BS EN 61914:2016

BSI Standards Publication

Cable cleats for electrical installations

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National foreword

This British Standard is the UK implementation of EN 61914:2016. It is identical to IEC 61914:2015. It supersedes BS EN 61914:2009 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/213, Cable management.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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EUROPEAN STANDARD

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English Version

Cable cleats for electrical installations (IEC 61914:2015)

Brides de câbles pour installations électriques (IEC 61914:2015)

Kabelhalter für elektrische Installationen (IEC 61914:2015)

This European Standard was approved by CENELEC on 2015-12-28. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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CENELEC

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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

The text of document 23A/786/FDIS, future edition 2 of IEC 61914, prepared by SC 23A “Cable management systems” of IEC/TC 23 “Electrical accessories" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61914:2016.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2016-09-28
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2018-12-28

This document supersedes EN 61914:2009.

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

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC).

Endorsement notice

The text of the International Standard IEC 61914:2015 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60068-2-75	NOTE	Harmonized as EN 60068-2-75.
IEC 60909-0	NOTE	Harmonized as EN 60909-0.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu

Publication	Year	Title	EN/HD	Year
IEC 60060-1	2010	High-voltage test techniques - Part 1: General definitions and test requirements	EN 60060-1	2010
IEC 60695-11-5	2004	Fire hazard testing - Part 11-5: Test flames - Needle-flame test method - Apparatus, confirmatory test arrangement and guidance	EN 60695-11-5	2005
ISO 4287	1997	Geometrical Product Specifications (GPS) - Surface texture: Profile method - Terms, definitions and surface texture parameters	EN ISO 4287	1998
ISO 4892-2	2006	Plastics - Methods of exposure to laboratory light sources - Part-2: Xenon-arc lamps	EN ISO 4892-2	2006 [1)]
ISO 9227	2012	Corrosion tests in artificial atmospheres - Salt spray tests	EN ISO 9227	2012

1) Superseded by EN ISO 4892-2:2013 (ISO 4892-2:2013).

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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CABLE CLEATS FOR ELECTRICAL INSTALLATIONS

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61914 has been prepared by subcommittee 23A: Cable management systems, of IEC technical committee 23: Electrical accessories.

This second edition cancels and replaces the first edition published in 2009. This edition constitutes a technical revision.

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

a) Additional declaration and test for lateral load retention depending on cleat mounting orientation with associated new figures;
b) Additional declaration of the distance between the cable centres in any short-circuit test and associated new figures;
c) Specification of the cable to be used in short-circuit testing and relaxation of the ambient temperature limits for the test;
d) Additional requirement to photograph the short-circuit test arrangement before and after the test and to record more complete details of the cable used;

e) Revised parameters for the test of resistance to UV light.

This edition also includes the following editorial changes with respect to the previous edition:

f) Revised and updated normative references and bibliography;

g) Editorial clarification of definitions;

h) Editorial clarification of procedures for selection of test samples and the testing of cleats designed for more than one cable;

i) Relaxation of some mandrel material requirements;

j) Clarification of the inspection requirements following a short-circuit test and adding the option of either a.c. or d.c. voltage testing following a second short-circuit;

k) Clarification that the resistance to corrosion test applies to all types of fixing;

l) New cleat example illustration;

m) Limitations of use of the formulae in Annex B added.

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

FDIS	Report on voting
23A/786/FDIS	23A/795/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.

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

In this standard, the following print types are used:

– requirements proper: in roman type;
– *test specifications: in italic type;*
– notes: in smaller roman type.

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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

CABLE CLEATS FOR ELECTRICAL INSTALLATIONS

1 Scope

This International Standard specifies requirements and tests for cable cleats and intermediate restraints used for securing cable in electrical installations. Cable cleats provide resistance to electromechanical forces where declared. This standard includes cable cleats that rely on a mounting surface specified by the manufacturer for axial and/or lateral retention of cables.

This standard does not apply to:

– cable glands;
– cable ties.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60695-11-5:2004, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

ISO 4287:1997, *Geometrical product specifications (GPS) – Surface texture: Profile method – Terms, definitions and surface texture parameters*

ISO 4892-2:2006, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ISO 9227:2012, *Corrosion tests in artificial atmospheres – Salt spray tests*

3 Terms, definitions and abbreviations

For the purposes of this document, the following terms, definitions and abbreviations apply.

3.1
cable cleat
device designed to provide securing of cables when installed at intervals along the length of cables

Note 1 to entry: A cable cleat is provided with a means of attachment to a mounting surface but does not rely on an unspecified mounting surface for the retention of the cables. Examples of mounting surfaces that may be specified are ladder, tray, strut (see Figure A.8) or rail. Where declared, cable cleats provide resistance to electromechanical forces.

Note 2 to entry: See Figure A.1 to Figure A.9 for some examples of cable cleats. These examples do not limit the use of other cable cleat designs that conform to the requirements of this standard.

3.2
intermediate restraint
cable retaining device designed to be used with cable cleats, without being attached to the mounting surface, to hold the cables together in order to provide resistance to electromechanical forces

3.3
metallic
consisting of metal only

3.4
non-metallic
consisting of non-metallic material only

3.5
composite
consisting of metallic and non-metallic materials

Note 1 to entry: Fibre reinforced resin materials are not considered to be composite under this definition.

3.6
short-circuit current
overcurrent resulting from a circuit condition in which the current flows through an abnormal or unintended path of negligible impedance between live conductors, or between a live conductor and an earth, having a difference in potential under normal operating conditions

3.7
peak short-circuit current
i_p
maximum possible instantaneous value of the short-circuit current (see Annex B)

3.8
initial r.m.s. symmetrical short-circuit current
I''_k
r.m.s. value of the a.c. symmetrical component of a short-circuit current, applicable at the instant of the short circuit if the impedance remains at the zero-time value (see Annex B)

3.9
decaying (aperiodic) component of short-circuit current
$i_{d.c.}$
mean value between the top and bottom envelope of a short-circuit current decaying from an initial value to zero (see Annex B)

3.10
steady-state short-circuit current
I_k
r.m.s. value of the short-circuit current which remains after the decay of the transient phenomena (see Annex B)

3.11
trefoil formation
formation of three cables so laid as to be mutually equidistant

Note 1 to entry: Viewed in cross-section, the lines joining the cable centres form an equilateral triangle (see Figure 5).

Note 2 to entry: The formation is known as “close trefoil” formation when the cables are touching each other.

3.12
flat formation
formation of a number of cables laid in a plane, usually with equal spacing between adjacent cables (see Figure 6)

3.13
electromechanical forces
induced forces acting on current-carrying conductors

3.14
retention
limiting the lateral and/or axial movement of the cable

3.15
securing
fixing to or from a mounting surface or another product

3.16
environmental influences
effect of corrosive substances or solar radiation, etc.

4 General requirements

Products covered by this standard shall be so designed and constructed that, when assembled and installed as for normal use according to the manufacturer’s instructions, they ensure securing of cables as declared in accordance with Clause 6 and shall not cause damage to the cable.

Compliance is checked by the relevant tests specified in this standard.

5 General notes on tests

5.1 Tests according to this standard are type tests.

- Products of all sizes shall comply with Clause 8 and 9.1a).
- For the requirements in 9.1b), 9.1c) and 9.1d) where there are a number of cleats in a range, the range is divided into one or more types. In this case, the smallest and the largest size of cleat of each type are tested.
- The test for compliance with 9.1e) is performed on the set of samples selected as defined in 9.5.1.

NOTE For guidance in determining types, cable cleats or intermediate restraints having material, construction characteristics, and classifications according to Clause 6 below, in common, are considered to be the same type.

5.2 Unless otherwise specified, all tests shall be carried out on three new samples of each size selected as specified in 5.1, assembled and installed as for normal use according to the manufacturer’s or responsible vendor's instructions. Where a cable cleat is designed to accommodate more than one cable the number, size and shape of the mandrels used in the test shall represent the number, size and shape of the cables for which the cable cleat is intended.

5.3 Tests on non-metallic and composite cleats and intermediate restraints shall not commence earlier than 168 h after manufacture.

5.4 Unless otherwise specified, the tests shall be carried out at an ambient temperature of (23^{+5}_{-5}) °C.

5.5 Compliance with this standard is satisfied if all the applicable test requirements are achieved. If only one of the samples does not satisfy a test due to a manufacturing fault, then that test and any preceding one which may have influenced the results of the test shall be repeated and also the tests which follow shall be made in the same required sequence on another full set of samples, all of which shall comply with the requirements.

The applicant, when submitting the first set of samples, may also submit an additional set of samples, which may be necessary should one sample fail. The test house should then, without further request, test the additional set of samples and should only reject if a further failure occurs. If the additional set of samples is not submitted at the same time, a failure of one sample would entail rejection.

5.6 When toxic or hazardous processes are used, due regard shall be taken of the safety of persons within the test area.

6 Classification

6.1 According to material

6.1.1 Metallic

6.1.2 Non-metallic

6.1.3 Composite

6.2 According to maximum and minimum temperature

Table 1 – Maximum temperature for permanent application

A. Maximum temperature °C
+ 40
+ 60
+ 85
+ 105
+ 120

Table 2 – Minimum temperature for permanent application

B. Minimum temperature °C
+ 5
− 5
− 15
− 25
− 40
− 60

For temperature values above 120 °C and below −60 °C, the manufacturer or responsible vendor may declare temperatures outside the values tabulated above.

6.3 According to resistance to impact

6.3.1 Very light

6.3.2 Light

6.3.3 Medium

6.3.4 Heavy

6.3.5 Very heavy

6.4 According to type of retention or resistance to electromechanical forces or both

6.4.1 General

Manufacturers of cleats shall declare a classification under 6.4.2 and may also declare a classification under 6.4.3. Manufacturers of cleats may also declare a classification under 6.4.4 or 6.4.5.

Manufacturers of intermediate restraints shall declare a classification under 6.4.4 or 6.4.5 in association with cleats.

6.4.2 With lateral retention

6.4.3 With axial retention

NOTE This value is for guidance purposes as it is not possible to replicate cables using mandrels.

6.4.4 Resistant to electromechanical forces, withstanding one short circuit

6.4.5 Resistant to electromechanical forces, withstanding more than one short circuit

NOTE The intent for cable cleats and intermediate restraints classified under 6.4.5 is that after one short circuit application, the cable cleat and intermediate restraints, if used, will continue to perform as designed and tested according to this standard. The physical condition of the cable cleats and intermediate restraints after short circuit application has only been evaluated under laboratory conditions. The continued use of the cable cleats and intermediate restraints, if used, following an actual short circuit incident, is solely at the discretion of the party responsible for the installation.

6.5 According to environmental influences

6.5.1 Resistant to ultraviolet light for non-metallic and composite components

6.5.1.1 Not declared

6.5.1.2 Resistant to ultraviolet light

6.5.2 Resistant to corrosion for metallic and composite components

6.5.2.1 Low

6.5.2.2 High

7 Marking and documentation

7.1 Marking

Each cleat and intermediate restraint shall be marked with

– the manufacturer’s or responsible vendor’s name or logo or trademark;
– the product identification or type.

Where it is not possible to apply the marking directly onto the product, then the marking shall be placed on the smallest supplied package.

7.2 Durability and legibility

Marking on the product shall be durable and easily legible to normal or corrected vision.

Compliance is checked by inspection and by rubbing the marking by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit.

After the test, the marking shall remain legible to normal or corrected vision.

Marking made by moulding, pressing or engraving is not subjected to the rubbing test.

NOTE Examples of methods for applying marking are by moulding, pressing, engraving, printing, adhesive labels, etc.

7.3 Documentation

The manufacturer or responsible vendor shall provide in their literature:

- the classifications according to Clause 6;
- the maximum and minimum cable or bundle diameters;
- the lateral load for cleats declared under 6.4.2;
- the axial load for cleats if declared under 6.4.3;
- the method of assembly and installation including tightening torques, where appropriate, and any limitation on mounting orientation for lateral retention.

Additionally, for cleats and/or intermediate restraints declared under 6.4.4 or 6.4.5, the manufacturer or responsible vendor shall provide in their literature:

- the peak short-circuit current;
- the initial r.m.s. symmetrical short-circuit current;
- the cable outside diameter and the distance between cable centres, S, used in the test in 9.5;
- the maximum spacing, D, as shown in Figure 4.

Compliance is checked by inspection.

NOTE Some or all of this information may also be required to be provided on packaging or instruction sheets supplied with the product.

8 Construction

The surfaces of cleats and intermediate restraints shall be free from sharp edges, burrs, flash, etc. that are likely to damage cables or inflict injury to the installer or user.

Compliance is checked by visual and manual inspection of the surface.

9 Mechanical properties

9.1 Requirements

Cleats and intermediate restraints shall be:

a) capable of accommodating the size or range of cable or cable bundle diameter declared by the manufacturer or responsible vendor without cracking or breaking, or stripping of the threads of screws or bolts;

Compliance is checked by measurement and by visual and manual inspection.

b) resistant to impact at the minimum declared temperature;

Compliance is checked by the test according to 9.2.

c) capable of withstanding the lateral load at the maximum declared temperature;

Compliance is checked by the test according to 9.3

d) capable of withstanding the axial load at the maximum declared temperature where declared in 6.4.3;

Compliance is checked by the test in 9.4.

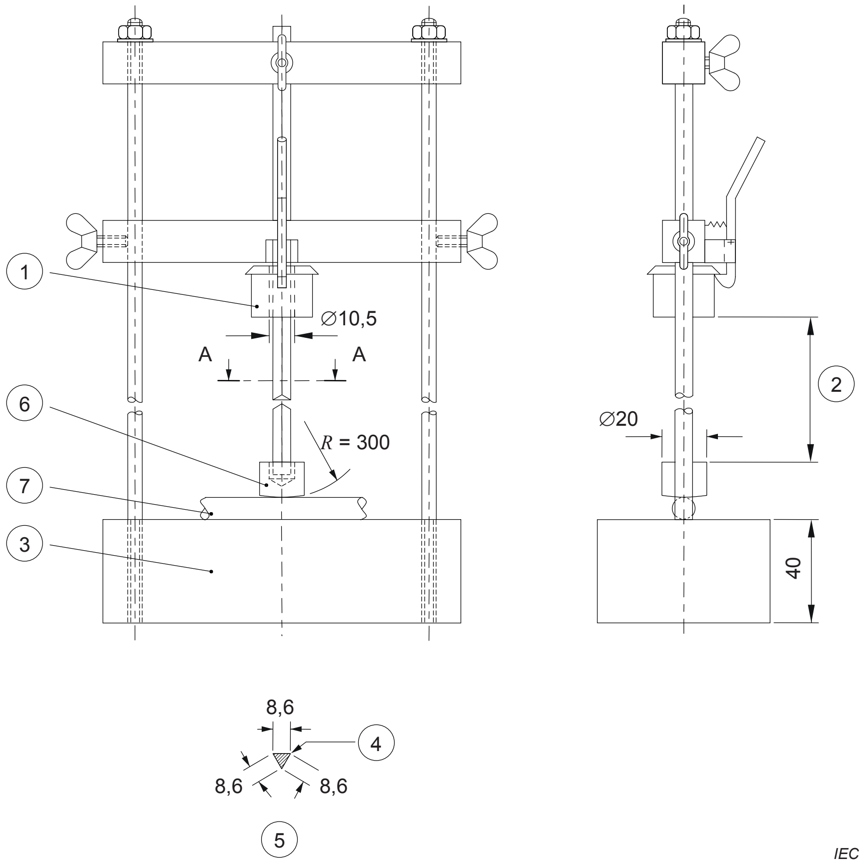
e) resistant to electromechanical forces, where declared in 6.4.4 or 6.4.5.

Compliance is checked by the test in 9.5.

9.2 Impact test

The impact test is carried out using a typical arrangement as shown in Figure 1. The component transmitting the impact to the cleat or intermediate restraint shall have a spherical radius of (300^{+5}_{-5}) *mm at the point of contact.*

Dimensions in millimetres



Key	
1	Hammer
2	fall height (see Table 3)
3	rigid steel base
4	slightly rounded edges
5	section A – A
6	steel intermediate piece
7	Sample

Figure 1– Typical arrangement for impact test

Before the test, the samples are assembled onto a solid polyamide or metal test mandrel having a diameter equivalent to the maximum declared diameter for which the cleat is designed and mounted on a rigid support.

For cleats and intermediate restraints taking more than one cable, the appropriate number of mandrels is used.

For metallic cleats and intermediate restraints, the test is carried out at ambient temperature.

For composite and non-metallic cleats and intermediate restraints, the samples are conditioned at the declared lowest temperature according to Table 2 with a tolerance of $\left(^{+2}_{-2}\right)$ *°C for a period of* $\left(60^{+5}_{0}\right)$ *min. The impact is applied within a period of* $\left(10^{0}_{-2}\right)$ *s after removal from the refrigerator.*

Each sample is placed in position on the steel base as shown in Figure 1. The energy value of the hammer is as declared in Table 3.

The impact is applied at the weakest point of the cleat or intermediate restraint and the direction of impact is radial to the centre of the mandrel nearest to the point of impact.

After the test, the samples shall show no signs of disintegration nor shall there be any cracks or damage, visible to normal or corrected vision, that are likely to impair normal use. In case of doubt, the samples are subjected to the test of 9.3.

Table 3 – Impact test values

Classification	Nominal Impact energy J	Equivalent mass kg (± 2%)	Height mm (± 1%)
Very light	0,5	0,25	200
Light	1,0	0,25	400
Medium	2,0	0,5	400
Heavy	5,0	1,7	300
Very heavy	20,0	5,0	400

NOTE The figures in Table 3 have been taken from IEC 60068-2-75.

9.3 Lateral load test

The cleat is mounted on a test rig as shown in Figure 2, or a similar arrangement. The mounting surface can be made of steel or aluminium plate, plywood or other material. For the purpose of applying the load, a rigid mandrel of circular, or other appropriate cross-section, is positioned within the cleat's aperture. For cleats and intermediate restraints taking more than one cable, the appropriate number of mandrels is used. Where more than one mandrel is used the load shall be applied to a mandrel furthest from the mounting surface. Care is taken to ensure that the load acts through the centre line of the mandrel. The mandrel size is the minimum for which the cleat is designed.

For metallic cable cleats, the declared load is applied gradually and held for a period of (60^{+5}_{0}) *min.*

For non-metallic and composite cleats, the sample assembly is placed in a full draft air-circulating oven. The tests are carried out after the oven temperature has reached and maintained the declared maximum temperature from Table 1 with a tolerance of $(^{+2}_{-2})$ *°C. The load is applied gradually and then held for a period of* (60^{+5}_{0}) *min.*

A cable cleat intended for a single mounting orientation shall be tested in that orientation and that orientation shall be declared in the documentation.

A cable cleat intended for multiple mounting orientations shall be tested in each mounting orientation using separate samples. The test load on one set of samples shall be applied perpendicular to the mounting surface (Figure 2a or Figure 2b), and to the second set of samples parallel to the mounting surface (Figure 2c or Figure 2d).

When it can be determined that a particular mounting orientation represents the most onerous condition, the results of the tests in that orientation may represent all mounting orientations.

Movement of the mandrel shall be less than 50 % of the mandrel diameter.

NOTE The test is meant to determine the lateral retention of the cleat and not the strength of the mounting surface.

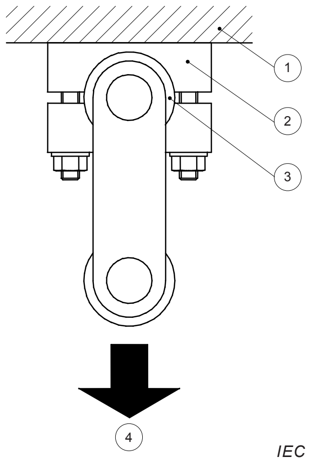


Figure 2a – Lateral load test with load applied perpendicular to mounting surface on cleat with two fixings

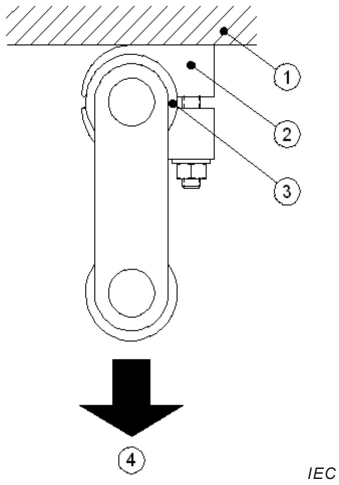


Figure 2b – Lateral load test with load applied perpendicular to mounting surface on cleat with single fixing

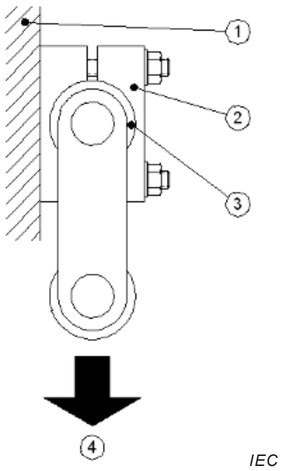


Figure 2c – Lateral load test with load applied parallel to mounting surface on cleat with two fixings

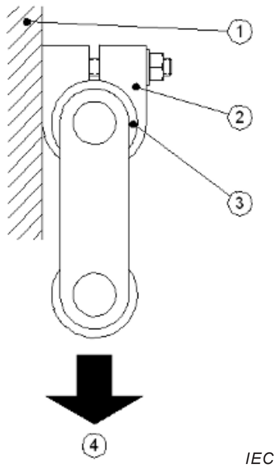


Figure 2d – Lateral load test with load applied parallel to mounting surface on cleat with single fixing

Key	
1	mounting surface
2	cleat
3	mandrel
4	direction of load

Figure 2 – Typical arrangements for lateral load test

9.4 Axial load test

The test is carried out using a mandrel with an overall cross section equivalent to the minimum declared cable cross section for which the cleat is designed. The test mandrel shall *have a diametrical tolerance of* $\left({}^{+0,2}_{-0,2}\right)$ *mm for mandrels up to and including 16 mm diameter and of* $\left({}^{+0,3}_{-0,3}\right)$ *mm for larger diameters. In the case of non-circular cables, a profile is to be used simulating the outer cable dimension, as declared by the manufacturer or responsible vendor. For cleats and intermediate restraints taking more than one cable, the appropriate number of mandrels is used. Where more than one mandrel is used the load shall be simultaneously applied to all mandrels.*

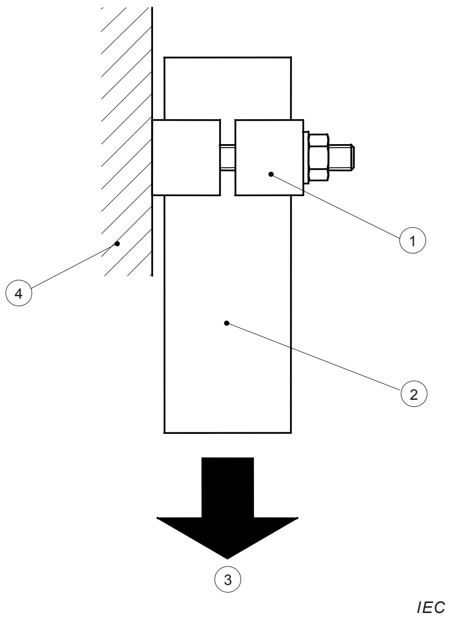
All mandrels shall have a surface roughness less than or equal to 7 μm Ra in accordance with ISO 4287. For test temperatures below 105 °C, test mandrels may be solid polyamide or metal. Metallic mandrels shall be used for test temperatures 105 °C and higher.

The cleat is mounted on a rigid mounting surface and assembled in the test rig as shown in Figure 3, or a similar arrangement. The mounting surface can be made of steel or aluminium plate, plywood or other material.

For metallic cable cleats, the declared load is applied gradually and held for a period of $\left(5^{+1}_{0}\right)$ *min.*

For non-metallic and composite cleats, the sample assembly is placed in a full draft air-circulating oven. The tests are carried out after the oven temperature has reached and maintained the declared maximum temperature from Table 1 with a tolerance of $\left({}^{+2}_{-2}\right)$ *°C. The load is applied gradually and held for a period of* $\left(5^{+1}_{0}\right)$ *min.*

After the test, the displacement of the mandrel(s) with respect to the cleat shall not be more than 5 mm.



Key	
1	cleat
2	mandrel
3	direction of load
4	mounting surface

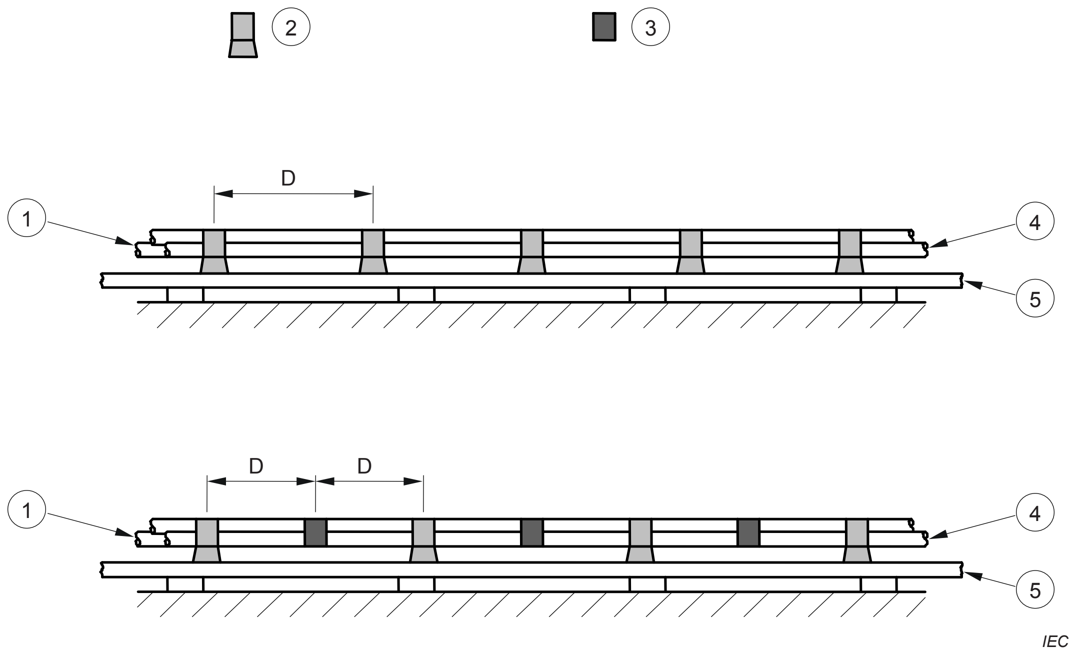
Figure 3 – Typical arrangement for axial load test

9.5 Test for resistance to electromechanical force

9.5.1 General

A short-circuit test is carried out as follows, using the manufacturer's or responsible vendor's declared values of peak short-circuit current(i_p) and initial r.m.s. symmetrical short-circuit current(I''_k). One set of cleats of each type and of a size suitable for the test cable shall be tested. The test is performed using unarmoured single core 600 V / 1 000 V stranded copper conductor cable of either (35^{+5}_{-5}) mm or (50^{+5}_{-5}) mm diameter.

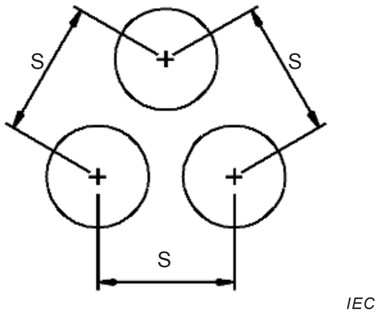
The temperature limits specified in 5.4 do not apply to this test. The test is carried out at the prevailing ambient temperature on the declared arrangement at the declared short-circuit level. The ambient temperature shall be recorded in the test report. Typical assemblies are shown in Figure 4.



Key	
1	supply end
2	Cable cleats
3	intermediate restraints
4	short-circuit busbar end
5	mounting surface
D	spacing

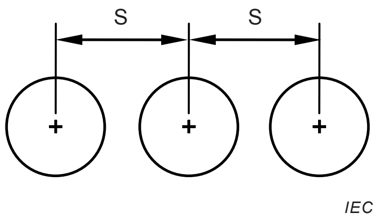
Figure 4 – Typical assemblies for test for resistance to electromechanical force

The arrangement of the cables is as shown in Figure 5 or Figure 6 with one cable per phase. One end of each cable is connected to a three phase supply and the other end to a short-circuiting busbar with all three phases being connected. The short-circuiting busbar shall be insulated from earth (ground). The cable is restrained at a minimum of 5 positions along the cable run. Where intermediate restraints are used, at least 4 cleats and at least 3 intermediate restraints shall be used. Cleats and intermediate restraints, where used, shall be equally spaced. The cleats are fixed to a mounting surface defined by the manufacturer (e.g. cable ladder) which shall be selected with regard to the forces likely to occur during the test.



Key	
S	cable centre spacing

Figure 5 – Typical arrangement of three cables in trefoil formation



Key	
S	Cable centre spacing

Figure 6 – Typical arrangement of cables in flat formation

Care is taken to ensure the cross-sectional area of the cable is adequate for the magnitude and duration of the test current which shall be chosen so that the I^2t (thermal stress) rating of the cable used is not exceeded.

The test report shall contain the following information:

- *the manufacturer's or responsible vendor's catalogue references of the cable cleat and intermediate restraint (where used);*
- *the assembly details showing:*
  - *the number of cleats and their spacing, D;*
  - *the number of intermediate restraints (where used) and their spacing, D;*
  - *the cable centre spacing, S;*
- *cable conductor diameter, insulation thickness, external diameter and markings*
- *a pre-test photograph of the test assembly and a post-test photograph documenting the condition of the cable cleats, and intermediate restraints if used*
- *the test duration;*
- *the ambient temperature during the test.*

If the test station has to undertake a calibration test, action is taken to ensure that the test installation is not affected.

The cables of the test arrangement are subjected to a three phase short circuit of duration of not less than 0,1 s. The duration of the test is recorded.

Care must be taken to ensure that there is adequate restraint for the cables at each end of the cable run to be tested.

Annex B may be used to calculate the theoretical forces that may be created during short circuits in order to plan testing.

9.5.2 For cable cleats and intermediate restraints classified in 6.4.4

Cleats and intermediate restraints classified under 6.4.4 shall comply with the following requirements:

- *there shall be no failure that will affect the intended function of holding the cables in place;*
- *the cable cleats and the intermediate restraints, if used, shall be intact with no missing parts including all devices used to secure the cleats to the mounting surface;*
- *there shall be no cuts or damage visible to normal or corrected vision to the outer sheath of each cable caused by the cable cleats or by the intermediate restraints, if used.*

9.5.3 For cable cleats and intermediate restraints classified in 6.4.5

Cleats and intermediate restraints classified under 6.4.5 shall comply with the inspection requirements of 9.5.2 after the first and after the second short-circuit applications.

After a second short-circuit application, a voltage withstand test is performed by applying a minimum test voltage of 2,8 kV d.c. or 1,0 kV a.c. for a period of (60^{+5}_{0}) *s according to the provisions of IEC 60060-1:2010, Clause 5, Tests with direct voltage or Clause 6, Tests with alternating voltage. The voltage withstand test shall be administered between the cable cores, which should be connected together, and the mounting frame. The mounting frame shall be bonded to the earthing system. The cable jackets and mounting frame shall be pre-wetted with sufficient water to facilitate a current leakage path along the outer jacket for* (2^{+1}_{0}) *min before the test begins.*

The cables shall meet the requirements of the voltage withstand test without failure of the insulation.

10 Fire hazards

10.1 Flame propagation

Non-metallic and composite cable cleats and intermediate restraints shall have adequate resistance to flame propagation.

Compliance is checked by the following test.

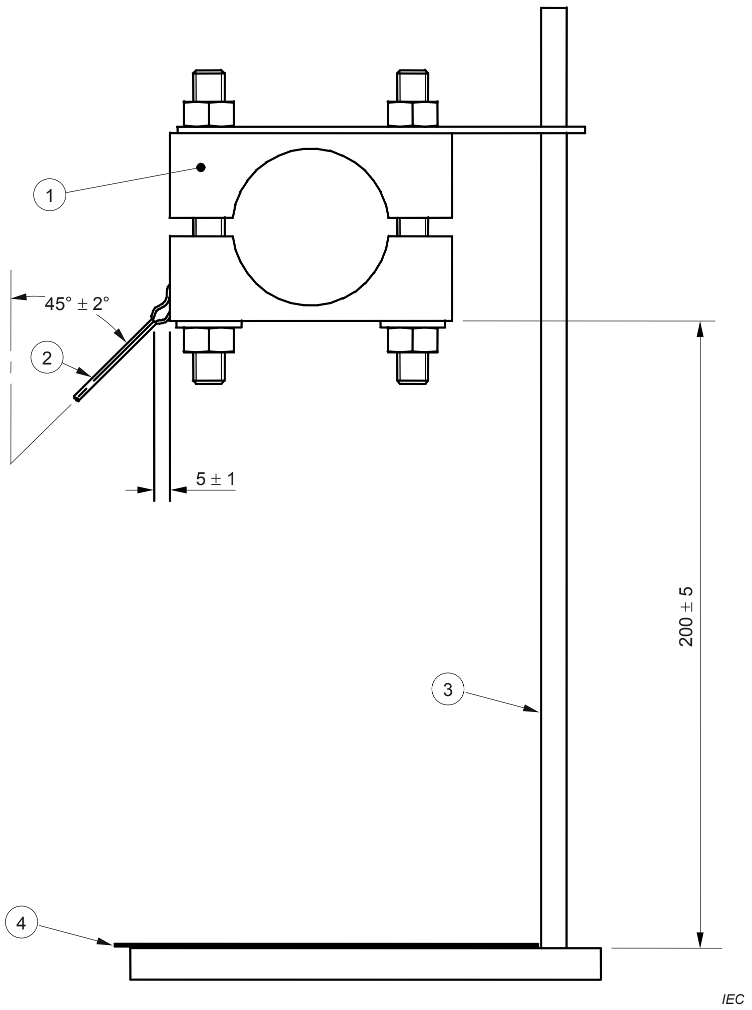
Using an arrangement as shown in Figure 7, the sample shall be submitted to the needle-flame test as specified in IEC 60695-11-5 with the following additional information:

- *the flame shall be applied to the outer surface of the sample,*
- *the time of application shall be* (30^{+0}_{-1}) *s,*
- *the underlying layer shall consist of three layers of tissue paper,*
- *there shall be a single application of the flame.*

The sample shall be deemed to have passed the test if:

- *30 s after the test flame is removed, there is no flaming of the sample,*
- *there is no ignition of the tissue paper.*

Dimensions in millimetres



Key	
1	cleat
2	burner
3	stand
4	tissue paper

Figure 7 – Typical arrangement of the needle-flame test

10.2 Smoke emission

The smoke emissions from cleats and intermediate restraints need not be considered because of their small size and quantity in normal use.

10.3 Smoke toxicity

The smoke toxicity from cleats and intermediate restraints need not be considered because of their small size and quantity in normal use.

11 Environmental influences

11.1 Resistance to ultraviolet light

Cleats and intermediate restraints classified according to 6.5.1.2 shall be subjected to ultraviolet light (UV) conditioning according to the following requirements.

When the product is provided in more than one colour, the colour having the heaviest organic pigment loading shall be subjected to this test. The samples tested are considered representative of the entire colour range.

Samples shall be mounted in the ultraviolet light apparatus in a convenient manner suitable for the product to be tested and the test equipment and so that the samples do not touch each other.

The samples are to be exposed for a minimum of 700 h to Xenon-arc, Method A, Cycle 1 in accordance with ISO 4892-2:2006. There shall be continuous exposure to light and intermittent exposure to water spray. The cycle shall consist of 102 min without water spray and 18 min with water spray. The apparatus shall operate with a water-cooled xenon-arc lamp, borosilicate glass inner and outer optical filters, a spectral irradiance of $(0{,}51^{+0.02}_{-0.02})$ *W/(m2•nm) at 340 nm and a black-standard temperature of* (63^{+3}_{-3}) *°C. The temperature of the chamber shall be* (38^{+3}_{-3}) *°C. The relative humidity in the chamber shall be* (50^{+10}_{-10}) *%.*

Following the exposure, the samples shall be held for a minimum of 30 min under ambient conditions.

After UV exposure, the samples shall show no signs of disintegration nor shall there be any cracks or damage, visible to normal or corrected vision. The samples shall then be subjected to the impact test, as described in 9.2 and shall comply with the impact test requirements.

NOTE Cleats that comply with IEC 61914:2009 do not need to be re-tested.

11.2 Resistance to corrosion

11.2.1 General

Metallic or composite cleats and intermediate restraints shall have adequate resistance to corrosion.

Compliance is determined by the test in 11.2.2 unless otherwise specified below.

Metallic or composite cleats and intermediate restraints, including fixings such as nuts, bolts, screws and washers, made of non-ferrous metals, cast-iron, malleable-iron or stainless steel containing at least 16 % chromium need not be tested and are assumed to meet the classification for high resistance to corrosion. Stainless steel containing at least 13 % chromium is assumed to meet the classification for low resistance to corrosion and need only be tested where declared in accordance with 6.5.2.2 for high resistance. Where corrosion protection is provided by a layer of zinc equal to or greater than that specified in Table 4, measurement of the zinc layer is required without the need to carry out further testing.

The mean and minimum thickness shall be determined by taking five measurements over the plated surface.

Fixings, such as nuts, bolts, screws and washers, shall not be subjected to the test in 11.2.2, however, the presence of a protective coating is required.

The presence of a coating on fixings shall be determined by inspection with normal or corrected vision.

A cut edge, a punched hole and the threaded surface of a tapped hole of a part formed from galvanized stock of thickness 2,5 mm or less is not required to be coated.

Table 4 – Resistance to corrosion

Classification	Typical usage	Mean zinc layer thickness µm	Minimum zinc layer thickness µm	Salt spray duration h
Low	Indoor, dry locations	5	3,5	24
High	Outdoor, wet locations [a]	25	18	192
[a] For use in marine or other corrosive environments additional protection may be required and additional consideration should be given to the appropriate duration of test exposure or to the use of an alternative test method..				

11.2.2 Salt spray test

All grease shall be removed from the parts to be tested, by cleaning with white spirit. All parts shall then be dried. The samples shall then be assembled onto a polyamide 66 mandrel with a diameter equal to the smallest cable diameter declared for the cleat or intermediate restraint.

Samples shall be subjected to a neutral salt spray (NSS) test according to ISO 9227 for the duration specified in Table 4.

Surfaces where a coating is not required under 11.2.1 shall be protected during the test in accordance with the directions in ISO 9227.

After the parts have been dried for a minimum of 10 min in a heating cabinet at a temperature of (100^{+5}_{-5}) *°C, any traces of rust on sharp edges and a yellowish film may be removed by rubbing.*

The sample shall have passed the test if there is no red rust visible to normal or corrected vision.

Zones that trap saltwater during the test are not considered for the test result.

12 Electromagnetic compatibility

12.1 Electromagnetic emission

Products covered by this standard are, in normal use, passive in respect of electromagnetic emission.

12.2 Inductive heating

Ferromagnetic materials (e.g. cast iron, mild steel) that surround single conductors in a.c. circuits are susceptible to heating from eddy currents. The manufacturer or responsible vendor of cleats made from ferromagnetic materials that may complete an electrical and magnetic circuit around the cable, shall issue a warning that the cleats shall not be used on single core cables in a.c. circuits.

Annex A
(informative)

Examples of cable cleats

Figures A.1 to A.9 show examples of cable cleats.

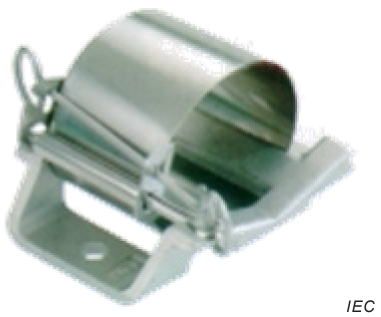


Figure A.1 –

Figure A.2 –

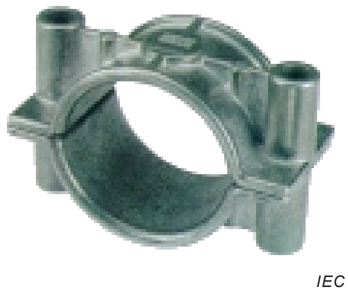


Figure A.3 –

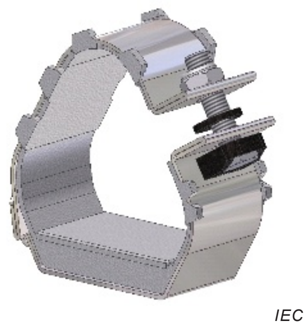


Figure A.4 –

Figure A.5 –

Figure A. 6 –

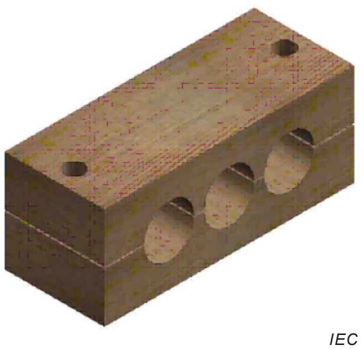


Figure A.7–

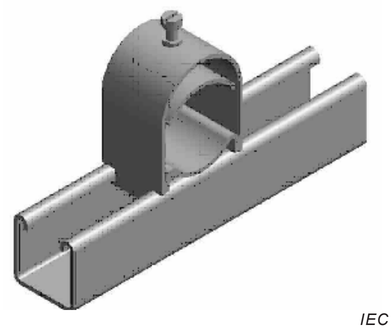


Figure A.8 –

Figure A.9 –

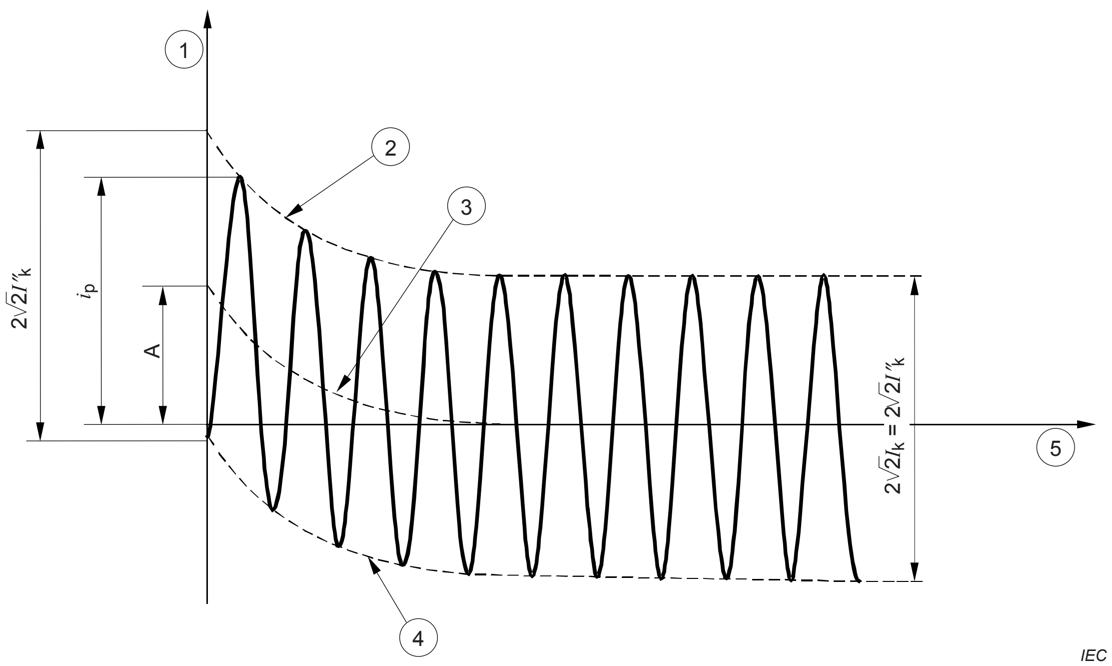
Annex B
(informative)

Calculation of forces caused by short-circuit currents

B.1 Characteristics

Recommendations for the calculation of short-circuit currents are given in the IEC 60909 series and IEC 61363-1. The latter covers ships and offshore units. The information given in this annex is based on IEC 60909-0.

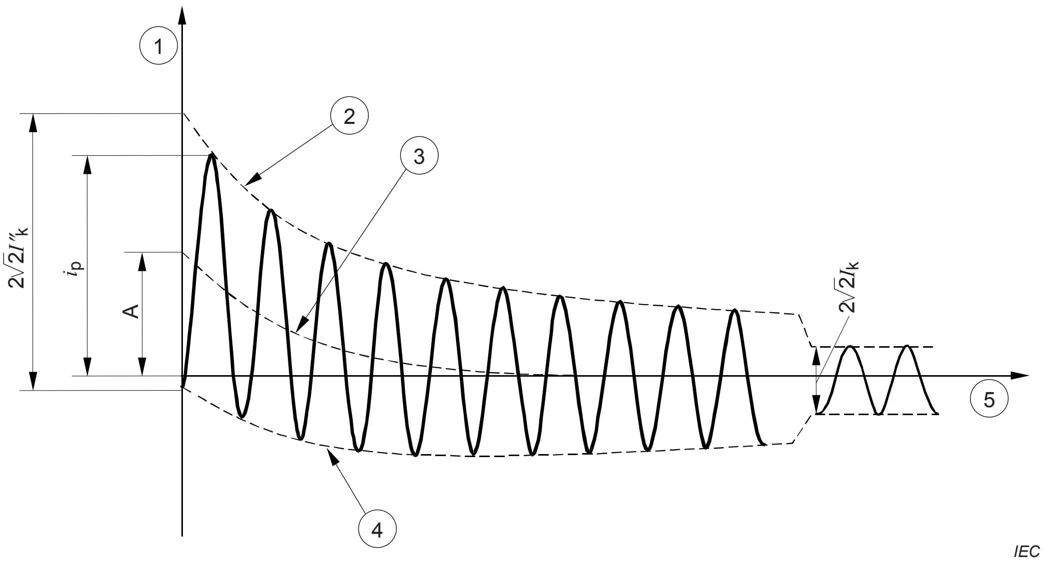
The characteristics of the current during a short circuit depend on a number of factors, including the electrical separation from the generator. Figure B.1 shows a current vs. time characteristic typical of a far-from-generator short circuit. The a.c. component in this case has a constant amplitude ($I''_k = I_k$) and is superimposed on a decaying d.c. component, $i_{d.c.}$ This falls from an initial value, A, to zero.



Key	
1	Current
2	top envelope
3	decaying d.c. component, $i_{d.c.}$ of the short-circuit current
4	bottom envelope
5	Time
A	initial value of the d.c. component, $i_{d.c.}$ of the short-circuit current

Figure B.1 – Short-circuit current of a far-from-generator short circuit with constant a.c. component

For near-to-generator short circuits, the a.c. component has a decaying amplitude ($I''_k > I_k$) and is also superimposed on a decaying d.c. component, $i_{d.c.}$ that falls from an initial value, A, to zero. Figure B.2 shows a typical current vs. time characteristic for a near-to-generator short circuit.



Key	
1	Current
2	top envelope
3	decaying d.c. component, $i_{d.c.}$ of the short-circuit current
4	bottom envelope
5	Time
A	initial value of the d.c. component, $i_{d.c.}$ of the short-circuit current

Figure B.2 – Short-circuit current of a near-to-generator short circuit with decaying a.c. component

B.2 Specification of the test current

A complete specification of short-circuit currents should give the currents as a function of time at the short-circuit location from the initiation of the short circuit up to its end. In most practical cases, this is not necessary. It is usually sufficient to know the peak current, i_p, and the values of the initial r.m.s. symmetrical, I''_k, and steady state, I_k, short-circuit currents.

In order to specify the current used in a short-circuit test the following are quoted:

– the peak current, $i_{p;}$
– the initial r.m.s. symmetrical short-circuit current, $I''_{k;}$
– the short-circuit duration, t.

B.3 Calculation of the mechanical forces between conductors

The electromagnetic force acting on a conductor is determined by the current in the conductor and the magnetic field from the neighbouring conductors. In cable installations, the distances between the cables are normally small and hence the forces may be considerable.

To calculate the forces a cleat may be subjected to during a short-circuit, the equations derived in this Annex may be used. The derivation of equations (B.5), (B.6) and (B.7) is based on a symmetrical fault current with no d.c. component. The derivation also assumes that the cables are rigid. For these reasons these equations should not be used to extrapolate short circuit test results.

In the case of two parallel conductors, the electromagnetic force on a conductor can be derived from Equation B1:

$$F(t) = B(t) \cdot i(t) \cdot l \tag{B.1}$$

where

l is the length;

$F(t)$ is the momentary electromagnetic force on a conductor;

$B(t)$ is the momentary magnetic field from the neighbouring conductor;

$i(t)$ is the momentary current in the neighbouring conductor.

If the d.c. component of the short-circuit current is disregarded, the momentary force has a sinusoidal variation with a frequency twice the frequency of the currents (Equation B.1). The d.c. component gives a decaying force-component with a frequency the same as the system frequency.

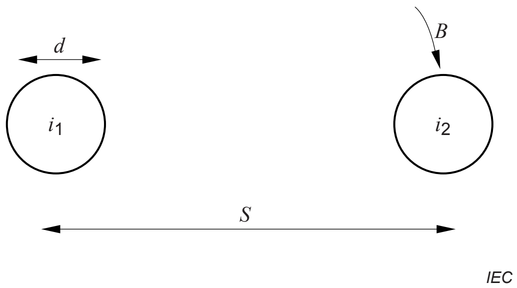


Figure B.3 – Two parallel conductors

For the two parallel conductors in Figure B.3., the magnetic field from current i_1, at the location of the other conductor is:

$$B = \mu_0 \cdot H = \mu_0 \cdot i_1 / 2 \cdot \pi \cdot S \tag{B.2}$$

where

$\mu_0 = 4 \cdot \pi \cdot 10^{-7}$ (H/m)

and the mechanical force is:

$$F = i_2 \times B = i_2 \cdot \mu_0 \cdot i_1 / 2 \cdot \pi \cdot S \tag{B.3}$$

This equation is usually written as:

$$F_s = 0{,}2 \cdot i_1 \cdot i_2 / S \tag{B.4}$$

In this equation, the force is given in N/m, i in kA and S in metres.

In a three phase system, the magnetic field in Equation B.2 is the resulting momentary vector value from the other two phases.

The vector Equation B.3 confirms that two parallel conductors are repelled if the two currents have a difference in phase angle of 180° and that the force is directed towards the other conductor for currents that have the same phase angle.

The evaluation of Equation B.4 requires $S >> d$ but gives an acceptable accuracy when the current distribution is uniform (or symmetrical) within the conductors.

For a three phase short circuit with the conductors in flat configuration, the forces on the two outer conductors are always directed outwards from the central conductor. The force on the central conductor is oscillating. The maximum force on the outer conductors in flat formation can be calculated by

$$F_{\text{fo}} = 0{,}16 \cdot {i_{\text{p}}}^2 / S \qquad \text{(B.5)}$$

The maximum force on the middle conductor in flat formation can be calculated by

$$F_{\text{fm}} = 0{,}17 \cdot {i_{\text{p}}}^2 / S \qquad \text{(B.6)}$$

For a three phase short circuit with the cables in a trefoil configuration the maximum force on the conductor is:

$$F_{\text{t}} = 0{,}17 \cdot {i_{\text{p}}}^2 / S \qquad \text{(B.7)}$$

where

F_{s} is the maximum force on the cable conductor in flat formation for a single phase short circuit [N/m];

F_{fo} is the maximum force on the outer cable conductors in flat formation for a three phase short circuit [N/m];

F_{fm} is the maximum force on the centre cable conductor in flat formation for a three phase short circuit [N/m];

F_{t} is the maximum force on the cable conductor in a trefoil configuration for a three phase short circuit [N/m];

i_{p} is the peak short-circuit current [kA];

d is the external diameter of the conductor [m];

S is the centre to centre distance between two neighbouring conductors [m].

Bibliography

IEC 60068-2-75, *Environmental testing – Part 2: Tests – Test Eh: Hammer tests*

IEC 60909-0, *Short-circuit currents in three-phase a.c. systems – Part 0: Calculation of currents*

IEC 61363-1, *Electrical installations of ships and mobile and fixed offshore units – Part 1: Procedures for calculating short-circuit currents in three-phase a.c.*

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