UL 60947-5-2

STANDARD FOR SAFETY

Low-Voltage Switchgear and Controlgear – Part 5-2: Control Circuit Devices and Switching Elements – Proximity Switches

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

UL Standard for Safety for Low-Voltage Switchgear and Controlgear – Part 5-2: Control Circuit Devices and Switching Elements – Proximity Switches, UL 60947-5-2

Fourth Edition, Dated March 31, 2022

Summary of Topics

Adoption of Edition 3.1 of IEC 60947-5-2, Standard for Low-Voltage Switchgear and Controlgear – Part 5-2: Control Circuit Devices and Switching Elements – Proximity Switches, as the Fourth Edition of ANSI/UL 60947-5-2.

This standard is an adoption of IEC 60947-5-2, Edition 3.0, issued May 2007 and amendment 1, issued 2012. Please note that the National Difference document incorporates all of the U.S. national differences for UL 60947-5-2.

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

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of UL.

UL provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgment (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

No Text on This Page

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

CSA Group
CSA C22.2 No. 60947-5-2:22
Second Edition
(IEC 60947-5-2:2007+A1:2012, MOD)

Underwriters Laboratories Inc.
UL 60947-5-2
Fourth Edition

Low-Voltage Switchgear and Controlgear – Part 5-2: Control Circuit Devices and Switching Elements – Proximity Switches

March 31, 2022

This national standard is based on IEC 60947-5-2, edition 3 (2007), consolidated with amendment 1 (2012).

ANSI/UL 60947-5-2-2022

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Documents
Document Sharing Hub

Full document details: UL 60947-5-2 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.

ISBN 978-1-4883-2956-2 © 2022 Canadian Standards Association

All rights reserved. No part of this publication may be reproduced in any form whatsoever without the prior permission of the publisher.

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.

To purchase CSA Group Standards and related publications, visit CSA Group’s Online Store at www.csagroup.org/store/ or call toll-free 1-800-463-6727 or 416-747-4044.

Copyright © 2022 Underwriters Laboratories Inc.

UL's Standards for Safety are copyrighted by UL. Neither a printed nor electronic copy of a Standard should be altered in any way. All of UL's Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of UL.

This ANSI/UL Standard for Safety consists of the Fourth Edition. The most recent designation of ANSI/UL 60947-5-2 as an American National Standard (ANSI) occurred on March 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.

To purchase UL Standards, visit UL's Standards Sales Site at http://www.shopulstandards.com/HowToOrder.aspx or call toll-free 1-888-853-3503.

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

CONTENTS

Preface 7

NATIONAL DIFFERENCES 9

FOREWORD 11

1 General 13
1DV Modification of Clause 1 by adding the following: 13
1.1 Scope and object 13
1.1DV Modification of 1.1 by adding the following: 14
1.2 Normative references 14
1.2DV Modification of 1.2 by adding the following: 15
2 Definitions 15
2.1 Basic definitions 17
2.2 Parts of a proximity switch 19
2.3 Operation of a proximity switch 20
2.4 Switching element characteristics 23
3 Classification 27
3.1 Classification according to sensing means 27
3.2 Classification according to the mechanical installation 27
3.3 Classification according to the construction form and size 27
3.4 Classification according to switching element function 27
3.5 Classification according to type of output 27
3.6 Classification according to method of connection 27
4 Characteristics 27
4.1 Summary of characteristics 27
4.2 Operating conditions 28
4.3 Rated and limiting values for the proximity switch and switching element(s) 31
4.4 Utilization categories for the switching element 33
4.4DV Modification of 4.4 by replacing it with the following: 33
5 Product information 33
5.1 Nature of information – Identification 33
5.1DV Modification of 5.1 by adding the following: 34
5.2 Marking 35
5.3 Instructions for installation, operation and maintenance 36
6 Normal service, mounting and transport conditions 36
6.1 Normal service conditions 36
6.2 Conditions during transport and storage 37
6.3 Mounting 37
7 Constructional and performance requirements 37
7.1 Constructional requirements 37
7.2 Performance requirements 42
7.3 Physical dimensions 53
7.4 Shock and vibration 53
8 Tests 54
8.1 Kinds of tests 54
8.2 Compliance with constructional requirements 55
8.3 Performances 55
8.4 Testing of operating distances 67
8.5 Testing for the frequency of operating cycles 71
8.6 Verification of the electromagnetic compatibility 76
8.7 Test results and test report 78

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

Annex A (informative) Typical dimensions and operating distances of proximity switches

A.1 (IA) Dimensions 79
A.2 (IA) Rated operating distances 80
A.3 (IA) Installation (mounting) 80
A.4 (IA) Frequency of operating cycles (*f*) in operating cycles per second – Minimum requirements 81
A.1 (IB) Dimensions 82
A.2 (IB) Rated operating distances 82
A.3 (IB) Installation (mounting) 83
A.4 (IB) Frequency of operating cycles (*f*) in operating cycles per second – Minimum requirements 83
A.1 (IC) Dimensions 84
A.2 (IC) Rated operating distance 87
A.3 (IC) Installation (mounting) 87
A.4 (IC) Frequency of operating cycles (*f*) in operating cycles per second – Minimum requirements 89
A.1 (ID) Dimensions 90
A.2 (ID) Rated operating distance 90
A.3 (ID) Installation (mounting) 91
A.4 (ID) Frequency of operating cycles (*f*) in operating cycles per second – Minimum requirements 91
A.1 (CA) Dimensions 92
A.2 (CA) Rated operating distance (s_n) 93
A.3 (CA) Installation (mounting) 93
A.4 (CA) Frequency of operating cycles (*f*) 93
A.1 (CC) Dimensions 94
A.2 (CC) Rated operating distances (s_n) 95
A.3 (CC) Installation (mounting) 96
A.4 (CC) Frequency of operating cycles (*f*) 96
A.1 (CD) Dimensions 97
A.2 (CD) Rated operating distance (s_n) 97
A.3 (CD) Installation (mounting) 97
A.4 (CD) Frequency of operating cycles (*f*) 98
A.1 (UA) Dimensions 99
A.2 (UA) Sensing range 100
A.3 (UA) Installation (mounting) 100
A.4 (UA) Frequency of operating cycles (*f*) 100
A.1 (UC) Dimensions 101
A.2 (UC) Sensing range 101
A.3 (UC) Installation (mounting) 102
A.4 (UC) Frequency of operating cycles (*f*) 102
A.1 (UD) Dimensions 103
A.2 (UD) Sensing range 103
A.3 (UD) Installation (mounting) 104
A.4 (UD) Frequency of operating cycles (*f*) 104

Annex B (normative) Class II proximity switches insulated by encapsulation – Requirements and tests

B.1 General 105
B.2 Definitions 105
B.5 Marking 105
B.7 Constructional and functional requirements 106
B.7.1 Choice of compound 106
B.7.2 Adhesion of the compound 106

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

B.7.3 Dielectric properties 106
B.8 Tests 107
B.8.1 Kind of tests 107

Annex C (normative) Additional requirements for proximity switches with integrally connected cables

C.1 General 109
C.2 Definitions 109
C.7 Constructional and performance requirements 109
C.7.1 Constructional requirements 109
C.7.2 Performance requirements 111
C.8 Tests 111
C.8.1 Type tests 111
C.8.2 Results to be obtained 114
C.8.2DV Modification of C.8.2 by adding the following: 114

Annex D (normative) Integral connectors for plug-in proximity switches

Annex E (normative) Additional requirements for proximity switches suitable for use in strong magnetic fields

E.1 General 120
E.1.2 Scope and object 120
E.2 Definitions 120
E.3 Classification 120
E.3.7 Classification according to the type of the influencing magnetic field 120
E.7 Construction and performance requirements 121
E.8 Tests 121
E.8.9 Verification of immunity 121

Annex F (informative) Symbols for proximity switches

Annex DVA (normative) Normative and informative content

Annex DVA Addition: Add Annex DVA as follows: 127

Annex DVB (normative) Standard references

Annex DVB Addition: Add Annex DVB as follows: 130

Annex DVC (normative) Standards for components

Annex DVC Addition: Add Annex DVC as follows: 132

Annex DVD (normative) Clearance and creepage distances for control circuit devices and switching elements

Annex DVD Addition: 133

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

No Text on This Page

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

Preface

This is the harmonized CSA Group and UL standard for Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches. It is the second edition of CSA C22.2 No. 60947-5-2, and the fourth edition of UL 60947-5-2. This edition of CSA C22.2 No. 60947-5-2 supersedes the previous edition published in 2014 as CAN/CSA-C22.2 No. 60947-5-2.

This harmonized standard is based on IEC Publication 60947-5-2: Edition 3.1, Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches, issued September 2012. IEC 60947-5-2 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. 60947-5-2 is to be used in conjunction with the current edition of CSA C22.2 No. 60947-1. Requirements of this standard, where stated, amend the requirements of CSA C22.2 No. 60947-1.

UL 60947-5-2 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 Group 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. 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.

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

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 60947-5-2, Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches, copyright 2012, 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.

These materials are subject to copyright claims of IEC and UL. No part of this publication may be reproduced in any form, including an electronic retrieval system, without the prior written permission of UL. All requests pertaining to this Standard should be submitted to UL.

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

NATIONAL DIFFERENCES

GENERAL

National Differences from the text of International Electrotechnical Commission (IEC) Publication 60947-5-2, Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches, copyright 2012, 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.

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

No Text on This Page

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

FOREWORD

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR – Part 5-2: Control circuit devices and switching elements – Proximity switches

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

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

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.

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

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

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

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

This consolidated version of IEC 60947-5-2 consists of the third edition (2007) [documents 17B/1570/FDIS and 17B/1576/RVD] and its amendment 1 (2012) [documents 17B/1733/CDV and 17B/1774/RVC]. It bears the edition number 3.1.

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

International Standard IEC 60947-5-2 has been prepared by subcommittee 17B: Low-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

The document 17B/1570/FDIS, circulated to the National Committees as Amendment 3, led to the publication of the new edition.

The main changes with respect to the previous edition are as follows:

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

– modification of Table 3;

– modifications of voltage dips and voltage interruptions immunity tests, in Table 8;

– modification of status of Annex A, now informative.

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

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 the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site 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.

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

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 DVB.2. Where specifically called for, any reference to IEC 60947-5-2 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.

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR – Part 5-2: Control circuit devices and switching elements – Proximity switches

1 General

The provisions of the general rules in 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 appendices, are identified by references to IEC 60947-1, e.g. subclause 7.1.9.3 of IEC 60947-1 or Annex C of IEC 60947-1.

Clauses 1 to 8 contain the general requirements. Specific requirements for the various types of proximity switches are given in Annex A.

1DV D2 ***Modification of Clause 1 by adding the following:***

Annex DVA defines the specific clauses, tables, and figures in this standard which are to be considered normative, informative, or not applicable. Compliance with the normative clauses, tables, and figures is mandatory; compliance with the informative clauses, tables, and figures is optional.

1.1 Scope and object

This part of IEC 60947 applies to inductive and capacitive proximity switches that sense the presence of metallic and/or non-metallic objects, ultrasonic proximity switches that sense the presence of sound reflecting objects, photoelectric proximity switches that sense the presence of objects and non-mechanical magnetic proximity switches that sense the presence of objects with a magnetic field.

These proximity switches are self-contained, have semiconductor switching elements(s) and are intended to be connected to circuits, the rated voltage of which does not exceed 250 V 50 Hz/60 Hz a.c. or 300 V d.c. This Standard is not intended to cover proximity switches with analogue outputs.

The object of this standard is to state for proximity switches:

– definitions;

– classification;

– characteristics;

– product information;

– normal service, mounting and transport conditions;

– constructional and performance requirements;

– tests to verify rated characteristics.

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

1.1DV D2 ***Modification of 1.1 by adding the following:***

This equipment is intended for use on industrial machinery or mass production industrial equipment as defined and installed in accordance with CSA C22.1, Canadian Electrical Code (CE Code, Part I), and CSA C22.2 No. 301 in Canada, and NFPA 70, National Electrical Code (NEC), and NFPA 79 in the USA.

1.2 Normative references

The following referenced documents are indispensable for the application 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 60050(441):1984, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*
Amendment 1 (2000)

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 60364 (all parts), *Low-voltage electrical installations*

IEC 60445:2010, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors*

IEC 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules*
Amendment 1:2010

IEC 61000-3-2:2005, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*
Amendment 1:2008
Amendment 2:2009

IEC 61000-3-3:2008, *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*
Amendment 1:2007
Amendment 2:2010

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

IEC 61000-4-4:2004, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-6:2008, *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*
Amendment 1:2009

IEC 61076-2 (all parts), *Connectors for electronic equipment – Product requirements – Part 2: Circular connectors*

IEC 61140:2001, *Protection against electric shock – Common aspects for installation and equipment*
Amendment 1 (2004)

CISPR 11:2009, *Industrial, scientific and medical equipment – Electromagnetic Radio-frequency disturbance characteristics – Limits and methods of measurement*
Amendment 1:2010

ISO 630 (all parts), *Structural steels*

1.2DV DC *Modification of 1.2 by adding the following:*

For a list of normative standards, see Table DVB.1 and Table DVB.2. See Table DVC.1 for component standards.

2 Definitions

Clause 2 of part 1 applies with the following additions:

Alphabetical index of definitions	*References*
A	
Adjuster of a proximity switch	2.2.15
Adjuster of a capacitive proximity switch	2.2.15.1
Adjuster of an ultrasonic proximity switch	2.2.15.2
Ambient light for a photoelectric proximity switch	2.4.7
Assured operating distance (s_a)	2.3.1.7
Axial approach	2.3.3
B	

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

Blind zone 2.3.1.3
Break function 2.4.1.2

C

Capacitive proximity switch 2.1.1.2
Currents (I) 2.4.5

D

Damping material 2.2.5
Differential travel (H) 2.3.5
Direct operated proximity switch 2.1.1.6

E

Effective operating distance (s_r) 2.3.1.5
Embeddable proximity switch 2.2.9
Emitter 2.2.12
Excess gain for a photoelectric proximity switch 2.4.6

F

Free zone 2.2.4
Frequency of operating cycle (f) 2.4.3

I

Independent (snap) action 2.4.2
Indirect operated proximity switch 2.1.1.7
Inductive proximity switch 2.1.1.1

L

Lateral approach 2.3.2

M

Make function 2.4.1.1
Make-break, or changeover function 2.4.1.3
Maximum operating distance 2.3.1.2.2
Minimum operating distance 2.3.1.2.1
Minimum operational current (I_m) 2.4.5.2

N

Neutral density filters 2.1.1.8
No-load supply current (I_o) 2.4.5.3
Non-damping material 2.2.6
Non-embeddable proximity switch 2.2.10
Non-mechanical magnetic proximity switch 2.1.1.5

O

OFF-state current (I_r) 2.4.5.1
Operating distances (s) 2.3.1
Operating range (r_o) 2.3.1.8
Operation of a proximity switch 2.3

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

P

Parts of proximity switches 2.2
Photoelectric proximity switch 2.1.1.4
Photoelectric proximity switch – type D 2.1.1.4.1
Photoelectric proximity switch – type R 2.1.1.4.2
Photoelectric proximity switch – type T 2.1.1.4.3
Proximity switch (IEV 441-14-51) 2.1.1

R

Rated operating distance (s_n) 2.3.1.1
Receiver 2.2.13
Reference axis 2.2.2
Reflector 2.2.14
Repeat accuracy (R) 2.3.4
Response time proximity switch 2.4.1.4

S

Semiconductor switching element 2.2.1
Sensing face 2.2.11
Sensing range (s_d) 2.3.1.2
Sound absorbing material 2.2.8
Sound reflecting material 2.2.7
Standard target 2.2.3
Switching element characteristics 2.4
Switching element function 2.4.1

T

Time delay before availability (t_v) 2.4.4
Total beam angle 2.3.1.4
Turn off time for a photoelectric proximity switch 2.4.1.6
Turn on time for a photoelectric proximity switch 2.4.1.5

U

Ultrasonic proximity switch 2.1.1.3
Usable operating distance (s_u) 2.3.1.6

2.1 Basic definitions

2.1.1
proximity switch
a position switch which is operated without mechanical contact with the moving part

[IEV 441-14-51][1)]

[1)] See IEC 60050(441).

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

2.1.1.1
inductive proximity switch
a proximity switch producing an electromagnetic field within a sensing zone and having a semiconductor switching element

2.1.1.2
capacitive proximity switch
a proximity switch producing an electric field within a sensing zone and having a semiconductor switching element

2.1.1.3
ultrasonic proximity switch (see Figure 2)
a proximity switch transmitting and receiving ultrasound waves within a sensing zone and having a semiconductor switching element

2.1.1.4
photoelectric proximity switch (see Figure 1)
a proximity switch which senses objects that either reflect or interrupt visible or invisible light and having a semiconductor switching element

2.1.1.4.1
type D
diffuse reflective photoelectric proximity switch which is directly operated through lateral or axial approach to its reference axis by a defined object

2.1.1.4.2
type R
retroreflective photoelectric proximity switch which is indirectly operated through lateral approach to its reference axis between emitter-receiver and reflector by a defined object

2.1.1.4.3
type T
through beam photoelectric proximity switch which is indirectly operated through lateral approach of its reference axis between emitter and receiver by a defined object

2.1.1.5
non-mechanical magnetic proximity switch
proximity switch which senses the presence of a magnetic field and has a semiconductor switching element and no moving parts in the sensing element

2.1.1.6
direct operated proximity switch
proximity switch which detects its target without the use of an external means, e.g. a reflector

2.1.1.7
indirect operated proximity switch
proximity switch which detects its target with the use of an external means, e.g. a reflector

2.1.1.8
neutral density filters
filters which uniformly attenuate the intensity of light over a broad spectral range

NOTE Attenuation is accomplished by using either a light-absorbing glass or a thin-film metal coating that combines absorption and reflection.

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

2.2 Parts of a proximity switch

2.2.1
semiconductor switching element
an element designed to switch the current of an electric circuit by controlling conductivity of a semiconductor

2.2.2 Reference axis

2.2.2.1
reference axis for inductive, capacitive, non-mechanical magnetic and ultrasonic proximity switches
an axis perpendicular to the sensing face and passing through its centre

2.2.2.2
reference axis for types R and D photoelectric proximity switches
an axis located midway between the optical axis of the emitter and this of receiver elements or lenses (see Figure 1)

2.2.2.3
reference axis for type T photoelectric proximity switches
an axis perpendicular to the centre of the emitter

2.2.3
standard target
a specified object used for making comparative measurements of the operating distances and sensing distances

2.2.4
free zone
a volume around the proximity switch which is kept free from any material capable of affecting the characteristics of the proximity switch

2.2.5
damping material
a material which has an influence on the characteristics of a proximity switch

2.2.6
non-damping material
a material which has negligible influence on the characteristics of a proximity switch

2.2.7
sound-reflecting material
a material which reflects the ultrasound waves and gives detectable echoes

2.2.8
sound-absorbing material
a material with negligible reflecting characteristics for ultrasound waves which gives no detectable echo

2.2.9
embeddable proximity switch
a proximity switch is "embeddable" when any damping material can be placed around the sensing face plane without influencing its characteristics

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

2.2.10
non-embeddable proximity switch
a proximity switch is "non-embeddable" when a specified free zone around its sensing face is necessary in order to maintain its characteristics

2.2.11 Sensing face

2.2.11.1
sensing face of an inductive proximity switch
a surface of the proximity switch through which the electromagnetic field emerges

2.2.11.2
sensing face of a capacitive proximity switch
a surface of the proximity switch through which the electric field emerges

2.2.11.3
sensing face of an ultrasonic proximity switch
a surface of the proximity switch where ultrasound is transmitted and received

2.2.11.4
sensing face of a non-mechanical magnetic proximity switch
a surface of the proximity switch through which the change in a magnetic field is detected

2.2.12
emitter
the light source, lens and necessary circuitry which provide the light beam

2.2.13
receiver
the detector, lens and necessary circuitry to monitor the presence of the light beam from the emitter

2.2.14
reflector
a specified device used to reflect light back to the receiver for type R photoelectric proximity switches

2.2.15 Adjuster

2.2.15.1
adjuster of a capacitive proximity switch
a part of capacitive proximity switch used to set the operating distance. Its use compensates for influence due to target material, transmission medium and installation (mounting) conditions

2.2.15.2
adjuster of an ultrasonic or a photoelectric proximity switch
a part of an ultrasonic or a photoelectric proximity switch used to set the operating distance within the sensing range

2.3 Operation of a proximity switch

2.3.1
operating distances (*s*)
a distance at which the target approaching the sensing face along the reference axis causes the output signal to change

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

2.3.1.1
rated operating distance (s_n)
the rated operating distance is a conventional quantity used to designate the operating distances. It does not take into account either manufacturing tolerances or variations due to external conditions such as voltage and temperature

2.3.1.2
sensing range (s_d)
the range within which the operating distance may be adjusted

2.3.1.2.1
minimum operating distance
the lower limit of the specified sensing range of an ultrasonic or photoelectric proximity switch

2.3.1.2.2
maximum operating distance
the upper limit of the specified sensing range of an ultrasonic or photoelectric proximity switch

2.3.1.3
blind zone
the zone between the sensing face and the minimum operating distance, where no object can be detected

2.3.1.4
total beam angle
the solid angle around the reference axis of an ultrasonic proximity switch, where the sound level drops by 3 dB

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

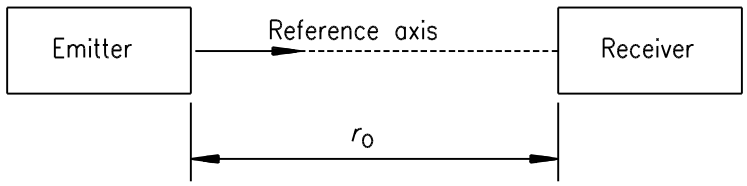


Figure 1a – Type T, emmitter and receiver – Through beam photoelectric

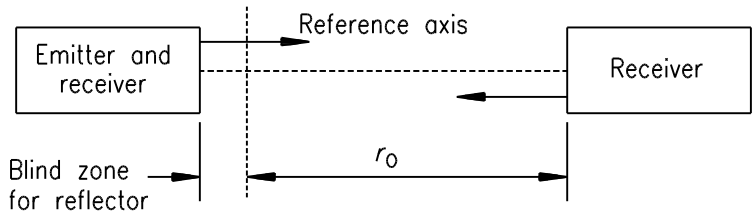


Figure 1b – Type R, emmitter–receiver and reflector – Retroreflective photoelectric

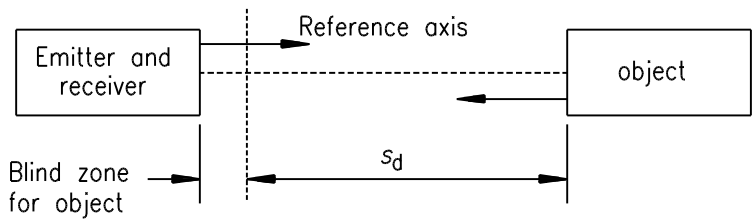


Figure 1c – Type D, emmitter–receiver and object – Diffuse reflective photoelectric
S4985

Figure 1

Sensing range and operating range of photoelectric proximity switches

(see 7.2.1.3 and 8.4)

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Documents
Document Sharing Hub

Full document details: UL 60947-5-2 2022

2.3.1.5
effective operating distance (s_r)
the operating distance of an individual proximity switch, measured at stated temperature, voltage and mounting conditions

2.3.1.6
usable operating distance (s_u)
the operating distance of an individual proximity switch, measured under specified conditions

2.3.1.7
assured operating distance (s_a)
the distance from the sensing face within which the correct operation of the proximity switch under specified conditions is assured

2.3.1.8 **operating range (r_o)**
range within which a lateral approach of the target causes the output signal of a through beam or retroreflective proximity switch to change

2.3.2
lateral approach
the approach of the target perpendicular to the reference axis

2.3.3
axial approach
the approach of the target with its centre maintained on the reference axis

2.3.4
repeat accuracy (*R*)
the value of variation of the effective operating distance (s_r) under specified conditions

2.3.5
differential travel (*H*)
the distance between the operating point when the target approaches the proximity switch and the release point when the target moves away

2.4 Switching element characteristics

2.4.1 switching element function

2.4.1.1
make function
a make function causes load current to flow when a target is detected and load current not to flow when a target is not detected

2.4.1.2
break function
a break function causes load current not to flow when a target is detected and load current to flow when a target is not detected

2.4.1.3
make-break, of changeover function
a switching element combination which contains one make function and one break function

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

2.4.1.4
response time for a proximity switch
the time required for the device switching element to respond after the target enters or exits the sensing zone

2.4.1.5
turn on time for a photoelectric proximity switch
the time required for the switching element to respond after the target enters the sensing range with excess gain of 2 (see 2.4.6)

2.4.1.6
turn off time for a photoelectric proximity switch
the time required for the switching element to respond after the target exits the sensing range with excess gain of 0,5 (see 2.4.6)

2.4.2
independent (snap) action
a switching element function substantially independent from the velocity of the target

2.4.3
frequency of operating cycles (*f*)
number of operating cycles performed by a proximity switch during a specified period of time

2.4.4
time delay before availability (t_v)
the time delay before availability is the time between the switching on of the supply voltage and the instant at which the proximity switch becomes ready to operate correctly

2.4.5 Currents (*I*)

2.4.5.1
off-state current (I_r)
the current which flows through the load circuit of the proximity switch in the OFF-state

2.4.5.2
minimum operational current (I_m)
the current which is necessary to maintain ON-state conduction of the switching element

2.4.5.3
No-load supply current (I_o)
the current drawn by a three or four-terminal proximity switch from its supply when not connected to a load

2.4.6
excess gain for a photoelectric proximity switch
the ratio of the light received by the photoelectric proximity switch to the light required to operate the photoelectric proximity switch

2.4.7
ambient light for a photoelectric proximity switch
for the purpose of this standard, ambient light is the light received by the receiver other than that originating from the emitter

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

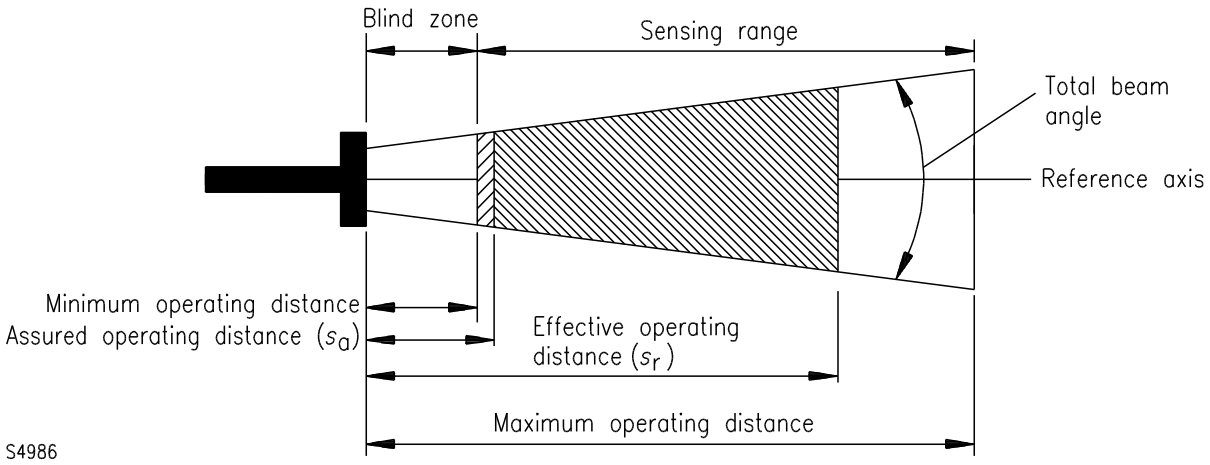


Figure 2

Ultrasonic proximity switch operating distances

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

Table 1
Classification of proximity switches

1st pos./1 digit	2nd pos./1 digit	3rd pos./3 digits	4th pos./1 digit	5th pos./1 digit	6th pos./1 digit
SENSING MEANS 3.1	**MECHANICAL INSTALLATION** 3.2	**CONSTRUCTION FORM AND SIZE** 3.3	**SWITCHING ELEMENT FUNCTION (OUTPUT)** 3.4	**TYPE OF OUTPUT** 3.5	**METHOD OF CONNECTION** 3.6
I = inductive C = capacitive U = ultrasonic D = diffuse reflective photoelectric M = non-mechanical magnetic R = retroreflective photoelectric T = through beam photoelectric	1 = embeddable 2 = non-embeddable 3 = either	FORM (1 capital letter) A = cylindrical threaded barrel B = cylindrical smooth barrel C = rectangular with square cross-section D = rectangular with rectangular cross-section DIMENSION (2 numbers) for diameter or side length	A = NO (make) B = NF (break) C = changeover (make-break) P = programmable by user S = other	P = PNP-output 3 or 4 terminal d.c. N = NPN-output 3 or 4 terminal d.c. D = 2 terminal d.c. F = 2 terminal a.c. U = 2 terminal a.c. or d.c. S = other	1 = integral leads 2 = plug-in 3 = screw 9 = other
Ultrasonic proximity switch example:					
U Ultrasonic	3 Either	A30 Cylindrical threaded ∅ 30 min	A NO (make) function	D 2 terminal d.c.	2 Plug in

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Documents
Document Sharing Hub

Full document details: UL 60947-5-2 2022

3 Classification

Proximity switches shall be classified according to various characteristics as shown in Table 1. It is recommended that their dimensions are in accordance with those listed in Annex A.

3.1 Classification according to sensing means

In this standard the sensing means is designated by a capital letter in the first position.

3.2 Classification according to the mechanical installation

The mechanical installation is designated by one digit in the second position.

3.3 Classification according to the construction form and size

The construction form and the size are designated by three digits, one capital letter and two numbers. This three-digit designation is placed in the third position.

The capital letter designates the construction form, e.g. cylindrical or rectangular.

The two numbers designate the size, e.g. the diameter of cylindrical types or a length of one side for rectangular types.

3.4 Classification according to switching element function

The switching element function is designated by a capital letter placed in the fourth position.

3.5 Classification according to type of output

The type of output is designated by a capital letter and placed in the fifth position.

3.6 Classification according to method of connection

The method of connection is designated by a one-digit number placed in the sixth position.

4 Characteristics

4.1 Summary of characteristics

The characteristics of a proximity switch shall be stated in the following terms.

– Operating conditions (4.2)

– Rated and limiting values (4.3)

Rated voltages (4.3.1)

Currents (4.3.2)

Rated supply frequency (4.3.3)

Frequency of operating cycles (4.3.4)

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

Normal load and abnormal load characteristics (4.3.5)

Short-circuit characteristics (4.3.6)

– Utilization categories for the switching element (4.4).

4.1.1 Operation of an inductive or capacitive proximity switch

The output signal is determined by the presence or absence of a designated object in the electromagnetic or electric field which absorbs or alters energy radiated from the sensing face.

4.1.2 Operation of an ultrasonic proximity switch

The output signal is determined by the presence or absence of a designated object in the sensing zone which reflects ultrasound energy radiated from the sensing face.

4.1.3 Operation of a photoelectric proximity switch

The output signal is determined by the presence or absence of a designated object that either reflects or interrupts visible or invisible light radiated from the emitter.

NOTE Many manufacturers of photoelectric proximity switches have traditionally used the terminology “light-operated” and “dark-operated”. In this case, if the presence of light at the receiver causes the output element to be in ON state then the device is called “light-operated”, and if the presence of light at the receiver causes the output to be in OFF state, then the device is called “dark-operated”.

4.1.4 Operation of a magnetic proximity switch

The output signal is determined by the presence or absence of a designated object, which produces a change in a magnetic field within the sensing zone.

4.2 Operating conditions

4.2.1 Operating distance (*s*) of inductive and capacitive proximity switches

The relationship between the operating distances is shown in Figure 3.

4.2.1.1 Rated operating distance (s_n)

Rated operating distances are specified in the relevant annexes.

4.2.2 Operating distance (*s*) of an ultrasonic proximity switch

The relationship between the operating distances is shown in Figure 4.

4.2.2.1 Sensing range (s_d)

Sensing range values are given in the relevant annexes.

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

4.2.3 Operating distance(s) of a photoelectric proximity switch

4.2.3.1 Sensing range (s_d)

For photoelectric proximity switches type D, the operating distances are given as the sensing range (s_d).

4.2.3.2 Operating range (r_o)

For photoelectric proximity switches type T and R, the operating distances are given as the operating range (r_o).

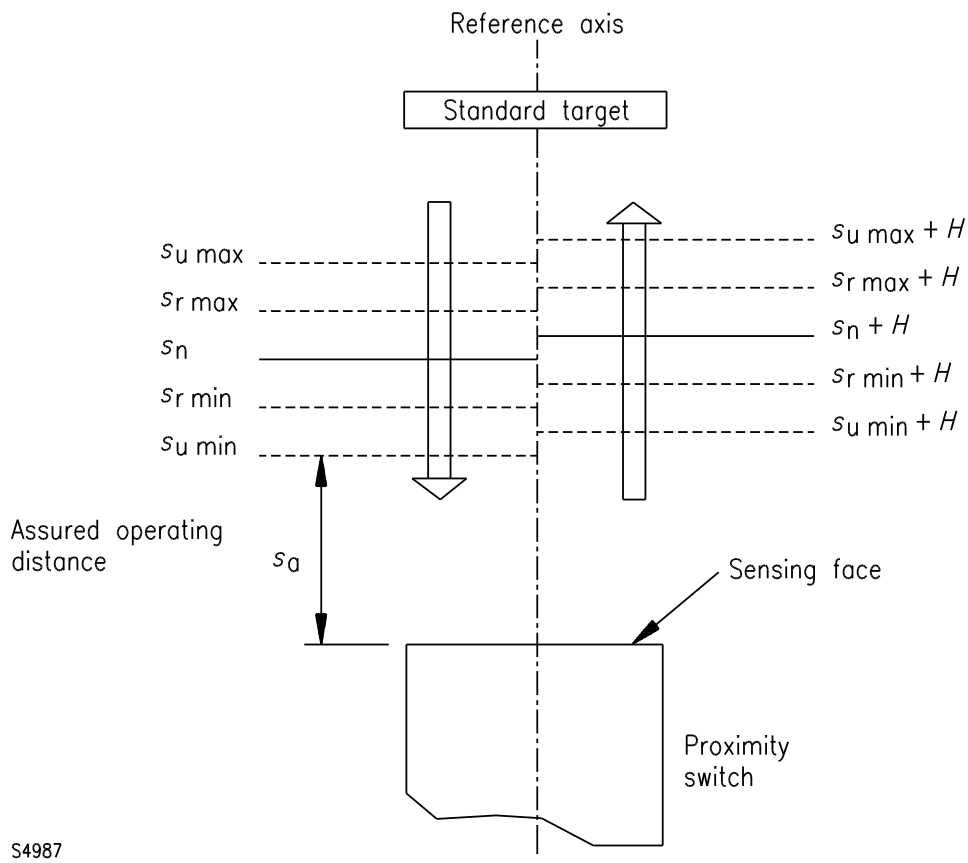


Figure 3

Relationship between operating distances of inductive and capacitive proximity switches

(see 4.2.1, 7.2.1.3 and 8.4.1)

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Documents Document Sharing Hub

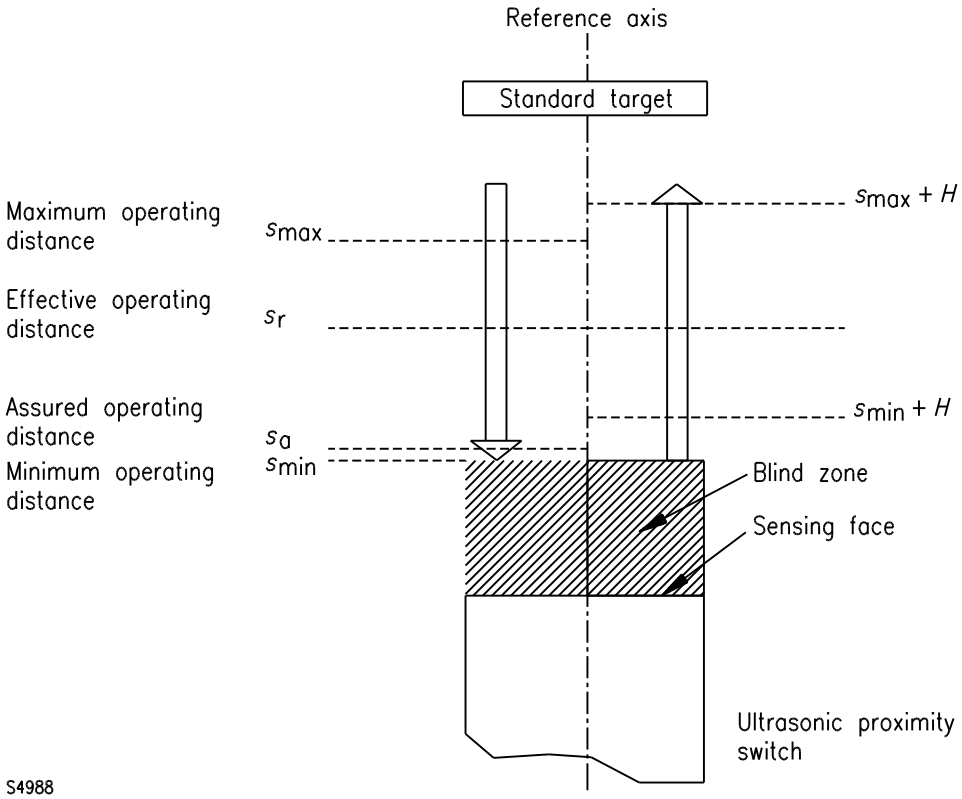


Figure 4

Relationship between operating distances of ultrasonic proximity switches

(see 4.2.2, 7.2.1.3 and 8.4.1)

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

4.3 Rated and limiting values for the proximity switch and switching element(s)

4.3.1 Voltages

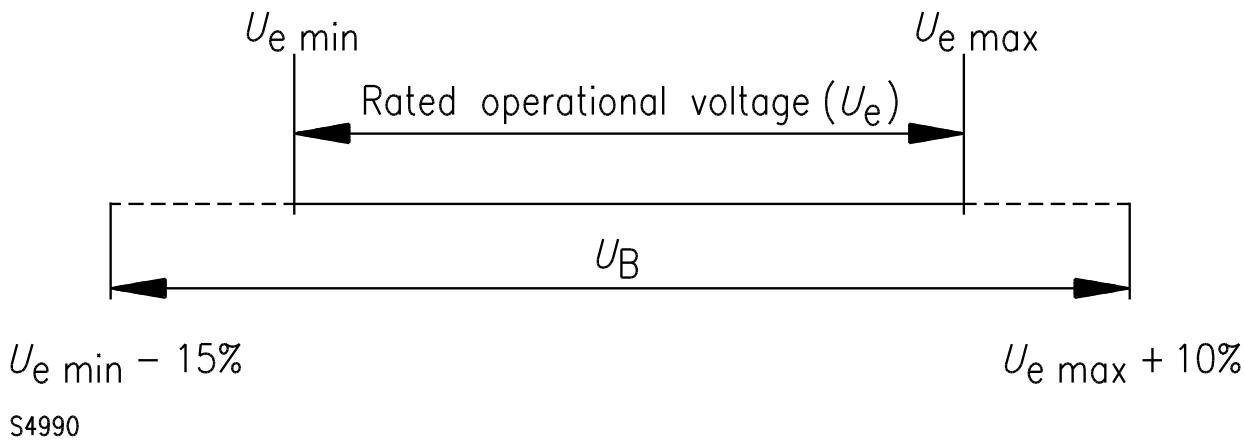
The proximity switch and its switching element(s) are defined by the following rated voltages:

4.3.1.1 Rated operational voltage (U_e)

The rated operational voltage (U_e) (or range) shall not exceed 250 V a.c. or 300 V d.c.

NOTE The manufacturer may state a range between the limiting values which include all the tolerances of U_e, this range shall be designated U_B.

The relationship between U_e and U_B is shown below:



4.3.1.2 Rated insulation voltage (U_i)

The rated insulation voltage of a proximity switch is the value of voltage to which the dielectric voltage tests and creepage distances are referred.

For proximity switches the highest rated operational voltage shall be considered to be the rated insulation voltage.

4.3.1.3 Rated impulse withstand voltage (U_{imp})

Subclause 4.3.1.3 of IEC 60947-1 applies.

4.3.1.4 Voltage drop (U_d)

The voltage drop is the voltage measured across the active output of the proximity switch when carrying the operational current flows under specified conditions. The values are specified in 7.2.1.15.

4.3.2 Currents

The proximity switch and its switching element are defined by the following currents.

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM
Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022

4.3.2.1 Rated operational current (I_e)

See 7.2.1.11.

4.3.2.2 Minimum operational current (I_m)

See 7.2.1.12.

4.3.2.3 OFF-state current (I_r)

See 7.2.1.13.

4.3.2.4 No-load supply current (I_o)

The no-load supply current of a three- or four-terminal proximity switch shall be stated by the manufacturer.

4.3.3 Rated supply frequency

The rated supply frequency shall be 50 Hz and/or 60 Hz.

4.3.4 Frequency of operating cycles (*f*)

The frequency of operating cycles shall be in accordance with the relevant annexes or stated by the manufacturer.

4.3.5 Normal load and abnormal load characteristics

4.3.5.1 Rated making and breaking capacities and behaviour of switching element under normal conditions

A switching element shall comply with the requirements given in Table 4.

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

4.3.5.1DV D2 ***Modification of 4.3.5.1 by replacing it with the following:***

A switching element shall comply with Table 4 of CSA C22.2 No. 60947-5-1/UL 60947-5-1.

4.3.5.2 Making and breaking capacities under abnormal conditions

A switching element shall comply with the requirements given in Table 5.

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

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

4.3.6 Short-circuit characteristics

4.3.6.1 Rated conditional short-circuit current

The rated conditional short-circuit current of a proximity switch is 100 A prospective. The proximity switch shall withstand satisfactorily the test specified in 8.3.4.

4.4 Utilization categories for the switching element

The utilization categories as given in Table 2 are considered standard. Any other type of application shall be based on agreement, between manufacturer and user, but information given in manufacturer's catalogue or tender may constitute such an agreement.

Table 2
Utilization categories for switching elements

Kind of current	Category	Typical applications
Alternating current	AC-12	Control of resistive loads and solid state loads with optical isolation
	AC-140	Control of small electromagnetic loads with holding (closed) current ≤0,2 A: e.g. contactor relays
Direct current	DC-12	Control of resistive loads and solid state loads with optical isolation
	DC-13	Control of electromagnets

4.4DV D2 ***Modification of 4.4 by replacing it with the following:***

The switching element rating and required load designation shall be in accordance with Table 4.4DV of CSA C22.2 No. 60947-5-1/UL 60947-5-1. In addition, utilization categories and/or additional load designations may be marked.

5 Product information

5.1 Nature of information – Identification

The following information shall be given by the manufacturer:

a) The manufacturer's name or trade mark.

b) A type designation or other marking which makes it possible to identify the proximity switch and get the relevant information from the manufacturer or his catalogue (see Table 1).

c) Reference to this standard if the manufacturer claims compliance.

Basic rated values and utilization

d) Rated operational voltage(s) (see 4.3.1.1).

e) Utilization category and rated operational currents at the rated operational voltages and rated frequency/frequencies or at direct current, d.c.

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

f) Rated insulation voltage (see 4.3.1.2).

g) Rated impulse withstand voltage (see 4.3.1.3).

h) IP code (see 7.1.10).

i) Pollution degree (see 6.1.3.2).

j) Type and maximum ratings of short-circuit protective device (see 7.2.5).

k) Rated conditional short-circuit current (see 4.3.6.1).

l) Electromagnetic compatibility (EMC) (see 7.2.6).

m) Operating distances (see 7.2.1.3).

n) Repeat accuracy (see 7.2.1.4).

o) Differential travel (see 7.2.1.5).

p) Frequency of operating cycles (see 7.2.1.6).

r) Minimum operational current (see 7.2.1.12).

s) OFF-state current (see 7.2.1.13).

t) No-load supply current (see 4.3.2.4).

u) Voltage drop (see 7.2.1.15).

v) Switching element function (see 2.4.1).

w) Mounting application, embeddable or non-embeddable (see 2.2.9 and 2.2.10).

x) Physical dimensions (see 7.3).

y) Excess gain (see 7.2.1.10).

5.1DV D2 ***Modification of 5.1 by adding the following:***

5.1DV.1 Items f) and j) through y) are optional.

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

5.1DV.3 Item h) 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.

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

5.2 Marking

5.2.1 General

Marking of data under a) and b) of 5.1 is mandatory on the nameplate or marked on the body of the proximity switch in order to permit the complete information to be obtained from the manufacturer.

Cylindrical proximity switches of 12 mm or smaller body diameter may provide this marking on the cord or on a tag permanently attached to the cord, located no further than 100 mm from the body of the device.

Marking shall be indelible and easily legible, and shall not be placed on parts normally removable in service.

Data under c) to y) when not included on the proximity switch, shall be included in the manufacturer's literature.

5.2.1DV D2 ***Modification of 5.2.1 by adding the following:***

5.2.1DV.1 The data specified in Items d) and e) of Clause 5.1 shall be marked on the nameplate of the proximity switch . Where space does not permit complete electrical ratings, one or more ratings shall be marked on the device, with additional rating(s) provided in the manufacturer's published literature.

5.2.1DV.2 When the marked ratings described in Item e) of Clause 5.1 are the code designations specified in CSA C22.2 No. 60947-5-1/UL 60947-5-1, Tables A.1, A.2, and A.3, the information concerning the voltage and overload current ratings for each contact rating code designation shall be published in a catalog, contained on a marking sheet packed with the product, or otherwise made available to the user.

5.2.1DV.3 A proximity switch that exceeds a temperature greater than 50 °K on an accessible surface shall be marked "WARNING – HOT SURFACE – RISK OF BURN".

In Canada, the equivalent French wording is as follows: "AVERTISSEMENT – SURFACE CHAUDE – RISQUE DE BRÛLURE".

5.2.2 Terminal identification and marking

Subclause 7.1.7.4 applies.

5.2.2DV D2 ***Modification of 5.2.2 by adding the following:***

A wiring diagram shall be provided to indicate the proper identification of field wiring leads, individual leads of integral cords, and pinout diagrams for connectors.

5.2.3 Functional markings

The sensing face shall be marked where this is not apparent by the construction of the proximity switch.

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

5.3 Instructions for installation, operation and maintenance

The manufacturer shall specify the conditions for installation, operation and maintenance of the proximity switch.

He shall also specify the recommended extent and frequency of maintenance, if any.

6 Normal service, mounting and transport conditions

6.1 Normal service conditions

Proximity switches complying with this standard shall be capable of operating under the following standard conditions.

NOTE If the conditions for operation differ from those given in this standard, the user shall state the deviations from the standard conditions and consult the manufacturer on the suitability for use under such conditions.

6.1.1 Ambient air temperature

6.1.1DV D2 ***Modification of 6.1.1 and all subclauses by replacing them with the following:***

Clause 6.1.1 of CSA C22.2 No. 60947-1/UL 60947-1 applies.

6.1.1.1 Inductive, capacitive, non-mechanical magnetic and ultrasonic proximity switches

These proximity switches shall operate between the ambient temperatures of –25 °C to +70 °C. The operating characteristics shall be maintained over the permissible range of ambient temperature.

NOTE For ultrasonic proximity switches, due to the fact that the speed of sound is dependent upon air temperature, the operating distance may change by 0,17 % per kelvin.

6.1.1.2 Photoelectric proximity switch

Photoelectric proximity switches shall operate between the ambient temperatures of –5 °C to +55 °C. The operating characteristics shall be maintained over the permissible range of ambient temperature.

6.1.2 Altitude

Subclause 6.1.2 of IEC 60947-1 applies.

6.1.3 Climatic conditions

6.1.3.1 Humidity

The relative humidity (RH) of the air shall not exceed 50 % at 70 °C. Higher relative humidities are permitted at lower temperatures, e.g. 90 % at +20 °C.

NOTE Condensation on the sensing face and the change of humidity may influence the operating distances. Care should be taken of condensation which may occur due to variations in temperature. (50 % RH at 70 °C equivalent to 100 % RH at 54 °C).

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

6.1.3.1DV D2 ***Modification of 6.1.3.1 by replacing it with the following:***

Clause 6.1.3.1 of CSA C22.2 No. 60947-1/UL 60947-1 applies.

6.1.3.2 Pollution degree

Unless otherwise stated by the manufacturer, a proximity switch is intended for installation under environmental conditions of pollution degree 3 as defined in 6.1.3.2 of IEC 60947-1. However, other pollution degrees may apply depending upon the micro-environment.

6.2 Conditions during transport and storage

A special agreement shall be made between the user and the manufacturer if the conditions during transport and storage, e.g. temperature and humidity conditions, differ from those defined in 6.1.

6.3 Mounting

Mounting dimensions and conditions shall be according to the relevant specification sheet of Annex A.

7 Constructional and performance requirements

7.1 Constructional requirements

7.1.1 Materials

Materials shall be suitable for the particular application and shall enable the equipment to comply with the relevant test requirements.

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

NOTE Requirements are under consideration.

7.1.1DV D2 ***Modification of 7.1.1 by replacing it with the following:***

Clause 7.1.2 and all subclauses of CSA C22.2 No. 60947-5-1/UL 60947-5-1 applies.

7.1.2 Current-carrying parts and their connections

Current-carrying parts shall have the necessary mechanical strength and current-carrying capacity for their intended use.

For electrical connections, no contact pressure shall be transmitted through insulating material other than ceramic or other material with characteristics not less suitable, unless there is sufficient resiliency in the metallic parts to compensate for any possible shrinkage or yielding of the insulation material.

7.1.3 Clearances and creepage distances

Subclause 7.1.4 of IEC 60947-1 applies.

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub

UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.

Full document details: UL 60947-5-2 2022

7.1.3DV D2 ***Modification of 7.1.3 by adding the following:***

Creepage and clearance distances at field wiring terminals shall be evaluated in accordance with Annex DVD. Where the design of the field wiring terminals is such that it precludes the possibility of reduced spacing due to stray strands or improper wiring installation, Clause 7.1.4 of CSA C22.2 No. 60947-1/UL 60947-1 applies. Creepage and clearance distances at other than field wiring terminals may be evaluated in accordance with Annex DVD or Clause 7.1.4 of CSA C22.2 No. 60947-1/UL 60947-1.

7.1.4 Actuation

Proximity switches are tested for operation by the presence or absence of the standard target, the characteristics of which are specified in 8.3.2.1.

7.1.5 Vacant

7.1.6 Vacant

7.1.7 Terminals

7.1.7.1 Constructional requirements

Subclause 7.1.8.1 of IEC 60947-1 applies.

7.1.7.2 Connecting capacity

Subclause 7.1.8.2 of IEC 60947-1 applies.

7.1.7.2DV D2 ***Modification of 7.1.7.2 by replacing it with the following text and Tables 7.1.7.2DV.1 and 7.1.7.2DV.2:***

Ampacity of conductors are sized to Table 7.1.7.2DV.1 and Table 7.1.7.2DV.2.

Table 7.1.7.2DV.1
Ampacities of insulated conductors

Wire size		60 °C (140 °F)		75 °C (167 °F)	
AWG	(mm^2)	Copper	Aluminum	Copper	Aluminum
24	(0,2)	2	–	–	–
22	(0,3)	3	–	–	–
20	(0,5)	5	–	–	–
18	(0,8)	7	–	–	–
16	(1,3)	10	–	–	–
14	(2,1)	15	–	15	–
12	(3,3)	20	15	20	15
10	(5,3)	30	25	30	25

This document is only permissible for use by MOHD AKHTAR of AECOM. 4/7/2022 4:44:43 PM

Documents
Document Sharing Hub
UL COPYRIGHTED MATERIAL – NOT AUTHORIZED FOR FURTHER REPRODUCTION OR DISTRIBUTION WITHOUT PERMISSION FROM UL INC.
Full document details: UL 60947-5-2 2022