

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**Appareillage à basse tension –
Partie 5-1: Appareils et éléments de commutation pour circuits de commande –
Appareils électromécaniques pour circuits de commande**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2024 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 Secretariat
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 It also gives information on projects, replaced and withdrawn publications.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.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

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.

IEC Products & Services Portal - products.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications, symboles graphiques et le glossaire. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 500 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 25 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**Appareillage à basse tension –
Partie 5-1: Appareils et éléments de commutation pour circuits de commande –
Appareils électromécaniques pour circuits de commande**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.120.40, 29.130.20

ISBN 978-2-8322-8326-4

**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.....	9
1 Scope.....	11
2 Normative references	12
3 Terms, definitions, symbols and abbreviated terms.....	14
3.1 Terms and definitions.....	14
3.1.1 General	14
3.1.2 Basic terms and definitions	14
3.1.3 Terms and definitions concerning automatic control switches	16
3.1.4 Terms and definitions concerning manually operated control switches	16
3.1.5 Terms and definitions concerning parts of control switches	18
3.1.6 Terms and definitions concerning operation of contactor relays	21
3.1.7 Terms and definitions concerning operation of pilot switches	21
3.1.8 Terms and definitions concerning operation of rotary switches.....	22
3.1.9 Terms and definitions concerning operation of mechanically operated control switches	22
3.1.10 Terms and definitions concerning reed contact magnetic switches	25
3.1.11 Terms and definitions concerning Class II control circuit devices	26
3.1.12 Terms and definitions concerning control circuit devices with integrally connected cables.....	26
3.1.13 Terms and definitions concerning semiconductor switching elements	27
3.1.14 Terms and definitions concerning indicator lights, indicating towers and audible signalling devices	27
3.1.15 Terms and definitions concerning control switches with direct opening action	28
3.1.16 Terms and definitions concerning digital communication interface	28
3.1.17 Alphabetical index of definitions.....	29
3.2 Symbols and abbreviated terms	33
4 Classification.....	33
4.1 Contact elements	33
4.2 Control switches	35
4.3 Control circuit devices.....	35
4.4 Time delay switching elements.....	35
4.5 Control switch mounting.....	35
5 Characteristics	35
5.1 Summary of characteristics	35
5.1.1 General	35
5.1.2 Operation of a control switch	35
5.2 Type of control circuit device or switching element.....	36
5.2.1 Kind of control circuit device	36
5.2.2 Kind of switching elements	36
5.2.3 Number of poles	36
5.2.4 Kind of current.....	36
5.2.5 Interrupting medium.....	36
5.2.6 Operating conditions.....	37
5.3 Rated and limiting values for switching elements	37
5.3.1 General	37
5.3.2 Rated voltages (of a switching element).....	37

5.3.3	Currents	37
5.3.4	Rated frequency	38
5.3.5	Vacant	38
5.3.6	Characteristics under normal and abnormal load conditions	38
5.3.7	Short-circuit characteristics – Rated conditional short-circuit current	40
5.4	Utilization categories for switching elements	40
5.5	Control circuits	40
5.6	Vacant	41
5.7	Vacant	41
5.8	Vacant	41
5.9	Vacant	41
5.10	Electrically separated contact elements	41
5.11	Actuating quantities for pilot switches	41
5.12	Pilot switches having two or more contact elements	41
6	Product information	41
6.1	Nature of information	41
6.2	Marking	43
6.2.1	General	43
6.2.2	Terminal identification and marking	43
6.2.3	Functional markings	43
6.2.4	Emergency stop	43
6.2.5	Operating diagram	43
6.2.6	Time delay markings	44
6.3	Instructions for installation, operation and maintenance, decommissioning and dismantling	45
6.4	Environmental information	45
6.4.1	Environmentally conscious design process (ECD process)	45
6.4.2	Procedure to establish material declaration	45
6.5	Additional information	45
7	Normal service, mounting and transport conditions	46
7.1	Normal service conditions	46
7.1.1	Ambient air temperature	46
7.1.2	Altitude	46
7.1.3	Atmospheric conditions	46
7.1.4	Shock and vibration	46
7.2	Conditions during transport and storage	46
7.3	Mounting	46
7.3.1	General	46
7.3.2	Mounting of single hole mounted devices	46
8	Constructional and performance requirements	48
8.1	Constructional requirements	48
8.1.1	General	48
8.1.2	Materials	48
8.1.3	Current-carrying parts and their connections	49
8.1.4	Clearances and creepage distances	49
8.1.5	Actuator	49
8.1.6	Indication of the contact position	50
8.1.7	Conditions for control switches suitable for isolation	50
8.1.8	Terminals	50

8.1.9	Vacant	50
8.1.10	Provisions for protective earthing	50
8.1.11	Enclosures for equipment	50
8.1.12	Degrees of protection of enclosed equipment	50
8.1.13	Conduit pull-out, torque and bending with metallic conduits	50
8.1.14	Requirements for control circuit devices with artificial optical radiation	50
8.1.15	Biological and chemical effects	51
8.1.16	Hygienic design	51
8.1.17	Security aspects	51
8.1.18	Limited energy source	51
8.1.19	Fault and abnormal conditions	53
8.1.20	Stored charge energy circuit	54
8.1.21	Embedded software	54
8.2	Performance requirements	54
8.2.1	Operating conditions	54
8.2.2	Temperature-rise	54
8.2.3	Dielectric properties	54
8.2.4	Ability to make and break under normal and abnormal load conditions	54
8.2.5	Conditional short-circuit current	55
8.2.6	Vacant	55
8.2.7	Additional requirements for control switches suitable for isolation	55
8.3	Electromagnetic compatibility (EMC)	55
8.3.1	General	55
8.3.2	Immunity	56
8.3.3	Emission	56
8.4	Special requirements	56
8.4.1	Additional requirements for reed contact magnetic switches	56
8.4.2	Class II control circuit devices	57
8.4.3	Additional requirements for control circuit devices with integrally connected cables	57
8.4.4	Additional requirements for semiconductor switching elements for control circuit devices	57
8.4.5	Special requirements for indicator lights, indicating towers and their optional audible functions	57
8.4.6	Special requirements for control switches with direct opening action	57
8.4.7	Special requirements for mechanically linked contact elements	57
8.4.8	Additional requirements for control circuit devices incorporating a built-in communication interface (SDCI)	57
9	Tests	57
9.1	Kinds of test	57
9.1.1	General	57
9.1.2	Type tests	57
9.1.3	Routine tests	58
9.1.4	Sampling tests	58
9.1.5	Special tests	58
9.2	Compliance with constructional requirements	59
9.2.1	General	59
9.2.2	Test of materials to abnormal heat and fire	59
9.2.3	Equipment	59
9.2.4	Degrees of protection	59

9.2.5	Mechanical and electrical properties of terminals	60
9.2.6	Verification of actuating force (or torque)	62
9.2.7	Verification of limitation of rotation (of a rotary switch)	62
9.2.8	Conduit pull-out test, torque test and bending test with metallic conduits	62
9.2.9	Test of earth continuity for protective earth	62
9.2.10	Limited energy source test	62
9.2.11	Breakdown of components	63
9.2.12	Artificial optical radiation test	63
9.2.13	Stored charge energy test	64
9.3	Performance	64
9.3.1	Test sequences	64
9.3.2	General test conditions	65
9.3.3	Performance under no-load, normal load and abnormal load conditions	66
9.3.4	Performance under conditional short-circuit current	70
9.4	Tests for EMC	72
9.4.1	General	72
9.4.2	Immunity	72
9.4.3	Emission	74
9.4.4	Test results and test report	75
Annex A (normative)	Electrical ratings based on utilization categories (see 4.1)	76
Annex B (informative)	Example of inductive test loads for DC contacts	78
B.1	General	78
B.2	Construction	78
Annex C (normative)	Special tests – Durability tests	80
C.1	General	80
C.1.1	Durability declaration	80
C.1.2	Test procedures	80
C.1.3	Failure criteria	80
C.2	Mechanical durability	81
C.2.1	General	81
C.2.2	Test procedures	81
C.3	Electrical durability	81
C.3.1	General	81
C.3.2	Test procedures	81
Annex D (normative)	Additional requirements for reed contact magnetic switches	84
Annex E (informative)	Items subject to agreement between manufacturer and user	87
Annex F (normative)	Class II control circuit devices – Requirements and tests	88
Annex G (normative)	Additional requirements for control circuit devices with integrally connected cables	93
Annex H (normative)	Additional requirements for semiconductor switching elements for control circuit devices	97
Annex I (informative)		103
Annex J (normative)	Special requirements for indicator lights, indicating towers and audible signalling devices	104
Annex K (normative)	Special requirements for control switches with direct opening action	110
Annex L (normative)	Special requirements for mechanically linked contact elements	115

Annex M (normative) Terminal marking, distinctive number and distinctive letter for control circuit devices	118
M.1 General.....	118
M.2 Terminal marking rule	118
M.2.1 General	118
M.2.2 Function digit.....	118
M.2.3 Sequence digit.....	118
M.2.4 Numbering method	119
M.3 Distinctive number and distinctive letter	119
M.3.1 General	119
M.3.2 Distinctive number	119
M.3.3 Distinctive letter.....	119
M.4 Terminal numbering sequence	120
M.5 Contactor relays designated by the distinctive letter E	120
M.6 Contactor relays designated by distinctive letters X, Y or Z	122
M.6.1 Contactor relays designated by the distinctive letter Z	122
M.6.2 Contactor relays designated by the distinctive letter X	122
M.6.3 Contactor relays designated by the distinctive letter Y	122
Annex N (normative) Procedure to determine reliability data for electromechanical devices in control circuits used in functional safety applications.....	123
N.1 General.....	123
N.1.1 Overview	123
N.1.2 Object.....	123
N.1.3 General requirements	123
N.2 Terms, definitions and symbols	123
N.3 Method based on durability test results	123
N.3.1 General method	123
N.3.2 Test requirements.....	123
N.3.3 Number of samples.....	124
N.3.4 Characterization of a failure mode	124
N.3.5 Weibull modelling	124
N.3.6 Useful life and upper limit of failure rate.....	124
N.3.7 Reliability data.....	124
N.4 Data information	124
N.5 Example.....	124
Annex O (normative) Additional requirements for control circuit devices incorporating a built-in communication interface complying with IEC 61131-9	125
Bibliography.....	127
Figure 1 – Operation of push-buttons	23
Figure 2 – Difference e between the over-travel of the actuator and that of the contact element.....	23
Figure 3 – Examples of contact elements (schematic sketches)	34
Figure 4 – Examples of the recommended method for drawing an operating diagram of a rotary switch	44
Figure 5 – Mounting hole diameter and dimensions of the key recess (if any)	47
Figure 6 – Voltage drop measurement at contact point of the clamping unit or terminal.....	61
Figure 7 – Test circuits for multi-pole control switches – Contacts of same polarity, not electrically separated	68

Figure 8 – Test circuits for multi-pole control switches – Electrically separated	68
Figure 9 – Load L_d details for test conditions requiring different values of make and break current and/or power factor (time constant)	69
Figure 10 – Current/time limits for DC test loads	69
Figure 11 – Test circuit, conditional short-circuit current	71
Figure B.1 – Construction of load for DC contacts	79
Figure C.1 – Normal circuit (see C.3.2.2)	83
Figure C.2 – Simplified circuit (see C.3.2.2)	83
Figure F.1 – Device insulated by encapsulation	88
Figure F.2 – Device insulated by double and reinforced insulation	89
Figure F.3 – Test apparatus	91
Figure H.1 – Relationship between U_e and U_B	98
Figure H.2 – Example of test circuit for the verification of voltage drop, minimum operational current and OFF-state current	100
Figure H.3 – Short-circuit testing	101
Figure J.1 – Mounting dimensions for indicating tower socket	105
Figure J.2 – Mounting dimensions for temperature-rise tests	107
Figure K.1 – Verification of robustness of the actuating system	114
Figure L.1 – Example of representation of NO and NC contacts which are mechanically linked and NC non-linked contact	116
Figure L.2 – Symbol for device containing mechanically linked contacts	116
Table 1 – Utilization categories for switching elements	36
Table 2 – Verification of making and breaking capacities of switching elements under normal load conditions corresponding to the utilization categories	39
Table 3 – Verification of making and breaking capacities of switching elements under abnormal conditions corresponding to the utilization categories	40
Table 4 – Mounting hole diameter and dimensions of the key recess (if any)	47
Table 5 – Preferred minimum distances between centres of mounting holes	47
Table 6 – Test conditions for glow-wire test	49
Table 7 – Limits for limited energy sources without an overcurrent protective device	52
Table 8 – Limits for limited energy sources with an overcurrent protective device	52
Table 9 – Limits for limited energy source with limited current impedance	53
Table 10 – Acceptance criteria	56
Table 11 – Test values for electrical performance and ageing test of screwless-type clamping units	61
Table 12 – Immunity tests	73
Table A.1 – Examples of contact rating designation based on utilization categories	76
Table A.2 – Examples of semiconductors switching element ratings for 50 Hz and/or 60 Hz	77
Table A.3 – Examples of semiconductors switching element ratings for direct current	77
Table B.1 – DC loads	79
Table C.1 – Making and breaking conditions for electrical durability	82
Table F.1 – Acceptance criteria for Annex F	90
Table G.1 – Material characteristics (informative)	

Table G.2 – Examples of standard cable types (informative)	95
Table G.3 – Tensile forces	95
Table M.1 – Diagrams of control switches	120
Table M.2 – Diagrams of contactor relays designated by the distinctive letter E	121
Table M.3 – Diagrams of contactor relays designated by the distinctive letter Y	122

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

**Part 5-1: Control circuit devices and switching elements –
Electromechanical control circuit devices**

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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60947-5-1 has been prepared by subcommittee 121A: Low-voltage switchgear and controlgear, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low voltage. It is an International Standard.

This fifth edition cancels and replaces the fourth edition published in 2016. This edition constitutes a technical revision.

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

- a) update of the scope structure and exclusions;
- b) requirements for control circuits;
- c) update of the normal service conditions (e.g. shock and vibration);
- d) update of information and marking requirements including environmental information requirements referencing IEC TS 63058:2021;

- e) update of the constructional requirements and the corresponding tests considering safety aspects (e.g. artificial optical radiation, security aspects, limited energy source, stored charge energy circuit);
- f) update of the EMC requirements according to the generic documents;
- g) new requirements for reed contact magnetic switches in Annex D;
- h) requirements for class II circuit devices achieved by double or reinforced insulation in Annex F;
- i) update of pull-out tests in Annex G;
- j) information requirements for audible signalling device in Annex J;
- k) insertion of new Annex O.

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

Draft	Report on voting
121A/585/FDIS	121A/598/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

This International Standard should be used in conjunction with IEC 60947-1.

The provisions of the general rules, IEC 60947-1, are applicable to this document, where specifically called for. General rules, clauses and subclauses thus applicable, as well as tables, figures and annexes are identified by a reference to IEC 60947-1, for example 1.2.3, Table 4 or Annex A of IEC 60947-1:2020.

The following differing practices of a less permanent nature exist in the countries indicated below.

- 8.2.4.1: Making and breaking capacities (United States of America and Canada).
- 9.3.3.5.2: Test circuits and connections (United States of America and Canada).

A list of all the parts in the IEC 60947 series, under the general title *Low-voltage switchgear and controlgear*, 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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices

1 Scope

This part of IEC 60947 applies to control circuit devices and switching elements intended for controlling, signalling, interlocking, etc., of switchgear and controlgear.

It applies to control circuit devices having a rated voltage not exceeding 1 000 V AC (at a frequency not exceeding 1 000 Hz) or 600 V DC.

This document applies to specific types of control circuit devices as contained in the following non exhaustive list:

- manually operated control switches;
- electromagnetically operated control switches, either time-delayed or instantaneous;
- contactor relays;
- pilot switches;
- pressure switches;
- temperature sensitive switches (thermostats);
- programmers;
- position switches;
- control switches operated by part of a machine or mechanism;
- associated control circuit equipment, for example indicator lights;
- control circuit devices incorporating semiconductor switching elements;
- control circuit devices incorporating a built-in single drop digital communication interface.

NOTE 1 Control circuit devices and switching elements are referred to as "equipment" or "device" equally in this document.

This document also applies to specific types of control circuit switching elements associated with other devices (whose main circuits are covered by other standards) as contained in the following non exhaustive list:

- auxiliary contacts of a switching device (e.g. contactor, circuit breaker) which are not dedicated exclusively for use with the coil of that device;
- interlocking contacts of enclosure doors;
- control circuit contacts of rotary switches;
- control circuit contacts of overload relays.

This document does not apply to:

- relays covered in the IEC 60255 or IEC 61810 series;
- automatic electrical control devices for household and similar purposes;
- the use of control circuit devices and switching elements with additional measure within explosive atmospheres. These are given in the IEC 60079 series;

This document does not address specific colour requirements or actuating force values.

NOTE 2 Colour requirements can be found in IEC 60073 and also in CIE S004/E-2001.

The object of this document is to state:

- definitions;
- classification;
- characteristics;
- product information;
- normal service, mounting and transport conditions;
- constructional and performance requirements, including electromagnetic compatibility (EMC) and all related product safety measures;
- tests to verify the requirements and the rated characteristics.

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

IEC 60068-2-14:2023, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

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

IEC 60068-2-78:2012, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60417, *Graphical symbols for use on equipment*,
available at <http://www.graphical-symbols.info/equipment>

IEC 60695-2-10:2021, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

IEC 60695-2-11:2021, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)*

IEC 60695-2-12:2021, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials*

IEC 60730-1:2022, *Automatic electrical controls – Part 1: General requirements*

IEC 60947-1:2020, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 60947-4-1:2018, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

IEC 60947-5-2:2019, *Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches*

IEC 60947-5-5:1997, *Low-voltage switchgear and controlgear – Part 5-5: Control circuit devices and switching elements – Electrical emergency stop device with mechanical latching function*

IEC 60947-5-5:1997/AMD1:2005

IEC 60947-5-5:1997/AMD2:2016

IEC 60999-1:1999, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm² up to 35 mm² (included)*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2020, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-5:2014/AMD1:2017

IEC 61000-4-6:2023, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11:2020, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase*

IEC 61131-9:2022, *Programmable controllers – Part 9: Single-drop digital communication interface for small sensors and actuators (SDCI)*

IEC 61140:2016, *Protection against electric shock – Common aspects for installation and equipment*

IEC 62262:2002, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

IEC 62471:2006, *Photobiological safety of lamps and lamp systems*

CISPR 11:2015, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*

CISPR 11:2015/AMD1:2016

CISPR 11:2015/AMD2:2019

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*

CISPR 32:2015/AMD1:2019

ISO 2859-1:1999, *Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptance quality limit AQL) for lot-by-lot inspection*

ISO 14159:2002, *Safety of machinery – Hygiene requirements for the design of machinery*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

3.1.1 General

For the purposes of this document, the terms and definitions given in IEC 60947-1:2020, as well as the following apply.

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

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

3.1.2 Basic terms and definitions

3.1.2.1

control circuit device

electrical device intended for the controlling, signalling, interlocking, etc., of switchgear and controlgear

Note 1 to entry: Control circuit devices include control switches and associated devices such as indicator lights.

Note 2 to entry: Control circuit devices can also include associated devices dealt with in other standards, such as instruments, potentiometers, relays, in so far as associated devices are used for the purposes specified above.

3.1.2.2

control switch

<control and auxiliary circuits> mechanical switching device which serves the purpose of controlling the operation of switchgear or controlgear, including signalling, electrical interlocking, etc.

Note 1 to entry: A control switch consists of one or more contact elements with a common actuating system.

Note 2 to entry: A control switch may include semiconductor elements or contact elements (see 3.1.5.2 and 3.1.5.3).

[SOURCE: IEC 60050-441:1984, 441-14-46, modified – Addition of a new Note 2 to entry.]

3.1.2.3

control switch suitable for isolation

control switch which, in the open position, complies with the requirements specified for the isolating function (see 3.3.19 and 8.1.7 of IEC 60947-1:2020)

Note 1 to entry: Such control switches are intended to provide a higher degree of safety to personnel when working on the equipment controlled. For this reason, they have to be manually actuated relying on the intelligence of instructed persons to react in case they would fail to operate, for example in case of insufficiently opened contacts.

3.1.2.4 control station

assembly of one or more control switches fixed on the same panel or located in the same enclosure

Note 1 to entry: A control station panel or enclosure may also contain related equipment, for example potentiometers, signal lamps, instruments, etc.

[SOURCE: IEC 60050-441:1984, 441-12-08]

3.1.2.5 limited energy source

source that is designed and protected such that, under both normal operating conditions and single fault conditions, the current that can be delivered is not hazardous with respect to fire hazard

[SOURCE: IEC 60947-4-1:2018, 3.6.4]

3.1.2.6 single fault condition

condition in which there is a fault of a single protection (but not a reinforced protection) or of a single component or a device

Note 1 to entry: If a single fault condition results in one or more other fault conditions, all are considered as one single fault condition.

[SOURCE: IEC Guide 104:2019, 3.8, modified – Deletion of Note 2 to entry.]

3.1.2.7 recovery time

time period between disruption and the point in time when the specified function is performed again

3.1.2.8 normal load condition

set of operating parameters for the switching element matching one or more of the utilization categories shown in Table 1, and identified as "normal" for the subject switching element

Note 1 to entry: The normal use of a control switch is to close, maintain and open circuits.

3.1.2.9 abnormal load condition

set of operating conditions resulting in operating parameters that exceed those identified in the relevant utilization category in Table 1 used to identify normal load conditions

Note 1 to entry: Abnormal load conditions may arise, for example, when the coil of a contactor is energized but the device fails to operate correctly.

3.1.2.10 low-current terminal

terminal intended to connect a conductor to a device capable of supplying a current not exceeding 300 mA to the device

Note 1 to entry: This does not apply to special terminal constructions intended to connect to flat or other multiwire cables by performing one "clamping action" only for more than one wire (e.g. bus connections).

[SOURCE: IEC 62873-3-1:2020, 3.6, modified – Deletion of "a voltage signal and/or".]

3.1.2.11**skilled personnel****electrically skilled person**

person with relevant education and experience to enable him or her to perceive risks and to avoid hazards that electricity can create

3.1.3 Terms and definitions concerning automatic control switches

NOTE Automatic control switches are operated by automatic control (see 3.6.5 of IEC 60947-1:2020). They are also designated as pilot switches (see 3.4.18 of IEC 60947-1:2020).

3.1.3.1**instantaneous contactor relay**

contactor relay operating without any intentional time delay

Note 1 to entry: Unless otherwise stated, a contactor relay is an instantaneous contactor relay.

[SOURCE: IEC 60050-441:1984, 441-14-36]

3.1.3.2**time-delay contactor relay**

contactor relay with specified time-delay characteristics

Note 1 to entry: The time-delay may be associated with energization (*e*-delay) or with de-energization (*d*-delay) or both.

Note 2 to entry: A time-delay contactor relay may also incorporate instantaneous contact elements.

[SOURCE: IEC 60050-441:1984, 441-14-37, modified – Addition of a new Note 2 to entry.]

3.1.3.3**position switch**

pilot switch the actuating system of which is operated by a moving part of the machine, when this part reaches a predetermined position

[SOURCE: IEC 60050-441:1984, 441-14-49]

3.1.3.4**programmer**

control switch having a multiplicity of switching elements which, after initiation, operates in a defined sequence

3.1.4 Terms and definitions concerning manually operated control switches

NOTE Manually operated control switches are operated by manual control (see 3.6.4 of IEC 60947-1:2020).

3.1.4.1**push-button**

control switch having an actuator intended to be operated by force exerted by a part of the human body, usually the finger or palm of the hand, and having stored energy (spring) return

[SOURCE: IEC 60050-441:1984, 441-14-53]

3.1.4.2**pull-button**

control switch having an actuator intended to be operated by manual pull, and having stored energy (spring) return

3.1.4.3**push-pull button**

control switch having an actuator intended to be operated by manual push and returned to its initial position by manual pull, or vice versa

Note 1 to entry: There are also "push-push" or "push-turn" or other combinations of buttons.

3.1.4.4**rotary button**

combination of push-button type switching elements having an actuator operated by a manual rotation (see also 3.1.4.15 to 3.1.4.18 inclusive)

EXAMPLE Selector switch.

Note 1 to entry: A rotary push-button may have more than two positions; it may or may not have a spring return.

3.1.4.5**latched push-button**

push-button with spring return, but which remains in the actuated position until a latch is released by a separate action

Note 1 to entry: The latching may be released by subsequent actuation (such as pushing, turning, etc.) of the same or of an adjacent push-button or by the action of an electromagnet, etc.

3.1.4.6**locked push-button**

push-button which may be secured in one or more of its positions by a separate action

Note 1 to entry: The locking may be obtained by turning the button, by turning a key, by operating a lever, etc.

3.1.4.7**key-operated push-button**

push-button which can only be operated as long as a key remains inserted

Note 1 to entry: Key withdrawal may be provided at any position.

3.1.4.8**time-delay push-button**

push-button having contacts of which return to the initial position only after a pre-determined interval of time following the release of the actuating force

3.1.4.9**delayed action push-button**

push-button in which the switching operation does not occur until after the force on the button has been maintained for a pre-determined interval of time

3.1.4.10**illuminated push-button**

push-button incorporating a signalling lamp in the button

3.1.4.11**covered push-button**

push-button in which the button is protected against inadvertent operation by a lid or a cover

3.1.4.12**shrouded push-button**

push button in which the button is protected against inadvertent operation in certain directions

3.1.4.13**free push-button**

push-button in which the rotation of the actuator around its axis is not limited

3.1.4.14

guided push-button

push-button in which the rotation of the actuator around its axis is prevented

EXAMPLE Push-buttons the actuators of which are keyed, square or rectangular.

3.1.4.15

rotary control switch

rotary switch

control switch having an actuator intended to be operated by rotation

3.1.4.16

key-operated rotary switch

rotary switch where a key is used as the actuator

Note 1 to entry: Key withdrawal may be provided at any position.

3.1.4.17

limited movement rotary switch

rotary switch with a restricted angular movement of its actuator

3.1.4.18

unidirectional movement rotary switch

rotary switch in which the actuating system allows rotation in one direction only

3.1.4.19

joy stick

control switch having an actuator consisting of a pin or stick projecting essentially at a right angle from the panel or enclosure when in one of its positions and intended to be operated by angular displacement

Note 1 to entry: A joy stick may have more than two positions associated with different directions of the displacement of the stick and operating the contact elements differently: such a joy stick is referred to as a joy stick selector.

Note 2 to entry: The pin or stick may or may not have a spring return.

3.1.4.20

wobble stick

joy stick which operates all contact elements alike, whatever be the direction of the displacement

3.1.4.21

foot switch

pedal

control switch having an actuator intended to be operated by force exerted by a foot

[SOURCE: IEC 60050-441:1984, 441-14-52, modified – Insertion of "force exerted by a".]

3.1.5 Terms and definitions concerning parts of control switches

3.1.5.1

switching element

element designed to close and open a conducting path of a circuit

Note 1 to entry: A switching element may be a semiconductor element (see 3.1.5.2) or a contact element (see 3.1.5.3)

3.1.5.2**semiconductor element**

element designed to switch the current of an electric circuit by means of the controlled conductivity of a semiconductor

3.1.5.3**contact element**

<control switch> parts, fixed and movable, conducting and insulating, of a control switch necessary to close and open one single conducting path of a circuit

Note 1 to entry: The contact element and the actuating system may form an indivisible unit, but frequently one or more contact elements may be combined with one or more actuating system or systems. The actuating systems may be different.

Note 2 to entry: Terms and definitions relating to various kinds of single contact elements of a control switch are given in 3.1.5.4 to 3.1.5.13 inclusive.

Note 3 to entry: This definition does not include control coils and magnet systems.

3.1.5.4**single gap contact element**

contact element which opens or closes the conducting path of its circuit on one location only

SEE: Figure 3 a) and Figure 3 c).

3.1.5.5**double gap contact element**

contact element which opens or closes the conducting path of its circuit in two locations in series

SEE: Figure 3 b), Figure 3 d) and Figure 3 e).

3.1.5.6**make-contact element****normally open**

contact element which closes a conducting path when the control switch is actuated

3.1.5.7**break-contact element****normally closed**

contact element which opens a conducting path when the control switch is actuated

3.1.5.8**change-over contact elements**

contact element combination which includes one make-contact element and one break-contact element

SEE: Figure 3 c), Figure 3 d) and Figure 3 e).

3.1.5.9**pulse contact element****fleeting contact element**

contact element which opens or closes a circuit for a part of the travel during the transition of the actuator from one position to another

3.1.5.10**electrically separated contact elements**

contact elements belonging to the same control switch, but adequately insulated from each other so that they can be connected into electrically separated circuits, which can be either same polarity or opposite polarity

[SOURCE: IEC 60050-441:1984, 441-15-24, modified – Supplemented by polarity statement.]

3.1.5.11**independent action contact element****snap action contact element**

contact element of a manual or automatic control device in which the velocity of contact motion is substantially independent of the velocity of motion of the actuator

3.1.5.12**dependent action contact element**

contact element of a manual or automatic control device in which the velocity of contact motion depends on the velocity of motion of the actuator

3.1.5.13**contact unit**

contact element or contact element combination which can be combined with similar units operated by a common actuating system

3.1.5.14**button**

external end of the actuator of a push-button, to which the actuating force is applied

3.1.5.15**flush-button**

button which is substantially levelled with the adjacent fixed surrounding surface when in its initial position and is below this surface when it is operated

3.1.5.16**recessed button**

button which is below the adjacent fixed surrounding surface in both its initial and operated positions

3.1.5.17**extended button**

button which protrudes above the adjacent fixed surrounding surface both in its initial position and in its operated position

3.1.5.18**mushroom button**

button, the protruding end of which has an enlarged diameter

3.1.5.19**locating mechanism**

<rotary switch> part of the actuating system which retains the actuator and/or the contact elements in their positions

Note 1 to entry: Other devices (e.g. a push-button with two positions, or an emergency stop) can also have such a function.

3.1.5.20**end stop**

device that limits the travel of a moving part

Note 1 to entry: An end stop may relate either to the actuator or to the contact element.

3.1.5.21**mechanically linked contact elements**

combination of n make-contact element(s) and m break-contact element(s) designed in such a way that they cannot be in closed position simultaneously under conditions defined in L.9.5

Note 1 to entry: One control circuit device may have more than one group of mechanically linked contact elements.

Note 2 to entry: See also L.8.1.9.

3.1.6 Terms and definitions concerning operation of contactor relays**3.1.6.1****e-delay**

<contact element> delay in the operation of a contact element of a contactor relay, following the energization of the coil of the electromagnet of this contactor relay

EXAMPLE Delay to close make-contacts (ON delay).

Note 1 to entry: The terms "e-delay" and "d-delay" may be applied to any kind of contact elements (see 3.1.5.3).

3.1.6.2**d-delay**

<contact element> delay in the operation of a contact element of a contactor relay, following the de-energization of the coil of the electromagnet of this contactor relay

EXAMPLE Delay to open make-contacts (OFF delay).

Note 1 to entry: The terms "e-delay" and "d-delay" may be applied to any kind of contact elements (see 3.1.5.3).

3.1.6.3**fixed delay**

<contact element> delay in the operation of a contact element of a contactor relay, which is not intended to be adjusted in value

3.1.6.4**adjustable delay**

<contact element> delay in the operation of a contact element of a contactor relay, which is intended to be adjusted to different values after the installation of the contactor relay

3.1.7 Terms and definitions concerning operation of pilot switches**3.1.7.1****actuating quantity**

physical quantity, the value of which is decisive for the actuation or non-actuation of a pilot switch

3.1.7.2**operating value**

value of the actuating quantity which is sufficient to cause a pilot switch to be actuated

3.1.7.3**return value**

value of the actuating quantity which has to be re-established in order to cause an actuated pilot switch to return to its position of rest

3.1.7.4

differential value

difference between the operating value and the return value

3.1.8 Terms and definitions concerning operation of rotary switches

3.1.8.1

definite position

<rotary switch> position into which the locating mechanism pulls the rotary switch and retains it as long as the actuating torque does not exceed a certain value

3.1.8.2

position of rest

stable (definite) position into which the locating mechanism tends to move back and retain the rotary switch by stored energy

3.1.8.3

transit position

(definite) position in which the locating mechanism produces an intended marked change in the operating torque, but in which the actuator cannot remain by itself

3.1.8.4

biased position

(definite) position of a rotary switch in which the actuator is pulled against a stop from which it will return to a position of rest by means of stored energy (for example, by means of a spring)

Note 1 to entry: During the transfer from a biased position to the adjacent position of rest, the rotary switch may pass through one or more transit positions.

3.1.8.5

latched position

biased position in which the return mechanism is held by a latching arrangement

Note 1 to entry: The latching arrangement may be released manually or otherwise.

3.1.8.6

locked position

(definite) position in which a rotary switch is secured by separate action

Note 1 to entry: The locking may be obtained by turning a key, operating a lever, etc.

3.1.8.7

operating diagram

representation of the intended order in which the contact elements of a rotary switch operate as a result of actuation

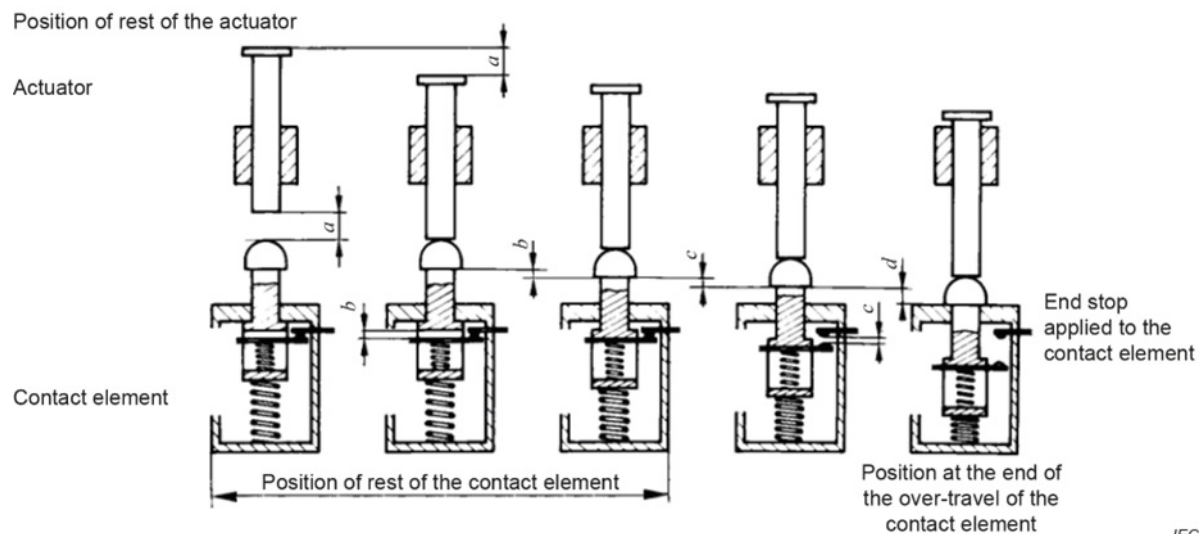
3.1.9 Terms and definitions concerning operation of mechanically operated control switches

3.1.9.1

pre-travel of the actuator

maximum travel of the actuator which causes no travel of the contact elements

Note 1 to entry: See dimension *a* in Figure 1.



IEC

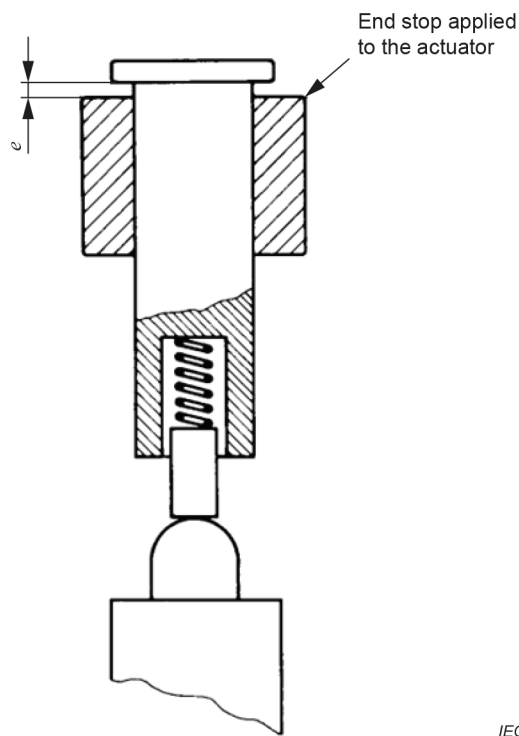
Key

- a* Pre-travel of the actuator
- b* Pre-travel of the contact element
- c* Minimum value required to give adequate contact gap
- d* Over-travel of the contact element

NOTE $b + c + d$ is the total travel of the contact element and $a + b + c + d + e$ the total travel of the actuator. Because of a possible resilient connection between the actuator and the contact element (for example, see Figure 2), the over-travel of the actuator can exceed the over-travel of the contact element by a length e .

Figure 1 – Operation of push-buttons**3.1.9.2****over-travel of the actuator**

travel of the actuator after all the contacts have reached their closed (open) position



IEC

Figure 2 – Difference e between the over-travel of the actuator and that of the contact element

3.1.9.3

direct drive

connection between actuator and contact element that excludes any pre-travel of the actuator

3.1.9.4

positive drive

connection between actuator and contact element such that the force applied to the actuator is directly transmitted to the contact element

3.1.9.5

limited drive

connection between actuator and contact element that limits the force transmitted to the contact element

3.1.9.6

actuating torque

torque applied to an actuator necessary to complete the intended operation

[SOURCE: IEC 60050-441:1984, 441-16-18, modified – Replacement of "moment" with "torque".]

3.1.9.7

restoring torque

torque provided to restore an actuator or a contact element to its initial position

[SOURCE: IEC 60050-441:1984, 441-16-20, modified – Replacement of "moment" with "torque".]

3.1.9.8

minimum starting force

smallest value of force initiating the pre-travel of the actuator

3.1.9.9

minimum starting torque

smallest value of torque initiating the pre-travel of the actuator

3.1.9.10

minimum actuating force

minimum value of the force to be applied to the actuator that will cause all contacts to reach their closed (open) position

3.1.9.11

minimum actuating torque

minimum value of the torque to be applied to the actuator that will cause all contacts to reach their closed (open) position

3.1.9.12

pre-travel of the contact element

relative movement which occurs within the contact element before the contacts make (break)

Note 1 to entry: See dimension *b* on Figure 1.

3.1.9.13

over-travel of the contact element

relative movement which occurs within the contact element after the contacts have reached the make (break) position

Note 1 to entry: See dimension *d* on Figure 1.

3.1.9.14**bounce time**

<contact which is closing/opening its circuit> time interval between the instant when the contact circuit first closes/opens and the instant when the circuit is finally closed/opened

[SOURCE: IEC 60050-444:2002, 444-05-04, modified – Figure 1 deleted.]

3.1.10 Terms and definitions concerning reed contact magnetic switches**3.1.10.1****reed contact magnetic switch**

control circuit device incorporating one or more reed contact switching element(s) operated by a magnetic actuator

EXAMPLES Reed contact proximity switch, reed contact float switch.

Note 1 to entry: Reed contact magnetic switch is called "reed contact magnetic proximity sensor" or "magnetic sensing device" in IEC 62246-4.

3.1.10.2**coded magnetic switch**

control circuit device incorporating two or more reed contact switching element(s) operated by a separate coded magnetic actuator, when this actuator reaches a predetermined position

EXAMPLE Magnetic actuator embedding coded permanent magnets.

3.1.10.3**rated operating distance**

s_n

conventional quantity used to designate the operating distances

Note 1 to entry: The rated operating distance does not consider either manufacturing tolerances or variations due to external conditions such as voltage and temperature.

[SOURCE: IEC 60947-5-2:2019, 3.3.1.1, modified – Note 2 to entry deleted.]

3.1.10.4**assured operating distance**

s_{ao}

distance from the sensing face within which the presence of the magnetic actuator is correctly detected under all specified environmental conditions and manufacturing tolerances

[SOURCE: IEC 60947-5-3:2013, 2.6.4, modified – "Specified target" replaced by "magnetic actuator".]

3.1.10.5**assured release distance**

s_{ar}

distance from the sensing face beyond which the absence of the magnetic actuator is correctly detected under all specified environmental conditions and manufacturing tolerances

[SOURCE: IEC 60947-5-3:2013, 2.6.5, modified – "Specified target" replaced by "magnetic actuator".]

3.1.10.6**magnetic actuator**

separate (or built-in) metal component, solenoids or other magnetic sources activating the reed contacts of the magnetic switch by changing the magnetic field value within the sensing zone

EXAMPLES Permanent magnets, ferromagnetic plates.

3.1.11 Terms and definitions concerning Class II control circuit devices

3.1.11.1

encapsulation

process by which all components, conductors and ends of integral cables are encased in an insulating compound by suitable means such as embedding or potting

3.1.11.2

embedding

process of completely encasing electrical device(s) by pouring a compound over it (them) in a mould, and removing the encased device(s) from the mould after solidification of the compound

3.1.11.3

potting

embedding process in which the mould remains attached to the encased electrical device(s)

3.1.11.4

compound

thermosetting, thermoplastic, catalytically cured and elastomeric materials with or without fillers and/or additives, after their solidification

3.1.11.5

double insulation

insulation comprising both basic insulation and supplementary insulation

[SOURCE: IEC 60050-195:2021, 195-06-08]

3.1.11.6

reinforced insulation

insulation of hazardous-live-parts which provides a degree of protection against electric shock equivalent to double insulation

Note 1 to entry: Reinforced insulation may comprise several layers which cannot be tested singly as basic insulation or supplementary insulation.

[SOURCE: IEC 60050-195:2021, 195-06-09, modified – Addition of the words "of hazardous-live-parts".]

3.1.12 Terms and definitions concerning control circuit devices with integrally connected cables

3.1.12.1

cable connected control circuit device

control circuit device having integrally connected leads for electrical connection to other equipment and/or to the power source

3.1.12.2

cable entrance sealing means

sealing means between the cable and device enclosure providing the required protection from cable abrasion and which may provide required sealing of enclosure and cable anchorage

3.1.12.3

cable anchorage

means to relieve mechanical stress from the cable termination so as to prevent damage to the electrical connection between the device and the cable

3.1.13 Terms and definitions concerning semiconductor switching elements

3.1.13.1 voltage drop

U_d

voltage measured across the semiconductor switching element when carrying the operational current under specified conditions

3.1.13.2 minimum operational current

I_m

current that is necessary to maintain ON-state conduction of the semiconductor switching element

3.1.13.3 OFF-state current

I_r

current which flows through the load circuit when the switching element is in the OFF-state

3.1.14 Terms and definitions concerning indicator lights, indicating towers and audible signalling devices

3.1.14.1 indicator light

light signal giving information either by lighting or extinguishing

3.1.14.2 lens of an indicator light

visible part, removable or not, constituting the surface intentionally made transparent or translucent

3.1.14.3 bezel

holder of a lens

3.1.14.4 indicator light with a built-in voltage-reducing device

indicator light, the body of which contains a device (transformer, resistor, etc.) intended to supply, at the terminals of a lamp, a voltage different from the rated operational voltage of the light

3.1.14.5 indicating tower

assembly including one or more signalling units giving information by visible or audible signals

Note 1 to entry: Other elements, for example network interface elements, can be added.

3.1.14.6 panel mounted audible signalling device

single hole mounted device, illuminated or not, giving information by an auditory signal

Note 1 to entry: According to definition 3.2 of ISO 7731:2003, panel mounted audible devices are commonly used to give auditory warning signals, but they are not intended for emergency signals.

3.1.14.7**sound pressure level**

ten times the logarithm to the base 10 of the ratio of the time-mean-square of a sound pressure signal to the square of the reference value

Note 1 to entry: Sound pressure level is expressed in decibels (dB).

Note 2 to entry: The reference value is 20 µPa.

[SOURCE: IEC 61672-1:2013, 3.2]

3.1.15 Terms and definitions concerning control switches with direct opening action**3.1.15.1****control switch with direct opening action**

control switch having one or more break-contact elements coupled to the switch actuator via non-resilient members so that full contact opening of the break-contact element(s) is obtained when the actuator is moved through the direct opening travel by applying the force stated by the manufacturer

3.1.15.2**direct opening action**

<contact element> achievement of contact separation as the direct result of a specified movement of the switch actuator through non-resilient members (for example not dependent upon springs)

3.1.15.3**direct opening travel**

travel from the beginning of actuation of the actuator and the position when the direct opening action of the opening contacts is completed

3.1.15.4**direct opening force**

actuation force applied to the actuator for the direct opening action

3.1.15.5**direct opening torque**

actuating torque, for a rotary control switch, applied to the actuator for the direct opening action

3.1.16 Terms and definitions concerning digital communication interface**3.1.16.1****single drop digital communication interface****SDCI**

digital communication interface for switching 24 V devices (e.g. IO-Link™¹) defining a point-to-point communication link for connecting sensors and actuators to a master unit

¹ IO-Link™ is a trade name of the "IO-Link Consortium". This information is given for the convenience of users of this publication and does not constitute an endorsement by IEC of the trade name holder or any of its products. Equivalent products may be used if they can be shown to lead to the same results.

3.1.17 Alphabetical index of definitions**A**

abnormal load condition	3.1.2.9
actuating quantity	3.1.7.1
actuating torque	3.1.9.6
adjustable delay (of a contact element)	3.1.6.4
assured operating distance	3.1.10.4
assured release distance	3.1.10.5

B

biased position	3.1.8.4
bezel.....	3.1.14.3
bounce time	3.1.9.14
break-contact element (normally closed)	3.1.5.7
button	3.1.5.14

C

cable anchorage	3.1.12.3
cable connected control circuit device	3.1.12.1
cable entrance sealing means	3.1.12.2
change-over contact elements	3.1.5.8
coded magnetic switch	3.1.10.2
compound	3.1.11.4
contact element	3.1.5.3
contact unit	3.1.5.13
control circuit device	3.1.2.1
control station	3.1.2.4
control switch	3.1.2.2
control switch suitable for isolation	3.1.2.3
control switch with direct opening action	3.1.15.1
covered push-button	3.1.4.11

D

<i>d</i> -delay (of a contact element)	3.1.6.2
definite position (of a rotary switch)	3.1.8.1
delayed action push-button	3.1.4.9
dependent action contact element	3.1.5.12
differential value	3.1.7.4
direct drive	3.1.9.3
direct opening action	3.1.15.2
direct opening force	3.1.15.4
direct opening torque	3.1.15.5
direct opening travel	3.1.15.3
double gap contact element	3.1.5.5
double insulation	3.1.11.5

E

<i>e</i> -delay (of a contact element)	3.1.6.1
electrically separated contact elements	3.1.5.10
embedding	3.1.11.2
encapsulation	3.1.11.1
end stop	3.1.5.20
extended button	3.1.5.17

F

fixed delay (of a contact element)	3.1.6.3
flush-button	3.1.5.15
foot-switch (pedal)	3.1.4.21
free push-button	3.1.4.13

G

guided push-button	3.1.4.14
--------------------------	----------

I

illuminated push-button	3.1.4.10
independent (snap) action contact element	3.1.5.11
instantaneous contactor relay	3.1.3.1

I

indicator light	3.1.14.1
indicator light with a built-in voltage-reducing device	3.1.14.4
indicating tower	3.1.14.5

J

joy stick	3.1.4.19
-----------------	----------

K

key-operated push-button	3.1.4.7
key-operated rotary switch	3.1.4.16

L

latched position	3.1.8.5
latched push-button	3.1.4.5
lens of an indicator light	3.1.14.2
limited drive	3.1.9.5
limited energy source	3.1.2.5
limited movement rotary switch	3.1.4.17
locating mechanism (of a rotary switch)	3.1.5.19
locked position	3.1.8.6
locked push-button	3.1.4.6
low-current terminal	3.1.2.10

M

magnetic actuator	3.1.10.6
make-contact element (normally open)	3.1.5.6
mechanically linked contact elements	3.1.5.21
minimum actuating force	3.1.9.10
minimum actuating torque	3.1.9.11
minimum operational current	3.1.13.2
minimum starting force	3.1.9.8
minimum starting torque	3.1.9.9
mushroom button	3.1.5.18

N

normal load condition	3.1.2.8
-----------------------------	---------

O

OFF-state current	3.1.13.3
operating diagram	3.1.8.7
operating value	3.1.7.2
over-travel of the actuator	3.1.9.2
over-travel of the contact element	3.1.9.13

P

panel mounted audible signalling device	3.1.14.6
pilot switch.....	3.1.7
position of rest	3.1.8.2
position switch	3.1.3.3
positive drive	3.1.9.4
potting	3.1.11.3
pre-travel of the actuator	3.1.9.1
pre-travel of the contact element	3.1.9.12
programmer	3.1.3.4
pull-button	3.1.4.2
pulse (fleeting) contact element	3.1.5.9
push-button	3.1.4.1
push-pull button	3.1.4.3

R

rated operating distance	3.1.10.3
recessed button	3.1.5.16
recovery time	3.1.2.7
reed contact magnetic switch	3.1.10.1
reinforced insulation	3.1.11.6
restoring torque	3.1.9.7
return value	3.1.7.3
rotary control switch	3.1.4.15
rotary button	3.1.4.4

S

semiconductor element	3.1.5.2
shrouded push-button	3.1.4.12
single drop digital communication interface	3.1.16.1
single fault condition	3.1.2.6
single gap contact element	3.1.5.4
skilled personnel	3.1.2.11
sound pressure level.....	3.1.14.7
switching element	3.1.5.1

T

time-delay contactor relay	3.1.3.2
time-delay push-button	3.1.4.8
transit position	3.1.8.3

U

unidirectional movement rotary switch	3.1.4.18
---	----------

V

voltage drop 3.1.13.1

W

wobble stick 3.1.4.20

3.2 Symbols and abbreviated terms

EMC	electromagnetic compatibility
EUT	equipment under test
I_e	rated operational current
I_{th}	conventional free air thermal current
I_{the}	conventional enclosed thermal current
SCPD	short-circuit protective device
$T_{0,95}$	time to reach 95 % of the steady-state current
U_c	rated control circuit voltage
U_e	rated operational voltage
U_i	rated insulation voltage
U_{imp}	rated impulse withstand voltage
U_s	rated control circuit supply voltage

4 Classification**4.1 Contact elements**

Contact elements may be classified as follows.

- a) Utilization categories (see 5.4).
- b) Electrical ratings based on utilization categories (see Annex A).
- c) One of the following form letters (see Figure 3):
 - Form A – Single gap make-contact element;
 - Form B – Single gap break-contact element;
 - Form C – Single gap make-break three terminal change-over contact element;
 - Form X – Double gap make-contact element;
 - Form Y – Double gap break-contact element;
 - Form Z – Double gap make-break four terminal change-over contact element.
- d) Other types not included in c).

NOTE 1 Regarding Figure 3 e) the two moving contact elements are electrically separated (see 3.1.5.10).

NOTE 2 Distinction is made between make before break (overlap) change-over contact elements where the two circuits are both closed for a part of the travel of the moving contacts from one position to the other, and break before make (non-overlap) change-over contact elements where the two circuits are both open for a part of the travel of the moving contacts from one position to the other. Unless otherwise stated, change-over contact elements are break before make.

Figure No	Figure	Symbols	Forms	Description
3a)			A	Single gap contact element with two terminals
			B	
3b)			X	Double gap contact element with two terminals
			Y	
3c)			C	Change-over, single gap, contact element with three terminals
3d)			Za	Change-over, double gap, contact element with four terminals ^b
3e)			Zb	Change-over, double gap, contact element with four terminals (The two moving contacts are electrically separated) ^c

IEC

^a Symbols according to IEC 60617.

^b The contacts are of the same polarity.

^c Multiple electrically separated contact configurations are also covered by Zb.

Figure 3 – Examples of contact elements (schematic sketches)

4.2 Control switches

Control switches may be classified according to the contact element and the nature of the actuating system, for example push-buttons, form X.

4.3 Control circuit devices

Control circuit devices may be classified according to the control switch and the associated control circuit equipment, for example push-buttons plus indicator lights.

4.4 Time delay switching elements

Distinction is made according to how the time delay of a switching element is achieved, for example electrical delay, magnetic delay, mechanical delay, or pneumatic delay.

4.5 Control switch mounting

The control switch mounting may be classified by the mounting hole size, for example D12, D16, D22, D30 (see 7.3.2).

5 Characteristics

5.1 Summary of characteristics

5.1.1 General

The characteristics of control circuit devices and switching elements shall be stated in the following terms, where such terms are applicable:

- type of equipment (see 5.2);
- rated and limiting values for switching elements (see 5.3);
- utilization categories of switching elements (see 5.4);
- normal and abnormal load characteristics (see 5.3.6);
- control circuits (see 5.5).

NOTE For items subject to agreement between manufacturer and user, see Annex E.

For information exchange in electronic format, for example electronic catalogue, IEC 62683, available in electronic format in the IEC CDD database, gives the data format of the essential characteristics of several control circuit devices and their accessories.

5.1.2 Operation of a control switch

The principal application of a control switch is the switching of control circuit loads as indicated for the various utilization categories in Table 1.

Other applications, for example the switching of tungsten filament lamps, small motors, etc., are not dealt with in detail in this document, but are mentioned in 5.3.6.1.

Table 1 – Utilization categories for switching elements

Kind of current	Category	Typical applications
Alternating current	AC-12	Control of resistive loads and solid state loads with isolation by optocouplers
	AC-13	Control of solid state loads with transformer isolation
	AC-14	Control of small electromagnetic loads (≤ 72 VA)
	AC-15	Control of electromagnetic loads (> 72 VA)
Direct current	DC-12	Control of resistive loads and solid state loads with isolation by optocouplers
	DC-13	Control of electromagnets
	DC-14	Control of electromagnetic loads having economy resistors in circuit

5.2 Type of control circuit device or switching element

5.2.1 Kind of control circuit device

The kind of control circuit device shall be stated:

- manual control switches, for example push-buttons, rotary switches, foot switches, etc.;
- electromagnetically operated control switches, either time delayed or instantaneous, for example contactor relays;
- pilot switches, for example pressure switches, temperature sensitive switches (thermostats), programmers, etc.;
- position switches;
- reed contact magnetic switches;
- associated control equipment, for example indicator lights, etc.

5.2.2 Kind of switching elements

The kind of switching elements shall be stated:

- auxiliary contacts of a switching device (e.g. contactor, circuit breaker, etc.) which are not dedicated exclusively for use with the coil of that device;
- interlocking contacts of enclosure doors;
- control circuit contacts of rotary switches;
- control circuit contacts of overload relays.

5.2.3 Number of poles

The number of poles shall be stated.

5.2.4 Kind of current

The kind of current shall be stated:

- alternating current;
- direct current.

5.2.5 Interrupting medium

The interrupting medium shall be stated:

- air;
- oil;
- gas;
- vacuum, etc.

5.2.6 Operating conditions

5.2.6.1 Method of operation

The method of operation shall be stated:

- manual;
- electromagnetic;
- pneumatic;
- electro-pneumatic.

5.2.6.2 Method of control

The method of control shall be stated:

- automatic;
- non-automatic;
- semi-automatic.

5.3 Rated and limiting values for switching elements

5.3.1 General

The rated values established for the switching elements of a control circuit device shall be stated in accordance with 5.3.2 to 5.3.6 inclusive but it is not necessary to specify all the values listed.

5.3.2 Rated voltages (of a switching element)

5.3.2.1 General

A switching element is defined by the rated voltages described in 5.3.2.2 to 5.3.2.4.

5.3.2.2 Rated operational voltage (U_e)

Subclause 5.3.1.1 of IEC 60947-1:2020 applies.

NOTE For applications of control switches with low current, see IEC 60947-5-4.

5.3.2.3 Rated insulation voltage (U_i)

Subclause 5.3.1.2 of IEC 60947-1:2020 applies.

5.3.2.4 Rated impulse withstand voltage (U_{imp})

Subclause 5.3.1.3 of IEC 60947-1:2020 applies.

5.3.3 Currents

5.3.3.1 General

A switching element is characterized by the currents described in 5.3.3.2 to 5.3.3.4.

5.3.3.2 Conventional free air thermal current (I_{th})

Subclause 5.3.2.1 of IEC 60947-1:2020 applies.

5.3.3.3 Conventional enclosed thermal current (I_{the})

Subclause 5.3.2.2 of IEC 60947-1:2020 applies.

5.3.3.4 Rated operational current (I_e)

The first paragraph of Subclause 5.3.2.3 of IEC 60947-1:2020 applies.

5.3.4 Rated frequency

Subclause 5.3.3 of IEC 60947-1:2020 applies.

5.3.5 Vacant**5.3.6 Characteristics under normal and abnormal load conditions****5.3.6.1 Rated making and breaking capacities and behaviour of switching elements under normal load conditions**

A switching element shall comply with both requirements given in Table 2 corresponding to the assigned utilization category and the requirements according to the rated operational voltage.

NOTE For a switching element to which a utilization category is assigned, it is not necessary to specify separately a making and breaking capacity.

A switching element designated for the switching of small motors and tungsten filament lamp loads shall be assigned a utilization category given in IEC 60947-4-1 and comply with the appropriate corresponding requirements in that publication.

EXAMPLE 1 A typical example for a small motor load is the motor-load for household or similar application (AC-7a, AC-7b), see Table 1 of IEC 60947-4-1:2018.

EXAMPLE 2 Typical examples for lamp loads are electric discharge lamp or incandescent lamp (AC-5a, AC-5b), see Table 1 of IEC 60947-4-1:2018.

Table 2 – Verification of making and breaking capacities of switching elements under normal load conditions corresponding to the utilization categories

Utilization category	Make ^{a, e}			Break ^{a, e}			Minimum on-time	Sequence, number and rate of operations			
	III_e	UIU_e		III_e	UIU_e						
AC			$\cos \varphi$			$\cos \varphi$	Cycles (at 50 Hz or 60 Hz)	Order no. ^{d, e}			
								1	2	3	4
AC-12	1	1	0,9	1	1	0,9	2	50	10	990	5 000
AC-13	2	1	0,65	1	1	0,65	2 ^b				
AC-14	6	1	0,3	1	1	0,3	2 ^b				
AC-15	10	1	0,3	1	1	0,3	2 ^b				
DC			$T_{0,95}$ ms			$T_{0,95}$ ms	Time ms				
DC-12	1	1	1	1	1	1	25	50	10	990	5 000
DC-13	1	1	$6 \times P^c$	1	1	$6 \times P^c$	70,95				
DC-14	10	1	15	1	1	15	25 ^b				
I_e rated operational current							I current to be made or broken				
U_e rated operational voltage							U voltage before make				
$P = U_e \times I_e$ steady-state power consumption, in W							$T_{0,95}$ time to reach 95 % of the steady-state current				
NOTE For the objective of the test, see 9.3.3.5.3.											
^a For tolerances on test quantities, see 9.3.2.2.											
^b Both on-time values (for I_{make} and for I_{break}) shall be at least equal to 2 cycles (or 25 ms for DC-14).											
^c The value " $6 \times P$ " results from an empirical relationship which is found to represent most DC magnetic loads to an upper limit of $P = 50$ W, i.e. $6 \times P = 300$ ms. Loads having power consumption greater than 50 W are assumed to consist of smaller loads in parallel. Therefore, 300 ms is to be an upper value, irrespective of the power. For control circuit devices with semiconductor switching elements, the maximum time constant shall be 60 ms i.e. $T_{0,95} = 180$ ms ($3 \times$ time constant).											
^d For all utilization categories, the test sequence shall be in the order given.											
^e The rate for the test shall be as follows: For order no.1: 6 operating cycles per minute, which shall be made with the test voltage raised to $U_e \times 1,1$ and the corresponding test current, the test current I having been first set with the voltage at U_e . For order no.2: as rapidly as possible whilst ensuring complete closing and opening of contacts. For order no.3: 60 operating cycles per minute. For order no.4: 6 operating cycles per minute. Exception: For testing of auxiliary contacts of a switching device (e.g. contactor or circuit breaker) which are dedicated exclusively for use with that device or a series thereof and the auxiliary contact is operated by the operating mechanism of the switching device the test can be performed with the maximum rate of operations of that switching device if this rate is lower than the values given in this table. When the auxiliary contact is dedicated for use with a series of switching devices, the rate shall be the maximum rate available within the series.											

5.3.6.2 Making and breaking capacities under abnormal load conditions

A switching element shall comply with the requirements given in Table 3 corresponding to the assigned utilization category. A control switch shall be able to break the current corresponding to such abnormal load conditions.

NOTE An example of an abnormal condition of use is one where the electromagnet does not operate and the switching elements have to interrupt the making current.

Table 3 – Verification of making and breaking capacities of switching elements under abnormal conditions corresponding to the utilization categories

Utilization category	Make ^a			Break ^a			Minimum on-time	Making and breaking operation	
	I/I_e	U/U_e		I/I_e	U/U_e			Number	Rate per minute
AC			$\cos \varphi$			$\cos \varphi$	Cycles (at 50 Hz or 60 Hz)		
AC-12	—	—	—	—	—	—	—	—	—
AC-13 ^b	10	1,1	0,65	1,1	1,1	0,65	2 ^c	10	6
AC-14	6	1,1	0,7	6	1,1	0,7	2	10	6
AC-15	10	1,1	0,3	10	1,1	0,3	2	10	6
DC			$T_{0,95}$ ms			$T_{0,95}$ ms	Time ms		
DC-12	—	—	—	—	—	—	—	—	—
DC-13 ^d	—	—	—	—	—	—	—	—	—
DC-14	10	1,1	15	10	1,1	15	25 ^c	10	6

I_e rated operational current I current to be made or broken

U_e rated operational voltage U voltage before make

$P = U_e \times I_e$ steady-state power consumption, in W $T_{0,95}$ time to reach 95 % of the steady-state current

NOTE The abnormal condition is to simulate a blocked open electromagnet. See 9.3.3.5.4.

^a For tolerances on test quantities, see 9.3.2.2.

^b For control circuit devices with semiconductor switching elements, an overload protective device specified by the manufacturer should be used to verify the abnormal conditions.

^c Both on-time values (for I_{make} and for I_{break}) shall be at least equal to 2 cycles (or 25 ms for DC-14).

^d The test for DC-13 under abnormal conditions is covered by the test under normal conditions.

5.3.7 Short-circuit characteristics – Rated conditional short-circuit current

Subclause 5.3.6.4 of IEC 60947-1:2020 applies.

5.4 Utilization categories for switching elements

The utilization categories as given in Table 1 are considered standard. Any other types of application shall be based on agreement between manufacturer and user, but information given in the manufacturer's catalogue or tender may constitute such an agreement.

5.5 Control circuits

Subclause 5.5.1 of IEC 60947-1:2020 applies with the following addition to the list of characteristics:

- limited energy (if the source is in accordance with 8.1.18 of this document);
- SELV (PELV) supply (in accordance with Annex N of IEC 60947-1:2020);
- power consumption of the electromagnet of a contactor relay, necessary for determining the characteristics of the power supply of the control circuit, which is given by:
 - holding power, and
 - pick-up power

in accordance to IEC 60947-4-1.

NOTE In the USA and Canada, control circuits can be supplied by class 2 sources as defined in NFPA 70, National Electrical Code, and CSA C22.1, CE Code, in lieu of or in addition to SELV (PELV) sources.

5.6 Vacant

5.7 Vacant

5.8 Vacant

5.9 Vacant

5.10 Electrically separated contact elements

The manufacturer shall state whether the contact elements of a control circuit device are electrically separated or not (see 3.1.5.10). Separated contact elements shall be assumed to be opposite polarity unless otherwise stated by the manufacturer.

5.11 Actuating quantities for pilot switches

The operating value and return value of the actuating quantity shall be determined on uniform rising values and normal falling values of the actuating quantity. Unless otherwise stated, the rate of change shall be regular and such that the operating (or return) value is reached in not less than 10 s.

The operating value and the return value may both be fixed values, or one of them or both may be adjustable (or the differential value may be adjustable).

Where appropriate, the manufacturer shall indicate a withstand value, either a maximum value higher than the highest setting of the operating value or a minimum value lower than the lowest setting of the return value. A withstand value implies no damage to the pilot switch or no change in its characteristics.

5.12 Pilot switches having two or more contact elements

Pilot switches having two or more contact elements which are not individually adjustable may have different operating and return values for each contact element.

A pilot switch having two or more contact elements which are individually adjusted is considered as a combination of pilot switches.

6 Product information

6.1 Nature of information

The following information shall be given by the manufacturer:

Identification

- a) manufacturer's name or trade mark;
- b) type designation or serial number that makes it possible to get the relevant information concerning the switching element (or the entire control switch) from the manufacturer or from his catalogue or by selection from Annex A;
- c) IEC 60947-5-1 if the manufacturer claims compliance with this document;

Characteristics

- d) rated operational voltages (see 5.3.2.2);
- e) utilization category and rated operational currents at the rated operational voltages of the control circuit device. If auxiliary contacts of a switching device (i.e. contactor or circuit breaker) are dedicated exclusively for use with that device or a series thereof (see footnote e of Table 2) the intended controlled load (i.e. switching device coil) shall be identified;
- f) value of the rated frequency/frequencies (see 5.3.4), where applicable, for example: 50 Hz, 50 Hz/60 Hz, and/or the indication "DC" or the symbol **==** (IEC 60417-5031:2002-10);
- g) actuating force (or torque), where applicable;
- h) recovery time, where applicable;

Safety and installation

- i) rated insulation voltage (see 5.3.2.3);
- j) rated impulse withstand voltage (see 5.3.2.4);
- k) rated control circuit voltage U_C (see 5.5), nature of current and rated frequency, where applicable;
- l) rated control circuit supply voltage U_S (see 5.5), nature of current and rated frequency where applicable;

In the case of electronically controlled electromagnets, other information may also be necessary, for example control circuit configuration (see 5.5);

- m) IP code (see Annex C of IEC 60947-1:2020);
- n) pollution degree (see 7.1.3.2);
- o) type and maximum ratings of short-circuit protective device (see 9.3.4.3);
- p) conditional short-circuit current;
- q) suitability for isolation, where applicable, with the symbol IEC 60617-S00288:2001-07;
- r) for each relevant circuit, suitability for use with SELV/PELV circuit with the corresponding maximum rated operational voltage (see IEC 61140 and Annex N of IEC 60947-1:2020);
- s) length of insulation to be removed before insertion of the conductor into the terminal;
- t) for non-universal screwless terminals:
 - "s" or "sol" for terminals declared for solid conductors;
 - "r" for terminals declared for solid and stranded conductors;
 - "f" for terminals declared for flexible conductors.
- u) indication of contact elements of same polarity;
- v) maximum number of contacts to be assembled within the control switch, where applicable;
- w) for light sources of the equipment, warning information depending on the expected optical radiation hazard, if any;

NOTE A hazard-related risk group classification and proposed warning information is described in 6.1 of IEC 62471:2006 and in IEC TR 62471-2:2009².

- x) environment A or environment B for EMC (see 8.3.1 of IEC 60947-1:2020).

The following optional information can be provided:

- y) material declaration according to IEC TS 63058:2021 (see 6.4.2).

² This publication has been withdrawn. At the time of publication of this document, no successor document of IEC TR 62471-2 was available.

6.2 Marking

6.2.1 General

Markings shall be indelible and easily legible and shall not be placed on screws and removable washers.

Marking of data under a) and b) of 6.1 is mandatory on the nameplate of the control circuit device in order to permit the complete information to be obtained from the manufacturer.

Marking of data under u) of 6.1 shall be included on the nameplate of the control circuit device in order to ensure proper wiring at installation.

Whenever space permits, data under c) to f) and i) to s) of 6.1 shall be included on the nameplate, or on the control circuit device or otherwise in the manufacturer's documentation.

The indication "s", "sol", "r" or "f" for non-universal screwless terminals shall be marked on the device or, if the space available is not sufficient, on the smallest package unit or in technical information provided with the product.

Marking of data under w) of 6.1 shall be provided.

Additional marking requirements are specified in the annexes of this document and shall be considered, where applicable.

6.2.2 Terminal identification and marking

Subclause 8.1.8.4 of IEC 60947-1:2020 applies, with the additional requirements stated in Annex M.

6.2.3 Functional markings

Actuators may be identified by indelible symbols. If a stop-button carries any symbol on the actuator, it shall be a circle or an oval (signifying the value zero). The symbols circle or oval shall be used for stop-buttons only.

Letters or words may be used where the space available is sufficient to ensure a clear identification. In all other cases, identification markings shall be placed on permanent labels closely adjacent to the actuator.

Symbols shall be in accordance with IEC 60417.

6.2.4 Emergency stop

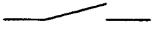
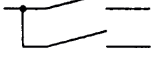
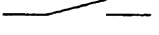
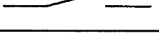
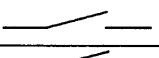
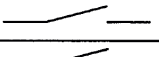
Subclause 4.2 of IEC 60947-5-5:1997 and IEC 60947-5-5:1997/AMD2:2016 applies.

6.2.5 Operating diagram

6.2.5.1 General

As rotary switches may have a multiplicity of contact elements and a multiplicity of actuator positions, it is necessary that the manufacturer indicates the relationship between the actuator positions and the associated contact element positions.

The relationship shall be given in the form of an operating diagram. Figure 4 shows examples together with explanatory notes.

Number of the example	Disposition of the contact element(s)	Actuator positions					
		1	2	3	4	5	
1		x					Contact element closed in actuator position No. 1 only.
2			x		x	x	Contact element closed in actuator positions No. 2, 4 and 5.
3			x		x		Two contact elements used as change-over contact elements with 3 terminals
4			x				Contact element with pulse (fleeting) contact closed between actuator positions No 2 and 3.
5		x		x	x	x	Contact element with pulse (fleeting) contact open between actuator positions No 3 and 4.
6					x	x	Contact element with maintained contact between actuator positions No 4 and 5.
7		x					Two contact elements with close-before-open contacts between actuator positions No 1 and 2.
8		x					Two contact elements with open-before-close contacts between actuator positions No 1 and 2 ^a .
9	A  B 	x		x			Operation in which contact element B is arranged to close before and open after contact element A.
		x		x			

^a Open-before-close contact elements may be used to break the current in one circuit before making the current in the other circuit, provided the time interval be properly related to the circuit conditions.

IEC

Figure 4 – Examples of the recommended method for drawing an operating diagram of a rotary switch

6.2.5.2 Position indication and contact position

Subclause 8.1.6.1 of IEC 60947-1:2020 applies with the following addition:

The position indication shall be clear, and the associated text or symbols shall be indelible and easily legible.

6.2.5.3 Terminal markings for operating diagrams

Terminal markings shall be clearly identifiable with respect to the operating diagram. See also Annex M.

6.2.6 Time delay markings

For time-delay contactor relays, the markings shall include the value of the time delay in the case of a fixed delay and the range of time delay in the case of an adjustable delay.

In the case of more than one time-delay contact element, the relative delay between the operation of each contact element and the following one shall be indicated for contact elements that follow the first delay.

If two or more contact elements have adjustable delays, it shall be indicated whether they are individually adjustable or not.

The manufacturer shall indicate, for each time-delay contact element, the characteristics of the delay, according to 3.1.6.1 or 3.1.6.2.

6.3 Instructions for installation, operation and maintenance, decommissioning and dismantling

Subclause 6.3 of IEC 60947-1:2020 applies with the following additions:

Safety information and instructions shall be provided when relevant in order to achieve the safe use of the control circuit device. Such information shall be easily understood by the user, i.e. in form of commonly used symbols and/or drawings. Examples can be found in ISO 7000 and IEC 60417.

Products within the scope of this document are intended to be selected, installed and maintained by skilled personnel only.

EXAMPLE Following symbols can be used for "skilled person".



IEC 60417-6182:2013-09
Installation, electrotechnical expertise



IEC 60417-6183:2013-09
Installation, mechanical expertise

6.4 Environmental information

6.4.1 Environmentally conscious design process (ECD process)

Assistance in the consideration of environmental aspects relating to products in scope of this document is given in Clause 4 and Clause 5 of IEC TS 63058:2021.

6.4.2 Procedure to establish material declaration

Providing the material declaration is at discretion of the manufacturer. When provided, Clause 7 of IEC TS 63058:2021 specifies content of the material declaration.

6.5 Additional information

Additional information necessary for certain types of control circuit devices shall appear according to the relevant rules given in the appropriate annexes for:

- Class II control circuit devices, see F.6.2;
- semiconductor switching elements for control circuit devices, see Clause H.6;
- indicator lights, indicating towers and audible signalling devices, see Clause J.6;
- control switches with direct opening action, see Clause K.6;
- mechanically linked contact elements, see Clause L.6;
- reliability data, see Clause N.4;
- interface specific information, see Clause O.6.

7 Normal service, mounting and transport conditions

7.1 Normal service conditions

7.1.1 Ambient air temperature

Subclause 7.1.1 of IEC 60947-1:2020 applies.

7.1.2 Altitude

Subclause 7.1.2 of IEC 60947-1:2020 applies.

7.1.3 Atmospheric conditions

7.1.3.1 Humidity

Subclause 7.1.3.1 of IEC 60947-1:2020 applies.

7.1.3.2 Pollution degree

Subclause 7.1.3.2 of IEC 60947-1:2020 applies with the following condition:

Unless otherwise stated by the manufacturer, a control circuit device is intended for installation under environmental conditions of pollution degree 3. However, other pollution degrees may apply, depending upon the micro-environment.

7.1.4 Shock and vibration

Standard conditions of shock and vibration of Table Q.1 of IEC 60947-1:2020 apply unless otherwise stated in this document.

7.2 Conditions during transport and storage

Subclause 7.2 of IEC 60947-1:2020 applies.

7.3 Mounting

7.3.1 General

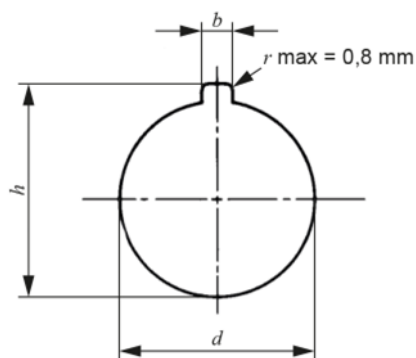
The equipment shall be mounted in accordance with the manufacturer's instructions.

7.3.2 Mounting of single hole mounted devices

7.3.2.1 Dimensions

The single hole mounted push-buttons and indicator lights are located in a circular hole of a panel (e.g. of a control station or a machine) or an enclosure, which may have a rectangular recess for a key.

The dimensions are indicated in Table 4 and in Figure 5.



IEC

Figure 5 – Mounting hole diameter and dimensions of the key recess (if any)

Table 4 – Mounting hole diameter and dimensions of the key recess (if any)

Size	Mounting hole diameter, d mm	Key recess (if any)	
		Height, h mm	Width, b mm
D30	$30,5^{+0,5}_0$	$33,0^{+0,5}_0$	$4,8^{+0,2}_0$
D22	$22,3^{+0,4}_0$	$24,1^{+0,4}_0$	$3,2^{+0,2}_0$
D16	$16,2^{+0,2}_0$	$17,9^{+0,2}_0$	$1,7^{+0,2}_0$
D12	$12,1^{+0,2}_0$	$13,8^{+0,2}_0$	$1,7^{+0,2}_0$

7.3.2.2 Location of the key recess (if any)

The standardized position of the key is in the up position (12 o'clock) and associated with the b dimension in Table 4.

7.3.2.3 Range of panel thickness

The device, with or without the sealing gasket indicated by the manufacturer, shall be capable of being mounted on any thickness of panel between 1 mm and 6 mm, if necessary by the use of packing piece(s) supplied for the purpose.

NOTE The sealing gasket is not standardized.

7.3.2.4 Grouping of devices

When a number of devices of the sizes given in 7.3.2.1 are mounted in rows on a panel, the distances a between the mounting centres in the same row and b between the centre lines of the rows shall be not less than those given in Table 5, unless otherwise stated by the manufacturer.

Table 5 – Preferred minimum distances between centres of mounting holes

Size	a mm	b mm
D30	50	65
D22	30	50
D16	25	25
D12	20	20

Distances a and b may be interchanged.

These values are intended to guide development; however, when it is intended to mount devices of different manufacture, the user shall establish the compatibility of the devices and ensure the clearances and creepage distances are maintained when the devices are installed and connected.

NOTE Depending on design details, connections, labels, etc., some devices can be capable of being mounted at distances less than those given in Table 5 in accordance with the indication of the manufacturer of the devices. On the other hand, certain types of devices can require distances greater than those given in Table 5.

8 Constructional and performance requirements

8.1 Constructional requirements

8.1.1 General

Subclause 8.1.1 of IEC 60947-1:2020 applies.

8.1.2 Materials

8.1.2.1 General materials requirements

Subclause 8.1.2.1 of IEC 60947-1:2020 applies with the following addition:

Special attention shall be called to humidity resisting qualities, and to the necessity to protect certain insulating materials against humidity.

Subclause 8.1.2.2 of this document applies instead of 8.1.2.2 of IEC 60947-1:2020.

8.1.2.2 Glow-wire testing

The suitability of materials used is verified by:

- a) making tests on the equipment; or
- b) making tests on sections taken from the equipment; or
- c) making tests on any parts of identical material having representative thickness; or
- d) providing data from the insulating material supplier fulfilling the requirements according to IEC 60695-2-12.

The suitability shall be determined with respect to resistance to abnormal heat and fire. It shall be indicated which method, amongst a), b), c) and d) is used to demonstrate compliance.

If an identical material having representative cross-sections has already satisfied the requirements of any of the tests of 9.2.2 of IEC 60947-1:2020, then those tests need not be repeated.

Tests on equipment shall be made by the glow-wire end-product test of IEC 60695-2-10 and IEC 60695-2-11.

Tests shall be made according to 9.2.2.1 of IEC 60947-1:2020 with the conditions given in Table 6.

For parts with a mass lower than 2 g and for small parts, as specified in IEC 60695-2-11, no other test is required.