

Australian Standard™

Low-voltage switchgear and controlgear

Part 5.4: Control circuit devices and switching elements—Methods of assessing the performance of low- energy contacts—Special tests



This Australian Standard was prepared by Committee EL-006, Industrial Switchgear and Controlgear. It was approved on behalf of the Council of Standards Australia on 22 July 2004.

This Standard was published on 23 September 2004.

The following are represented on Committee EL-006:

Australasian Railway Association
Australian Chamber of Commerce and Industry
Australian Electrical and Electronic Manufacturers Association
Bureau of Steel Manufacturers of Australia
Electricity Supply Association of Australia
Engineers Australia
National Electrical and Communications Association
National Electrical Switchboard Manufacturers Association
Testing Interests (Australia)

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about Standards can be found by visiting the Standards Web Shop at www.standards.com.au and looking up the relevant Standard in the on-line catalogue.

Alternatively, the printed Catalogue provides information current at 1 January each year, and the monthly magazine, *The Global Standard*, has a full listing of revisions and amendments published each month.

Australian Standards™ and other products and services developed by Standards Australia are published and distributed under contract by SAI Global, which operates the Standards Web Shop.

We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Contact us via email at mail@standards.org.au, or write to the Chief Executive, Standards Australia International Ltd, GPO Box 5420, Sydney, NSW 2001.

This Standard was issued in draft form for comment as DR 04165.

Australian Standard™

Low-voltage switchgear and controlgear

Part 5.4: Control circuit devices and switching elements—Methods of assessing the performance of low-energy contacts—Special tests

Originated as AS/NZS 3947.5.4:2000.
Revised and redesignated as AS 60947.5.4—2004.

COPYRIGHT

© Standards Australia International

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher.

Published by Standards Australia International Ltd GPO Box 5420, Sydney, NSW 2001, Australia

ISBN 0 7337 6262 X

PREFACE

This Standard was prepared by the Standards Australia Committee EL-006, Industrial Switchgear and Controlgear to supersede AS/NZS 3947.5.4:2000.

Control switches may not be suitable for use at very low voltages and therefore it is recommended to seek the advice of the manufacturer concerning any application with a low value of operational voltage, for example, below 100 V a.c. or d.c. (see AS 60947.5.1, note 2 of 4.3.1.1).

However, the development of electronic systems and programmable controllers in industrial processes increases the use of switching elements in low-voltage circuit control.

It is thus necessary to define how predirectional behaviour of contacts in this area should be established (with an acceptable confidence level), by using precise conventional testing methods, down to specified values (such as 24 V, 1 mA; 5 V, 10 mA).

The objective of this Standard is to define such a method of assessing the performance of low-energy contacts and to bring Australian requirements into line with Edition 2.0 (2002-10) of IEC 60947-5-4.

This Standard is Part 5.4 of a series which, when complete, will consist of the following:

AS 60947	Low-voltage switchgear and controlgear
AS 60947.1*	Part 1: General rules
AS 60947.2*	Part 2: Circuit-breakers
AS 60947.3	Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units
AS 60947.3 Suppl	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 60947.4.1*	Part 4.1: Contactors and motor-starters—Electromechanical contactors and motor-starters
AS 60947.4.2*	Part 4.2: Contactors and motor-starters—A.C. semiconductor motor controllers and starters
AS 60947.4.3	Part 4.3: Contactors and motor-starters—A.C. semiconductor controllers and contactors for non-motor loads
AS 60947.5.1*	Part 5.1: Control circuit devices and switching elements—Electromechanical control circuit devices
AS 60947.5.2*	Part 5.2: Control circuit devices and switching elements—Proximity switches
AS 60947.5.3	Part 5.3: Control circuit devices and switching elements—Requirements for proximity devices with defined behaviour under fault conditions
AS 60947.5.4*	Part 5.4: Control circuit devices and switching elements—Methods of assessing the performance of low-energy contacts—Special tests (this Standard)
AS 60947.5.5	Part 5.5: Control circuit devices and switching elements—Electrical emergency stop devices with mechanical latching function
AS 60947.5.6	Part 5.6: Control circuit devices and switching elements—D.C. interface for proximity sensors and switching amplifiers (NAMUR)

AS 60947.5.7*	Part 5.7:	Control circuit devices and switching elements—Requirements for proximity devices with analogue output
AS 60947.6.1	Part 6.1:	Multiple function equipment—Automatic transfer switching equipment
AS 60947.6.2*	Part 6.2:	Multiple function equipment—Control and protective switching devices (or equipment) (CPS)
AS 60947.7.1*	Part 7.1:	Ancillary equipment—Terminal blocks for copper conductors
AS 60947.7.2*	Part 7.2:	Ancillary equipment—Protective conductor terminal blocks for copper conductors
AS 60947.7.3*	Part 7.3:	Ancillary equipment—Safety requirements for terminal blocks for the reception of cartridge fuse-links
AS 60947.8*	Part 8:	Control units for built-in thermal protection for rotating machines

It is the intention of the Committee to align the numbering of this series of Standards with that of the corresponding IEC 60947 series of Standards.

Standards from the list above that are marked with an asterisk (*) are, at the time of publication of this document, available as a part of the AS 60947 series of Standards.

Standards that are not so marked remain as AS/(NZS) 3947 series Standards. Following the next amendment or revision of the corresponding IEC Standard, each of these Standards remaining in the AS/(NZS) 3947 series will be revised and renumbered as a part of the AS 60947 series.

This Standard is identical with and has been reproduced from, Edition 2.0 (2002-10) of IEC 60947-5-4:2002, *Low-voltage switchgear and controlgear – Part 5-4: Control circuit devices and switching elements—Method of assessing the performance of low-energy contacts—Special tests*.

The provisions of the general rules dealt with in AS 60947.1 (hereinafter referred to as Part 1) are applicable to this Standard, where specifically called for. Clauses and subclauses, tables, figures and appendices of the general rules thus applicable are identified by reference to Part 1, for example, 1.2.3 of Part 1, table 4 of Part 1, or annex A of Part 1. Where reference is made to other parts of the AS 60947 (AS/NZS 3947) series, they too are referred to as their relevant parts after the initial reference. For instance, AS 60947.5.1 is referred to as Part 5.1.

This Standard differs from AS/NZS 3947.5.4:2000 in the following areas:

- (a) Reference list has been updated.
- (b) Definition of entity as an individual item has been removed.
- (c) Figures have been redrawn for clarity.
- (d) The note requiring testing of both make and break contacts has been removed.
- (e) Prospective current of 5 mA added.
- (f) Test voltage limit of 70% for the input of the programmable controller has been removed.
- (g) Various editorial corrections have been made.

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

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

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the annex to which they apply. A ‘normative’ annex is an integral part of a Standard, whereas an ‘informative’ annex is only for information and guidance.

CONTENTS

	<i>Page</i>
1 Scope and object	1
2 Normative references	1
3 Definitions and list of symbols used	2
3.1 Definitions	2
3.2 List of symbols used	4
4 General principles	5
5 General test method	6
6 General characteristics	7
6.1 Measurement methods	7
6.2 Sequences of operations	8
6.3 Electrical characteristics	10
6.4 Characteristics of operation	11
7 Characterization of defects	11
7.1 Basic method	11
7.2 Monitoring the load (figure 3)	12
8 Ambient conditions	12
8.1 Normal conditions	12
8.2 Preconditioning	12
8.3 Particular conditions	12
9 Methods of reporting	13
9.1 Failure criterion	13
9.2 Reporting the failure rate	13
10 Information to be provided in the test report	15
 Annex A (normative) Information to be supplied by the manufacturer	 17
 Bibliography	 20

STANDARDS AUSTRALIA

Australian Standard

Low-voltage switchgear and controlgear
Part 5.4: Control circuit devices and switching elements—Methods of
assessing the performance of low-energy contacts—Special tests

1 Scope and object

This part of ~~IEC 60947~~ **AS 60947** applies to separable contacts used in the utilization area considered, such as switching elements for control circuits.

This standard takes into consideration two rated voltage areas:

- a) above (and including) 10 V (typically 24 V) where contacts are used for switching loads with possible electrical erosion, such as programmable controller inputs;
- b) below 10 V (typically 5 V) with negligible electrical erosion, such as electronic circuits.

This standard does not apply to contacts used in the very low energy area of measurement, for example, sensor or thermocouple systems.

The object of this standard is to propose a method of assessing the performances of low energy contacts giving

- useful definitions;
- general principles of test methods which are to monitor and record the behaviour of contacts at each operation;
- functional bases for the definition of a general testing equipment;
- preferred test values;
- particular conditions for testing contacts intended for specific applications (such as switching of PC inputs);
- information to be given in the test report;
- interpretation and presentation of the test results.

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.

References to international standards that are struck through in this clause are replaced by references to 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 identified as such.

~~IEC 60068-1:1988, *Environmental testing—Part 1: General and guidance*~~
~~Amendment 1 (1992)~~

AS 60068.1, *Environmental testing, Part 1: General and guidance* (identical to IEC 60068-1:1988)

~~IEC 60068-2 (all parts), *Environmental testing—Part 2: Tests*~~

AS 60068.2 (all parts), *Environmental testing, Part 2: Tests* (identical to IEC 60068-2 (all parts))

IEC 60605-6:1997, *Equipment reliability testing – Part 6: Tests for the validity of the constant failure rate or constant failure intensity assumptions*

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

AS 60947.1, *Low-voltage switchgear and controlgear, Part 1: General rules*

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

AS 60947.5.1, *Low-voltage switchgear and controlgear, Part 5.1: Control circuit devices and switching elements – Electromechanical control-circuit devices*

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

3 Definitions and list of symbols used

3.1 Definitions

For the purpose of this part of ~~IEC 60947~~ AS 60947, the following definitions apply.

In this standard the term “time interval” is expressed as the “number of operating cycles”, as appropriate in definitions.

3.1.1

reliability

probability that an item can perform a required function, under given conditions, for a given time interval (t_1 , t_2)

NOTE 1 It is generally assumed that the item is in a state to perform this required function at the beginning of the time interval.

NOTE 2 The term “reliability” is also used to denote the reliability performance quantified by this probability (see IEC 191-02-06).

[IEV 191-12-01]

3.1.2

contact reliability

probability that a contact can perform a required function, under given conditions, for a given number of operating cycles

3.1.3

failure

termination of the ability of an item to perform a required function

NOTE 1 After a failure the item has a fault.

NOTE 2 “Failure” is an event, as distinguished from “fault”, which is a state.

NOTE 3 This concept as defined does not apply to items consisting of software only.

[IEV 191-04-01]

¹ ~~A consolidated version of this standard exists.~~

² ~~A consolidated version of this standard exists.~~

3.1.4 defect

non-fulfilment of an intended requirement or an expectation for an entity, including one concerned with safety

NOTE The requirement or expectation should be reasonable under the existing circumstances.

3.1.5 observed failure rate λ_{ob}

for a stated period in the life of an item, ratio of the total number of failures in a sample to cumulated observed number of cycles on that sample. The observed failure rate is to be associated with particular and stated numbers of operating cycles (or summation of operating cycles) in the life of the item and with stated conditions

3.1.6 assessed failure rate λ_c

failure rate of an item determined by a limiting value or values of the confidence interval associated with a stated confidence level, based on the same data as the observed failure rate of nominally identical items

NOTE 1 The source of the data should be stated.

NOTE 2 Results can be accumulated (combined) only when all conditions are similar.

NOTE 3 The assumed underlying distribution of failures against time should be stated.

NOTE 4 It should be stated whether a one-side or a two-side interval is being used.

NOTE 5 Where only one limiting value is given, this is usually the upper limit.

3.1.7 constant failure rate period

that period, if any, in the life of a non-repaired item during which the failure rate is approximately constant

[IEV 191-10-09]

NOTE In reliability engineering, it is often assumed that the failure rate λ is constant, that is that the times to failure are distributed exponentially.

3.1.8 controlling unit

equipment generating commands to run a specified test sequence controlling synchronization and the flow of orders (such as starts, measurements, stops)

3.1.9 steady state (of the contacts after closing) state of the contact after mechanical stabilization (after operation bounces)

3.1.10 load device which is to be controlled by the contact under test

3.1.11 duty ratio ratio, for a given time interval, of the on-load duration to the total time [IEV 151-04-13]

3.1.12 contact voltage drop U_k voltage between the contact members in the steady state