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Interested committees:

Title: BS EN IEC 60947-5-3 Low-voltage switchgear and controlgear

Part 5-3: Control circuit devices and switching elements - Requirements for proximity devices with defined behaviour under fault conditions (PDDb)

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



121A/568/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER: IEC 60947-5-3 ED3	
DATE OF CIRCULATION: 2023-08-11	CLOSING DATE FOR COMMENTS: 2023-10-06
SUPERSEDES DOCUMENTS: 121A/494/CD, 121A/518A/CC	

IEC SC 121A : LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR	
SECRETARIAT: France	SECRETARY: Mr Michaël LAHEURTE
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 44,TC 65	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.
FUNCTIONS CONCERNED: ☒ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☒ SAFETY	

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TITLE:

Low-voltage switchgear and controlgear - Part 5-3: Control circuit devices and switching elements - Requirements for proximity devices with defined behaviour under fault conditions (Pddb)

NOTE FROM TC/SC OFFICERS:

Secretary Note: NC experts are kindly requested to refer their comments to line numbers.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

**Part 5-3: Control circuit devices and switching elements –
Requirements for proximity devices with defined
behaviour under fault conditions (PDDB)**

FOREWORD

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International Standard IEC 60947-5-3 has been prepared by subcommittee SC121A: Low-voltage switchgear and controlgear, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low voltage.

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

- a) ...under consideration

This standard is to be read in conjunction with IEC 60947-1, *Low voltage switchgear and controlgear – Part 1: General rules* and IEC 60947-5-2, *Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches*. The provisions of Part 1 and Part 5-2 are only applicable to this standard where specifically called for. The numbering of the subclauses of this standard is sometimes not continuous because it is based on the numbering of the subclauses of IEC 60947-1 or IEC 60947-5-2.

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

FDIS	Report on voting
xxx	xxx

331
332 Full information on the voting for the approval of this standard can be found in the report on
333 voting indicated in the above table.

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

335 A list of all parts in the IEC 60947 series, published under the general title *Low-voltage*
336 *switchgear and controlgear*, can be found on the IEC website.

337 The committee has decided that the contents of this publication will remain unchanged until the
338 stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to
339 the specific publication. At this date, the publication will be

- 340 • reconfirmed,
341 • withdrawn,
342 • replaced by a revised edition, or
343 • amended.

344

345

346

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 5-3: Control circuit devices and switching elements – Requirements for proximity devices with defined behaviour under fault conditions (PDDB)

1 Scope

This part of IEC 60947 series provides additional requirements to those given in IEC 60947-5-2 and IEC 60947-5-1 Annex D (magnetic switches).. It addresses the fault performance aspects of proximity devices with a defined behaviour under fault conditions (PDDB). It does not address any other characteristics that can be required for specific applications.

This document does not apply to protective equipment to detect the presence of persons, that are covered by IEC 61496 series or IEC/TS 62998 series.

This product standard does not cover proximity devices with analogue output.

This product standard does not deal with any specific requirements on acoustic noise as the noise emission of proximity devices is not considered to be a relevant hazard.

For a PDDB used in applications where additional characteristics, dealt with in other standards, are required, the requirements of all relevant standards apply.

A PDDB product is intended to be used as sensing subsystem of a safety related control system according to IEC 62061 or ISO 13849-1. Depending on construction principles and complexity, this standard is based on product development of IEC 61508 in order to meet the product specific requirements of IEC 61508, IEC 62061 and/or ISO 13849.

NOTE The PDDB type classification regarding functional safety correlates with IEC 62683-2-3:xxxx,

This standard contains requirements for PDDBs when designed for use as interlocking devices according to ISO 14119:202x.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 + 12 h cycle)*

IEC 60204-1:2016, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 60529:1989+AMD1:1999+AMD2:2013 CSV, *Degrees of protection provided by enclosures (IP Code)*

IEC 60812:2018, *Failure modes and effects analysis (FMEA and FMECA)*

- 386 IEC 60947-1:2020, *Low-voltage switchgear and controlgear – Part 1: General rules*
- 387 IEC 60947-5-1:2016, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit*
388 *devices and switching elements – Electromechanical control circuit devices*
- 389 IEC 60947-5-2:2019, *Low-voltage switchgear and controlgear – Part 5-2: Control circuit*
390 *devices and switching elements – Proximity switches*
- 391 IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and*
392 *measurement techniques – Electrostatic discharge immunity test*
- 393 IEC 61000-4-3:2020, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and*
394 *measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*
- 395 IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and*
396 *measurement techniques – Electrical fast transient/burst immunity test*
- 397 IEC 61000-4-5:2014+AMD1:2017 CSV, *Electromagnetic compatibility (EMC) – Part 4-5:*
398 *Testing and measurement techniques – Surge immunity test*
- 399 IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and*
400 *measurement techniques – Immunity to conducted disturbances, induced by radio-frequency*
401 *fields*
- 402 IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and*
403 *measurement techniques – Power frequency magnetic field immunity test*
- 404 IEC 61000-4-11:2020, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and*
405 *measurement techniques – Voltage dips, short interruptions and voltage variations immunity*
406 *tests*
- 407 IEC 61131-2:2017, *Programmable controllers – Part 2: Equipment requirements and tests*
- 408 IEC 61140:2016, *Protection against electric shock – Common aspects for installation and*
409 *equipment*
- 410 IEC 61508-1:2010, *Functional safety of electrical/electronic/programmable electronic safety-*
411 *related systems – Part 1: General requirements*
- 412 IEC 61508-2:2010, *Functional safety of electrical/electronic/programmable electronic safety-*
413 *related systems – Part 2: Requirements for electrical/electronic/programmable electronic*
414 *safety-related systems*
- 415 IEC 61508-3:2010, *Functional safety of electrical/electronic/programmable electronic safety-*
416 *related systems – Part 3: Software requirements*
- 417 IEC 62061:2021, *Safety of machinery – Functional safety of safety-related electrical, electronic*
418 *and programmable electronic control systems*
- 419 IEC 62683-2-3:xxxx,
- 420 ISO 13849-1:2016, *Safety of machinery – Safety-related parts of control systems – Part 1:*
421 *General principles for design*

422 ISO 14119:202x, *Safety of machinery — Interlocking devices associated with guards —*
423 *Principles for design and selection*

424 ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of*
425 *uncertainty in Measurement (GUM)*

426 ISO/IEC Guide 99:2007, *International vocabulary of metrology – basic and general concepts*
427 *and associated terms (VIM)*

428 IEC Guide 115:2021, *Application of uncertainty of measurement to conformity assessment*
429 *activities in the electrotechnical sector*

430 **3 Terms and definitions**

431 For the purposes of this document, the terms and definitions given in IEC 60947-1 and IEC
432 60947-5-2, as well the following, apply.

433 ISO and IEC maintain terminological databases for use in standardization at the following
434 addresses:

- 435 • IEC Electropedia: available at <https://www.electropedia.org/>
- 436 • ISO Online browsing platform: available at <https://www.iso.org/obp>

437 **3.1 General terms and definitions**

438 **3.1.1**

439 **PDDB proximity device with a defined behaviour**

440 proximity switch based on IEC 60947-5-2 according to 5.5.1 .

441 Note 1 to entry: In a safety function, the PDDB is a device or subsystem, characterized according to
442 clause 4.9 (device type)

443 Note 2 to entry: A PDDB is often used as interlocking device according to 3.2 (ISO 14119).

444 **3.1.2**

445 **interlocking device**

446 device for preventing the operation of hazardous machine functions under specified conditions
447 (generally as long as a guard is not closed)

448 Note 1 to entry: An interlocking device may be combined with a guard locking device according to

449 [SOURCE: ISO 14119:202x, 3.1]

450 **3.1.3**

451 **OSSD output signal switching device**

452 component (s) or output terminal(s) of the PDDB connected to the machine control system
453 which, when the PDDB detects the presence or absence of the specified target, responds by
454 going to the OFF-state according to the defined behaviour.

455 Note to entry The PDDB is designed with one or more redundant component per logical signal, depending on
456 the HFT or category according to table 2.

457 SOURCE IEC 61496-1:2020, 3.19, modified for a PDDB

3.1.4**OTE output of test**

state in which the OSSDs interrupt the flow of current.

Note to entry: OTE is corresponding with SSD (secondary switching device) according to IEC 61496-1:2020, 3.24.

[SOURCE: ISO 13849-1:2023, 6.1.3.2.4]

3.1.5**Off-state**

state in which the OSSDs interrupt the flow of current.

Note to entry: In general, the OFF-state corresponds with the safe state according to IEC 61508-4:2010, 3.1.14, but it may differ according to 5.3.7.

3.1.6**ON-state**

state in which the OSSDs permit the flow of current. For Interface Types A0 and B0 according to B.3 and B.4, the test pulses from the sink passes thorough.

3.1.7**fault response time**

maximum period of time during which OSSDs can deviate from the defined behaviour.

Note to entry: Within this time the output gets into to OFF-state in case of a detected failure.

3.1.8**EUT Equipment under Test**

representative test sample of a PDDb, usually assembled in the manufacturing line without a selection of components or any special settings or adjustments.

Note 1 to entry: Adjustments, if any, are done according to the manufacturer's assembling instructions

Note 2 to entry: ISO/IEC GUIDE 98-3:2008 uses the term 'specimen' for a EUT

[SOURCE: IEC 60947-1:2020, 9.3.2.1 Paragraph 1]

3.1.9**Modified EUT**

test sample, modified to test the behaviour of a EUT at the limit of its specified conditions. Normally, components are selected or or configurations adjusted at the limit of its specified operating range.

EXAMPLE Adjustment of an amplifier to the specified minimum or maximum gain.

3.1.10**LOT**

Unique identifier assigned to a batch of EUT

a group of EUT's, used for verification tests. A Lot number or identifier is used for unique identification.

3.1.11**Project documentation**

documentation done by the manufacturer and not public available.

Note to entry: Project documentation is intended for use upon request from authorities

3.1.12**Quantity (measurable)**

attribute of a phenomenon or body that may be distinguished qualitatively and determined quantitatively

Note to entry The measurable quantity is a value measured (ISO/IEC Guide 98-3:2008, B.2.2), of a measurand (B.2.9), expressed with a measurement result (B.2.11), accompanied by a statement of the uncertainty (B.2.18)

EXAMPLE Quantities in a general sense: length, time, mass, temperature, electrical resistance

[SOURCE: ISO/IEC Guide 98-3:2008, B.2.1 and 3.1.1]

3.1.13**Quantity (Influence Quantity)**

quantity that is not the measurand but that affects the result of the measurement

EXAMPLE Influence of the ambient temperature to the output voltage

Note to entry The term 'quantity' is used in ISO/IEC GUIDE 98-3:2008 and as 'Input quantity' in IEC 60947-1:2020. It is used in the meaning of physical input quantities as temperature and supply voltage and others, which may have an impact to the behaviour and the measurement result.
IEC 60947-1:2020, 9.3.2 General test conditions
IEC 60947-1:2020, 9.3.2.2 Test quantities

[SOURCE: ISO/IEC Guide 98-3:2008, B.2.10, 3.1.5, 4.1.3]

3.1.14**set of test quantity**

A grouped set of quantities, each specified with a range or a specific value

EXAMPLE 1 Ambient temperature: 20 ± 2 °C, humidity 50 ± 5 %, Supply Voltage DC 29 ± 0.2 V, Load Current DC $1.0 \text{ A} \pm 0.05 \text{ A}$

EXAMPLE 2 Ambient Temperature: $0 - 80$ °C, humidity $40 - 90$ %, Supply Voltage DC $19.2 - 28.8 (\pm 0.1)$ V, Load Current DC $0.0 - 1.0 (\pm 0.05)$

Note to entry: Value or range of temperature, humidity, supply voltage, load current, operating condition, etc

[SOURCE: ISO/IEC Guide 98-3:2008, 4.1.3]

3.2 Terms and definitions concerning Annex B**3.2.1****Information source (source)**

transmitting information to the information sink (hereafter referred as source)

Note to entry Typically, the source is the PDDb and the sink the control system which processes the OSSD data from the PDDb.

3.2.2**Information sink (sink)**

The information sink (hereafter referred to as sink) is receiving information from the information source. The sink input is connected to the output of the source. A sink can meet requirements of several interface types at the same time.

EXAMPLE The sink could be a control system, which is receiving the signal information. The term refers to the analysis of the information and not to the analysis of the test pulses. Analysis of test pulses can be located in different parts of the system, depending on the interface type.

3.2.3**Interface type**

The interface type is a standardized interface for transmitters of signals (sources) and receivers of signals (sinks). Generation and analysis of test pulses is specified per interface type.

3.2.4**Class**

The class is a group of sources and sinks with compatible technical data within an interface type based on the test pulses in use.

3.2.5**Test pulse generation (TG)**

Part of the system that generates test pulses used for system diagnosis.

3.2.6**Test pulse evaluation (TE)**

Part of the system that evaluates test pulses for system diagnosis.

3.2.7**Supply voltage**

Supply voltage is the voltage continuously supplied to a device.

Test pulse

A test pulse is a temporary change of a signal voltage level used to verify the proper operation of the output or device or the transmission path.

3.2.8**Test pulse duration t_i**

The test pulse duration t_i is the time from the start of the test pulse (e.g. falling edge) until the end of the test pulse (e.g. rising edge).

3.2.9**Test pulse interval T**

The test pulse interval is the time between the start of a test pulse and the start of the next test pulse on the same output.

3.2.10**Test pulse delay Δt_i**

The test pulse delay Δt_i is a pulse delay introduced by the source, between the input and the output of the information source.

3.2.11**Discrepancy time Δt_{dis}**

Temporal shift of the rising and falling signal flanks between different output channels. (Concurrency of the signals at interface type C).

3.2.12**Test pulse phase shift Δt_c**

Time shift of test pulses between different test generation channels (interface type C).

3.2.13**Output current I_n**

The output current I_n is the nominal ON state current of an output.

3.2.14**Leakage current $I_{Leakage}$**

The leakage current $I_{Leakage}$ is the remaining current of an output for a source (PDDb) or sink in the OFF-state.

3.2.15**Load capacitance C_L**

The load capacitance C_L is the capacitive part of the load impedance.

3.2.16**Inductive load L_L**

The load inductance L_L is the inductive part of the load impedance.

3.3 Symbols and abbreviations**Table 1 – Symbols and abbreviations**

Symbol or abbreviation	Description	Definition
DC	diagnostic coverage	ISO 13849-1:2023, 3.1.35
EUT	Equipment under Test	3.1.8
FIT	failures in time, number of failures in total 10^9 hours of operation of one or more components	
HFT	hardware fault tolerance	IEC 61508-2:2010, 7.4.4.1.1
$MTTF_D$	mean time to dangerous failure	ISO 13849-1:2015 3.1.25
OSSD	output signal switching device	3.1.3
OTE	output of test	3.1.4
$PFH_D^{a)}$	average frequency of a dangerous failure over a given period of time	IEC 61508-4:201, 3.6.19
PFD	probability of dangerous failure on demand	IEC 61508-4:2010, 3.6.17
PL	performance level	ISO 13849-1:2015, 3.1.23
$S_{As}^{b)}$	safety related distance in operating mode TP and TP&TA, where the OSSDs have been switching to the OFF-state, when the target moved from the switch	5.2.2
$S_{Ps}^{b)}$	safety related distance in operating mode TA and TP&TA, where the OSSDs have been switching to the OFF-state, when the target moved towards the switch	5.2.3
SFF	safe failure fraction	IEC 61508-4:2010, 3.6.15

Symbol or abbreviation	Description	Definition
SIL	safety integrity level	IEC 61508-4:2010, 3.5.8
SRP/CS	safety-related part of a control system	ISO 13849-1:2023, 3.1.1
T_M	mission time	ISO 13849-1:2015, 3.1.28
TG	test pulse generation	3.2.5
TE	Test pulse evaluation	3.2.6
t_i	Test pulse duration	3.2.8
T	Test pulse interval	3.2.9
Δt_i	Test pulse delay	3.2.10
Δt_{dis}	Discrepancy time	3.2.11
Δt_c	Test pulse phase shift	3.2.12
I_n	Output current	3.2.13
$I_{Leakage}$	Leakage current	3.2.14
C_L	Load capacitance	3.2.15
L_L	Inductive load	3.2.16
a	Index 'D' is often used to indicate 'dangerous' fault or probability	
b	safety related variable is marked with an index 's'	

596

597 **4 Classification**598 **4.1 General**

599 Pddb devices vary in terms of technology, operating mode, safety level, application, and
600 availability.

601 Clause 4.1 of IEC 60947-5-2:2019 applies, if applicable.

602 **4.2 Classification according to sensing means**

603 Clause 4.2 of IEC 60947-5-2:2019 shall apply. The designated capital letter can be omitted,
604 when the applied sensing mean is not listed in IEC 60947-5-2:2019 Table 1, Column 1 (Sensing
605 Means).

606 **4.3 Classification according to the mechanical installation**

607 Clause 4.3 of IEC 60947-5-2:2019 applies, if applicable.

608 **4.4 Classification according to the construction form and size**

609 Clause 4.4 of IEC 60947-5-2:2019 applies, if applicable.

610 **4.5 void**611 **4.6 Classification according to type of output**

612 Clause 4.6 of IEC 60947-5-2:2019 applies, if applicable.

613 NOTE For functional safety devices often the term 'device type' is being used.

4.6.1 Interface Type

When the OSSD(s) are intended for use with digital inputs according to IEC 61131-2:2017, 6.4.4, an interface type shall be defined according to Table 2.

OSSDs defined as binary interface operating at 24 VDC, the interface type shall be classified according to Table 2.

Table 2 – Interface types of PDBs

Interface Type a)	Designation	Description	Clause
A0	Interface Type A0	Test pulse generated from the control unit (sink), without any delay of the test pulse	B.3 b), d)
B0	Interface Type B0	Test pulses generated from the control unit (sink). Test pulse may be delayed.	B.4 c), d)
C0	Interface Type C0	Test pulse generated from the PDB (source), any test pulse duration	B.5
C1	Interface Type C1	Test pulse generated from the PDB (source), maximum test pulse duration = 1000 µs	B.5
C2	Interface Type C2	Test pulse generated from the PDB (source), maximum test pulse duration = 500 µs	B.5
C3	Interface Type C3	Test pulse generated from the PDB, maximum test pulse duration = 100 µs	B.5
^a Interface types according to Annex B ^b Interface Type A0 interrupts in the OFF-state the flow of the current and the transmission of the test pulses from the sink through the PDB according to B.3. ^c Interface Type B0 interrupts in the OFF-state the flow of the current and the transmission of the test pulses from the sink according to B.4. ^d Alternate safe state, see 5.3.7			

The identifying key according to B.2.2 shall be defined for interface types A0, B0, C0, C1, C2 and C3.

NOTE Annex B defines the characteristics and aspects of the interface types.

4.7 Classification according to method of connection

Clause 4.7 of IEC 60947-5-2:2019 applies, if applicable.

4.8 Electrical Equipment Class

Protection against electrical shock is achieved by provisions of IEC 61140:2016 for devices, assigned for a class of electrical equipment according to the following subclauses.

4.8.1 Void

4.8.2 Void

4.8.3 Electrical Equipment Class III

Devices of Electrical Equipment Class III shall be connected only to SELV or PELV systems.

SOURCE IEC 61140:2016, 7.5 and table 1, IEC 60204-1:2016, 6.4.1 and IEC 60947-1:2020, Annex N

4.9 Pddb types

The Pddb types define the functional safety characteristic values, used for information exchange for the user. The manufacturer of the Pddb specifies the type classification.

NOTE 1 For functional safety devices often the term 'device type' is being used.

NOTE 2 The Pddb type corresponds with the device type according to ISO 13849-1:2022 ANNEX O, IEC 62683:xxxx and IEC 62683-2-3:xxxx

NOTE 3 Characteristic safety values for each Pddb type are given in clause 5.5.2

4.9.1 Pddb Type 1

A Pddb Type 1 has the highest integration level. Pre-designed safety systems with integrated diagnostics are typical. This type is SIL or PL-classified in line with the intended use.

4.9.2 Pddb Type 2

Additional application data as circuit structure, diagnostic coverage (DC) and consideration of common cause failure (CCF)) are needed in order for the user to assess a safety function.

4.9.3 Pddb Type 3

Pddb Type 3 are devices with a failure mode, which depends on the operating cycles.

NOTE Examples for device type 3: Electromechanical components that are subject to wear, e.g. switches, interlocking devices

4.10 Interlocking Device Type

If a Pddb is intended for use as an interlocking device according to ISO 14119:202x, the interlocking type and target code shall be defined according to the subclauses 4.10.1, 4.10.2, and 4.11.

NOTE 1 ISO 14119 uses the term actuator for the specified target according to IEC 60947-5-3.

NOTE 2 IEC 60947-1:2020, 3.5.17 Actuator is defining as the part of the actuating the contacts

4.10.1 Interlocking Device Type 3

The Pddb is intended for use as an interlocking device Type with non-contact actuated position switch with an uncoded target.

SOURCE ISO 14119:202x, 3.17

The coding level of the target shall be defined to low according to 4.11.1

4.10.2 Interlocking Device Type 4

The Pddb is intended for use as an interlocking device Type with non-contact actuated position switch with a coded target.

SOURCE ISO 14119:202x, 3.18

The coding level of the target shall be defined to medium or high according to 4.11.2 or 4.11.3.

4.11 Target Coding

When specified targets with coding levels are defined by the manufacturer, the coding levels shall be stated in the user documentation according to this clause.

SOURCE ISO 14119:202x, 3.12

4.11.1 Coding Level low

The target shall be designed as coded actuator according to ISO 14119:202x, 3.12.1 for which 1 to 9 variations in code are available and the different codes are evaluated by the PDDb.

4.11.2 Coding Level medium

The target shall be designed as coded actuator according to ISO 14119:202x, 3.12.2 for which 10 to 1000 variations in code are available and the different codes are evaluated by the PDDb.

4.11.3 Coding Level high

The target shall be designed as coded actuator according to ISO 14119:202x, 3.12.2 for which more than 1000 variations in code are available and the different codes are evaluated by the PDDb.

4.12 Operating Mode

The PDDb shall be defined with an operating mode TP, TA or both.

Table 3 – Operating Modes of PDDBs

Operating Mode	TP	TA
Description	Target Present	Target Absent
OSSD state when Target is present to the switch	ON	OFF
OSSD state when Target is absent from the switch	OFF	ON
safety related switching distances	s_{As}	s_{Ps}
Reference	4.12.1, Figure 1	4.12.2, Figure 2

4.12.1 Operating Mode TP

The OSSDs are in the ON-state when the target is present to the switch ($s < s_p$).

The OSSDs shall get in the OFF-state, when the target is absent from the switch ($s > s_{As}$) according to Figure 1.

4.12.2 Operating Mode TA

The OSSDs are in the ON-state when the target is absent from the switch ($s > s_A$).

The OSSDs shall get in the OFF-state, when the target is present to the switch ($s < s_{Ps}$) according to Figure 2.

4.12.3 Combined operating Mode TP&TA

The OSSDs are in the ON-state when the target is between the distance s_p and s_A .

696 The OSSDs shall get in the OFF-state, when the target is absent from the switch (Figure 1,
697 $s > s_{As}$) and when it is close to the switch (Figure 2, $s < s_{Ps}$).

698 5 Characteristics

699 5.1 General

700 NOTE Clause 5 in this standard deviates from the Clause 5 of IEC 60947-5-2:2021.
701

702 5.1.1 Summary of characteristics

703 The characteristics of a Pddb shall be stated in the following terms.

- 704 • Operating conditions (5.2)
- 705 • Rated and limiting values (5.3)
 - 706 – Voltages (5.3.1)
 - 707 – Currents (5.3.2)
 - 708 – Rated Supply frequency (5.3.3), for AC powered devices
 - 709 – Normal load and abnormal load characteristics (5.3.5)
 - 710 – Short-circuit characteristics (5.3.6)
 - 711 – OFF-state of the OSSD (5.3.7)
 - 712 – Interface Type A0, B0, C0, C1, C2, C3 (5.3.8)
- 713 • Utilization categories for the switching element (5.4)
- 714 • Safety related characteristics (5.5)
- 715 • Electrical Equipment Class (5.6)
- 716

717 5.1.2 Safety function

718 The Pddb is a subsystem of a safety function. The OSSDs are initiated by the presence or
719 absence (or both) of the specified target. The state of the outputs depends on the operating
720 mode and the position of the target to the sensing face of the switch. The state is defined
721 according to Table 3 and and clause 5.2.

722 5.2 Safety related switching distances

723 5.2.1 General

724 The switching distances may be defined as safety related or not, according to the intended use
725 as described in clause 4.12. Safety related switching distances shall be marked with an index
726 's' and verified according to clause 9.4.

727 NOTE The same principles of characteristics and verification may be applied for non-safety related switching
728 distances and other quantities. The index 's' in the variable is in this case omitted.
729

730 5.2.2 Switching distance s_{As}

731 The safety related switching distances s_{As} is the distance of the target from the switch, where
732 the output shall have been changing its state, when the target is moved away from the switch.
733 In operation mode TP and TP&TA, the switching distance s_{As} is safety related and shall be
734 marked with an index 's' and verified according to clause 9.4.

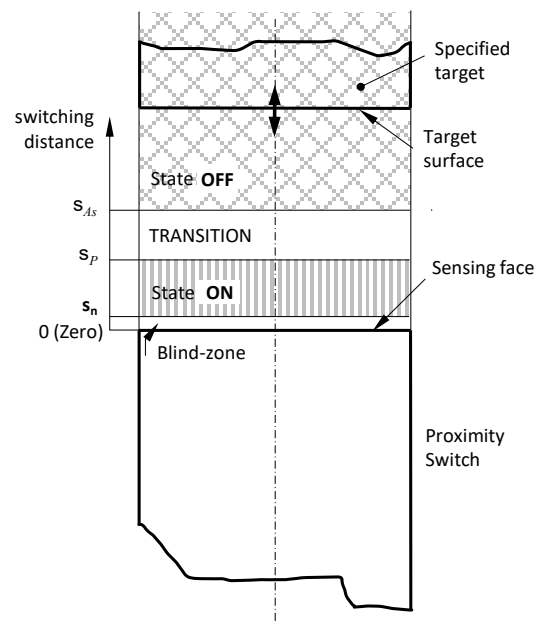


Figure 1 – Safety related switching distance s_{As} and switching distance s_p for a PDDB with Operating Mode TP (Target Present)

NOTE 1 For the operating mode TP, the OSSD may differ from the ON-state in the near-range (switching distances between 0 (Zero) to $s < s_p$).

NOTE 2 distance s_A to be distinguished from s_a according to IEC 60947-5-2:2019, 3.3.1.7

NOTE 3 distance s_p correspondent with $s_{u \min}$ of IEC 60947-5-2:2019

NOTE 4 In the blind-zone, if specified with s_b , the state of the OSSD is undefined.

5.2.3 Switching distance s_{Ps}

The switching distances s_P is the distance of the target from the switch, where the output shall have been changing its state, when the target is moved towards the switch. In operation mode TA and TP&TA, the switching distance s_{Ps} is safety related and shall be marked with an index 's' and verified according to clause 9.4.

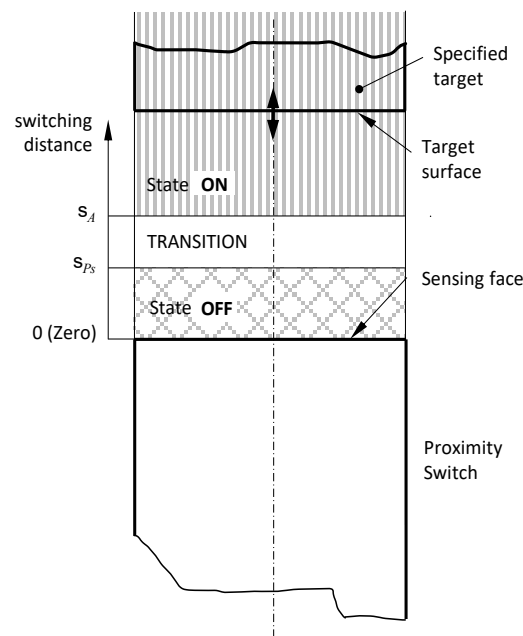


Figure 2 – Safety related switching distance s_{Ps} and switching distance s_A for a PDDB with Operating Mode TA (Target Absent)

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

5.3.1 Voltages

5.3.1.1 Rated operational voltage (U_e)

Clause 5.3.1.1 of IEC 60947-5-2:2019 applies.

5.3.1.2 Rated insulation voltage (U_i)

Clause 5.3.1.2 of IEC 60947-5-2:2019 applies for Electrical Equipment Class I and II.

5.3.1.3 Rated impulse withstand voltage (U_{imp})

Clause 5.3.1.3 of IEC 60947-5-2:2019 applies for Electrical Equipment Class I and II.

5.3.1.4 Voltage drop (U_d)

Clause 5.3.1.4 of IEC 60947-5-2:2019 applies with the specified values in 8.2.1.13.

5.3.1.5 Operating voltage range (U_B)

Clause 5.3.1.5 of IEC 60947-5-2:2019 applies with the following addition:

The voltage of the incoming power supplies for the PDDb shall be within the limits:

a) – 15 % / + 20 % for DC

b) – 15 % / + 10 % for AC

SOURCE IEC 61131-2:2017, 6.2.1.1.

NOTE 1 In addition to the voltage tolerances, a total AC component having a peak value of 5 % of the rated voltage is allowed. The absolute limits are DC 30/19,2 V for DC 24 V and DC 60/38,4 V for DC 48 V.

NOTE 2 While the voltage of the incoming power supply is limited up to the stated values of 5.3.1.1, the PDDb shall be designed to operate at least within these limits. Expanded robustness to lower and higher voltages are recommended,

NOTE 3 For interoperability with digital inputs according to IEC 61131-2:2017, 6.4.4, see clause 4.6.1.

5.3.1.6 Maximum OFF-state Voltage ($U_{L\ max}$)

Solid state OSSD of interface type A0, B0, C0, C1, C2, C3 shall have a maximum voltage in the OFF-state according to 8.2.1.14..

5.3.2 Currents**5.3.2.1 Rated operational current (I_e)**

Clause 5.3.2.1 of IEC 60947-5-2:2019 applies

5.3.2.2 Minimum operational current (I_m)

See 8.2.1.10.

5.3.2.3 Off-state current (I_r)

See 8.2.1.11.

5.3.2.4 No-load supply current (I_o)

Clause 5.3.2.4 of IEC 60947-5-2:2019 applies.

5.3.3 Rated supply frequency

Clause 5.3.3 of IEC 60947-5-2:2019 applies for AC powered devices.

5.3.4 void**5.3.5 Normal load and abnormal load characteristics**

Clause 5.3.5 of IEC 60947-5-2:2019 applies.

5.3.6 Short-circuit characteristics

Clause 5.3.5 of IEC 60947-5-2:2019 applies with the following addition:

– For short-circuit proof solid state outputs, the rated short circuit current is omitted.

SOURCE IEC 61131-2:2007, 6.4.6.4.

5.3.7 OFF-state of the OSSD

The OFF-state of the OSSDs interrupt the flow of the current other than residual OFF-state current (I_r).

When stated by the manufacturer in the user documentation, the safe state of the OSSD may differ from the OFF-state according to 3.5. For example, the OSSD may be designed as two antivalent switching contacts (NC and NO) or using dynamic signals.

NOTE Annex B covers functional safety aspects covered by dynamic testing. Clause 8.2.1.10, 8.2.1.11, 8.2.1.12 and 8.2.1.13 covers compliance of the OSSDs with digital inputs U/I operation regions according to IEC 61131-2:2021, 6.4.4.1.

5.3.8 Interface Type A0, B0, C0, C1, C2, C3

The requirements for static characteristics (5.3.8.1) and dynamic characteristics (5.3.8.2) applies for interface type A0, B0, C0, C1, C2 and C3.

Further characteristics of binary interfaces are given in Annex B.

5.3.8.1 Static characteristics

With the listed characteristics of Table 4 the OSSD of a PDDb comply with a digital input according to IEC 61131-2:2017, 6.4.4.

Table 4 – Static Characteristics of Interface Types A0, B0, C0, C1, C2 and C3

Characteristic	Clause
Operating voltage range (U_B)	5.3.1.5
Voltage drop (U_d)	5.3.1.4 8.2.1.13
Maximum OFF-state Voltage ($(U_{L\ max})$)	5.3.1.6 8.2.1.14
Leakage current (Off-state current I_r)	5.3.2.3 8.2.1.11

5.3.8.2 Dynamic Characteristics

Table 5 – Dynamic Characteristics of Interface Types C0, C1, C2 and C3

Interface Type	Dynamic Char.
A0	B.3.2
B0	B.4.2
C0, C1, C2, C3	B.5.2

5.4 Utilization categories for the switching element

Clause 5.4 of IEC 60947-5-2:2019 applies.

5.5 Safety related characteristics

5.5.1 Proximity device with defined behaviour

A PDDb is composed of the following elements: