



BSI Standards Publication

Low-voltage fuses

Part 2: Supplementary requirements for fuses for use by
authorized persons (fuses mainly for industrial application) —
Examples of standardized systems of fuses A to K

National foreword

This British Standard is the UK implementation of HD 60269-2:2013+A2:2024. It is identical to IEC 60269-2:2013, incorporating amendments 1:2016 and 2:2024. It supersedes BS HD 60269-2:2013+A1:2022, which will be withdrawn on 20 December 2027.

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 tags **[C]** **[C]**.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by **[A1]** **[A1]**.

This standard covers the following British Fuse systems that are included in BS HD 60269-2:2013 (BS 88-2:2013) and amendments 1:2016 and 2:2024:

Fuse system A — Fuses with fuse-links with blade contacts (NH fuse system)

Fuse system B — Fuses with striker fuse-links with blade contacts (NH fuse system)

Fuse system C — Fuse-rails (NH fuse system)

Fuse system E — Fuses with fuse-links for bolted connections (BS bolted fuse system)

Fuse system G — Fuses with fuse-links with offset blade contacts (BS clip-in fuse system)

Fuse system I — gU fuse-links with wedge tightening contacts

This standard is part of a series of British Standards for Low Voltage Fuses. These cover the related parts and examples of systems of fuses in the associated IEC 60269 series of standards.

These British Standards together with their IEC counterparts are:
BS EN 60269-1:2007+A1:2009 (BS 88-1:2007) — General requirements (IEC 60269-1)

BS HD 60269-2:2013 (BS 88-2:2013) — Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) (IEC 60269-2, Fuse systems E, G and I)

BS HD 60269-3:2010 (BS 88-3:2010) — Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications) (IEC 60269-3, Fuse system C)

BS EN 60269-4:2009+A1:2012 (BS 88-4:2009+A1:2012) — Supplementary requirements for fuse-links for the protection of semiconductor devices (IEC 60269-4)

PD IEC/TR 60269-5:2010 (PD 88-5:2010) — Guidance for the application of low voltage fuses (IEC/TR 60269-5:2010)

BS EN 60269-6:2011 — Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems (IEC 60269-6:2010).

The text for BS HD 60269-2:2013/BS 88-2:2013 has been extracted from IEC 60269-2:2013 and is identical to the text for sections E, G, and I. However, wherever a reference is made to IEC 60269-1 in the text this should be taken as a reference to BS EN 60269-1 (BS 88-1).

The UK participation in its preparation was entrusted to Technical Committee PEL/32, Fuses.

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

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For the Great Britain market (England, Scotland and Wales), if UK Government has designated this publication for conformity with UKCA marking (or similar) legislation, it may contain an additional National Annex. Where such a National Annex exists, it shows the correlation between this publication and the relevant UK legislation. If there is no National Annex of this kind, the relevant Annex ZA or ZZ in the body of the European text will indicate the relationship to UK regulation applicable in Great Britain. References to EU legislation may need to be read in accordance with the UK designation and the applicable UK law. Further information on designated standards can be found at www.bsigroup.com/standardsandregulation.

For the Northern Ireland market, UK law will continue to implement relevant EU law subject to periodic confirmation. Therefore Annex ZA/ZZ in the European text, and references to EU legislation, are still valid for this market.

UK Government is responsible for legislation. For information on legislation and policies relating to that legislation, consult the relevant pages of www.gov.uk.

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Amendments/corrigenda issued since publication

Date	Text affected
31 March 2014	Standard amended to only include fuses E, G and I
28 February 2023	Implementation of IEC amendment 1:2016 with CENELEC endorsement A1:2022
31 January 2025	Implementation of IEC amendment 2:2024 with CENELEC endorsement A2:2024

**Low-voltage fuses -
Part 2: Supplementary requirements for fuses for use by authorized
persons (fuses mainly for industrial application) -
Examples of standardized systems of fuses A to K
(IEC 60269-2:2013, modified)**

Fusibles basse tension -
Partie 2: Exigences supplémentaires pour
les fusibles destinés à être utilisés par des
personnes habilitées (fusibles pour
usages essentiellement industriels) -
Exemples de systèmes de fusibles
normalisés A à K
(CEI 60269-2:2013, modifiée)

Niederspannungssicherungen -
Teil 2: Zusätzliche Anforderungen an
Sicherungen zum Gebrauch durch
Elektrofachkräfte bzw. elektrotechnisch
unterwiesene Personen (Sicherungen
überwiegend für den industriellen
Gebrauch) -
Beispiele für genormte
Sicherungssysteme A bis K
(IEC 60269-2:2013, modifiziert)

This Harmonization Document was approved by CENELEC on 2013-08-15. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for implementation of this Harmonization Document at national level.

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

This Harmonization Document exists in three official versions (English, French, German).

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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 32B/611/FDIS, future edition 5 of IEC 60269-2:2013, prepared by SC 32B, "Low-voltage fuses", of IEC/TC 32, "Fuses" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as HD 60269-2:2013.

A draft amendment, which covers common modifications to IEC 60269-2:2013, was prepared by CLC/SR 32B "Low-voltage fuses" and approved by CENELEC.

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) 2014-08-15
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) 2016-08-15

This document supersedes HD 60269-2:2010.

HD 60269-2:2013 includes the following significant technical changes with respect to HD 60269-2:2010:

- a) fuse systems A and B: modified values for the power dissipation of NH aM fuse-links;
- b) fuse systems A and B: introduction of dimension r for NH fuse-links;
- c) addition of new fuse system K: gK fuse-links with contacts for bolted connections.

This part is to be used in conjunction with EN 60269-1:2007 + A1:2009, *Low-voltage fuses – Part 1: General requirements*.

This Part 2 supplements or modifies the corresponding clauses or subclauses of Part 1.

Where no change is necessary, this Part 2 indicates that the relevant clause or subclause applies.

Tables and figures which are additional to those in Part 1 are numbered starting from 101 in fuse system A, from 201 in fuse system B, etc. Additional annexes are numbered AA, BB, etc.

Clauses, subclauses, notes, tables, figures and annexes which are additional to those in IEC 60269-2:2013 are prefixed "Z".

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 60269-2:2013 was approved by CENELEC as a Harmonisation Document with agreed common modifications.

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

IEC 60060-1	NOTE Harmonised as EN 60060-1.
IEC 60060-2	NOTE Harmonised as EN 60060-2.
IEC 60060-3	NOTE Harmonised as EN 60060-3.
IEC 60529	NOTE Harmonised as EN 60529.
IEC 60672-1	NOTE Harmonised as EN 60672-1.
IEC 60672-2	NOTE Harmonised as EN 60672-2.
IEC 60672-3	NOTE Harmonised as EN 60672-3.
IEC 62262	NOTE Harmonised as EN 62262.
ISO 898-1	NOTE Harmonised as EN ISO 898-1.
ISO 1207	NOTE Harmonised as EN ISO 1207.
ISO 4589-1	NOTE Harmonised as EN ISO 4589-1.

European foreword to Amendment 1

The text of document 32B/641/CDV, future IEC 60269-2/A1, prepared by SC 32B "Low-voltage fuses" of IEC/TC 32 "Fuses" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as HD 60269-2:2013/A1:2022.

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) 2023-05-11
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2025-11-11

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Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice to Amendment 1

The text of the International Standard IEC 60269-2:2013/A1:2016 was approved by CENELEC as a European Standard without any modification.

European foreword to amendment A2

The text of document 32B/743/FDIS, future IEC 60269-2/AMD2, prepared by SC 32B "Low-voltage fuses" of IEC/TC 32 "Fuses" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as HD 60269-2:2013/A2:2024.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2025-06-20 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2027-12-20 document have to be withdrawn

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 standardization request addressed to CENELEC by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

For the relationship with EU Legislation, see informative Annex ZZ, which is an integral part of this document.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 60269-2:2013/AMD2:2024 was approved by CENELEC as a European Standard without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 Where 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.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60112	-	Method for the determination of the proof and the comparative tracking indices of solid insulating materials	EN IEC 60112	2020
IEC 60269-1	-	Low-voltage fuses – Part 1: General requirements	EN 60269-1	2007
			+ A2	2014
IEC 60664-1	-	Insulation coordination for equipment within low-voltage supply systems - Part 1: Principles, requirements and tests	EN IEC 60664-1	2020
			+ AC	2020-12
IEC 60999-1	-	Connecting devices - Electrical copper conductors - Safety requirements for screw-type and screwless-type clamping units - Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm ² up to 35 mm ² (included)	EN 60999-1	2000
IEC 60999-2	-	Connecting devices - Electrical copper conductors - Safety requirements for screw-type and screwless-type clamping units - Part 2: Particular requirements for clamping units for conductors above 35 mm ² up to 300 mm ² (included)	EN 60999-2	2003
ISO 22479	-	Corrosion of metals and alloys – Sulfur dioxide test in a humid atmosphere (fixed gas method)	EN ISO 22479	2022

Annex ZZ (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 standardisation request relating to harmonised 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 harmonisation 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 ZZ.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding safety objectives of that Directive, and associated EFTA regulations.

Table ZZ.1 — Correspondence between this European standard and Annex I of Directive 2014/35/EU [2014 OJ L96]

Safety objectives of Directive 2014/35/EU	Clause(s) / sub-clause(s) of this EN	Remarks / Notes
(1)(a)	Clause 6	None
(1)(b)	Subclause 7.1.2, Annex E7	None
(1)(c)	See items 2 and 3 of this table	None
(2)(a)	Clause 7, Subclauses 7.2, 7.9, 8.2, 8.5, 8.8	Remark to 8.8: Must meet the requirements of standard 61439 and subsequent parts when installed.
(2)(b)	Subclauses 5.5, 5.6, 7.10, 8.3, 8.5, 8.9, 8.11.2.2, 8.11.2.4, 8.11.2.5	None
(2)(c)	Subclauses 5.5, 5.6, 7.1, 7.3, 7.5, 7.11, 7.13, 7.14, 8.3, 8.5, 8.8, 8.10, 8.11.1, 8.11.2.2	None
(2)(d)	See item 2(a) of this table	None
(3)(a)	Clause 7	None
(3)(b)	Clauses 7, 8	None
(3)(c)	Clause 5, Subclauses 7.4, 7.5, 7.10, 8.3, 8.4, 8.5, 8.10	None

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.

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INTRODUCTION

IEC 60269 consists of the following parts, under the general title *Low-voltage fuses*:

- Part 1: General requirements
- Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Examples of standardized systems of fuses A to K
- Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household or similar application) – Examples of standardized systems of fuses A to F
- Part 4: Supplementary requirements for fuse-links for the protection of semiconductor devices
- Part 5: Guidance for the application of low-voltage fuses
- Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems

LOW-VOLTAGE FUSES –

Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Examples of standardized systems of fuses A to K

1 General scope

1.1 Scope

Fuses for use by authorized persons are generally designed to be used in installations where the fuse-links are accessible to, and may be replaced by, authorized persons only.

Fuses for use by authorized persons according to the following fuse systems also comply with the requirements of the corresponding subclauses of IEC 60269-1, unless otherwise defined in this standard.

This standard is divided into fuse systems, each dealing with a specific example of standardized fuses for use by authorized persons:

- Fuse system A: Fuses with fuse-links with blade contacts (NH fuse system)
- Fuse system B: Fuses with striker fuse-links with blade contacts (NH fuse system)
- Fuse system C: Fuse-rails (NH fuse system)
- Fuse system D: Fuse-bases for busbar mounting (NH fuse system)
- Fuse system E: Fuses with fuse-links for bolted connections (BS bolted fuse system)
- Fuse system F: Fuses with fuse-links having cylindrical contact caps (NF cylindrical fuse system)
- Fuse system G: Fuses with fuse-links with offset blade contacts (BS clip-in fuse system)
- Fuse system H: Fuses with fuse-links having "gD" and "gN" characteristic (class J and class L A_1 and class T time delay and non time delay fuse types) A_1
- Fuse system I: gU fuse-links with wedge tightening contacts
- Fuse system J: Fuses with fuse-links having "gD class CC" and "gN class CC" characteristics (class CC time delay and non-time delay fuse types)
- Fuse system K: gK fuse-links with blade for bolted connections – High fuse-link ratings from 1 250 A up to 4 800 A (master fuse-links)

C The following fuse systems are standardized systems in respect to their safety aspects. The National Committees shall select at least one complete fuse system of this European Standard for their national standards. The time current characteristics "gD" and "gN" are only relevant for the fuse system H. C

1.2 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 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

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

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

IEC 60999 (all parts), *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units*

IEC 60999-1, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm² up to 35 mm² (included)*

IEC 60999-2, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 2: Particular requirements for clamping units for conductors above 35 mm² up to 300 mm² (included)*

☐_{A2} Text deleted ☐_{A2}

☐_{A2} ISO 22479, *Corrosion of metals and alloys – Sulfur dioxide test in a humid atmosphere (fixed gas method)* ☐_{A2}

Fuse system A – Fuses with fuse-links with blade contacts (NH fuse system)

1 General

IEC 60269-1 applies with the following additional and modified requirements.

1.1 Scope

The following additional requirements apply to fuses with fuse-links having blade contacts intended to be replaced by means of a device, for example, replacement handle (see Figure 103), which complies with the dimensions specified in Figures 101 and 102. Such fuses have rated currents up to and including 1 600 A and rated voltages up to and including 1 000 V a.c. or 1 500 V d.c.

The following characteristics of the fuses are specified in addition to IEC 60269-1:

- minimum rated breaking capacities;
- time-current characteristics;
- I^2t characteristics;
- standard conditions of construction;
- power dissipation and acceptable power dissipation.

2 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60269-1, as well as the following, apply.

2.1.101

gripping-lugs

parts of a fuse-link which are engaged with the replacement handle or the fuse-carrier

Note 1 to entry: Gripping-lugs may be made of metal or insulating material. Metal gripping-lugs may be live or not live under service conditions.

2.1.102

live gripping-lugs

metal gripping-lugs electrically connected to the blade contacts of the fuse-link

Note 1 to entry: Metal gripping-lugs without electrical contact to the blade contacts are also deemed to be live in case of inadequate creepage distances and clearances according to this standard.

2.1.103

isolated gripping-lugs

not-live gripping-lugs made of insulating material or metal

Note 1 to entry: If they are made of metal the required creepage distances and clearances according to the relevant overvoltage category should be met between the gripping-lugs and the blade contacts as well as between the gripping-lugs and the fuse-base contacts.

3 Conditions for operation in service

IEC 60269-1 applies.

4 Classification

IEC 60269-1 applies.

5 Characteristics of fuses

IEC 60269-1 applies with the following supplementary requirements.

5.2 Rated voltage

For a.c., the standard values of rated voltage are 400 V, 500 V and 690 V. For d.c., the rated voltages are 250 V and 440 V. The standard values of d.c. rated voltage are not related to the standard values of a.c. rated voltage. For example, the following standard combinations are possible: 500 V a.c. and 250 V d.c., 500 V a.c. and 440 V d.c., 500 V a.c., etc.

The rated voltage of fuse-bases according to Figure 102 is 690 V or higher.

5.3.1 Rated current of the fuse-link

For each size the maximum rated currents are given in Figure 101. These values depend upon the utilization categories and rated voltages.

 Text deleted 

5.3.2 Rated current of the fuse-holder

The rated current for the different sizes of the fuse-bases is given in Figure 102.

5.5 Rated power dissipation of a fuse-link and rated acceptable power dissipation of a fuse-holder

The maximum values of rated power dissipation for the different sizes of fuse-links are specified in Figure 101. The values apply to the maximum rated currents of the fuse-links. The values of rated acceptable power dissipation of fuse-bases are given in Figure 102.

5.6 Limits of time-current characteristics

5.6.1 Time-current characteristics, time-current zones and overload curves

The tolerance on time-current characteristics given by the manufacturer shall not deviate by more than $\pm 10\%$ in terms of current. The time-current zones given in Figure 104, including manufacturing tolerances shall be met by all pre-arcing and total times measured at the test voltage according to 8.7.4.

5.6.2 Conventional times and currents

The conventional times and currents, in addition to the values of IEC 60269-1, are given in Table 101.

Table 101 – Conventional time and current for "gG" fuse-links with rated current lower than 16 A

Rated current I_n A	Conventional time h	Conventional current	
		I_{nf}	I_f
$I_n \leq 4$	1	$1,5 I_n$	$2,1 I_n$
$4 < I_n < 16$	1	$1,5 I_n$	$1,9 I_n$

5.6.3 Gates

For "gG" fuse-links the gates given in Table 102 apply in addition to the gates of IEC 60269-1.

Table 102 – Gates for specified pre-arcing and operating times of "gG" fuse-links

I_n A	$I_{min} (10 \text{ s})$ A	$I_{max} (5 \text{ s})$ A	$I_{min} (0,1 \text{ s})$ A	$I_{max} (0,1 \text{ s})$ A
2	3,7	9,2	6,0	23,0
4	7,8	18,5	14,0	47,0
6	11,0	28,0	26,0	72,0
8	16,0	35,2	41,6	92,0
10	22,0	46,5	58,0	110,0
12	24,0	55,2	69,6	140,4

 Text deleted 

5.7.2 Rated breaking capacity

The minimum rated breaking capacities are specified in Table 103.

Table 103 – Minimum rated breaking capacities

 Rated voltage	Minimum rated breaking capacities
$\leq 690 \text{ V AC}$	50 kA
$690 \text{ V AC} < U \leq 1\,000 \text{ V AC}$	20 kA
$\leq 750 \text{ V DC}$	25 kA
$750 \text{ V} < U \leq 1\,500 \text{ V DC}$	10 kA 

6 Markings

IEC 60269-1 applies with the following supplementary requirements.

Fuse-links and fuse-holders which meet the requirements and tests of fuse system A of this standard may be marked with IEC 60269-2.

6.1 Markings of fuse-holders

In addition to IEC 60269-1, the following marking applies:

– size.

The marking of the rated current and the rated voltage shall be discernible from the front when a fuse-link has not been fitted.

6.2 Markings of fuse-links

In addition to IEC 60269-1, the following marking applies:

- size or reference;
- rated breaking capacity.

The marking of the rated current and the rated voltage shall be discernible from the front. Furthermore, fuse-links shall be marked as described in Table 104.

Table 104 – Marking of fuse-links

Characteristic	gG		aM	
Colour of marking	Black		Green	
Kind of print	Strip with inverse print	Normal print	Strip with inverse print	Normal print
Voltage				
400 V ^a	X		X	
500 V		X		X
690 V	X		X	
^a For 400 V gG, a blue colour is also permitted.				

Fuse-links with isolated gripping-lugs may be marked in a place easily visible from the front with the graphical symbol of a gripping-lug in a square. If marked, conformity of these fuse-links is verified according to 7.2.

NOTE See Figure 112 for detailed dimensions of the symbol.

7 Standard conditions for construction

IEC 60269-1 applies with the following supplementary requirements.

7.1 Mechanical design

The dimensions of fuse-links and fuse-bases are given in Figures 101 and 102.

7.1.2 Connections, including terminals

There are different kinds of terminals. As far as lug terminals are concerned, the range of cross-sections which the terminals shall be capable of accepting results from the following ranges of rated currents of fuse-links of each size.

Terminals designed for unprepared conductors shall be capable of accepting as a minimum three consecutive sizes of conductors within the cross-sectional ranges given in Table 105. In case the terminal is a lug terminal (see IEC 60999 series), the torques which shall be applied are given in Table 111. Torque values for other terminals should be given in the manufacturer's instructions.

Table 105 – Minimum cross-sectional ranges of unprepared conductors

A ₂ Size	Range of the rated currents of the fuse-links A	Cross-sectional area ranges mm ²	
		Copper	Aluminium
000	2 to 160	6 to 70	25 to 95
00	2 to 160	6 to 70	25 to 95
1	80 to 250	25 to 120	35 to 150
2	125 to 400	50 to 240	70 to 300
3	315 to 630	50 to 2 × 185	70 to 2 × 240
4	500 to 1 250	stated in the manufacturer's literature	
4a	500 to 1 600	stated in the manufacturer's literature (A ₂)	

Connections of larger and/or smaller cross-sectional area may be necessary. This can be achieved either by the construction of the terminal or by additional means of connection as recommended by the manufacturer.

Whether the terminals for unprepared conductors are suitable for copper, aluminium or copper and aluminium shall be marked accordingly. Furthermore, the range of cross-sections shall be marked on or near to the clamping saddle or given in the manufacturer's literature.

7.1.3 Fuse-contacts

The contact surfaces of fuse-links and fuse-bases should be silver-plated; If the surface plating of the blade contacts of a fuse-link or the contacts of the fuse-base is other than silver, the test according to 8.10 shall be conducted with dummy fuse-links as described in 8.10.1. Permissible combinations of surface plating shall be defined by the manufacturer.

If fuse-links are intended to be removed or inserted under load, the construction of the fuse, in particular the fuse-contacts, should be suitable for this purpose.

7.1.6 Construction of fuse-bases

The dynamic short-circuit withstand of the fuse shall – whenever needed – meet the cut-off currents as given in Table 112.

Fuse-bases shall meet the temperature rise test according to 8.3 including all protective covers intended to be used.

7.1.7 Construction of a fuse-link

The preferred construction is as follows: the blade contacts shall be made of solid material. If any other construction of blade contacts is used the manufacturer shall demonstrate that this construction is adequate for the purpose.

With the exception of the attachment for the replacement handle, the endplates are not permitted to protrude radially from the insulation body. For some applications it is preferable to insulate the gripping-lugs from live parts.

Fuse-links shall have an indicator. Electrically conductive parts of indicators shall not be ejected from the fuse-link during operation.

7.2 Insulating properties and suitability for insulation

The creepage distances and clearances of the fuses and fuse-accessories shall meet the requirements of IEC 60664-1 for overvoltage category III and pollution degree 3. The minimum clearances are also applicable to metal parts which are not permanently live but may be touched. They shall not be diminished during replacement of the fuse-link. The creepage distances between isolated metal gripping-lugs and live parts are chosen according to the rated voltage divided by $\sqrt{3}$.

For insulation stressed only for a short time, the creepage distances of isolated metal gripping-lugs corresponding to two voltage steps lower may be used.

Insulating parts of the fuse-base supporting live parts have to pass the test at PTI 400 carried out according to IEC 60112 using test solution A.

7.7 I^2t characteristics

For the fuse-links covered by this fuse system, the maximum pre-arcing I^2t values given in Table 7 of IEC 60269-1 apply for the maximum operating I^2t values. A_2 Values for rated currents lower than 16 A are given in Table 106. A_2

Table 106 – Pre-arcing and operating I^2t values at 0,01 s for "gG" fuse-links

I_n A	$I^2t_{\min}$ A ² s	$I^2t_{\max}$ A ² s
2	1	23
4	6,25	90,25
6	24	225
8	49	420
10	100	576
12	160	750

A_2 Text deleted A_2

A_2 The maximum operating I^2t values are given in Table 107 for the stated test value. A_2

Table 107 – Maximum operating I^2t values for "aM" fuse-links

Rated voltage U_n V a.c.	$I^2t_{\max}$ A ² s
$U_n \leq 400$	$18 I_n^2$
$400 < U_n \leq 500$	$24 I_n^2$
$500 < U_n \leq 690$	$35 I_n^2$
NOTE For a voltage of 230 V a.c. the maximum operating I^2t value is $12 I_n^2$	

These values apply for the prospective currents corresponding to pre-arcing times less than 0,01 s.

7.8 Overcurrent discrimination of fuse-links

gG fuse-links in series with rated current ratio of 1:1,6 and rated currents 16 A and above have to discriminate up to the values specified in 8.7.4.

With regard to discrimination when circuit-breakers are used, the following I^2t values in Table 108 shall be followed.

Table 108 – Pre-arcing I^2t values for discrimination of gG fuse-links

I_n A	I^2t_{min} A ² s	at I_p A
16	250	500
20	450	670
25	810	900
32	1 400	1 180
40	2 500	1 580
50	4 000	2 000
63	6 300	2 510
80	10 000	3 160
100	16 000	4 000
125	24 000	4 900
160	42 500	6 520
200	78 000	8 830

7.9 Protection against electric shock

The protection against electric shock can be increased by means of partition walls and covers of the fuse-contacts.

Operation of the fuse-links is considered safe when carried out by authorized persons, instructed in electrical matters, using replacement handles according to this fuse system or linked fuse-carriers. Insulating covers and/or phase separators may be used where applicable.

8 Tests

IEC 60269-1 applies with the following supplementary requirements.

8.1.4 Arrangement of the fuse and dimensions

The requirements of 7.2 are verified on fuse-bases. The fuse-bases are connected to conductors having the minimum and maximum cross-sections of the range as given in Table 105.

In the case of isolated metal gripping-lugs, the creepage distances and clearances of the fuse-link according to 7.2 are verified. The clearances are also verified on a fuse-link inserted into a A_2 reference A_2 fuse-base according to Figure 111.

8.1.6 Testing of fuse-holders

In addition to the test given in IEC 60269-1, the fuse-holders shall be subjected to the tests according to Table 109.

Table 109 – Survey of tests on fuse-holders and number of fuse-holders to be tested

Test according to subclause		Number of fuse-holders				
		3	1	1	1	5
8.5.5.1	Verification of the peak withstand current of a fuse-base		X	X		
8.9	Verification of resistance to heat				X	
8.10.1.2	Direct terminal clamps					X
8.11.1.2	Mechanical strength of the fuse-base	X				
8.11.2.4	Non-deterioration of insulating parts of fuse-link and fuse-base	X				

8.2.2.1 Points of application of the test voltage

In addition to IEC 60269-1 the following applies:

- e) between isolated metal gripping-lugs and the terminals of the A_2 reference fuse-base A_2 .

8.2.3.2 Value of test voltage

The insulating properties of isolated metal gripping-lugs may optionally be verified by an impulse withstand voltage test. The relevant rated impulse withstand voltage is given in Table 110 with reference to the rated voltage of the fuse-link.

Table 110 – Rated impulse withstand voltage

Rated voltage V	Rated impulse withstand voltage kV
400	4
500	4
690	6

8.2.3.3 Test method

Five impulses of both polarities and of the shape 1,2/50 μ s according to IEC 60060-1 and at the rated withstand voltage level according to Table 110 are applied to the test object. The minimum period between the impulses shall be 1 s.

If not otherwise specified, the impedance of the impulse generator should not exceed 500 Ω .

NOTE See IEC 60060-1, IEC 60060-2 and IEC 60060-3 for a detailed description of the test equipment.

8.2.4 Acceptability of test results

8.2.4.3 No flash-over or puncture shall occur during the test. Partial discharges are ignored.

Fuse-links with metal gripping-lugs without electrical contact to the blade contacts which do not comply with the requirements of 7.2 are not considered as isolated in service. They need, however, to fulfil the requirements of 8.9.2 and 8.11.1.8.

8.2.5 Resistance to tracking

The test of insulating parts supporting live parts of the fuse-links (fuse body) and fuse-bases is carried out according to IEC 60112 using test solution A. Five specimens shall be tested and shall pass at PTI 400. Ceramic isolators need not to be tested.

8.3 Verification of temperature rise and power dissipation

8.3.1 A_2 Arrangement of the fuse and dimensions A_2

If the manufacturer specifies values of torque, they shall be used for the tests of 8.3 and 8.10. If not, the screws or nuts of the terminals shall be fastened in accordance with Table 111.

In case the test arrangement contains more than one fuse, the test specimens are mounted in the conventional service position on a wooden plate or other insulating material at a distance between centre lines of 3 times e_2 according to Figure 101.

Copper bars as used for 500 A to A_2 1 600 A test currents shall be A_2 painted mat black.

Table 111 – Torque to be applied to the terminal screws

A_2 I_n A	Size	Size of screws	Torque Nm
160	000	M 8	10
160	00	M 8	10
250	1	M 10	32
400	2	M 10/12	32/40
630	3	M 10/12	32/40
1 250	4	M 12	40
1 600	4a	2 $\times$ M 12 or 1 $\times$ M16	40 56 A_2

8.3.2 Measurement of the temperature rise

Protective covers and fuse-carriers as provided by the manufacturer shall be mounted.

8.3.4.1 Temperature rise of the fuse-holder

The dummy is given in Figure 105. The point at which the temperature rise is measured is marked with E in Figure 106.

8.3.4.2 Power dissipation of a fuse-link

The points between which the power dissipation of a fuse-link is measured are marked with S in Figure 106.

8.4.3.1 Verification of conventional non-fusing and fusing current

In the case where the non-fusing current test is also used for the verification of the time current characteristic, a second test specimen shall be used for b) I_{A2} (see Table 11 – Survey of complete tests on fuse-links and number of fuse-links to be tested of IEC 60269-1:2024) I_{A2} .

8.4.3.5 Conventional cable overload protection test (for "gG" fuse-links only)

NOTE The tests in IEC 60269-1 are deemed to give satisfactory results at $1,45 I_n$ in typical three-phase applications at an ambient temperature of 30 °C. A special test can be required by some countries to prove that fuses and miniature circuit-breakers (MCBs) are equivalent protective devices. Details of the special test are given in Annex AA.

8.5.5 Test method

Subclause 8.5.5 of IEC 60269-1 applies with the following additions.

8.5.5.1 Verification of the peak withstand current of a fuse-base

The verification of the peak withstand current of a fuse-base need not be carried out, if this has already been verified during the breaking capacity test of the fuse-links with the highest rating of the size.

8.5.5.1.1 Arrangement of the fuse

The test shall be of the single-phase type. The test set-up for the fuse-base shall be in line with 8.5.1 of IEC 60269-1.

The current shall be limited by a fuse-link of the highest rating for the particular size. The peak values of the test currents attained shall lie in the ranges shown in Table 112.

Table 112 – Test currents

I_{A2} Size	Cut-off current kA
000	22...24
00	22...24
1	34...37
2	44...48
3	65...70 I_{A2}

The maximum values may be exceeded as long as the requirements stated under 8.5.5.1.3 are met.

If the cut-off current range cannot be attained with the highest rating of the size, correspondingly higher series connected fuse shall be used. In this case the test specimen shall be equipped with a dummy fuse-link. Its external dimensions correspond to the dimensions given in Figure 101.

8.5.5.1.2 Test method

The test shall be performed on two fuse-bases. In the case of fuse-base no. 1, a hardened and polished test knife of steel, shown in Figure 107, shall be inserted by hand in order to open up the contacts to a certain extent. The purpose of this test is to ensure that the resilient spring travel is limited to the elastic range. The contacts shall be opened up three times. This test will be dispensed with if a mechanical stop limits the gap to less than 7 mm so that the test blade cannot be correctly fitted by hand. Fuse-base no. 2 is tested in accordance with 8.11.1.2. The values of $F_{\max}$ according to Table 118 shall be adhered to. After these pre-tests the above-mentioned current test shall be performed.

8.5.5.1.3 Acceptability of test results

The fuse-links shall not be ejected. There shall be no signs of arcing or welding or other damage likely to prevent further use of the fuse-bases. Pitting marks on the contacts are permissible. ^{A2} The fuse or the circuit-breaker of the source shall not operate. ^{A2}

^{A2} Text deleted ^{A2}

8.7.4 ^{A2} Verification of overcurrent selectivity ^{A2}

The overcurrent discrimination for fuses with rated current up to 12 A and the overcurrent discrimination ratio of 1:1,6 for fuses with rated currents higher than 12 A is verified by the I^2t values evaluated from the recorded test results.

^{A2} The samples are arranged as for the breaking capacity tests according to 8.5. Regarding the power factor Table 20, Test No.2, of IEC 60269-1:2024 applies.

The tolerances for prospective currents for minimum pre-arcing I^2t and maximum operating I^2t tests are $\pm 5\%$. ^{A2}

Four samples are tested, two samples are tested at the r.m.s. prospective test current I , corresponding to the minimum pre-arcing I^2t values, the other samples at the r.m.s. prospective test current I , corresponding to the operating I^2t values.

The test voltage for all fuses is $\frac{1,1 \cdot U_n}{\sqrt{3}}$ with tolerances of $-3\% / +2\%$.

^{A2} Text deleted ^{A2}

Table 113 – Test currents and I^2t limits for selectivity test

I_n A	Minimum pre-arcing I^2t		Maximum operating I^2t		Selectivity ratio
	Prospective I RMS kA	I^2t A ² s	Prospective I RMS kA	I^2t A ² s	
2	0,013	0,67	0,064	16,4	Can be calculated
4	0,035			67,6	
6	0,064			193,6	
8	0,1	40	0,31	390	
10	0,13	67,6	0,4	640	
12	0,18	130	0,45	820	
13	0,18	190	0,55	950	1:1,6 $\sqrt[4]{A_2}$
16	0,27	291	0,55	1 210	
20	0,4	640	0,79	2 500	
25	0,55	1 210	1	4 000	
32	0,79	2 500	1,2	5 750	
35	0,79	3 000	1,5	7 000	
40	1	4 000	1,5	9 000	
50	1,2	5 750	1,85	13 700	
63	1,5	9 000	2,3	21 200	
80	1,85	13 700	3	36 000	
100	2,3	21 200	4	64 000	
125	3	36 000	5,1	104 000	
160	4	64 000	6,8	185 000	
200	5,1	104 000	8,7	302 000	
224	5,9	139 000	10,2	412 000	
250	6,8	185 000	11,8	557 000	
300	8,7	302 000	15	900 000	
315	8,7	302 000	15	900 000	
355	10,2	412 000	20	1 200 000	
400	11,8	557 000	20	1 600 000	
425	11,8	650 000	26	1 900 000	
500	15	900 000	26	2 700 000	
630	20	1 600 000	37	5 470 000	
800	26	2 700 000	50	10 000 000	
1 000	37	5 470 000	66	17 400 000	
1 250	50	10 000 000	90	33 100 000	
1 600	66	17 400 000	120	50 000 000	

The evaluated I^2t values shall lie within the corresponding I^2t limits specified in Table 113.

8.9 Verification of resistance to heat

These tests apply to fuse-links and fuse-bases.

Fuse-holders fitted with fuse-links having the maximum power dissipation corresponding to the acceptable power dissipation of the fuse-holder shall be cyclically loaded as pre-treatment. The pre-treatment is specified in 8.4.3.2 of IEC 60269-1. After cooling to normal temperature the breaking capacity shall be tested at I_1 in accordance with 8.5 of IEC 60269-1.

Fuse-links containing organic material in the body or filler shall be subjected to the same test as described above. These fuse-links shall interrupt the test currents I_1 and I_5 .

8.9.1 Fuse-base

The test given below should be applied if it is not obvious that the components are not affected adversely by the given temperature and withdrawal forces.

8.9.1.1 Test arrangement

A dummy fuse-link according to Figure 105 is fitted into a fuse-base and also suspended from a measuring device as shown, for example, in Figure 108. The manner in which the dummy is fitted and secured (for example, by locking pins), in fuse-bases shall ensure that heat dissipation is not seriously affected. The conductor cross-section depends upon the rated current (see IEC 60269-1, Table 17), and the connections outside the heating chamber shall be at least 1 m long. The test set-up is installed in such a heating chamber or below a heatable cowl of at least 50 l capacity, care being taken to see that the bushings etc. for the measuring facility and connections are suitably sealed. The heaters shall be such as to ensure that during the test sequence described below a temperature of (80^{+5}_0) °C is maintained with or without the test current, the temperature being measured at a horizontal distance of 150 mm from the dummy centre point.

8.9.1.2 Test method

The temperature in the heating chamber is raised to (80^{+5}_0) °C, and maintained for 2 h. The dummy is then loaded with approximately 160 % rated current with a tolerance of ± 2 % for 2 h. The test may be carried out at reduced voltage.

After loading and 3 min after switching off, a tensile force $F_{\max}$ (see Table 118) is applied smoothly to the dummy. The force $F_{\max}$ is exerted for a period of 15 s.

8.9.1.3 Acceptability of test results

After this test the contact pieces of the fuse-base shall not have moved to such an extent as to affect the further use of the fuse-base. After pulling out of the dummy the dimensions of Figure 102 are to be considered. The insulating mounting part of the fuse-base shall neither be broken nor shall it show any signs of cracks.

8.9.2 Fuse-links with gripping-lugs of moulded material or of metal fixed in moulded material

8.9.2.1 Test arrangement

A fuse-link of the highest rating for a size is fitted into a fuse-base; it shall be arrested there and also suspended from a measuring device as shown in Figure 108.

8.9.2.2 Test method

The temperature in the heating chamber is raised to (80^{+5}_0) °C and maintained for 2 h. The fuse-link is then loaded with 150 % rated current until it operates, but the test is restricted to the conventional time. A reduced test voltage may be used. Three minutes after the fuse-link has operated or the conventional testing time has expired, a tensile force $F_{\max}$ (see

Table 118) is applied smoothly to the gripping-lugs. The force is exerted for a period of about 15 s.

8.9.2.3 Acceptability of test results

The gripping-lugs shall remain fully operational, and the length of the neck ($2,5^{+0,5}_0$) mm in particular shall not be exceeded by more than 2 mm, in keeping with the dimensions d of Figure 101. The same applies to the maximum values of dimension c_2 .

8.10 Verification of non-deterioration of contacts

8.10.1 Arrangement of the fuse

The dummy fuse-link is given in Figure 105. The dummy fuse-link shown with silver-plated blade contacts is representative for fuse-links with silver-plated blade contacts. If the non-deterioration test proves that a surface plating of the blade contacts of a fuse-link other than silver fulfils the requirements, then the surface of the blade contacts of the dummy fuse-link shall be plated accordingly.

For lug terminals, the torques are given in Table 111.

The insulation of the conductors shall be removed over the whole length. All covers of contacts and terminals shall be removed for this test only.

8.10.1.1 Contacts

Subclause 8.10.1 of IEC 60269-1 applies.

8.10.1.2 Direct terminal clamps

Subclause 8.10.1 of IEC 60269-1 applies with the following additions:

The test shall be performed on 10 direct terminal clamps of five fuse-bases.

The test arrangement shall be as follows: the fuse-bases shall be mounted in a vertical position, side by side with a distance between the fuse-base centres of at least three times e_2 , shown in Figure 101. The test of direct terminal clamps which can be used for copper as well as aluminium conductors shall be made with aluminium conductors.

If there is no information given by the manufacturer, the screws of the direct terminal clamps shall be tightened with a torque according to Table 114.

NOTE 1 The torques are based on a friction coefficient of $\mu = 0,12$ for thread and head of the screw and a maximum elongation of $R_{p0,2}$ according to ISO 898-1. The shaft of the screws will be stressed up to 90 % of these values during tightening. The torques are based on class 5.6 screws.

NOTE 2 Torques for lug terminals are given in Table 111.

Table 114 – Torques to be applied when no values are given by the manufacturer

Thread	Torque Nm
M5	2,6
M6	4,5
M8	11
M10	21
M12	38

Direct terminal clamps only for copper conductors are tested like direct terminal clamps for aluminium with the exception that cleaning and storage are not necessary. Furthermore, for copper clamps, the test can be part of the test of contacts. If the requirements for the contacts after 250 cycles (see 8.10.2.1) are met, the clamps for copper have satisfied this requirement.

The conductor cross-section depends upon the rated current (for copper conductors see Table 17 of IEC 60269-1).

The relevant cross-sections for aluminium conductors are given in Table 115.

Table 115 – Cross-sectional area of aluminium conductors for tests corresponding to 8.10

Rated current A	Cross-sectional area mm ²
40	25
50	25
63	35
80	50
100	70
125	95
160	95
200	150
250	185
315	240
400	300

In case of insulation piercing clamping units, only the insulation outside the clamping area will be removed.

The contact area of six conductors shall be prepared as follows.

The conductors shall be cleaned with a suitable abrasive and connected within a time not greater than 5 min.

The remaining four conductors, after removing only the insulation and the grease, shall be stored indoors for 14 days. These uncleaned conductors shall not be treated before being connected.

The bolts of the clamps shall be fixed as stated by the manufacturer. A readjustment of the bolts during the tests is not allowed.

For stranded aluminium conductors, it shall be ensured that the test current goes into the cross-section as equally as possible. This can be achieved by welding or compressing the conductor in the middle of its length.

8.10.2 Test method

A test cycle consists of a load period and a no-load period referred to as the conventional time. The test currents for the load period and the no-load period are specified as follows.

Test current: conventional non-fusing current I_{nf}

Load period: 25 % of the conventional time see Table 2 of IEC 60269-1

No-load period: 10 % of the conventional time

A test voltage lower than the rated voltage may be used.

During the no-load period the samples are cooled down to a temperature lower than 35 °C; additional cooling (for example, a fan) is allowed.

The temperature rise is measured in accordance with 8.10.2 of IEC 60269-1 at rated current.

The voltage drop shall be measured after 50 cycles and 250 cycles and, if necessary, after 500 cycles and 750 cycles.

The voltage drop is measured at direct current of $I_m = (0,05 \text{ to } 0,20) I_{nf}$. ^{A2} However, the measuring current I_m ^{A2} shall be chosen so as to give a voltage drop of at least 100 µV. If it is necessary, the upper limit of I_m may be increased to $0,30 I_{nf}$.

The tolerance of I_m during the measurement shall not be greater than $^{+1}_0$ %.

The voltage drop shall be changed into the resistance of the contacts. Before measurement, the sample shall be cooled down to room temperature. If the room temperature T during the measurement deviates from 20 °C, the following formula may be applied:

$$R_{20} = \frac{R_T}{1 + \alpha_{20}(T - 20)}$$

The relevant coefficient α_{20} according to the conductor material (aluminium or copper) shall be used.

8.10.2.1 Contacts

The points between which the voltage drop is measured are marked as A and B in Figure 106.

At the conclusion of the test after 250 cycles and 750 cycles, the withdrawal forces are measured. For this purpose a hardened and polished steel test knife as shown in Figure 107 shall be inserted in order, if possible, to open the contacts up, to a certain extent (see 8.5.5.1.2).

Afterwards, the withdrawal forces are measured with a test link made of hardened steel as described in 8.11.1.2. The test link is inserted three times in the fuse-base. The withdrawal forces shall be within the limits of Table 118. If the measured values are too low, the dynamic test in accordance with 8.5.5.1 shall be performed.

8.10.2.2 Direct terminal clamps

The points between which the voltage drop ΔU of the test sample is measured are given in Figure 110. The point of measurement on the conductor F shall be a centre punch point where solid conductors are concerned or a bare wire wrapped around stranded conductors. For aluminium conductors, special precautions shall be implemented by use, for example, of a welded equalizer (the aluminium cable is cut; the conductors of each part are welded together, then the two parts are welded and the measure can be carried out in a hole drilled in a welded part).

Additionally, for aluminium conductors the voltage drop before starting the cycle test shall be measured. In any case for aluminium conductors, the test shall be performed for 750 cycles.

The test sequence for all types of conductors (aluminium and copper) is given in Table 116.

Table 116 – Test sequence for direct terminal clamps

Verification of temperature rise at I_n
Measurement of $R_{cl\ 0}$
50 cycles
Measurement of $R_{cl\ 50}$
200 cycles
Measurement of $R_{cl\ 250}$
Verification of temperature rise at I_n
250 cycles
Measurement of $R_{cl\ 500}$
250 cycles
Measurement of $R_{cl\ 750}$
Verification of temperature rise at I_n

At the end of the cycle test, the verification of the temperature rise shall be performed in accordance with 8.3.4.1. The conductor with removed insulation used for the cycle test remains fastened. The point F at which the temperature rise is measured on the conductor is at a distance of 10 mm from the clamp (see Figure 110).

8.10.3 Acceptability of test results

The permissible changes given are based on laboratory experience. The final criterion shall be met; it is not the summation of the intermediate criteria.