



Edition 3.0 2026-07

INTERNATIONAL STANDARD

**Short-circuit currents in three-phase AC systems -
Part 0: Calculation of currents**

FOREWORD	5
INTRODUCTION	7
1 Scope	8
2 Normative references	9
3 Terms and definitions	9
4 Symbols, subscripts and superscripts	14
4.1 General	14
4.2 Symbols	14
4.3 Subscripts	16
4.4 Superscripts	17
5 Characteristics of short-circuit currents: calculating method	17
5.1 General	17
5.2 Method of calculation	20
5.2.1 General	20
5.2.2 Equivalent voltage source at the short-circuit location	22
5.2.3 Installations modelled as current sources	23
5.2.4 Calculation assumptions	24
5.2.5 Symmetrical components	24
6 Modelling of electrical equipment for short-circuit calculations	25
6.1 General	25
6.2 Overhead lines and cables	25
6.3 Transformers	25
6.3.1 Two-winding transformers	25
6.3.2 Three-winding transformers	26
6.3.3 Impedance correction factors for two- and three-winding network transformers	28
6.4 Reactors	29
6.4.1 General	29
6.4.2 Shunt reactors	29
6.4.3 Series reactors	29
6.5 Capacitors	29
6.5.1 Shunt capacitors	29
6.5.2 Series capacitors	29
6.6 Non-rotating loads	30
6.7 Network feeders	30
6.8 Synchronous machines	31
6.8.1 General	31
6.8.2 Synchronous generators	33
6.8.3 Synchronous compensators	33
6.8.4 Synchronous motors	33
6.9 Asynchronous machines	33
6.9.1 General	33
6.9.2 Asynchronous generators	34
6.9.3 Asynchronous motors	35
6.10 Power electronic converters	35
6.10.1 Power electronic converters with diodes or with thyristors	35

This is a preview of IEC 60909-0 Ed. 3.0 en:2026. Click [here](#) to purchase the full version from the ANSI store.

turned off, for example IGBT	35
6.11 Power station units	36
6.11.1 General.....	36
6.11.2 Power station units with synchronous generators	36
6.11.3 Power station units with asynchronous generator	37
6.11.4 Power station units with doubly fed asynchronous generator	37
6.11.5 Power station units with full-size converter	38
6.12 Power plants	39
6.13 Converter-fed motors	40
6.13.1 General.....	40
6.13.2 Converter-fed motors with grid-side converters using diodes or thyristors.....	41
6.13.3 Converter-fed motors with grid-side converters using semiconductor devices that can be turned off, for example IGBT	41
6.14 FACTS devices and HVDC transmission systems.....	41
6.14.1 FACTS devices.....	41
6.14.2 HVDC transmission systems	41
7 Calculation of initial short-circuit currents	42
7.1 Overview	42
7.1.1 General.....	42
7.1.2 Maximum short-circuit currents.....	44
7.1.3 Minimum short-circuit currents.....	45
7.2 Three-phase short circuit.....	45
7.3 Line-to-line short circuit.....	46
7.4 Line-to-line short circuit with earth connection	47
7.5 Line-to-earth short circuit.....	48
8 Calculation of peak short-circuit currents.....	48
8.1 Single-fed three-phase short circuit	48
8.2 Multiple-fed three-phase short circuits	49
8.3 Unbalanced short circuits	50
9 Calculation of symmetrical breaking currents	51
9.1 Single-fed three-phase short circuits.....	51
9.1.1 Symmetrical breaking currents fed by synchronous machines.....	51
9.1.2 Symmetrical breaking current fed by asynchronous machines.....	52
9.1.3 Symmetrical breaking current fed by power station units with doubly fed asynchronous generator	53
9.1.4 Symmetrical breaking current fed by power station units with full-size converter	54
9.1.5 Symmetrical breaking current fed by network feeders	54
9.2 Multiple-fed three-phase short circuits	54
9.3 Single-fed and multiple-fed unbalanced short circuits	55
10 DC component and unbalanced asymmetrical breaking current	55
11 Calculation of steady-state short-circuit currents	56
11.1 General	56
11.2 Three-phase short circuits	56
11.2.1 Steady-state short-circuit currents single-fed by one synchronous machine or one power station unit with synchronous generator.....	56
11.2.2 Steady-state short-circuit currents of asynchronous machines	59

asynchronous generators.....	59
11.2.4 Steady-state short-circuit currents of a power station unit with full-size converter	59
11.2.5 Steady-state short-circuit currents of a network feeder.....	60
11.2.6 Steady-state short-circuit currents in case of multiple-fed short circuits	60
11.3 Unbalanced single-fed and multiple-fed short circuits	60
12 Short circuits at the low-voltage side of transformers, if one line conductor is interrupted at the high-voltage side.....	61
13 Terminal short circuits of asynchronous motors.....	62
14 Thermal equivalent short-circuit current and Joule integral.....	62
Annex A (informative) Short-circuit current inside a power station unit with synchronous generator.....	66
Annex B (normative) Formulas for the calculation of the factors m and n	70
Bibliography.....	71
Figure 1 – Short-circuit current (schematic diagram)	19
Figure 2 – Illustration for calculating the initial symmetrical short-circuit current I_k''	21
Figure 3 – Characterization of short circuits and their currents	22
Figure 4 – Three-winding transformer	27
Figure 5 – System diagram and equivalent circuit diagram for network feeders	31
Figure 6 – Example of a power plant with short-circuit locations consisting of power station units according to 6.11.3 to 6.11.5.....	39
Figure 7 – Equivalent circuit diagram (positive-sequence system) of a power plant with power station units PA, PD, and PC for a short circuit at location F2.....	39
Figure 8 – Examples of single-fed short circuits.....	43
Figure 9 – Example of multiple-fed short circuit	44
Figure 10 – Factor κ for series circuit as a function of ratio R/X or X/R	49
Figure 11 – Factor μ for calculation of symmetrical three-phase short-circuit breaking current I_b fed by synchronous or asynchronous machines	52
Figure 12 – Factor q for the calculation of the symmetrical three-phase short-circuit breaking current of asynchronous machines	53
Figure 13 – Factors $\lambda_{\min}$ and $\lambda_{\max}$ factors for cylindrical rotor synchronous machines	58
Figure 14 – Factors $\lambda_{\min}$ and $\lambda_{\max}$ for salient-pole synchronous machines	58
Figure 15 – Transformer secondary short-circuits, if one line (fuse) is opened on the high-voltage side of a transformer Dy(n)5.....	61
Figure 16 – Factor m for the heat effect of the DC component of the short-circuit current	64
Figure 17 – Factor n for the heat effect of the AC component of the short-circuit current.....	65
Figure A.1 – Initial short-circuit currents and initial partial short-circuit currents for three different short-circuit locations inside a power station unit with synchronous generator.....	68

This is a preview of IEC 60909-0 Ed. 3.0 en:2026. [Click here to purchase the full version from the ANSI store.](#)

Table 2 – Factors α and β for the calculation of short-circuit currents with Formula (94), rated transformation ratio $t_r = U_{rTHV}/U_{rTLV}$	62
Table 3 – Calculation of short-circuit currents of asynchronous motors in the case of a short circuit at the terminals.....	63

Short-circuit currents in three-phase AC systems - Part 0: Calculation of currents

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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). [IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch> and/or www.iso.org/patents. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60909-0 has been prepared by IEC technical committee 73: Short-circuit currents. It is an International Standard.

This third edition cancels and replaces the second edition published in 2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) restructuring and complementing of the clauses, especially restructuring and updating of Clause 6.
- b) restructuring of subscripts.

This is a preview of IEC 60909-0 Ed. 3.0 en:2026. Click [here](#) to purchase the full version from the ANSI store.

Draft	Report on voting
73/220/CDV	73/236/RVC

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60909 series, published under the general title *Short-circuit currents in three-phase AC systems*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

This is a preview of IEC 60909-0 Ed. 3.0 en:2026. [Click here to purchase the full version from the ANSI store.](#)

Main aim of IEC 60909-0 is calculation of maximum and minimum short-circuit currents of bolted short circuits (see 5.2.4). Calculation results can serve as input for further evaluations such as calculation of arcing current as described in, for example, IEEE 1584.

This part of IEC 60909 is applicable to the calculation of short-circuit currents

- in low-voltage three-phase AC systems,
- in high-voltage three-phase AC systems, and
- operating at a nominal frequency of 50 Hz or 60 Hz.

Systems at highest voltages of 550 kV and above with long transmission lines are outside the scope of this document.

This document establishes a general, practicable and concise procedure leading to results which are generally of acceptable accuracy. For this calculation method, an equivalent voltage source at the short-circuit location is introduced. This does not exclude the use of special methods, for example the superposition method, adjusted to particular circumstances, if they give at least the same precision. The superposition method gives the short-circuit current related to the one load flow presupposed. This method, therefore, does not necessarily lead to the maximum respective minimum short-circuit current.

This document deals with the calculation of short-circuit currents in the case of balanced or unbalanced short circuits.

A single line-to-earth fault occurring in networks with isolated or resonant earthing of the neutral point is beyond the scope of this document.

For currents during two separate simultaneous single-phase line-to-earth short circuits in an isolated neutral system or a resonance earthed neutral system, see IEC 60909-3.

Short-circuit currents and short-circuit impedances can also be determined by system tests, by measurement on a network analyser, or numerical simulations with electromagnetic programs. In existing low-voltage systems, it is possible to determine the short-circuit impedance on the basis of measurements at the location of the prospective short circuit considered.

The calculation of the short-circuit impedance is in general based on the rated data of the electrical equipment and the topological arrangement of the system and has the advantage of being possible both for existing systems and for systems at the planning stage.

In general, two types of short-circuit currents, which differ in their magnitude, are considered:

- maximum short-circuit current which determines the capacity or rating of electrical equipment;
- minimum short-circuit current which can be a basis, for example, for the selection of fuses, for the setting of protective devices, and for checking the run-up of motors.

NOTE The current in a three-phase short circuit is assumed to be made simultaneously in all poles. Investigations of non-simultaneous short circuits, which can lead to higher aperiodic components of short-circuit currents, are beyond the scope of this document.

This document does not cover short-circuit currents deliberately created under controlled conditions (short-circuit testing stations).

This document does not deal with the calculation of short-circuit currents in installations on board ships and aeroplanes.

This document does not distinguish between grid-forming and grid-following converters for the calculation of short-circuit currents.

This is a preview of IEC 60909-0 Ed. 3.0 en:2026. [Click here to purchase the full version from the ANSI store.](#)

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60050-131, *International Electrotechnical Vocabulary (IEV) - Part 131: Circuit theory*

IEC 60038:2009, *IEC standard voltages*

IEC 60050-151, *International Electrotechnical Vocabulary - Part 151: Electric and magnetic devices*, available at www.electropedia.org

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

IEC TR 60909-1:2002, *Short-circuit currents in three-phase a.c. systems - Part 1: Factors for the calculation of short-circuit currents according to IEC 60909-0*

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

IEC 60909-3, *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*

IEC TR 60909-4:2021, *Short-circuit currents in three-phase AC systems - Part 4: Examples for the calculation of short-circuit currents*

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 62428, *Electric power engineering - Modal components in three-phase a.c. systems - Quantities and transformations*

IEC/IEEE 62271-37-013, *IEEE/IEC International Standard for high-voltage switchgear and controlgear - Part 37-013: Alternating current generator circuit-breakers*

IEEE 1584, *IEEE Guide for performing arc-flash hazard calculations*