



BSI Standards Publication

General requirements for arc fault detection devices

National foreword

This British Standard is the UK implementation of EN 62606:2013, including amendment A1:2017. It is identical to IEC 62606:2013, including amendment A1:2017. It supersedes BS EN 62606:2013, which will be withdrawn on 1 December 2020.

The text of IEC amendment A1:2017 has been provided in its entirety at the beginning of this document. BSI's policy of providing consolidated content remains unchanged; however, in the interest of expediency, in this instance BSI have chosen to collate the relevant content at the beginning of this document.

The CENELEC common modifications have been implemented at the appropriate places in the text. The start and finish of each common modification is indicated in the text by **■** **■**.

The UK participation in its preparation was entrusted to Technical Committee PEL/23/1, Circuit breakers and similar equipment for household use.

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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Amendments/corrigenda issued since publication

Date	Text affected
31 March 2018	Implementation of IEC amendment 1:2017 with CENELEC endorsement A1:2017

General requirements for arc fault detection devices
(IEC 62606:2013, modified)

Exigences générales des dispositifs pour
la détection de défaut d'arcs
(CEI 62606:2013, modifiée)

Allgemeine Anforderungen an
Fehlerlichtbogen-Schutzeinrichtungen
(IEC 62606:2013, modifiziert)

This European Standard was approved by CENELEC on 2013-08-13. 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

Foreword

The text of document 23E/785/FDIS, future edition 1 of IEC 62606, prepared by SC 23E, "Circuit-breakers and similar equipment for household use", of IEC TC 23, "Electrical accessories", was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62606:2013.

A draft amendment, which covers common modifications to IEC 62606 (23E/785/FDIS), was prepared by CLC/TC 23E, "Circuit breakers and similar devices for household and similar applications" and approved by CENELEC.

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) 2014-08-13
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2016-08-13

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.

In this standard, the following print types are used:

- *compliance statements: in italic type.*

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For the relationship with EU Directive(s) see informative Annex ZZ, which is an integral part of this document.

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 62606:2013 was approved by CENELEC as a European Standard with common modifications.

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

IEC 60060-2	NOTE Harmonized as EN 60060-2.
IEC 60112:2003	NOTE Harmonized as EN 60112:2003 (not modified).
IEC 60269-1:2006	NOTE Harmonized as EN 60269-1:2007 (not modified).
IEC 60664-3	NOTE Harmonized as EN 60664-3.
IEC 60664-5	NOTE Harmonized as EN 60664-5.
IEC 60695-2-11:2000	NOTE Harmonized as EN 60695-2-11:2001 (not modified).
IEC 61000-4-2	NOTE Harmonized as EN 61000-4-2.
IEC 61000-4-3	NOTE Harmonized as EN 61000-4-3.
IEC 61000-4-4	NOTE Harmonized as EN 61000-4-4.
IEC 61000-4-5:2005	NOTE Harmonized as EN 61000-4-5:2006 (not modified).

IEC 61000-4-6	NOTE Harmonized as EN 61000-4-6.
IEC 61000-4-16:1998	NOTE Harmonized as EN 61000-4-16:1998 (not modified).
+A1:2001 +A2:2009	+A1:2004 +A2:2011
IEC 61210	NOTE Harmonized as EN 61210.

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 When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60068-2-30	2005	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)	EN 60068-2-30	2005
IEC 60068-3-4	2001	Environmental testing - Part 3-4: Supporting documentation and guidance - Damp heat tests	EN 60068-3-4	2002
IEC 60364	Series	Low-voltage electrical installations	HD 60364	Series
IEC 60364-4-44 (mod)	2007	Low-voltage electrical installations - Part 4-44: Protection for safety - Protection against voltage disturbances and electromagnetic disturbances	HD 60364-4-442	2012
IEC 60417	Data base	Graphical symbols for use on equipment	-	-
IEC 60479	Series	Effects of current on human beings and livestock	-	-
IEC 60529	-	Degrees of protection provided by enclosures (IP Code)	-	-
IEC 60664-1	2007	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests	EN 60664-1	2007
IEC 60695-2-10	2000	Fire hazard testing - Part 2-10: Glowing/hot-wire based test methods - Glow-wire apparatus and common test procedure	EN 60695-2-10 ¹⁾	2001
IEC/TR 60755	-	General requirements for residual current operated protective devices	-	-
IEC 60898-1 (mod)	2002	Electrical accessories - Circuit breakers for overcurrent protection for household and similar	EN 60898-1	2003
-	-	installations -	+ corr. February	2004
-	-	Part 1: Circuit-breakers for a.c. operation	+ A11	2005
-	-		+ A12	2008
-	-		+ A13	2012
IEC 61008-1 (mod)	2010	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCB's) - Part 1: General rules	EN 61008-1	2012
IEC 61009-1 (mod)	2010	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) - Part 1: General rules	EN 61009-1	2012

¹⁾ EN 60695-2-10 is superseded by EN 60695-2-10:2013, which is based on IEC 60695-2-10:2013.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61543	1995	Residual current-operated protective devices	EN 61543	1995
+ A1 (mod)	2004	(RCDs) for household and similar use -	+ corr. December	1997
+ A2	2005	Electromagnetic compatibility	+ A11	2003
-	-		+ corr. May	2004
			+ A2	2006
			+ A12	2005
IEC 62423	-	Type F and type B residual current operated circuit-breakers with and without integral overcurrent protection for household and similar uses	EN 62423	-
CISPR 14-1	2005	Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus -	EN 55014-1	2006
+ A1	2008	Part 1: Emission	+ A1	2009
IEC 60228	2004	Conductors of insulated cables	EN 60228	2005
IEC 61000-3-2	2014	Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)	EN 61000-3-2	2014
IEC 61543	1995	Residual current-operated protective devices (RCDs) for household and similar use - Electromagnetic compatibility	EN 61543	1995
-	-		+ corrigendum Dec.	1997
-	-		+ A11	2003
-	-		+ A12	2005
+ A1	2004		+ A1 +	2004
+ A2	2005		A2	2006

Annex ZZ
(informative)

Coverage of Essential Requirements of EU Directives

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers all relevant essential requirements as given in Article 1 of Annex I of the EU Directive 2004/108/EC.

Compliance with this standard provides one means of conformity with the specified essential requirements of the Directive(s) concerned.

WARNING: Other requirements and other EU Directives may be applicable to the products falling within the scope of this standard.

English Version

**General requirements for arc fault detection devices
(IEC 62606:2013/A1:2017)**

Exigences générales des dispositifs pour la détection de
défaut d'arcs
(IEC 62606:2013/A1:2017)

Allgemeine Anforderungen an Fehlerlichtbogen-
Schutzeinrichtungen
(IEC 62606:2013/A1:2017)

This amendment A1 modifies the European Standard EN 62606:2013; it was approved by CENELEC on 2017-03-16. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this amendment 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 amendment 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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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 23E/993/FDIS, future edition 1 of IEC 62606:2013/A1:2017, prepared by IEC/SC 23E "Circuit-breakers and similar equipment for household use", of IEC/TC 23, "Electrical accessories" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62606:2013/A1:2017.

The following dates are fixed:

- latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2018-09-01
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) 2020-12-01

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

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For the relationship with EU Directives see informative Annex ZZA and ZZB, which are integral parts of this document.

Endorsement notice

The text of the International Standard IEC 62606:2013/A1:2017 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 60038 | NOTE Harmonized as EN 60038 (modified). |
| IEC 61000-3-2 | NOTE Harmonized as EN 61000-3-2 (not modified). |

Annex ZZA (informative)

Relationship between this European standard and the essential requirements of Directive 2014/30/EU [2014 OJ L96] aimed to be covered

This European standard has been prepared under the European Commission standardisation request C(2016) 7641 final of 30.11.2016¹, ('M/552'), as regards harmonised standards in support of Directive 2014/30/EU relating to electromagnetic compatibility, to provide one voluntary means of conforming to essential requirements of Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility [2014 OJ L96].

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of this standard given in Table ZZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

Table ZZA.1 – Correspondence between this European standard and the Essential Requirements set out in Directive 2014/30/EU [2014 OJ L96]

Essential requirements of Directive 2014/30/EU	Clause(s) / sub-clause(s) of this EN	Remarks / Notes
Annex I. 1(a) (electromagnetic disturbances)	9.21	In accordance with EN 61543:1995 Clause 4.
Annex I. 1(b) (electromagnetic immunity)	8.15 9.21	All immunity requirements are covered by complying with clauses 8.15 and 9.21 of the standard.

WARNING 1: Presumption of conformity stays valid only as long as a reference to this European standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2: Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

¹ COMMISSION IMPLEMENTING DECISION C(2016) 7641 final of 30.11.2016 on a standardisation request to the European Committee for Standardisation, to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards harmonised standards in support of Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility.

Annex ZZB

(informative)

Relationship between this European standard and the safety objectives of Directive 2014/35/EU [2014 OJ L96] aimed to be covered

This European Standard has been prepared under a Commission's standardization request relating to harmonized standards in the field of the Low Voltage Directive, M/511, to provide one voluntary means of conforming to safety objectives of Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits [2014 OJ L96].

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of this standard given in Table ZZB.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

Table ZZB.1 – Correspondence between this European standard and Article 3 of Directive 2014/35/EU [2014 OJ L153]

Safety Objectives of Directive 2014/35/EU	Clause(s) / sub-clause(s) of this EN	Remarks / Notes
(1)(a)	1, 2, 3, 4, 5, 6 – 9.3	
(1)(b)	8.1 and 8.2 – 9.4 and 9.5, Annex D, Annex J, Annex K, Annex L	
(1)(c)	7 – 9.1 and 9.2, 8.6 – 9.9, 8.18 – 9.23, 9.22, 8.Z1 – 9.Z1, Annex E	
(2) (a)	8.3 – 9.6, 8.7 – 9.10, 8.17 – 9.17, 8.12 – 9.17, 8.13 – 9.18	
(2) (b)	8.5 – 9.8, 8.7 – 9.10, 8.8 – 9.11 and Annex C, 8.6 – 9.9, 8.14 – 9.19 and 9.20, Annex A	
(2) (c)	8.2.2 – 9.15	
(2) (d)	8.2.3 – 9.7, Annex B, 8.4 – 9.7	
(3) (a)	8.9 – 9.12, 8.2.4 – 9.16	
(3) (b)	8.10 – 9.13, 8.11 – 9.14, 8.16 – 9.9.4, 8.15 – 9.21	
(3) (c)	8.12 – 9.17, 8.8 – 9.11 and Annex C	

WARNING 1 — Presumption of conformity stays valid only as long as a reference to this European standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2 — Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

AMENDMENT 1 AMENDEMENT 1

General requirements for arc fault detection devices

Exigences générales des dispositifs pour la détection de défaut d'arcs

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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FOREWORD

This amendment has been prepared by subcommittee 23E: Circuit-breakers and similar equipment for household use, of IEC technical committee 23: Electrical accessories.

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

FDIS	Report on voting
23E/993/FDIS	23E/1003/RVD

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

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

1 Scope

Replace the existing first paragraph by the following new first paragraph:

This International Standard applies to arc fault detection devices (AFDDs) for household and similar uses, intended to be used in a.c. circuits, for rated voltages not exceeding 440 V a.c., with rated frequencies of 50 Hz, 60 Hz or 50/60 Hz and rated currents not exceeding 63 A.

Replace, in the fourth paragraph, the words “final circuits” by “a final circuit”.

Delete the eighth and ninth paragraphs.

Add, at the end of this clause, the following new note:

NOTE 5 AFDD for d.c. applications are under consideration.

2 Normative references

Add the following new references:

IEC 60228, *Conductors of insulated cables*

IEC 61000-3-2:2014, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

IEC 61543:1995, *Residual current-operated protective devices (RCDs) for household and similar use – Electromagnetic compatibility*
IEC 61543:1995/AMD1:2004
IEC 61543:1995/AMD2:2005

3 Terms and definitions

3.2

arc fault

arcing fault

Replace the existing definition by the following new definition:

dangerous unintentional arc

3.4

arc fault detection unit

AFD unit

Replace, at the end of the note, the reference “see (4.1.3)” by “(see 4.1.3)”.

4.1 According to the method of construction

4.1.1 Replace the existing text by the following new text:

4.1.1 AFDD as one single device, comprising an AFD unit and opening means not providing overcurrent or residual current protection.

4.3 According to the number of poles and current paths

Add to the existing list the following two new dashes:

- Three-pole AFDD;
- Four-pole AFDD.

Delete NOTE 1 and renumber “NOTE 2” as “NOTE”.

5.3.1 Preferred values of rated voltage (U_n)

Replace the existing text by the following new text:

Preferred values of rated voltage are as indicated in Table 22.

Table 22 – Preferred values of rated voltage

AFDD	Circuit supplying the AFDD	Rated voltage of AFDDs for use in systems 230 V or 230/400 V or 400 V V	Rated voltage of AFDDs for use in systems 120/240 V or 240 V V
Single-pole (with two current paths)	Single phase (phase to earthed middle conductor or phase to neutral)	230	120
Two-pole	Single phase (phase to neutral or phase to phase or phase to earthed middle conductor)	230, 400	120, 240
Three-pole	Three phases (3-wire or 4-wire) (400 V or 230/400 V or 230 V-system)	230 400	
Four-pole	Three phases (4-wire) (230/400 V-system)	400	

NOTE 1 In IEC 60038 the network voltage value of 230/400 V has been standardized. This value is likely to progressively supersede the values of 220/380 V and 240/415 V.

NOTE 2 Wherever in this standard there is a reference to 230 V or 400 V, they can be read as 220 V or 240 V, 380 V or 415 V, respectively.

NOTE 3 Wherever in this standard there is a reference to 120 V or 120/240 V or 240 V, they can be read as 100 V, 100/200 V or 200 V, respectively.

NOTE 4 Wherever in this standard there is a reference to 240 V three phases, it can be read as 100 V or 120/208 V.

NOTE In Japan, the phase to neutral conductor and phase to earthed conductor (grounded conductor) are considered in a different way because single phase 2-wire systems supplied from a 2-wire system source do not have a neutral point.

5.3.3 Preferred values of rated frequency

Replace the heading of 5.3.3 by the following new heading:

5.3.3 Standard values of rated frequency

Replace, in the first paragraph, “Preferred” by “Standard”.

Delete the second paragraph.

5.3.7.1 Limit values of operating criteria for AFDDs at low arc currents up to 63 A

Table 1 – Limit values of break time for $U_n = 230$ V AFDDs

Replace the heading of Table 1 by the following new heading:

Table 1 – Limit values of break time for $U_n = 230$ V and 400 V AFDDs

5.3.7.2 Limit values of operating criteria for AFDDs at high arc currents above 63 A

Table 3 – Maximum allowed number of arcing half-cycles within 0,5 s for U_n 230 V AFDDs and $U_n = 120$ V AFDDs

Replace the heading of Table 3 by the following new heading:

Table 3 – Maximum allowed number of arcing half-cycles within 0,5 s

6.1 Marking

Replace, in the first sentence of the sixth paragraph, “c & e” by “c and e”.

Replace, in the second sentence of the sixth paragraph, “a, b, d, f & i” by “a, b, d, f, i and j”.

Replace, in the third sentence of the sixth paragraph, “the information under h” by “the information under i”.

8.2.3 Clearances and creepage distances (see Annex B)

Replace, in the third paragraph, “and arrangements of 9.7.2 items b), c), d) and e)” by “and arrangements of 9.7.3 items b), c), d) and e)”.

Replace, in the third paragraph, the existing first indent by the following new indent:

- tests according to 9.7.3 to 9.7.6 as applicable;

Replace, in NOTE 1, “9.7.6” by “9.7.7.2”.

8.17 Performance of the AFD test device

Delete, at the end of the penultimate paragraph, the words “is operated”.

Add the following new subclause:

8.18 Performance in case of partial loss of supply connections

Three-pole AFDDs and four-pole AFDDs shall also perform as required for series, parallel and earth arc fault when connected as follows:

- for three-pole AFDD, with two phases only;
- for four-pole AFDD: with three phases without neutral, with two phases only, and one phase and neutral.

Compliance is checked by the tests of 9.23.

9.1.2 The characteristics of AFDDs are checked by means of tests

Table 10 – List of type tests

Add, at the end of the table, the following new row:

- Verification of the behaviour in case of partial loss of supply connections 9.23

9.7.2.4 Condition of the AFDD after the test

Replace “9.7.7” by “9.7.6”.

9.7.3 Insulation resistance of the main circuit

Replace the existing item c) by the following new item c):

- c) with the AFDD in the closed position, between all poles connected together and the frame, including a metal foil or part in contact with the outer surface of the housing of insulating material but with the terminal areas kept completely free to avoid flashover between terminals and the metal foil.

9.7.5 Insulation resistance and dielectric strength of auxiliary circuits

Replace the existing item b) by the following new item b):

- b) The measurements of the insulation resistance are carried out:
 - between the auxiliary circuits connected to each other and to the frame;
 - between each of the parts of the auxiliary circuits which might be isolated from the other parts in normal service and the whole of the other parts connected together;

at a voltage of approximately 500 V d.c. after this voltage has been applied for 1 min.

The insulation resistance shall be not less than 2 MΩ.

9.7.7.1 General testing procedure for the impulse withstand voltage tests

Replace, in NOTE 1, “9.7.6.2” by “9.7.7.2”.

9.7.7.2 Verification of clearances with the impulse withstand voltage

Add, in the first line of the first paragraph, “of” before “Table 7”.

9.8.2 Test procedure

Replace the existing second paragraph by the following two new paragraphs:

For four-pole AFDD, the test is first made by passing the specified current through the three phase poles only.

The test is then repeated by passing the current through the pole intended for the connection of the neutral and the pole adjacent to the neutral.

9.9.1 General

Replace the existing fourth paragraph by the following new paragraph:

For an AFDD having more than one rated frequency, the tests shall be carried out at each rated frequency.

9.9.2.1 General

Add, after the first paragraph, the following new paragraph:

The AFDD being supplied with all phases, the tests shall be performed, if applicable, between one phase, chosen at random and neutral, and between two phases chosen at random.

Replace the existing second paragraph by the following new paragraph:

The tests shall be conducted by connecting a cable specimen (prepared in accordance with 9.9.2.6) in series with the AFDD according to Figure 4 for tests of 9.9.2.2 to 9.9.2.5 and according to Figure 38 for tests of 9.9.2.8 and 9.9.2.9.

Replace the existing third paragraph by the following new paragraph:

The adjustment of the test currents without arcing, in the line where the cable specimen is placed, is achieved by application of the line to neutral voltage reduced by 50 V to take into account the value of the arc voltage during the test. For three-pole AFDD, the mid-point of the resistors in Figure 38 shall be connected directly to the neutral. For tests of 9.9.2.2, and at the rated current only, the adjustment of the test current in the cable specimen without arcing is achieved by application of the rated voltage.

Delete the fourth paragraph.

9.9.2.3 Verification of correct operation in case of inserting load a with a series arc fault

Replace the title of subclause 9.9.2.3 by the following new title:

9.9.2.3 Verification of correct operation in case of inserting a load with series arc fault

9.9.2.5 Test at the temperature limits

Add, at the end of the second dash, the following new text:

For the tripping tests, the flow of rated current may be interrupted, provided that the total interruption period does not exceed 30 s. As soon as the sum of interruption periods exceeds 30 s, the AFDD shall be loaded again with rated current for 5 min before the next tripping time measurement.

9.9.2.6 Preparation of the cable specimens

Replace the existing text of item c) by the following new text:

- c) A slit or incision, perpendicular to the cable specimens axis, is to be made in the insulation of the cable approximately half way along the length of the cable so as to expose the conductors without severing any strands.

Replace the existing text of item e) by the following new text:

- e) The conductors are to be stripped at one end, approximately 12 mm (or 0,5 in), for connection to the test circuits.

Add the following new subclauses:

9.9.2.8 Verification of correct operation in case of arc in a three-phase system with unbalanced load

This test is applicable for a four-pole AFDD only.

The detection test shall be performed for each pole and neutral separately. Whatever the rated current value, the current in the three phases shall be adjusted at 2,5 A, 5 A and the rated current (see Figure 38), according to 9.9.2.1. The arc test shall be performed on each phase, in turn, at the previously adjusted current.

The test procedure shall be according to 9.9.2.2.

9.9.2.9 Verification of correct operation in case of arc in a three-phase system with balanced load

This test is applicable for a three-pole AFDD and a four-pole AFDD.

The detection test shall be performed for each pole, except the neutral. The load current in each phase shall be adjusted at the lowest arc current value and at the rated current of the AFDD (see Figure 38), according to 9.9.2.1.

The test procedure shall be applied according to 9.9.2.2.

9.9.3.1 Verification of correct operation in case of parallel arc with limited current

Add, after the third paragraph, the following new paragraph:

The AFDD being supplied with all phases, the tests shall be performed between a phase chosen at random and neutral (if any), and between two phases chosen at random, if applicable.

9.9.3.2 Verification of correct operation in case of parallel arc cable cutting test

Add, after the second paragraph, the following new paragraph:

The tests shall be performed between a phase chosen at random and neutral (if any), and between two phases chosen at random, if applicable.

9.9.4.1 General

Add, after the first paragraph, the following new paragraph:

The AFDD being supplied with all phases, the tests shall be performed between a phase chosen at random and neutral (if any), and between two phases chosen at random, if applicable.

9.9.4.2 Masking test with inhibition loads

Add, before the existing first paragraph, the following new paragraph:

This test applies to a single-pole AFDD with two current paths and a two-pole AFDD.

Add, after item b), the following new note:

NOTE 1 THD can be calculated with the formula of IEC 61000-3-2:2014, 3.14.2, for total harmonic distortion

$$THD = \sqrt{\sum_{h=2}^{40} \left(\frac{I_h}{I_1} \right)^2}$$

Replace the existing text of item c) by the following new text:

- c) A capacitor start (air compressor type) motor, with a peak inrush current of 130 A ± 10 % for a 120 V rated voltage AFDD, is to be started under load (compressor operating without any air pressure in the air tank) and operated. For a 230 V rated voltage AFDD, a 2,2 kW capacitor start (air compressor type) motor is to be used;

Replace in d) "NOTE" by "NOTE 2".

Add, after the sixth paragraph, the following new paragraph:

For selecting the maximum break time in Table 1 or Table 2, the test arc current is the current in the cable specimen without arcing; it is measured by application of the rated voltage reduced by 50 V.

9.9.4.3 Masking test with EMI filter

Replace the existing text of item a) by the following new text:

- a) Two EMI filters of 0,22 µF shall be installed. One filter shall be installed at one end of two resistive loads of 15 m (or 50 feet) in length and 2,5 mm² (or 12 AWG) in cross-section; the cable shall comply with IEC 60228. Each filter shall be on the end of approximately 2,0 m (or 6 feet) in length and of 1,5 mm² (or 16 AWG) in cross-section. The arcing shall be initiated as shown in Figure 12.

Replace the existing text of item b) by the following text:

- b) An EMI filter as described in Figure 14 shall be installed at the end of 15 m (or 50 feet), in length and 2,5 mm² (or 12 AWG) in cross-section; the cable shall comply with IEC 60228. The filter shall be on the end of 2,0 m (or 6 feet) in length and 1,5 mm² (or 16 AWG) in cross-section flexible cable. The AFDD and the arcing shall be located as shown in Figure 13.

Add the following new subclause:

9.9.4.5 Masking test with inhibition loads for three-pole and four-pole AFDDs

A series of tests is performed with inhibition loads according to 9.9.2.9. The AFDD and arc fault tester are connected in the circuit according to Figure 39.

The AFDD shall be tested with each of the following masking loads at AFDD rated voltage and rated frequency:

- a) a three-phase asynchronous motor loaded to draw $2,5 \text{ A }^{+20}_0$ % per AFDD pole for 400 V rated voltage AFDD and 5 A ^{+20}_0 % per AFDD pole for 230 V rated voltage AFDD;
- b) a variable speed drive with a three-phase asynchronous motor adjusted in such a way that the voltage applied to the motor is equal to the 80 % of the AFDD rated voltage and the ratio U_n/f^2 remains constant where U_n is the rated voltage and f the rated frequency.

The asynchronous motor consumption shall be adjusted for consuming $2,5 \text{ A }^{+20}_0$ % per AFDD pole for 400 V rated voltage AFDD and 5 A ^{+20}_0 % per AFDD pole for 230 V rated voltage AFDD.

The switching frequency of the variable speed drive shall be between 10 kHz and 12 kHz.

Systems comprising variable speed drives, motors and cabling, shall be confirmed by the drive supplier to fulfil the requirements regarding the limit of harmonic current emissions as defined in IEC 61000-3-2 for Class A equipments. The AFDD shall clear the arcing fault as specified in Table 1 or Table 2 when using carbonized cable specimen or within 2,5 times the break time in Table 1 or Table 2 when using the arc generator.

9.9.5.1 General

Add, after the existing first paragraph, the following new paragraph:

The AFDD being supplied with all phases, the tests shall be performed between a phase, chosen at random and neutral (if any), and between two phases chosen at random, if applicable.

9.9.5.2 Cross talk test

Replace the existing first paragraph by the following new paragraph:

Two branch circuits installed as close as possible in the same panel are supplied with the same phase and neutral, if any, as described in Figure 16, one with AFDD protection and one without AFDD protection (but with conventional overcurrent protection). Both circuits are connected to a resistive load drawing a current equal to 5 A. For three-pole and four-pole AFDDs, a 3-phase resistive load with 5 A in each phase shall be used.

Replace the existing second paragraph by the following new paragraph:

An arc is initiated with an arc generator (according to 9.9.2.7) or a cable specimen (according to 9.9.2.6) in the circuit without the AFDD, according to the test conditions of 9.9.2.2. The arc conditions shall be sustained for a duration of minimum 0,5 s for 230 V and for 400 V circuits, or a duration of minimum 1 s for a 120 V circuit; the AFDD shall not trip.

9.9.5.4 Test with various disturbing loads

Replace the title by the following new title:

9.9.5.4 Test with various disturbing loads for single-pole AFDD with two current path and two-pole AFDD

Replace, in the existing first paragraph, "9.9.4.1" by "9.9.4.2".

Add the following new subclause:

9.9.5.5 Test with various disturbing loads for three-pole and four-pole AFDDs

The AFDD is tested as in 9.9.4.5 but without the arc fault tester shown in Figure 39.

The AFDD shall be tested with each of the following loads:

- a) a three-phase (asynchronous motor) fan consuming, $2,5 \text{ A }^{+20}_0$ % per AFDD pole for a 400 V rated voltage AFDD and 5 A ^{+20}_0 % per AFDD pole for 230 V rated voltage AFDD;
- b) a variable speed drive with a three-phase (asynchronous motor) adjusted in such a way that the voltage applied to the fan is equal to the 80 % of the AFDD rated voltage and the ratio U_n/f^2 remains constant where U_n is the rated voltage and f the rated frequency.

The fan consumption shall be adjusted for consuming, $2,5 \text{ A }^{+20}_0$ % per AFDD pole for a 400 V rated voltage AFDD and 5 A ^{+20}_0 % per AFDD pole for 230 V rated voltage AFDD.

The switching frequency of the variable speed drive shall be between 10 kHz and 12 kHz.

The variable speed drive shall not be equipped with optional EMC filters.

If an acceleration ramp is used for reaching the voltage applied to the fan, it shall not take more than 5 s.

The loads are energized during at least 10 s. Five Start/Stop operations shall be performed.

The AFDD shall not trip.

9.10.2 Test procedure

Replace the existing third dash of the third paragraph by the following new dash:

- 500, or in the case of no test device 1 000, operating cycles by tripping the AFDD. The tripping means and conditions will be decided between the manufacturer and the laboratory.

9.11.2.2 General conditions for test

Add, in item a), the following new dashes:

- a three-pole AFDD;
- a four-pole AFDD.

Replace, in item a) after the sentence “ Z_2 , suitably calibrated, is an impedance used to obtain one of the following currents:”, the two existing dashes by the following new dashes:

- the rated making and breaking capacity on one pole I_{m1} ;
- the rated conditional short-circuit current on one pole I_{nc1} .

Replace, in the third paragraph of item e), “ I_{c1} ” by “ I_{nc1} ”.

Replace, in the first dash of item i), “9.7.6.3” by “9.7.7.3”.

Replace, in the second dash of item i), “9.7.3” by “9.7.4”.

Replace, in the second paragraph of item i), “9.7.2” by “9.7.3” (2 times).

9.11.2.4 Verification of the rated making and breaking capacity on one pole (I_{m1}) of AFDDs and their suitability for use in IT systems

Replace the existing first paragraph of item b) by the following new paragraph:

The following sequence of operations is performed. The closing is performed by an actuator operating the mechanism of the AFDD and opening at least 0,05 s later to ensure that current flows in the AFDD.

9.11.2.5 Verification of the coordination between the AFDD and the declared protective device

Delete, in the third paragraph of item c) 1), the word “residual”.

9.19.3 Test with temperature of 40 °C

Delete the note.

Add, at the end of the third paragraph, the following new sentence:

For a four-pole AFDD, only three poles are loaded.

9.21.1 General

Replace the existing text by the following new text:

AFDDs shall be submitted to the EMC tests according to IEC 61543:1995, IEC 61543:1995/AMD1:2004 and IEC 61543:1995/AMD2:2005 and according to the additional information given in 9.21.2, 9.21.3, and 9.21.4.

Add the following new subclause:

9.23 Verification of the behaviour in case of partial loss of supply connections

A three-pole AFDD shall be tested with two-poles connected, chosen at random.

A four-pole AFDD shall be tested with two phases chosen at random, with one phase chosen at random and neutral, and with three phases without neutral.

The following tests shall be performed: 9.9.2.2, 9.9.2.3, 9.9.2.4, 9.9.3.2 and 9.9.3.3.

Replace, in Figures 4, 6, 7, 9, 10 and 13, “Neutral” by “Phase or neutral”

Figure 4 – Test circuit for series arc fault tests

Add the following new note:

NOTE This figure represents a single-phase test set-up. Three-pole and four-pole devices are supplied as for normal use.

Add the following new Figure 38:

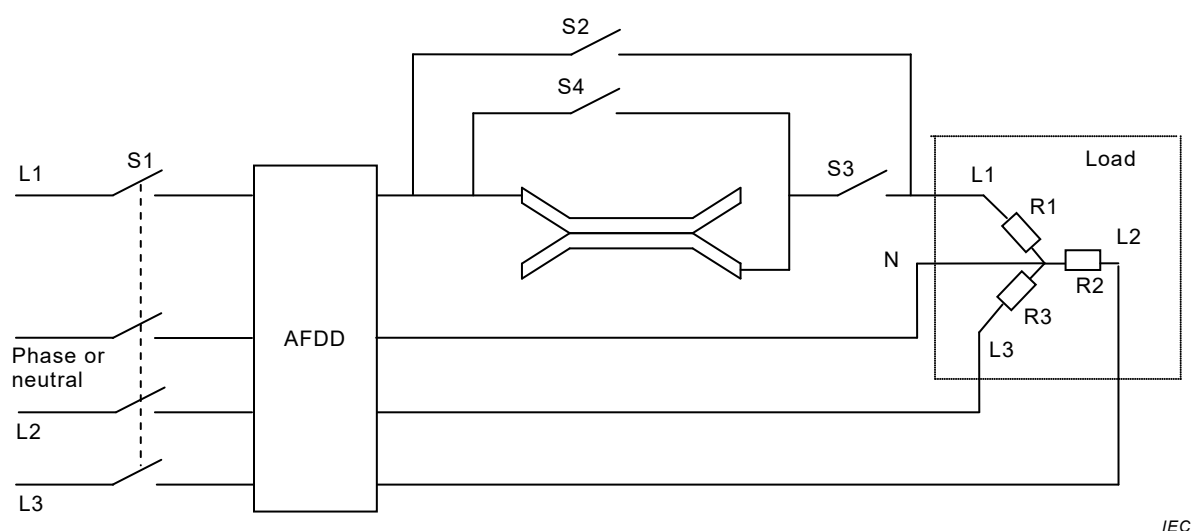


Figure 38 – Test circuit for series arc in a three-phase system with balanced and unbalanced load

Add the following new Figure 39:

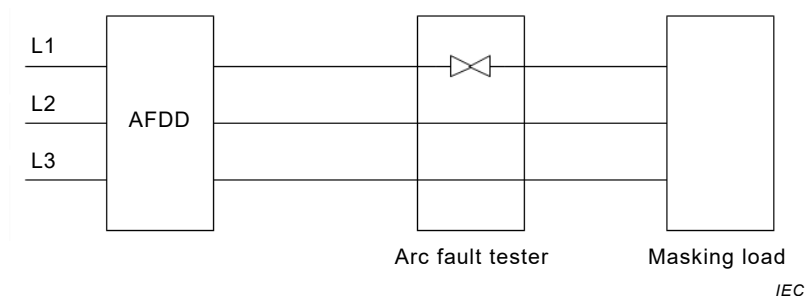
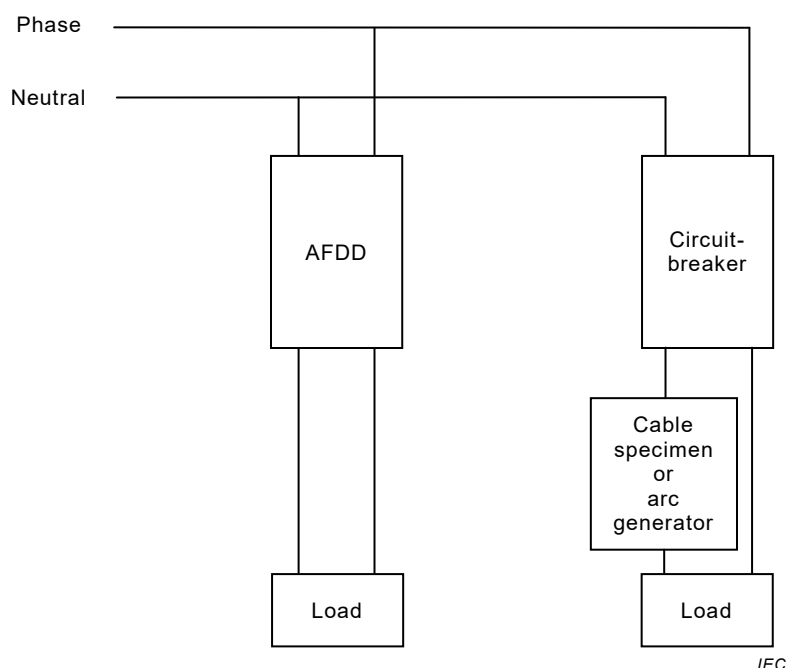


Figure 39 – Test configuration for masking tests for three-pole and four-pole AFDDs

Figure 16 – Cross talk test

Replace the existing Figure 16 by the following new figure:



NOTE This figure represents only single-phase devices. For three-pole and four-pole devices, adapt accordingly.

Figure 16 – Cross talk test

Figure 17 – Controlled current test circuit

Delete the title and figure and replace with the following:

Figure 17 – Void

Figure 18 – Controlled current with delay angle 45°, 90° and 135°

Delete the title and figure and replace with the following:

Figure 18 – Void

Replace, in the paragraph “Explanation of letter symbols used in Figures 19, 20 and 21” (below Figure 18), the explanations for Z_2 and I_4 by the following:

Z_2 = Adjustable impedance for the calibration of I_{m1} and I_{nc1} , if applicable

I_4 = Additional current sensor, if needed

Replace the existing figure and its title by the following new figure and title:

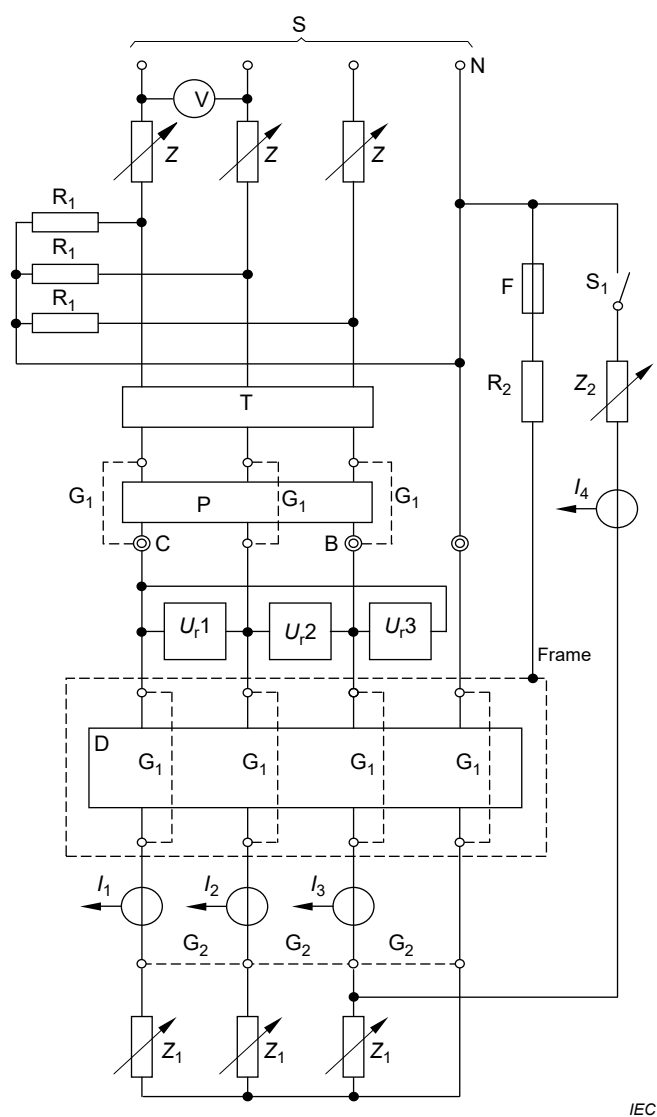


Figure 19 – Typical diagram for all short circuit tests except for 9.11.2.4 c)

Figure 20 – Typical diagram for short circuit tests ((9.11.2.4c)

Replace the existing figure and its title by the following new figure and title:

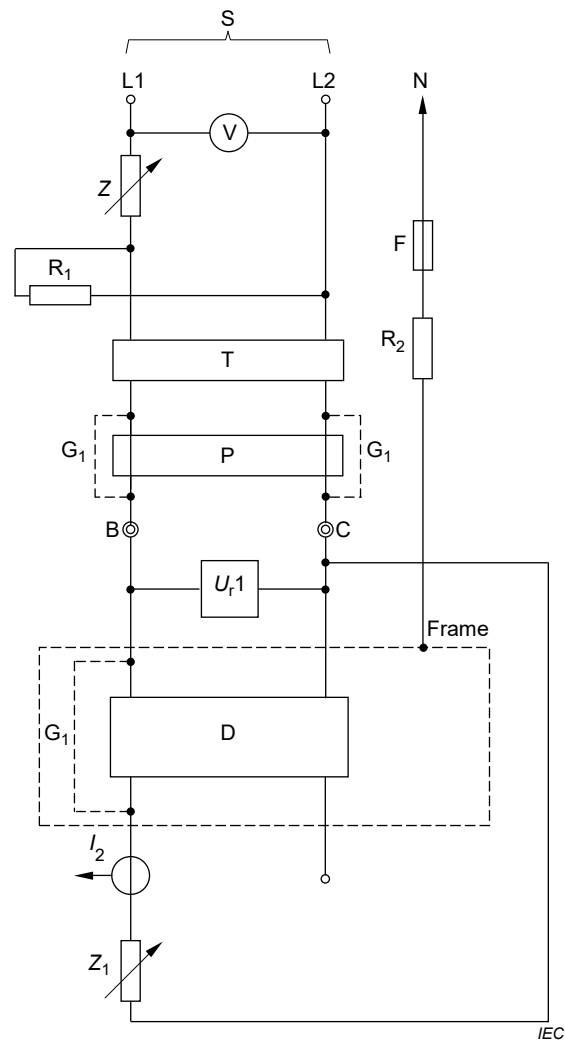


Figure 20 – Typical diagram for short circuit tests of 9.11.2.4.c)

Figure 36 – Preparation of the cable specimens (9.9.2.6)

Replace the existing figure by the following new figure:

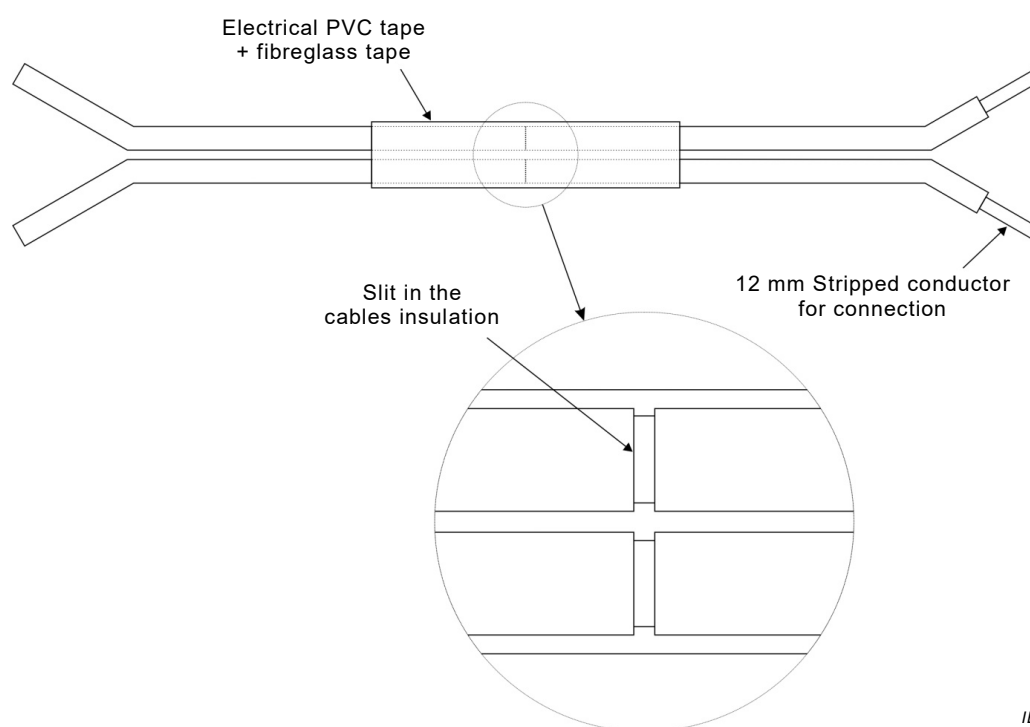


Figure 36 – Preparation of the cable specimens (9.9.2.6)

Annex A – Test sequence and number of samples to be submitted for certification¹ purposes

Replace, in Tables A.1, A.2 and A.3, the existing test sequences B and H with the following new test sequences:

Test sequence	Clause or subclause	Test (or inspection)
B	9.7.7.4	Resistance of the insulation of open contacts and basic insulation against an impulse voltage in normal conditions
	9.7.7.5	Verification of the behaviour of components bridging the basic insulation
	9.7.2	Resistance to humidity
	9.7.3	Insulation resistance of the main circuit
	9.7.4	Dielectric strength of the main circuit
	9.7.5	Insulation resistance and dielectric strength of auxiliary circuits
	9.7.6	Capability of control circuits connected to the main circuits withstanding high d.c. voltages due to insulation measurements
	9.7.7.2	Verification of clearances with the impulse withstand voltage
	9.8	Temperature rise
	9.19.3	Reliability at 40 °C
	9.20	Ageing of electronic components

Test sequence	Clause or subclause	Test (or Inspection)
H	IEC 61543:1995/AMD1:2004, Table 4 – T1.1	Harmonics, interharmonics
	IEC 61543:1995/AMD1:2004, Table 4 – T1.2	Signalling voltage
	9.21, Table 21 – T2.3	Surges

¹ The term “certification” denotes either a Declaration of Conformity by the manufacturer, or a Third Party Certification, e.g. by an independent testing station.

Table A.1 – Test sequences for AFDDs classified according to 4.1.1

Replace the existing test sequence D with the following new test sequence:

Test sequence		Clause or subclause	Test (or Inspection)
D	D ₀	9.9.2	Operating characteristics (series arc fault)
		9.9.3	Operating characteristics (parallel arc fault)
		9.23	Verification of behaviour in case of partial loss of supply connections
	D ₁	9.9.4	Masking test
		9.9.5	Unwanted tripping
		9.18	Behaviour in the case of surge currents
		9.11.2.4 a) b)	Performance at I_{m1}
		9.12	Resistance to mechanical shock and impact
		9.17	Non-operating current under overcurrent conditions
	D ₂	9.11.2.4 c)	Verification of the suitability in IT-systems

Add the following note:

NOTE Test of sequence B, in 9.7, can be done on separate samples.

Table A.2 – Test sequences for AFDDs classified according to 4.1.2

Replace the existing test sequence D with the following new test sequence:

Test sequence		Clause or subclause	Test (or Inspection)
D	D ₀	9.9.2	Operating characteristics (series arc fault)
		9.9.3	Operating characteristics (parallel arc fault)
		9.23	Verification of behaviour in case of partial loss of supply connections
	D ₁	9.9.4	Masking test
		9.9.5	Unwanted tripping
		9.18	Behaviour in the case of surge currents
		9.12	Resistance to mechanical shock and impact
		9.17	Non-operating current under overcurrent conditions
	D ₂	9.11.1	Verification of AFDDs after sequence C ₂ of IEC 60898-1, sequence D ₂ of IEC 61008-1 or sequence C ₂ of IEC 61009-1

Table A.3 – Test sequences for AFDDs classified according to 4.1.3

Delete, in the existing test sequence A, D.6.4.

Replace the existing test sequence D with the following new test sequence:

Test sequence		Clause or subclause	Test (or Inspection)
D	D ₀	D.6.4	Verification for devices declared to be disassembled
		9.9.2	Operating characteristics (series arc fault)
		9.9.3	Operating characteristics (parallel arc fault)
		9.23	Verification of behaviour in case of partial loss of supply connections
	D ₁	9.9.4	Masking test
		9.9.5	Unwanted tripping
		9.18	Behaviour in the case of surge currents
		9.12	Resistance to mechanical shock and impact
		9.17	Non-operating current under overcurrent conditions
	D ₂	9.11.1	Verification of AFDDs after sequence C ₂ of IEC 60898-1, sequence D ₂ of IEC 61008-1 or sequence C ₂ of IEC 61009-1

Table A.5 – Number of samples for simplified test procedure

Add, after the existing test sequence A, the following new test sequence A₂:

Test sequence	Number of samples ^{a b}
A ₂	3 max. rating I _n

Annex D – Additional requirements and tests for AFDDs according to the classification 4.1.3 designed to be assembled on site together with a main protective device (circuit-breaker or RCCB or RCBO)

D.6.4 Verification of marking and constructional requirements of AFDDs

Delete, in the first paragraph, “and D.5.4” in order to read “... of D.4.1, D.4.2, D.4.3, D.5.1, D.5.2 and D.5.3...”.

Replace, at the end of the second paragraph, “in Table A.1” by “in Table A.3”.

Bibliography

Add, before the reference for IEC 60060-2, the following new reference:

IEC 60038, IEC Standard voltages

Add, after the reference for IEC 60884-1, the following new reference:

IEC 61000-3-2, Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)

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INTRODUCTION

This International Standard aims to provide necessary requirements and testing procedures for devices to be installed by skilled people in households and similar uses to mitigate the risk of igniting an electrical fire downstream of the device.

Residual Current Devices (RCDs) are recognised as efficient to reduce the risk of fire by detection of leakage current and arcing to ground as a consequence of tracking currents within an electrical installation. However, RCDs as fuses or circuit-breakers are not able to reduce the risk of electrical fire due to series or parallel arcing between live conductors.

During a series arc fault, there is no leakage to ground therefore RCDs cannot detect such a fault. Moreover, the impedance of the series arc fault reduces the load current, which will keep the current below the tripping threshold of the circuit-breaker and the fuse. In the case of a parallel arc between phase and neutral conductor, the current is only limited by the impedance of the installation. In the worst cases of sporadic arcs, the conventional circuit breakers were not designed for that purpose.

Experience and information available confirmed that the r.m.s. current value of an earth fault current caused by an arcing fault, which is able to ignite a fire, is not limited to the rated power supply frequency of 50/60 Hz, but may contain a much higher frequency spectrum that is not taken into account for the testing of RCDs.

It has been recognised that the risk of igniting a fire within an electrical installation can also be a consequence of an overvoltage due to a broken neutral in a three phase installation.

This standard covers devices designed to be installed in a distribution board at the origin of one or several final circuits of a fixed installation.

GENERAL REQUIREMENTS FOR ARC FAULT DETECTION DEVICES

1 Scope

This International Standard applies to arc fault detection devices (AFDD) for household and similar uses in a.c. circuits.

 note deleted 

An AFDD is designed by the manufacturer:

- either as a single device having opening means able to open the protected circuit in specified conditions; or
- as a single device integrating a protective device; or
- as a separate unit, according to Annex D assembled on site with a declared protective device.

The integrated protection device is either a circuit-breaker in accordance with IEC 60898-1 or an RCD in accordance with IEC 61008-1, IEC 61009-1 or IEC 62423.

These devices are intended to mitigate the risk of fire in final circuits of a fixed installation due to the effect of arc fault currents that pose a risk of fire ignition under certain conditions if the arcing persists.

Protection against fire ignition due to overvoltage due to a broken neutral within a three phase installation to be included in this type of equipment as an additional option is under consideration in 9.22.

 NOTE 1  Tracking current leads to arcing and therefore may ignite fire.

This International Standard applies to devices performing simultaneously the detection and discrimination of arcing current with regards to fire hazards and defines operating criteria under specified conditions for the opening of the circuit when the arcing current exceeds the limit values given in this standard.

AFDDs complying with this standard, with the exception of those with an uninterrupted neutral, are suitable for use in IT systems.

The maximum rated voltage is 240 V a.c. AFDDs, according to this standard, are supplied either between line and neutral or between two lines.

The maximum rated current (I_n) is 63 A a.c.

AFDDs energised from batteries or a circuit other than the protected circuit are not covered by this standard.

AFDDs provide isolation, they are intended to be operated by uninstructed persons and do not require maintenance.

Particular requirements may be necessary for:

- AFDDs incorporated in or intended only for association with plugs and socket-outlets or with appliance couplers for household or similar general purposes;
- AFDDs intended to be used at frequencies other than 50 Hz or 60 Hz.

NOTE 2 For AFDDs incorporated in, or intended only for socket-outlets the requirements of this standard can be used, as far as applicable, in conjunction with the requirements of IEC 60884-1 or the national requirements of the country where the product is placed on the market.

NOTE 3 In the UK, the plug part and the socket-outlet part(s) need not comply with any IEC 60884-1 requirements. In the UK, the plug part shall comply with BS 1363-1 and the socket-outlet part(s) shall comply with BS 1363-2.

Special precautions (e.g. surge protective devices) may be necessary when excessive overvoltages are likely to occur on the supply side.

The requirements of this standard apply for standard conditions of temperature and environment. They are applicable to AFDDs intended for use in an environment with pollution degree 2. Additional requirements may be necessary for devices used in locations having more severe environmental conditions.

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 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 + 12 h cycle)*

IEC 60068-3-4:2001, *Environmental testing – Part 3-4: Supporting documentation and guidance – Damp heat tests*

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

IEC 60364-4-44:2007, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*

IEC 60417, *Graphical symbols for use on equipment*, available from: <<http://www.graphical-symbols.info/equipment>>

IEC 60479 (all parts), *Effects of current on human beings and livestock*

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

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60695-2-10:2000, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

IEC/TR 60755, *General requirements for residual current operated protective devices*

IEC 60898-1:2002, *Electrical accessories – Circuit-breakers for overcurrent protection for household and similar installations – Part 1: Circuit-breakers for a.c. operation*

IEC 61008-1:2010, *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – Part 1: General rules*

IEC 61009-1:2010, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – Part 1: General rules*

IEC 61543:1995, *Residual current-operated protective devices (RCDs) for household and similar use – Electromagnetic compatibility*
Amendment 1:2004
Amendment 2:2005

IEC 62423, *Type F and type B residual current operated circuit-breakers with and without integral overcurrent protection for household and similar uses*

CISPR 14-1:2009, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC/TR 60755, IEC 60898-1, IEC 61008-1, IEC 61009-1, IEC 62423 and the following apply.

NOTE Where the terms "voltage" or "current" are used, they imply r.m.s. values, unless otherwise specified.

3.1

arc arcing

luminous discharge of electricity across an insulating medium, usually accompanied by the partial volatilization of the electrodes

Note 1 to entry: A complete sinusoidal current half cycle is not considered to be an arcing half cycle.

3.2

arc fault arcing fault

dangerous unintentional parallel or series arc between conductors

3.3

arc fault detection device AFDD

device intended to mitigate the effects of arcing faults by disconnecting the circuit when an arc fault is detected

3.4

arc fault detection unit AFD unit

part of the AFDD ensuring the function of detection and discrimination of dangerous earth, parallel and series arc faults and initiating the operation of the device to cause interruption of the current

Note 1 to entry: The interruption of the current can either be provided by opening means (see 4.1.1) or by a protective device integrating an AFD unit (see 4.1.2) or by a protective device assembled with an AFD unit see (4.1.3).

3.5

detection

function consisting in sensing the presence of an arc fault current

3.6

interruption

function consisting in bringing automatically the main contacts of the AFDD from the closed position into the open position, thereby interrupting the arc fault current(s) flowing through them

3.7

earth arc fault

arc fault where the current is flowing from active conductor to the earth

Note 1 to entry: The earth arc current may have a value close to the parallel arc current in some installations (e.g. TN installation).

3.8

parallel arc fault

arc fault where the arc current is flowing between active conductors in parallel with the load of the circuit.

3.9

series arc fault

arc fault where the current is flowing through the load(s) of the final circuit protected by an AFDD

3.10

closed position

position in which the predetermined continuity of the main circuit of the AFDD is secured

3.11

open position

position in which the predetermined clearance between open contacts in the main circuit of the AFDD is secured

3.12

pole

that part of an AFDD associated exclusively with one electrically separated conducting path of its main circuit provided with contacts intended to connect and disconnect the main circuit itself and excluding those portions which provide a means for mounting and operating the poles together

3.13

switched neutral pole

pole only intended to switch the neutral and not intended to have a short-circuit capacity

3.14

isolation

isolating function

function intended to cut off the supply from the whole installation or a discrete section of it by separating it from every source of electrical energy for reasons of safety

[SOURCE: IEC 60947-1:2007, 2.1.19]

3.15

isolating distance

clearance between open contacts, meeting the safety requirements specified for isolation purposes

[SOURCE: IEC 60050-441:1984, 441-17-35, modified – "disconnectors" has been replaced by "isolation purposes".]

3.16

making capacity

value of the a.c. component of a prospective current that an AFDD is capable of making at a stated voltage under prescribed conditions of use and behaviour

3.17

breaking capacity

value of the a.c. component of a prospective current that an AFDD is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

3.18

conditional short-circuit current

I_{nc}

value of the a.c. component of a prospective current, which an AFDD, protected by a suitable short-circuit protective device (SCPD) in series can withstand under specified conditions of use and behaviour

3.19

prospective current

current that would flow in the circuit, if each main current path of the AFDD were replaced by a conductor of negligible impedance

Note 1 to entry: The prospective current may be qualified in the same manner as an actual current, for example: prospective breaking current, prospective peak current, etc.

3.20

maximum prospective peak current (of an a.c. circuit)

prospective peak current, when the initiation of the current takes place at the instant which leads to the highest possible value

3.21

short-circuit (making and breaking) capacity

alternating component of the prospective current, expressed by its r.m.s. value, which the AFDD is designed to make, to carry for its opening time and to break under specified conditions

3.22

thread forming tapping screw

tapping screw having an uninterrupted thread

Note 1 to entry: It is not a function of this thread to remove material from the hole.

Note 2 to entry: An example of a thread forming tapping screw is shown in Figure 1.

3.23

thread cutting tapping screw

tapping screw having an interrupted thread

Note 1 to entry: It is a function of this thread to remove material from the hole.

Note 2 to entry: An example of a thread cutting tapping screw is shown in Figure 2.

4 Classification

4.1 According to the method of construction

4.1.1 AFDD as one single device, comprising an AFD unit and opening means and intended to be connected in series with a suitable short circuit protective device declared by the manufacturer complying with one or more of the following standards IEC 60898-1, IEC 61009-1 or IEC 60269 series

4.1.2 AFDD as one single device, comprising an AFD unit integrated in a protective device complying with one or more of the following standards IEC 60898-1, IEC 61008-1, IEC 61009-1 or IEC 62423.

4.1.3 AFDD according to Annex D, comprised of an AFD unit and a declared protective device, intended to be assembled on site.

4.2 According to the method of mounting and connection

Panel board type AFDDs, also referred to as distribution board types, can be connected as follows:

- a) AFDDs the connections of which are not associated with the mechanical mounting;
- b) AFDDs the connections of which are associated with the mechanical mounting, for example:
 - 1) plug-in type;
 - 2) bolt-on type.

NOTE Some AFDDs of the plug-in type or bolt-on type on the line side only, the load terminals being usually suitable for wiring connection.

4.3 According to the number of poles and current paths

 text deleted 

- Two-pole AFDD.

NOTE 1 Extension to three or four-pole AFDDs is under consideration.

NOTE 2 In China uninterrupted neutral AFDDs are not allowed.

4.4 AFDD providing monitoring information

AFDD providing monitoring information are under consideration

Under consideration.

5 Characteristics of AFDDs

5.1 Summary of characteristics and conditions to mitigate the risk of fire

An AFDD shall ensure detection for:

- earth arc fault (see 3.7); and
- parallel arc fault (see 3.8); and
- series arc fault (see 3.9).

The characteristics of an AFDD shall be stated in the following terms:

- rated current I_n (see 5.2.2);
- rated voltage U_n (see 5.2.1);

- rated frequency (see 5.2.3);
- rated making and breaking capacity I_m (see 5.2.4);
- rated making and breaking capacity on one pole I_{m1} (see 5.2.5);
- degree of protection (see IEC 60529);
- rated conditional short-circuit current I_{nc} (see 5.3.6 and 5.5.2);
- rated conditional short-circuit current on one pole I_{nc1} (see 5.3.6 and 5.5.2);
- method of connection (see 4.2).

5.2 Rated quantities and other characteristics

5.2.1 Rated voltage

5.2.1.1 Rated operational voltage (U_n)

The rated operational voltage (hereafter referred to as "rated voltage") of an AFDD is the value of voltage, assigned by the manufacturer, to which its performance is referred.

The same AFDD may be assigned for a number of rated voltages.

5.2.1.2 Rated insulation voltage (U_i)

The rated insulation voltage of an AFDD is the value of voltage, assigned by the manufacturer, to which dielectric test voltages and creepage distances are referred.

Unless otherwise stated, the rated insulation voltage is the value of the maximum rated voltage of the AFDD. In no case shall the maximum rated voltage exceed the rated insulation voltage.

5.2.1.3 Rated impulse withstand voltage (U_{imp})

The rated impulse withstand voltage of an AFDD shall be equal to or higher than the standard values of rated impulse withstand voltage according to Table F.1 of IEC 60664-1:2007 and Table 4 of this standard.

5.2.2 Rated current (I_n)

The value of current, assigned to the AFDD by the manufacturer, which the AFDD can carry in uninterrupted duty.

5.2.3 Rated frequency

The rated frequency of an AFDD is the power frequency for which the AFDD is designed and to which the values of the other characteristics correspond.

The same AFDD may be assigned a number of rated frequencies.

5.2.4 Rated making and breaking capacity (I_m)

The r.m.s. value of the a.c. component of prospective current, assigned by the manufacturer, which an AFDD can make, carry and break under specified conditions.

The conditions are those specified in 9.11.2 for AFDDs classified according to 4.1.1 and in the standard of the declared protective device (e.g. IEC 60898-1, IEC 61008-1, IEC 61009-1, IEC 62423) for AFDDs classified according to 4.1.2 and 4.1.3.

5.2.5 Rated making and breaking capacity on one pole (I_{m1})

The r.m.s. value of the a.c. component of prospective current, assigned by the manufacturer, which an AFDD can make, carry and break with one pole, under specified conditions.

5.3 Standard and preferred values

5.3.1 Preferred values of rated voltage (U_n)

Preferred values of rated voltage are as follows

- 230 V: wherever in this standard there is a reference to 230 V they may be read as 220 V or 240 V respectively;

 text deleted 

5.3.2 Preferred values of rated current (I_n)

Preferred values of rated current are:

6 – 8 – 10 – 13 – 16 – 20 – 25 – 32 – 40 – 50 – 63 A.

5.3.3 Preferred values of rated frequency

 Preferred values of rated frequency is 50 Hz. 

If another value is used, the rated frequency shall be marked on the device and the tests carried out at this frequency.

5.3.4 Minimum value of the rated making and breaking capacity (I_m)

The minimum value of the rated making and breaking capacity I_m is 10 I_n or 500 A, whichever is the greater.

The associated power factors are given in 9.11.2 for AFDDs classified according to 4.1.1 and in the standard of the declared protective device for AFDDs classified according to 4.1.2 and 4.1.3.

5.3.5 Minimum value of the rated making and breaking capacity on one pole (I_{m1})

The minimum value of the rated making and breaking capacity on one pole I_{m1} is 10 I_n or 500 A, whichever is the greater.

The associated power factors are given in 9.11.2 for AFDDs classified according to 4.1.1 and in the standard of the declared protective device for AFDDs classified according to 4.1.2 and 4.1.3.

5.3.6 Standard and preferred values of the rated conditional short-circuit current (I_{nc}) and standard and preferred values of the rated conditional short circuit current for one pole (I_{nc1})

5.3.6.1 General

The standard and preferred values of the rated conditional short-circuit current I_{nc} and I_{nc1} are specified as follows:

5.3.6.2 Values up to and including 10 000 A

Up to and including 10 000 A, the standard values of the rated conditional short-circuit current I_{nc} and I_{nc1} are:

3 000 – 4 500 – 6 000 – 10 000 A.

The associated power factors are given in 9.11.2 for AFDDs classified according to 4.1.1 and in the standard of the declared protective device for AFDDs classified according to 4.1.2 and 4.1.3.

☐ note deleted ☐

5.3.6.3 Values above 10 000 A

For values above 10 000 A up to and including 25 000 A, a preferred value is 20 000 A.

The associated power factors are given in 9.11.2 for AFDDs classified according to 4.1.1 and in the standard of the declared protective device for AFDDs classified according to 4.1.2 and 4.1.3.

Values above 25 000 A are not considered in this standard.

5.3.7 Limiting values of operating criteria for AFDDs for low and high arc currents

5.3.7.1 Limit values of operating criteria for AFDDs at low arc currents up to 63 A

Table 1 – Limit values of break time for $U_n = 230$ V AFDDs

Test arc current (r.m.s. values)	2,5 A	5 A	10 A	16 A	32 A	63 A
Maximum break time	1 s	0,5 s	0,25 s	0,15 s	0,12s	0,12 s

NOTE Low arc currents can occur due to insulation faults phase to earth or series arcing

☐ table deleted ☐

When the test current to which the AFDD is exposed is not one of the values in Tables 1 or 2, the allowable break time shall be determined by linear interpolation between the break time values above and below the actual test current.

5.3.7.2 Limit values of operating criteria for AFDDs at high arc currents above 63 A

**Table 3 – Maximum allowed number of arcing half-cycles within 0,5 s
for U_n 230 V AFDDs ☐ text deleted ☐**

Test arc current ^a (r.m.s. values)	75 A	100 A	150 A	200 A	300 A	500 A
N ^b	12	10	8	8	8	8
^a This test current is the prospective current before arcing in the testing circuit.						
^b N is the number of half cycles at the rated frequency.						

NOTE High arc currents can occur due to insulation faults phase to earth or parallel arcing.

5.4 Standard value of rated impulse withstand voltage (U_{imp})

Table 4 gives the standard value of rated impulse withstand voltages as a function of the nominal voltage of the installation.

Table 4 – Rated impulse withstand voltage as a function of the nominal voltage of the installation

Rated impulse withstand voltage U_{imp} kV	Nominal voltage of the installation	
	Three-phase systems V	Single-phase system with mid-point earthed V
2,5 ^a		☐ text deleted ☐ ^b
4 ^a	230/400	☐ text deleted ☐ 240 ^c
NOTE 1 For test voltages to check the insulation, see Table 15.		
NOTE 2 For test voltages to check the isolation distance across open contacts, see Table 16.		
^a The values 3 kV and 5 kV respectively are used for verifying the isolating distances across open contacts at the altitude of 2 000 m (see Table 16).		
^b For installation practice in Japan.		
^c For installation practice in North American countries.		

In case an AFDD is intended to be connected (see 4.1.1) or integrated (see 4.1.2) or assembled (see 4.1.3) with one or several declared protective devices whose standard values of rated impulse withstand voltage are more severe than those mentioned in Table 4, the standard conditions for operation in service and for installation of the most severe protective device standard shall apply.

5.5 Coordination with short-circuit protective devices (SCPDs)

5.5.1 General

AFDDs shall be protected against short-circuits by means of circuit-breakers or fuses complying with their relevant standards according to the installation rules of the IEC 60364 series.

Coordination between AFDDs and the SCPD shall be verified under the general conditions of 9.11 to verify that there is an adequate protection of the AFDDs against short-circuit currents up to the conditional short-circuit current I_{nc} .

5.5.2 Rated conditional short-circuit current (I_{nc}) and rated conditional short-circuit on one pole (I_{nc1})

The r.m.s. value of prospective current, assigned by the manufacturer, which an AFDD, protected by a SCPD, can withstand under specified conditions without undergoing alterations impairing its functions.

The conditions are those specified in 9.11.

5.5.3 Operating characteristics of opening means for AFDDs according to 4.1.1

5.5.3.1 General

Opening means shall meet all applicable requirements of this standard.

The following acronyms I_{m1} and I_{nc1} are used for testing on one pole only.