IEC 60947-5-1

Edition 5.0 2024-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

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



IEC 60947-5-1:2024-03(en-fr)



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 29.120.40, 29.130.20

ISBN 978-2-8322-8326-4

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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) 94

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

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

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

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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.

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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 mm^2 up to 35 mm^2 (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

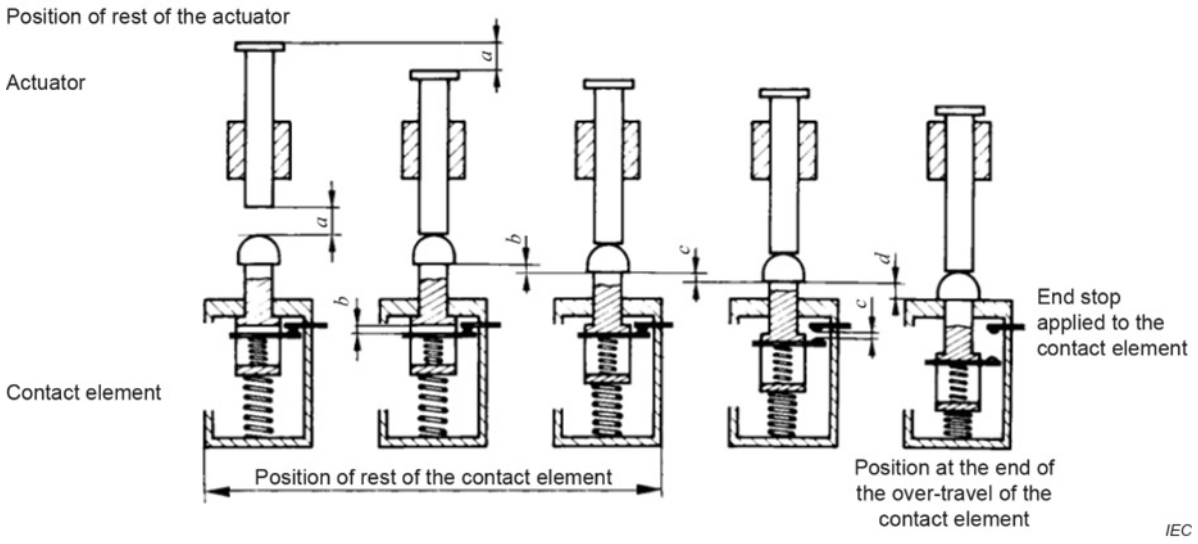
Note 1 to entry: The locking may be obtained by turning a key, operating a lever, etc.

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.



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

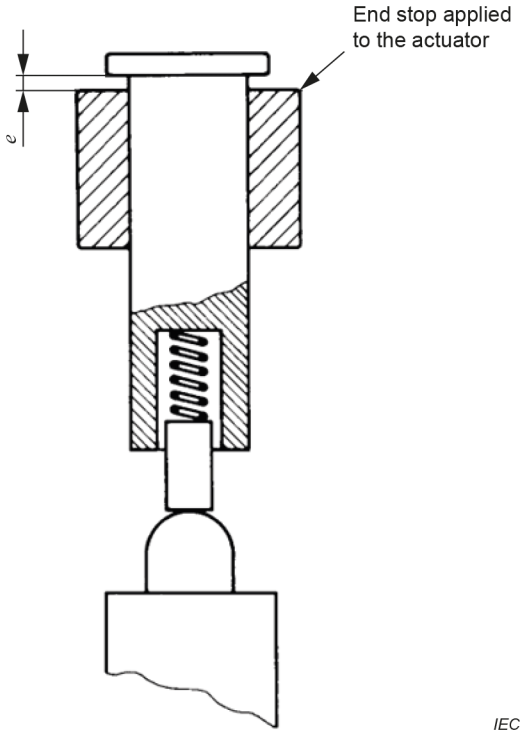


Figure 2 – Difference e between the over-travel of the actuator and that of the contact element

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

d-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

e-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.