

Low-voltage switchgear and controlgear —

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

The European Standard EN 60947-5-3:1999, incorporating amendment A1:2005, has the status of a British Standard

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National foreword

This British Standard was published by BSI. It is the UK implementation of EN 60947-5-3:1999, incorporating amendment A1:2005. It is identical with IEC 60947-5-3:1999, incorporating amendment 1:2005.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** **A1**. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by **A1** **A1**.

The UK participation in its preparation was entrusted by Technical Committee PEL/17, Switchgear, controlgear, and HV-LV co-ordination, to Subcommittee PEL/17/2, Low voltage switchgear and controlgear.

A list of organizations represented on PEL/17/2 can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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English version

**Low-voltage switchgear and controlgear
Part 5-3: Control circuit devices and switching elements
Requirements for proximity devices with defined behaviour
under fault conditions (PDF)
(IEC 60947-5-3:1999)**

Appareillage à basse tension
Partie 5-3: Appareils et éléments
de commutation pour circuits de
commande
Prescriptions pour dispositifs de
détection de proximité
à comportement défini dans des
conditions de défaut (PDF)
(CEI 60947-5-3:1999)

Niederspannungsschaltgeräte
Teil 5-3: Steuergeräte und
Schaltelemente
Anforderungen für Näherungsschalter
mit definiertem Verhalten unter
Fehlerbedingungen (PDF)
(IEC 60947-5-3:1999)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 17B/963/FDIS, future edition 1 of IEC 60947-5-3, prepared by SC 17B, Low-voltage switchgear and controlgear, of IEC TC 17, Switchgear and controlgear, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60947-5-3 on 1999-05-01.

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2000-02-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2002-05-01

This standard is to be used in conjunction with EN 60947-1 and EN 60947-5-2.

Annexes designated "normative" are part of the body of the standard.
In this standard, annexes A and ZA are normative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60947-5-3:1999 was approved by CENELEC as a European Standard without any modification.

Foreword to amendment A1

The text of document 17B/1388/FDIS, future amendment 1 to IEC 60947-5-3:1999, prepared by SC 17B, Low-voltage switchgear and controlgear, of IEC TC 17, Switchgear and controlgear, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 60947-5-3:1999 on 2005-03-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2005-12-01
- latest date by which the national standards conflicting
with the amendment have to be withdrawn (dow) 2008-03-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of amendment 1:2005 to the International Standard IEC 60947-5-3:1999 was approved by CENELEC as an amendment to the European Standard without any modification.

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

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

1 General

The provisions of General Rules in IEC 60947-1 and IEC 60947-5-2 are only applicable to this international Standard where specifically called for.

General rules, clauses and subclauses thus applicable, as well as tables, figures and annexes are identified by references to those standards.

The types of PDF referred to in this standard are intended to form the basis for the selection of devices with appropriate characteristics for the application. They take into account the general principles of [A1](#) ISO 13849-1, [A1](#) but they are not directly equivalent to the categories defined in clause 6 of that standard.

1.1 Scope

This part of IEC 60947 applies to proximity devices with an enhanced resistance to failure (PDF).

It specifies requirements for four different types of PDF.

NOTE – Due to their enhanced resistance to failure, PDFs apply for instance to:

- interlocking devices (see ISO 14119);
- the detection of the presence or absence of protective devices (see ISO/TR 12100-1).

For a PDF used in applications where additional characteristics, dealt with in other standards, are required, it will be necessary to satisfy the requirements of all relevant standards.

1.2 Normative references

[A1](#) 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. [A1](#)

[A1](#) CISPR 11:2003, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement*
Amendment 1 (2004) [A1](#)

IEC 60050(191):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 191: Dependability and quality of service*

[A1](#) Amendment 1 (1999)
Amendment 2 (2002) [A1](#)

IEC 60068-2-1:1990, *Environmental testing – Part 2: Tests. Tests A: Cold*
[A1](#) Amendment 1 (1993)
Amendment 2 (1994) [A1](#)

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests. Tests B: Dry heat*
[A1](#) Amendment 1 (1993)
Amendment 2 (1994) [A1](#)

IEC 60204-1:1997, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*
[A1](#) Amendment 1 (1999) [A1](#)

IEC 60249-2 (all specifications), *Base materials for printed circuits – Part 2: Specifications*

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

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

 Amendment 1 (1999) 

IEC 60664-1:1992, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

 Amendment 1 (2000)

Amendment 2 (2002) 

 Text deleted 

 IEC 61558-1:1997, *Safety of power transformers, power supply units and similar – Part 1: General requirements and tests*

Amendment 1 (1998) 

IEC 60812:1985, *Analysis techniques for system reliability – Procedure for failure mode and effects analysis (FMEA)*

 IEC 60947-1:2004, *Low-voltage switchgear and controlgear – Part 1: General rules* 

 IEC 60947-5-1:2003, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices* 

IEC 60947-5-2:1997, *Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches*

 Amendment 1 (1999)

Amendment 2 (2003) 

 IEC 61000-3-2:2000, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

Amendment 1 (2001)

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

Amendment 1 (2001)

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

Amendment 1 (1998)

Amendment 2 (2000)

IEC 61000-4-3:2002, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated radio-frequency electromagnetic field immunity test*

Amendment 1 (2002)

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

IEC 61000-4-6:2003, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields* 

 IEC 61000-4-8:1993, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*
Amendment 1 (2000)

IEC 61000-4-11:1994, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*
Amendment 1 (2000)

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

IEC 61025:1990, *Fault tree analysis (FTA)*

 IEC 61131-2:2003, *Programmable controllers – Part 2: Equipment requirements and tests* 

IEC 61496-1:1997, *Safety of machinery – Electrosensitive protective equipment – Part 1: General requirements and tests*

 IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems* 

 ISO 13849-1:1999, *Safety of machinery – Safety related parts of control systems – Part 1: General principles for design* 

ISO/TR 12100-1:1992, *Safety of machinery – Basic concept, general principles for design – Part 1: Basic terminology, methodology*

ISO/TR 14119:1998, *Safety of machinery – Interlocking devices associated with guards – Principles for design and selection*

2 Definitions

Clause 2 of IEC 60947-5-2 applies, with the following additions or modifications.

A1		Reference
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	Assured release distance of a PDF (s_{ar})	2.3.10
	C	
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	Sensing means	2.2.16

A1

2.1 Basic definitions

2.1.1.5

PDF

proximity device with defined behaviour under fault conditions

2.1.1.5.1

PDF with designed reliability (PDF-D)

proximity device with an enhanced reliability of achieving its defined behaviour

2.1.1.5.2

PDF with test capability (PDF-T)

proximity device in which the defined behaviour is verified by simulating the absence of the specified target. The simulation is initiated by external means

2.1.1.5.3

PDF with single fault tolerance (PDF-S)

proximity device with no loss of the defined behaviour in spite of a single fault

2.1.1.5.4

PDF with self-monitoring (PDF- M)

proximity device with no loss of the defined behaviour in spite of more than one fault

2.2 Parts of a PDF

2.2.16

sensing means

part of the PDF which detects the presence or absence of a defined target

2.2.17

output signal switching device (OSSD)

component of the PDF which goes to the OFF-state according to the defined behaviour

2.2.18

control and monitoring device

device which receives and processes signals from the sensing means, provides signals to the OSSD(s) and monitors correct operation

2.2.19

integrated circuit – complex or programmable

a monolithic, hybrid or module circuit, where the internal connections are not accessible, which satisfies one or more of the criteria below:

- a) more than 1 000 gates are used in the digital mode;
- b) more than 24 functionally different external electrical connections are available for use;
- c) the functions can be programmed.

NOTE 1 – Examples include ASICs, PROMs, EPROMs, PALs, CPUs, PLAs and PLDs.

NOTE 2 – The circuits may function in the analogue mode, the digital mode, or a combination of the two modes.

2.2.20

integrated circuit – simple

a monolithic, hybrid or module circuit, where the internal connections are not accessible, and which satisfies none of the criteria in 2.2.19

NOTE 1 – Examples are SSI or MSI logic ICs, comparators.

NOTE 2 – The circuits may function in the analogue mode, the digital mode, or a combination of the two modes.

2.3 Operation of a PDF

2.3.6

defined behaviour (of PDF)

changing of the OSSD(s) to the OFF-state in the defined position of the specified target and in accordance with the requirements of this standard

2.3.7

OFF-state

state in which the output circuit interrupts the flow of current other than residual current (I_r)

2.3.8

ON-state

state in which the output circuit permits the flow of current

2.3.9

assured operating distance of a PDF (s_{ao})

distance from the sensing face within which the presence of the specified target is correctly detected under all specified environmental conditions and manufacturing tolerances

2.3.10

assured release distance of a PDF (s_{ar})

distance from the sensing face beyond which the absence of the specified target is correctly detected under all specified environmental conditions and manufacturing tolerances

2.3.11
risk time
maximum period of time during which OSSD(s) may not conform to the defined behaviour

2.3.12
lock-out state
state, initiated by a fault, preventing normal operation of the PDF which is automatically attained. In the lock-out state, at least one OSSD is in the OFF-state and remains in the OFF-state

2.3.13
failure (of equipment)
termination of the ability of an item to perform a required function

NOTE 1 – After failure the item has a fault.

NOTE 2 – "Failure" is an event, as distinguished from "fault", which is a state.

NOTE 3 – The concept of "failure" as defined does not apply to items consisting of software only.

[IEV 191-04-01]

2.3.14
fault
state of an item characterised by inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources

NOTE 1 – A fault is often the result of a failure of the item itself, but may exist without prior failure.

NOTE 2 – In English the term "fault" and its definition are identical to those given in IEV 191-05-01. In the field of machinery, the French term "défaut" and the German term "Fehler" are used rather the terms "panne" and "Fehlzustand" that appear with this definition.

3 Classification

Clause 3 of IEC 60947-5-2 applies, with the following addition.

3.7 Classification according to defined behaviour

A PDF is designated by one of the following capital letters to be added to table 1 of IEC 60947-5-2 in the form of a seventh column:

7 th pos./1 digit
DEFINED BEHAVIOUR 3.7 D = designed reliability T = with test capability S = single fault tolerant M = self-monitoring
M Self-monitoring

4 Characteristics

Clause 4 of IEC 60947-5-2 applies, with the following additions.

4.5 Constructional characteristics

4.5.1 Proximity device with defined behaviour

A PDF is composed of the following elements:

- sensing means;
- OSSD(s);
- control and monitoring device (when required).

These elements may be integrated into a single device or may be separate devices.

4.5.2 Specified target

The manufacturer shall specify the necessary target to achieve the distances s_{ao} and s_{ar} .

5 Product information

5.1 Nature of information

The following information shall be given by the manufacturer.

5.1.1 Identification

Subclause 5.1.1 of IEC 60947-5-2 applies with the following additions:

- aa) Assured operating distance.
- ab) Assured release distance.
- ac) Specified target.
- ad) Risk time.

The manufacturer of the PDF shall supply the information required to enable the total risk time to be calculated.

5.2 Marking

5.2.1 General

Subclause 5.2.1 of IEC 60947-5-2 applies, with the following additions:

In the case of a PDF comprising separate devices, the marking of data under items a) and b) of 5.1.1 of IEC 60947-5-2 on every device is mandatory.

Data under items c) to ad), when not included on the proximity device or on any separate device, shall be included in the manufacturer's literature.