

Australian/New Zealand 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 (PDF)**



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Australian/New Zealand Standard™

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL/6, Industrial Switchgear and Controlgear.

The objective of this Standard is to specify requirements and tests for proximity devices with an enhanced resistance to failure (PDF).

This Standard is Part 5.3 of a series which, when complete, will consist of the following:

AS/(NZS) 3947		Low-voltage switchgear and controlgear
AS/NZS 3947.1	Part 1:	General rules
AS 3947.2	Part 2:	Circuit-breakers
AS/NZS 3947.3	Part 3:	Switches, disconnectors, switch-disconnectors and fuse-combination units
AS/NZS 3947.3 Supp1	Part 3:	Switches, disconnectors, switch-disconnectors and fuse-combination units Supplement 1: Fuse-switch-disconnectors and switch-disconnectors for use with low voltage aerial bundled cables
AS 3947.4.1	Part 4.1:	Contactors and motor-starters—Electromechanical contactors and motor-starters
AS 3947.4.2	Part 4.2:	Contactors and motor-starters—A.C. semiconductor motor controllers and starters
AS/NZS 3947.4.3	Part 4.3:	Contactors and motor-starters—A.C. semiconductor controllers and contactors for non-motor loads
AS/NZS 3947.5.1	Part 5.1	Control circuit devices and switching elements—Electromechanical control circuit devices
AS/NZS 3947.5.2	Part 5.2:	Control circuit devices and switching elements—Proximity switches
AS/NZS 3947.5.3	Part 5.3	Control circuit devices and switching elements—Requirements for proximity devices with defined behaviour under fault conditions
AS/NZS 3947.5.4	Part 5.4:	Control circuit devices and switching elements—Methods of assessing the performance of low-energy contacts—Special tests
AS/NZS 3947.5.5	Part 5.5	Control circuit devices and switching elements—Electrical emergency stop devices with mechanical latching function
AS/NZS 3947.5.6	Part 5.6	Control circuit devices and switching elements—D.C. interface for proximity sensors and switching amplifiers (NAMUR)
AS 3947.6.1	Part 6.1:	Multiple function equipment—Automatic transfer switching equipment
AS 3947.6.2	Part 6.2:	Multiple function equipment—Control and protective switching devices (or equipment) (CPS)
AS 3947.7.1	Part 7.1:	Ancillary equipment—Terminal blocks for copper conductors

AS 3947.7.2	Part 7.2:	Ancillary equipment—Protective conductor terminal blocks for copper conductors
AS/NZS 3947.7.3	Part 7.3:	Ancillary equipment—Safety requirements for terminal blocks for the reception of cartridge fuse-links

This Standard is identical with and has been reproduced from IEC 60947-5-3:1999, *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)*.

In January 1997, the IEC commenced numbering its Standards from 60000 by adding 60000 to the number of each existing Standard. This coordinates IEC numbering with ISO numbering. During the transition period an IEC Standard might be identified by its new number or its old number (for example, IEC 60050 or IEC 50).

A reference to an International Standard identified in the Normative References Clause by strikethrough (~~example~~) is replaced by a reference to the Australian or Australian/New Zealand Standard(s) listed immediately thereafter and identified by shading (**example**). Where the struck-through referenced document and the referenced Australian or Australian/New Zealand Standard are identical, this is indicated in parenthesis after the title of the latter.

As this Standard is reproduced from an International Standard, the following applies:

- (a) Its number does not appear on each page of text and its identity is shown only on the cover and title page.
- (b) In the source text ‘this standard’ should read ‘this Australian/New Zealand Standard’.
- (c) A full point should be substituted for a comma when referring to a decimal marker.

The term ‘normative’ has been used in this Standard to define the application of the annex to which it applies. A ‘normative’ annex is an integral part of a Standard.

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Australian/New Zealand 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 (PDF)**

Any IEC table, figure or passage of text that is struckthrough is not part of this Standard. Any Australian/New Zealand table, figure or passage of text that is added (and identified by shading) is part of this Standard.

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 ISO/DIS 13849-1, 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

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60947. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60947 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

References to International Standards that are struck through in this Clause are replaced by references to equivalent Australian or Australian/New Zealand Standards that are listed immediately thereafter and identified by shading. Any Australian or Australian/New Zealand Standard that is identical to the International Standard it replaces is appropriately identified.

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

IEC 60068-2-1:1990, *Environmental testing – Part 2: Tests. Tests A: Cold*

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests. Tests B: Dry heat*

IEC 60204-1:1997, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

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

IEC 60446:1989, *Identification of conductors by colours or numerals*

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

AS 1939, *Degrees of protection provided by enclosures for electrical equipment (IP Code)*
(Identical to IEC 60529:1989)

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

IEC 60664-3:1992, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coatings to achieve insulation coordination of printed board assemblies*

~~IEC 60742:1983, Isolating transformers and safety isolating transformers—Requirements~~

AS/NZS 3108, *Approval and test specification—Particular requirements for isolating transformers and safety isolating transformers*

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

~~IEC 60947 1:1996, Low-voltage switchgear and controlgear—Part 1: General rules~~

AS/(NZS) 3947, *Low-voltage switchgear and controlgear*
AS/NZS 3947.1 *Part 1: General rules* (Identical to IEC 60947-1:1996)

~~IEC 60947 5 1:1997, Low voltage switchgear and controlgear—Part 5 1: Control circuit devices and switching elements—Electromechanical control circuit devices~~

AS/(NZS) 3947, *Low-voltage switchgear and controlgear*
AS/NZS 3947.5.1 *Part 5.1: Control circuit devices and switching elements – Electromechanical control circuit devices* (Identical to IEC 60947-5-1:1997)

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

AS/(NZS) 3947, *Low-voltage switchgear and controlgear*
 AS/NZS 3947.5.2 *Part 5-2: Control circuit devices and switching elements – Proximity switches* (Identical to IEC 60947-5-2:1997)

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

~~IEC 61131-2:1992, *Programmable controllers – Part 2: Equipment requirements and tests*~~

AS 4168, *Programmable controllers*
 AS 4168.2 *Part 2: Equipment requirements and test*
 (Identical to IEC 61131-2:1992)

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 9000 3:1997, *Quality management and quality assurance standards – Part 3: Guidelines for the application of ISO 9001:1994 to the development, supply, installation and maintenance of computer software*~~

AS/NZS.ISO 9000.3 (Int), *Quality management and quality assurance Standards Part: 3 Guidelines for the application of AS/NZS ISO 9001:1994 to the development, supply, installation and maintenance of computer software* (Identical to ISO 9000-3:1997)

~~ISO 9001:1994, *Quality systems – Model for quality assurance in design, development, production, installation and servicing*~~

AS/NZS ISO 9001, *Quality systems—Model for quality assurance in design, development, production, installation and servicing* (Identical to ISO 9001:1994)

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

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

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.

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.