

BS EN 61020-1:2009

Incorporating corrigendum May 2012



BSI Standards Publication

Electromechanical switches for use in electrical and electronic equipment —

Part 1: Generic specification

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National foreword

This British Standard is the UK implementation of EN 61020-1:2009. It is identical to IEC 61020-1:2009. It supersedes BS EN 196000:1993, BS EN 196103:2000, BS EN 196500:1993, BS QC 960000:1992, BS QC 960100:1992, BS QC 960200:1992, BS QC 960201:1992, BS QC 960300:1992, BS QC 960400:1992 and BS QC 960500:1992, which are withdrawn.

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

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EN 61020-1

September 2009

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Supersedes EN 196000:1992 + A1:2001, EN 196103:1998 and EN 196500:1993 + A1:2001

English version

**Electromechanical switches
for use in electrical and electronic equipment -
Part 1: Generic specification
(IEC 61020-1:2009)**

Interrupteurs électromécaniques
pour équipements électriques
et électroniques -
Partie 1: Spécification générique
(CEI 61020-1:2009)

Elektrisch-mechanische Schalter
zur Verwendung in Geräten
der Elektrotechnik und Elektronik -
Teil 1: Fachgrundspezifikation
(IEC 61020-1:2009)

This European Standard was approved by CENELEC on 2009-08-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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CENELEC

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

Central Secretariat: Avenue Marnix 17, B - 1000 Brussels

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Foreword

The text of document 23J/325/FDIS, future edition 2 of IEC 61020-1, prepared by SC 23J, Switches for appliances, of IEC TC 23, Electrical accessories, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61020-1 on 2009-08-01.

This European Standard supersedes EN 196000:1992 + A1:2001, EN 196103:1998 and EN 196500:1993 + A1:2001.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2010-05-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2012-08-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61020-1:2009 was approved by CENELEC as a European Standard without any modification.

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

IEC 60062	NOTE Harmonized as EN 60062:2005 (not modified).
IEC 60065 + A1	NOTE Harmonized as EN 60065:2002 (modified) + A1:2006 (modified).
IEC 60068-2-27	NOTE Harmonized as EN 60068-2-27:2009 (not modified).
IEC 60068-2-38	NOTE Harmonized as EN 60068-2-38:2009 (not modified).
IEC 60068-2-44	NOTE Harmonized as EN 60068-2-44:1995 (not modified).
IEC 60068-2-46	NOTE Harmonized as HD 323.2.46 S1:1988 (not modified).
IEC 60068-2-77	NOTE Harmonized as EN 60068-2-77:1999 (not modified).
IEC 60512	NOTE Harmonized in EN 60512 series (not modified).
IEC 60664-1	NOTE Harmonized as EN 60664-1:2007 (not modified).
IEC 60695-11-10 + A1	NOTE Harmonized as EN 60695-11-10:1999 + A1:2003 (not modified).
IEC 60721-3-3 (+ A1) + A2	NOTE Harmonized as EN 60721-3-3:1995 + A2:1997 (not modified).
IEC 61190-1-3	NOTE Harmonized as EN 61190-1-3:2007 (not modified).
ISO/IEC 17050-1	NOTE Harmonized as EN ISO/IEC 17050-1:2004 (not modified).
ISO/IEC 17050-2	NOTE Harmonized as EN ISO/IEC 17050-2:2004 (not modified).
ISO 286-1	NOTE Harmonized as EN 20286-1:1993 (not modified).
ISO 1101	NOTE Harmonized as EN ISO 1101:2005 (not modified).
ISO 9001	NOTE Harmonized as EN ISO 9001:2008 (not modified).

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

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

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60027	Series	Letter symbols to be used in electrical technology	EN 60027	Series
IEC 60050-581	2008	International Electrotechnical Vocabulary - Part 581: Electromechanical components for electronic equipment	-	-
IEC 60068-1 A1	1988 1992	Environmental testing - Part 1: General and guidance	EN 60068-1 ¹⁾	1994
IEC 60068-2-1	2007	Environmental testing - Part 2-1: Tests - Test A: Cold	EN 60068-2-1	2007
IEC 60068-2-2	2007	Environmental testing - Part 2-2: Tests - Test B: Dry heat	EN 60068-2-2	2007
IEC 60068-2-6	2007	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	EN 60068-2-6	2008
IEC 60068-2-10	2005	Environmental testing - Part 2-10: Tests - Test J and guidance: Mould growth	EN 60068-2-10	2005
IEC 60068-2-13	1983	Environmental testing - Part 2: Tests - Test M: Low air pressure	EN 60068-2-13	1999
IEC 60068-2-14	2009	Environmental testing - Part 2-14: Tests - Test N: Change of temperature	EN 60068-2-14	2009
IEC 60068-2-17	1994	Environmental testing - Part 2: Tests - Test Q: Sealing	EN 60068-2-17	1994
IEC 60068-2-20	2008	Environmental testing - Part 2-20: Tests - Test T: Test methods for solderability and resistance to soldering heat of devices with leads	EN 60068-2-20	2008
IEC 60068-2-21	2006	Environmental testing - Part 2-21: Tests - Test U: Robustness of terminations and integral mounting devices	EN 60068-2-21	2006
IEC 60068-2-30	2005	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)	EN 60068-2-30	2005
IEC 60068-2-42	2003	Environmental testing - Part 2-42: Tests - Test Kc: Sulphur dioxide test for contacts and connections	EN 60068-2-42	2003

¹⁾ EN 60068-1 includes corr. October 1988 and A1:1992 to IEC 60068-1.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60068-2-43	2003	Environmental testing - Part 2-43: Tests - Test Kd: Hydrogen sulphide test for contacts and connections	EN 60068-2-43	2003
IEC 60068-2-45 A1	1980 1993	Environmental testing - Part 2: Tests - Test Xa and guidance: Immersion in cleaning solvents	EN 60068-2-45 A1	1992 1993
IEC 60068-2-49	1983	Environmental testing - Part 2: Tests - Guidance to Test Kc: Sulphur dioxide test for contacts and connections	-	-
IEC 60068-2-58	1999	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)	EN 60068-2-58	1999 ²⁾
IEC 60068-2-61	1991	Environmental testing - Part 2: Test methods - Test Z/ABDM: Climatic sequence	EN 60068-2-61	1993
IEC 60068-2-68	1994	Environmental testing - Part 2: Tests - Test L: Dust and sand	EN 60068-2-68	1996
IEC 60068-2-78	2001	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state	EN 60068-2-78	2001
IEC 60529 A1	1989 1999	Degrees of protection provided by enclosures (IP Code)	EN 60529 + corr. May A1	1991 1993 2000
IEC 60617	data- base	Graphical symbols for diagrams	-	-
IEC 61058-1 (mod) + A1 A2	2000 2001 2007	Switches for appliances - Part 1: General requirements	EN 61058-1 A2	2002 2008
ISO 1000	1992	SI units and recommendations for the use of their multiples and of certain other units	-	-

²⁾ EN 60068-2-58 is superseded by EN 60068-2-58:2004, which is based on IEC 60068-2-58:2004.

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INTRODUCTION

This generic specification covers the general requirements and test methods for electromechanical switches with optional quality assurance procedures. It provides the general requirements and test methods for use in any detail specifications for pushbutton switches, rotary switches, sensitive switches, toggle switches, and other electromechanical switches. It also provides guidelines for appropriate quality assurance procedures in Annex A (informative).

Where it is intended that an electromechanical switch comply with requirements related to safety, the specific safety requirements are specified in IEC 61058-1.

ELECTROMECHANICAL SWITCHES FOR USE IN ELECTRICAL AND ELECTRONIC EQUIPMENT –

Part 1: Generic specification

1 Scope and object

1.1 Scope

This generic specification relates to electromechanical switches intended for use in electrical and electronic appliances. Switches covered by this specification:

- a) are devices which open, close, or change the connection of a circuit by the mechanical motion of conducting parts (contacts);
- b) have a maximum rated voltage of 480 V;
- c) have a maximum rated current of 63 A.

This generic specification does not include keyboards and keypads which are intended for use in information-handling systems. Electromechanical key switches may be included under the scope of this generic specification.

Switch families shall be described in any detail specifications that will reference this generic specification.

1.2 Object

The object of this generic specification is to provide consistency in detail specifications for electromechanical switches by specifying the terminology, symbols, test methods and other necessary information.

2 General

2.1 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 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60050-581:2008, *International Electrotechnical Vocabulary – Part 581: Electromechanical components for electronic equipment*

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*
Amendment 1 (1992)

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

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

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

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

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

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

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

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

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

IEC 60068-2-30:2005, *Environmental testing – Part 2-30: 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 2-45: Tests – Test XA and guidance: Immersion in cleaning solvents*
Amendment 1 (1993)

IEC 60068-2-49:1983, *Environmental testing – Part 2-49: Tests – Guidance to Test Kc: Sulphur dioxide test for contacts and connections*

IEC 60068-2-58:1999, *Environmental testing Part 2-58: Tests – Tests Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60068-2-61:1991, *Environmental testing – Part 2-61: Test methods – Test Z/ABDM: Climatic sequence*

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

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

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*
Amendment 1 (2001)

IEC 60617, *Graphical symbols for diagrams*

IEC 61058-1:2000, *Switches for appliances – Part 1: General requirements*
Amendment 1 (2001)
Amendment 2 (2007)

ISO 1000:1992, *SI units and recommendation for the use of their multiples and of certain other units*

2.2 Units and symbols

Units, graphic symbols, and letter symbols shall be, whenever possible, in accordance with ISO 1000, IEC 60027 and IEC 60617.

Graphic symbols and letter symbols peculiar to a particular switch subfamily shall be defined in the applicable detail specification. Graphic symbols and letter symbols peculiar to a group of structurally similar switches shall be defined in the detail specification. When additional units or symbols are required, they shall be derived in accordance with the principles of the documents listed above whenever possible.

2.3 Terms and definitions

For the purposes of this document the terminology of IEC 60050-581 as well as the following terms and definitions apply.

Terminology peculiar to a particular switch subfamily shall be defined in the applicable detail specification. Terminology peculiar to a group of structurally similar switches shall be defined in the detail specification.

The following terminology is common to all electromechanical switches. Where the definition is compatible with an established IEC 60050 definition, the IEV number for the related definition is given in brackets.

2.3.1

category temperature range

range of ambient temperature for which the switch has been designed to operate continuously

2.3.2

clearance

shortest distance in air between two conductive parts

2.3.3

contact bounce

intermittent and random opening of closed contacts and closing of open contacts which may occur after contact transfer and which is caused by the switch mechanism

2.3.4

contact bounce time

time period measured from the moment of first closure of two mating contacts or first opening of two closed contacts to the moment when all contact bounce ceases

2.3.5

contact disturbance

intermittent and random closing of open contacts and/or opening of closed contacts caused by external influences such as shock and vibration

2.3.6

contact separation (gap)

distance between mating contacts when the contacts are open

2.3.7

contact set

group of contacts which all function in relation to the same pole of a switch

2.3.8

creepage distance

shortest distance along the surface of the insulation material between two conductive parts

[IEV 151-15-50 modified]

2.3.9

double break switch

switch that opens a conductor at two points in series with each other

2.3.10

double throw

term applied to a contact arrangement to denote that each contact form included is a make-break

2.3.11

duty cycle

ratio of conducting (ON) time to the total time for one cycle; for example, 30 % ON

2.3.12

electromechanical switch

switch which opens, closes, or changes the connection of an electrical circuit by the mechanical motion of conducting parts (contacts)

2.3.13

lower category temperature

minimum ambient temperature for which a switch has been designed to operate continuously

2.3.14

pole of a switch

the part of the switch associated exclusively with one, electrically separated, conducting path of the switch

NOTE 1 Those parts that provide a means for mounting and operating all poles together are excluded from the definition of a pole.

NOTE 2 A switch is called "single-pole" if it has only one pole. If it has more than one pole, it may be called "multi-pole" (two-pole, three-pole, etc.) provided that the poles are coupled in such a manner as to operate together.

2.3.15

operating cycle

succession of operations from one position to another and back to the first position through all other positions, if any

[IEV 441-16-02]

2.3.16

opposite polarity

two parts of a switch such that when connected together may result in operation of the line fuses to the power supply

2.3.17

single throw

term applied to a contact arrangement to denote that each contact form included is a single contact pair

2.3.18

snap-action

type of switching action in which the speed of the moving contact is relatively independent of the speed of the actuating mechanism

2.3.19**surface mounting switch**

small-sized switch which is suitable for surface mounting on the printed wiring board, consisting of terminals and framing parts

2.3.20**upper category temperature**

maximum ambient temperature for which a switch has been designed to operate continuously

2.4 Preferred values

The detail specification may prescribe any preferred values for rated and limiting values, characteristics, tolerances, requirements and dimensions applicable to the whole subfamily.

2.4.1 Clearance and creepage distances

The detail specification shall specify either the minimum clearance and creepage distances or the minimum dielectric test voltage under specified air pressure for functional insulation. For basic, supplementary or reinforced insulation the minimum clearance and creepage distances shall be specified in accordance with Clause 20 of IEC 61058-1.

2.5 Marking

Where space permits after national or contractual marking requirements (for example, safety requirements) have been satisfied, each switch shall be marked with the following information:

- a) manufacturer's name or trademark;
- b) identification number;
- c) terminal identification when specified by the detail specification;
- d) date code: the date code shall be in accordance with IEC 60062.

Other markings may be applied to the switches provided they do not obscure or confuse the required markings. When conditions do not permit full marking on the switch, the markings shall be applied in the order of preference shown above. Any required marking that cannot be applied to the switch, shall be marked on the smallest packing unit of the switch.

3 Quality assessment procedures

NOTE See Annex A (informative) for guidelines on quality assurance procedures.

4 Test and measurement procedures**4.1 General**

Any detail specification shall contain tables showing the tests to be conducted, the measurements to be made before and after each test or group of tests, and the sequence in which they shall be carried out. The measuring conditions shall be the same for initial and final measurements. When tests are performed in a sequence, the final measurements of one test may be taken as the initial measurements for the succeeding test.

If national specifications within any quality assessment system include test methods other than those specified in the above documents, the test methods shall be fully described.

Not all the test methods prescribed herein are applicable to all types of switches. The detail specification shall prescribe the test methods which are applicable for that type of switch.

When necessary, additional test methods and/or details of the test methods shall be prescribed by the detail specification.

4.1.1 Tolerances

Unless otherwise specified, the actual value of the parameters, for example test voltage, test current, test force or test torque shall be within 5 % of the specified values of the switch.

4.1.2 Preconditioning

Unless specified by the test method, the switches shall not be subjected to any special preparations, such as cleaning, prior to or during the tests.

4.1.3 Mounting

When mounting is prescribed by the test method, the switch shall be rigidly mounted by its normal mounting means and connected as specified in the detail specification. The method of mounting and the materials used for mounting shall not adversely affect the electrical or mechanical performance of the switch.

4.2 Standard atmospheric conditions

The standard atmospheric conditions shall be in accordance with Clause 5 of IEC 60068-1.

4.3 General examination

4.3.1 Visual examination

4.3.1.1 Method

The visual examination shall be carried out by one of the following methods:

- a) with the naked eye (normal strength of vision, normal colour perception, at the most favourable viewing distance and with suitable illumination);
- b) with magnifiers, if specified.

For the purpose of this standard, special methods, for example using polarized light (for observing internal tensions in materials) or other indicators (for observing internal material cracks or pores), are not permitted unless explicitly required by the detail specification.

4.3.1.2 Features

The following features shall be examined without magnification:

- a) markings according to 2.5;
- b) general appearance;
- c) workmanship.

4.3.1.3 Requirement

The markings shall be correct and legible. The switch shall be manufactured in a careful and workmanlike manner.

4.3.1.4 Details to be specified

When this test is required by the detail specification, the following details shall be specified:

- a) details to be examined;
- b) features to be checked;

- c) acceptability;
- d) power of magnifier, if specified;
- e) any deviation from the standard test method.

4.3.2 Dimensions

4.3.2.1 Method

The examination of dimensions shall be carried out with appropriate measuring equipment, for example:

- a) with a vernier gauge, a micrometer and a dial gauge;
- b) with a measuring projector with a suitable linear magnification;
- c) with a measuring microscope.

The following details shall apply.

- a) The specified outline dimensions, detailed dimensions, clearances and creepage distances shall be measured.
- b) The accuracy and resolution of the measuring equipment (micrometers, callipers, visual comparators, etc.) shall be commensurate with the dimensions being measured.

4.3.2.2 Requirement

The dimensions shall be within the limits specified by the detail specification.

4.3.2.3 Details to be specified

When this test is required by the detail specification, the following details shall be specified:

- a) features to be checked;
- b) gauging details, if applicable;
- c) type and power of measuring equipment;
- d) acceptability;
- e) any deviation from the standard test method.

4.3.3 Dimensions, gauging

4.3.3.1 Method

The dimensions prescribed by the detail specifications as being suitable for gauging shall be checked using the gauges or gauge dimensions specified by the detail specification.

4.3.3.2 Requirement

The switch shall comply with the prescribed gauging.

4.3.3.3 Details to be specified

When this test is required by the detail specification, the following details shall be specified:

- a) features to be checked;
- b) gauging details, if applicable;
- c) type and power of measuring equipment;
- d) acceptability;
- e) any deviation from the standard test method.

4.3.4 Mass

4.3.4.1 Method

The checking of mass should be carried out with appropriate measuring equipment, for example, with a balance.

The following details shall apply.

- a) The accuracy and resolution of the measuring equipment shall be commensurate with the mass being measured.
- b) The measurement shall include all removable parts (mounting hardware, etc.) prescribed by the detail specification.

4.3.4.2 Requirement

The mass shall be within the limits specified by the detail specification.

4.3.4.3 Details to be specified

When this test is required by the detail specification, the following details shall be specified:

- a) features to be checked;
- b) gauging details, if applicable;
- c) type and power of measuring equipment;
- d) acceptability;
- e) any deviation from the standard test method.

4.3.5 Functional operation

4.3.5.1 Object

The objective of the examination is the assessment of the proper functioning of all switching operations.

4.3.5.2 Method

For coded switches, each switching circuit shall be connected to a monitoring circuit which has a maximum current of 150 mA, and provides an indication of current flow. With the exception of coded switches, the test facility may use the contact resistance test to check the switching circuit.

The correct functioning of all mechanical detents, latching, locking, interlocking, and self-return mechanisms shall be checked.

The correct functioning of all electrical non-switching operations, such as lamp circuits or solenoids, shall be checked at their rated voltage and/or rated current.

4.3.5.3 Requirement

The functional operation of the switch, including the sequence of contact operations, shall comply with the requirements specified by the detail specification.

4.3.6 Operating characteristics

4.3.6.1 Operating force

4.3.6.1.1 Object

The objective of this test is to measure the force to move the actuating part of a switch from any one position to the next.

4.3.6.1.2 Preparation of specimens

The specimens shall be prepared as specified by the detail specification.

The specimens shall be rigidly mounted on a metal plate using the fixing devices specified in the detail specification. The metal plate shall be strong enough to withstand the forces applied. The length and width of the metal plate shall be such that the contour of the specimen is exceeded.

4.3.6.1.3 Method of measurement

The force shall be applied to the actuating part in the direction and at the point specified in the detail specification. Unless otherwise specified, the force shall be applied until the actuating part has travelled from a first stable equilibrium position to its next stable equilibrium position or a stop, and the switch has operated electrically or the specified contact resistance is achieved." The maximum force necessary to move the actuating part to the next stable position or stop shall be measured and recorded. In the case of a switch in which the actuator does not take up a second stable equilibrium position (momentary position), the force required to move the actuator to the operating position shall be measured and recorded.

If appropriate, the measurements of operating force shall be carried out in both directions. In each direction, the number of measurements shall be as specified in the detail specification.

The method for measuring other mechanical operating characteristics shall be specified by the detail specification. The method for measuring other operating characteristics such as temperature, air pressure, etc. shall be specified by the detail specification.

4.3.6.1.4 Requirement

All measured values shall be within the limits specified in the detail specification.

4.3.6.1.5 Details to be specified

When this test is required by the detail specification, the following details shall be given:

- a) preparation of specimen;
- b) number of measurements;
- c) point and direction of force application;
- d) rate of increase of force or operating speed;
- e) permissible minimum and maximum values of force;
- f) kind of measuring system;
- g) shape of the actuating tip of the system;
- h) temperature other than normal ambient, if appropriate;
- i) any deviation from the standard test method.

4.3.6.2 Operating torque

4.3.6.2.1 Object

The objective of this test is to measure the maximum force to move the actuating part of a switch from one stable position to the next position where the switch has operated electrically.

4.3.6.2.2 Preparation of specimens

The specimen shall be prepared as specified by the detail specification.

The specimen shall be rigidly mounted on a metal plate using the fixing devices specified in the detail specification. The metal plate shall be strong enough to withstand the forces applied. The length and width of the metal plate shall be such that the contour of the specimen is exceeded.

4.3.6.2.3 Method of measurement

The torque shall be applied to the operating spindle in the direction specified. Unless otherwise specified, the torque shall be applied until the actuating part has travelled from a first stable equilibrium position to its next stable equilibrium position or a stop, and the switch has operated electrically or the specified contact resistance is achieved. The maximum torque necessary to move the actuating part to the next stable position or stop shall be measured and recorded. In the case of a switch in which the actuator does not take up a second stable equilibrium position (momentary position), the torque required to rotate or pivot the actuator to the next operating position shall be measured and recorded.

If appropriate, the measurements of operating torque shall be carried out in both directions. In each direction, the number of measurements shall be as specified in the detail specification.

The method for measuring other mechanical operating characteristics shall be specified by the detail specification. The method for measuring other operating characteristics such as temperature, air pressure, etc. shall be specified by the detail specification.

4.3.6.2.4 Requirement

All measured values shall be within the limits specified in the detail specification.

4.3.6.2.5 Details to be specified

When this test is required by the detail specification, the following details shall be given:

- a) preparation of specimen;
- b) number of measurements;
- c) direction of operation;
- d) rate of increase of torque or rotary speed;
- e) minimum and maximum values of torque permissible;
- f) kind of measuring system;
- g) shape of the actuating tip of the system;
- h) temperature other than normal ambient, if appropriate;
- i) any deviation from the standard test method.

4.3.7 Contact bounce

4.3.7.1 Object

The objective of the measurement is to determine the duration of the intermittent and random opening of closed contacts and closing of open contacts which may occur after contact transfer and is caused by the switch mechanism. Electronic logic circuits may produce spurious data due to the kinetic behaviour of the switching contacts.

4.3.7.2 Method

The switch shall be mounted in accordance with 4.1.3.

The test circuit shown in Figure 1, or an equivalent, shall be used for detecting contact bounce. The values for the d.c. test voltage and test current shall be specified in the detail specification, but shall not exceed an open circuit voltage of 10 V d.c. and a test current of 100 mA.

The detection and display means (oscilloscope or equivalent) utilized in the circuit shall have a band width of 1 MHz or greater, a minimum time base accuracy of $\pm 5\%$, and shall be capable of showing the quiescent contact state prior to contact transfer unless otherwise specified.

The switch shall be actuated at a constant velocity at the rate specified in the detail specification. When the contact bounce is affected by the actuation force and/or actuation characteristic, the limits of the force and the actuation characteristic shall be specified in the detail specification.

The duration of the contact bounce shall be the maximum measurement occurring in five consecutive measurements of contact closure and of contact opening. For the purpose of this test, the contacts shall be open when the voltage drop across the contacts is at least 90 % of the open circuit voltage. The contacts shall be closed when the voltage drop across the contacts is no greater than 10 % of the open circuit voltage. When the contacts are closed, the voltage variations within the 10 % limit are due to variations in the dynamic contact resistance. Contact bounce is the time duration measured from the moment of first closure (or opening) to the moment when the contacts remain closed (or opened). The values for the resistor and the input impedance of the detection and display means shall be specified in the detail specification. See Figures 1 and 2.

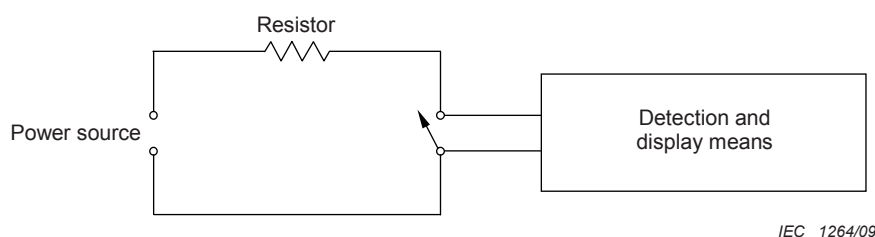


Figure 1 – Contact bounce test circuit

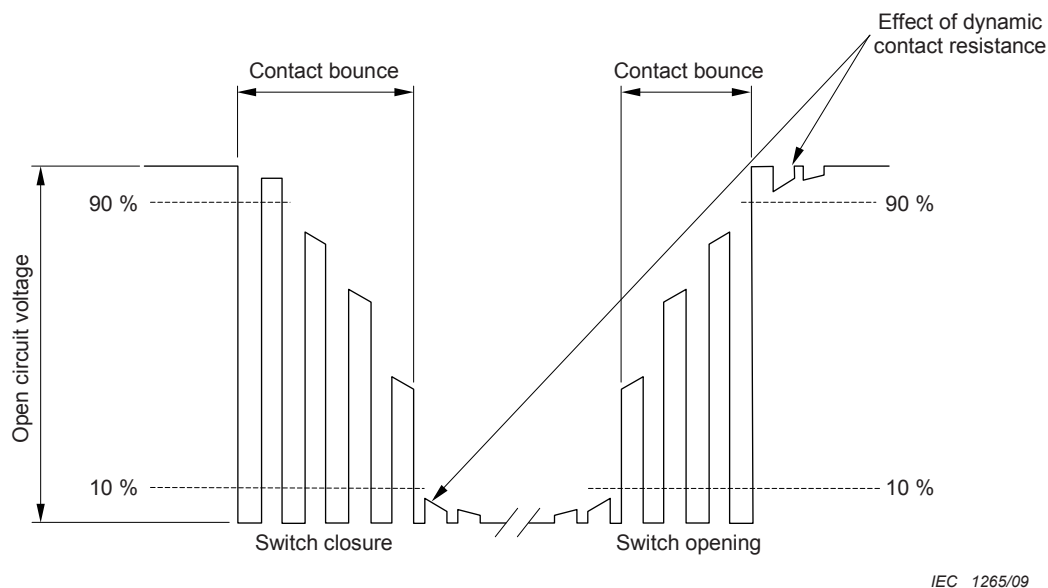


Figure 2 – Typical trace of contact bounce

4.3.7.3 Requirement

The duration of the contact bounce shall be within the limits specified by the detail specification.

4.3.7.4 Details to be specified

When this test is required by the detail specification, the following details shall be given:

- a) preparation of specimen;
- b) speed of operation;
- c) point and direction of force application;
- d) test voltage and current;
- e) any deviation from the standard test method.

4.4 Resistance measurements

4.4.1 Contact resistance – Millivolt level

4.4.1.1 Object

The objective of the measurement is the determination of the total electrical resistance of the conducting switching circuits, including the switch terminations, at a voltage which has no electrical effect on the contact material.

4.4.1.2 Method

The measurement shall be performed as follows.

- a) Measurements may be carried out with direct current or alternating current. For a.c. measurements, the frequency shall not exceed 2 kHz. In the case of dispute, the d.c. measurements shall govern.
- b) The accuracy of the measuring apparatus shall be such that the total error does not exceed 1 %.

- c) The contact resistance shall be derived normally from the voltage drop measured between the zones intended for connection of the wiring to the contacts at the points specified in the detail specification.
- d) The contact shall not be operated while the measuring voltage is applied. Care shall be taken during the measurement to avoid exerting abnormal pressure on the contacts under test and to avoid movement of the test cables.
- e) Where the connection points specified in the detail specification are not directly accessible, the resistance of the cable or wire used shall be subtracted from the measured value. The corrected value shall be recorded.
- f) The contacts to be measured shall be chosen in accordance with the detail specification.
- g) Test current and voltage: In order to prevent the breakdown of insulating films on the contacts, the open circuit voltage of the measuring circuit shall not exceed 20 mV d.c. or a.c. peak. The test current shall not exceed 100 mA, a.c. or d.c.
- h) One measuring cycle shall be performed on each switching circuit, where one measuring cycle for d.c. consists of
 - application of the voltage,
 - measurement with current flowing in one direction,
 - measurement with current flowing in the opposite direction,
 - disconnection of the voltage source;
 and one measuring cycle for a.c. consists of
 - application of the voltage,
 - making the measurement,
 - disconnection of the voltage source.

NOTE Unless otherwise specified, the made contact(s) should not be disturbed between the end of the preceding test and the application of the voltage in this test.

- i) When contact resistance is dependent upon the operating force, the contact resistance shall be measured at the operating force specified by the detail specification.

4.4.1.3 Requirement

The contact resistance shall be within the limits specified by the detail specification.

The contact resistance measurement with d.c. shall be the average of the two readings obtained with forward and reverse current.

Use of the following equation will ensure that the calculated resistance is always correct:

$$R = \frac{|V_{mf} - V_{mr}|}{|I_f| + |I_r|}$$

NOTE In the equation, the sign of the voltage measurements must be included.

where

- R is the resistance,
- V_{mf} is the measured forward voltage,
- V_{mr} is the measured reverse voltage,
- I_f is the forward current,
- I_r is the reverse current.

NOTE Any deviation from the standard test procedure should be clearly indicated in the test report.