



**NSAI**  
Standards

Irish Standard  
I.S. EN 60909-3:2010

# 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

**I.S. EN 60909-3:2010**

*Incorporating amendments/corrigenda/National Annexes issued since publication:*

The National Standards Authority of Ireland (NSAI) produces the following categories of formal documents:

I.S. xxx: Irish Standard — national specification based on the consensus of an expert panel and subject to public consultation.

S.R. xxx: Standard Recommendation — recommendation based on the consensus of an expert panel and subject to public consultation.

SWiFT xxx: A rapidly developed recommendatory document based on the consensus of the participants of an NSAI workshop.

*This document replaces/revises/consolidates the NSAI adoption of the document(s) indicated on the CEN/CENELEC cover/Foreword and the following National document(s):*

*NOTE: The date of any NSAI previous adoption may not match the date of its original CEN/CENELEC document.*

*This document is based on:*

EN 60909-3:2010

*Published:*

2010-03-12

*This document was published under the authority of the NSAI and comes into effect on:*

2015-02-19

ICS number:

NOTE: If blank see CEN/CENELEC cover page

NSAI  
1 Swift Square,  
Northwood, Santry  
Dublin 9

T +353 1 807 3800  
F +353 1 807 3838  
E standards@nsai.ie  
W NSAI.ie

Sales:  
T +353 1 857 6730  
F +353 1 857 6729  
W standards.ie

Údarás um Chaighdeáin Náisiúnta na hÉireann

EUROPEAN STANDARD

**EN 60909-3**

NORME EUROPÉENNE

EUROPÄISCHE NORM

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**

## 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.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
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	-	-

This page is intentionally left blank



**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**





## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2009 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland  
Email: [inmail@iec.ch](mailto:inmail@iec.ch)  
Web: [www.iec.ch](http://www.iec.ch)

### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: [www.iec.ch/online\\_news/justpub](http://www.iec.ch/online_news/justpub)

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: [www.iec.ch/webstore/custserv](http://www.iec.ch/webstore/custserv)

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: [csc@iec.ch](mailto:csc@iec.ch)  
Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00

### A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

### A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: [www.iec.ch/searchpub/cur\\_fut-f.htm](http://www.iec.ch/searchpub/cur_fut-f.htm)

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,...). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: [www.iec.ch/online\\_news/justpub](http://www.iec.ch/online_news/justpub)

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: [www.iec.ch/webstore/custserv/custserv\\_entry-f.htm](http://www.iec.ch/webstore/custserv/custserv_entry-f.htm)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:

Email: [csc@iec.ch](mailto:csc@iec.ch)  
Tél.: +41 22 919 02 11  
Fax: +41 22 919 03 00





**IEC 60909-3**

Edition 3.0 2009-02

# **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**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

PRICE CODE **XA**  
CODE PRIX

---

ICS 17.220.01; 29.240.20

ISBN 978-2-88910-328-7

## CONTENTS

FOREWORD.....	5
1 Scope and object.....	7
2 Normative references .....	8
3 Terms and definitions .....	8
4 Symbols .....	10
5 Calculation of currents during two separate simultaneous line-to-earth short circuits .....	12
5.1 Initial symmetrical short-circuit current .....	12
5.1.1 Determination of $\underline{M}_{(1)}$ and $\underline{M}_{(2)}$ .....	12
5.1.2 Simple cases of two separate simultaneous line-to-earth short circuits.....	13
5.2 Peak short-circuit current, symmetrical short circuit breaking current and steady-state short-circuit current .....	13
5.3 Distribution of the currents during two separate simultaneous line-to-earth short circuits.....	14
6 Calculation of partial short-circuit currents flowing through earth in case of an unbalanced short circuit.....	14
6.1 General.....	14
6.2 Line-to-earth short circuit inside a station .....	15
6.3 Line-to-earth short circuit outside a station .....	16
6.4 Line-to-earth short circuit in the vicinity of a station .....	18
6.4.1 Earth potential $\underline{U}_{ETn}$ at the tower $n$ outside station B .....	19
6.4.2 Earth potential of station B during a line-to earth short circuit at the tower $n$ .....	19
7 Reduction factor for overhead lines with earth wires .....	20
8 Calculation of current distribution and reduction factor in case of cables with metallic sheath or shield earthed at both ends .....	21
8.1 Overview .....	21
8.2 Three-core cable .....	22
8.2.1 Line-to-earth short circuit in station B .....	22
8.2.2 Line-to-earth short circuit on the cable between station A and station B .....	23
8.3 Three single-core cables .....	26
8.3.1 Line-to-earth short circuit in station B .....	26
8.3.2 Line-to-earth short circuit on the cable between station A and station B .....	26
Annex A (informative) Example for the calculation of two separate simultaneous line-to-earth short-circuit currents.....	30
Annex B (informative) Examples for the calculation of partial short-circuit currents through earth .....	33
Annex C (informative) Example for the calculation of the reduction factor $r_1$ and the current distribution through earth in case of a three-core cable .....	43
Annex D (informative) Example for the calculation of the reduction factor $r_3$ and the current distribution through earth in case of three single-core cables .....	48

Figure 1 – Driving point impedance $Z_P$ of an infinite chain, composed of the earth wire impedance $Z_Q = Z'_Q d_T$ and the footing resistance $R_T$ of the towers, with equal distances $d_T$ between the towers .....	9
Figure 2 – Driving point impedance $Z_{Pn}$ of a finite chain with $n$ towers, composed of the earth wire impedance $Z_Q = Z'_Q d_T$ , the footing resistance $R_T$ of the towers, with equal distances $d_T$ between the towers and the earthing impedance $Z_{EB}$ of station B from Equation (29) .....	10
Figure 3 – Characterisation of two separate simultaneous line-to earth short circuits and the currents $I''_{KEE}$ .....	12
Figure 4 – Partial short-circuit currents in case of a line-to-earth short circuit inside station B .....	15
Figure 5 – Partial short-circuit currents in case of a line-to-earth short circuit at a tower T of an overhead line .....	16
Figure 6 – Distribution of the total current to earth $I_{ETtot}$ .....	17
Figure 7 – Partial short-circuit currents in the case of a line-to-earth short circuit at a tower $n$ of an overhead line in the vicinity of station B .....	18
Figure 8 – Reduction factor $r$ for overhead lines with non-magnetic earth wires depending on soil resistivity $\rho$ .....	21
Figure 9 – Reduction factor of three-core power cables .....	23
Figure 10 – Reduction factors for three single-core power cables .....	27
Figure A.1 – Two separate simultaneous line-to-earth short circuits on a single fed overhead line (see Table 1) .....	30
Figure B.1 – Line-to-earth short circuit inside station B – System diagram for stations A, B and C .....	34
Figure B.2 – Line-to-earth short circuit inside station B – Positive-, negative- and zero-sequence systems with connections at the short-circuit location F within station B .....	34
Figure B.3 – Line-to-earth short circuit outside stations B and C at the tower T of an overhead line – System diagram for stations A, B and C .....	36
Figure B.4 – Line-to-earth short circuit outside stations B and C at the tower T of an overhead line – Positive-, negative- and zero-sequence systems with connections at the short-circuit location F .....	37
Figure B.5 – Earth potentials $u_{ETn} = U_{ETn}/U_{ET}$ with $U_{ET} = 1,912$ kV and $u_{EBn} = U_{EBn}/U_{EB}$ with $U_{EB} = 0,972$ kV, if the line-to-earth short circuit occurs at the towers $n = 1, 2, 3, \dots$ in the vicinity of station B .....	42
Figure C.1 – Example for the calculation of the cable reduction factor and the current distribution through earth in a 10-kV-network, $U_n = 10$ kV; $c = 1,1$ ; $f = 50$ Hz .....	44
Figure C.2 – Short-circuit currents and partial short-circuit currents through earth for the example in Figure C.1 .....	45
Figure C.3 – Example for the calculation of current distribution in a 10-kV-network with a short circuit on the cable between A and B (data given in C.2.1 and Figure C.1) .....	46
Figure C.4 – Line-to-earth short-circuit currents, partial currents in the shield and partial currents through earth .....	47
Figure D.1 – Example for the calculation of the reduction factor and the current distribution in case of three single-core cables and a line-to-earth short circuit in station B .....	49
Figure D.2 – Positive-, negative- and zero-sequence system of the network in Figure D.1 with connections at the short-circuit location (station B) .....	50
Figure D.3 – Current distribution for the network in Figure D.1, depending on the length, $\ell$ , of the single-core cables between the stations A and B .....	51

Figure D.4 – Example for the calculation of the reduction factors $r_3$ and the current distribution in case of three single-core cables and a line-to-earth short circuit between the stations A and B .....	52
Figure D.5 – Positive-, negative- and zero-sequence system of the network in Figure D.4 with connections at the short-circuit location (anywhere between the stations A and B) .....	52
Figure D.6 – Current distribution for the cable in Figure D.4 depending on $l_A$ , $R_{EF} \rightarrow \infty$ .....	54
Figure D.7 – Current distribution for the cable in Figure D.4 depending on $l_A$ , $R_{EF} = 5 \Omega$ .....	56
Table 1 – Calculation of initial line-to-earth short-circuit currents in simple cases .....	13
Table 2 – Resistivity of the soil and equivalent earth penetration depth .....	20
Table C.1 – Results for the example in Figure C.1 .....	45
Table C.2 – Results for the example in Figure C.3, $l = 5$ km .....	47
Table C.3 – Results for the example in Figure C.3, $l = 10$ km .....	47

This is a free preview. Purchase the entire publication at the link below:

[Product Page](#)

- 
- [Looking for additional Standards? Visit Intertek Inform Infostore](#)
  - [Learn about LexConnect, All Jurisdictions, Standards referenced in Australian legislation](#)
-