INTERNATIONAL STANDARD

IEC 62314

First edition
2006-05

Solid-state relays

Reference number
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SOLID-STATE RELAYS

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International Standard IEC 62314 has been prepared by technical committee 94: All-or-nothing electrical relays.

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

FDIS	Report on voting
94/232/FDIS	94/235/RVD

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

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

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SOLID-STATE RELAYS

1 Scope and object

This International Standard applies to particular all-or-nothing electrical relays denominated solid-state relays intended for performing electrical operations by single step function changes to the state of electric circuits between the OFF-state and the ON-state and vice versa. It is applicable to solid-state relays with rated voltages up to 750 V and with a.c. output current up to 160 A.

NOTE Requirements for solid-state relays with d.c. output circuits are under consideration.

This standard deals with solid-state relays which are intended for incorporation in other products or equipment. As such, solid state relays are considered to be components and this standard defines the basic safety-related and functional requirements for solid-state relays as stand-alone components.

Such solid-state relays are incorporated in products or equipment which themselves have to comply with the relevant product and/or application standard(s) to meet their intended application. The following are examples of such applications:

– general industrial equipment;
– electrical facilities;
– electrical machines;
– electrical appliances;
– office communications;
– building automation and environmental control;
– automation and process control;
– electrical installation engineering;
– medical engineering;
– telecommunications;
– vehicle engineering;
– transportation engineering;
– lighting control.

Solid state relays are components (not stand alone devices) and as such do not perform a direct function. Therefore, no EMC requirements are included in this standard.

NOTE This is in line with the European EMC Directive.

Where the application of a solid-state relay determines additional requirements such as EMC and overcurrent protection, the solid-state relay shall be assessed in accordance with the relevant IEC standard(s).

Solid-state switching devices with monolithic structures fall within the scope of IEC subcommittee 47E and are not covered in this standard.

Semiconductor controllers and contactors fall within the scope of the IEC 60947 series of standards – *Low-voltage switchgear and controlgear* – developed by IEC subcommittee 17B and are not covered in this standard.

Compliance with the requirements of this standard is verified by the type tests indicated.

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The object of this standard is to state:

– the characteristics of solid-state relays;
– the requirements which solid-state relays shall comply with reference to
  a) their operation and behaviour;
  b) their dielectric properties;
  c) the degrees of protection provided by their enclosures, where applicable;
– the tests verifying that the requirements have been met, and the test methods to be adopted;
– the information to be given with the solid-state relay or in the manufacturer's documentation.

2 Normative references

The following referenced documents are indispensable for the application 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.

IEC 60038:1983, *IEC standard voltages*
Amendment 1 (1994)
Amendment 2 (1997)

IEC 60050-195:1998, *International Electrotechnical Vocabulary (IEV) – Part 195: Earthing and protection against electric shock*

IEC 60050-444:2002, *International Electrotechnical Vocabulary (IEV) – Part 444: Elementary relays*

IEC 60068-2-1:1990, *Environmental testing – Part 2: Tests. Tests A: Cold*

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests. Tests B: Dry heat*

IEC 60068-2-14:1984, *Environmental testing – Part 2: Tests. Test N: Change of temperature*
Amendment 1 (1986)

IEC 60068-2-20:1979, *Environmental testing – Part 2: Tests. Test T: Soldering*
Amendment 2 (1987)

IEC 60068-2-78:2001, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60112:2003, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

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*

IEC 60664-3:2003, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution*

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

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IEC 60695-10-2:2003, *Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test*

IEC 60695-11-10:2003, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60999-1:1999, *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)*

IEC 61210:1993, *Connecting devices – Flat quick-connect terminations for electrical copper conductors – Safety requirements*

IEC 61760-1:1998, *Surface mounting technology – Part 1: Standard method for the specification of surface mounting components (SMDs)*

3 Terms and definitions

For the purposes of this document the terms and definitions given in IEC 60050(444) and the following apply. .

3.1 Terms and definitions related to relays

3.1.1
solid-state relay
electrical relay in which the intended response is produced by electronic, magnetic, optical or other components without mechanical motion

[IEV 444-01-06]

3.1.2
electrical relay
device designed to produce sudden and predetermined changes in one or more output circuits when certain conditions are fulfilled in the electrical input circuits controlling the device

[IEV 444-01-01]

3.1.3
rated operational voltage
U_e
value of voltage which determines the application of the solid-state relay and to which the relevant tests and the load categories are referred

3.1.4
rated insulation voltage
U_i
value of voltage to which dielectric tests and creepage distances are referred

3.1.5
rated impulse withstand voltage
U_{imp}
peak value of an impulse voltage of prescribed form and polarity which the solid-state relay is capable of withstanding without failure under specified conditions of test and to which the values of the clearances are referred

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3.1.6
rated operational current
I_e
normal operating current when the solid-state relay is in the ON-state and takes into account the rated operating voltage, the rated frequency (see 4.3), the load category (see 4.4) and the overload characteristics at 40 °C ambient temperature unless otherwise specified

3.1.7
rated uninterrupted current
I_u
value of current, stated by the manufacturer, which the solid-state relay can carry in uninterrupted duty

3.1.8
rated frequency
supply frequency for which a solid-state relay is designed and to which the other characteristic values correspond

NOTE The same solid-state relay may be assigned a number or a range of rated frequencies or be rated for both a.c. and d.c.

3.1.9
overload current profile
gives the current/time coordinates for the controlled overload current

3.1.10
operating capability
represents the combined capabilities of

– current-commutation and current-carrying in the ON-state, and
– establishing and sustaining the OFF-state (blocking),

at maximum rated voltage under specified load and overload conditions in accordance with load category, overload current profile and specified duty cycles

3.1.11
rated conditional short-circuit current
value of prospective current, stated by the manufacturer, which the solid-state relay, protected by a short-circuit protective device specified by the manufacturer, can withstand satisfactorily for the operating time of this device under the test conditions specified in the relevant product standard

3.1.12
leakage current
I_l
r.m.s. value of maximum current, stated by the manufacturer, which the solid-state relay can carry in OFF-state condition

3.1.13
ON-state voltage drop
U_d
peak value of voltage, stated by the manufacturer, between solid-state relay terminals in the ON-state condition

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3.2 Terms and definitions related to insulation coordination (see Annex A)

3.2.1
clearance
shortest distance in air between two conductive parts

(IEC 60664-1, 1.3.2)

3.2.2
creepage distance
shortest distance along the surface of the insulating material between two conductive parts

(IEC 60664-1, 1.3.3)

3.2.3
functional insulation
insulation between conductive parts which is necessary only for the proper functioning of the equipment

(IEC 60664-1, 1.3.17.1)

3.2.4
solid insulation
solid insulating material interposed between two conductive parts

(IEC 60664-1, 1.3.4)

3.2.5
basic insulation
insulation applied to live parts to provide basic protection against electric shock

NOTE Basic insulation does not necessarily include insulation used exclusively for functional purposes.

(IEC 60664-1, 1.3.17.2)

3.2.6
supplementary insulation
independent insulation applied in addition to basic insulation, in order to provide protection against electric shock in the event of a failure of basic insulation

(IEC 60664-1, 1.3.17.3)

3.2.7
double insulation
insulation comprising both basic insulation and supplementary

(IEC 60664-1, 1.3.17.4)

3.2.8
reinforced insulation
single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in the relevant IEC standard

NOTE A single insulation system does not imply that the insulation must be one homogeneous piece. It may comprise several layers which cannot be tested singly as basic or supplementary insulation.

(IEC 60664-1, 1.3.17.5)

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3.2.9
overvoltage
any voltage having a peak value exceeding the corresponding peak value of the steady-state voltage at normal operating conditions

(IEC 60664-1, 1.3.7)

3.2.10
overvoltage category
numeral defining a transient overvoltage condition

NOTE Overvoltage categories I, II, III and IV are used, see 2.2.2.1 of IEC 60664-1.

(IEC 60664-1, 1.3.10)

3.2.11
pollution
any addition of foreign matter, solid, liquid or gaseous that can result in a reduction of electric strength or surface resistivity of the insulation

(IEC 60664-1, 1.3.11)

3.2.12
micro-environment
immediate environment of the insulation which particularly influences the dimensioning of the creepage distances

(IEC 60664-1, 1.3.12.2)

3.2.13
macro-environment
environment of the room or other location in which the equipment is installed or used

(IEC 60664-1, 1.3.12.1)

3.2.14
pollution degree
numeral characterising the expected pollution of the micro-environment

NOTE Pollution degrees 1, 2, 3 and 4 are used, see 2.5.1 of IEC 60664-1.

(IEC 60664-1, 1.3.13)

3.2.15
type 1 protection
protection against pollution by the use of coating, potting or moulding assuming Pollution degree 1 under the protection

NOTE 1 Requirements and tests are given in IEC 60664-3.

NOTE 2 Pollution degree 1 is specified in A.2.3.

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4 Characteristics of solid-state relays

4.1 Summary of characteristics

The characteristics of solid-state relays shall be stated with the following terms, where such terms are applicable:

– type of solid-state relay (see 4.2);

– rated and limiting values for load circuits (see 4.3);

– load category (see 4.4);

– rated and limiting values for control circuits (see 4.5).

4.2 Type of solid-state relay

The following shall be stated:

– number of poles;

– type of poles.

4.3 Rated and limiting values for load circuits

The rated and limiting values established for solid-state relays shall be stated in accordance with the following, but it need not to be performed to establish all applicable values by tests.

Rated voltages

– rated operational voltage (U_e);

– ON-state voltage drop (U_d);

– rated insulation voltage (U_i).

In no case shall the maximum value of the rated operational voltage exceed that of the rated insulation voltage.

NOTE Where no rated insulation voltage is specified for a solid-state relay, the highest value of the rated operational voltage is considered to be the rated insulation voltage.

– rated impulse withstand voltage (U_{imp}).

The rated impulse withstand voltage of a solid-state relay shall be equal to or higher than the values stated for the transient overvoltages occurring in the circuit in which the solid-state relay is incorporated.

Rated currents

– rated operational current (I_e);

– rated uninterrupted current (I_u);

– leakage current (I_l).

The requirements shall be given by the manufacturer.

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Rated frequency

Normal load and overload characteristics

– overload current profile

The overload current as a multiple of I_e (see Table 4) and represents the maximum value of operating current under operational overload conditions.

Deliberate overcurrents not exceeding ten cycles of the power-line frequency which may exceed the stated values of Table 4 are disregarded for the overload current profile.

– operating capability

Operating capability is characterized by

- rated operational voltage;
- rated operational current;
- overload current profile;
- load category.

Requirements are given in Clause 8.

Rated conditional short-circuit current

4.4 Load category

The load categories as given in Table 1 are considered standard. Any other type of load shall be based on agreement between manufacturer and user, but information given in the manufacturer's catalogue or tender may constitute such an agreement.

Each load category (see Table 1) is characterized by the values of the currents, voltages, power factors and other data of Tables 4 and 5 and by the test conditions specified in this standard.

A designated solid-state relay with a rating for one load category which has been verified by testing can be assigned other load categories without testing provided that

- the rated operational current and voltage that are verified by testing shall be not less than the ratings that are to be assigned without testing;
- the load category and duty cycle requirements for the tested rating shall be equal to or more severe than the rating that is to be assigned without testing;
- the overload current profile for the tested rating shall be equal to or more severe than the rating that is to be assigned without testing.

Table 1 – Load categories

Load category	Typical application
LC A	Resistive or slightly inductive loads
LC B	Motor loads
LC C	Electric discharge lamps
LC D	Incandescent lamps
LC E	Transformers
LC F	Capacitive loads

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4.5 Rated and limiting values for control circuits

The characteristics of electronic control circuits are:

– kind of current;
– power consumption;
– rated frequency;
– rated control circuit voltage, U_c;
– rated control supply voltage, U_s;
– switch-off voltage;
– switch-on voltage.

The rated control circuit voltage and rated frequency, if any, are the values on which the operating and temperature-rise characteristics of the control circuit are based. The manufacturer shall state the absolute minimum and the maximum operating values of the control circuit voltage U_c and the control supply voltage U_s.

NOTE 1 The manufacturer should be prepared to state the value or values of the current taken by the control circuit(s) at the rated control supply voltage.

NOTE 2 A distinction is made between control circuit voltage, U_c, which is the controlling input signal, and control supply voltage, U_s, which is the voltage applied to energize the power supply terminals of the control circuit equipment and may be different from U_c due to built-in transformers, rectifiers, etc.

5 Marking and documentation

5.1 Marking

Data 1a) and 1b) in Table 2 shall be marked on the solid-state relay so that they are legible and durable. If there is enough space on the solid-state relay 2a), 2b) and 2c) as well as the rated control supply voltage and terminal identification shall be marked additionally on the solid-state relay.

The test indicated below is carried out when only additional material(s) are used for marking (e.g. inkjet or pad printing).

Compliance with the durability requirements of for the marking is checked by inspection and by rubbing the marking by hand as follows:

a) 15 back-and-forth movements in about 15 s with a piece of cloth soaked with distilled water, followed by
b) 15 back-and-forth movements in about 15 s with a piece of cloth soaked with petroleum spirit.

During the tests, the soaked piece of cloth shall be pressed on the marking with a pressure of about 2 N/cm^2.

After these tests, the marking shall still be legible.

NOTE The petroleum spirit used is defined as an aliphatic solvent hexane with a content of aromatics of maximum 0,1 volume %, a kauributanol-value of 29, initial boiling point approximately 65 °C, dry point approximately 69 °C and specific gravity of 0,68 g/cm^3.

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5.2 Data

The manufacturer shall have available the data listed in Table 2:

Table 2 – Required data

N°	Data	Place of indication
1 *Identification*		
1a	The manufacturer's name or trademark	Solid-state relay
1b	Type designation or part number	Solid-state relay
1c	Number of this standard	Catalogue or instruction sheet
2 *Characteristics, basic rated values and load*		
2a	Rated operational voltages	Solid-state relay or catalogue or instruction sheet
2b	Rated operational currents	Solid-state relay or catalogue or instruction sheet
2c	Conditions for rated current	Solid-state relay or catalogue or instruction sheet
2d	ON-state voltage drop	Catalogue or instruction sheet
2e	Leakage current	Catalogue or instruction sheet
2f	Load category	Catalogue or instruction sheet
2g	Overload current profile	Catalogue or instruction sheet
2h	Value of the rated frequency/frequencies	Catalogue or instruction sheet
3 *Safety and installation*		
3a	Rated insulation voltage	Catalogue or instruction sheet
3b	Rated impulse withstand voltage	Catalogue or instruction sheet
3c	Pollution degree	Catalogue or instruction sheet
3d	Safety maximum load integral I^2t between 1 ms and 10 ms	Catalogue or instruction sheet
3e	Degree of protection according to IEC 60529	Catalogue or instruction sheet
4 *Control circuits*		
4a	Rated control circuit voltage, U_c, nature of current and rated frequency, and, if necessary, rated control supply voltage, U_s, nature of current and rated frequency and any other information (for example impedance matching requirements) necessary to ensure satisfactory operation of the control circuits	Solid-state relay or catalogue or instruction sheet

5.3 Instructions for installation, operation and maintenance

The manufacturer shall provide instructions for installation, operation and maintenance.

6 Normal conditions

6.1 Normal service, transport and storage conditions

6.1.1 Ambient temperature

The preferred ambient temperature range is –5 °C to +40 °C for operation and –25 °C to +85 °C for transport and storage of the solid-state relay, unless otherwise specified.

For operation outside this range see the manufacturer's specifications.

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6.1.2 Atmospheric conditions

6.1.2.1 Humidity and altitude

The manufacturer shall state the maximum relative humidity and altitude for storage, transport and operation.

6.1.2.2 Degree of pollution

Unless otherwise stated by the manufacturer, solid-state relays are intended for use in pollution degree 2 environmental conditions, as defined in Annex A.

6.2 Normal mounting conditions

The manufacturer shall specify the method of mounting.

7 Constructional requirements

7.1 Materials

The maximum permissible temperature of incorporated materials used in solid-state relays shall not exceed their safe operating limits, which shall be verified by testing according to 7.3 by at least one of the following means:

a) testing of the fully assembled device; or
b) testing of individual parts, or group of parts forming a subassembly, taken from the device; or
c) samples of identical material with a representative cross-section.

7.2 Clearances and creepage distances

See Clause A.3.

7.3 Heat and fire resistance

If an identical material with representative cross-sections has already satisfied the requirements of any of the tests in 7.3, then these tests need not be repeated.

The manufacturer may provide data from the insulating material supplier to demonstrate compliance with this requirement.

7.3.1 Glow wire test

The glow wire test shall be made in accordance with Annex B.

7.3.2 Flammability test

The flammability test shall be made in accordance with IEC 60695-11-10.

7.4 Terminals

7.4.1 Quick-connect terminations

See Annex C.

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7.4.2 Screw-type and screwless-type clamping-units

See IEC 60999-1.

7.4.3 Solder terminals

7.4.3.1 Resistance to soldering heat

Solder terminals and their supports shall have a sufficient resistance to soldering heat.

After the test of the resistance to soldering heat and subsequent cooling to room temperature, the solid-state relays shall fulfil their normal operation.

7.4.3.1.1 Solder pins

The test is carried out according to test Tb of IEC 60068-2-20 as given in Table 3 for method 1A.

Terminals for mounting on printed circuit boards shall be fitted with a thermal screen (simulating a printed board) of (1,5 ± 0,1) mm thickness. During the test, immersion shall be effectuated only up to the lower surface of this screen.

Table 3 – Test conditions for test Tb

Subclauses of IEC 60068-2-20	Conditions
5.3	No initial measurement
5.4	Method 1A: Solder bath at 260 °C (see Note)
5.4.3	Duration of immersion: (5 ± 1) s
5.6	Method 2: Soldering iron at 350 °C (see Note)
5.6.1	Soldering iron of size B
5.6.3	No cooling device
5.6.3	Duration of application of the soldering iron: (10 ± 1) s
NOTE Current practice, for example lead free solder may require a higher test temperature, in which case, this should be stated in the applicable detail specification.	

7.4.3.1.2 Terminals for surface mounting (SMD)

This test shall be carried out according to the procedure of 7.2.2 of IEC 61760-1 as stated by the manufacturer.

7.4.3.1.3 Other solder terminations (e.g. soldering lugs)

This test shall be carried out as indicated by the manufacturer in accordance with test Tb of IEC 60068-2-20 as given in Table 3.

The test shall be carried out as specified by the manufacturer according to Method 1A or Method 2.

8 Performance requirements

8.1 Temperature-rise

8.1.1 General

Solid-state relays are considered non-accessible during normal operation. In those applications requiring or permitting accessibility, the temperature-rise limitations of solid-state relays shall be determined in accordance with the relevant application requirements by the end user.

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The solid-state relays rated operational current rating shall be derated in accordance with the manufacturer's specification for operation at ambient temperatures above 40 °C.

8.1.2 Test conditions

The temperature measurements shall be carried out in air as undisturbed as possible. Therefore, the specimen shall be mounted in an enclosure which protects the immediate environment from external movements of air. The enclosure should be made of a non-heat-reflective material.

The sides of the enclosure may be movable to accommodate different specimen sizes. The sides shall not be closer than 200 mm from the edges of the specimen. The enclosure may have a lid, any such lid shall be provided with ventilation apertures to minimize any rise in ambient temperature caused by the heating effect of the specimen under test.

The specimen is to be arranged in the enclosure in a horizontal plane, 50 mm above the bottom of the enclosure and at least 150 mm below the top and equidistant from the sides. As far as possible, the specimen shall be in free suspension. If this is not possible, a thermal insulating material with a thermal conductivity 2 W/mK may be used, provided that not more than 20 % of the surface of the specimen is in contact with the insulating material.

If temperatures are measured with temperature probes, the probe leads shall pass through the insulation walls of the enclosure. Other methods of temperature measurement are permissible.

The point at which the ambient temperature is measured shall be located in a horizontal plane passing through the lowest vertical point of the specimen. It shall be located 100 mm to 150 mm from the mid-point of the edge of the longest side of the specimen. Care shall be taken to protect the probe against radiant heat.

The point for measuring the temperature of the specimen shall be as near as practicable to the output semiconductor of each specimen.

A current at a certain ambient temperature according to the manufacturer’s specification (e. g. derating curve) shall be maintained until thermal stability is achieved. This is defined as when three consecutive values of temperature-rise, taken at 5 min intervals, do not differ by more than 2 K from each other.

8.2 Overload test

Solid-state relays shall be required to establish an ON-state, to commutate, to carry designated levels of load and, if applicable, overload currents, and to establish and sustain an OFF-state condition without failure or any type of damage, when tested in accordance with 8.2.1.

For solid-state relays designated for the load categories LC A, LC B, LC C, LC D, LC E, LC F are intended for use without a bypass.

Ratings shall be verified under the conditions stated in Table 4.

Where test current I_c is greater than 1 000 A, verification of the overload capability shall be subject to agreement between manufacturer and user (for example by computer modelling).

More severe test values than given in Table 4 may be specified by the manufacturer.

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Table 4 – Minimum requirements for overload capability test conditions

Load category	Parameters of the test circuit			Operation cycle [a] ON-time	Operation cycle [a] OFF-time	Number of operating cycles
	I_c/I_e	U_c/U_e	cos φ	s	s	
LC A	1,5	1,1	0,8	5	10	5
LC B	8	1,1	0,35	1,6	1440	3
LC C	3,0	1,1	0,45	0,05	10	5
LC D	1,5	1,1	[b]	0,05	60	50
LC E	30	1,1	< 1	0,05	10	5
LC F	[d]	1,1	[c]	0,05	10	1 000

I_c is the test current.

I_e is the rated operational current.

U_e is the rated operational voltage.

U_c is the test voltage.

Temperature conditions

The initial case temperature T_c, for each test shall be not less than 40 °C plus the maximum case temperature-rise during the temperature-rise test. During the test, the ambient air temperature shall be between +10 °C and +40 °C.

[a] Changeover time shall be not greater than three full periods of the power frequency.

[b] Tests to be carried out with an incandescent light load.

[c] Tests to be carried out with a capacitive load.

[d] Capacitive ratings may be derived by capacitor switching tests or assigned on the basis of established practice and experience. The peak inrush current of capacitor shall be less than or equal to the non-repetitive peak ON-state surge current rating of the SSR.

8.2.1 Overload capability test procedure

a) Test conditions

1) Refer to Table 4.

2) Solid-state relays utilizing a current-controlled cut-out device in addition to an overcurrent protective means that provides protection against overload conditions during running in the ON-state, shall be tested with the cut-out device in place. In this test, it is acceptable for the cut-out device to switch the specimen to the OFF-state in a time shorter than the specified ON-time.

b) Specimen adjustments

1) Specimens shall be adjusted to minimize the time to establish the test current level.

2) Specimens fitted with a current-limit function shall be set to the values of Table 4.

c) Test

1) Establish initial conditions.

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2) Apply test voltage to the input main circuit terminals of the specimen.

The test voltage shall be applied for the duration of the test.

3) Switch the specimen to ON-state.

4) After the ON-time (see Table 4), switch the specimen to the OFF-state.

d) Verify the criteria

1) No loss of commutating capability.

2) No loss of blocking capability.

3) No loss of functionality.

4) No visual evidence of damage.

8.3 Endurance test

8.3.1 During the endurance test described in this clause, there shall be no electrical or structural breakdown of the solid-state relay. After the test, the device shall comply with the requirements of the rated impulse withstand voltage per Annex A, Table A.1.

8.3.2 The conditions for the endurance test shall be the same as the conditions for the overload test as specified in 8.2 except as described in this subclause.

8.3.3 The solid-state relay is to close and open a test circuit having the applicable current and power factor cos φ specified in Table 5. The number of test cycles and the test cycle times are to be as specified in Table 5. The closed circuit test voltage shall be 100 % to 110 % of the rated operational voltage U_e.

8.3.4 If tungsten-filament lamps are used as the load, the load shall be made up of the smallest possible number of 500-watt lamps, or of larger lamps if agreed between manufacturer and user; except that one or two lamps smaller than the 500-watt size may be used if necessary to make up the required load.

Table 5 – Endurance test

Intended device application	Test current, amperes	Power factor (cos φ)	Number of cycles	Test cycle times, seconds	
				ON	OFF
LC A	Rated current	0,75 – 0,80	6000	1	9
LC B	Twice full-load current	0,40 – 0,50	1000	0,5[1]	0,5[1]
LC C	Twice rated current	0,40 – 0,50	6000	1	9
LC D	Rated current. See 8.3.4 – 8.3.7	1,0	6000	1[2]	59[2]
LC E	Under consideration	[3]	Under consideration	Under consideration	Under consideration
LC F	Rated current	[4]	6000	1	9

1 For reversing motors the test cycle time is 0,5 s forward, 0,5 s reverse and 1 s off. If the device operation will not permit these cycle times, times as close as possible to these are to be used.

2 A control may be operated faster than 1 cycle per minute if synthetic loads are used or if a sufficient number of banks of lamps controlled by a commutator are employed so that each bank will cool for at least 59 s between successive applications.

3 The load shall consist of commercially available transformers.

4 The load shall consist of commercially available capacitors.

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8.3.5 With regard to 8.3.4, the circuit shall be such that the peak value of the inrush current will be reached in 1/240 of a second after the circuit is closed.

8.3.6 A synthetic load may be used in place of tungsten-filament lamps if it is equivalent to a tungsten-filament lamp load on the test circuit in question, and the inrush current is at least ten times the normal current.

8.3.7 A synthetic load used in place of tungsten-filament lamps may consist of non-inductive resistors if they are connected and controlled so that a portion of the resistance is shunted during the closing of the switch under test. A synthetic load may also consist of a non-inductive resistor or resistors that are connected in parallel with a capacitor.

8.4 Insulation tests

See Annex A.

8.5 Impact test

Under consideration. This test applies only when required.

8.6 Ball pressure test

The test shall be made in accordance with IEC 60695-10-2. This test applies only when required.

8.7 OFF-state leakage current measurement

The OFF-state leakage current shall be in accordance with the manufacturer's specification. It is supposed to use an appropriate equipment.

8.8 ON-state voltage drop measurement

The ON-state voltage drop shall be in accordance with the manufacturer's specification. It is supposed to use an appropriate equipment.

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9 Type test

The tests according to this standard are type tests.

NOTE Tests according to this standard can be applied to routine and sampling tests as appropriate.

Table 6 – Type testing

Clause	Tests	Inspection lot	Number of specimens
5	Marking and documentation	1	1
8.5	Impact test		
8.6	Ball pressure test		
7.3	Heat and fire resistance		
A.2.4.1	Comparative tracking index	2	1
8.4	Clearances, creepage distances and distances through solid insulation	3	1 (not potted) and 1 (potted)
A.4.1.2	Insulation resistance and AC power frequency voltage test	4	3
7.4.1	Quick-connect terminations (if applicable)	5	According to manufacturer specification
7.4.2	Screw-type and screwless-type clamping-units (if applicable)		
7.4.3	Solder terminals (if applicable)		
	Alternative termination types (if applicable)		
8.1	Temperature-rise		
8.2	Overload test		
8.3	Endurance test		
8.7	OFF-state leakage current		
8.8	ON-state voltage drop		

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Annex A
(normative)

Insulation coordination

A.1 General

Terms and definitions which apply to this annex are given in 3.2.

A.2 Basis for insulation coordination

A.2.1 Basic principles

The requirements and tests of this standard are based on the provisions of IEC 60664-1, where further information and guidance related to insulation coordination within low-voltage equipment is provided.

Insulation coordination implies the selection of the electric insulation characteristics of the solid-state relay with regard to its application and in relation to its surroundings.

Insulation coordination can only be achieved if the design of the solid-state relay is based on the stresses to which it is likely to be subjected during its anticipated lifetime.

NOTE The standard insulation for solid-state relays is the basic insulation. However, there are cases of application in which higher quality insulation (supplementary, reinforced, or double insulation) is required.

A.2.2 Rated impulse withstand voltage

The rated impulse withstand voltages for solid-state relays connected directly to the supply system (mains) are listed in Table A.1. This table gives the rated impulse withstand voltages for different overvoltage categories depending upon the selected line-to-neutral voltage. If applicable, the latter shall be derived from the nominal voltage of the mains as indicated in Table A.1, also.

NOTE In particular cases, the provisions of the relevant IEC standard for the equipment in which the solid-state relay is incorporated may apply in addition.

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Table A.1 – Rated impulse withstand voltages (waveform: 1,2/50 µs) for solid-state relays connected directly to the mains

Nominal voltage of the supply system (mains) based upon IEC 60038 V		**Voltage line-to-neutral derived from nominal voltages a.c. or d.c. up to and including** V	**Rated impulse withstand voltage** V			
			Overvoltage category			
Three phase	**Single phase**		**I**	**II**	**III**	**IV**
		50	330	500	800	1 500
		100	500	800	1 500	2 500
	120-240	150	800	1 500	2 500	4 000
230/400/ 277/480		300	1 500	2 500	4 000	6 000
400/690		600	2 500	4 000	6 000	8 000
1 000		1 000	4 000	6 000	8 000	12 000

Remark:	The descriptions of overvoltage categories below are for information. The actual overvoltage category to be considered has to be taken from the equipment standard defining the application of the solid-state relay. In special cases (particular for existing designs), intermediate values derived by interpolation may be used.
Overvoltage category I	Applies to equipment intended for connection to fixed installations of buildings, but where measures have been taken (either in the fixed installation or in the equipment) to limit transient overvoltages to the level indicated.
Overvoltage category II	Applies to equipment intended for connection to fixed installations of buildings.
Overvoltage category III	Applies to equipment in fixed installations, and for cases where a higher degree of availability of the equipment is expected.
Overvoltage category IV	Applies to equipment intended for use at or near the origin of the installation, from the main distributor towards the supply mains.

Normally overvoltage category III is relevant for solid-state relays; this means, for example 4 kV for a.c. 230 V (voltage line-to-neutral).

Voltages higher than the rated impulse withstand voltages can occur during solid-state relay operation. If required, the user shall take measures to limit the effects of overvoltage.

A.2.3 Pollution

The pollution degree refers to the environmental conditions under which the solid-state relay shall operate.

For the immediate external environment of the solid-state relay, the following three pollution degrees are defined for the assessment of the clearances and creepage distances:

- Pollution degree 1: No pollution or only dry, non-conductive pollution occurs. The pollution has no influence.
- Pollution degree 2: Only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is to be expected.
- Pollution degree 3: Conductive pollution occurs or dry non-conductive pollution occurs which becomes conductive due to condensation which is to be expected.

Solid-state relays are designed for pollution degree 2 unless otherwise specified by the manufacturer.

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A.2.4 Insulating materials

A.2.4.1 Comparative tracking index (CTI)

A.2.4.1.1 With regard to tracking, an insulating material can be roughly characterized according to the damage it suffers from the concentrated release of energy during scintillations when a surface leakage current is interrupted due to the drying-out of the contaminated surface. The following behaviour of an insulating material in the presence of scintillations can occur:

– no decomposition of the insulating material;

– the wearing away of insulating material by the action of electrical discharges (electrical erosion);

– the progressive formation of conductive paths which are produced on the surface of insulating material due to the combined effects of electric stress and electrolytically conductive contamination on the surface (tracking).

NOTE Tracking or erosion will occur when:

– a liquid film carrying the surface leakage current breaks, and

– the applied voltage is sufficient to break down the small gap formed when the film breaks, and

– the current is above a limiting value which is necessary to provide sufficient energy locally to thermally decompose the insulating material beneath the film.

Deterioration increases with the time for which the current flows.

A.2.4.1.2 A method of classification for insulating materials according to A.2.4.1.1 does not exist. The behaviour of the insulating material under various contaminants and voltages is extremely complex. Under these conditions, many materials may exhibit two or even all three of the characteristics stated. A direct correlation with the material groups of A.2.4.1.3 is not practical. However, it has been found by experience and tests that insulating materials having a higher relative performance and also have approximately the same relative ranking according to the comparative tracking index (CTI). Therefore, this standard uses the CTI values to categorize insulating materials.

A.2.4.1.3 For the purposes of this standard, materials are classified into four groups according to their CTI values. These values are determined in accordance with IEC 60112 using solution A. The groups are as follows:

– material group I: $600 \le$ CTI;

– material group II: $400 \le$ CTI < 600;

– material group IIIa: $175 \le$ CTI < 400;

– material group IIIb : $100 \le$ CTI < 175.

The proof tracking index (PTI) is used to verify the tracking characteristics of materials. A material may be included in one of these four groups on the basis that the PTI, verified by the method of IEC 60112 using Solution A, is not less than the lower value specified for the group.

A.2.4.1.4 The test for comparative tracking index (CTI) in accordance with IEC 60112 is designed to compare the performance of various insulating materials under test conditions. It gives a qualitative comparison in the case of insulating materials under test conditions. It gives a qualitative comparison and in the case of insulating materials having a tendency to form tracks, it also gives a quantitative comparison.

A.2.4.1.5 For glass, ceramics or other inorganic insulating materials which do not track, creepage distances need not be greater than their associated clearance for the purpose of insulation co-ordination. The dimensions of Table A.2 for inhomogeneous field conditions are appropriate.

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A.3 Requirements and dimensioning rules

A.3.1 Dimensioning of clearances

Unless clearances are verified by electrical test (see A.4.1.1), clearances shall be equal to or greater than the minimum values of Table A.2.

NOTE The values are identical to those in IEC 60664-1 (Case A, inhomogeneous field).

Table A.2 – Minimum clearances

<table>
<tr><th rowspan="3">Required impulse withstand voltage [a]

kV</th><th colspan="3">Minimum clearances in air in millimetres up to 2 000 m above sea level
Pollution degree</th></tr>
<tr><th>1</th><th>2</th><th>3</th></tr>
<tr><th>mm</th><th>mm</th><th>mm</th></tr>
<tr><td>0,33</td><td>0,01</td><td rowspan="3">0,2</td><td rowspan="4">0,8</td></tr>
<tr><td>0,50</td><td>0,04</td></tr>
<tr><td>0,80</td><td>0,1</td></tr>
<tr><td>1,5</td><td>0,5</td><td>0,5</td></tr>
<tr><td>2,5</td><td>1,5</td><td>1,5</td><td>1,5</td></tr>
<tr><td>4,0</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>6,0</td><td>5,5</td><td>5,5</td><td>5,5</td></tr>
<tr><td>8,0</td><td>8</td><td>8</td><td>8</td></tr>
<tr><td>12</td><td>14</td><td>14</td><td>14</td></tr>
<tr><td colspan="4">[a] In special cases (particular for existing designs), intermediate values derived by interpolation may be used for the dimensioning of clearances.</td></tr>
</table>

The dimensions of Table A.2 apply to functional, basic and supplementary insulation. Where reinforced insulation is required the dimensions indicated for one step higher in the sequence of impulse withstand voltage values shall be chosen.

As the dimensions in Table A.2 are valid for altitudes up to and including 2000 m above sea level, clearances for altitudes above 2000 m are to be multiplied by the altitude correction factor specified in Table A.2 in IEC 60664-1. For any part for which the dielectric properties are not sensitive to altitude (e.g. opto-coupler, potted parts, etc.) the correction factor for altitude is not applicable.

A.3.2 Dimensioning of creepage distances

A.3.2.1 Voltage

For values which are not given in Table A.3, the next higher value shall be taken.

The creepage distances between circuits and accessible surfaces shall be in accordance with the highest rated voltage for electrically connected circuits which have different rated voltages.

Creepage distances between the circuits shall be in accordance with the highest rated voltage for electric circuits which are insulated from each other.

A.3.2.2 Dimensioning of creepage distances of basic, supplementary and reinforced insulation

Creepage distances for basic and supplementary insulation shall comply with the minimum dimensions given in Table A.3.

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In the case of reinforced insulation, the creepage distances shall not be inferior to twice the distance required for basic insulation.

For printed wiring materials with type 1 protection the values for pollution degree 1 of Table A.3 apply beneath the coating. For verification, the requirements in IEC 60664-3 are applicable.

Table A.3 – Minimum creepage distances for solid-state relays

Voltage r.m.s. [a] V	Creepage distances in millimetres						
	Pollution degree						
	1	2			3		
	[b] mm	Material group			Material group		
		I mm	II mm	III mm	I mm	II mm	III [c] mm
10	0,08	0,4	0,4	0,4	1	1	1
12,5	0,09	0,42	0,42	0,42	1,05	1,05	1,05
16	0,1	0,45	0,45	0,45	1,1	1,1	1,1
20	0,11	0,48	0,48	0,48	1,2	1,2	1,2
25	0,125	0,5	0,5	0,5	1,25	1,25	1,25
32	0,14	0,53	0,53	0,53	1,3	1,3	1,3
40	0,16	0,56	0,8	1,1	1,4	1,6	1,8
50	0,18	0,6	0,85	1,2	1,5	1,7	1,9
63	0,2	0,63	0,9	1,25	1,6	1,8	2
80	0,22	0,67	0,95	1,3	1,7	1,9	2,1
100	0,25	0,71	1	1,4	1,8	2	2,2
125	0,28	0,75	1,05	1,5	1,9	2,1	2,4
160	0,32	0,8	1,1	1,6	2	2,2	2,5
200	0,42	1	1,4	2	2,5	2,8	3,2
250	0,56	1,25	1,8	2,5	3,2	3,6	4
320	0,75	1,6	2,2	3,2	4	4,5	5
400	1	2	2,8	4	5	5,6	6,3
500	1,3	2,5	3,6	5	6,3	7,1	8
630	1,8	3,2	4,5	6,3	8	9	10
800	2,4	4	5,6	8	10	11	12,5
1000	3,2	5	7,1	10	12,5	14	16

[a] This voltage is:

– for functional insulation: the working voltage;

– for basic and supplementary insulation of the circuit energized directly from the low-voltage mains: the rated voltage, or the rated insulation voltage;

– for basic and supplementary insulation of solid-state relay circuits not energized directly from the low-voltage mains: the highest r.m.s. voltage which can occur in the circuit when the solid-state relay is supplied at rated voltage and under the most onerous combination of conditions of operation within the solid-state relay rating.

[b] Material groups I, II, IIIa and IIIb.

[c] Material group IIIb is not recommended for application in pollution degree 3 above 630 V.

NOTE For material groups see A.2.4.1.3.

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A.3.3 Requirements for solid insulating materials

Solid insulation shall withstand the impulse voltage specified in A.2.2 in case of basic and supplementary insulation. For reinforced insulation, the value one step higher in the sequence of impulse withstand voltage values shall be chosen.

In addition, solid insulation shall withstand:

– the short-term temporary overvoltages of U_n + 1 200 V for durations up to 5 s, and
– the long-term temporary overvoltages of U_n + 250 V for durations longer than 5 s

where U_n is the r.m.s. value of the line-to-neutral voltage in case of supply systems with earthed neutral conductor. For reinforced insulation, twice these values apply.

In those cases where the basic insulation and the supplementary insulation cannot be tested separately, the test voltage specified for reinforced insulation shall be used.

Neither through mechanical action nor through breaking, unfastening or detachment of a wire, the insulation of the protective separation may be impaired to such an extent that the insulation no longer fulfils the requirements for basic insulation.

Application of type 2 protection is under consideration.

A.4 Tests and measurements

A.4.1 Tests

The following tests are intended for use as type tests with respect to insulation coordination.

A.4.1.1 Test for verification of clearances

The verification is carried out by measurement of clearances (see A.4.2).

The test shall be carried out in accordance with A.4.1.2.2. No flashover or breakdown shall occur. This test may be combined with the test sequence given in A.4.1.2.4.

A.4.1.2 Electrical tests for solid insulation

The electrical tests for solid insulation shall be carried out in accordance with the test sequence given in A.4.1.2.4.

NOTE The partial discharge test described in 4.1.2.4 of IEC 60664-1 is under consideration for solid-state relays within the scope of this standard.

The tests shall be carried out on new test specimens unless otherwise specified.

A.4.1.2.1 Preconditioning

The test specimens shall undergo the following preconditioning in order to produce stationary initial conditions:

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Table A.4 – Preconditioning

Climatic sequence		
–25 °C	96 h	Cold (storage and transportation simulation) according to IEC 60068-2-1
125 °C	168 h	Dry heat according to IEC 60068-2-2
–25 °C / +125 °C	15 cycles	Rapid change of temperature according to IEC 60068-2-14 Transition time 2 min to 3 min Dwell time 1 h
40 °C / 93 % r.h.	96 h	Damp heat, steady state according to IEC 60068-2-78 with d.c. 100 V applied to adjacent contacts

A.4.1.2.2 Impulse voltage test

This test is conducted with rated impulse withstand voltage according to Table A.1 and a waveform of 1,2/50 µs. Five pulses for each polarity are required with a minimum time interval of 1 s between subsequent pulses.

A dielectric test with a.c. voltage with a peak value which is equal to the impulse test voltage is also permitted as an alternative to the standard impulse voltage test. The test shall be carried out for a minimum of 3 cycles of the a.c. test voltage. However, it should be noted that this means that the solid-state relay is exposed to a much higher stress.

No puncture or breakdown of solid insulation shall occur during the test.

A.4.1.2.3 AC power frequency voltage test

The a.c. test voltage shall be raised uniformly from 0 V to the short-term temporary overvoltage within not more than 5 s and held at that value for 5 s. Instead of raising the test voltage gradually, it may also be applied immediately.

There shall be no breakdown of solid insulation during the test.

The insulation test with d.c. voltage is not permitted as an alternative test.

A current of lower than or equal to 3 mA is not considered as a breakdown, unless otherwise stated.

A.4.1.2.4 Test sequence

a) Preconditioning.
b) Impulse voltage test or dielectric test with a.c. voltage.
c) AC power frequency voltage test.

A.4.2 Measurement of creepage distances and clearances

The width X specified in examples 1 to 11 apply to all examples as a function of the pollution degree as follows:

Pollution degree	Width X
1	≥ 0,25 mm
2	≥ 1,0 mm
3	≥ 1,5 mm

If the associated clearance is less than 3 mm, the minimum width X may be reduced to one-third of this clearance.

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The methods of measuring creepage distances and clearances are indicated in the following Examples 1 to 11. These cases do not differentiate between gaps and grooves or between types of insulation.

The following assumptions are made:

– any recess is assumed to be bridged with an insulating link having a length equal to the specified width X and being placed in the most unfavourable position (see Example 3);

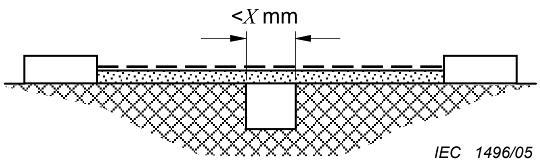
– where the distance across a groove is equal to or larger than the specified width X, the creepage distance is measured along the contours of the groove (see Example 2);

– creepage distances and clearances measured between parts which can assume different positions in relation to each other, are measured when these parts are in their most unfavourable position.

Explanation for Examples 1 to 11:

______ clearance

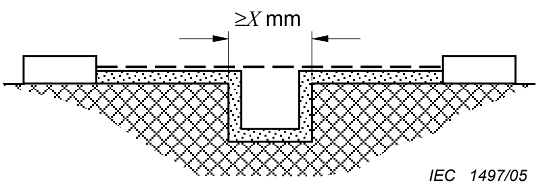
creepage distance



Example 1

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

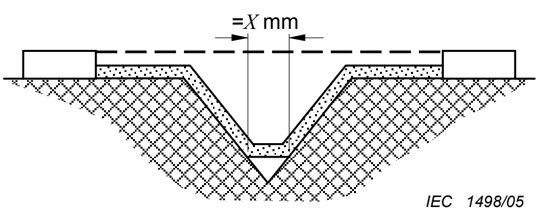
Rule: Creepage distance and clearance are measured directly across the groove as shown.



Example 2

Condition: Path under consideration includes a parallel-sided groove of any depth and with a width equal to or more than "X" mm.

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



Example 3

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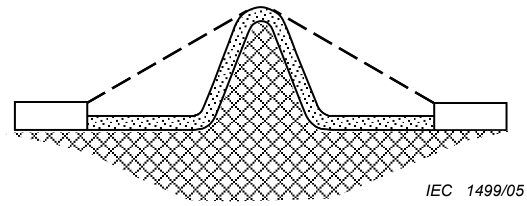
Condition: Path under consideration includes a V-shaped groove with a width greater than "*X*" mm.

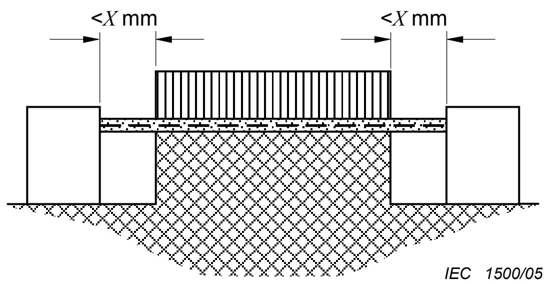
Rule: Clearance is the "line-of-sight" distance. Creepage path follows the contour of the groove but "short-circuits" the bottom of the groove by an "*X*" mm link.



Example 4

Condition: Path under consideration includes a rib.

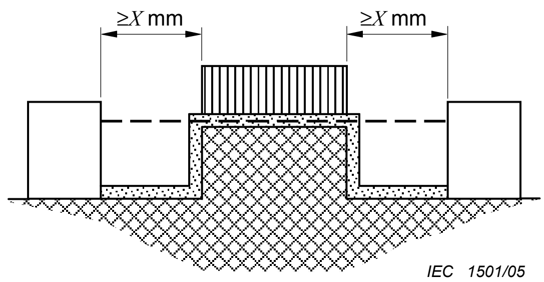
Rule: Clearance is the shortest direct air path over the top of the rib. Creepage path follows the contour of the rib.



Example 5

Condition: Path under consideration includes an uncemented joint with grooves 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.

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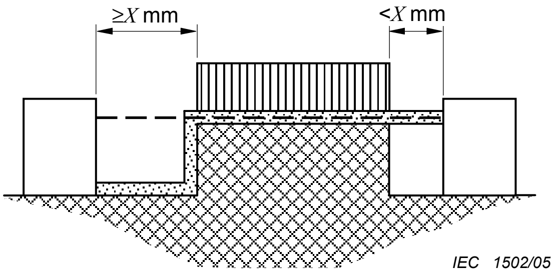
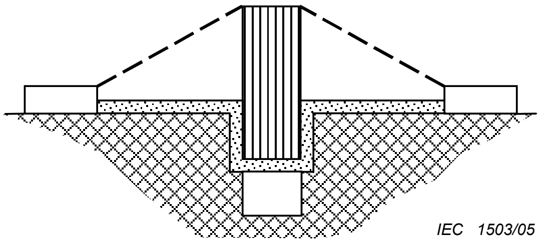


Example 7

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.

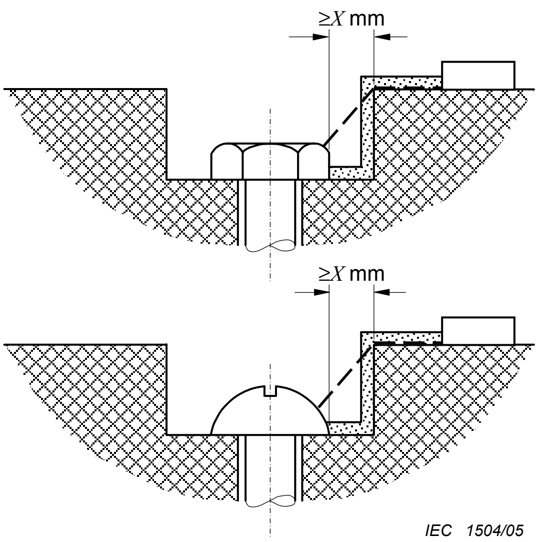
Rule: Clearance and creepage paths are as shown.



Example 8

Condition: Creepage distance through an uncemented joint is less than creepage distance over a barrier.

Rule: Clearance is the shortest direct air path over the top of the barrier.



Example 9

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

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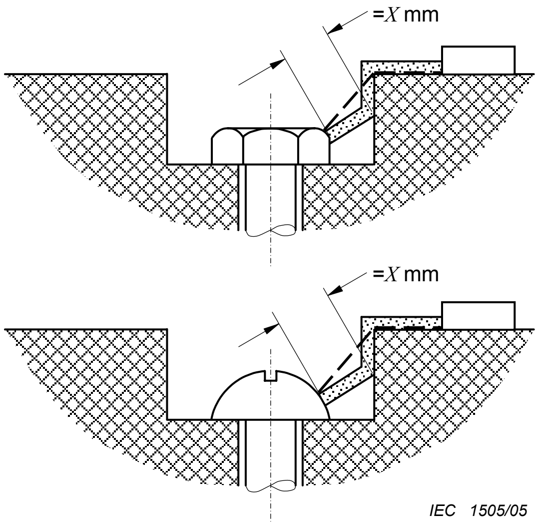
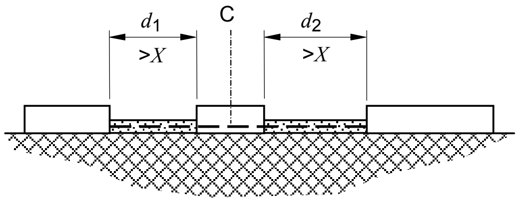


Example 10

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.



Example 11

Key

C floating part
Clearance is the distance $d_1 + d_2$
Creepage distance is also $d_1 + d_2$

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Annex B
(normative)

Glow-wire test

In IEC 60695-2-10 the glow-wire test is specified, simulating the effect of thermal stress which can be produced by heat sources such as glowing parts and overloaded components, in order to assess the risk of fire.

The test described in that standard is applicable mainly to electrotechnical equipment, their subassemblies and components, but may also be used for solid insulating materials and other combustible materials.

The following applies for this standard:

Compliance with the requirements for heat and fire resistance is verified with the glow-wire test at 650 °C (see Figures B.1 and B.2).

If the application of the solid-state relay necessitates more stringent requirements (e.g. household appliances, consumer electronics), the temperature of the glow-wire shall be either 750 °C or 850 °C for parts which are in contact with or support current-carrying parts or electrical connections, in particular when the deterioration of such parts could cause overheating.

When the solid-state relay is either too small or of an inconvenient shape to carry out the test, the test is made using a specimen of the respective material from which the solid-state relay is manufactured. This specimen shall have an appropriate shape of 500 mm^2 minimum and not more than 3 mm thick. The dimensions shall be indicated in the test report.

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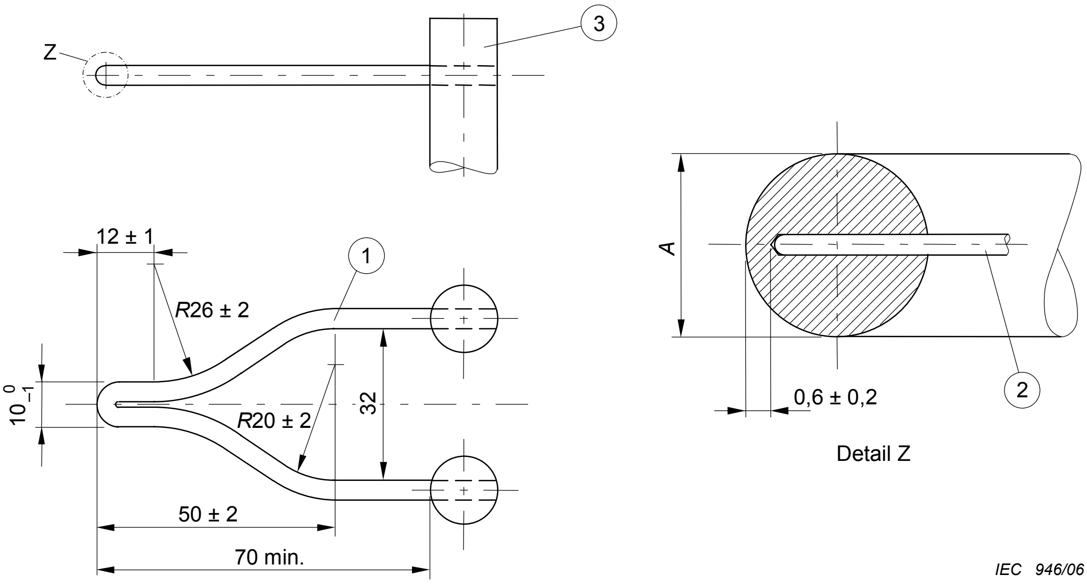
Dimensions in millimetres



Key

1 Glow-wire
2 Thermocouple
3 Stud

Glow-wire material:	Nickel/chromium (80/20)
Diameter:	4,0 mm ± 0,04 mm (before bending)
Diameter A:	(after bending) see 6.1 of IEC 60695-2-10

When forming the glow-wire loop, care shall be taken to avoid fine cracking at the tip.

NOTE Annealing is a suitable process for prevention of fine cracking at the tip.

Figure B.1 – Glow-wire and position of the thermocouple

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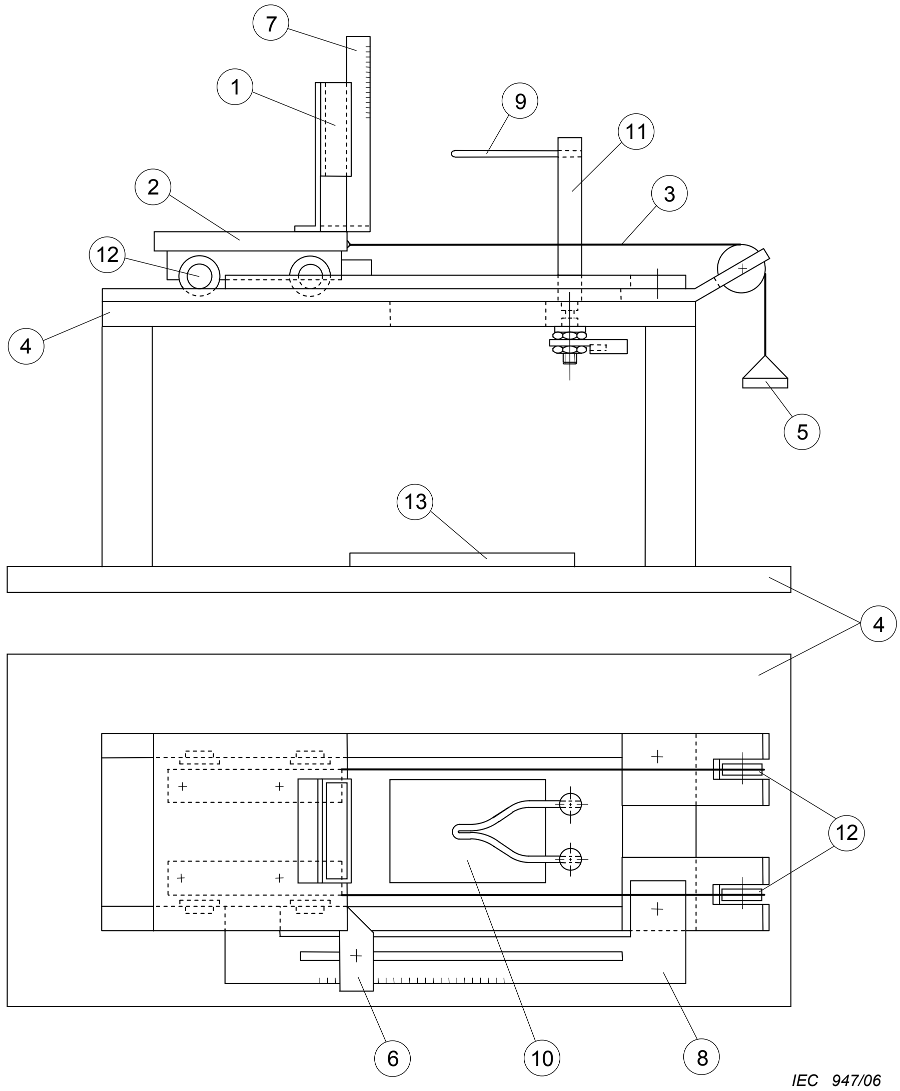

Key

1 Test specimen support
2 Carriage
3 Tensioning cord
4 Base plate
5 Weight
6 Adjustable stop
7 Scale to measure height of flame
8 Penetration adjustment
9 Glow-wire
10 Cut-out in base plate for falling particles
11 Glow-wire mounting stud
12 Low-friction rollers
13 Specified layer

Figure B.2 – Glow-wire test apparatus (example)

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Annex C
(normative)

Quick-connect terminations

C.1 Purpose

In this annex, requirements and tests for quick-connect (QC) terminations are compiled. Reference is made to IEC 61210, the basic safety standard for such QC terminations.

C.2 Requirements

C.2.1 Temperature-rise

Under the conditions specified in 8.2, the temperature of the terminals shall not exceed the maximum value as listed for various materials in Annex A of IEC 61210, and the maximum temperature-rise shall not exceed 45 K.

C.2.2 Size

Male tabs of QC terminations which are part of a solid-state relay shall comply with the dimensions given in Table 10-1 of IEC 61210.

C.2.3 Material

The material and the coating (if applicable) of the male tab shall be appropriate to the maximum temperature given in Annex A of IEC 61210.

C.2.4 Stability

Male tabs shall withstand connection and disconnection of an appropriate female connector without damage to the solid-state relay such as to impair compliance with the requirements of this standard.

C.2.5 Distance

Tabs shall be adequately spaced to allow the connection of the appropriate uninsulated female connectors.

C.3 Recommended values

The following values of the maximum resistive current carried by flat QC terminations with respect to the termination size are recommended:

2,8 mm	6 A
4,8 mm	16 A
6,3 mm	25 A
9,5 mm	32 A

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C.4 Test

C.4.1 Temperature-rise test

Solid-state relays with flat quick-connect tabs shall be fitted with conductors of a length of 1 m and having the appropriate cross-sectional area as given in Table C.1. The material of the female test connectors shall be tin-plated brass for temperatures up to 120 °C.

C.4.2 Mechanical stability

The mechanical stability of male tabs shall be checked by the mechanical overload force test as specified in 9.2 of IEC 61210.

Compliance with the requirement for adequate spacing of tabs is checked by applying an appropriate female connector (see Table 11 of IEC 61210) to each tab in the most onerous orientation; during this operation, no strain or distortion shall occur to any of the tabs or to their adjacent parts, nor shall the creepage distances or clearances be reduced to values less than those specified.

Table C.1 – Cross-sectional areas for conductors depending on the resistive current carried by the terminal

Resistive current carried by the terminal A		**Flexible conductors**	**Rigid conductors**
Over	**Up to an including**	**Cross-sectional areas** mm^2	**Cross-sectional areas** mm^2
–	3	0,5	0,75
3	6	0,75	1,0
6	10	1,0	1,5
10	16	1,5	2,5
16	25	2,5	4,0
25	32	4,0	6,0
32	40	6,0	10,0
40	63	10,0	16,0

NOTE This table is an excerpt from Table 4 of IEC 61058-1: 2000, *Switches for appliances – Part 1: General requirements*.

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