BS EN 62246-1:2015

BSI Standards Publication

Reed switches

Part 1: Generic specification

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National foreword

This British Standard is the UK implementation of EN 62246-1:2015. It is identical to IEC 62246-1:2015. It supersedes BS EN 62246-1:2011 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/94, General purpose relays and reed contact units.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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English Version

Reed switches - Part 1: Generic specification (IEC 62246-1:2015)

Contacts à lames souples - Partie 1: Spécification générique (IEC 62246-1:2015)

Reedschalter - Teil 1: Fachgrundspezifikation (IEC 62246-1:2015)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 94/377/FDIS, future edition 3 of IEC 62246-1, prepared by IEC TC 94 "All-or-nothing electrical relays" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62246-1:2015.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2015-12-04
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2018-03-04

This document supersedes EN 62246-1:2011.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 62246-1:2015 was approved by CENELEC as a European Standard without any modification.

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

IEC 60027 (series)	NOTE	Harmonized as EN 60027 (series).
IEC 61000-4-5:2014	NOTE	Harmonized as EN 61000-4-5:2014.
IEC 61810-1:2008	NOTE	Harmonized as EN 61810-1:2008.
IEC 61810-2	NOTE	Harmonized as EN 61810-2.
IEC 62246-1-1:2013	NOTE	Harmonized as EN 62246-1-1:2013.
IEC 61811-1	NOTE	Harmonized as EN 61811-1.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60068-1	2013	Environmental testing -- Part 1: General and guidance	EN 60068-1	2014
IEC 60068-2-1	2007	Environmental testing -- Part 2-1: Tests - Test A: Cold	EN 60068-2-1	2007
IEC 60068-2-2	2007	Environmental testing -- Part 2-2: Tests - Test B: Dry heat	EN 60068-2-2	2007
IEC 60068-2-6	2007	Environmental testing -- Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	EN 60068-2-6	2008
IEC 60068-2-7	1983	Basic environmental testing procedures - Part 2-7: Tests - Test Ga and guidance: Acceleration, steady state	EN 60068-2-7	1993
IEC 60068-2-11	1981	Environmental testing -- Part 2: Tests - Test Ka: Salt mist	EN 60068-2-11	1999
IEC 60068-2-13	1983	Environmental testing -- Part 2: Tests - Test M: Low air pressure	EN 60068-2-13	1999
IEC 60068-2-14	2009	Environmental testing -- Part 2-14: Tests - Test N: Change of temperature	EN 60068-2-14	2009
IEC 60068-2-17	1994	Basic environmental testing procedures -- Part 2: Tests - Test Q: Sealing	EN 60068-2-17	1994
IEC 60068-2-20	2008	Environmental testing -- Part 2-20: Tests - Test T: Test methods for solderability and resistance to soldering heat of devices with leads	EN 60068-2-20	2008
IEC 60068-2-21	2006	Environmental testing -- Part 2-21: Tests - Test U: Robustness of terminations and integral mounting devices	EN 60068-2-21	2006
IEC 60068-2-27	2008	Environmental testing -- Part 2-27: Tests - Test Ea and guidance: Shock	EN 60068-2-27	2009
IEC 60068-2-30	2005	Environmental testing -- Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)	EN 60068-2-30	2005
IEC 60068-2-78	-	Environmental testing -- Part 2-78: Tests - Test Cab: Damp heat, steady state	EN 60068-2-78	-
IEC 60096	series	Radio-frequency cables	-	series
IEC 60947-5-1	2003	Low-voltage switchgear and controlgear -- Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices	EN 60947-5-1	2004
-	-		+corrigendum Nov.	2004
-	-		+corrigendum Jul.	2005

CONTENTS

INTRODUCTION

Reed switches which are in mass production and which are widely used in practice could be classified by the following characteristics:

a) Size:
   - normal or standard reed switches with a tube more than 50 mm in length and more than 5 mm in diameter;
   - sub-miniature reed switches with a tube > 25 mm and < 50 mm in length and < 5 mm in diameter;
   - miniature reed switches with a tube > 10 mm and < 25 mm in length and > 2 mm and < 5 mm in diameter;
   - micro-miniature reed switches with a tube > 4 mm and < 10 mm in length and > 1,5 mm and < 2 mm in diameter.

b) Type of switching of electric circuit:
   - closing or normally open – A type;
   - opening or normally closed – B type;
   - changeover – C type.

c) Withstand voltage level:
   - low-voltage (up to 1 000 V);
   - high-voltage (more than 1 000 V).

d) Switches power:
   - low-power (up to 60 VA);
   - power (100 to 1 000 VA);
   - high-power (more than 1 000 VA).

e) Types of electric contacts:
   - the tube is filled with dry air, gas mixture, vacuumized, or high pressurized.

This standard selects and specifies test procedures for reed switches where enhanced requirements for the verification of generic specification apply.

An international standard IEC 62246-1-1 (a quality assessment specification including information of detail specification (DS)) was published in 2013.

REED SWITCHES –

Part 1: Generic specification

1 Scope

This part of IEC 62246 which is a generic specification applies to all types of reed switches including magnetically biased reed switches of assessed quality for use in general and industrial applications.

NOTE 1 Mercury wetted reed switches are not covered by this standard due to their possible environmental impact.

It lists the tests and measurement procedures which may be selected for use in detail specifications for such reed switches.

This standard applies to reed switches which are operated by an applied magnetic field; it is not restricted to any particular type of contact load.

For elementary relays with reed switches, this standard is recommended to be used together with the standards IEC 61810-1, IEC 61811-1 as applicable.

For applications of reed switches, this standard is recommended to be used together with specific product standards.

NOTE 2 Where any discrepancies occur for any reasons, documents rank in the following order of authority:

a) the detail specification,

b) the sectional specification,

c) the generic specification,

d) any other international documents (for example, of the IEC) to which reference is made.

The same order of precedence applies to equivalent national documents.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-6:2007, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-7:1983, *Basic environmental testing procedures – Part 2-7: Tests – Test Ga and guidance: Acceleration, steady state*

IEC 60068-2-11:1981, *Basic environmental testing procedures – Part 2-11: Tests – Test Ka: Salt mist*

IEC 60068-2-13:1983, *Basic environmental testing procedures – Part 2-13: Tests – Test M: Low air pressure*

IEC 60068-2-14:2009, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-17:1994, *Basic environmental testing procedures – Part 2-17: Tests – Test Q: Sealing*

IEC 60068-2-20:2008, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60068-2-21:2006, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30:2005, *Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-78, *Basic environmental testing procedures – Part 2: Tests – Test Cab: Damp heat, steady state*

IEC 60096 (all parts), *Radio frequency cables*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE Definitions of terms not stipulated in this standard are given in the IEC 60050 series, in particular in IEC 60050-444.

3.1 Reed switch types

3.1.1
type
products having similar design features and nominal dimensions manufactured by the same techniques and falling within a range of ratings specified by the manufacturer

Note 1 to entry: Mounting accessories are ignored, provided they have no significant effect on the test results.

3.1.2
variant
variation within a type having specific characteristics

3.1.3
reed switch
assembly containing contact blades, partly or completely made of magnetic material, hermetically sealed in an envelope and controlled by means of an externally generated magnetic field

Note 1 to entry: For example, an energizing quantity applied to a coil.

Note 2 to entry: See Figure 1.

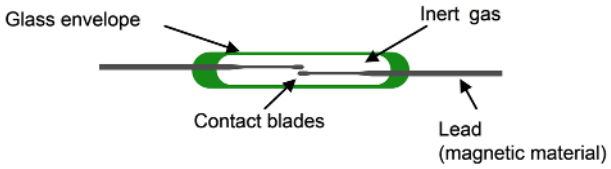


Figure 1 – Example of reed switch structure

3.1.4
high voltage vacuum reed switch
reed switch, in which ability to switch high voltages is achieved by a high vacuum within the hermetically sealed envelope

3.1.5
heavy-duty reed switch
reed switch, in which greater switching capacity is achieved

Note 1 to entry: See Figure 2.

Note 2 to entry: Blades having additional contact tips or a contact tip and spring which separate the magnetic path and electric path are typical examples of techniques to increase switching capacity.

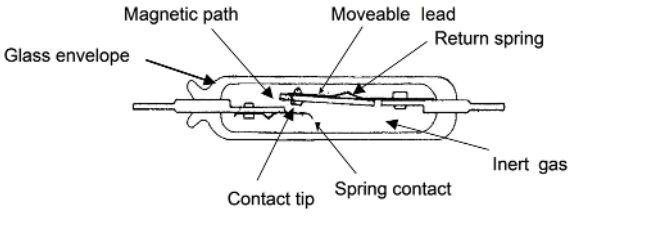


Figure 2 – Example of heavy-duty reed switch structure

3.1.6
magnetically biased reed switch
reed switch to which a biasing magnetic field is applied, determining the functional characteristics and the operate and release position

3.2 Operating values

3.2.1
preferred position
position recommended for use and in which tests are normally performed, unless otherwise specified

3.2.2
rated value
value of a quantity used for specification purpose, established for a specific set of operating conditions

3.2.3
operate position
position in which the make contact is closed and the break contact is open

3.2.4
release position
position in which the make contact is open and the break contact is closed

3.2.5
just-operate value
value of the magnetic and electro magnetic fields at which the released reed switch just operates

Note 1 to entry: See Figure 3.

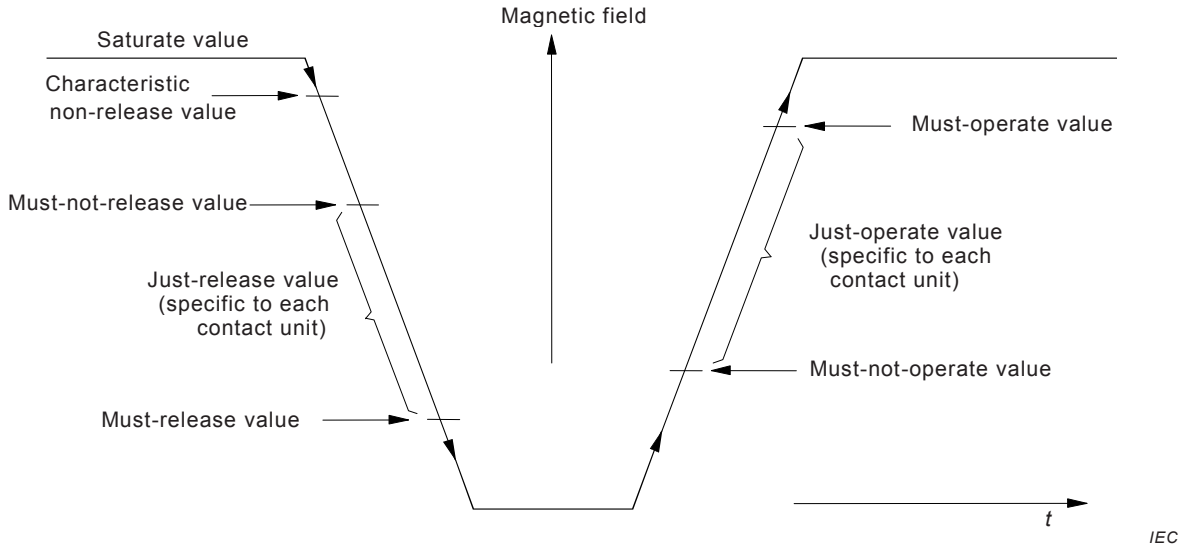


Figure 3 – Functional characteristics

3.2.6
must-operate value
stated limit of the applied magnetic field at which the reed switch operates

Note 1 to entry: See Figure 3.

3.2.7
just-release value
value of the applied magnetic field at which the operated reed switch just releases

Note 1 to entry: See Figure 3.

3.2.8
must-release value
stated limit of the applied magnetic field at which the operated reed switch releases

Note 1 to entry: See Figure 3.

3.2.9
must-not-operate value
stated limit of the applied magnetic field at which the reed switch does not operate

Note 1 to entry: See Figure 3.

3.2.10
must-not-release value
stated limit of the applied magnetic field at which the operated reed switch remains operated

Note 1 to entry: See Figure 3.

3.2.11
characteristic non-release value
stated value of the applied magnetic field above which the operated reed switch fulfils specified qualities, for example contact resistance, noise characteristics, etc.

Note 1 to entry: See Figure 3.

3.2.12
saturate value
value of the applied magnetic field at which the reed switch is unaffected by further increase of the applied magnetic field

Note 1 to entry: See Figure 3.

3.2.13
contact bounce
phenomenon which can occur while a contact circuit is making or breaking and which is characterized by the contact points successively touching and separating before reaching their final position

3.2.14
magnetic dwell
difference in the values of applied magnetic field when the break contact just opens and the make contact just closes, or vice versa

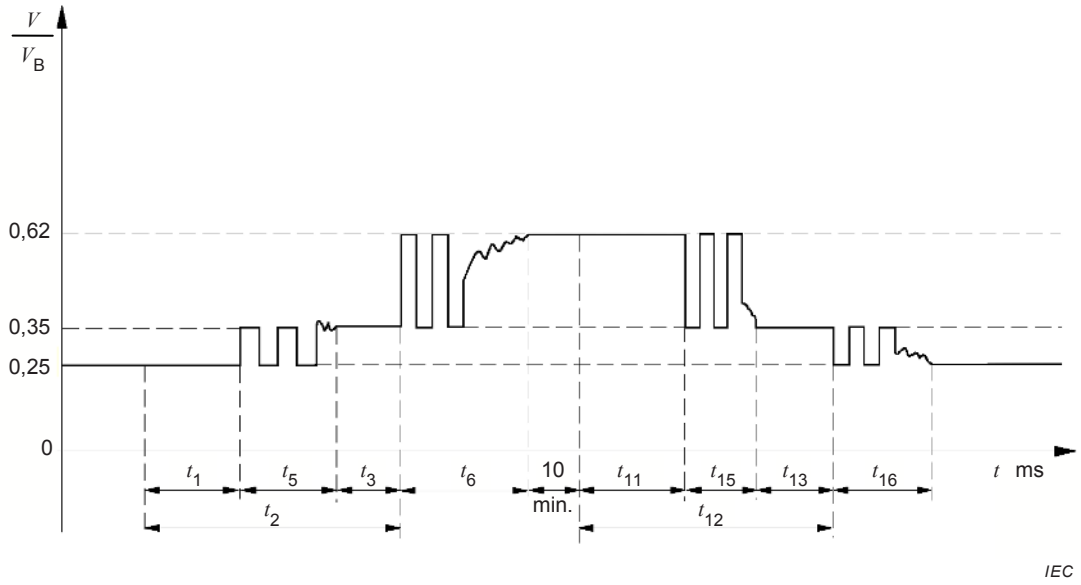
3.3 Operating times (see Figure 4)

3.3.1
bounce time
for a contact which is closing/opening its circuit, time interval between the instant when the contact circuit first closes/opens and the instant when the circuit is finally closed/opened

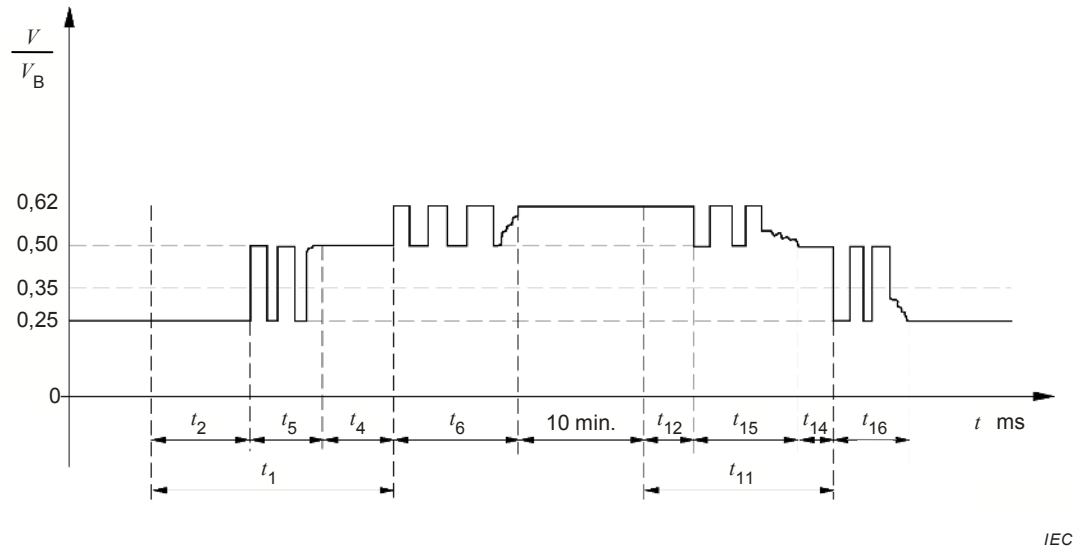
3.3.2
operate time
time interval between the application of the specified magnetic field to a reed switch in the release condition and the change of state of the last output circuit (not including bounce time)

3.3.3
release time
time interval between the removal of the specified magnetic field to a reed switch in the operate condition, and the change of state of the last output circuit (not including bounce time)

Oscilloscope diagram



a) Break-before-make



b) Make-before-break

Energization of the test coil

t_1: operate break time

t_2: operate make time

t_3: operate transfer time

t_4: operate bridging time

t_5 and t_6: bounce times

De-energization of the test coil

t_{11}: release break time

t_{12}: release make time

t_{13}: release transfer time

t_{14}: release bridging time

t_{15} and t_{16}: bounce times

Refer to Figures 10 and 11 for key to V_B.

Figure 4 – Time definitions

3.3.4
transfer time
time interval during which both contact circuits are open (not including bounce time)

Note 1 to entry: Form C contact only.

3.3.5
bridging time
time interval during which both contact circuits are closed (not including bounce time)

Note 1 to entry: Form C contact only.

3.3.6
operate make time
time interval between the instant of the application of a magnetic field to the reed switch and the instant of the first closing of the make contact

3.3.7
operate break time
time interval between the instant of the application of a magnetic field to the reed switch and the instant of the first opening of the break contact

3.3.8
release make time
time interval between the instant of the removal of an applied magnetic field from the reed switch and the instant of the first closing of the break contact

3.3.9
release break time
time interval between the instant of the removal of an applied magnetic field from the reed switch and the instant of the first opening of the make contact

3.3.10
operate transfer time
transfer time measured when the break-before-make reed switch moves from the release position to the operate position

Note 1 to entry: Form C contact only.

3.3.11
release transfer time
transfer time measured when the break-before-make reed switch moves from the operate position to the release position

Note 1 to entry: Form C contact only.

3.3.12
minimum time of operate energization
minimum time between the instant of the first application of a magnetic field (at a stated value), and the instant of reduction of that field to the characteristic non-release value to ensure that the reed switch is maintained in the operate condition

3.3.13
time to stable closed position
time between the instant of application of a specified magnetic field to the instant at which the reed switch fulfils specified qualities, for example, contact resistance, noise characteristics

3.4 Contacts

3.4.1
contact blade
metal blade providing the functions of either the electric or magnetic circuit or both functions combined as in the case of dry reed switches

3.4.2
biasing magnetic field
continuous magnetic field intended to determine the operate and the release position of the contact, which can be adjusted to form a monostable or bistable switch

Note 1 to entry: For bistable switches, operate and release conditions have to be defined in the detail specification with reference to applied magnetic field polarity.

3.4.3
applied magnetic field
externally generated field (for example by a test coil) intended to change the position of the contact

3.4.4
switch, mechanically biased
switch where the biasing, to determine the operate and release positions, is achieved mechanically

3.4.5
make contact
contact which is closed when the reed switch is in its operate condition and which is open when the switch is in its release condition, there is no applied magnetic field

Note 1 to entry: Form A contact.

Note 2 to entry: See Figure 5.

Note 3 to entry: The make contact is also known as a normally open (NO) contact.

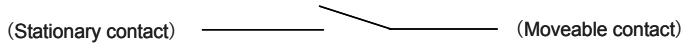


Figure 5 – Contact diagram of make contact

3.4.6
break contact
contact which is open when the reed switch is in its operate condition and which is closed when the switch is in its release condition, there is no applied magnetic field

Note 1 to entry: Form B contact.

Note 2 to entry: See Figure 6.

Note 3 to entry: The break contact is also known as a normally closed (NC) contact.

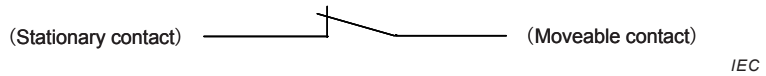


Figure 6 – Contact diagram of break contact

3.4.7
change-over contact
contact set which contains a make contact and a break contact within a single envelope, one contact blade being common. Change-over contact in which the break contact circuit opens before the make contact circuit closes or the make contact circuit makes before the break contact circuit breaks

Note 1 to entry: Form C contact.

Note 2 to entry: See Figure 7.

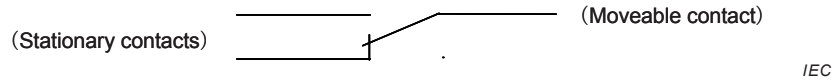


Figure 7 – Contact diagram of change-over contact

3.4.8
maximum cycling frequency
maximum number of cycles per second, at and below which the reed switch still meets the specifications

3.4.9
failure-to-make
fault condition of the contacts, indicated by the contact circuit resistance of the unit exceeding a specified value, for a specified applied magnetic field, within a specified period

3.4.10
failure-to-break
fault condition of the contacts, indicated by the contact circuit resistance of the unit failing to exceed a specified value, for a specified applied magnetic field, within a specified period

3.4.11
contact sticking
failure-to-break of a reed switch due to residual magnetic, physical or chemical effects

3.4.12
maximum switching current
maximum allowed switched DC or peak current in correlation to a given number and frequency of operations and load, under specified conditions

3.4.13
limiting continuous current
greatest value of electric current which a closed contact is capable of carrying continuously under specified conditions

3.4.14
maximum switching voltage
maximum allowed switched AC/DC or peak voltage, in correlation to a given number of operations and load, under specified conditions

3.4.15
contact noise
spurious voltage which appears across the terminals of a closed contact

3.4.16
thermal e.m.f.
e.m.f. generated by the reed switch, when connected to an external circuit in an operate position and subjected to a temperature differential

3.4.17
duty factor
ratio of the duration of energization to the total period of operation

Note 1 to entry: The duty factor can be expressed as a percentage of the total period.

3.4.18
rated conditional short-circuit current
value of prospective current, stated by the manufacturer, which the switch, protected by a short-circuit protective device specified by the manufacturer, can withstand satisfactorily under specified conditions

3.4.19
cycle-related failure rate
mean number of failures relative to the number of cycles of service of the switch

Note 1 to entry: λ_c is the reciprocal of $MTBF_c$.

3.4.20
frequency of operation
number of cycles per unit of time

3.4.21
mechanical endurance
number of cycles until contact failure, with unloaded output circuit(s) and under specified operating conditions

3.4.22
electrical endurance
number of cycles until contact failure, with specified electrical loading of the output circuit(s) and under specified operating conditions

3.4.23
rated making current capacity
value of electric current which the reed switch is capable of making under specified conditions such as contact voltage, number of makes, power factor, time constant

Note 1 to entry: For AC the r.m.s. value is specified.

3.4.24
rated breaking current capacity
value of electric current which the reed switch is capable of breaking under specified conditions such as contact voltage, number of breaks, power factor, time constant

Note 1 to entry: For AC the r.m.s. value is specified.

3.4.25
rated insulation voltage
value of voltage to which dielectric tests and creepage distances are referred

3.4.26
open circuit voltage across contacts
voltage between the terminals of a make switch in the release position, and between the terminals of a break switch in the operate position

3.4.27
rated operational voltage
U_e
value of voltage which, combined with a rated operational current, determines the application of the equipment and to which the relevant tests and the classification are referred

3.4.28
rated operational current
I_e
value of current which, combined with a rated operational voltage, determines the application of the equipment and to which the relevant tests and the classification are referred

4 Rated values

4.1 General

The recommended values listed below do not comprise all technical possibilities; unless otherwise stated in the detail specification other values may be adopted according to conditions of operation and use.

4.2 Frequency of operation

Recommended frequencies: 1; 2; 5; 8; 10; 12,5; 16; 20; 25; 30; 50; 60; 100; 120; 200; 500 operations per second.

4.3 Duty factor

Recommended value: 50 %.

4.4 Open-circuit voltage across contacts

a) 0,01 V a.c.; 0,1 V a.c.; 5 V a.c.; 12 V a.c.; 24 V a.c., 30 V a.c.; 40 V a.c.; 50 V a.c.; 100 V a.c.; 110 V a.c.; 120 V a.c.; 127 V a.c.; 150 V a.c.; 170 V a.c.; 175 V a.c.; 200 V a.c.; 220 V a.c.; 240 V a.c.; 250 V a.c.; 265 V a.c.; 300 V a.c.; 380 V a.c.; 400 V a.c.; 500 V a.c.; 1 000 V a.c.; 1 500 V a.c.; 2 000 V a.c. (r.m.s.).

b) 0,01 V d.c.; 0,03 V d.c.; 0,05 V d.c.; 0,1 V d.c.; 1 V d.c.; 1,5 V d.c.; 4,5 V d.c.; 5 V d.c.; 6 V d.c.; 6,3 V d.c.; 10 V d.c.; 12 V d.c.; 15 V d.c.; 17 V d.c.; 20 V d.c.; 24 V d.c.; 28 V d.c.; 30 V d.c.; 36 V d.c.; 40 V d.c.; 48 V d.c.; 50 V d.c.; 60 V d.c.; 72 V d.c.; 80 V d.c.; 96 V d.c.; 100 V d.c.; 110 V d.c.; 125 V d.c.; 150 V d.c.; 170 V d.c.; 175 V d.c.; 200 V d.c.; 220 V d.c.; 250 V d.c.; 265 V d.c.; 280 V d.c.; 350 V d.c.; 400 V d.c.; 440 V d.c.; 500 V d.c.; 600 V d.c.; 800 V d.c.; 1 000 V d.c.;1 200 V d.c.; 1 500 V d.c.; 2 000 V d.c.; 3 500 V d.c.; 5 000 V d.c.; 10 000 V d.c.; 15 000 V d.c.

4.5 Current rating

Recommended values: 1 A; 1,25 A; 1,5 A; 1,6 A; 2 A; 2,5 A; 3 A; 3,15 A; 3,5 A; 4 A; 5 A; 6,3 A; 7 A; 7,5; 8 A or the decimal multiples or submultiples of these figures in A.

4.6 Load ratings

Recommended values: 0,3 VA; 1 VA; 2 VA; 3 VA; 5 VA; 10 VA; 15 VA; 16 VA; 20 VA; 25 VA; 30 VA; 40 VA; 50 VA; 70 VA; 100 VA; 150 VA; 250 VA; 500 VA, 750 VA; 1 000 VA; 1 800 VA; 3 600 VA; 7 200 VA.

Recommended values: 0,1 W; 0,3 W; 1 W; 2 W; 3 W; 5 W; 10 W; 15 W; 16 W; 20 W; 25 W; 30 W; 40 W; 50 W; 70 W; 100 W; 150 W; 250 W; 500 W.

4.7 Number of operations

Recommended number of cycles: 5 000, 10 000, 20 000, 50 000,

1×10^5, 2×10^5, 1×10^6, 2×10^6, 5×10^6, 1×10^7, 2×10^7, 5×10^7, 1×10^8, 2×10^8, 5×10^8, 1×10^9, 1×10^{10}.

4.8 Climatic category

The climatic category (see Annex A of IEC 60068-1:2013) of a reed switch, both steady state and cyclic, shall be established by a selection from the following preferred standard values of lower and upper ambient temperatures and damp heat values.

a) The preferred values of lower ambient temperature are:
   –65 °C, –55 °C, –50 °C, –40 °C, –25 °C, –10 °C
b) The preferred values of upper ambient temperature are:
   40 °C, 55 °C, 70 °C, 85 °C, 100 °C, 125 °C, 150 °C, 180 °C, 200 °C
c) The preferred times of exposure to damp heat, steady state are:
   4, 10, 21, 42, 56 days
d) The preferred climatic categories are:
   65 / 125 / 56
   40 / 100 / 56
   40 / 100 / 21
   40 / 85 / 56
   40 / 70 / 21
   25 / 70 / 21
   25 / 55 / 04
   10 / 40 / 04
   10 / 55 / 04

4.9 Environmental severities

a) Vibration (IEC 60068-2-6, Test Fc)

Frequency	Vibration amplitude or acceleration	No. of sweep cycles
10 Hz to 500 Hz	0,35 mm or 49 m/s² (5 g_n)	10
10 Hz to 500 Hz	0,75 mm or 98 m/s² (10 g_n)	10
10 Hz to 2 000 Hz	0,75 mm or 98 m/s² (10 g_n)	8
10 Hz to 2 000 Hz	1,5 mm or 196 m/s² (20 g_n)	8
10 Hz to 2 000 Hz	3,5 mm or 490 m/s² (50 g_n)	12

   Duration of the sweep endurance in each of the three axes is given by a specified number of sweep cycles. Sweep rate: 1 octave per minute ± 10 %.

   Cross-over frequency between 57 Hz and 62 Hz.

b) Shock (IEC 60068-2-27, Test Ea)
   6 ms, 980 m/s^2, 100 g_n
   11 ms, 490 m/s^2, 50 g_n
   11 ms, 294 m/s^2, 30 g_n
c) Acceleration (IEC 60068-2-7, Test Ga)

m/s^2	g_n
98	10
196	20
490	50
19 600	2 000

49 000	5 000
98 000	10 000
196 000	20 000
294 000	30 000

Duration of 1 min in each direction prescribed in the specification.

d) Low air pressure (IEC 60068-2-13, Test M): 80 hPa

4.10 Surge voltage

a) 800 V, 1 500 V, 2 500 V, 3 000 V, 4 000 V, 5 000 V

b) 1,2 × 50 μs, 10 × 700 μs or 1 000 μs.

4.11 Classification

The classification as given in Table 1 is preferred. Any other types of application shall be based on agreement between manufacturer and user, but information given in the manufacturer's catalogue or tender may constitute such an agreement.

Table 1 – Classification

Kind of current	Classification	Typical application
AC	AC inductive load (contactor coil, solenoid valve)	Control of electromagnetic loads >72 VA
DC	DC inductive load (contactor coil, solenoid valve)	Control of electromagnets

Utilization categories as given in IEC 60947-5-1 may also apply; in such cases all the relevant requirements and tests from IEC 60947-5-1 shall be fulfilled, e.g. the requirements regarding the ability to make and break under normal and abnormal load conditions, conditional short-circuit current, etc.

NOTE Special requirement for capacitive and filament lamp loads can be applied.

4.12 Contact reliability

Recommended values of failure rates: 1; 5; 10 failures per 10^9 cycles.

5 Marking

The sectional or detail specifications shall indicate the identification criteria and other information to be shown on the unit and/or package. The letter or colour code shall be described in full or reference made to the appropriate specifications. The order of priority for marking small units shall be specified.

Information given in the manufacturer's literature may take the place of marking of contact ratings (examples of contact ratings are shown in Annex F and Annex G).

The marking shall, as a minimum, consist of:

– the trade mark or the manufacturer's name;

– the unit, type and variants' code;

– the coded date of manufacture, quantified by months or less.

Each package of reed switches shall be marked with the following information:

– date code;

– number of the detail specification;
– manufacturer's factory identification code;
– additional marking as required by the detail specification.

6 Test and measurement procedures

6.1 General

The blank detail specifications shall contain tables showing the tests to be made, which measurements are to be made before and after each test or subgroup of tests, and the sequence in which they shall be carried out.

6.2 Alternative procedures

The test and measurement methods given in the relevant specification are not necessarily the only methods which can be used. However, the manufacturer shall satisfy the National Supervising Inspectorate that any alternative methods which he uses will give results equivalent to those obtained by the methods specified.

Alternative methods shall not be used where methods are specifically designated as referee or reference methods.

6.3 Standard conditions for testing

Unless otherwise prescribed, all tests shall be carried out under standard atmospheric conditions for testing, as specified in IEC 60068-1. The stages of each test shall be carried out in the order written.

For those measurements that require the switch to be energized, the switch shall be positioned in its test coil as prescribed in the detail specification.

Test coils and test systems shall, wherever possible, be selected from the list of standard test coils in Annex A.

The test shall be carried out in an environment such that no external field or body can influence the test results by an amount equivalent to 0,5 A × turns or 2 %, whichever is the greater.

The voltage of the test supply as measured at the test specimen shall remain within 0,5 % of the nominal value at all test conditions other than the voltage test, unless otherwise prescribed.

6.4 Visual inspection and check of dimensions

6.4.1 Visual inspection

Unless otherwise prescribed in the detail specification, inspection shall be performed under normal visual conditions. The workmanship, seals, finish, and marking shall be as prescribed in the detail specification.

If prescribed in the detail specification, more detailed visual inspection under specified magnification shall be made for failures such as:

– glass defects: cracks, bubbles, crystallisation, devitrification, chips, cold-seals, short-seals, un-wetted parts, etc;
– geometrical defects: contact alignment, overlapping failures, burrs, parallelism, etc;

– mechanical defects: blistering, un-plated areas, staining, rusting, magnetic and non-magnetic dirt, whisker growth, etc.

6.4.2 Outline dimensions

The outline dimensions shall be checked and shall comply with those prescribed in the detail specification.

6.4.3 Mass

The nominal mass shall be prescribed in the detail specification whenever required.

6.4.4 Information to be stated in the detail specification

The detail specification shall include the following:

a) For visual inspection, typically: conditions of light and magnification, inspection limits.

b) Outline dimensions.

c) Nominal mass.

6.5 Functional tests

6.5.1 Procedures

6.5.1.1 Procedures for reed switches

Functional tests shall be applied, in the order given, to the switch mounted in a test coil. Unless otherwise prescribed, the increase and decrease of the energization of the coil shall be performed at a rate not greater than:

– 5 A × turns/ms for saturate value and zero energization;

– 1 A × turns/ms for must-not-release, must-release, must-not-operate, must-operate, just-release and just-operate values.

Either of the following monitoring procedures may be used:

Procedure 1: Contact circuits shall be monitored, throughout the tests, for failure-to-make and failure-to-break at the appropriate values of test coil energization.

Procedure 2a: Physical opening and closing of the contact shall be monitored throughout the tests by magnetic induction or other equivalent methods.

a) Saturate: The test coil shall be energized for a specified period to the saturate value. The contact is then in the operate position.

b) Must-not-release: When prescribed, the energization of the coil shall be reduced to the must-not-release value (see Notes 1 and 2).

c) Must-release: The energization of the coil shall be reduced from the must-not-release value (or in its absence, the saturate value) to the must-release value. Unless otherwise prescribed, the release energization attained shall then be reduced to zero for a minimum period of 20 ms.

d) Must-not-operate: When prescribed, the energization of the coil shall be increased from zero to the must-not-operate value (see Note 1).

e) Must-operate: The energization of the coil shall be increased from zero (or from the must-not-operate value, when specified) to the must-operate value.

Procedure 2b: Physical opening and closing of the contact shall be monitored throughout the tests by magnetic induction or other equivalent methods.

a) Saturate: The test coil shall be energized for a specified period to the saturate value. The contact is then in the operate condition.

b) Zero energization: The energization shall be reduced to zero for a period of 20 ms.

c) Must-not-operate: When prescribed, the energization of the coil shall be increased from zero to the must-not-operate value (see Note 1).

d) Must-operate: The energization of the coil shall be increased from zero (or from the must-not-operate value, when specified) to the must-operate value.

e) Must-not-release: When prescribed, the energization of the coil shall be reduced to the must-not-release value (see Notes 1 and 2).

f) Must-release: The energization of the coil shall be reduced from the must-not-release value (or in its absence, the saturate value) to the must-release value.

NOTE 1 Must-not-release and must-not-operate tests are optional and are performed only when prescribed in the detail specification.

NOTE 2 When prescribed, the functional test for the must-not-release can be replaced by a similar test performed at the characteristic non-release value.

6.5.1.2 Special procedures for magnetically biased switches

The procedures of 6.5.1.1 apply with a rate of 0,1 A × turns/ms for must-not-release, must release, must-not-operate, must-operate, just-release, and just-operate values.

Either of the following test systems may be used (see Annex B):

Procedure for test system 1

a) The central coil M energization shall be zero.

b) The L coil energization shall be increased to the saturate value of the release position and afterwards decreased to zero.

c) The R coil energization shall be increased from zero to the must-operate value.

d) The R coil energization shall further be increased to the saturate value of the operate position and afterwards decreased to zero.

e) The L coil energization shall be increased to the must-release value.

Procedure for test system 2

a) The central coil M energization shall be brought to the saturate value of the operate position and shall afterwards be decreased to zero.

b) The energization of the coil shall then be increased to the opposite polarity to the release value and further increased to the saturate value of the release position and afterwards brought back to zero.

c) The energization of the coil shall be increased in the opposite polarity to the operate position.

6.5.2 Requirements

Procedure 1: The contact circuit resistance limits for failure-to-make and failure-to-break shall be complied with.

Procedure 2: Physical opening and closing of the contact shall be within the limits of must-release, must-not-release, must-operate and must-not-operate.

6.5.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Test coil (and test system, if applicable)

b) Method of monitoring opening and closing of the contact

c) Saturate value and period of application

d) Must-not-release value (if applicable)

e) Must-release value

f) Must-not-operate value (if applicable)

g) Must-operate value

h) Characteristic non-release value (if applicable)

i) Failure-to-make (for Procedure 1): contact circuit resistance limit

j) Failure-to-break (for Procedure 1): contact circuit resistance limit

k) Time at zero energization if other than 20 ms

l) Rate of increase and decrease of energization (if applicable).

6.6 Remanence test (see Figure 8)

6.6.1 Procedure

Functional tests shall be applied, in the order given, to the switch mounted in a test coil. The position of the switch in the test coil and the influence of the external fields shall remain constant during the test. Contact circuits shall be monitored throughout the tests for failure to make and failure to break at the appropriate values of test coil energization.

a) Saturate:

   The test coil shall be energized to the saturate value for a minimum period of 20 ms, unless otherwise prescribed. The contact is then in the operate position. The saturate energization shall be reduced to zero and shall remain at zero for a minimum period of 20 ms.

b) Just-operate (1):

   The energization of the coil shall be increased from zero, in the same polarity to the just-operate value.

c) Saturate (reverse polarity):

   The energization shall be reduced from the just-operate value through zero to the saturate value in the reverse polarity, for a minimum period of 20 ms, unless otherwise prescribed.

d) Just-operate (2):

   The energization shall then revert from the saturate value (reverse polarity) through zero to the original polarity, to the just-operate (2) value.

6.6.2 Requirements

The remanence value is the difference between the just-operate (2) and just-operate (1) value divided by the just-operate (1) value (see 6.6.1). The contact circuit resistance limit for failure-to-make shall be complied with, for procedure 1 according to 6.5.2.

6.6.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Test coil.

b) Saturate value.

c) Remanence value in %: $100 \times \frac{\text{just - operate (2)} - \text{just - operate (1)}}{\text{just - operate (1)}}$ %

d) Failure-to-make contact circuit resistance limit for procedure 1 of 6.5.2.

e) Time at zero energization if other than 20 ms.

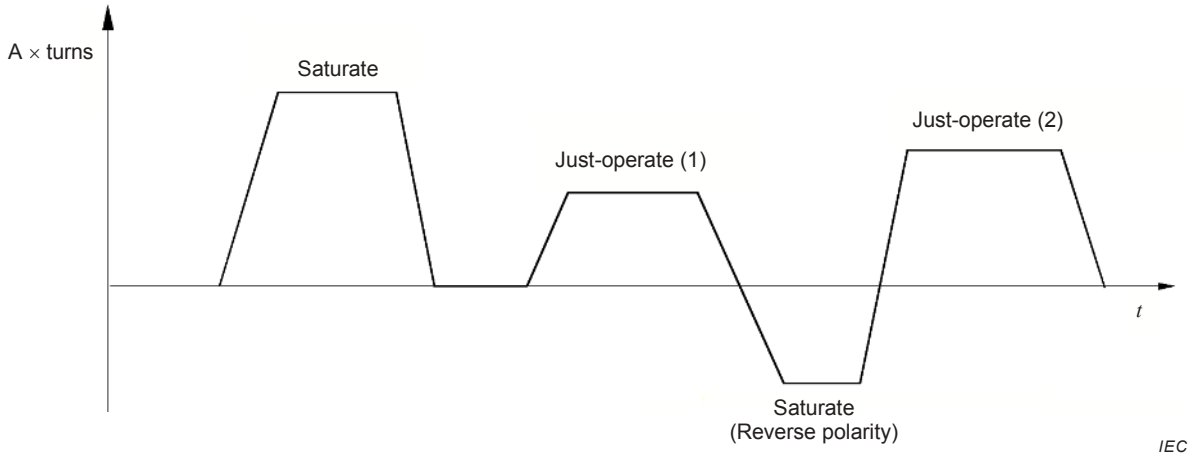


Figure 8 – Remanence test sequence

6.7 Contact circuit resistance

6.7.1 Procedure

The contact circuit resistance shall be measured by the 4 point (Kelvin) method at a point 6 mm from the point of emergence of the termination from the seal, or as prescribed in the detail specification.

The voltage and current applied to the contact circuit shall not exceed 6 V and 1 A AC r.m.s. or DC unless otherwise prescribed in the detail specification.

The frequency of the alternating current shall be in the audio frequency range.

The value of contact resistance shall be the mean of the two values.

The switch shall be saturated magnetically unless otherwise prescribed and the test coil energization reduced to a value prescribed in the detail specification.

The break contact circuit resistance shall be measured without energization of the test coil unless otherwise specified.

The measurement circuit may be connected to the switch at instants 0 or t_2 (see Figure 4) as prescribed in the detail specification.

The measurement circuit shall be disconnected from the switch at the instant t_3 as prescribed in the detail specification.

The measurement of the contact resistance shall be made between instant t_2 and t_3 for the make contact and between t_5 and t_6 for the break contact, see Figure 9.

6.7.2 Requirements

The contact circuit resistance shall not exceed the value prescribed in the detail specification.

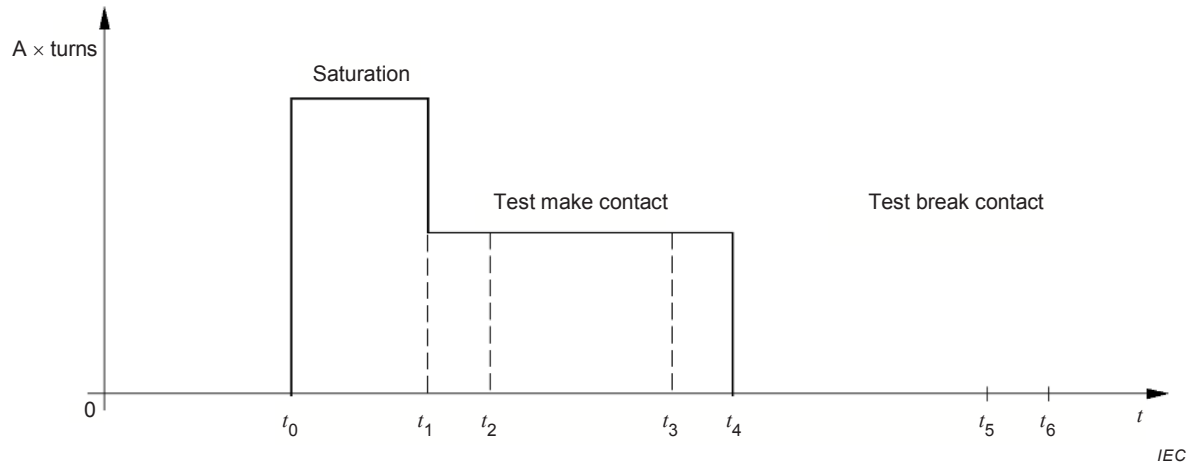


Figure 9 – Sequence of contact circuit resistance measurement

6.7.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Test coil.

b) Point of measurement, if other than 6 mm.

c) Contact circuit resistance.

d) Value of saturation and the reduced value.

e) t_1, t_2, t_3, t_4, t_5 and t_6.

f) Applied measurement voltage and current (if applicable).

g) The frequency of the applied qualities used for contact circuit resistance test, where applicable.

6.8 Dielectric test

6.8.1 Procedures

The insulation is subjected to a voltage of substantially sine wave form or a DC voltage. The test voltage shall be raised uniformly from 0 V to the value prescribed in (a) below.

When the terminals of the test equipment are short-circuited, the current shall be between 0,1 mA and 1 mA.

a) Procedure 1

The test voltage shall be selected from 4.4, unless otherwise prescribed in the detail specification:

– between the terminals of a normally open switch in the release position,

– between the terminals of the make and break contact for both the operate and the release positions of the switch, unless otherwise prescribed in the detail specifications (form C contact),

– between all specified conductive parts of the switch.

The test voltage (DC or AC) (45 Hz – 65 Hz) shall be applied between the terminals for one of the following durations:

– for (60 ± 5) s,

– for 1 s (at 1,1 times the specified voltage).

b) Procedure 2

The method prescribed in (a) above can be applied with an appropriate preconditioning ionization method.

Unless otherwise prescribed in the detail specification, one of the test durations of procedure 1 shall be applied.

c) Procedure 3

While at its maximum normal operating temperature, industrial control equipment shall withstand for 1 min without breakdown the application of a 60 Hz essentially sinusoidal voltage or a direct-current potential.

– between uninsulated live parts and the enclosure with the contacts open and closed;
– between terminals of opposite polarity with the contacts closed; and
– between uninsulated live parts of different circuits.

The test voltage shall be the following values for alternating-current, or 1,414 times the following values for direct-current.

– 500 V – For industrial control equipment rated not more than 50 V;
– 1 000 V plus twice the rated voltage of the equipment – For industrial control equipment rated 51 V to 600 V;
– 1 000 V – For industrial control equipment rated 51 V to 250 V and intended for use in a pollution degree 2 location; or
– 2 000 V plus 2,25 times maximum rated voltage – For industrial control equipment rated 601 V to 1 500 V.

6.8.2 Requirements

The leakage current through the switch shall not exceed a specified value for a specified duration as prescribed in the detail specification.

6.8.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Procedure 1, 2 or 3.
b) Preconditioning, if applicable.
c) Voltage between the terminals of the make contact (and break contact, for both the operate and the release positions of the switch; form C contact) unless otherwise prescribed in detail specifications.
d) Conductive parts.
e) Duration of application of the test voltage.
f) Maximum value of leakage current.
g) Maximum duration of leakage current.
h) Time that elapses between preconditioning ionization and monitoring for a leakage current, if applicable.

6.9 Insulation resistance

6.9.1 Procedure

The test voltage, as prescribed in the detail specification, shall be applied:

– between the terminals of the make contact (and break contact, in both the release and the operate positions of the switch; form C contact), unless otherwise prescribed in the detail specification;
– between specified metallic parts of the reed switch.

The insulation resistance of the reed switch shall be measured at the d.c. voltage level prescribed in the detail specification, which should be one of the following:

– 100 V, or
– 500 V.

The voltage shall be applied for at least 0,5 s, or for a longer period as is necessary to obtain a stable reading, after which the insulation resistance shall be recorded.

6.9.2 Requirements

The insulation resistance value obtained shall be not less than that prescribed in the detail specification.

6.9.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Insulation test voltage.
b) Minimum value of insulation resistance.
c) Conductive parts.

6.10 Operating times (see Figures 4, 10 and 11)

6.10.1 Procedure

6.10.1.1 General

Suitable test circuits shall be used.

The test coil shall be energized from an adjustable DC supply via a bounce-free switch with a high open-circuit impedance and without any damping circuit.

NOTE The result of the time measurements upon switches made in a test coil depend not only upon the switch itself but also upon the test coil, and the impedances of the total circuit in the open and closed positions.

6.10.1.2 Operate make, break and transfer or bridging time

The zero energization shall be maintained for a minimum period of 10 ms. The DC supply voltage shall be set to provide a steady current equivalent to 150 % of the must-operate value. This shall be applied to the test coil and the times t_1 (t_2, t_3, t_4 if applicable) of the switch shall be measured.

6.10.1.3 Bounce time (operate) (t_5, t_6)

The bounce time (operate) shall be measured, under the same condition as the operate time. Discontinuities of less than 10 μs shall be ignored, unless otherwise prescribed.

6.10.1.4 Release make, break, bridging or transfer time

The DC supply shall be set to 150 % of the must-operate value and maintained for a minimum period of 10 ms prior to disconnection of the coil energization, and the times t_{11} (t_{12}, t_{13}, t_{14} if applicable) of the switch shall be measured.

6.10.1.5 Bounce time (release) (t_{15}, t_{16})

The bounce time (release) shall be measured, under the same conditions as the release time. Discontinuities of less than 10 μs shall be ignored, unless otherwise prescribed.

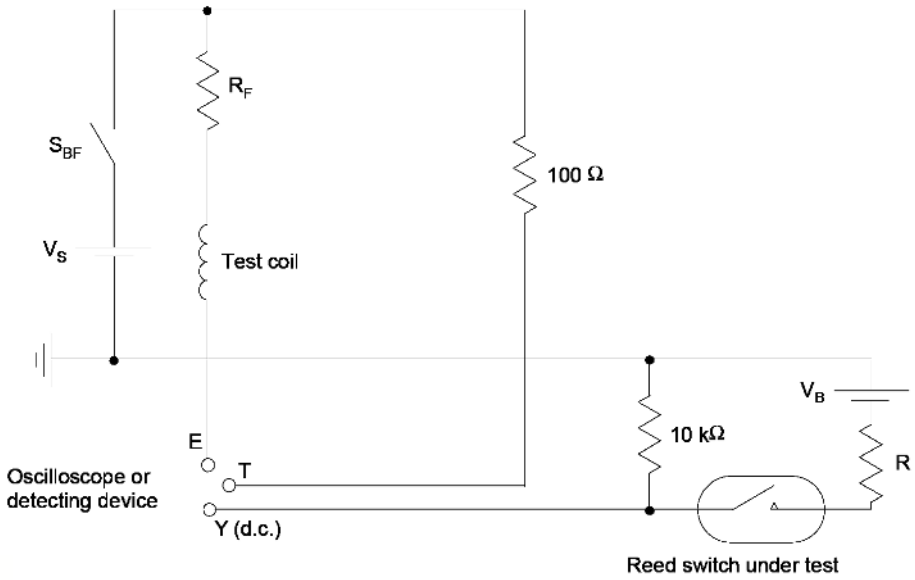
6.10.2 Requirements

The time(s) shall not exceed that (those) prescribed in the detail specification.

6.10.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Test coil number (see Annex A).
b) Test system description.
c) Must-operate value.
d) Operate time, maximum.
e) Release time, maximum.
f) Operate bounce time, maximum (where specified).
g) Release bounce time, maximum (where specified).
h) Test circuit potentials and resistances.
i) Repetition rate and duty cycle.
j) Transfer time, maximum and minimum } form C contact.
k) Bridging time, maximum and minimum }



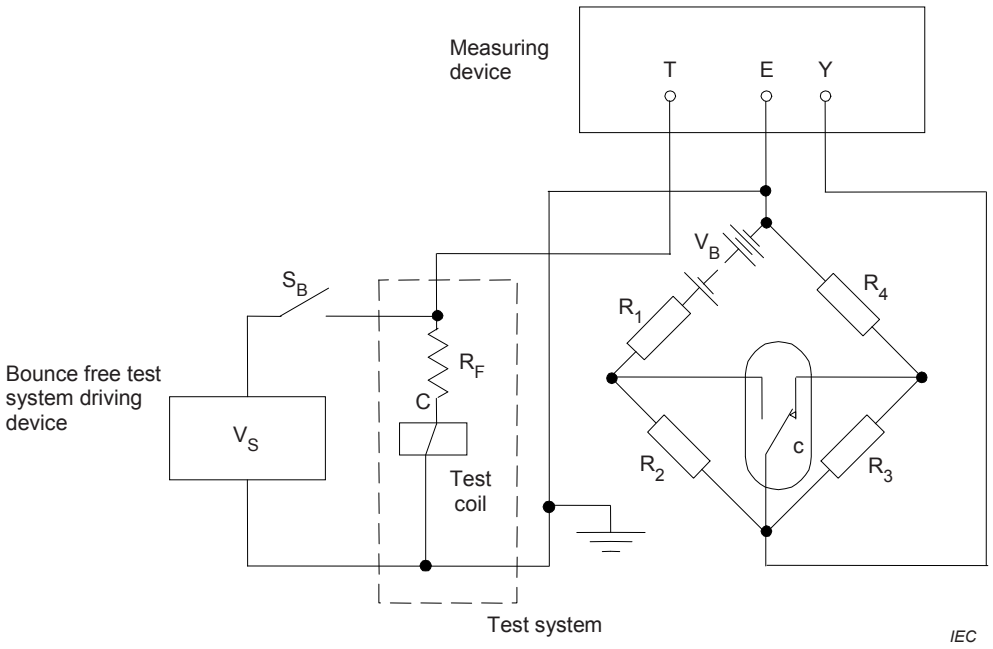
E: Common

T: Trigger

Y: Amplifier

NOTE All symbols that are not defined in this figure can be found in the key of Figure 11.

Figure 10 – Test circuit for the measurement of release and bounce time of a make contact



C: Test coil
c: Switch under test
V_s: Energization voltage supply
S_{BF}: Switch, bounce-free
V_B: Test supply voltage
R_1 to R_4: Resistors
R_F: Fixed resistor
T: Trigger input
Y and E: Measuring inputs

In order to distinguish between bridging and transfer time it is recommended to take the following ratios for the resistors: $R_1 = 1$, $R_2 = 2$, $R_3 = 2/3$, $R_4 = 1$.

Figure 11 – Test circuit for the measurement of time parameters of a change-over contact

6.11 Contact sticking

6.11.1 Thermal sticking

Procedure 1: Change of release time and operate time

The test circuit of 6.10 shall be used.

a) Make contact

The switch under test shall be mounted in a test coil and the coil energized at 150 % of the must-operate value, and then while at room ambient temperature the release break time shall be measured.

With the coil energization maintained, the ambient temperature shall be raised to the upper limit according to the given climatic category over 1 h approximately.

The switch shall be held operated at 150 % of the must-operate value at this temperature for not less than 24 h. The coil energization shall then be disconnected without any physical disturbance to the switch under test and the release break time shall be measured at this temperature (see 6.10.1).

The difference between the first and the second measurements indicates the degree of contact sticking.

b) Break contact

The switch under test shall be mounted in a test coil with no coil energization and then while at room ambient temperature, the operate break time shall be measured by applying 150 % of the must-operate value of energization.

The ambient temperature shall be raised to the upper limit according to the given climatic category over 1 h approximately without coil energization.

The switch shall be held at this temperature for at least 24 h without coil energization.

Without any physical disturbance to the switch under test, the operate break time shall be measured while still at this temperature by applying 150 % of the must-operate value of energization.

The difference between the first and the second measurements indicates the degree of contact sticking.

c) Requirements

The difference between the two time measurements shall not exceed the value prescribed in the detail specification.

d) Information to be stated in the detail specification

1) Test coil.
2) Upper category temperature.
3) The maximum permitted value of the difference between the first and the second measurement.
4) Test circuit description.
5) Test period.

Procedure 2: Change of just-release value and just-operate value

a) Make contact

The just-release value shall be measured according to 6.5, except that the saturate value shall not be applied.

The switch under test shall be mounted in a test coil and the coil energized at 150 % of the must-operate values, and then while at room ambient temperature, the just-release value shall be measured.

With the coil energization maintained, the ambient temperature shall be raised to the upper limit according to the given climatic category within 1 h.

The switch shall be held operated at 150 % of the must-operate value at this temperature for at least 24 h.

Without any physical disturbance to the switch under test the just-release value shall be measured at this temperature.

The difference between these two measurements indicates the degree of contact sticking.

b) Break contact

The just-operate values shall be measured according to 6.5, except that the saturate value shall not be applied.

The switch under test shall be mounted in a test coil and the coil energization shall be increased from zero, and then while at room ambient temperature, the just-operate value shall be measured.

The ambient temperature shall be raised to the upper limit according to the given climatic category within 1 h, without coil energization.

The switch shall be held at this temperature for at least 24 h without coil energization.

Without any physical disturbance to the switch under test the just-operate value shall be measured at this temperature.

The difference between these two measurements indicates the degree of contact sticking.

c) Requirements

The difference between the two measurements shall not exceed the value prescribed in the detail specification.

d) Information to be stated in the detail specification

1) Test coil.
2) Upper category temperature.
3) The maximum permitted value of the difference between the two measurements.
4) Rate of change of energization if other than 1 A × turns/ms.
5) Method of monitoring.
6) Failure-to-break contact circuit resistance limit, when using procedure 1 of 6.5.1.1.

6.11.2 Magnetostrictive sticking

a) Procedure

1) Make contact

The switch under test shall be mounted in a coil energized with 2 000 square wave pulses at a specified pulse rate. The peak-to-peak value of the pulses shall be as values prescribed in the detail specification.

The upper value of energization shall be above the must-operate value and the lower value of energization shall be above the must-not-release value.

The coil energization shall then be disconnected at the higher value without any physical disturbance of the switch under test and the unit shall be checked for failure-to-break (see 6.5).

The checking voltage for failure-to-break shall be removed before the test coil is re-energized.

The above cycle of tests shall be performed at least five times.

A failure shall be any occasion on which the contact fails to break, measured within a specified period after the interruption of the energization of the test coil.

NOTE 1 A tendency to stick can also be estimated by comparing release value and release break time during the test as under 6.11.1.

2) Break contact

The switch under test shall be mounted in a test coil energized with 2 000 square wave pulses at a specified pulse rate. The peak-to-peak value of the pulses shall be as prescribed in the detail specification.

The upper value of energization shall be lower than the must-not-operate value and the lower value of energization shall be lower than the must-release value.

The coil energization shall then be increased to 150 % of the must-operate value without any physical disturbance of the switch under test and the unit shall be checked for failure-to-break (see 6.5). The checking voltage for failure-to-break shall be removed before the test coil energization is disconnected.

The above cycle of tests shall be repeated at least five times.

A failure shall be any occasion on which the contact fails to break, measured within a specified period after the energization of the test coil.

NOTE 2 A tendency to stick can also be estimated by comparing operate value and operate break time during the test as under 6.11.1.

b) Requirements

The total number of failures-to-break shall not exceed that prescribed in the detail specification.

c) Information to be stated in the detail specification

1) Test coil.
2) Pulsing rate.
3) Limits for the peak-to-peak value of the pulses.
4) Number of test cycles.

5) Acceptable number of failures-to-break.
6) Minimum contact circuit resistance defining failure-to-break.
7) Specified period of measurement.

6.12 Robustness of terminals

6.12.1 Procedure

The switch shall be subjected to the appropriate procedures of Tests U of IEC 60068-2-21.

6.12.2 Requirements

The terminals and seals shall not show any visible damage, except where degradation of the terminals is permitted to the extent explicitly described in the detail specification. The changes in the functional characteristics shall not exceed the values prescribed in the detail specification.

6.12.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Applicable Tests U of IEC 60068-2-21.
b) Information required by the tests chosen from IEC 60068-2-21.
c) Permissible changes of functional characteristics.
d) Test method Qk or Ql of IEC 60068-2-17 and leakage rate or arc time duration test.

6.13 Soldering (solderability and resistance to soldering heat)

6.13.1 Procedure

a) Solderability

   Prior to the test, the switch shall be subjected to an accelerated ageing procedure either by exposing it to steam for 1 h or to dry heat at 155 °C for 16 h from IEC 60068-2-20, as required by the detail specification.

   The switch shall be subjected to one of the methods for solderability of Test Ta of IEC 60068-2-20.

b) Resistance to soldering heat

   The switch shall be subjected to one of the methods for resistance to soldering heat of Test Tb of IEC 60068-2-20.

6.13.2 Requirements

The requirements for solderability and resistance to soldering heat shall be prescribed in the detail specification.

6.13.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Method.
b) Information required by the methods chosen from IEC 60068-2-20.

6.14 Climatic sequence

6.14.1 General

In the climatic sequence, an interval of not more than three days is permitted between any of these tests, except between damp heat, cyclic, first cycle and dry cold.

In such a case, the cold test shall follow immediately after the recovery period specified for the damp heat test.

The tests and measurements shall be performed in the order given from 6.14.2 to 6.14.4.

6.14.2 Procedure

a) Dry heat

The switch shall be subjected to Test Ba of IEC 60068-2-2, at the upper limit according to the specified climatic category.

b) Damp heat, cyclic, first cycle

– This shall be carried out in accordance with Test Db of IEC 60068-2-30, for one cycle of 24 h.

– After recovery, the switch shall be immediately subjected to the cold test.

c) Cold

The switch shall be subjected to Test A of IEC 60068-2-1, at the lower limit according to the given climatic category.

d) Low air pressure

The switch shall be subjected to Test M of IEC 60068-2-13, using the degree of severity prescribed in the detail specification. The preferred severity is stated in 4.8.

e) Damp heat, cyclic, remaining cycles

The switch shall be subjected to Test Db of IEC 60068-2-30.

The number of cycles shall be prescribed in the detail specification.

Upon completion, the switch shall be exposed to the recovery conditions appropriate to the chosen severity.

6.14.3 Requirements

At the end of this climatic sequence the switches shall meet the requirements of the following tests as prescribed in the detail specification:

a) visual inspection (6.4);

b) functional tests (6.5);

c) contact circuit resistance (6.7);

d) dielectric test (6.8);

e) insulation resistance test (6.9);

f) sealing (6.21).

6.14.4 Information to be stated in the detail specification

The detail specification shall include the following:

a) Degree of severity for Test M.

b) Duration for Tests Aa and Ba.

c) Number of cycles for Test Db.

d) Permissible changes of functional characteristics.

e) Contact circuit resistance.

f) Maximum value of leakage current permissible.

g) Insulation resistance.

h) Method Qk or Ql of IEC 60068-2-17 and leakage rate or arc time duration test.

6.15 Damp heat, steady state

6.15.1 Procedure

The switch shall be subjected to Test Cab of IEC 60068-2-78, using the appropriate degree of severity prescribed in the detail specification.

6.15.2 Requirements

At the end of this test the switch shall meet the requirements of the following tests as prescribed in the detail specification:

a) visual inspection (6.4);
b) functional tests (6.5);
c) contact circuit resistance (6.7);
d) dielectric test (6.8);
e) insulation resistance test (6.9);
f) sealing (6.21);
g) solderability (6.13).

6.15.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Degree of severity for Test Cab of IEC 60068-2-78.
b) Permissible changes of functional characteristics.
c) Contact circuit resistance.
d) Maximum value of leakage current permissible.
e) Insulation resistance.
f) Test method Qk or Ql of IEC 60068-2-17 and leakage rate or arc time duration test.

6.16 Rapid change of temperature

6.16.1 Procedure

The switch shall be subjected to Test Na or Nc of IEC 60068-2-14.

6.16.2 Requirements

The switch shall be visually examined. There shall be no visible damage, except as explicitly described in the detail specification, and the marking shall be legible as prescribed in the detail specification. The switch shall meet the requirements of the sealing test (6.21).

6.16.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Test Na or Test Nc of IEC 60068-2-14.
b) Information required by the test selected (in particular test conditions and severities).
c) Test method Qk or Ql of IEC 60068-2-17 and leakage rate or arc time duration test.

6.17 Salt mist

6.17.1 Procedure

The switch shall be subjected to Test Ka of IEC 60068-2-11.

6.17.2 Requirements

The switch shall be visually examined. There shall be no visible damage and the marking shall be legible as prescribed in the detail specification.

6.17.3 Information to be stated in the detail specification

As stated in Test Ka of IEC 60068-2-11.

6.18 Vibration

6.18.1 Vibration 1 – Functional

6.18.1.1 Procedure

The switch shall be subjected to Test Fc of IEC 60068-2-6. Subclauses 8.2 (vibration response investigation) followed by 8.3.1 (endurance by sweeping) and finally 8.2 (vibration response investigation) of IEC 60068-2-6:2007 shall apply. The preferred severity is stated in 4.9.

Vibration shall be applied in three mutually perpendicular axes unless otherwise prescribed in the detail specification.

For the purpose of this test, the sample shall be rigidly mounted in the test coil.

During this test, the test coil shall be alternately energized at 150 % of the must-operate value and de-energized, the change in condition to synchronize with the completion of each vibration sweep, ignoring the defects in the resonance frequency band.

The switch under test shall be continuously monitored to detect false contact opening or closing.

Adequate precautions shall be taken to shield the switch from the magnetic field of the vibration table.

6.18.1.2 Requirements

During the test, no failure-to-make (or failure-to-break) shall exceed 10 μs.

Immediately following the tests, the switches shall meet the requirements of the following tests as prescribed in the detail specification:

a) visual inspection (6.4);
b) functional tests (6.5);
c) sealing (6.21).

6.18.1.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Axis of mounting if different from above.
b) Identification of the direction of movement of the contacts (if appropriate).
c) Severity.
d) Permissible changes of functional characteristics.
e) Mounting jig.
f) Test method Qk or Ql of IEC 60068-2-17 and leakage rate or arc time duration test.

6.18.2 Vibration 2 – Survival

6.18.2.1 Procedure

The switch shall be mounted in the jig prescribed in the detail specification.

The vibration test shall be carried out at 50 Hz for 6 h with a vibration amplitude of 0,35 mm unless otherwise prescribed in the detail specification.

Unless otherwise prescribed in the detail specification, vibration shall only be applied normal to the longitudinal axis with the direction of acceleration in the same direction as the movement of the contacts during make and break.

6.18.2.2 Requirements

Immediately following the test, the switches shall meet the requirements of the following tests as prescribed in the detail specification:

a) visual inspection (6.4);
b) functional tests (6.5);
c) sealing (6.21).

6.18.2.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Axis of mounting, if different from above.
b) Identification of the direction of movement of the contacts (if appropriate).
c) Permissible changes of functional characteristics.
d) Mounting jig.
e) Test method Qk or Ql of IEC 60068-2-17 and leakage rate or arc time duration test.

6.19 Shock

6.19.1 Procedure

6.19.1.1 General

The switch shall be subjected to Test Ea of IEC 60068-2-27.

The environmental severities are stated in 4.9.

The severity shall be prescribed in the detail specification.

Shock shall be applied in three mutually perpendicular axes unless otherwise prescribed in the detail specification.

6.19.1.2 Method 1 – Functional

For the purpose of this test, the switch shall be rigidly mounted in a test coil. The sample shall then be submitted to one half of the number of shocks with the test coil energized at 150 % of the must-operate value; and the other half of the number of shocks while de-energized.

The switch under test shall be continuously monitored to detect false opening or closing.

6.19.1.3 Method 2 – Survival

During this test, the switch shall be rigidly mounted in the jig prescribed in the detail specification and subjected to the required number of shocks.

6.19.2 Requirements

6.19.2.1 Method 1

During the test, no failure-to-make or failure-to-break shall exceed 10 μs. Immediately following the test, the switch shall meet the requirements of the following tests as prescribed in the detail specification:

a) visual inspection (6.4);

b) functional tests (6.5);

c) sealing (6.21).

6.19.2.2 Method 2

Immediately following the shock test, the switch shall meet the requirements of the following tests as prescribed in the detail specification:

a) visual inspection (6.4);

b) functional tests (6.5);

c) sealing (6.21).

6.19.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Information required by Test Ea of IEC 60068-2-27.

b) Method 1 or 2.

c) Mounting jig.

d) Identification of the direction of movement of the contacts (if appropriate).

e) Permissible changes of functional characteristics.

f) Test method Qk or Ql of IEC 60068-2-17 and leakage rate or arc time duration test.

6.20 Acceleration test – Functional test only

6.20.1 Procedure

The switches shall be subjected to Test Ga of IEC 60068-2-7.

The environmental severities are stated in 4.9.

Unless otherwise prescribed in the detail specification, the acceleration shall only be applied normal to the longitudinal axis with the direction of acceleration in the same direction as the movement of the contacts during make and break.

For the purpose of this test, the sample shall be rigidly mounted in the test coil.

During this test, the test coil shall be alternately energized at 150 % of the must-operate value and de-energized, for at least 10 times, unless otherwise prescribed in the detail specification.

The switch under test shall be continuously monitored to detect opening or closing.

6.20.2 Requirements

Immediately following the acceleration test, the switch shall meet the requirements of the following tests as prescribed in the detail specification:

a) visual inspection (6.4);
b) functional tests (6.5);
c) sealing (6.21).

6.20.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Information required by Test Ga of IEC 60068-2-7.
b) Mounting jig.
c) Identification of the direction of movement of the contacts.
d) Permissible changes of functional characteristics.
e) Test method Qk or Ql of IEC 60068-2-17 and leakage rate or arc time duration test.

6.21 Sealing

6.21.1 Procedure

The switches shall be subjected to Test Qk or Ql of IEC 60068-2-17.

For heavy-duty reed switches the integrity of the hermetic seal shall be checked by means of an arc time duration test, while switching a load, as prescribed in the detail specification.

6.21.2 Requirements

The requirements are as follows:

a) The leakage rate shall not exceed the rate prescribed in the detail specification.
b) The specimens shall be visually inspected and electrically and mechanically checked as required by the relevant specification (Test Ql of IEC 60068-2-17).
c) The arcing time shall not exceed a value prescribed in the detail specification (arc time duration test).

6.21.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Test Qk or Ql of IEC 60068-2-17 or arc time duration test.
b) Pressure and duration for Test Ql of IEC 60068-2-17 or severity for Test Qk of IEC 60068-2-17 or switching load and frequency for arc time duration test.
   – for Test Qk: leakage rate;
   – for Test Ql: information on how the specimens shall be visually inspected and electrically and mechanically checked;
   – for arc duration test: maximum arcing time.

6.22 Electrical endurance

6.22.1 Types of electrical endurance test

The appropriate type of electric endurance test shall be selected by the manufacturer. There are four types which may be used:

a) Standard electrical endurance test

b) Maximum electrical endurance test

c) Overload test

d) Application simulation endurance test

Application simulation tests are electrical endurance tests performed under specified conditions related to a well-defined application. Due to the diversity and numerous possible applications, these endurance tests cannot be specified in a harmonized specification.

NOTE With respect to the establishment and assessment of reliability data for the switches such as failure mode analysis or Weibull parameter analysis, reference is made to IEC 61810-2.

6.22.2 Standard electrical endurance tests

These tests are standardized as far as possible to allow comparison of several products and give information on reliability and assessed quality under standardized conditions.

6.22.3 General test arrangements

The test arrangement is shown in Annex C.

The input energization source incorporates a power supply unit complete with the stabilization circuitry consistent with the given energization and impedance limits, and the corresponding over-current protection. The switching device provides a pulse pattern of the desired frequency, duty cycle and waveform to operate the reed contact via the test coil.

The control device provides signals for operating the switching device and controls starts, measurement stops, etc.

The switches shall be mounted in test coils according to Annex A.

The load shall be a component, a cable or a combination of several components and / or cables. The source for output energization shall supply the voltages or currents for energizing the load and may provide voltages or currents necessary for the measurements. Together the load and the source for output energization define the load conditions. The load conditions shall be selected from the standard loads as prescribed in the blank detail specification or in the detail specification.

The measuring and indication device shall be capable of performing the specified measurements. It shall also indicate which type of failure was detected in which reed contact and indicate when this occurred. Other functions which this device may provide are the indication of data and time, limiting and mean values of measurements and tests, failures of the test equipment; and the provision of commands to the control device to de-energize switches which have failed.

The electrical endurance testing equipment shall be capable of performing standard electrical endurance tests as specified in this subclause or application simulation endurance tests as specified in a detail specification. Application simulation tests shall be so written that the test equipment capable of performing the standard electrical endurance tests will be equally suitable for the simulation tests.

The test shall be performed under standard atmospheric conditions.

The frequency of operation, load condition, numbers of operations, rated switching current and rated switching voltage shall be given in the detail specification.

The switching polarity shall comply with the detail specification.

The wiring of the control, measuring and indicating devices shall not effectively influence the current through, and the voltage across, the contact during operation. For example, the test points may be switchable for this purpose.

6.22.4 Procedure

The test shall be performed under standard atmospheric conditions.

a) Standard electrical endurance test

The operate energization of the test coils shall be 150 % of the must-operate value of the reed switches to be tested. The release energization shall be zero, unless otherwise prescribed in the detail specification. The frequency of operation shall be selected from: 10; 12,5; 16; 20; 25; 50 and 60 operations per second, unless otherwise prescribed in the detail specification.

The pulse pattern shall be of a rectangular waveform with a duty cycle of 50 % unless otherwise prescribed in the detail specification.

b) Maximum electrical endurance test and overload test

The operate energization of the test coils shall be 150 % of the must-operate value of the reed switches to be tested. The release energization shall be zero, unless otherwise prescribed in the detail specification. The frequency of operation shall be 6 operations per second.

The pulse pattern shall be of a rectangular waveform with a duty cycle of 50 % unless otherwise prescribed in the detail specification.

The source for input energization should be a voltage source with low internal impedance.

The test coils in which the switches are mounted shall be energized individually or in parallel, with precautions against interactions. When coil suppression (electrical components to suppress or reduce unwanted transients) is used it shall be prescribed in the detail specification.

Each switch shall be connected to a separate load with or without additional contact protection, as prescribed in the detail specification.

NOTE 1 A relay can be considered as a test system for the purposes of endurance testing.

Each switch shall be tested for failure to make and failure to break at each operation, unless otherwise prescribed in the detail specification. This test may be done by measuring the voltage drop across the switch under normal load conditions.

The measuring period τ_1, for failure to make, starts at a time t_1 after the start of the coil energization.

The measuring period τ_2, for failure to break, starts at a time t_2 after the end of the coil energization.

The times t_1, t_2, τ_1 and τ_2 shall be given in the detail specification.

At intervals prescribed in the detail specification, the contact circuit resistance of each contact shall be measured according to the method in 6.7, excepting that the measuring period shall start at time t_3 and shall last τ_3, as given in the detail specification and the energization shall be 150 % of the must-operate energization value.

The integration times of the measuring device shall be shorter than τ_1, τ_2, and τ_3 respectively.

The integration time is the time required by the monitoring device to register the mean value of a signal. In the case of an input step voltage at the failure criteria level, it is the time required to register a failure.

The load shall be switched on and off by the reed switch under test. The wiring to the loads shall be as short as possible.

The wiring of the control, the measuring and indicating devices shall not effectively influence the current through and the voltage across the switch during operation. For example, the test point may be switchable for this purpose.

If the source for output energization is a voltage source it shall be connected with one terminal to earth. The voltage source shall have an internal resistance R_i and surge impedance Z_s so that the following conditions are met $R_i < 0{,}02 \times$ resistance of DC load and $Z_s < 0{,}02\ Z$ of the load up to 1 MHz (see 6.3).

If several loads are connected in parallel via the respective switch under test to the same voltage source, the combined load shall be taken into account.

The tolerance on the voltage source shall be a maximum of ±10 % on 30 mV and a maximum of ±2 % for the other values.

If the switch is an unsymmetrical type having a preferred switching polarity, this should by stated in the detail specification.

NOTE 2 This procedure describes only tests for the make contact. If the break contact is tested, similar test conditions are described in the detail specification. If both contacts are to be tested, when two separate loads will be needed, the two circuits are independent of each other.

6.22.5 Standard load conditions

The standard electrical endurance test load conditions shall be selected from the following loads:

a) Resistive loads (see Table 2)

   The load, including the connection wires, shall have a maximum rise time of 0,1 μs, an inductance $<10^{-4}$ Henry and a capacitance <50 pF. (Overshoot under consideration.)

   If more stringent test conditions are required, these shall be prescribed in the blank detail specification.

   The test point of the measuring and indicating device should be connected to the switch under test via a resistor ≥50 kΩ.

Table 2 – Resistive loads

Type of voltage	Voltage of output source V	Current through closed contacts mA
DC	0,03	1
	0,03	10
	0,10	1
	5	5
	5	10
	10	100
	12	2
	12	10
	24	50
	50	10
	50	100
	60	10
	60	100
	100	50
	120	50
	200	100
	350	1
	500	1
	1 000	1
	2 000	1
	3 500	1
	5 000	1
	10 000	1
	15 000	1
AC	0,03	10
	0,1	1
	230	100
	230	500
	230	1 000
NOTE Preferred loads are underlined.		

b) Combined loads (e.g. for telephony applications)

The source for output energization shall supply a DC voltage. The load shall consist of a resistive load combined with a cable or contact protection or both connected. The cable shall fulfil the requirements of the relevant IEC 60096 publication. The resistor and the connection wires shall fulfil the requirements under a) above.

Combined loads of this subclause are derived from Table 3 in conjunction with cables chosen from Table 4.

Table 3 – Loads

Voltage of output source V DC	Current through closed contacts mA
12	10
24	50
50	50
50	100
60	50
100	50
NOTE Preferred loads are underlined.	

Table 4 – Cables

Cable n°	Cable type	IEC 60096 designation	Z_C Ω	Lengths m
1	Coaxial	50-3-1	50	1 3 10 100
2	Coaxial	75-4-4	75	1 3 10 100
3	Coaxial	100-4-1	100	1 3 10 100
4	Shielded	---	140	1 3 10 100
NOTE 1 Preferred cables and cable lengths are underlined for reed switches.				
NOTE 2 The introduction of extra inductance should be avoided by, for example, the use of bifilar winding.				

c) Inductive loads

Loads corresponding to utilization categories given in IEC 60947-5-1. For electrical endurance tests for contacts rated according to utilization categories given in IEC 60947-5-1, durability tests defined in IEC 60947-5-1 apply. See Table 5.

Table 5 – Making and breaking capacity for electrical endurance tests

Current	Classification	Making			Breaking		
AC	AC inductive load (contactor coil, solenoid valve)	I	U	cosφ	I	U	cosφ
		10 I_e	U_e	0,7[a]	I_e	U_e	0,4[a]
DC	DC inductive load (contactor coil, solenoid valve) [b]	I	U	$T_{0,95}$	I	U	$T_{0,95}$
		I_e	U_e	$6\times P^c$	I_e	U_e	$6\times P^c$

I_e is the rated operating current
I is the switching current
U_e is the rated operating voltage
U is the switching voltage
P is $U_e\ I_e$ steady-state power in watts
$T_{0,95}$ is the time to reach 95 % of the steady-state current, in milliseconds

a The power factors indicated are conventional values and appear only in test circuits in which electrical characteristics of coils are simulated. Reference is made to the fact that for circuits with a power factor of 0,4, shunt resistors are used to simulate the damping effect due to eddy current losses.

b For DC inductive loads provided with a switching device to operate an economy resistor, the rated operating current shall be equal to at least the highest making current.

c The value "$6\times P$" is derived from an empirical relationship appropriate for most DC inductive loads up to P = 50 W, where $6\times P$ = 300 ms. Loads with a rated power above 50 W can be considered to comprise small loads in parallel. Therefore, 300 ms is an upper limit independent of the power value.

Recommended values for U_e:

AC: 12 V, 24 V, 50 V, 100 V, 110 V, 120 V, 200 V, 220 V, 230 V, 240 V, 380 V, 400 V, 480 V, 500 V, 550 V, 600 V (r.m.s.)

DC: 12 V, 24 V, 48 V, 100 V, 110 V, 120 V, 125 V, 200 V, 220 V, 250 V.

Recommended values for I_e:

1 mA; 10 mA; 15 mA; 30 mA; 50 mA; 100 mA; 0,3 A; 0,5 A; 1 A; 2 A; 3 A; 5 A.

d) Inrush current loads

The circuits for capacitive and filament lamp loads are described in Annex D.

e) Motor loads

The example motor loads are described in Annex G.

6.22.6 Maximum load conditions

Maximum load conditions are described in Table 6.

Table 6 – Maximum load conditions for endurance test

Test current A	Power factor	Number of cycles	Test cycle times s	
			ON	OFF
Rated current	d.c.	6 000	1	9
Rated current	1,0	6 000	1	9

6.22.7 Overload test conditions

The overload test conditions are described in Table 7.

Table 7 – Overload test conditions for endurance test

Intended device application	Current A	Power factor
DC resistive load	1,5 times of rated value	d.c.
AC resistive load	1,5 times of rated value	1,0

6.22.8 Requirements

Any single switch shall be considered to have failed (become a 'defective') when a definitive failure occurs during the specified number of operations. Thus for the purpose of the endurance test, the end of life of a switch (a 'defective') occurs when a definitive failure has been assessed before the number of operations specified for that test has been completed.

A definitive failure occurs in one single switch when the number of failures registered is equal to or greater than a specified number. These failures may be specified in each of the following categories:

a) failure to make;

b) failure to break;

c) failure to meet the contact circuit resistance requirements;

d) any combination of a), b) and c), as prescribed in the detail specification.

6.22.9 Information to be stated in the detail specification

The detail specification shall include the following:

a) Energization conditions
   - test coil number selected from the list given in Annex A,
   - coil suppression, if applicable;
   - frequency of operation;
   - duty cycle if other than 50 %;
   - polarity, when applicable.

b) Load conditions
   - for resistive loads: voltage and current selected from Table 2;
   - for resistive loads combined with cable discharge: voltage and current selected from Table 3; cable selected from Table 4 together with the preferred cable length;
   - for inductive loads: voltage and current selected from Table 5;
   - for inrush current loads: see Annex D.

c) Failure criteria
   - the total number of operations required;
   - monitoring during test:
     - limits for: failure to make: ..... Ω,
       failure to break: ..... Ω,
     - monitoring times: t_1, τ_1, t_2, τ_2,
     - the number of failures in one switch making a definitive failure of that switch in the test;
   - periodic measurements:
     - number of operations at which contact resistance measurement shall be done,
     - monitoring times: t_3, τ_3,
     - failure limit for contact resistance and number of contact resistance failures of a single switch, making a definitive failure of that switch in the test;
     - number of operations at which functional values (A × turns) shall be measured;
     - maximum permissible change in contact circuit resistance (mΩ) and in functional values (A × turns) or limiting values of contact resistance and functional values as prescribed in the detail specification, making a definitive failure of that switch in the test;
   - monitoring for bridging for form C contact: if prescribed in the detail specification (not applicable for form A and form B contacts):
     - monitoring time,
     - monitoring interval;
   - measurements before and after endurance test:

     maximum permissible change in contact circuit resistance (mΩ) and in functional values (A × turns) or limiting values of contact resistance and functional values as prescribed in the detail specification, making a definitive failure of that switch in the test.

     NOTE Defective switch: A defective switch for this endurance test is a switch which has at least one definitive failure in the different modes of measurement such as monitoring during test, periodic measurements, measurements before and after endurance test. Results of monitoring have priority over the periodic measurements in assessment of definitive failure.

d) Application:

– any other types of application shall be based on agreement between manufacturer and user, but information given in the manufacturer's catalogue or tender may constitute such an agreement.

6.23 Mechanical endurance

6.23.1 General test arrangements

Most of the endurance testing equipments are built corresponding to the block diagram of Figure C.2 with no load applied to the contacts. Furthermore, the general test arrangements mentioned in 6.23.3 remain valid.

6.23.2 Procedure

The test shall be performed under standard atmospheric conditions.

The operate energization of the test coils shall be 150 % of the must-operate value of the reed switches to be tested.

The release energization shall be zero, unless otherwise prescribed in the detail specification.

The frequency of operation shall be selected from 10, 20, 50, 75 or 100 operations per second. The pulse pattern shall be a rectangular waveform with a duty cycle of 50 %, unless otherwise prescribed in the detail specification.

The source for input energization should be a voltage source with low internal impedance.

The test coils in which the switches are mounted shall be energized individually or in parallel, with precautions against interactions. When coil suppression (electrical components to suppress or reduce unwanted transients) is used, it shall be prescribed in the detail specification.

Each switch shall be tested for failure to make and failure to break at each operation by measuring the contact circuit resistance of the unit under test according to the method in 6.7.

The measuring period τ_1, for failure to make, starts at a time t_1 after the start of the coil energization.

The measuring period τ_2, for failure to break, starts at a time t_2 after the end of the coil energization.

The times t_1, t_2, τ_1 and τ_2 shall be given in the detail specification.

At intervals prescribed in the detail specification, the contact circuit resistance of each switch shall be measured according to the method in 6.7, excepting that the measuring period shall start at time t_3 and shall last τ_3, as given in the detail specification and the energization shall be 150 % of the must-operate energization value.

The integration times of the measuring device shall be shorter than τ_1, τ_2, and τ_3 respectively.

The integration time is the time required by the monitoring device to register the mean value of a signal. In the case of an input step voltage at the failure criteria level, it is the time required to register a failure.

NOTE This procedure only describes tests for the make contact. If the break contact is tested, similar tests are described in the detail specification.

6.23.3 Requirements

Any single switch shall be considered to have failed (become a 'defective') when a definitive failure occurs during the specified number of operations. Thus for the purpose of the endurance test, the end of life of a switch (a 'defective') occurs when a definitive failure has been assessed before the number of operations specified for that test has been completed.

A definitive failure occurs in one single switch when the number of failures registered is equal to or greater than a specified number. These failures may be specified in each of the following categories:

a) failure to make;

b) failure to break;

c) failure to meet the contact circuit resistance requirements;

d) any combination of a), b) and c), as prescribed in the detail specification.

6.23.4 Information to be stated in the detail specification

The detail specification shall include the following:

a) Energization conditions
   - Test coil number selected from the list given in Annex A;
   - Coil suppression, if applicable;
   - Frequency of operation;
   - Duty cycle if other than 50 %;
   - Polarity, when applicable.

b) Failure criteria
   - The total number of operations required;
   - Periodic measurements:
     - number of operations at which contact resistance measurement shall be done,
     - monitoring times: t_3, τ_3,
     - failure limit for contact resistance and number of contact resistance failures of a single switch, making a definitive failure of that switch in the test;
     - number of operations at which functional values (A × turns) shall be measured;
     - maximum permissible change in contact circuit resistance (mΩ) and in functional values (A × turns) or limiting values of contact resistance and functional values as prescribed in the detail specification, making a definitive failure of that switch in the test;
   - Measurements before and after endurance test:

     maximum permissible change in contact circuit resistance (mΩ) and in functional values (A × turns) or limiting values of contact resistance and functional values as prescribed in the detail specification, making a definitive failure of that reed switch in the test.

     NOTE Defective switch: A defective switch for this endurance test is a switch which has at least one definitive failure in the different modes of measurement: periodic measurements, measurements before and after endurance test.

6.24 Maximum cycling frequency

6.24.1 Procedure

NOTE The result of the maximum cycling frequency measurement upon a switch in a test system depends not only on the switch itself but also on the test system and the impedance of the total circuit in the operate and release positions.

The test circuit of 6.11 shall be used.

The test system shall be energized from an adjustable DC energization supply via a bounce-free device with a high open-circuit impedance and without any damping circuit.

The cycling frequency of the bounce free test system driving device shall be increased continuously from a minimum cycling frequency of 10 operations per second, unless otherwise prescribed, to the maximum cycling frequency stated in the detail specification.

The switch shall fulfil the specified requirements throughout this frequency range.

The following checks shall be made:

a) operation and release of the switch;
b) bridging or transfer time (form C contact);
c) bounce time.

Discontinuities of less than 10 μs may be ignored unless otherwise prescribed.

6.24.2 Requirements

Within the total frequency range, the switch shall operate and release and the transfer time, bridging time and bounce time shall be within specified limits.

6.24.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Transfer time: minimum – maximum.
b) Bridging time: minimum – maximum.

} form C contact only

c) Bounce time: maximum.
d) Test coil (see annex A).
e) Test circuit description.
f) Duty cycle.
g) Maximum cycling frequency.

6.25 Surge withstand test

6.25.1 Procedure

The test shall be performed under standard atmospheric conditions.

The test surge voltage (see IEC 61000-4-5) shall have a value of peak voltage (V_{peak}) as prescribed in the detail specification, the value shall be selected from those stated in 4.10:

– between the terminals of a make switch in the release position;
– between the terminals of a break switch in the operate position;
– across the switch in the open position unless otherwise prescribed;
– during a specified number of pulses with a prescribed interval between these pulses, as prescribed in the detail specification.

Measurement shall take place after preconditioning as prescribed in the detail specification (number of hours in darkness, screening from radiation).

6.25.2 Requirements

The leakage current through the reed switch shall not exceed the value specified in the detail specification.

6.25.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Preconditioning

b) V_{peak}
   - t_1 (pulse rising edge)
   - t_2 (pulse decreasing edge)

c) Number of pulses

d) Specified interval between the pulses

e) Series resistor value or network

f) Number of hours in darkness

g) Leakage current

6.26 Making and breaking capacities

6.26.1 General test arrangements

The tests are intended to verify that the contact is capable of performing its intended duty according to the classification and verified switching over-voltage.

The test arrangement is shown in Annex C.

6.26.2 Procedure

The test shall be performed under standard atmospheric conditions.

The operate energization of the test coil shall be at 150 % of the must-operate value or specified value of the switch to be tested.

The release energization shall be zero, unless otherwise prescribed in the detail specification.

6.26.3 Requirements

a) For making and breaking capacities under normal conditions:
   - the switch shall have the performance stated in the corresponding classification in Table 6 without having any failure.

b) For making and breaking capacities under abnormal conditions:
   - the switch shall have the performance stated in the corresponding classification in Table 7 without having any failure.

6.26.4 Information to be stated in the detail specification

The detail specification shall include the following:

a) Energization conditions
   - test coil number selected from the list given in Table A.1;
   - coil suppression, if applicable;
   - frequency of operation;
   - duty cycle if other than 50 %;
   - polarity, when applicable;

b) Load conditions
   – voltage, current and load constant selected from Tables 8, 9 and F.1 and G.1;

c) Failure criteria (see 6.22)
   – the total number of operations required;
   – monitoring during test:
      • limits for: failure to make:..... Ω,
        failure to break:..... Ω,
      • monitoring times: t_1, τ_1, t_2, τ_2,
      • the number of failures in one switch making a definitive failure of that switch in the test;
   – periodic measurements (see 6.7):
      • number of operations at which contact resistance measurement shall be done,
      • monitoring times: t_3, τ_3,
      • failure limit for contact resistance and number of contact resistance failures of a switch, making a definitive failure of that switch in the test;
   – monitoring for bridging for form C contact: if prescribed in the detail specification (not applicable for form A and form B contacts):
      • monitoring time,
      • monitoring interval.

Table 8 – Verification of making and breaking capacity under normal conditions

Classification	Making			Breaking			Number of cycles and frequency		
	I/I_e	U/U_e	cosφ	I/I_e	U/U_e	cosφ	Number of cycles	Frequency cycles/min	Duration of energization s
AC inductive load (contactor coil, solenoid valve)	10	[c]	0,3	1	[c]	0,3	50	6	0,05
	10	1	0,3	1	1	0,3	10	> 60 [b]	0,05
	10	1	0,3	1	1	0,3	990	60	0,05
	10	1	0,3	1	1	0,3	5 000	6	0,05
	Total number of cycles						6 050		
	I/I_e	U/U_e	$T_{0,95}$	I/I_e	U/U_e	$T_{0,95}$	Number of cycles	Frequency in cycles per minute	Duration of energization
DC inductive load (contactor coil, solenoid valve)	1	[c]	$6\times P^a$	1	[c]	$6\times P^a$	50	6	$T_{0,95}$
	1	1	$6\times P^a$	1	1	$6\times P^a$	10	> 60 [b]	$T_{0,95}$
	1	1	$6\times P^a$	1	1	$6\times P^a$	990	60	$T_{0,95}$
	1	1	$6\times P^a$	1	1	$6\times P^a$	5 000	6	$T_{0,95}$
	Total number of cycles						6 050		

I_e is the rated operating current
U_e is the rated operating voltage
P is U_e I_e steady-state power in watts.
$T_{0,95}$ is the time to reach 95 % of the steady-state current, in milliseconds.
I is the switching current
U is the switching voltage

a The value "6 × P" derived from an empirical relationship appropriate for most DC inductive loads up to P = 50 W, where 6 × P = 300 ms. Loads with a related power above 50 W can be considered to comprise small loads in parallel. Therefore, 300 ms is an upper limit independent of the power value.

b With maximum permissible frequency (ensuring reliable making and breaking of contacts).

c The test is carried out of a voltage of U_e × 1,1, with the test current I_e adjusted at U_e .

Utilization categories as given in IEC 60947-5-1 may also apply; in such cases all the relevant requirements and tests from IEC 60947-5-1 shall be fulfilled.

Table 9 – Verification of making and breaking capacity under abnormal conditions

Classification	Make			Break			Minimum on-time cycles (at 50 Hz or 60 Hz)	Making and breaking operations	
	I/I_e	U/U_e	cosφ	I/I_e	U/U_e	cosφ		Number	Rate per minute
AC inductive load (contactor coil, solenoid valve)	10	1,1	0,3	10	1,1	0,3	2	10	6
	I/I_e	U/U_e	$T_{0,95}$	I/I_e	U/U_e	$T_{0,95}$	**Time**		
DC inductive load (contactor coil, solenoid valve)	1,1	1,1	6×P[a]	1	1	6×P[a]	$T_{0,95}$	10	6

I_e is the rated operating current

U_e is the rated operating voltage

P is $U_e \times I_e$ steady-state power in watts

$T_{0,95}$ is the time to reach 9 5% of the steady-state current, in milliseconds

I is the switching current

U is the switching voltage

a The value "6 × P" is derived from an empirical relationship appropriate for most DC inductive loads up to P = 50 W, where 6 × P = 300 ms. Loads with a related power above 50 W can be considered to comprise small loads in parallel. Therefore, 300 ms is an upper limit independent of the power value.

Utilization categories as those given in IEC 60947-5-1 may also apply; in such cases all the relevant requirements and tests from IEC 60947-5-1 shall be fulfilled.

6.27 Conditional short-circuit current test

6.27.1 General test arrangements

The switch under test shall be in a new and clean condition, mounted as in service.

The test arrangement is shown in Annex E.

The details of the specified short-circuit protective device shall be stated by the manufacturer unless specified in the detail specification.

6.27.2 Procedure

The test shall be performed under standard atmospheric conditions.

The operate energization of the test coil shall be at 150 % of the must-operate value. The release energization shall be zero, unless otherwise prescribed in the detail specification.

6.27.3 Requirements

The switch shall endure the stress generated from the short-circuit current under specified conditions. The switch may be operated several times before test, at no load or at any current not exceeding the rated current. The test shall be performed using the circuit as shown in Annex B with the switch under test in the closed position.

The test is performed by applying the current three times at random times by operation of the separate switching device and the current shall be maintained until the short-circuit protective device (SCPD) operates. The SCPD shall be reset or replaced after each test.

The switching device shall be in series with the switch. The time interval between three tests shall be not less than 3 min. The actual time interval shall be stated in the test report.

After the rated conditional short-circuit test, the switch shall satisfy the requirements of the following tests:

a) visual inspection (6.4);

b) functional tests (6.5);

c) dielectric test (6.8).

6.27.4 Information to be stated in the detail specification

The detail specification shall include the following:

a) Energization conditions
   – test coil number selected from the list given in Table A.1, coil suppression, if applicable.

b) Short-circuit current and time.

c) Operation of SCPD: I^2t (A^2 s).

6.28 Contact reliability test

6.28.1 General

The reliability test evaluates the reliability of the reed switches under conditions stated in the detail specification.

NOTE With respect to the establishment and assessment of reliability data for reed switches, reference is made to IEC 61810-2.

The reliability test evaluates random failures including those occurring in the range of minimum operational voltage and current.

An example of a block diagram for reliability testing equipment is shown in Annex H.

The wiring of the control, the measuring and indicating devices shall not effectively influence the current through and the voltage across the switch unit during operation.

6.28.2 Procedure

The test shall be performed under standard atmospheric conditions.

The operate energization of the test coils shall be 150 % of the must-operate value of the switches to be tested. The release energization shall be zero, unless otherwise prescribed in the detail specification. The frequency of operation shall be selected from 4.2.

The pulse pattern shall be a rectangular waveform with a duty cycle of 50 % unless otherwise prescribed in the detail specification.

The source for input energization shall be a voltage source with low internal impedance.

The test coils in which the switches are mounted shall be energized individually or in parallel, with precautions against interactions. When coil suppression (electrical components to suppress or reduce unwanted transients) is used, it shall be described in the test report.

Each switch shall be tested for failure to make and failure to break at each operation unless otherwise prescribed by measuring the voltage of the load according to 6.28.4.

The measuring period τ_1, for failure to make, starts at a time t_1 after the start of the coil energization.

The measuring period τ_2, for failure to break, starts at a time t_2 after the end of the coil energization.

The times t_1, t_2, τ_1 and τ_2 shall be given in the detail specification.

At intervals prescribed in the detail specification, the contact circuit resistance of each switch shall be measured according to the method described in 6.7, except that the measuring period shall start at time t_3 and shall last τ_3, as given in the detail specification and the energization shall be 150 % of the must-operate energization value.

The integration times of the measuring device shall be shorter than τ_1, τ_2, and τ_3 respectively.

NOTE The integration time is the time required by the monitoring device to register the mean value of a signal. In the case of an input step voltage at the failure criteria level, it is the time required to register a failure.

The load shall be switched on and off by the switch under test. The wiring to the loads shall be as short as practicable.

6.28.3 Requirements

Any single switch shall be considered to have failed (become a 'defective') when a definitive failure occurs during the specified number of operations. Thus, for the purpose of the reliability test, the end of life of a switch (a 'defective') occurs when a definitive failure has been assessed before the number of operations specified for that test has been completed

A definitive failure occurs in one switch when the number of failures registered is equal to or greater than a specified number. These failures may be specified in the following categories:

a) failure to make;

b) failure to break;

c) failure to meet the contact circuit resistance requirements;

d) any combination of a), b) and c), as prescribed in the detail specification.

6.28.4 Information to be stated in the detail specification

The detail specification shall include the following:

a) Energization conditions:

- test coil number selected from the list given in Table A.1;
- coil suppression, if applicable;
- frequency of operation; see 4.2;
- duty cycle if other than 50 %;
- polarity, when applicable.

b) Load conditions:
- for switching loads: voltage and current; minimum operational voltage and current.

c) Failure criteria (see Annex H):
- the total number of operations required;
- monitoring during test:
  - limits for: failure to make: ..... V,
    failure to break: ..... V,
  - monitoring times: t_1, τ_1, t_2, τ_2,
  - the number of failures in one switch making a definitive failure of that switch in the test;
- periodic measurements:
  - number of operations at which contact resistance shall be measured,
  - monitoring times: t_3, τ_3,
  - failure limit for contact resistance and number of contact resistance failures of a switch making a definitive failure of that switch in the test;
  - number of operations at which functional values (A × turns) shall be measured;
  - maximum permissible change in contact circuit resistance (mΩ) and in functional values (A × turns) or limiting values of contact resistance and functional values as prescribed in the detail specification, making a definitive failure of that switch in the test;
- monitoring for bridging for form C contact: if prescribed in the detail specification (not applicable for form A and form B contacts):
  - monitoring time,
  - monitoring interval;
- measurements before and after reliability test:

  maximum permissible change in contact circuit resistance (mΩ) and in functional values (A × turns) or limiting values of contact resistance and functional values as prescribed in the detail specification making a definitive failure of that switch in the test.

d) Application:
- any other types of application shall be based on agreement between manufacturer and user, but information given in the manufacturer's catalogue or tender may constitute such an agreement.

  NOTE Defective switch: A defective switch is a unit which has at least one definitive failure in the different modes of measurement such as monitoring during test, periodic measurements, measurements before and after reliability test. Results of monitoring have priority over the periodic measurements in assessment of definitive failure.

6.29 Temperature rise

6.29.1 Procedure

The limiting continuous current stated in 4.5 shall be applied for the specified duration.

The length of wire connected to each terminal shall be 1 m and, unless otherwise stated, the cross-section of the wire shall be determined according to the load current (IEC 61810-1).

6.29.2 Requirements

The temperature rise shall not exceed 45 K unless otherwise specified in the detail specification and shall not cause any damage to the reed switch (IEC 61810-1).

After the temperature rise test, the switch shall satisfy the requirements of the following tests:

a) visual inspection (6.4);
b) functional tests (6.5);
c) contact circuit resistance (6.7).

6.29.3 Information to be stated in the detail specification

The detail specification shall include the following:

a) Energization condition:
   – test coil number selected from the list given in Table A.1, coil suppression, if applicable.
b) Test current.
c) Measurement positions.
d) Measurement duration.
e) Maximum temperature rise if less than 45 K.

6.30 Making current capacity test

6.30.1 General

An example of test arrangement and the test sequence are shown in Annex I.

The frequency of operation, load condition, numbers of operations, rated making current and rated making voltage shall be as specified in the detail specification unless otherwise stated by the manufacturer.

6.30.2 Procedure

The test shall be performed under standard atmospheric conditions.

The operate energization of the test coil shall be at 150 % of the must-operate value. The release energization shall be zero, unless otherwise prescribed in the detail specification.

6.30.3 Requirements

Any single switch shall be considered to have failed (become a 'defective') when a definitive failure occurs during the specified number of operations. Thus for the purpose of the endurance test, the end of life of a switch (a 'defective') occurs when a definitive failure has been assessed before the number of operations specified for that test has been completed.

A definitive failure occurs in one single switch when the number of failures registered is equal to or greater than a specified number. These failures may be specified in each of the following categories:

a) failure to make;
b) failure to break;
c) failure to meet the contact circuit resistance requirements.

6.30.4 Information to be stated in the detail specification

The detail specification shall include the following:

a) Energization conditions:
   – test coil number selected from the list given in Table A.1,
   – coil suppression, if applicable;
   – frequency of operation;
   – duty cycle if other than 50 %;
   – polarity, when applicable.
b) Making load conditions:
   – for inductive loads: see Annex I.
c) Failure criteria:
   – the total number of operations required;
   – monitoring during test:
      • limits for: failure to make and failure to break: ..... Ω,
      • monitoring times: t_1, τ_1,
      • the number of failures in one switch that result in a definitive failure of that switch in the test;
   – periodic measurements:
      • number of operations at which contact resistance shall be measured,
      • monitoring times: t_3, τ_3,
      • failure limit for contact resistance and number of contact resistance failures of a switch making a definitive failure of that switch in the test;
   – monitoring for bridging for form C contact: if prescribed in the detail specification (not applicable for form A and form B contacts):
      • monitoring time,
      • monitoring interval,
   – measurements before and after endurance test,
      • maximum permissible change in contact circuit resistance (mΩ) and in functional values (A × turns) or limiting values of contact resistance and functional values as prescribed in the detail specification, making a definitive failure of that switch in the test.
d) Application:
   – any other types of application shall be based on agreement between manufacture and user, but information given in the manufacturer's catalogue or tender may constitute such an agreement.

6.31 Breaking current capacity test

6.31.1 General

An example of test arrangement and the test sequence are shown in Annex J.

The frequency of operation, load condition, numbers of operations, rated breaking current and rated breaking voltage shall be as specified in the detail specification unless otherwise stated by the manufacturer.

6.31.2 Procedure

The test shall be performed under standard atmospheric conditions.

The operate energization of the test coil shall be at 150 % of the must-operate value. The release energization shall be zero, unless otherwise prescribed in the detail specification.

6.31.3 Requirements

Any single switch shall be considered to have failed (become a 'defective') when a definitive failure occurs during the specified number of operations. Thus for the purpose of the endurance test, the end of life of a switch (a 'defective') occurs when a definitive failure has been assessed before the number of operations specified for that test has been completed.

A definitive failure occurs in one single switch when the number of failures registered is equal to or greater than a specified number. These failures may be specified in each of the following categories:

a) failure to break;

b) failure to make;

c) failure to meet the contact circuit resistance requirements.

6.31.4 Information to be stated in the detail specification

The detail specification shall include the following:

a) Energization conditions:
   - test coil number selected from the list given in Table A.1, coil suppression, if applicable;
   - frequency of operation;
   - duty cycle if other than 50 %;
   - polarity, when applicable.

b) Breaking load conditions:
   - for inductive loads: see Annex J;

c) Failure criteria:
   - the total number of operations required;
   - monitoring during test:
     - limits for: failure to break and failure to make: ..... Ω,
     - monitoring times: t_2, τ_2,
     - the number of failures in one switch making a definitive failure of that switch in the test;
   - periodic measurements:
     - number of operations at which contact resistance measurement shall be done,
     - monitoring times: t_3, τ_3,
     - failure limit for contact resistance and number of contact resistance failures of a switch making a definitive failure of that switch in the test;
   - monitoring for bridging for form C contact: if prescribed in the detail specification (not applicable for form A and form B contacts):
     - monitoring time,
     - monitoring interval;
   - measurements before and after endurance test;
     - maximum permissible change in contact circuit resistance (mΩ) and in functional values (A × turns) or limiting values of contact resistance and functional values as prescribed in the detail specification making a definitive failure of that switch in the test.

d) Application:

– any other types of application shall be based on agreement between manufacturer and user, but information given in the manufacturer's catalogue or tender may constitute such an agreement.

Annex A
(normative)

Standard test coils for reed switches

See Figure A.1 and Table A.1.

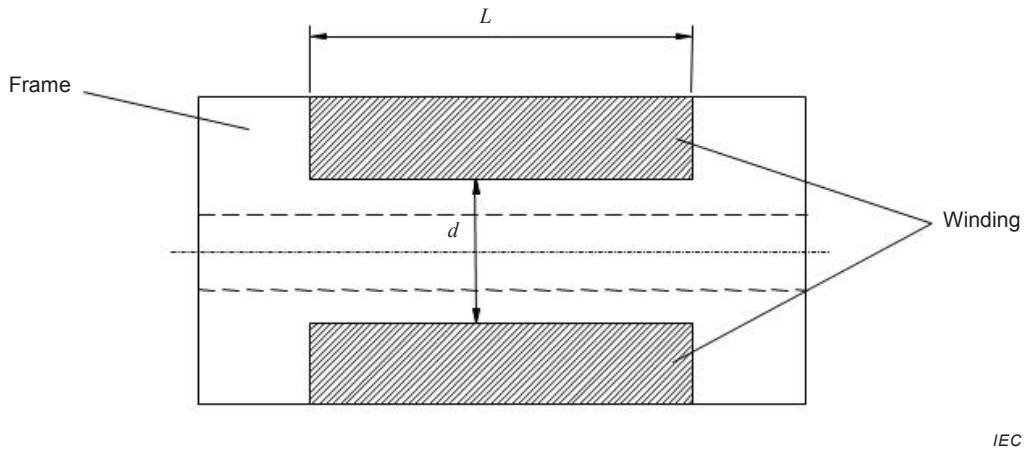


Figure A.1 – Configuration of test coils

Table A.1 – List of standard test coils *(1 of 2)*

Test coil No.	Winding length *L* (±0,1 mm) mm	Inside coil diameter *d* (±0,1 mm) mm	Number of turns (±1 turn)	Nominal copper wire diameter (Note) mm	Nominal resistance Ω
1	10	3,3	5 000	0,063 (0,060)	600
2	10	4,6	5 000	0,080	550
3	10,4	3,96	5 000	0,040	1 145
4	10,75	3,55	2 900	0,056	305
5	11	4,6	10 000	0,063	1 900
6	11,68	4,57	10 000	0,032	4 500
7	15	3,7	5 000	0,071 (0,070)	450
8	18,5	5,2	5 000	0,071	470
9	19	4,2	10 000	0,032	3 500
10	19,05	4,32	10 000	0,032	3 500
11	19,5	4,32	10 000	0,040	2 500
12	20,5	4,3	10 000	0,080	1 000
13	21	4,6	5 000	0,071 (0,070)	500
14	23	5,5	10 000	0,080	1 000
15	25,4	6,8	10 000	0,040	3 420
16	25,4	7,6	10 000	0,071	1 500
17	25,4	8,75	5 000	0,101	385
18	32,51	5,54	10 000	0,071	1 400
19	43	9,35	10 000	0,127	630
20	43	11,1	10 000	0,127	820

Table A.1 *(2 of 2)*

Test coil No.	Winding length L (±0,1 mm) mm	Inside coil diameter d (±0,1 mm) mm	Number of turns (±1 turn)	Nominal copper wire diameter (Note) mm	Nominal resistance Ω
21	48,2	7,3	10 000	0,090	1 000
22	54,5	5,9	10 000	0,100	670
23	19,0	8,1	10 000	0,10	1 245
24	28,3	7,4	10 000	0,07	1 630
25	33,5	10,5	3 000	0,2	80
26	48,2	14,2	10 000	0,11	1 000
27	25,4	8,05	1 100	0,11	54,8
28	26,6	6,2	9 500	0,058 (0,06)	1 520
29	36,3	7,2	10 000	0,08	1 020
30	28,2	13,8	5 200	0,17	253
NOTE Winding copper wires conforming to IEC 60317-1 (Grade 1).					

The centre lines of the standard test coil and of the switch envelope shall coincide unless otherwise prescribed in the detail specification.

The coil shall be layer-wound (i.e. turns to be distributed uniformly throughout the length of the coil).

The inside form coil diameter shall be prescribed in the detail specification.

It is recommended that material of the coil frame be chosen so as to be non-magnetic and electrically non-conductive and have nearly the same coefficient of expansion as the wires used in the winding.

Damage of the test coil by temperature rise due to the energization shall be avoided.

Ideal solenoid

The ideal solenoid is a cylindrical coil of which all the turns are assumed to be in planes normal to an axis and equally spaced.

This coil gives a homogeneous field.

Dimensions of the coil:

– inside coil diameter 80 mm minimum;
– length of the coil minimum 9 mm × the inside coil diameter.

The results obtained by using such a coil are directly given in SI units (A/m).

This coil shall be used for the calibration of the small coils.

Annex B
(normative)

Test systems

Two test systems are defined:

– system 1 with electromagnetic biasing;
– system 2 with permanent magnetic biasing.

System 1

The system is shown in Figure B.1.

Test coils are chosen from Table A.1.

System 2

The system is shown in Figure B.2.

Test coil is chosen from Table A.1.

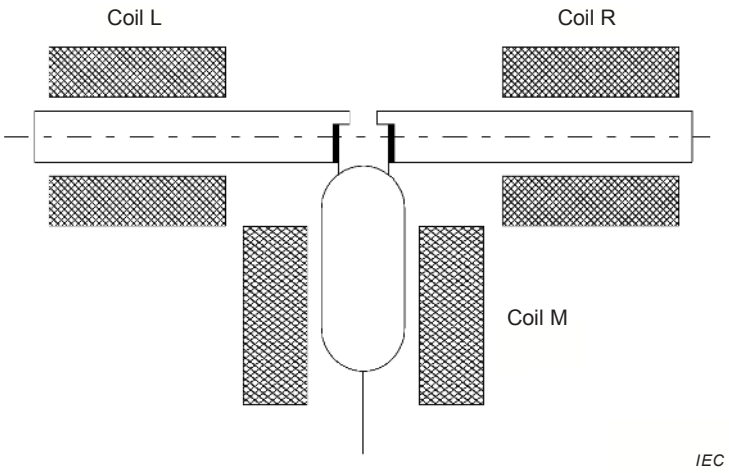


Figure B.1 – Test system 1

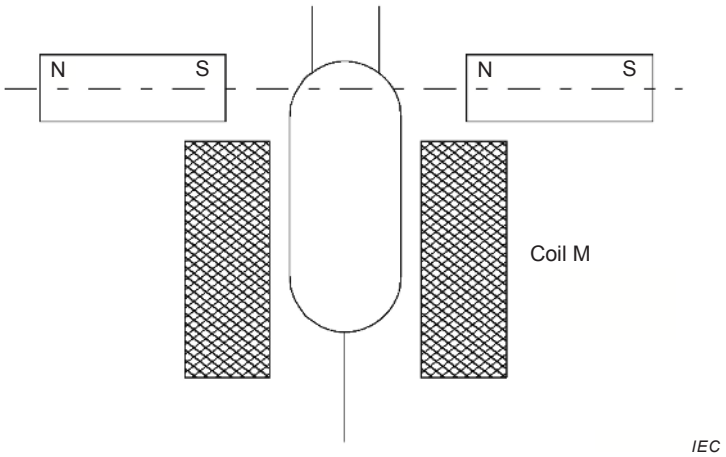


Figure B.2 – Test system 2

Coils M, L and R if applicable are chosen out of Table A.1.

Dimensions and additional details on test system construction are to be given in the detail specification.

Conditions of testing

Test procedures

System 1

The test procedures for sensitivity, timing and other tests where applicable shall indicate the energization of the three coils M, L and R.

System 2

The test procedure for sensitivity, timing and other tests where applicable shall indicate the energization of test coil M.

NOTE If a relay construction is chosen as a test system, full details are given in the detail specification. If the relay coil is only defined by the coil resistance and the dimensions, the limits of the functional values of the contact units are stated.

Annex C
(informative)

Electrical endurance test circuit

A generalized endurance test circuit is given in Figure C.1 and a functional block diagram in Figure C.2.

Load selection switch, position 1: Make test when different load (inrush current) is needed.

Load selection switch, position 2: Make and break (or cyclic) tests with same load.

Isolating switch: Used to connect/disconnect the load circuit, independent of the switch under test.

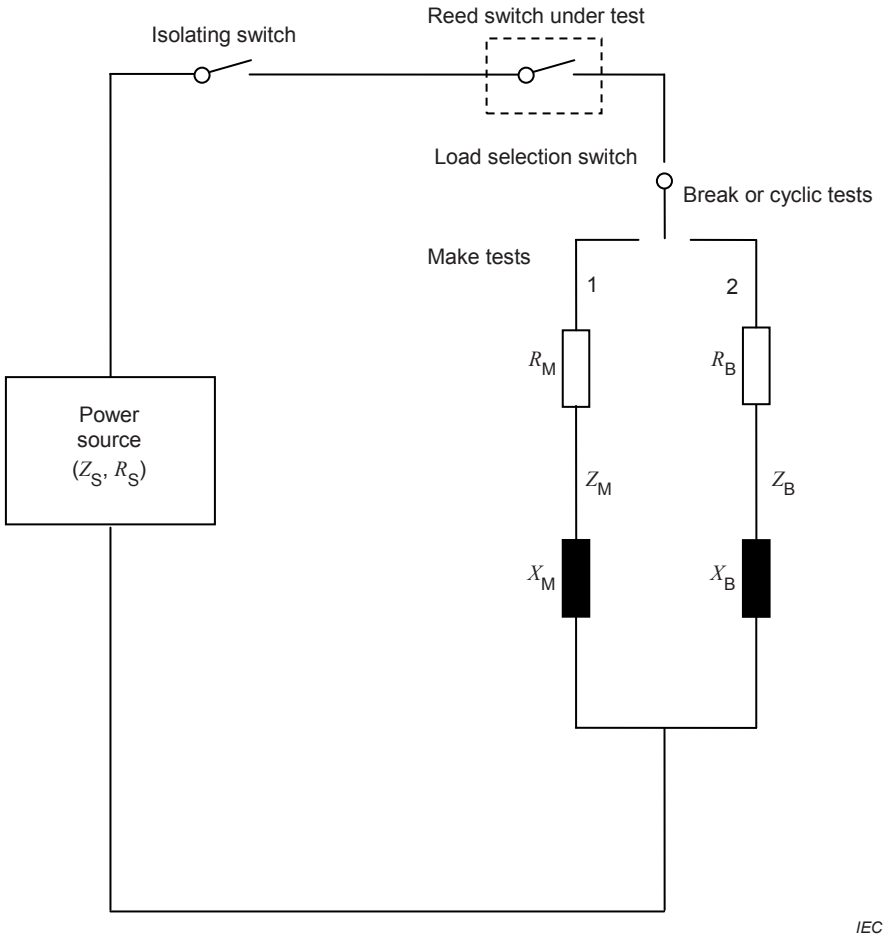


Figure C.1 – Generalized endurance test circuit

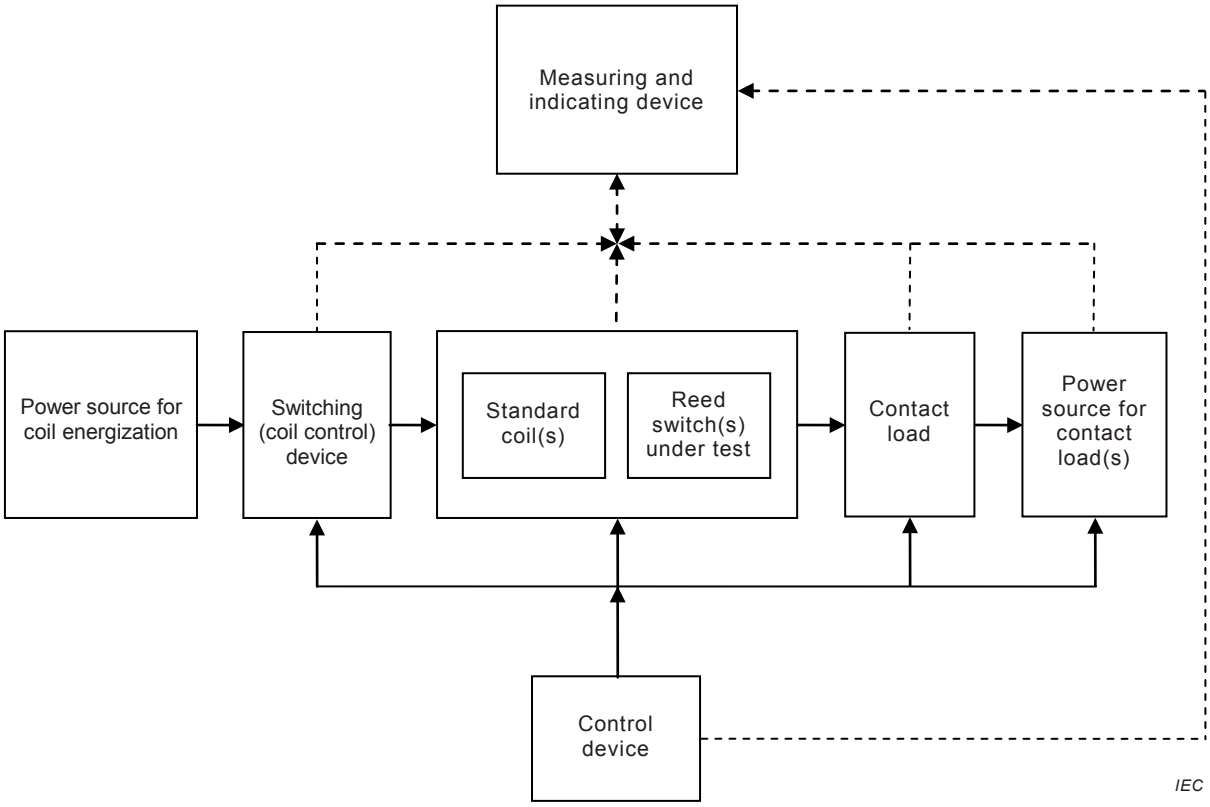


Figure C.2 – Functional block diagram

Annex D
(informative)

Inrush current loads

D.1 Filament lamp loads

The load circuit should be in accordance with Figure D.1, unless otherwise specified.

Test details should be as specified by the manufacturer.

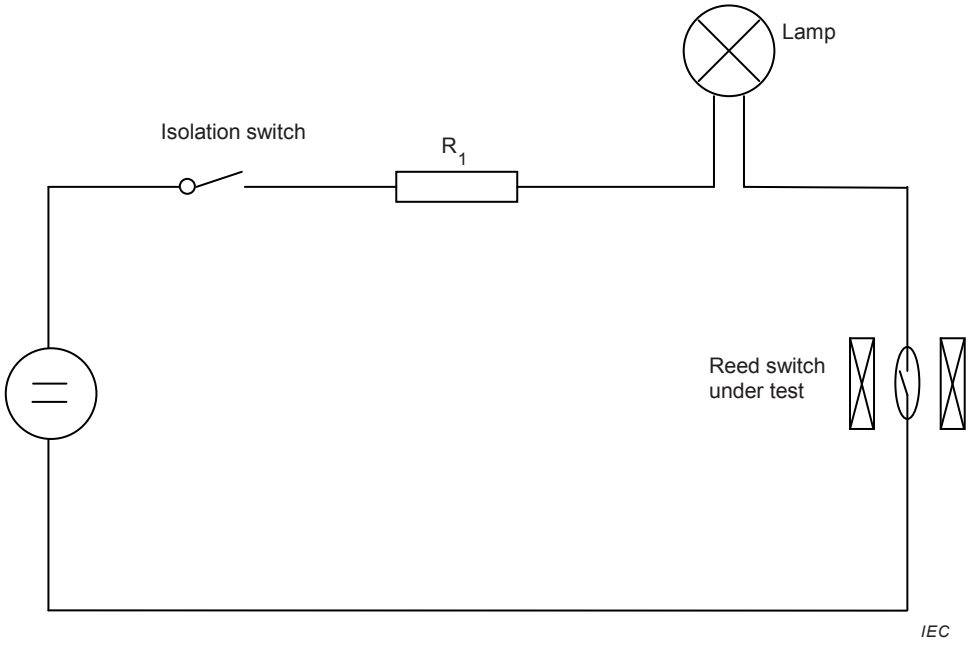


Figure D.1 – Circuit for filament lamp load

D.2 Capacitive loads

The load circuit should be in accordance with Figure D.2, unless otherwise specified.

Test details should be as specified by the manufacturer.

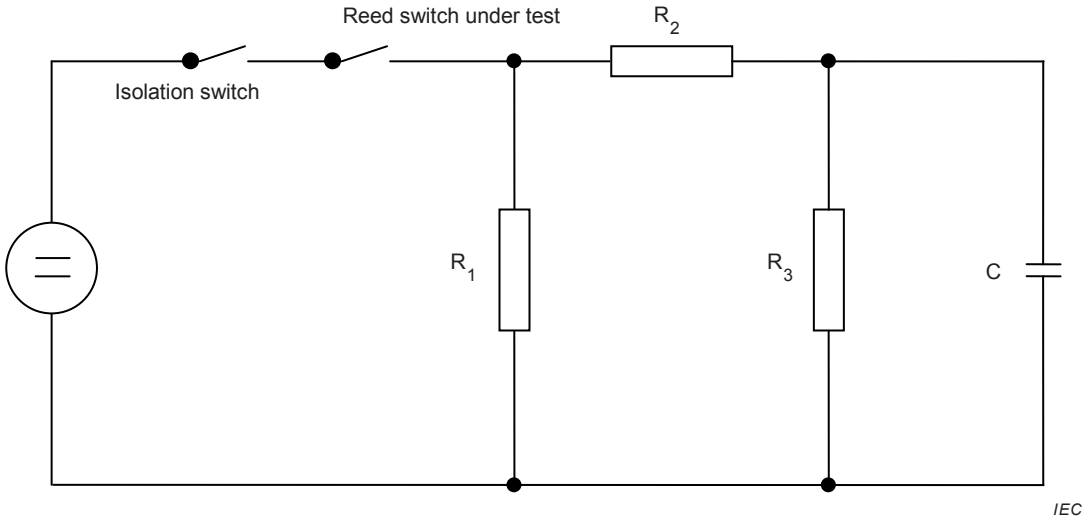
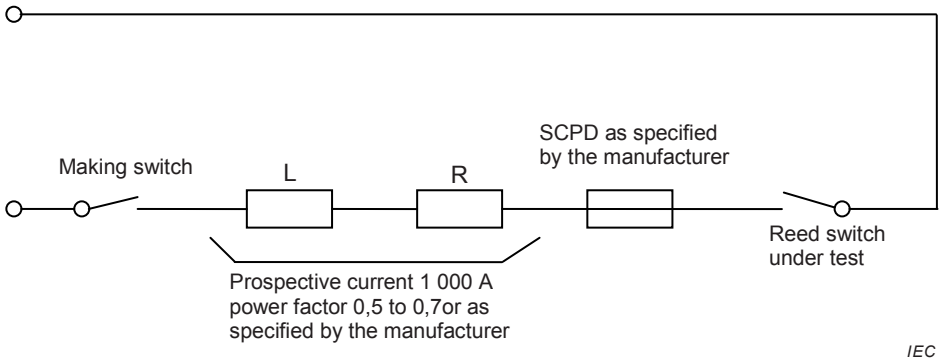


Figure D.2 – Example for capacitive load test

Annex E
(informative)

Conditional short-circuit current test circuit

See Figure E.1.



SCPD: short-circuit protective device (e.g. fuse)

Figure E.1 – Conditional short-circuit current test circuit

Annex F
(informative)

Electrical ratings based on classification (see Table F.1)

Table F.1 – Examples of contact rating designation based on classification

Desi-gnation[a]	Classifi-cation	Conventional Thermal current I_{the} (A)	Rated operational current I_e (A) at rated operational voltages U_e (V)						VA rating	
Alternating current			120 V	240 V	380 V	480 V	500 V	600 V	Make	Break
A150	AC inductive load (contactor coil, solenoid valve)	10	6	-	-	-	-	-	7 200	720
A300		10	6	3	-	-	-	-	7 200	720
A600		10	6	3	1,9	1,5	1,4	1,2	7 200	720
B150		5	3	-	-	-	-	-	3 600	360
B300		5	3	1,5	-	-	-	-	3 600	360
B600		5	3	1,5	0,95	0,75	0,72	0,6	3 600	360
C150		2,5	1,5	-	-	-	-	-	1 800	180
C300		2,5	1,5	0,75	-	-	-	-	1 800	180
C600		2,5	1,5	0,75	0,47	0,375	0,35	0,3	1 800	180
D150		1,0	3,60	0,60	-	-	-	-	432	72
D300		1,0	3,60	0,60	1,80	0,30	-	-	432	72
E150		0,5	1,80	0,30	-	-	-	-	216	36
Direct current			125 V	250 V		400 V	500 V	600 V	Make	Break
N150	DC inductive load (contactor coil, solenoid valve)	10	2,2	-		-	-	-	275	275
N300		10	2,2	1,1		-	-	-	275	275
N600		10	2,2	1,1		0,63	0,55	0,4	275	275
P150		5	1,1	-		-	-	-	138	138
P300		5	1,1	0,55		-	-	-	138	138
P600		5	1,1	0,55		0,31	0,27	0,2	138	138
Q150		2,5	0,55	-		-	-	-	69	69
Q300		2,5	0,55	0,27		-	-	-	69	69
Q600		2,5	0,55	0,27		0,15	0,13	0,1	69	69
R150		1,0	0,22	-		-	-	-	28	28
R300		1,0	0,22	0,11		-	-	-	28	28

[a] The letter stands for the conventional thermal current and identifies AC or DC; for example B means 5 A AC.

NOTE 1 The rated operational current I_e (A), the rated operational voltage U_e (V) and the break apparent power B (V.A) are connected by the formula $B = U_e \times I_e$.

NOTE 2 Utilization categories as given in IEC 60947-5-1 can also apply; in such cases all the relevant requirements and tests from IEC 60947-5-1 are fulfilled.

Annex G
(informative)

Example of horsepower ratings

The relationship between horsepower ratings and equivalent control circuit contact ratings is shown in Table G.1.

Table G.1 – Examples of horsepower ratings

Switch rating single phase horsepower	Maximum rating of coil VA	Equivalent control circuit contact rating code
1	720	A150, A300, A600
1/2	360	B150, B300, B600
1/8	180	C150, C300
1/10	72	D150, D300

NOTE An auxiliary device that complies with the requirements for across-the-line motor starting of an alternating-current motor is acceptable for alternating-current pilot duty without further tests provided that the overload test current is at least 150 % of the pilot-duty inrush current at the same voltage and the power factor is 0,5 or less.

For codes A, B, and C, and for devices with ratings not expressed using codes, the pilot-duty inrush current (make) is ten times the steady state current value (break); and, for Codes D and E, the pilot-duty inrush current (make) is six times the steady state current value (break).

Annex H
(informative)

Example of test arrangement for contact reliability test (see Figure H.1)

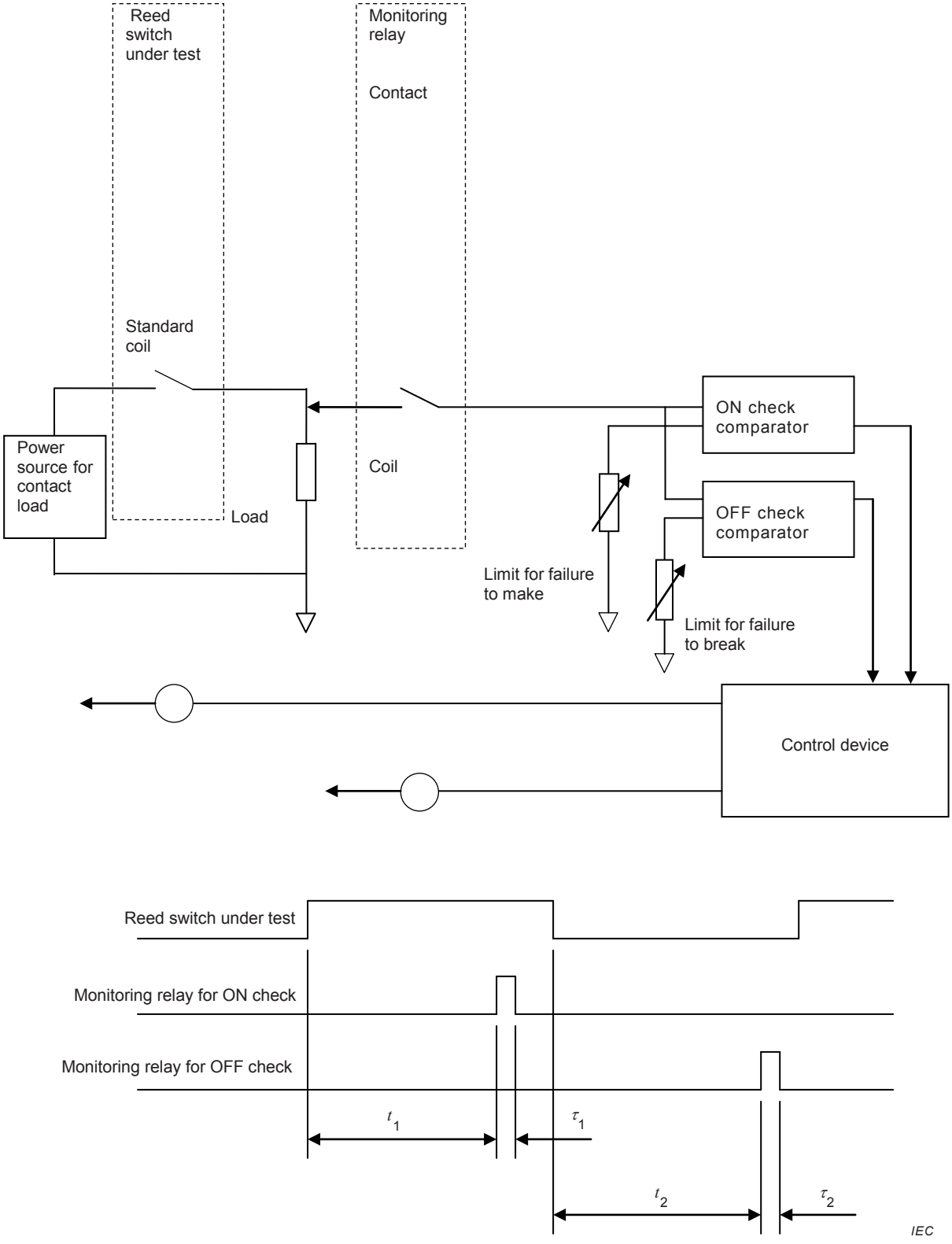


Figure H.1 – Contact reliability test circuit

The measuring period τ_1, for failure to make, starts at a time t_1 after the start of the coil energization.

The measuring period τ_2, for failure to break, starts at a time t_2 after the end of the coil energization.

Where not stated in the detail specification, the relationship between the operational voltage and limits for failure to make and break should be based on agreement between manufacturer and user, but information given in the manufacturer's catalogue or tender may constitute such an agreement.

Annex I
(informative)

Example of test arrangement for making current capacity test

Test details shall be specified by the manufacturer. See Figure I.1

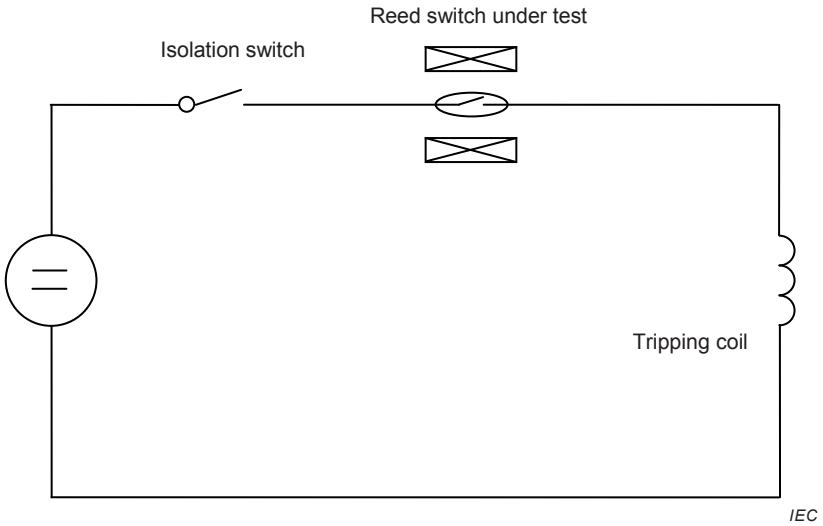


Figure I.1 – Making current capacity test circuit

The test sequence is given in Figure I.2

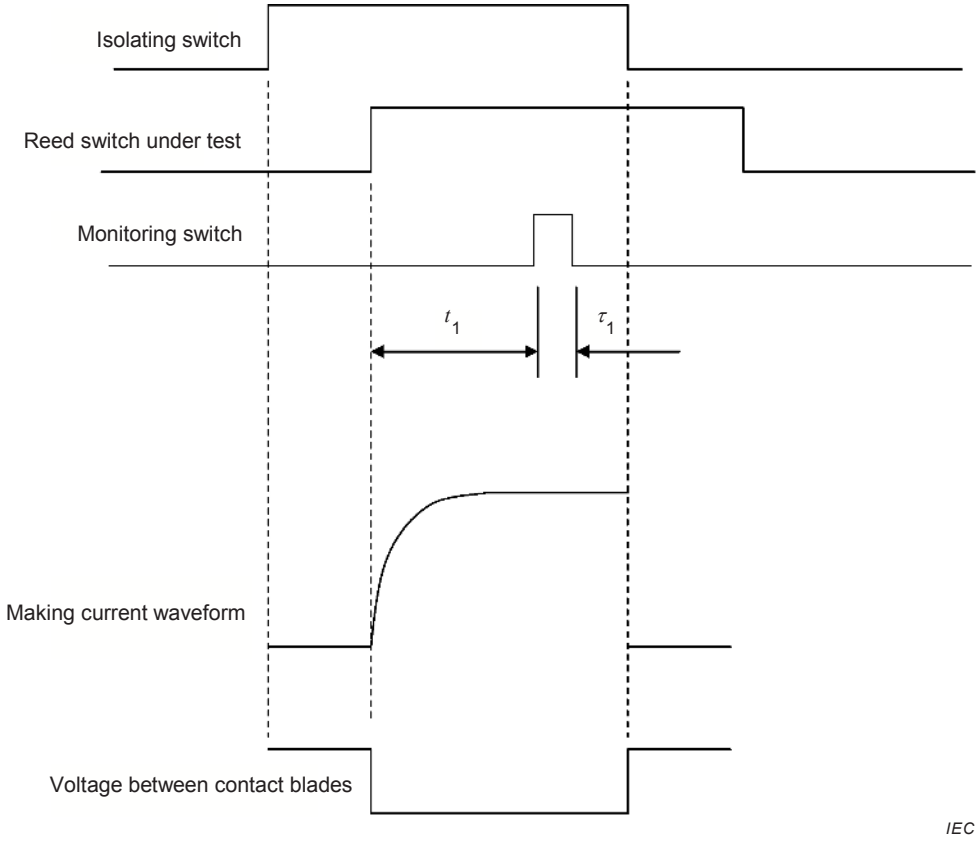


Figure I.2 – Making current capacity test sequence

The measuring period τ_1, for failure to make, starts at a time t_1 after the start of the coil energization.

Annex J
(informative)

Example of test arrangement for breaking current capacity test

Test details shall be specified by the manufacturer. See Figure J.1.

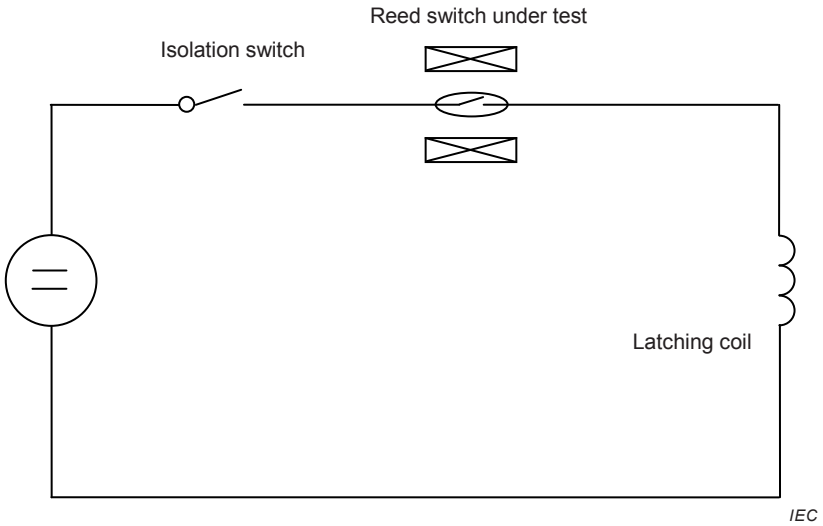


Figure J.1 – Breaking current capacity test circuit

The test sequence is given in Figure J.2.

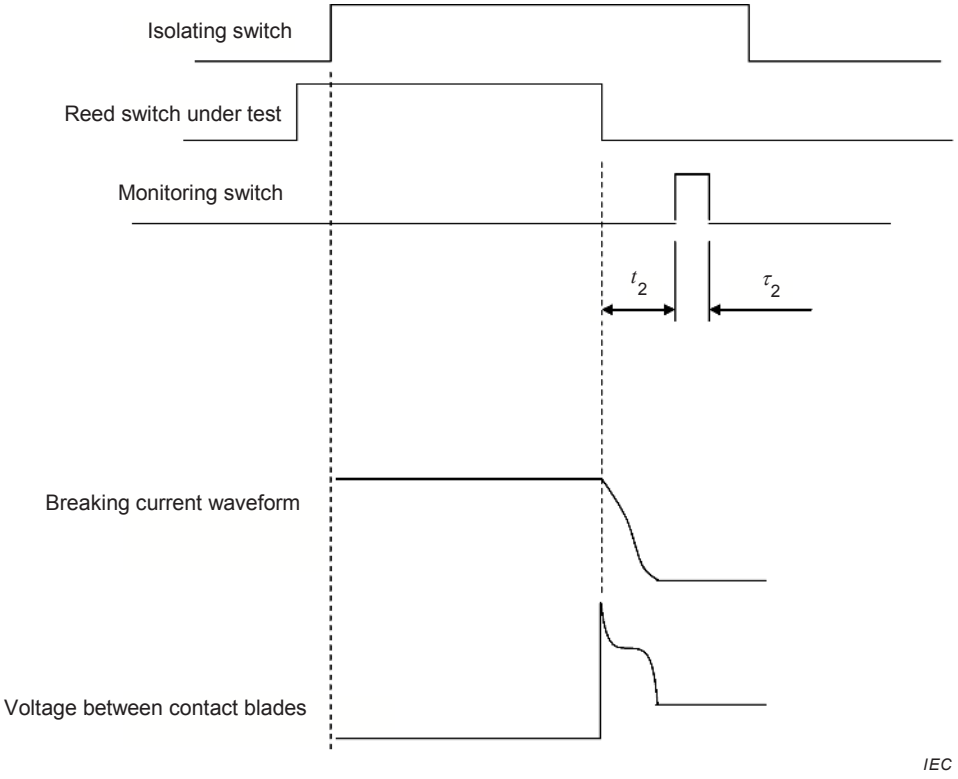


Figure J.2 – Breaking current capacity test sequence

The measuring period τ_2, for failure to break, starts at a time t_2 after the end of the coil energization.

Bibliography

IEC 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60050 (all parts): *International Electrotechnical Vocabulary* (available at http://www.electropedia.org)

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

IEC 60317-1, *Specifications for particular types of winding wires – Part 1: Polyvinyl acetal enamelled round copper wire, class 105*

IEC 60617 DB, *Graphical symbols for diagrams*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61810-1:2008, *Electromechanical elementary relays – Part 1: General requirements*

IEC 61810-2, *Electromechanical elementary relays – Part 2: Reliability*

IEC 61811-1, *Electromechanical non-specified time all-or-nothing relays of assessed quality – Part 1: Generic specification*

IEC 62246-1-1:2013, *Reed switches – Part 1-1: Generic specification – Quality assessment*

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