

TECHNICAL REPORT

RAPPORT TECHNIQUE

Low-voltage switchgear and controlgear – Overcurrent protective devices –
Part 1: Application of short-circuit ratings

Appareillage à basse tension – Dispositifs de protection contre les surintensités –
Partie 1: Application des caractéristiques de court-circuit

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**LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –
OVERCURRENT PROTECTIVE DEVICES –****Part 1: Application of short-circuit ratings**

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IEC 61912-1, which is a technical report, has been prepared by subcommittee 17B: Low-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

This edition cancels and replaces the first edition of IEC 61912, published in 2006, and corrigendum 1 (May 2006). The changes are only editorial.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
17B/1547/DTR	17B/1564/RVC

Full information on the voting for the approval of this technical report 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 the parts of the IEC 61912 series, under the general title *Low-voltage switchgear and controlgear – Overcurrent protective devices*, 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

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INTRODUCTION

Low-voltage equipment standards IEC 60947 and IEC 60439 currently include short-circuit ratings for products and assemblies respectively, defined in terms of the ability of the equipment to operate at a level of peak current, an r.m.s. current for a specified time and/or a level of current conditional upon a short-circuit protective device in series. In practice the correct application of the various short-circuit ratings needs to be fully understood by the circuit designer to avoid leaving a circuit or equipment with inadequate short-circuit protection. It is also useful to take full advantage of the capability of devices and systems to avoid over-engineering, with the consequent unnecessary additional cost.

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR – OVERCURRENT PROTECTIVE DEVICES –

Part 1: Application of short-circuit ratings

1 Scope

This technical report, which serves as an application guide for the short-circuit ratings given in IEC standards for low-voltage switchgear and controlgear and assemblies, summarises the definitions of the ratings and provides examples of their application.

NOTE This document does not concern itself with household (domestic) installations.

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 60255 (all parts), *Electrical relays*

IEC 60269-1, *Low-voltage fuses – Part 1: General requirements*

IEC 60364 (all parts), *Low-voltage electrical installations*

IEC 60439-1, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies*

IEC 60439-2, *Low-voltage switchgear and controlgear assemblies – Part 2: Particular requirements for busbar trunking systems (busways)*

IEC 60898-1, *Electrical accessories – Circuit-breakers for overcurrent protection for household and similar installations – Part 1: Circuit-breakers for a.c. operation*

IEC 60947-1, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 60947-2, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*

IEC 60947-3, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 60947-4-1, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

IEC 60947-6-2, *Low-voltage switchgear and controlgear – Part 6-2: Multiple function equipment – Control and protective switching devices (or equipment) (CPS)*

IEC 61009-1, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – Part 1: General rules*

3 Alphabetical list of definitions and characteristics

	Clause
B	
Breaking capacity of a fuse-link	6.3.1
C	
Circuit-breaker according to IEC 60898-1	6.2 b) ii)
Circuit-breaker according to IEC 60947-2	6.2 b) ii)
Conditional short-circuit rating (back-up protection)	4
Control and protective switching device (CPS) according to IEC 60947-6-2	6.2 b) iv)
Cut-off current of a circuit-breaker according to IEC 60947-2	6.3.2
Cut-off current of a fuse-link	6.3.1
F	
Fuse-combination unit to IEC 60947-3	6.2 b) i)
O	
Operating I^2t (Joule integral) of a circuit-breaker according to IEC 60947-2	6.3.2
Operating I^2t (Joule integral) of a fuse-link.....	6.3.1
P	
Peak short-circuit current I_p	4
Prospective (available) short-circuit current I_{cp}	4
Protected starter according to IEC 60947-4-1	6.2 b) iii)
Protected switching device according to IEC 60947-4-1	6.2 b) iii)
R	
Rated conditional short-circuit current I_q of a contactor or motor starter	7.4.2
Rated conditional short-circuit current I_{cc} of a circuit of an assembly	5
Rated peak withstand current I_{pk} of a circuit of an assembly	5
Rated service short-circuit breaking capacity I_{cs} of a circuit-breaker according to IEC 60947-2	6.3.2
Rated short-circuit breaking capacity I_{cs} of a CPS	6.3.3
Rated short-circuit capacity I_{cn} of a circuit-breaker according to IEC 60898-1 and of a residual current operated circuit-breaker with integral overcurrent protection (RCBO)	6.3.4
Rated short-circuit making capacity I_{cm} of a circuit-breaker according to IEC 60947-2	6.3.2
Rated short-time withstand current I_{cw} of a circuit of an assembly	5
Rated short-time withstand current I_{cw} of a circuit-breaker according to IEC 60947-2	6.3.2
Rated ultimate short-circuit breaking capacity I_{cu} of a circuit-breaker according to IEC 60947-2	6.3.2
Residual current operated circuit-breaker with integral overcurrent protection (RCBO) according to IEC 61009-1.....	6.2 b) ii)
S	
Service short-circuit capacity I_{cs} of a circuit-breaker according to IEC 60898-1 and of a residual current operated circuit-breaker with integral overcurrent protection (RCBO)	7.5
Short-circuit protective device (SCPD).....	4
Steady-state short-circuit current I_k	4
Symmetrical short-circuit breaking current I_b	4

4 Principle of application – Installation

In order to ensure the capability of equipment under short-circuit conditions, the circuit designer shall firstly have available the value of the prospective fault level at the point of installation of each item of equipment. This is produced by a system protection study. Short-circuit parameters are defined in terms that include the following:

- **prospective (available) short-circuit current I_{cp}**
current that would flow if the short-circuit were replaced by an ideal connection of negligible impedance without any change of the supply
- **peak short-circuit current I_p**
maximum possible instantaneous value of the prospective (available) short-circuit current
- **symmetrical short-circuit breaking current I_b**
r.m.s. value of an integral cycle of the symmetrical a.c. component of the prospective (available) short-circuit current at the instant of contact separation of the first pole of a switching device
- **steady-state short-circuit current I_k**
r.m.s. value of the prospective short-circuit current which remains, after the decay of the transient phenomena:
 - unlimited
 - limited by an SCPD (short-circuit protective device)

Additional useful definitions:

- **short-circuit protective device (SCPD)**
device intended to protect a circuit or part of a circuit against short-circuit currents by interrupting them
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- **conditional short-circuit rating (back-up protection)**
short-circuit rating, of a device or an assembly, dependent on an SCPD connected in series with the device or assembly

5 Characteristics – Low-voltage assemblies (switchboard, distribution board, etc.)

An assembly will have a short-circuit rating assigned by the manufacturer specified as the maximum permissible prospective short-circuit current, defined in terms of current and time, at the point of connection to the incoming terminals. The short-circuit rating of the assembly should be equal to or exceed the maximum prospective short-circuit current at the point of connection to the system. The assembly manufacturer is responsible for ensuring the capability of the equipment between the incoming and outgoing terminals of the assembly (incoming and outgoing devices, busbars, connections, etc.). The short-circuit rating will have been determined by the manufacturer, in accordance with the applicable part of the IEC 60439 series.

The terminology to define the short-circuit rating of an assembly is given in the standard as follows:

- **rated short-time withstand current I_{cw} (of a circuit of an assembly)**
Summarised as: r.m.s value of short-time current that a circuit of an assembly can carry without damage under specified test conditions, defined in terms of a current and time, e.g. 20 kA, 0,2 s.

- **rated peak withstand current I_{pk} (of a circuit of an assembly)**
Summarised as: value of peak current that a circuit can withstand satisfactorily under specified test conditions.
- **rated conditional short-circuit current I_{cc} (of a circuit of an assembly)**
Summarised as: r.m.s. value of prospective short-circuit current that a circuit, protected by a specified short-circuit protective device (SCPD), can withstand satisfactorily for the operating time of that device, under specified test conditions.

NOTE The short-circuit protective device may form an integral part of the assembly or may be a separate unit.

An assembly may be assigned a value of I_{cc} alone.

An assembly may be assigned values of I_{cw} and I_{pk} (but cannot be assigned a value of I_{cw} or I_{pk} alone).

An assembly may be assigned values of I_{cw} , I_{pk} and I_{cc} .

An assembly may be assigned different values of I_{cc} for different circuit protective devices and/or system voltages.

An assembly may be assigned different values of I_{cw} for different short-time periods e.g. 0,2 s, 0,5 s, 1 s.

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6 Characteristics – Switching devices

6.1 General

IEC TR 61912-1:2007

In terms of short-circuit capability, switching devices shall be considered in respect of their function in the particular application. A switching device is considered in two respects, self-protection and use as a short-circuit protective device (SCPD) where applicable.

6.2 Switching devices – Self-protection against short-circuit

The following cases are considered:

- a) Load and overload switching alone, without any short-circuit switching capability.
In this case the switching device will be short-circuit rated on a similar basis to a circuit of an assembly (see Clause 5), with a rating of I_{cw} and/or a conditional short-circuit rating, but will in addition have a rated short-circuit making capacity I_{cm} .
- b) Load, overload and short-circuit switching capability:
 - i) Fuse-combination units according to IEC 60947-3 – a fuse-combination unit is normally self-protecting up to the breaking capacity of the fuse. In this case the short-circuit breaking function is provided by the integral fuses and the switching device will have a conditional short-circuit rating.
 - ii) Circuit-breakers according to IEC 60947-2, circuit-breakers according to IEC 60898-1 and residual current operated circuit-breakers with integral overcurrent protection (RCBOs) according to IEC 61009-1 – the device will be self-protecting up to its breaking capacity rating (see 6.3.2). At fault levels above the breaking capacity rating, a circuit-breaker may be capable of operating with “back-up” protection by an SCPD (this is in effect a conditional rating, but the term is not generally used in this context).
 - iii) Protected switching devices and protected starters according to IEC 60947-4-1 – a contactor, semiconductor controller or a motor-starter, including overload protection, a manual switching device and an SCPD rated as a unit. These devices have a rated conditional short-circuit current I_q and are self-protecting up to this level.

- iv) Control and protective switching devices (CPS) according to IEC 60947-6-2 – a switching device (or equipment) capable of operation other than by hand, but with or without local manual operating means. A CPS is capable of making, carrying and breaking currents under normal conditions, including specified operating overload conditions and of making, carrying for a specified time and breaking currents under specified abnormal conditions such as those of short-circuits. A CPS has a rated service short-circuit breaking capacity and is self-protecting up to this level.

6.3 Switching devices – Application as SCPD

6.3.1 Fuse-combination units and fuses as SCPD

Since the short-circuit breaking function in fuse-combination units is provided by the fuses, it is the fuse characteristics that are considered. These are given in IEC 60269-1 as follows:

- **breaking capacity of a fuse-link**
Summarised as: value (for a.c. the r.m.s. value of the a.c. component) of prospective current that a fuse-link is capable of breaking at a stated voltage under prescribed conditions of use.
- **cut-off current of a fuse-link**
Summarised as: maximum instantaneous value reached by the current during the breaking operation of a fuse-link when it operates to prevent the current reaching the prospective peak.
- **operating I^2t (Joule integral) of a fuse-link**
Summarised as: integral of the square of the current over the operating time of the fuse-link under short-circuit conditions.

Sometimes referred to as “let-through energy”. When expressed in A²s gives the energy dissipated per ohm and thus represents the thermal effect on the circuit.

See Figure 1: Example of the I^2t characteristic of a fuse.

6.3.2 Circuit-breakers according to IEC 60947-2 as SCPD

The short-circuit breaking function is provided by the circuit-breaker itself and the following characteristics should be considered.

Moulded-case circuit-breakers (MCCBs) and air circuit-breakers (ACBs) are rated according to IEC 60947-2 as follows:

- **rated short-circuit making capacity I_{cm}**
Summarised as: maximum peak prospective current that the circuit-breaker can make satisfactorily.
- **rated ultimate short-circuit breaking capacity I_{cu}**
Summarised as: r.m.s prospective current that the circuit-breaker is capable of breaking at a specified voltage, under defined test conditions which include one break operation and one make/break operation.

The I_{cu} rating of a circuit-breaker should be equal to or exceed the prospective (available) short-circuit current at the point of installation. The exception being where the circuit-breaker is itself protected by another SCPD, the combination being rated for a higher short-circuit current.

See Figure 3: Example of SCPDs in combination.

- **rated service short-circuit breaking capacity I_{cs}**
Summarised as: r.m.s prospective current that the circuit-breaker is capable of breaking at a specified voltage, under defined test conditions which include one break operation and two make/break operations.