

Electrical apparatus for explosive gas atmospheres —

Part 7: Increased safety “e”

The European Standard EN 60079-7:2003 has the status of a
British Standard

ICS 29.260.20

National foreword

This British Standard is the official English language version of EN 60079-7:2003. It is identical with IEC 60079-7:2001, including Corrigendum February 2004. It supersedes BS 4683-4:1973 which is withdrawn and BS EN 50019:2000 which remains current as obsolescent but will be withdrawn no later than 1 July 2006. It also partially supersedes DD ENV 50269:1997 which will be withdrawn on the publication of BS EN 60079-15.

Readers should not that BS 5501-6:1977 and BS EN 50019:1994 were withdrawn on 30 June 2003.

The UK participation in its preparation was entrusted by Technical Committee GEL/31, Electrical apparatus for use in explosive atmospheres, to Subcommittee GEL/31/14, Increased safety “e”, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

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English version

Electrical apparatus for explosive gas atmospheres
Part 7: Increased safety "e"
(IEC 60079-7:2001)

Matériel électrique pour atmosphères
explosives gazeuses
Partie 7: Sécurité augmentée "e"
(CEI 60079-7:2001)

Elektrische Betriebsmittel für
gasexplosionsgefährdete Bereiche
Teil 7: Erhöhte Sicherheit "e"
(IEC 60079-7:2001)

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CENELEC

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Foreword

The text of the International Standard IEC 60079-7:2001, prepared by IEC TC 31, Electrical apparatus for explosive atmospheres, was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 60079-7 on 2003-07-01.

This European Standard supersedes EN 50019:2000 + corrigendum April 2003 and ENV 50269:1997 + corrigendum March 1997.

This European Standard covers essential requirements of the EC Directive 94/9/EC (the ATEX Directive). This standard and the related standards provide protection in accordance with Category 2 or Category M2.

Explosive atmospheres include the presence of combustible dusts for Group I equipment.

NOTE Other EC Directives may be applicable.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2004-07-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2006-07-01

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annexes A, B and ZA are normative and annexes C, D, E and F are informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60079-7:2001 was approved by CENELEC as a European Standard without any modification.

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

IEC 60086-1	NOTE	Harmonized as EN 60086-1:2001 (not modified).
IEC 60095-1	NOTE	EN 50342:2001, related but not equivalent, applies instead.
IEC 60622	NOTE	Harmonized as EN 60622:2003 (not modified).
IEC 60623	NOTE	Harmonized as EN 60623:2001 (not modified).
IEC 61056-1	NOTE	Harmonized as EN 61056-1:2003 (not modified).
IEC 61150	NOTE	Harmonized as EN 61150:1993 (not modified).
IEC 62013-1	NOTE	Harmonized as EN 62013-1:2002 (modified).

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ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES –

Part 7: Increased safety "e"

1 Scope

This part of IEC 60079 specifies the requirements for the design, construction, testing and marking of electrical apparatus with type of protection increased safety "e" intended for use in explosive gas atmospheres. This standard applies to electrical apparatus with a rated value of supply voltage not exceeding 11 kV r.m.s. a.c. or d.c. Additional measures are applied to ensure that the apparatus does not produce arcs, sparks, or excessive temperatures in normal operation or under specified abnormal conditions.

These specific requirements are additional to the general requirements in IEC 60079-0 that apply to type of protection increased safety "e" unless specifically excluded.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60079. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60079 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60034-1, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-5, *Rotating electrical machines – Part 5: Degrees of protection provided by internal design of rotating electrical machines (IP code) – Classification*

IEC 60044-6, *Instrument transformers – Part 6: Requirements for protective current transformers for transient performance*

IEC 60050(426), *International Electrotechnical Vocabulary (IEV) – Chapter 426: Electrical apparatus for explosive atmospheres*

IEC 60050(486), *International Electrotechnical Vocabulary (IEV) – Chapter 486: Secondary cells and batteries*

IEC 60061-1, *Lamp caps and holders together with gauges for the control of interchangeability and safety – Part 1: Lamp caps*

IEC 60061-2, *Lamp caps and holders together with gauges for the control of interchangeability and safety – Part 2: Lampholders*

IEC 60064, *Tungsten filament lamps for domestic and similar general lighting purposes – Performance requirements*

IEC 60068-2-6, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27, *Environmental testing – Part 2: Tests – Test Ea and guidance: Shock*
IEC 60068-2-42, *Basic environmental testing procedures – Part 2: Tests – Test Kc: Sulphur dioxide test for contacts and connections*

IEC 60068-2-42, *Environmental testing – Part 2: Tests – Test Kc: Sulphur dioxide test for contacts and connections*

IEC 60079-0:1998, *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements*¹

IEC 60079-1, *Electrical apparatus for explosive gas atmospheres – Part 1: Flameproof enclosures "d"*

IEC 60079-4, *Electrical apparatus for explosive gas atmospheres – Part 4: Method of test for ignition temperature*

IEC 60079-11, *Electrical apparatus for explosive gas atmospheres – Part 11: Intrinsic safety 'i'*

IEC 60079-17, *Electrical apparatus for explosive gas atmospheres – Part 17: Inspection and maintenance of electrical installations in hazardous areas (other than mines)*

IEC 60085, *Thermal evaluation and classification of electrical insulation*

IEC 60112, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions*

IEC 60238, *Edison screw lampholders*

IEC 60317-3, *Specifications for particular types of winding wires – Part 3: Polyester enamelled round copper wires, class 155*

IEC 60317-7, *Specifications for particular types of winding wires – Part 7: Polyamide enamelled round copper wire, class 220*

IEC 60317-8, *Specifications for particular types of winding wires – Part 8: Polyesterimide enamelled round copper winding wire, class 180*

IEC 60317-13, *Specifications for particular types of winding wires – Part 13: Polyester or polyesterimide overcoated with polyamide-imide enamelled round copper wire, class 200*

IEC 60364-3, *Electrical installations of buildings – Part 3: Assessment of general characteristics*

IEC 60400, *Lampholders for tubular fluorescent lamps and starterholders*

¹ A consolidated edition exists 1.1 (2000) that includes IEC 60079-0 (1998) and its amendment 1 (2000).

IEC 60432-1, *Incandescent lamps – Safety specifications – Part 1: Tungsten filament lamps for domestic and similar general lighting purposes*

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

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements, and tests*²

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

IEC 60947-7-1, *Low-voltage switchgear and controlgear, Part 7 – Ancillary equipment – Section 1: Terminal blocks for copper conductors*

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*

IEC 60999-2, *Connecting devices – Safety requirements for screw-type and screwless-type clamping units for electrical copper connectors – Part 2: Particular requirements for conductors from 35 mm² up to 300 mm²*

IEC 61195, *Double-capped fluorescent lamps – Safety specifications*

IEC 62086-1, *Electrical apparatus for explosive gas atmospheres – Electrical resistance trace heating – Part 1: General and testing requirements*

3 Definitions

For the purpose of this part of IEC 60079, the definitions and certain terms used in IEC 60079-0, together with the following terms and definitions apply.

For the definitions of any other terms, particularly those of a more general nature, reference should be made to IEC 60050(426) or other appropriate parts of the IEV (International Electrotechnical Vocabulary).

NOTE Where a word, for example "battery", is shown in parentheses in a term, it may be omitted when there is no risk of confusion or misunderstanding.

3.1 cells and batteries

3.1.1

cell

assembly of electrodes and electrolytes which constitutes the smallest electrical unit of a battery

NOTE A sketch illustrating the various parts of a cell is given in figure 1. This sketch is included for descriptive purposes only and is not intended to imply any requirements or preference for a particular form of construction.

3.1.2

primary cell or battery

electrochemical system capable of producing electrical energy by chemical reaction

² A consolidated edition exists 1.1 (2000) that includes IEC 60664-1 (1992) and its amendment 1 (2000).

3.1.3

secondary cell or battery

electrically rechargeable electrochemical system capable of storing electrical energy and delivering it by chemical reaction

3.1.4

open cell or battery

secondary cell or battery having a cover provided with an opening through which gaseous products may escape

[IEV 486-01-18 modified]

3.1.5

sealed valve regulated cell or battery

cell or battery which is closed under normal conditions, but which has an arrangement which allows the escape of gas if the internal pressure exceeds a predetermined value. The cell cannot normally receive an addition to the electrolyte.

[IEV 486-01-20 modified]

NOTE This definition differs from the IEC definition 486-01-20 by virtue of the fact it applies to either a cell or battery.

3.1.6

sealed gas-tight cell or battery

cell or battery which remains closed and does not release either gas or liquid when operated within the limits of charge or temperature specified by the manufacturer

NOTE 1 Such cell and batteries may be equipped with a safety device to prevent dangerously high internal pressure. The cell or battery does not require addition to the electrolyte and is designed to operate during its life in its original sealed state.

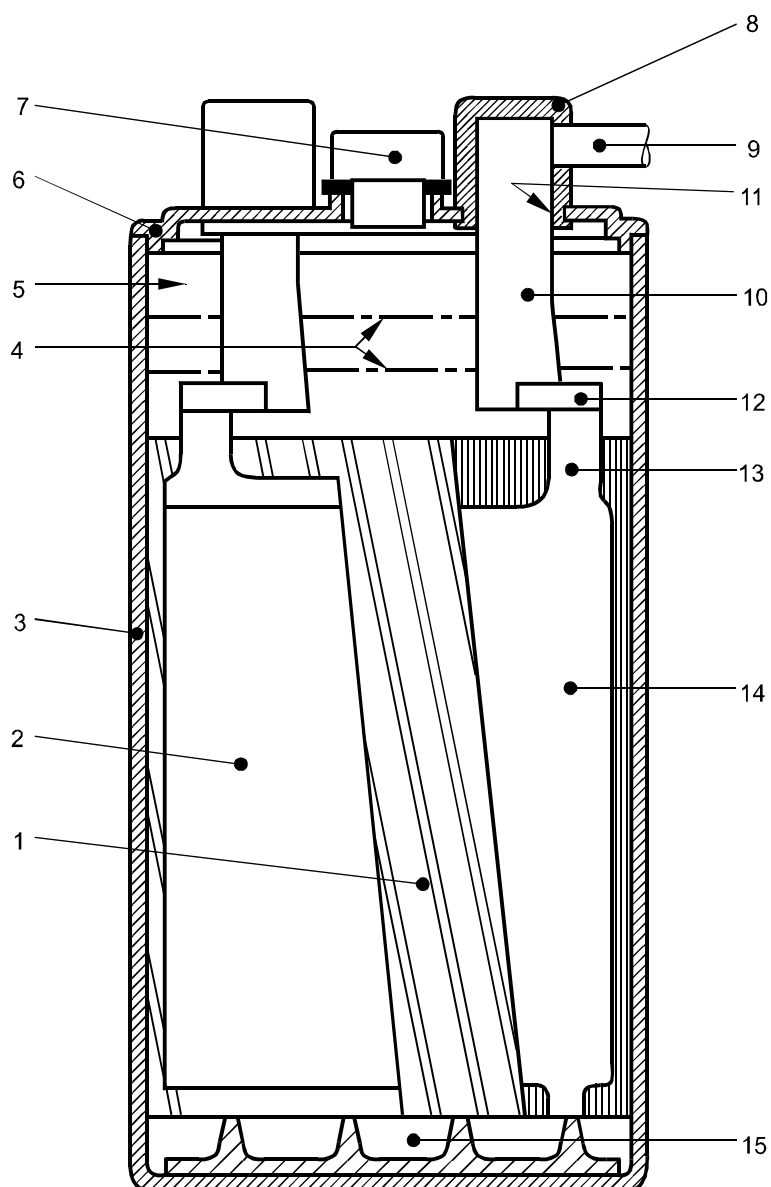
NOTE 2 The above definition is taken from IEC 60079-11. It differs from the IEC definition 486-01-21 by virtue of the fact it applies to either a cell or battery.

3.1.7

battery

assembly of two or more cells electrically connected to each other to increase the voltage or capacity

NOTE Where the terms "cell" or "cells" are used, the text refers to individual single cells. Where the terms "battery" or "batteries" are used, the text refers to both cells and batteries.



IEC 1807/01

Key

- | | |
|---------------------------------------|---|
| 1 Separator | 9 Intercell connector |
| 2 Positive plate | 10 Terminal post |
| 3 Cell container | 11 Electrolyte-tight terminal post seal |
| 4 Electrolyte level (maximum/minimum) | 12 Group bar |
| 5 Headspace | 13 Plate lug |
| 6 Electrolyte-tight lid seal | 14 Negative plate |
| 7 Filler and vent plug | 15 Slurry space |
| 8 Post encapsulation | |

Figure 1 – Parts of a cell

3.1.8

capacity

quantity of electricity or electric charge, which a fully charged battery can deliver under specified conditions

NOTE The SI unit for electrical charge is the coulomb (1 C = 1 As) but in practice, battery capacity is usually expressed in ampere-hours (Ah).

3.1.9

nominal voltage

(of a cell or battery) voltage specified by the manufacturer

3.1.10

maximum open circuit voltage

(of a cell or battery) voltage which is the maximum attainable voltage under normal conditions, that is, from either a new primary cell, or a secondary cell just after a full charge

NOTE The maximum open circuit voltage for acceptable cells is given in tables 9 and 10.

3.1.11

charging

act of forcing current through a secondary cell in the opposite direction to the normal flow to restore the energy stored originally

3.1.12

reverse charging

act of forcing current through either a primary cell or secondary cell in the same direction as the normal flow

NOTE For example in an expired battery.

3.1.13

deep discharge

event which reduces a cell voltage below that recommended by the cell or battery manufacturer

3.1.14

container (of a cell)

container for the plate pack and electrolyte of a cell made of a material impervious to attack by the electrolyte

[IEV 486-02-20]

3.1.15

(battery) container

enclosure to contain the battery

NOTE The cover is a part of the battery container.

3.1.16

plate pack

assembly of the positive and negative plate groups with separators

[IEV 486-02-15]

3.1.17

partition wall

integral part of a battery container dividing it into individual sections and increasing its mechanical strength

3.1.18

insulating barrier

electrical insulating material between groups of cells subdividing the battery

3.1.19

intercell connector

conductor of electricity used for carrying current between cells

3.2

clearance

shortest distance in air between two conductive parts

3.3

connections internal

terminations intended for connection in the factory under controlled conditions

3.4

connections external

terminations intended for connection in the field

3.5

creepage distance

shortest distance along the surface of an electrically insulating material between two conductive parts

3.6

increased safety "e"

type of protection applied to electrical apparatus in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and of the occurrence of arcs and sparks in normal service or under specified abnormal conditions

NOTE 1 This type of protection is denoted by "e". The "additional measures" are those required for compliance with this standard.

NOTE 2 Apparatus producing arcs or sparks in normal service is excluded by this definition of increased safety.

3.7

initial starting current I_A

highest r.m.s. value of current absorbed by an a.c. motor when at rest or by an a.c. magnet with its armature clamped in the position of maximum air gap when supplied at rated voltage and rated frequency

NOTE Transient phenomena are ignored.

3.8

limiting temperature

maximum permissible temperature for apparatus or parts of apparatus equal to the lower of the two temperatures determined by:

- a) the danger of ignition of the explosive gas atmosphere;
- b) the thermal stability of the materials used

NOTE This temperature may be the maximum surface temperature (see both 3.8 and clause 5 of IEC 60079-0) or a lower value (see 4.8).

3.9

normal service, motors

continuous operation at the nameplate rating (or set of ratings) including starting conditions

3.10**rated dynamic current I_{dyn}**

peak value of the current, the dynamic effect of which the electrical apparatus can sustain without damage

3.11**rated short-time thermal current I_{th}**

r.m.s. value of the current required to heat up the conductor within 1 s from the temperature reached in rated service at the maximum ambient temperature to a temperature not exceeding the limiting temperature

3.12**rated voltage**

value of voltage assigned by the manufacturer to a component, device or equipment and to which operation and performance characteristics are referred

3.13**resistance-heating devices and resistance-heating units****3.13.1****resistance-heating device**

part of a resistance heating unit comprising one or more heating resistors, typically composed of metallic conductors or an electrically conductive compound suitably insulated and protected

3.13.2**resistance-heating unit**

apparatus comprising an assembly of one or more resistance heating devices associated with any devices necessary to ensure that the limiting temperature is not exceeded

NOTE It is not intended that the devices necessary to ensure that the limiting temperature is not exceeded should have type of protection "e", or any type of protection when they are located outside the hazardous area.

3.13.3**workpiece**

object to which a resistance-heating device or unit is applied

3.13.4**self-limiting property**

property such that the thermal output of a resistance-heating device at its rated voltage decreases as the temperature of its surroundings increases until the device reaches a temperature at which its thermal output is reduced to a value at which there is no further rise in temperature

NOTE The temperature of the surface of the element is then effectively that of its surroundings.

3.13.5**stabilized design**

concept where the temperature of the resistance-heating device or unit will, by design and use, stabilize below the limiting temperature, under the most unfavourable conditions, without the need for a protective system to limit the temperature

3.14**short-circuit current I_{sc}**

maximum r.m.s. value of the short-circuit current to which the apparatus may be subjected in service

NOTE This maximum value is recorded in the documentation according to 23.2 of IEC 60079-0.

3.15

starting current ratio I_A/I_N

ratio between initial starting current I_A and rated current I_N

3.16

time t_E

time taken for an a.c. rotor or stator winding, when carrying the initial starting current I_A , to be heated up to the limiting temperature from the temperature reached in rated service at the maximum ambient temperature (see figure A.1)

3.17

trace heating

utilization of electric trace heater cables, pads, panels and support components, externally applied and used to raise or maintain the temperature of contents in piping, tanks and associated equipment

3.18

working voltage (identical with 1.3.5 of IEC 60664-1)

highest r.m.s. value of the a.c. or d.c. voltage across any particular insulation which can occur when the equipment is supplied at rated voltage

NOTE 1 Transients are disregarded.

NOTE 2 Both open-circuit conditions and normal operating conditions are taken into account.

4 Constructional requirements for all electrical apparatus

4.1 General

The requirements of this clause apply, unless otherwise stated in clause 5, to all electrical apparatus with type of protection "e". They are additional to the general requirements of IEC 60079-0 and are themselves supplemented for certain electrical apparatus by the supplementary requirements in clause 5.

4.2 Terminals for external connections

Terminals for connections to external circuits shall be generously dimensioned to permit the effective connection of conductors of cross-section equal to at least that corresponding to the rated current of the electrical apparatus.

The number and sizes of conductors that can be safely connected to terminals shall be specified in the descriptive documents according to 23.2 of IEC 60079-0.

NOTE 1 Attention is drawn to the use of aluminium wire because of the difficulties associated with controlling critical creepage and clearance distances with the application of anti-oxidant materials. The connection of aluminium wire to external terminals may be accomplished by the use of suitable bi-metallic ferrule connections providing a copper connection to the terminal.

Terminals shall be subjected to the terminal insulating material tests of 6.9.

These terminals shall

- a) be fixed to their mountings without possibility of self-loosening,
- b) be constructed in such a way that the conductors cannot slip out from their intended location during tightening of the terminal,

- c) be such that proper contact is assured without damage to the conductors that would impair the ability of the conductors to fulfil their function, even if multi-stranded conductors are used in terminals intended for direct clamping of a conductor.

NOTE 2 The use of crimped cable terminations is allowed provided that the requirements in a), b) and c) are fulfilled.

In particular, terminals shall not

- have sharp edges which would damage the conductors,
- be able to turn, twist or be permanently deformed during normal tightening which shall be defined by the manufacturer of the apparatus and which shall not be less than that specified in IEC 60947-7-1, IEC 60999-1 or IEC 60999-2, where applicable,
- be constructed of aluminium.

Terminals shall be such that the contact they assure is not appreciably impaired by temperature changes occurring in normal service. The contact pressure shall not be transmitted through insulating material.

Terminals intended for clamping stranded conductors shall include a resilient intermediate part. Terminals for connecting conductors of rated cross-sections not exceeding 4 mm² (12 AWG) shall also be suitable for the effective connection of conductors at least two ISO wire-sizes smaller.

NOTE 3 Special precautions against vibration and mechanical shock may be required.

NOTE 4 Special precautions against electrolytic corrosion should be considered.

NOTE 5 Special precautions against corrosion should be considered where ferrous material is used.

4.3 Internal connections

Connections within electrical apparatus and forming an integral part of that apparatus shall not be subject to undue mechanical stress. Only the following means for the connection of conductors are permitted:

- a) screwed fasteners with means of locking;
- b) crimping;
- c) soldering, provided that the conductors are not supported by the soldered connection alone;
- d) brazing;
- e) welding; and
- f) any means of connection complying with the requirements of 4.2.

NOTE Special precautions against electrolytic corrosion should be considered.

Connections which are terminals shall be subjected to the terminal insulating material tests of 6.9.

4.4 Clearances

Clearances between bare conductive parts at different potentials shall be as given in table 1 with a minimum value for external connections of 3 mm.

Spacings at wiring terminals shall be evaluated with the conductor size that produces the minimum clearance.

NOTE For requirements for lamps with screw caps see 5.3.3.1.4.

Clearances shall be determined as a function of the working voltage. Where the apparatus is intended for more than one rated voltage or for a range of rated voltage, the value of working voltage to be used shall be based on the highest value of rated voltage. In determining the clearances, examples 1 to 11 (inclusive) in figure 2 illustrate the features to be taken into account and the appropriate clearances.

Table 1 – Creepage distances and clearances

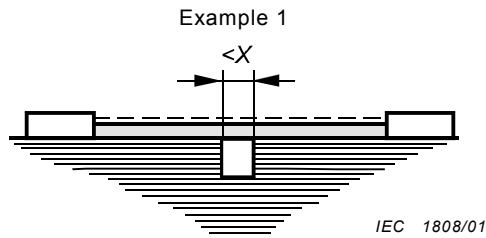
Voltage (see note 1) <i>U</i> _{r.m.s.} a.c. or d.c. V	Minimum creepage distance mm			Minimum clearance mm
	Material group			
	I	II	IIIa	
10 (see note 3)	1,6	1,6	1,6	1,6
12,5	1,6	1,6	1,6	1,6
16	1,6	1,6	1,6	1,6
20	1,6	1,6	1,6	1,6
25	1,7	1,7	1,7	1,7
32	1,8	1,8	1,8	1,8
40	1,9	2,4	3,0	1,9
50	2,1	2,6	3,4	2,1
63	2,1	2,6	3,4	2,1
80	2,2	2,8	3,6	2,2
100	2,4	3,0	3,8	2,4
125	2,5	3,2	4	2,5
160	3,2	4	5	3,2
200	4,0	5,0	6,3	4,0
250	5	6,3	8	5
320	6,3	8,0	10,0	6,0
400	8	10	12,5	6
500	10,0	12,5	16,0	8,0
630	12,0	16,0	20,0	10
800	16,0	20,0	25,0	12
1 000	20	25	32	14
1 250	22	26	32	18
1600	23	27	32	20
2 000	25	28	32	23
2 500	32	36	40	29
3 200	40	45	50	36
4 000	50	56	63	44
5 000	63	71	80	50
6 300	80	90	100	60
8 000	100	110	125	80
10 000	125	140	160	100

NOTE 1 Voltages shown are derived from IEC 60664-1. The working voltage may exceed by 10 % the voltage level given in the table. This is based on the rationalization of supply voltages given in table 3b of IEC 60664-1.

NOTE 2 The creepage distance and clearance values shown are based on a maximum supply voltage tolerance of ± 10 %.

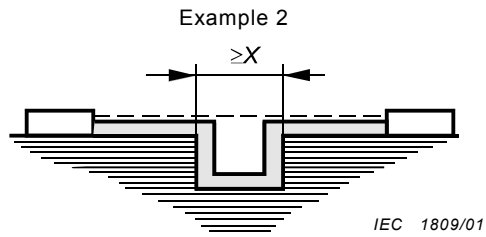
NOTE 3 At 10 V and below, the value of CTI is not relevant and materials not meeting the requirement for material group IIIa may be acceptable.

NOTE These examples are identical with those given in IEC 60664-1



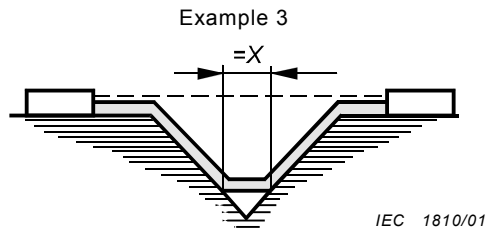
Condition: Path under consideration includes a parallel- or converging-sided groove of any depth with a width less than X mm.

Rule: Creepage distance and clearance are measured directly across the groove as shown.



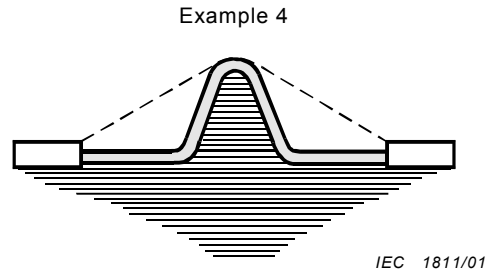
Condition: Path under consideration includes a parallel-sided groove of any depth *d* equal to or more than X mm.

Rule: Clearance is the "line of sight" distance. Creepage path follows the contour of the groove



Condition: Path under consideration includes a V-shaped groove with a width greater than X mm.

Rule: Clearance is the "line of sight" distance. Creepage path follows the contour of the groove but "short circuits" the bottom of the groove by X mm link.

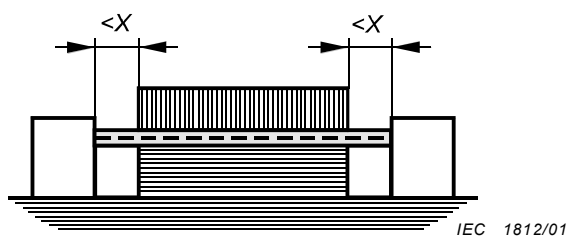


Condition: Path under consideration includes a rib.

Rule: Clearance is the shortest direct air path over the top of the rib. Creepage path follows the contour of the rib

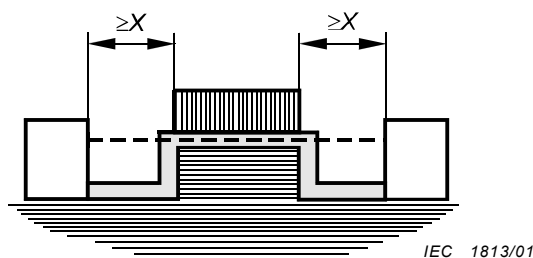


Example 5



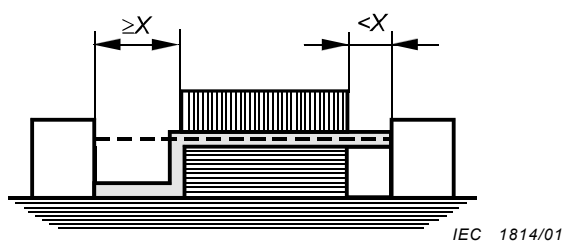
Condition: Path under consideration includes an uncemented joint with groove less than X mm wide on each side
Rule: Creepage and clearance path is the "line of sight" distance shown.

Example 6



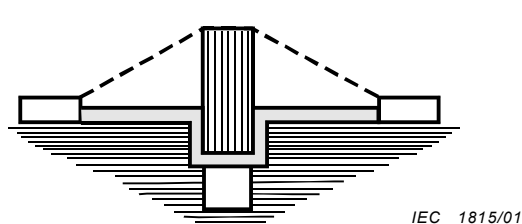
Condition: Path under consideration includes an uncemented joint with grooves equal to or more than X mm wide on each side.
Rule: Clearance is the "line of sight" distance. Creepage path follows the contour of the grooves.

Example 7



Condition: Path under consideration includes an uncemented joint with a groove on one side less than X mm wide and the groove on the other side equal to or more than X mm wide.
Rule: Clearance and creepage paths are as shown.

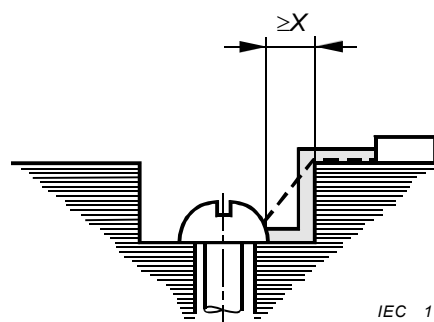
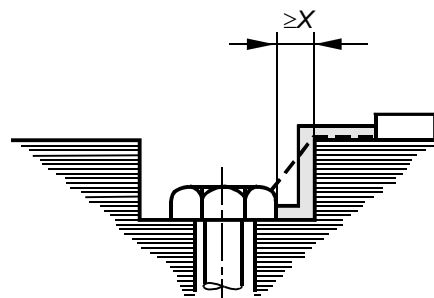
Example 8



Condition: Creepage distance through uncemented joint is less than creepage distance over barrier.
Rule: Clearance is the shortest direct air path over the top of the barrier.

--- 1 ■ 2
1 clearance 2 creepage distance

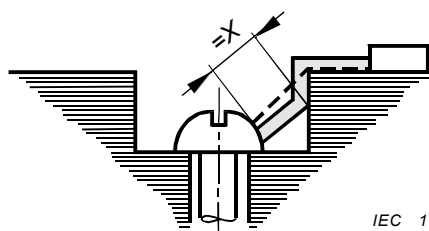
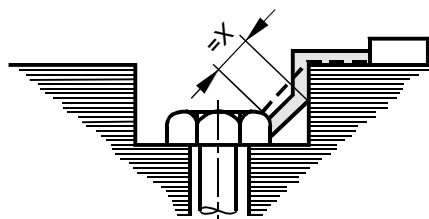
Example 9



IEC 1816/01

Gap between head of screw and wall of recess wide enough to be taken into account.

Example 10



IEC 1817/01

Gap between head of screw and wall of recess too narrow to be taken into account.

Measurement of creepage distance is from screw to wall when the distance is equal to X mm.

- - - - - 1  2
 1 clearance 2 creepage distance

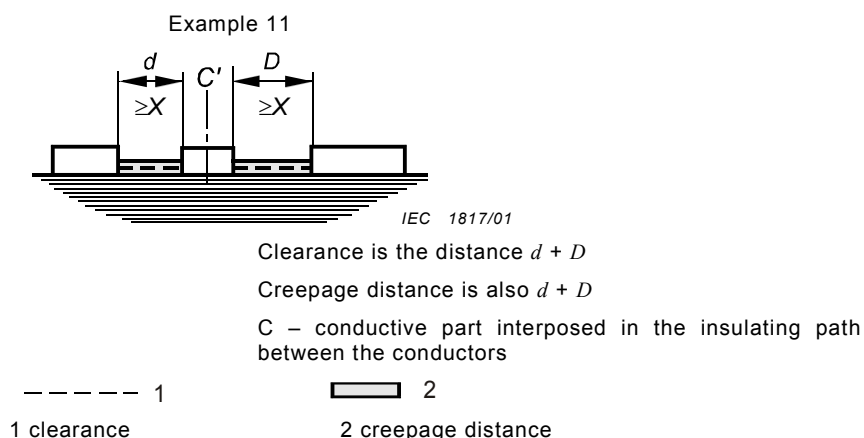


Figure 2 – Determination of creepage distances and clearances

4.5 Creepage distances

4.5.1 The required values of creepage distance are dependent on the working voltage, the resistance to tracking of the electrical insulating material and its surface profile.

Table 2 gives the grouping of electrical insulating materials according to the comparative tracking index (CTI) determined in accordance with IEC 60112. Inorganic insulating materials, for example glass and ceramics, do not track and need not therefore be subjected to the determination of the CTI. They are conventionally classified in material group I.

The grouping given in table 2 is applied to insulating parts without ribs or grooves. If there are ribs or grooves in accordance with 4.5.3 the minimum permissible creepage distances for working voltages up to 1 100 V shall be based on the next highest material group, for example material group I instead of material group II.

NOTE 1 The material groups are identical with those given in IEC 60664-1.

NOTE 2 Transient overvoltages are ignored as they do not normally influence tracking phenomena. However, temporary and functional overvoltages may have to be considered, depending upon the duration and frequency of occurrence (see IEC 60664-1 for additional information).

Table 2 – Tracking resistance of insulating materials

Material group	Comparative tracking index (CTI)
I	$600 \leq \text{CTI}$
II	$400 \leq \text{CTI} < 600$
IIIa	$175 \leq \text{CTI} < 400$

4.5.2 Creepage distances between bare conductive parts at different potentials shall be as given in table 1, with a minimum value for external connections of 3 mm, and shall be determined as a function of the working voltage specified by the manufacturer of the apparatus.

NOTE For requirements for lamps with screw caps, see 5.3.3.1.4

4.5.3 In determining the creepage distance, figure 2 illustrates the features to be taken into account and the appropriate creepage distance. The value of dimension 'X' is 2,5 mm.

The effects of ribs and grooves may be taken into account provided that

- a) ribs on the surface are at least 2,5 mm high and of a thickness appropriate to the mechanical strength of the material with a minimum value of 1,0 mm,
- b) grooves on the surface are at least 2,5 mm deep and at least 2,5 mm wide. If the associated clearance is less than 3 mm, the minimum groove width may be reduced to 1,5 mm.

NOTE 1 Projections above or depressions below the surface are considered as being either ribs or grooves, irrespective of their geometric form.

NOTE 2 Cemented constructions (see clause 12 of IEC 60079-0) are considered to be solid parts.

4.6 Solid electrical insulating materials

NOTE This term describes the form in which the materials are used and not necessarily that in which they are supplied; for example, insulating varnishes when cured are considered as being solid electrical insulating materials.

4.6.1 The mechanical characteristics of the materials that affect their functional behaviour, for example, strength and rigidity, shall be satisfactory either

- a) at a temperature up to at least 20 K above the maximum temperature attained in rated service, and at least 80 °C, or
- b) for insulated windings (see 4.8.3 and table 3), for internal wiring (see 4.9) and for cables permanently connected to electrical apparatus (see 14.1 of IEC 60079-0) up to the maximum temperature attained in rated service.

4.6.2 Insulating parts made of plastics or laminates, where the original surface is removed during manufacture, shall be coated with an insulating varnish having at least the same grading according to CTI as the original surface. This requirement does not apply to materials where these actions have not affected the grading according to CTI or where the specified creepage distance is provided by other parts not subjected to these actions.

4.7 Windings

4.7.1 Insulated conductors shall comply with the requirements of either 4.7.1.1 or 4.7.1.2.

4.7.1.1 The conductors shall be covered with at least two layers of insulation, only one layer of which may be an enamel.

4.7.1.2 Enamelled round winding wires shall be in accordance with either:

- a) grade 1 of IEC 60317-3, IEC 60317-7, IEC 60317-8, or IEC 60317-13 provided that:
 - when tested in accordance with clause 13 of IEC 60317-3, IEC 60317-7, IEC 60317-8 or IEC 60317-13 there shall be no failure with the minimum values of breakdown voltage listed for grade 2; and that
 - when tested in accordance with clause 14 of IEC 60317-3, IEC 60317-7, IEC 60317-8 or IEC 60317-13 there shall be not more than six faults per 30 m of wire irrespective of diameter; or
- b) grade 2 of IEC 60317-3, IEC 60317-7, IEC 60317-8, or IEC 60317-13; or
- c) grade 3 of IEC 60317-3, IEC 60317-7, IEC 60317-8, or IEC 60317-13.