



NSAI
Standards

Irish Standard
I.S. EN 60865-1:2012

Short-circuit currents - Calculation of effects -- Part 1: Definitions and calculation methods (IEC 60865-1:2011 (EQV))

I.S. EN 60865-1:2012

Incorporating amendments/corrigenda 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.

<i>This document replaces:</i> EN 60865-1:1993	<i>This document is based on:</i> EN 60865-1:2012 EN 60865-1:1993	<i>Published:</i> 23 March, 2012 20 December, 1993
This document was published under the authority of the NSAI and comes into effect on: 17 April, 2012		ICS number: 17.220.01 29.240.20
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		

English version

**Short-circuit currents -
Calculation of effects -
Part 1: Definitions and calculation methods
(IEC 60865-1:2011)**

Courants de court-circuit -
Calcul des effets -
Partie 1: Définitions et méthodes de calcul
(CEI 60865-1:2011)

Kurzschlussströme -
Berechnung der Wirkung -
Teil 1: Begriffe und Berechnungsverfahren
(IEC 60865-1:2011)

This European Standard was approved by CENELEC on 2011-11-28. 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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre 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, Turkey and the United Kingdom.

CENELEC

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

Management Centre: Avenue Marnix 17, B - 1000 Brussels

I.S. EN 60865-1:2012

EN 60865-1:2012

- 2 -

Foreword

The text of document 73/152/CDV, future edition 3 of IEC 60865-1, prepared by IEC/TC 73 "Short-circuit currents" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60865-1:2012.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2012-09-23
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2014-11-28

This document supersedes EN 60865-1:1993.

EN 60865-1:2012 includes the following significant technical changes with respect to EN 60865-1:1993:

- The determinations for automatic reclosure together with rigid conductors have been revised.
- The influence of mid-span droppers to the span has been included.
- For vertical cable-connection the displacement and the tensile force onto the lower fixing point may now be calculated.
- Additional recommendations for foundation loads due to tensile forces have been added.
- The subclause for determination of the thermal equivalent short-circuits current has been deleted (it is now part of EN 60909-0).
- The regulations for thermal effects of electrical equipment have been deleted.
- The standard has been reorganized and some of the symbols have been changed to follow the conceptual characteristic of international standards.

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

Endorsement notice

The text of the International Standard IEC 60865-1:2011 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 61936-1 NOTE Harmonized as EN 61936-1.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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	Series	Short-circuit currents calculation in three-phase a.c. systems	EN 60909	Series
IEC 60909-0	-	Short-circuit currents in three-phase a.c. systems - Part 0: Calculation of currents	EN 60909-0	-
IEC 60949	-	Calculation of thermally permissible short-circuit currents, taking into account non-adiabatic heating effects	-	-
IEC 60986	-	Short-circuit temperature limits of electric cables with rated voltages from 6 kV ($U_m = 7,2$ kV) up to 30 kV ($U_m = 36$ kV)	-	-
IEC 61660-2	-	Short-circuit currents in d.c. auxiliary installations in power plants and substations - Part 2: Calculation of effects	EN 61660-2	-

This page is intentionally left BLANK.

CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms, definitions, symbols and units	7
3.1 Terms and definitions	7
3.2 Symbols and units	9
4 General	12
5 Rigid conductor arrangements	13
5.1 General	13
5.2 Calculation of electromagnetic forces	13
5.2.1 Calculation of peak force between the main conductors during a three-phase short-circuit.....	13
5.2.2 Calculation of peak force between the main conductors during a line-to-line short-circuit.....	13
5.2.3 Calculation of peak value of force between coplanar sub-conductors.....	14
5.3 Effective distance between main conductors and between sub-conductors	14
5.4 Calculation of stresses in rigid conductors.....	16
5.4.1 Calculation of stresses	16
5.4.2 Section modulus and factor q of main conductor composed of sub-conductors.....	17
5.4.3 Permitted conductor stress	20
5.5 Structure loads due to rigid conductors	21
5.6 Consideration of automatic reclosing	21
5.7 Calculation with special regard to conductor oscillation	22
5.7.1 General	22
5.7.2 Determination of relevant natural frequency.....	23
5.7.3 The factors V_F , $V_{\sigma m}$, $V_{\sigma s}$, V_{rm} and V_{rs}	23
6 Flexible conductor arrangements	26
6.1 General	26
6.2 Effects on horizontal main conductors	27
6.2.1 General	27
6.2.2 Characteristic dimensions and parameter	27
6.2.3 Tensile force $F_{t,d}$ during short-circuit caused by swing out (short-circuit tensile force) without dropper in midspan	30
6.2.4 Dynamic change of sag due to elongation of conductor and change of shape of the conductor curve.....	31
6.2.5 Tensile force $F_{t,d}$ during short-circuit caused by swing out (short-circuit tensile force) with dropper in the middle of the span.....	32
6.2.6 Tensile force $F_{f,d}$ after short-circuit caused by drop (drop force).....	33
6.2.7 Horizontal span displacement b_h and minimum air clearance a_{min}	33
6.3 Effects on vertical main conductors (droppers)	34
6.4 Effects on bundled conductors	35
6.4.1 Characteristic dimensions and parameter	35
6.4.2 Tensile force $F_{pi,d}$ in the case of clashing sub-conductors	38
6.4.3 Tensile force $F_{pi,d}$ in the case of non-clashing sub-conductors	38
6.5 Structure loads due to flexible conductors	41
6.5.1 Design load for post insulators, their supports and connectors	41

6.5.2	Design load for structures, insulators and connectors with tensile forces transmitted by insulator chains	41
6.5.3	Design load for foundations	42
7	The thermal effect on bare conductors	42
7.1	General	42
7.2	Calculation of thermal equivalent short-circuit current	42
7.3	Calculation of temperature rise and rated short-time withstand current density for conductors	43
7.4	Calculation of thermal short-time strength for different durations of the short-circuit	44
Annex A (normative)	Equations for calculation of diagrams	46
Bibliography	51
Figure 1	– Factor k_{1s} for calculating the effective conductor distance	15
Figure 2	– Loading direction and bending axis for multiple conductor arrangements	18
Figure 3	– Factor e for the influence of connecting pieces in Equation (17)	24
Figure 4	– Factors V_F , $V_{\sigma m}$ and $V_{\sigma s}$ to be used with the three-phase and line-to-line short-circuits	25
Figure 5	– Factors V_{rm} and V_{rs} to be used with three-phase automatic reclosing	26
Figure 6	– Maximum swing out angle δ_{max} for a given maximum short-circuit duration T_{k1}	30
Figure 7	– Factor ψ for tensile force in flexible conductors	31
Figure 8	– Geometry of a dropper	33
Figure 9	– v_2 as a function of v_1	37
Figure 10	– $v_3 \cdot \sin \frac{180^\circ}{n}$ as a function of a_s/d	37
Figure 11	– ξ as a function of j and ε_{st}	38
Figure 12	– η as a function of j and ε_{st}	41
Figure 13	– Relation between rated short-circuit withstand current density ($T_{kr} = 1$ s) and conductor temperature	44
Table 1	– Effective distance a_s between sub-conductors for rectangular cross-section dimensions	16
Table 2	– Maximum possible values of $V_{\sigma m}V_{rm}$, $V_{\sigma s}V_{rs}$, V_FV_{rm}	19
Table 3	– Factors α , β , γ for different busbar support arrangements	20
Table 4	– Factor q	22
Table 5	– Section moduli W_m of main conductors with two or more stiffening elements between two adjacent supports. The stiffening elements are black	22
Table 6	– Recommended highest temperatures for mechanically stressed conductors during a short-circuit	43

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SHORT-CIRCUIT CURRENTS – CALCULATION OF EFFECTS –

Part 1: Definitions and calculation methods

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60865-1 has been prepared by IEC technical committee 73: Short-circuit currents.

This third edition cancels and replaces the second edition published in 1993. This edition constitutes a technical revision.

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

- The determinations for automatic reclosure together with rigid conductors have been revised.
- The influence of mid-span droppers to the span has been included.
- For vertical cable-connection the displacement and the tensile force onto the lower fixing point may now be calculated.
- Additional recommendations for foundation loads due to tensile forces have been added.

- The subclause for determination of the thermal equivalent short-circuits current has been deleted (it is now part of IEC 60909-0).
- The regulations for thermal effects of electrical equipment have been deleted.
- The standard has been reorganized and some of the symbols have been changed to follow the conceptual characteristic of international standards.

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

CDV	Report on voting
73/152/CDV	73/153/RVC

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 60865 series, under the general title, *Short-circuit currents – Calculation of effects* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability 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 – CALCULATION OF EFFECTS –

Part 1: Definitions and calculation methods

1 Scope

This part of IEC 60865 is applicable to the mechanical and thermal effects of short-circuit currents. It contains procedures for the calculation of

- the electromagnetic effect on rigid conductors and flexible conductors,
- the thermal effect on bare conductors.

For cables and insulated conductors, reference is made, for example, to IEC 60949 and IEC 60986. For the electromagnetic and thermal effects in d.c. auxiliary installations of power plants and substations reference is made to IEC 61660-2.

Only a.c. systems are dealt with in this standard.

The following points should, in particular, be noted:

- a) The calculation of short-circuit currents should be based on IEC 60909. For the determination of the greatest possible short-circuit current, additional information from other IEC standards may be referred to, e.g. details about the underlying circuitry of the calculation or details about current-limiting devices, if this leads to a reduction of the mechanical stress.
- b) Short-circuit duration used in this standard depends on the protection concept and should be considered in that sense.
- c) These standardized procedures are adjusted to practical requirements and contain simplifications which are conservative. Testing or more detailed methods of calculation or both may be used.
- d) In Clause 5 of this standard, for arrangements with rigid conductors, only the stresses caused by short-circuit currents are calculated. Furthermore, other stresses can exist, e.g. caused by dead-load, wind, ice, operating forces or earthquakes. The combination of these loads with the short-circuit loading should be part of an agreement and/or be given by standards, e.g. erection-codes.

The tensile forces in arrangements with flexible conductors include the effects of dead-load. With respect to the combination of other loads the considerations given above are valid.

- e) The calculated loads are design loads and should be used as exceptional loads without any additional partial safety factor according to installation codes of, for example, IEC 61936-1 [1]¹.

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 (all parts) *Short-circuit current calculation in three-phase a.c. systems*

¹ Figures in square brackets refer to the bibliography.

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](#)
-