

Australian/New Zealand Standard™

Low-voltage fuses

Part 3.1: Supplementary requirements
for fuses for use by unskilled persons
(fuses mainly for household and similar
applications)
Sections I-IV: Examples of types of
standardized fuses



AS/NZS 60269.3.1:2002

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-007, Power Switchgear to supersede AS 2005.30—1991, when used in conjunction with AS/NZS 60269.3.0.

AS/NZS 60269.3.0:2000 provides generic supplementary requirements to those stated in AS/NZS 60269.1:2000 for fuses for use by unskilled persons.

The objective of this Standard is to provide specific examples of the application of these supplementary requirements stated in AS/NZS 60269.3.0:2000.

This Standard is Part 3.1 of a series which, when complete, will consist of the following:

AS/NZS

60269	Low-voltage fuses
60269.1	Part 1: General requirements
60269.2.0	Part 2.0: Supplementary requirements for fuses for use by authorized persons (mainly for industrial application)
60269.2.1	Part 2.1: Supplementary requirements for fuses for use by authorized persons (mainly for industrial application)— Sections I to V: Examples of types of standardized fuses
60269.3.0	Part 3.0: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)
60269.3.1	Part 3.1: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)— Sections I to IV: Examples of types of standardized fuses (This Standard)
60269.4.0	Part 4.0: Supplementary requirements for fuse-links for the protection of semi-conductor devices
60269.4.1	Part 4.1: Supplementary requirements for fuse-links for the protection of semi-conductor devices—Section 1: Examples of types of standardized fuse-links

The requirements of this Standard do not apply to fuses manufactured to AS 3135—1997.

This Standard is identical with and has been reproduced from IEC 60269-3-1:1994, *Low-voltage fuses-Part 3-1: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)-Sections I to IV* incorporating its Amendment 1:1995 and Amendment 2:2001.

This Standard includes requirements for 240 V and 415 V cylindrical fuses type B previously contained in AS 2005.30—1991 as 240 V type I and 415 V type II fuses. Requirements for other fuse types specified in this Standard were not previously specified in the AS 2005 series.

A reference to an International Standard identified in the normative references clause by strikethrough (~~example~~) is replaced by a reference to the Australian or Australian/New Zealand Standard(s) listed immediately thereafter and identified by shading (**example**). Where the struck-through referenced document and the referenced Australian or Australian/New Zealand Standard are identical, this is indicated in parenthesis after the title of the latter.

In view of the fact that this standard should be read together with AS/NZS 60269.1, *Low-voltage Fuses, Part 1: General Requirements*, the numbering of its clauses and sub-clauses is made to correspond to the latter. Regarding the tables, their numbering also corresponds to that of AS/NZS 60269.1, however, when additional tables appear, they are referred to by capital letters, for example, Table A, Table B, etc.

The term 'informative' has been used in this Standard to define the application of the annex to which it applies. An 'informative' annex is only for information and guidance.

As this Standard is reproduced from an International Standard, the following applies:

- (a) Its number does not appear on each page of text and its identity is shown only on the cover and title page.
- (b) In the source text 'this standard' should read 'this Australian/New Zealand Standard'.
- (c) A full point should be substituted for a comma when referring to a decimal marker.

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Australian/New Zealand Standard

Low-voltage fuses

Part 3.1: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)
Sections I-IV: Examples of types of standardized fuses

Sections I to IV

EXPLANATORY NOTE In view of the fact that this standard should be read together with IEC 60269-1 and 60269-3, the numbering of its clauses and subclauses is made to correspond to the latter. Regarding the tables, their numbering also corresponds to that of IEC 60269-1: however, when additional tables appear, they are referred to by capital letters: e.g. table A, table B, etc.

1 General

Fuses for use by unskilled persons according to the following sections shall comply with all subclauses of:

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

IEC 60269-3: *Low-voltage fuses – Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)*

and shall comply with the requirements laid down in the relevant sections.

This standard is divided into four sections, each dealing with a specific example of standardized fuses:

Section I: D-type fuses (fuse-links and fuse-holders)

Section II: Cylindrical fuses:

Type A

Type B

Type C

Section III: Pin-type fuses

Section IV: Cylindrical fuse-links (primarily used in plugs)

NOTE 1 - Examples of standardized fuses complying with the requirements of IEC 60269-1 and IEC 60269-3 are listed in the present standard. Other examples may be added, provided that they comply with these requirements.

NOTE 2 - The following fuse-systems are standardized systems with respect to their safety aspects.

The National Committees may select from the examples of standardized fuses one or more systems for their own standards. Colour codes are not specified for each fuse-system. Where colour codes are indicated, they apply only to that particular fuse-system.

1.0 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60269. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60269 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

References to International Standards that are struck through in this Clause are replaced by references to equivalent Australian or Australian/New Zealand Standards that are listed immediately thereafter and identified by shading. Any Australian or Australian/New Zealand Standard that is identical to the International Standard it replaces is appropriately identified.

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

AS 1939, *Degrees of protection provided by enclosures for electrical equipment (IP Code)*
(Identical to IEC 60529:1989)

~~IEC 60269-1:1998, Low-voltage fuses—Part 1: General requirements~~

AS/NZS 60269.1, *Low-voltage fuses, Part 1: General requirements* (Identical to IEC 60269-1:1998)

~~IEC 60269-3:1987, Low-voltage fuses—Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)~~

AS/NZS 60269.3.0, *Low-voltage fuses, Part 3.0: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)* (Identical to IEC 60269-3:1987)

IEC 60664: *Insulation co-ordination for equipment within low-voltage systems*

~~IEC 60898:1987, Circuit-breakers for overcurrent protection for household and similar installations~~

AS/NZS 4898, *Approval and test specification—Circuit-breakers for overcurrent protection for household and similar installations*

IEC 60999:1990: *Connecting devices – Safety requirements for screw-type and screwless-type clamping units for electrical copper conductors*

ISO 228-1:1994, *Pipe threads where pressure-tight joints are not made on the threads – Part 1: Dimensions, tolerances and designation*

ISO 228-2:1987, *Pipe threads where pressure-tight joints are not made on the threads – Part 2: Verification by means of limit gauges*

ISO 965-1:1998, *ISO general-purpose metric screw threads – Tolerances – Part 1: Principles and basic data*

Section I – D-type fuses

1.1 Scope

The following additional requirements apply to D-type fuses. These fuses have rated currents up to and including 100 A and rated voltages of up to and including 500 V a.c. and 500 V d.c.

5 Characteristics of fuses

5.2 Rated voltage

For a.c., the standard values of rated voltages are 400 V for size DO1, DO2 and DO3¹⁾ and 500 V for size DII, DIII and DIV.

For d.c., the rated voltages are 250 V for DO1, DO2 and DO3 and 500 V for DII, DIII and DIV.

5.3.1 Rated current of the fuse-link

The rated currents of the fuse-links are given in figure 6.

5.3.2 Rated current of the fuse-holder

The rated currents of the fuse-carriers are given in figure 7. The rated currents of the fuse-bases are given in figure 8.

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

The maximum values of power dissipation of D-type fuse-links are specified in table A.

5.6 Limits of time-current characteristics

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

In addition to the limits of pre-arcing time given by the gates and the conventional times and currents, time-current zones are stated in figure 1. 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 1, including manufacturing tolerances, shall be met for all pre-arcing and operating times measured at the test voltage according to 8.7.4.

¹⁾ These three sizes are also applicable for 415 V networks.

Table A – Maximum values of power dissipation

Rated current I_n A	Maximum power dissipation W	
	DO1 – DO3	DII – DIV
2	2,5	3,3
4	1,8	2,3
6	1,8	2,3
10	2,0	2,6
13	2,2	2,8
16	2,5	3,2
20	3,0	3,5
25	3,5	4,5
35*	4,0	5,2
50	5,0	6,5
63	5,5	7,0
80	6,5	8,0
100	7,0	9,0

* In some countries, the rating of 35 A is replaced by 32 A and 40 A.

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 II.

Table II – Conventional time and current for 'gG' fuse-links

Rated current I_n A	Conventional time h	Conventional current	
		I_{nf}	I_f
2 and 4	1	$1,5 I_n$	$2,1 I_n$
6 and 10	1	$1,5 I_n$	$1,9 I_n$
$13 \leq I_n \leq 35$	1	$1,25 I_n$	$1,9 I_n$

5.6.3 Gates

For 'gG' fuse-links, in addition to the gates of IEC 60269-1, the gates given in table III apply.

Table III – Gates for specified pre-arcing times of 'gG' fuse-links with rated currents 2 A, 4 A, 6 A, 10 A and 35 A

I_n A	$I_{min.}$ (10 s) A	$I_{max.}$ (5 s) A	$I_{min.}$ (0,1 s) A	$I_{max.}$ (0,1 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
10	22,0	46,5	58,0	111,0
13	26,0	59,8	75,4	144,3
35	89,0	175,0	255,0	445,0

5.7 Breaking range and breaking capacity

5.7.2 Rated breaking capacity

Table A of IEC 60269-3 is replaced by the following values:

- not less than 50 kA a.c.
- not less than 8 kA d.c.

NOTE - D-type fuses are frequently used in a.c. installations with short-circuit currents higher than 20 kA, and also in d.c. installations. Therefore, all fuses have to comply with the requirements of this subclause.

6 Markings

Fuse-links and fuse-holders which meet the requirements and tests of this section may be marked with 'IEC 60269-3-1'. For devices according to this standard, national approvals can be awarded by national test-houses. Such national approvals may be marked on the relevant parts of the fuse. The marking shall be durable. This durability shall be proved by appropriate tests.

7 Standard conditions for construction

7.1 Mechanical design

Deviations from the dimensions specified in the standard sheets may be made, but only if they provide a technical advantage and do not adversely affect the purpose and safety of fuses complying with the standard sheets, especially with regard to interchangeability and to non-interchangeability. Fuses with such deviations shall, however, comply with all other requirements of this specification as far as they reasonably apply.

7.1.2 Connections including terminals

The terminals shall be capable of accepting the cross-sections of conductors indicated in table B.

The largest cross-sectional areas specified in table B may be reduced to 6 mm² (size DII); 16 mm² (size DIII) and 35 mm² (size DIV), provided that the fuse-base terminals are connected to internal wiring of switchboards, fuse-boxes, etc. and external conductors are consequently fitted to separate supply terminals of a type-tested or partially type-tested assembly.

7.1.3 Fuse-contacts

The fuse-contacts shall be nickel plated or protected by other materials of at least similar protective properties.

Fuse-link contacts of rated currents 50 A and above shall be silver plated with a minimum thickness of the silver layer of 3 µm.

Table B – Cross-sections of rigid (solid or stranded) or flexible copper conductors

Fuse-base		Cross-section mm ²
Size	I_n A	
DO1	16	1,5 to 4
DO2	63	1,5 to 25
DO3	100	10 to 50
DII	25	1,5 to 10
DIII	63	2,5 to 25
DIV	100	10 to 50
NOTE – This table is provisional, awaiting the results of subcommittees 17B and/or 23F.		

7.1.4 Non-interchangeability

For rated currents below 10 A non-interchangeability is not required.

7.1.5 Construction of a fuse-base

Current-carrying parts of solid copper alloy shall contain at least 50% copper and those made from rolled material at least 62% copper.

For fuse-bases of size DII and size DIII there are two types which differ with respect to the construction of the gauge-piece:

- fuse-bases for screw-in gauge rings (figure 8b)
- fuse-bases for push-in gauge rings (figure 8c)

See figures 7d, 7f, 8a, 8b, 8c and 9d.

7.1.6 Construction of a fuse-carrier

The screwed shell shall be of solid copper alloy containing at least 50% copper and those made from rolled sheet at least 62% copper. The insulating parts shall be of ceramic or other sufficiently heat-resistant material.

The hole for the voltage tester is optional.

See figures 7a, 7b, 7c, 7d and 7e.

7.1.7 Construction of a fuse-link

The fuse-link body shall be of ceramic material. Contact pieces shall be of copper or an alloy containing at least 62% copper. The colour of the fuse-indicator shall be in accordance with figure 6b.

See figures 6a and 6b.

7.1.8 Construction of a gauge-piece

The contact pieces, if any, shall be in one piece and made of copper alloy containing at least 50% copper. Their contact surfaces shall be flat and free from burrs.

The metal portion of gauge-pieces of sizes DII and DIII shall have smooth contact surfaces on both sides without burrs within the prescribed area, and both contact surfaces shall protrude from the adjacent ceramic material.

For DII, DIII and DIV-fuses, the part forming the calibration ring shall be of ceramic material. The colour of the face of the calibration ring shall be in accordance with the colour of the fuse indicator given in the table in figure 6b.

NOTE - Gauge-pieces ensure non-interchangeability. Therefore, they are so designed as to be insertable or replaceable only by special hand keys which are not available to unskilled persons.

Compliance with the requirements of the subclause is to be checked by inspection.

With respect to the two types of fuse-bases of size DII and DIII there are two types of gauge-pieces:

- screw-in gauge-pieces (figure 9b)
- push-in gauge-pieces (figure 9c).

See figures 9a, 9b, 9c and 9d.

7.2 Insulating properties

The minimum creepage distances, clearances and distances through the insulation material or sealing compound shall comply with the values given in table C.

Table C – Creepage distances, clearances and distances through sealing compound

Creepage distance mm	DII – DIV	DO1 – DO3
Between metal parts, including contacts, which are of different polarity when the fuse-link has operated	5	4
Between live parts and accessible metal parts, including fuse-base fixing screws or metallic fixing means for rail mounting, with a fuse-carrier, a fuse-link and a gauge-piece in position	5	3
Between live parts and cover-fixing screws or metallic fixing means for rail mounting which are not earthed and not accessible to the standard test finger	3	2
Clearance mm	DII – DIV	DO1 – DO3
Between metal parts, including contacts, which are of different polarity when the fuse-link has operated	5	3
Between live parts and accessible metal parts, including fuse-base fixing screws or metallic fixing means for rail mounting, with a fuse-carrier, a fuse-link and a gauge-piece in position	5	3
Between live parts and cover-fixing screws or metallic fixing means for rail mounting which are not earthed and not accessible to the standard test finger	3	2
Distance mm	DII – DIV	DO1 – DO3
Between live parts and the surface on which a fuse-base for front connection is mounted	10	6
Through sealing compound between live parts covered with at least 2,5 mm of sealing compound and the surface on which a fuse-base for front connection is mounted	5	3
NOTE 1 - The standard test finger referred to in the above table is that specified in IEC 60529.		
NOTE 2 - Pending the results of sub-committee 17B, technical committee 23 and sub-committee 28A, the table is provisional.		

7.3 Temperature rise, power dissipation of the fuse-link and power acceptance of the fuse-holder

Instead of table 4 of IEC 60269-1, table IV of IEC 60269-3 applies.

7.7 I^2t characteristics

7.7.1 Pre-arcing I^2t values

In addition to table 6 of IEC 60269-1, the following pre-arcing I^2t values apply:

Table VI – Pre-arcing I^2t values at 0,01 s for 'gG' fuse-links

I_n A	I^2t_{min} A^2s	I^2t_{max} A^2s
2	1,0	23,0
4	6,2	90,2
6	24,0	225,0
10	100,0	676,0
13	170,0	900,0
35	2 250,0	8 000,0

7.7.2 Operating I^2t values

The maximum pre-arcing I^2t values given in table 6 of this standard and of IEC 60269-1 shall be taken as maximum operating I^2t values and shall be verified by the breaking capacity test specified in 8.7.1 of IEC 60269-1.

7.8 Overcurrent discrimination of 'gG' fuse-links

Fuse-links 16 A and above in series, with the rated current ratio of 1:1,6 have to operate selectively in the whole breaking range (see 8.7.4).

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

I_n A	I^2t_{min} A^2s	I_p A
16	250	500
20	450	670
25	810	900
35	2 000	1 410
50	4 000	2 000
63	6 300	2 510
80	10 000	3 160
100	16 000	4 000

7.9 Protection against electric shock

For D-type fuses, the operation of replacing a fuse-link is considered in two stages which are: 'removing the fuse-link and the fuse-carrier' and 'fuse-link and fuse-carrier removed'. The first stage is considered to represent D-type fuses under normal service conditions. Only when the fuse-link and the fuse-carrier are removed, the degree of protection may temporarily be reduced to IP1X.

NOTE - The temporary suspension of the complete protection 'IP2X' against electric shock (after many years of sufficiently safe application of the D-type fuse-system by unskilled users) need not be regarded as dangerous, as there is enough experience with interchanging of incandescent lamps, where comparable degrees of safety exist.

8 Tests

8.1.4 Arrangement of the fuse and dimensions

The thickness of the screwed shell of fuse-bases and fuse-carriers is measured by means of a micrometer with pointed noses. The mean values of two sets of three measurements shall be at least equal to the value specified in figures 7a to 7c and 8a to 8c.

The two sets of measurements are made on one of two different longitudinal lines which are at least 30° displaced with respect to each other.

Generally, the three measurements along the longitudinal line are equally distributed over this, if possible, at the most unfavourable points.

For rolled thread, one of the measurements is made at the top, one at the bottom of the thread and the remaining one between these as one likes.

For fuse-carriers the measurements are made at the part of the screwed shell which protrudes from the insulator.

For fuse-bases no measurement is made in the first course of the thread.

8.1.5.1 Complete tests

The following additional tests are required according to tables VII and D.

Table VII – Survey of tests on fuse-links

Test according to subclause		Number of test samples					
		3	4	1	1	2	1
8.4.3.2	Verification of rated current	x					
8.7.4	Verification discrimination		x				
8.11.1	Mechanical strength			x	x		
8.11.2.4	Heat storage at elevated temperature					x	x
8.11.2.6	Dimensions and non-interchangeability	x	x				

Table D – Survey of tests on fuse-bases, fuse-carriers and gauge-pieces

Test according to subclause		Number of test samples									
		Fuse-bases				Fuse-carriers					Gauge-pieces
		1	1	3	1	1	1	1	3	1	1
8.9	Verification of resistance to heat	x				x					
8.11.1	Mechanical strength		x				x	x			x
8.11.2.4	Heat storage at elevated temperature			x	x				x	x	
8.11.2.6	Dimensions and non-interchangeability									x	x

8.1.5.2 Testing of fuse-links of a homogeneous series

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

Fuse-links having different contact parts and different shapes of ceramic bodies only intended to provide non-interchangeability and not affecting the performance may be considered to meet the requirements of a homogeneous series.

8.2 Verification of insulating properties

8.2.1 Arrangement of the fuse-holder

The metal covering (can be aluminium foil) shall not be pressed on to the inspection window. For fuse-carriers, for example, a distance of 3 mm from the outer lower edge of the insulating part shall be left uncovered by metal covering.

8.2.4.1 This test shall be performed immediately after the humidity treatment described in 8.2.4.2 of IEC 60269-1. The fuse-holder shall be submitted to the test voltage given in table 9 of IEC 60269-1.

8.2.6 Creepage distances, clearances and distances through sealing compound

8.2.6.1 Test method

Creepage distances, clearances and distances are measured on the complete fuse, first using conductors with the smallest cross-sectional areas specified in table B, and then the largest.

NOTE - The contribution to the creepage distance of any groove less than 1 mm wide is limited to its width. Any air gap less than 1 mm wide is ignored in computing the total clearance.

8.2.6.2 Acceptability of test results

Creepage distances, clearances and distances shall not be less than the values in millimetres in table C.

8.3 Verification of temperature rise and power dissipation

8.3.1 Arrangement of the fuse

The fuse-carrier shall be inserted with a torque as indicated in table E.

Table E – Test torque for verification of temperature rise and power dissipation

Size	Torque Nm
DO1	1,0
DO2	1,0
DO3	1,7
DII	2,7
DIII	4,3
DIV	6,7

The torque applied to the screws of the terminals is two thirds of the values given in table C of IEC 60269-3.

8.3.3 Measurement of the power dissipation of the fuse-link

The power dissipation shall be measured between the endcaps of the fuse-link (see figure 5b).

8.3.4.1 Temperature rise of the fuse-holder

The test shall be made with a dummy fuse-link as specified in figure 2 for the rated current of the fuse-holder (see figure 5b).

8.3.5 Acceptability of test results

For terminals, the temperature rise limits, when the fuse-base is fitted with conductors having a cross-section as indicated in table 10, 8.3 of IEC 60269-1 for the corresponding rated current of the fuse-base, shall comply with table IV of IEC 60269-3.

The power dissipation of the fuse-link shall not exceed the values specified in table G.

8.4.3.1 Verification of conventional non-fusing and fusing current

This test will be performed using a test rig as shown in figure 3.

8.4.3.2 Verification of rated current of fuse-links

Three fuse-links are subjected to 100 operating cycles, each cycle comprising a period of 1 h during which the test current flows and a period of 15 min without the current flowing.

The test current of $1,2 I_n \pm 2,5\%$ applies only for fuse-links with rated current < 16 A. For fuse links with rated current ≥ 16 A these requirements are deemed to be met by test of 8.4.3.2 of IEC 60269-1, with the exception that three samples are tested.

During these cycles, the fuse-links shall not operate. They are allowed to cool down to approximately room temperature and are then loaded with a current equal to 0,9 times I_{nf} shown in table 2 of IEC 60269-1 and this standard. The fuse-links shall not operate within the conventional time shown in table 2 of IEC 60269-1 and table II of this standard.

After the fuses have been allowed to cool down to approximately room temperature, they are loaded with I_f . The fuse-links shall operate within the conventional time.

8.4.3.5 Conventional cable overload protection

The test procedure described under 8.4.3.5 of IEC 60269-1 is not valid for fuses <16A.

NOTE - (for gG fuses only) – The tests in IEC 60269-1 are deemed to give satisfactory results at $1,45 I_n$ in typical applications at an ambient temperature of 30 °C. A special test may be required by some countries to prove that fuses and MCBs are equivalent protective devices. Details of the special test are given in annex A of this standard.

8.4.3.6 Operation of indicating devices and strikers, if any

In addition to IEC 60269-1 concerning indicating devices, the following applies:

If the test is performed at reduced voltages, the test circuit voltage shall be $100 \text{ V} \pm 5 \text{ V}$ and the test current shall be $2 \times I_f + 20\%$.

8.5.2 Characteristics of the test circuit

For the test with d.c. current, table 12B of IEC 60269-1 applies, with the following exception.

Test according to 8.5.5.1

	No. 1	No. 2	No. 3	No. 4	No. 5
Time constant	15 ms ⁺⁵ ₀ ms *		≤3 ms		
* The above-mentioned time-constant is within the limits given in IEC 60269-1.					

8.5.8 Acceptability of test results

In addition to 8.5.8 of IEC 60269-1, the following applies:

After this test, the endcaps of the fuse-links may have small holes, blisters, spots and localized bulging as long as the gauge-piece and the fuse-carrier are not damaged.

8.7.4 Verification of overcurrent discrimination

The samples are arranged as for breaking-capacity test according to 8.5 of IEC 60269-1.

Two samples are tested at the current $I_{\min}$, and two others at the current $I_{\max}$. The current values are given in table F.

The a.c. test voltage is: $\frac{1,1 \times U_n}{\sqrt{3}}$

The other characteristics of the test circuit are the same as for the breaking-capacity test No. 2 (see table 12A of IEC 60269-1).

The evaluated I^2t values shall meet the I^2t limits specified in table F.

Table F – Test currents and I^2t limits for the discrimination test

Minimum pre-arcing I^2t value			Operating I^2t value		Selectivity ratio
I_n A	Prospective I_{min} kA r.m.s	I^2t_{min} A ² s	Prospective I_{max} kA r.m.s.	I^2t_{max} A ² s	
2	0,013	0,67	0,064	16,4	
4	0,035	4,90	0,130	67,6	
6	0,064	16,40	0,220	193,6	
10	0,130	67,60	0,400	640,0	
13	0,200	160,0	0,480	922,0	
16	0,270	291,00	0,550	1 210,0	1:1,6
20	0,400	640,00	0,790	2 500,0	
25	0,550	1 210,00	1,000	4 000,0	
32	0,790	2 500,00	1,200	5 750,0	
35	0,870	3 030,00	1,300	6 750,0	
40	1,000	4 000,00	1,500	9 000,0	
50	1,200	5 750,00	1,850	13 700,0	
63	1,500	9 000,00	2,300	21 200,0	
80	1,850	13 700,00	3,000	36 000,0	
100	2,300	21 200,00	4,000	64 000,0	

The pre-arcing I^2t values measured at the test current I_{min} shall be higher than the I^2t value, specified in column 3 of table F. The operating I^2t values measured at the test current I_{max} shall be lower than I^2t values specified in column 5 of table F.

8.9 Verification of resistance to heat

8.9.1 Fuse-base

The test is carried out only on fuse-bases of non-ceramic insulating material.

8.9.1.1 Test arrangement

The fuse-base to be tested is fitted with a dummy fuse-link according to figure 2, whose power dissipation at test current lies within the limits indicated in table G.

The torque applied to the fuse-carrier shall be two-thirds of the torque specified in table H. The cross-sectional area of the conductors connected depends on the maximum rated current of the largest fuse-link to be inserted in the fuse-base (see IEC 60269-1, table 10).

Table G – Power dissipation of a dummy fuse-link at rated and conventional fusing currents including tolerances

Size	DO1	DO2	DO3	DII	DIII	DIV
Power dissipation at I_n W	2,5	5,5	7,0	4,0	7,0	9,0
Power dissipation at test current I_f^* W	6,7	14,1	17,9	10,3	17,9	23,0
Force applied to the dummy fuse-link N	35,0	50,0	75,0	50,0	75,0	110,0
* For these values a tolerance of $\pm 3\%$ applies.						

The fuse is placed in a test arrangement according to figure 4 and placed in a heating chamber, the conductors emerging from the cabinet are sealed. The length of the connected conductors shall be at least 1 m outside the heating chamber. The heating chamber must be such that during the test, the air temperature is kept at $80^{\circ}\text{C} \pm 5^{\circ}\text{C}$, measured in the plane of the sample at a distance of approximately 15 cm.

8.9.1.2 Test method

The air temperature in the heating chamber is raised to $80^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and is maintained for 2 h. Immediately afterwards, but while maintaining the temperature of the heating chamber, the sample is loaded with a test current corresponding to approximately I_f . At this test current the power dissipation of the dummy fuse-link shall lie within the limits indicated in table G. The current shall be kept constant during the whole test duration of 2 h. At the end of the test, a weight is applied straight and not jerkily at position 4 (see figure 4), which (taking into account the lever-arm relations) generates along arrow G a force according to table G on the dummy fuse-link. For applying the force, the inspection window has to be removed. The sample may be connected to a reduced voltage source ($\geq 42\text{ V}$).

8.9.1.3 Acceptability of test results

After applying the force, a current shall continue to flow through the sample. The force is maintained for 15 min and the current shall continue to flow unchanged through the sample. Furthermore, after this test, the fuse-base shall not show any damage impairing its further use.

8.9.2 Fuse-carrier

8.9.2.1 Test arrangement

A fuse-base shall be mounted on a 15 mm thick plywood board. The arrangement shall be the same as in normal use. The fuse-base is fitted with a dummy fuse-link according to figure 2. The cross-sectional area of conductors depends on the rated current of the fuse-base (see IEC 60269-1, table 10). The length of the conductors shall be at least 1 m outside the heating chamber in which the test arrangement is to be placed.

The torque applied to the fuse-carrier shall correspond to table H. For tightening and later loosening of the fuse-carrier, a nut is used, the interior form of which enables a tight connection to the insulated part of the fuse-carrier. The nut is tightened with a torque wrench with a square-section shank – as is usual in service – (see figure 5a). The nut and the described test device shall be placed in the above-mentioned heating chamber.

8.9.2.2 Test method

The air temperature in the heating chamber is raised to $80^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and maintained for 2 h. Immediately afterwards, the fuse is loaded with a test current, corresponding to approximately I_f , for 2 h and the test current must be adjusted in such a way that the power dissipation of the dummy fuse-link lies within the limits indicated in table G.

The test current shall be kept constant during the 2 h test. Immediately after the opening of the test chamber, the nut heated up during the test is fitted to the torque wrench, and with this torque wrench, the fuse-carrier is loosened twice and tightened again.

8.9.2.3 Acceptability of test results

After this test, the fuse-carrier shall show no damage impairing its further use; especially, the insulating material shall not show any fissures or inadmissible shrinkage.

8.10 Verification of non-deterioration of contacts

Subclause 8.10 of IEC 60269-1 applies.

8.10.1 Arrangement of the fuse

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

The dummy fuse-link is given in figure 2 of this standard.

Torques to be applied to the fuse carrier are equal to 40% of the values given in table H.

8.10.2 Test method

The following wording is added after the first paragraph of 8.10.2 in IEC 60269-1:

The test-current is the conventional non-fusing current.

The load period is 75% of the conventional time.

The non-load period is 25% of the conventional time.

The conventional time, as well as the non-fusing current, are stated in table 2 of IEC 60269-1. 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 (e.g. a fan) is allowed.

The third paragraph of 8.10.2 in IEC 60269-1 is replaced by the following wording:

Before the beginning of the cycling test, the temperature rise of the contacts shall be measured at rated current when steady-state conditions have been obtained. The measurement shall be repeated after 250 cycles and, if necessary, after 750 cycles.

The voltage drop of the contacts is measured after 50, 250 and 750 cycles at direct current of $I_m = (0,05 \text{ to } 0,30) I_n$. However, the current I_m has to be chosen as to give a voltage drop of at least 100 µV.

The tolerance of I_m during the measurement shall not be greater than $^{+10}_0\%$. The points between which the voltage drop is measured are marked A, B, C and D in figure 5b.

The resistance of the contact is then determined on the basis of the voltage drop. Before measurement, the sample has to be cooled down to room temperature. If the room temperature during the measurement deviates from 20 °C, the following formula may be applied:

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

where

R_{20} is the resistance at temperature 20 °C;

R_T is the resistance at temperature T ;

α_{20} is the temperature coefficient.

8.10.3 Acceptability of test results

At the end of 250 cycles (equation 1) and at the end of 750 cycles (equation 2), the following limits shall not be exceeded:

$$\frac{R_{250} - R_{50}}{R_{50}} \leq 15 \% \quad (1)$$

$$\frac{R_{750} - R_{50}}{R_{50}} \leq 40 \% \quad (2)$$

Alternatively, the temperature measured according to figure 5b can be used for verification. As measuring points, the terminating lugs of the fuse-base (figure 5b) should be chosen. In this case, the following limits shall not be exceeded:

After 250 cycles, the measured temperature rise values shall not exceed the temperature at the beginning of the test by more than 15 K and after 750 cycles, the measured temperature rise values shall not exceed the values measured at the beginning of the tests by more than 20 K.

8.11 Mechanical and miscellaneous tests

8.11.1 Mechanical strength

8.11.1.1 Mechanical strength of the gauge-piece

The following tests refer only to gauge-pieces of sizes DII and DIII (screw-in gauge-pieces).

Gauge-pieces shall be so constructed that the current-carrying parts are in one piece and that they withstand the mechanical stress occurring in normal use.

Compliance is checked by inspection and by the following tests:

The gauge-piece is screwed into a fuse-base by applying a torque of 1 Nm for 1 min. It is then withdrawn with the aid of the appropriate hand-key. In addition, an axial force of 10 N is applied in both directions between the metal part and the ceramic part of the gauge-piece. The test is made on the gauge-piece as delivered. For gauge-pieces having parts which are cemented or glued together, the test is repeated after the samples have been immersed for 24 h in water at the temperature of 20°C ±5°C, and again after the samples have been conditioned for 1 h at a temperature of 200°C ±5°C.

After these tests, the samples shall show no change impairing their future use; in particular, the thread shall not be damaged and the ceramic parts still be securely fixed to each other and shall not be detached from the metal part.

8.11.1.2 Mechanical strength of the fuse-carrier

A force of 2,5 N (fuse-carrier DO1 and DO2) and 5 N (in all other cases) is applied gently to the inspection window from the inside, using a steel rod of 6 mm diameter. The inspection window shall neither break nor be displaced during the test.

A test mandrel, having the maximum diameter of the fuse-link d_3 or d_4 as specified in figure 6a or figure 6b is inserted five times in the fuse-carrier. After this test, a fuse-link (smooth ceramic surface) with a minimum outside diameter d_3 or d_4 according to figure 6a or figure 6b shall be retained in the fuse-carrier when this is turned upside down.

8.11.1.3 Mechanical strength of the fuse-link

The fuse-links shall have adequate mechanical strength and their contacts shall be securely fixed. For compliance they shall be tested as follows:

The fuse-link is placed in the appropriate fuse-carrier complying with figure 7 which is screwed into a fuse-base complying with figure 8, a gauge-piece complying with figure 9 being in position. The gauge-piece has a diameter d_1 equal to the minimum value specified for the relevant rated current.

The torque applied to the fuse-carrier is equal to that specified in table H and the fuse-carrier is then withdrawn. The fuse-carrier is screwed in and withdrawn five times. After this test, the fuse-link shall show no damage within the meaning of this standard. It shall not be possible to remove the fuse-link endcaps by hand.

8.11.1.4 Mechanical strength of the fuse

The fuse carrier fitted with a fuse-link complying with the standards is screwed five times into the fuse-base fitted with the gauge-piece by applying a torque as given in table H and withdrawn five times. After this test, the samples shall show no change impairing their further use.

NOTE - The tests specified in 8.11.1.3 and 8.11.1.4 may be performed at the same time.

Table H – Test-torque for mechanical strength

Size	Torque Nm
DO1	1,5
DO2	1,5
DO3	2,5
DII	4,0
DIII	6,5
DIV	10,0

8.11.2.4 Resistance to storage at elevated temperature

8.11.2.4.1 Test arrangement

Three fuse-carriers and three fuse-bases shall be placed in a heating chamber at a temperature of $180^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for a period of 168 h for the test on insulating parts other than ceramics supporting current-carrying parts.

Covers shall be placed in a heating chamber at the following temperature for a period of 168 h: $100^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

A complete fuse shall be exposed for 1 h to a temperature of $150^{\circ}\text{C} \pm 5^{\circ}\text{C}$ to meet the requirements for cemented parts, sealing compound and colour markings.

8.11.2.4.2 Test method

After cooling down to room temperature the following shall be tested:

One fuse-carrier and fuse-base shall be exposed to humid atmospheric conditions as described in 8.2.4.2 of IEC 60269-1. Immediately after this treatment, the insulating properties shall be verified at a test voltage of 2,0 kV, according to 8.2.1, 8.2.2 and 8.2.4.1 of IEC 60269-1, with the exception of table 9.

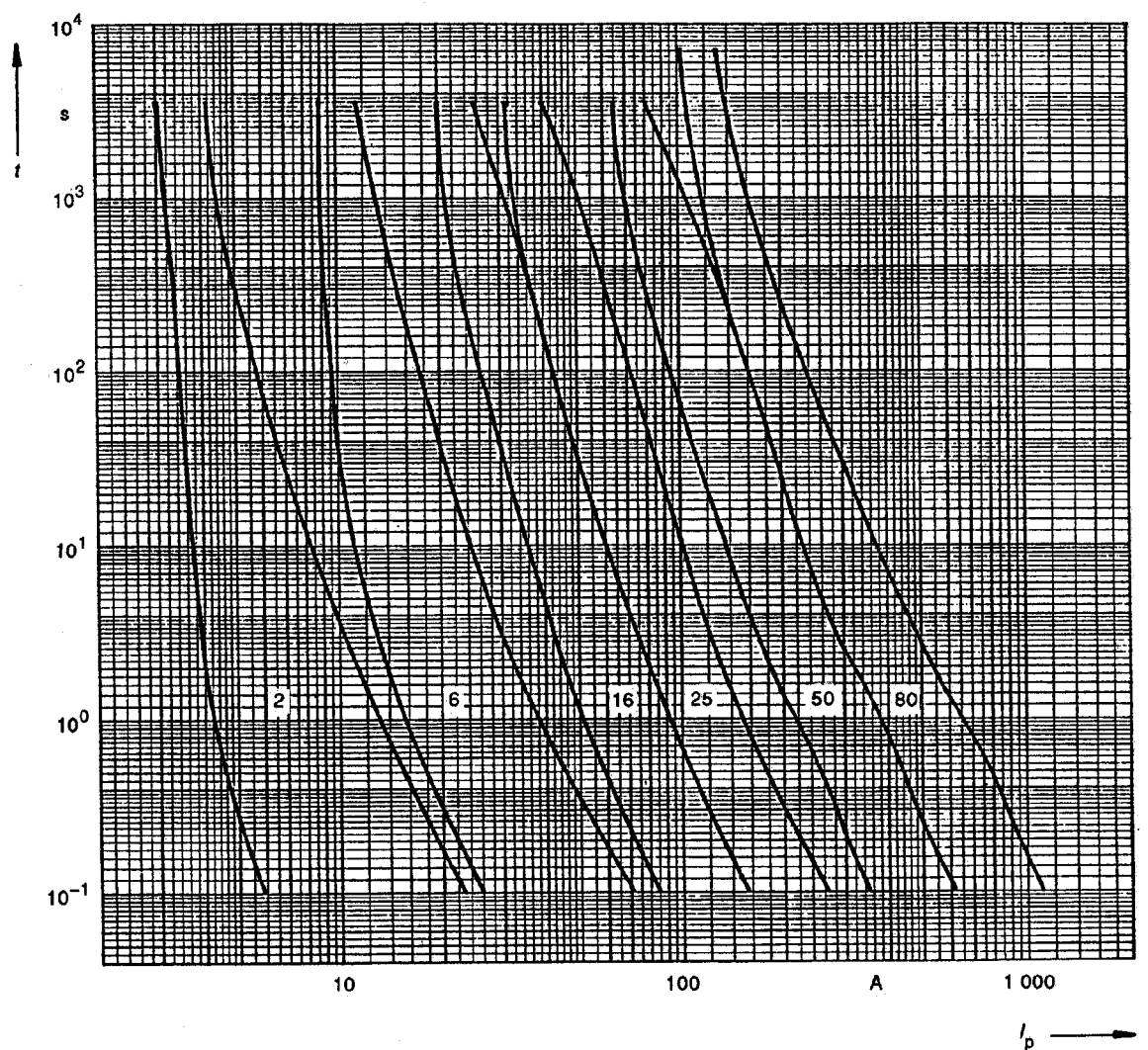
The other two fuse-carriers and fuse-bases shall be tested as follows:

The fuse-carriers fitted with a fuse-link complying with the standards are screwed five times into the fuse-bases fitted with gauge-pieces by applying a torque as given in table E and withdrawn five times.

8.11.2.4.3 Acceptability of test results

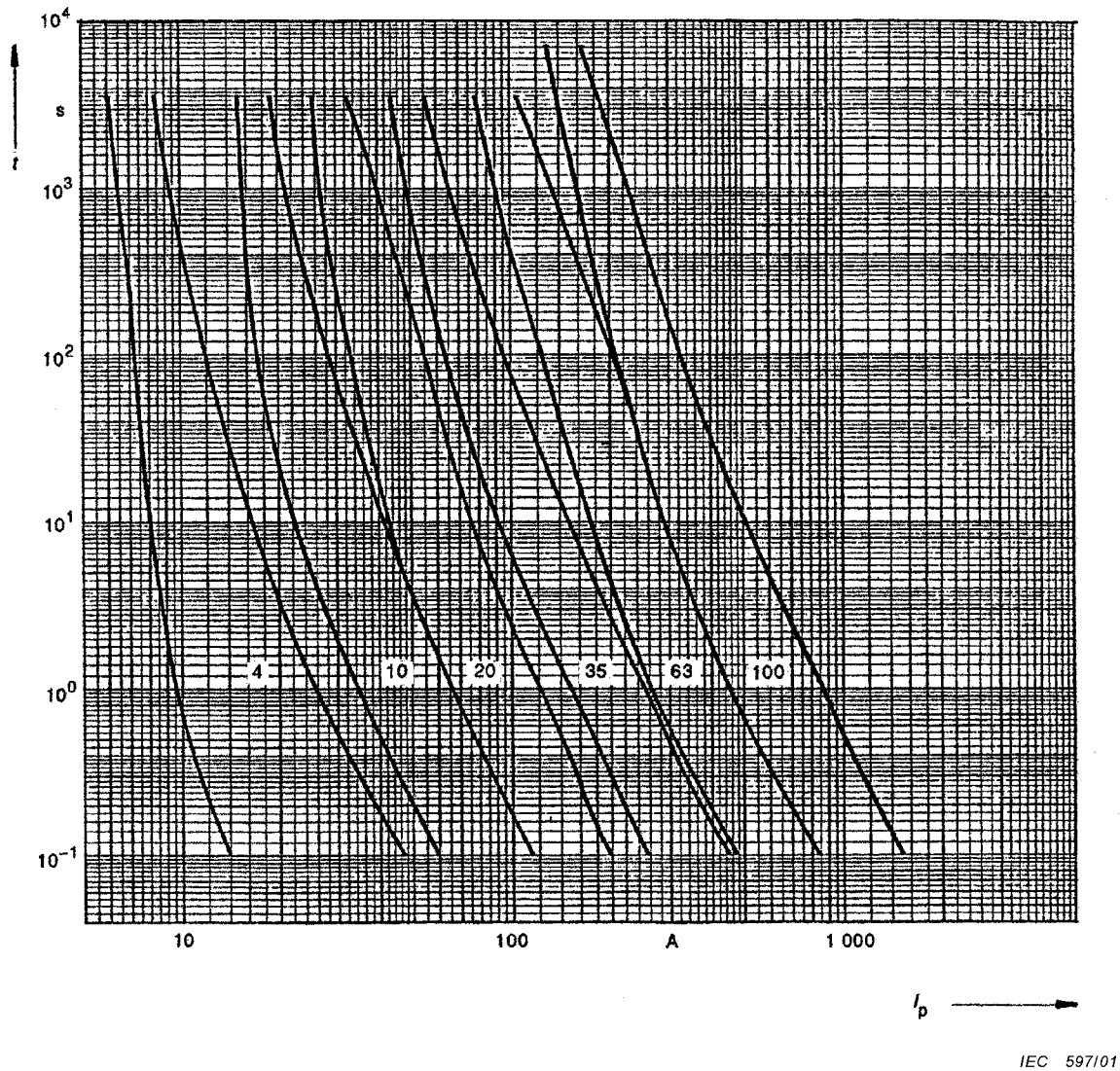
After this test, the test samples shall show no change impairing their further use. The mechanical strength, especially of the cemented parts, shall be maintained.

Sealing compound shall not have moved to such an extent that live parts are exposed. After this test, the identification colour shall not have changed appreciably.



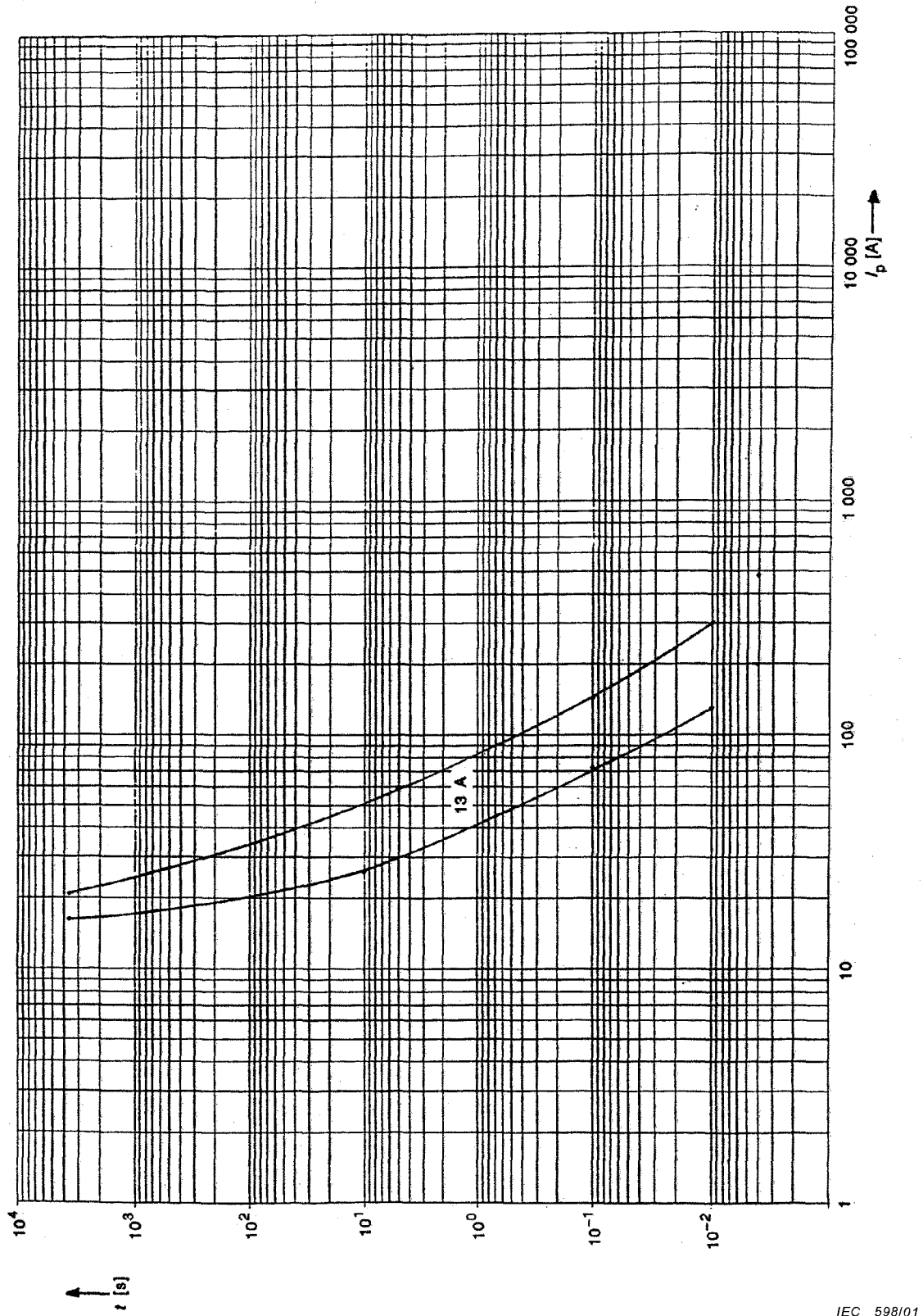
IEC 596/01

Figure 1a – Time-current zones for 'gG' fuse-links



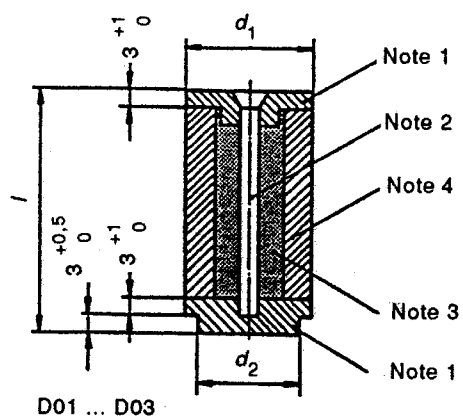
IEC 597/01

Figure 1b – Time-current zones for 'gG' fuse-links



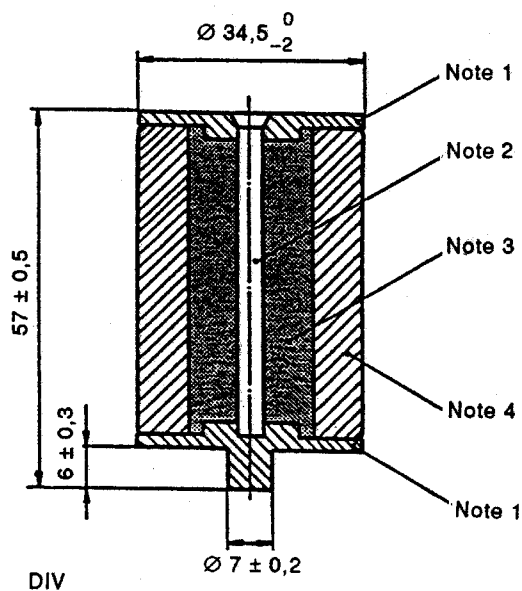
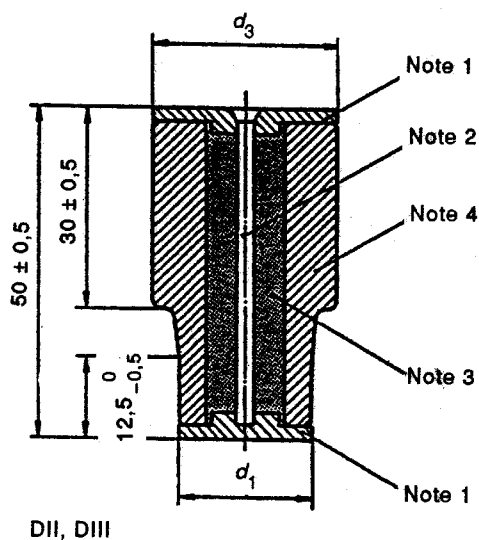
IEC 598/01

Figure 1c – Time-current zone for 'gG' fuse-links 13A



Size	$d_1 \begin{smallmatrix} 0 \\ -0,5 \end{smallmatrix}$	$d_2 \begin{smallmatrix} 0 \\ -0,5 \end{smallmatrix}$	$l \pm 0,5$
DO1	10,5	6	36
DO2	15	10	36
DO3	22	18	43

Size	$d_1 \begin{smallmatrix} +0,2 \\ -0,4 \end{smallmatrix}$	$d_3 \begin{smallmatrix} 0 \\ -1,5 \end{smallmatrix}$
DII	14	22,5
DIII	20	28



NOTE 1 - Contact CuZn, silver plated.

NOTE 2 - CuNi 56/44 or an equivalent material with similar values of specific resistance and temperature coefficient.

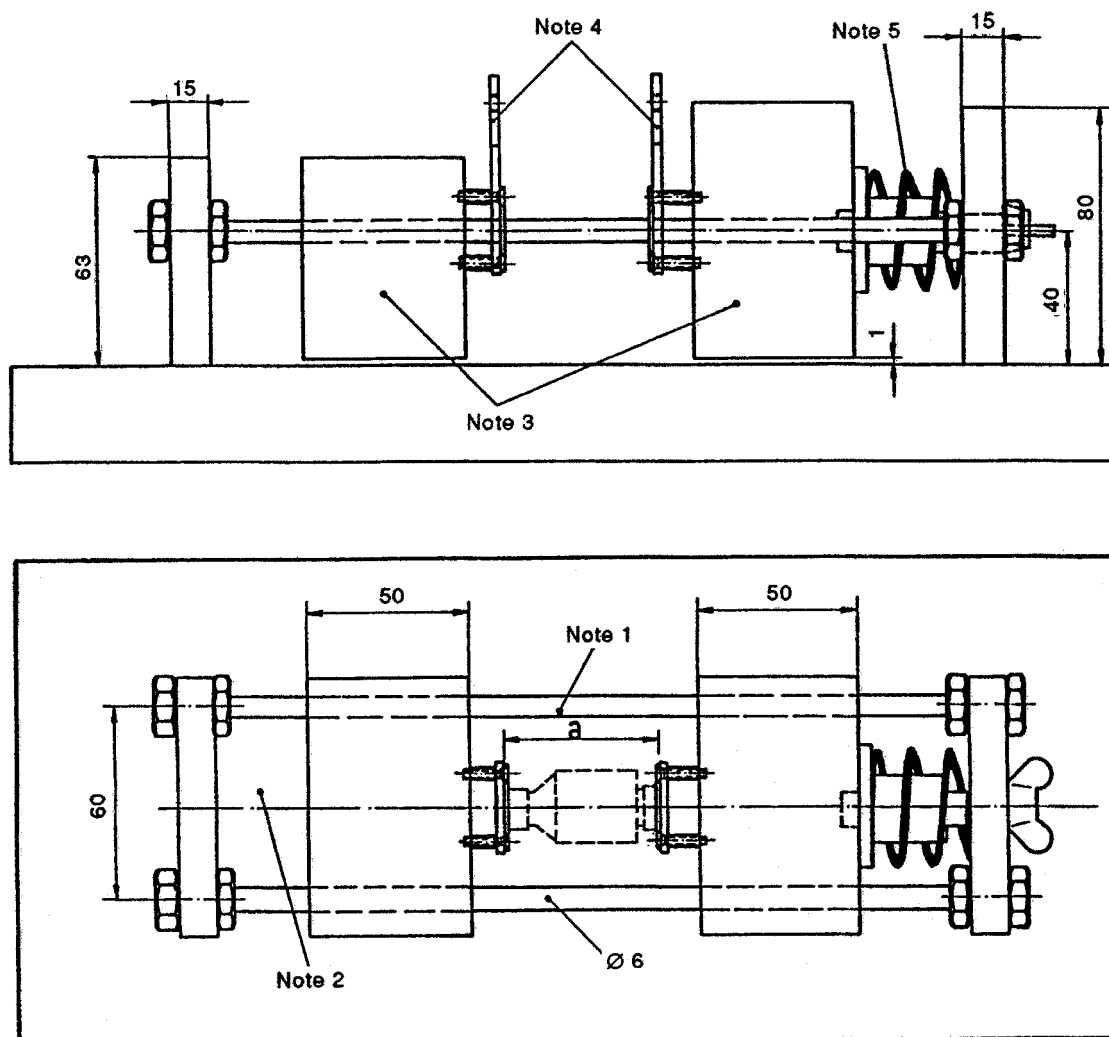
NOTE 3 - Quartz sand.

NOTE 4 - Ceramic body.

IEC 599/01

Dimensions in millimetres

Figure 2 – Dummy fuse-links according to 8.3 and 8.9.1.1



IEC 600101

Dimensions in millimetres
Dimension a see figure 3b

NOTE 1 - Metallic rod.

NOTE 2 - Distance for adjusting of the contact force.

NOTE 3 - Insulating material.

NOTE 4 - Silver-plated contact pieces.

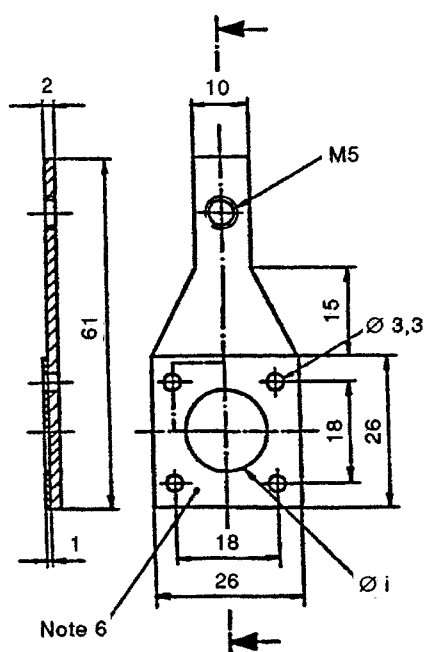
NOTE 5 - Steel spring.

Figure 3a – Test rigs for fuse-links

Size	Dimensions		Contact force N
	<i>a</i>	Ø i	
DO1	35 ⁺² ₀	11,5	40 ±10%
DO2	35 ⁺² ₀	16,0	80 ±10%
DO3	42 ⁺² ₀	23,0	120 ±10%
DII	49 ⁺² ₀	14,5	200 ±10%
DIII	49 ⁺² ₀	20,5	320 ±10%
DIV	56 ^{+2,5} ₀	—	550 ±10%

Dimensions in millimetres

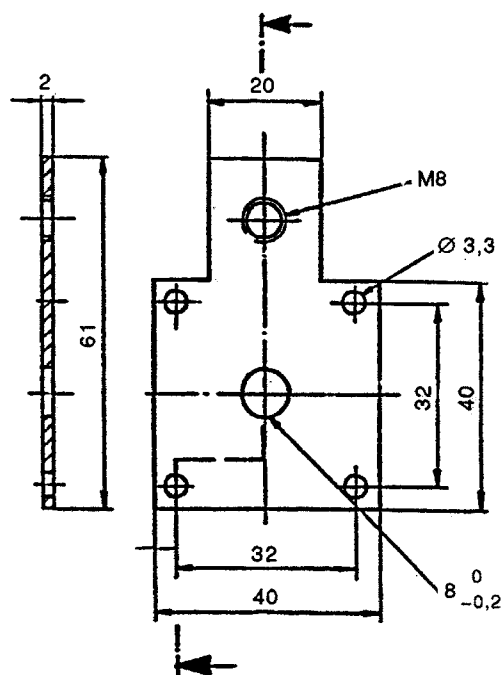
Silver-plated contact pieces (see note 4 of figure 3a)



Note 6

Sizes DO1 to DO3 and DII, DIII

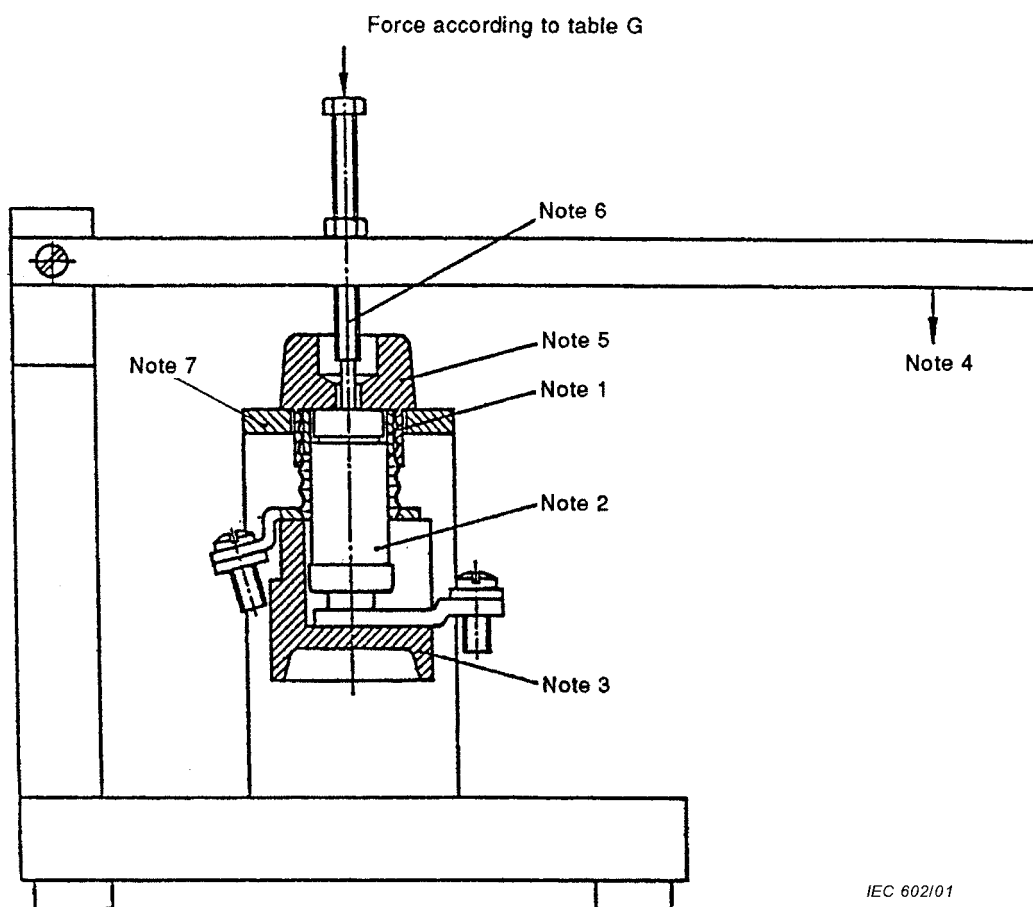
NOTE 6 - Centring plate of insulating material.



IEC 601/01

Size DIV

Figure 3b – Test rigs for fuse-links



NOTE 1 - Isolation between the end-cap and the screwed shell except at the face.

NOTE 2 - Dummy fuse-link.

NOTE 3 - Fuse-base.

NOTE 4 - Direction of the applied force.

NOTE 5 - Fuse-carrier.

NOTE 6 - Piston.

NOTE 7 - Assembly platform.

Figure 4 – Test arrangement for fuse-bases according to 8.9.1.2

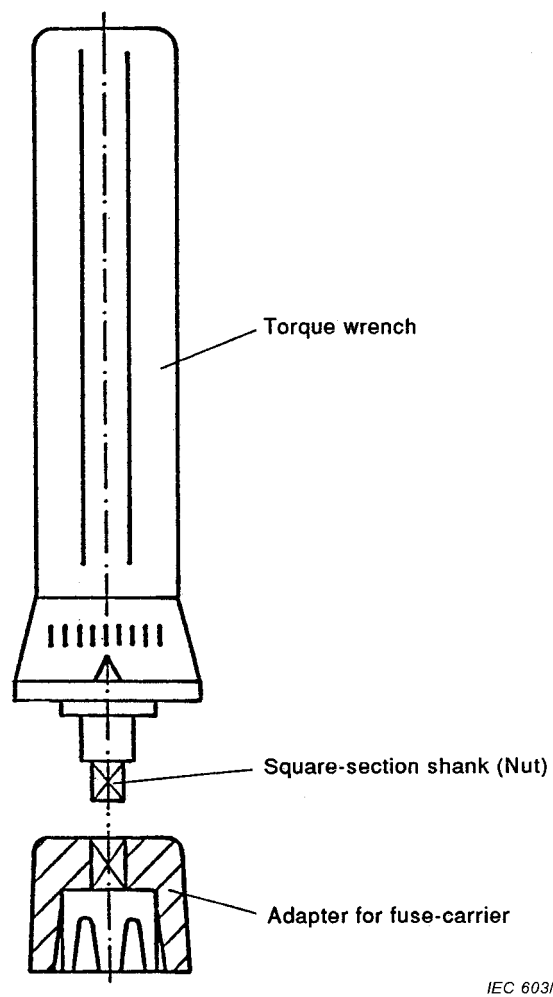
*IEC 603101*

Figure 5a – Example of a torque wrench according to 8.9.2

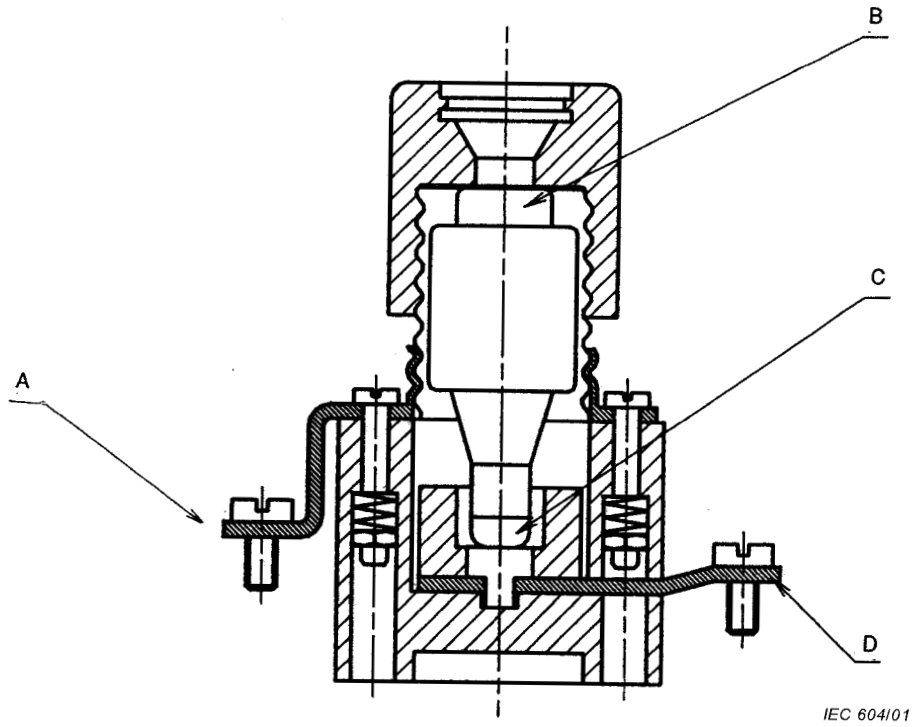


Figure 5b – Measuring points for the voltage drop (B, C) or the temperature rise (A, D)