

INTERNATIONAL STANDARD

**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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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)**

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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. It is an International Standard.

This third edition cancels and replaces the second edition published in 2013. This edition constitutes a technical revision.

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

- a) Update of the scope, refined fault performance aspects and relation to standards of functional safety.
- b) The 'safe state' is generally determined as 'OFF-state' (see 3.1.8).

- c) Update of EMC requirements in 8.2.6 with references to IEC 60947-5-2:2019 for acceptance criteria A, B and C and requirements of Table 17 for acceptance criterion DS.
- d) Interface types for binary interfaces are introduced (see 4.6.2 and Annex B).
- e) Functional safety device types according to ISO 13849-1:2023 Annex O (see 4.9).
- f) Interlocking device type and coding level according to ISO 14119 are adapted (see 4.10 and 4.11).
- g) The operating modes target present (4.12.2) and target absent (4.12.3) are introduced.
- h) The 'switching distance' replaces the terms 'release' and 'operating'. The behaviour of the PDDb is described according to the operating mode (4.12).
- i) The context and verification of the switching distances are considered according to ISO/IEC Guide 98-3:2008 (GUM) and IEC TR 63649¹ (see 8.2.1.3 and 9.4.2).
- j) Requirements for electrical equipment class III are refined.
- k) The risk time is replaced with the safety response time (3.1.11).
- l) Annex A gives a new example of safety related control system.
- m) The test sequences (see 9.3.1) are updated for the specific behaviour of a PDDb.

This document is to be read in conjunction with IEC 60947-1:2020 and IEC 60947-5-2:2019. The provisions of Part 1 and Part 5-2 are only applicable to this document where specifically called for. The numbering of the subclauses of this document is sometimes not continuous because it is based on the numbering of the subclauses of IEC 60947-1:2020 or IEC 60947-5-2:2019.

The text of this International Standard is based on the following documents:

Draft	Report on voting
121A/716/FDIS	121A/728/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

¹ Under preparation. Stage at the time of publication: IEC DTR 63649:2025.

1 Scope

This part of IEC 60947 provides additional requirements to those given in IEC 60947-5-2 and IEC 60947-5-1:2024, Annex D (reed contact magnetic switches). It addresses the fault performance aspects of proximity devices with a defined behaviour under fault conditions (PDDDB). It does not address any other characteristics that can be required for specific applications.

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

NOTE 1 A PDDDB device can be used to detect indirectly the presence of a person, for example by detecting the position of a platform on which the operator stands (example, garbage trucks).

This document does not specify requirements for the analogue output of PDDDB, if any.

This document 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.

A PDDDB 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 document is based on product development of the IEC 61508 series to meet the product specific requirements of one or more of the following:

- IEC 61508 series;
- IEC 62061;
- ISO 13849 series.

NOTE 2 The Functional safety device type classification regarding functional safety correlates with IEC 62683-2-3.

This document includes requirements for PDDDB when designed for use as part of an interlocking device according to ISO 14119.

This document does not consider aspects of:

- software updates and self-evolving behaviour;
- explosive atmospheres.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60068-2-1, *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 60204-1:2016/AMD1:2021

IEC 60730-1, *Automatic electrical controls - Part 1: General requirements*

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

IEC 60947-1:-², *Low-voltage switchgear and controlgear - Part 1: General rules*

IEC 60947-5-1:2024, *Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices*

IEC 60947-5-2:2019, *Low-voltage switchgear and controlgear - Part 5-2: Control circuit devices and switching elements - Proximity switches*

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

IEC 61000-4-3, *Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test*

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

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

IEC 61000-4-6, *Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8, *Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test*

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

IEC 61000-4-29, *Electromagnetic compatibility (EMC) - Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port - immunity tests*

IEC 61131-2:2017, *Programmable controllers - Part 2: Equipment requirements and tests*

IEC 61140:2016, *Protection against electric shock - Common aspects for installation and equipment*

IEC 61508-2:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems*

IEC 61508-3, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 3: Software requirements (see Functional Safety and IEC 61508)*

IEC 62061:2021, *Safety of machinery - Functional safety of safety-related control systems*
IEC 62061:2021/AMD1:2024

ISO 13849-1:2023, *Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design*

ISO 14119:2024, *Safety of machinery - Interlocking devices associated with guards - Principles for design and selection*

² Under preparation. Stage at the time of publication: IEC CDV 60947-1:2026.

3 Terms, definitions, symbols and abbreviated terms

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

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

3.1 General terms and definitions

3.1.1

proximity device with a defined behaviour

PDDB

proximity switch used as a safety-related sensing subsystem to detect the presence or absence of an object or the position of a part

Note 1 to entry: In a safety function, the PDDB is a device and a safety related subsystem characterized according to 4.9.

Note 2 to entry: A PDDB is often used as interlocking device according to ISO 14119:2024, 3.1.

3.1.2

interlocking device

mechanical, electrical or other type of device, which has the purpose to prevent the operation of hazardous machine functions under specified conditions (generally as long as a guard is not closed)

Note 1 to entry: An interlocking device can be combined with a guard locking device.

[SOURCE: ISO 14119:2024, 3.1, modified – The admitted term “interlock” has been deleted, the figure has been deleted and Note 1 has been replaced by the new Note 1.]

3.1.3

output signal switching device

OSSD

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

Note 1 to entry: The PDDB is designed with one or more redundant components per logical signal, depending on the hardware fault tolerance (HFT) or category.

[SOURCE: IEC 61496-1:2020, 3.19, modified – modified for a PDDB.]

3.1.4

secondary switching device

SSD

device which, in a lock-out condition goes to the OFF-state

Note 1 to entry: It can be used to initiate an appropriate machine control action, for example de-energizing the machine secondary control element

Note 2 to entry: SSD corresponds to OTE (output of test equipment) according to ISO 13849-1:2023, 6.1.3.2.4.

[SOURCE: IEC 61496-1:2020, 3.24, modified – Note 2 has been added.]

3.1.5**ON-zone**

range of distance from the target to the switch where the ON-state of the OSSDs is reached

Note 1 to entry: Illustrated in Figure 1 and Figure 2.

3.1.6**ON-state**

state in which the OSSDs permit the flow of current

Note 1 to entry: For Interface Types A0 and B0 according to Clause B.3 and Clause B.4, the test pulses coming from the sink pass through.

3.1.7**OFF-zone**

range of distance from the target to the switch where the OFF-state of the OSSDs is reached

Note 1 to entry: Illustrated in Figure 1 and Figure 2.

3.1.8**OFF-state**

state in which the OSSDs interrupt the flow of current

Note 1 to entry: In general, the OFF-state corresponds with the safe state according to IEC 61508-4:2010, 3.1.13, but it can differ according to 5.3.7.

3.1.9**maximum turn-off time**

$t_{\text{off max}}$

maximum response time between the request of the safety function from the movement of the target to the moment where the OSSD is getting into OFF-state

Note 1 to entry: See 8.2.1.6.3.

3.1.10**fault response time**

t_{fr}

maximum time which an OSSD takes from an event of a fault, detected by an automatic diagnostic test, to get into the OFF-state

3.1.11**safety response time**

t_{sr}

relevant response time to be considered in the application of the PDDB in a safety function

3.1.12**mission time**

T_{M}

period of time covering the intended use of a PDDB

Note 1 to entry: The PFH value considers the failure probability evaluated with FIT values for mission times T_{M} .

[SOURCE: ISO 13849-1:2023, 3.1.36, modified – SRP/CS replaced with PDDB, note to entry added.]

3.1.13**maximum disturbance time** t_d

time of allowed deviation of the OSSDs from the defined behaviour

Note 1 to entry: See 8.2.1.6.6.

3.1.14**equipment under test****EUT**

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 product documentation.

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

3.1.15**modified EUT**

test sample, modified to test the behaviour of an EUT at the limit of the specified characteristics of its components and assembly

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

Note 1 to entry: Normally, components are selected, or configurations adjusted at the limit of their specified operating range.

3.1.16**test-lot**

group of EUTs, used for verification tests

Note 1 to entry: A test-lot number or identifier is used for unique identification.

3.1.17**technical documentation**

documentation that enables the conformity of the product with the requirements of the standard(s) to be assessed

Note 1 to entry: Technical documentation is intended for use upon request from authorities.

[SOURCE: IEC 60050-426:2020, 426-27-06, modified, – Notes 1 and 2 deleted and a new note has been added.]

3.1.18**quantity (measurable)**

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

Note 1 to entry: The measurable quantity is a value measured (ISO/IEC Guide 98-3:2008, B.2.2), of a measurand (ISO/IEC Guide 98-3:2008, B.2.9), expressed with a measurement result (ISO/IEC Guide 98-3:2008, B.2.11), accompanied by a statement of the uncertainty (ISO/IEC Guide 98-3:2008, 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, modified – The notes and Examples 2 and 3 have been deleted and a new note has been added.]