

UL 60947-5-2

# Low-Voltage Switchgear and Controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches

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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

Second Edition, Dated May 31, 2007

### **Summary of Topics**

***This new edition of ANSI/UL 60947-5-2 contains the requirements for proximity switches and is to be used in conjunction with the third edition of UL 60947-1.***

The new requirements are substantially in accordance with UL's Proposal(s) on this subject dated August 4, 2006 and February 23, 2007.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: <http://ulstandardsinfo.net/ulforeword.html>

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the preface. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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This Standard consists of pages dated as shown in the following checklist:

| Page       | Date         |
|------------|--------------|
| 1-140..... | May 31, 2007 |

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ANSI/UL 60947-5-2-2007

UL 60947-5-2

**Standard for Low-Voltage Switchgear and Controlgear – Part 5-2: Control  
circuit devices and switching elements – Proximity switches**

**Second Edition**

**May 31, 2007**

The most recent designation of ANSI/UL 60947-5-2 as an American National Standard (ANSI) occurred on May 30, 2007.

This ANSI/UL Standard for Safety, which consists of the Second edition is under continuous maintenance, whereby each revision is ANSI approved upon publication.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements. 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 <http://csds.ul.com>.

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## Preface (UL)

This UL Standard, UL 60947-5-2, Standard for Safety for Low-Voltage Switchgear and Controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches, is to be used in conjunction with the third edition of UL 60947-1. The requirements for proximity switches are contained in this part 2 Standard and UL 60947-1.

Requirements of this part 2 Standard, where stated, amend the requirements of UL 60947-1.

Efforts have been made to synchronize the UL edition number with that of the corresponding IEC standard with which this standard is harmonized. As a result, one or more UL edition numbers have been skipped to match that of the IEC edition number.

The text, figures and tables of the IEC Publication for Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches, IEC 60947-5-2 Second edition, copyright 1997 as amended in 1999 are used in this Standard with the consent of the IEC and the American National Standards Institute (ANSI). The IEC copyrighted material has been reproduced with permission from ANSI. ANSI should be contacted regarding the reproduction of any portion of the IEC material. The IEC Foreword and Introduction are not a part of the requirements of this Standard but are included for information purposes only. Copies of IEC Publication 60947-5-2 may be purchased from ANSI, 11 West 42nd Street, New York, New York, 10036, (212) 642-4900.

**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.**

### UL Effective Date

As of May 31, 2017, all products Listed or Recognized by UL must comply with the requirements in this standard.

Between May 31, 2012 and May 31, 2017, all new product submittals will be evaluated to this standard. Revisions to existing UL 508 products will be evaluated to this standard unless the manufacturer specifically requests that the products be evaluated to the superseded requirements of UL 508.

Between May 31, 2007 and May 31, 2012, new product submittals to UL may be evaluated under this standard or, if requested in writing, evaluated under UL 508.

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## National Differences

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-Edition 2:1997 Consolidated with Amendment 1:1999 are indicated by notations (differences) and are presented in bold text.

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.

**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 based on **safety practices**. These are differences for IEC requirements that may be acceptable, but adopting the IEC requirements would require considerable retesting or redesign on the manufacturer's part.

**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**.

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

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 or figure. Addition is not meant to include adding select words to the base IEC text.

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

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

## FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

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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.

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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.

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This consolidated version of IEC 60947-5-2 is based on the second edition (1997) [documents 17B/833/FDIS and 17B/854/RVD], its amendment 1 (1999) [documents 17B/981/FDIS and 17B/993/RVD] and its amendment 2 (2003) [documents 17B/1298/FDIS and 17B/1310/RVD].

It should be used in conjunction with IEC 60947-5-1.

It bears the edition number 2.2.

A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2.

Annexes A, B, C, D and E form an integral part of this standard.

Annex F is for information only.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until 2006. At this date, the publication will be

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

**101DV D2 Modification of the two statements referencing Annexes:**

**101DV.1 Annexes 101.DVA, and 101.DVB form an integral part of this standard.**

**101DV.2 Annexes A, B, C, D, and E are informative.**

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# 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 part 1 (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 part 1, e.g. subclause 7.1.9.3 of part 1 or annex C of part 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 Modify Clause 1 by replacing with the following:**

**1DV.1 The provisions of the general rules dealt with in Part 1 (UL Publication ANSI/UL 60947-1) are applicable to this standard. Where specifically called for, any references to Part 1 shall be to the referenced clause as amended by the USA national differences, if any.**

### 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.

#### **1.1DV DR Addition of 1.1DV.1 – 1.1DV.3**

**1.1DV.1 This equipment is for use in ordinary locations in accordance with the National Electrical Code, NFPA 70.**

**1.1DV.2** These requirements cover electronic proximity switches for use on industrial machinery or mass-production industrial equipment as defined by the Electrical Standard for Industrial Machinery, NFPA 79.

**1.1DV.3** Equipment intended for use in hazardous locations as defined by the National Electrical Code, NFPA 70 are covered by the Standard for Industrial Control Equipment for Use in Hazardous (Classified) Locations, UL 698.

**1.1DV D1 Addition of 1.1DV.4:**

**1.1DV.4** Equipment requirements are intended for use in an ambient temperature of 0 to 40° C degrees unless specified otherwise.

## 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 60068-2-6:1995,  
*Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-14:1984,  
*Environmental testing – Part 2: Tests – Test N: Change of temperature Amendment 1 (1986)*

IEC 60068-2-27:1987,  
*Environmental testing – Part 2: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30:1980,  
*Environmental testing – Part 2: Tests – Test Db and guidance: Damp heat, cyclic (12 + 12 hour cycle) Amendment 1 (1985)*

IEC 60364 (all parts),  
*Electrical installations of buildings*

IEC 60446:1999,  
*Basic and safety principles for man-machine interface, marking and identification – Identification of conductors by colours or numerals*

IEC 60947-1:1999,  
*Low-voltage switchgear and controlgear – Part 1: General rules Amendment 1 (2000) Amendment 2 (2001)*

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IEC 60947-5-1:1997,  
*Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*  
Amendment 1 (1999)  
Amendment 2 (1999)

IEC 61000-3-2:2000,  
*Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current  $\leq 16$  A per phase)*  
Amendment 1 (2001)

IEC 61000-3-3:1994,  
*Electromagnetic compatibility (EMC) – Part 3: Limits – Section 3: Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current  $\leq 16$  A*  
Amendment 1 (2001)

IEC 61000-4-2:1995,  
*Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 2: Electrostatic discharge immunity test – Basic EMC publication*  
Amendment 1 (1998)  
Amendment 2 (2000)

IEC 61000-4-3:2002,  
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*Electromechanical switches for use in electronic equipment – Part 5: Sectional specification for pushbutton switches – Section 1: Blank detail specification*

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*Protection against electric shock – Common aspects for installation and equipment*

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*Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement  
 Amendment 1 (1999)*

ISO 630:1995,  
*Structural steels – Plates, wide flats, bars, sections and profiles*

### 1.2DV D2 Addition:

1.2DV.1 For a list of United States normative standards, see Annex DVB of Part 1.

## 2 Definitions

Clause 2 of part 1 applies with the following additions:

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## 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]<sup>1)</sup>

<sup>1)</sup> See IEC 60050(441).

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.

## 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

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**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

**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

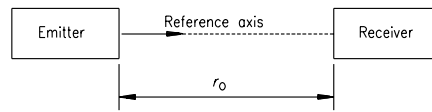


Figure 1a – Type T, emitter and receiver – Through beam photoelectric

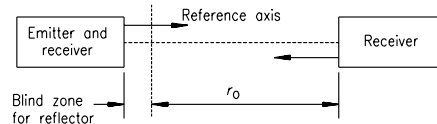


Figure 1b – Type R, emitter-receiver and reflector – Retroreflective photoelectric

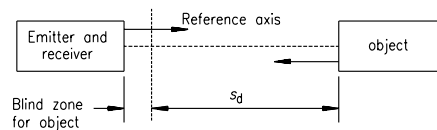


Figure 1c – Type D, emitter-receiver and object – Diffuse reflective photoelectric  
S4985

### Figure 1 – Sensing range and operating range of photoelectric proximity switches

(see 7.2.1.3 and 8.4)

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 ( $s_u$ )**

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

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 ( $I_o$ )** 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

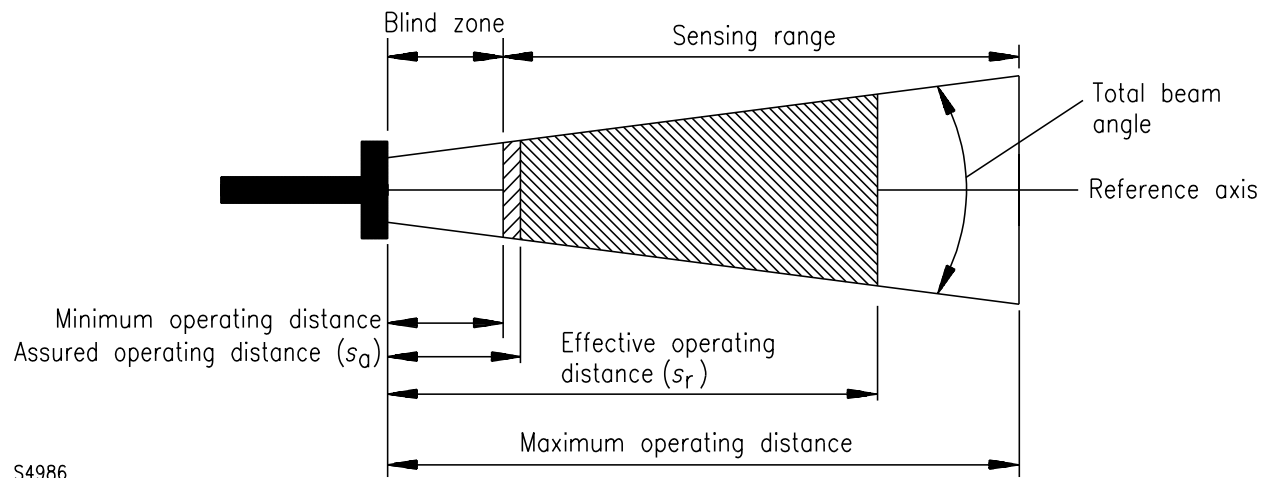


Figure 2 – Ultrasonic proximity switch operating distances

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

**Table 1 – Classification of proximity switches Continued**

| 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    | MECHANICAL INSTALLATION | CONSTRUCTION FORM AND SIZE              | SWITCHING ELEMENT FUNCTION (OUTPUT) | TYPE OF OUTPUT       | METHOD OF CONNECTION |
| 3.1              | 3.2                     | 3.3                                     | 3.4                                 | 3.5                  | 3.6                  |
| U<br>Ultrasonic  | 3<br>Either             | A30<br>Cylindrical threaded<br>Ø 30 min | A<br>NO (make) function             | D<br>2 terminal d.c. | 2<br>Plug in         |

**3 Classification****3DV D2 Deletion of Clause 3:****3DV.1 Clause 3 of this Part 2 does not apply.**

Proximity switches are classified according to various general characteristics as shown in table 1.

**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.

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### 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)
  - 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.

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#### 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

#### 4.2DV D2 Deletion of subclause 4.2:

##### 4.2DV.1 Subclause 4.2 of this Part 2 does not apply.

#### 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.

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#### 4.2.2.1 Sensing range ( $s_d$ )

Sensing range values are given in the relevant annexes.

#### 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 ( $r_o$ ).

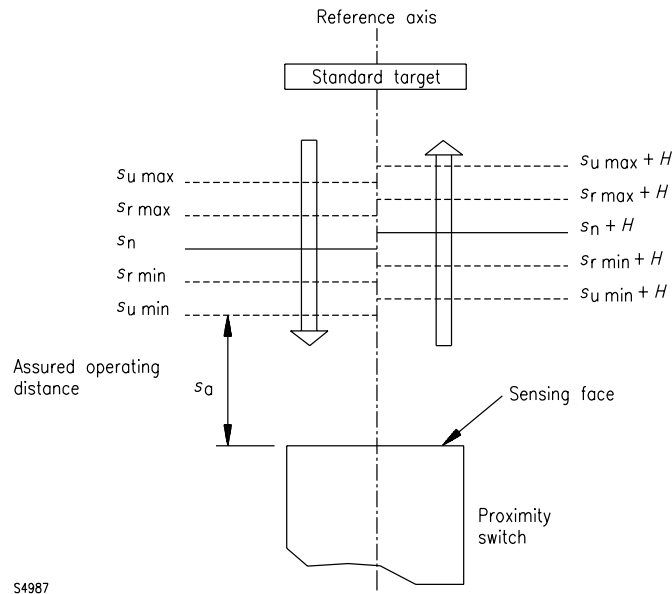


**Figure 3 – Relationship between operating distances of inductive and capacitive proximity switches**

(see 4.2.1, 7.2.1.3 and 8.4.1)

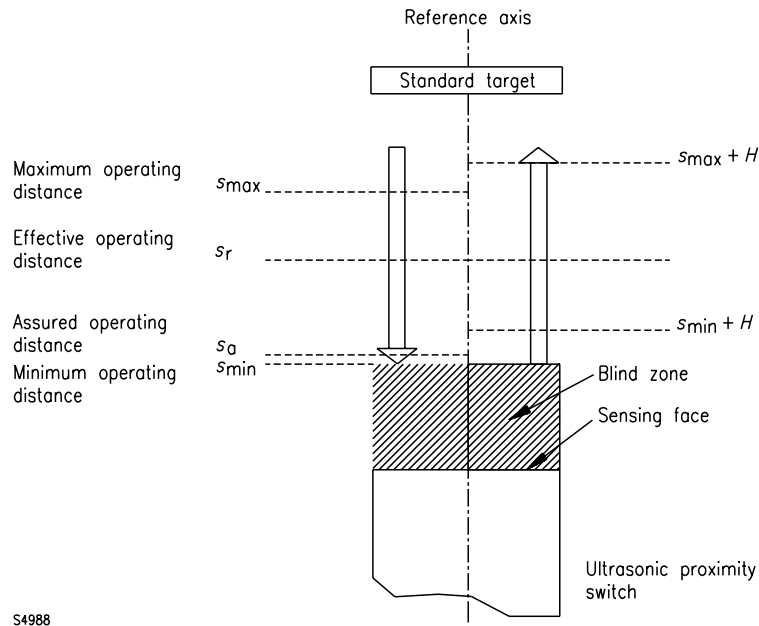


**Figure 4 – Relationship between operating distances of ultrasonic proximity switches**

(see 4.2.2, 7.2.1.3 and 8.4.1)

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

#### 4.3.1 Voltages

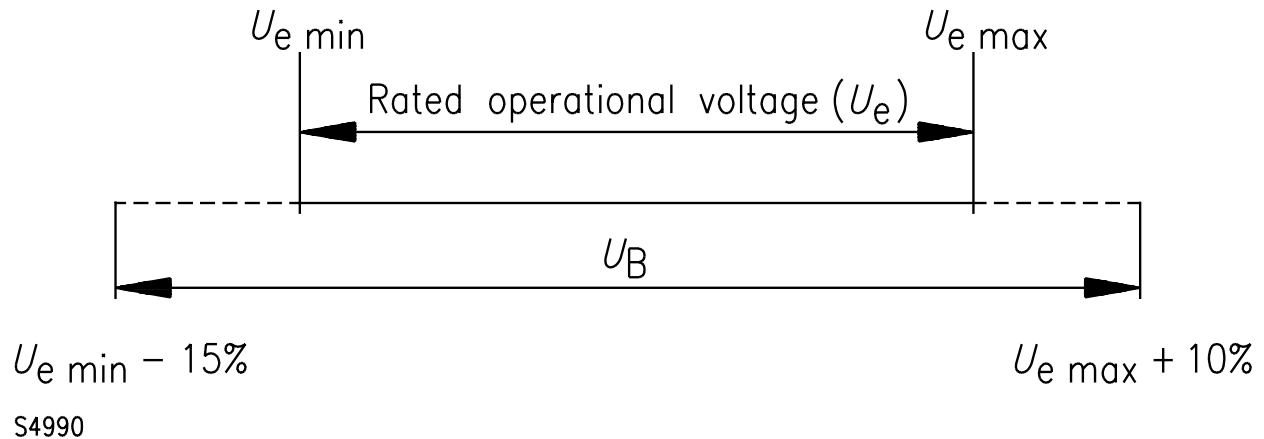
The proximity switch and its switching element(s) are defined by the following rated voltages:

##### 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.

##### 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.

#### **4.3.2.4DV D2 Deletion of subclause 4.3.2.4:**

##### **4.3.2.4DV.1 Subclause 4.3.2.4 does not apply.**

#### 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.

#### **4.3.4DV D2 Deletion of 4.3.4:**

##### **4.3.4DV.1 Subclause 4.3.4 of this Part 2 does not apply.**

#### 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:**

##### **4.3.5.1DV.1 Annex 101.DVA applies in the United States.**

##### 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.

##### **4.3.5.2DV D2 Modification of 4.3.5.2:**

##### **4.3.5.2DV.1 Annex 101.DVA applies in the United States.**

#### 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.

##### **4.3.6DV D2 Delete subclause 4.3.6:**

##### **4.3.6DV.1 Subclause 4.3.6 of this Part 2 does not apply.**

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#### 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 $\leq 0,2$ A:<br>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 subclause 4.4:

#### 4.4DV.1 Subclause 4.4 of this Part 2 does not apply.

### 5 Product information

#### 5.1 Nature of information

The following information shall be given by the manufacturer.

##### 5.1.1 Identification

- The manufacturer's name or trade mark.
- 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).
- Reference to this standard if the manufacturer claims compliance.

#### *Basic rated values and utilization*

- Rated operational voltage(s) (see 4.3.1.1).
- Utilization category and rated operational currents at the rated operational voltages and rated frequency/frequencies or at direct current, d.c.
- Rated insulation voltage (see 4.3.1.2).
- Rated impulse withstand voltage (see 4.3.1.3).
- IP code (see 7.1.10).
- Pollution degree (see 6.1.3.2).
- Type and maximum ratings of short-circuit protective device (see 7.2.5).
- 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).

**5.1.1DV D1 Modification of 5.1.1 of this Part 2 by including items z, aa, ab, ac, ad, ae, and af:**

**5.1.1DV.1 z) Wiring diagram shall be provided to indicate the proper connections for the power supply, load, and control circuit.**

**5.1.1DV.2 aa) If the manufacturer produces or assembles proximity devices at more than one factory, each finished item shall have a distinctive marking, by which it may be identified as the product of a particular factory.**

**5.1.1DV.3 ab) Class 2 supply, where applicable.**

**5.1.1DV.4 ac) Enclosure type rating per Part 1.**

**5.1.1DV.5 ad) Electrical rating.**

**5.1.1DV.6 ae) Ambient temperature rating**

**5.1.1DV.7 af) Overcurrent protection ratings (associated with the ampacity of the flexible cord).**

## 5.2 Marking

### 5.2.1 General

Marking of data under a) and b) of 5.1.1 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 Modify 5.2.1 by adding 5.2.1DV.1 – 5.2.1DV.4:**

**5.2.1DV.1** Data under aa) through ad) 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.

**5.2.1DV.2** A secondary circuit intended to be supplied from a Class 2 transformer or power source (as the defined in the NEC) in the field shall be marked "Class 2" next to the voltage rating of the device, that is, 30 Vac Class 2, or the equivalent. Class 2 is not to be confused with Class II as defined in Annex B.

**5.2.1DV.3** Equipment with a maximum ambient temperature rating of 40°C (104°F) is not required to be marked.

**5.2.1DV.4** Data under c) to y) and af) when not included on the proximity switch, shall be included in the manufacturer's literature.

### 5.2.2 Terminal identification and marking

Subclause 7.1.7.4 applies.

### 5.2.3 Functional markings

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

## 5.3 Instruction for installation, operation and maintenance

The manufacturer shall specify in his documents or catalogues the conditions for installation, operation and maintenance of the proximity switch.

The above documents shall indicate 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

##### 6.1.1.1 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.

##### 6.1.1.1DV D2 Modify 6.1.1.1 by adding the following:

**6.1.1.1DV.1** The proximity switches shall operate between the ambient temperatures stated by the manufacturer.

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#### 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.

##### **6.1.1.2DV D2 Modify 6.1.1.2 by adding the following:**

**6.1.1.2DV.1 Photoelectric proximity switches shall operate between the ambient temperatures stated by the manufacturer.**

#### 6.1.2 Altitude

Subclause 6.1.2 of part 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).

##### 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 part 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.

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### 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.

**7.1.1DV D2 Modify 7.1.1 by adding the following:**

**7.1.1DV.1 Enclosure construction and performance requirements are defined in Annex DVB, Table DVB.3, Ref. No. 4, of Part 1.**

**NOTE** Requirements are under consideration.

#### 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.

**7.1.2DV D2 Modify 7.1.2 by adding the following:**

**7.1.2DV.1 Subclause 7.1.2DV of Part 1 applies.**

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### 7.1.3 Clearances and creepage distances

Subclause 7.1.3 of IEC 60947-1 applies.

#### **7.1.3DV D2 Modify 7.1.3 by adding the following:**

##### **7.1.3DV.1 Subclause 7.1.3 of Part 1 applies.**

**7.1.3DV.2 For other than providing isolation between different circuits or in a safety circuit, spacings between traces of different potential on a printed wiring board are not required to comply with the spacing requirements of this standard when:**

- a) The printed wiring board has a flammability rating of V-0;**
- b) The printed wiring board base material has a minimum Comparative Tracking Index (CTI) of 100 volts; and**
- c) The equipment complies with the Printed Wiring Board Abnormal Operation Test (8.1.2DV.1).**

**7.1.3DV.3 To determine whether spacings at specific points on printed wiring boards comply with this requirement, each point of the printed wiring board so identified shall be tested as described in 8.101DV with adjacent printed circuit paths short-circuited one at a time until the operation of an integral protective device, the opening of a component as described in 8.101DV, or until thermal conditions have stabilized, up to a maximum of 7 hours.**

### 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

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#### 7.1.7.1 Constructional requirements

Subclause 7.1.7.1 of part 1 applies.

**7.101DV D2 Addition of the following to subclause 7.1.7.1 of Part 1:**

##### **7.101DV Evaluation of field wiring leads**

**7.101DV.1** A lead that is intended to be spliced in the field to a circuit conductor shall not be smaller than 0.2 mm<sup>2</sup> (24 AWG) and the insulation, when rubber or thermoplastic, shall not be less than 0.8 mm (1/32 inch) thick.

**7.101DV.2** The free length of a field wiring lead shall be not less than 152 mm (6 inches) long or not be less than 100 mm (4 inches) long when intended for installation in an outlet box.

**7.101DV.3** A field wiring lead shall comply with the Strain Relief Test in 8.1.2.

#### 7.1.7.2 Connecting capacity

Subclause 7.1.7.2 of part 1 applies.

#### 7.1.7.3 Connection means

Subclause 7.1.7.3 of part 1 applies with the following additions.

Proximity switches may have integral connecting leads; in this case the outer sheath of the connecting leads shall be 2<sub>0</sub><sup>+0.1</sup> m long.

**7.102DV DR Addition of the following to subclause 7.1.7.3 of Part 1:**

**7.102DV.1** Cable lengths other than 2 m long are acceptable in accordance with the NEC.

**7.102DV.2** Ampacity of conductors are sized to Table 7.102DV.1.

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Table 7.102DV.1 – Ampacity of conductors

| Conductor Size, mm <sup>2</sup> (AWG)                                                                                                                                                                                                                                                                                                                                                                                                              | Ampacity, amperes |                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|----------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 2                 | 3 <sup>a</sup> |
| 0.2 (24)                                                                                                                                                                                                                                                                                                                                                                                                                                           | 2                 | 2              |
| 0.32 (22)                                                                                                                                                                                                                                                                                                                                                                                                                                          | 3                 | 3              |
| 0.5 (20)                                                                                                                                                                                                                                                                                                                                                                                                                                           | 5                 | 5              |
| 1.0 (18)                                                                                                                                                                                                                                                                                                                                                                                                                                           | 10                | 7              |
| 1.5 (16)                                                                                                                                                                                                                                                                                                                                                                                                                                           | 13                | 10             |
| 2.5 (14)                                                                                                                                                                                                                                                                                                                                                                                                                                           | 18                | 15             |
| <sup>a</sup> Where more than three current-carrying conductors are provided, the ampacity of each of the conductors shall be: 80 percent of these values for 4 – 6 conductors; 70 percent of these values for 7 – 9 conductors; 50 percent of these values for 10 – 20 conductors; 45 percent of these values for 21 – 30 conductors; 40 percent of these values for 31 – 40 conductors; and 35 percent of these values for 41 or more conductors. |                   |                |

## 7.1.7.4 Connection identification and marking

Subclause 7.1.7.4 of part 1 applies with the following additions.

Proximity switches with integral connecting leads shall have wires identified with colours according to table 3.

Proximity switches with terminal connections shall be identified according to table 3.

**7.1.7.4DV DR Delete Table 3:****7.1.7.4DV.1 Table 3 does not apply.**

Table 3 – Connection and wiring identification

| Type                                                        | Function   | Wire   | Wire colour                                                             | Terminal number <sup>2)</sup> |
|-------------------------------------------------------------|------------|--------|-------------------------------------------------------------------------|-------------------------------|
| 2 terminals a.c. and<br><br>2 terminals d.c.<br>unpolarized | NO (make)  |        | Any colour <sup>1)</sup> except<br>Yellow, Green or Green<br>and yellow | 3                             |
|                                                             |            |        |                                                                         | 4                             |
|                                                             | NC (break) |        |                                                                         | 1                             |
|                                                             |            |        |                                                                         | 2                             |
| 2 terminals d.c.<br>polarized                               | NO (make)  | +      | Brown                                                                   | 1                             |
|                                                             |            | –      | Blue                                                                    | 4                             |
|                                                             | NC (break) | +      | Brown                                                                   | 1                             |
|                                                             |            | –      | Blue                                                                    | 2                             |
| 3 terminals d.c.<br>polarized                               | NO (make)  | +      | Brown                                                                   | 1                             |
|                                                             |            | –      | Blue                                                                    | 3                             |
|                                                             |            | Output | Black                                                                   | 4                             |
|                                                             | NC (break) | +      | Brown                                                                   | 1                             |
|                                                             |            | –      | Blue                                                                    | 3                             |
|                                                             |            | Output | Black                                                                   | 2                             |
| 3 terminals a.c. and                                        | NO (make)  | L      | Brown                                                                   | 1                             |
|                                                             |            |        | Blue                                                                    | 3                             |
|                                                             |            | Output | Black                                                                   | 4                             |

**Table 3 – Connection and wiring identification Continued**

| Type                            | Function                  | Wire      | Wire colour | Terminal number <sup>2)</sup> |
|---------------------------------|---------------------------|-----------|-------------|-------------------------------|
| 3 terminals a.c./d.c. polarized | NC (break)                | L         | Brown       | 1                             |
|                                 |                           |           | Blue        | 3                             |
|                                 |                           | Output    | Black       | 2                             |
| 4 terminals d.c. polarized      | Change over (make/ break) | +         | Brown       | 1                             |
|                                 |                           | –         | Blue        | 3                             |
|                                 |                           | NO output | Black       | 4                             |
|                                 |                           | NC output | White       | 2                             |

<sup>1)</sup> It is recommended that both wires are of the same colour.

<sup>2)</sup> Terminal numbers (except for a.c. proximity switches and proximity switches using 3 terminals 8 mm connector) shall be the same as integral connector pin numbers.

The bi-colour of green-and-yellow (green/yellow) shall be used only to identify the protective conductor (IEC 60446). To maintain historic integrity of earth security, the colour green shall not be used for any other purpose than to identify the protective earth conductor.

#### 7.1.8 Vacant

#### 7.1.9 Provisions for protective earthing

##### 7.1.9.1 Constructional requirements

Subclause 7.1.9.1 of part 1 applies with the following addition.

**NOTE 1** For proximity switches having class II insulation, the outside metal enclosure is not required to be connected to the protective earth terminal (see IEC 61140).

**NOTE 2** Proximity switches with maximum rated voltages not exceeding either 50 V a.c. or 120 V d.c. need no provision for protective earthing.

Consideration must be given to the safety insulation of the supply and its transformer (if any) in accordance with the installation rules (see IEC 60364).

#### 7.1.9.2 Protective earth terminal

Subclause 7.1.9.2 of part 1 applies.

#### 7.1.9.3 Protective earth terminal marking and identification

Subclause 7.1.9.3 of part 1 applies.

#### 7.1.10 Degree of protection

Proximity switches, when installed in accordance with the manufacturer's instruction shall have minimum IP65 protection, except for photoelectric switches which shall have minimum IP54 protection and shall be verified according to 8.2.

**NOTE** During the test for the degree of protection the operation of the proximity switch is not required.

**7.1.10DV D2 Modify 7.1.10 by adding the following:**

**7.1.10DV.1 Subclause 7.1.10 of Part 1 applies.**

#### 7.1.11 Requirements for proximity switches with integrally connected cables

See annex C.

**7.1.11DV D2 Modify 7.1.11 by referencing Annex 101.DVB:**

**7.1.11DV.1 See Annex 101.DVB.**

#### 7.1.12 Class II proximity switches

**7.1.12DV D2 Modification of title:**

**7.1.12DV.1 Title of 7.1.12 should read, "Double Insulated Switches".**

These devices shall not be provided with means for protective earthing (see IEC 61140).

For class II proximity switches insulated by encapsulation, see annex B.

**7.1.12DV D2 Modify 7.1.2 by replacing with the following:**

**7.1.12DV.2 In lieu of complying with protective earthing requirements, a proximity switch may use double insulation protection provided that it complies with all the applicable requirements in the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097.**

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## 7.2 Performance requirements

The following requirements apply to clean new equipment.

### 7.2.1 Operating conditions

#### 7.2.1.1 General

The equipment shall be mounted in accordance with the instructions given in the relevant specification sheet (annex A) or by the manufacturer.

For the tests of 7.2.1.3 through 7.2.1.6 the load shall be adjusted to provide  $0,2 I_e$ .

#### **7.2.1.1DV D2 Delete 7.2.1.1:**

#### **7.2.1.1DV.1 Subclause 7.2.1.1 does not apply.**

#### 7.2.1.2 Operating limits

The proximity switch shall operate satisfactorily

- a) between 85 % and 110 % of  $U_e$ , or
- b) between 85 %  $U_{e \min}$  and 110 % of  $U_{e \max}$ , or
- c) over the range  $U_B$ .

For d.c., the value of the ripple voltage (peak to peak) shall not exceed  $0,1 U_e$  (see 4.3.1.1).

#### **7.2.1.2DV D2 Modify 7.2.1.2 by adding the following:**

#### **7.2.1.2DV.1 For d.c. products with electromagnetic output, a device shall operate at 80% of its minimum rated voltage.**

#### 7.2.1.3 Operating distances

The operating distances are measured according to 8.4. The operating distances are stated when the target is moving towards the proximity switch in an axial approach.

For inductive and capacitive proximity switches, the relationship between the operating distances is shown in figure 3.

For ultrasonic proximity switches, the relationship between the operating distances is shown in figure 4.

For photoelectric proximity switches, the relationship between the operating distances is shown in figure 1.

#### **7.2.1.3DV D2 Delete 7.2.1.3:**

#### **7.2.1.3DV.1 Subclause 7.2.1.3 does not apply.**