IEC 60077-5

Edition 2.0 2019-10
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Railway applications – Electric equipment for rolling stock – Part 5: Electrotechnical components – Rules for HV fuses

IEC 60077-5:2019-10 RLV(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 45.060.01

ISBN 978-2-8322-7581-8

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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RAILWAY APPLICATIONS – ELECTRIC EQUIPMENT FOR ROLLING STOCK –

Part 5: Electrotechnical components – Rules for HV fuses

FOREWORD

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International Standard IEC 60077-5 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This second edition cancels and replaces the first edition, issued in 2003. It constitutes a technical revision.

This edition includes the following main technical changes with regard to the previous edition:

a) test method of test duty III for verification of breaking capacity is reviewed.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
9/2539/FDIS	9/2555/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

This document should be read in conjunction with IEC 60077-1 and IEC 60077-2.

A list of all parts in the IEC 60077 series, published under the general title *Railway applications – Electric equipment for rolling stock*, 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 "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,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

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RAILWAY APPLICATIONS – ELECTRIC EQUIPMENT FOR ROLLING STOCK –

Part 5: Electrotechnical components – Rules for HV fuses

1 Scope ~~and object~~

The purpose of this part of IEC 60077 is to give additional or amended rules for high voltage (HV) fuses as a supplement to those given by IEC 60077-2.

NOTE 1 In this document the term high voltage fuses is used in the context of the voltages used in the field of railway rolling stock.

The high voltage fuses concerned are those ~~to be~~ connected into power and/or auxiliary circuits. The nominal voltage of these circuits lies between 600 V DC and 3 000 V DC, according to IEC 60850. These fuses ~~may~~ can also be used in auxiliary AC circuits up to a nominal voltage of 1 500 V.

NOTE 2 Certain of these rules ~~may~~, after agreement between the user and the manufacturer, ~~be~~ are used for fuses installed on vehicles other than rail rolling stock such as mine locomotives, trolleybuses, etc.

This document together with IEC 60077-2 states specifically:

a) the characteristics of the fuses;

b) the service conditions with which the fuses ~~have to~~ comply with reference to:
   - operation and behaviour in normal service;
   - operation and behaviour in case of short circuit;
   - dielectric properties.

c) the tests intended for confirming the compliance of the fuse with the characteristics under the service conditions and the methods ~~to be~~ adopted for these tests;

d) the information ~~to be~~ marked on, or given with, the fuse.

This document does not cover parallel connection of fuses.

During preparation of this document, IEC 60269-1 and IEC 60282-1 have been considered and their requirements have been kept as far as possible.

This document makes reference to the general rules for electrotechnical components given in IEC 60077-2, but for general conditions reference is made directly to IEC 60077-1.

2 Normative references

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(441):1984, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*~~

~~IEC 60050(811):1991, *International Electrotechnical Vocabulary (IEV) – Chapter 811: Electric traction*~~

IEC 60077-1:~~1999~~2017, *Railway applications – Electric equipment for rolling stock – Part 1: General service conditions and general rules*

IEC 60077-2:~~1999~~2017, *Railway applications – Electric equipment for rolling stock – Part 2: Electrotechnical components – General rules*

IEC 60269-1:~~1998~~2006, *Low-voltage fuses – Part 1: General* requirements
IEC 60269-1:2006/AMD1:2009
IEC 60269-1:2006/AMD2:2014

IEC 60282-1:~~2002~~2009, *High-voltage fuses – Part 1: Current-limiting fuses*
IEC 60282-1:2009/AMD1:2014

~~IEC 60850:2000, *Railway applications – Supply voltages of traction systems*~~

IEC 61373~~:1999~~, *Railway applications – Rolling stock equipment – Shock and vibration tests*

ISO 3~~:1973~~, *Preferred numbers – Series of preferred numbers*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in Clause 3 of IEC 60077-1:2017 and Clause 3 of IEC 60077-2:2017, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Components

NOTE For terminologies of a fuse, see also Figure 1 in IEC 60282-1:2009/AMD1:2014.

3.1.1
fuse
device that, by the fusing of one or more of its specifically designed and proportioned components, opens the circuit in which it is inserted by breaking the current when this exceeds a given value for a sufficient time

Note 1 to entry: The fuse comprises all the parts that form the complete device.

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-18-01, modified – The second sentence has been changed to Note 1 to entry.]

3.1.2
fuse-link
part of a fuse (including the fuse-element(s)) intended to be replaced after the fuse has operated

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-18-09]

3.1.3
fuse-element
part of the fuse-link designed to melt under the action of current exceeding some definite value for a definite period of time

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-18-08]

3.1.4
fuse-base
fixed part of a fuse provided with contacts and terminals

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-18-02]

3.1.5
indicating device, <of a fuse>
part of a fuse provided to indicate whether the fuse has operated

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-18-17]

3.1.6
open box type fuse
fuse installed in an open box equipped with an arc chute in order to reduce arc quickly

3.1.7
homogeneous series, <of fuse-links>
series of fuse-links, deviating from each other only in such characteristics that, for a given test, the testing of one or a reduced number of particular fuse-link(s) of that series can be taken as representative for all the fuse-links of the homogeneous series

Note 1 to entry: The relevant publications specify the characteristics by which the fuse-links of a homogeneous series may deviate, the particular fuse-links to be tested and the specific test concerned.

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-18-34, modified – "may" has been replaced with "can".]

3.2 Operational characteristics

3.2.1
prospective current, <of a circuit and with respect to a switching device or a fuse>
current that would flow in the circuit if each pole of the switching device or the fuse were replaced by a conductor of negligible impedance

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-01, modified – Note has been deleted.]

3.2.2
prospective peak current
peak value of a prospective current during the transient period following ~~fault current~~ initiation

Note 1 to entry: This term is commonly associated with short-circuit conditions.

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-02, modified – Note to entry has been replaced.]

3.2.3
pre-arcing time
interval of time between the beginning of a current large enough to cause a break in the fuse-element(s) and the instant when an arc is initiated

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-18-21]

3.2.4
arcing time, <of a pole or a fuse>
interval of time between the instant of the initiation of the arc in a pole or a fuse and the instant of final arc extinction in that pole or that fuse

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-37~~, modified~~]

3.2.5
operating time
sum of the pre-arcing time and the arcing time

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-18-22]

3.2.6
arc voltage, <of a fuse>
instantaneous value of voltage which appears across the terminals of a fuse during the arcing time

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-18-30]

3.2.7
peak arc voltage, <of a fuse>
maximum instantaneous value of voltage which under prescribed conditions appears across the terminals of a fuse during the arcing time

Note 1 to entry: After extinction of the arc, an overvoltage (transient recovery voltage) may be present across the terminals. The value of this will depend on the circuit characteristics and the fuse. This overvoltage is not part of the peak arc voltage (see Figure D.2 and Figure D.3).

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-30, modified – "a pole of a switching device" has been replaced with "a fuse". Note 1 to entry has been added.]

3.2.8
DC~~ or power frequency~~ steady-state recovery voltage
recovery voltage in a DC circuit after the transient voltage phenomena have subsided, expressed by the mean value where ripple is present

Note 1 to entry: This is shown as B_1 and B_2 in Figure D.2 and Figure D.3.

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-28, modified – Note 1 to entry has been added.]

3.2.9
peak let-through current
maximum instantaneous value of current attained during the operation of a fuse

~~[IEV 441-17-12, modified]~~

3.2.10
joule integral
I*²*t
integral of the square of the current over a given time interval

$$I^2t=\int_{t_0}^{t_1} i^2\mathrm{d}t$$

Note 1 to entry: The pre-arcing I^2t is the I^2t integral extended over the pre-arcing time of the fuse.

Note 2 to entry: The operating I^2t is the I^2t integral extended over the operating time of the fuse.

Note 3 to entry: The energy in joules liberated in one ohm of resistance in a circuit protected by a fuse is equal to the value of the operating I^2t expressed in A^2s.

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-18-23]

3.2.11
time-current characteristic
curve giving the time, e.g. pre-arcing time or operating time, as a function of the prospective current under stated conditions of operation

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-17-13]

3.2.12
conventional non-fusing current
value of current specified as that which the fuse-link is capable of carrying for a specified time (conventional time) without melting

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-18-27]

3.2.13
conventional fusing current
value of current specified as that which causes operation of the fuse-link within a specified time (conventional time)

[SOURCE: IEC 60050-441:1984/AMD1:2000, 441-18-28]

3.2.14
rated value
~~quantity value, generally assigned by a manufacturer, for a specified operating condition of a fuse~~

value of a quantity used for specification purposes, established for a specified set of operating conditions of a component, device, equipment, or system

~~[IEV 811-11-02, modified]~~

Note 1 to entry: The rated values usually stated for fuses are voltage, current, breaking capacity and power dissipation.

[SOURCE: IEC 60050-151:2001, 151-16-08, modified – Note 1 to entry has been added.]

3.3 Abbreviated terms

AC Alternating Current

DC Direct Current

HV High Voltage

4 Classification

4.1 Breaking range ~~(see also Annex B)~~

Fuse-links are classified according to whether they are:

a) "g" fuse-link: with a full range breaking capacity, i.e. capable under specified conditions of breaking all currents which cause melting of the fuse-element up to its rated breaking capacity;

b) "a" fuse-link: with a partial range breaking capacity, i.e. capable of breaking under specified conditions all currents between their minimum breaking capacity and their rated breaking capacity. They may be used in conjunction with another switching device where protection is required against overcurrent below their minimum breaking capacity.

NOTE 1 Comparison between "a" and "g" fuse time current characteristics is shown in Figure B.1 of Annex B.

NOTE 2 Examples of "a" fuse-link protection ~~may~~ can be those for protection of semiconductor devices, motors, etc.

4.2 Utilisation category

Fuse-links may be categorised according to whether they are to be subjected in normal service to:

– current values which do not exceed their continuous rating;

– current values which briefly exceed their continuous rating on a regular basis, such as when starting a rotating machine;

– current values which do not exceed their continuous rating but which are switched or change significantly in a frequently repeated pattern;

or they have to provide a special protection as, for example:

– semiconductor conditions, where fast action is required in order to limit the peak let-through current and the operating I^2t;

– provide a time delayed operation.

5 Characteristics

The characteristics of a fuse shall be stated in terms of the following:

– rated voltage(s) DC and/or AC;

– rated current (I_n);

– rated frequency;

– rated breaking capacity;

– breaking range;

– rated power dissipation;

– time-current characteristics. The conventional times and currents for "g" fuse-links are given in Table 1;

– overload capability;

– I^2t characteristics (minimum pre-arcing I^2t and maximum operating I^2t);

– peak let-through current related to prospective current and time constant;

– current rating correction factors versus ambient temperature;

– peak arc voltage related to operating voltage;

– rated insulation voltage (U_{Nm}) for fuse-bases;

– rated impulse voltage (U_{Ni}) for fuse-bases.

When presented graphically, the I^2t characteristics shall be given with prospective current as abscissa and I^2t values as ordinate. Logarithmic scales shall be used on both co-ordinate axes.

Table 1 – Conventional times for "g" fuse-links

Rated current A	Specified time (conventional time) h
$I_n \leq 63$	1
$63 < I_n \leq 160$	2
$160 < I_n \leq 400$	3
$I_n > 400$	4

6 Product information

6.1 Documentation

This information shall be given in the manufacturer's catalogue or manual.

6.1 of IEC 60077-2:2017 applies, supplemented by the following:

– rated voltage;
– rated current;
– rated breaking capacity and time constant;
– suitable applications (see 4.2);
– I^2t characteristics (minimum pre-arcing I^2t and maximum operating I^2t);
– correction factors for current rating versus ambient temperature, varying load and overload;
– physical dimensions;
– special instructions for storage, installation, maintenance, if applicable.

6.2 Marking

Fuse-links and fuse-bases shall possess durable and legible nameplates or engraved markings in accordance with 6.2 of IEC 60077-2:2017.

For the open box type fuse nameplates or engraved markings shall be placed on the box.

The markings of the fuse-link and fuse-base shall include the following data:

– manufacturer's name or trade mark;
– manufacturer's type designation;
– rated voltage (DC and/or AC);
– rated current.

7 Normal service conditions

These conditions are given in Clause 7 of IEC 60077-1:2017.