

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Electromechanical switches for use in electrical and electronic equipment –
Part 1: Generic specification**

**Interrupteurs électromécaniques pour équipements électriques et électroniques –
Partie 1: Spécification générique**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2019 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Electromechanical switches for use in electrical and electronic equipment –
Part 1: Generic specification**

**Interrupteurs électromécaniques pour équipements électriques et électroniques –
Partie 1: Spécification générique**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 31.220.20

ISBN 978-2-8322-6388-4

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references	9
3 Terms, definitions, units and symbols	11
3.1 Terms and definitions.....	11
3.2 Units and symbols.....	13
4 Test and measurement procedures.....	14
4.1 General.....	14
4.1.1 General requirements to tests and measuring procedures	14
4.1.2 Tolerances	14
4.1.3 Preconditioning.....	14
4.1.4 Mounting	14
4.2 Standard atmospheric conditions	14
4.3 General examination	15
4.3.1 Visual examination	15
4.3.2 Dimensions.....	15
4.3.3 Dimensions, gauging	16
4.3.4 Mass	16
4.3.5 Functional operation	17
4.3.6 Operating characteristics	17
4.3.7 Contact bounce	21
4.4 Resistance measurements	23
4.4.1 Contact resistance – Millivolt level	23
4.4.2 Contact resistance – Specified current.....	26
4.4.3 Resistance from actuator to mounting bushing (surface).....	27
4.4.4 Insulation resistance	28
4.5 Withstand voltage	29
4.5.1 Withstand voltage at standard atmospheric conditions	29
4.5.2 Withstand voltage at low air pressure	30
4.6 Heating	31
4.6.1 Object.....	31
4.6.2 Method	31
4.6.3 Requirement.....	31
4.6.4 Items to be specified in the detail specification	31
4.7 Dynamic stress	32
4.7.1 Shock	32
4.7.2 Vibration.....	32
4.7.3 Contact disturbance.....	33
4.8 Mechanical strength.....	34
4.8.1 Robustness of actuator	34
4.8.2 Robustness of mounting bushing	37
4.8.3 Robustness of screw mounting	37
4.8.4 Robustness of terminations	37
4.9 Mechanical endurance	38
4.9.1 Mechanical endurance – Standard atmospheric conditions	38
4.9.2 Mechanical endurance – Category temperature range	39

4.10	Electrical endurance	40
4.10.1	Electrical endurance – Standard atmospheric conditions	40
4.10.2	Electrical endurance – Upper category temperature.....	42
4.10.3	Electrical endurance – Category temperature range	43
4.10.4	Electrical endurance – low air pressure	43
4.10.5	Logic loads (TTL).....	44
4.10.6	Low level endurance test	45
4.11	Overload	46
4.11.1	Electrical overload	46
4.11.2	Capacitive load switching	47
4.12	Environmental testing	48
4.12.1	Climatic sequence	48
4.12.2	Dry heat	50
4.12.3	Cold.....	51
4.12.4	Damp heat, steady state	53
4.12.5	Damp heat, cyclic	54
4.12.6	Rapid change of temperature.....	56
4.12.7	Mould growth (resistance).....	57
4.12.8	Corrosion, industrial atmosphere	58
4.12.9	Dust and sand	62
4.12.10	Salt mist	64
4.12.11	Contact resistance stability	65
4.13	Soldering	66
4.13.1	Solderability, wetting, solder bath method.....	66
4.13.2	Solderability, wetting, soldering iron method	67
4.13.3	Solderability, dewetting.....	68
4.13.4	Resistance to soldering heat, solder bath method	68
4.13.5	Resistance to soldering heat, soldering iron method	69
4.14	Panel seal.....	70
4.14.1	General	70
4.14.2	Drip – Proof.....	70
4.14.3	Splash – Proof.....	70
4.14.4	Immersion.....	71
4.14.5	Submersion	72
4.15	Enclosure seal	73
4.15.1	General	73
4.15.2	Watertight immersion	73
4.15.3	Resilient or hermetic seal	74
4.16	Fluid resistance – Immersion in cleaning solvents (marking)	74
4.16.1	Object.....	74
4.16.2	Method	74
4.16.3	Requirement.....	75
4.16.4	Items to be specified in the detail specification	75
4.17	Fire hazard	75
4.18	Capacitance.....	75
4.18.1	Object.....	75
4.18.2	Method	75
4.18.3	Requirement.....	75
4.18.4	Items to be specified in the detail specification	75

4.19	Illumination	76
4.19.1	Chromaticity	76
4.19.2	Transmittancy	76
4.19.3	Temperature of illuminated surface	77
4.20	Soldering for surface mounting switches	77
4.20.1	Solderability, solder bath method (surface mounting switches)	77
4.20.2	Solderability, reflow method (surface mounting switches)	78
4.20.3	Solderability, soldering iron method (surface mounting switches)	79
4.20.4	Resistance to soldering heat, solder bath method (surface mounting switches)	80
4.20.5	Resistance to soldering heat, reflow method (surface mounting switches)	80
4.20.6	Resistance to soldering heat, soldering iron method (surface mounting switches)	81
4.21	Mechanical strength (surface mounting switches)	82
4.21.1	Substrate bending (surface mounting switches)	82
4.21.2	Pull-off and push-off (surface mounting switches)	82
4.21.3	Shear (surface mounting switches)	83
4.21.4	Body strength (surface mounting switches)	84
5	Preferred values	84
5.1	General	84
5.2	Clearance and creepage distances	84
6	Marking	85
6.1	Markings on switch body	85
6.2	Markings on packaging	85
	Bibliography	86
	Figure 1 – Measuring direction of operating force and torque	18
	Figure 2 – Example of measuring points specified in detail specifications	20
	Figure 3 – Contact bounce test circuit	22
	Figure 4 – Typical trace of contact bounce	22
	Figure 5 – Low voltage and current method (by DC)	25
	Figure 6 – Low voltage and current method (by AC)	25
	Figure 7 – Specified current method (by DC)	27
	Figure 8 – Specified current method (by AC)	27
	Figure 9 – Application of forces and torques for 4.8.1	36
	Figure 10 – Composition of one cycle	56
	Figure 11 – Composition of cycle of test procedure	63
	Figure 12 – Submersion seal enclosure	73
	Table 1 – Torque values for mounting screws	37
	Table 2 – Climatic sequence	49
	Table 3 –Remain cycles	49
	Table 4 – Concentration of H ₂ S	59
	Table 5 – Test temperature	59
	Table 6 – Test duration	59
	Table 7 – Concentration of SO ₂	59

Table 8 – Test temperature	61
Table 9 – Test duration	61
Table 10 – Solderability, bath method: Test severities (duration and temperature).....	67

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMECHANICAL SWITCHES FOR USE IN ELECTRICAL AND ELECTRONIC EQUIPMENT –

Part 1: Generic specification

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61020-1 has been prepared by subcommittee 23J: Switches for appliances, of IEC technical committee 23: Electrical accessories.

This third edition cancels and replaces the second edition published in 2009.

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

- a) In accordance with the ISO/IEC Directives, Part 2:2016, Clause 2 General has been replaced by two new clauses: Clause 2 Normative references and Clause 3 Terms, definitions, units and symbols.
2.4 Preferred values and 2.5 Marking have been moved to Clauses 5 and 6. In addition, 6.2 Markings on packaging has been added.
- b) Clause 3 Quality assurance procedures and Annex A have been deleted.
- c) 4.3.6.3 Returning force has been added.
- d) 4.3.6.4 Travel (movement of the actuator) has been added.
- e) 4.12 Environmental testing:

4.12.1.3 and 4.12.1.5 have been renumbered 4.12.2 and 4.12.3, respectively. 4.12.1.4 and 4.12.1.7 have been integrated in 4.12.5. 4.12.10 Salt mist has been added.

f) Following publication of IEC 61058-1-1:2016, some cross-references to IEC 61058-1 have been updated.

g) The following items have been updated with respect to the second edition.

– Tables and figures:

Tables 1 and 3 have been deleted, Table 4 has been renumbered to Table 10. New Tables 2, 3, 4, 5, 6, 7, 8 and 9 have been added.

Figure 1 has been renumbered to Figure 3, Figure 2 renumbered to Figure 4, Figure 3 renumbered to Figure 9 and Figure 4 renumbered to Figure 12. Added new Figures 1, 2, 5, 6, 7, 8, 10 and 11 have been added.

– Specific words and common names have been unified.

The text of this International Standard is based on the following documents:

CDV	Report on voting
23J/443/CDV	23J/448/RVC

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

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

A list of all parts in the IEC 61020 series, published under the general title *Electromechanical switches for use in electrical and electronic equipment*, can be found on the IEC website.

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

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

INTRODUCTION

This document 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.

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

ELECTROMECHANICAL SWITCHES FOR USE IN ELECTRICAL AND ELECTRONIC EQUIPMENT –

Part 1: Generic specification

1 Scope

This part of IEC 61020 specifies the terminology, symbols, test methods and other necessary information to provide consistency in detail specifications for electromechanical switches.

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

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

Switch families will be described in any detail specifications that reference this document.

This document is a performance standard intended to describe evaluation methods to better clarify the capabilities of a switch.

NOTE 1 Safety requirements for switches for household and similar fixed electrical installations are given in IEC 60669 (all parts).

NOTE 2 Safety requirements for appliance switches are given in IEC 61058 (all parts).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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, *International Electrotechnical Vocabulary – Part 581: Electromechanical components for electronic equipment*

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

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

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

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

IEC 60068-2-10, *Environmental testing – Part 2-10: Tests – Test J and guidance: Mechanical shock*

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

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

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

IEC 60068-2-17, *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, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

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

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

IEC 60068-2-38:2009, *Environmental testing – Part 2-38: Tests – Test Z/AD: Composite temperature/humidity cyclic test*

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

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

IEC 60068-2-45, *Environmental testing – Part 2-45: Tests – Test XA and guidance: Immersion in cleaning solvents*

IEC 60068-2-46, *Basic environmental testing procedures – Part 2-46: Tests – Guidance to test Kd: Hydrogen sulphide test for contacts and connections*

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

IEC 60068-2-58:2015, *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 60068-2-58:2015/AMD1:2017

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 60068-2-77, *Environmental testing – Part 2-77: Tests – Test 77: Body strength and impact shock*

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

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60617, *Graphical symbols for diagrams* (available at: <http://std.iec.ch/iec60617/>)

IEC 60721-3-3, *Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weatherprotected locations*

IEC 61058-1:2016, *Switches for appliances – Part 1: General requirements*

IEC 61058-1-1:2016, *Switches for appliances – Part 1-1: Requirements for mechanical switches*

ISO 80000-1, *Quantities and units – Part 1: General*

3 Terms, definitions, units and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-581 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

Note 1 to entry: Terminology peculiar to a particular switch subfamily is defined in the applicable detail specification. Terminology peculiar to a group of structurally similar switches is defined in the detail specification.

Note 2 to entry: The following terminology is common to all electromechanical switches. Where the definition is compatible with an established IEC 60050 definition, the IEC 60050 reference for the related definition is given as source information.

3.1.1

category temperature range

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

3.1.2

clearance

shortest distance in air between two conductive parts

3.1.3

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

3.1.4

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

3.1.5

contact disturbance

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

3.1.6

creepage distance

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

[SOURCE: IEC 60050-151:2001, 151-15-50, modified – “a solid insulating material” has been replaced by “the insulation material”.]

3.1.7

detail specification

declarations of switch parameters including ratings, test conditions and performance criteria, agreed upon by the manufacturer and/or all interested parties

3.1.8

duty cycle

ratio of conducting (ON) time to the total time for one cycle

EXAMPLE 30 % ON.

3.1.9

electrical load

element connected to a circuit to pass a certain current through a specimen switch

Note 1 to entry: Resistor, coil and capacitor are examples of elements.

3.1.10

electromechanical switch

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

3.1.11

latch

latching mechanism for holding the button at the position when the operating button of a switch is pushed down

3.1.12

lever switch

switch where the actuating member is a lever which has to be moved (tilted) to one or more indexed positions in order to achieve a change in contact state

3.1.13

lower category temperature

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

3.1.14

mounting bushing

component of a switch by which the switch is mounted on an equipment and which also serves as a bearing

3.1.15

operating cycle

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

[SOURCE: IEC 60050-441:2000, 441-16-02]

3.1.16

operation

movement of a contact from a position to an adjacent position

3.1.17

operation test

test in which a switch is operated with the electric load connected under the simulated state of actual use

3.1.18**pole**

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

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

Note 2 to entry: 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.

3.1.19**push-button switch**

switch where the actuating member is a button which has to be pushed in order to achieve a change in contact state

3.1.20**rated current**

current assigned by the manufacturer for a specified operating condition

3.1.21**rated voltage**

voltage assigned by the manufacturer for a specified operating condition

3.1.22**returning force**

force possessed by the automatic returning mechanism which returns the actuator to the position before operation when the operating force is removed

3.1.23**rocker switch**

switch where the actuating member is a low profile lever (rocker) which has to be tilted to one or more indexed positions in order to achieve a change in contact state

3.1.24**rotary switch**

switch where the actuating member is a shaft or a spindle which has to be rotated to one or more indexed positions in order to achieve a change in contact state

Note 1 to entry: The rotation of the actuating member may be unlimited or restricted in either direction.

3.1.25**slide switch**

switch, the actuating member of which is a button which has to be displaced laterally in order to achieve a change in contact state

3.1.26**surface mounting switch**

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

3.1.27**upper category temperature**

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

3.2 Units and symbols

Units, graphical symbols, and letter symbols shall be, whenever possible, in accordance with ISO 80000-1, IEC 60617 and IEC 60027 (all parts), respectively.

Graphical symbols and letter symbols peculiar to a particular switch subfamily shall be defined in the applicable detail specification. Graphical 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.

4 Test and measurement procedures

4.1 General

4.1.1 General requirements to tests and measuring procedures

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 specified in this document are applicable to all types of switches. The detail specification shall specify 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 specified by the detail specification.

Unless otherwise specified by the detail specification, the test sequence shall be as specified in this document.

4.1.2 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.

4.1.3 Preconditioning

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

4.1.4 Mounting

When mounting is specified by the test methods, the switch shall be rigidly mounted by its normal mounting means and connected as specified in the detail specification. The methods 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 4 of IEC 60068- 1:2013.

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 document, 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 Clause 6;
- 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 Items to be specified in the detail specification

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 methods.

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 calliper, 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.

- 1) The specified outline dimensions, detailed dimensions, clearances and creepage distances shall be measured according to Annex A of IEC 61058-1:2016.
- 2) 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 Items to be specified in the detail specification

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 methods.

4.3.3 Dimensions, gauging

4.3.3.1 Method

The dimensions specified 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 specified gauging.

4.3.3.3 Items to be specified in the detail specification

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 methods.

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.) specified 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 Items to be specified in the detail specification

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 methods.

4.3.5 Functional operation

4.3.5.1 Objective

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

4.3.5.2 Method

For logic 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 logic 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

The force shall be applied to the actuating part in the direction and at the point specified in the detail specification (see Figure 1). 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 methods for measuring other mechanical operating characteristics shall be specified by the detail specification. The methods for measuring other operating characteristics such as temperature, air pressure, etc. shall be specified by the detail specification.

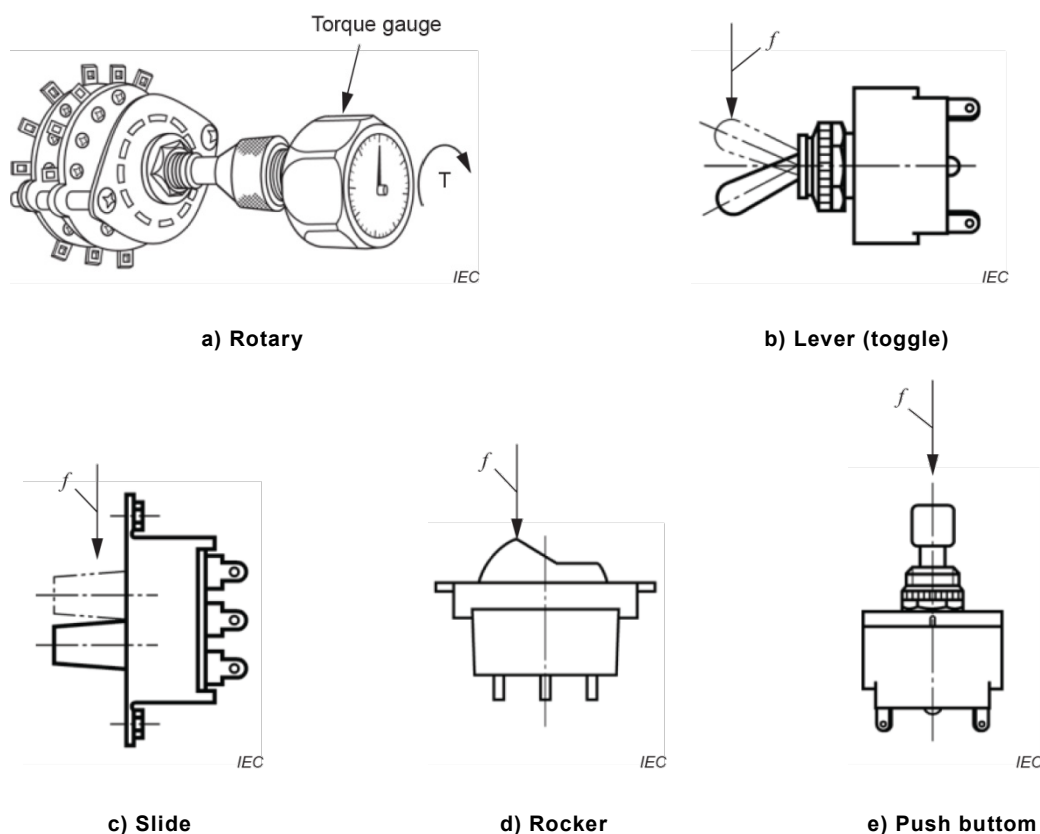


Figure 1 – Measuring direction of operating force and torque

4.3.6.1.4 Requirement

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

4.3.6.1.5 Items to be specified in the detail specification

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

- preparation of specimen;
- number of measurements;
- point and direction of force application;
- rate of increase of force or operating speed;
- permissible minimum and maximum values of force;
- kind of measuring system;
- shape of the actuating tip of the system;
- temperature other than normal ambient, if appropriate;
- any deviation from the standard test methods.

4.3.6.2 Operating torque

4.3.6.2.1 Object

The objective of this test is to measure the maximum torque 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 torque 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

The torque shall be applied to the operating spindle in the direction specified (see Figure 1 a)). 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 methods for measuring other mechanical operating characteristics shall be specified by the detail specification. The methods 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 Items to be specified in the detail specification

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 methods.

4.3.6.3 Returning force

4.3.6.3.1 Object

The objective of this test is to measure the returning force by which the operating part of automatic returning switch returns to the rest position.

4.3.6.3.2 Method

A specimen shall be mounted on a metal plate in normal condition of use.

Unless otherwise specified in detail specifications, the metal plate of push-button or rocker switch shall be set in a horizontal position (see Figure 1 d) and e)).

Switches other than push-button or rocker actuation shall be mounted on the mounting plate in vertical position (see Figure 1 b) and c)).

The test, whether it is conducted with or without a knob or the like, shall be based on the detail specifications.

The test shall be conducted as follows.

- a) Unless otherwise specified in detail specifications, the operating force is applied to the normal operating portion of the specimen and it is operated until its operating limit.
- b) In the process of releasing the operating force gradually and getting the operating parts from the operating limit back to the original position, the following measurement and/or check in 1) and 2), respectively, shall be made (see Figure 2).
 - 1) The returning force which gets the operating portion from the limit to the original position is measured at a point specified in detail specifications.
 - 2) It is checked if the operating portion has returned to the original stop position correctly.

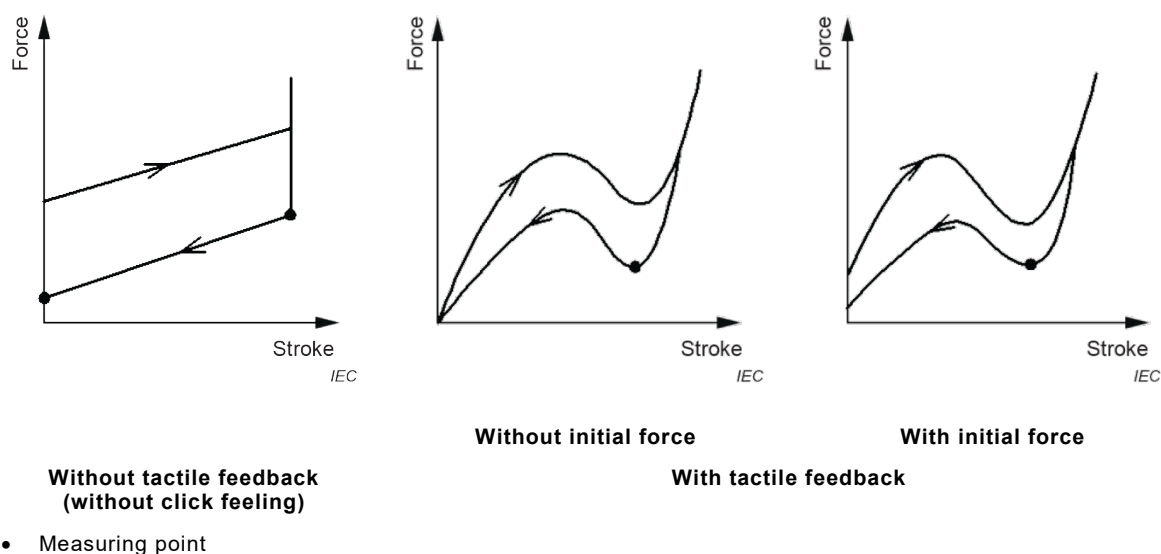


Figure 2 – Example of measuring points specified in detail specifications

4.3.6.3.3 Items to be specified in detail specification

The following items shall be specified in the detail specification:

- a) orientation of mounting (if specified);

- b) with or without knob, etc.;
- c) position and direction of applying force (if specified);
- d) measuring point of a returning force;
- e) any deviation from the standard test methods.

4.3.6.4 Travel (movement of the actuator)

4.3.6.4.1 Object

The objective of this test is to measure the travel from original position to the operating limit position.

4.3.6.4.2 Method

A specimen shall be mounted in normal condition of use and the travel shall be measured by the methods of a) or b).

- a) For switches whose travel is expressed as an angle: moving the operating part gradually, the angle is measured between the specified stop positions in the detail specifications.
- b) For switches whose operating range is expressed as a distance: moving the operating part gradually, the distance is measured between the specified stop positions in the detail specifications.

4.3.6.4.3 Items to be specified in detail specification

The following items shall be specified in the detail specification:

- a) test method 4.3.6.4.2 a) or b);
- b) type of travel;
- c) measuring point (if specified);
- d) number of times of measurement (if specified);
- e) any deviation from the standard test methods.

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 4.1.4.

The test circuit shown in Figure 3, or an equivalent, shall be used for detecting contact bounce. The values for the DC test voltage and test current shall be specified in the detail specification, but shall not exceed an open circuit voltage of 10 V DC 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 3 and 4.

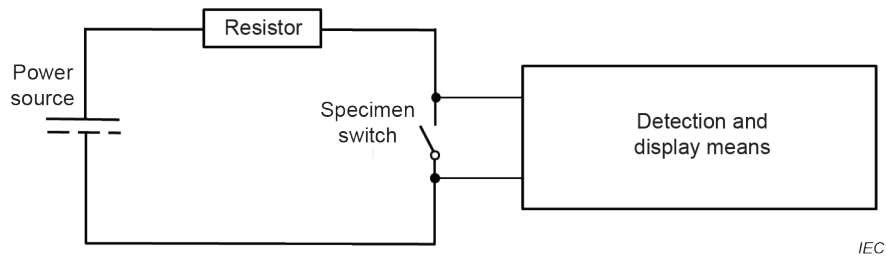


Figure 3 – Contact bounce test circuit

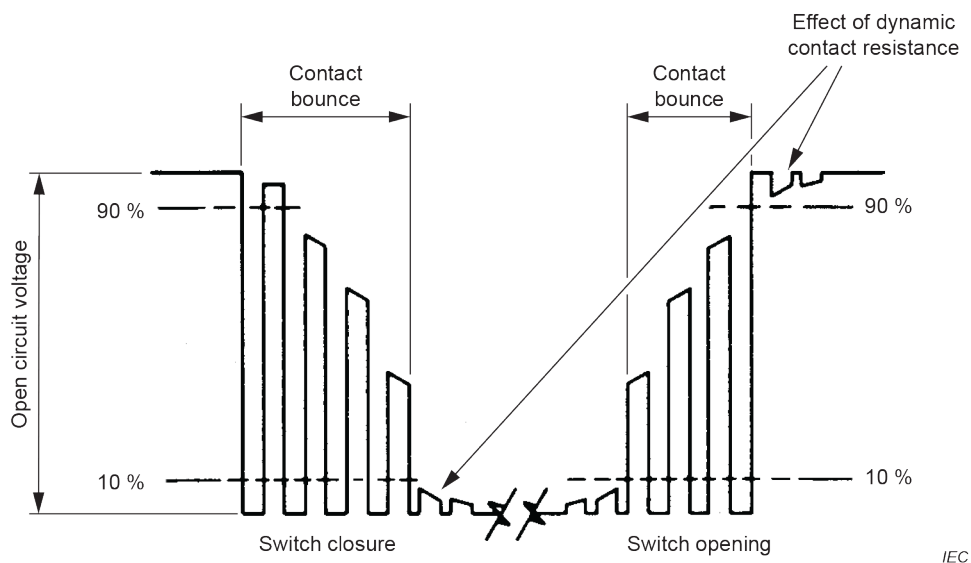


Figure 4 – Typical trace of contact bounce

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 Items to be specified in the detail specification

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

- preparation of specimen;
- speed of operation;
- point and direction of force application;
- test voltage and current;
- any deviation from the standard test methods.

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 alternating current or preferably, direct current. For AC measurements, the frequency shall not exceed 2 kHz, see Figure 6 for the test circuit. For DC measurements, see Figure 5 for the test circuit.
- 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. During the measurement, avoid exerting abnormal pressure on the contacts under test and 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 DC or AC peak. The test current shall not exceed 100 mA, AC or DC.
- h) One measuring cycle shall be performed on each switching circuit, where one measuring cycle for DC consists of
 - application of the voltage,
 - measurement with current flowing in one direction,
 - measurement with current flowing in the opposite direction, and
 - disconnection of the voltage source;and one measuring cycle for AC consists of
 - application of the voltage,
 - making the measurement, and
 - disconnection of the voltage source.

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 DC shall be the average of the two readings obtained with forward and reverse current.

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

$$R = \frac{|V_{mf} - V_{mr}|}{|I_f| + |I_r|} \quad (1)$$

NOTE In the formula, the sign of the voltage measurements is 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;

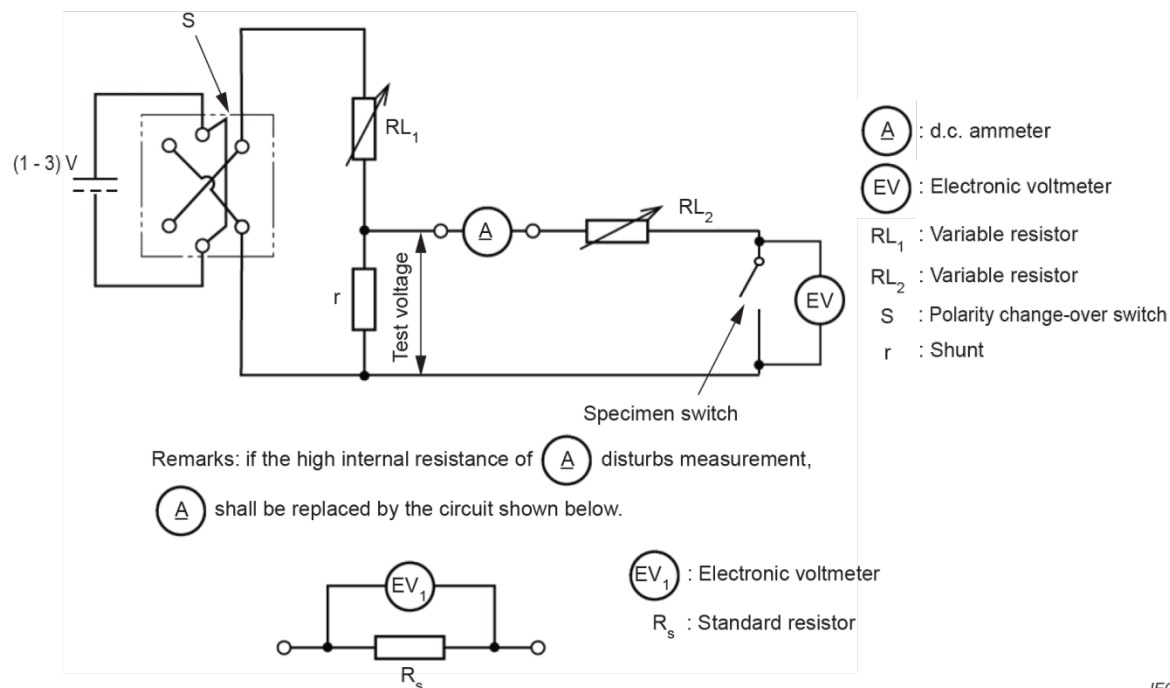
I_r is the reverse current.

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

4.4.1.4 Items to be specified in the detail specification

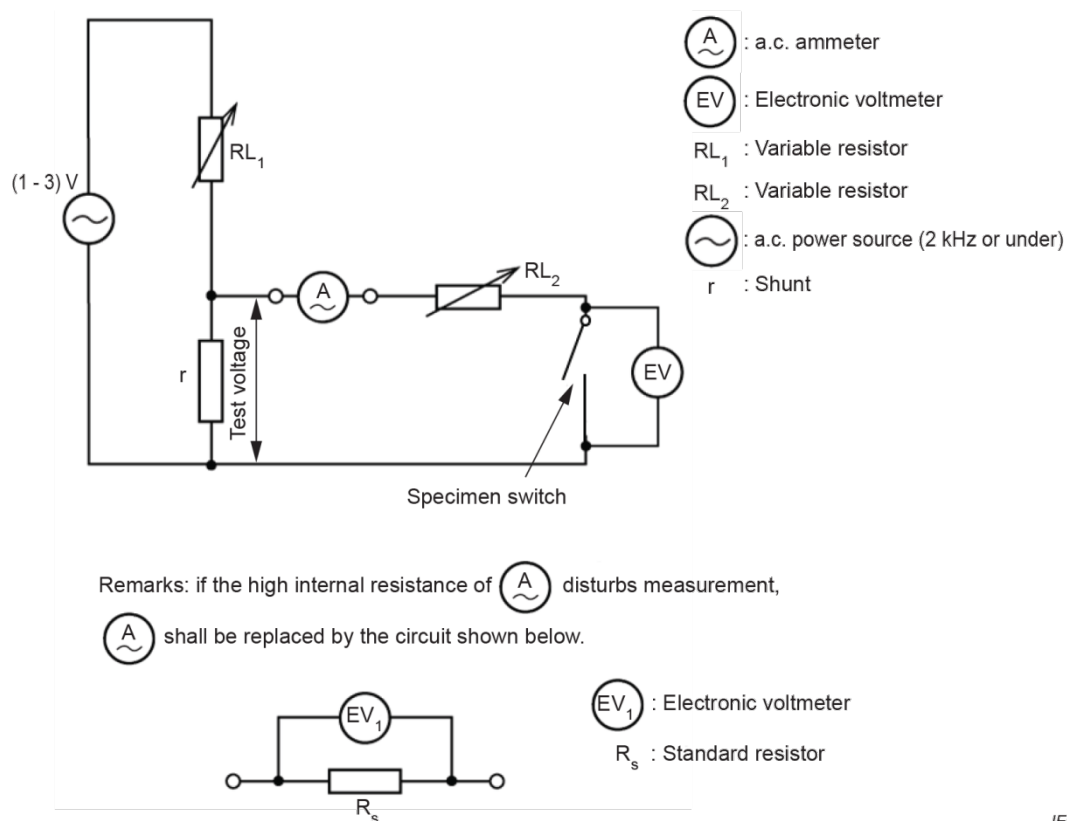
When this test is required by the detail specification, the following details shall be specified:

- a) the measuring points;
- b) the number of contacts to be measured;
- c) the permissible limits of contact resistance;
- d) whether the specimens are operated to 20 cycles with no current prior to the measurements;
- e) accuracy of measuring instruments (if specified);
- f) power source voltage for testing;
- g) test frequency (if specified);
- h) maximum test voltage at open circuit (if different from 4.4.1.2);
- i) any deviation from the standard test methods.



IEC

Figure 5 – Low voltage and current method (by DC)



IEC

Figure 6 – Low voltage and current method (by AC)

4.4.2 Contact resistance – Specified current

4.4.2.1 Object

The objective of the measurement is the determination of the total electrical resistance of the conducting switching circuit, including the switch terminations, at a voltage greater than the melting voltage of the contact material.

4.4.2.2 Method

The measurement shall be performed as follows.

- a) Measurements may be carried out with alternating current or preferably, direct current. For AC measurements, the frequency shall not exceed 2 kHz, see Figure 8 for the test circuit. For DC measurements, see Figure 7 for the test circuit.
- 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. During the measurement, avoid exerting abnormal pressure on the contacts under test and 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: The contact resistance shall be measured with the rated alternating current or direct current as specified in the detail specification. The open circuit voltage of the source shall be at least 1 V DC or AC peak. Contact resistance shall be calculated according to Formula (1).
- h) Measurements shall be made on individual contacts within 1 min following application of the test current.
- i) One measuring cycle shall be performed on each switching circuit, where one measuring cycle for DC consists of
 - application of the voltage,
 - measurement with current flowing in one direction,
 - measurement with current flowing in the opposite direction, and
 - disconnection of the voltage source;and one measuring cycle for AC consists of
 - application of the voltage,
 - making the measurement, and
 - disconnection of the voltage source.

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.

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

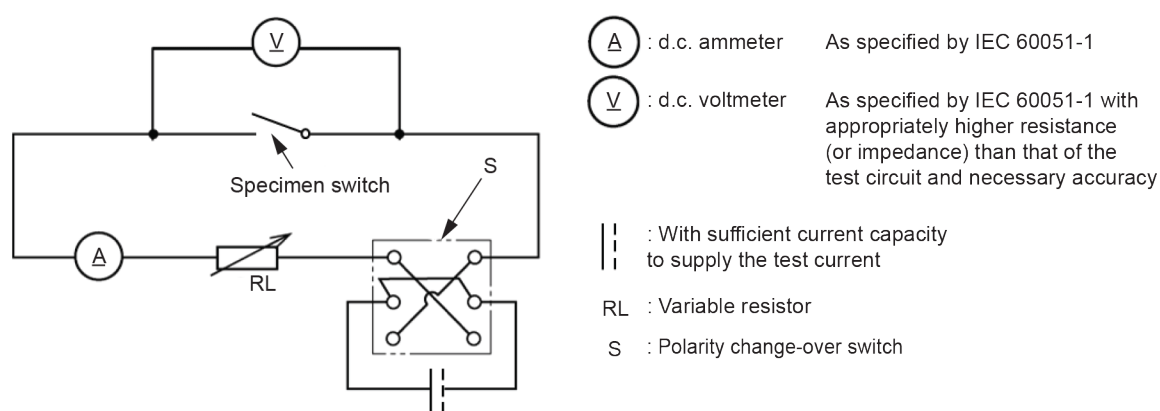
4.4.2.3 Requirement

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

4.4.2.4 Items to be specified in the detail specification

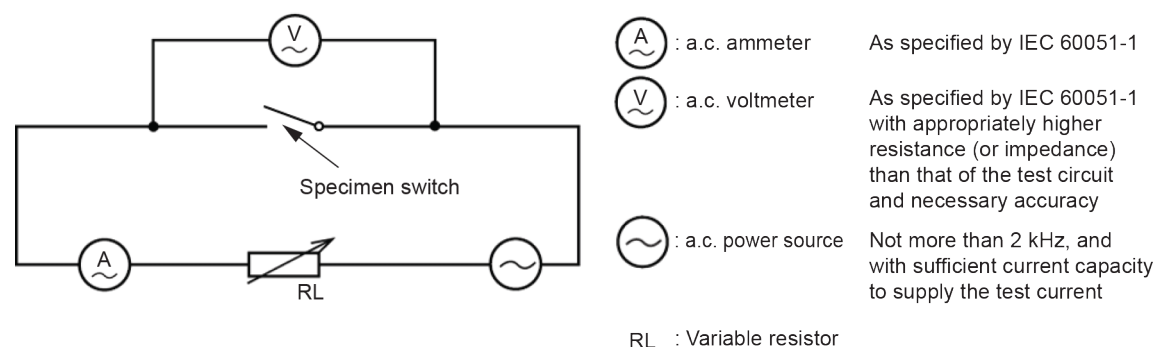
When this test is required by the detail specification, the following details shall be specified:

- the measuring points;
- the number of contacts to be measured;
- the measuring current;
- the permissible limits of contact resistance;
- accuracy of measuring instruments (if specified);
- power source voltage for testing;
- test frequency (if specified);
- maximum test voltage at open circuit (if different from 4.4.1.2);
- any deviation from the standard test methods.



IEC

Figure 7 – Specified current method (by DC)



IEC

Figure 8 – Specified current method (by AC)

4.4.3 Resistance from actuator to mounting bushing (surface)

4.4.3.1 Object

The objective of the measurement is the assessment of the total electrical resistance between the conductive portion of the switch actuator and the mounting bushing.

4.4.3.2 Method

The measurement shall be performed as follows.

- a) Connections shall be between suitable exterior points on the switch actuator and the mounting bushing. The actuator shall have no external force applied to it during measurement of resistance.
- b) One complete cycle of the actuator may be made prior to test.
- c) Actuations during test shall be limited to the maximum movement necessary to put the actuator into its next reading position.
- d) Resistance measurements shall be made in each of two actuator positions, as far apart as possible for rotary switches; at each normal actuator position for lever switches; or as specified in the detail specification.
- e) One resistance measurement shall be made in each actuator test position.
- f) Resistance shall be measured in accordance with 4.4.2 with a test voltage less than 15 V and a test current between 10 A and 25 A.
- g) The voltage drop measurement shall be made between a suitable point on the mounting bushing and the conductive part of the switch actuator (or the shield used for electromagnetic interference, if applicable).

4.4.3.3 Requirement

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

4.4.3.4 Items to be specified in the detail specification

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

- a) measurement positions of actuator if other than specified in 4.4.3.2;
- b) maximum allowable resistance;
- c) any deviation from the standard test methods.

4.4.4 Insulation resistance

4.4.4.1 Object

The objective of this test is to assess the insulation resistance of electromechanical components.

4.4.4.2 Method

Proceed as follows.

- a) The insulation resistance shall be measured with a closed-circuit of DC voltage of 100 V $\pm$ 15 V, 250 V $\pm$ 25 V or 500 V $\pm$ 50 V, using an insulation resistance tester, high resistance bridge or other suitable measuring apparatus.
- b) The insulation resistance shall be measured only when a stable reading is obtained. If a stable condition is not reached, the insulation resistance reading shall be recorded within 60 s $\pm$ 5 s after application of voltage.
- c) The insulation resistance shall be measured:
 - between terminals and earthed metal parts;
 - between terminals of adjacent mutually insulated circuits;
 - between all unconnected terminals of the same switching circuits;

At the option of the manufacturer, terminals may be grouped together to reduce the duration of the test. In the event of a failure with the terminals grouped together, each terminal shall be tested individually for acceptance.

 - between live parts and accessible non-live metal parts, and/or live metal parts and insulated operating parts.

- d) The measurement shall be performed in each actuator position up to a maximum of six positions.
- e) The detail specification may specify a reduction of measurements for switches having more than six poles, wafers, or cells and for switches with more than six operating positions.

4.4.4.3 Requirement

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

4.4.4.4 Items to be specified in the detail specification

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

- a) measuring points to be tested;
- b) value of the test voltage;
- c) minimum value of the insulation resistance;
- d) special preparation, mounting, etc. (if specified);
- e) number of tests (if more than one);
- f) any deviation from the standard test methods.

4.5 Withstand voltage

4.5.1 Withstand voltage at standard atmospheric conditions

4.5.1.1 Object

The objective of this test is to determine the ability of a component to withstand specified test voltages applied in a specified manner.

4.5.1.2 Method

Proceed as follows.

The power source for this test shall be capable of raising the test voltage gradually from 0 V to the specified test voltage (RMS value or DC voltage), and lowering the test voltage from the specified test voltage to 0 V under specified load for this test.

When the test voltage is 1 000 V or more, the power source shall be 500 VA or more.

- a) A DC or AC peak test voltage shall be applied for 5 s. If an AC test voltage is used, it shall have a frequency of 50 Hz to 60 Hz and be approximately sinusoidal in waveform. The rate of application of the test voltage shall not exceed 500 V/s.
- b) The test voltage shall be applied to any of the following measuring positions:
 - between terminals and earthed metal parts;
 - between terminals of adjacent mutually insulated circuits;
 - between all unconnected terminals of the same switching circuits;

At the option of the manufacturer, terminals may be grouped together to reduce the duration of the test. In the event of a failure with the terminals grouped together, each terminal shall be tested individually for acceptance.

 - between live parts and accessible non-live metal parts, and/or live metal parts and insulated operating parts.
- c) The test voltage shall be specified in the detail specification.
- d) The leakage current shall be measured by any appropriate means.
- e) The test shall be performed in each actuator position.

4.5.1.3 Requirement

During the test, the switch shall withstand the application of the test voltage without flashover, sparkover, or breakdown. The leakage current requirement shall be within the limits specified by the detail specification. Unless otherwise specified in the detail specification, the maximum permissible leakage current shall be 2 mA.

4.5.1.4 Items to be specified in the detail specification

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

- a) points of measurement;
- b) value and nature of the test voltage;
- c) contacts to be tested;
- d) maximum permissible leakage current, if different from 2 mA;
- e) special preparation, mounting, etc. (if specified);
- f) any deviation from the standard test methods.

4.5.2 Withstand voltage at low air pressure

4.5.2.1 Object

The objective of the test is the assessment of the ability of an insulation to resist breakdown when subjected to voltage stress under simulated altitude conditions.

4.5.2.2 Method

Proceed as follows.

- a) Preconditioning shall be specified in the detail specification, if necessary.
- b) Initial measurements shall be carried out as specified by the detail specification.
- c) The test shall be performed in a sealed test chamber in accordance with IEC 60068-2-13, Test M. The internal air pressure in the chamber shall be maintained at $8 \text{ kPa} \pm 5 \%$ (approximately 17 600 m of altitude) for 4 h, unless otherwise specified. The chamber shall be suitably equipped with electrical connections through the chamber wall.
- d) Unless otherwise specified, the test voltage shall be 400 V AC (RMS) for switches with a rated voltage above 42 V.

4.5.2.3 Requirement

During the test, the switch shall withstand the application of the test voltage without flashover, spark over, or breakdown. The leakage current shall be within the limits specified by the detail specification.

4.5.2.4 Items to be specified in the detail specification

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

- a) methods of mounting and wiring the specimen;
- b) conditioning severity (pressure);
- c) initial measurements;
- d) requirement for the measurements;
- e) duration of the exposure, if necessary;
- f) maximum leakage current;
- g) any deviation from the standard test methods.

4.6 Heating

4.6.1 Object

The objective of the measurement is the assessment of the rise in the temperature of the switch terminal at rated current.

4.6.2 Method

The measurement shall be performed in accordance with Clause 16 of IEC 61058-1:2016. The following details shall apply.

- a) The switch shall be mounted on a flat horizontal nonconductive surface.
- b) The temperature sensing device shall be a thermocouple located on the terminal as close as possible to the switch housing.
- c) The heating test shall be performed before the electrical endurance test and/or immediately following the electrical endurance test.
- d) The test current before the electrical endurance test shall be 1,06 times the maximum rated current of the switch. The test current after the electrical endurance test is the rated current.

Before the endurance test:

- switches with an upper category temperature of 55 °C are tested at 25 °C ± 10 °C;
 - other switches are tested at their upper category temperature. After the endurance test, all switches are tested at 25 °C ± 10 °C.
- e) The test duration shall be 1 h. The test may be terminated after three consecutive readings, taken at 5 min intervals, indicating no change in temperature greater than ± 2 °C.

4.6.3 Requirement

4.6.3.1 Before the electrical endurance test

The temperature rise shall not exceed 45 K at the terminals.

4.6.3.2 After the electrical endurance test

The temperature rise shall not exceed 55 K at the terminals.

4.6.4 Items to be specified in the detail specification

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

- a) wire size;
- b) wiring of specimen and type of termination;
- c) mounting of specimen;
- d) location, nature and characteristics of temperature-sensing devices;
- e) current, AC or DC;
- f) number of specimens, if necessary;
- g) measurement before and/or after an electrical endurance test;
- h) any deviation from standard test methods.

4.7 Dynamic stress

4.7.1 Shock

4.7.1.1 Object

The objective of this test is to assess the ability of components to withstand specified severities of shock.

4.7.1.2 Method

The test shall be performed in accordance with IEC 60068-2-27, Test Ea. The following details shall apply.

- a) Initial measurements shall be carried out as specified by the detail specification.
- b) The switch shall be mounted by its normal mounting means.
- c) Unless otherwise specified, the shock pulse shall be a half-sine pulse with a peak acceleration of 490 m/s^2 (50 g) and with a pulse width of 11 ms.
- d) The shock pulse shall be applied three times in each direction of the three mutually perpendicular axes of the switch for a total of 18 shock pulses.
- e) When specified by the detail specification, the switch contacts shall be monitored for contact disturbance in accordance with the contact disturbance test (see 4.7.3).
- f) After the test, the switch shall be visually examined for broken, deformed, displaced or loose parts. After the test group sequence, the switch shall be subjected to the functional operation test (see 4.3.5).

4.7.1.3 Requirement

When specified by the detail specification, there shall be no closing of open contacts or opening of closed contacts in excess of the value specified by the detail specification. After the test, there shall be no damage that impairs the electrical or mechanical operation of the switch.

4.7.1.4 Items to be specified in the detail specification

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

- a) methods of mounting specimen and associated cable(s)/wire bundle, including the unsupported length of cable from contact to first clamp;
- b) pulse shape;
- c) test severity (acceleration level and duration);
- d) axes and direction of shock;
- e) limit of duration of contact disturbance;
- f) maximum value of contact resistance, if necessary;
- g) operational characteristics to be checked;
- h) any deviation from the standard test methods.

4.7.2 Vibration

4.7.2.1 Object

The objective of this test is to assess the ability of components to withstand specified severities of sinusoidal vibration.

4.7.2.2 Method

The test shall be performed in accordance with IEC 60068-2-6, Test Fc. The following details shall apply.

- a) Initial measurements shall be carried out as specified by the detail specification.
- b) The switch shall be mounted by its normal mounting means.
- c) The frequency range and amplitude shall be specified by the detail specification.
- d) The duration of the endurance shall be 12 sweep cycles for each axis.
- e) The vibration frequency shall be varied logarithmically between the limits of the frequency range. The entire frequency range shall be swept from the lowest frequency to the highest frequency and returned to the lowest frequency.
- f) When specified by the detail specification, the switch contacts shall be monitored for contact disturbance in accordance with the contact disturbance test (see 4.7.3).
- g) After the test, the switch shall be visually examined for broken, deformed, displaced or loose parts. After the test group sequence, the switch shall be subjected to the functional operation test (see 4.3.5).
- h) For switches with lead wires, the lead wires shall also be fixed together with the switch.
- i) In the case of switches fixed on a printed wiring board, the specimen shall be soldered on a printed wiring board. The assembly shall be fastened to the vibration table directly or by means of mounting jigs.
- j) If the detail specification specifies the operation test or electrical load during -test, the operation test shall be carried out or the electrical load shall be connected during test.

4.7.2.3 Requirement

When specified by the detail specification, there shall be no closing of open contacts or opening of closed contacts in excess of the value specified by the detail specification. After the test, there shall be no damage which impairs the electrical or mechanical operation of the switch.

4.7.2.4 Items to be specified in the detail specification

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

- a) methods of mounting specimen and associated cable(s)/wire bundle, including the unsupported length of cable from contact to first clamp;
- b) test severity (frequency range, displacement amplitude, acceleration level, duration);
- c) limit of duration of contact disturbance, closing time for open contact or opening time for closed contact;
- d) maximum value of contact resistance, if necessary;
- e) operational characteristics to be checked;
- f) any deviation from the standard test methods.

4.7.3 Contact disturbance

4.7.3.1 Object

The objective of this test is to detect contact disturbance under specified dynamic conditions.

4.7.3.2 Method

The monitoring shall be performed as follows.

- a) The switch shall be mounted by its normal mounting means.
- b) The contact disturbance shall be determined under dynamic conditions. The duration of the opening of closed contacts and/or the closing of open contacts shall be determined when the component is subjected to bump, shock, vibration, or acceleration tests. The monitoring of contact disturbance shall be made during the period specified in the relevant test and/or detail specification. The contacts may be monitored individually or in one or more groups as specified in the detail specification. When monitored in groups, closed contacts may be connected in series and open contacts may be connected in parallel.

If failure is indicated when testing contacts in groups, it is permitted to test individual contacts subsequently.

- c) The switch shall be continuously monitored for the duration of the dynamic stress tests.
- d) The measurement shall be made with DC not exceeding 100 mA. The open circuit voltage of the source shall not exceed 10 V.
- e) A closed contact is considered disturbed when the voltage across it exceeds 50 % of the source open circuit voltage. An open contact is considered disturbed when the voltage across it drops below 50 % of the source open circuit voltage. In the case where the contact disturbance is considered to be a change of electrical resistance, this change shall be specified by the detail specification.
- f) Test equipment shall be provided with following characteristics:
 - capable to supply 10 V 100 mA DC max.; and
 - capable to detect voltage change (voltage increase or voltage decrease) exceeding 50 % of the open circuit voltage.

4.7.3.3 Requirement

The duration of the contact disturbance shall not exceed the value specified in the detail specification. Preferred values are 1 µs, 10 µs, 100 µs, 1 ms and 10 ms, unless otherwise specified in the detail specification.

4.7.3.4 Items to be specified in the detail specification

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

- a) methods of mounting and wiring the test specimen;
- b) monitoring period, if different from that specified in the relevant test methods;
- c) contacts to be monitored and their operated condition;
- d) limit of duration of contact disturbance;
- e) change of contact resistance, if required;
- f) magnitude of current and voltage to apply to the specimen;
- g) any deviation from the standard test methods.

4.8 Mechanical strength

4.8.1 Robustness of actuator

4.8.1.1 Object

The objective of the test is the assessment of the mechanical strength of the switch actuator using static pressure.

4.8.1.2 Method

The following items shall be applied as initial measurements:

- appearance (4.3.1),
- functional operation (4.3.5),
- contact resistance (4.4.1 and 4.4.2),
- insulation resistance (4.4.4),
- withstand voltage (4.5.1), and
- operating characteristics (4.3.6).

The switch shall be mounted by its normal mounting means. The detail specification shall specify the force or torque to be applied and the direction in which the force shall be applied. The direction of the applied force is shown in Figure 9.

The force or torque shall be steadily increased to the specified value and then maintained for 1 min. The specified force shall be applied in succession to each switch. If the switch actuators cannot be readily gripped by the fingers, forces F_5 , F_6 , T_1 and T_2 may be omitted. If the switch actuator is protected from the directional force, the force may be omitted. For example, F_1 and F_2 may be omitted for rocker switches which are flush with the panel.

After the test, the switch shall be visually examined for broken, deformed, displaced or loose parts.

After the test group sequence, following items shall be applied as final measurements:

- functional operation test (4.3.5),
- contact resistance (4.4.1 and 4.4.2),
- insulation resistance (4.4.4),
- withstand voltage (4.5.1), and
- operating characteristics (4.3.6).

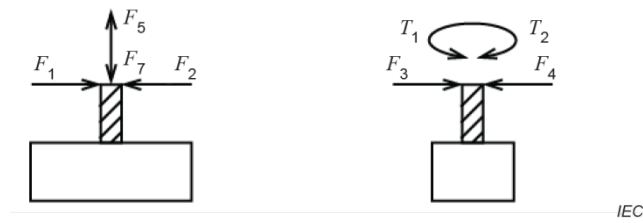
4.8.1.3 Requirement

After the test, there shall be no damage which impairs the electrical and/or mechanical operation of the switch.

4.8.1.4 Items to be specified in the detail specification

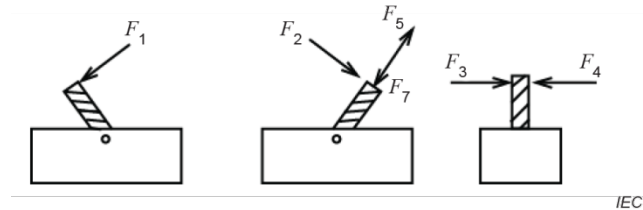
When this test is required by the detail specification, the following details shall be given:

- a) items of initial measurements;
- b) methods of mounting of the specimen;
- c) speed or characteristic of the force or torque to be applied;
- d) point and direction of force application;
- e) holding period of push, pull or torque;
- f) items of final measurements;
- g) any deviation from the standard test methods.



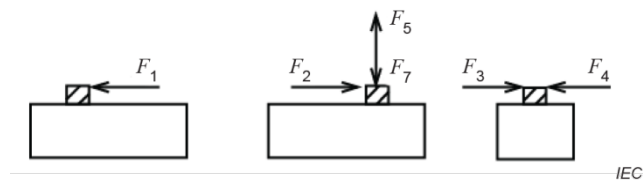
IEC

a) Spindle, button, plunger



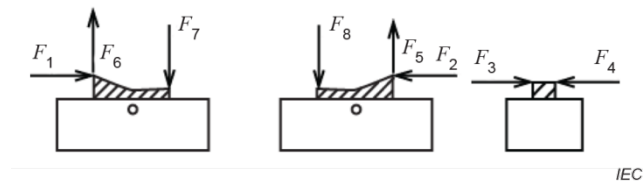
IEC

b) Lever



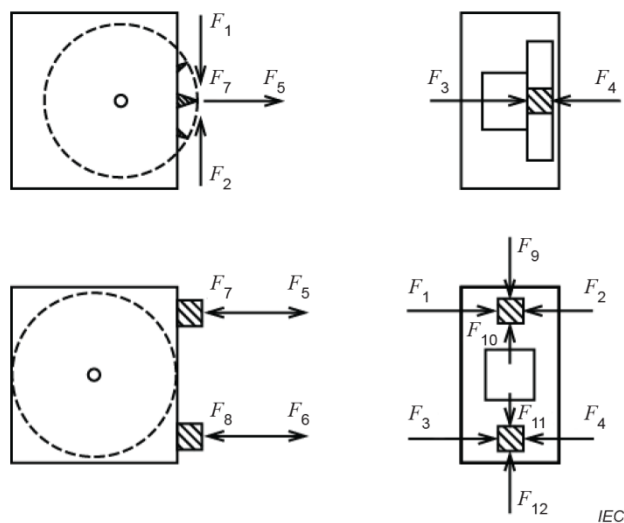
IEC

c) Slider



IEC

d) Rocker



IEC

e) Thumbwheel

Figure 9 – Application of forces and torques for 4.8.1

4.8.2 Robustness of mounting bushing

4.8.2.1 Object

The objective of the test is the assessment of a switch with a threaded mounting bushing to withstand the normal forces mounting a switch.

4.8.2.2 Method

The switch shall be mounted through an appropriate size hole in a metal plate using its normal mounting means or the specified mounting hardware, if any. The mounting nut shall be tightened with a torque equal to 125 % of the mounting torque specified in the detail specification. The torque shall be maintained for 1 min then loosened. The nut shall be tightened and then loosened a total of five times.

4.8.2.3 Requirement

After the test, there shall be no mechanical damage which would impair normal switch operation.

4.8.3 Robustness of screw mounting

4.8.3.1 Object

The objective of the test is the assessment of a switch which is mounted by screws to withstand the normal forces when mounting the switch.

4.8.3.2 Method

The test shall be performed in accordance with IEC 60068-2-21, Severity 1, Test Ud. The following details shall apply.

- The test shall be applied to the screws specified for mounting the switch. If no screws are specified, the largest screw which may be used to mount the switch shall be selected.
- The torque values according to Table 1 shall be applied for a period of 10 s to 15 s based on the degree of severity.
- After the test, the switch shall be visually examined for broken, deformed, displaced or loose parts.

Table 1 – Torque values for mounting screws

Nominal thread diameter mm	2,6	3,0	3,5	4,0	5,0	6,0
Torque Nm	0,4	0,5	0,8	1,2	2,0	2,5

4.8.3.3 Requirement

After the test, there shall be no mechanical damage which would impair normal operation.

4.8.4 Robustness of terminations

4.8.4.1 Object

The objective of this test is to verify that the terminations of the component will withstand such stresses as are likely to be applied during normal assembly or handling operations.

4.8.4.2 Method

The test shall be performed in accordance with IEC 60068-2-21, Test U. The following details shall apply:

- a) The switch shall be mounted by its normal mounting means.
- b) Test Ua1 (tensile) and test Ua2 (thrust) of IEC 60068-2-21 shall apply to all terminals.
Additional tests may be specified by the detail specification.
- c) After the test, the switch shall be visually examined for broken, deformed, displaced or loose parts.

4.8.4.3 Requirement

After the test, there shall be no mechanical damage which would impair normal switch operation.

4.8.4.4 Items to be specified in the detail specification

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

- a) applicable tests;
- b) method of preparation and mounting of the specimen;
- c) test conditions, such as values of the forces, number of bends, etc.;
- d) any deviation from the standard test method.

4.9 Mechanical endurance

4.9.1 Mechanical endurance – Standard atmospheric conditions

4.9.1.1 Object

The objective of the test is the assessment of the proper mechanical functioning of the switch within a category temperature range of 0 °C to 55 °C through its rated mechanical life and for switches such as inline switches which are not rated for actuation at extreme temperatures.

4.9.1.2 Method

The following items shall be applied as initial measurements:

- appearance (4.3.1),
- functional operation (4.3.5),
- contact resistance (4.4.1 and 4.4.2),
- insulation resistance (4.4.4),
- withstand voltage (4.5.1), and
- operating characteristics (4.3.6).

The test shall be performed as follows.

- a) The switch shall be connected as specified in the detail specification. The test equipment shall be arranged to apply only forces necessary for operation of the switch. Excessive operating force shall not be applied to the specimens.

NOTE Test circuit(s) are given in Table 2 of IEC 61058-1:2016. They can be used as far as applicable.

- b) The specimen shall be subjected to a mechanical operational endurance test in accordance with the requirements of the detail specification (without electrical load).
- c) The specimen shall be operated in the normal manner. The number of cycles of operation and the frequency of actuation shall be specified by the detail specification.

d) After the test group sequence, the switch shall be subjected to following test:

- the appearance (4.3.1),
- functional operation test (4.3.5), and
- the operating characteristics test (4.3.6).

If applicable, the switch shall also be subjected to following test:

- resistance measurements (4.4),
- withstand voltage (4.5.1), and
- sealing (4.14 and 4.15).

4.9.1.3 Requirement

After the test, there shall be no damage which impairs the mechanical or electrical operation of the switch. When specified by the detail specification, operating characteristics after the test may deviate from the specified values by 20 % maximum.

4.9.1.4 Items to be specified in the detail specification

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

- a) preparation of the specimen, including type of cable/wire bundle to be used;
- b) mounting of the specimen;
- c) number, frequency and speed of operations;
- d) requirements for final measurements;
- e) items of initial measurement;
- f) panel seal characteristics (if applicable);
- g) any deviation from the standard test methods.

4.9.2 Mechanical endurance – Category temperature range

4.9.2.1 Object

The objective of the test is the assessment of the proper mechanical functioning of the switch within its category temperature range through its rated mechanical life. This test applies when the switch has a category temperature range other than 0 °C to 55 °C.

4.9.2.2 Method

The test shall be performed in accordance with 4.9.1.2 except for the following details.

One half of the test samples shall be tested at the lower category temperature and the remaining half shall be tested at the upper category temperature.

The following items shall be applied as final measurements:

- appearance (4.3.1) except marking in 6.2,
- contact resistance (4.4.1 and 4.4.2),
- resistance from the operating part to the mounting bushing (if applicable) (4.4.3),
- insulation resistance (4.4.4),
- operating characteristics (4.3.6), and
- panel seal (if applicable) (4.14).

4.9.2.3 Requirement

After the test, there shall be no damage which impairs the mechanical or electrical operation of the switch.

4.9.2.4 Items to be specified in the detail specification

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

- a) preparation of the specimen, including type of cable/wire bundle to be used;
- b) mounting of the specimen;
- c) number, frequency and speed of operations;
- d) requirements for final measurements;
- e) items of initial measurement;
- f) panel seal characteristics (if applicable);
- g) any deviation from the standard test methods.

4.10 Electrical endurance

4.10.1 Electrical endurance – Standard atmospheric conditions

4.10.1.1 Object

The objective of the tests in 4.10.1.2 is the assessment of the ability of the switch to properly control its rated power (above 6 V or 0,5 A electrical loads) throughout its rated electrical life at standard atmospheric conditions. Additional tests for switches above 6 V and 0,5 A are specified in 4.10.2 to 4.10.4.

For switches rated below 6 V or 0,5 A, tests in accordance with the logic loads (TTL) test (see 4.10.5) or with the low level endurance test (see 4.10.6) may be selected.

4.10.1.2 Method

The following items shall be applied as initial measurements:

- appearance (4.3.1),
- functional operation (4.3.5),
- contact resistance (4.4.1 and 4.4.2),
- insulation resistance (4.4.4),
- withstand voltage (4.5.1), and
- operating characteristics (4.3.6).

The test shall be performed as follows.

- a) The switch shall be connected as specified in the detail specification. The test equipment shall be arranged to apply only forces necessary for operation of the switch. Excessive operating force shall not be applied to the specimens.

NOTE 1 Test circuit(s) are given in Table 2 of IEC 61058-1:2016. They can be used as far as applicable.

- b) The switch shall be loaded as specified in the detail specification.

NOTE 2 The loads are as specified in Table 102 and/or Table 103 of IEC 61058-1-1:2016.

- c) The switch shall be mounted by its normal mounting means. When safety requirements must be met, the metal mounting plate and the metal test actuator shall be electrically grounded.
- d) The switch shall be tested for the number of cycles specified by the detail specification.
- e) The frequency of actuation shall be specified by the detail specification.

- f) Unless otherwise specified, the duty cycle for each electrical load shall be a minimum of 25 % ON.
- g) Switches previously tested for overload shall be tested using the same set of contacts which had been tested during overload.
- h) The switch shall be tested at the specified electrical load ratings which exceed 6 V and 0,5 A. Electrical endurance tests at the highest rated voltage may represent tests at a lower voltage of the same frequency if the volt-amperes at the lower voltage are not greater than the volt-amperes at the higher voltage. Electrical endurance tests on AC inductive loads may represent tests on AC resistive loads if the rated AC resistive current is not greater than the AC inductive current.
- i) Unless otherwise specified, the nominal frequency of the AC voltage shall be 50 Hz to 60 Hz.
- j) For two-way switches, half of the test samples shall be tested with the test load connected to the contacts of one way and the remaining test samples shall be tested with the electrical load connected to the contacts of the other way. For multiple pole switches, all poles shall be tested simultaneously.
- k) The power source shall have sufficient capacity to provide the required test current(s) after the closure of the switch while maintaining the required test voltage at the switch termination.
- l) Unless otherwise specified, the switch shall be connected in the test circuit between the high side of the voltage source and the electrical load.
- m) A separate and independent electrical load shall be provided for each pole of the switch.
- n) When specified, the switch shall be continuously monitored to determine if any contact has failed to open (a "stick") or to close (a "miss") its individual circuit in proper sequence. The monitoring circuit shall not shunt inductive components of the electrical load or the switch contacts. The monitoring device shall either provide a record of the switching action of the contacts or shall automatically stop the test if the switch fails to open or close the circuit. The maximum number of contact malfunctions shall be specified by the detail specification.

The preferred values for sticks and/or misses are as follows:

- 0 sticks or misses;
 - 1 stick or miss per each 10^6 cycles;
 - 1 stick or miss per each 10^5 cycles;
 - 1 stick or miss per each 10^4 cycles;
 - 1 stick or miss per each 1 000 cycles;
 - 5 sticks and/or misses per each 1 000 cycles;
 - 10 sticks and/or misses per each 1 000 cycles;
 - no contact monitoring.
- o) The size of the connecting wire shall be appropriate to its rating.
The values given in Table 4 of IEC 61058-1:2016 shall be used.
 - p) After the test group sequence, the switch shall be subjected to the following test:
 - contact resistance specified current test (4.4.2),
 - functional operation test (4.3.5),
 - withstand voltage test (4.5.1),
 - visual examination (4.3.1) except marking,
 - insulation resistance (4.4.4), and
 - operating characteristics (4.3.6).

4.10.1.3 Requirement

When specified, the switch shall have no sticks and/or misses during the test in excess of those permitted. After the test, there shall be no damage which impairs the mechanical or electrical operation of the switch.

4.10.1.4 Items to be specified in the detail specification

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

- a) preparation of the specimen, including type and size of cable/wire bundle to be used;
- b) mounting of the specimen;
- c) type of load;
- d) voltage, AC or DC value, harmonic content and crest factor, if appropriate;
- e) current value;
- f) atmospheric pressure, if other than standard;
- g) number, speed and frequency of operations;
- h) requirements for final measurements and tests to be used;
- i) mechanical aids;
- j) initial measurements;
- k) number of sticks or misses of contact (if applicable);
- l) any deviation from the standard test methods.

4.10.2 Electrical endurance – Upper category temperature

4.10.2.1 Object

The objective of the test is the assessment of the effects of the upper category temperature on the ability of the switch to properly control its rated power (above 6 V and 0,5 A electrical loads) throughout its rated electrical life at standard atmospheric pressure.

4.10.2.2 Method

The test shall be performed as specified in 4.10.1 except that during the test the switch shall be subjected to upper category temperature specified for the switch.

4.10.2.3 Requirement

When specified, the switch shall have no sticks and/or misses during the test in excess of those permitted. After the test, there shall be no damage which impairs the mechanical or electrical operation of the switch.

4.10.2.4 Items to be specified in the detail specification

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

- a) preparation of the specimen, including type of cable/wire bundle to be used;
- b) mounting of the specimen;
- c) type of load;
- d) voltage, AC or DC value, harmonic content and crest factor, if appropriate;
- e) current value;
- f) atmospheric pressure, if other than standard;
- g) number, speed and frequency of operations;
- h) requirements for final measurements and tests to be used;
- i) mechanical aids;
- j) initial measurements;
- k) number of sticks or misses of contact (if applicable);
- l) temperature in the test chamber during test;

m) any deviation from the standard test methods.

4.10.3 Electrical endurance – Category temperature range

4.10.3.1 Object

The objective of the test is the assessment of the effect of the category temperature range on the ability of the switch to properly control its rated power (above 6 V and 0,5 A electrical load) throughout its rated electrical life at standard atmospheric pressure.

4.10.3.2 Method

The test shall be performed as specified in 4.10.1 except that during the test, the specified cycles of operation shall be performed in the following sequence:

- 80 % at standard atmospheric conditions;
- 10 % at the lower category temperature;
- 10 % at the upper category temperature.

4.10.3.3 Requirement

When specified, the switch shall have no sticks and/or misses during the test in excess of those permitted. After the test there shall be no damage which impairs the mechanical or electrical operation of the switch.

4.10.3.4 Items to be specified in the detail specification

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

- a) preparation of the specimen, including type of cable/wire bundle to be used;
- b) mounting of the specimen;
- c) type of load;
- d) voltage, AC or DC value, harmonic content and crest factor, if appropriate;
- e) current value;
- f) atmospheric pressure, if other than standard;
- g) number, speed and frequency of operations;
- h) requirements for final measurements and tests to be used;
- i) mechanical aids;
- j) initial measurements;
- k) number of sticks or misses of contact (if applicable);
- l) lower category temperature;
- m) upper category temperature;
- n) any deviation from the standard test methods.

4.10.4 Electrical endurance – low air pressure

4.10.4.1 Object

The objective of the test is the assessment of the effect of reduced air pressure on the ability of the switch to properly control its rated power (above 6 V and 0,5 A electrical loads) throughout its rated electrical life.

4.10.4.2 Method

The test shall be performed as specified in 4.10.1.2 except that during the test, the switch shall be subjected to a reduced air pressure equivalent to the altitude rating specified for the switch.

The initial and final measurements shall be visual examination (4.3.1), functional operation (4.3.5) and withstand voltage at standard atmospheric conditions (4.5.1).

4.10.4.3 Requirement

When specified, the switch shall have no sticks and/or misses during the test in excess of those permitted. After the test, there shall be no damage which impairs the mechanical or electrical operation of the switch.

4.10.4.4 Items to be specified in the detail specification

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

- a) preparation of the specimen, including type of cable/wire bundle to be used;
- b) mounting of the specimen;
- c) type of load;
- d) voltage, AC or DC value, harmonic content and crest factor, if appropriate;
- e) current value;
- f) atmospheric pressure, if other than standard;
- g) number, speed and frequency of operations;
- h) requirements for final measurements and tests to be used;
- i) mechanical aids;
- j) initial measurements;
- k) number of sticks or misses of contact (if applicable);
- l) low atmospheric pressure value during test;
- m) any deviation from the standard test methods.

4.10.5 Logic loads (TTL)

4.10.5.1 Object

The objective of the test is the assessment of the ability of the switch to properly control a specified logic level electrical load which exceeds the melting voltage of the contact material (approximately 0,4 V) and is less than the arcing voltage and arcing current (approximately 6 V and 0,5 A). The application circuit is presumed to buffer the initial 10 ms to exclude any contact bounce.

4.10.5.2 Method

The test shall be performed as follows.

- a) The switch shall be mounted by its normal mounting means.
- b) Each pair of specimen contacts shall be tested using a $(5 \pm 0,5)$ V DC, (10 ± 1) mA resistive load. During each closure and each opening of each pair of contacts, the contacts shall be monitored with a device which does not alter the specified test parameters for the contacts. The monitoring device shall either record the proper opening and closing of the contacts, or shall discontinue the test in the event of a contact failure.
 - Monitoring during closure:

The contact voltage drop shall be monitored for no less than 50 % of each contact static closure. The contacts shall not be monitored until 10 ms after the initial contact closure to exclude any contact bounce. A contact voltage drop of 2,1 V or greater shall constitute a contact "miss" (failure to properly close the circuit).

- Monitoring during opening:
The contact voltage drop shall be monitored for no less than 50 % of each contact opening. The contacts shall not be monitored until 10 ms after the initial contact opening to exclude any contact bounce. A contact voltage drop less than 4,5 V shall constitute a contact "stick" (failure to properly open the circuit).
- c) The maximum number of contact malfunctions shall be specified by the detail specification. The recommended values for sticks and/or misses are as follows:
 - 0 sticks or misses;
 - 1 stick or miss per each 10^6 cycles;
 - 1 stick or miss per each 10^5 cycles.
- d) Unless otherwise specified, the test shall be performed under standard atmospheric conditions.
- e) The number of cycles of operation shall be as specified by the detail specification.
- f) The test voltage, test current, and monitoring apply for TTL logic circuits only. Other values may be specified by the detail specification for other types of electronic logic circuits.

4.10.5.3 Requirement

During the test, the switch shall open and close each switching circuit in proper sequence.

4.10.5.4 Items to be specified in the detail specification

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

- a) preparation of the specimen, including type of cable/wire bundle to be used;
- b) mounting of the specimen;
- c) type of load;
- d) voltage, AC or DC value, harmonic content and crest factor, if appropriate;
- e) current value;
- f) atmospheric pressure, if other than standard;
- g) number, speed and frequency of operations;
- h) requirements for final measurements and tests to be used;
- i) mechanical aids;
- j) initial measurements;
- k) number of sticks or misses of contact (if applicable);
- l) any deviation from the standard test methods.

4.10.6 Low level endurance test

4.10.6.1 Object

The objective of the test is the assessment of the ability of the switch to properly control a specified low level electrical load which is less than the softening voltage of the contact material (approximately 80 mV). The application circuit is presumed to buffer the initial 10 ms to any contact bounce.

4.10.6.2 Method

The test shall be performed as follows.

- a) The switch shall be mounted by its normal mounting means.
- b) Each pair of specimen contacts shall be tested using a 20 mV maximum, 10 mA maximum resistive load. During each closure and each opening of each pair of contacts, the contacts

shall be monitored with a device which does not alter the specified test parameters for the contacts. The monitoring device shall either record the proper opening and closing of the contacts, or shall discontinue the test in the event of a contact failure.

– Monitoring during closure:

The contact voltage drop shall be monitored for no less than 50 % of each contact static closure. The contacts shall not be monitored until 10 ms after the initial contact closure to exclude any contact bounce. A contact voltage drop of 50 % of the open circuit voltage or greater shall constitute a contact "miss" (failure to properly close the circuit).

– Monitoring during opening:

The contact voltage drop shall be monitored for no less than 50 % of each contact opening. The contacts shall not be monitored until 10 ms after the initial contact opening to exclude any contact bounce. A contact voltage drop less than 90 % of the open circuit voltage shall constitute a contact "stick" (failure to properly open the circuit).

c) The maximum number of contact malfunctions shall be specified by the detail specification.

The recommended values for sticks and/or misses are as follows:

- 0 sticks or misses;
- 1 stick or miss per each 10^6 cycles;
- 1 stick or miss per each 10^5 cycles.

d) Unless otherwise specified, the test shall be performed at standard atmospheric conditions.

e) The number of cycles of operation shall be as specified by the detail specification.

4.10.6.3 Requirement

During the test, the switch shall open and close each switching circuit in proper sequence.

4.10.6.4 Items to be specified in the detail specification

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

- a) preparation of the specimen, including type of cable/wire bundle to be used;
- b) mounting of the specimen;
- c) type of load;
- d) voltage, AC or DC value, harmonic content and crest factor, if appropriate;
- e) current value;
- f) atmospheric pressure, if other than standard;
- g) number, speed and frequency of operations;
- h) requirements for final measurements and tests to be used;
- i) mechanical aids;
- j) initial measurements;
- k) number of sticks or misses of contact (if applicable);
- l) voltage between contacts;
- m) any deviation from the standard test methods.

4.11 Overload

4.11.1 Electrical overload

4.11.1.1 Object

The objective of this test is to assess the performance of contacts with a specified electrical overload current.

4.11.1.2 Method

The test shall be performed as follows.

- a) Details a), c), e), f), i), j), k), l), m) and o) of 4.10.1.2 shall apply.
- b) The test shall be performed on the same contacts which will be subjected to the tests in 4.10.1 through 4.10.4.
- c) The switch shall be subjected to 100 cycles of operation.
So far as the design allows, except for locked rotor tests, capacitive and simulated lamp load tests, the switches are operated at a rate of
 - 30 operations per minute if the rated current does not exceed 10 A,
 - 15 operations per minute if the rated current exceeds 10 A but is less than 25 A,
 - 7,5 operations per minute if the rated current is 25 A or more,with the ON period being 25^{+5}_0 % and the OFF period being 75^{+5}_0 % of an operating cycle.
- d) The loads used are those specified for tests according to 4.10.1, the voltage then being increased to 1,15 times the rated voltage, thus also increasing the overload test current.
- e) During the test, the switch shall be continuously monitored to determine if the switch has failed to open or to close its circuit or circuits in proper sequence.
- f) The operating speed shall be specified by the detail specification.

4.11.1.3 Requirement

During the test, the switch shall not fail to open or to close its individual switching circuits in proper sequence.

4.11.1.4 Items to be specified in the detail specification

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

- a) preparation of the specimen;
- b) type and size of electrical wire or cable;
- c) minimum or maximum voltages to be applied;
- d) currents to be applied;
- e) air pressure, if not standard;
- f) requirements for final measurements;
- g) initial measurements;
- h) operating speed;
- i) any deviation from the standard test methods.

4.11.2 Capacitive load switching

4.11.2.1 Object

The objective of the test is the assessment of the making and breaking ability of a switch which is intended for use as a main switch. This test is also suitable for the simulation of high peak inrush currents.

4.11.2.2 Method

The test shall be performed as follows.

- a) The switch shall be mounted by its normal mounting means.

- b) The test circuit shall be that given in Figure 8 or 9 of IEC 61058-1:2016. Single pole switches should break the test circuit.
- c) When the inrush current rating of the switch is specified, the values given in Figure 8 or 9 of IEC 61058-1:2016 shall be used.
- d) The load circuit components shall be such that the load current is within ± 10 % of its specified value.
- e) The source impedance shall be sufficiently low so as not to affect the test results.
- f) The switch shall be subjected to a total of 10 000 cycles of operation unless otherwise specified in the detail specification. The duty cycles shall be approximately 50 %. The rate of cycling shall be seven cycles per minute.
- g) The switch closure shall not be synchronized with the supply frequency in order to obtain random load conditions.
- h) After the test group sequence, the switch shall be subjected to dielectric strength test (see 4.5.1) except the test voltage shall be decreased to 75 % of the corresponding test voltage and the functional operation test (see 4.3.5).
- i) Test voltage shall be 250 V AC if not specified in detail specifications.
- j) Test peak current shall be 8, 16 or 32 times the rated current.

4.11.2.3 Requirement

After the test, there shall be no damage which impairs the mechanical or electrical operation of the switch.

4.11.2.4 Items to be specified in the detail specification

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

- a) preparation of specimen;
- b) voltage to be applied;
- c) test current (shall not be greater than the normal current rating of the specimen);
- d) inrush current;
- e) required number of cycles, if other than 10 000;
- f) requirements for initial and final measurements;
- g) additional requirements, if any;
- h) any deviation from the standard test methods.

4.12 Environmental testing

4.12.1 Climatic sequence

4.12.1.1 Object

The objective of the test is the assessment of the ability of non heat dissipating switches (temperature rise is less than 5 K) to withstand exposure to specified environments without degradation.

4.12.1.2 Method

The test sequence shall be carried out in accordance with IEC 60068-2-61, Test Z/ABDM climatic sequence. Severity and intermediate measurements for the different steps shall be carried out as specified by the detail specification.

Initial measurement shall be performed as follows:

- visual examination (4.3.1),