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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electromechanical elementary relays – Part 2-1: Reliability – Procedure for the verification of B_{10} values

Relais électromécaniques élémentaires – Partie 2-1: Fiabilité – Procédure de vérification des valeurs de B_{10}

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ELECTROMECHANICAL ELEMENTARY RELAYS –

Part 2-1: Reliability – Procedure for the verification of B_{10} values

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International Standard IEC 61810-2-1 has been prepared by IEC technical committee 94: All-or-nothing electrical relays.

This second edition cancels and replaces the first edition published in 2011. This edition constitutes a technical revision.

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

a) limitation of tests to 10 M cycles in Clause 5;
b) reduction of required number of test samples to 5 in specified cases;
c) introduction of WeiBayes analysis for routine test under Clause 4.

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

FDIS	Report on voting
94/416/FDIS	94/419/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

This International Standard is to be used in conjunction with IEC 61810-2:2017.

A list of all parts in the IEC 61810 series, published under the general title *Electromechanical elementary relays*, 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 "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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INTRODUCTION

Based on the general provisions of IEC 61810-2, this part of IEC 61810 specifies reliability test procedures for electromechanical elementary relays where enhanced requirements for the verification of reliability apply. A type test is passed and then confirmed by routine tests with specified periodicity. This document describes how figures for B_{10} (the mean number of cycles until 10 % of the relays have failed) are derived from these life tests performed with representative relay samples.

In particular when electromechanical elementary relays are intended to be incorporated in safety-related control systems of machinery in accordance with IEC 62061 and ISO 13849-1, the mean time to dangerous failure ($MTTF_d$) is a measure that can be taken into account when assessing the probability of dangerous failure of the safety function concerned. Although a component failure cannot be defined as “dangerous” unless the detailed application is known, it is common to consider a failure mode that is likely to result in danger in a typical application of the component, and to refer to this failure mode as a “dangerous failure”. The $MTTF_d$ then becomes the expectation of the mean time to failure in this "dangerous" mode. For the calculation of $MTTF_d$ for electromechanical relays, the data provided by the manufacturer for B_{10D} can be used (see Clause C.4 of ISO 13849-1:2015).

Electromechanical elementary relays with forcibly guided (mechanically linked) contacts offer the possibility of a high diagnostic coverage according to 4.5.3 of ISO 13849-1:2015.

NOTE Requirements for such relays are given in IEC 61810-3.

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ELECTROMECHANICAL ELEMENTARY RELAYS –

Part 2-1: Reliability – Procedure for the verification of B_{10} values

1 Scope

This part of IEC 61810 specifies reliability test procedures for electromechanical elementary relays when enhanced requirements for the verification of reliability apply.

Particular provisions are given for relays incorporated in safety-related control systems of machinery in accordance with IEC 62061 and ISO 13849-1. For such relays, B_{10} values for dangerous failures (B_{10D} values) are derived from the tests specified in this document.

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 61810-1:2015, *Electromechanical elementary relays – Part 1: General and safety requirements*

IEC 61810-2:2017, *Electromechanical elementary relays – Part 2: Reliability*

IEC 61810-3, *Electromechanical elementary relays – Part 3: Relays with forcibly guided (mechanically linked) contacts*

IEC 62061, *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*

ISO 13849-1:2015 *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61810-2 and the following apply.

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

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

3.1
dangerous failure
failure which has the potential to put the safety-related part of a control system in a hazardous or fail-to-function state

[SOURCE: ISO 13849-1:2015, 3.1.5, modified – In the definition, the abbreviated term "SRP/CS" has been replaced by "safety-related part of a control system".]

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3.2 Definitions related to tests

3.2.1
type test
conformity test made on sample representative of the production to get basic performance data or to verify that these relays comply with the specified requirements

[SOURCE: IEC 61810-2:2017, 3.21.1]

3.2.2
routine test
conformity test made on sample without any modifications and specification changes during or after mass production with specified repetition

Note 1 to entry: The results from routine tests are used to verify that the level of technical performance is maintained.

[SOURCE: IEC 61810-2:2017, 3.21.2, modified – The note has been added.]

4 Verification of B_{10}

4.1 General

Clause 4 specifies requirements where the reliability of the relay has to be assessed and verified.

This procedure is applicable to relays where wearout mechanisms prevail.

NOTE 1 For relays where random failures prevail, provisions are under consideration.

NOTE 2 For relays intended to be used in safety-related control systems of machinery, the provisions of Clause 5 are applicable.

The following failure modes can occur:

- failure to open of a relay contact;
- failure to close of a relay contact;
- unintended bridging of a change-over contact;
- insulation failure of the relay.

From a type test, a value for B_{10} is obtained that indicates the probability of the occurrence of a relay failure. The value for B_{10} is given in numbers of cycles.

NOTE 3 With the knowledge of the frequency of operation (cycling rate) of the relay within a specific application, the number of cycles can be transformed into respective times.

Verification that this B_{10} value is applicable to relays from the series production shall be carried out by routine tests.

An overview of this procedure is given in Figure 1.

4.2 Requirements

4.2.1 Test specimens

The test shall be carried out in accordance with IEC 61810-2.

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4.2.2 Test circuit

The test circuit described in Annex C of IEC 61810-1:2015 shall be used, unless otherwise specified by the manufacturer and explicitly indicated in the test report. When feasible, one of the circuits in accordance with Annex D of IEC 61810-1:2015 is to be used.

4.2.3 Contact loads

The contact loads shall be specified by the manufacturer and indicated in the test report. It is recommended to select appropriate resistive loads according to 5.8 of IEC 61810-1:2015 or inductive loads according to Annex B of IEC 61810-1:2015.

4.2.4 Environmental conditions

The conditions of Table 1 of IEC 61810-1:2015 apply. However, an extended ambient temperature range of 18 °C to 40 °C is permitted.

4.2.5 Operating conditions

The provisions of 5.3 of IEC 61810-2:2017 apply.

Unless otherwise specified by the manufacturer, each cycle of the coil energization shall be 1 s ON and 9 s OFF.

The test is performed without coil suppression, unless explicitly specified.

4.2.6 Failure criteria

Generally, the test is to be continued until all test specimens have failed. When the test is truncated at a specific number of cycles, all relays that have not yet failed are considered to fail at that number of cycles (worst case assumption). However, at least 2/3 of the tested relays shall fail, or each test specimen shall reach a lifetime of 10 M cycles.

For the assessment of recorded malfunctions severity B according to Clause 6 of IEC 61810-2:2017 applies. The dielectric test is performed

- between coil and contacts,
- between adjacent contacts, and
- across open contacts.

A contact that fails to open cannot be tested for compliance with the requirements for open contacts.

The insulation requirements shall be verified according to 11.4 of IEC 61810-1:2015. This may be performed in either of the following ways.

a) During the test, the dielectric test is performed periodically at given numbers of cycles. When the relay does not pass the dielectric test, the number of cycles for the previous dielectric test that has been passed is considered as the cycles to failure value for this individual relay.

b) In the case that no periodical monitoring according to item a) is performed, the dielectric test shall be made when a relay under test fails due to a functional contact failure (see 4.1). If the relay does not comply with the dielectric test, the whole test is not passed. The same applies when the test is truncated at a certain number of cycles.

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4.3 Performance of the tests

4.3.1 Type test

The type test is carried out with a sample of 10 relays. Each failure shall be recorded.

The B_{10} value is evaluated based on the procedure given in IEC 61810-2. For the purpose of the following routine test according to 4.3.2.3, the shape parameter β and the characteristic life η shall be evaluated according to IEC 61810-2.

After completion of a type test, the first routine test shall be initiated for verification in accordance with the periodicity specified under 4.3.2.

4.3.2 Routine test

4.3.2.1 General

The routine test shall be performed in regular intervals as specified by the manufacturer.

4.3.2.2 Routine test with Weibull

The test shall be performed with at least 5 relays, and B_{10} value shall be determined in accordance with IEC 61810-2.

4.3.2.3 Routine test with WeiBayes

The test shall be performed with at least 5 relays, and B_{10} value shall be determined in accordance with IEC 61810-2. In the event of deviation from 4.2.6, the test is stopped with no failures recorded (WeiBayes without failure), and a WeiBayes confidence level of 90 % shall be achieved.

4.3.2.4 Acceptance criteria of routine test

For each routine test, the evaluated B_{10} value shall be at least 80 % of the B_{10} value obtained from the type test. For the routine test with WeiBayes, the B_{10} value obtained shall be at least 90 % of that of the type test.

NOTE 1 This requirement is intended to take into account possible variations for the routine tests.

NOTE 2 In IEC 61810-2 the WeiBayes result is determined using the characteristic life result from the initial Weibull test. Accordingly, here the acceptance of the routine test can be evaluated by comparing the characteristic life values of the initial Weibull and the WeiBayes from the routine test.

In the event that these requirements are not met, suitable corrective actions have to be taken to remove the failure causes. The routine test shall be repeated with appropriately modified test specimens. If it is not possible to achieve a positive routine test with non-constructive corrective actions, constructional changes to the relay (e.g. new contact material, dimensional changes of contact) are necessary, and the modified relay shall be regarded as a new construction, and a new independent test procedure starting a with type test shall be performed.

5 Evaluation and verification of B_{10D}

5.1 General

Clause 5 specifies requirements for relays intended to be used in safety-related control systems of machinery in accordance with IEC 62061 and ISO 13849-1. For this purpose, Clause 4 does not apply.

This procedure is applicable to relays where wearout mechanisms prevail.

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NOTE 1 For relays where random failures prevail, provisions are under consideration.

The following failure modes can occur:

- failure to open of a relay contact;
- failure to close of a relay contact;
- unintended bridging of a change-over contact;
- insulation failure of the relay.

NOTE 2 The term "unintended bridging of a changeover contact" is equivalent to "simultaneous short-circuit between the three terminals of a changeover contact" (used in Table D.9 of ISO 13849-2:2012).

For a given application, it has to be assessed which of the above-listed failure mode(s) is (are) to be considered as dangerous failure(s).

Simultaneous closing of make contacts and break contacts is excluded if forcibly guided (mechanically linked) contacts are used which offer the possibility of a high diagnostic coverage according to 4.5.3 of ISO 13849-1:2015. Electromechanical elementary relays with forcibly guided (mechanically linked) contacts are specified in IEC 61810-3.

NOTE 3 In typical applications, the failure to open of a make contact and the insulation failure are dangerous failure modes (see 7.2.2 and Table D.1 of ISO 13849-2:2012, where basic safety principles are compiled, in particular the use of de-energisation with a normally open (make) contact for relays to achieve a system safe state).

Where it is not clear which failure mode is to be considered as a dangerous failure, the manufacturer shall record during the test any malfunction (in number of cycles and type of malfunction). This allows them to evaluate B_{10} values for any failure mode after the test has been completed.

From a type test, a value for B_{10D} is obtained that indicates the probability of the occurrence of a dangerous failure. This value is given in number of cycles.

NOTE 4 With the knowledge of the frequency of operation (cycling rate) of the relay within a specific application, the number of cycles can be transformed into respective times.

Verification that these B_{10D} values are applicable to relays from the series production shall be carried out by routine tests.

An overview of this procedure is given in Figure 2.

5.2 Requirements

5.2.1 Test specimens

The test shall be carried out for each contact load rating in accordance with IEC 61810-2. In the case of relays with several contacts, those two contacts – of the same type (e.g. two make contacts) if available – shall be tested which are considered as most critical with respect to a possible insulation failure.

NOTE In general, adjacent contacts are the most critical ones.

5.2.2 Test circuit

The test circuit described in Annex C of IEC 61810-1:2015 shall be used, unless otherwise specified by the manufacturer and explicitly indicated in the test report. When feasible, one of the circuits in accordance with Annex D of IEC 61810-1:2015 is to be used.

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