SLOVENSKI STANDARD
SIST IEC 61663-1:2000

01-april-2000

Lightning protection - Telecommunication lines - Part 1: Fibre optic installations

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Protection contre la foudre - Lignes de télécommunication - Partie 1: Installations ŕ fibres optiques

Ta slovenski standard je istoveten z: **IEC 61663-1 Ed. 1.0**

ICS:

33.040.50	Vodi, zveze in tokokrogi	Lines, connections and circuits
91.120.40	Zaščita pred strelo	Lightning protection

SIST IEC 61663-1:2000 **en**

NORME INTERNATIONALE

INTERNATIONAL STANDARD

CEI
IEC
61663-1

Première édition
First edition
1999-07

Protection contre la foudre – Lignes de télécommunication –

Partie 1: Installations à fibres optiques

Lightning protection – Telecommunication lines –

Part 1: Fibre optic installations

International Electrotechnical Commission
3, rue de Varembé Geneva, Switzerland
Telefax: +41 22 919 0300
e-mail: inmail@iec.ch
IEC web site http://www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE V

Pour prix, voir catalogue en vigueur
For price, see current catalogue

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61663-1 has been prepared by IEC technical committee 81: Lightning protection.

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

FDIS	Report on voting
81/136/FDIS	81/142/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.

Annexes A, B, C, D and G form an integral part of this standard.

Annexes E, F, H and I are for information only.

LIGHTNING PROTECTION – TELECOMMUNICATION LINES –

Part 1: Fibre optic installations

1 Scope and object

This part of IEC 61663 concerns the lightning protection of telecommunication lines in fibre optic installations.

Its object is to limit the number of possible primary failures occurring in the optical fibre cable in a specified installation to within values which are lower than or equal to the limit value, defined as the tolerable frequency of primary failures.

Consequently this standard points out the method for calculating the possible number of primary failures, choosing the feasible protective measures and indicating the tolerable frequency of primary failures.

Secondary failures are not considered in this standard.

The tests described in annex G of this standard are convenient only for the risk evaluation associated with lightning in fibre optic installations. Tests for the qualification of a cable design are outside the scope of this standard.

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 IEC and ISO maintain registers of currently valid International Standards.

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

IEC 61024-1:1990, *Protection of structure against lightning – Part 1: General principles*

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*

ITU Lightning Handbook: *The protection of telecommunication lines and equipment against lightning discharges, ITU, 1974, 1978 and 1995*

3 Definitions

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

3.1
primary failures
primary failures on the optical fibre cable are those which cause the interruption of service due to breakage of one or more optical fibres, an unacceptable increase in attenuation of the optical fibre, or an interruption in the remote power supply in the equipment if powered by metallic conductors inside the optical cable.

Primary failures are also those that damage the cable, such as destruction of the protective covering, moisture barrier, interconnecting elements and protective jelly, which, due to other mechanisms acting on the damage, lead to an unacceptable increase in attenuation of the optical fibre

3.2
secondary failures
secondary failures on the optical fibre cable are those that damage the cable, such as the puncturing of the plastic protective covering (pinholing), but do not cause primary failures

3.3
frequency of primary failures (F_p)
average annual number of expected primary failures in an optical fibre installation due to direct lightning flashes. The inverse of the F_p due to lightning will yield the mean time between primary failure in years

3.4
risk of primary failures (R_d)
probable average annual loss of function in the optical fibre installation due to direct lightning flashes

3.5
tolerable frequency of primary failures (F_a)
maximum value of expected average annual frequency of primary failures in an optical fibre installation due to direct lightning flashes not requiring additional protective means due to direct lightning flashes

3.6
tolerable risk of primary failures (R_a)
maximum level of the risk of primary failures, R_d, due to direct lightning flashes, not requiring additional protective means

3.7
direct lightning flash
lightning flash to aerial cable or to the ground surface within the equivalent arcing distance, D, from buried cable

3.8
direct lightning flash frequency (N_d)
expected average annual number of direct lightning flashes to an optical fibre installation

3.9
equivalent arcing distance (D)
average distance from buried cable at which a lightning flash can arc to the cable

3.10
failure current (I_a)
minimum peak value of the lightning current giving rise to a direct arc on the cable and causing primary failures

3.11
sheath breakdown current (I_s)
current flowing in the metallic sheath which causes breakdown voltages between metallic elements inside the cable core and the metallic sheath, thus leading to primary failures

3.12
connection current (I_c)
minimum current value causing primary failures (see 3.1), evaluated with the test for surge current resistibility of the interconnecting elements (see G.3)

3.13
interconnecting elements
metallic elements connecting metallic parts of optical fibre cable at joints and cable ends

3.14
test current (I_t)
current causing primary failures which is evaluated with the test for surge current resistibility shown in G.3 for interconnecting elements and in G.4 or G.5 for buried or aerial cables respectively

3.15
impulse current (I_p)
current to be used in the test for surge current resistibility of optical fibre cables. The test generator of this current is under consideration [2]*

NOTE – Test currents used in certain countries include the following:

– double exponential waveform current with a rise time of 10 µs and a time to half value of 350 µs (10/350 µs waveform);

– damped oscillatory current with a maximum time-to-peak value of 15 µs and a maximum frequency of 30 kHz. The time to half value of its waveform envelope shall be 40 µs to 70 µs. These values apply to the waveforms measured with the test sample in place.

3.16
breakdown voltage (U_b)
impulse breakdown voltage between metallic elements inside the cable core and the metallic sheath of the optical cable

* Figures in square brackets refer to the bibliography given in annex I.

3.17
damage correction factor (K_d)
factor which allows a conservative evaluation of the frequency of primary failures

NOTE – The derivation of factor K_d is explained in annex E.

3.18
surge protective device (SPD)
device that is intended to limit transient overvoltages and divert surge currents. It contains at least one non-linear component

3.19
equipotential bonding bar (EBB)
an 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 IEC 61024-1)

3.20
direct lightning current to aerial cables (J)
the minimum lightning current which strikes an aerial cable causing a flashover to ground

3.21
exposed structure
a structure, e.g. telecommunication tower, high building, which needs to be protected against direct lightning strokes, as required by IEC 61024-1-1

3.22
thunderstorm days (T_d)
number of thunderstorm days per year obtained from isokeraunic maps (see IEC 61024-1-1)

3.23
ground flash density (N_g)
average ground flash density expressed in flashes per square kilometre per year, concerning the region where the structure or the optical fibre cable is located

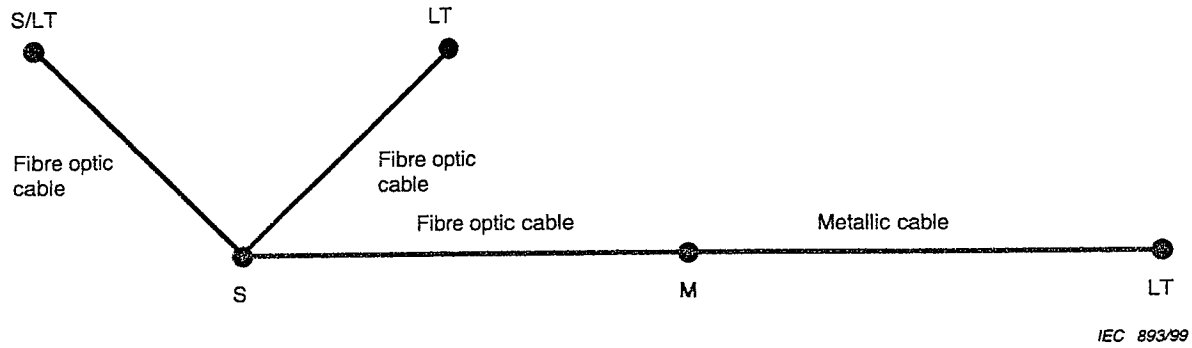
3.24
lightning collection area
an area of ground surface which has the same annual frequency of direct lightning as the structure or the line

3.25
stroke diversion factor
for an isolated structure or line, the lightning collection area is the area enclosed within the border line obtained from the interception between the ground surface and a straight line with 1/3 slope which passes from the upper parts of the structure or line (touching it there) and rotating around it. The number 3, which is the reverse of the slope number, is the stroke diversion factor (see IEC 61024-1-1)

3.26
telecommunication line or network
a transmission medium intended for communication between equipment that may be located in separate buildings

4 Reference configuration

Figure 1 represents the reference configuration for optical fibre installations, where the connections with optical fibre cables between two switches, between switch and line termination, and between switch and line equipment are shown.



S switch

M equipment

LT line termination

Equipment: e.g. multiplexor, optical network unit

Figure 1 – Reference configuration

NOTE – For the requirements on protection against lightning of the metallic cable installation between equipment and subscriber, see [1].

5 Construction characteristics of the cable

5.1 General

This standard applies to the following types of optical fibre cables:

- type A: cable with dielectric core but having no metal elements (dielectric, or metal-free cable);
- type B: cable with dielectric core and metal sheath or sheaths: there are no metal elements in the core of the cable which has a metal sheath (for example the moisture barrier) or a metallic supporting wire;
- type C: cable with metal elements in the core and with a metal sheath or sheaths: there are metal elements, such as conductors or strength members, in the core of the cable which has one or more metal sheaths;
- type D: cable with metal elements in the core and without a metal sheath.

For cable types B, C and D, the possible value of failure current, I_a, shall be evaluated.

5.2 Failure current for buried cables

The failure current, I_a, is the lower value of the following values (figure 2) (see H.1):

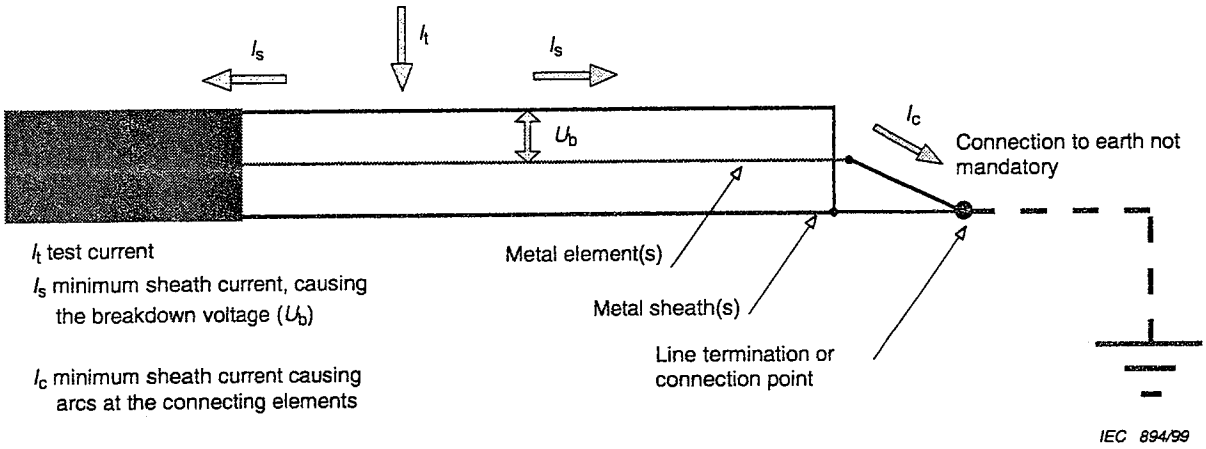


Figure 2 – Currents in a cable test sample

– twice the connection current, I_c, evaluated with the test for surge current resistibility of the interconnecting elements (see G.3);

– the test current, I_t, evaluated with the type test for surge current resistibility for buried cables shown in G.4;

– twice the sheath breakdown current, I_s, flowing in the cable sheath, which causes breakdown voltage between metallic elements inside the cable core and the metallic sheath with or without insulating plastic covering. This current, I_s, is calculated using equation (B.1).

Then

$$I_a = I_t \quad \text{if} \quad I_t < 2I_s;\ I_t < 2I_c \tag{1}$$

or

$$I_a = 2I_s \quad \text{if} \quad I_t > 2I_s;\ I_s < I_c \tag{2}$$

or

$$I_a = 2I_c \quad \text{if} \quad I_t > 2I_c;\ I_c < I_s \tag{3}$$

5.3 Failure current for aerial cables

The failure current, I_a, is the lower value of the following values (figure 2) (see H.2):

– twice the connector current, I_c, evaluated with the test for surge current resistibility of the interconnecting elements (see G.3);

– the test current, I_t, evaluated with the type test for surge current resistibility for aerial cables shown in G.5.

a) Aerial cable without earth connections of the metal sheath

– The direct lightning current, J, (see 3.20), which strikes the aerial cable and causes a flashover to ground. This lightning current, J, is estimated using equation (B.3).

Then

$$I_a = I_t \quad \text{if} \quad I_t < J;\ I_t < 2I_c \tag{4}$$

or

$$I_a = J \quad \text{if} \quad I_t > J;\ J < I_c \tag{5}$$

or

$$I_a = 2I_c \quad \text{if} \quad I_t > 2I_c;\ 2I_c < J \tag{6}$$

b) Aerial cable with earth connections of the metal sheath

– Twice the breakdown sheath current, I_s, which, in this case, may be estimated using equation (B.4).

Then

$$I_a = I_t \quad \text{if} \quad I_t < 2I_s;\ I_t < 2I_c \tag{7}$$

or

$$I_a = 2I_s \quad \text{if} \quad I_t > 2I_s;\ I_s < I_c \tag{8}$$

or

$$I_a = 2I_c \quad \text{if} \quad I_t > 2I_c;\ I_c < I_s \tag{9}$$

For cables without metallic elements inside the cable core or for cables with more than one metal sheath, the current I_s shall not be evaluated.

6 Need for protection

The need for lightning protection of an optical fibre installation depends on the frequency of primary failures, F_p, and its accepted frequency of primary failures, F_a.

The frequency of primary failures, F_p, is given by the following equation:

$$F_p = F_{pb} + F_{pa} + F_{ps} \tag{10}$$

where

F_{pb} is the frequency of primary failures to buried cables;

F_{pa} is the frequency of primary failures to aerial cables;

F_{ps} is the frequency of primary failures due to direct lightning strokes to exposed structure that the optical fibre cable enters.

The frequency of primary failures, F_p, is estimated by using annex A, in particular equation (A.6) for F_{pb}, equation (A.9) for F_{pa} and equation (A.10) for F_{ps}.

If the frequency of primary failures, F_p, is higher than the tolerable frequency of primary failures, F_a, protective measures are necessary to reduce F_p and minimise the risk of primary failures, R_d.

The risk of primary failures is estimated with the following equation (see annex F) (see IEC 61662):

$$R_d = F_p \times \delta \tag{11}$$

where δ is the relative amount of the expected losses per primary failures and the frequency of primary failures, F_p, is given by the equation (10).