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Electromechanical elementary relays –

Part 7:
Test and measurement procedures

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMECHANICAL ELEMENTARY RELAYS –

Part 7: Test and measurement procedures

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 61810-7 has been prepared by IEC technical committee 94: All-or-nothing electrical relays.

This second edition cancels and replaces the first edition published in 1997. This second edition constitutes a technical revision.

This new edition has been revised in order to

– update all normative references,
– adapt its contents to the newest issues of the other parts of this series of basic relay standards (IEC 61810-1 and IEC 61810-2),
– establish coherence with other IEC standards (for example of the IEC 60068-2 series),
– improve test and measurement procedures where appropriate,
– delete those tests no longer used in case of elementary relays for industrial application.

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

FDIS	Report on voting
94/226/FDIS	94/231/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.

IEC 61810 consists of the following parts, under the general title *Electromechanical elementary relays:*

Part 1: General and safety requirements

Part 2: Reliability

Part 7: Test and measurement procedures

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.

ELECTROMECHANICAL ELEMENTARY RELAYS –

Part 7: Test and measurement procedures

1 Scope

This part of IEC 61810 states the test and measurement procedures for electromechanical elementary relays. It covers basic considerations which are, in general, common to all types of electromechanical elementary relays. Supplementary requirements may be necessitated by specific designs or application.

The test and measurement procedures of this standard are described as individual provisions covering a specific requirement. When combining them in a test programme, care must be taken (for example by suitable grouping of tested relays) to ensure that preceding tests do not devalue subsequent ones.

Where in this standard the term “specified” is used, this means a prescription in the appropriate documentation for the relay, for example manufacturer’s data sheet, test specification, customer detail specification. For application within the IECQ system such prescriptions are contained in the detail specification as defined in Clause A.7 of QC 001001.

NOTE 1 To improve the readability of this standard, the term “relay” is generally used in place of “electromechanical elementary relay”.

NOTE 2 Requirements and tests related to the type testing of electromechanical elementary relays are contained in IEC 61810-1. For that purpose, the generally described test and measurement procedures of this standard have been prescribed in a more restricted and stringent form in IEC 61810-1.

NOTE 3 Standards covering relays subjected to quality assessment in accordance with IECQ are compiled in the IEC 61811 series of publications.

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 60068-2-1:1990, *Environmental testing – Part 2: Tests – Tests A: Cold*
Amendment 1 (1993)
Amendment 2 (1994)

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests – Tests B: Dry heat*
Amendment 1 (1993)
Amendment 2 (1994)

IEC 60068-2-6:1995, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-7:1983, *Environmental testing – Part 2: Tests – Test Ga: Acceleration, steady state*
Amendment 1 (1986)

IEC 60068-2-10:2005, *Environmental testing – Part 2: Tests – Test J and guidance: Mould growth*

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

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

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

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

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

IEC 60068-2-21:1999, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 60068-2-27:1987, *Environmental testing – Part 2: Tests – Test Ea and guidance: Shock*

IEC 60068-2-29:1987, *Environmental testing – Part 2: Tests – Test Eb and guidance: Bump*

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

IEC 60068-2-42:2003, *Environmental testing – Part 2-42: Tests – Test Kc: Sulphur dioxide test for contacts and connections*

IEC 60068-2-43:2003, *Environmental testing – Part 2-43: Tests – Test Kd: Hydrogen sulphide test for contacts and connections*

IEC 60068-2-45:1980, *Environmental testing – Part 2: Tests – Test XA and guidance: Immersion in cleaning solvents*
Amendment 1 (1993)

IEC 60068-2-58:2004, *Environmental testing – Part 2-58: Tests – Test Td – Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60068-2-64:1993, *Environmental testing – Part 2: Test methods – Test Fh: Vibration, broad-band random (digital control) and guidance*

IEC 60068-2-68:1994, *Environmental testing – Part 2: Tests – Test L: Dust and sand*

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

IEC 60512-7: 1993, *Electromechanical components for electronic equipment; basic testing procedures and measuring methods – Part 7: Mechanical operating tests and sealing tests*

IEC 60695-2 (all parts), *Fire hazard testing – Part 2: Test methods*

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

IEC 60695-2-11:2000, *Fire hazard testing – Part 2-11: Glowing/hot wire based test methods – Glow-wire flammability test method for end-products*

IEC 60695-2-12:2000, *Fire hazard testing – Part 2-12: Glowing/hot wire based test methods – Glow-wire flammability test method for materials*

IEC 60695-2-13:2000, *Fire hazard testing – Part 2-13: Glowing/hot wire based test methods – Glow-wire ignitability test method for materials*

IEC 60695-11-5:2004, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 60999-1:1999, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm^2 up to 35 mm^2 (included)*

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

IEC 61180-1:1992, *High-voltage test techniques for low-voltage equipment – Part 1: Definitions, test and procedure requirements*

IEC 61180-2:1994, *High-voltage test techniques for low-voltage equipment – Part 2: Test equipment*

IEC 61672-1:2002, *Electroacoustics – Sound level meters – Part 1: Specifications*

IEC 61810-1:2004, *Electromechanical elementary relays – Part 1: General and safety requirements*

IECQ QC 001001:2000, *IEC Quality Assessment System for Electronic Components (IECQ) – Basic Rules*

3 Terms and definitions

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

3.1 Types of relays

3.1.1
electromechanical relay
electrical relay in which the intended response results mainly from the movement of mechanical elements

[IEV 444-01-04]

3.1.2
all-or-nothing relay
electrical relay, which is intended to be energized by a quantity, the value of which is either within its operative range or effectively zero

[IEV 444-01-02]

3.1.3
elementary relay
all-or-nothing relay which operates and releases without any intentional time delay

[IEV 444-01-03]

3.1.4
monostable relay
electrical relay which, having responded to an energizing quantity and having changed its condition, returns to its previous condition when that quantity is removed

[IEV 444-01-07]

3.1.5
bistable relay
electrical relay which, having responded to an energizing quantity and having changed its condition, remains in that condition after the quantity has been removed; a further appropriate energization is required to make it change its condition

[IEV 444-01-08]

3.1.6
polarized relay
electrical relay, the change of condition of which depends upon the polarity of its DC energizing quantity

[IEV 444-01-09]

3.1.7
non-polarized relay
electrical relay, the change of condition of which does not depend upon the polarity of its energizing quantity

[IEV 444-01-10]

3.2 Types of relays, based upon environmental protection (relay technology RT)

3.2.1
RT 0 unenclosed relay
relay not provided with a protective case

3.2.2
RT I dust protected relay
relay provided with a case which protects its mechanism from dust

3.2.3
RT II flux proof relay
relay capable of being automatically soldered without allowing the migration of solder fluxes beyond the intended areas

NOTE Where an enclosed construction is used, venting to the outside atmosphere is permissible.

3.2.4
RT III wash tight relay
relay capable of being automatically soldered and subsequently undergoing a washing process to remove flux residues without allowing the ingress of flux or washing solvents

NOTE In service, this type of relay is sometimes vented to the atmosphere after the soldering or washing process.

3.2.5
RT IV sealed relay
relay provided with a case which has no venting to the outside atmosphere, and having a time constant better than 2×10^4 s (see IEC 60068-2-17)

3.2.6
RT V hermetically sealed relay
sealed relay having an enhanced level of sealing, assuring a time constant better than 2×10^6 s (see IEC 60068-2-17)

3.3 Functions of a relay

3.3.1
release condition
for a monostable relay, specified condition of the relay when it is not energized; for a bistable relay, one of the conditions, as declared by the manufacturer

[IEV 444-02-01]

3.3.2
operate condition
for a monostable relay, specified condition of the relay when it is energized by the specified energizing quantity and has responded to that quantity; for a bistable relay, the condition other than the release condition as declared by the manufacturer

[IEV 444-02-02]

3.3.3
operate (verb)
change from the release condition to the operate condition

[IEV 444-02-04]

3.3.4
release (verb)
for a monostable relay, change from the operate condition to the release condition

[IEV 444-02-05]

3.3.5
reset (verb)
for a bistable relay, change from the operate condition to the release condition

[IEV 444-02-06]

3.3.6
change over (verb)
for a monostable relay, operate or release; for a bistable relay, operate or reset

[IEV 444-02-07]

3.3.7
cycle (verb)
for a monostable relay, operate and then release or vice versa; for a bistable relay, operate and then reset or vice-versa

[IEV 444-02-08]

3.3.8
revert (verb)
for a specific type of polarized relay, release/reset again, or remain in the release condition, when supplied with a coil voltage in excess of that required for operation and of the same polarity as required for operation

[IEV 444-02-09, modified]

3.3.9
revert reverse (verb)
for a specific type of polarized bistable relay, operate again, or remain in the operate condition, when supplied with a coil voltage in excess of that required for resetting and of the same polarity as required for resetting

[IEV 444-02-10, modified]

3.4 Types of contacts

3.4.1
make contact
contact which is closed when the relay is in its operate condition and which is open when the relay is in its release condition

[IEV 444-04-17]

3.4.2
break contact
contact which is open when the relay is in its operate condition and which is closed when the relay is in its release condition

[IEV 444-04-18]

3.4.3
change-over contact
combination of two contact circuits with three contact members, one of which is common to the two contact circuits; such that when one of these contact circuits is open, the other is closed

[IEV 444-04-19]

3.4.4
change-over make-before-break contact
change-over contact in which the make contact circuit closes before the break contact circuit opens

[IEV 444-04-20]

3.4.5
change-over break-before-make contact
change-over contact in which the break contact circuit opens before the make contact circuit closes

[IEV 444-04-21]

3.5 Prefixes for the values applicable to relays

Values may be defined as rated, actual (“just”), test (“must”) or characteristic value and identified as such by using one of these words as a prefix. The prefixes are also applicable to timing values.

3.5.1
rated value
value of a quantity used for specification purposes, established for a specified set of operating conditions of a relay

[IEV 444-02-18, modified]

3.5.2
actual ("just") value
value of a quantity determined by measurement on a specific relay, during performance of a specified function

[IEV 444-02-21]

3.5.3
test ("must") value
value of a quantity for which the relay shall comply with a specified action during a test

[IEV 444-02-20]

3.5.4
characteristic value
value of a quantity with which, in the initial condition of a relay or for a specified number of cycles as specified, the relay shall comply with a specified requirement

[IEV 444-02-19, modified]

3.6 Energization values

3.6.1
energizing quantity
electrical quantity which, when applied to the coil(s) of a relay under specified conditions, enables it to fulfil its purpose

[IEV 444-03-01, modified]

NOTE 1 For elementary relays, the energizing quantity is usually a voltage. Therefore, the input voltage as energizing quantity is used in the definitions given below. When a relay is energized by a given current instead, the respective terms and definitions apply with "current" used instead of "voltage".

NOTE 2 The general term "input voltage" used in IEV Chapter 444 applies to all types of elementary relays (e.g. including solid-state relays). For electromechanical elementary relays the more specific term "coil voltage" has been chosen for the terms of 3.6, as in IEC 61810-1.

3.6.2
coil voltage
voltage applied as an energizing quantity

[IEV 444-03-03]

3.6.3
operative range
range of values of coil voltage for which a relay is able to perform its specified function

[IEV 444-03-05, modified]

NOTE For the following terms, refer also to Figures 3 to 7 which show the sequential functions of relays covered by the definitions.

3.6.4
magnetic preconditioning value
value of the coil voltage at which the relay attains a defined magnetic condition

[IEV 444-03-19]

NOTE 1 For polarized relays, distinction is made between preconditioning in forward (operate) direction, and preconditioning in reverse direction.

NOTE 2 For bistable relays, preconditioning may also be used to set the relay to a defined position.

3.6.5
non-operate voltage
value of the coil voltage at which a relay does not operate

[IEV 444-03-07, modified]

3.6.6
operate voltage, set voltage (for bistable relays only)
value of the coil voltage at which a relay operates

[IEV 444-03-06, modified]

3.6.7
non-release voltage
value of the coil voltage at which a monostable relay does not release

[IEV 444-03-09, modified]

3.6.8
release voltage
value of the coil voltage at which a monostable relay releases

[IEV 444-03-08, modified]

3.6.9
non-reset voltage
value of the coil voltage at which a bistable relay does not reset

[IEV 444-03-11, modified]

3.6.10
reset voltage
value of the coil voltage at which a bistable relay resets

[IEV 444-03-10, modified]

3.6.11
revert voltage
for a specific type of polarized relay, value of the coil voltage greater than and with the same polarity as the operate voltage, at which the relay reverts

[IEV 444-03-12, modified]

3.6.12
non-revert voltage
for a specific type of polarized relay, value of the coil voltage greater than and with the same polarity as the operate voltage, at which the relay does not revert

[IEV 444-03-13, modified]

3.6.13
revert reverse voltage
for a specific type of polarized bistable relay, value of the coil voltage greater than and with the same polarity as the reset voltage, at which the relay reverts reverse

[IEV 444-03-14, modified]

3.6.14
non-revert reverse voltage
for a specific type of polarized bistable relay, value of the coil voltage greater than and with the same polarity as the reset voltage, at which the relay does not revert reverse

[IEV 444-03-15, modified]

3.6.15
reverse polarity voltage
for a polarized monostable relay, value of the coil voltage of reverse polarity at which the relay does not operate

[IEV 444-03-16, modified]

3.6.16
active power
under periodic conditions, mean value, taken over one period T, of the instantaneous power p:

$$P = 1/T \int_0^T p \, \mathrm{d}t$$

NOTE 1 Under sinusoidal conditions, the active power is the real part of the complex power.

NOTE 2 The SI unit for active power is the watt.

[IEV 131-11-42]

3.6.17
apparent power
product of the r.m.s. voltage U between the terminals of a two-terminal element or two-terminal circuit and the r.m.s. electric current I in the element or circuit:

$$S = UI$$

NOTE 1 Under sinusoidal conditions, the apparent power is the modulus of the complex power.

NOTE 2 The SI unit for apparent power is the voltampere.

[IEV 131-11-41]

3.7 Electrical properties of contacts

3.7.1
contact current
electric current which a relay contact carries before opening or after closing

[IEV 444-04-26]

3.7.2
switching current
electric current which a relay contact makes and/or breaks

[IEV 444-04-27]

3.7.3
switching voltage
voltage between the contact members before closing or after opening of a relay contact

[IEV 444-04-25, modified]

3.7.4
limiting continuous current
greatest value of electric current which a closed contact is capable of carrying continuously under specified conditions

[IEV 444-04-28, modified]

3.7.5
contact noise
spurious voltage which appears across the terminals of a closed contact

[IEV 444-04-33]

3.8 Contact load categories

3.8.1
contact load category 0
CC 0
load characterized by a maximum switching voltage of 30 mV and a maximum switching current of 10 mA

3.8.2
contact load category 1
CC 1
low load without contact arcing

NOTE Arcing with a duration of up to 1 ms is disregarded.

3.8.3
contact load category 2
CC 2
high load where contact arcing can occur

3.9 Mechanical properties of contacts

3.9.1
contact tip
contact point
part of a contact member at which the contact circuit opens or closes

[IEV 444-04-06]

3.9.2
contact gap
gap between the contact tips (points) when the contact circuit is open

[IEV 444-04-09, modified]

3.9.3
contact force
force which two contact members exert against each other at their contact tips (points) in the closed position

[IEV 444-04-10, modified]

3.9.4
contact member
conductive part designed to co-act with another to close or open the contact

[IEV 444-04-05, modified]

3.10 Terms relating to times

3.10.1
operate time
time interval between the application of the specified coil voltage to a relay in the release condition and the change of state of the last contact circuit, bounce time not included

[IEV 444-05-01, modified]

NOTE The operate time covers the closing time of a make contact, and the opening time of a break contact.

3.10.2
release time
time interval between the removal of the specified coil voltage from a monostable relay in the operate condition and the change of state of the last contact circuit, bounce time not included

[IEV 444-05-02, modified]

NOTE The release time covers the opening time of a make contact and the closing time of a break contact.

3.10.3
reset time
time interval between the application of the specified coil voltage to a bistable relay in the operate condition and the change of state of the last contact circuit, bounce time not included

[IEV 444-05-03, modified]

NOTE The reset time covers the opening time of a make contact and the closing time of a break contact.

3.10.4
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

[IEV 444-05-04]

3.10.5
transfer time; transit time
for a change-over break-before-make contact, time interval during which both contact circuits are open

[IEV 444-05-06]

3.10.6
bridging time
for a change-over make-before-break contact, the time interval during which both contact circuits are closed

[IEV 444-05-05]

3.10.7
stabilization time
time interval between the instant when a specified coil voltage is applied and the instant when the last contact circuit is closed/opened and fulfils the specified requirements, bounce time included

[IEV 444-05-07, modified]

3.10.8
minimum time of energization
minimum duration of application of the coil voltage to ensure that the relay operates or resets

[IEV 444-05-08, modified]

3.10.9
contact time difference
for a relay having several contacts of the same type, difference between the maximum value of the operate (release/reset) time and the minimum value of the operate (release/reset) time

3.11 Miscellaneous terms

3.11.1
coil transient suppression device
device connected to the relay coil to limit its back electromotive force (e.m.f.) to a prescribed value

3.11.2
thermal equilibrium
variation of less than 1 K between any two out of three consecutive measurements made at an interval of 5 min

4 Test and measurement procedures

4.1 General

The test and measurement procedures specified in this part of IEC 61810 are recommended to be used for the testing of parameters given for a relay.

4.2 Deviations

Any test and measurement procedures deviating from those given in this standard may be applied but shall be indicated in the documentation of the relay.

4.3 Precision of measurement

Measurement inaccuracies shall be taken into account when evaluating the results. If not otherwise specified, all measurements shall be taken with an accuracy of ±2 % for electrical, of ±5 % for mechanical parameters and with ±2 K for temperatures.

4.4 Power supplies

Unless otherwise specified, the following shall apply to power supplies and their connections:

Voltage or current shall be maintained within a tolerance range of ±5 % of the specified value.

The alternating component (ripple content) of the output of a d.c. supply shall not exceed 6 %.

NOTE 1 The alternating component in d.c., expressed as a percentage, is defined as:

$$(\text{maximum value} - \text{minimum value}) \times 10/(\text{d.c. component})$$

The frequency of an a.c. supply shall be maintained within a tolerance range of ±2 % of the specified value, and the distortion factor shall not exceed 5 %.

NOTE 2 The distortion factor is defined as the ratio of the harmonic content obtained by subtracting the fundamental wave from a non-sinusoidal harmonic quantity and the r.m.s. value of the non-sinusoidal quantity. It is usually expressed as a percentage.

The following shall be earthed as applicable: one side of the d.c. power supply, one side of the single-phase a.c. power supply, or the neutral of the three-phase a.c. power supply. The earthed side of the power supply shall be connected to: one terminal of each of one or more

coils of the relay under test and one terminal of each of the loads connected to the relay under test.

4.5 Reference conditions for testing

4.5.1 General conditions

Unless otherwise specified, all tests shall be carried out under the standard atmospheric conditions for testing as follows:

- temperature 23 °C ± 5 °C
- relative humidity 25 % to 75 %
- air pressure 86 kPa to 106 kPa (860 mbar to 1 060 mbar)

Before testing, the relays shall be subjected to the standard atmospheric conditions for a time sufficient to allow them to reach thermal equilibrium.

Unless otherwise specified, the terms a.c. voltage and current indicate r.m.s. values throughout this standard.

4.5.2 Use of sockets

4.5.2.1 General considerations

Relays with the option of connection via an appropriate socket may be tested using a specified socket or via direct electrical connections. In either case, the wiring to the relay or socket should follow any requirements specified in the test clause. Where this is not possible, any deviation shall be recorded in the test report.

Where a socket is used, the test report must identify the related test clause(s) and the socket type/part number.

NOTE Reference to “terminal” or “relay terminal” within a test clause of this standard must be taken to mean “socket terminal”, where a socket is used.

4.5.2.2 Precautions

The use of a socket can artificially improve some (relay) test results. As a consequence, the checks under 4.5.2.4 must be performed prior to conducting any tests using a socket.

The use of a socket can affect some test results to the detriment of the relay test results. As a consequence, the option remains for the test to be conducted without a socket, where it is practically possible to do so.

4.5.2.3 Socket mounting

Where a socket is employed for the shock, bump, vibration and acceleration tests (see 4.26 through 4.29), the method and conditions of mounting and the use of any retaining devices as recommended by the manufacturer must be specified.

4.5.2.4 Preliminary socket checks

Prior to conducting any tests via a socket, it shall be established that the resistance introduced at the relay terminal/socket receptacle interface does not exceed 10 % of the declared contact resistance for the relay.

Prior to conducting any tests via a socket, it shall be established that the insulation resistance (see 4.11) and the dielectric strength (see 4.9), between all electrically separate terminations, exhibited by the socket is no less than the values declared for the relay.

4.6 Visual inspection and check of dimensions

4.6.1 Purpose

To ensure that the relay marking and the key dimensions are in compliance with the requirements specified for the relay, and that there are no visible mechanical defects.

4.6.2 Procedure

Unless otherwise specified, visual inspection shall be performed under normal factory lighting and visual conditions. External inspection and check of key dimensions shall be carried out as non-destructive tests.

Visual inspection shall include:

a) correctness of marking (complete and legible);
b) correctness of terminal identification;
c) correct housing;
d) absence of mechanical defects.

The relays (and their accessories, if applicable) shall be checked for conformity to the outline drawings, including creepage distances and clearances as specified.

4.6.3 Conditions to be specified

The conditions to be specified are the following:

a) dimensions and tolerances, marking and terminals to be checked;
b) minimum values of outside creepage distances and clearances to be checked;
c) particular lighting and/or optical devices, if required;
d) mechanical properties to be checked, and required results.

4.7 Mechanical tests and weighing

4.7.1 Purpose

To ensure that particular mechanical properties are within specified limits.

4.7.2 Procedure

The relay shall be weighed. Mechanical test procedures, if required (for example contact force, armature travel, contact gaps) shall be as specified for the relay.

4.7.3 Conditions to be specified

The conditions to be specified are the following:

a) mechanical properties to be tested, methods of tests and required results;
b) mass of the relay and tolerances.

4.8 Relay coil properties

4.8.1 Coil resistance

4.8.1.1 Purpose

To ensure that the d.c. resistance of the relay coil(s) is within the specified limits.

4.8.1.2 Procedure

The resistance shall be measured between the terminals of the relay. The method shall involve negligible temperature rise. The reference temperature shall be 23 °C unless otherwise specified.

4.8.1.3 Conditions to be specified

The conditions to be specified are the following:

a) coil resistance limits;
b) reference temperature, if other than 23 °C;
c) temperature coefficient of the wire material, if other than electrolytic copper;
d) any special precautions due to the presence of resistors, diodes, etc., in the coil circuit.

4.8.2 Coil inductance

4.8.2.1 Purpose

To ensure that the inductance of the relay coil(s) is within the specified limits.

4.8.2.2 Procedure

The coil inductance shall be measured with the armature both in open and closed position (for this purpose mechanical means will be adopted, when necessary, in order to keep the armature in a fixed position). The relay shall be mounted with no adjacent metal parts. Unless required, no preconditioning is applied to the relay coil.

Method 1 (a.c.): The coil inductance shall be measured in the rated energized condition of the relay. Unless otherwise prescribed, the a.c. voltage U applied for measurement shall be sinusoidal at a frequency f equal to the nominal frequency of the energizing quantity or, for d.c. relays, as specified. Coil resistance R (see 4.8.1) and current I are measured; then the coil inductance L is calculated applying the following formulas:

$$Z = U/I; \qquad Z^2 = R^2 + (2\,\pi f\,L)^2$$

Method 2 (d.c.): The inductance shall be measured by determining the time constant t. The value of t is determined as the time necessary for reaching 63,21 % of the rated current I when the rated voltage U is applied to the coil. Then, the value L of the inductance is calculated applying the following formula:

$$L = R\,t$$

Method 3: Direct measurement with LCR meter at a frequency of 1 kHz and rated coil voltage, unless otherwise specified.

4.8.2.3 Conditions to be specified

The conditions to be specified are the following:

a) method 1, 2 or 3;
b) coil inductance limits;
c) voltage of the applied a.c. or d.c. supply;
d) frequency of the applied a.c. supply;
e) rated energization value;
f) any alternative procedure, if the above is not applicable.

4.8.3 Coil impedance and power consumption

4.8.3.1 Purpose

To ensure that the impedance of the relay coil(s) or the power consumption is within the specified limits.

4.8.3.2 Procedure

The relay shall be mounted with no adjacent metal parts.

Method 1: The coil impedance shall be measured in the non-energized and the rated energized condition of the relay. Unless otherwise prescribed, the a.c. voltage applied for measurement shall be sinusoidal at a frequency equal to the nominal frequency of the coil voltage or, for d.c. relays, as prescribed by the manufacturer.

When d.c. energization is to be superimposed in the winding during measurement, adequate means for isolation of the a.c. and d.c. circuits shall be provided.

Method 2: The power consumption (active power for d.c. or apparent power for a.c.) shall be measured in the rated energized condition of the relay or, for a relay the power consumption of which varies with the position of its moving parts, in the energized conditions as prescribed by the manufacturer.

4.8.3.3 Conditions to be specified

The conditions to be specified are the following:

a) method 1 or 2;
b) coil impedance or power consumption limits;
c) rated value of the coil voltage or, with method 2, the values of the coil voltage;
d) method 1: voltage of the applied a.c. supply and its frequency;
e) any alternative procedures, if the above is not applicable.

4.8.4 Coil transient suppression test

4.8.4.1 Purpose

To verify that the back-e.m.f. (electromotive force) generated by the relay coil is not greater than the maximum specified induced transient voltage.

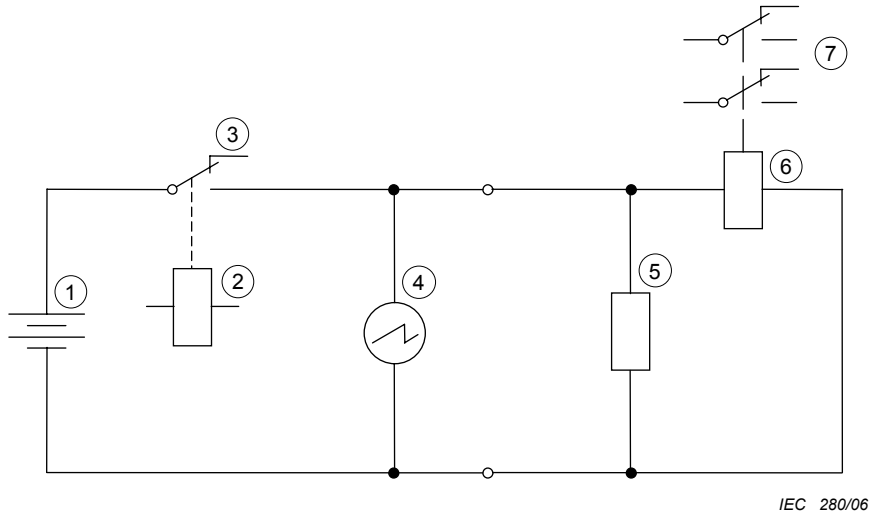
4.8.4.2 Procedure

The relay shall be connected to a test circuit (a typical example is shown in Figure 1) and energized at rated coil voltage. The switching relay is operated from a source voltage independent of the relay energizing source.

It is important that the energizing source is a low impedance source with no limiting resistor or potentiometer used to regulate the line voltage.

The switching relay shall be closed for a minimum of 10 times the operate time of the relay under test to allow the monitoring device (for example oscilloscope) and circuit-network to stabilize and then opened to obtain the induced voltage deflection trace. The cycling rate and duty factor of the relay shall be as specified by the manufacturer .

The reading shall be observed on the monitoring device. The magnitude of the induced transient voltage shall be noted. A typical oscilloscope trace is presented in Figure 2.



Key

① energization supply (low impedance)

② coil of the switching relay

③ contact of the switching relay (bounce free)

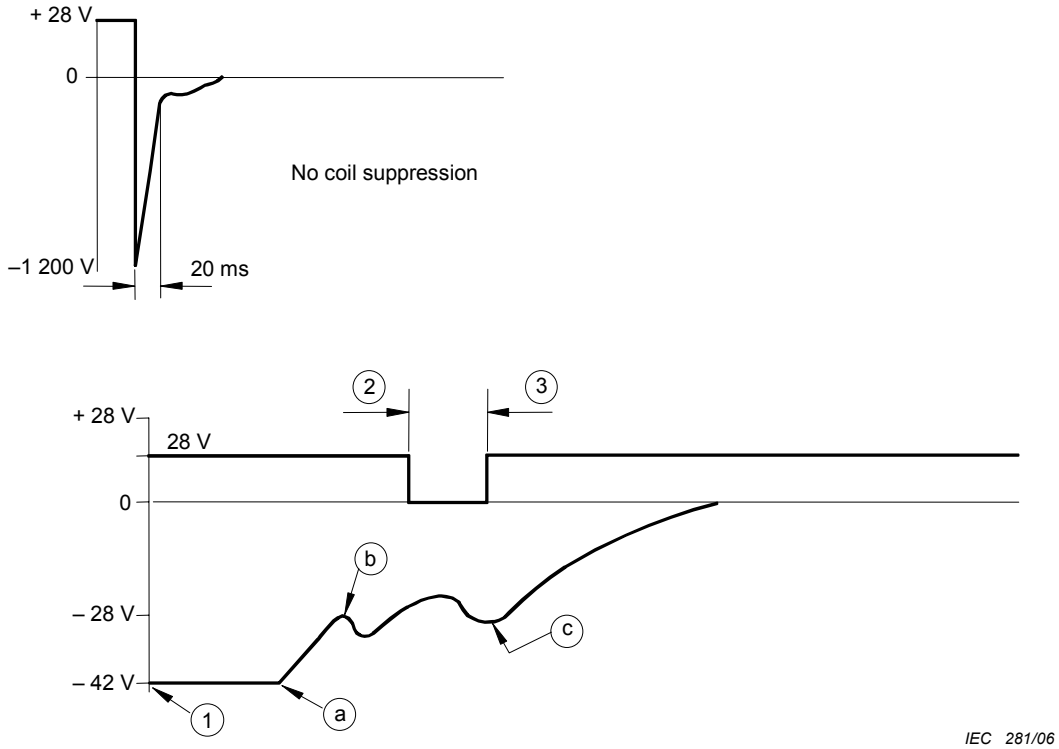
④ monitoring device (oscilloscope)

⑤ suppression circuit

⑥ coil of the relay under test

⑦ contacts of the relay under test

Figure 1 – Typical circuit for the measurement of coil transient suppression



Key

① switching relay contact opens

② test relay contact opens (break contact)

③ test relay contact closes (make contact)

a cut off due to suppression component use

b start armature movement

c end armature movement

Figure 2 – Typical traces on an oscilloscope screen during transient voltage measurement

4.8.4.3 Conditions to be specified

The conditions to be specified are the following:

a) rated coil voltage;
b) cycling rate;
c) duty factor;
d) number of consecutive readings, if different from three;
e) ambient temperature, if different from (23 ± 5) °C;
f) limits for back-e.m.f.

4.9 Dielectric strength test

4.9.1 Purpose

To ensure that the withstand capability of the insulation between specific circuits of the relay or across open contact(s) is sufficient.

4.9.2 Procedure

The test voltage specified for a circuit shall be applied to the respective relay terminals. The a.c. test voltage shall be of sinusoidal waveform having a frequency of 50 Hz or 60 Hz and may be substituted by a d.c. test voltage of a value equal to the peak value of the a.c. test voltage. Unless otherwise specified, the test voltage is applied for 1 min across the insulation or disconnection. An application time of 1 s is permissible, provided the test voltage value is increased to 110 % of the rated value. For even shorter periods, the manufacturer shall evaluate an appropriate value ensuring the same level of dielectric withstand capability. No flashover or breakdown shall occur. A current of not more than 3 mA is permitted.

NOTE 1 For relays, the following types of insulation are applicable: functional, basic and reinforced insulation. Micro-disconnection (covers also micro-interruption) and full-disconnection apply to relay contacts. See also 10.3 of IEC 61810-1.

NOTE 2 Values for a.c. and d.c. test voltages depending on the rated voltage of a circuit and the insulation or disconnection to be tested are given in Table 9 and Table 10 of IEC 61810-1.

The high-voltage transformer used for the test shall be designed so that, when the output terminals are short-circuited after the output voltage has been adjusted to the test voltage, the output current is at least 200 mA unless otherwise prescribed by the manufacturer. Care shall be taken that the r.m.s. value of the test voltage is measured within ±3 %.

Special components which might render the test impractical such as light emitting diodes, free-wheeling diodes, varistors are disconnected at one pole, or bridged, or removed, as appropriate to the insulation being tested.

If prescribed, a relay in the new condition shall be subjected to the following preconditioning, unless other procedures and values are specified:

The preconditioning comprises the tests “dry heat” and “damp heat”.

The test dry heat is carried out in a heat chamber. The air temperature is maintained at 55 °C with an accuracy of ±2 K in the area where the specimens are mounted. The specimens are kept in the chamber for 48 h.

The test damp heat is carried out in a climatic test cabinet at a relative humidity between 91 % and 95 %. The air temperature shall be maintained at 25 °C with an accuracy of ±5 K in the area where the specimens are mounted. The specimens are kept in the chamber for 48 h. There shall be no condensation.

4.9.3 Conditions to be specified

The conditions to be specified are the following:

a) terminals to which the test voltage shall be applied, selected from the following:
   - terminals of each contact circuit; break contacts shall be opened for this test,
   - all terminals requiring the same test voltage connected together and any exposed conductive part not intended to be electrically connected, the latter being simulated by a foil wrapped around relays having an insulating enclosure,
   - terminals of separate windings (bifilar or not),

- all coil terminals requiring the same test voltage connected together and all contact circuit terminals connected together,
- terminals of separate contact circuits;

b) test voltage or voltages;

c) duration of the test: 1 s or 1 min;

d) reductions for repetition tests, for example for final measurement after an endurance test. Reductions shall be specified together with such tests;

e) details of the preconditioning, if prescribed.

4.10 Impulse voltage test

4.10.1 Purpose

To ensure that the relay withstands specified transient overvoltages.

4.10.2 Procedure

The impulse test voltage of peak value and waveform as specified shall be applied to the relevant parts of the relay as prescribed by the manufacturer. The standard waveform for the simulation of lightning overvoltages is characterized by a front time of 1,2 µs and a time to half-value of 50 µs. The test details are given in IEC 61180-1 and IEC 61180-2. Other waveforms and test setups may be specified.

NOTE The 10/700 µs test impulse described in ITU-T Recommendation K.44 may be also relevant for telecom applications.

In any case, the output impedance of the impulse generator shall not be higher than 500 Ω.

The test shall be conducted for a minimum of three impulses of each polarity with an interval of at least 1 s between pulses.

A breakdown through solid insulation or a flashover is not permitted.

There shall be no flashover across an open contact, unless otherwise specified by the manufacturer. In this case the flashover shall not cause any permanent damage, and the output energy of the generator shall be specified.

If prescribed, a relay in the new condition shall be subjected to the following preconditioning, unless other procedures and values are specified:

The preconditioning comprises the tests “dry heat” and “damp heat”.

The test dry heat is carried out in a heat chamber. The air temperature is maintained at 55 °C with an accuracy of ±2 K in the area where the specimens are mounted. The specimens are kept in the chamber for 48 h.

The test damp heat is carried out in a climatic test cabinet at a relative humidity between 91 % and 95 %. The air temperature shall be maintained at 25 °C with an accuracy of ±5 K in the area where the specimens are mounted. The specimens are kept in the chamber for 48 h. There shall be no condensation.

4.10.3 Conditions to be specified

The conditions to be specified are the following:

a) number of impulses, if other than three positive and three negative impulses;

b) terminals to which the impulse test voltage is applied;

c) waveform and generator characteristics (including output energy);

d) peak value of the impulse voltage;

e) details of preconditioning, if required;

f) required test results and final measurements to verify compliance.

4.11 Insulation resistance

4.11.1 Purpose

To ensure that a sufficient electrical resistance is maintained between specified circuits of a relay.

4.11.2 Procedure

The d.c. measurement voltage shall be applied to the relevant parts of the relay as specified by the manufacturer. The value of that measurement voltage shall be 500 V unless otherwise prescribed. The resistance measurement shall be made at least 5 s after applying the voltage.

If prescribed, a relay in the new condition shall be subjected to the following preconditioning, unless other procedures and values are specified:

The preconditioning comprises the tests “dry heat” and “damp heat”.

The test dry heat is carried out in a heat chamber. The air temperature is maintained at 55 °C with an accuracy of ±2 K in the area where the specimens are mounted. The specimens are kept in the chamber for 48 h.

The test damp heat is carried out in a climatic test cabinet at a relative humidity between 91 % and 95 %. The air temperature shall be maintained at 25 °C with an accuracy of ±5 K in the area where the specimens are mounted. The specimens are kept in the chamber for 48 h. There shall be no condensation.

4.11.3 Conditions to be specified

The conditions to be specified are the following:

a) terminals to which the test voltage shall be applied, selected from the following:
   - terminals of each contact circuit; break contacts shall be opened for this test,
   - all terminals requiring the same test voltage connected together and any exposed conductive part not intended to be electrically connected, the latter being simulated by a foil wrapped around relays having an insulating enclosure,
   - terminals of separate windings (bifilar or not),
   - all coil terminals requiring the same test voltage connected together and all contact circuit terminals connected together,
   - terminals of separate contact circuits;

b) measurement voltage, if other than 500 V;

c) time to steady-state reading;

d) details of preconditioning, if required;

e) minimum value(s) of insulation resistance(s).

4.12 Contact-circuit resistance (or voltage drop)

4.12.1 Purpose

To check that the resistance across a closed contact remains within specified limits.

4.12.2 Procedure

The resistance shall be measured using a four-terminal bridge, by the voltmeter-ammeter method, or, particularly for dynamic tests, using automatic monitoring equipment. Measurements shall be made with alternating voltage at a frequency of 0,8 kHz to 2 kHz, or as prescribed. If d.c. is prescribed, the resistance shall be measured for both polarities except for dynamic testing.

One measurement shall be made per cycle.

The type of measurement shall be as prescribed, and be selected from the following:

- static contact resistance measurement denotes that, for each measurement, the contacts remain closed for an interval sufficient to allow all transients to decay. Three test cycles shall be made;
- dynamic contact resistance measurement denotes that the relay coil is energized by a square wave, the frequency being as prescribed. A specified number of cycles shall be made, and each of the cycles shall be monitored. Monitoring shall start after the contact has reached stable closed condition, or after at least 30 % of the closed part of each cycle has elapsed, whichever is later.

  Any irregularity in contact-circuit resistance not exceeding a duration of 10 µs shall be ignored, unless another value is prescribed by the manufacturer.

The coil shall be energized at the rated voltage, unless otherwise specified.

There shall be no preconditioning cycle prior to the measurement.

The voltage shall be applied after the contacts are closed, and removed before the contacts are opened, except for CC 0 contacts where load switching is permitted if so specified, and under the conditions prescribed by the manufacturer.

If a relay contact belongs to more than one contact category (CC), the test shall be based on the requirements for the lowest category.

During an endurance test, checking of contact resistance may be carried out by another method, for example by checking the voltage drop across the tested contact with the load current flowing through the contact, unless otherwise stated.

4.12.3 Conditions to be specified

The conditions to be specified are the following:

a) frequency of the test voltage, if other than 0,8 kHz to 2 kHz;

b) type of measurement: steady-state or dynamic operation;

c) for dynamic tests, the frequency of the square wave, the number of cycles, and the rated measurement time;

d) coil voltage value, if other than rated value;

e) points of measurement;

f) test contact current, which shall be selected from the following:
   - contact load category CC 0: 10 mA max.
   - contact load category CC 1: 100 mA max.
   - contact load category CC 2: 1 A max.

g) test contact voltage, which shall be selected as appropriate from the following:
   - contact load category CC 0: 30 mV max.
   - contact load category CC 1: 10 V max.
   - contact load category CC 2: 30 V max.

h) maximum contact resistance.

4.13 Functional tests

4.13.1 Purpose

To ensure that the relay performs satisfactorily at its specified energization values.

4.13.2 Procedure

Table 1 sets out the applicable values and the significance of the functional tests, referring to Figures 3 to 7, which give typical examples.

Testing is made by attributes, and shall be made in the order given below, unless otherwise specified.

Table 1 – Coil voltage values and corresponding functions

Diagram code (see Figures 3-7)	Applied value of the coil voltage	The relay shall	Applicable to
a	Non-operate voltage	Not operate	All types
b	Operate voltage	Operate	All types
c	Rated voltage	Remain operated	All types
d	Non-revert voltage	Remain operated	Polarized
e/g	Non-release voltage	Not release	All types
f/h	Release voltage	Release	All types
i	Reverse rated voltage	Remain non-operated	Bistable polarized
j	Reverse non-revert voltage	Not operate	Bistable polarized
k	Reverse polarity voltage	Not operate	Monostable polarized
x	Preconditioning value	Be preconditioned	All if required
y	Setting voltage	Be set in required position	All if required
z	Reverse setting voltage	Be set in required position	All if required

When required, the magnetic preconditioning shall be applied, and the orientation of the relay shall take account of any external magnetic field.

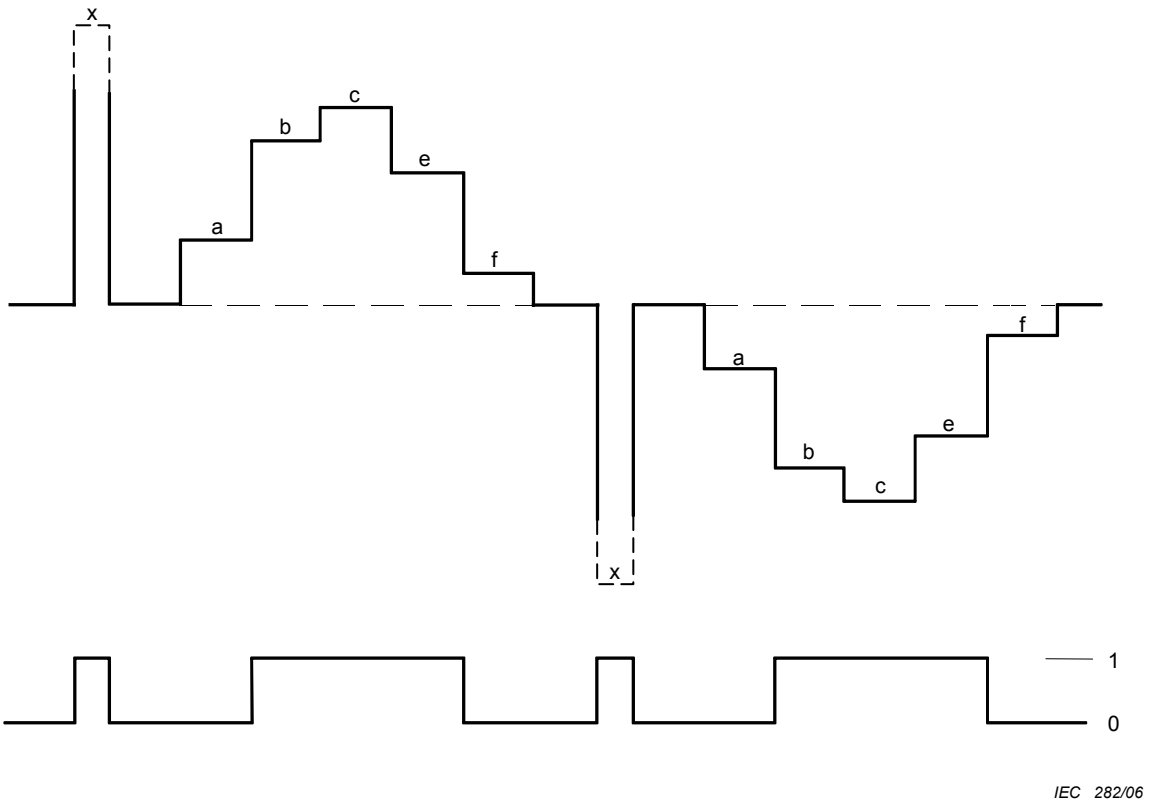
When proceeding from one step to the next, the characteristics of the coil voltage shall be as specified. The corresponding function of the relay shall be checked by visual inspection or, if this is impracticable, by monitoring the contacts.

Explanatory notes concerning performance diagrams, Figures 3 to 7:

The drawings are not to scale.

The preconditioning pulses are examples only. Any other waveform direction, duration or amplitude may be used.

The sequence of Figure 7, bistable polarized relay, is an example only. Other sequences might apply to further types of such relays.

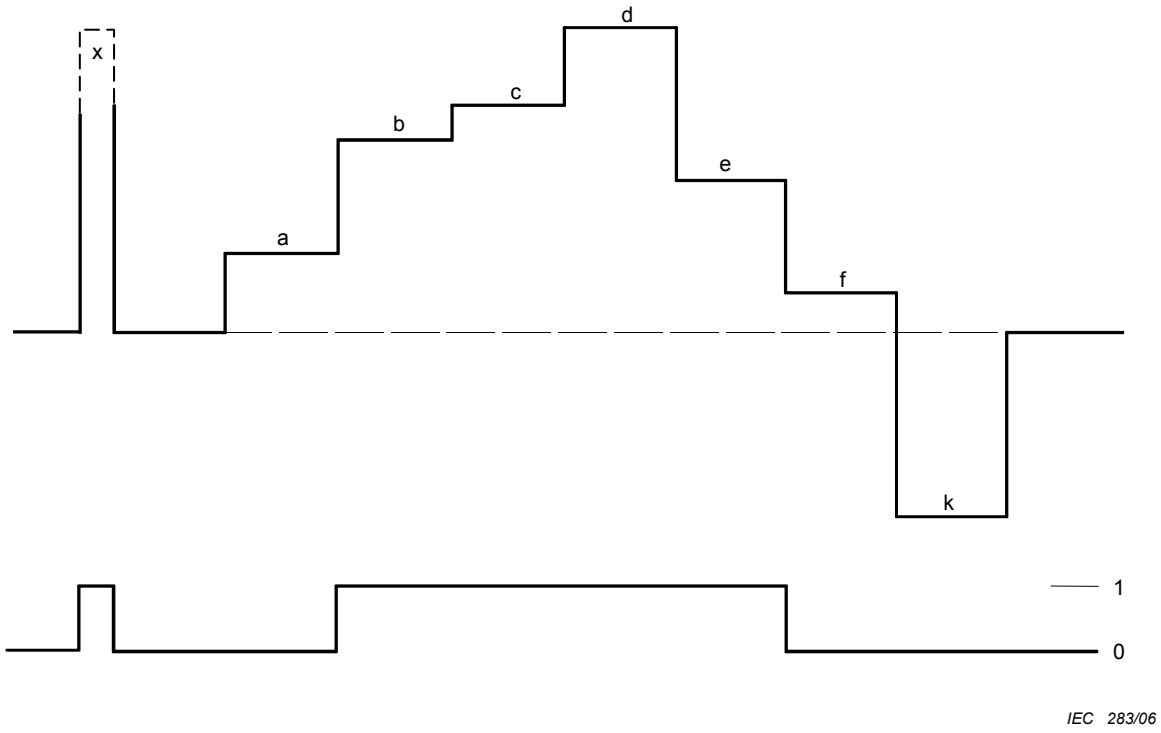


Key

a	non-operate voltage	e	non-release voltage (monostable relays)
b	operate voltage	f	release voltage (monostable relays)
c	rated voltage	x	preconditioning voltage

The upper traces each represent the energization values, the lower traces indicate the condition of the contact (0 = release condition, 1 = operate condition).

Figure 3 – Monostable non-polarized relay

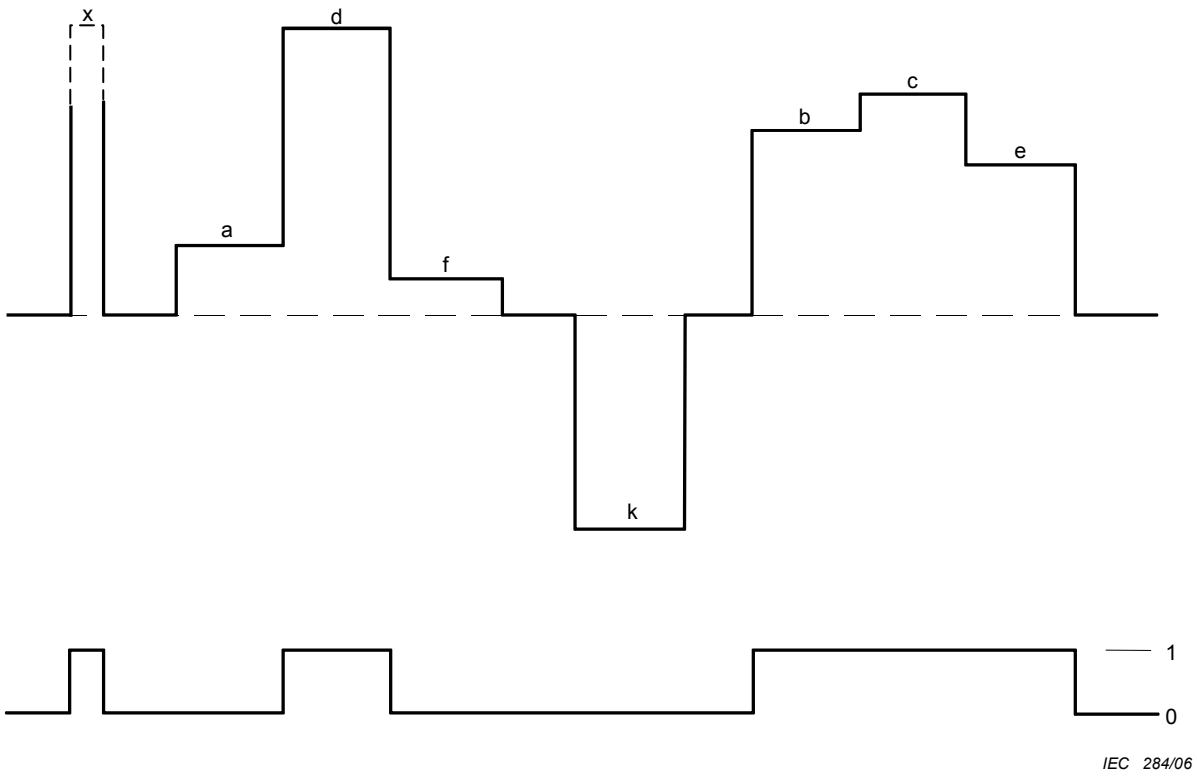


Key

a	non-operate voltage	e	non-release voltage (monostable relays)
b	operate voltage	f	release voltage (monostable relays)
c	rated voltage	k	reverse polarity voltage
d	non-revert voltage	x	preconditioning voltage

The upper traces each represent the energization values, the lower traces indicate the condition of the contact (0 = release condition, 1 = operate condition).

Figure 4 – Monostable relay polarized by diode

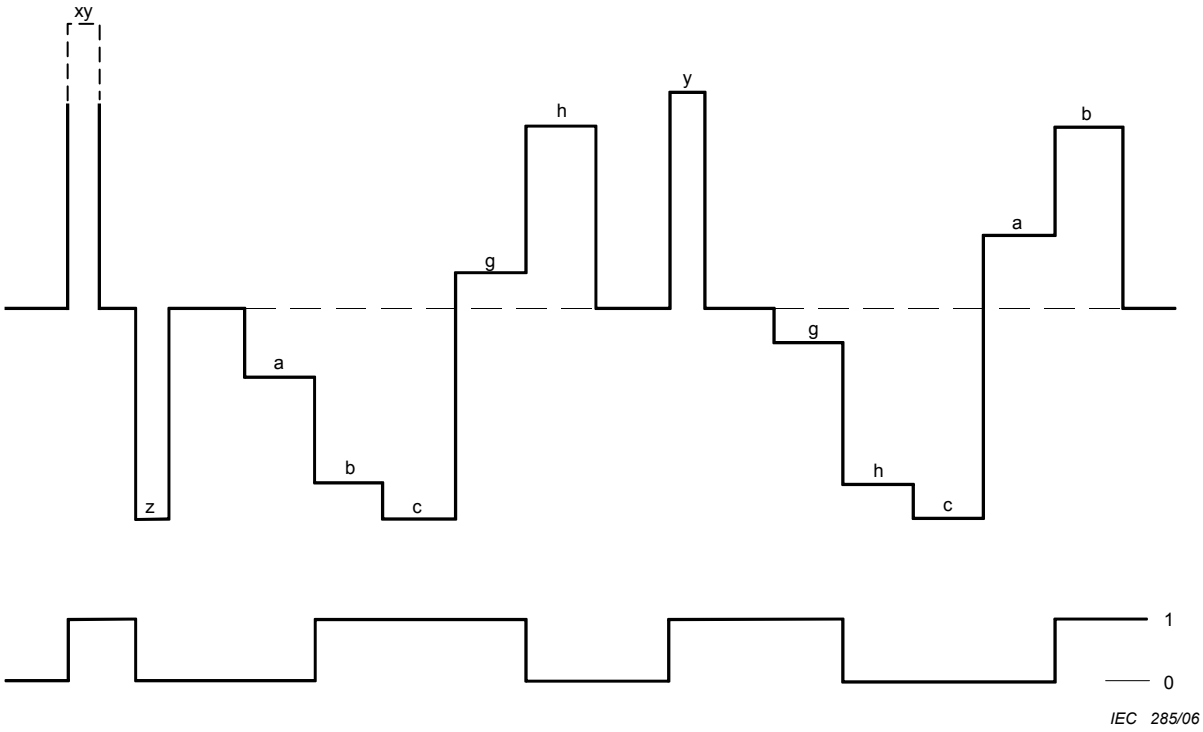


Key

a	non-operate voltage	e	non-release voltage (monostable relays)
b	operate voltage	f	release voltage (monostable relays)
c	rated voltage	k	reverse polarity voltage
d	non-revert voltage	x	preconditioning voltage

The upper traces each represent the energization values, the lower traces indicate the condition of the contact (0 = release condition, 1 = operate condition).

Figure 5 – Monostable polarized relay with magnetic biasing

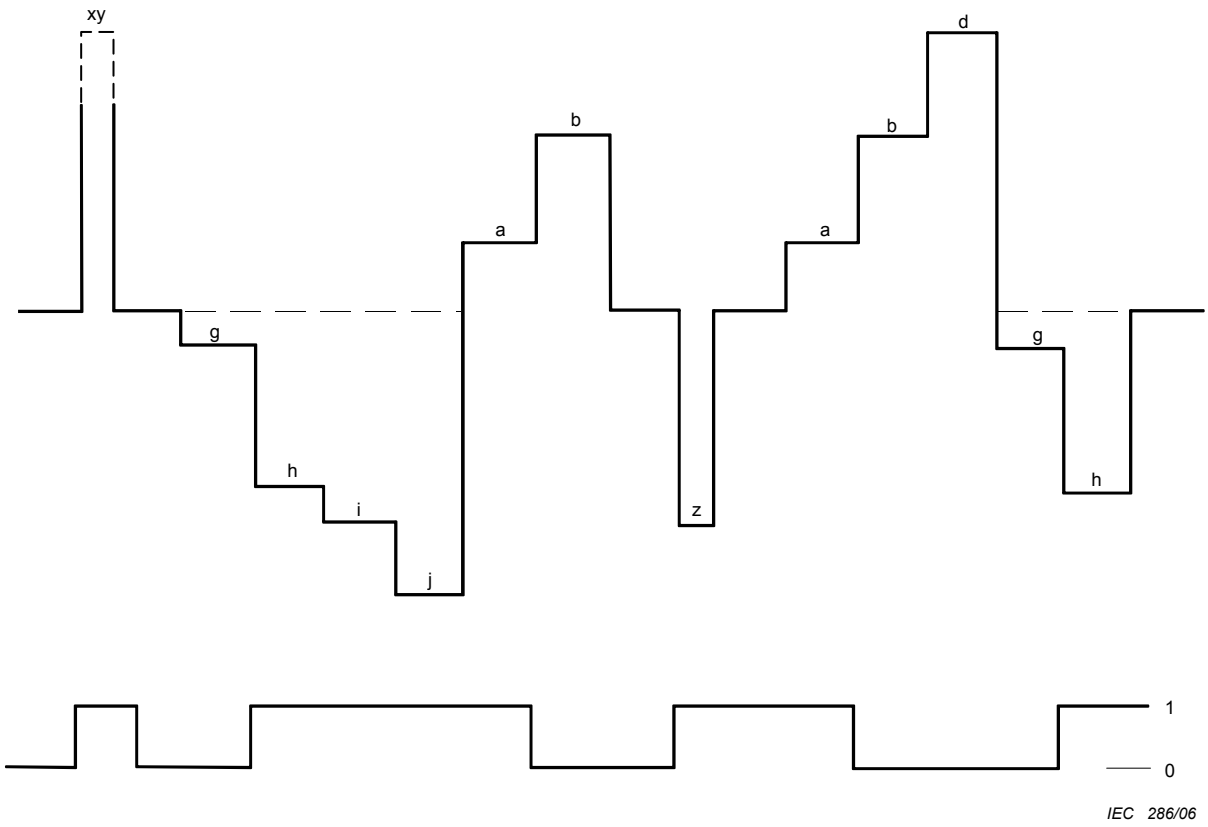


Key

a	non-operate voltage	h	release voltage (bistable relays)
b	operate voltage	x	preconditioning voltage
c	rated voltage	y	operating (setting) voltage
g	non-release voltage (bistable relays)	z	reverse operating (setting) voltage

The upper traces each represent the energization values, the lower traces indicate the condition of the contact (0 = release condition, 1 = operate condition).

Figure 6 – Bistable non-polarized relay (not applicable to remanence relays)



Key

a	non-operate voltage	i	reverse rated voltage
b	operate voltage	j	non-revert reverse voltage
d	non-revert voltage	x	preconditioning voltage
g	non-release voltage (bistable relays)	y	operating (setting) voltage
h	release voltage (bistable relays)	z	reverse operating (setting) voltage

The upper traces each represent the energization values, the lower traces indicate the condition of the contact (0 = release condition, 1 = operate condition).

Figure 7 – Bistable polarized relay (example)

4.13.3 Conditions to be specified

The conditions to be specified are the following:

a) coil voltage values and values for preconditioning, as required, and their polarity;

b) order of steps, if different from above;

c) application of consecutive pulses or voltage ramp, instead of stepwise changes, if applicable;

d) time between the steps, or device to be used to perform them, if a more precise specification is required;

e) application of the test to new relays or after a specified number of cycles;

f) magnetic orientation, if required;

g) details of monitoring, if required.

4.14 Timing tests

4.14.1 Purpose

To ensure that the times are within the specified limits.

4.14.2 Procedure

For the energization of the coil, the output impedance of the source shall be chosen to ensure that the maximum voltage drop and the setting time do not exceed the values prescribed.

The switching voltage shall be as prescribed.

The switching current shall be 10 mA, unless otherwise specified. The switch for switching the coil shall be bounce-free.

For a.c. relays, a synchronous switching device, variable in point on wave, shall be used. The phase shall be set either to obtain the maximum time interval, or to the specified points on wave, as prescribed. As an alternative, a d.c. energization of the coil with a value that causes an equivalent temperature rise of the coil may be used.

For the measurement of operate time, transfer time, bridging time, release time and bounce time, a suitable circuit is given in Figure 8, and typical traces on the oscilloscope screen are shown in Figure 9. The time coefficient shall be such that the display covers the whole screen.

4.14.2.1 Operate time: operate time, transfer time and bridging time shall be measured by a suitable method when the relay is energized as specified.

4.14.2.2 Release time: release time, transfer time and bridging time shall be measured by a suitable method after the disconnection of the specified energization.

4.14.2.3 Bounce time: contact bounce time shall be measured using a suitable test circuit such as that shown in Figure 8.

The test shall be made on at least one specified contact circuit, using a resistive load.

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

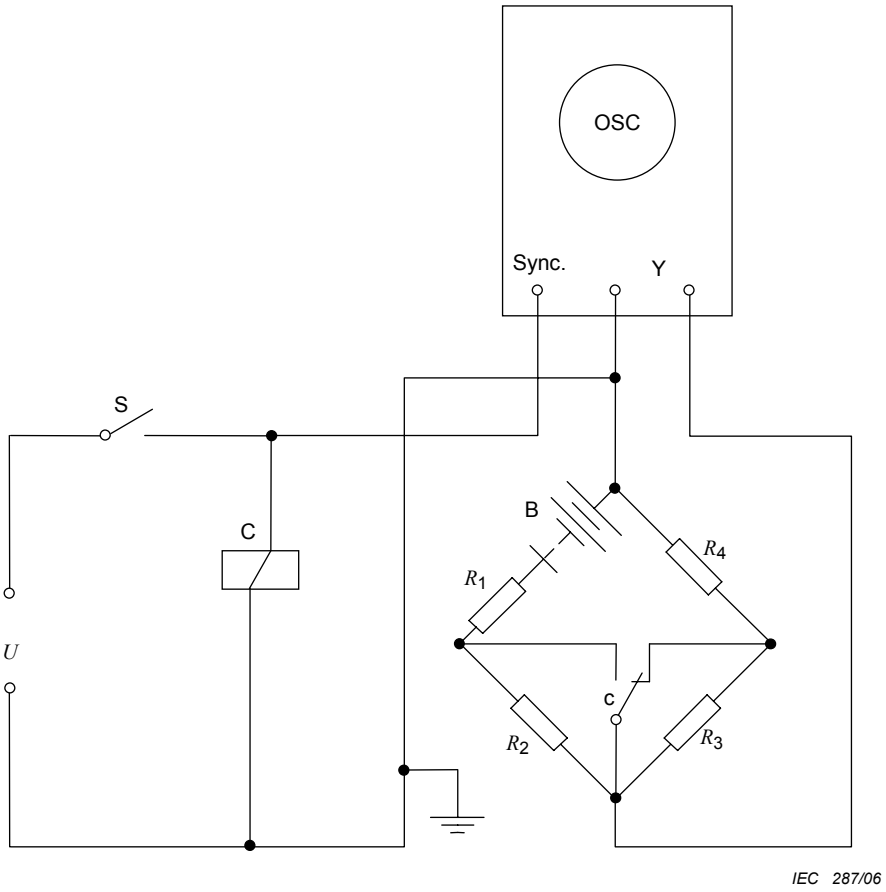
4.14.2.4 Time to stable closed condition: the test shall be made on at least one contact circuit by applying the coil voltage values and measuring contact parameters after the time to stable closed conditions, all details being as prescribed, if this test is required.

4.14.2.5 Minimum time of energization: the test shall be made on at least one contact circuit. The relay shall be energized with its rated coil voltage and, after elapse of the specified minimum time of operate energization, the energization shall be reduced to

- zero, for bistable relays;
- the specified characteristic non-release voltage, for monostable relays.

After the reduction, the specified contact parameters shall be measured, all details being as prescribed, if this test is required.

4.14.2.6 Contact time difference: the test shall be made on two or more specified contact circuits, each of them being monitored by a suitable method. An example using an oscilloscope is given in Figures 8 and 9. With this example, the oscilloscope shall have the number of traces required to observe the differences in time.

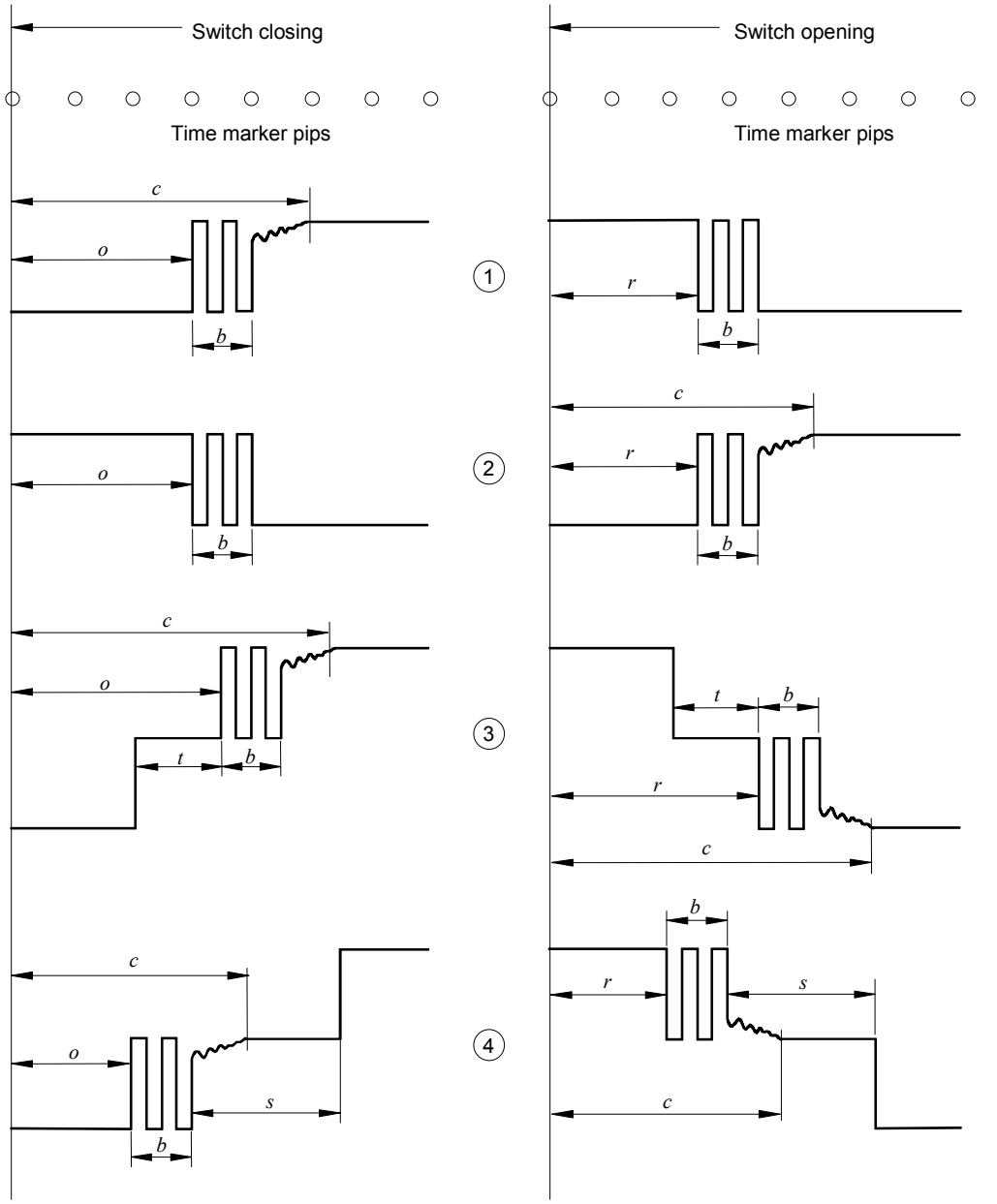


Components

C	coil of the relay
c	contact of the relay
U	energization supply
S	switch, bounce-free
B	battery
R1 to R4	resistors
OSC	oscilloscope
Sync	trigger input
Y	vertical deflection input

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

Figure 8 – Typical circuit for the measurement of time parameters



Key

①	make contact	*o*	operate time
②	break contact	*r*	release time
③	break-before-make contact	*b*	bounce time
④	make-before-break contact	*t*	transfer time
		s	bridging time
		c	time to stable closing

Figure 9 – Typical traces on an oscilloscope screen during time measurements

4.14.3 Conditions to be specified

The conditions to be specified are the following:

a) mounting or position of the relay;

b) coil voltage value, cycling rate and duty factor of the energization. Preferably, the lower limit of the operative range should be used for testing the operate time, and the upper limit for testing the release time;

c) means for the disconnection for release time measurement, if of importance. Short-circuiting the relay coil while protecting the power supply source from overload may be specified as an alternative;

d) maximum voltage drop and settling time of the source;

e) switching voltage and switching current in accordance with 4.14.2;

f) times to be measured, their limits and contact sequencing; for a.c. also point(s) on wave;

g) further details required under 4.14.2.4 and 4.14.2.5;

h) contact(s) to be checked;

i) discontinuities to be ignored if limit other than 10 µs;

j) suppression components on coil or contact, if required.

4.15 Climatic tests/sequence

4.15.1 Purpose

To determine the ability of the relay to withstand certain climatic test conditions, or a sequence of such climatic test conditions. For this purpose, the individual climatic tests described under 4.15.2 to 4.15.6 hereinafter may be carried out as separate tests. However, when a climatic sequence is required, this sequence shall be as specified below, unless otherwise prescribed by the manufacturer.

4.15.2 Dry heat

4.15.2.1 This test shall be carried out in accordance with test Ba or, if in relation to the test facilities, the relay is to be considered as an appreciably heat-dissipating specimen, with test Bc of IEC 60068-2-2.

4.15.2.2 The duration period shall be 16 h. During the last 2 h of the dry heat exposure time, the relay shall be energized as specified and as follows:

a) for relays for continuous duty, the coil voltage shall be applied continuously for the 2 h;

b) for relays for short-time or intermittent duty, the coil voltage shall be applied by pulses at the number of cycles per hour and the duty factor, both as declared by the manufacturer;

c) contacts shall be loaded as specified.

4.15.2.3 Immediately following the 2 h operating period and still under dry heat exposure, all relays shall have a functional test as prescribed.

4.15.3 Damp heat, cyclic, first cycle

4.15.3.1 This test shall be carried out when prescribed.

4.15.3.2 This test shall be carried out in accordance with test Db variant 2 of IEC 60068-2-30 for one cycle of (12+12) h.

4.15.3.3 Upon completion of the cycle, the relay shall be removed from the chamber and exposed to the recovery conditions specified.

4.15.3.4 After recovery, the relay shall be immediately subjected to the cold test.

4.15.4 Cold

4.15.4.1 This test shall be carried out in accordance with test Aa (sudden change of temperature) or test Ab (gradual change of temperature) of IEC 60068-2-1.

The duration period shall be 2 h.

4.15.4.2 At the end of the conditioning period and before removal from the chamber, the relay shall be energized for 100 cycles at the coil voltage value as specified.

4.15.4.3 During the operating tests, all contacts shall be loaded as specified. The contact function shall be checked as specified.

4.15.5 Low air pressure

4.15.5.1 This test shall be carried out in accordance with test M of IEC 60068-2-13, and if prescribed. The duration period shall be 30 min at normal ambient temperature.

4.15.5.2 At the end of the test period, and while the relay is still under low pressure, a dielectric test voltage as specified shall be applied between:

a) the two ends of the coil connected together (positive) and all other terminals together with the exposed conductive parts (negative);
b) the terminals of an open circuit contact; break contacts shall be opened for this test.

4.15.5.3 During the dielectric test, there shall be no flashover or breakdown of the insulation of the relay.

4.15.6 Damp heat, cyclic, all or remaining cycles

4.15.6.1 This test shall be carried out when required.

4.15.6.2 This test shall be carried out in accordance with test Db variant 2 of IEC 60068-2-30. The number of cycles shall be as specified.

4.15.6.3 Upon completion of the cycles, the relay shall be removed from the chamber and exposed to the recovery conditions specified.

4.15.7 Intermediate measurements

If required, intermediate measurements shall be made as specified.

4.15.8 Final measurements

4.15.8.1 After recovery of not less than 1 h and not more than 2 h, the relay shall be visually inspected in accordance with 4.6. There shall be no evidence of corrosion, peeling, chipping, or of mechanical deterioration that could impair operation.

4.15.8.2 Insulation resistance shall be measured in accordance with 4.11. Degradation shall be permitted to the extent specified.

4.15.8.3 Contact circuit resistance shall be measured in accordance with 4.12. Increase shall be permitted to the extent specified.

4.15.8.4 Other final measurements, if required, as specified.

4.15.9 Conditions to be specified

The conditions to be specified are the following:

a) degree of severity of the climatic conditions and recovery conditions;
b) coil voltage value, contact load during dry heat exposure, last 2 h;
c) details of the functional test after dry heat exposure;
d) whether or not the damp heat, cyclic, first cycle test is required;
e) for the cold test, method Aa or Ab;
f) coil voltage value, contact load after cold exposure for 100 cycles and criteria of contact function, if required;
g) whether or not the low pressure exposure is required;
h) value of the dielectric test voltage during low pressure exposure;
i) whether or not the damp heat, cyclic, all or remaining cycles test is required;
j) permitted degradation in insulation resistance;
k) permitted increase in contact circuit resistance;
l) mechanical deterioration to be checked;
m) duration period for dry heat if different from 16 h;
n) duration period for cold if different from 2 h;
o) duration period for low air pressure if different from 30 min;
p) temperature for low air pressure if different from normal ambient temperature;
q) other final measurements, if required.

4.16 Damp heat, steady state

4.16.1 Purpose

To assess the suitability of the relay for use and/or storage under conditions of high relative humidity.

4.16.2 Procedure

This test shall be carried out in accordance with test Cab of IEC 60068-2-78. During the exposure time of the relays, one half of the number of samples exposed shall have a potential of (100 ± 10) V d.c. or as prescribed, applied between the two ends of the coil connected together (positive) and all other terminals together with the exposed conductive parts (negative). When assessing the suitability for storage conditions only, it is not necessary to apply voltage.

At the end of the conditioning period, the relays shall be removed from the chamber and exposed to the recovery conditions specified by the manufacturer.

4.16.3 Conditions to be specified

The conditions to be specified are the following:

a) severity (temperature, relative humidity and duration), details of the conditioning and recovery conditions;
b) voltage to be applied if other than (100 ± 10) V d.c.;

c) final measurements:

- visual inspection as specified in 4.6. There shall be no evidence of corrosion, peeling or chipping, or of mechanical deterioration that could impair operation,
- insulation resistance as specified in 4.11 and the extent of degradation permitted,
- contact circuit resistance as specified in 4.12 and the extent of increase permitted,
- other final measurements, if required.

4.17 Thermal resistance of the coil

4.17.1 Purpose

To determine whether the thermal resistance of the relay coil is within the specified limits.

4.17.2 Procedure

The relay shall be mounted as specified by the manufacturer. The relay shall be energized successively at four values approximately equally distributed throughout its operative range, and the temperature rise shall be determined for each of them after thermal equilibrium has been reached. All measurements shall be made at a constant ambient temperature and the relay shall be protected from draughts, solar irradiation and the like.

The temperature rise shall, for coils made of one conductive material, be calculated by the formula:

$$\Delta t_{\mathrm{w}} = \frac{R_{\mathrm{w}} - R_{\mathrm{a}}}{R_{\mathrm{a}}}\left(t_{\mathrm{a}} + \frac{1}{\alpha_0}\right)[\mathrm{K}]$$

where

Δt_{w} is the average temperature rise;

R_{w} is the resistance of the coil in thermal equilibrium;

R_{a} is the resistance of the coil at ambient temperature;

t_{a} is the ambient temperature;

α_0 is the temperature coefficient of the resistivity of the conductor material at 0 °C.

This formula can be held valid for temperatures between 0 °C and 120 °C.

For copper

$$\alpha_0 = \frac{1}{234{,}5}\left[\mathrm{K}^{-1}\right]$$

From the temperature rise, the thermal resistance is calculated by the formula:

$$R_{\mathrm{th}} = \frac{\Delta t_{\mathrm{w}}}{P_{\mathrm{w}}}[\mathrm{K/W}]$$

where P_{W} is the value of the power supplied to the coil at thermal equilibrium.

The value to be compared with the specified value is, unless otherwise prescribed by the manufacturer, the average of the results of the four measurements.

4.17.3 Conditions to be specified

The conditions to be specified are the following:

a) mounting of the relay;
b) energization values if other than four values equally distributed throughout the operative range;
c) temperature coefficient of the wire material, if other than electrolytic copper;
d) evaluation procedure if other than the average value of four measurements is required;
e) limits of thermal resistance.

4.18 Heating

4.18.1 Purpose

To determine that the temperature rise of given relay parts does not exceed the specified limits.

4.18.2 Procedure

The relay shall be mounted and energized as follows, unless otherwise specified.

The test is carried out with three relays mounted side by side in the same direction, see Annex A. Unless specifically designed otherwise, the specimens are tested in horizontal position with the terminals pointing downward. The mounting distance shall be stated by the manufacturer.

Terminal screws and/or nuts are tightened with a torque equal to two-thirds of that specified in IEC 60999-1.

In case of screwless terminals, care is to be taken to ensure that the conductors are correctly fitted to the terminals in accordance with IEC 60999-1.

The ambient temperature shall be as specified and held constant within a range of ±2 K.

The contacts shall be loaded with a current as specified by the manufacturer for the contact set, until thermal equilibrium is reached.

The coil(s) shall be energized:

- with the rated coil voltage unless otherwise specified,
- without coil voltage (for example testing of bistable relays or break contacts).

The relays shall be mounted in a sufficiently large heat chamber without forced convection.

The specimen shall be protected against air draught and is not allowed to be subjected to any artificial cooling.

During the test, the predetermined ambient temperature of the heat chamber shall not be influenced by the relay.

The temperature rise of the relay parts shall be determined:

- for relays for continuous duty: after thermal equilibrium has been reached;
- for relays for short-time or intermittent duty: at the highest temperature attained during such operation.

The temperature(s) of the coil(s) shall be determined by the resistance method and the temperature rise calculated according to the following formula:

$$\Delta t = \frac{R_2 - R_1}{R_1} (234{,}5 + t_1) - (t_2 - t_1)$$

where

Δt is the temperature rise;

R_1 is the resistance at the beginning of the test;

R_2 is the resistance at the end of the test;

t_1 is the ambient temperature at the beginning of the test;

t_2 is the ambient temperature at the end of the test.

NOTE The value of 234,5 applies to electrolytic copper (EC58). For other materials, the respective values have to be used instead and indicated by the manufacturer.

The temperature rise of other relay parts as specified shall be measured with fine wire thermocouples or equivalent sensors that do not significantly influence the temperature being determined of those parts.

For the various terminal types, the following test arrangements apply:

– Solder terminals

The electrical interconnections between the relays are made with rigid conductors with cross-sectional area according to Table 2. The connections of the relay to the voltage or current source(s) are realized with flexible conductors of 500 mm or 1 400 mm length and cross-sectional area according to Table 2.

Table 2 – Cross-sectional areas and lengths of conductors dependent on the current carried by the terminal

Current carried by the terminal A		**Rigid and flexible conductors**	**Flexible conductors**
above	**up to and including**	**Cross-sectional area** mm^2	**Minimum conductor length for testing** mm
-	3	0,5	500
3	6	0,75	500
6	10	1,0	500
10	16	1,5	500
16	25	2,5	500
25	32	4,0	500
32	40	6,0	1 400
40	63	10,0	1 400

– Flat quick-connect terminations

The electrical interconnections between the relays as well as to the voltage or current source(s) shall be made using female connectors (made of nickel-plated steel) according to IEC 61210 and with flexible conductors with length and cross-sectional area according to Table 2 that are soldered in the crimping area.

NOTE This prescription is intended to enable the determination of the flat quick-connect termination of the relay without considerable influence neither from the female connector nor the quality of the crimping.

– Screw-type and screwless-type terminations

The electrical interconnections between the relays are made with rigid conductors with cross-sectional areas according to Table 2. The connections of the relay to the voltage or current source(s) are realized with flexible conductors with length and cross-sectional area according to Table 2.

– Alternative termination types

The electrical interconnections between the relays are made with rigid conductors with cross-sectional areas according to Table 2. The connections of the relay to the voltage or current source(s) are realized with flexible conductors with length and cross-sectional area according to Table 2.

4.18.3 Conditions to be specified

The conditions to be specified are the following:

a) mounting of the relay;
b) value and, if applicable, duration of energization;
c) temperature coefficient of the wire material, if other than electrolytic copper;
d) ambient temperature;
e) contact load, if required;
f) limits of temperature rise for all relay parts specified.

4.19 Rapid change of temperature

4.19.1 Purpose

To determine the ability of the relay to withstand rapid changes of air temperature.

4.19.2 Procedure

The test shall be carried out in accordance with test Na of IEC 60068-2-14.

4.19.3 Conditions to be prescribed

The conditions to be prescribed are the following:

a) temperature extremes and duration;
b) contact load, if required;
c) final measurements:
   - visual inspection as specified in 4.6. There shall be no evidence of corrosion, peeling and chipping, or of mechanical deterioration that could impair operation,
   - insulation resistance as specified in 4.11,
   - contact circuit resistance as specified in 4.12. The contact circuit resistance shall not exceed twice the specified initial value,
   - other final measurements, if required.

4.20 Enclosure

4.20.1 Purpose

To determine the effectiveness of the relay enclosure in regards to either sealing or protection against ingress of dust.

4.20.2 Sealing

4.20.2.1 Procedure

Procedure 1*:* The immersion test shall be carried out in accordance with test Qc, method 1 or 2 of IEC 60068-2-17. Immersion times shorter than 10 min may be specified by the manufacturer. Bubbles shall not exceed the limits given in IEC 60068-2-17.

Procedure 2*:* The helium detection test shall be carried out in accordance with test Qk, method 1 or 2 of IEC 60068-2-17. Where procedure 2 is used and the existence of a gross leak cannot be ruled out, it shall be followed by procedure 1.

NOTE The helium leak rate is not equal to the leak rate of the gases normally used within sealed relays.

If the time interval between sealing and testing has been more than 48 h, the relay shall be exposed to an atmosphere of helium at high pressure.

The difference pressure and the duration of exposure shall be as prescribed by the manufacturer.

After the exposure, the absorbed helium shall be cleaned from the surface as prescribed by the manufacturer.

The leak rate shall not exceed the value specified by the manufacturer in accordance with IEC 60068-2-17.

Procedure 3: This test (pressure rise) shall be carried out in accordance with test Qy of IEC 60068-2-17.

4.20.2.2 Conditions to be prescribed

The conditions to be prescribed are the following:

a) procedure or sequence of procedures, and methods in them;
b) procedure 1: immersion time if different from 10 min;
c) procedure 2: severity if different from 1 000 h;
d) absolute immersion pressure, if required;
e) free internal volume V (cm^3);
f) procedure 3: maximum leak rate, or time constant.

4.20.3 Dust protection

4.20.3.1 Procedure

This test shall be carried out in accordance with test La2 of IEC 60068-2-68. The non-operated relay shall be mounted in the test chamber as specified by the manufacturer. The air pressure within the relay shall be that of the ambient air pressure in the test chamber (category 2 enclosure), unless otherwise prescribed by the manufacturer. The relay shall be subjected to talc (hydrated magnesium silicate) for 8 h. After a recovery period of 2 h under normal atmospheric conditions and after cleaning (removal of external surface dust), the function of the relay shall not be impaired.

4.20.3.2 Conditions to be specified

The conditions to be specified are the following:

a) pressure reduction inside the relay, if required;
b) position of the relay, if other than normal operating position;
c) final measurements
   - functional tests as specified in 4.13;
   - dielectric test as specified in 4.9;
   - any other measurement, if required.

4.21 Internal moisture

This test is only applicable to RT III, RT IV and RT V relays.

4.21.1 Purpose

To determine whether internal moisture has an adverse effect on certain properties of the relay.

4.21.2 Procedure

Method 1: The relay coil shall be energized as specified by the manufacturer while the relay is under its maximum rated operating temperature for 1 h, and then under the minimum rated operating temperature for one additional hour. At the end of the low temperature exposure, the coil shall be de-energized or, for bistable relays, rated release voltage shall be momentarily applied. It shall be verified that the contact(s) has (have) changed over.

Method 2: The relay coil shall be energized at room temperature at 140 % of its rated energization value for 2,5 min: the insulation resistance between all contacts and the relay enclosure shall be monitored at 30 s intervals. None of the readings shall be lower than the value prescribed by the manufacturer.

4.21.3 Conditions to be prescribed

The conditions to be prescribed are the following:

a) method 1 or 2, or both;
b) energization value(s);
c) method 1:
   1) maximum and minimum rated operating temperature,
   2) contact load for change-over verification;
d) method 2: limit value of insulation resistance.

4.22 Corrosive atmospheres

4.22.1 Salt mist

4.22.1.1 Purpose

To assess the suitability of the relay for use and/or storage in a salt-laden atmosphere.

4.22.1.2 Procedure

The test shall be carried out in accordance with test Ka of IEC 60068-2-11. Upon completion of the exposure period, the relay shall be removed from the chamber and exposed to the recovery conditions specified by the manufacturer.

4.22.1.3 Conditions to be specified

The conditions to be specified are the following:

a) recovery conditions;

b) final measurements:

- visual inspection as specified in 4.6. There shall be no evidence of corrosion, peeling and chipping, or of mechanical deterioration that could impair operation,
- insulation resistance as specified in 4.11. The initial limit shall apply.

4.22.2 Polluted atmospheres

4.22.2.1 Purpose

To assess the resistance of a relay to atmospheres polluted with sulphur dioxide or hydrogen sulphide.

4.22.2.2 Procedure

The test shall be carried out in accordance with the sulphur dioxide test according to test Kc of IEC 60068-2-42 and/or with the hydrogen sulphide test according to test Kd of IEC 60068-2-43. There shall be no preconditioning, unless otherwise specified. The initial value of the contact circuit resistance of all relay contacts shall be measured. Then the non-energized relay (without any electrical contact load) is placed in the test chamber and kept in the polluted atmosphere for a period as specified by the manufacturer. After a recovery period of not more than 24 h, the contact circuit resistance of all contacts is measured. Its value shall not exceed twice the initial value.

4.22.2.3 Conditions to be specified

The conditions to be specified are the following:

a) test Kc or Kd, or both;

b) preconditioning, only if required;

c) initial value(s) of contact circuit resistance as specified in 4.12;

d) duration of the test (chosen from 4, 10 or 21 days);

e) final measurements:

- contact circuit resistance value(s) as specified in 4.12. The contact circuit resistance value(s) shall not exceed twice the specified initial value(s),
- any other measurements if required.

4.23 Mould growth

4.23.1 Purpose

To assess the extent of mould growth on a relay, or the effect of mould growth on the function of a relay.

4.23.2 Procedure

The test shall be carried out in accordance with test J of IEC 60068-2-10, and – regarding test duration, initial measurements and final examination – as specified by the manufacturer.

4.23.3 Conditions to be specified

The conditions to be specified are the following.

All details following items a) to h) of Clause 13 of IEC 60068-2-10.

4.24 Robustness of terminals

4.24.1 Purpose

To determine the ability of terminals to withstand direct axial pulls, bending or twisting, and nuts and threaded terminals to withstand torques likely to be experienced during normal assembly operations.

4.24.2 Procedure

Terminals shall be subjected to test Ua_1, Ua_2, Ub, Uc, Ud or Ue (for SMD terminals) of IEC 60068-2-21, as appropriate.

Screw terminals and screwless terminals shall be tested as specified in IEC 60999-1.

Flat quick-connect terminations shall be tested as specified in IEC 61210.

A minimum of three terminals shall be tested.

4.24.3 Conditions to be specified

The conditions to be specified are the following:

a) applicable tests of IEC 60068-2-21, or IEC 60999-1, or IEC 61210, and corresponding loads;

b) number of terminals to be tested, if different from three

final measurements:

- visual inspection as specified in 4.6,
- coil resistance as specified in 4.8.1,
- contact circuit resistance as specified in 4.12,
- other final measurements, if required.

4.25 Soldering

This test is applicable only to relays with solder terminals

4.25.1 Purpose

To determine the ability of relay terminals to wet easily with solder, and/or the ability of the relay to withstand soldering heat.

4.25.2 Procedure

Prior to the tests, printed wiring terminals shall be fitted with a (1,5 ± 0,5) mm thick thermal screen, and shall be immersed no further than the underside of that screen.

Test 1: Solderability (except SMD). The test shall be conducted in accordance with the procedures for solderability described in method 1, 2 or 3 as applicable of test Ta of IEC 60068-2-20, as specified by the manufacturer.

Test 2: Resistance to soldering heat (except SMD). The test shall be conducted in accordance with one of the procedures for resistance to soldering heat of test Tb of IEC 60068-2-20, as specified by the manufacturer.

Test 3: Solderability – surface mounting terminals. The test shall be conducted in accordance with the methods for wetting in IEC 60068-2-58, as prescribed by the manufacturer.

Test 4: Resistance to soldering heat – surface mounting terminals. The test shall be conducted in accordance with the methods in IEC 60068-2-58, as prescribed by the manufacturer.

4.25.3 Conditions to be specified

The conditions to be specified are the following:

a) test 1 or 2 (or both), or test 3 or 4 (or both) respectively, and the methods in either of them; severities (duration and temperatures) and other details for those methods;
b) test 1 and 3: ageing/preconditioning procedures, if required;
c) number of terminals to be inspected;
d) final measurements:
   - visual inspection as specified in 4.6 for test 1 extended by examination of the solder wetting; or as specified (for SMD) in Annex A of IEC 60068-2-58 respectively,
   - coil resistance as specified in 4.8.1,
   - sealing test for sealed relays (RT III to RT V),
   - other final measurements as required.

4.26 Shock

4.26.1 Purpose

To prove the capability of the relay to function during and/or after non-repetitive shocks encountered in service or during transportation.

4.26.2 Procedure

The test shall be conducted in accordance with test Ea of IEC 60068-2-27.

4.26.2.1 Method 1: Capability to function during shocks. During this test, the relay shall be subjected to one series of shocks while being in its operate condition (in case of monostable relays energized at rated coil voltage unless otherwise specified) and one further series while being in its release/reset condition. Both series of tests shall be performed in both directions of each of the three mutually perpendicular axes.

During the test, the contact action shall be monitored. No opening or closing of any closed or opened contact circuit respectively shall exceed 10 µs unless another value is specified, both while the relay is in operate condition and in release condition.

The contact load shall be as prescribed.

4.26.2.2 Method 2: Capability to function after shocks. During this test, the relay shall be subjected to a series of shocks in both directions of each of the three mutually perpendicular axes. The relay shall not be energized, and the contacts shall not be monitored.

4.26.3 Conditions to be specified

The conditions to be specified are the following:

a) method 1 or 2;

b) pulse shape, peak acceleration and duration shall be chosen from Table 1 of IEC 60068-2-27, with a half-sine wave of 11 ms as preferred pulse shape;

c) number of shocks if different from those given in IEC 60068-2-27;

d) method of mounting of the relay direct on the shaker plate as prescribed by the manufacturer;

e) permitted duration of opening or closing, if other than 10 µs and details of monitoring device;

f) method 1:

- energization value, preferably the lower limit of the operative range (for monostable and bistable relays),
- contact load;

g) final measurements:

- visual inspection as specified in 4.6,
- functional test as specified in 4.13,
- method 1: Contact circuit resistance as specified in 4.12: initial value,
- method 2: Contact circuit resistance as specified in 4.12. The resistance shall not exceed twice the initial specified value,
- other final measurements, if required.

4.27 Bump

4.27.1 Purpose

To prove the capability of the relay to function during and/or after repetitive bumps encountered in service or during transportation.

4.27.2 Procedure

The test shall be conducted in accordance with test Eb of IEC 60068-2-29, at a peak acceleration as specified.

Method 1: Capability to function during bumps. During this test, the relay shall be subjected to one half of the total number of bumps while being in its operate condition (in case of monostable relays energized at rated coil voltage unless otherwise specified) and the other half of the total number of bumps while being in its release/reset condition. Both series of tests shall be performed in both directions of each of the three mutually perpendicular axes.

During the test, the contact action shall be monitored. No opening or closing of any closed or opened contact circuit respectively shall exceed 10 µs unless another value is specified, both while the relay is in operate condition and in release condition.

The contact load shall be as specified.

Method 2: Capability to function after bumps. During this test, the relay shall be subjected to the required number of bumps in each direction of the three mutually perpendicular axes. The relay shall not be energized and the contacts shall not be monitored.

4.27.3 Conditions to be specified

The conditions to be specified are the following:

a) method 1 or 2;

b) peak acceleration and number of bumps;

c) method of mounting of the relay direct on the shaker plate as prescribed by the manufacturer;

d) permitted duration of opening or closing, if other than 10 µs, and detail of monitoring device;

e) method 1:

- energization value, preferably the lower limit of the operative range (for monostable and bistable relays),
- contact load;

f) final measurements:

- visual inspection as specified in 4.6,
- functional test as specified in 4.13,
- method 1: Contact circuit resistance as specified in 4.12: initial value,
- method 2: Contact circuit resistance as specified in 4.12. The resistance shall not exceed twice the initial specified value,
- other final measurements, if required.

4.28 Vibration

4.28.1 Purpose

To prove the capability of the relay to withstand conditions of vibration encountered in service or during transportation.

4.28.2 Procedure

4.28.2.1 Procedure 1: Vibration sinusoidal. This test shall be carried out in accordance with test Fc of IEC 60068-2-6. Subclauses 8.1 (vibration response investigation), followed by 8.2.1 (endurance by sweeping) and finally 8.1 again of IEC 60068-2-6 shall apply.

4.28.2.2 Procedure 2: Vibration, broad-band random (digital control). This test shall be carried out in accordance with test Fh of IEC 60068-2-64, unless another procedure ensuring an equivalent reproducibility is specified by the manufacturer.

4.28.2.3 During vibration, the relay shall be alternately in its operate condition (in case of monostable relays energized at rated coil voltage unless otherwise specified) and in its release/reset condition, the change in condition being synchronized with the completion of each vibration sweep cycle.

During this test, care shall be taken to make sure that the stray field of the vibration generator does not affect the relay.

During the test, the contact action shall be monitored. No opening or closing of any closed or opened contact circuit respectively shall exceed 10 µs unless another value is specified, both while the relay is in operate condition and in release condition.

The relay shall be subjected to vibration in each of three mutually perpendicular axes.

The contact load shall be as specified.

4.28.3 Conditions to be specified

The conditions to be specified are the following:

a) amplitude or acceleration level for procedure 1; acceleration spectral density level and curve shape, and other characteristics given in Clause 11 of IEC 60068-2-64 for procedure 2; duration and frequency range;

b) energization value, preferably the lower limit of the operative range (for monostable and bistable relays);

c) method of mounting of the relay direct on the shaker plate as prescribed by the manufacturer;

d) permitted duration of opening or closing, if other than 10 µs, and details of monitoring;

e) contact load;

f) final measurements:

- visual inspection as specified in 4.6,
- functional test as specified in 4.13,
- insulation resistance as specified in 4.11,
- contact circuit resistance as specified in 4.12. The resistance shall not exceed twice the initial specified value,
- other final measurements, if required;

g) procedure, if other than test procedure 1 and/or procedure 2 of 4.28.2, and required details.

4.29 Acceleration

4.29.1 Purpose

To prove the capability of the relay to function during and/or after being subjected to forces produced by steady acceleration environments (such as moving vehicles, aircraft and projectiles).

4.29.2 Procedure

This test shall be carried out in accordance with test Ga of IEC 60068-2-7.

4.29.2.1 Method 1: Capability to function during acceleration. During this test, the relay shall be in its operate condition (in case of monostable relays energized at rated coil voltage unless otherwise specified) for 50 % of the time of exposure. During the remaining 50 % of the time of exposure, the relay shall be in its release/reset condition. Both exposures shall be performed in both directions of each of the three mutually perpendicular axes.

During the test, the contact action shall be monitored. No opening or closing of any closed or opened contact circuit respectively shall exceed 10 µs unless another value is specified, both while the relay is in operate condition and in release condition.

The contact load shall be as specified.

4.29.2.2 Method 2: Capability to function after acceleration. During this test, the relay shall be subjected to the required acceleration in both directions of each of the three mutually perpendicular axes. The relay shall not be energized, and the contacts shall not be monitored.

4.29.3 Conditions to be specified

The conditions to be specified are the following:

a) method 1 or 2;

b) acceleration and duration if the latter is other than 10 s;

c) method of mounting of the relay direct on the shaker plate as prescribed by the manufacturer;

d) permitted opening or closing time, if other than 10 µs, and details of monitoring device;

e) method 1:

- energization value, preferably the lower limit of the operative range (for monostable and bistable relays),
- contact load;

f) final measurements:

- visual inspection, as specified in 4.6,
- functional test as specified in 4.13,
- method 1: contact circuit resistance as specified in 4.12: initial value,
- method 2: contact circuit resistance as specified in 4.12. The resistance shall not exceed twice the initial specified value,
- other final measurements, if required.

4.30 Electrical endurance

4.30.1 Purpose

To check the performance of the relay under operating conditions and for the number of cycles specified by the manufacturer.

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

4.30.2 Procedure

The test is performed on each contact load and each contact material as specified by the manufacturer.

Relays shall be mounted in the manner intended for normal service; in particular relays for mounting onto printed circuit boards are tested in horizontal position, unless otherwise specified.

All specified devices (for example protective or suppression circuits), if any, which are part of the relay or stated by the manufacturer as necessary for particular contact loads, shall be operated during the test as required.

If required any exposed metallic parts of the relay (with the exception of live parts) shall be connected to the power supply negative and/or neutral point or earthed, via a fuse rated as specified by the manufacturer. The fuse shall not open during the test.

The relay shall be energized at its rated coil voltage or at any appropriate value within its operative range as specified. The test shall be conducted at the ambient conditions prescribed by the manufacturer. Unless otherwise specified the switching action shall not be synchronous with the source of the load circuit, if this is a.c. The frequency of operation and the duty cycle shall be as specified.

The contacts are connected to the load(s) in accordance with Table 3 as specified and indicated by the manufacturer. If not otherwise specified by the manufacturer, any load shall be applied to both make and break side of a change-over contact. The contact loading should be resistive, inductive, capacitive, cable, lamp or motor load – d.c. or a.c. preferably at 50 Hz or 60 Hz.

The relay shall be subjected to the number of cycles specified and the contact action shall be monitored continuously as follows.

During the test, the contact action shall be monitored to detect malfunctions to open and malfunctions to close, as well as unintended bridging (simultaneous closure of make and break side of a change-over contact). A temporary malfunction is an event that has to be eliminated during the test at the latest after one additional energization cycle without any external influence, or as prescribed by the manufacturer.

Three severity levels are specified.

– Severity A: The first detected malfunction is defined as a failure.
– Severity B: The sixth detected malfunction or two consecutive malfunctions are defined as a failure.
– Severity C: As specified by the manufacturer.

When the applicable failure criteria is not met, the relay has not passed the endurance test.

The test circuit described in Annex C shall be used, unless otherwise specified by the manufacturer and explicitly indicated in the test report.

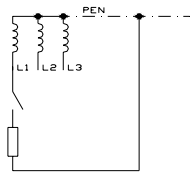
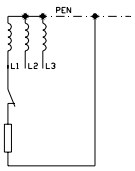
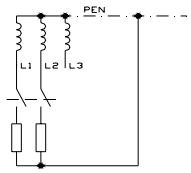
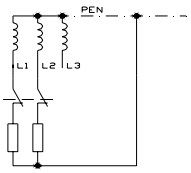
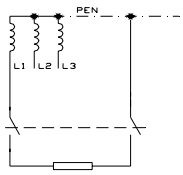
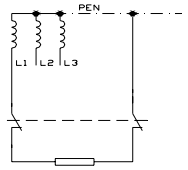
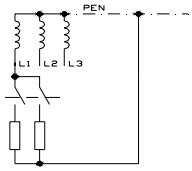
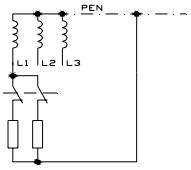
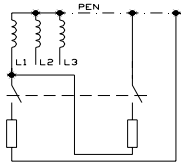
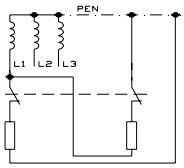
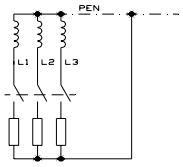
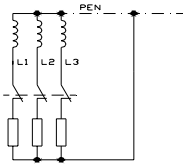
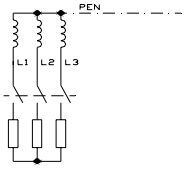
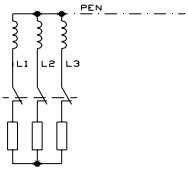
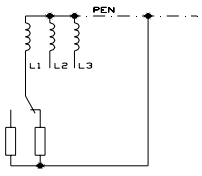
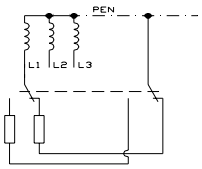
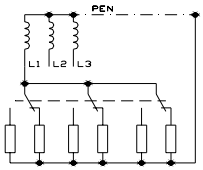
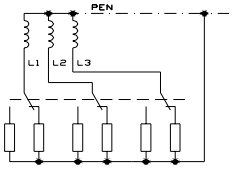
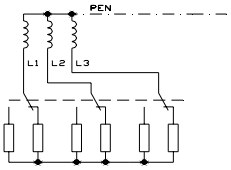
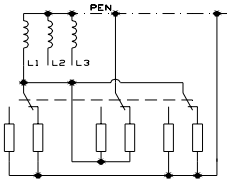
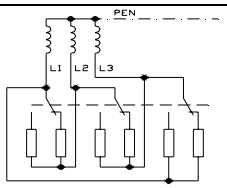
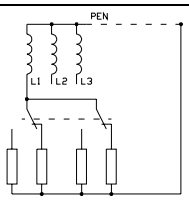
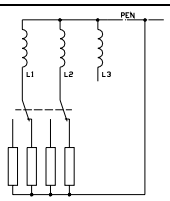
Relays provided with an additional actuating member for manual operation (for example push-button) shall be tested respectively to verify that the relay is capable to switch on and off properly its maximum rated switching current at related voltage for the number of manual operations within a time diagram stated by the manufacturer.

4.30.3 Conditions to be specified

The conditions to be specified are the following:

a) type of relay and contact material;
b) total number of cycles or test duration for each contact and number of contacts to be tested simultaneously;
c) severity level;
d) ambient conditions (particularly ambient temperature);
e) energization value and, if required, frequency;
f) frequency of operation (in number of cycles per hour) and duty factor;
g) protective and transient suppression devices, if required;
h) details of test circuit or checking equipment, adapters, etc., if required, and fuse rating;
i) load: see Annex C or Annex D;
j) final measurements:
   - dielectric test as specified in 4.9 with 75 % of the specified initial value for new condition;
   - any other measurements as specified by the manufacturer.

Table 3 – Schematics for contact loading

Single-pole contact	a 	b 	
Double-pole contact	c 	d 	e 
	f 	g 	h 
	i 	j 	
Multi-pole contact	k 	l 	m 
	n 		
Change-over contact	o 	p 	q 
	r 	s 	t 
	u 	v 	w 
If none of the schematics applies, the manufacturer shall indicate an appropriate one.			

4.31 Mechanical endurance

4.31.1 Purpose

To assess the mechanical performance of relays under rated energization conditions over an extended number of cycles.

4.31.2 Procedure

The relay shall be energized with the rated coil voltage or as otherwise specified, and the test shall be conducted at ambient room temperature. The switching action shall not be synchronous with the source of the monitoring circuit, if this is a.c. The frequency of operation shall be as specified; the relay shall however, attain both the operate and release/reset condition within one cycle.

Method 1: Continuous checking. The mechanical operation of the relay shall be monitored electrically, with all contacts of the same type of the relay permitted to be connected in parallel, using a contact load as specified. The contact load chosen shall ensure reliable monitoring of the performed cycles, while not causing a level of wear of the contact points that might devalue the test. At any time during the test, the accumulated number of malfunctions shall not be greater than that specified by the manufacturer.

Method 2: Intermediate checking. After each 20 % of the mechanical endurance specified, intermediate measurements shall be made as specified.

Method 3: Final checking. After the mechanical endurance specified the final measurements of 4.31.3 shall be carried out.

4.31.3 Conditions to be specified

The conditions to be specified are the following:

a) method 1, 2 or 3;
b) energization value;
c) monitoring voltage and current;
d) number of cycles per hour and duty factor;
e) total number of cycles or test duration for each contact and number of contacts to be tested simultaneously or not;
f) method 1: allowable number of malfunctions;
g) method 2: tests to be performed during intermediate checking, and required results;
h) final measurements:
   - performance of ten operating cycles at rated coil voltage or at the lower limit of the operative range, the opening and closing of the contacts shall be monitored,
   - any other measurement, if required.

4.32 Thermal endurance

4.32.1 Purpose

To assess the effect of high temperature conditions on the relay when energized for long periods.

4.32.2 Procedure

The test shall be carried out at the upper value of the operating temperature range with the relay energized as specified, and with all contacts carrying their limiting continuous currents (maximum loading of the contact set).

4.32.3 Conditions to be specified

The conditions to be specified are the following:

a) method of mounting, and type of sockets used (if applicable);
b) duration (1 000 h minimum);
c) ambient temperature;
d) energization value;
e) intermediate measurements as specified;
f) final measurements:
   - functional tests as specified in 4.13,
   - other final measurements, if required.

4.33 Limiting continuous current

4.33.1 Purpose

To assess the suitability of the contacts to carry the limiting continuous current.

4.33.2 Procedure

The relay terminals shall be connected as given in 4.18.

The coil(s) shall be energized with the rated coil voltage unless otherwise specified (testing in operate condition), and not energized (testing in release/reset condition).

The contacts shall be loaded with a current as specified by the manufacturer for the contact set, until thermal equilibrium is reached.

After this, the relay shall perform ten operating cycles with rated coil voltage; unless otherwise specified, the opening and closing of the contacts shall be monitored.

4.33.3 Conditions to be specified

The conditions to be specified are the following:

a) energization value;
b) limiting continuous current for make contacts;
c) limiting continuous current for break contacts.

4.34 Overload (contact circuit)

4.34.1 Purpose

To assess the performance of a relay when subjected to fault conditions.

4.34.2 Procedure

During the test, the relay mounting face and any exposed metallic parts shall be connected to the power supply negative and/or neutral point or earthed via a fuse rated at 5 % of the maximum switching current, or 100 mA, whichever is the greater, unless otherwise specified.

The number of cycles shall be 50 ± 2 for d.c. contact loads, and 50 ± 2 for a.c. contact loads, unless otherwise specified.

4.34.2.1 DC loads: the relay coil shall be energized as specified and subjected to the appropriate number of cycles specified by the manufacturer at the rated frequency of operation and duty factor, with the contacts switching twice their maximum rated current for a resistive load at their maximum rated voltage, unless otherwise specified.

4.34.2.2 AC loads: the relay coil shall be energized as specified and subjected to the appropriate number of cycles specified by the manufacturer at the rated frequency of operation and duty factor, with the contacts switching twice their maximum rated current for an inductive load at their rated voltage, unless otherwise specified.

4.34.2.3 The relays shall make and break the above loads, and the fuse shall not blow.

4.34.3 Conditions to be specified

The conditions to be specified are the following:

a) method of mounting;

b) energization value, frequency of operation and duty factor;

c) switching current (fault condition), if other than twice the maximum rated current; power factor (cos φ), time constant (L/R) and test circuit details as appropriate;

d) total number of cycles, if other than 50 cycles;

e) any specific operating conditions to enable the relay to meet its performance as declared by the manufacturer and the number of contacts simultaneously loaded;

f) fuse rating if other than 5 % or 100 mA.

4.35 Load transfer

4.35.1 Purpose

To check that a relay with two or more changeover contacts is capable of changing over two (or more) phase systems from one source to another.

4.35.2 Procedure

The relay shall be connected to a suitable test circuit (an example for three-phase systems is shown in Figure 10), the voltage, frequency and load being as prescribed by the manufacturer. During the test, the relay mounting parts and any exposed conductive parts shall be connected to the common point of the load, via a fuse rated at 5 % of the rated load current, or 100 mA, whichever is the greater, unless otherwise specified.

The relay shall be energized as specified, and operated at the frequency of operation and for the number of cycles specified by the manufacturer. Continuous monitoring shall be used to detect phase-to-phase arcing and contact welding. The fuse shall not blow during the test.

Unless otherwise specified, the relay shall be (5 ± 1) s in the operate condition and (5 ± 1) s in the release condition for each cycle.

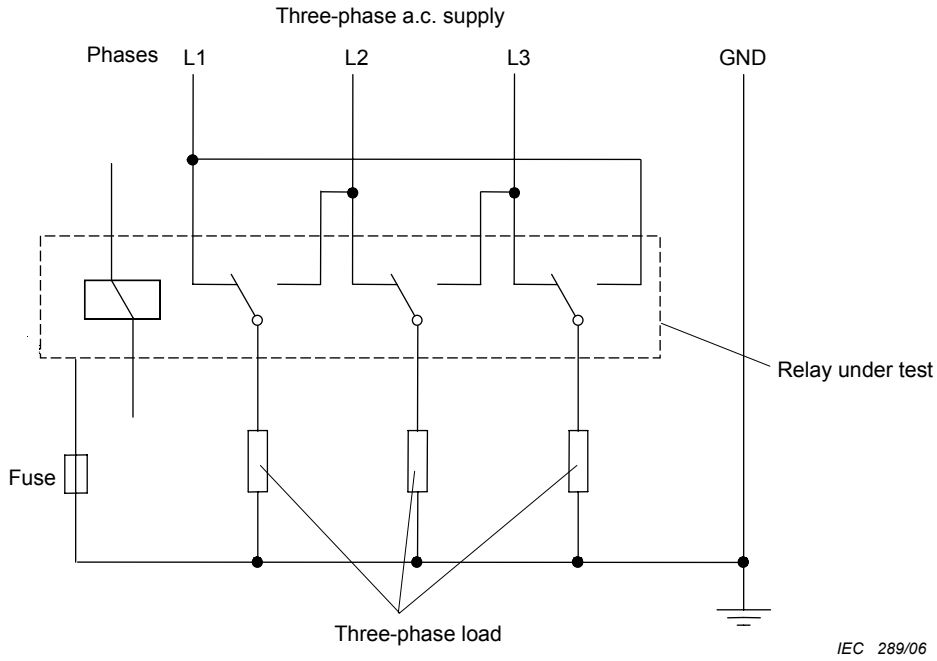


Figure 10 – Test circuit for load transfer

4.35.3 Conditions to be specified

The conditions to be specified are the following:

a) energization value;
b) voltage and frequency of the multi-phase system;
c) load parameters;
d) fuse rating, if other than 5 % or 100 mA;
e) frequency of operation, number of cycles, and times, if other than (5 ± 1) s;
f) final measurements:
   - dielectric test as specified in 4.9,
   - insulation resistance as specified in 4.11,
   - contact circuit resistance as specified in 4.12.

4.36 Electromagnetic compatibility

Electromechanical elementary relays are components intended to be incorporated in an apparatus. Therefore, no EMC requirements and tests apply to such relays, only to the complete apparatus.

NOTE This is in line with the European Directive 89/336/EEC.

4.37 Magnetic interference

4.37.1 Purpose

To check that the values of functional performance of the relay remain within specified limits when the relay is subjected to the effects of external magnetic inductions.

4.37.2 Procedure

Method 1: The relay shall be mounted by suitable non-magnetic means within the central volume of a test coil. The axis of maximum sensitivity of the relay shall be aligned with the longitudinal axis of the test coil. Operate and release values shall be measured, as specified in 4.13 in zero magnetic field in air and

- for magnetically shielded relays: in 8×10^3 A/m;
- for all other relays: in $0{,}8 \times 10^3$ A/m,

magnetic field of both polarities.

Method 2: The relay under test and eight similar relays shall be mounted in the same physical orientation by non-magnetic means, as shown in Figure 11, unless otherwise specified by the manufacturer. Operate and release values of the relay under test shall be measured as specified in 4.13, with the coils of the eight outer relays energized at rated voltage, and with the coils not energized. The magnetic polarity of each relay shall be similarly orientated.

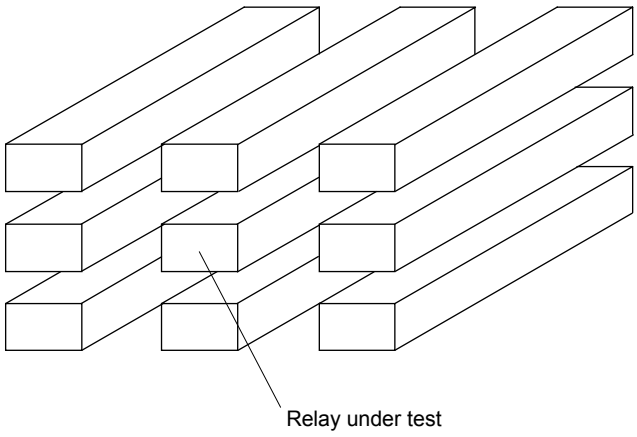
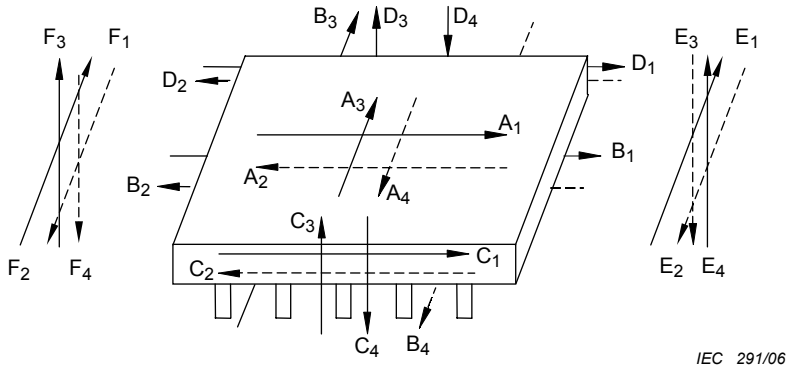


Figure 11 – Mounting array for adjacent similar relays

Method 3: The relay to be tested shall be mounted by non-magnetic means. A conducting wire of 0,5 mm diameter shall be placed on the test relay surface in 24 directions as shown in Figure 12. One current impulse shall be applied in each of these directions. Operate and release values of the relay under test shall be measured as specified in 4.13 in each of the wire positions after the respective current impulse. The following current impulse shall be used, unless otherwise specified by the manufacturer:

- impulse shape: in conformity with the voltage impulses as specified in 4.10;
- test current: 1 kA.



A_1 to F_4 Test current directions

Figure 12 – Directions of the test current for magnetic interference test, method 3

4.37.3 Conditions to be specified

The conditions to be specified are the following:

a) method 1, 2 or 3;
b) method 1: dimensions of the test coil;
c) method 2: mounting grid pattern;
d) method 3:
   - number of current impulses and their frequency, if more than one impulse,
   - impulse shape;
e) any particular procedure, if the above is not applicable;
f) admissible limits of the operate and release/reset values.

4.38 Crosstalk and insertion loss

No requirements at present.

4.39 Electrical contact noise

4.39.1 Purpose

To check that the electrical noise produced by relay contacts in a circuit does not exceed specified limits under specified conditions.

4.39.2 Procedure

The relay is energized at a value(s) as specified by the manufacturer. The relay is subjected to shock and vibration only if explicitly required. The relay contact is inserted in a circuit formed of a resistor(s), and of a voltage source as specified. The noise across the relay contact or across a resistance is measured by an oscilloscope, or by a noise-level meter, with or without a filter inserted, as prescribed by the manufacturer.

4.39.3 Conditions to be specified

The conditions to be specified are the following:

a) energization value(s);
b) shock and/or vibration parameters, if required;
c) test circuit;
d) measuring equipment;
e) limits of noise voltage.

4.40 Thermoelectric e.m.f.

4.40.1 Purpose

To check that the electromotive force (e.m.f.) generated by relay contacts subjected to elevated temperatures does not exceed specified limits.

4.40.2 Procedure

The terminals of a make contact shall be soldered to bare copper wires. The bare copper wires shall be connected to measuring equipment maintained at room temperature. The relay shall be within ±5 K of its maximum permissible operating temperature. The coil shall be energized at its rated voltage. After thermal equilibrium has been reached, or after 4 h, whichever is the shorter, the voltage across the bare copper wires shall be measured.

4.40.3 Conditions to be specified

The conditions to be specified are the following:

a) method and material for soldering;
b) ambient temperature of the test chamber;
c) limits of e.m.f.

4.41 Capacitance

4.41.1 Purpose

To check that the capacitances formed by parts of the relay do not exceed specified limits.

4.41.2 Procedure

The capacitances shall be measured by means of a measuring bridge, at a frequency of 1 kHz, and at a voltage not exceeding 10 V, unless otherwise specified by the manufacturer.

4.41.3 Conditions to be specified

The conditions to be specified are the following:

a) measuring frequency and voltage, if other than 1 kHz and 10 V;
b) points of measurement(s) and points to be earthed;
c) limiting value(s) of capacitances.

4.42 Contact sticking (delayed release)

4.42.1 Purpose

To check that closed contacts of a relay do not fail to open within a specified time, due to, for example, effects of remanence, chemical effects, or high temperature.

4.42.2 Procedure

The relay shall be energized for 24 h at the upper limit of its operative range, beginning at room temperature.

Within 1 h after the beginning, the temperature shall be increased to and maintained for the remaining time at the maximum operating temperature. No load shall be applied to the contacts. At the end of this period, without physically disturbing the relay, the coil shall be de-energized, and the release time shall be measured as in 4.14.

4.42.3 Conditions to be specified

The conditions to be specified are the following:

a) upper limit of the operative range;

b) limit of release time;

c) maximum operating temperature.

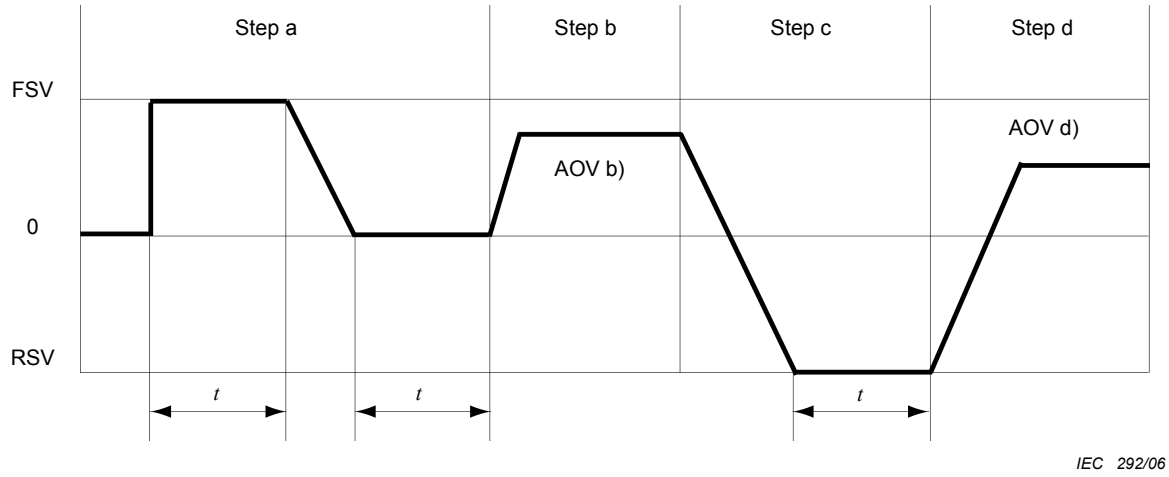
4.43 Magnetic remanence

4.43.1 Purpose

To check that the effect of remanence in the magnetic circuit, from one cycle to the next, does not exceed the specified limits.

4.43.2 Procedure

This test is only applicable to monostable relays with d.c. energization. Influences of external fields shall remain constant during the test. Contact circuits shall be monitored throughout the test for failure to make or to break at the appropriate values of energization. For the energization, current values only shall be considered so as to avoid effects of changes in coil resistance. The test is carried out in four steps, as follows (see Figure 13):



Key

FSV	Forward saturate value
RSV	Reverse saturate value
t	20 ms unless otherwise specified
AOV b)	Actual operate value b)
AOV d)	Actual operate value d)

Figure 13 – Sequential diagram for magnetic remanence test

a) the relay is energized at a specified saturate value and, unless otherwise specified, for a period of at least 20 ms. The relay shall then be in operate condition. The energization shall then be reduced to zero, and shall remain at zero for at least a further 20 ms. The relay shall now be in release condition;

b) the energization value shall be increased from zero, at the same polarity as under step a), until the relay operates, and the actual operate value shall be measured;

c) the energization shall be reduced and changed from the actual operate value through zero to the specified reverse saturate value, and shall, unless otherwise specified, remain at that value for at least 20 ms;

d) the energization shall be reduced and changed from the reverse saturate value through zero until, at the same polarity as under steps a) and b), the relay operates and the actual operate value shall be measured again.

The remanence rate, as a percentage, is equal to:

$$100 \times \frac{\text{actual operate value b)} - \text{actual operate value d)}}{\text{actual operate value b)}}$$

It shall not exceed the value specified.

4.43.3 Conditions to be specified

The conditions to be specified are the following:

a) saturate value and reverse saturate value and duration of application, if other than 20 ms;

b) criteria for contact making and, if necessary, for contact breaking;

c) limits of remanence rate.

4.44 Acoustic noise

4.44.1 Purpose

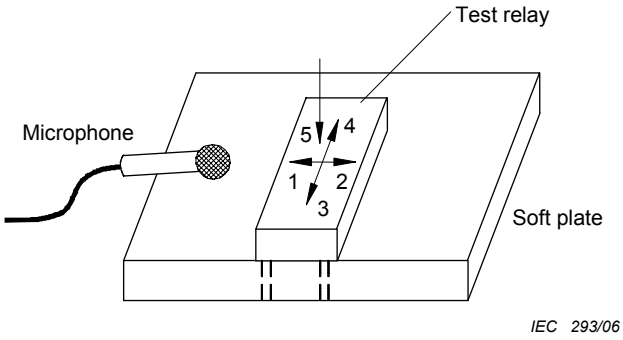
Test for noise emission: to ensure that the operating, releasing and cycling noise of the relay is within the specified limits. The test is preferably applicable for automobile and telecom relays.

Test for noise immunity: to prove the capability of the relay to function when subjected to external noise. The test is preferably applicable for aircraft relays.

4.44.2 Procedure

Test for noise emission: The relay shall be placed on a soft plate (for example sponge) as shown in Figure 14. The acoustic noise shall be measured using a class 2 sound level meter according to the requirements of IEC 61672-1 while the relay is energized, not energized and cycled. The test shall be performed by applying the following:

- relay coil voltage: rated voltage;
- relay energization: operate condition, release condition and cycling condition with 10 cycles per second;
- relay coil: without suppression diode or/and with suppression diode;
- distance between relay and microphone: 5 cm, or 10 cm, or as specified;
- measuring direction: all five directions (see Figure 14), or the most critical one as specified by the manufacturer;
- frequency weighting according to IEC 61672-1: A;
- background noise: at least 10 dB lower than the relay noise level specified;
- relay noise levels: as specified by the manufacturer.



1, 2, 3, 4 and 5: Test directions

Figure 14 – Installation for the test for acoustic noise emission

Test for noise immunity: The relay, positioned in a sound absorbing chamber, shall be subjected to a noise of:

A = 140 dB,

B = 150 dB or

C = 160 dB

each +6 dB in the frequency range of 20 Hz up to 2 000 Hz for 1 h.

During this time, the relay coil shall be energized for 30 min and then de-energized for 30 min. No opening or closing of any closed or opened contact respectively shall exceed 10 µs unless another value is prescribed by the manufacturer, both while the relay is in operate condition and in release condition.

4.44.3 Conditions to be specified

The conditions to be specified are the following:

a) test for noise emission and/or noise immunity;

b) test for noise emission:
   - coil voltage, if other than rated voltage,
   - relay energization, if other than stated in 4.44.2,
   - suppression diode, if applicable,
   - distance between tested relay and microphone,
   - measuring directions, if other than stated in Figure 14,
   - limit of relay noise level;

c) test for noise immunity:
   - coil voltage,
   - suppression diode, if applicable,
   - noise level A, B or C.

4.45 Continuity of protective earth connection

4.45.1 Purpose

To ensure that the connection between an earth terminal and parts required to be connected thereto is of low resistance. This test applies only to relays suitable to be connected to mains circuits and which are provided with a protective earth terminal.

4.45.2 Procedure

A current of 1,5 times the rated current, but not less than 25 A, and derived from an a.c. source with a no-load voltage not exceeding 12 V, is passed between the earth terminal and each of the parts, in turn. The voltage drop between the earth terminal and the part is measured, and the resistance calculated from the current and this voltage drop. In no case shall the resistance exceed 0,1 Ω, unless a different value is specified by the manufacturer. The test is continued until steady conditions have been established.

NOTE Care should be taken that the contact resistance between the tip of the measuring probe and the metal part under test does not influence the test results.

4.45.3 Conditions to be specified

The conditions to be specified are the following.

Limit of resistance, if other than 0,1 Ω.

4.46 Fluid contamination

4.46.1 Purpose

To ensure that the relay is suitable for use when subjected to contamination by fluids found in aerospace applications and similar. This test applies to RT III to RT V relays only.

4.46.2 Procedure

The relay shall be freely suspended in a test chamber in which the temperature shall be maintained as stated in Table 4. It shall be sprayed with the fluid selected from that table, so that it is thoroughly wetted. It shall be kept in the chamber at the stated temperature for not less than 48 h. The relay shall then be removed from the chamber and allowed to regain room temperature.

A separate relay shall be used for each test fluid.

Table 4 – Test fluids and temperatures of tests

Fluid represented	Test fluid	Temperature of test °C
Fuel	70 % iso-octane and 30 % toluene by volume	20 ± 5
Hydraulic fluid	a) 80 % ethylene glycol monoethyl ether and 20 % castor oil by volume	50 ± 2
	b) Ester based synthetic hydraulic fluid	70 ± 2
	c) Silicone based (high temperature) hydraulic fluid	70 ± 2
Lubricating oil	Ester based lubricating oil	100 ± 2

4.46.3 Conditions to be specified

The conditions to be specified are the following:

a) test fluid or fluids;
b) any deviations from the above procedure;
c) any permitted degradation during the final tests;
d) final measurements:
   - visual inspection as specified in 4.6,
   - dielectric test as specified in 4.9,
   - insulation resistance as specified in 4.11,
   - operate and release values as specified in 4.13,
   - sealing, if applicable, as specified in 4.20.2.

4.47 Resistance to cleaning solvents

4.47.1 Purpose

To insure that the relay marking remains legible after immersion in cleaning solvents and that no damage, as visually determined, has occurred.

4.47.2 Procedure

The test shall be conducted in accordance with test XA of IEC 60068-2-45, method 1 or 2. The relay shall be totally immersed in a specified solvent at the temperature prescribed by the manufacturer. The following solvent shall be used, but other solvents may be specified:

- demineralized or distilled water having a resistivity of not less than 500 Ωm corresponding to a conductivity of 2 mS/m. The solvent shall not be agitated during the test.

4.47.3 Conditions to be specified

The conditions to be specified are the following:

a) solvent(s) to be used;
b) solvent temperature:
   - for demineralized or distilled water: (55 ± 5) °C,
   - for any other solvent, the required temperature;
c) method 1 or 2 of test XA, and rubbing material for method 1;
d) recovery time before final measurements, if required;
e) final measurements:
   - for all relays: visual inspection of the marking as specified in 4.6,
   - for RT III to RT V relays, in addition: functional tests chosen from 4.13, if required.

Warning: When performing these tests with other solvents, suitable precautions should be taken.

4.48 Fire hazard

4.48.1 Purpose

To ensure that under defined conditions the relay will not cause ignition of parts, or that a combustible part ignited by the test has a limited duration or extent of burning, without spreading fire by flames or burning/glowing particles falling from the specimen.

4.48.2 Procedure

The testing shall be conducted in accordance with one or both of the following tests.

- Glow-wire test as described in IEC 60695-2-10, IEC 60695-2-11, IEC 60695-2-12 and IEC 60695-2-13 as appropriate;
- Needle flame test as described in IEC 60695-11-5.

The conditions of the test and the criteria of failure shall be as prescribed in Annex B.

4.48.3 Conditions to be specified

The conditions to be specified are the following:

a) test in accordance with IEC 60695-2-10, IEC 60695-2-11, IEC 60695-2-12, IEC 60695-2-13 and/or IEC 60695-11-5;
b) all conditions required according to the provisions of Annex B.

4.49 Temperature rise at rated load

4.49.1 Purpose

To check that the relay terminals do not exceed a given temperature rise, with the relay permanently energized and the contact(s) loaded with maximum rated resistive load.

4.49.2 Procedure

This test shall be performed at the maximum ambient temperature and altitude (if applicable) specified for the class of relays being tested.

During the first 3 h of this test, the relay coil shall not be energized. Break contacts shall be loaded with the highest rated resistive load.

During the next portion of the test, the coil of the relay shall be energized continuously for 97 h. The coil voltage shall be set to the maximum specified value. Make contacts shall carry the highest rated resistive current at any convenient voltage.

Immediately following the operating period and with the relay still at the specified temperature, the relay shall be tested to determine that the energized function is completed when operate voltage is applied. Terminal temperature rise shall be monitored throughout the test.

4.49.3 Condition to be specified

The condition to be specified is the following:

Maximum permissible temperature rise of the terminals.

4.50 Mechanical interlock

4.50.1 Purpose

To verify that with one contact assembly held in the closed position, the other contact assembly will not close when the respective coil is energized. Applies to relays with dual coil circuits and a built-in mechanical interlock.

4.50.2 Procedure

With one contact assembly maintained in the closed position (either by applying maximum operating voltage to the respective coil, or by mechanical means), maximum operating voltage shall be applied to the actuating coil of the opposing contact assembly for 200 operating cycles. The operating cycle shall consist of 0,5 s ‘ON’ and 2,5 s ‘OFF’. The condition of the contacts shall be monitored. The opposing contact assembly shall not close.

4.50.3 Conditions to be prescribed

The conditions to be specified are the following:

a) any deviations from the above test procedure;

b) details of mechanical means to keep one contact circuit closed, if applicable.

4.51 Insertion and withdrawal force (mating relay and socket)

4.51.1 Purpose

To measure the insertion and withdrawal forces of the mating relay and socket.

4.51.2 Procedure

The insertion and withdrawal forces of the mating relay and socket shall be tested as specified in Test 13b (Clause 2) of IEC 60512-7.

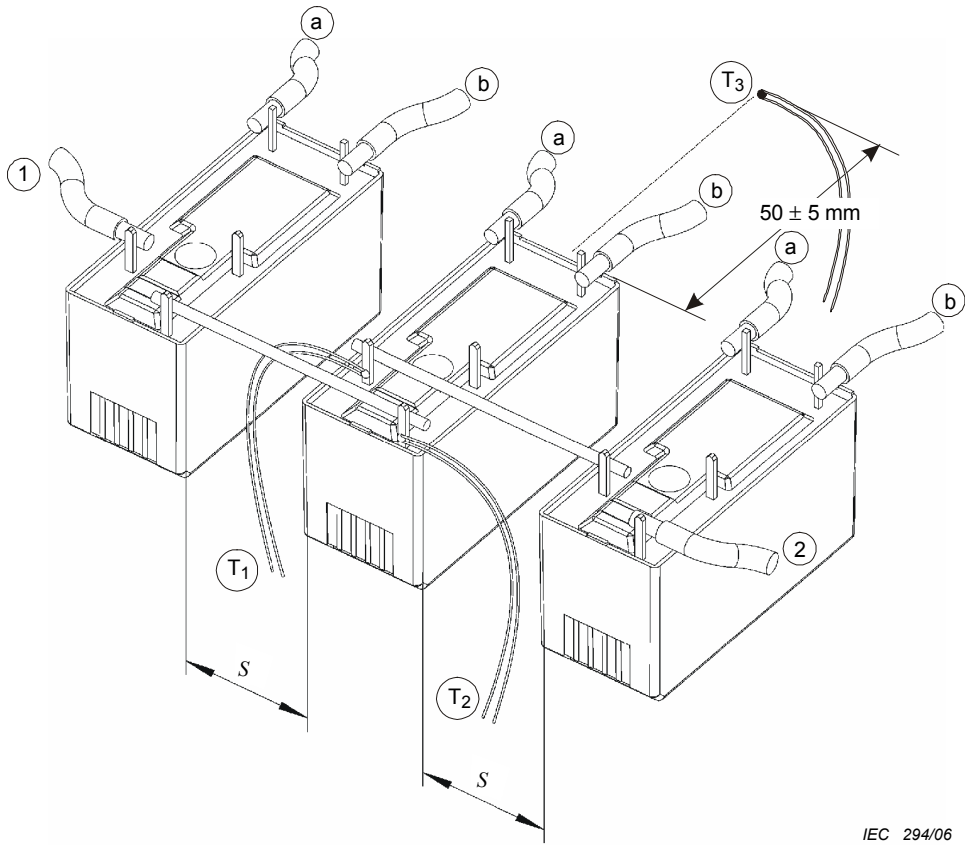
4.51.3 Conditions to be prescribed

The conditions to be specified are the following:

a) maximum insertion force;
b) maximum and minimum withdrawal force;
c) number of insertion and withdrawal cycles;
d) speed rate of insertion and withdrawal, if necessary;
e) description of test groups, if applicable;
f) description of test unit, if applicable;
g) description of the lubricant, if applicable.

Annex A
(normative)

Heating test arrangement



Components

1, 2	contact terminals
T_i , T_2, T_3	thermocouples
a, b	coil terminals
S	mounting distance

The test point for measuring the ambient temperature shall be in that horizontal plane defined by the axis of the centre relay. The distance from the coil side of the relay shall be (50 ± 5) mm.

Figure A.1 – Test arrangement

The test shall be made as indicated in Figure A.1 with the terminals pointing downward, however, and on an insulating plate.

In particular cases, the manufacturer may submit the relays mounted on pc board as in actual use. All relevant details of the test arrangement (for example material and thickness of the pc board, width and thickness of the conductors on the board, plating or coating (if applicable), length and cross-sectional area of external conductors) are to be indicated in the test report.

NOTE Soldering should be carried out with adequate tools and care.

Annex B
(normative)

Fire hazard testing

B.1 Glow-wire test

In IEC 60695-2-10, IEC 60695-2-11, IEC 60695-2-12 and IEC 60695-2-13, the glow-wire tests are specified, simulating the effect of thermal stress which can be produced by heat sources such as glowing parts and overloaded components, in order to assess the risk of fire.

The tests described in those standards are applicable mainly to electrotechnical equipment, their subassemblies and components, but may also be used for solid insulating materials and other combustible materials.

The following applies for this standard.

Relays shall be submitted to the test procedure specified in IEC 60695-2-11 for end-products.

Materials shall be tested in accordance with the provisions given in either IEC 60695-2-12 or IEC 60695-2-13.

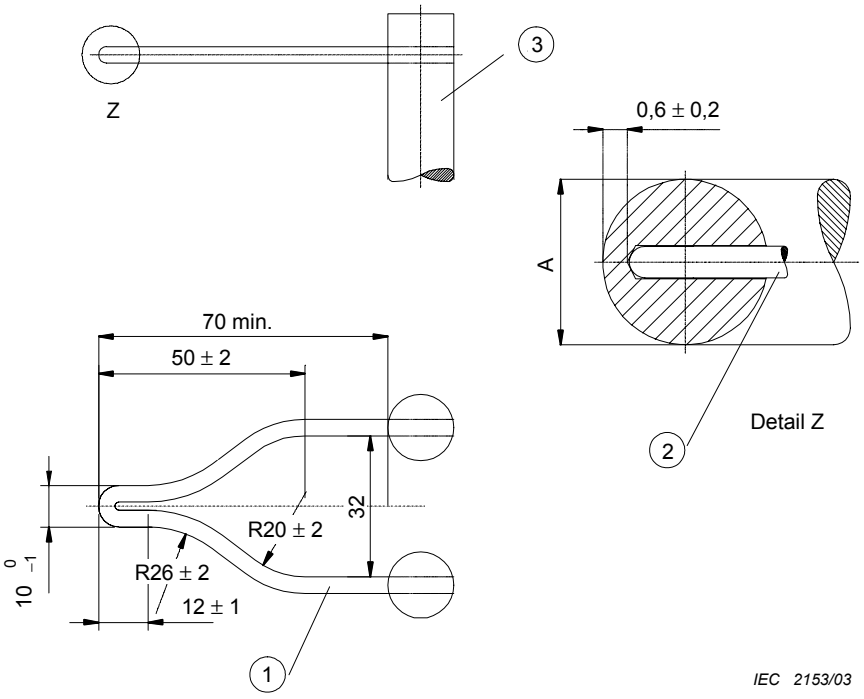
The test conditions as required by the applicable part of IEC 60695-2 shall be specified by the manufacturer.

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

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

When the relay is either too small or of an inconvenient shape to carry out the test, the test is made using a specimen of the respective material from which the relay is manufactured. This specimen shall have an appropriate shape of 60 mm × 60 mm minimum and a thickness of not more than 3 mm. The dimensions shall be indicated in the test report.

Dimensions in millimetres



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

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

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

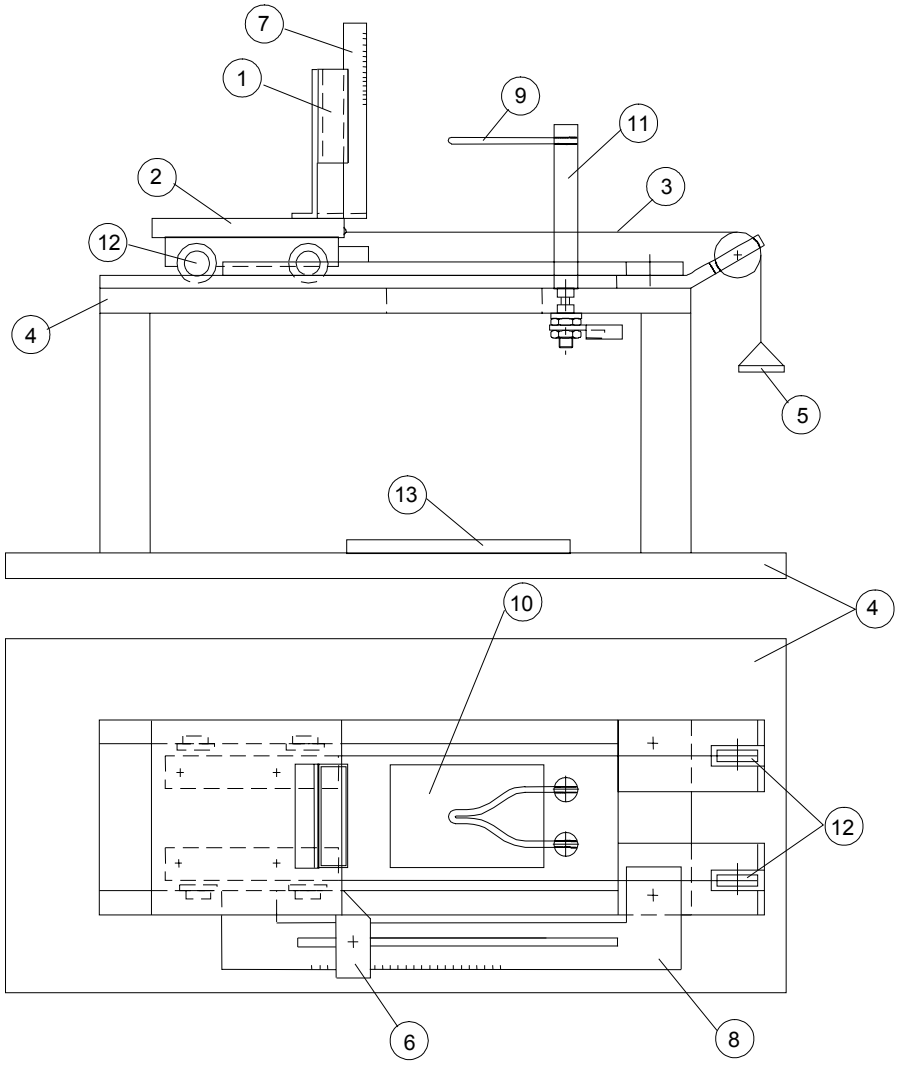
Key

1 glow-wire

2 thermocouple

3 stud

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



Key

1 test specimen support
2 carriage
3 tensioning cord
4 base plate
5 weight
6 adjustable stop
7 scale to measure height of flame
8 penetration adjustment
9 glow-wire
10 cut-out in base plate for falling particles
11 glow-wire mounting stud
12 low-friction rollers
13 specified layer

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

B.2 Needle flame test

The purpose of the needle flame test is to assess the fire hazard of electrotechnical equipment, its subassemblies and components, and of solid insulating materials and other combustible materials through simulation of the effect of small flames which may result from fault conditions within the equipment.

The needle flame test is carried out in accordance with IEC 60695-11-5.

For the purpose of this standard, the following applies:

The test arrangement is shown in Figure B.3.

The specimen is stored for 24 h in an atmosphere having a temperature between 15 °C and 35 °C and a relative humidity between 45 % and 75 % before starting the test.

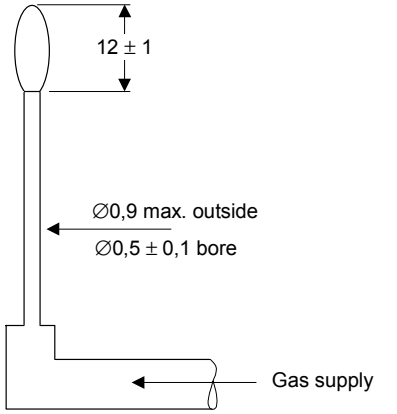
The duration of application of the test flame on the specimen is (30 + 1) s. For relay volumes up to 1 000 mm^3 a reduction to (10+1) s may be chosen, however.

At the beginning of the test, the test flame shall be positioned so that at least the tip of the flame is in contact with the surface of the specimen. During the test, the burner must not be moved. The test flame is removed immediately after the specified time.

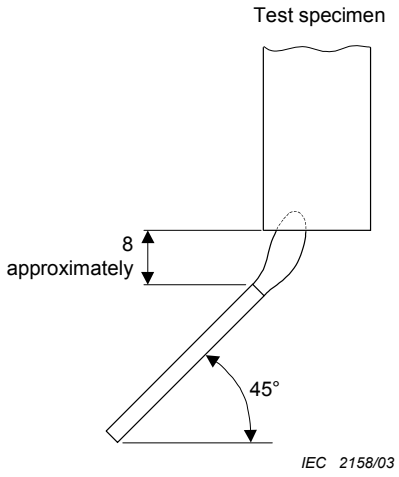
The test is carried out on one specimen. If the specimen does not pass the test, it is repeated on two additional specimens, both of which shall pass the test.

The tissue paper shall not ignite, and the white pinewood board shall not show traces of burning; changes in colour of the white pinewood board are ignored.

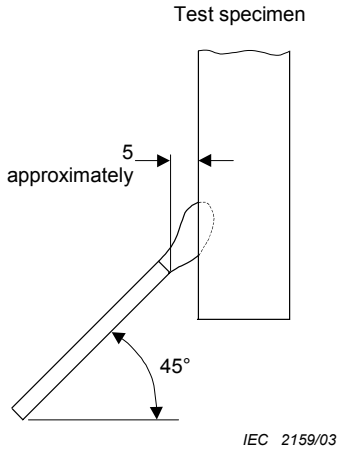
Dimensions in millimetres



a) Flame adjustment



b) Test position (example)



c) Test position (example)

Figure B.3 – Needle flame test details

Annex C
(normative)

Test circuit for endurance tests

C.1 Test circuit

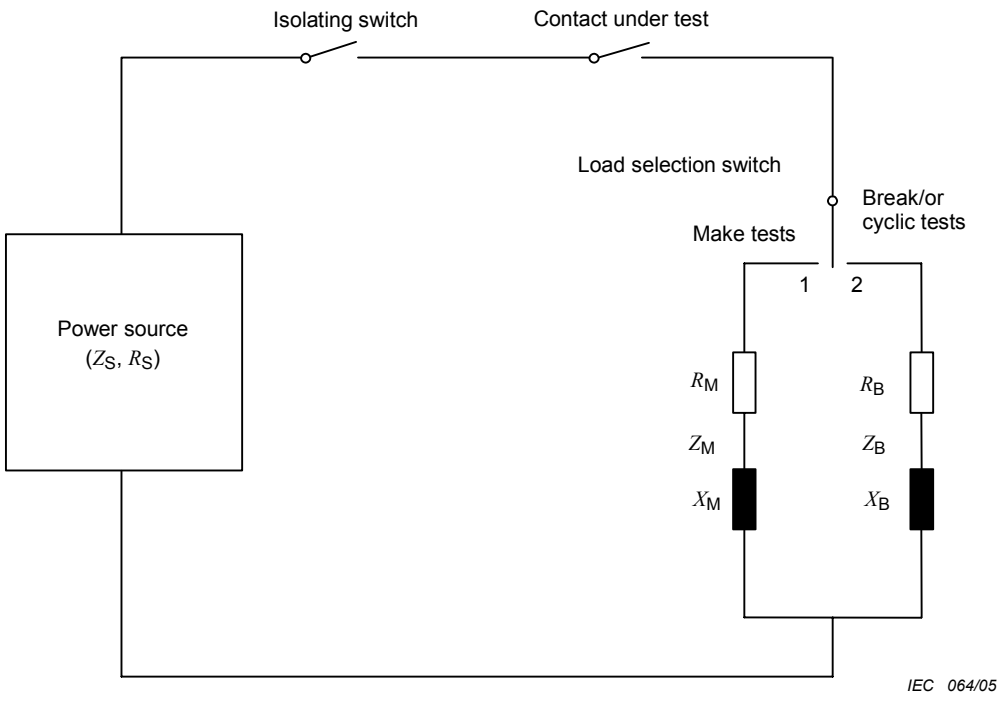
A generalized test circuit is given in Figure C.1 and a functional block diagram in Figure C.2.

NOTE The isolating switch, the load selection switch and the contact under test must be sequenced appropriate to the test conditions specified.

The characteristics indicated in Tables C.1 and C.2 apply, unless otherwise specified.

The test conditions given in 4.30 apply.

The declared value of the current shall be expressed in terms of the steady state (r.m.s. if a.c.) value of current in the contact circuit.



Contact categories 0 and 1	Contact category 2
Z_s < 0,02 $Z_{M,B}$ (a.c.)	Z_s < 0,05 $Z_{M,B}$ (a.c.)
R_s < 0,02 $R_{M,B}$ (d.c.)	R_s < 0,05 $R_{M,B}$ (d.c.)

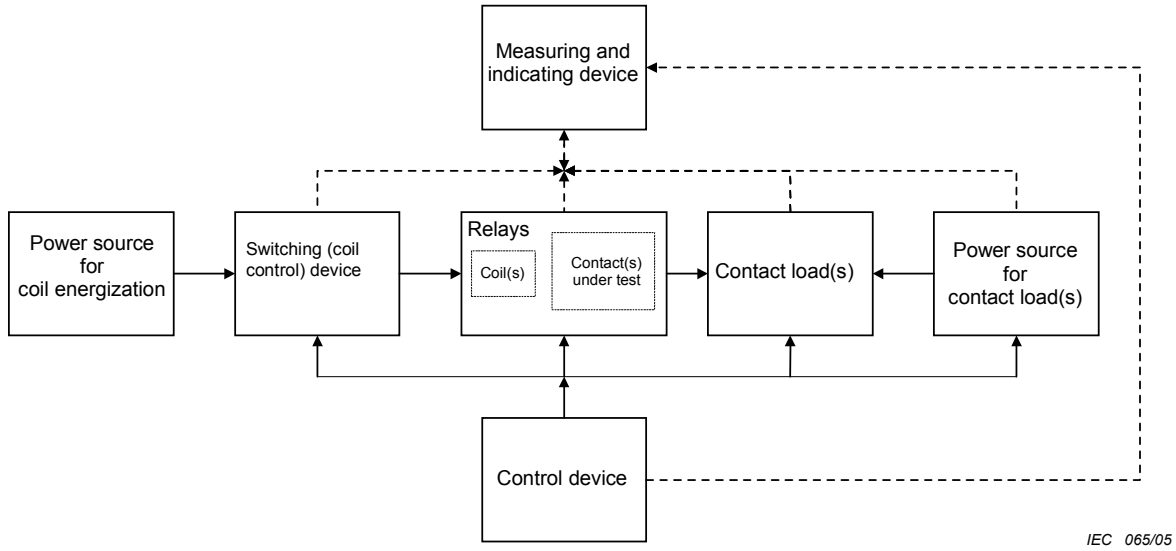
For standard load values and tolerances for L/R and cos φ: see Table C.2.

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

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 contact under test.

Figure C.1 – Standard test circuit



NOTE The relays under test include any suppression and/or indicating device.

Figure C.2 – Functional block diagram

Table C.1 – Characteristics of power sources for contact loads

Characteristic	Standard values Power supply	Contact load categories (see 3.8)	Tolerances	Notes
Voltage	Preferred and other specified values	0 and 1	±2 %	Voltage across the load including the closed contact
		2	±5 %	
Current	Preferred and other specified values	0 and 1	±5 %	
		2	Minimum: rated test current	Transient currents as required for the test shall be properly provided
Frequency	Standard rated values	0 … 2	±2 %	See Table 1 of IEC 61810-1
Waveform	Sinusoidal	0 … 2	Maximum distortion factor: 5 %	See Table 1 of IEC 61810-1
Alternating component in d.c. (ripple)	0	0 … 2	Maximum: 6 %	See Table 1 of IEC 61810-1
Direct component in a.c.	0	0 … 2	Max. 2 % of peak value	See Table 1 of IEC 61810-1

Table C.2 – Standard contact load characteristics

Load characteristics	Standard values		Contact load categories (see 3.8)	Tolerances	Notes
	DC supply	AC supply			
CC 0 load (≤ 30 mV/≤10 mA)	L/R ≤ 10^{-7} s	cos φ ≥ 0,95	0 … 2		L is the unavoidable inherent circuit inductance
Resistive load	L/R ≤ 10^{-7} s		0 and 1		
	L/R ≤ 10^{-6} s		2		
		cos φ ≥ 0,95	0 … 2		
Inductive load	L/R = 0,005 s		0 and 1	±15 %	
	L/R = 0,040 s		2		
		cosφ = 0,4	0 … 2	±0,1	
NOTE For inductive loads, values other than the standard values may be used if declared by the manufacturer. However, the tolerances should be as indicated in this table.					

C.2 Description and requirements

C.2.1 Power source for coil energization

The power source for the energization of the relay coil(s) comprises the power supply including provisions for stabilization within given voltage limits and given impedances including safety arrangements, for example, fuses.

The source shall deliver the rated values of the coil voltage with a tolerance of ±5 % for steady-state conditions. The input voltage envelope shall be rectangular.

The source and, when necessary, its polarity shall be able to be controlled externally.

C.2.2 Switching (coil control) device

This is circuitry to effect the various switching actions required during a cycle of testing, including the connections to the relays under test and having the ability to change the polarity of the connections to bistable relays.

This device shall be capable of handling the rated values of the coil voltage without affecting the stated tolerances.

C.2.3 Power source for contact loads

The power source supplying the load circuit(s) comprises the power supply including provisions for stabilization within given voltage and impedance limits including safety arrangements, for example, fuses.

The requirements for source impedance and resistance are given in Figure C.1. The tolerance of the power supply shall be in accordance with Table C.1.

C.2.4 Control device

This equipment generates the commands to run a specified test sequence controlling synchronization and the flow of orders (for example, starts, measurements, stops).

C.2.5 Measuring and indicating device

This device facilitates detection of the making and breaking of the relay contacts over every cycle, compared against the waveform generated by the control device. Any failure to perform the intended function shall be indicated and recorded. This device shall not have any significant influence on the outcome of the test.

C.3 Test schematic

Test schematics shall be selected from those shown in Table 3, unless otherwise specified.

C.4 Special loads for telecom and signal relays

For relays intended to be used in telecom and signalling applications, a cable load test may be applicable when specified by the manufacturer.

The load circuit shall be in accordance with Figure C.3.

Test details (in particular the cable characteristics) shall be as specified by the manufacturer.

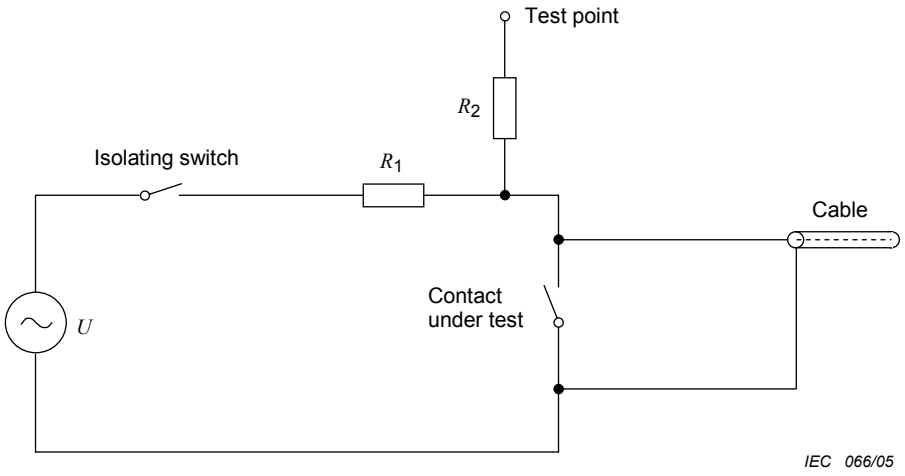


Figure C.3 – Circuit for cable load

C.5 Special loads with inrush current

For relays intended to be used in applications with inrush currents, a respective test may be applicable when specified by the manufacturer.

The load circuit shall be in accordance with Figures C.4, C.6 or C.7 as appropriate, unless otherwise specified. However, the manufacturer is permitted to specify and declare a time constant other than 2,5 ms (standard value for tungsten filament lamps) for the cases described in Figures C.4 and C.6. The time periods for the open and closed contact shall be no less than 4 times the time constant $C \times R_3$ and $C \times R_2$, respectively.

Special contact ratings for inrush current loads established by tests in accordance with Figures C.4 and C.6 shall be described in the following format:

Steady state current/Peak inrush current/Voltage/Time constant

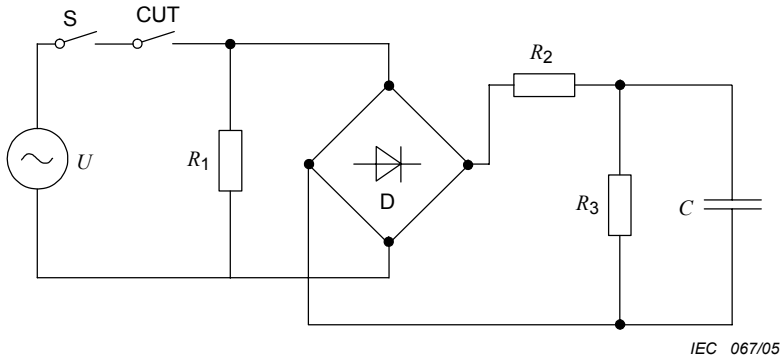
The steady state current represents the rated current for special inrush loads.

See Figure C.5 with an example for the testing of relays rated 10/100 A/250 V~/2,5 ms.

In case of contact ratings established in accordance with Figure C.7 for inrush current loads with power-factor correction the following format shall be used:

Steady state current/Voltage/Current limiting resistance (R_2)/Capacitance(C_F)

The values of the current limiting resistance and the capacitance need to be indicated only when deviating from the values indicated in Figure C.7.

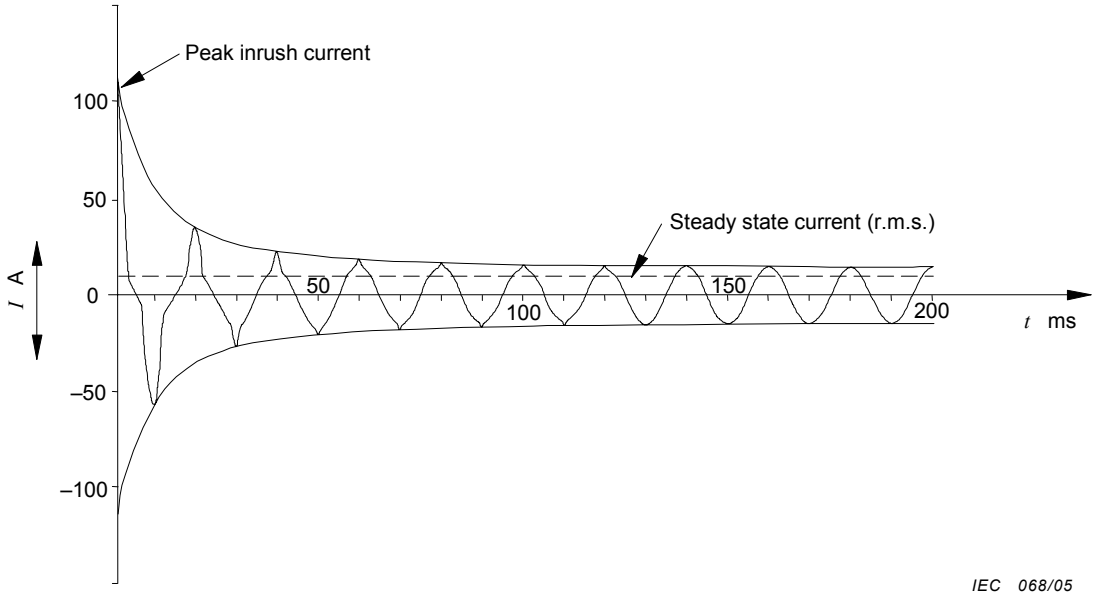


Components

$R_1 = U/I$	where U is the rated voltage and I is the steady state current of the load
$R_2 = R_1 \times 1{,}414/(X - 1)$	where X is the ratio between the peak inrush current and the steady state current
$R_3 = (800/X) \times R_1$	
$C \times R_2$ = 2 500 µs	standard value for lamp load, other values are permitted
D	rectifier-bridge
S	isolating switch
CUT	contact under test

The circuit elements and the source impedance are chosen so as to ensure a 10 % accuracy of the peak inrush current, and the steady state current.

Figure C.4 – Test circuit for inrush current loads (for example capacitive loads and simulated tungsten filament lamp loads) – a.c. circuits



Values calculated from Figure C.4

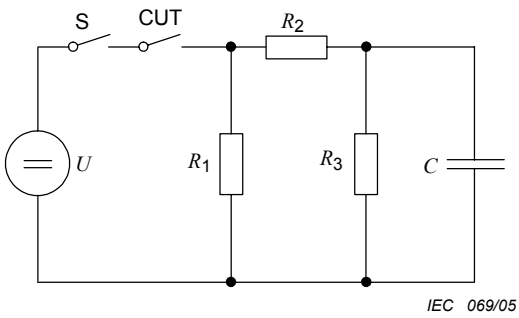
R_1 = 25 Ω

R_2 = 3,93 Ω

R_3 = 2 000 Ω

C = 636 µF

Figure C.5 – Example for a tungsten filament lamp test for relays rated 10/100 A/250 V~/2,5 ms

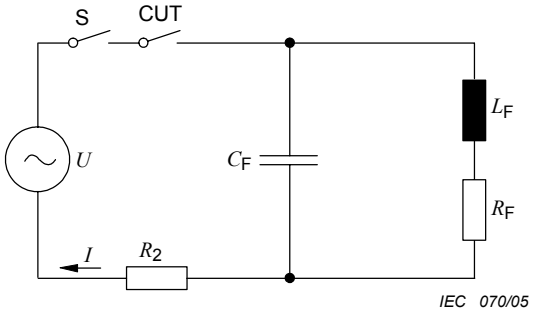


Components

$R_1 = U/I$	where U is the rated voltage and I is the steady state current
$R_2 = R_1/(X - 1)$	where X is the ratio between the peak inrush current and the steady state current
$R_3 = (800/X) \times R_1$	
$C \times R_2$ = 2 500 µs	standard value for lamp load, other values are permitted
CUT	contact under test
S	isolating switch

The circuit elements and the source impedance are chosen so as to ensure a 10 % accuracy of the peak inrush current, and the steady state current.

Figure C.6 – Test circuit for inrush current loads (for example capacitive loads and simulated lamp loads) – d.c. circuits



Components

CUT contact under test
S isolating switch
C_F = 70 µF ± 10 % (I ≤ 6 A), where I is the steady state current,
= 140 µF ± 10 % (6 A < I ≤ 20 A), where I is the steady state current
unless otherwise specified and declared by the manufacturer
L_F and R_F adjusted to have I = steady state current and 0,9 (lagging) power factor
R_2 (including wire resistance) = 0,25 Ω unless otherwise specified and declared by the manufacturer

The source impedance and the circuit elements are chosen so as to ensure

– a prospective short-circuit current of the supply of 3 kA to 4 kA;
– an accuracy of ±5 % of the rated voltage U;
– an accuracy of the steady state current I of $^{-0}_{+5}$ %;
– an accuracy of the power factor of ±0,05.

Figure C.7 – Test circuit for inrush current loads (for example simulated fluorescent lamp loads) with power-factor correction

Annex D
(informative)

Inductive contact loads

(the utilization categories and the test values correspond to those indicated in IEC 60947-5-1)

Table D.1 – Verification of the making and breaking capacity for AC-15/DC-13 (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	cos φ	Number of cycles	Frequency in 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	Rated operating current	I	Switching current
U_e	Rated operating voltage	U	Switching voltage
$P = U_e \times I_e$	Steady-state power in W	$T_{0,95}$	Time to reach 95 % of the steady-state current in ms

[a] The value "$6 \times P$" is derived from an empirical relation appropriate for most of the DC inductive loads up to P = 50 W, where $6 \times P$ = 300 ms. Loads with a rated power above 50 W 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 the contacts).

[c] The test is carried out at a voltage of $U_e \times 1{,}1$, with the test current I_e adjusted at U_e.

Table D.2 – Making and breaking capacity for electrical endurance test

Current	Utilization category	Making			Breaking		
AC	AC-15	I/I_e	U/U_e	cos φ	I/I_e	U/U_e	cos φ
		10	1	0,7 [a]	1	1	0,4 [a]
DC [b]	DC-13	I/I_e	U/U_e	$T_{0,95}$	I/I_e	U/U_e	$T_{0,95}$
		1	1	$6 \times P$ [c]	1	1	$6 \times P$ [c]
I_e	Rated operating current			I	Switching current		
U_e	Rated operating voltage			U	Switching voltage		
$P = U_e \times I_e$	Steady-state power in W			$T_{0,95}$	Time to reach 95 % of the steady-state current in ms		

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

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

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

Other loads may be specified by the manufacturer.

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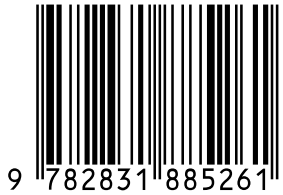

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