

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Low-voltage switchgear and controlgear –
Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination
units**

**Appareillage à basse tension –
Partie 3: Interrupteurs, sectionneurs, interrupteurs-sectionneurs et combinés-
fusibles**

Withdawn



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

**Part 3: Switches, disconnectors, switch-disconnectors
and fuse-combination units**

FOREWORD

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International Standard IEC 60947-3 has been prepared by subcommittee 17B: Low-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

This third edition cancels and replaces the second edition published in 1999, Amendment 1 (2001) and Amendment 2 (2005). This edition constitutes a technical revision.

The document 17B/1601/FDIS, circulated to the National Committees as amendment 3, led to the publication of the new edition.

This edition includes the following significant technical changes with respect to the previous edition:

- alignment with the fifth edition of IEC 60947-1;
- a switching operation without current allowed between making and breaking operation (Table 3);
- increased number of operations for AC-23 allowed with agreement of the manufacturer (Table 3);

- simplified test procedure amended, f) added to 8.3.2.1.3;
- temperature rise test shall be made at the rated operational current I_e instead of the conventional enclosed thermal current I_{the} (8.3.3.1).

The text of this standard is based on the first edition, its amendment 1, amendment 2 and the following documents:

FDIS	Report on voting
17B/1601/FDIS	17B/1608/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.

A list of all parts of the IEC 60947 series can be found, under the general title *Low-voltage switchgear and controlgear*, on the IEC website.

This part is to be used in conjunction with IEC 60947-1. The numbering of the subclauses is sometimes not continuous because it is based on IEC 60947-1.

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

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- withdrawn;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

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units

1 General

The provisions of the general rules dealt with in IEC 60947-1 are applicable to this part, where specifically called for. Clauses and subclauses, tables, figures and appendices of the general rules thus applicable are identified by reference IEC 60947-1, e.g., 4.3.4.1 of IEC 60947-1, Table 4 of IEC 60947-1, or Annex A of IEC 60947-1.

1.1 Scope and object

This part of IEC 60947 applies to switches, disconnectors, switch-disconnectors and fuse-combination units to be used in distribution circuits and motor circuits of which the rated voltage does not exceed 1 000 V a.c. or 1 500 V d.c.

The manufacturer shall specify the type, ratings and characteristics according to the relevant standard of any incorporated fuses.

This part does not apply to equipment coming within the scope of IEC 60947-2, IEC 60947-4-1 and IEC 60947-5-1; however, when switches and fuse-combination units coming into the scope of this part are normally used to start, accelerate and/or stop an individual motor they shall also comply with the additional requirements given in Annex A.

The requirements for single pole operated three pole switches are included in Annex C.

Auxiliary switches fitted to equipment within the scope of this part shall comply with the requirements of IEC 60947-5-1.

This part does not include the additional requirements necessary for electrical apparatus for explosive gas atmospheres.

NOTE 1 Depending on its design, a switch (or disconnector) can be referred to as "a rotary switch (disconnector)", "cam-operated switch (disconnector)", "knife-switch (disconnector)", etc.

NOTE 2 In this part, the word "switch" also applies to the apparatus referred to in French as "commutateurs", intended to modify the connections between several circuits and *inter alia* to substitute a part of a circuit for another.

NOTE 3 In general, throughout this part switches, disconnectors, switch-disconnectors and fuse-combination units will be referred to as "equipment".

The object of this part is to state

- a) the characteristics of the equipment;
- b) the conditions with which the equipment shall comply with reference to
 - 1) operation and behaviour in normal service;
 - 2) operation and behaviour in case of specified abnormal conditions, e.g. short circuit;
 - 3) dielectric properties;
- c) the tests for confirming that these conditions have been met and the methods to be adopted for these tests;

- d) the information to be marked on the equipment or made available by the manufacturer, e.g. in the catalogue.

1.2 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 60050-441:1984, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*
Amendment 1 (2000)

IEC 60269 (all parts), *Low-voltage fuses*

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

IEC 60417-DB:2000¹, *Graphical symbols for use on equipment*

IEC 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 60947-2:2006, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*

IEC 60947-4-1:2000, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*
Amendment 1 (2002)
Amendment 2 (2005)

IEC 60947-5-1:2003, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*
Amendment 1 (1998)
Amendment 2 (2000)

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*
Amendment 1 (2007)

IEC 61000-4-4:2004, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2005, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2003, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*
Amendment 1 (2004)
Amendment 2 (2006)

CISPR 11:2003, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement*

¹ "DB" refers to the IEC on-line database.

Amendment 1 (2004)
Amendment 2 (2006)

CISPR 22:2005, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

Amendment 1 (2005)
Amendment 2 (2006)

2 Terms and definitions

For the purposes of this part of IEC 60947, the terms and definitions given in IEC 60050-441, IEC 60947-1 and the following apply.

	Reference
D	
Dependent manual operation (of a mechanical switching device).....	2.13
Disconnecter.....	2.2
Disconnecter-fuse.....	2.7
F	
Fuse-combination unit.....	2.4
Fuse-disconnector.....	2.8
Fuse-switch.....	2.6
Fuse-switch-disconnector.....	2.10
I	
Independent manual operation (of a mechanical switching device).....	2.14
M	
Multiple tip contact system.....	2.12
S	
Semi-independent manual operation.....	2.15
Single pole operated three pole switch.....	2.11
Stored energy operation (of a mechanical switching device).....	2.16
Switch (mechanical).....	2.1
Switch-disconnector.....	2.3
Switch-disconnector-fuse.....	2.9
Switch-fuse.....	2.5

2.1

(mechanical) switch

mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions which may include specified operating overload conditions and also carrying for a specified time currents under specified abnormal circuit conditions such as those of short-circuit

NOTE A switch may be capable of making, but not breaking, short-circuit currents.
[IEV 441-14-10]

2.2

disconnecter

mechanical switching device which, in the open position, complies with the requirements specified for the isolating function

[IEV 441-14-05, modified]

NOTE 1 This definition differs from IEV 441-14-05 by referring to isolating function instead of isolating distance.

NOTE 2 A disconnector is capable of opening and closing a circuit when either a negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the poles of the disconnector occurs. It is also capable of carrying currents under normal circuit conditions and carrying for a specified time currents under abnormal conditions such as those of short circuit.

2.3

switch-disconnector

switch which, in the open position, satisfies the isolating requirements specified for a disconnector

[IEV 441-14-12]

2.4

fuse-combination unit

combination of a mechanical switching device and one or more fuses in a composite unit, assembled by the manufacturer or in accordance with his instructions

[IEV 441-14-04]

NOTE (Not included in IEV 441-14-04.) This is a general term for fuse switching devices (see also from 2.5 to 2.10 and Table 1).

2.5

switch-fuse

switch in which one or more poles have a fuse in series in a composite unit

[IEV 441-14-14]

2.6

fuse-switch

switch in which a fuse-link or a fuse-carrier with fuse-link forms the moving contact

[IEV 441-14-17]

2.7

disconnector-fuse

disconnector in which one or more poles have a fuse in series in a composite unit

[IEV 441-14-15]

2.8

fuse-disconnector

disconnector in which a fuse-link or fuse-carrier with fuse-link forms the moving contact

[IEV 441-14-18]

2.9

switch-disconnector-fuse

switch-disconnector in which one or more poles have a fuse in series in a composite unit

[IEV 441-14-16]

2.10

fuse-switch-disconnector

switch-disconnector in which a fuse-link or a fuse-carrier with fuse-link forms the moving contact

[IEV 441-14-19]

2.11

single pole operated three pole switch

device consisting of three individually operable single pole switch disconnecting devices according to this part, rated as a complete unit for use in a three-phase system

NOTE These devices are intended for power distribution systems where switching and/or isolation of an individual phase may be necessary and they should not be used for the switching of the primary circuit of three-phase equipment.

2.12

multiple tip contact system

system that consists of more than one contact gap per pole, which can be switched, in series and/or in parallel

2.13

dependent manual operation (of a mechanical switching device)

operation solely by means of directly applied manual energy such that the speed and force of the operation are dependent upon the action of the operator

[IEV 441-16-13]

2.14

independent manual operation (of a mechanical switching device)

stored energy operation where the energy originates from manual power, stored and released in one continuous operation, such that the speed and force of the operation are independent of the action of the operator

[IEV 441-16-16]

2.15

semi-independent manual operation

operation solely by means of directly applied manual energy such that the manual force is increased up to a threshold value beyond which the independent switching operation is achieved unless deliberately delayed by the operator

2.16

stored energy operation (of a mechanical switching device)

operation by means of energy stored in the mechanism itself prior to the completion of the operation and sufficient to complete it under predetermined conditions

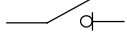
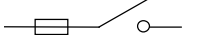
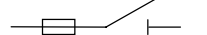
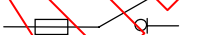
NOTE This kind of operation may be subdivided according to

- a) the manner of storing the energy (spring, weight, etc.);
- b) the origin of the energy (manual, electric, etc.);
- c) the manner of releasing the energy (manual, electric, etc.).

[IEV 441-16-15]

A summary of equipment definitions is given in Table 1.

Table 1 – Summary of equipment definitions

Functions		
Making and breaking current	Isolating	Making, breaking and isolating
Switch 2.1 	Disconnecter 2.2 	Switch-disconnector 2.3 
Fuse-combination units 2.4		
Switch-fuse 2.5  a	Disconnecter-fuse 2.7  a	Switch-disconnector-fuse 2.9  a
Fuse-switch 2.6 	Fuse-disconnector 2.8 	Fuse-switch-disconnector 2.10 
NOTE 1 All equipment may be single-break or multi-break. NOTE 2 Numbers are subclause references of the relevant definitions. NOTE 3 Symbols are based on IEC 60617-7.		
a The fuse may be on either side of or in a stationary position between the contacts of the equipment.		

3 Classification

3.1 According to the utilization category

See 4.4.

3.2 According to the method of operation of manually operated equipment

- dependent manual operation (see 2.13);
- independent manual operation (see 2.14);
- semi-independent manual operation (see 2.15).

NOTE The method of operation on closing may be different from the method for opening.

3.3 According to suitability for isolation

- suitable for isolation (see 7.1.7 of IEC 60947-1 and 7.1.7.1);
- not suitable for isolation.

3.4 According to the degree of protection provided

See 7.1.12 of IEC 60947-1.

4 Characteristics

4.1 Summary of characteristics

The characteristics of the equipment shall be stated in terms of the following as applicable:

- type of equipment (see 4.2);
- rated and limiting values for the main circuit (see 4.3);
- utilization category (see 4.4);
- control circuits (see 4.5);
- auxiliary circuits (see 4.6);

4.2 Type of equipment

The following shall be stated.

4.2.1 Number of poles

4.2.2 Kind of current

Kind of current (a.c. or d.c.) and, in the case of a.c., number of phases and rated frequency.

4.2.3 Number of positions of the main contacts (if more than two)

4.3 Rated and limiting values for the main circuit

Rated values are assigned by the manufacturer. They shall be stated in accordance with 4.3.1 to 4.3.6.4 but it may not be necessary to establish all the rated values listed.

4.3.1 Rated voltages

An equipment is defined by the following rated voltages.

4.3.1.1 Rated operational voltage (U_e)

Subclause 4.3.1.1 of IEC 60947-1 applies.

4.3.1.2 Rated insulation voltage (U_i)

Subclause 4.3.1.2 of IEC 60947-1 applies.

4.3.1.3 Rated impulse withstand voltage (U_{imp})

Subclause 4.3.1.3 of IEC 60947-1 applies.

4.3.2 Currents

An equipment is defined by the following currents.

4.3.2.1 Conventional free air thermal current (I_{th})

Subclause 4.3.2.1 of IEC 60947-1 applies.

4.3.2.2 Conventional enclosed thermal current (I_{the})

Subclause 4.3.2.2 of IEC 60947-1 applies.

4.3.2.3 Rated operational currents (I_e) (or rated operational powers)

Subclause 4.3.2.3 of IEC 60947-1 applies.

4.3.2.4 Rated uninterrupted current (I_u)

Subclause 4.3.2.4 of IEC 60947-1 applies.

4.3.3 Rated frequency

Subclause 4.3.3 of IEC 60947-1 applies.

4.3.4 Rated duty

The rated duties considered as normal are as follows.

4.3.4.1 Eight-hour duty

Subclause 4.3.4.1 of IEC 60947-1 applies.

4.3.4.2 Uninterrupted duty

Subclause 4.3.4.2 of IEC 60947-1 applies.

4.3.5 Normal load and overload characteristics**4.3.5.1 Ability to withstand motor switching overload currents**

See Annex A.

4.3.5.2 Rated making capacity

Subclause 4.3.5.2 of IEC 60947-1 applies with the following additions.

The rated making capacity is stated by reference to the rated operational voltage and rated operational current and to the utilization category according to Table 3.

Not applicable to AC-20 or DC-20 equipment.

4.3.5.3 Rated breaking capacity

Subclause 4.3.5.3 of IEC 60947-1 applies with the following additions.

The rated breaking capacity is stated by reference to the rated operational voltage and rated operational current and to the utilization category according to Table 3.

Not applicable to AC-20 or DC-20 equipment.

4.3.6 Short-circuit characteristics**4.3.6.1 Rated short-time withstand current (I_{cw})**

The rated short-time withstand current of a switch, a disconnector or a switch-disconnector is the value of short-time withstand current, assigned by the manufacturer, that the equipment can carry without any damage under the test conditions of 8.3.5.1.

The value of the rated short-time withstand current shall be not less than twelve times the maximum rated operational current and, unless otherwise stated by the manufacturer, the duration of the current shall be 1 s.

For a.c., the value of the current is the r.m.s. value of the a.c. component and it is assumed that the highest peak value likely to occur does not exceed n times this r.m.s. value, the factor n being given by Table 16 of IEC 60947-1.

4.3.6.2 Rated short-circuit making capacity (I_{cm})

The rated short-circuit making capacity of a switch or a switch-disconnector is the value of short-circuit making capacity assigned to the equipment by the manufacturer for the rated operational voltage, at rated frequency (if any) and at a specified power-factor (or time-constant). It is expressed as the maximum prospective peak current.

For a.c., the relationship between power-factor, prospective peak current and r.m.s. current shall be in accordance with Table 16 of IEC 60947-1.

Not applicable to AC-20 or DC-20 equipment.

4.3.6.3 Vacant

4.3.6.4 Rated conditional short-circuit current

Subclause 4.3.6.4 of IEC 60947-1 applies.

4.4 Utilization category

The utilization categories define the intended applications and are given in Table 2.

Each utilization category is characterized by the values of the currents and voltages, expressed as multiples of the rated operational current and the rated operational voltage, as well as the power-factors or time-constants of the circuit. The conditions for making and breaking given in Table 3 correspond in principle to the applications listed in Table 2.

The designation of utilization categories is completed by the suffix A or B according to whether the intended applications require frequent or infrequent operations (see Table 4).

Utilization categories with suffix B are appropriate for devices which, due to design or application, are only intended for infrequent operation. This could apply, for example, to disconnectors normally only operated to provide isolation for maintenance work or switching devices where the fuse-link blade forms the moving contact.

The distinction between frequent and infrequent operation is based on the manufacturer's rated operation and the number of operating cycles used as a test criterion in Table 4.

For a particular rated operational current I_e , a device will be designated for frequent use (category A) if the manufacturer's rated operating life is more than the number of operating cycles indicated in columns 3, 4 or 5 of Table 4.

Table 2 – Utilization categories

Nature of current	Utilization categories		Typical applications
	Category A	Category B	
Alternating current	AC-20A ^a	AC-20B ^a	– Connecting and disconnecting under no-load conditions
	AC-21A	AC-21B	– Switching of resistive loads including moderate overloads
	AC-22A	AC-22B	– Switching of mixed resistive and inductive loads, including moderate overloads
	AC-23A	AC-23B	– Switching of motor loads or other highly inductive loads
Direct current	DC-20A ^a	DC-20B ^a	– Connecting and disconnecting under no-load conditions
	DC-21A	DC-21B	– Switching of resistive loads including moderate overloads
	DC-22A	DC-22B	– Switching of mixed resistive and inductive loads, including moderate overloads (e.g. shunt motors)
	DC-23A	DC-23B	– Switching of highly inductive loads (e.g. series motors)
^a The use of these utilization categories is not permitted in the USA.			

Category AC-23 includes occasional switching of individual motors. The switching of capacitors or of tungsten filament lamps shall be subject to agreement between manufacturer and user.

The utilization categories referred to in Tables 2 and 3 do not apply to an equipment normally used to start, accelerate and/or stop individual motors. The utilization categories for such an equipment are dealt with in Annex A.

4.5 Control circuits

Subclause 4.5 of IEC 60947-1 applies.

4.6 Auxiliary circuits

Subclause 4.6 of IEC 60947-1 applies.

4.7 Relays and releases

Subclause 4.7 of IEC 60947-1 applies.

5 Product information

5.1 Nature of information

Subclause 5.1 of IEC 60947-1 applies as appropriate for a particular design.

5.2 Marking

5.2.1 Each equipment shall be marked in a durable and legible manner with the following data.

The markings for a), b) and c) below shall be on the equipment itself or on a name-plate or name-plates attached to the equipment, and shall be located at a place such that they are legible from the front after mounting the equipment in accordance with the manufacturer's instructions.

- a) Indication of the open and closed position. The open and closed position shall be respectively indicated by the graphical symbols 60417-IEC-5007 and 60417-IEC-5008 of IEC 60417-2 (see 7.1.6.1 of IEC 60947-1).
- b) Suitability for isolation.
The appropriate symbols of Table 1 shall be used.
- c) Additional marking for disconnectors.

Devices of utilization category AC-20A, AC-20B, DC-20A and DC-20B shall be marked "Do not operate under load", unless the device is interlocked to prevent such operation.

NOTE Symbols of the various types of equipment are given in Table 1.

5.2.2 The following data shall also be marked on the equipment but need not be visible from the front when the equipment is mounted:

- a) manufacturer's name or trade mark;
- b) type designation or serial number;
- c) rated operational currents (or rated powers) at the rated operational voltage and utilization category (see 4.3.1, 4.3.2 and 4.4);
- d) value (or range) of the rated frequency or the indication "d.c." (or the symbol $\equiv$);
- e) for fuse-combination units, the fuse type and maximum rated current and the power loss of the fuse-link;
- f) IEC 60947-3, if the manufacturer claims compliance with this part;
- g) degree of protection of enclosed equipment (see Annex C of IEC 60947-1).

5.2.3 The following terminals shall be identified:

- a) line and load terminals unless the connection is immaterial (see 8.3.3.3.1);
- b) neutral pole terminal, if applicable, by the letter "N" (see 7.1.8.4 of IEC 60947-1);
- c) protective earth terminal (see 7.1.10.3 of IEC 60947-1).

5.2.4 The following data shall be made available in the manufacturer's published information:

- a) rated insulation voltage;
- b) rated impulse withstand voltage for equipment suitable for isolation or when determined;
- c) pollution degree, if different from 3;
- d) rated duty;
- e) rated short-time withstand current and duration, where applicable;
- f) rated short-circuit making capacity, where applicable;
- g) rated conditional short-circuit current, where applicable.

5.3 Instructions for installation, operation and maintenance

Subclause 5.3 of IEC 60947-1 applies.

6 Normal service, mounting and transport conditions

Clause 6 of IEC 60947-1 applies with the following addition.

Pollution degree (see 6.1.3.2 of IEC 60947-1).

Unless otherwise stated by the manufacturer, the equipment is intended for installation under environmental conditions of pollution degree 3.

7 Constructional and performance requirements

7.1 Constructional requirements

Subclause 7.1 of IEC 60947-1 applies, with the following additions.

7.1.2 Materials

The suitability of materials used shall be verified with respect to resistance to abnormal heat and fire by conducting tests

- a) on the equipment; or
- b) on sections taken from the equipment; or
- c) on samples of identical material having a representative cross-section.

If an identical material having a representative cross-section has already satisfied the requirements, then those tests need not be repeated.

7.1.2.2 Glow wire testing

Subclause 7.1.2.2 of IEC 60947-1 applies with the following additions.

Parts of insulating material necessary to retain current-carrying parts in position shall conform to the glow-wire tests of 8.2.1.1.1 of IEC 60947-1 at a test temperature of 960 °C.

7.1.4 Clearances and creepage distances

Subclause 7.1.4 of IEC 60947-1 applies with the following addition.

Guidance on the measurement of clearances and creepage distances is given in Annex G of IEC 60947-1.

7.1.7 Additional requirements for equipment suitable for isolation

Subclause 7.1.7 of IEC 60947-1 applies with the following additions.

7.1.7.1 Additional constructional requirements

The equipment shall be marked according to 5.2.1 b).

When no indication of the position of the contacts is provided, for example by the actuator or a separate indicator, all the main contacts shall be clearly visible in the open position.

The strength of the actuating mechanism and the reliability of the indication of the open position shall be checked according to 8.2.5. Moreover, when means are provided by the manufacturer to lock the equipment in the open position, locking shall only be possible when the main contacts are in the open position (see 8.2.5).

This requirement does not apply to equipment where the main contact position is visible in the open position and/or the open position is indicated by other means than the actuator.

NOTE Locking in the closed position is permitted for particular applications.

The clearance across the open contacts of the same pole when in the open position shall not be less than the minimum clearance given in Table 13 of IEC 60947-1 and shall also comply with the requirements of 7.2.3.1 b) of IEC 60947-1.

7.1.7.2 Supplementary requirements for equipment with provision for electrical interlocking with contactors or circuit-breakers

If an equipment suitable for isolation is provided with an auxiliary switch for the purpose of electrical interlocking with contactor(s) or circuit-breaker(s) and intended to be used in motor circuits, the following requirements shall apply unless the equipment is rated for AC-23 utilization category.

An auxiliary switch shall be rated according to IEC 60947-5-1 as stated by the manufacturer.

The time interval between the opening of the contacts of the auxiliary switch and the contacts of the main poles shall be sufficient to ensure that the associated contactor or circuit-breaker interrupts the current before the main poles of the equipment open.

Unless otherwise stated in the manufacturer's technical literature, the time interval shall be not less than 20 ms when the equipment is operated according to the manufacturer's instructions.

Compliance shall be verified by measuring the time interval between the instant of opening of the auxiliary switch and the instant of opening of the main poles under no-load conditions when the equipment is operated according to the manufacturer's instructions.

During the closing operation, the contacts of the auxiliary switch shall close after or simultaneously with the contacts of the main poles.

A suitable opening time interval may also be provided by an intermediate position (between the ON and OFF positions) at which the interlocking contact(s) is (are) open and the main poles remain closed.

7.1.7.3 Supplementary requirements for equipment provided with means for padlocking the open position

The locking means shall be designed in such a way that it cannot be removed with the appropriate padlock(s) installed. When the equipment is locked by even a single padlock, it shall not be possible by operating the actuator, to reduce the clearance between open contacts to the extent that it no longer complies with the requirements of 7.2.3.1 b) of IEC 60947-1.

Alternatively, the design may provide padlockable means to prevent access to the actuator.

Compliance with the requirements to padlock the actuator shall be verified using a padlock specified by the manufacturer or an equivalent gauge, giving the most adverse conditions, to simulate locking. The force F , specified in 8.2.5.2 shall be applied to the actuator in an attempt to operate the equipment from the open position to the closed position. Whilst the force F is applied, the equipment shall be subjected to a test voltage across open contacts. The

equipment shall be capable of withstanding the test voltage required according to Table 14 of IEC 60947-1 appropriate to the rated impulse withstand voltage.

7.1.9 Additional requirements for equipment provided with a neutral pole

Subclause 7.1.9 of IEC 60947-1 applies except for the note referring to an over-current release.

7.1.12 Degrees of protection of enclosed equipment

Degrees of protection of enclosed equipment and relevant tests are given in Annex C of IEC 60947-1.

7.2 Performance requirements

7.2.1 Operating conditions

7.2.1.1 General

Subclause 7.2.1.1 of IEC 60947-1 applies with the following additions.

The following requirements apply to fuse-switches, fuse-disconnectors and fuse-switch-disconnectors with a rated short-circuit making capacity exceeding 10 kA and for which the closing operation is by direct manual operation without an interposing mechanism (dependent and semi-independent manual operation see 2.13 and 2.15).

The test speed for the making operations specified in 8.3.6.2 shall be determined as follows.

- a) The equipment shall be operated 15 times manually under no-load conditions in accordance with the manufacturer's instructions, 5 times by each of three persons. The velocity of the hand actuator at the instant of contact closure of the last closing contact shall be determined by oscillographic or other appropriate means at any convenient part of the device.

The point at which the measurement is made and the velocity at the measurement point shall be stated in the test report. The mean velocity shall be determined after deleting the highest and lowest values.

- b) The test apparatus shall ensure that the equipment under test fully closes and that there is no impediment to the free closing movement of the device. The actual test speed shall not exceed the mean velocity determined according to a).

The mass of the moving parts of the test apparatus (without the equipment under test) shall be $2 \text{ kg} \pm 10 \%$.

7.2.2 Temperature rise

Subclause 7.2.2 of IEC 60947-1 applies with the following addition.

For fuse-combination units, the temperature rise of the fuse-link contacts during the test according to 8.3.3.1 shall not cause any damage of a nature which impairs the subsequent performance of the equipment in test sequence I.

7.2.3 Dielectric properties

Subclause 7.2.3 of IEC 60947-1 applies with the following additions.

7.2.3.1 Impulse withstand voltage

Subclause 7.2.3.1 of IEC 60947-1 applies with the following addition.

Clearances across the open contacts of a device not suitable for isolation shall withstand the test voltage given in Table 12 of IEC 60947-1 appropriate to the rated impulse withstand voltage.

7.2.3.2 Power-frequency withstand voltage of the main, auxiliary and control circuits

Subclause 7.2.3.2 c) of IEC 60947-1 applies with the following addition.

For equipment suitable for isolation, maximum values of leakage current are specified for all the test sequences in 8.3.3.5, 8.3.4.3, 8.3.5.4, 8.3.6.4 and 8.3.7.3 respectively.

7.2.4 Ability to make and break under no-load, normal load and overload conditions

7.2.4.1 Making and breaking capacities

The rated making and breaking capacities are stated by reference to the rated operational voltage and rated operational current and to the utilization category according to Table 3.

The test conditions are specified in 8.3.3.3.1.

Table 3 – Verification of rated making and breaking capacities (see 8.3.3.3) – Conditions for making and breaking corresponding to the various utilization categories

Utilization categories	Rated operational current	Making ^a			Breaking			Number of operating cycles ^c
		I/I_e	U/U_e	$\cos \phi$	I_c/I_e	U_r/U_e	$\cos \phi$	
AC-20A ^b – AC-20B ^b AC-21A – AC-21B AC-22A – AC-22B AC-23A – AC-23B	All values All values All values $0 < I_e \leq 100 \text{ A}$ $100 \text{ A} < I_e$	– 1,5 3 10 10	– 1,05 1,05 1,05 1,05	– 0,95 0,65 0,45 0,35	– 1,5 3 8 8	– 1,05 1,05 1,05 1,05	– 0,95 0,65 0,45 0,35	5 5 5 3 ^d
Utilization categories	Rated operational categories	I/I_e	U/U_e	L/R ms	I_c/I_e	U_r/U_e	L/R ms	Number of operating cycles
DC-20A ^b – DC-20B ^b DC-21A – DC-21B DC-22A – AC-22B DC-23A – DC-23B	All values All values All values All values	7 1,5 4 4	– 1,05 1,05 1,05	– 1 2,5 15	– 1,5 4 4	– 1,05 1,05 1,05	– 1 2,5 15	5 5 5 5
I = making current I_c = breaking current I_e = rated operational current U = applied voltage U_e = rated operational voltage U_r = operational frequency or d.c. recovery voltage								
^a For a.c. the making current is expressed by the r.m.s. value of the periodic component of the current. ^b The use of these utilization categories is not permitted in the USA. ^c One switching operation without current between each making and breaking operation is allowed, providing it does not alter the time interval between the prescribed operations as defined in 8.3.3.3.1. ^d In order to cover both AC-21 and AC-22 categories, an increase in the number of operations for AC-23 from 3 to 5 is allowed with the agreement of the manufacturer.								

7.2.4.2 Operational performance

Tests concerning the verification of the operational performance of an equipment are intended to verify that the equipment is capable of making and breaking without failure the currents flowing in its main circuit for the intended use.

The number of operating cycles and the test circuit parameters for the operational performance test for the various utilization categories are given in Tables 4 and 5.

The test conditions are specified in 8.3.4.1.

**Table 4 – Verification of operational performance –
Number of operating cycles corresponding to the rated operational current**

1	2	3	4	5	6	7	8
Rated operational current I_e	Number of operating cycles per hour	Number of operating cycles					
		AC and DC A categories			AC and DC B categories		
		Without current	With current	Total	Without current	With current	Total
$0 < I_e \leq 100$	120	8 500	1 500	10 000	1 700	300	2 000
$100 < I_e \leq 315$	120	7 000	1 000	8 000	1 400	200	1 600
$315 < I_e \leq 630$	60	4 000	1 000	5 000	800	200	1 000
$630 < I_e \leq 2 500$	20	2 500	500	3 000	500	100	600
$2 500 < I_e$	10	1 500	500	2 000	300	100	400
The values in the table apply to all utilization categories except AC-20A, AC-20B, DC-20A and DC-20B. These categories shall comply with the total number of operating cycles in columns 5 or 8 without current. Column 2 gives the minimum operating rate. The operating rate for any utilization category may be increased with the consent of the manufacturer.							

Table 5 – Test circuit parameters for Table 4

Utilization categories	Values of the rated operational current I_e	Making ^a			Breaking		
		I/I_e	U/U_e	$\cos \phi$	I_c/I_e	U_r/U_e	$\cos \phi$
AC-21A AC-21B	All values	1	1	0,95	1	1	0,95
AC-22A AC-22B	All values	1	1	0,8	1	1	0,8
AC-23A AC-23B	All values	1	1	0,65	1	1	0,65
		I/I_e	U/U_e	L/R ms	I_c/I_e	U_r/U_e	L/R ms
DC-21A DC-21B	All values	1	1	1	1	1	1
DC-22A DC-22B	All values	1	1	2	1	1	2
DC-23A DC-23B	All values	1	1	7,5	1	1	7,5
I = making current I_c = breaking current I_e = rated operational current U = voltage before make (applied voltage) U_e = rated operational voltage U_r = operational frequency or d.c. recovery voltage							
^a For a.c., the making current is expressed by the r.m.s. value of the periodic component of the current.							

7.2.4.3 Mechanical durability

Subclause 7.2.4.3.1 of IEC 60947-1 applies. Test conditions are specified in 8.5.1.

7.2.4.4 Electrical durability

Subclause 7.2.4.3.2 of IEC 60947-1 applies. Test conditions are specified in 8.5.2.

7.2.5 Ability to make, break or withstand short-circuit currents

The equipment shall be so constructed as to be capable of withstanding, under the conditions specified in this part, the thermal, dynamic and electrical stresses resulting from short-circuit currents.

Short-circuit currents may be encountered during current making, current carrying in the closed position and current interruption.

The ability of the equipment to make, carry and break short-circuit currents is stated in terms of one or more of the following ratings.

- a) Rated short-time withstand current (see 4.3.6.1).
- b) Rated short-circuit making capacity (see 4.3.6.2).
- c) Rated conditional short-circuit current (see 4.3.6.4).

7.2.6 Vacant

7.2.7 Additional performance requirements for equipment suitable for isolation

These requirements only apply to equipment with rated operational voltage greater than 50 V.

With the equipment in new condition and the contacts in the open position the equipment shall withstand the dielectric test of 8.3.3.2.

If tests according to 8.3.3.3 and 8.3.4.1 have been made, the equipment in the condition after the tests shall meet the leakage current requirements of 8.3.3.5.

7.2.8 Vacant

7.2.9 Overload requirements for equipment incorporating fuses

The main circuit of an equipment shall be capable of carrying an overload current according to 8.3.7.1 and shall not cause any damage of a nature which impairs the subsequent performance of the equipment in test sequence V.

7.3 Electromagnetic compatibility

7.3.1 Vacant

7.3.2 Immunity

7.3.2.1 Equipment not incorporating electronic circuits

Equipment within the scope of this part standard not incorporating electronic circuits are not sensitive to electromagnetic disturbances in normal service conditions and therefore no immunity tests are required.

7.3.2.2 Equipment incorporating electronic circuits

Equipment incorporating electronic circuits (e.g. an electronic fuse-blowing indicator) shall have a satisfactory immunity to electromagnetic disturbances (see 8.4.1.2).

Table 6 – Immunity tests

Types of immunity test	Applicable basic standards	Severity levels required
Electrostatic discharge	IEC 61000-4-2	Air discharge 8 kV or contact discharge 4 kV
Electromagnetic field	IEC 61000-4-3	10 V/m
Fast transient/burst	IEC 61000-4-4	2 kV
Surge	IEC 61000-4-5	2 kV (common mode) 1 kV (differential mode)
Conducted disturbances induced by RF fields	IEC 61000-4-6	10 V
NOTE A simple rectifier is not sensitive to electromagnetic disturbances in normal service conditions and does not therefore require immunity tests.		

7.3.3 Emission

7.3.3.1 Equipment not incorporating electronic circuits

For equipment not incorporating electronic circuits, electromagnetic disturbances can only be generated during occasional switching operations. The duration of disturbances is in the order of milliseconds.

The frequency, level and consequences of these emissions are considered as a part of the normal electromagnetic environment of low-voltage installations.

As a result, the requirements for electromagnetic emissions are deemed to be satisfied and no verification is necessary.

7.3.3.2 Equipment incorporating electronic circuits

Equipment incorporating electronic circuits (e.g. an electronic fuse-blowing indicator) may generate continuous electromagnetic disturbances.

Emission shall fulfil the requirements of class A, group 1 of CISPR 11 or those of class A of CISPR 22 (see 8.4.2.2).

Table 7 – Emission limits

Ports	Frequency ranges MHz	Limits ^d	Standards
Enclosure ^b	30 to 230 ^a	30 dB (µV/m) quasi peak measured at 30 m distance ^c	CISPR 11
	230 to 1 000 ^a	37 dB (µV/m) quasi peak measured at 30 m distance ^c	Class A - Group 1
AC power	0,15 to 0,5 ^a	79 dB (µV) quasi peak 66 dB (µV) average	or
	0,5 to 5 ^a	73 dB (µV) quasi peak 60 dB (µV) average	CISPR 22
	5 to 30 ^a	73 dB (µV) quasi peak 60 dB (µV) average	Class A

^a The lower limit should apply at the transition frequency.

^b Applicable only to mechanical switching devices containing parts which operate at frequencies higher than 9 kHz, e.g. microprocessors.

^c May also be measured at a 10 m distance using the limits increased by 10 dB, or at a 3 m distance using the limits increased by 20 dB.

^d These limits have been copied, without alteration, from CISPR 11 and CISPR 22.

These limits are given for mechanical switching devices which are used exclusively in an industrial environment. When there exists a likelihood of use outside the industrial environment, the following notice shall be included in the manufacturer's published information.

Caution

This is a class A product. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures.

However, this notice is not necessary when the emission limits given in CISPR 22, class B are fulfilled.

8 Tests

8.1 Kind of tests

8.1.1 General

Subclause 8.1.1 of IEC 60947-1 applies.

8.1.2 Type tests

Subclause 8.1.2 of IEC 60947-1 applies. Type tests are given in Table 9 of this part.

8.1.3 Routine tests

Subclause 8.1.3 of IEC 60947-1 applies with the following additions.

8.1.3.1 General

The following tests apply:

- mechanical operation test (see 8.1.3.2)
operation of the switch, disconnecter, switch-disconnector or fuse-combination unit during manufacture and/or other routine test may take the place of the tests listed above, provided the same conditions apply and the number of operations is not less than that specified;
- dielectric test (see 8.1.3.3)
if, by the control of materials and manufacturing processes, the integrity of the dielectric properties has been proven, these tests may be replaced by sampling tests according to a recognized sampling plan (see IEC 60410).

8.1.3.2 Mechanical operation test

A test shall be made to verify the correct mechanical operation of the equipment by 5 closing and opening operations.

8.1.3.3 Dielectric test

The test conditions shall be in accordance with 8.3.3.4.2 of IEC 60947-1. As an alternative, the combined test according to 8.3.3.4.2, item 3), of IEC 60947-1 is allowed. The value of the test voltage shall be in accordance with that given in Table 12A of IEC 60947-1. The duration of the test shall not be less than 1 s and the test voltage shall be applied as follows:

- with the equipment in the open position, between each pair of terminals which are electrically connected together when the equipment is closed;
- with the equipment in the closed position, between each pole and the adjacent pole(s) and between each pole and the frame;

- for equipment incorporating electronic circuits connected to the main poles, with the equipment in the open position, between each pole and the adjacent pole(s) and between each pole and the frame, either on the incoming side or the outgoing side depending on the position of the electronic components.

Alternatively, disconnection of the electronic circuit(s) is permitted during dielectric tests.

8.1.4 Sampling tests

Sampling tests for verification of clearances shall be made according to 8.3.3.4.3 of IEC 60947-1 in accordance with a recognized sampling plan (see IEC 60410).

8.1.5 Special tests

Special tests (see 2.6.4 of IEC 60947-1) are specified in 8.5.

8.2 Type tests for constructional requirements

Subclause 8.2 of IEC 60947-1 applies with the following additions.

8.2.4 Mechanical properties of terminals

Subclause 8.2.4 of IEC 60947-1 applies with the following addition.

Where equipment is designed to be provided with different designs of terminals, the tests shall be conducted on every design.

8.2.5 Verification of the effectiveness of indication of the main contacts position of equipment suitable for isolation

Subclause 8.2.5 of IEC 60947-1 applies with the following additions.

8.2.5.1 Condition of equipment for tests

The test of the actuator mechanism and position indicating device shall be conducted as part of test sequence I (see 8.3.3 and Table 11).

If different types of actuators exist, either additional or integral, only one design shall be tested during sequence I. Moreover, the sample representative of the more critical case shall be tested according to 8.3.3.7.

8.2.5.2 Method of test

8.2.5.2.1 Dependent and independent manual operation

The force necessary to operate the device to the open position shall be measured at the extremity of the actuator. The measured force F shall be equal to the average value of maximum force obtained from 3 consecutive operations, with the device in a clean and new condition. This force F shall then be used for the establishment of the test force in Table 8.

With the equipment in the closed position, fixed and moving contacts of the pole for which the test is deemed to be the most severe shall be kept closed by appropriate means. The actuator shall be submitted to the test force as defined in Table 8 according to its type. Where the device has more than one contact system in series, each contact system shall be held in the closed position.

In the case of multiple tip contact systems, the least number of parallel contact tips shall be fixed together as necessary to hold the contact system closed in order to allow the test force to be applied without the contacts separating.

The appropriate means to keep the contact(s) closed and the number of contacts shall be specified by the manufacturer. The number of contacts and the method shall be stated in the report.

This force shall be applied without shock to the actuator in a direction to open the contacts for a period of 10 s.

The direction of the force, as shown in Figure 1, shall be maintained throughout the test.

If locking means are provided to lock the actuator in the open position it shall not be possible to lock the actuator in this position while the test force is applied.

8.2.5.2.2 Dependent power operation

With the equipment in the closed position, the fixed and moving contacts of the pole for which the test is deemed to be the most severe shall be fixed together, for example by welding. Where the device has more than one contact system in series, each contact system shall be held in the closed position.

In the case of multiple tip contact systems, the least number of parallel contact tips shall be fixed together as necessary to hold the contact system closed in order to allow the test force to be applied without the contacts separating.

The appropriate means to keep the contact(s) closed and the number of contacts shall be specified by the manufacturer. The number of contacts and the method shall be stated in the report.

The supply voltage to the power operator shall be applied at 110 % of its normal rated value to attempt to open the contact system of the equipment.

Three attempts to operate the equipment at 5 min intervals by the power operator shall be made, each for a period of 5 s, unless an associated protective device of the power operator limits the time to a shorter period.

Verification shall be made according to 8.2.5.3.2.

NOTE In the USA, devices meeting these additional requirements are not accepted as assuring isolation by themselves. Isolation requirements and procedures are covered in the relevant Federal regulations and maintenance standards.

8.2.5.2.3 Independent power operation

With the equipment in the closed position, the fixed and moving contacts of the pole for which the test is deemed to be the most severe shall be fixed together, for example by welding. Where the device has more than one contact system in series, each contact system shall be held in the closed position.

In the case of multiple tip contact systems, the least number of parallel contact tips shall be fixed together as necessary to hold the contact system closed in order to allow the test force to be applied without the contacts separating.

The appropriate means to keep the contact(s) closed and the number of contacts shall be specified by the manufacturer. The number of contacts and the method shall be stated in the report.

The stored energy of the power operator shall be released to attempt to open the contact system of the equipment.

Three attempts to operate the equipment by releasing the stored energy shall be made.

Verification shall be made according to 8.2.5.3.2.

NOTE In the USA, devices meeting these additional requirements are not accepted as assuring isolation by themselves. Isolation requirements and procedures are covered in the relevant Federal regulations and maintenance standards.

8.2.5.3 Condition of equipment during and after test

8.2.5.3.1 Dependent and independent manual operation

After the test and when the test force is no longer applied to the actuator with the actuator being left free, the indication of the open position shall not be wrongly given.

Table 8 – Actuator test forces

Types of actuator	Test force	Minimum test force	Maximum test force
		N	N
Pushbutton (see Figure 1a)	$3 F$	50	150
One-finger operated (see Figure 1b)	$3 F$	50	150
Two-finger operated (see Figure 1c)	$3 F$	100	200
One-hand operated (see Figure 1d and 1e)	$3 F$	150	400
Two-hand operated (see Figure 1f)	$3 F$	200	600
Two-hand operated (see Figure 1g)	$3 F$	200	600
<i>F</i> is the normal operating force in new condition. The test force shall be $3 F$ with the stated minimum and maximum values and be applied as shown in Figure 1.			

8.2.5.3.2 Dependent and independent power operation

During and after the test, the open position shall not be indicated by any of the means provided and the equipment shall not show any damage such as to impair its normal operation.

When the equipment is provided with means for padlocking in the open position, it shall not be possible to lock the equipment during the test.

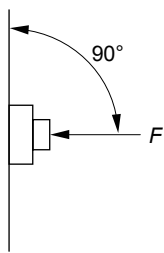


Figure 1a

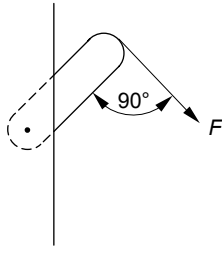


Figure 1b

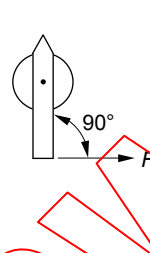


Figure 1c

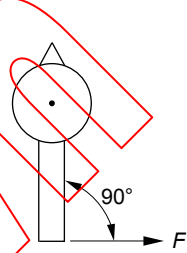


Figure 1d

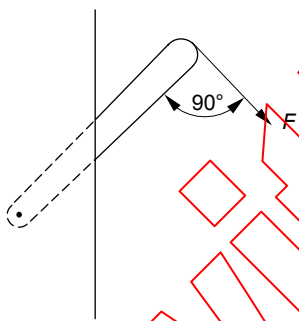


Figure 1e

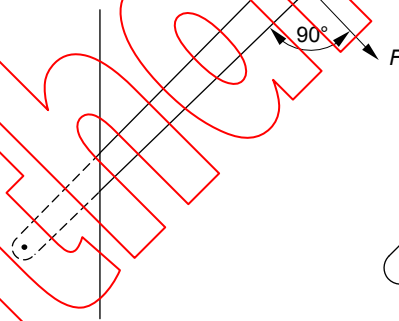


Figure 1f

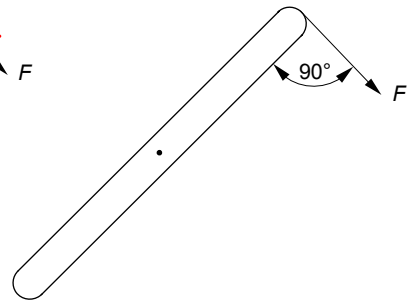


Figure 1g

IEC 1399/08

Figure 1 – Actuator applied force F

Table 9 – List of type tests applicable to a given equipment

Tests	Switch	Fuse-switch	Switch-fuse	Dis-connector	Disconnector-fuse	Fuse dis-connector	Switch dis-connector	Switch dis-connector-fuse	Fuse-switch dis-connector
Temperature-rise ^a	o	o	o	o	o	o	o	o	o
Temperature-rise verification	o	o	o	o	o	o	o	o	o
Dielectric properties	o	o	o	o	o	o	o	o	o
Dielectric verification	o	o	o	o	o	o	o	o	o
Leakage current	–	–	–	o	o	o	o	o	o
Rated making and breaking capacities (overload)	o	o	o	–	–	–	o	o	o
Operational performance	o	o	o	o	o	o	o	o	o
Rated short-time withstand current	o	–	–	o	–	–	o	–	–
Rated short-circuit making capacity	o	–	–	–	–	–	o	–	–
Rated conditional short-circuit current	o	o	o	o	o	o	o	o	o
Strength of actuator mechanism	–	–	–	o	o	o	o	o	o
Overload test	–	o	o	–	o	o	–	o	o
o = test									
– = no test required									
NOTE This list of type tests is for information only, see also footnote "a" in Tables 14 and 15.									
^a Applies to 8.3.2.1.3 only.									

8.3 Performance

Performance type tests to which equipment may be submitted according to its kind are listed in Table 9.

8.3.1 Test sequences

Type tests are grouped together in a number of sequences as shown in Table 10.

For each sequence, tests shall be made in the order listed in accordance with the requirements of the appropriate subclause, apart from the temperature-rise test (simplified testing only) and dielectric properties test of test sequence I, which may be conducted on a separate sample.

Table 10 – Overall scheme of test sequences

Sequences	Tests
General performance characteristics (see 8.3.3 and Table 11)	Temperature-rise ^{e, f} Dielectric properties ^e Making and breaking capacities ^a Dielectric verification ^a Leakage current ^b Temperature-rise verification Strength of actuator mechanism
Operational performance capability (see 8.3.4 and Table 13)	Operational performance Dielectric verification Leakage current ^b Temperature-rise verification
Short-circuit performance capability ^c (see 8.3.5 and Table 14)	Short-time withstand current Short-circuit making capacity ^a Dielectric verification Leakage current ^b Temperature-rise verification
Conditional short-circuit current ^c (see 8.3.6 and Table 15)	Fuse protected short-circuit withstand Fuse protected short-circuit making ^a Dielectric verification Leakage current ^b Temperature-rise verification
Overload performance capability ^d (see 8.3.7 and Table 16)	Overload test Dielectric verification Leakage current ^b Temperature-rise verification
^a Not applicable to AC-20 or DC-20 equipment. See 4.3.5.2 and 4.3.5.3. ^b Only required for equipment suitable for isolation of rated voltage greater than 50 V. ^c Either test sequence III or test sequence IV to be made according to the ratings stated by the manufacturer. ^d Not required for switches, disconnectors and switch-disconnectors. ^e May be conducted outside of the sequence, see 8.3.1. ^f Applies to 8.3.2.1.3 only.	

8.3.2 General test conditions

8.3.2.1 General requirements

Subclause 8.3.2.1 of IEC 60947-1 applies to all type tests as applicable. The equipment at the start of any test sequence shall be in new and clean condition.

The force applied for any opening operation shall not be greater than the test force determined in 8.2.5.2 and shall be applied in the same manner without shock.

Where doubt exists as to the correct opening operation, no more than 3 attempts to operate the equipment to the open position are allowed.

In order to reduce multiple testing for the same fundamental design of equipment, the following test requirements may be used.

8.3.2.1.1 Simplified test for equipment having the same fundamental design

When submitting simultaneously a range of switches, disconnectors, switch-disconnectors or fuse combination units of the same fundamental design, the following variations are permitted provided the equipment complies in all other respects.

8.3.2.1.2 Requirements for equipment having the same fundamental design

Switches, disconnectors, switch-disconnectors or fuse combination units shall be evaluated with respect to the following criteria during the determination of acceptance as the same fundamental design:

- a) the material, finish and dimensions of the current-carrying parts are identical, except for variation in design of terminals and means of fuse attachment;
- b) the contact size, material, configuration and method of attachment are identical;
- c) the operating mechanism is of the same fundamental design, materials and physical characteristics are identical;
- d) the closing and opening speeds of contacts are substantially the same;
- e) moulding and insulating materials are identical;
- f) method, materials and construction of any arc extinction device are identical.

The following variations are also permitted, provided the simplified test procedure given in 8.3.2.1.3 is used:

- g) utilization category and operational voltage;
- h) application for 50 Hz or 60 Hz;
- i) three or four pole equipment (switched or non-switched neutral), provided the requirements of 7.1.9 are applicable;
- j) design of terminal provided that clearances and creepage distance are not reduced (see 7.1.4, 8.2.4 and 8.3.3.2 of this part and 8.3.3.1 of IEC 60947-1);
- k) different types of actuators, either additional or integral, provided the requirements for strength of actuator are verified (see 8.2.5) on each type of actuator, one of which during test sequence I;
- l) fuse-base contacts of switch-fuses, disconnector-fuses and switch-disconnector-fuse with different types of fuse-links (fuse-link removed only under no-load conditions).

8.3.2.1.3 Simplified test procedure

The following simplified test procedure shall be used.

- a) If equipment having the same fundamental design is marked claiming more than one utilization category and/or more than one operational voltage, the number of test samples may be reduced, providing the tests are conducted under the most severe conditions.

For short-circuit, making and breaking, and operational performance tests, the conditions are deemed more severe if the following conditions are simultaneously fulfilled:

- operational rated voltage equal or higher;
- test current equal or higher;
- power factor equal or lower;
- number of operations equal or higher.

- b) Tests performed at 50 Hz are deemed to cover 60 Hz applications and vice versa with the following exceptions:

- temperature-rise test according to 8.3.3.1 for devices having a current greater than 800 A;

NOTE By agreement between manufacturer and user, tests at 50 Hz may be accepted for operation at 60 Hz and vice versa for currents greater than 800 A.

- temperature-rise and operational performance of relays and releases (see 7.2.2 and 7.2.2.6 of IEC 60947-1). Temperature-rise tests of coils shall be performed for each frequency, but only one included in the relevant test sequence, and if separate supplying of coils and other circuits is possible, it is accepted that other circuits remain supplied at 50 Hz.

- c) Tests performed on three pole devices are deemed to cover also four pole devices with a non-switched neutral pole, provided a single-phase test on the neutral pole is performed according to 8.3.3.3.4 of IEC 60947-1.

Tests performed on four switched pole devices are deemed to cover also three switched pole devices provided that all poles are identical and the closing and opening speeds of contacts are substantially the same (only the requirements of 7.1.9 are applicable concerning closing and opening of the neutral pole). However, the four switched pole devices shall always be connected in a three-phase arrangement (see Figure 11 of IEC 60947-1).

- d) Tests performed with different types of fuse-base contacts.

Where switch-fuse, disconnecter-fuse or switch-disconnector-fuse are designed to be provided with different types of fuse-base contacts, temperature-rise tests according to 8.3.3.1 shall be conducted on each type at the corresponding highest fuse rated current.

The type having the maximum temperature-rise among those of the maximum test current shall be used for tests to sequences I, II and V.

Sequence IV shall be conducted on each type of fuse-base contacts whose fuse connecting means are other than bolted connection, at the highest rated conditional short circuit corresponding current, and, if different, with the type of fuse having the maximum let-through energy at the highest test voltage.

- e) Tests performed with different terminal designs.

Where equipment is designed to be provided with different designs of terminal, the requirements and tests according to 8.3.3.1 and 8.2.4 of IEC 60947-1 shall be conducted on each design.

Where equipment has terminals to be used on plug-on busbars, tests according to 8.3.3.1, 8.3.5.1 or 8.3.6.2.1 a), as applicable, shall be performed. Verification of the plugging operation shall be made. The number of operating cycles shall be 50, the cycle being from the connected position to the disconnected position and back to the connected position.

The test is considered to be satisfactory if the operating conditions of the apparatus have not been impaired.

- f) By tests to 8.3.2.1.3, items d) and e), it is possible to test the temperature-rise at terminals and accessible parts.

If the temperature-rise limits of accessible parts are tested in 8.3.2.1.3 and comply with Table 3 of IEC 60947-1 no further tests of these parts at 8.3.3.6 are necessary.

Since the intention of the tests to 8.3.2.1.3, items d) and e), is to establish the worst case, the values of Table 2 of IEC 60947-1 do not apply.

8.3.2.2 Test quantities

Subclause 8.3.2.2 of IEC 60947-1 applies.

8.3.2.3 Evaluation of test results

The behaviour of the equipment during the tests and its condition after the tests are specified in the appropriate test clause.

8.3.2.4 Test report

Subclause 8.3.2.4 of IEC 60947-1 applies.

8.3.3 Test sequence I: general performance characteristics

This test sequence applies to the types of equipment listed in Table 11 and comprises the tests according to the table.

8.3.3.1 Temperature-rise

Subclause 8.3.3.3 of IEC 60947-1 applies with the following additions.

The test shall be made at the rated operational current I_e .

Fuse-combination units shall be fitted with fuse-links having a rated current equal to the conventional thermal current of the combination unit.

The fuse-link shall have a power loss not exceeding the maximum value specified by the equipment manufacturer.

NOTE 1 The test may be made with a "dummy" fuse-link of essentially similar design to the standardized fuse-link and having the specified power loss.

In the case of tests carried out on a fuse-switch, a fuse-disconnector or a fuse-switch-disconnector where the blades of the fuse-links are part of the make-breaking contacts, fuse-links shall be used.

NOTE 2 For a fuse-switch or a fuse-switch-disconnector where the blades of the fuse-links are part of the make-breaking contacts, dummies or copper links may not replace the fuse links due to the fact that the blades of the fuse-links in these devices wear. The wear of the fuse-blades influences the thermal verification according to 8.3.3.6.

Details of the fuse-links used for the test, i.e. the manufacturer's name and reference, the rated current, the power loss of the fuse-link, and the breaking capacity, shall be given in the test report. The type test with the specified fuse-links shall be deemed to cover the use of any other fuse-link having a power loss, at the conventional thermal current of the combination unit, not exceeding the power loss of the fuse-link used for the test.

In the case of tests carried out on a switch-fuse or a switch-disconnector-fuse, fuse-links may be replaced by suitable copper links of dimensions and mass electrically equivalent to those of the fuse-links recommended by the manufacturer.

Table 11 – Test sequence I: general performance characteristics

Tests	Sub-clause No.	Samples ^c	Types of equipment and order of tests					
			Switch	Fuse-switch and switch-fuse	Disconnector	Disconnector-fuse and fuse-disconnector	Switch-disconnector	Switch-disconnector-fuse and fuse-switch-disconnector
Temperature-rise ^{d, e}	8.3.3.1	A,B,C,F	1	1	1	1	1	1
Dielectric properties ^d	8.3.3.2	A,C,F	2	2	2	2	2	2
Making and breaking capacities	8.3.3.3	A,D	3	3	a	a	3	3
Dielectric verification	8.3.3.4	A,D	4	4	a	a	4	4
Leakage current ^b	8.3.3.5	A,D	-	-	3	3	5	5
Temperature-rise verification	8.3.3.6	A,D	5	5	4	4	6	6
Strength of actuator mechanism	8.3.3.7	A,E	-	-	5	5	7	7

^a This test is not required for disconnectors (AC-20 or DC-20). See 4.3.5.2 and 4.3.5.3.

^b Test required only for U_e greater than 50 V.

^c Only tests marked by the same letter shall be applied in sequence to a given sample: "A" is a sample from each fundamental design, chosen from the highest rated current I_e and if applicable, having the maximum temperature-rise according to 8.3.2.1.3, item d).

Other samples if applicable:

"B" is a different sample for 60 Hz test, if applicable, according to 8.3.2.1.3, item b);

"C" are samples of each other terminal design tested at correspondent maximum rated current;

"D" are samples to verify as many combinations of U_e , I_e , AC or DC voltage ratings, to be tested (see 8.3.2.1.3);

"E" is the extra sample as specified in 8.2.5.1 and can be one of sample B, C or D;

"F" are samples of every type of fuse-carrier of fuse-combination unit according to 8.3.2.1.3, item d).

^d May be conducted outside of the sequence, see 8.3.1.

^e Applies only to 8.3.2.1.3.

8.3.3.2 Test of dielectric properties

Subclause 8.3.3.4.1, items 1), 2), 3), 7) and, if applicable, 8) of IEC 60947-1 applies with the following addition.

When, in agreement with the manufacturer, devices are disconnected for the test according to 8.3.3.4.1, item 3) c) of IEC 60947-1, the test report shall state these devices.

For equipment suitable for isolation (see 3.3) having an operational voltage U_e greater than 50 V, the leakage current shall be measured through each pole with the contacts in the open position, at a test voltage of 1,1 U_e and shall not exceed 0,5 mA.