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INTERNATIONAL STANDARD

Reed contact units –
Part 2: Heavy-duty reed switches

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REED CONTACT UNITS –

Part 2: Heavy-duty reed switches

FOREWORD

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International Standard IEC 62246-2 has been prepared by IEC technical committee 94: All-or-nothing electrical relays.

This part of IEC 62246 is to be read in conjunction with IEC 62246-1.

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

CDV	Report on voting
94/243/CDV	94/257A/RVC

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

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

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

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

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- withdrawn,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

A bilingual version of this publication may be issued at a later date.

REED CONTACT UNITS –

Part 2: Heavy-duty reed switches

1 General

1.1 Scope

This part of IEC 62246 applies to the switching performance of heavy-duty reed switches for use in industrial applications based upon Part 1.

This part of IEC 62246 specifies reliability tests, rated making and breaking capacities, rated impulse voltages, rated conditional short-circuit currents, temperature rise and construction testing in addition to the requirements of Part 1.

Heavy-duty reed switches are glass sealed contact units and include high pressure sealed types. This part of IEC 62246 does not apply to mercury-wetted reed contact units.

NOTE 1 Heavy-duty reed switches are mainly used within electromagnetic switching devices, valves, solenoids, power relays, etc., as the electromagnetic load switching elements. The load conditions should be selected from the standard inductive loads and the load specifications specified in IEC 61810-1 and IEC 60947-5-1.

NOTE 2 For elementary relays using heavy-duty reed switches as contact elements, this standard should be used together with IEC 61810-1 and IEC 61811-1 as applicable.

NOTE 3 For electromechanical control circuit devices using heavy-duty reed switches as contact elements, this standard should be used together with IEC 60947-5-1 as applicable.

1.2 Normative references

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

IEC 62246-1:2002, *Reed contact units – Part 1: Generic specification*

IECEE 01:2006, *IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components (IECEE) – Basic rules*

IECEE 03:2006, *Rules of Procedure of the Scheme of the IECEE for Mutual Recognition of Conformity Assessment Certificates for Electrotechnical Equipment and Components (CB-FCS)*

IECQ 01:2003, *IEC Quality Assessment System for Electronic Components (IECQ) – Basic Rules*

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

1.3 Terms, definitions, abbreviations and symbols

For the purposes of this document, 1.3 of Part 1 applies with the following amendments.

Replace 1.3.1 as follows:

1.3.1
heavy-duty reed switch
assembly containing contact blades, some or all of magnetic material, in which greater switching capacity is achieved by either blades having additional contact tips or a contact tip and spring which separate the magnetic path and electric path, hermetically sealed in an envelope and controlled by means of externally generated magnetic field (e.g. an energizing quantity applied to a coil, or magnet actuator)

Add:

1.3.56
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 for the operating time of this device under the test conditions specified in the relevant product standard

1.4 Preferred values

1.4.1 Frequency of operation

Subclause 1.4.1 of Part 1 applies.

1.4.2 Duty cycle

Subclause 1.4.2 of Part 1 applies.

1.4.3 Open-circuit voltage across contacts

Subclause 1.4.3 of Part 1 applies.

1.4.4 Current ratings

Subclause 1.4.4 of Part 1 applies.

1.4.5 Load ratings

Subclause 1.4.5 of Part 1 applies with the following additions:

750; 1 000; 1 800; 3 600; 7 200 VA.

1.4.6 Number of operations

Subclause 1.4.6 of Part 1 applies.

1.4.7 Climatic category

Subclause 1.4.7 of Part 1 applies.

1.4.8 Preferred environmental severities

Subclause 1.4.8 of Part 1 applies.

1.4.9 Rated operational voltage; U_e

The following values are preferred.

AC 12, 24, 50, 100, 110, 120, 200, 220, 240, 380, 480, 500, 550, 600, 800, 1 000 V (r.m.s.)

DC 1, 6, 12, 24, 48, 100, 110, 120, 125, 200, 220, 250, 400, 500, 600, 800, 1 200, 1 500 V.

1.4.10 Rated switching current; I_e

The following values are preferred.

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

1.4.11 Rated insulation voltage

The following values of rated insulation voltage are preferred.

a) AC 250, 380, 500, 600 V (r.m.s.)

b) DC 250, 440, 500, 600 V.

1.4.12 Rated impulse voltage

The following values of rated impulse voltage and waveform are preferred.

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

b) 1,2 × 50 μs.

1.4.13 Utilization categories

The utilization categories as given in Table 1 are 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 – Utilization categories

Kind of current	Category	Typical application
AC	AC-12	Control of resistive loads and solid state loads with isolation by opto-couplers
	AC-13	Control of solid state loads with transformer isolation
	AC-14	Control of small electromagnetic loads ≤72 VA
	AC-15	Control of electromagnetic loads ≥72 VA
DC	DC-12	Control of resistive loads and solid state loads with isolation by opto-couplers
	DC-13	Control of electromagnets
	DC-14	Control of small electromagnetic loads having economy resistors in circuit
NOTE These utilization categories correspond to those indicated in IEC 60947-5-1.		

1.4.14 Contact reliability

The following values of contact reliability are preferred.

5; 50; 500 failures per 10^9 cycles.

1.4.15 Limiting continuous current; I_{th}

The following values of limiting continuous current (I_{th}) are preferred.

2,5; 3; 5; 8, 10 A.

1.5 Marking

Subclause 1.5 of Part 1 applies. Information given in the manufacturer's catalogue or tender may substitute for marking of contact ratings (examples of contact ratings are shown in Annex C).

1.6 Order of precedence

Subclause 1.6 of Part 1 applies.

1.7 Precautions regarding mercury (for mercury wetted contact units)

Heavy-duty reed switches shall not contain mercury-wetted contacts.

2 Quality assessment procedures

2.1 General

For the application of this standard, it is not mandatory to use quality assessment procedures. However, if quality assessment is required, the following provisions apply.

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

a) self-certification in which the manufacturer declares conformity,

b) two-party certification 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.

2.2 Self-certification

When self-certification 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.

2.3 Two-party certification

When two-party certification 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.

2.4 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 or IECEE system shall be used, unless incompatible with existing market conditions.

- IECQ System:

  - when the IECQ-System is used, the basic rules and rules of procedure for the quality assessment system shall be in accordance with publications IECQ 01 and QC 001002-1, respectively. The provisions of Clause 2 of Part 1 apply.

- IECEE Scheme:
  - when the IECEE Scheme is used, the rules and procedures for the quality assessment system shall be in accordance with IECEE Publications IECEE 01 and IECEE 03, respectively.

3 Test and measurement procedures

3.1 General

Subclause 3.1 of Part 1 applies.

3.2 Alternative procedures

Subclause 3.2 of Part 1 applies.

3.3 Standard conditions for testing

Subclause 3.3 of Part 1 applies with the exception that the test coils shall be selected from those listed in Annex E.

3.4 Visual inspection and check of dimensions

Subclause 3.4 of Part 1 applies.

3.5 Functional tests

Subclause 3.5 of Part 1 applies.

3.6 Remanence test

Subclause 3.6 of Part 1 applies.

3.7 Contact circuit resistance

Subclause 3.7 of Part 1 applies with the following exception:

The voltage and current applied to the contact circuit shall be not more than 6 V and 1 A a.c. r.m.s. or d.c. unless otherwise prescribed in the detail specification.

The frequency of the alternating current shall be stated in the detail specification.

3.8 Dielectric test

Subclause 3.8 of Part 1 applies.

When the terminals of the test equipment are short-circuited, the current shall be between 0,1 mA and 5 mA.

3.9 Insulation resistance

Subclause 3.9 of Part 1 applies.

3.10 Operate, release, transfer or bridging, and bounce times

Subclause 3.10 of Part 1 applies.

3.11 Contact sticking

Subclause 3.11 of Part 1 applies.

3.12 Robustness of terminals

Subclause 3.12 of Part 1 applies.

3.13 Soldering (solderability and resistance to soldering heat)

Subclause 3.13 of Part 1 applies.

3.14 Climatic sequence

Subclause 3.14 of Part 1 applies.

3.15 Damp heat, steady state

Subclause 3.15 of Part 1 applies.

3.16 Rapid change of temperature

Subclause 3.16 of Part 1 applies.

3.17 Salt mist

Subclause 3.17 of Part 1 applies.

3.18 Bump

Subclause 3.18 of Part 1 applies.

3.19 Vibration

Subclause 3.19 of Part 1 applies, but unless otherwise prescribed in the detail specification, vibration shall be applied in three mutually perpendicular axes.

3.20 Shock

Subclause 3.20 of Part 1 applies, but unless otherwise prescribed in the detail specification, shock shall be applied in three mutually perpendicular axes.

3.21 Acceleration test – Functional test only

Subclause 3.21 of Part 1 applies.

3.22 Sealing

Subclause 3.22 of Part 1 applies.

3.23 Electrical endurance

3.23.1 General

The load conditions shall be selected from the standard inductive loads (see Tables 3 and 4).

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.

3.23.2 Types of electrical endurance test

a) Standard electrical endurance test.

b) Application simulation endurance test.

3.23.3 Standard electrical endurance test

3.23.3.1 General test arrangements

The electrical endurance test evaluates failures caused by the electrical wear of contact surface when switching voltage and current.

The test arrangement is shown in Annex A.

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 selected with reference to subclause 1.4.

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.

3.23.3.2 Procedure

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 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. Coil suppression (electrical components to suppress or reduce unwanted transients) shall not be used, unless specified in the detail specification.

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

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

Each contact shall be tested for failure to make and failure to break at each operation, unless otherwise prescribed in the detail specification. This may be done by measuring the voltage drop across the contacts 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 described in 3.7, 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.

This procedure describes only tests for make contacts. If break contacts are 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 shall be independent of each other.

3.23.4 Application simulation endurance test

Details shall be stated in the detail specification or agreed between manufacturer and user.

3.23.5 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 number specified in the detail specification. 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.

3.23.6 Information to be stated in the detail specification

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

b) Load conditions:
   - for inductive loads: voltage, current and load constant selected from Table 2.

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 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 or transfer for Form D 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.

3.24 Mechanical endurance

Subclause 3.24 of Part 1 applies.

3.25 Maximum cycling frequency

Subclause 3.25 of Part 1 applies.

3.26 Mounting position test (for mercury wetted contact units)

See 1.7.

3.27 Drain time test (for mercury wetted contact units)

See 1.7.

3.28 Voltage surge test

This subclause of Part 1 does not apply.

3.29 Rated impulse voltage

3.29.1 Procedure

The test shall be performed under standard atmospheric conditions.

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

– across the contact of the switch in the open position unless otherwise prescribed;
– throughout a specified number of pulses with an interval between these pulses, as prescribed in the detail specification.

The impulse withstand voltage shall be measured at the peak voltage (V_{peak}) prescribed in the detail specification and the value should be selected from those stated in 1.4.12.

The voltage shall be applied three times each with positive and negative polarity and then the insulation resistance shall be measured.

3.29.2 Requirements

There shall be no disruptive discharge (sparkover, flashover or puncture) during test. After the test, the switch shall comply with all relevant performance requirements.

3.29.3 Information to be stated in the detail specification

a) Preconditioning

b) V_{peak}

c) Number of pulses.

3.30 Rated making and breaking capacities

3.30.1 General test arrangements

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

The test arrangement is shown in Annex A.

3.30.2 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 of the contact unit to be tested.

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

3.30.3 Requirements

a) For making and breaking capacities under normal conditions:
   – the switch shall have the performance stated in the corresponding category in Table 3 without having any failure.

b) For making and breaking capacities under abnormal conditions:
   – the switch shall have the performance stated in the corresponding category in Table 4 without having any failure.

3.30.4 Information to be stated in the detail specification

a) Energization conditions
   – test coil number selected from the list given in Table A.1 of Part 1 or Table E.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 Table 2 and Table 3;

c) Failure criteria (see 3.23)
   – 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 3.7 of Part 1):
  - 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 or transfer for Form D contact: if prescribed in the detail specification (not applicable for Form A and Form B contacts):
  - monitoring time,
  - monitoring interval.

Table 2 – Making and breaking capacity for electrical endurance tests

Current	Utilization category	Making			Breaking		
AC	AC-15	I	U	cos φ	I	U	cos φ
		10 I_e	U_e	0,7 [a]	I_e	U_e	0,4 [a]
DC	DC-13 [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 Switching current

U_e is the rated operating voltage.

U Switching voltage

P is $U_e \times I_e$ 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 d.c. 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 d.c. 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.

Table 3 – Verification of making and breaking capacity for AC-15 / DC-13 under normal conditions

Utilization category	Making			Breaking			Number of cycles and frequency		
	I/I_e	U/U_e	cos φ	I/I_e	U/U_e	cosφ	Number of cycles	Frequency (cycles per minute)	Duration of energization (s)
AC-15	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-13	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. I Switching current

U_e is the rated operating voltage. U Switching voltage

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

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

[a] The value "$6\times P$" is derived from an empirical relationship appropriate for most d.c. inductive loads up to P = 50 W, where $6 \times P$ = 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 $U_e \times 1{,}1$, with the test current I_e adjusted at U_e.

NOTE These values correspond to those indicated in IEC 60947-5-1.

Table 4 – Verification of making and breaking capacity for AC-15 / DC-13 under abnormal conditions

Utilization category	Make			Break			Minimum on-time Cycles (at 50 Hz or 60 Hz)	Making and breaking operations	
	I/I_e	U/U_e	cos φ	I/I_e	U/U_e	cos φ		Number	Rate per minute
AC-15	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-13	1,1	1,1	$6\times P$ [a]	1	1	$6\times P$ [a]	$T_{0,95}$	10	6

I_e is the rated operating current. I Switching current

U_e is the rated operating voltage. U Switching voltage

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

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

[a] The value "$6\times P$" is derived from an empirical relationship appropriate for most d.c. inductive loads up to P = 50 W, where $6 \times P$ = 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.

NOTE These values correspond to those indicated in IEC 60947-5-1.

3.31 Rated conditional short-circuit current

3.31.1 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 B.

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

3.31.2 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.

3.31.3 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 (3.4)

b) Functional tests (3.5)

c) Dielectric test (3.8)

3.31.4 Information to be stated in the detail specification

a) Energization conditions

– test coil number selected from the list given in Table A.1 of Part 1 or Table E.1, coil suppression, if applicable.

b) Short-circuit current and time.

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

3.32 Contact reliability test

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

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

3.32.1 General test arrangements

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 D.

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.

3.32.2 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 1.4.1.

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 3.32.4.

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 3.7, 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 contact unit under test. The wiring to the loads shall be as short as practicable.

3.32.3 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.

3.32.4 Information to be stated in the detail specification

a) Energization conditions:
   - test coil number selected from the list given in Table A.1 of Part 1 or Table E.1;
   - coil suppression, if applicable;
   - frequency of operation; see 1.4.1;
   - 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 D):
   - 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;

– monitoring for bridging for Form C contact or transfer for Form D 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 for this reliability test 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.

3.33 Temperature rise

3.33.1 Procedure

The limiting continuous current stated in 1.4.15 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 0,75 mm^2.

3.33.2 Requirements

The temperature rise shall not exceed 45 K unless otherwise specified in the detail specification and shall not cause any damage to the heavy-duty reed switch.

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

a) Visual inspection (3.4)

b) Functional tests (3.5)

c) Contact circuit resistance (3.7).

3.33.3 Information to be stated in the detail specification

a) Energization conditions:

– test coil number selected from the list given in Table A.1 of Part 1 or Table E.1, coil suppression, if applicable.

b) Test current.

c) Measurement positions.

d) Measurement duration.

e) Maximum temperature rise if less than 45 K.

3.34 Making current capacity test

3.34.1 General

The making current capacity test evaluates failures caused by the electrical wear of contact surfaces when making current.

The test arrangement is shown in Annex A and the test sequence is shown in Annex F.

Frequency of operation, load condition, numbers of operations, rated making current and rated making voltage are specified in 1.4.

3.34.2 Procedure

Subclause 3.23.3.2 without breaking applies.

3.34.3 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 meet the contact circuit resistance requirements.

3.34.4 Information to be stated in the detail specification

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

b) Making load conditions:
   - for inductive loads: voltage, current and load constant selected from 1.4.3, 1.4.4 and 1.4.14.

c) Failure criteria:
   - the total number of operations required;
   - monitoring during test:
     - limits for: failure to make:..... Ω,
     - monitoring times: t_1, τ_1,
     - 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;

– monitoring for bridging for Form C contact or transfer for Form D 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.

3.35 Breaking current capacity test

3.35.1 General

The breaking current capacity test evaluates failures caused by the electrical wear of contact surface when breaking current.

The test arrangement is shown in Annex A and the test sequence is shown in Annex G.

For the frequency of operation, load condition, numbers of operations, rated breaking current and rated breaking voltage see 1.4.

3.35.2 Procedure

Subclause 3.23.3.2 without making applies.

3.35.3 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 meet the contact circuit resistance requirements.

3.35.4 Information to be stated in the detail specification

a) Energization conditions:

– test coil number selected from the list given in Table A.1 of Part 1 or Table E.1, coil suppression, if applicable;

– frequency of operation;

– duty cycle if other than 50 %;

– polarity, when applicable.

b) Breaking load conditions:

– for inductive loads: voltage, current and load constant selected from sub-clause 1.4.3, 1.4.4 and 1.4.14;

c) Failure criteria:

- the total number of operations required;
- monitoring during test:
  - limits for: failure to break:..... 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 or transfer for Form D 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.

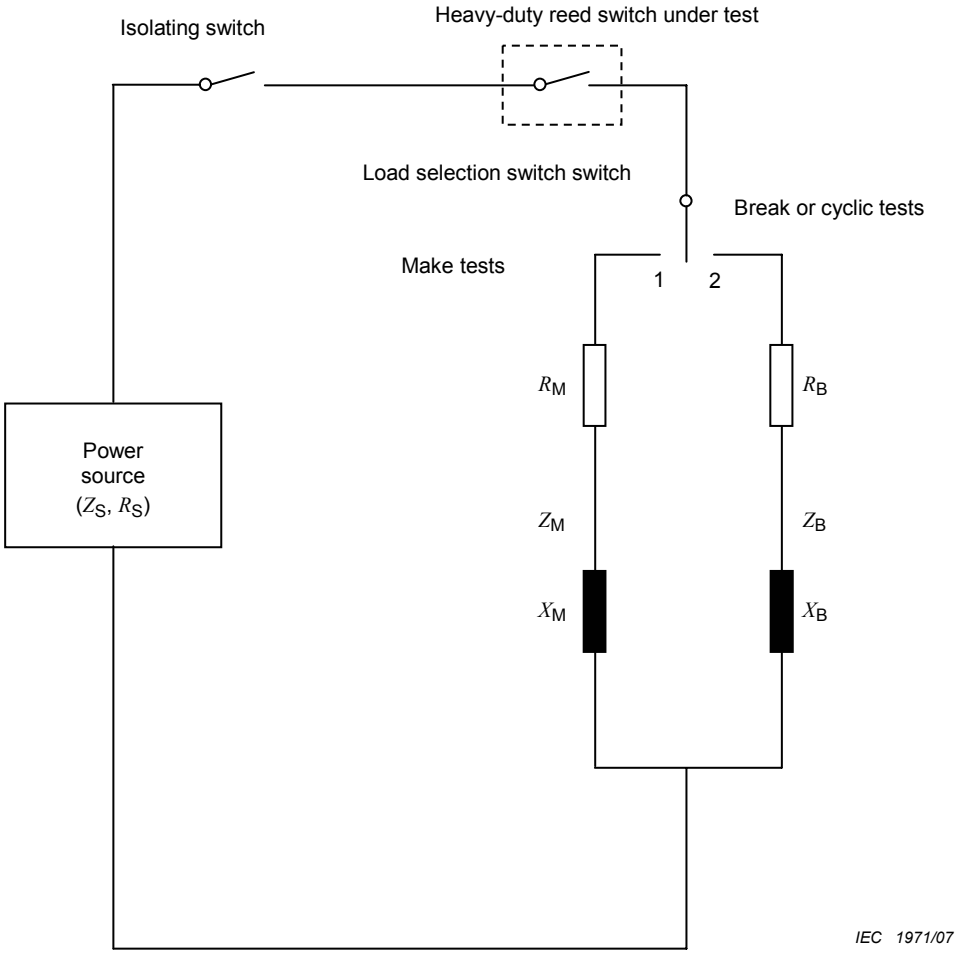
d) Application:

- 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.

Annex A
(informative)

Electrical endurance test circuit

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

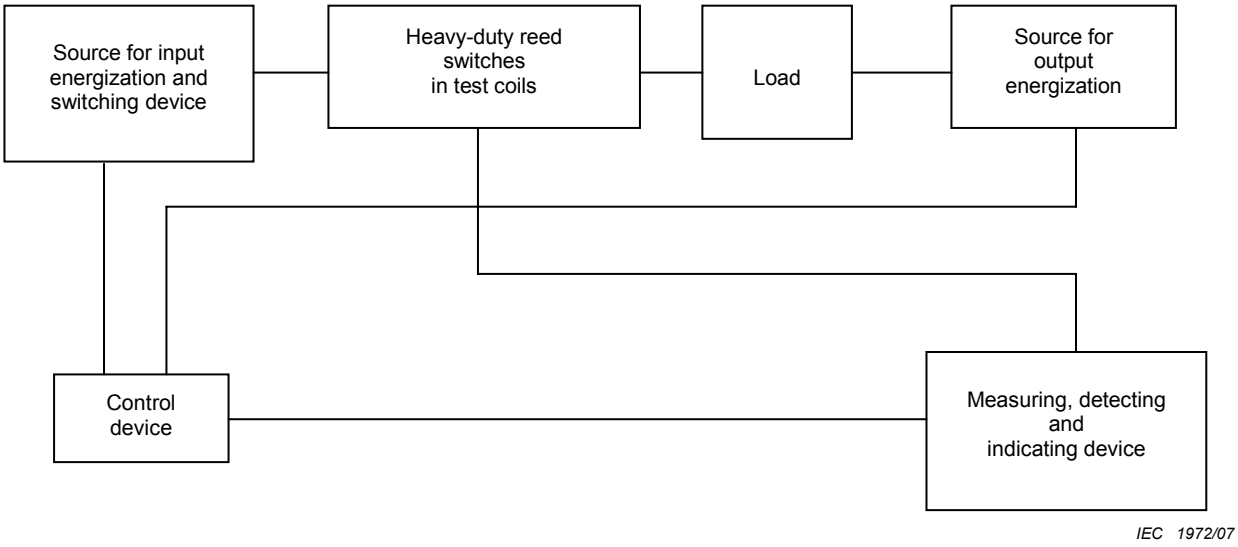
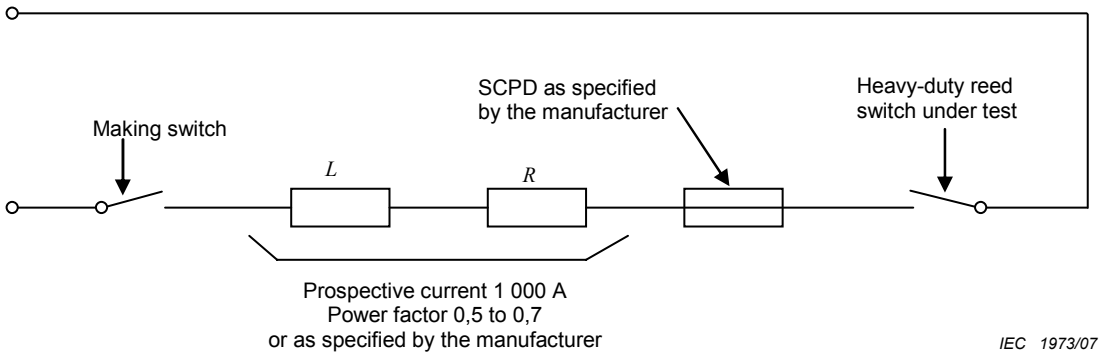


Figure A.2 – Functional block diagram

Annex B
(informative)

Rated conditional short-circuit current test circuit



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

Figure B.1 – Rated conditional short-circuit current test circuit

Annex C
(informative)

Electrical ratings based on utilization categories

Table C.1 – Examples of contact rating designation based on utilization categories

Designation [a]	Utilization category	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-15	10	6	-	-	-	-	-	7 200	720
A300	AC-15	10	6	3	-	-	-	-	7 200	720
A600	AC-15	10	6	3	1,9	1,5	1,4	1,2	7 200	720
B150	AC-15	5	3	-	-	-	-	-	3 600	360
B300	AC-15	5	3	1,5	-	-	-	-	3 600	360
B600	AC-15	5	3	1,5	0,95	0,75	0,72	0,6	3 600	360
C150	AC-15	2,5	1,5	-	-	-	-	-	1 800	180
C300	AC-15	2,5	1,5	0,75	-	-	-	-	1 800	180
C600	AC-15	2,5	1,5	0,75	0,47	0,375	0,35	0,3	1 800	180
Direct current			125 V	250 V		400 V	500 V	600 V	Make	Break
N150	DC-13	10	2,2	-		-	-	-	275	275
N300	DC-13	10	2,2	1,1		-	-	-	275	275
N600	DC-13	10	2,2	1,1		0,63	0,55	0,4	275	275
P150	DC-13	5	1,1	-		-	-	-	138	138
P300	DC-13	5	1,1	0,55		-	-	-	138	138
P600	DC-13	5	1,1	0,55		0,31	0,27	0,2	138	138
Q150	DC-13	2,5	0,55	-		-	-	-	69	69
Q300	DC-13	2,5	0,55	0,27		-	-	-	69	69
Q600	DC-13	2,5	0,55	0,27		0,15	0,13	0,1	69	69

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

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

NOTE 2 The values correspond to those indicated in IEC 60947-5-1.

Annex D
(informative)

Example of test arrangement for contact reliability test

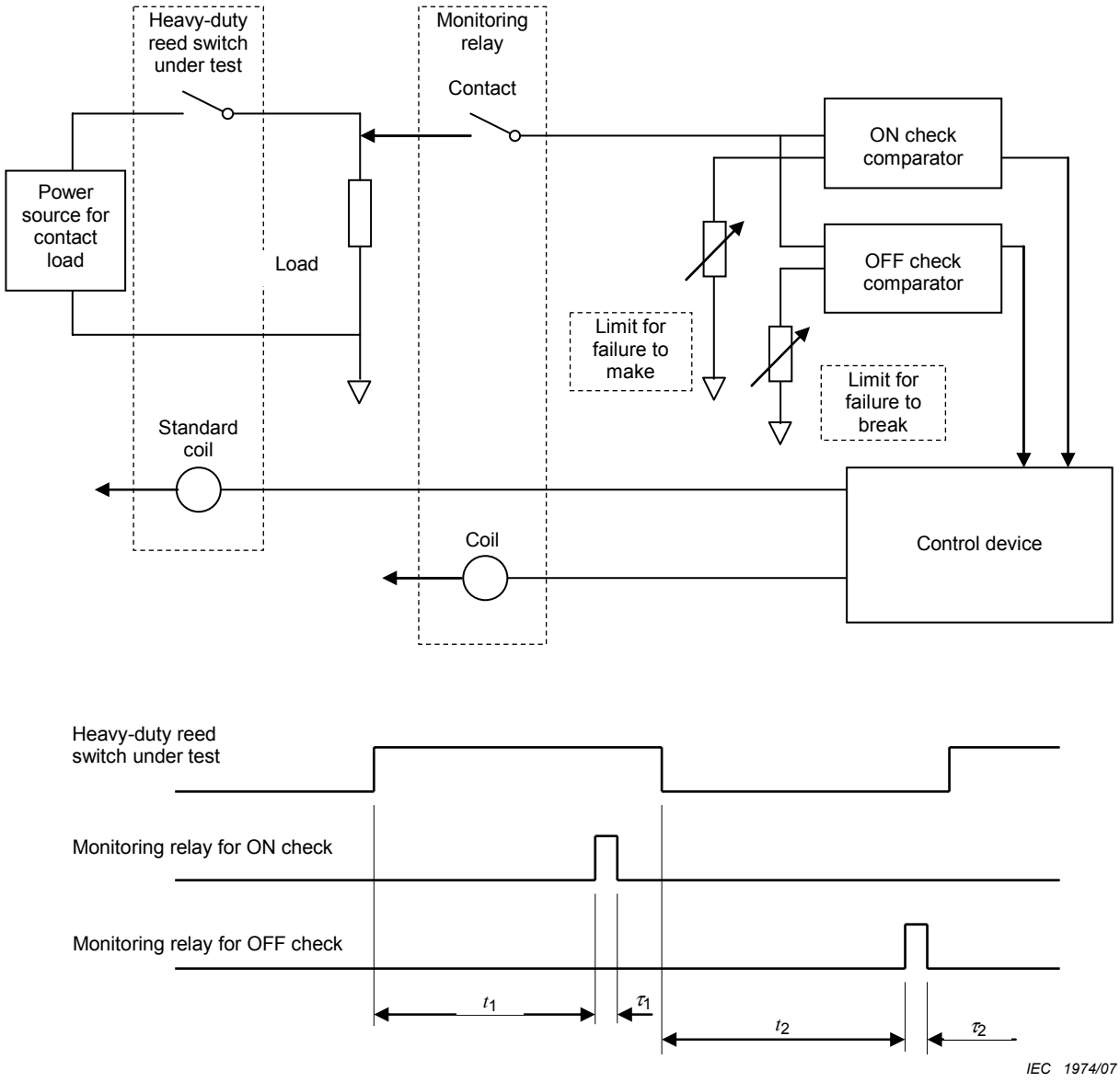


Figure D.1 – Contact reliability test circuit

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 E
(informative)

Standard test coils for heavy-duty reed switches

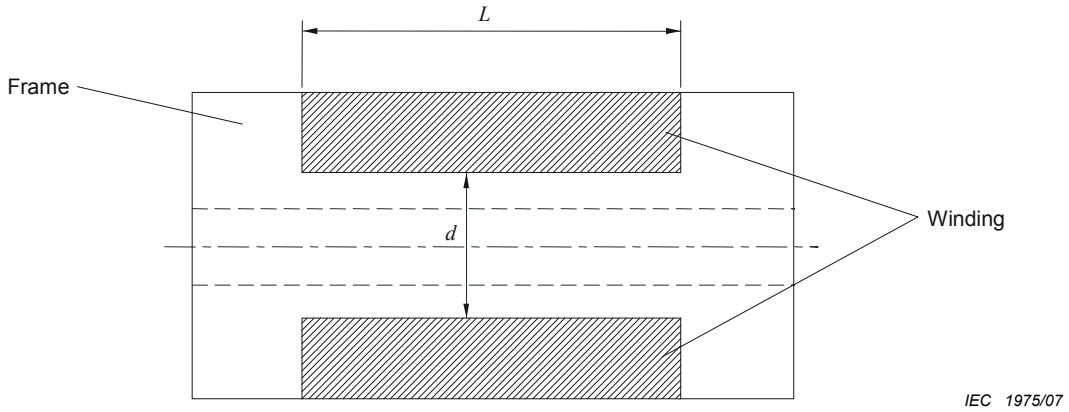


Figure E.1 – Configuration of test coils

Table E.1 – List of standard test coils

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	19,0	8,1	10 000	0,10	1 245
2	28,3	7,4	10 000	0,07	1 630
3	33,5	10,5	3 000	0,2	80
4	48,2	14,2	10 000	0,11	1 000
5	25,4	8,05	1 100	0,11	54,8
6	26,6	6,2	9 500	0,058 (0,06)	1 520
7	36,3	7,2	10 000	0,08	1 020
8	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 reed contact unit envelope should coincide unless otherwise prescribed in the detail specification.

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

Annex F
(informative)

Making current capacity test sequence

A generalized test circuit and functional block diagram are given in Figures A.1 and A.2.

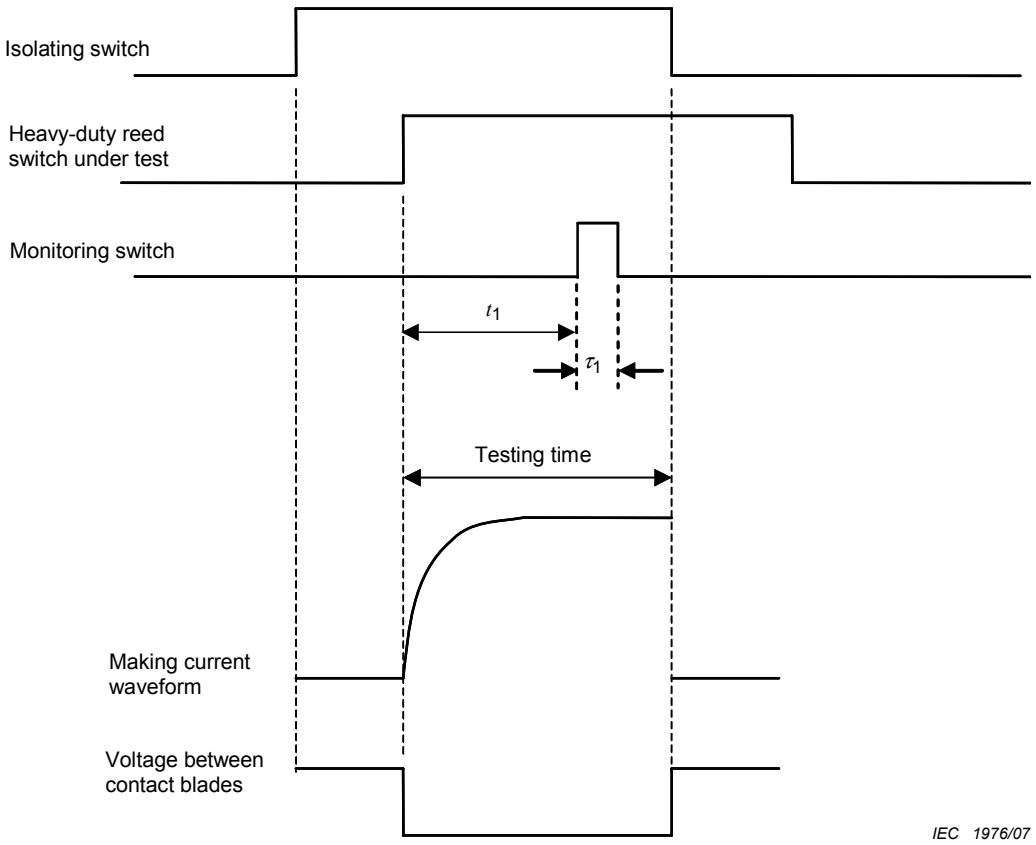


Figure F.1 – Making current capacity test sequence

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

Annex G
(informative)

Breaking current capacity test sequence

A generalized test circuit and functional block diagram are given in Figures A.1 and A.2.

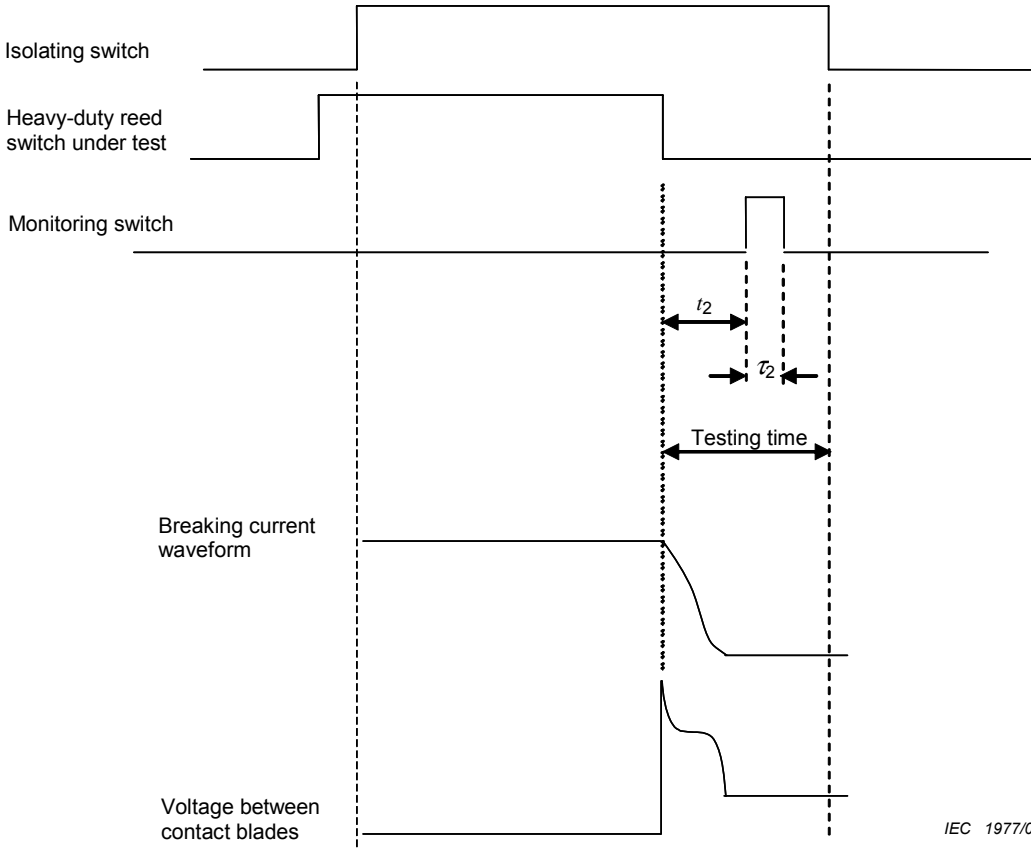


Figure G.1 – Breaking current capacity test sequence

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

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