

Lightning protection — Telecommunication lines —

Part 2: Lines using metallic conductors

The European Standard EN 61663-2:2001 has the status of a British Standard

ICS 29.020; 33.040; 91.120.40

National foreword

This British Standard is the official English language version of EN 61663-2:2001. It is identical with IEC 61663-2:2001.

The UK participation in its preparation was entrusted to Technical Committee GEL/81, Protection against lightning, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
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Part 2: Lines using metallic conductors
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Protection contre la foudre -
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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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Foreword

The text of document 81/164/FDIS, future edition 1 of IEC 61663-2, prepared by IEC TC 81, Lightning protection, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61663-2 on 2001-05-01.

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- latest date by which the EN has to be implemented
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- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2002-05-01

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annexes A, B, C and ZA are normative and annexes D, E, F, G and H are informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61663-2:2001 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

Lightning protection of telecommunication lines using metallic conductors concerns protection against overvoltages and overcurrents on such lines due to lightning. Overvoltages and overcurrents are characterized by parameters such as peak value, front time, time to half-value and specific energy. Parameters of expected overvoltages and overcurrents consist of highly varying values, statistically distributed, which also depend on several factors, for example, location and line characteristics.

Therefore a lightning protection method for telecommunication lines, in accordance with this standard, cannot guarantee absolute protection to the line and connected equipment; however, application of this standard will significantly reduce the risk of damage caused by lightning to the line and connected equipment.

The procedure for the application of this standard is given in annex A.

LIGHTNING PROTECTION – TELECOMMUNICATION LINES –

Part 2: Lines using metallic conductors

1 Scope and object

This part of IEC 61663 deals with protection against lightning of outdoor telecommunication lines using metallic conductors (for example, access networks, lines between buildings).

These lines concern:

- telecommunication lines connecting a switch with a network termination (NT1);
- telecommunication or signal lines connecting equipment located in different buildings, e.g. ISDN lines or signal lines between computers.

NOTE In this standard, such lines are called "telecommunication lines".

The object of this standard is to protect telecommunication lines and connected equipment against the direct and indirect influence of lightning by limiting the risk of damage due to overvoltages and overcurrents, liable to occur in these lines, to values which are lower than or equal to the tolerable risk of damage. For more details, see annex A.

The type of building can also have an effect on the risk assessment of lightning damage to telecommunication lines, as well as the physical layout of the equipment installation. However, these and other similar aspects are covered by appropriate specific standards and are beyond the scope of this standard.

Fibre optical cable with metallic pairs in the cable core must be protected, following the requirements of this standard, together with those requirements defined in IEC 61663-1.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61663. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 61663 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

IEC 60364-4-443:1995, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 44: Protection against overvoltages – Section 443: Protection against overvoltages of atmospheric origin or due to switching*

IEC 61024-1-1:1993, *Protection of structures against lightning – Part 1: General principles – Section 1: Guide A: Selection of protection levels for lightning protection systems*

IEC 61312-1:1995, *Protection against lightning electromagnetic impulse – Part 1: General principles*

IEC 61662/TR:1995, *Assessment of the risk of damage due to lightning*

IEC 61663-1:1999, *Lightning protection – Telecommunication lines – Part 1: Fibre optics installations*

ITU-T Recommendation K.12:1995, *Characteristics of gas discharge tubes for the protection of telecommunications installations*

ITU-T Recommendation K.20:1996, *Resistibility of telecommunication switching equipment to overvoltages and overcurrents*

ITU-T Recommendation K.21:1996, *Resistibility of subscriber's terminal to overvoltages and overcurrents*

ITU-T Recommendation K.22:1995, *Overvoltage resistibility of equipment connected to an ISDN T/S bus*

ITU-T Recommendation K.27:1996, *Bonding configurations and earthing inside a telecommunication building*

ITU-T Recommendation K.28:1993, *Characteristics of semiconductor arrester assemblies for the protection of telecommunications installations*

ITU-T Recommendation K.31:1993, *Bonding configurations and earthing of telecommunication installations inside a subscriber's building*

EN 50310:1998, *Application of equipotential bonding and earthing at premises with information technology equipment*

3 Definitions

For the purpose of this part of IEC 61663, the following definitions apply.

3.1

expected loss per damage δ

relative amount of expected service loss per damage δ caused by lightning to telecommunication line

3.2

expected loss per damage caused by direct lightning to aerial line δ_a

relative amount of expected service loss per damage δ_a caused by direct lightning to aerial telecommunication line

3.3

expected loss per damage caused by direct lightning to buried line δ_b

relative amount of expected service loss per damage δ_b caused by direct lightning to buried telecommunication line

3.4

expected loss per damage caused by indirect lightning to telecommunication line δ_{pi}

relative amount of expected service loss per damage δ_{pi} caused by indirect lightning to telecommunication line

3.5

expected loss per damage caused by direct lightning to exposed structure δ_{ps}

relative amount of expected service loss per damage δ_{ps} caused by direct lightning to exposed structure where telecommunication line enters

3.6

equipotential bonding bar EBB

electrically conductive bar whose electric potential is used as common reference, and to which metal installation, extraneous conductive parts, electrical power and telecommunication lines and other cables can be bonded (see 3.19 of IEC 61663-1)

3.7

tolerable frequency of damage F_a

maximum value of expected average annual frequency of damage to a telecommunication line due to direct and indirect lightning flashes not requiring additional protective means

3.8

frequency of damage F_p

average annual occurrences of expected damage to the telecommunication line due to lightning

NOTE The inverse of F_p yields the mean time between occurrences of damage in years.

3.9

frequency of damage caused by direct lightning to aerial line F_{pa}

average annual occurrences of expected damage to aerial telecommunication line caused by direct lightning

3.10

frequency of damage caused by direct lightning to buried line F_{pb}

average annual occurrences of expected damage to buried telecommunication line caused by direct lightning

3.11

frequency of damage caused by indirect lightning to telecommunication line F_{pi}

average annual occurrences of expected damage to telecommunication line caused by indirect lightning

3.12

frequency of damage caused by direct lightning to exposed structure F_{ps}

average annual occurrences of expected damage caused by direct lightning to exposed structure where telecommunication line enters

3.13**direct lightning current I**

peak value of the lightning current striking the structure, which causes a sheath breakdown, current I_s or a failure wire current I_c in shielded or unshielded cable, respectively

3.14**failure current I_a**

minimum peak value of the lightning current giving rise to a direct arc to or from the cable and causing damage

3.15**failure wire current I_c**

current flowing in the metallic wire of the telecommunication cable which causes damage to the cable

3.16**sheath breakdown current I_s**

current flowing in the metallic sheath of the telecommunication cable which causes breakdown voltage between metallic conductors inside the cable core and the metallic sheath

3.17**damage correction factor K_d**

factor which allows a conservative evaluation of the frequency of damage

NOTE The derivation of factor K_d is explained in annex E of IEC 61663-1.

3.18**environmental factor K_e**

factor which takes into account protective and shielding properties of the area where the line section is installed to the direct and indirect lightning effects on the line section itself

3.19**installation factor K_i**

factor which takes into account the installation conditions, i.e. above (aerial) or below (buried) ground, of line section

3.20**protection factor K_p**

factor taking into account the effect of protection means

3.21**shielding factor K_{si}**

factor which characterizes the cable-shielding characteristics of each line section

3.22**conventional line-section length L_{ci}**

product between the environmental factor K_{ei} of the area where the i^{th} line section is installed, the shielding factor K_{si} , the installation factor K_{ii} and the length L_i of the i^{th} line section

$$L_{ci} = K_{ei} \times K_{si} \times K_{ii} \times L_i$$

3.23

conventional transition point length L_{CT}

sum of several conventional line-section lengths constituting the telecommunication line or the two parts of the telecommunication line related to the considered transition point

3.24

line termination LT

physical interface used to terminate outdoor telecommunication lines

3.25

direct lightning flash frequency N_d

expected average annual number of direct lightning flashes to the telecommunication line or to the structure in which the telecommunication line ends

3.26

ground flash density N_g

average ground lightning density expressed in flashes per square kilometre per year, concerning the region where the structure or the telecommunication line is located (IEC 61024-1-1)

3.27

tolerable risk of damage R_a

maximum level of risk of damage (see 3.28) due to direct and indirect lightning not requiring additional protective means

3.28

risk of damage R_p

expected annual loss of service to the telecommunication line due to direct and indirect lightning

3.29

risk of damage caused by direct lightning to aerial line R_{pa}

probable average annual loss of service caused by direct lightning to aerial telecommunication line

3.30

risk of damage caused by direct lightning to buried line R_{pb}

probable average annual loss of service caused by direct lightning to buried telecommunication line

3.31

risk of damage caused by indirect lightning to telecommunication line R_{pi}

probable average annual loss of service caused by indirect lightning to telecommunication line

3.32

risk of damage caused by direct lightning to exposed structure R_{ps}

probable average annual loss of service caused by direct lightning to exposed structure where the telecommunication line enters

3.33

surge protective device SPD

device that is intended to limit transient overvoltages and divert surge currents. It contains at least one non-linear component

3.34**transition points T**

points at the interface between

a) external line and building or volume

T_E : transition point between switch building and telecommunication line;

T_S : transition point between customer's building and telecommunication line;

b) cables with different resistibility and/or buried and aerial cables

T_1 : transition point between buried cable with paper-insulated conductors and buried cable with plastic-insulated conductors;

T_{2a} : transition point between buried cable with paper-insulated conductors and aerial cable with plastic-insulated conductors;

T_{2p} : transition point between buried cable and aerial cable both with plastic-insulated conductors;

c) shielded and unshielded cables

T_3 : transition point between shielded (buried or aerial) and unshielded (buried or aerial) cable;

d) line and equipment in the network

T_M : transition point between the telecommunication line and the equipment in the network;

e) different environments

T_0 : transition point between two adjacent sections with the same shielding and installation factors but different environment factors.

3.35**thunderstorm days T_d**

number of thunderstorm days per year obtained from isokeraunic maps (see IEC 61024-1-1)

3.36**breakdown voltage U_b**

impulse breakdown voltage between metallic conductors inside the cable core and the metallic sheath of the telecommunication cable

3.37**damage**

damage on the telecommunication line to the cable, such as perforation of the insulation or melting of conductors, and/or damage to the equipment connected to the line which causes interruption or degradation of service below acceptable limits

3.38**environment**

urban or rural area where the telecommunication line is installed

3.39**exposed structure**

structure, for example, telecommunication tower or high building, which needs to be protected against direct lightning, as required by IEC 61024-1-1

3.40**indirect influences**

overvoltages and overcurrents in the telecommunication line resulting from indirect lightning

3.41

indirect lightning

lightning which does not strike the telecommunication line but may cause an indirect influence to the telecommunication line by electromagnetic and/or resistive coupling

3.42

line section

part of the telecommunication line between two adjacent transition points characterized by the same shielding factor K_{si} , installation factor K_{ij} , environmental factor K_{ei} , and cable resistibility

3.43

lightning protective cables

special cable with increased dielectric strength and whose metallic sheath is in continuous contact with the soil either directly or by the use of conducting plastic covering

3.44

lightning protective cable ducts

cable duct of low resistivity in contact with the soil (for example, concrete with interconnected structural steel reinforcements or metallic duct)

3.45

resistibility

ability of an equipment to withstand an overvoltage/overcurrent without damage

NOTE The equipment can lose some function during the overvoltage/overcurrent but works correctly after the application of the overvoltage/overcurrent.

3.46

rural area

area located outside of densely populated communities

NOTE In densely populated communities, plenty of metallic lines and pipes are located in the neighbourhood of the telecommunication network. A rural area is considered as an exposed environment.

3.47

shielded cable

cable with continuous metallic shield jointed across all splices

3.48

telecommunication line

transmission medium intended for communication between equipment that may be located in separate buildings

3.49

telecommunication switch

system for switching telecommunication services using electrical/electronic components

3.50

urban area

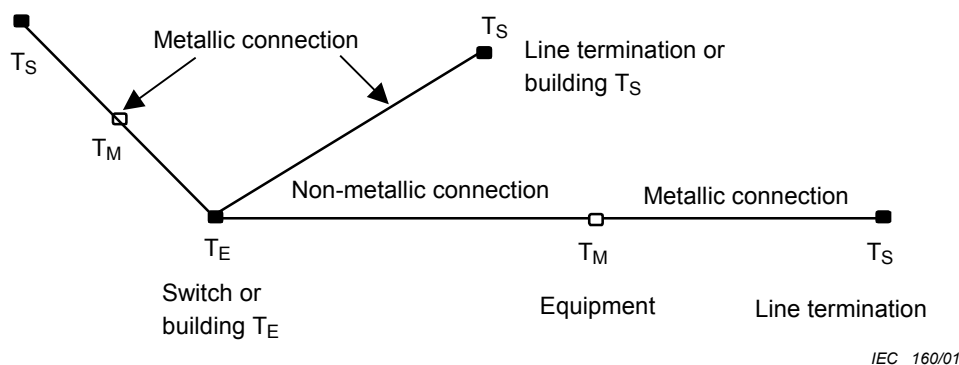
area of densely populated communities where plenty of metallic lines and pipes are located in the neighbourhood of the telecommunication network

4 Reference configuration

The telecommunication line can be constituted of several different line sections, which can make use of

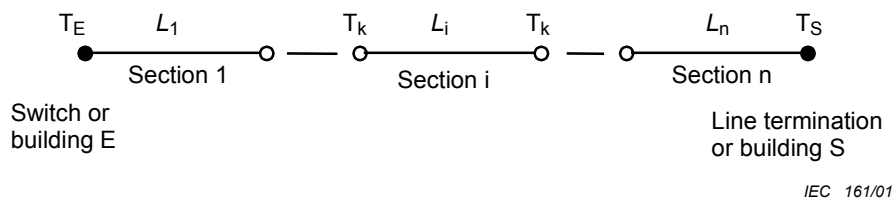
- buried or aerial cable;
- shielded or unshielded cable;
- cable with paper- or plastic-insulated conductors.

Figure 1 shows the reference configurations for the telecommunication line (see also figures 2 and 3).



Equipment: for example multiplexor, optical network unit ONU

Figure 1a – Connections between telecommunication switch and line termination or between equipment in different buildings



- NOTE 1 Point T_E and points T_k ($k = 1-4$), T_M and T_S are the transition points (see 3.34).
 NOTE 2 L_i is the length of the i^{th} line section.

Figure 1b – Line sections

Figure 1 – Reference configurations

An example of a reference configuration is shown in figure 2.

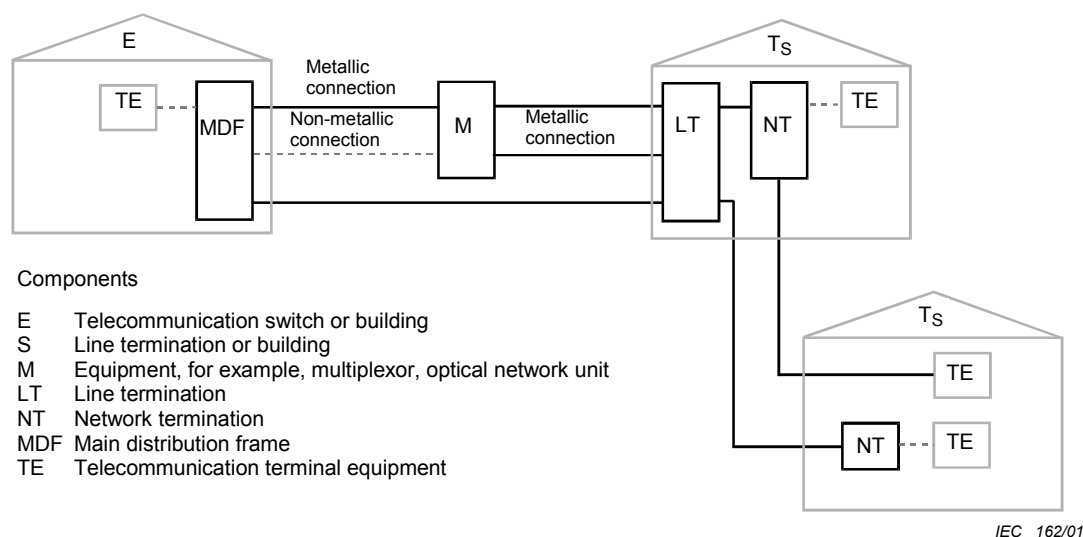


Figure 2 – Example of a reference configuration

5 Environmental factor K_e , installation factor K_i , shielding factor K_s and conventional transition point length L_{cT}

5.1 Environmental factor K_e

This standard assumes that the telecommunication line is composed of one or more line sections (see figure 3).

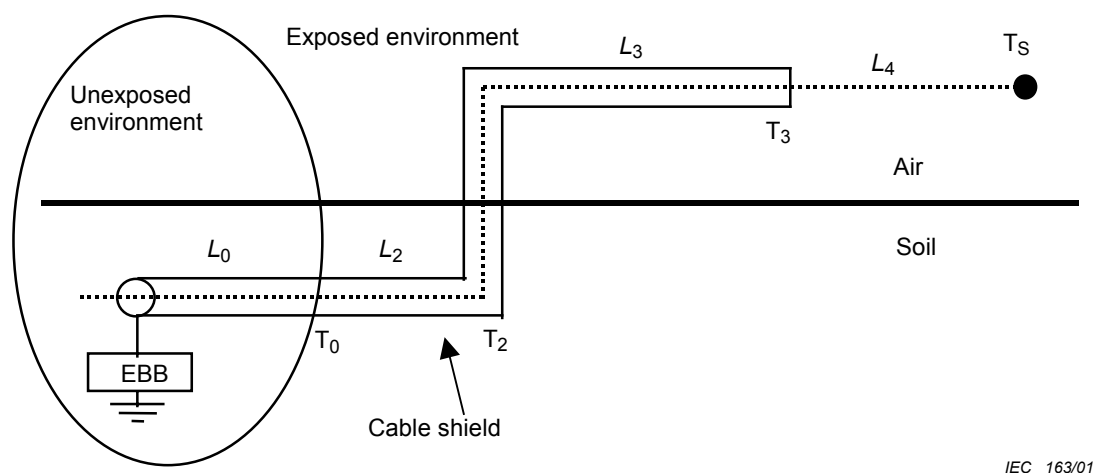


Figure 3 – Telecommunication line sections with buried shielded cable in an unexposed and exposed environment, aerial shielded and unshielded cable in an exposed environment

NOTE The point T_0 shown in figures 3 and 4, represents the transition point between two adjacent sections, with the same shielding and installation factors but with different environment factors. This standard does not require evaluation of the protection need of point T_0 .

Each section is installed in a defined area and has a specific installation condition. The area where the line section is installed is characterized by the following environmental factor K_e :

- $K_e = 0$ for an unexposed area;
- $K_e = 1$ for an exposed area.

The network operator or the owner of the installation shall evaluate if the line is installed in an unexposed or exposed area. If this evaluation cannot be carried out, this standard suggests that an urban area can be considered as unexposed environment and a rural area as exposed environment.

NOTE An experimental method to evaluate K_e is given in annex F.

5.2 Installation factor K_i

The i^{th} line section is characterized by the installation factor values K_{ij} for aerial or buried section, independently of the shielding characteristics of the cable.

The installation factor values are shown in table 1.

Table 1 – Installation factors

Installation condition	K_{ij}
Aerial	1
Buried	0,5

5.3 Shielding factor K_s

The use of shielded cables instead of unshielded cable is a means to improve the shielding factor of the different line sections.

The intrinsic shielding factor values, as a function of the d.c. shield resistance per unit length, can be calculated with the following equation:

$$K_s = \frac{1}{\left(1 + \frac{46}{r}\right)} \quad (1)$$

where

r is the d.c. shield resistance per unit length.

Table 2 shows typical measured values of intrinsic shielding factors.

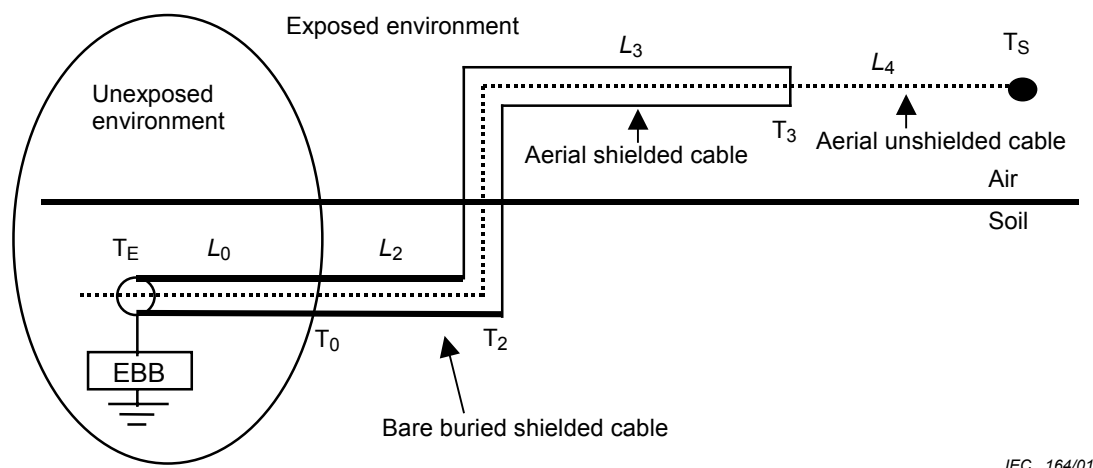
Table 2 – Typical measured values of intrinsic shielding factors of shielded cables

Cable characteristics	K_{si}
Shielded communication cables with d.c. resistance equal to 20 Ω/km	0,3
Shielded communication cables with d.c. resistance equal to 5 Ω/km	0,1
Shielded communication cables with d.c. resistance equal to 1 Ω/km	0,02

These values represent intrinsic shielding factors and shall only be used in the following cases (see figure 4):

- at the point in the telecommunication line where protection is considered, the telecommunication line being shielded;
- or
- the shield is in continuous contact with the soil (for example, bare buried cable or cable with conducting plastic covering).

In the other cases, the cables shall always be considered as unshielded ($K_{Si} = 1$) if, at the point where the protection need is considered, the telecommunication line is unshielded. In these cases, the shielding factor of the shielded line sections can have a value less than 1 only if the shield is connected to earth at least at both ends. In this case, the shielding factor value is also a function of the earthing resistance of the connections to earth of the shield. An approximated value of the effective shielding factor K_{Se} is 0,5 when the earthing resistance value of the connections to earth of the shield is some tens of ohms.



IEC 164/01

Point	K_{Si} values			
	Section 0 ^a	Section 2	Section 3	Section 4
r [Ω/km]	Not relevant	1	5	–
T_E, T_2	Not relevant	0,02	0,1	1
T_3	Not relevant	0,02	0,1	1
T_S	Not relevant	0,02	1	1
^a Buried shielded cable in unexposed environment ($K_{e0} = 0$)				

Figure 4 – Examples of shielding factor values in a practical case

5.4 Conventional transition point length L_{cT}

Each section has a conventional length L_{ci} which is defined by the product between the environmental factor K_{ei} of the area where the i^{th} line section is installed, the shielding factor K_{Si} , the installation factor K_{ij} and the length L_i of the i^{th} line section:

$$L_{ci} = K_{ei} \times K_{Si} \times K_{ij} \times L_i \quad (2)$$

This standard requires that the conventional length be calculated as seen from each of the transition points of the telecommunication line.

The value of the shielding factor of each line section depends on the shielding characteristic of the considered transition point and on the earth connection of the shield (see 5.3).