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colour inside

Railway applications – Electric equipment for rolling stock – Part 2: Electrotechnical components – General rules

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RAILWAY APPLICATIONS – ELECTRIC EQUIPMENT FOR ROLLING STOCK –

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FOREWORD

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International Standard IEC 60077-2 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This second edition cancels and replaces the first edition of IEC 60077-2, issued in 1999. It constitutes a technical revision.

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

a) Short circuit breaking capacity;
b) Rated short-time withstand current;
c) Critical currents range;
d) Climatic conditions are specified.

This standard is to be read in conjunction with IEC 60077-1.

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

FDIS	Report on voting
9/2267/FDIS	9/2279/RVD

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

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.

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

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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- withdrawn,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.

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RAILWAY APPLICATIONS – ELECTRIC EQUIPMENT FOR ROLLING STOCK –

Part 2: Electrotechnical components – General rules

1 Scope ~~and object~~

In addition to the rules given in IEC 60077-1, this part of IEC 60077 provides general rules for all electrotechnical components installed in power circuits, auxiliary circuits, control and indicating circuits, etc., on railway rolling stock.

The purpose of this document is to adapt the general rules given in IEC 60077-1 to all electrotechnical components for rolling stock, in order to obtain uniformity of requirements and tests for the corresponding range of components.

Electrotechnical components are mainly switchgear and controlgear, including also relays, valves, resistors, fuses, etc., irrespective of the nature of their control.

~~NOTE 1~~ The incorporation of electronic components or electronic subassemblies into electrotechnical components is now common practice. Although this document is not applicable to electronic equipment, the presence of electronic components does not give grounds to exclude such electrotechnical components from the scope of this document.

Electronic subassemblies ~~should~~ comply with the relevant standard.

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

This document states:

a) the characteristics of the components;

b) the service conditions with which components have to comply;

c) the tests intended to confirm compliance of the components with these characteristics under these service conditions, and the methods to be adopted for these tests;

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

This document does not cover industrial electrotechnical components which comply with their own product standard. In order to ensure satisfactory operation of these components for rolling stock, this document ~~should be~~ is used to specify only the particular requirements for railway application. In that case, a specific document ~~should~~ would state the additional requirements with which the industrial components are to comply, e.g.:

– to be adapted (for example for control voltage, environmental conditions, etc.); or

– to be installed and used so as not to have to endure specific railway conditions; or

– to be additionally tested to prove that these components can satisfactorily withstand railway conditions.

In the event of there being a difference in requirements between this document and a railway rolling stock relevant product standard, then the product standard requirements take precedence.

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(446):1983, *International Electrotechnical Vocabulary (IEV) – Chapter 446: Electrical relays*~~

~~IEC 60050(604):1987, *International Electrotechnical Vocabulary (IEV) – Chapter 604: Generation, transmission and distribution of electricity – Operation*~~

IEC 60050-811:~~1991~~ 2017, *International Electrotechnical Vocabulary (IEV) – Chapter 811: Electric traction*

IEC 60068-2-1~~:1990~~, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2~~:1974~~, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

~~IEC 60068-2-3:1969, *Environmental testing – Part 2: Tests – Test Ca: Damp heat, steady state*~~

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-52~~:1996~~, *Environmental testing – Part 2-52: Test methods – Test Kb: Salt mist, Cyclic (Sodium, chloride solution)*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

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

~~IEC 60077-3, —, *Railway applications – Electric equipment for rolling stock – Part 3: Electrotechnical components – Rules for d.c. circuit-breakers*[1)]~~

~~IEC 60077-4, —, *Railway applications – Electric equipment for rolling stock – Part 4: Electrotechnical components – Rules for a.c. circuit-breakers*[1)]~~

~~IEC 60077-5, —, *Railway applications – Electric equipment for rolling stock – Part 5: Electrotechnical components – Rules for HV fuses*[1)]~~

IEC 60417, *Graphical symbols for use on equipment* (available at http://www.graphical-symbols.info/equipment)

IEC 60529~~:1989~~, *Degrees of protection provided by enclosures (IP Code)*

~~1) To be published.~~

IEC TR 60943~~:1998~~, *Guidance concerning the permissible temperature rise for parts of electrical equipment, in particular for terminals*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in IEC 60077-1 as well as the following apply.

~~NOTE – The definitions are also given to be used as reference terminology for the other parts of this series of standards, as well as for other particular documents.~~

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

3.1.1
active electrical component
simple device or assembly of devices which, in response to a control signal, executes a function or various inseparable functions of logical or analogical nature by changing their state, for which the control or the function is electrical (e.g. contactor, relay, etc.)

Note 1 to entry: Passive electical component is defined as the antonym of this term.

3.1.2
passive electrical component
simple device or assembly of devices which are not included in the active electrical components group and have at least one electrical function (e.g. mounting insulator, permanent connection, resistor, capacitor, etc.)

3.1.3
switchgear and controlgear
general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-11-01]

3.1.4
switchgear
general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended in principle for use in connection with generation, transmission, distribution and conversion of electric energy

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-11-02]

3.1.5
controlgear
general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended in principle for the control of electric energy consuming equipment

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-11-03]

3.1.6
switching device
device designed to make or break the current in one or more electric circuits

Note 1 to entry: A switching device may perform one or both of these operations.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-14-01, modified – Note 1 to entry has been added.]

3.1.7
fuse
device that, by the fusing of one or more of its specially 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 / AMD1:2007, 441-18-01, modified – The second sentence has been changed to Note 1 to entry.]

3.1.8
<mechanical> **switch**
mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions which may include specified operating overload conditions and also carrying for a specified time currents under specified abnormal circuit conditions such as those of short-circuit

Note 1 to entry: A switch may be capable of making but not breaking short-circuit currents.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-14-10]

3.1.9
mechanical switching device
switching device designed to close and open one or more electric circuits by means of separable contacts

Note 1 to entry: Any mechanical switching device may be designated according to the medium in which its contacts open and close, e.g. air, SF6, oil.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-14-02]

3.1.10
circuit-breaker
mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under specified abnormal circuit conditions such as those of short-circuit

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-14-20]

3.1.11
~~**(mechanical)**~~ **contactor**
mechanical switching device having only one position of rest, operated otherwise than by hand, capable of making, carrying and breaking currents under normal circuit conditions including operating overload conditions ~~[IEV 811-29-07]~~

Note 1 to entry: Contactors may be designated according to the method by which the force for closing the main contacts is provided.

Note 2 to entry: The definition is the same as"mechanical contactor": IEC 60050-441:1984 / AMD1:2007, 441-14-33.

~~**3.1.11**~~
~~**surge arrester**~~
~~device designed to protect the electrical apparatus from high transient overvoltages and to limit the duration and frequently the amplitude of the follow-on current [IEV 604-03-51]~~

3.1.12
disconnector ~~**(isolator)**~~
mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements

Note 1 to entry: A disconnector is capable of opening and closing a circuit only when negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the poles of the disconnector occurs. It is also capable of carrying currents under normal circuit conditions and carrying for a specified time currents under abnormal conditions such as those of short circuit.

[SOURCE: IEC 60050-811:2017, 811-29-17]

3.2 Component parts

3.2.1
pole of a switching device
portion of a switching device associated exclusively with one electrically separated conducting path of its main circuit and excluding those portions which provide a means for mounting and operating all poles together

Note 1 to entry: A switching device is called single-pole if it has only one pole. If it has more than one pole, it may be called multipole (two-pole, three-pole, etc.) provided the poles are or can be coupled in such a manner as to operate together.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-01]

3.2.2
main circuit, <of a switching device>
all the conductive parts of a switching device included in the circuit which it is designed to close or open

Note 1 to entry: This does not include parts that are included in the auxiliary circuit of the switching device (see 3.2.4).

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-02, modified – Note 1 to entry has been added.]

3.2.3
control circuit, <of a switching device>
all the conductive parts (other than the main circuit) of a switching device which are included in a circuit used for the closing operation or opening operation, or both, of the device

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-03]

3.2.4
auxiliary circuit, <of a switching device>
all the conductive parts of a switching device which are intended to be included in a circuit other than the main circuit and the control circuits of the device

Note 1 to entry: Some auxiliary circuits fulfil supplementary functions such as signalling, interlocking, etc., and, as such, they may be part of the control circuit of another switching device.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-04]

3.2.5
contact, <of a mechanical switching device>
conductive parts designed to establish circuit continuity when they touch and which, due to their relative motion during an operation, open or close a circuit or, in the case of hinged or sliding contacts, maintain circuit continuity

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-05]

3.2.6
main contact
contact included in the main circuit of a mechanical switching device, intended to carry, in the closed position, the current of the main circuit

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-07]

3.2.7
auxiliary contact
contact included in an auxiliary circuit and mechanically operated by the switching device

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-10]

3.2.8
make contact
~~control or auxiliary~~ contact which is closed when the main contacts of the mechanical switching device are ~~closed and open when they are open~~ in their operate condition and which is open when they are in their release condition

Note 1 to entry: See complementary information in Annex A of this document.

Note 2 to entry: "normally open contact" is a deprecated term.

[SOURCE: IEC 60050-811:2017, 811-31-03, modified – "relay" is replaced with "main contacts of the mechanical switching device". Note 1 to entry and Note 2 to entry have been added.]

3.2.9
break contact
~~control or auxiliary~~ contact which is open when the main contacts of the mechanical switching device are ~~closed and closed when they are open~~ in their operate condition and which is closed when they are in their release condition

Note 1 to entry: See complementary information in Annex A of this document.

Note 2 to entry: "normally closed contact" is a deprecated term.

[SOURCE: IEC 60050-811:2017, 811-31-04, modified – "relay" is replaced with "main contacts of the mechanical switching device". Note 1 to entry and Note 2 to entry have been added.]

3.2.10
<electric~~al~~> **relay**
device designed to produce sudden predetermined changes in one or more electric~~al~~ output circuits, when certain conditions are fulfilled in the electric~~al~~ input circuits controlling the device

~~[IEV 446-11-01]~~

Note 1 to entry: This definition may also be applied to relays for which the actuation is not electric~~al~~.

[SOURCE: IEC 60050-151:2001, 151-13-31, modified – Note 1 to entry has been added.]

3.2.11
release, <of a mechanical switching device>
device, mechanically connected to a mechanical switching device, which releases the holding means and permits the opening or the closing of the switching device

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-17]

3.3 Operational features

3.3.1
operation, <of a mechanical switching device>
transfer of the moving contact(s) from one position to an adjacent position

Note 1 to entry: For a circuit-breaker, this may be a closing operation or an opening operation.

Note 2 to entry: If distinction is necessary, an operation in the electrical sense, e.g. make or break, is referred to as a switching operation, and an operation in the mechanical sense, e.g. close or open, is referred to as a mechanical operation.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-01]

3.3.2
operating cycle, <of a mechanical switching device>
succession of operations from one position to another and back to the first position through all other positions, if any

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-02]

~~**3.3.3**~~
~~**operating sequence (of a mechanical switching device)**~~
~~succession of specified operations with specified time intervals [IEV 441-16-03]~~

3.3.3
manual control
control of an operation by human intervention

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-04]

3.3.4
closed position, <of a mechanical switching device>
position in which the predetermined continuity of the main circuit of the device is secured

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-22]

3.3.5
open position, <of a mechanical switching device>
position in which the predetermined dielectric withstand voltage requirements are satisfied between open contacts in the main circuit of the device

Note 1 to entry: This definition differs from IEV 441-16-23 to meet the requirements of dielectric properties.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-23, modified – "clearance…is secured" is changed to "dielectric withstand voltage requirements are satisfied". Note 1 to entry has been added.]

3.3.6
breaking current, <of a switching device or a fuse>
current in a pole of a switching device or in a fuse at the instant of initiation of the arc during a breaking process

Note 1 to entry: For AC the current is expressed as the symmetrical RMS value of the AC component.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-07, modified. Note 1 to entry has been added.]

3.3.7
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

Note 1 to entry: The method to be used to evaluate and to express the prospective current is to be specified in the relevant publications.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-01]

3.3.8
prospective making current, <for a pole of a switching device>
prospective current when initiated under specified conditions

Note 1 to entry: The specified conditions may relate to the method of initiation, e.g. by an ideal switching device, or to the instant of initiation, e.g. leading to the maximum prospective peak current in an AC circuit, or to the highest rate of rise. The specification of these conditions is given in the relevant publications.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-05]

3.3.9
prospective breaking current, <for a pole of a switching device or a fuse>
prospective current evaluated at a time corresponding to the instant of the initiation of the breaking process

Note 1 to entry: Specifications concerning the instant of the initiation of the breaking process are to be found in the relevant publications. For mechanical switching devices or fuses, it is usually defined as the moment of initiation of the arc during the breaking process.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-06]

3.3.10
breaking capacity, <of a switching device or a fuse>
value of prospective breaking current that a switching device or a fuse is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

Note 1 to entry: The voltage to be stated and the conditions to be prescribed are dealt with in the relevant publications.

Note 2 to entry: For AC, the current is expressed as the symmetrical RMS value of the AC component.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-08, modified – Note 2 to entry has been changed.]

3.3.11
short circuit breaking capacity
breaking capacity for which the prescribed conditions include a short-circuit at the terminals of the switching device

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-11]

3.3.12
critical current
critical currents range
value (or range of values) of ~~d.c.~~ current at which the component is not capable of operating without risk of failure to break

Note 1 to entry: For AC current only AC contactor is applicable.

3.3.13
making capacity, <of a switching device or a fuse>
value of prospective making current that a switching device is capable of making at a stated voltage under prescribed conditions of use and behaviour

Note 1 to entry: The voltage to be stated and the conditions to be prescribed are dealt with in the relevant publications.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-09, modified – In Note 1 to entry "specifications" is replaced with "publications".]

3.3.14
short circuit making capacity
making capacity for which the prescribed conditions include a short circuit at the terminals of the switching device

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-10]

3.3.15
short-time withstand current
current that a circuit or a switching device in the closed position can carry during a specified short time under prescribed conditions of use and behaviour

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-17]

~~**3.3.17**~~
~~**applied voltage (for a switching device)**~~
~~the voltage which exists across the terminals of a pole of a switching device just before the making of the current [IEV 441-17-24]~~

~~NOTE – This definition applies to a single-pole device. For a multipole device it is the phase-to-phase voltage across the supply terminals of the device.~~

3.3.16
recovery voltage
voltage which appears across the terminals of a pole of a switching device or a fuse after the breaking of the current

Note 1 to entry: This voltage may be considered in two successive intervals of time, one during which a transient voltage exists, followed by a second one during which the power-frequency ~~voltage~~ or the steady-state recovery voltage alone exists.

Note 2 to entry: This definition applies to a single-pole device. For a multipole device it is the phase-to-phase voltage across the supply terminals of the device.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-25, modified – Note 2 to entry has been added.]

3.3.17
peak arc voltage, <of a mechanical switching device>
maximum instantaneous value of voltage which, under prescribed conditions, appears across the terminals of a pole of a switching device during the arcing time

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-30]

3.3.18
opening time, <of a mechanical switching device>
interval of time between the specified instant of initiation of the opening operation and the instant when the arcing contacts have separated in all poles

Note 1 to entry: The instant of initiation of the opening operation, i.e. the application of the opening command (e.g. energising the release, etc.) is given in the relevant publications.

Note 2 to entry: Closing time is defined as the antonym of this term.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-36, modified – Note 2 to entry has been added.]

3.3.19
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 / AMD1:2007, 441-17-37]

3.3.20
break time
interval of time between the beginning of the opening time of a mechanical switching device (or the pre-arcing time of a fuse) and the end of the arcing time

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-39]

3.3.21
closing time
interval of time between the initiation of the closing operation and the instant when the contacts touch in all poles

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-41]

3.4 Abbreviated terms

AC Alternating Current
DC Direct Current
EMC Electromagnetic Compatibility
RMS Root Mean Square value

4 Classification

This clause is intended to list the characteristics of a component on which information is given by the manufacturer and which shall be verified by testing where relevant.

The components are classified:

– according to their operational frequency C1, C2 or C3;

  The characteristics of these categories, applicable to active electrical components only, are given in 5.4;

– according to their component category A1, A2, A3, A4 or B;

  The characteristics of these categories are given in 5.5;

– according to the type of design:
  - open construction;
  - construction with an enclosure;

– according to the degree of protection provided by the enclosure (see IEC 60529).

5 Characteristics

5.1 List of characteristics

The characteristics of a component shall be stated, as applicable, among those of the following list:

– type of component (5.2);
– rated and limiting values of the main circuit (5.3);
– operational frequencies (5.4);
– component category (5.5);
– electric control circuits (5.6);
– pneumatic control circuit (5.7);
– manual control (5.8);
– electric auxiliary circuits (5.9);
– pneumatic auxiliary circuits (5.10);
– peak arc voltages (5.11).

5.2 Type of component

It is necessary to indicate the following, as applicable:

– type of component (e.g., DC contactor, disconnector, master controller, braking controller, etc.);
– number of poles;
– rated and limiting voltages of the main circuit (5.3);
– rated and limiting currents of the main circuit (5.3);
– interrupting medium;
– polarity;
– operating conditions (method of operation, method of control, etc.);
– type of design (Clause 4);
– degree of protection provided by the enclosure (Clause 4).

5.3 Rated and limiting values for the main circuit

5.3.1 General

Rated values are assigned by the manufacturer. They shall be stated in accordance with 5.3.2 to 5.3.5.

5.3.2 Rated voltages

A component is defined by the following rated voltages given in 5.2 of IEC 60077-1:2017:

– rated operational voltage (~~U_e~~ U_r);
– rated insulation voltage (~~U_i~~ U_{Nm});
– rated impulse ~~withstand~~ voltage (U_{Ni} ~~U_{imp}~~);
– power-frequency test voltage (U_a).

NOTE The limiting values of operating conditions are given in 8.2.1of IEC 60077-1:2017.

5.3.3 Rated currents

A component is defined by the following rated currents:

– rated operational current (~~I_e~~ I_r) at the rated time constant τ_2 (see 5.3.4) or for the rated power factor (see 5.3.5) where relevant (given in 5.4 of IEC 60077-1:2017);

– rated short time withstand current (I_{cw}) (see 3.3.15);

– conventional free air thermal current (I_{th});

– conventional enclosed thermal current (I_{the}).

The conventional free air thermal current is the maximum value of the test current to be used for temperature rise tests of equipment in free air at the maximum ambient air temperature.

The conventional enclosed thermal current is the maximum value of the test current to be used for temperature rise tests of equipment mounted in the specified enclosure at the maximum ambient air temperature.

Free air is understood to be air under normal indoor conditions, reasonably free from draughts and external radiation.

For a continuous duty, the maximum value of the rated operational current shall be less than the value of the conventional free air thermal current if no forced cooling is used.

5.3.4 Rated time constants (for DC switchgear)

A component is characterised according to the applicable rated time constants τ_1, τ_2 and τ_3 given in Table 1. τ_2 is the rated time constant for operating conditions considered as normal; it is used for the tests specified in 9.3.3.6. τ_1 and τ_3 are time constants corresponding to extreme situations; they are used for the tests as specified in 9.3.6.

If necessary, the time constant values may be defined by agreement between the user and the manufacturer.

Table 1 – Rated time constants

Rated operational voltage V	Rated time constants ms		
	τ_1	τ_2	τ_3
~~U_e~~ $U_r \leq 900$	0	15	50
$900 < $ ~~U_e~~ $U_r \leq 1\,800$	0	15	40
~~U_e~~ $U_r > 1\,800$	0	15	30
NOTE A time constant of 0 ms signifies that the loads for the tests are made up of resistors without any intentional addition of reactors.			

5.3.5 Rated power factor (for AC switchgear)

The operational performance capability of a component is defined for a rated power factor of 0,8, whatever the rated operational voltage and current. If necessary the power factor for short-circuit and overload tests will be as agreed between the user and the manufacturer.

5.4 Operational frequencies

The operational frequencies C1, C2 and C3 are defined below:

– C1: light operational frequency (e.g. component which is part of the protection and/or isolation equipment which operates only when a failure is detected);

– C2: medium operational frequency (e.g. component which is part of equipment that operates in any of the following cases: at each commencement of service, each start,

each stop, each neutral section (IEC 60050-811:2017, 811-36-16), each sectioning point (IEC 60050-811:2017, 811-36-11), each end of service);

– C3: heavy operational frequency (e.g. component which is part of equipment that operates during each traction sequence or braking sequence, or component such as a compressor contactor).

NOTE The references in brackets refer to definitions given in IEC 60050-811:2017.

5.5 Component categories

There are several component categories:

– A1: switching devices for auxiliary circuits (IEC 60050-811:2017, 811-25-05) or low-voltage circuits (IEC 60050-811:2017, 811-25-02) (e.g. relays, auxiliary contactors and their accessories, etc.) irrespective of the nature of their control, except components with manual control;

– A2: switching devices for power circuits (IEC 60050-811:2017, 811-25-03) (e.g. DC power contactors), irrespective of the nature of their control, except components with manual control.

NOTE 1 Main circuit-breakers are covered by their own product standard (see IEC 60077-3 and IEC 60077-4).

– A3: manually-controlled switching devices (e.g. switches, push-buttons, etc., for control equipment);

– A4: power switchgear which does not operate on load (e.g. disconnector, system changeover switch (IEC 60050-811:2017, 811-29-37), etc.);

– B: other components not covered by the above.

NOTE 2 The references in brackets refer to definitions given in IEC 60050-811:2017.

5.6 Electric control circuits

The characteristics of electric control circuits are as follows:

– rated frequency, if AC;

– rated voltage of the control circuit and its limiting values;

– rated voltage of the control supply (if it differs from the rated voltage of control circuit due to the presence of built-in transformers, rectifiers, resistors, etc.);

– power consumption of the control supply at its rated voltage.

The rated control circuit voltage and rated frequency, if any, are the values on which the operating and temperature rise characteristics of the control circuit are based. The correct operating conditions are based upon values of the control supply voltage as defined in 5.3 of IEC 60077-1:2017.

5.7 Pneumatic control circuits

The characteristics of air supply control circuits (pneumatic or electro-pneumatic) are as follows:

– rated air pressure of the control circuit and limiting values;

– rated air pressure of the control supply (if it differs from the rated air pressure of the control circuit due to the presence of built-in regulators);

– volume of air, for each rated air pressure, required for each closing and each opening operation.

The rated air pressure of a pneumatic or electro-pneumatic component is the air pressure on which the operating characteristics of the pneumatic control system are based.

The rated operating conditions are based upon a value of the rated air pressure as defined in 5.6 of IEC 60077-1:2017.

5.8 Manual control

If necessary, the following characteristics may be specified:

– form of the manual actuator (handle, knob, push-button, etc.);
– actuating force (or torque): the force (or torque) necessary to complete the intended operation;
– restoring force (or torque): the force (or torque) provided to restore the actuator to its initial position;
– travel: the displacement (linear or rotary) of the actuator.

5.9 Electric auxiliary circuits

The characteristics of the electric auxiliary circuits are the number and nature of the contacts (make contact, break contact, etc.) of each of these circuits and their rated characteristics, as follows:

– rated operational voltage(s) ($U_{r)}$);
– rated insulation voltage (U_{Nm});
– rated operational current(s) ($I_{r)}$);
– conventional free air thermal current (I_{th});
– minimum current associated with an operational voltage that the auxiliary circuit is capable of making and carrying reliably;
– sequence of the auxiliary contacts in relation to the main contacts;
– rated short time withstand current (I_{cw}).

5.10 Pneumatic auxiliary circuits

The characteristics of pneumatic auxiliary circuits are the number and nature of the valves of each of these circuits and their rated characteristics, as follows:

– rated air pressure;
– rated air flow;
– sequence of the pneumatic auxiliary valves in relation to the main contacts.

5.11 Peak arc voltages

The manufacturer shall specify the maximum value of the peak arc voltages caused by operating the component.

6 Product information

6.1 Nature of the information

6.1.1 General

The information shall be given in the manufacturer's catalogue or manual. It concerns the identification and characteristics.

In addition, other information relative to the application may be especially required. This information shall be the result of an agreement.

6.1.2 Component documentation

6.1.2.1 General

The information listed below shall be given in the manufacturer's catalogue or manual:

6.1.2.2 Identification

– manufacturer's name or trademark;
– type designation;
– modification status (if applicable);
– reference to the present document if the manufacturer declares compliance with it;

6.1.2.3 Characteristics (as applicable)

– each rated operational voltage (~~U_e~~ U_r);
– each rated operational current (~~I_e~~ I_r) at the relevant rated operational voltage;
– conventional free air thermal current (I_{th}) or conventional enclosed thermal current (I_{the}) if this differs from the rated operational current; this shall be supplemented by the value of the maximum ambient air temperature ~~at which the component was calibrated~~;
– each rated operational frequency (f_r) if the manufacturer declares compliance with one or several of them;
– each component category if the manufacturer declares compliance with one or several of them;
– rated insulation voltage (~~U_i~~ U_{Nm});
– rated impulse ~~withstand~~ voltage (~~U_{imp}~~ U_{Ni});
– power-frequency test voltage (U_a);
– peak arc voltages, under relevant test conditions;
– rated short-circuit making and breaking capacities at corresponding rated time constants or rated power factor;
– maximum current consumption or maximum power consumption;
– IP code in the case of an enclosed component (according to IEC 60529);
– pollution degree (according to 7.9 of IEC 60077-1:2017);
– rated voltage and current (including frequency if applicable) of each control circuit;
– rated air pressure and limiting values;
– number and type of electric auxiliary circuits and their characteristics;
– number and type of pneumatic auxiliary circuits and their characteristics;
– overall dimensions;
– minimum size of the enclosure and, if applicable, data concerning ventilation, to which the rated characteristics apply;
– minimum distance between the components and metal parts connected to earth for components which are intended for use without an enclosure;
– weight.

6.1.3 Other information

When the application requires a special utilisation of the component, agreed by the manufacturer, supplementary information shall be given on request.

This may concern, for example:

– range of operational current under special operating conditions;

– overload duty at fault occurrence;
– overload duty without any breaking on load;
– etc.

6.2 Marking

The following data or identification shall be marked:

– manufacturer's name or trade mark;
– type designation;
– reference to this document if the manufacturer declares compliance with it;
– serial number designation, or date or code of manufacture;
– rated operational voltage (~~U_e~~ U_r) and associated rated operational current (~~I_e~~ I_r);
– terminals and polarity, when necessary (this may be done in the form of a diagram);
– protective bonding terminal, where applicable, designated by the symbol  IEC 60417-5019 (2006-08).

The above information is preferably marked on the name plate, if any, or on the component itself in order to permit the complete data to be obtained from the manufacturer (traceability). The marking shall be indelible and easily legible before installation without removal of any parts.

The type designation, serial number and terminal markings should be visible after installation of the component.

6.3 Instructions for storage, installation, operation and maintenance

These instructions shall comply with 6.3 of IEC 60077-1:2017.

7 Normal service conditions

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

8 Constructional and performance requirements

8.1 Constructional requirements

8.1.1 General

8.1 of IEC 60077-1:2017 applies, with the additions given hereinafter.

8.1.2 Terminals and connecting capacity

Terminals and their connecting capacity should be designed in accordance with IEC TR 60943.

8.1.3 Protective bonding terminal

In order to comply with 8.1.1 of IEC 60077-1:2017, the component shall have a protective bonding connection when there are exposed conductive parts which could become live in case of insulation failure. This is generally achieved by a terminal provided solely for this function, named commonly protective bonding terminal.

The protective bonding terminal shall be readily accessible and visible, and so placed that the connection of the component to the vehicle structure or to the protective conductor is maintained when the cover or any other removable part is removed.

The protective bonding terminal shall be suitably protected against corrosion. Efficiency of bonding provided by assembly shall be proved on a sample.

~~NOTE~~ For ~~U_r~~ U_{Nm} ≤ 120 V DC or 50 V AC, bonding may be achieved by the equipment or component fixtures when the metallic parts are electrically connected to the fixtures, and when the equipment or component is screwed to a metallic plate which is itself connected to the vehicle structure.

If non conductive coatings are used, a spring washer capable of breaking through the insulating layer may be inserted below screw or bolt heads.

8.2 Performance requirements

8.2.1 Operating conditions

8.2.1 of IEC 60077-1:2017 applies, with the additions given hereinafter:

a) All components:

After stabilisation of its temperature in an ambient air temperature of ~~–25 °C~~ minimum and maximum temperature defined in IEC 60077-1:2017, the component shall be able to operate ~~correctly~~ satisfactorily within the limiting values of the equipment voltage.

b) Components supplied by a contact line, a transformer, generator, alternator, electronic converter or a battery off charge system (see 5.3.3.2, 8.2.1.2, 8.2.1.3, 8.2.1.5 and 8.2.1.6 of IEC 60077-1:2017).

The component ~~designed for an ambient air temperature T_a (25 °C or 55 °C)~~ shall be able to operate ~~correctly~~ satisfactorily within the limiting values of the equipment voltage after stabilisation of its temperature under the permanent supply at the maximum equipment voltage~~, and the ambient air limiting temperature equal to (T_a + 15) °C.~~

c) Components supplied ~~from~~ by a float charge battery system (see 5.3.3.2, 8.2.1.4 of IEC 60077-1:2017).

The component ~~designed for an ambient air temperature T_a (25 °C or 55 °C)~~ shall be able to operate ~~correctly~~ satisfactorily at the maximum ambient air temperature:

1) within ~~a range of 0,7 to 1,25 times~~ the ~~nominal~~ full equipment voltage range according to IEC 60077-1:2017, Table 1 after stabilisation of its temperature under the permanent supply at the nominal equipment voltage~~, and the ambient air limiting temperature equal to (T_a + 15) °C~~,

2) and within a range of 0,8 to 1,25 times the nominal equipment voltage after stabilisation of its temperature under the permanent supply at the rated operational voltage~~, and the ambient air limiting temperature equal to (T_a + 15) °C~~.

d) Electropneumatic components:

The component shall be able to operate ~~correctly~~ satisfactorily at the minimum air pressure for the test at ~~–25 °C~~ minimum temperature defined in IEC 60077-1:2017 and at the maximum air pressure for the other tests. The operating conditions apply for all the supply air pressures within the limiting values.

8.2.2 Temperature ~~rise~~ limits

Temperatures shall not reach values likely to cause an irreversible change to the component.

8.2.2 of IEC 60077-1:2017 applies, along with Table 2 given below.

Table 2 – Temperature rise limits and temperature limits

Parts of component	Maximum temperatures °C	Example of temperature rise limits for maximum air ambient temperature of [a]	
		40 °C (T_r = 25 °C) K	70 °C (T_r = 55 °C) K
Flexible connections in copper (braids)		90	60
Flexible contacts (in the form of a spring)			
– in copper (not recommended)		35	
– in brass or in bronze		65	35
Non-flexible contacts:			
– in copper		75	45
– silver-plated or nickel-plated		75	45
– in solid silver		100	70
– tin-plated	105 [a]		
– other metals or sintered metals	[b]		
Other conductive parts including non-insulated coils and bars	[b]		
Bolted connections other than terminals			
– in copper		75	45
– in brass or in bronze		75	45
– silver-plated or nickel-plated		75	45
– tin-plated	105 [a]		

[a] These values given for common materials, for which service is proven, are in accordance with the recommendations of IEC TR 60943.

[b] Values to be determined by the characteristics of the metals used and limited by the obligation of not causing damage to themselves and to adjacent parts, in particular for metal parts in contact with insulating materials.

8.2.3 Operation following inactivity

8.2.3 of IEC 60077-1:2017 applies.

8.2.4 Electromagnetic compatibility (EMC)

8.2.4 of IEC 60077-1:2017 applies.

8.2.5 Acoustic noise emission

8.2.5 of IEC 60077-1:2017 applies.

8.2.6 ~~Dielectric properties~~ Clearances

8.2.6 of IEC 60077-1:2017 applies.

8.2.7 Creepage distances

8.2.7 of IEC 60077-1:2017 applies.

8.2.8 Switching overvoltages

8.2.8 of IEC 60077-1:2017 applies, with the additional requirements given below.

The manufacturer shall declare the peak arc voltage generated by switching of DC components during the operational performance capability tests in accordance with the provisions of sequence I and the critical current tests of sequence IV of Table 7.

~~The switching of d.c. components, for which the rated insulation voltage (U_i) is between 660 V and 4 800 V, shall not generate peak arc voltages higher than 3 times U_i.~~

The peak arc voltages shall exceed neither the rated impulse voltage of the equipment nor three times the rated insulation voltage (U_{Nm}).

8.2.9 Operational performance capability

Category B components shall be capable of complying with the provisions stated by agreement between the user and the manufacturer.

Unless specific requirements are given in a particular product standard, the category A components shall be capable of complying (as a function of their operational frequency and their component category) with the provisions of Table 3 to Table 6 under the test conditions stated in 9.3.3.6.

Each switching cycle consists either of a closing operation followed by an opening operation (cycle without current), or (as applicable) of a making operation followed by a breaking operation (cycle with current).

Each sequence consists of performing a number of operating cycles without current as specified in Table 3 to Table 6, column 3, followed (as applicable) by a number of operating cycles with current, as specified in Table 3 to Table 6, column 4.

Each sequence is repeated the number of times specified in Table 3 to Table 6, column 2.

In total, the component performs the number of operating cycles without current as specified in Table 3 to Table 6, column 5, and (as applicable) the number of operating cycles with current specified in Table 3 to Table 6, column 6.

In the case where the electrical durability of the component without any maintenance operation is specified equal to the number of operating cycles with current of only one sequence as specified in Table 3 to Table 6, column 4, then it is only necessary to perform one sequence of the cycle with current.

~~NOTE~~ A different number of sequences may be adopted provided that the proportion of operating cycles with and without current in each cycle is equal to that specified in Table 3 to Table 6.

When the component has more than two positions the number of operating cycles shall be distributed using the C1 to C3 categories so that:

– the distribution represents the expected service for the rolling stock;
– all positions are tested.

NOTE For example, a master controller ~~may be~~ is considered as being of category C3 as regards its traction and braking handle, whereas its emergency braking position is considered of C1 usage. Then, the number of operations can be distributed 70 % for traction positions and 30 % for braking positions, as estimated for the actual service expected for the rolling stock (tram, locomotive, etc.).

The rate of operating cycles, selected by mutual agreement between the user and the manufacturer, is chosen to keep all parts of the component within acceptable limits of temperature rise and this value has to be mentioned in the test report.

Table 3 – Operational performance capability for category A1 components

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Operational frequency	Number of sequences	Number of operating cycles per sequence		Total number of operating cycles	
		Without current	With current	Without current	With current
C1	1	100 000	10 000	100 000	10 000
C2	5	200 000	20 000	1 000 000	100 000
C3	10	1 000 000	100 000	10 000 000	1 000 000

~~NOTE 1 – The rate of operating cycles is chosen to keep all parts of the component within acceptable limits of temperature rise.~~

~~NOTE 2 – The rate of operating cycles selected by mutual agreement between the manufacturer and the user, has to be mentioned in the test report.~~

NOTE The operating cycles with current are applicable at the end of each sequence.

Table 4 – Operational performance capability for category A2 components

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Operational frequency	Number of sequences	Number of operating cycles per sequence		Total number of operating cycles	
		Without current	With current	Without current	With current
C1	1	20 000	200	20 000	200
C2	5	40 000	400	200 000	2 000
C3	10	200 000	800	2 000 000	8 000

~~NOTE 1 – The rate of operating cycles is chosen to keep all parts of the component within acceptable limits of temperature rise.~~

~~NOTE 2 – The rate of operating cycles, selected by mutual agreement between the manufacturer and the user, has to be mentioned in the test report.~~

NOTE The operating cycles with current are applicable only at the end of each sequence and the following rates are recommended:

– 30 cycles/hour for rated operational current less than or equal to 2 000 A;

– 15 cycles/hour for rated operational current greater than 2 000 A.

Table 5 – Operational performance capability for category A3 components

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Operational frequency	Number of sequences	Number of operating cycles per sequence		Total number of operating cycles	
		Without current	With current	Without current	With current
C1	1	200 000	20 000	200 000	20 000
C2	5	200 000	20 000	1 000 000	100 000
C3	10	200 000	20 000	2 000 000	200 000

~~NOTE 1 – The rate of operating cycles is chosen to keep all parts of the component within acceptable limits of temperature rise.~~

~~NOTE 2 – The rate of operating cycles, selected by mutual agreement between the manufacturer and the user, has to be mentioned in the test report.~~

NOTE The operating cycles with current are applicable at the end of each sequence.

Table 6 – Operational performance capability for category A4 components

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Operational frequency	Number of sequences	Number of operating cycles per sequence		Total number of operating cycles	
		Without current	With current	Without current	With current
C1	1	20 000	0	20 000	0
C2	5	25 000	0	125 000	0
C3	10	25 000	0	250 000	0

~~NOTE 1 – The rate of operating cycles is chosen to keep all parts of the component within acceptable limits of temperature rise~~

~~NOTE 2 – The rate of operating cycles, selected by mutual agreement between the manufacturer and the user, has to be mentioned in the test report.~~

8.2.10 Ability to withstand vibration and shock

8.2.10 of IEC 60077-1:2017 applies.

8.2.11 Ability to withstand short-time current

Components shall be capable of withstanding the rated short-time current (I_{cw}) ~~with testing conditions stated by the manufacturer (see 5.3.2 of IEC 60077-1)~~ during a rated duration (t_{cw}) according to 5.4.2 of IEC 60077-1:2017.

The recommended values of the rated duration (t_{cw}) are 50 ms and 100 ms.

If it is necessary, a value lower or higher than the recommended values may be chosen under agreement between the user and the manufacturer.

In addition, if other short-time withstand currents are required by the user, they shall be the subject of investigation tests by agreement between the user and the manufacturer.

NOTE Examples of short-circuit duration for protection can be found in IEC 62313.

9 Tests

9.1 Kinds of tests

9.1 of IEC 60077-1:2017 applies.

In addition, when investigation tests or type tests in addition to those specified in this document are required for a special application, they shall be the subject of an agreement between the user and the manufacturer, and may include, for example:

– the influence of harmonics on the temperature rise and breaking characteristics;
– the temperature rise for temporary overload conditions.

9.2 Verification of constructional requirements

The compliance with the constructional requirements described in 8.1 shall be verified, in accordance with 9.2 of IEC 60077-1:2017.

9.3 Type tests

9.3.1 Test sequences

Type tests are grouped together in a number of sequences as shown in Table 7.

Table 7 – List of test sequences

Test sequences		Tests	Subclause
I	General performance characteristics	Operating limits Temperature rise Dielectric properties Operational performance capability Verification of dielectric withstand Verification of temperature rise	9.3.3
II	Rated service making and breaking capacities (if appropriate)	Rated short-time withstand current Short-circuit making capacity Short-circuit breaking capacity	9.3.4
III	Ability to withstand vibrations and shocks	Vibrations Shocks Verification of mechanical operation Verification of dielectric withstand	9.3.5
IV	Critical currents range (if appropriate)	Searching for critical currents range	9.3.6
V	Climatic conditions (if required)	Environmental tests (dry heat, damp heat, cold, etc.)	9.3.7
VI	Other tests (if required)	Electromagnetic compatibility (EMC) Acoustic noise emission ~~Short-time withstand current~~ ~~Short-circuit making capacity~~	9.3.8

For sequences I and III, the tests shall be carried out in the order listed.

A new sample may be used for each sequence.

A routine test (see 9.4) shall be carried out on every sample before the type test.

9.3.2 General test conditions

The components to be tested shall comply in all their details with the drawings of the type which they represent.

Each sequence I, III and IV (described in Table 7) shall be made on a single specimen in a clean and new condition (or considered as such after refurbishment).

Unless otherwise indicated, the tests shall be performed at the rated operational values (current, voltage, air pressure) for all the circuits (main, control and auxiliary), and in accordance with the values indicated in 5.3.

The values recorded in the test report shall be within the tolerances given in Table 8, unless otherwise specified in the relevant clauses. However, with the agreement of the manufacturer, the tests may be made under more severe conditions than those specified.

For each test, the ambient air temperature shall be measured and recorded in the test report.

The component under test shall be mounted complete on its own support in an enclosure representing the conditions of installation when these are prescribed by the manufacturer, or, alternatively, under the conditions of installation envisaged on the rolling stock under consideration.

Table 8 – Tolerances on test values

All tests	Tests under no load, normal load, and overload conditions	Tests under short-circuit conditions
– Testing duration: ± 5 %		
– Main circuit: Current: $^{+5}_{0}$ % Voltage: $^{+5}_{0}$ % (including power frequency recovery voltage) – Control and auxiliary circuit: Voltage: ± 5 % Air pressure: ± 5 %	– Power factor: ± 0,05 – Time constant: $^{+15}_{0}$ % – Frequency: ± 5 %	– Power factor: $^{0}_{0,05}$ – Time constant: $^{+25}_{0}$ % – Frequency: ± 5 %
NOTE For τ_1 time constant tolerance refer to the note of Table 1.		

9.3.3 Test sequence I: General performance characteristics

9.3.3.1 General

This sequence includes the tests and verifications described in Table 7.

9.3.3.2 Operating limits

In addition to the requirements given in 9.3.1 of IEC 60077-1:2017, the tests shall be carried out according to the relevant case stated in 8.2.1.

During and after the tests the component shall operate satisfactorily and, if appropriate, shall comply with the air-tightness tests according to 9.3.4.2 of IEC 60077-1:2017.

9.3.3.3 Measurement of the resistance of circuits

The measurement of the main circuit shall be made with a direct current by measuring the voltage drop or resistance across the terminals of each pole. Alternatively for AC equipment AC impedance may be measured at AC rated frequency.

The current during the measurement shall have any convenient value between 10 % and 100 % of the conventional thermal current.

NOTE Experience shows that an increase of the main circuit resistance cannot alone be considered as a reliable evidence of bad contacts or connections. In such a case, the measurement is repeated with a higher current, as close as possible to the conventional thermal current.

9.3.3.4 Temperature rise

The test shall be carried out according to 9.3.2 of IEC 60077-1:2017, with the following additional requirements:

– temperature rise limits and temperature limits given in 8.2.2;

– where appropriate, the voltage drops along the main circuit shall be measured, especially on terminals and main contacts. This shall be done at the beginning and the end of the temperature rise test.

9.3.3.5 Dielectric properties

The test shall be carried out according to 9.3.3.1 and 9.3.3.2 of IEC 60077-1:2017.

9.3.3.6 Operational performance capability

Taking into account the operating and component categories declared by the manufacturer, the test shall be performed in accordance with requirements of 8.2.9.

For all components, the operations shall be carried out with all appropriate electric and pneumatic circuits supplied at their rated values for each circuit. During each operating cycle, the component shall remain in the closed position for a sufficient time to ensure that the current is fully established, but without exceeding 2 s.

For DC components the peak arc voltage shall be measured.

Between each sequence, inspection and maintenance operations in accordance with instructions previously given by the manufacturer are permitted.

During these operations, the replacement of parts, if any, shall be limited to the contacts (or other parts subject to electric arc) of the main circuit of the component.

At the end of the last sequence, no maintenance operation is permitted before the verifications required in 9.3.3.7 and 9.3.3.8.

9.3.3.7 Verification of dielectric withstand

After the test described in 9.3.3.6 the component shall be able to withstand the dielectric tests required as a routine test in 9.3.3.3 of IEC 60077-1:2017, but with the test voltage values reduced to 75 %.

9.3.3.8 Verification of temperature rise

~~After the verification described in 9.3.3.7, a temperature rise test shall be carried out on the main circuit at the current defined and in accordance with the conditions defined in 9.3.3.2~~

~~At the beginning of the test, the voltage drops along the main circuit should be compared with those measured as specified in 9.3.3.2. If the differences are not significant the temperature rise verification may be discontinued, in which case the values shall be recorded in the test report.~~

~~At the end of the test, the temperature rise values shall not exceed the values specified in 8.2.2 of IEC 60077-1 and 8.2.2 of this standard, and they shall not exceed those recorded during the test required in 9.3.3.2 by more than 20 K.~~

After the verification described in 9.3.3.7, resistance measurement shall be carried out according to 9.3.3.3.

The verification of the temperature rise according to 9.3.3.4 is required only when the resistance of the main circuit (without maintenance) has increased by more than 50 % of the value before the test according to 9.3.3.3. A small number of no-load operations are allowed in an endeavour to bring the resistance down below this figure; if the test has to be performed, then the temperature rise limits and temperature limits on the contacts mentioned in Table 2 are allowed to be exceeded by 10 K.

For the measurement points, refer to 9.3.2.2 of IEC 60077-1:2017.

9.3.4 Test sequence II: Rated service making and breaking capacities (if appropriate)

9.3.4.1 General

This sequence specifies the following tests:

– rated short-time withstand current;
– short-circuit making capacity;
– short-circuit breaking capacity.

The tests shall be carried out according to the test specification agreed between the user and the manufacturer. The short-circuit breaking or making capacity test shall be carried out in the following conditions:

– voltage equal to the rated operational voltage;
– break time being measured;
– current equal to the maximum breaking or making current of the contactor;
– specified time constant for DC contactor or specified power factor for AC contactor;
– three opening or closing operations should be performed.

9.3.4.2 Verification of the ability to carry the rated short-time withstand current

9.3.4.2.1 General

The test shall be made with the equipment in the closed position. The control mechanism shall be operated at the minimum voltage or air pressure. The current shall be applied for the specified time t_{cw} and shall be at least equal to the specified value I_{cw} at the rated operational voltage. In the case of the testing station having difficulty in making this test at the rated operational voltage, it may be made at any convenient lower voltage, the actual test current being, in this case, equal to the rated short-time withstand current (I_{cw}). This shall be stated in the test report. If, however, momentary contact separation occurs during the test, the test shall be repeated at the rated operational voltage. For this test, over-current releases, if any, likely to operate during the test, shall be rendered inoperative.

9.3.4.2.2 AC test

The value of the current during the calibration is the average of the RMS values of the AC components in all phases. The average value shall be equal to the rated value. The current shall be applied for the specified time t_{cw}. The highest peak value of the current during its first cycle shall be not less than 1,42 times the rated short-time withstand current. When, however, the characteristics of the testing station are such that the above requirements cannot be obtained, the following alternatives are permitted provided that:

$$\int_0^{t_{test}} i_{test}^2 dt \geq I^2 \cdot t_{cw}$$

where

t_{test} is the duration of the test;

t_{cw} is the rated duration;

i_{test} is the calibration current if the AC component is not constant or $\geq I_{cw}$.

I is the actual calibration current assumed to have a constant AC component. If the decrement of the short-circuit current of the testing station is such that the rated short-time withstand current cannot be obtained for the rated time without applying initially an excessively high current, the RMS value of the current may be permitted to fall during the test below the specified value, the duration being increased appropriately, provided that the value of the highest peak current is not less than that specified. If, in order to obtain the required peak

value, the RMS value of the current has to be increased above the specified current, the duration of the test shall be reduced accordingly.

9.3.4.2.3 DC test

When the characteristics of the testing station are such that the above requirements cannot be obtained for the rated time without applying initially an excessively high current, the value of the current may be permitted to fall during the test below the specified value, the duration being increased appropriately, provided that the maximum value of the current is not less than that specified. If the testing station is unable to make these tests on DC, they may, if agreed between the user and the manufacturer, be made on AC, provided suitable precautions are taken: for instance, the peak value of current shall not exceed the permissible current.

9.3.4.2.4 Behaviour of the equipment during the test

All component shall be capable of carrying their rated short-time withstand current without causing mechanical damage to any part or separation of the contacts.

It is recognized that, during the test, the temperature rise of current-carrying and adjacent parts of the mechanical switching device may exceed the limits specified in 8.2.2. No temperature rise limits are specified for the short-time current withstand tests but the maximum temperature reached shall not cause significant damage to adjacent parts.

9.3.4.2.5 Behaviour of the equipment after the test

A no-load operation of the mechanical switching device shall be performed immediately after the test, and the contacts shall be open at the first attempt.

After the test, the component shall not show significant deterioration.

As a minimum, visual inspection and verification of dielectric test according to 9.3.3.7 shall be carried out.

9.3.5 Test sequence III: Ability to withstand vibration and shock

9.3.5.1 General

This sequence includes the tests and checks given in Table 7.

9.3.5.2 Vibration

The vibration tests shall be carried out in accordance with the requirements given in 9.3.5 of IEC 60077-1:2017.

When the component has several mechanical states, the test duration shall be distributed so that:

– this distribution represents the expected service;
– all mechanical states are tested.

The tested object shall not change state during the functional random vibration test.

9.3.5.3 Shock

The shock tests shall be carried out in accordance with the requirements given in 9.3.5 of IEC 60077-1:2017.

~~When the component has several positions, the total number of shocks shall be distributed so that all positions are tested.~~

The test shall include both operational states and the apparatus shall not change state during the test.

9.3.5.4 Verification of ~~mechanical~~ functional operation

After the test described in 9.3.5.3, the ~~mechanical~~ functional operation shall be checked in accordance with the requirements given in 9.4.2.

9.3.5.5 Verification of dielectric withstand

After the verification described in 9.3.5.4, the component shall be able to withstand the dielectric tests required in 9.3.3.7.

9.3.6 Test sequence IV: Critical currents range

This test concerns searching for critical currents range for DC and AC switchgears of categories A1 and A2 according to the definitions given in 5.5. This test shall be carried out for:

– a test voltage equal to the rated operational voltage;

– a current range from the rated operational current to zero;

– the two rated time constants τ_1 and τ_3 according to Table 1 for DC switchgear;

– the rated power factor according to 5.3.5 for AC switchgear;

– minimum five operations at each value of current.

The exact values of current are not important, provided that each current is approximately half of the previous current.

Lower time constants at τ_3 or power factors are accepted provided that the circuit load inductance has a minimum value of 50 mH.

For DC components the peak arc voltage shall be measured.

NOTE The test enables the manufacturer to supply curves of the arcing time and the peak arc voltage as a function of the breaking current.

9.3.7 Test sequence V: Climatic conditions

This sequence includes the supplementary tests listed below which shall be carried out according to the relevant method of ~~IEC 60068-2-1 (cold), IEC 60068-2-2 (dry heat), IEC 60068-2-3 (damp heat), IEC 60068-2-52 (salt mist, cyclical test)~~ the standards at the recommended test severity listed in Table 9 unless otherwise specified.

Table 9 – Test method and severity

Standard	Test method	Test severity
IEC 60068-2-1 (cold)	Test Ab	At the minimum ambient air temperature Duration not less than 16 h
IEC 60068-2-2 (dry heat)	Test Bd or Be	At the maximum ambient air temperature Duration not less than 16 h.
IEC 60068-2-78 (damp heat, steady state) or IEC 60068-2-30 (damp heat, cyclic)	Test Cab or Test Db	At 40 °C and 95 % of relative humidity Duration not less than 2 days or Temperature between + 25 °C and + 55 °C 95 % of relative humidity Minimum 2 cycles.
IEC 60068-2-52 (salt mist, cyclical test)	Test Kb	Test severity 3

In addition, other tests may be prescribed by the test document according to the specifically defined environmental conditions.

The operating conditions during the tests and the test acceptance criteria shall be stated in the test specification agreed between the user and the manufacturer. In the absence of any specific acceptance criteria, the component shall be capable of performing the ~~mechanical~~ functional operation tests (see 9.4.2).

The particular parameters shall be recorded in the test report.

Where applicable, an air-tightness test shall be carried out during and after exposure at dry heat and cold in accordance with 9.3.4.2 of IEC 60077-1:2017.

A new sample should be used for each test. However, the same sample may be used again if it is considered as new after refurbishment.

9.3.8 Test sequence VI: Other tests

9.3.8.1 General

This sequence may include supplementary tests such as:

– electromagnetic compatibility;

– acoustic noise emission.

~~– short-circuit making capacity;~~

~~– short-time withstand current.~~

~~The tests shall be carried out according to the test specification agreed between manufacturer and user.~~

9.3.8.2 Electromagnetic compatibility (EMC)

EMC shall be carried out, if applicable, in accordance with the requirements given in 9.3.6 of IEC 60077-1:2017.

9.3.8.3 Acoustic noise emission

Acoustic noise emission may be carried out, if requested, in accordance with the requirements given in 9.3.7 of IEC 60077-1:2017.

9.4 Routine tests

9.4.1 General

Engineering and statistical analyses may show that routine tests on each component are not always necessary; in this case sampling tests shall be made.

9.4.2 ~~Mechanical operation~~ Functional test

The test shall be carried out according to 9.3.1.2 of IEC 60077-1:2017.

In the absence of specific requirements, the test shall consist of checking 20 times in succession that the component operates ~~correctly under the following conditions~~ satisfactorily under no current in the main circuit.

~~– ambient air temperature of the test area;~~

~~– no current in the main circuit;~~

~~– rated control voltage;~~

~~– rated air pressure (for pneumatic components).~~

9.4.3 Measurement of resistance or impedance

The test shall be carried out according to 9.2.3 of IEC 60077-1:2017.

9.4.4 Air-tightness (for pneumatic components)

The test shall be carried out according to 9.3.4.2 of IEC 60077-1:2017.

9.4.5 Dielectric withstand

The test shall be carried out according to 9.3.3.3 of IEC 60077-1:2017.

9.4.6 Check on the setting and operation of protective equipment and relays (calibration)

The test shall be carried out according to 9.3.4.5 of IEC 60077-1:2017.

Annex A
(normative)

Correspondence between auxiliary contacts and steady states of switchgear

Auxiliary contacts shall indicate the position of the main circuit of the switchgear. To this purpose, two types of auxiliary contacts are generally defined by the terminology of IEC 60050-441 [SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-12 and 441-15-13]:

– the make contact ("a" contact), and

– the break contact ("b" contact).

These definitions are related to a given steady state, taken as reference, which is:

– the position maintained by the switchgear when it is not activated, if it has a biased position in such conditions;

– the position where the main circuit is open if the switchgear has no biased position when it is not activated;

– a position to be defined if neither of the above definitions is applicable.

A switchgear may be considered to be ~~well~~ fully closed for all stable positions of its movement for which compliance with temperature rise requirements can be proved. If this cannot be fulfilled, it shall be considered as not ~~well~~ fully closed.

In the same way, a switchgear may be considered as sufficiently open for all positions of its movement for which the dielectric voltage required between its main contacts can be withstood. If this cannot be fulfilled, it shall be considered as not sufficiently open.

Auxiliary contacts shall therefore be designed so as to be capable of indicating whether the switchgear is:

– ~~well~~ fully closed, or

– sufficiently open, or

– in an intermediate position, if neither of the previous indications can be obtained.

A make contact "a" should be named "a_1" if its closing indicates that the main contact is well closed, and "a_0" if its opening indicates that the main contact is sufficiently open.

A break contact "b" should be named "b_1" if its opening indicates that the main contact is well closed, and "b_0" if its closing indicates that the main contact is sufficiently open.

Figure A.1 shows the different types of auxiliary contacts.

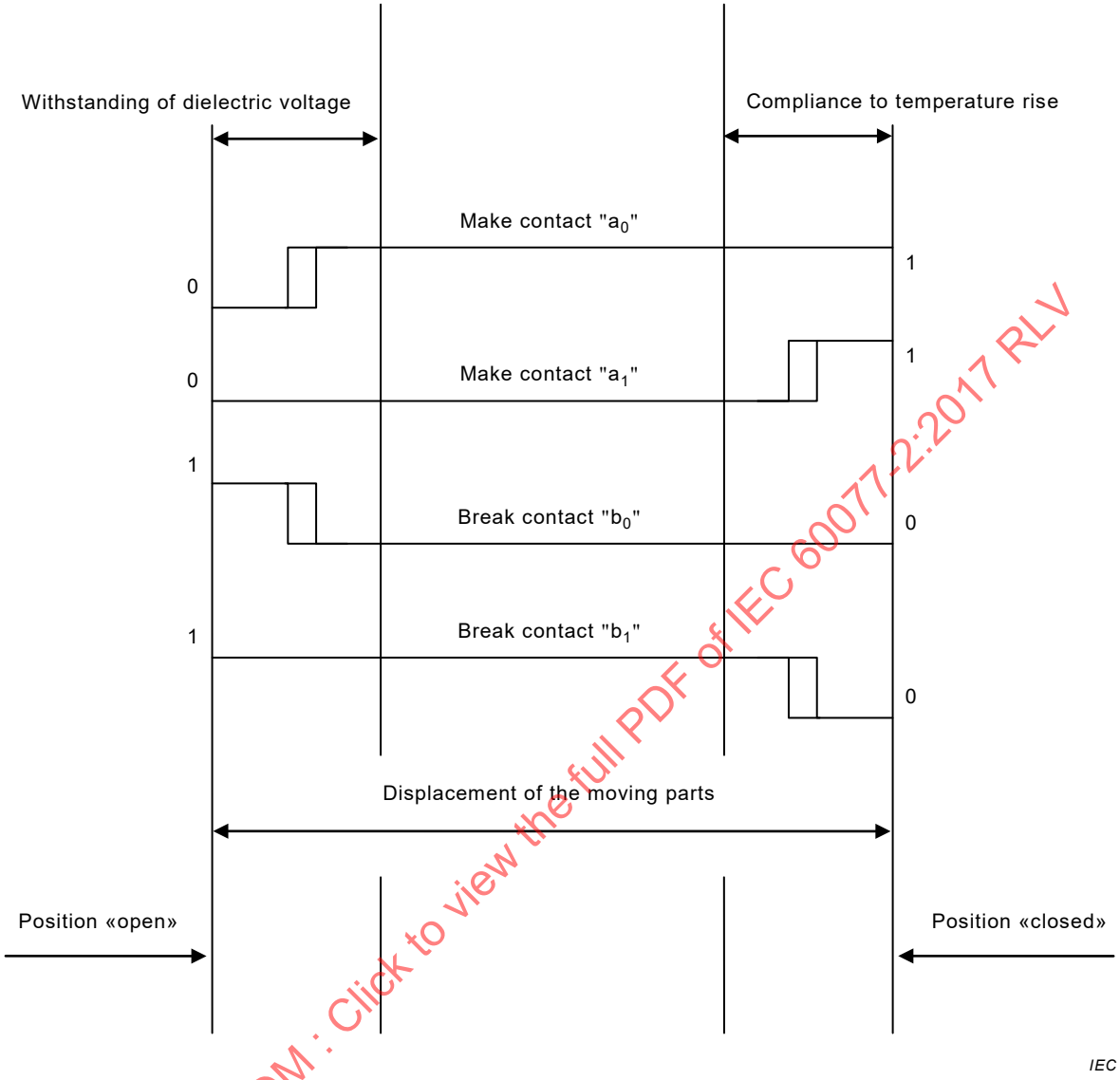

Figure A.1 – Relationship between auxiliary contacts and steady states of switchgear

Bibliography

IEC 60050-441:1984, *International Electrotechnical Vocabulary – Switchgear, controlgear and fuses*
IEC 60050-441:1984/AMD1:2000

IEC 60077-3, *Railway applications – Electric equipment for rolling stock – Part 3: Electrotechnical components – Rules for d.c. circuit-breakers*

IEC 60077-4, *Railway applications – Electric equipment for rolling stock – Part 4: Electrotechnical components – Rules for a.c. circuit-breakers*

IEC 60077-5, *Railway applications – Electric equipment for rolling stock – Part 5: Electrotechnical components – Rules for HV fuses*

~~IEC/TR 60536:1976, *Classification of electrical and electronic equipment with regard to protection against electric shock*~~

IEC 60571, *Railway applications – Electronic equipment used on rolling stock*

IEC 60850~~:1988~~, *Railway applications – Supply voltages of traction systems*

IEC 60947-1~~:1996~~, *Low-voltage switchgear and controlgear – Part 1: General rules*

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

IEC 61140, *Protection against electric shock – Common aspects for installations and equipment*

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

IEC 62236-3-1, *Railway applications – Electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle*

IEC 62236-3-2, *Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus*

IEC 62313, *Railway applications – Power supply and rolling stock – Technical criteria for the coordination between power supply (substation) and rolling stock*

IEC 62497-1, *Railway applications – Insulation coordination – Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment*

IEC 62498-1, *Railway applications – Environmental conditions for equipment – Part 1: Equipment on board rolling stock*

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Electric equipment for rolling stock –
Part 2: Electrotechnical components – General rules

Applications ferroviaires – Equipements électriques du matériel roulant –
Partie 2: Composants électrotechniques – Règles générales

IEC 60077-2:2017-07(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

RAILWAY APPLICATIONS – ELECTRIC EQUIPMENT FOR ROLLING STOCK –

Part 2: Electrotechnical components – General rules

FOREWORD

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International Standard IEC 60077-2 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This second edition cancels and replaces the first edition of IEC 60077-2, issued in 1999. It constitutes a technical revision.

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

a) Short circuit breaking capacity;
b) Rated short-time withstand current;
c) Critical currents range;
d) Climatic conditions are specified.

This standard is to be read in conjunction with IEC 60077-1.

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

FDIS	Report on voting
9/2267/FDIS	9/2279/RVD

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

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.

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

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

RAILWAY APPLICATIONS – ELECTRIC EQUIPMENT FOR ROLLING STOCK –

Part 2: Electrotechnical components – General rules

1 Scope

In addition to the rules given in IEC 60077-1, this part of IEC 60077 provides general rules for all electrotechnical components installed in power circuits, auxiliary circuits, control and indicating circuits, etc., on railway rolling stock.

The purpose of this document is to adapt the general rules given in IEC 60077-1 to all electrotechnical components for rolling stock, in order to obtain uniformity of requirements and tests for the corresponding range of components.

Electrotechnical components are mainly switchgear and controlgear, including also relays, valves, resistors, fuses, etc., irrespective of the nature of their control.

The incorporation of electronic components or electronic subassemblies into electrotechnical components is now common practice. Although this document is not applicable to electronic equipment, the presence of electronic components does not give grounds to exclude such electrotechnical components from the scope of this document.

Electronic subassemblies comply with the relevant standard.

Some of these rules, after agreement between the user and the manufacturer, are used for electrotechnical components installed on vehicles other than railway rolling stock, such as mine locomotives, trolleybuses, etc.

This document states:

a) the characteristics of the components;

b) the service conditions with which components have to comply;

c) the tests intended to confirm compliance of the components with these characteristics under these service conditions, and the methods to be adopted for these tests;

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

This document does not cover industrial electrotechnical components which comply with their own product standard. In order to ensure satisfactory operation of these components for rolling stock, this document is used to specify only the particular requirements for railway application. In that case, a specific document would state the additional requirements with which the industrial components are to comply, e.g.:

– to be adapted (for example for control voltage, environmental conditions, etc.); or

– to be installed and used so as not to have to endure specific railway conditions; or

– to be additionally tested to prove that these components can satisfactorily withstand railway conditions.

In the event of there being a difference in requirements between this document and a railway rolling stock relevant product standard, then the product standard requirements take precedence.

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 60050-811:2017, *International Electrotechnical Vocabulary (IEV) – Chapter 811: Electric traction*

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-52, *Environmental testing – Part 2-52: Test methods – Test Kb: Salt mist, cyclic (sodium, chloride solution)*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

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

IEC 60417, *Graphical symbols for use on equipment* (available at http://www.graphical-symbols.info/equipment)

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC TR 60943, *Guidance concerning the permissible temperature rise for parts of electrical equipment, in particular for terminals*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in IEC 60077-1 as well as 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

3.1.1
active electrical component
simple device or assembly of devices which, in response to a control signal, executes a function or various inseparable functions of logical or analogical nature by changing their state, for which the control or the function is electrical (e.g. contactor, relay, etc.)

Note 1 to entry: Passive electical component is defined as the antonym of this term.

3.1.2
passive electrical component
simple device or assembly of devices which are not included in the active electrical components group and have at least one electrical function (e.g. mounting insulator, permanent connection, resistor, capacitor, etc.)

3.1.3
switchgear and controlgear
general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-11-01]

3.1.4
switchgear
general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended in principle for use in connection with generation, transmission, distribution and conversion of electric energy

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-11-02]

3.1.5
controlgear
general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended in principle for the control of electric energy consuming equipment

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-11-03]

3.1.6
switching device
device designed to make or break the current in one or more electric circuits

Note 1 to entry: A switching device may perform one or both of these operations.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-14-01, modified – Note 1 to entry has been added.]

3.1.7
fuse
device that, by the fusing of one or more of its specially 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 / AMD1:2007, 441-18-01, modified – The second sentence has been changed to Note 1 to entry.]

3.1.8
<mechanical> **switch**
mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions which may include specified operating overload conditions and also carrying

for a specified time currents under specified abnormal circuit conditions such as those of short-circuit

Note 1 to entry: A switch may be capable of making but not breaking short-circuit currents.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-14-10]

3.1.9
mechanical switching device
switching device designed to close and open one or more electric circuits by means of separable contacts

Note 1 to entry: Any mechanical switching device may be designated according to the medium in which its contacts open and close, e.g. air, SF6, oil.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-14-02]

3.1.10
circuit breaker
mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under specified abnormal circuit conditions such as those of short-circuit

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-14-20]

3.1.11
contactor
mechanical switching device having only one position of rest, operated otherwise than by hand, capable of making, carrying and breaking currents under normal circuit conditions including operating overload conditions

Note 1 to entry: Contactors may be designated according to the method by which the force for closing the main contacts is provided.

Note 2 to entry: The definition is the same as"mechanical contactor": IEC 60050-441:1984 / AMD1:2007, 441-14-33.

3.1.12
disconnector
mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements

Note 1 to entry: A disconnector is capable of opening and closing a circuit only when negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the poles of the disconnector occurs. It is also capable of carrying currents under normal circuit conditions and carrying for a specified time currents under abnormal conditions such as those of short circuit.

[SOURCE: IEC 60050-811:2017, 811-29-17]

3.2 Component parts

3.2.1
pole of a switching device
portion of a switching device associated exclusively with one electrically separated conducting path of its main circuit and excluding those portions which provide a means for mounting and operating all poles together

Note 1 to entry: A switching device is called single-pole if it has only one pole. If it has more than one pole, it may be called multipole (two-pole, three-pole, etc.) provided the poles are or can be coupled in such a manner as to operate together.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-01]

3.2.2
main circuit, <of a switching device>
all the conductive parts of a switching device included in the circuit which it is designed to close or open

Note 1 to entry: This does not include parts that are included in the auxiliary circuit of the switching device (see 3.2.4).

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-02, modified – Note 1 to entry has been added.]

3.2.3
control circuit, <of a switching device>
all the conductive parts (other than the main circuit) of a switching device which are included in a circuit used for the closing operation or opening operation, or both, of the device

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-03]

3.2.4
auxiliary circuit, <of a switching device>
all the conductive parts of a switching device which are intended to be included in a circuit other than the main circuit and the control circuits of the device

Note 1 to entry: Some auxiliary circuits fulfil supplementary functions such as signalling, interlocking, etc., and, as such, they may be part of the control circuit of another switching device.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-04]

3.2.5
contact, <of a mechanical switching device>
conductive parts designed to establish circuit continuity when they touch and which, due to their relative motion during an operation, open or close a circuit or, in the case of hinged or sliding contacts, maintain circuit continuity

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-05]

3.2.6
main contact
contact included in the main circuit of a mechanical switching device, intended to carry, in the closed position, the current of the main circuit

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-07]

3.2.7
auxiliary contact
contact included in an auxiliary circuit and mechanically operated by the switching device

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-10]

3.2.8
make contact

contact which is closed when the main contacts of the mechanical switching device are in their operate condition and which is open when they are in their release condition

Note 1 to entry: See complementary information in Annex A of this document.

Note 2 to entry: “normally open contact” is a deprecated term.

[SOURCE: IEC 60050-811:2017, 811-31-03, modified – “relay” is replaced with “main contacts of the mechanical switching device”. Note 1 to entry and Note 2 to entry have been added.]

3.2.9
break contact
contact which is open when the main contacts of the mechanical switching device are in their operate condition and which is closed when they are in their release condition

Note 1 to entry: See complementary information in Annex A of this document.

Note 2 to entry: “normally closed contact” is a deprecated term.

[SOURCE: IEC 60050-811:2017, 811-31-04, modified – “relay” is replaced with “main contacts of the mechanical switching device”. Note 1 to entry and Note 2 to entry have been added.]

3.2.10
<electric> **relay**
device designed to produce sudden predetermined changes in one or more electric output circuits, when certain conditions are fulfilled in the electric input circuits controlling the device

Note 1 to entry: This definition may also be applied to relays for which the actuation is not electric.

[SOURCE: IEC 60050-151:2001, 151-13-31, modified – Note 1 to entry has been added.]

3.2.11
release, <of a mechanical switching device>
device, mechanically connected to a mechanical switching device, which releases the holding means and permits the opening or the closing of the switching device

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-17]

3.3 Operational features

3.3.1
operation, <of a mechanical switching device>
transfer of the moving contact(s) from one position to an adjacent position

Note 1 to entry: For a circuit-breaker, this may be a closing operation or an opening operation.

Note 2 to entry: If distinction is necessary, an operation in the electrical sense, e.g. make or break, is referred to as a switching operation, and an operation in the mechanical sense, e.g. close or open, is referred to as a mechanical operation.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-01]

3.3.2
operating cycle, <of a mechanical switching device>
succession of operations from one position to another and back to the first position through all other positions, if any

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-02]

3.3.3
manual control
control of an operation by human intervention

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-04]

3.3.4
closed position, <of a mechanical switching device>
position in which the predetermined continuity of the main circuit of the device is secured

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-22]

3.3.5
open position, <of a mechanical switching device>
position in which the predetermined dielectric withstand voltage requirements are satisfied between open contacts in the main circuit of the device

Note 1 to entry: This definition differs from IEV 441-16-23 to meet the requirements of dielectric properties.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-23, modified – "clearance…is secured" is changed to "dielectric withstand voltage requirements are satisfied". Note 1 to entry has been added.]

3.3.6
breaking current, <of a switching device or a fuse>
current in a pole of a switching device or in a fuse at the instant of initiation of the arc during a breaking process

Note 1 to entry: For AC the current is expressed as the symmetrical RMS value of the AC component.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-07, modified. Note 1 to entry has been added.]

3.3.7
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

Note 1 to entry: The method to be used to evaluate and to express the prospective current is to be specified in the relevant publications.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-01]

3.3.8
prospective making current, <for a pole of a switching device>
prospective current when initiated under specified conditions

Note 1 to entry: The specified conditions may relate to the method of initiation, e.g. by an ideal switching device, or to the instant of initiation, e.g. leading to the maximum prospective peak current in an AC circuit, or to the highest rate of rise. The specification of these conditions is given in the relevant publications.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-05]

3.3.9
prospective breaking current, <for a pole of a switching device or a fuse>
prospective current evaluated at a time corresponding to the instant of the initiation of the breaking process

Note 1 to entry: Specifications concerning the instant of the initiation of the breaking process are to be found in the relevant publications. For mechanical switching devices or fuses, it is usually defined as the moment of initiation of the arc during the breaking process.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-06]

3.3.10
breaking capacity, <of a switching device or a fuse>
value of prospective breaking current that a switching device or a fuse is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

Note 1 to entry: The voltage to be stated and the conditions to be prescribed are dealt with in the relevant publications.

Note 2 to entry: For AC, the current is expressed as the symmetrical RMS value of the AC component.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-08, modified – Note 2 to entry has been changed.]

3.3.11
short circuit breaking capacity
breaking capacity for which the prescribed conditions include a short-circuit at the terminals of the switching device

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-11]

3.3.12
critical current
critical currents range
value (or range of values) of current at which the component is not capable of operating without risk of failure to break

Note 1 to entry: For AC current only AC contactor is applicable.

3.3.13
making capacity, <of a switching device or a fuse>
value of prospective making current that a switching device is capable of making at a stated voltage under prescribed conditions of use and behaviour

Note 1 to entry: The voltage to be stated and the conditions to be prescribed are dealt with in the relevant publications.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-09, modified – In Note 1 to entry "specifications" is replaced with "publications".]

3.3.14
short circuit making capacity
making capacity for which the prescribed conditions include a short circuit at the terminals of the switching device

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-10]

3.3.15
short-time withstand current
current that a circuit or a switching device in the closed position can carry during a specified short time under prescribed conditions of use and behaviour

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-17]

3.3.16
recovery voltage
voltage which appears across the terminals of a pole of a switching device or a fuse after the breaking of the current

Note 1 to entry: This voltage may be considered in two successive intervals of time, one during which a transient voltage exists, followed by a second one during which the power-frequency or the steady-state recovery voltage alone exists.

Note 2 to entry: This definition applies to a single-pole device. For a multipole device it is the phase-to-phase voltage across the supply terminals of the device.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-25, modified – Note 2 to entry has been added.]

3.3.17
peak arc voltage, <of a mechanical switching device>
maximum instantaneous value of voltage which, under prescribed conditions, appears across the terminals of a pole of a switching device during the arcing time

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-30]

3.3.18
opening time, <of a mechanical switching device>
interval of time between the specified instant of initiation of the opening operation and the instant when the arcing contacts have separated in all poles

Note 1 to entry: The instant of initiation of the opening operation, i.e. the application of the opening command (e.g. energising the release, etc.) is given in the relevant publications.

Note 2 to entry: Closing time is defined as the antonym of this term.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-36, modified – Note 2 to entry has been added.]

3.3.19
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 / AMD1:2007, 441-17-37]

3.3.20
break time
interval of time between the beginning of the opening time of a mechanical switching device (or the pre-arcing time of a fuse) and the end of the arcing time

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-39]

3.3.21
closing time
interval of time between the initiation of the closing operation and the instant when the contacts touch in all poles

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-41]

3.4 Abbreviated terms

AC Alternating Current

DC Direct Current

EMC Electromagnetic Compatibility

RMS Root Mean Square value

4 Classification

This clause is intended to list the characteristics of a component on which information is given by the manufacturer and which shall be verified by testing where relevant.

The components are classified:

– according to their operational frequency C1, C2 or C3;

  The characteristics of these categories, applicable to active electrical components only, are given in 5.4;

– according to their component category A1, A2, A3, A4 or B;

  The characteristics of these categories are given in 5.5;

– according to the type of design:

  • open construction;

  • construction with an enclosure;

– according to the degree of protection provided by the enclosure (see IEC 60529).

5 Characteristics

5.1 List of characteristics

The characteristics of a component shall be stated, as applicable, among those of the following list:

– type of component (5.2);
– rated and limiting values of the main circuit (5.3);
– operational frequencies (5.4);
– component category (5.5);
– electric control circuits (5.6);
– pneumatic control circuit (5.7);
– manual control (5.8);
– electric auxiliary circuits (5.9);
– pneumatic auxiliary circuits (5.10);
– peak arc voltages (5.11).

5.2 Type of component

It is necessary to indicate the following, as applicable:

– type of component (e.g., DC contactor, disconnector, master controller, braking controller, etc.);
– number of poles;
– rated and limiting voltages of the main circuit (5.3);
– rated and limiting currents of the main circuit (5.3);
– interrupting medium;
– polarity;
– operating conditions (method of operation, method of control, etc.);
– type of design (Clause 4);
– degree of protection provided by the enclosure (Clause 4).

5.3 Rated and limiting values for the main circuit

5.3.1 General

Rated values are assigned by the manufacturer. They shall be stated in accordance with 5.3.2 to 5.3.5.

5.3.2 Rated voltages

A component is defined by the following rated voltages given in 5.2 of IEC 60077-1:2017:

– rated operational voltage (U_r);
– rated insulation voltage (U_{Nm});
– rated impulse voltage (U_{Ni});
– power-frequency test voltage (U_a).

NOTE The limiting values of operating conditions are given in 8.2.1of IEC 60077-1:2017.

5.3.3 Rated currents

A component is defined by the following rated currents:

– rated operational current (I_r) at the rated time constant τ_2 (see 5.3.4) or for the rated power factor (see 5.3.5) where relevant (given in 5.4 of IEC 60077-1:2017);
– rated short time withstand current (I_{cw}) (see 3.3.15);
– conventional free air thermal current (I_{th});
– conventional enclosed thermal current (I_{the}).

The conventional free air thermal current is the maximum value of the test current to be used for temperature rise tests of equipment in free air at the maximum ambient air temperature.

The conventional enclosed thermal current is the maximum value of the test current to be used for temperature rise tests of equipment mounted in the specified enclosure at the maximum ambient air temperature.

Free air is understood to be air under normal indoor conditions, reasonably free from draughts and external radiation.

For a continuous duty, the maximum value of the rated operational current shall be less than the value of the conventional free air thermal current if no forced cooling is used.

5.3.4 Rated time constants (for DC switchgear)

A component is characterised according to the applicable rated time constants τ_1, τ_2 and τ_3 given in Table 1. τ_2 is the rated time constant for operating conditions considered as normal; it is used for the tests specified in 9.3.3.6. τ_1 and τ_3 are time constants corresponding to extreme situations; they are used for the tests as specified in 9.3.6.

If necessary, the time constant values may be defined by agreement between the user and the manufacturer.

Table 1 – Rated time constants

Rated operational voltage V	Rated time constants ms		
	τ_1	τ_2	τ_3
$U_r \leq 900$	0	15	50
$900 < U_r \leq 1\,800$	0	15	40
$U_r > 1\,800$	0	15	30
NOTE A time constant of 0 ms signifies that the loads for the tests are made up of resistors without any intentional addition of reactors.			

5.3.5 Rated power factor (for AC switchgear)

The operational performance capability of a component is defined for a rated power factor of 0,8, whatever the rated operational voltage and current. If necessary the power factor for short-circuit and overload tests will be as agreed between the user and the manufacturer.

5.4 Operational frequencies

The operational frequencies C1, C2 and C3 are defined below:

– C1: light operational frequency (e.g. component which is part of the protection and/or isolation equipment which operates only when a failure is detected);

– C2: medium operational frequency (e.g. component which is part of equipment that operates in any of the following cases: at each commencement of service, each start, each stop, each neutral section (IEC 60050-811:2017, 811-36-16), each sectioning point (IEC 60050-811:2017, 811-36-11), each end of service);

– C3: heavy operational frequency (e.g. component which is part of equipment that operates during each traction sequence or braking sequence, or component such as a compressor contactor).

NOTE The references in brackets refer to definitions given in IEC 60050-811:2017.

5.5 Component categories

There are several component categories:

– A1: switching devices for auxiliary circuits (IEC 60050-811:2017, 811-25-05) or low-voltage circuits (IEC 60050-811:2017, 811-25-02) (e.g. relays, auxiliary contactors and their accessories, etc.) irrespective of the nature of their control, except components with manual control;

– A2: switching devices for power circuits (IEC 60050-811:2017, 811-25-03) (e.g. DC power contactors), irrespective of the nature of their control, except components with manual control.

NOTE 1 Main circuit-breakers are covered by their own product standard (see IEC 60077-3 and IEC 60077-4).

– A3: manually-controlled switching devices (e.g. switches, push-buttons, etc., for control equipment);

– A4: power switchgear which does not operate on load (e.g. disconnector, system changeover switch (IEC 60050-811:2017, 811-29-37), etc.);

– B: other components not covered by the above.

NOTE 2 The references in brackets refer to definitions given in IEC 60050-811:2017.

5.6 Electric control circuits

The characteristics of electric control circuits are as follows:

– rated frequency, if AC;
– rated voltage of the control circuit and its limiting values;
– rated voltage of the control supply (if it differs from the rated voltage of control circuit due to the presence of built-in transformers, rectifiers, resistors, etc.);
– power consumption of the control supply at its rated voltage.

The rated control circuit voltage and rated frequency, if any, are the values on which the operating and temperature rise characteristics of the control circuit are based. The correct operating conditions are based upon values of the control supply voltage as defined in 5.3 of IEC 60077-1:2017.

5.7 Pneumatic control circuits

The characteristics of air supply control circuits (pneumatic or electro-pneumatic) are as follows:

– rated air pressure of the control circuit and limiting values;
– rated air pressure of the control supply (if it differs from the rated air pressure of the control circuit due to the presence of built-in regulators);
– volume of air, for each rated air pressure, required for each closing and each opening operation.

The rated air pressure of a pneumatic or electro-pneumatic component is the air pressure on which the operating characteristics of the pneumatic control system are based.

The rated operating conditions are based upon a value of the rated air pressure as defined in 5.6 of IEC 60077-1:2017.

5.8 Manual control

If necessary, the following characteristics may be specified:

– form of the manual actuator (handle, knob, push-button, etc.);
– actuating force (or torque): the force (or torque) necessary to complete the intended operation;
– restoring force (or torque): the force (or torque) provided to restore the actuator to its initial position;
– travel: the displacement (linear or rotary) of the actuator.

5.9 Electric auxiliary circuits

The characteristics of the electric auxiliary circuits are the number and nature of the contacts (make contact, break contact, etc.) of each of these circuits and their rated characteristics, as follows:

– rated operational voltage(s) (U_r);
– rated insulation voltage (U_{Nm});
– rated operational current(s) (I_r);
– conventional free air thermal current(I_{th});
– minimum current associated with an operational voltage that the auxiliary circuit is capable of making and carrying reliably;
– sequence of the auxiliary contacts in relation to the main contacts;
– rated short time withstand current (I_{cw}).

5.10 Pneumatic auxiliary circuits

The characteristics of pneumatic auxiliary circuits are the number and nature of the valves of each of these circuits and their rated characteristics, as follows:

– rated air pressure;
– rated air flow;
– sequence of the pneumatic auxiliary valves in relation to the main contacts.

5.11 Peak arc voltages

The manufacturer shall specify the maximum value of the peak arc voltages caused by operating the component.

6 Product information

6.1 Nature of the information

6.1.1 General

The information shall be given in the manufacturer's catalogue or manual. It concerns the identification and characteristics.

In addition, other information relative to the application may be especially required. This information shall be the result of an agreement.

6.1.2 Component documentation

6.1.2.1 General

The information listed below shall be given in the manufacturer's catalogue or manual:

6.1.2.2 Identification

– manufacturer's name or trademark;
– type designation;
– modification status (if applicable);
– reference to the present document if the manufacturer declares compliance with it;

6.1.2.3 Characteristics (as applicable)

– each rated operational voltage (U_r);
– each rated operational current (I_r) at the relevant rated operational voltage;
– conventional free air thermal current (I_{th}) or conventional enclosed thermal current (I_{the}) if this differs from the rated operational current; this shall be supplemented by the value of the maximum ambient air temperature;
– each rated operational frequency (f_r) if the manufacturer declares compliance with one or several of them;
– each component category if the manufacturer declares compliance with one or several of them;
– rated insulation voltage (U_{Nm});
– rated impulse voltage (U_{Ni});
– power-frequency test voltage (U_a);
– peak arc voltages, under relevant test conditions;
– rated short-circuit making and breaking capacities at corresponding rated time constants or rated power factor;

– maximum current consumption or maximum power consumption;
– IP code in the case of an enclosed component (according to IEC 60529);
– pollution degree (according to 7.9 of IEC 60077-1:2017);
– rated voltage and current (including frequency if applicable) of each control circuit;
– rated air pressure and limiting values;
– number and type of electric auxiliary circuits and their characteristics;
– number and type of pneumatic auxiliary circuits and their characteristics;
– overall dimensions;
– minimum size of the enclosure and, if applicable, data concerning ventilation, to which the rated characteristics apply;
– minimum distance between the components and metal parts connected to earth for components which are intended for use without an enclosure;
– weight.

6.1.3 Other information

When the application requires a special utilisation of the component, agreed by the manufacturer, supplementary information shall be given on request.

This may concern, for example:

– range of operational current under special operating conditions;
– overload duty at fault occurrence;
– overload duty without any breaking on load;
– etc.

6.2 Marking

The following data or identification shall be marked:

– manufacturer's name or trade mark;
– type designation;
– reference to this document if the manufacturer declares compliance with it;
– serial number designation, or date or code of manufacture;
– rated operational voltage (U_r) and associated rated operational current (I_r);
– terminals and polarity, when necessary (this may be done in the form of a diagram);
– protective bonding terminal, where applicable, designated by the symbol  IEC 60417-5019 (2006-08).

The above information is preferably marked on the name plate, if any, or on the component itself in order to permit the complete data to be obtained from the manufacturer (traceability). The marking shall be indelible and easily legible before installation without removal of any parts.

The type designation, serial number and terminal markings should be visible after installation of the component.

6.3 Instructions for storage, installation, operation and maintenance

These instructions shall comply with 6.3 of IEC 60077-1:2017.

7 Normal service conditions

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

8 Constructional and performance requirements

8.1 Constructional requirements

8.1.1 General

8.1 of IEC 60077-1:2017 applies, with the additions given hereinafter.

8.1.2 Terminals and connecting capacity

Terminals and their connecting capacity should be designed in accordance with IEC TR 60943.

8.1.3 Protective bonding terminal

In order to comply with 8.1.1 of IEC 60077-1:2017, the component shall have a protective bonding connection when there are exposed conductive parts which could become live in case of insulation failure. This is generally achieved by a terminal provided solely for this function, named commonly protective bonding terminal.

The protective bonding terminal shall be readily accessible and visible, and so placed that the connection of the component to the vehicle structure or to the protective conductor is maintained when the cover or any other removable part is removed.

The protective bonding terminal shall be suitably protected against corrosion. Efficiency of bonding provided by assembly shall be proved on a sample.

For $U_{Nm} \leq$ 120 V DC or 50 V AC, bonding may be achieved by the equipment or component fixtures when the metallic parts are electrically connected to the fixtures, and when the equipment or component is screwed to a metallic plate which is itself connected to the vehicle structure.

If non conductive coatings are used, a spring washer capable of breaking through the insulating layer may be inserted below screw or bolt heads.

8.2 Performance requirements

8.2.1 Operating conditions

8.2.1 of IEC 60077-1:2017 applies, with the additions given hereinafter:

a) All components:

After stabilisation of its temperature in an ambient air temperature of minimum and maximum temperature defined in IEC 60077-1:2017, the component shall be able to operate satisfactorily within the limiting values of the equipment voltage.

b) Components supplied by a contact line, a transformer, generator, alternator, electronic converter or a battery off charge system (see 5.3.3.2, 8.2.1.2, 8.2.1.3, 8.2.1.5 and 8.2.1.6 of IEC 60077-1:2017).

The component shall be able to operate satisfactorily within the limiting values of the equipment voltage after stabilisation of its temperature under the permanent supply at the maximum equipment voltage.

c) Components supplied by a float charge battery system (see 5.3.3.2, 8.2.1.4 of IEC 60077-1:2017).

The component shall be able to operate satisfactorily at the maximum ambient air temperature:

1) within the full equipment voltage range according to IEC 60077-1:2017, Table 1 after stabilisation of its temperature under the permanent supply at the nominal equipment voltage,
2) and within a range of 0,8 to 1,25 times the nominal equipment voltage after stabilisation of its temperature under the permanent supply at the rated operational voltage,

d) Electropneumatic components:

The component shall be able to operate satisfactorily at the minimum air pressure for the test at minimum temperature defined in IEC 60077-1:2017 and at the maximum air pressure for the other tests. The operating conditions apply for all the supply air pressures within the limiting values.

8.2.2 Temperature limits

Temperatures shall not reach values likely to cause an irreversible change to the component.

8.2.2 of IEC 60077-1:2017 applies, along with Table 2 given below.

Table 2 – Temperature rise limits and temperature limits

Parts of component	Maximum temperatures °C	Example of temperature rise limits for maximum air ambient temperature of [a]	
		40 °C (T_r = 25 °C) K	70 °C (T_r = 55 °C) K
Flexible connections in copper (braids)		90	60
Flexible contacts (in the form of a spring)			
– in copper (not recommended)		35	
– in brass or in bronze		65	35
Non-flexible contacts:			
– in copper		75	45
– silver-plated or nickel-plated		75	45
– in solid silver		100	70
– tin-plated	105 [a]		
– other metals or sintered metals	[b]		
Other conductive parts including non-insulated coils and bars	[b]		
Bolted connections other than terminals			
– in copper		75	45
– in brass or in bronze		75	45
– silver-plated or nickel-plated		75	45
– tin-plated	105 [a]		

[a] These values given for common materials, for which service is proven, are in accordance with the recommendations of IEC TR 60943.

[b] Values to be determined by the characteristics of the metals used and limited by the obligation of not causing damage to themselves and to adjacent parts, in particular for metal parts in contact with insulating materials.

8.2.3 Operation following inactivity

8.2.3 of IEC 60077-1:2017 applies.

8.2.4 Electromagnetic compatibility (EMC)

8.2.4 of IEC 60077-1:2017 applies.

8.2.5 Acoustic noise emission

8.2.5 of IEC 60077-1:2017 applies.

8.2.6 Clearances

8.2.6 of IEC 60077-1:2017 applies.

8.2.7 Creepage distances

8.2.7 of IEC 60077-1:2017 applies.

8.2.8 Switching overvoltages

8.2.8 of IEC 60077-1:2017 applies, with the additional requirements given below.

The manufacturer shall declare the peak arc voltage generated by switching of DC components during the operational performance capability tests in accordance with the provisions of sequence I and the critical current tests of sequence IV of Table 7.

The peak arc voltages shall exceed neither the rated impulse voltage of the equipment nor three times the rated insulation voltage (U_{Nm}).

8.2.9 Operational performance capability

Category B components shall be capable of complying with the provisions stated by agreement between the user and the manufacturer.

Unless specific requirements are given in a particular product standard, the category A components shall be capable of complying (as a function of their operational frequency and their component category) with the provisions of Table 3 to Table 6 under the test conditions stated in 9.3.3.6.

Each switching cycle consists either of a closing operation followed by an opening operation (cycle without current), or (as applicable) of a making operation followed by a breaking operation (cycle with current).

Each sequence consists of performing a number of operating cycles without current as specified in Table 3 to Table 6, column 3, followed (as applicable) by a number of operating cycles with current, as specified in Table 3 to Table 6, column 4.

Each sequence is repeated the number of times specified in Table 3 to Table 6, column 2.

In total, the component performs the number of operating cycles without current as specified in Table 3 to Table 6, column 5, and (as applicable) the number of operating cycles with current specified in Table 3 to Table 6, column 6.

In the case where the electrical durability of the component without any maintenance operation is specified equal to the number of operating cycles with current of only one

sequence as specified in Table 3 to Table 6, column 4, then it is only necessary to perform one sequence of the cycle with current.

A different number of sequences may be adopted provided that the proportion of operating cycles with and without current in each cycle is equal to that specified in Table 3 to Table 6.

When the component has more than two positions the number of operating cycles shall be distributed using the C1 to C3 categories so that:

– the distribution represents the expected service for the rolling stock;

– all positions are tested.

NOTE For example, a master controller is considered as being of category C3 as regards its traction and braking handle, whereas its emergency braking position is considered of C1 usage. Then, the number of operations can be distributed 70 % for traction positions and 30 % for braking positions, as estimated for the actual service expected for the rolling stock (tram, locomotive, etc.).

The rate of operating cycles, selected by mutual agreement between the user and the manufacturer, is chosen to keep all parts of the component within acceptable limits of temperature rise and this value has to be mentioned in the test report.

Table 3 – Operational performance capability for category A1 components

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Operational frequency	Number of sequences	Number of operating cycles per sequence		Total number of operating cycles	
		Without current	With current	Without current	With current
C1	1	100 000	10 000	100 000	10 000
C2	5	200 000	20 000	1 000 000	100 000
C3	10	1 000 000	100 000	10 000 000	1 000 000
NOTE The operating cycles with current are applicable at the end of each sequence.					

Table 4 – Operational performance capability for category A2 components

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Operational frequency	Number of sequences	Number of operating cycles per sequence		Total number of operating cycles	
		Without current	With current	Without current	With current
C1	1	20 000	200	20 000	200
C2	5	40 000	400	200 000	2 000
C3	10	200 000	800	2 000 000	8 000
NOTE The operating cycles with current are applicable only at the end of each sequence and the following rates are recommended: – 30 cycles/hour for rated operational current less than or equal to 2 000 A; – 15 cycles/hour for rated operational current greater than 2 000 A.					

Table 5 – Operational performance capability for category A3 components

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Operational frequency	Number of sequences	Number of operating cycles per sequence		Total number of operating cycles	
		Without current	With current	Without current	With current
C1	1	200 000	20 000	200 000	20 000
C2	5	200 000	20 000	1 000 000	100 000
C3	10	200 000	20 000	2 000 000	200 000
NOTE The operating cycles with current are applicable at the end of each sequence.					

Table 6 – Operational performance capability for category A4 components

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Operational frequency	Number of sequences	Number of operating cycles per sequence		Total number of operating cycles	
		Without current	With current	Without current	With current
C1	1	20 000	0	20 000	0
C2	5	25 000	0	125 000	0
C3	10	25 000	0	250 000	0

8.2.10 Ability to withstand vibration and shock

8.2.10 of IEC 60077-1:2017 applies.

8.2.11 Ability to withstand short-time current

Components shall be capable of withstanding the rated short-time current (I_{cw}) during a rated duration (t_{cw}) according to 5.4.2 of IEC 60077-1:2017).

The recommended values of the rated duration (t_{cw}) are 50 ms and 100 ms.

If it is necessary, a value lower or higher than the recommended values may be chosen under agreement between the user and the manufacturer.

In addition, if other short-time withstand currents are required by the user, they shall be the subject of investigation tests by agreement between the user and the manufacturer.

NOTE Examples of short-circuit duration for protection can be found in IEC 62313.

9 Tests

9.1 Kinds of tests

9.1 of IEC 60077-1:2017 applies.

In addition, when investigation tests or type tests in addition to those specified in this document are required for a special application, they shall be the subject of an agreement between the user and the manufacturer, and may include, for example:

– the influence of harmonics on the temperature rise and breaking characteristics;

– the temperature rise for temporary overload conditions.

9.2 Verification of constructional requirements

The compliance with the constructional requirements described in 8.1 shall be verified, in accordance with 9.2 of IEC 60077-1:2017.

9.3 Type tests

9.3.1 Test sequences

Type tests are grouped together in a number of sequences as shown in Table 7.

Table 7 – List of test sequences

Test sequences		Tests	Subclause
I	General performance characteristics	Operating limits Temperature rise Dielectric properties Operational performance capability Verification of dielectric withstand Verification of temperature rise	9.3.3
II	Rated service making and breaking capacities (if appropriate)	Rated short-time withstand current Short-circuit making capacity Short-circuit breaking capacity	9.3.4
III	Ability to withstand vibrations and shocks	Vibrations Shocks Verification of mechanical operation Verification of dielectric withstand	9.3.5
IV	Critical currents range (if appropriate)	Searching for critical currents range	9.3.6
V	Climatic conditions (if required)	Environmental tests (dry heat, damp heat, cold, etc.)	9.3.7
VI	Other tests (if required)	Electromagnetic compatibility (EMC) Acoustic noise emission	9.3.8

For sequences I and III, the tests shall be carried out in the order listed.

A new sample may be used for each sequence.

A routine test (see 9.4) shall be carried out on every sample before the type test.

9.3.2 General test conditions

The components to be tested shall comply in all their details with the drawings of the type which they represent.

Each sequence I, III and IV (described in Table 7) shall be made on a single specimen in a clean and new condition (or considered as such after refurbishment).

Unless otherwise indicated, the tests shall be performed at the rated operational values (current, voltage, air pressure) for all the circuits (main, control and auxiliary), and in accordance with the values indicated in 5.3.

The values recorded in the test report shall be within the tolerances given in Table 8, unless otherwise specified in the relevant clauses. However, with the agreement of the manufacturer, the tests may be made under more severe conditions than those specified.

For each test, the ambient air temperature shall be measured and recorded in the test report.

The component under test shall be mounted complete on its own support in an enclosure representing the conditions of installation when these are prescribed by the manufacturer, or, alternatively, under the conditions of installation envisaged on the rolling stock under consideration.

Table 8 – Tolerances on test values

All tests	Tests under no load, normal load, and overload conditions	Tests under short-circuit conditions
– Testing duration: ± 5 %		
– Main circuit: Current: $^{+5}_{0}$ % Voltage: $^{+5}_{0}$ % (including power frequency recovery voltage) – Control and auxiliary circuit: Voltage: ± 5 % Air pressure: ± 5 %	– Power factor: ± 0,05 – Time constant: $^{+15}_{0}$ % – Frequency: ± 5 %	– Power factor: $^{0}_{0,05}$ – Time constant: $^{+25}_{0}$ % – Frequency: ± 5 %
NOTE For τ_1 time constant tolerance refer to the note of Table 1.		

9.3.3 Test sequence I: General performance characteristics

9.3.3.1 General

This sequence includes the tests and verifications described in Table 7.

9.3.3.2 Operating limits

In addition to the requirements given in 9.3.1 of IEC 60077-1:2017, the tests shall be carried out according to the relevant case stated in 8.2.1.

During and after the tests the component shall operate satisfactorily and, if appropriate, shall comply with the air-tightness tests according to 9.3.4.2 of IEC 60077-1:2017.

9.3.3.3 Measurement of the resistance of circuits

The measurement of the main circuit shall be made with a direct current by measuring the voltage drop or resistance across the terminals of each pole. Alternatively for AC equipment AC impedance may be measured at AC rated frequency.

The current during the measurement shall have any convenient value between 10 % and 100 % of the conventional thermal current.

NOTE Experience shows that an increase of the main circuit resistance cannot alone be considered as a reliable evidence of bad contacts or connections. In such a case, the measurement is repeated with a higher current, as close as possible to the conventional thermal current.

9.3.3.4 Temperature rise

The test shall be carried out according to 9.3.2 of IEC 60077-1:2017, with the following additional requirements:

– temperature rise limits and temperature limits given in 8.2.2;

– where appropriate, the voltage drops along the main circuit shall be measured, especially on terminals and main contacts. This shall be done at the beginning and the end of the temperature rise test.

9.3.3.5 Dielectric properties

The test shall be carried out according to 9.3.3.1 and 9.3.3.2 of IEC 60077-1:2017.

9.3.3.6 Operational performance capability

Taking into account the operating and component categories declared by the manufacturer, the test shall be performed in accordance with requirements of 8.2.9.

For all components, the operations shall be carried out with all appropriate electric and pneumatic circuits supplied at their rated values for each circuit. During each operating cycle, the component shall remain in the closed position for a sufficient time to ensure that the current is fully established, but without exceeding 2 s.

For DC components the peak arc voltage shall be measured.

Between each sequence, inspection and maintenance operations in accordance with instructions previously given by the manufacturer are permitted.

During these operations, the replacement of parts, if any, shall be limited to the contacts (or other parts subject to electric arc) of the main circuit of the component.

At the end of the last sequence, no maintenance operation is permitted before the verifications required in 9.3.3.7 and 9.3.3.8.

9.3.3.7 Verification of dielectric withstand

After the test described in 9.3.3.6 the component shall be able to withstand the dielectric tests required as a routine test in 9.3.3.3 of IEC 60077-1:2017, but with the test voltage values reduced to 75 %.

9.3.3.8 Verification of temperature rise

After the verification described in 9.3.3.7, resistance measurement shall be carried out according to 9.3.3.3.

The verification of the temperature rise according to 9.3.3.4 is required only when the resistance of the main circuit (without maintenance) has increased by more than 50 % of the value before the test according to 9.3.3.3. A small number of no-load operations are allowed in an endeavour to bring the resistance down below this figure; if the test has to be performed, then the temperature rise limits and temperature limits on the contacts mentioned in Table 2 are allowed to be exceeded by 10 K.

For the measurement points, refer to 9.3.2.2 of IEC 60077-1:2017.

9.3.4 Test sequence II: Rated service making and breaking capacities (if appropriate)

9.3.4.1 General

This sequence specifies the following tests:

– rated short-time withstand current;

– short-circuit making capacity;

– short-circuit breaking capacity.

The tests shall be carried out according to the test specification agreed between the user and the manufacturer. The short-circuit breaking or making capacity test shall be carried out in the following conditions:

– voltage equal to the rated operational voltage;
– break time being measured;
– current equal to the maximum breaking or making current of the contactor;
– specified time constant for DC contactor or specified power factor for AC contactor;
– three opening or closing operations should be performed.

9.3.4.2 Verification of the ability to carry the rated short-time withstand current

9.3.4.2.1 General

The test shall be made with the equipment in the closed position. The control mechanism shall be operated at the minimum voltage or air pressure. The current shall be applied for the specified time t_{cw} and shall be at least equal to the specified value I_{cw} at the rated operational voltage. In the case of the testing station having difficulty in making this test at the rated operational voltage, it may be made at any convenient lower voltage, the actual test current being, in this case, equal to the rated short-time withstand current (I_{cw}). This shall be stated in the test report. If, however, momentary contact separation occurs during the test, the test shall be repeated at the rated operational voltage. For this test, over-current releases, if any, likely to operate during the test, shall be rendered inoperative.

9.3.4.2.2 AC test

The value of the current during the calibration is the average of the RMS values of the AC components in all phases. The average value shall be equal to the rated value. The current shall be applied for the specified time t_{cw}. The highest peak value of the current during its first cycle shall be not less than 1,42 times the rated short-time withstand current. When, however, the characteristics of the testing station are such that the above requirements cannot be obtained, the following alternatives are permitted provided that:

$$\int_0^{t_{test}} i_{test}^2 dt \geq I^2 \cdot t_{CW}$$

where

t_{test} is the duration of the test;

t_{cw} is the rated duration;

i_{test} is the calibration current if the AC component is not constant or $\geq I_{cw}$.

I is the actual calibration current assumed to have a constant AC component. If the decrement of the short-circuit current of the testing station is such that the rated short-time withstand current cannot be obtained for the rated time without applying initially an excessively high current, the RMS value of the current may be permitted to fall during the test below the specified value, the duration being increased appropriately, provided that the value of the highest peak current is not less than that specified. If, in order to obtain the required peak value, the RMS value of the current has to be increased above the specified current, the duration of the test shall be reduced accordingly.

9.3.4.2.3 DC test

When the characteristics of the testing station are such that the above requirements cannot be obtained for the rated time without applying initially an excessively high current, the value of the current may be permitted to fall during the test below the specified value, the duration being increased appropriately, provided that the maximum value of the current is not less than that specified. If the testing station is unable to make these tests on DC, they may, if agreed

between the user and the manufacturer, be made on AC, provided suitable precautions are taken: for instance, the peak value of current shall not exceed the permissible current.

9.3.4.2.4 Behaviour of the equipment during the test

All component shall be capable of carrying their rated short-time withstand current without causing mechanical damage to any part or separation of the contacts.

It is recognized that, during the test, the temperature rise of current-carrying and adjacent parts of the mechanical switching device may exceed the limits specified in 8.2.2. No temperature rise limits are specified for the short-time current withstand tests but the maximum temperature reached shall not cause significant damage to adjacent parts.

9.3.4.2.5 Behaviour of the equipment after the test

A no-load operation of the mechanical switching device shall be performed immediately after the test, and the contacts shall be open at the first attempt.

After the test, the component shall not show significant deterioration.

As a minimum, visual inspection and verification of dielectric test according to 9.3.3.7 shall be carried out.

9.3.5 Test sequence III: Ability to withstand vibration and shock

9.3.5.1 General

This sequence includes the tests and checks given in Table 7.

9.3.5.2 Vibration

The vibration tests shall be carried out in accordance with the requirements given in 9.3.5 of IEC 60077-1:2017.

When the component has several mechanical states, the test duration shall be distributed so that:

– this distribution represents the expected service;
– all mechanical states are tested.

The tested object shall not change state during the functional random vibration test.

9.3.5.3 Shock

The shock tests shall be carried out in accordance with the requirements given in 9.3.5 of IEC 60077-1:2017.

The test shall include both operational states and the apparatus shall not change state during the test.

9.3.5.4 Verification of functional operation

After the test described in 9.3.5.3, the functional operation shall be checked in accordance with the requirements given in 9.4.2.

9.3.5.5 Verification of dielectric withstand

After the verification described in 9.3.5.4, the component shall be able to withstand the dielectric tests required in 9.3.3.7.

9.3.6 Test sequence IV: Critical currents range

This test concerns searching for critical currents range for DC and AC switchgears of categories A1 and A2 according to the definitions given in 5.5. This test shall be carried out for:

– a test voltage equal to the rated operational voltage;
– a current range from the rated operational current to zero;
– the two rated time constants τ_1 and τ_3 according to Table 1 for DC switchgear;
– the rated power factor according to 5.3.5 for AC switchgear;
– minimum five operations at each value of current.

The exact values of current are not important, provided that each current is approximately half of the previous current.

Lower time constants at τ_3 or power factors are accepted provided that the circuit load inductance has a minimum value of 50 mH.

For DC components the peak arc voltage shall be measured.

NOTE The test enables the manufacturer to supply curves of the arcing time and the peak arc voltage as a function of the breaking current.

9.3.7 Test sequence V: Climatic conditions

This sequence includes the supplementary tests listed below which shall be carried out according to the relevant method of the standards at the recommended test severity listed in Table 9 unless otherwise specified.

Table 9 – Test method and severity

Standard	Test method	Test severity
IEC 60068-2-1 (cold)	Test Ab	At the minimum ambient air temperature Duration not less than 16 h
IEC 60068-2-2 (dry heat)	Test Bd or Be	At the maximum ambient air temperature Duration not less than 16 h.
IEC 60068-2-78 (damp heat, steady state) or IEC 60068-2-30 (damp heat, cyclic)	Test Cab or Test Db	At 40 °C and 95 % of relative humidity Duration not less than 2 days or Temperature between + 25 °C and + 55 °C 95 % of relative humidity Minimum 2 cycles.
IEC 60068-2-52 (salt mist, cyclical test)	Test Kb	Test severity 3

In addition, other tests may be prescribed by the test document according to the specifically defined environmental conditions.

The operating conditions during the tests and the test acceptance criteria shall be stated in the test specification agreed between the user and the manufacturer. In the absence of any specific acceptance criteria, the component shall be capable of performing the functional operation tests (see 9.4.2).

The particular parameters shall be recorded in the test report.

Where applicable, an air-tightness test shall be carried out during and after exposure at dry heat and cold in accordance with 9.3.4.2 of IEC 60077-1:2017.

A new sample should be used for each test. However, the same sample may be used again if it is considered as new after refurbishment.

9.3.8 Test sequence VI: Other tests

9.3.8.1 General

This sequence may include supplementary tests such as:

– electromagnetic compatibility;
– acoustic noise emission.

9.3.8.2 Electromagnetic compatibility (EMC)

EMC shall be carried out, if applicable, in accordance with the requirements given in 9.3.6 of IEC 60077-1:2017.

9.3.8.3 Acoustic noise emission

Acoustic noise emission may be carried out, if requested, in accordance with the requirements given in 9.3.7 of IEC 60077-1:2017.

9.4 Routine tests

9.4.1 General

Engineering and statistical analyses may show that routine tests on each component are not always necessary; in this case sampling tests shall be made.

9.4.2 Functional test

The test shall be carried out according to 9.3.1.2 of IEC 60077-1:2017.

In the absence of specific requirements, the test shall consist of checking 20 times in succession that the component operates satisfactorily under no current in the main circuit.

9.4.3 Measurement of resistance or impedance

The test shall be carried out according to 9.2.3 of IEC 60077-1:2017.

9.4.4 Air-tightness (for pneumatic components)

The test shall be carried out according to 9.3.4.2 of IEC 60077-1:2017.

9.4.5 Dielectric withstand

The test shall be carried out according to 9.3.3.3 of IEC 60077-1:2017.

9.4.6 Check on the setting and operation of protective equipment and relays (calibration)

The test shall be carried out according to 9.3.4.5 of IEC 60077-1:2017.

Annex A
(normative)

Correspondence between auxiliary contacts and steady states of switchgear

Auxiliary contacts shall indicate the position of the main circuit of the switchgear. To this purpose, two types of auxiliary contacts are generally defined by the terminology of IEC 60050-441 [SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-12 and 441-15-13]:

– the make contact ("a" contact), and
– the break contact ("b" contact).

These definitions are related to a given steady state, taken as reference, which is:

– the position maintained by the switchgear when it is not activated, if it has a biased position in such conditions;
– the position where the main circuit is open if the switchgear has no biased position when it is not activated;
– a position to be defined if neither of the above definitions is applicable.

A switchgear may be considered to be fully closed for all stable positions of its movement for which compliance with temperature rise requirements can be proved. If this cannot be fulfilled, it shall be considered as not fully closed.

In the same way, a switchgear may be considered as sufficiently open for all positions of its movement for which the dielectric voltage required between its main contacts can be withstood. If this cannot be fulfilled, it shall be considered as not sufficiently open.

Auxiliary contacts shall therefore be designed so as to be capable of indicating whether the switchgear is:

– fully closed, or
– sufficiently open, or
– in an intermediate position, if neither of the previous indications can be obtained.

A make contact "a" should be named "a_1" if its closing indicates that the main contact is well closed, and "a_0" if its opening indicates that the main contact is sufficiently open.

A break contact "b" should be named "b_1" if its opening indicates that the main contact is well closed, and "b_0" if its closing indicates that the main contact is sufficiently open.

Figure A.1 shows the different types of auxiliary contacts.

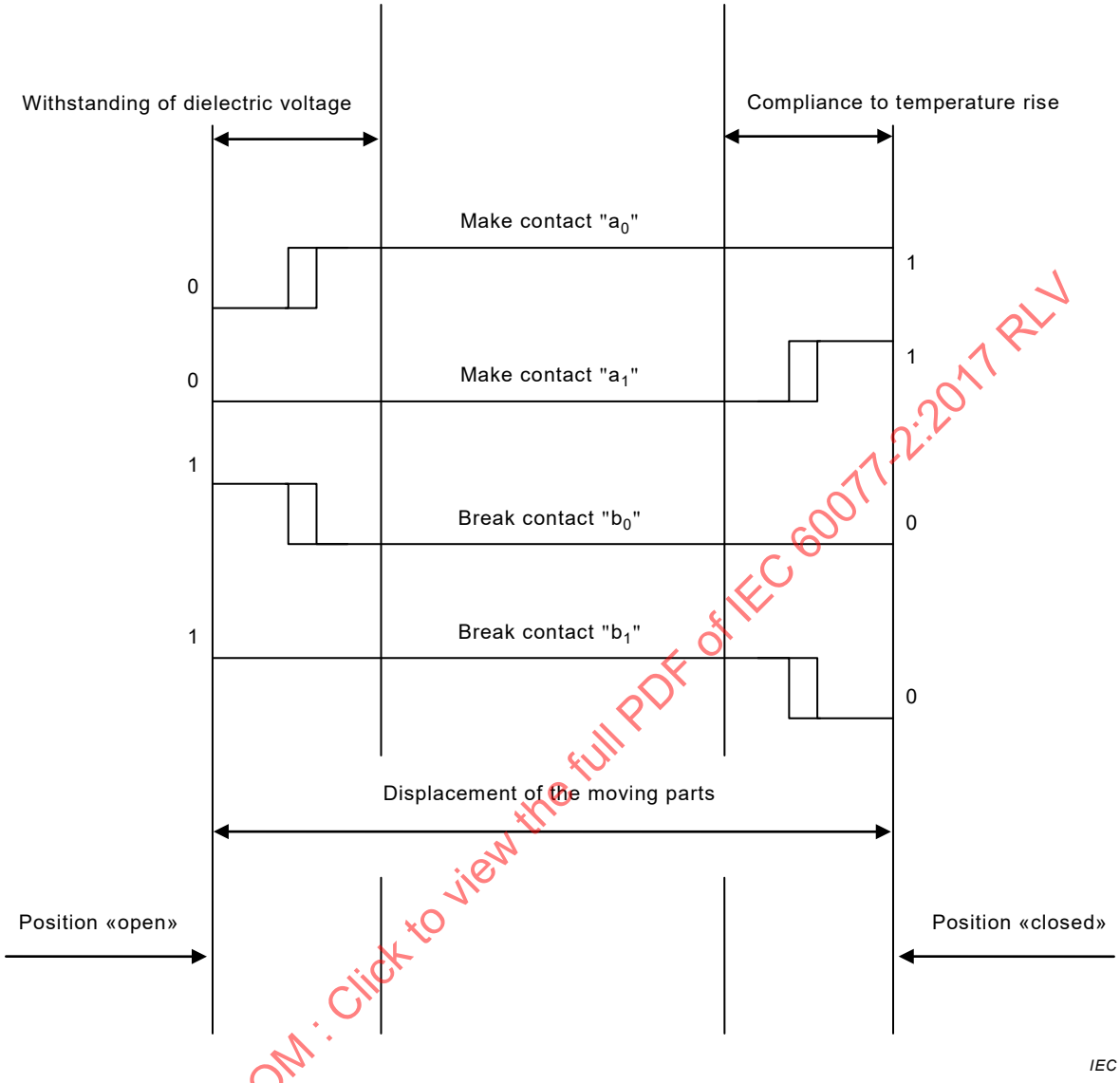

Figure A.1 – Relationship between auxiliary contacts and steady states of switchgear

Bibliography

IEC 60050-441:1984, *International Electrotechnical Vocabulary – Switchgear, controlgear and fuses*
IEC 60050-441:1984/AMD1:2000

IEC 60077-3, *Railway applications – Electric equipment for rolling stock – Part 3: Electrotechnical components – Rules for d.c. circuit-breakers*

IEC 60077-4, *Railway applications – Electric equipment for rolling stock – Part 4: Electrotechnical components – Rules for a.c. circuit-breakers*

IEC 60077-5, *Railway applications – Electric equipment for rolling stock – Part 5: Electrotechnical components – Rules for HV fuses*

IEC 60571, *Railway applications – Electronic equipment used on rolling stock*

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

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

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

IEC 61140, *Protection against electric shock – Common aspects for installations and equipment*

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

IEC 62236-3-1, *Railway applications – Electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle*

IEC 62236-3-2, *Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus*

IEC 62313, *Railway applications – Power supply and rolling stock – Technical criteria for the coordination between power supply (substation) and rolling stock*

IEC 62497-1, *Railway applications – Insulation coordination – Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment*

IEC 62498-1, *Railway applications – Environmental conditions for equipment – Part 1: Equipment on board rolling stock*

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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APPLICATIONS FERROVIAIRES – ÉQUIPEMENTS ÉLECTRIQUES DU MATÉRIEL ROULANT –

Partie 2: Composants électrotechniques – Règles générales

AVANT-PROPOS

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La Norme internationale IEC 60077-2 a été établie par le comité d'études 9 d'IEC: Matériels et systèmes électriques ferroviaires.

Cette seconde édition annule et remplace la première édition de l'IEC 60077-2, publiée en 1999. Elle constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) Pouvoir de coupure en court-circuit;
b) Courant assigné de courte durée admissible;
c) Plage de courants critiques;

d) Spécification des conditions climatiques.

Cette norme doit être lue conjointement avec l'IEC 60077-1.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
9/2267/FDIS	9/2279/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Une liste de toutes les parties de la série IEC 60077, publiées sous le titre général *Applications ferroviaires – Équipements électriques du matériel roulant*, peut être consultée sur le site web de l'IEC.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous «http://webstore.iec.ch» dans les données relatives à la publication recherchée. A cette date, la publication sera

- reconduite,
- supprimée,
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- amendée.

APPLICATIONS FERROVIAIRES – ÉQUIPEMENTS ÉLECTRIQUES DU MATÉRIEL ROULANT –

Partie 2: Composants électrotechniques – Règles générales

1 Domaine d'application

La présente partie de l'IEC 60077 donne, en complément des règles énoncées dans l'IEC 60077-1, les règles générales applicables à tous les composants électrotechniques installés dans les circuits de puissance, circuits auxiliaires, circuits de commande et de contrôle, etc., installés sur le matériel roulant ferroviaire.

Le présent document a pour but d'adapter les règles générales données dans l'IEC 60077-1 aux composants électrotechniques du matériel roulant afin d'harmoniser les exigences et les essais à la gamme de composants correspondante.

Les composants électrotechniques sont principalement les appareillages de connexion et de commande, comprenant les relais, les électrovalves, les résistances, les fusibles, etc., quelle que soit la nature de leur commande.

L'incorporation de composants électroniques ou de sous-ensembles électroniques dans les composants électrotechniques est maintenant une pratique courante. Bien que le présent document ne soit pas applicable aux matériels électroniques, la présence de composants électroniques n'est pas une raison suffisante pour exclure ces composants électrotechniques du champ d'application du présent document.

Ces sous-ensembles électroniques sont conformes à la norme appropriée.

Après accord entre utilisateur et fabricant, certaines règles sont utilisées pour les composants électrotechniques installés sur des véhicules autres que ceux du matériel roulant ferroviaire, tels que les locomotives de mine, les trolleybus, etc.

Le présent document énonce:

a) les caractéristiques des composants;

b) les conditions de service auxquelles les composants doivent satisfaire;

c) les essais destinés à confirmer que les composants satisfont à ces caractéristiques dans ces conditions de service et les méthodes correspondantes;

d) les informations qu'il faut marquer ou fournir avec l'appareil.

Le présent document ne couvre pas les composants électrotechniques industriels qui répondent aux exigences de leurs propres normes de produit(s). Dans le but d'obtenir un fonctionnement satisfaisant de ceux-ci sur le matériel roulant, le présent document est employé uniquement pour spécifier les exigences particulières relatives à l'application ferroviaire. Dans ce cas, un document spécifique indiquerait les exigences complémentaires auxquelles il faut que les composants industriels satisfassent, par exemple:

– pour être adaptés (tension de commande, conditions d'environnement, etc.), ou

– pour être installés et utilisés de sorte qu'ils n'aient pas à subir les conditions particulières du milieu ferroviaire, ou

– pour subir des essais additionnels afin de prouver que ces composants peuvent supporter de manière satisfaisante les conditions ferroviaires.

Dans l'éventualité où une différence existerait entre les exigences du présent document et une norme de produit ferroviaire de matériel roulant pertinente, les exigences de la norme de produit prévaudraient.

2 Références normatives

Les documents suivants cités dans le texte constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60050-811:2017, *Vocabulaire Electrotechnique International – Chapitre 811: Traction électrique*

IEC 60068-2-1, *Essais d'environnement – Partie 2-1: Essais – Essais A: froid*

IEC 60068-2-2, *Essais d'environnement – Partie 2-2: Essais – Essais B: chaleur sèche*

IEC 60068-2-30, *Essais d'environnement – Partie 2-30: Essais – Essai Db: essai cyclique de chaleur humide (cycle de 12 h + 12 h)*

IEC 60068-2-52, *Essais d'environnement – Partie 2-52: Essais – Essai Kb: brouillard salin, essai cyclique (solution de chlorure de sodium)*

IEC 60068-2-78, *Essais d'environnement – Partie 2-78: Essais – Essais Cab: chaleur humide, essai continu*

IEC 60077-1:2017, *Applications ferroviaires – Equipements électriques du matériel roulant – Partie 1: Conditions générales de service et règles générales*

IEC 60417, *Symboles graphiques utilisables sur le matériel* (disponible à http://www.graphical-symbols.info/equipment)

IEC 60529, *Degrés de protection procurés par les enveloppes (code IP)*

IEC TR 60943, *Guide concernant l'échauffement admissible des parties des matériels électriques, en particulier les bornes de raccordement*

3 Termes, définitions et termes abrégés

Pour les besoins du présent document, les termes et définitions donnés dans l'IEC 60077-1 ainsi que les suivants s'appliquent.

L'ISO et l'IEC entretiennent des bases de données terminologiques pour l'usage de la normalisation aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1 Composants

3.1.1
composant électrique actif
organe simple ou assemblage d'organes qui, en réponse à une commande, exécute une fonction ou diverses fonctions indissociables de nature logique ou analogique par

changement d'état, et pour lequel la commande ou la fonction est électrique (par ex. contacteur, relais, etc.)

Note 1 à l'article: Le terme «composant électrique passif» est défini comme l'antonyme de ce terme.

3.1.2
composant électrique passif
organe simple, ou assemblage d'organes, qui n'appartient pas aux composants électriques actifs et a au moins une fonction électrique (par ex. isolateur, connexion permanente, résistance, condensateur, etc.)

3.1.3
appareillage
terme général applicable aux appareils de connexion et à leur combinaison avec des appareils de commande, de mesure, de protection et de réglage qui leur sont associés, ainsi qu'aux ensembles de tels appareils avec les connexions, les accessoires, les enveloppes et les supports correspondants

[SOURCE: IEC 60050-441:1984 / AMD1:2007,441-11-01]

3.1.4
appareillage de connexion
terme général applicable aux appareils de connexion et à leur combinaison avec des appareils de commande, de mesure, de protection et de réglage qui leur sont associés, ainsi qu'aux ensembles de tels appareils avec les connexions, les accessoires, les enveloppes et les supports correspondants, destinés en principe à être utilisés dans le domaine de la production, du transport, de la distribution et de la transformation de l'énergie électrique

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-11-02]

3.1.5
appareillage de commande
terme général applicable aux appareils de connexion et à leur combinaison avec des appareils de commande, de mesure, de protection et de réglage qui leur sont associés, ainsi qu'aux ensembles de tels appareils avec les connexions, les accessoires, les enveloppes et les supports correspondants, destinés en principe à la commande des appareils utilisateurs d'énergie électrique

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-11-03]

3.1.6
appareil de connexion
appareil destiné à établir ou à interrompre le courant dans un ou plusieurs circuits électriques

Note 1 à l'article: Un appareil de connexion peut effectuer l'une de ces manœuvres ou les deux.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-14-01, modifié – La Note 1 à l'article a été ajoutée.]

3.1.7
fusible
appareil qui, par la fusion d'un ou de plusieurs de ses éléments conçus et calibrés à cet effet, ouvre le circuit dans lequel il est inséré en coupant le courant lorsque celui-ci dépasse pendant un temps suffisant une valeur donnée

Note 1 à l'article: Le fusible comprend toutes les parties qui constituent l'appareil complet.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-18-01, modifié – La deuxième phrase a été changée en Note 1 à l'article]

3.1.8
interrupteur, <mécanique>
appareil mécanique de connexion capable d'établir, de supporter et d'interrompre des courants dans les conditions normales du circuit, y compris éventuellement les conditions spécifiées de surcharge en service, ainsi que de supporter pendant une durée spécifiée des courants dans des conditions anormales spécifiées du circuit telles que celles du court-circuit

Note 1 à l'article: Un interrupteur peut être capable d'établir des courants de court-circuit mais n'est pas capable de les couper.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-14-10]

3.1.9
appareil mécanique de connexion
appareil de connexion destiné à fermer et à ouvrir un ou plusieurs circuits électriques au moyen de contacts séparables

Note 1 à l'article: Tout appareil mécanique de connexion peut être désigné en fonction du milieu dans lequel ses contacts s'ouvrent et se ferment, par exemple: air, SF6, huile.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-14-02]

3.1.10
disjoncteur
appareil mécanique de connexion capable d'établir, de supporter et d'interrompre des courants dans les conditions normales du circuit, ainsi que d'établir, de supporter pendant une durée spécifiée et d'interrompre des courants dans les conditions anormales spécifiées du circuit telles que celles du court-circuit

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-14-20]

3.1.11
contacteur
appareil mécanique de connexion ayant une seule position de repos, commandé autrement qu'à la main, capable d'établir, de supporter et d'interrompre des courants dans les conditions normales du circuit, y compris les conditions de surcharge en service

Note 1 à l'article: Les contacteurs peuvent être désignés suivant la façon dont est fourni l'effort nécessaire à la fermeture des contacts principaux.

Note 2 à l'article: La définition est la même que «contacteur mécanique»: IEC 60050-441:1984/AMD1:2007, 441-14-33.

3.1.12
sectionneur
appareil mécanique de connexion qui assure, en position d'ouverture, une distance de sectionnement satisfaisant à des conditions spécifiées

Note 1 à l'article: Un sectionneur est capable d'ouvrir et de fermer un circuit seulement lorsqu'un courant d'intensité négligeable est interrompu ou établi, ou bien lorsqu'il ne se produit aucun changement notable de la tension aux bornes de chacun des pôles du sectionneur. Il est aussi capable de supporter des courants dans les conditions normales du circuit et de supporter des courants pendant une durée spécifiée dans des conditions anormales telles que celles du court-circuit.

[SOURCE: IEC 60050-811:2017, 811-29-17]

3.2 Parties de composant

3.2.1
pôle d'un appareil de connexion
élément constituant d'un appareil de connexion associé exclusivement à un chemin conducteur électriquement séparé appartenant à son circuit principal, cet élément ne

comprenant pas les éléments constituants assurant la fixation et le fonctionnement d'ensemble de tous les pôles

Note 1 à l'article: Un appareil de connexion est appelé unipolaire s'il n'a qu'un pôle. S'il a plus d'un pôle, il peut être appelé multipolaire (bipolaire, tripolaire, etc.) à condition que les pôles soient ou puissent être liés entre eux de façon qu'ils fonctionnent ensemble.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-01]

3.2.2
circuit principal, <d'un appareil de connexion>
ensemble des pièces conductrices d'un appareil de connexion insérées dans le circuit qu'il a pour fonction de fermer ou d'ouvrir

Note 1 à l'article: Cela ne comprend pas les parties du circuit auxiliaire d'un appareil de connexion (voir 3.2.4).

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-02, modifié – La Note 1 à l'article a été ajoutée.]

3.2.3
circuit de commande, <d'un appareil de connexion>
ensemble des pièces conductrices d'un appareil de connexion, autres que celles du circuit principal, insérées dans un circuit utilisé pour commander la manœuvre de fermeture ou la manœuvre d'ouverture ou les deux manœuvres de l'appareil

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-03]

3.2.4
circuit auxiliaire, <d'un appareil de connexion>
ensemble des pièces conductrices d'un appareil de connexion destinées à être insérées dans un circuit autre que le circuit principal et les circuits de commande de l'appareil

Note 1 à l'article: Certains circuits auxiliaires remplissent des fonctions supplémentaires, telles que la signalisation, le verrouillage, etc., et, à ce titre, ils peuvent faire partie du circuit de commande d'un autre appareil de connexion.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-04]

3.2.5
contact, <d'un appareil mécanique de connexion>
pièces conductrices destinées à établir la continuité d'un circuit lorsqu'elles se touchent et qui, par leur mouvement relatif pendant une manœuvre, ouvrent ou ferment un circuit ou, dans le cas de contacts pivotants ou glissants, maintiennent la continuité du circuit

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-05]

3.2.6
contact principal
contact inséré dans le circuit principal d'un appareil mécanique de connexion, prévu pour supporter, dans la position de fermeture, le courant du circuit principal

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-07]

3.2.7
contact auxiliaire
contact inséré dans un circuit auxiliaire et manœuvré mécaniquement par l'appareil de connexion

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-10]

3.2.8
contact de travail
contact fermé lorsque le contact principal d'un appareil mécanique de connexion est à l'état de travail et ouvert lorsque le contact principal d'un appareil mécanique de connexion est à l'état de repos

Note 1 à l'article: Voir les informations complémentaires à l'Annexe A du présent document.

Note 2 à l'article: «contact à fermeture» est un terme déconseillé.

[SOURCE: IEC 60050-811:2017, 811-31-03, modifié – «relais» est remplacé par «le contact principal d'un appareil mécanique de connexion». La Note 1 à l'article et la Note 2 à l'article ont été ajoutées.]

3.2.9
contact de repos
contact ouvert lorsque le contact principal d'un appareil mécanique de connexion est à l'état de travail et fermé lorsque le contact principal d'un appareil mécanique de connexion est à l'état de repos

Note 1 à l'article: Voir les informations complémentaires à l'Annexe A du présent document.

Note 2 à l'article: «contact à ouverture» est un terme déconseillé.

[SOURCE: IEC 60050-811:2017, 811-31-04, modifié – «relais» est remplacé par «contact principal d'un appareil mécanique de connexion». La Note 1 à l'article et la Note 2 à l'article ont été ajoutées.]

3.2.10
relais, <électrique>
dispositif destiné à produire des modifications soudaines prédéterminées, dans un ou plusieurs circuits électriques de sortie, lorsque certaines conditions sont remplies dans les circuits électriques d'entrée dont il subit l'action

Note 1 à l'article: La présente définition peut également être appliquée à des relais dont la commande n'est pas électrique.

[SOURCE: IEC 60050-151:2001, 151-13-31, modifié – La Note 1 à l'article a été ajoutée.]

3.2.11
déclencheur, <d'un appareil mécanique de connexion>
dispositif raccordé mécaniquement à un appareil mécanique de connexion dont il libère les organes de retenue et qui permet l'ouverture ou la fermeture de l'appareil

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-15-17]

3.3 Caractéristiques de fonctionnement

3.3.1
manœuvre, <d'un appareil mécanique de connexion>
passage d'un ou de plusieurs contacts mobiles d'une position à une position adjacente

Note 1 à l'article: Par exemple, pour un disjoncteur, ce pourra être une manœuvre de fermeture ou une manœuvre d'ouverture.

Note 2 à l'article: Si une distinction est nécessaire, on emploiera les mots manœuvre électrique (par exemple: établissement ou coupure) et manœuvre mécanique (par exemple: fermeture ou ouverture).

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-01]

3.3.2
cycle de manœuvres, <d'un appareil mécanique de connexion>
suite de manœuvres d'une position à une autre avec retour à la première position en passant par toutes les autres positions, s'il en existe

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-02]

3.3.3
commande manuelle
commande d'une manœuvre, effectuée par intervention humaine

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-04]

3.3.4
position de fermeture, <d'un appareil mécanique de connexion>
position dans laquelle la continuité prédéterminée du circuit principal de l'appareil est assurée

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-22]

3.3.5
position d'ouverture, <d'un appareil mécanique de connexion>
position dans laquelle les exigences déterminées de tension de tenue diélectrique entre contacts ouverts sont assurées dans le circuit principal de l'appareil

Note 1 à l'article: Cette définition diffère de celle du VEI 441-16-23 pour satisfaire aux exigences relatives aux propriétés diélectriques.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-16-23, modifié – «la distance d'isolement» est remplacé par «les exigences de tension de tenue diélectrique». La Note 1 à l'article a été ajoutée.]

3.3.6
courant coupé, <d'un appareil de connexion ou d'un fusible>
courant dans un pôle d'un appareil de connexion ou dans un fusible évalué à l'instant de l'amorçage de l'arc au cours d'une coupure

Note 1 à l'article: En courant alternatif, ce courant est exprimé par la valeur efficace symétrique de la composante alternative.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-07, modifié – La Note 1 à l'article a été ajoutée.]

3.3.7
courant présumé, <d'un circuit et relatif à un appareil de connexion ou à un fusible>
courant qui circulerait dans le circuit si chaque pôle de l'appareil de connexion ou le fusible était remplacé par un conducteur d'impédance négligeable

Note 1 à l'article: La méthode à employer pour évaluer et pour exprimer le courant présumé doit être spécifiée dans la publication correspondante.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-01]

3.3.8
courant établi présumé, <pour un pôle d'un appareil de connexion>
courant présumé lorsqu'il est établi dans des conditions spécifiées

Note 1 à l'article: Les conditions spécifiées peuvent se rapporter à la méthode d'établissement, par exemple par un appareil de connexion idéal, ou à l'instant d'établissement, par exemple conduisant à la valeur maximale de crête ou à la vitesse maximale d'accroissement. La spécification de ces conditions est donnée dans la publication correspondante.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-05]

3.3.9
courant coupé présumé, <pour un pôle d'un appareil de connexion ou un fusible>
courant présumé évalué à l'instant correspondant au début du phénomène de coupure

Note 1 à l'article: Des spécifications concernant l'instant du début du phénomène de coupure sont disponibles dans la publication correspondante. Pour les appareils mécaniques de connexion ou les fusibles, cet instant est habituellement choisi comme l'instant du début d'un arc au cours d'une coupure.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-06]

3.3.10
pouvoir de coupure, <d'un appareil de connexion ou d'un fusible>
valeur de courant présumé qu'un appareil de connexion ou un fusible est capable d'interrompre sous une tension donnée et dans des conditions prescrites d'emploi et de comportement

Note 1 à l'article: La tension à fixer et les conditions à prescrire sont précisées dans la publication correspondante.

Note 2 à l'article: En courant alternatif, ce courant est exprimé par la valeur efficace symétrique de la composante alternative.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-08, modifié – La Note 2 à l'article a été modifiée]

3.3.11
pouvoir de coupure en court-circuit
pouvoir de coupure pour lequel les conditions prescrites comprennent un court-circuit aux bornes de l'appareil de connexion

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-11]

3.3.12
courant critique
plage de courants critiques
valeur de courant ou plage de valeurs pour lesquelles le composant n'est pas capable de fonctionner sans risque de défaut de coupure

Note 1 à l'article: En courant alternatif, seul le contacteur à courant alternatif est applicable.

3.3.13
pouvoir de fermeture, <d'un appareil de connexion>
valeur du courant présumé établi qu'un appareil de connexion est capable d'établir sous une tension donnée et dans des conditions prescrites d'emploi et de comportement

Note 1 à l'article: La tension à fixer et les conditions à prescrire sont précisées dans les publications correspondantes.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-09, modifié – Dans la Note 1 à l'article, «spécifications individuelles» est remplacé par «publications»]

3.3.14
pouvoir de fermeture en court-circuit
pouvoir de fermeture pour lequel les conditions prescrites comprennent un court-circuit aux bornes de l'appareil de connexion

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-10]

3.3.15
courant de courte durée admissible
courant qu'un circuit ou un appareil de connexion dans la position de fermeture peut supporter pendant un court intervalle de temps spécifié et dans des conditions prescrites d'emploi et de comportement

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-17]

3.3.16
tension de rétablissement
tension qui apparaît entre les bornes d'un appareil de connexion ou d'un fusible après l'interruption du courant

Note 1 à l'article: Cette tension peut être considérée durant deux intervalles de temps consécutifs, l'un durant lequel existe une tension transitoire, suivi par un second intervalle durant lequel la tension de rétablissement à fréquence industrielle ou en régime établi existe seule.

Note 2 à l'article: Cette définition s'applique à un appareil unipolaire. Pour un appareil multipolaire, c'est la tension entre phases entre les bornes d'alimentation de l'appareil.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-25, modifié – La Note 2 à l'article a été ajoutée.]

3.3.17
tension d'arc, <d'un appareil mécanique de connexion> (en valeur de crête)
valeur maximale instantanée de tension, qui dans des conditions prescrites, apparaît entre les bornes d'un pôle d'un appareil de connexion pendant la durée d'arc

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-30]

3.3.18
durée d'ouverture, <d'un appareil mécanique de connexion>
intervalle de temps entre l'instant spécifié de début de la manœuvre d'ouverture et l'instant de la séparation des contacts d'arc sur tous les pôles

Note 1 à l'article: L'instant de début de la manœuvre d'ouverture, c'est-à-dire l'émission de l'ordre d'ouverture (par exemple, l'alimentation d'un déclencheur, etc.) est donné dans la publication correspondante.

Note 2 à l'article: Le terme «durée de fermeture» est défini comme l'antonyme de ce terme.

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-36, modifié – La Note 2 à l'article a été ajoutée.]

3.3.19
durée d'arc, <d'un pôle ou d'un fusible>
intervalle de temps entre l'instant de début de l'arc sur un pôle ou sur un fusible et l'instant de l'extinction finale de l'arc sur ce pôle ou ce fusible

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-37]

3.3.20
durée de coupure
intervalle de temps entre le début de la durée d'ouverture d'un appareil mécanique de connexion, ou le début de la durée de préarc d'un fusible, et la fin de la durée d'arc

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-39]

3.3.21
durée de fermeture
intervalle de temps entre le début de la manœuvre de fermeture et l'instant où les contacts se touchent dans tous les pôles

[SOURCE: IEC 60050-441:1984 / AMD1:2007, 441-17-41]

3.4 Termes abrégés

CA Courant alternatif

CC Courant continu

CEM Compatibilité électromagnétique

RMS Valeur efficace (Root Mean Square value)

4 Classification

Cet article est destiné à énumérer les caractéristiques d'un composant sur lesquelles le fabricant donne des informations, et qui doivent être vérifiées par des essais si nécessaire.

Les composants sont classés:

– selon leur fréquence de fonctionnement C1, C2 ou C3;

  Les caractéristiques de ces catégories, applicables uniquement aux composants électriques actifs, sont données en 5.4;

– selon leur classe de composant A1, A2, A3, A4 ou B;

  Les caractéristiques de ces catégories sont données en 5.5;

– selon le type de conception:

  • construction ouverte;

  • construction sous enveloppe;

– selon le degré de protection procuré par l'enveloppe (voir l'IEC 60529).

5 Caractéristiques

5.1 Liste des caractéristiques

Les caractéristiques d'un composant doivent être celles de la liste suivante selon le cas:

– type de composant (5.2);
– valeurs assignées et valeurs limites du circuit principal (5.3);
– fréquences de fonctionnement (5.4);
– classes de composants (5.5);
– circuits de commande électriques (5.6);
– circuits de commande pneumatiques (5.7);
– commande manuelle (5.8);
– circuits auxiliaires électriques (5.9);
– circuits auxiliaires pneumatiques (5.10);
– valeurs crêtes de la tension d'arc (5.11).

5.2 Type de composant

Il est nécessaire d'indiquer selon le cas:

– le type de composant (par ex. contacteur à courant continu, sectionneur, manipulateur de conduite, manipulateur de freinage, etc.);
– le nombre de pôles;
– les tensions assignées et les valeurs limites de tension du circuit principal (5.3);
– les courants assignés et les valeurs limites de courant du circuit principal (5.3);
– le moyen de coupure;
– la polarité;
– les conditions de fonctionnement (méthode de fonctionnement, méthode de commande, etc.);
– le type de conception (Article 4);
– le degré de protection procuré par l'enveloppe (Article 4).

5.3 Valeurs assignées et valeurs limites du circuit principal

5.3.1 Généralités

Les valeurs assignées sont fixées par le fabricant. Elles doivent l'être conformément aux 5.3.2 à 5.3.5.

5.3.2 Tensions assignées

Un composant est défini par les tensions assignées suivantes définies en 5.2 de l'IEC 60077-1:2017:

– tension assignée d'emploi (U_r);
– tension assignée d'isolement (U_{Nm});
– tension assignée de choc (U_{Ni});
– tension d'essai à fréquence industrielle (U_a).

NOTE Les valeurs limites de fonctionnement sont données en 8.2.1 de l'IEC 60077-1:2017.

5.3.3 Courants assignés

Un composant est défini par les courants assignés suivants:

– courant assigné d'emploi (I_r) à la constante de temps assignée τ_2 (voir 5.3.4) ou pour le facteur de puissance assigné (voir 5.3.5), selon le cas (donné en 5.4 de l'IEC 60077-1:2017);
– courant assigné de courte durée admissible (I_{cw}) (voir 3.3.15);
– courant thermique conventionnel à l'air libre (I_{th});
– courant thermique conventionnel sous enveloppe (I_{the}).

Le courant thermique conventionnel à l'air libre est la valeur maximale du courant d'essai à utiliser pour les essais d'échauffement du matériel, à l'air libre à la température ambiante maximale.

Le courant thermique conventionnel sous enveloppe est la valeur maximale du courant d'essai à utiliser pour les essais d'échauffement du matériel installé dans l'enveloppe spécifiée à la température ambiante maximale.

On entend par air libre l'air qui existe dans les conditions normales à l'intérieur, raisonnablement exempt de courants d'air et de radiations externes.

En fonctionnement continu, la valeur maximale du courant assigné d'emploi doit être inférieure à la valeur du courant thermique conventionnel à l'air libre en l'absence de ventilation forcée.

5.3.4 Constantes de temps assignées (pour les appareillages de connexion à courant continu)

Un composant est caractérisé par les constantes de temps assignées appropriées τ_1, τ_2 et τ_3 données dans le Tableau 1. τ_2 est la constante de temps assignée pour un fonctionnement considéré comme normal; elle est utilisée pour les essais spécifiés en 9.3.3.6. Les constantes de temps τ_1 et τ_3 correspondent aux situations extrêmes; elles sont utilisées pour les essais spécifiés en 9.3.6.

Si nécessaire, les valeurs des constantes de temps peuvent être définies par accord entre l'utilisateur et le fabricant.

Tableau 1 – Constantes de temps assignées

Tensions assignées d'emploi V	Constantes de temps assignées ms		
	τ_1	τ_2	τ_3
$U_r \leq 900$	0	15	50
$900 < U_r \leq 1\,800$	0	15	40
$U_r > 1\,800$	0	15	30
NOTE Une constante de temps nulle signifie que pour les essais, les charges sont faites de résistances, sans aucune volonté d'ajouter de l'inductance.			

5.3.5 Facteurs de puissance assignés (pour les appareillages de connexion à courant alternatif)

L'aptitude au fonctionnement en service d'un composant est définie pour un facteur de puissance assigné de 0,8 quels que soient les courants et tensions d'emploi assignés. Si nécessaire, le facteur de puissance pour les essais de court-circuit et de surcharge fera l'objet d'un accord entre l'utilisateur et le fabricant.

5.4 Fréquences de fonctionnement

Les fréquences de fonctionnement C1, C2 et C3 sont définies ci-après:

– C1: faible fréquence de fonctionnement (par ex. composant appartenant à la protection et/ou à l'équipement d'isolement, fonctionnant seulement en cas de défauts);

– C2: fréquence moyenne de fonctionnement (par ex. composant appartenant à un équipement fonctionnant dans l'un des cas suivants: chaque mise en service, chaque démarrage, chaque arrêt, chaque section neutre (IEC 60050-811:2017, 811-36-16), chaque section de séparation (IEC 60050-811:2017, 811-36-11), chaque fin de service);

– C3: fréquence élevée de fonctionnement (par ex. composant appartenant à un équipement fonctionnant à chaque séquence de traction, ou à chaque freinage, ou composant tel qu'un contacteur de compresseur).

NOTE Les références données entre parenthèses renvoient à des définitions données dans l'IEC 60050-811:2017.

5.5 Classes de composants

On distingue plusieurs classes de composants:

– A1: appareils de connexion des circuits auxiliaires (IEC 60050-811:2017, 811-25-05) ou circuits basse tension (IEC 60050-811:2017, 811-25-02) (par ex. relais, contacteurs auxiliaires et leurs accessoires, etc.), quelle que soit la nature de leur commande, à l'exception des composants à commande manuelle;