
UTP / STP Cable Requirements for Ethernet Applications

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1. SCOPE

This document specifies the cable requirements for 100 Mbit/s and 1 Gbit/s Ethernet applications.

2. APPLICABLE DOCUMENTS

- Channel and Components Requirements for 1000BASE-T1 Link Segment Type A (UTP) Version 2.0
- Channel and Components Requirements for 1000BASE-T1 Link Segment Type A (STP) Version 2.0
- IEEE 100BASE-T1 Definitions for Communication Channel Version 1.0
- LV 112-1 – „Elektrische Leitungen für Kraftfahrzeuge – Kupferleitung, einadrig, ungeschirmt
- LV 112-4 – „Elektrische Leitungen für Kraftfahrzeuge – Leitungen aus Kupferlegierungen; einadrig, ungeschirmt“
- LV 213-2 – Hochfrequenzleitungen für Kraftfahrzeuge – die keine einzelnen Koaxialleitungen sind
- 114-18858 – „Nano MQS“
- 114-94288 – „Nano Tab 0.5x0.4“

3. QUALITY ASSURANCE

3.1 Quality Continuity

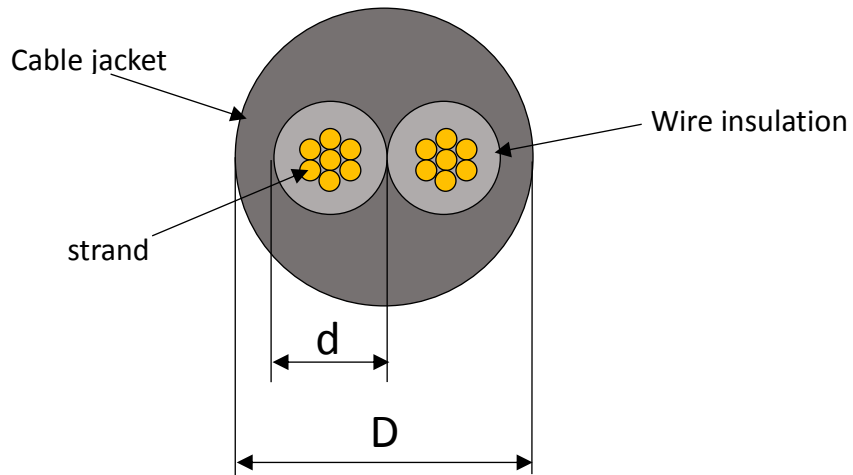
No intentional change shall be made in the manufacturing processes that produces the cable without first obtaining approval from the responsible Product Engineering Department.

3.2 Submitting Samples

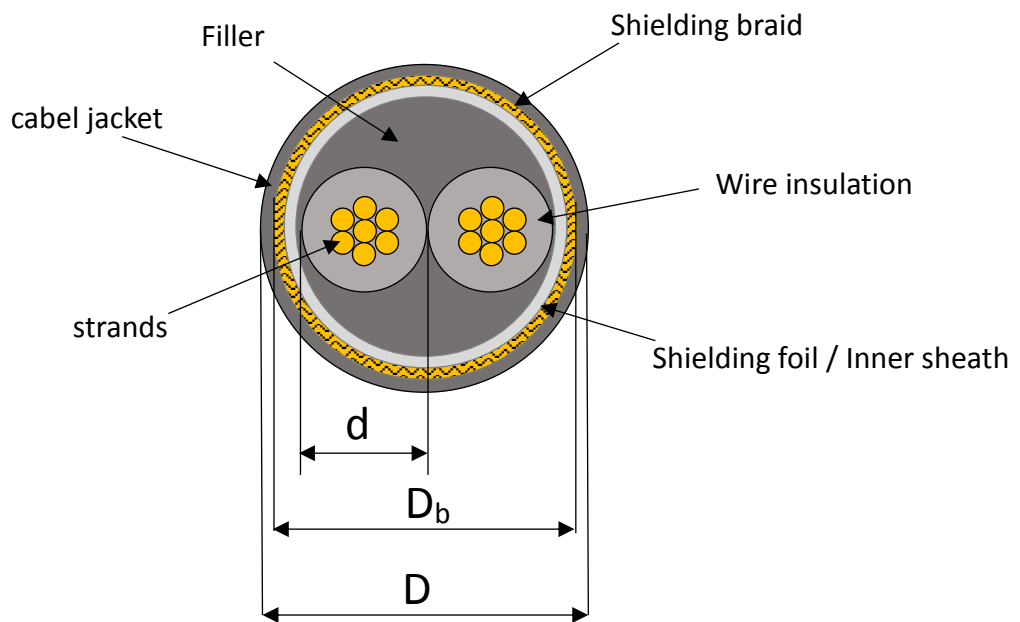
Samples shall be submitted to the responsible Product Engineering Department for approval and shall be produced by the same manufacturing process as the final product. Any subsequent changes to the manufacturing process shall require additional samples to be submitted.

4. CABLE - TECHNICAL REQUIREMENTS

4.1 Cable Construction - UTP



4.2 Cable Construction – STP



4.3 Cable Dimensions

Standard	Acc. to LV 112-4 (tensile improved)		Acc. to LV 112-1	
	Wire cross section	0.13mm ²	0.17mm ²	0.35mm ²
Wire material	CuMg02; CuSn03 CuAg01	CuAg01	Cu	
Wire structure	7 x 0.02mm ²		7 x 0.05mm ²	7 x 0.02mm ²
Wire insulation diameter "d"	1.10mm max.		1.25mm max	1.10mm max
UTP- Jacket diameter, "D"	3.2mm ±0.15		4.0mm ±0.15	3.2mm ±0.15
STP- Jacket diameter, "D"	4.1mm ±0.2		<i>tbd</i>	4.1mm ±0.2
STP- Braid diameter "D _b "	3.3mm ±0.2			
Pitch of layers	Min. 15mm			

4.4 Processing requirements

- Outer jacket ovality 8%
- Wire insulation colors: Two different colors, definite detectable by camera e.g. green/white
- Lay Length of wire twist: min. 15mm (20mm)
- Jacket wall thickness (D/2-d): ≥ 0.4mm
- Lay length of strand acc. to LV 112-1 / LV112-4
- Bending stiffness acc. to LV112-1 / LV112-4
- Tight fit outer jacket* 15 – 45N
- Tight fit wire jacket* 5 – 25N
- Tight fit Inner filler* 15 – 45N
- Bending radius single bending 5xd; multiple bending 15xd
- Shielding braid coverage ≥ 85%
- Marking printable with common marking technologies

(*) l = 50mm; v = 50m/min

4.5 Mechanical/thermal/environmental requirements

All mechanical requirements must be in accordance to:

- LV112-4
- LV112-1

Operating temperature range: -40°C...+125°C
Flammability: according to LV212-1
Chemical resistance: according to LV212-1

4.6 Materials

Processing additives like separation powder agent content must be as minimized as possible to assure easy separation under consideration of a non-polluted manufacturing environment.
No chlorinated polymers allowed.

5. RF REQUIREMENTS

All RF parameter must be in their limits under consideration of the complete range of environmental / mechanical conditions.

5.1 Requirements for 100Mbit

For UTP only.

Excerpt from IEEE 100BASE-T1 Definitions for Communication Channel Version 1.0.

Test parameter		Test standard	Limit (max. value for parameter)
CIDM	Z_{RF}	IEC 62153-1-1	100 Ω +/- 10 %, valid for 700 ps rise time evaluation) ₃ Evaluation window: l = 0.5m to 1.5m, see) ₄
IL) ₅	S_{dd21}) ₂	ISO/IEC 11801 DIN EN 50289-1-1	<u>Maximum length of SCC = 15m:</u> 1 MHz: 0.06 dB/m 10 MHz: 0,16 dB/m 33 MHz: 0.31 dB/m 66 MHz: 0.45 dB/m <u>Maximum length of SCC = 10m:</u> 1 MHz: 0.09 dB/m 10 MHz: 0,24 dB/m 33 MHz: 0.46 dB/m 66 MHz: 0.68 dB/m
RL	S_{dd11}, S_{dd22}) ₁		1 MHz: 20.0 dB 20 MHz: 20.0 dB 66 MHz: 14.8 dB
LCL	S_{dc11}, S_{dc22}) ₁		1 MHz: 46.0 dB
LCTL	S_{dc21}, S_{dc12}) ₁		50 MHz: 46.0 dB 200 MHz: 34.0 dB

)₁ linear axis for dB, linear interpolation for limit value at logarithmic frequency axis

)₂ logarithmic axis for dB, linear interpolation for limit value at logarithmic frequency axis

)₃ two measurements are required: systems rise time \leq 25 ps for information purpose only, systems rise time 700 ps for limit comparison

)₄ refer to Figure 5-1 for evaluation window definition

)₅ for IL limits for cables, two classes of cable are specified, depending on maximum length of implemented SCC

5.2 Requirements for 1Gbit/s

5.2.1 UTP

Excerpt from Channel and Components Requirements for 1000BASE-T1 Link Segment Type A (UTP) Version 2.0

Test Parameter		Requirement
CIDM	Z_{RF}	$100 \Omega \pm 5 \%$ (at 500 ps rise time)
Propagation Delay	t_d	<p>For use in SCC with maximum length of 15m</p> $\leq 6 \text{ ns} / \text{m}$ <p>For use in SCC with maximum length of 10m</p> $\leq 9 \text{ ns} / \text{m}$ <p>$2 \leq f \leq 600$, frequency f in MHz</p> <p>Port reference impedances: 100 Ω (DM), 200 Ω (CM)</p>
IL	S_{dd21}	<p>For use in SCC with maximum length of 15 m</p> $\leq \frac{1}{15} \left(0.0023f + 0.5907\sqrt{f} - 6 * 0.01\sqrt{f} + 0.0639/\sqrt{f} \right) \text{ dB} / \text{m}$ <p>For use in SCC with maximum length of 10 m</p> $\leq \frac{1}{10} \left(0.0023f + 0.5907\sqrt{f} - 6 * 0.01\sqrt{f} + 0.0639/\sqrt{f} \right) \text{ dB} / \text{m}$ <p>$1 \leq f \leq 600$, frequency f in MHz</p> <p>Port reference impedances: 100 Ω (DM), 200 Ω (CM)</p>
RL	S_{dd11}, S_{dd22}	$\geq \begin{pmatrix} 22 & 1 \leq f < 10 \\ 27 - 51 \log f & 10 \leq f < 40 \\ 19 & 40 \leq f < 130 \\ 40 - 10 \log f & 130 \leq f < 400 \\ 14 & 400 \leq f \leq 600 \end{pmatrix} \text{ dB}$ <p>$1 \leq f \leq 600$, frequency f in MHz</p> <p>Port reference impedances: 100 Ω (DM), 200 Ω (CM)</p>
LCL LCTL	S_{dc11}, S_{dc22} S_{dc21}, S_{dc12}	$\geq \begin{pmatrix} 55 & 10 \leq f \leq 80 \\ 77 - 11.51 \log(f) & 80 < f \leq 600 \end{pmatrix} \text{ dB}$ <p>$10 \leq f \leq 600$, frequency f in MHz</p> <p>Port reference impedances: 100 Ω (DM), 200 Ω (CM)</p>

5.2.2 STP

Excerpt from Channel and Components Requirements for 1000BASE-T1 Link Segment Type A (STP) Version 2.0

Test parameter	Symbol or related S-parameter	Requirement
CIDM	Z_{RF}	$100 \Omega \pm 5 \%$ (at 500 ps rise time)
Propagation Delay	t_d	For use in SCC with maximum length of 15 m $\leq 6 \text{ ns/m}$ For use in SCC with maximum length of 10 m $\leq 9 \text{ ns/m}$ $2 \leq f \leq 600$, frequency f in MHz
IL	S_{dd21}	For use in SCC with maximum length of 15 m $\leq \frac{1}{15} \left(0.0023f + 0.5907\sqrt{f} - 6 * 0.01\sqrt{f} + \frac{0.0639}{\sqrt{f}} \right) \text{ dB/m}$ For use in SCC with maximum length of 10 m $\leq \frac{1}{10} \left(0.0023f + 0.5907\sqrt{f} - 6 * 0.01\sqrt{f} + \frac{0.0639}{\sqrt{f}} \right) \text{ dB/m}$ $1 \leq f \leq 600$, frequency f in MHz
RL	S_{dd11}, S_{dd22}	$\geq \begin{pmatrix} 22 & 1 \leq f < 10 \\ 27 - 5 \log f & 10 \leq f < 40 \\ 19 & 40 \leq f < 130 \\ 40 - 10 \log f & 130 \leq f < 400 \\ 14 & 400 \leq f \leq 600 \end{pmatrix} \text{ dB}$ $1 \leq f \leq 600$, frequency f in MHz
LCL	S_{dc11}, S_{dc22} class 1	$\geq \begin{pmatrix} 50 & 10 \leq f \leq 50 \\ 81.5 - 18.53 \log(f) & 50 < f \leq 600 \end{pmatrix} \text{ dB}$ $10 \leq f \leq 600$, frequency f in MHz
	S_{dc11}, S_{dc22} class 2	No requirement
LCTL	S_{dc21}, S_{dc12} class 1	$\geq \begin{pmatrix} 46 & 10 \leq f \leq 50 \\ 71.2 - 14.83 \log(f) & 50 < f \leq 600 \end{pmatrix} \text{ dB}$ $10 \leq f \leq 600$, frequency f in MHz
	S_{dc21}, S_{dc12} class 2	No requirement

Test parameter	Symbol	Requirement
Coupling attenuation	$a_{c \text{ class1}}$	$\geq 70 \text{ dB}$
	$a_{c \text{ class2}}$	$30 \leq f \leq 600$, frequency f in MHz
Screening attenuation	$a_{s \text{ class1}}$	$\geq 35 \text{ dB}$ $30 \leq f \leq 600$, frequency f in MHz
	$a_{s \text{ class2}}$	$\geq 45 \text{ dB}$ $30 \leq f \leq 600$, frequency f in MHz

6. DELIVERY CONDITIONS

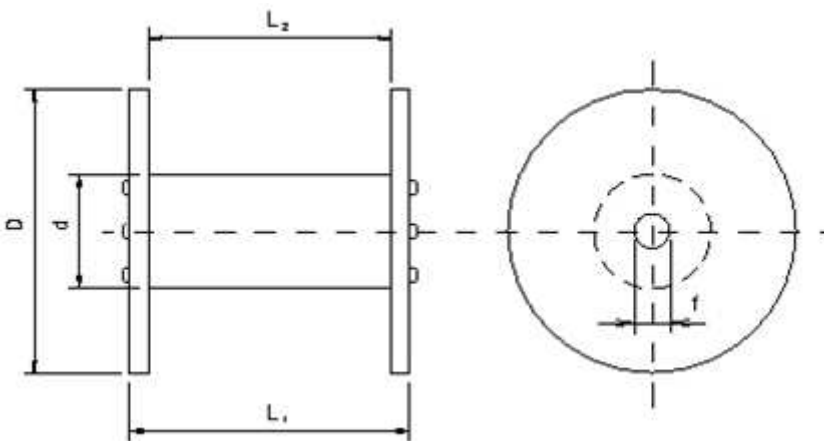
6.1 Splice

- Maximum 3 cable segments each coil allowed
- Min. 100m length of segment

6.2 Marking

- Print on cable jacket in continuously order every 200mm

7. PACKAGEING:



- $d=400\text{mm}$
- $D=800\text{mm}$ should be defined by the cable supplier. Memory effect on the cable has to be avoided.
- $L_1=510\text{mm}$
- $L_2=400\text{mm}$
- $f=56/80/83\text{ mm}$
- max. weight: 300kg

8. GLOSSARY

9. HISTORIE:

Revision	Change	Date
A	First release	30.08.2016
B	4.3 Cable Dimension - Jacket Diameter split into UTP and STP - UTP Jacket Diameter changed into 4.0mm	11.10.2016
C	LCL requirements for STP 1GBps added	07.05.2018
D	Chapter 3 - Delete 3.3 Chapter 4 – missing requirement added Chapter 5 – Update of RF requirements Final Release	27.01.2021