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.

No Text on This Page

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Underwriters Laboratories Inc.
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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).

Approved American National Standard

ANSI/UL 60947-5-1-2022

Commitment for Amendments

This standard is issued jointly by the Canadian Standards Association (operating as “CSA Group”) and Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the standard may be submitted to CSA Group or UL at anytime. Revisions to this standard will be made only after processing according to the standards development procedures of CSA Group, and UL. CSA Group and UL will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue.

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This Standard is subject to review within five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. The technical content of IEC and ISO publications is kept under constant review by IEC and ISO. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

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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.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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CONTENTS

No Text on This Page

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.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

IEC copyright

For CSA Group, the text, figures, and tables of International Electrotechnical Commission 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 used in this Standard with the consent of the International Electrotechnical Commission. The IEC Foreword is not a part of the requirements of this Standard but is included for information purposes only.

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.

DE – These are National Differences based on **editorial comments or corrections**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

> ***Addition / Add*** - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.
>
> ***Modification / Modify*** - A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base IEC text.
>
> ***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

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

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6) All users should ensure that they have the latest edition of this publication.

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8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 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 restructuration of subclauses in 7.1;

c) addition of material requirements and test;

d) udpate of EMC requirements;

e) clarification of requirements and update of 8.2;

f) addition of requirements for screwless-type clamping units;

g) udpate 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:2002[1], *Graphical symbols for use on equipment*

IEC 60617-DB:2012[2], *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.

IEC 60695-2-10:2013, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

IEC 60695-2-11:2014, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)*

IEC 60695-2-12:2010, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials*
IEC 60695-2-12:2010/AMD1:2014

IEC 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules*
IEC 60947-1:2007/AMD1:2010
IEC 60947-1:2007/AMD2:2014

IEC 60947-4-1:2009, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*
IEC 60947-4-1:2009/AMD1:2012

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 61000-3-2, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current < 16 A per phase)*

IEC 61000-3-3, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current <16 A per phase and not subject to conditional connection*

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

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*
IEC 61000-4-3:2006/AMD1:2007
IEC 61000-4-3:2006/AMD2:2010

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 61000-4-6:2013, *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 61000-4-11:2004, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-4-13:2002, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and measurement techniques – Harmonics and interharmonics including mains signalling at a.c. power port, low frequency immunity tests*
IEC 61000-4-13:2002/AMD1:2009
IEC 61000-4-13:2002/AMD2:2015

IEC 61140:2015, *Protection against electric shock – Common aspects for installation and equipment*
IEC 61140:2015/AMD1:2004

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.

Alphabetical index of definitions	References
A	
Actuating quantity	2.4.2.1
Adjustable delay (of a contact element)	2.4.1.4
B	
Biased position	2.4.3.4
Bounce time	2.4.4.10
Break-contact element (normally closed)	2.3.3.4
Button	2.3.4
C	
Change-over contact elements	2.3.3.5
Contact element (of a control switch)	2.3.3

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.