



UL 60947-5-1

STANDARD FOR SAFETY

Low-Voltage Switchgear and
Controlgear – Part 5-1: Control Circuit
Devices and Switching Elements –
Electromechanical Control Circuit
Devices

UL Standard for Safety for Low-Voltage Switchgear and Controlgear – Part 5-1: Control Circuit Devices and Switching Elements – Electromechanical Control Circuit Devices, UL 60947-5-1

Fourth Edition, Dated May 31, 2022

Summary of Topics

Adoption of the Fourth edition of IEC 60947-5-1, Standard for Low-Voltage Switchgear and Controlgear – Part 5-1: Control Circuit Devices and Switching Elements – Electromechanical Control Circuit Devices, as the Fourth edition ANSI/UL 60947-5-1.

This standard is an adoption of IEC 60947-5-1, Edition 4.0 published in May 2016 and corrigendum 1 issued July 2016. Please note that the national difference document incorporates all of the U.S. national differences for UL 60947-5-1.

The requirements are substantially in accordance with Proposal(s) on this subject dated February 7, 2020 and September 27, 2021.

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(IEC 60947-5-1:2016, MOD)



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UL 60947-5-1
Fourth Edition

Low-Voltage Switchgear and Controlgear – Part 5-1: Control Circuit Devices and Switching Elements – Electromechanical Control Circuit Devices

May 31, 2022

This national standard is based on IEC 60947-5-1, Edition 4 (2016) and corrigendum 1 (2016).



ANSI/UL 60947-5-1-2022



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This ANSI/UL Standard for Safety consists of the Fourth Edition. The most recent designation of ANSI/UL 60947-5-1 as an American National Standard (ANSI) occurred on May 31, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

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Preface

This is the harmonized CSA Group and UL standard for Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices. It is the second edition of CSA C22.2 No. 60947-5-1 and the fourth edition of UL 60947-5-1. This edition of CSA C22.2 No. 60947-5-1 supersedes the previous edition published in 2014 as CAN/CSA-C22.2 No. 60947-5-1 (adopted IEC 60947-5-1:2003).

This harmonized standard is based on IEC Publication 60947-5-1: fourth edition, Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices, issued May 2016. IEC 60947-5-1 is copyrighted by the IEC.

This harmonized standard was prepared by CSA Group and Underwriters Laboratories Inc. (UL). The efforts and support of the Technical Harmonization Committee for Industrial Control Equipment, of the Council on the Harmonization of Electrotechnical Standards of the Nations of the Americas (CANENA), are gratefully acknowledged.

This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

This standard was reviewed by the CSA Integrated Committee on Industrial Control, under the jurisdiction of the CSA Technical Committee on Industrial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee. This standard has been developed in compliance with Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is considered a minimum quantity.

Note: Although the intended primary application of this Standard is stated in its scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

CSA C22.2 No. 60947-5-1 is to be used in conjunction with the current edition of CSA C22.2 No. 60947-1. The requirements of this Standard, where stated, amend the requirements of CSA C22.2 No. 60947-1.

UL 60947-5-1 is to be used in conjunction with the current edition of UL 60947-1. Requirements of this standard, where stated, amend the requirements of UL 60947-1.

Level of harmonization

This standard adopts the IEC text with national differences.

This standard is published as an identical standard for CSA and UL.

An identical standard is a standard that is exactly the same in technical content except for national differences resulting from conflicts in codes and governmental regulations and basic safety principles and requirements. Presentation is word for word except for editorial changes.

All national differences from the IEC text are included in the CSA Group and UL versions of the standard. While the technical content is the same in each organization's version, the format and presentation may differ.

Reasons for differences from IEC

National differences from the IEC are being added in order to address safety and regulatory situations present in the US and Canada.

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NATIONAL DIFFERENCES

GENERAL

National Differences from the text of International Electrotechnical Commission (IEC) Publication 60947-5-1, Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices, copyright 2016 are indicated by notations (differences) and are presented in bold text. The national difference type is included in the body.

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

DR – These are National Differences based on the **national regulatory requirements**.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are National Differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

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Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

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FOREWORD

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices

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International Standard 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.

This fourth edition cancels and replaces the third edition published in 2003 and its Amendment 1:2009. This edition constitutes a technical revision.

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

- a) update of normative references;
- b) update and restructuring of subclauses in 7.1;
- c) addition of material requirements and test;

- d) update of EMC requirements;
- e) clarification of requirements and update of 8.2;
- f) addition of requirements for screwless-type clamping units;
- g) update of existing Tables 4 and 5;
- h) addition of new Tables 6, 7, 8 and 9;
- i) addition of a new Figure 10;
- j) addition of a new Annex N.

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

FDIS	Report on voting
121A/62/FDIS	121A/76/RVD

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

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

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 standard, 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 60947-1:2007.

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

- 7.2.4.1: Making and breaking capacities (United States of America and Canada)
- 8.3.3.5.2: 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 publication will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

The contents of the corrigendum of July 2016 have been included in this copy.

DV.1 DE Modification of the IEC Foreword by adding the following:

The numbering system in the standard uses a space instead of a comma to indicate thousands and uses a comma instead of a period to indicate a decimal point. For example, 1 000 means 1,000 and 1,01 means 1.01.

DV.2 D2 Modification of the IEC Foreword by adding the following:

This standard shall be read in conjunction with Canadian and United States equivalent standards to the IEC 60947 series per [Table DVA.2](#). Where specifically called for, any reference to IEC 60947-5-1 or IEC 60947-1 shall be to the applicable clause, either the national difference “DV” clause or IEC clause, or a reference to the applicable standard listed in the Annex. The provisions of the general rules are applicable to this standard, where specifically called for.

No Text on This Page

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR – Part 5-1:

Control circuit devices and switching elements – Electromechanical control circuit devices

1 General

1.1 Scope and object

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 a.c. (at a frequency not exceeding 1 000 Hz) or 600 V d.c.

However, for operational voltages below 100 V a.c. or d.c., see [4.3.2.2](#).

This standard applies to specific types of control circuit devices such as:

- 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, for example control switches operated by part of a machine or mechanism;
- associated control circuit equipment, for example indicator lights, etc.

NOTE 1 A control circuit device includes (a) control switch(es) and associated devices such as (an) indicator light(s).

NOTE 2 A control switch includes (a) switching element(s) and an actuating system.

NOTE 3 A switching element can be a contact element or a semiconductor element.

It also applies to specific types of switching elements associated with other devices (whose main circuits are covered by other standards) such as:

- 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.

Contactor relays also comply with the requirements and tests of IEC 60947-4-1 except for the utilization category which comply with this standard.



This standard does not include the relays covered in IEC 60255 or in the IEC 61810 series, nor automatic electrical control devices for household and similar purposes.

The colour requirements of indicator lights, push-buttons, etc., are found in IEC 60073 and also in CIE S 0004/E-2001 from the Commission of Illumination (CIE).

The object of this standard is to state:

- a) the characteristics of control circuit devices;
- b) the electrical and mechanical requirements with respect to:
 - 1) the various duties to be performed;
 - 2) the significance of the rated characteristics and of the markings;
 - 3) the tests to verify the rated characteristics;
- c) the functional requirements to be satisfied by the control circuit devices with respect to:
 - 1) environmental conditions, including those of enclosed equipment;
 - 2) dielectric properties;
 - 3) terminals.

1.1DV D2 Modification of 1.1 by adding the following:

This equipment is intended for installation in accordance with CSA C22.1, Canadian Electrical Code (CE Code, Part I), and the US National Electrical Code (NEC), NFPA 70.

1.2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 60068-2-14:2009, *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 60073:2002, *Basic and safety principles for man-machine interface, marking and identification – Coding principles for indications and actuators*

IEC 60417-DB:2002¹, *Graphical symbols for use on equipment*

IEC 60617-DB:2012², *Graphical symbols for diagrams*

¹ “DB” refers here to the IEC on-line database, available at: <http://www.graphical-symbols.info/equipment>.

² “DB” refers there to the IEC on-line database, available at: <http://std.iec.ch/iec60617>.

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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)*

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IEC 61000-4-3:2006/AMD2:2010

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

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IEC 61140:2015, *Protection against electric shock – Common aspects for installation and equipment*

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

CIE S 004/E-2001, *Colours of Light Signals*

1.2DV DC Modification of 1.2 by adding the following:

For a list of normative standards, see [Table DVA.1](#) and [Table DVA.2](#). See [Table DVB.1](#) for component standards.

2 Terms and definitions

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

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2.1 Basic terms and definitions

2.1.1

control circuit device

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

Note 1 to entry: Control circuit devices can 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.

2.1.2

control switch (for control and auxiliary circuits)

a 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 [2.3.2](#) and [2.3.3](#)).

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

2.1.3

control switch suitable for isolation

a control switch which, in the open position, complies with the requirements specified for the isolating function (see 2.1.19 and 7.1.7 of IEC 60947-1:2007)

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, e.g. in case of insufficiently opened contacts.

2.1.4

control station

an 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, e.g. potentiometers, signal lamps, instruments, etc.

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

2.2 Control switches

2.2.1

automatic control switches

Note 1 to entry: Automatic control switches are operated by automatic control (see 2.4.5 of IEC 60947-1:2007). They are also designated as pilot switches (see 2.2.18 of IEC 60947-1:2007).

2.2.1.1

instantaneous contactor relay

a 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]

2.2.1.2

time-delay contactor relay

a 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.]

2.2.1.3

position switch

a 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]

2.2.1.4

programmer

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

2.2.2

manually operated control switches

Note 1 to entry: Manually operated control switches are operated by manual control (see 2.4.4 of IEC 60947-1:2007).

2.2.2.1

push-button

a 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]

2.2.2.2

pull-button

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

2.2.2.3

push-pull button

a 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.

2.2.2.4

rotary button

a combination of push-button type switching elements having an actuator operated by a manual rotation (see also [2.2.2.15](#) to [2.2.2.18](#) inclusive)

EXAMPLE A 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

2.2.2.5

latched push-button

a 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.

2.2.2.6

locked push-button

a 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.

2.2.2.7

key-operated push-button

a 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.

2.2.2.8

time-delay push-button

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

2.2.2.9

delayed action push-button

a 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

2.2.2.10

illuminated push-button

a push-button incorporating a signalling lamp in the button

2.2.2.11

covered push-button

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

2.2.2.12

shrouded push-button

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

2.2.2.13

free push-button

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

2.2.2.14

guided push-button

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

Note 1 to entry: Examples of guided push-buttons: the actuators of which are keyed, square or rectangular, etc.

2.2.2.15

rotary control switch**rotary switch**

a control switch having an actuator intended to be operated by rotation

2.2.2.16

key-operated rotary switch

a rotary switch where a key is used as the actuator

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

2.2.2.17

limited movement rotary switch

a rotary switch with a restricted angular movement of its actuator

2.2.2.18

unidirectional movement rotary switch

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

2.2.2.19

joy stick

a 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.

2.2.2.20

wobble stick

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

2.2.2.21

foot switch**pedal**

a 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".]

2.3 Parts of control switches

2.3.1

switching element

a switching element may be a semiconductor element (see [2.3.2](#)) or a contact element (see [2.3.3](#))

2.3.2

semiconductor element

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

2.3.3

contact element

<control switch> the 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 contact elements are given in [2.3.3.1](#) to [2.3.3.10](#) inclusive.

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

The following definitions refer to a single contact element of a control switch:

2.3.3.1

single gap contact element

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

Note 1 to entry: See [Figure 4 a\)](#) and [Figure 4 c\)](#).

2.3.3.2

double gap contact element

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

Note 1 to entry: See [Figure 4 b\)](#), [Figure 4 d\)](#) and [Figure 4 e\)](#).

2.3.3.3

make-contact element

normally open

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

2.3.3.4

break-contact element

normally closed

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

2.3.3.5

change-over contact elements

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

Note 1 to entry: See [Figure 4 c\)](#), [Figure 4 d\)](#) and [Figure 4 e\)](#).

2.3.3.6

pulse contact element

fleeting contact element

a 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

2.3.3.7

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]

2.3.3.8

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

a 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

2.3.3.9

dependent action contact element

a 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

2.3.3.10

contact unit

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

2.3.4

button

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

2.3.4.1

flush-button

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

2.3.4.2

recessed button

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

2.3.4.3

extended button

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

2.3.4.4

mushroom button

a button, the protruding end of which has an enlarged diameter

2.3.5

locating mechanism

<rotary switch> that 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.

2.3.6

end stop

a 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.

2.4 Operation of control switches

2.4.1 Operation of contactor relays

2.4.1.1

e-delay

<contact element> a 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 [2.3.3](#)).

2.4.1.2

d-delay

<contact element> a 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 [2.3.3](#)).

2.4.1.3

fixed delay

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

2.4.1.4

adjustable delay

<contact element> a 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

2.4.2 Operation of pilot switches

2.4.2.1

actuating quantity

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

2.4.2.2

operating value

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

2.4.2.3

return value

the 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

2.4.2.4

differential value

the difference between the operating value and the return value

2.4.3 Operation of rotary switches

2.4.3.1

definite position (of a rotary switch)

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

2.4.3.2

position of rest

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

2.4.3.3

transit position

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

2.4.3.4

biased position

a (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.

2.4.3.5

latched position

a 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.

2.4.3.6

locked position

a (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.

2.4.3.7

operating diagram

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

2.4.4 Operation of mechanically operated control switches

2.4.4.1

pre-travel of the actuator

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

Note 1 to entry: See Dimension a on [Figure 2](#).

2.4.4.2

over-travel of the actuator

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

2.4.4.3

direct drive

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

2.4.4.4

positive drive

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

2.4.4.5

limited drive

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

2.4.4.6

minimum starting force**minimum starting moment**

the smallest value of force (or moment) initiating the pre-travel of the actuator

2.4.4.7

minimum actuating force**minimum actuating moment**

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

2.4.4.8

pre-travel of the contact element

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

Note 1 to entry: See Dimension *b* on [Figure 2](#).

2.4.4.9

over-travel of the contact element (dimension *d* on [Figure 2](#))

the 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 2](#).

2.4.4.10

bounce time

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

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

3 Classification

3.1 Contact elements

Contact elements may be classified as follows:

- a) Utilization categories (see [4.4](#)).
- b) Electrical ratings based on utilization categories (see Annex [A](#)).



c) One of the following form letters (see [Figure 4](#)):

- 1) Form A – Single gap make-contact element;
- 2) Form B – Single gap break-contact element;
- 3) Form C – Single gap make-break three terminal change-over contact element;
- 4) Form X – Double gap make-contact element;
- 5) Form Y – Double gap break-contact element;
- 6) Form Z – Double gap make-break four terminal change-over contact element.

d) Other types not included in c).

NOTE 1 Regarding [Figure 4e](#), the two moving contact elements are electrically separated (see [2.3.3.7](#)).

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.

3.2 Control switches

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

3.3 Control circuit devices

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

3.4 Time delay switching elements

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

3.5 Control switch mounting

The control switch mounting may be classified by the mounting hole size, e.g. D12, D16, D22, D30 (see [6.3.1](#)).

4 Characteristics

4.1 Summary of characteristics

4.1.1 General

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

- type of equipment (see [4.2](#));
- rated and limiting values for switching elements (see [4.3](#));

- utilization categories of switching elements (see [4.4](#));
- normal and abnormal load characteristics (see [4.3.6](#)).

4.1.2 Operation of a control switch

The principal application of a control switch is the switching of loads as indicated for the various utilization categories in [Table 1](#).

Other applications, e.g. the switching of tungsten filament lamps, small motors, etc., are not dealt with in detail in this standard, but are mentioned in [4.3.6.2](#).

4.1.2.1 Normal conditions of use

The normal use of a control switch is to close, maintain and open circuits in accordance with the utilization category shown in [Table 1](#). Also refer to [Table 4](#).

4.1.2.2 Abnormal conditions of use

Abnormal conditions may arise, for example, when an electromagnet, although energized, has failed to close. Refer to [Table 5](#).

A control switch shall be able to break the current corresponding to such conditions of use.

4.2 Type of control circuit device or switching element

4.2.1 Kind of control circuit device

The kind of control circuit device shall be stated:

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

4.2.2 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.

4.2.3 Number of poles

The number of poles shall be stated.

4.2.4 Kind of current

The kind of current shall be stated:

Alternating current or direct current.

4.2.5 Interrupting medium

The interrupting medium shall be stated:

Air, oil, gas, vacuum, etc.

4.2.6 Operating conditions

4.2.6.1 Method of operation

The method of operation shall be stated:

Manual, electromagnetic, pneumatic, electro-pneumatic.

4.2.6.2 Method of control

The method of control shall be stated:

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

4.3 Rated and limiting values for switching elements

4.3.1 General

The rated values established for the switching elements of a control circuit device shall be stated in accordance with [4.3.2](#) to [4.3.6](#) inclusive but it is not necessary to specify all the values listed.

4.3.2 Rated voltages (of a switching element)

4.3.2.1 General

A switching element is defined by the rated voltages described in [4.3.2.2](#) to [4.3.2.4](#).

4.3.2.2 Rated operational voltage (U_e)

Subclause 4.3.1.1 of IEC 60947-1:2007 applies with the following additions:

For three-phase circuits, U_e is stated as r.m.s. voltage between phases.

NOTE A switching elements can be assigned a number of combinations of rated operational voltage and rated operational current.

Control switches dealt with in this standard are not normally intended to be used at very low voltages and they may not be suitable for such a service. It is therefore recommended to seek the advice of the manufacturer concerning any application with a low value of operational voltage, e.g. below 100 V a.c. or d.c.

4.3.2.3 Rated insulation voltage (U_i)

Subclause 4.3.1.2 of IEC 60947-1:2007 applies.

4.3.2.4 Rated impulse withstand voltage (U_{imp})

Subclause 4.3.1.3 of IEC 60947-1 applies.

4.3.3 Currents

A switching element is characterized by the currents described in [4.3.3.1](#) to [4.3.3.3](#).

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

Subclause 4.3.2.1 of IEC 60947-1:2007 applies.

4.3.3.2 Conventional enclosed thermal current (I_{the})

Subclause 4.3.2.2 of IEC 60947-1:2007 applies.

4.3.3.3 Rated operational current (I_e)

The first paragraph of 4.3.2.3 of IEC 60947-1:2007 applies.

4.3.4 Rated frequency

Subclause 4.3.3 of IEC 60947-1:2007 applies.

4.3.5 Vacant

4.3.6 Normal and abnormal load characteristics

4.3.6.1 Rated making and breaking capacities and behaviour of switching elements under normal conditions

A switching element shall comply with both requirements given in [Table 4](#) 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.

4.3.6.2 Making and breaking capacities under abnormal conditions

A switching element shall comply with the requirements given in [Table 5](#) corresponding to the assigned utilization category.

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.

4.3.7 Short-circuit characteristics

4.3.7.1 Rated conditional short-circuit current

Subclause 4.3.6.4 of IEC 60947-1:2007 applies.

4.4 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.

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

4.4DV D2 Modification of 4.4 by adding the following text and Table 4.4DV:

The equipment rating and required load designation shall be in accordance with [Table 4.4DV](#). In addition, utilization categories and/or additional load designations may be marked.

Table 4.4DV
Ratings of a device controlling an external load

Load type	Equivalent ¹ utilization category	Equipment rating	Required load marking	Additional load designations
AC pilot duty	AC-15, AC-14	Amperes	See NOTE	See NOTE
DC pilot duty	DC-13	Amperes	See NOTE	See NOTE

Table 4.4DV Continued on Next Page

Table 4.4DV Continued

Load type	Equivalent ¹ utilization category	Equipment rating	Required load marking	Additional load designations
AC general purpose – Noninductive or slightly inductive	AC-1	Amperes	None	General use; AC-1
DC general purpose – Noninductive or slightly inductive	DC-1	Amperes	None	General use; DC-1
AC resistance (not air heating)	–	Amperes	Resistive	Res.
DC resistance (not air heating)	–	Amperes	Resistive	Res.
Incandescent lamp	AC-5b	Amperes or watts	Tungsten	AC-5b
Incandescent lamp	DC-6	Amperes or watts	Tungsten	DC-6
Ballast (electric discharge lamp)	AC-5a	Amperes	Ballast	AC-5a
NOTE: Equipment marking may be: a) in the form of a code designation in accordance with Table A.1, Table A.2 or Table A.3 as applicable; b) voltage and the words “standard duty” (codes B and P) or “heavy duty” (codes A and N); or c) volts, amperes, and inrush amperes; volts and volt-amperes; or volts, amperes, and the words “pilot duty”. (1) See Annex A of CSA C22.2 No. 60947-1/UL 60947-1 for utilization category-relevant product standards.				

4.5 Vacant**4.6 Vacant****4.7 Vacant****4.8 Vacant****4.9 Vacant****4.10 Electrically separated contact elements**

The manufacturer shall state whether the contact elements of a control circuit device are electrically separated or not (see [2.3.3.7](#)). Separated contact elements shall be assumed to be opposite polarity unless otherwise stated by the manufacturer.

4.11 Actuating quantities for pilot switches

The operating value and return value of the actuating quantity are to 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.

4.12 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.

5 Product information

5.1 Nature of information

The following information shall be given by the manufacturer:

Identification

- a) The manufacturer's name or trade mark.
- b) A 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 standard.

Basic rated values and utilization

- d) Rated operational voltages (see [4.3.2.2](#)).
- e) Utilization category and rated operational currents at the rated operational voltages of the control circuit device.
- f) Rated insulation voltage (see [4.3.2.3](#)).
- g) Rated impulse withstand voltage (see [4.3.2.4](#)).
- h) Vacant.
- i) IP code, in case of an enclosed control circuit device (see 5.1 and Annex C of IEC 60947-1:2007/AMD1:2010).
- j) Pollution degree (see [6.1.3.2](#)).
- k) Type and maximum ratings of short-circuit protective device (see [8.3.4.3](#)).
- l) Conditional short-circuit current.
- m) Suitability for isolation, where applicable, with the symbol S00288 of IEC 60617.

- n) Indication of contact elements of same polarity.
- o) Length of insulation to be removed before insertion of the conductor into the terminal.
- p) For non-universal screwless terminals:
 - "s" or "sol" for terminals declared for rigid-solid conductors;
 - "r" for terminals declared for rigid (solid and stranded) conductors;
 - "f" for terminals declared for flexible conductors.

5.1DV D2 Modification of 5.1 by adding the following:

5.1DV.1 Items f) and l) are optional.

5.1DV.2 Item g) is optional except when evaluating creepage and clearance distances per 7.1.4 of CSA C22.2 No. 60947-1/UL 60947-1.

5.1DV.3 Item i) is optional and may be in addition to the required enclosure Type ratings according to 7.1.12DV of CSA C22.2 No. 60947-1/UL 60947-1.

5.1DV.4 Item m) does not apply.

5.1DV.5 Terminal markings for tightening torque, number of conductors, solid or stranded and wire range shall comply with 5.2 and 5.2DV.6 of CSA C22.2 No. 60947-1/UL 60947-1 for non-screwless terminals.

5.1DV.6 Items o) and p) are replaced by the following:

o) Length of insulation to be removed before insertion of the conductor into the screwless terminal.

p) For screwless terminals:

- "s" or "sol" for terminals declared for solid conductors;
- "str" for terminals declared for stranded conductors.

5.2 Marking

5.2.1 General

Marking of data under a) and b) of [5.1](#) 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 n) of [5.1](#) shall be included on the nameplate of the control circuit device in order to ensure proper wiring at installation.

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

Whenever space permits, data under c) to m) and o) of [5.1](#) shall be included on the nameplate, or on the control circuit device or otherwise in the manufacturer's published literature.