

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Reed switches –
Part 1: Generic specification**

**Contacts à lames souples –
Partie 1: Spécification générique**

Withdrawn



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

REED SWITCHES –

Part 1: Generic specification

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62246-1 has been prepared by IEC technical committee 94: All-or-nothing electrical relays.

This standard cancels and replaces the first edition of IEC 62246-1 published in 2002 and the first edition of IEC 62246-2 published in 2007. It constitutes a technical revision.

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

- update of references, terms and definitions;
- renumbering of clauses to bring them into a more logical order;
- inclusion of the generic specifications for all types of reed switches, but mercury wetted reed switches have been removed from the scope due to their potential for environmental impact;
- inclusion of three fundamental conformity assessment procedures for quality assessment;

- improvement of electrical endurance tests covering resistive, inductive, capacitive and filament lamp contact loads;
- renumbering of all annexes in the order they are referenced in the body of the standard;
- improvement of test procedures;
- inclusion of a new Annex C (informative) for electrical endurance test circuit, an Annex D (informative) for inrush current loads, an Annex E (informative) for conditional short-circuit current test circuit, an Annex F (informative) for electrical ratings based on classification, an Annex G (informative) for example of test arrangement for contact reliability test, an Annex H (informative) for example of test arrangement for making current capacity test and an Annex I (informative) for example of test arrangement for breaking current capacity test.

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

FDIS	Report on voting
94/314/FDIS	94/323/RVD

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

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

The detail specifications (DS), the sectional specifications (SS) and the blank detail specifications (BDS) deriving from this document are not yet available and the IEC/PAS 62246-2-1 (a quality assessment specification) is intended to be developed to become a full IEC standard.

A list of all parts of the IEC 62246 series can be found, under the general title *Reed switches*, on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

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

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

REED SWITCHES –

Part 1: Generic specification

1 Scope

This part of IEC 62246 series, 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 also specifies the quality assessment procedures to be followed.

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.

NOTE 2 For elementary relays with reed switches, this standard is recommended to be used together with the standards IEC 61810-1 and IEC 61811-1 as applicable.

NOTE 3 The applications of reed switches can be covered by specific product standards and the use of the IEC 62246 series does not guarantee compliance with those standards.

NOTE 4 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 referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-1:1988, *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 + 12 h cycle)*

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

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

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

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

IECQ 001002-1:1998, *IEC Quality Assessment System for Electronic Components (IECQ System) – Rules of Procedure – Part 1: Administration*

IECQ 001002-3:2005, *IEC Quality Assessment System for Electronic Components (IECQ System) – Rules of Procedure – Part 3: Approval procedures*

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 the IEC 60050-444.

3.1 Terms and definitions of 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 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 (e.g. an energizing quantity applied to a coil)

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 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.

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 Terms and definitions of 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 electromagnetic fields at which the released reed switch just operates (see Figure 1)

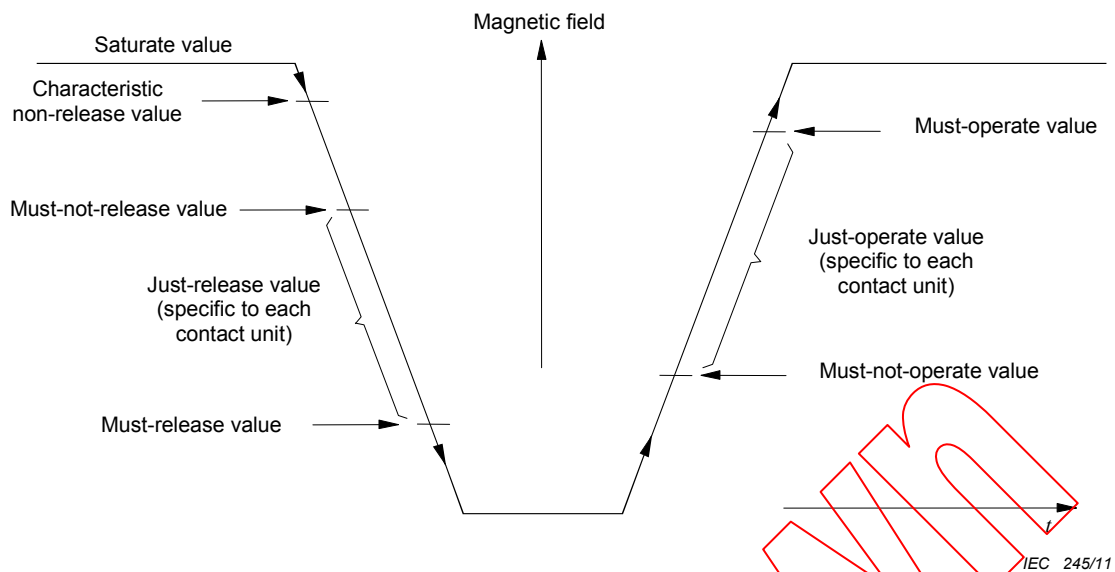


Figure 1 – Functional characteristics

3.2.6

must-operate value

stated limit of the applied magnetic field at which the reed switch operates (see Figure 1)

3.2.7

just-release value

value of the applied magnetic field at which the operated reed switch just releases (see Figure 1)

3.2.8

must-release value

stated limit of the applied magnetic field at which the operated reed switch releases (see Figure 1)

3.2.9

must-not-operate value

stated limit of the applied magnetic field at which the reed switch does not operate (see Figure 1)

3.2.10

must-not-release value

stated limit of the applied magnetic field at which the operated reed switch remains operated (see Figure 1)

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. (see Figure 1)

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 (see Figure 1)

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** (only for change-over switches)

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 Terms and definitions related to operating times (see Figure 2)**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**

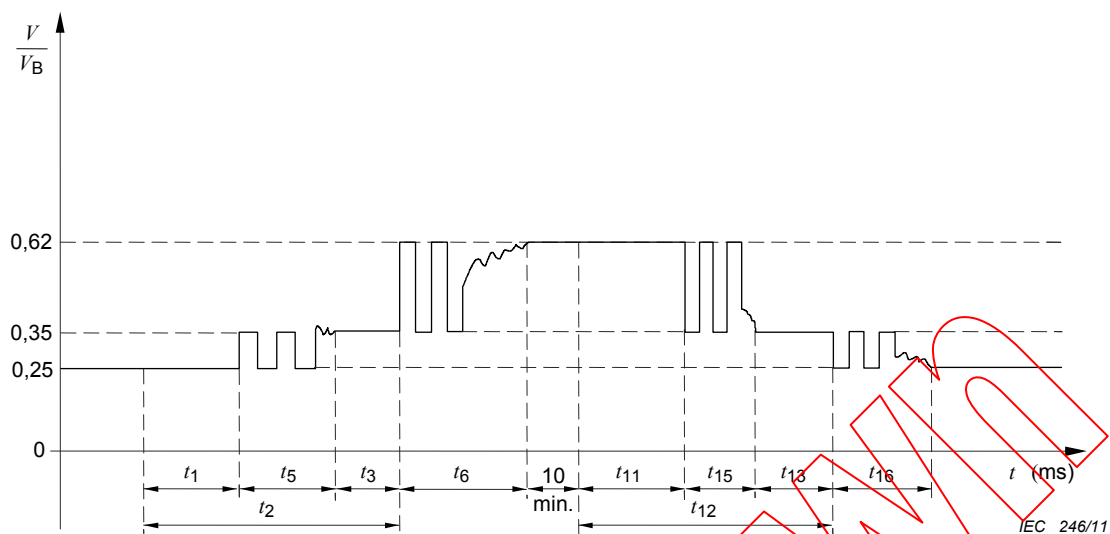
time interval between the application of the specified magnetic field to a reed switch in the release condition and the change of state of the last output circuit (not including bounce time)

3.3.3**release time**

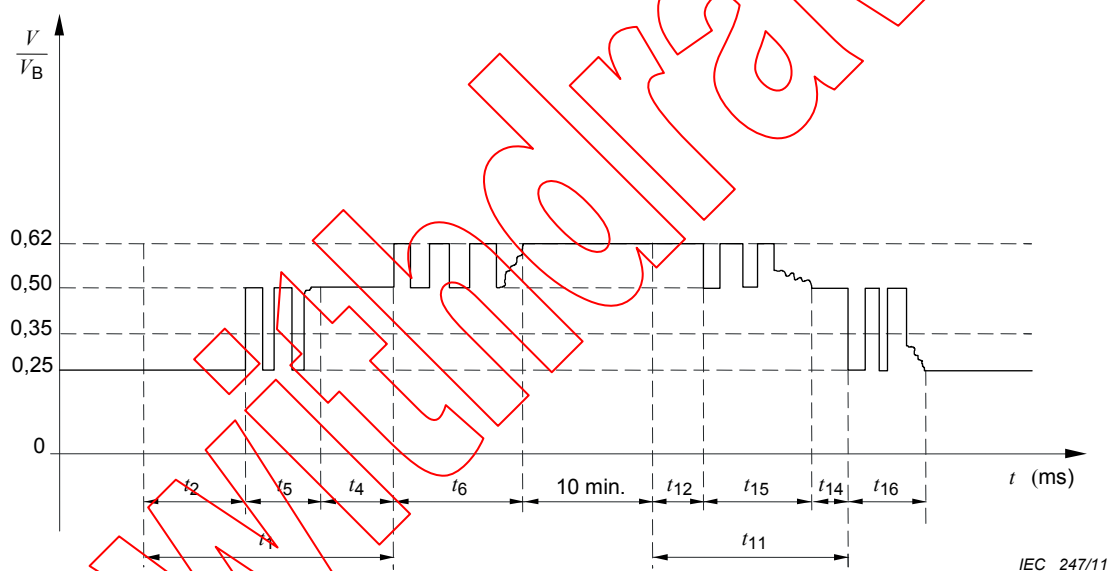
time interval between the removal of the specified magnetic field to a reed switch in the operate condition, and the change of state of the last output circuit (not including bounce time)

Withholding

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

Refer to Figures 5 and 6 for key to V_B .

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

Figure 2 – Time definitions

3.3.4**transfer time** (form C contact)

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

3.3.5**bridging time** (form D contact)

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

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** (form C contact)

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

3.3.11**release transfer time** (form C contact)

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

3.3.12**operate bridging time** (form D contact)

bridging time during which the make-before-break reed switch moves from the release to the operate position

3.3.13**release bridging time** (form D contact)

bridging time during which the make-before-break reed switch moves from the operate to the release position

3.3.14**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

3.3.15**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 Terms and definitions related to 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 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 (form A 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 Also known as a normally open (NO) contact.

3.4.6

break contact (form B 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 Also known as a normally closed (NC) contact.

3.4.7

change-over contact (form C/O contact)

contact set which contains a make contact and a break contact within a single envelope, one contact blade being common

3.4.7.1

change-over break-before-make reed switch (form C contact)

change-over contact in which the break contact circuit opens before the make contact circuit closes

3.4.7.2

change-over make-before-break reed switch (form D contact)

change-over contact in which the make contact circuit closes before the break contact circuit opens

3.4.7.3

change-over reed switch with unspecified switching sequence

(form A and form B contacts)

change-over reed switch where the switching sequence can be either make-before-break or break-before-make

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 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 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 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 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; 0,1; 5; 12; 24; 30; 40; 50; 100; 110; 120; 127; 150; 170; 175; 200; 220; 250; 265; 300; 380; 400; 500; 1 000; 1 500; 2 000 V AC (r.m.s.).
- b) 0,01; 0,03; 0,05; 0,1; 1; 1,5; 4,5; 5; 6; 6,3; 10; 12; 15; 17; 20; 24; 28; 30; 36; 40; 48; 50; 60; 80; 100; 110; 150; 170; 175; 200; 220; 250; 265; 280; 350; 400; 440; 500; 600; 800; 1 000; 1 200; 1 500; 2 000; 3 500; 5 000; 10 000; 15 000 V DC.

4.5 Current rating

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

4.6 Load ratings

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

Recommended values: 0,1; 0,3; 1; 2; 3; 5; 10; 15; 16; 20; 25; 30; 40; 50; 70; 100; 150; 250; 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) 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	Number of sweep cycles
10 Hz to 500 Hz	0,35 mm or 49 m/s ² (5 g _n)	10
10 Hz to 500 Hz	0,75 mm or 98 m/s ² (10 g _n)	10
10 Hz to 2 000 Hz	0,75 mm or 98 m/s ² (10 g _n)	8
10 Hz to 2 000 Hz	1,5 mm or 196 m/s ² (20 g _n)	8
10 Hz to 2 000 Hz	3,5 mm or 490 m/s ² (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 $\pm$ 10 %.

Cross-over frequency between 57 Hz and 62 Hz.

b) Shock (IEC 60068-2-27, Test Ea)

6 ms, 980 m/s², 100 g_n

11 ms, 490 m/s², 50 g_n

11 ms, 294 m/s², 30 g_n

c) Acceleration (IEC 60068-2-7, Test Ga)

m/s² 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.

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

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.

Special requirement for capacitive and filament lamp loads may 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).

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 Quality assessment procedures

6.1 General

The appropriate quality assessment procedure shall be selected by the manufacturer. There are three fundamental conformity assessment processes which may be used:

- a) supplier's declaration of conformity in which the manufacturer declares conformity,
- b) second-party conformity assessment in which the customer verifies conformity,
- c) third-party certification in which an independent third party verifies conformity.

NOTE Whichever process is selected, the recommendations of ISO/IEC Guide 60 should be applied insofar as they reasonably apply.

6.2 Supplier's declaration of conformity

When supplier's declaration of conformity is selected, the manufacturer shall, as a minimum, use a quality management system such as ISO 9000 or similar.

NOTE 1 This does not mandate that the quality management system be certified by an accredited body (see ISO 9001).

NOTE 2 It is recommended that the manufacturer's declaration of conformity be in accordance with ISO/IEC 17050-1.

6.3 Second-party conformity assessment

When second-party conformity assessment is selected, both the manufacturer and the customer shall, as a minimum, use a quality management system such as ISO 9000 or similar.

NOTE 1 This does not mandate that the quality management system be certified by an accredited body (see ISO 9001).

NOTE 2 It is recommended that the manufacturer's declaration of conformity be in accordance with ISO/IEC 17050-1.

6.4 Third-party certification

When third-party certification is selected, a recognized third-party approval system shall be used to confirm the compliance of the product with the product specification. The international IECQ system or IECEE system may be used.

6.5 IECEE scheme

When the IECEE system is used, the rules and procedures for the system shall be followed.

6.6 IECQ system

6.6.1 General

The basic rules and rules of procedure shall be accordance with IECQ system for quality assessment is to provide assurance to the purchaser that the components which are released conform to the requirements in the relevant specifications.

Before a manufacturer is permitted to produce, test and deliver components under the IECQ quality assessment system, it is necessary that his production organization, facilities, storage and delivery systems organization, facilities for inspection and tests of components, and arrangements for calibration meet the requirements of the IECQ system. In particular, it shall be demonstrated that all appropriate parts of the organization and its facilities are under the direct control or surveillance of the person appointed as chief inspector. This approval of manufacturers is granted in accordance with IECQ 001002-1.

The procedures for the qualification approval of electronic components as stipulated in IECQ 001002-1 comprise the following consecutive basic steps:

- a) qualification approval;
- b) quality conformance inspection.

6.6.2 Primary stage of manufacture

The primary stage of manufacture is defined as the plating and related processing of the contact blades.

6.6.3 Structurally similar components

The blank detail specification(s) shall define those reed switches within its scope which may be considered as structurally similar.

6.6.4 Subcontracting

Subcontracting is permitted for any stages preceding the primary stage of manufacture (see 6.6.2). Subcontracting shall be in accordance with requirements of Annex B to Clause 2 of IECQ 001002-3. Subcontracting the primary stage of manufacture and/or subsequent stages to an unapproved manufacturer is forbidden.

6.6.5 Qualification approval procedures

The manufacturer shall comply with the requirements for the primary stage of manufacture (see 6.6.2), as well as with the requirements given in the sectional and detail specifications.

In addition, the manufacturer shall produce test evidence of conformance to the specification requirements either on three consecutive lots for lot-by-lot inspection and on one lot for periodic inspection, or on a fixed sample subjected to the prescribed sequences of tests.

Samples shall be taken from the lots in accordance with IEC 60410. Normal inspection shall be used, but where the sample size is less than that which would give acceptance on zero defectives, additional specimens shall be taken to meet the sample size required to give acceptance on one defective.

6.6.6 Quality conformance inspection requirements

The blank detail specification shall prescribe the minimum test schedule which shall be included in each detail specification for those reed contact units covered by the scope of the specification.

This test schedule shall also specify the division into groups and subgroups (see 3.2.3 of IECQ 001002-3) for the purpose of lot-by-lot and periodic inspection.

The blank detail specification shall show the order in which the tests or conditions in the subgroup shall be carried out where this order may affect the test results. The blank detail specification shall also indicate wherever any particular order of testing in any subgroup is to be observed.

Where a subgroup contains a destructive test, this shall either be stated in full or the symbol "D" shall be placed alongside of the title of the subgroup in the schedule of inspection requirements in the blank detail specification.

6.6.7 Delivery of units subjected to destructive tests or non-destructive tests

Units subjected to destructive tests shall not be included in the lot for delivery. Units subjected to non-destructive tests may be delivered provided they are re-tested to Group A (see 3.2.3 of IECQ 001002-3) requirements and satisfy them.

6.6.8 Delayed delivery

Units which have been held by the manufacturer for a period exceeding 12 months following acceptance inspection shall be re-inspected as prescribed in the detail specification, unless another period is specified therein.

If this has been done for the complete lot, no further retesting before delivery is needed for another period of one year or as otherwise specified in the detail specification.

6.6.9 Supplementary procedure for deliveries

Manufacturers may, at their discretion, supply units that have met a higher assessment level against orders for a lower assessment level.

6.6.10 Unchecked parameters

When, in detail specifications, supplementary information is given, this shall not be the subject of inspection.

6.6.11 Release for delivery before the completion of Group B tests

When the conditions of IEC 60410 for reduced inspection have been satisfied for all Group B (see 3.2.3 of IECQ 001002-3) tests, the manufacturer is permitted to release the units before the completion of such tests.

6.6.12 Screening procedures

When screening is specified in the detail specification or the purchase order, it is to be applied to all devices in the production lot prior to the formation of samples for quality conformance testing (lot-by-lot and periodic).

The test shall be performed in the given order; when, however, part of screening sequence is already performed during production and in the same sequence, it need not be repeated.

Any device found defective during any of the tests shall be removed and not considered as part of the production lot for subsequent sampling purposes.

7 Test and measurement procedures

7.1 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.

7.2 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.

7.3 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 $0,5 \text{ A} \times \text{turns}$ 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.

7.4 Visual inspection and check of dimensions

7.4.1 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, dévitrification, 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.

7.4.2 Outline dimensions

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

7.4.3 Mass

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

7.4.4 Information to be stated in the detail specification

- a) For visual inspection, typically: conditions of light and magnification, inspection limits.
- b) Outline dimensions.
- c) Nominal mass.

7.5 Functional tests

7.5.1 Procedures

7.5.1.1 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:

- a) 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.
- b) Procedure 2a: Physical opening and closing of the contact shall be monitored throughout the tests by magnetic induction or other equivalent methods.
 - 1) Saturate: The test coil shall be energized for a specified period to the saturate value. The contact is then in the operate position.
 - 2) Must-not-release: When prescribed, the energization of the coil shall be reduced to the must-not-release value (see Notes 1 and 2).
 - 3) 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.
 - 4) Must-not-operate: When prescribed, the energization of the coil shall be increased from zero to the must-not-operate value (see Note 1).
 - 5) 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.
- c) Procedure 2b: Physical opening and closing of the contact shall be monitored throughout the tests by magnetic induction or other equivalent methods.
 - 1) Saturate: The test coil shall be energized for a specified period to the saturate value. The contact is then in the operate condition.
 - 2) Zero energization: The energization shall be reduced to zero for a period of 20 ms.
 - 3) Must-not-operate: When prescribed, the energization of the coil shall be increased from zero to the must-not-operate value (see Note 1).
 - 4) 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.
 - 5) Must-not-release: When prescribed, the energization of the coil shall be reduced to the must-not-release value (see Notes 1 and 2).
 - 6) 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 may be replaced by a similar test performed at the characteristic non-release value.

7.5.1.2 Special procedures for magnetically biased switches

The procedures of 7.5.1.1 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):

a) Procedure for test system 1

- 1) The central coil M energization shall be zero.
- 2) The L coil energization shall be increased to the saturate value of the release position and afterwards decreased to zero.
- 3) The R coil energization shall be increased from zero to the must-operate value.
- 4) The R coil energization shall further be increased to the saturate value of the operate position and afterwards decreased to zero.
- 5) The L coil energization shall be increased to the must-release value.

b) Procedure for test system 2

- 1) The central coil M energization shall be brought to the saturate value of the operate position and shall afterwards be decreased to zero.
- 2) 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.
- 3) The energization of the coil shall be increased in the opposite polarity to the operate position.

7.5.2 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.

7.5.3 Information to be stated in the detail specification

- 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).

7.6 Remanence test (see Figure 3)

7.6.1 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.

7.6.2 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 7.6.1). The contact circuit resistance limit for failure-to-make shall be complied with, for procedure 1 according to 7.5.2.

7.6.3 Information to be stated in the detail specification

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 7.5.2.

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

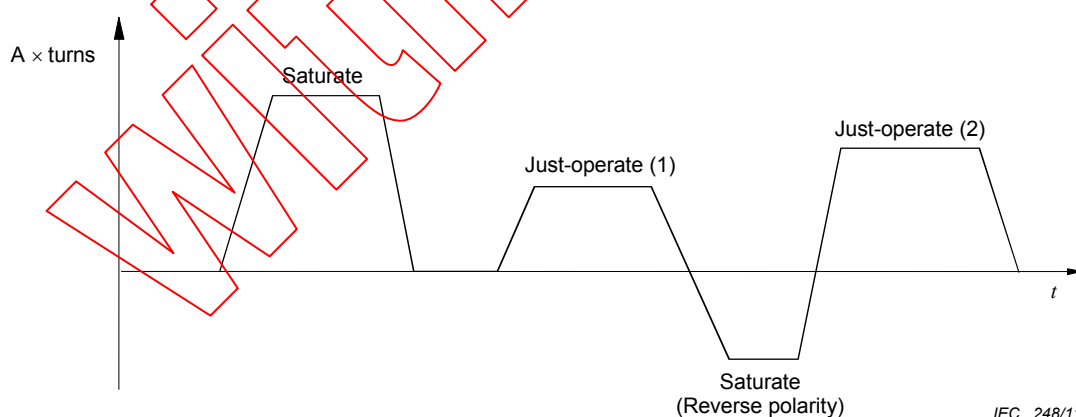


Figure 3 – Remanence test sequence

7.7 Contact circuit resistance

7.7.1 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 4.

7.7.2 Requirements

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

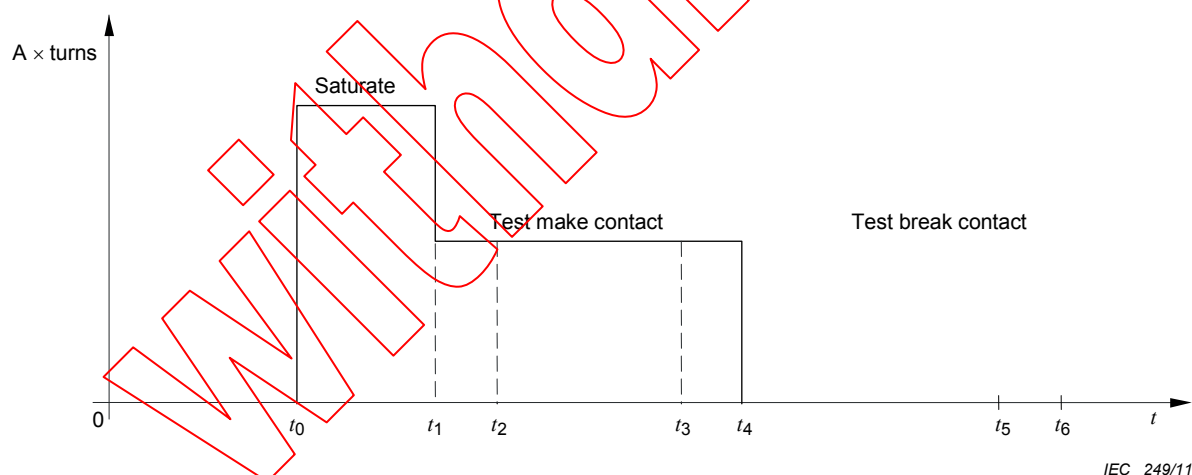


Figure 4 – Sequence of contact circuit resistance measurement

7.7.3 Information to be stated in the detail specification

- Test coil.
- Point of measurement, if other than 6 mm.
- Contact circuit resistance.
- Saturate value and the reduced value.
- t_1 , t_2 , t_3 , t_4 , t_5 and t_6 .
- Applied measurement voltage and current (if applicable).
- The frequency of the applied qualities used for contact circuit resistance test, where applicable.

7.8 Dielectric test

7.8.1 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 and form D contacts),
- 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.

7.8.2 Requirements

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

7.8.3 Information to be stated in the detail specification

- a) Procedure 1 or 2.
- 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 and form D contacts) 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.

7.9 Insulation resistance

7.9.1 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 and form D contacts), 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 DC 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.

7.9.2 Requirements

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

7.9.3 Information to be stated in the detail specification

- Insulation test voltage.
- Minimum value of insulation resistance.
- Conductive parts.

7.10 Operating times (see Figures 2, 5 and 6)

7.10.1 Procedure

7.10.1.1 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.

7.10.1.2 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.

7.10.1.3 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 μ s shall be ignored, unless otherwise prescribed.

7.10.1.4 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.

7.10.1.5 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 μ s shall be ignored, unless otherwise prescribed.

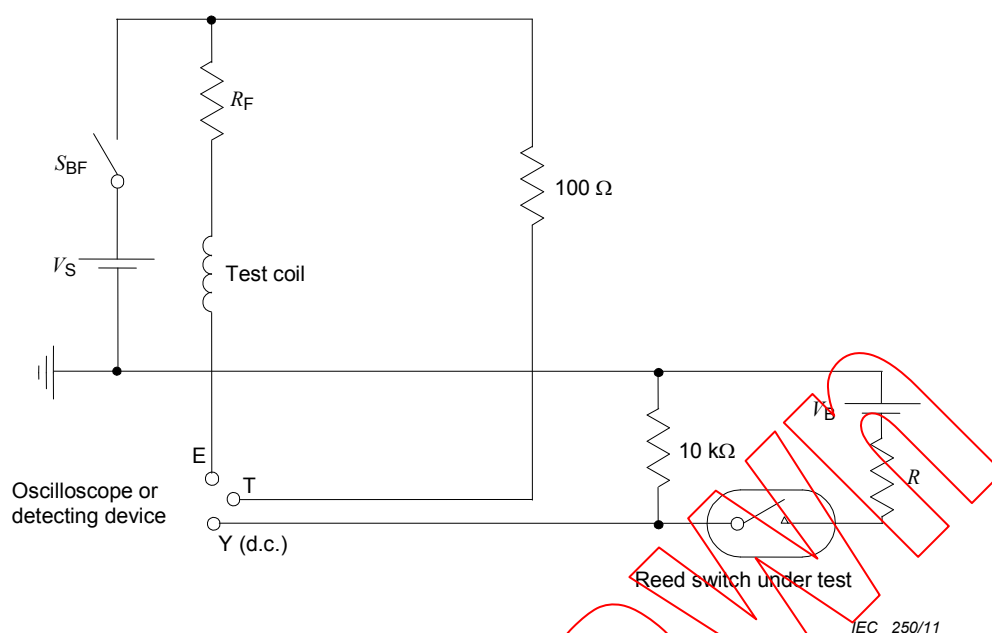
7.10.2 Requirements

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

7.10.3 Information to be stated in the detail specification

- 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 and form D contacts.
- k) Bridging time, maximum and minimum }

Withhold



Key

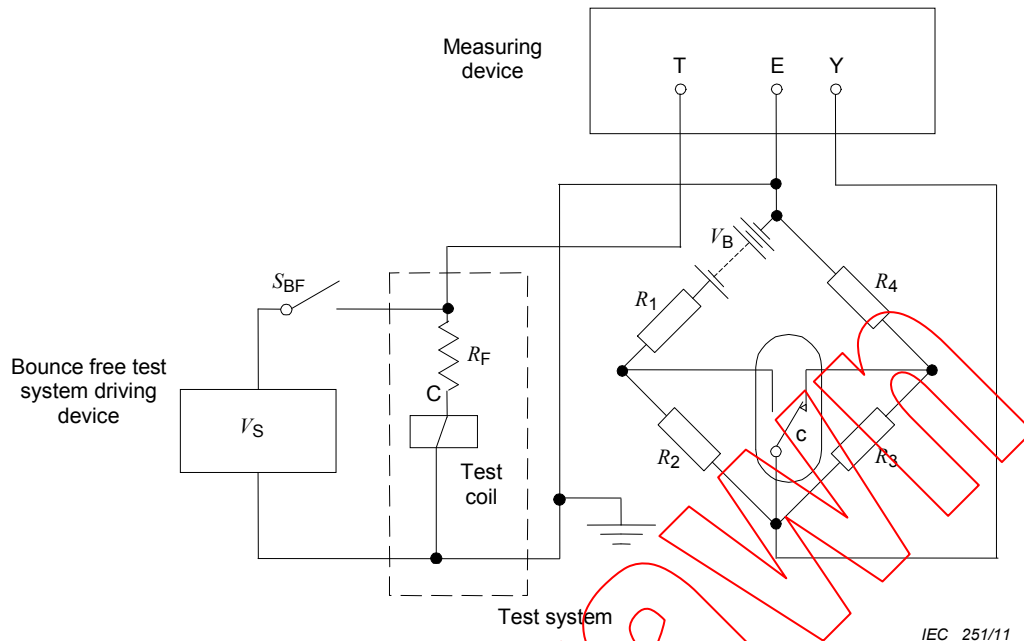
E: Common

T: Trigger

Y: Amplifier

NOTE All symbols that are not defined in this figure can be found in the key of Figure 6.

Figure 5 – Test circuit for the measurement of release and bounce time of a make switch



Key

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

NOTE 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 6 – Test circuit for the measurement of time parameters of a change-over switch

7.11 Contact sticking

7.11.1 Thermal sticking

Procedure 1: Change of release time and operate time

The test circuit of 7.10 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 7.10.1).

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 7.5, 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 7.5, 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 7.5.1.

7.11.2 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 7.5).

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 7.11.1.

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 7.5). 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 7.11.1.

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.

7.12 Robustness of terminals**7.12.1 Procedure**

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

7.12.2 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.

7.12.3 Information to be stated in the detail specification

- 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.

7.13 Soldering (solderability and resistance to soldering heat)**7.13.1 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.

7.13.2 Requirements

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

7.13.3 Information to be stated in the detail specification

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

7.14 Climatic sequence

7.14.1 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 7.14.2 to 7.14.4.

7.14.2 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.

7.14.3 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 (7.4);
- b) functional tests (7.5);
- c) contact circuit resistance (7.7);
- d) dielectric test (7.8);
- e) insulation resistance test (7.9);
- f) sealing (7.21).

7.14.4 Information to be stated in the detail specification

- 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.

7.15 Damp heat, steady state

7.15.1 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.

7.15.2 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 (7.4);
- b) functional tests (7.5);
- c) contact circuit resistance (7.7);
- d) dielectric test (7.8);
- e) insulation resistance test (7.9);
- f) sealing (7.21);
- g) solderability (7.13).

7.15.3 Information to be stated in the detail specification

- 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.

7.16 Rapid change of temperature

7.16.1 Procedure

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

7.16.2 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 (7.21).

7.16.3 Information to be stated in the detail specification

- 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.

7.17 Salt mist

7.17.1 Procedure

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

7.17.2 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.

7.17.3 Information to be stated in the detail specification

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

7.18 Vibration

7.18.1 Vibration 1 – Functional

a) 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.

b) Requirements

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

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

- 1) visual inspection (7.4);
- 2) functional tests (7.5);
- 3) sealing (7.21).

c) Information to be stated in the detail specification

- 1) Axis of mounting if different from above.
- 2) Identification of the direction of movement of the contacts (if appropriate).
- 3) Severity.
- 4) Permissible changes of functional characteristics.
- 5) Mounting jig.
- 6) Test method Qk or Ql of IEC 60068-2-17 and leakage rate.

7.18.2 Vibration 2 – Survival

a) 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.

b) Requirements

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

- 1) visual inspection (7.4);
 - 2) functional tests (7.5);
 - 3) sealing (7.21).
- c) Information to be stated in the detail specification
- 1) Axis of mounting, if different from above.
 - 2) Identification of the direction of movement of the contacts (if appropriate).
 - 3) Permissible changes of functional characteristics.
 - 4) Mounting jig.
 - 5) Test method Qk or Ql of IEC 60068-2-17 and leakage rate.

7.19 Shock

7.19.1 Procedure

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.

a) 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.

b) 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.

7.19.2 Requirements

a) Method 1

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

- 1) visual inspection (7.4);
- 2) functional tests (7.5);
- 3) sealing (7.21).

b) Method 2

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

- 1) visual inspection (7.4);
- 2) functional tests (7.5);
- 3) sealing (7.21).

7.19.3 Information to be stated in the detail specification

- 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.

7.20 Acceleration test – Functional test only

7.20.1 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.

7.20.2 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 (7.4),
- b) functional tests (7.5),
- c) sealing (7.21).

7.20.3 Information to be stated in the detail specification

- 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.

7.21 Sealing

7.21.1 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.

7.21.2 Requirements

- 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 QI of IEC 60068-2-17).
- c) The arcing time shall not exceed a value prescribed in the detail specification (arc time duration test).

7.21.3 Information to be stated in the detail specification

- a) Test Qk or QI of IEC 60068-2-17 or arc time duration test.
- b) Pressure and duration for Test QI 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 QI: information on how the specimens shall be visually inspected and electrically and mechanically checked;
 - For arc duration test: maximum arcing time.

7.22 Electrical endurance

7.22.1 Types of electrical endurance test

- a) Standard electrical endurance test
- b) 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.

7.22.2 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.

7.22.3 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.

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.

7.22.4 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; 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.

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 may 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 7.7, 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 7.3).

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 $\pm 10\%$ on 30 mV and a maximum of $\pm 2\%$ for the other values.

If the switch is an unsymmetrical type having a preferred switching polarity, this should be 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 should be described in the detail specification. If both contacts are to be tested, when two separate loads will be needed, the two circuits should be independent of each other.

7.22.5 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 μ s, an inductance $< 10^{-4}$ H 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 k Ω .

Table 2 – Resistive loads

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