SLOVENSKI STANDARD
SIST EN 60909-3:2010

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Nadomešča:
SIST EN 60909-3:2004

Kratkostični toki v trofaznih izmeničnih sistemih - 3. del Toki med dvema ločenima sočasnima kratkima stikoma linijski-ozemljitveni vodnik in delnim kratkostičnim tokom, ki teče skozi ozemljitev (IEC 60909-3:2009))

Short-circuit currents in three-phase a.c systems - Part 3: Currents during two separate simultaneous line-to-earth short-circuits and partial short-circuit currents flowing through earth (IEC 60909-3:2009)

Kurzschlussströme in Drehstromnetzen - Teil 3: Ströme bei Doppelerdkurzschluss und Teilkurzschlussströme über Erde (IEC 60909-3:2009)

Courants de court-circuit dans les réseaux triphasés à courant alternatif - Partie 3: Courants durant deux court-circuits monophasés simultanés séparés à la terre et courants de court-circuit partiels s'écoulant à travers la terre (CEI 60909-3:2009)

Ta slovenski standard je istoveten z: **EN 60909-3:2010**

ICS:

17.220.01	Elektrika. Magnetizem. Splošni vidiki	Electricity. Magnetism. General aspects
29.240.20	Daljnovodi	Power transmission and distribution lines

SIST EN 60909-3:2010 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60909-3

March 2010

ICS 17.220.01; 29.240.20

Supersedes EN 60909-3:2003

English version

Short-circuit currents in three-phase a.c systems - Part 3: Currents during two separate simultaneous line-to-earth short-circuits and partial short-circuit currents flowing through earth (IEC 60909-3:2009)

Courants de court-circuit dans les réseaux triphasés à courant alternatif - Partie 3: Courants durant deux courts-circuits monophasés simultanés séparés à la terre et courants de court-circuit partiels s'écoulant à travers la terre (CEI 60909-3:2009)

Kurzschlussströme in Drehstromnetzen - Teil 3: Ströme bei Doppelerdkurzschluss und Teilkurzschlussströme über Erde (IEC 60909-3:2009)

This European Standard was approved by CENELEC on 2010-03-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: Avenue Marnix 17, B - 1000 Brussels

Ref. No. EN 60909-3:2010 E

Foreword

The text of document 73/148/FDIS, future edition 3 of IEC 60909-3, prepared by IEC TC 73, Short-circuit currents, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60909-3 on 2010-03-01.

This standard is to be used in conjunction with EN 60909-0:2001.

This European Standard supersedes EN 60909-3:2003.

The main changes with respect to EN 60909-3:2003 are listed below:

– New procedures are introduced for the calculation of reduction factors of the sheaths or shields and in addition the current distribution through earth and the sheaths or shields of three-core cables or of three single-core cables with metallic non-magnetic sheaths or shields earthed at both ends;

– The information for the calculation of the reduction factor of overhead lines with earth wires are corrected and given in the new Clause 7;

– A new Clause 8 is introduced for the calculation of current distribution and reduction factor of three-core cables with metallic sheath or shield earthed at both ends;

– The new Annexes C and D provide examples for the calculation of reduction factors and current distribution in case of cables with metallic sheath and shield earthed at both ends.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2010-12-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2013-03-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60909-3:2009 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60909-0	2001	Short-circuit currents in three-phase a.c. systems - Part 0: Calculation of currents	EN 60909-0	2001
IEC/TR 60909-2	2008	Short-circuit currents in three-phase a.c. systems - Part 2: Data of electrical equipment for short-circuit current calculations	-	-

IEC 60909-3

Edition 3.0 2009-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Short-circuit currents in three-phase AC systems – Part 3: Currents during two separate simultaneous line-to-earth short circuits and partial short-circuit currents flowing through earth

Courants de court-circuit dans les réseaux triphasés à courant alternatif – Partie 3: Courants durant deux courts-circuits monophasés simultanés séparés à la terre et courants de court-circuit partiels s'écoulant à travers la terre

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SHORT-CIRCUIT CURRENTS IN THREE-PHASE AC SYSTEMS –

Part 3: Currents during two separate simultaneous line-to-earth short circuits and partial short-circuit currents flowing through earth

FOREWORD

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International Standard IEC 60909-3 has been prepared by IEC technical committee 73: Short-circuit currents.

This International Standard is to be read in conjunction with IEC 60909-0.

This third edition cancels and replaces the second edition published in 2003. This edition constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

– New procedures are introduced for the calculation of reduction factors of the sheaths or shields and in addition the current distribution through earth and the sheaths or shields of three-core cables or of three single-core cables with metallic non-magnetic sheaths or shields earthed at both ends;

– The information for the calculation of the reduction factor of overhead lines with earth wires are corrected and given in the new Clause 7;

- A new Clause 8 is introduced for the calculation of current distribution and reduction factor of three-core cables with metallic sheath or shield earthed at both ends;
- The new Annexes C and D provide examples for the calculation of reduction factors and current distribution in case of cables with metallic sheath and shield earthed at both ends.

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

FDIS	Report on voting
73/148/FDIS	73/149/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 the IEC 60909 series, published under the general title *Short-circuit currents in three-phase a.c. systems*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

SHORT-CIRCUIT CURRENTS IN THREE-PHASE AC SYSTEMS –

Part 3: Currents during two separate simultaneous line-to-earth short circuits and partial short-circuit currents flowing through earth

1 Scope and object

This part of IEC 60909 specifies procedures for calculation of the prospective short-circuit currents with an unbalanced short circuit in high-voltage three-phase a.c. systems operating at nominal frequency 50 Hz or 60 Hz, i. e.:

a) currents during two separate simultaneous line-to-earth short circuits in isolated neutral or resonant earthed neutral systems;

b) partial short-circuit currents flowing through earth in case of single line-to-earth short circuit in solidly earthed or low-impedance earthed neutral systems.

The currents calculated by these procedures are used when determining induced voltages or touch or step voltages and rise of earth potential at a station (power station or substation) and the towers of overhead lines.

Procedures are given for the calculation of reduction factors of overhead lines with one or two earth wires.

The standard does not cover:

a) short-circuit currents deliberately created under controlled conditions as in short circuit testing stations, or

b) short-circuit currents in the electrical installations on board ships or aeroplanes, or

c) single line-to-earth fault currents in isolated or resonant earthed systems.

The object of this standard is to establish practical and concise procedures for the calculation of line-to-earth short-circuit currents during two separate simultaneous line-to-earth short circuits and partial short-circuit currents through earth, earth wires of overhead lines and sheaths or shields of cables leading to conservative results with sufficient accuracy. For this purpose, the short-circuit currents are determined by considering an equivalent voltage source at the short-circuit location with all other voltage sources set to zero. Resistances of earth grids in stations or footing resistances of overhead line towers are neglected, when calculating the short-circuit currents at the short-circuit location.

This standard is an addition to IEC 60909-0. General definitions, symbols and calculation assumptions refer to that publication. Special items only are defined or specified in this standard.

The calculation of the short-circuit currents based on the rated data of the electrical equipment and the topological arrangement of the system has the advantage of being possible both for existing systems and for systems at the planning stage. The procedure is suitable for determination by manual methods or digital computation. This does not exclude the use of special methods, for example the super-position method, adjusted to particular circumstances, if they give at least the same precision.

As stated in IEC 60909-0, short-circuit currents and their parameters may also be determined by system tests.

2 Normative references

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

IEC 60909-0:2001, *Short-circuit currents in three-phase a.c. systems – Part 0: Calculation of currents*

IEC/TR 60909-2:2008, *Short-circuit currents in three-phase a.c. systems – Part 2: Data of electrical equipment for short-circuit current calculations*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
two separate simultaneous line-to earth short circuits
line-to-earth short circuits at different locations at the same time on different conductors of a three-phase a.c. network having a resonant earthed or an isolated neutral

3.2
initial short-circuit currents during two separate simultaneous line-to-earth short circuits I''_{kEE}
r.m.s value of the initial short-circuit currents flowing at both short-circuit locations with the same magnitude

3.3
partial short-circuit current through earth $I_{E\delta}$
r.m.s. value of the current flowing through earth in a fictive line in the equivalent earth penetration depth δ

NOTE In case of overhead lines remote from the short-circuit location and the earthing system of a station, where the distribution of the current between earthed conductors and earth is nearly constant, the current through earth depends on the reduction factor of the overhead line (Figures 4 and 5). In case of cables with metallic sheaths or shields, earthed at both ends in the stations A and B, current through earth between the stations A and B (Figures 9a) and 10a)), respectively between the short-circuit location and the stations A or B (Figures 9b) and 10b)).

3.4
total current to earth I_{ETtot} **at the short-circuit location on the tower T of an overhead line**
r. m. s. value of the current flowing to earth through the footing resistance of an overhead line tower far away from a station connected with the driving point impedances of the overhead line at both sides, see Figure 5

3.5
total current to earth I_{EBtot} **at the short-circuit location in the station B**
r.m.s. value of the current flowing to earth through the earthing system of a station B (power station or substation) with connected earthed conductors (earth wires of overhead lines or sheaths or shields or armouring of cables or other earthed conductors as for instance metallic water pipes), see Figure 4

3.6
current to earth I_{ETn}
r.m.s. value of the current flowing to earth causing the potential rise at an overhead line tower n in the vicinity of a station

3.7
current to earth $I_{\mathrm{EB}n}$
r.m.s. value of the current flowing to earth causing the potential rise $U_{\mathrm{EB}n}$ of a station B, in case of a line-to-earth short circuit at an overhead line tower n in the vicinity of the station B

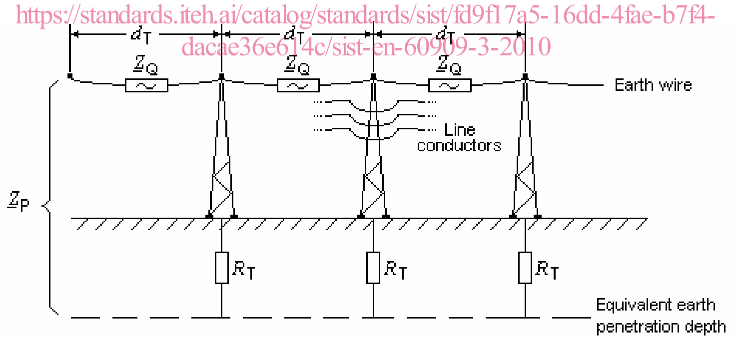
3.8
reduction factor r
for overhead lines, which determines the part of the line-to-earth short-circuit current flowing through the earth remote from the short-circuit location and the earthing systems of the stations

3.9
reduction factor r_1
for three-core cables with metallic sheath or shield earthed at both ends

3.10
reduction factor r_3
for three single-core cables with metallic sheaths or shields earthed at both ends

3.11
driving point impedance $\underline{Z}_{\mathrm{P}}$ of an infinite chain
composed of the earth-wire impedance $\underline{Z}_{\mathrm{Q}}$ between two towers with earth return and the footing resistance R_{T} of the overhead line towers (Figure 1):

$$\underline{Z}_{\mathrm{P}} = 0{,}5\underline{Z}_{\mathrm{Q}} + \sqrt{(0{,}5\underline{Z}_{\mathrm{Q}})^2 + R_{\mathrm{T}}\underline{Z}_{\mathrm{Q}}} \qquad (1)$$



IEC 160/09

Figure 1 – Driving point impedance $\underline{Z}_{\mathrm{P}}$ of an infinite chain, composed of the earth wire impedance $\underline{Z}_{\mathrm{Q}} = \underline{Z}'_{\mathrm{Q}} d_{\mathrm{T}}$ and the footing resistance R_{T} of the towers, with equal distances d_{T} between the towers

The driving point impedance $\underline{Z}_{\mathrm{P}}$ can be assumed constant at a distance from the short-circuit location F longer than the far-from-station distance D_{F} defined by Equation (19).

3.12
driving point impedance $\underline{Z}_{\mathrm{P}n}$ of a finite chain
with n towers of an overhead line as given in Figure 2 and with the impedance $\underline{Z}_{\mathrm{EB}}$ at the end, calculated according to Equation (2).

$$\underline{Z}_{\mathrm{P}n} = \frac{\underline{Z}_{\mathrm{P}}\left(\underline{Z}_{\mathrm{EB}} + \underline{Z}_{\mathrm{P}}\right)\underline{k}^{n} + \left(\underline{Z}_{\mathrm{P}} - \underline{Z}_{\mathrm{Q}}\right)\left(\underline{Z}_{\mathrm{EB}} - \underline{Z}_{\mathrm{P}} + \underline{Z}_{\mathrm{Q}}\right)\underline{k}^{-n}}{\left(\underline{Z}_{\mathrm{EB}} + \underline{Z}_{\mathrm{P}}\right)\underline{k}^{n} - \left(\underline{Z}_{\mathrm{EB}} - \underline{Z}_{\mathrm{P}} + \underline{Z}_{\mathrm{Q}}\right)\underline{k}^{-n}} \qquad (2)$$