ratio shall be applied for the lowest ambient temperature of the bus cable.		
[a]		

shall be in accordance with IEC 60079-14.

our is used for identification.

ıe stranded conductor is used: 0,1 mm is the minimum value required for the diameter of a wire.

Table A.6 – Connectors for copper cabling CPs not based on Ethernet

	IEC 60807-2 or IEC 60807-3	IEC 60947-5-2 or IEC 61076-2-101			IEC 61169-8	ANSI/(NFPA) T3.5.29 R1-2007		Others		
	Sub-D	M12-5 with A-coding	M12-5 with B-coding	M12-n with X-coding	Coaxial (BNC)	M 18	7/8-16 UN-2B THD	Open style	Terminal block	Others
CP 3/1	9 pin	No	Yes	No	No	No	No	No	Yes	Hybrid style
NOTE For M12-5 connectors, there are many applications using these connectors that are not compatible and when mixed can cause damage to the applications.										

IEC 61784-5-3, Annex B, CP 3/2 (PROFIBUS)

Table B.9 – Information relevant to copper cable: fixed cables

Characteristic	Type A (Reference)	Type B	Type C	Type D
Cable description	Twisted pair, shielded	One or more twisted pairs, total shielding	Several twisted pairs, not shielded	Several non-twisted pairs, not shielded
Nominal conductor cross sectional area	0,8 mm^2 (AWG 18) (Ø1,024 mm)	0,32 mm^2 (AWG 22) (Ø 0,644 mm)	0,13 mm^2 (AWG 26) (Ø 0,511 mm)	1,25 mm^2 (AWG 16) (Ø 1,291 mm)
Maximum d.c. resistance (loop)	44 Ω/km	112 Ω/km	264 Ω/km	40 Ω/km
Characteristic impedance at 31,25 kHz	100 Ω ±20 %	100 Ω ±30 %	[a]	[a]
Maximum attenuation at 39 kHz	3 dB/km	5 dB/km	8 dB/km	8 dB/km
Maximum capacitive unbalance	2 nF/km	2 nF/km	[a]	[a]
Group delay distortion (7,9 kHz to 39 kHz)	1,7 µs/km	[a]	[a]	[a]
Surface covered by shield	90%	[a]	–	–
Extent of network including spur cables	1 900 m	1 200 m	400 m	200 m

[a] Not specified.

Table B.11 – Connectors for copper cabling CPs not based on Ethernet

	IEC 60807-2 or IEC 60807-3	IEC 60947-5-2 or IEC 61076-2-101			EN 122120	ANSI/(NFPA) T3.5.29 R1-2007		Others		
	Sub-D	M12-5 with A-coding	M12-5 with B-coding	M12-n with X-coding	Coaxial (BNC)	M 18	7/8-16 UN-2B THD	Open style	Terminal block	Others
CP 3/2	9 pin	No	No	M12-4 with A-coding	No	No	No	No	No	No
NOTE For M12-5 connectors, there are many applications using these connectors that are not compatible and when mixed can cause damage to the applications.										

IEC 61784-5-6, Annex A, CPF 6 Type 8

Table A.3 – Information relevant to balanced cable: fixed ca

Characteristic	Type 8 netw
Nominal impedance of cable (tolerance)	120 Ω ± 20 % at f = 0,064 MH 100 Ω ± 15 Ω at f > 1 MHz Test method IEC 61156-1:200
DCR of conductors	max. 9,6 Ω / 100 m Test method IEC 60189-1:200

Table A.4 – Information relevant to balanced cable: c

Characteristic	Type 8 n
Nominal impedance of cable (tolerance)	120 Ω ± 20 % at f = 0,06 100 Ω ± 15 Ω at f > 1 MH Test method IEC 61156-1
DCR of conductors	max. 9,6 Ω / 100 m Test method IEC 60189-1

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

Characteristic	Type 8 network
Basic transmission technology	Type 8
Length / transmission speed	**Segment length** m
500 kbit/s	400 m between nodes [a]
2 Mbit/s	150 m between nodes [a]
8 Mbit/s	125 m between nodes [a]
16 Mbit/s	100 m between nodes [a]
Maximum capacity	**Max. No.**
Devices / segment	Remote bus: 256 [b] Local bus: 63 [b]
Number of devices / network	Remote bus: 256 [b] Local bus: 256 [b]

[a] The maximum length of a Type 8 network depends on the number of devices supported by the master and could be calculated by multiplication of link length by the number of devices.

[b] The maximum number of all device in one Type 8 network is limited to 256.

+ much more details

Table A.6 – Connectors for copper cabling CPs not based on Ethernet

	IEC 60807-2 or IEC 60807-3	IEC 61076-2-101			IEC 61169-8	ANSI/NFPA T3.5.29 R1-2007		Others		
	Sub-D	M12-5 with A-coding	M12-5 with B-coding	M12-n with X-coding	Coaxial (BNC)	M 18	7/8-16 UN-2B THD	Open style	Terminal block	M23, 9 pos
CPF 6 Type 8 net work	Yes	No	Yes	No	No	No	No	Yes	Yes	Yes [a]

NOTE For M12-5 connectors, there are many applications using these connectors that are not compatible and when mixed can cause damage to the applications.

[a] Hybrid connector as specified in IEC 61158-2:2013, M.3.

IEC 61784-5-8, Annex A, CP 8/1 and CP 8/2 (CC-Link/V1+V2)

Table A.2 – Bus t-branch network charac

Characteristic	Transmission speed	
Length / transmission speed	156 kbit/s	625 kbit/s
Maximum trunk segment length (m)	500	100
Maximum branch length (m)	8	8
Maximum overall branch length (m)	200	50
Maximum capacity		
Maximum devices / branch segment	6	6

Table A.3 – Information relevant to copper cable: fixed cables

Characteristic	CP 8/1, CP 8/2
Nominal impedance of cable (tolerance)	110 Ω (± 15 Ω) at 1 MHz 110 Ω (± 6 Ω) at 5 MHz
DCR of conductors	≤ 37,8 Ω/km
DCR of shield	–
Number of conductors	3
Shielding	with drain wire
Colour code for conductor	signal DA = BU (blue) signal DB = WH (white) signal DG = YE (yellow)
Jacket colour requirements	–
Jacket material	Application dependent
Resistance to harsh environment (e.g. UV, oil resist, LS0H)	Application dependent
Agency ratings	Application dependent
Conductor cross-sectional area	0,518 mm^2 (20 AWG)
Dielectric strength	≥ 500 Vr.m.s.
Insulation resistance (after dielectric strength test)	≥ 10 000 MΩ · km
Mutual capacitance (at 1 kHz)	≤ 60 nF / km
Maximum attenuation for 100 m	≤ 1,6 dB at 1 MHz ≤ 3,5 dB at 5 MHz

Table A.4 – Connectors for copper cabling CPs nc

	IEC 60807-2 or IEC 60807-3	IEC 61076-2-101			IEC 61169 -8	ANSI/(T3.5.29 R1-2007				
	Sub-D	**M12-5 with A-coding**	**M12-5 with B-coding**	**M12-n with X-coding**	**Coaxial (BNC)**	**M 18**	**7/8-16 UN-2B THD**	**Open style**	**Terminal block**	**Others**
CP 8/1	No	No	No	No	No	No	No	Yes	Yes	≥ 4 pins
CP 8/2	No	No	No	No	No	No	No	Yes	Yes	≥ 4 pins

IEC 61784-5-8, Annex B, CP 8/3 (CC-Link/LT)

Table B.2 – CP 8/3 additional topology length limits

Parameter	Value			Comment
	156 kbit/s	625 kbit/s	2 500 kbit/s	
Max. trunk segment length	500 m	100 m	35 m	Not including branch l
Max. branch length	60 m	16 m	4 m	Cable length per bran
Max. overall branch length	200 m	50 m	15 m	Total length of all bra combined
Max. spur length	60 m	16 m	4 m	Spurs must be include branch total length ca
Max. cable length between connected devices	500 m	100 m	35 m	
Max. cable length between t-branches	no limit			
Max. number of devices connected per branch	8			

Table B.3 – Information relevant to copper cable: flat cable

Characteristic	CP 8/3 Flat
Nominal impedance of cable (tolerance)	130 Ω (± 25 Ω)
DCR of conductors	≤ 23,4 Ω / km
DCR of shield	–
Number of conductors	4
Shielding	–
Colour code for conductor	see Figure B.3, Figure B.4 and Figure B.5
Jacket colour requirements	see Figure B.3, Figure B.4 and Figure B.5
Jacket material	Flexible resin
Resistance to harsh environment (e.g. UV, oil resist, LS0H)	–
Agency ratings	–
Conductor cross-sectional area	0,823 mm² (18 AWG)
Dielectric strength (conductor - conductor)	≥ 500 Vrms
Dielectric strength (conductor - shield)	–
Insulation resistance (after dielectric strength test)	≥ 10 MΩ · km
Mutual capacitance (at 1 kHz)	≤ 55 nF / km
Maximum attenuation for 100 m	≤ 3,04 dB at 1 MHz ≤ 4,83 dB at 2 MHz

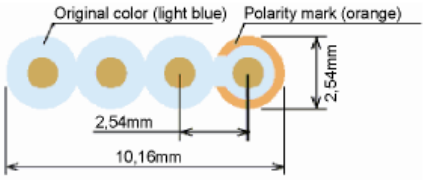


Figure B.4 – Flat cable cross section - without key

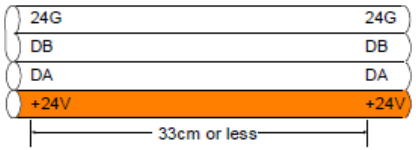
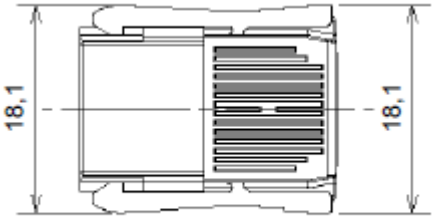


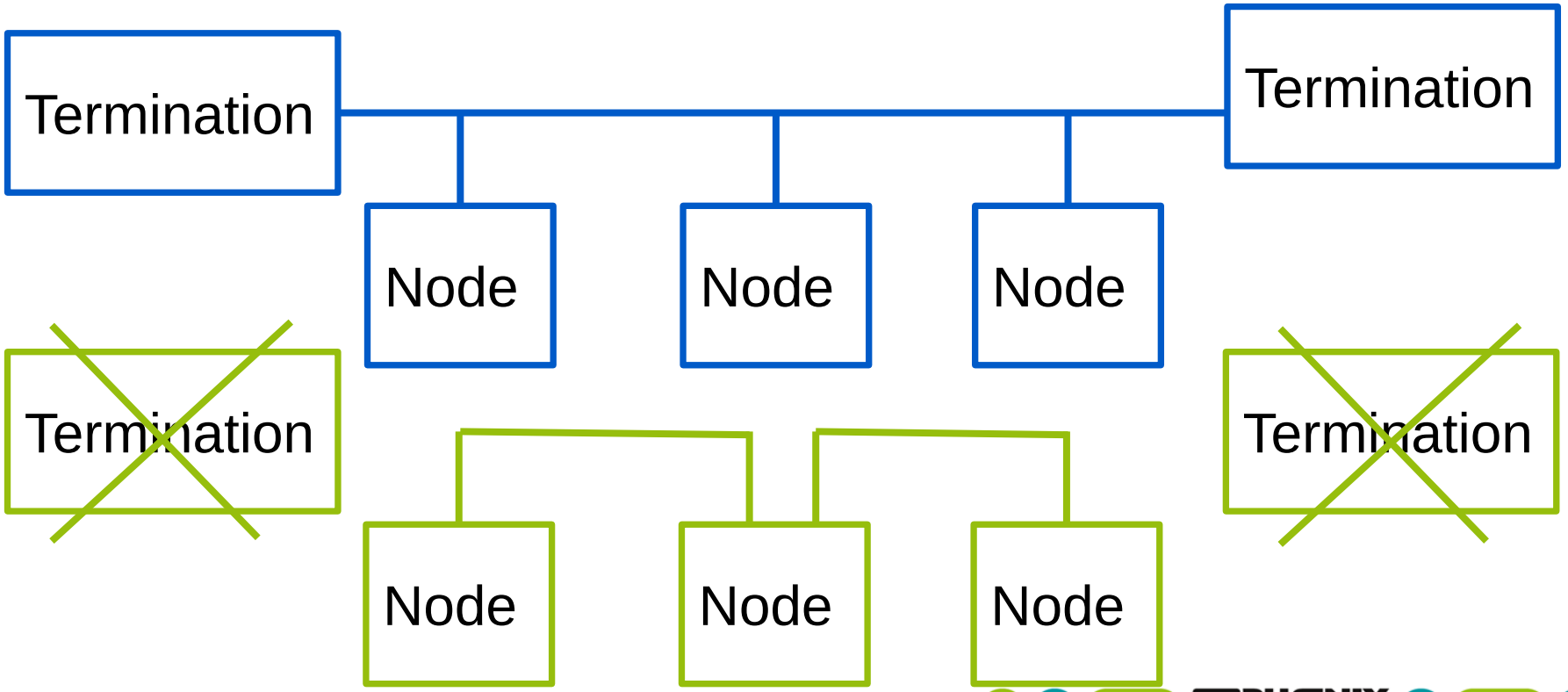
Figure B.5 – Flat cable polarity marking



A) Body and connector

Conversion of bus topologies

1. Mostly passive bus topologies
2. Length between 2 nodes mostly much more less than total length
3. Cabling can be transformed into active linear topology
    1. Typical link length decreases
    2. Existing cabling can be reused
    3. Only new connectors and termination needed



Outlook

Conclusion

1. Mostly bus topology
2. Parameters only sparely defined
3. Compilation as Word-Document existing
4. Comparisan as Excel-Document existing
5. Next steps tbd

Proposal for next steps

Determine the necessary signal integrity parameters
Gather parameters and data from guidelines and standards => done
Measurement program for unknown data

Thanks for your attention

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