

PUBLICLY AVAILABLE SPECIFICATION PRE-STANDARD

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

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

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This specification is only intended to be used in conjunction with IEC 61810-2.

IEC-PAS 61810-2-1 has been processed by IEC technical committee 94: All-or-nothing electrical relays.

The text of this PAS is based on the following documents:

| | |
|------------|------------------|
| Draft PAS | Report on voting |
| 94/272/PAS | 94/274/RVD |

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

Following publication of this PAS, which is a pre-standard publication, the technical committee concerned may transform it into an International Standard.

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

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INTRODUCTION

This Publicly Available Specification (PAS) is published as an interim IEC document. Its content is intended to be incorporated in the next edition of IEC 61810-2 during the upcoming maintenance cycle of that standard.

Based on the general provisions of IEC 61810-2 this PAS specifies reliability test procedures for electromechanical elementary relays where enhanced requirements for the verification of reliability apply. An initial conformity test has to be passed and then confirmed by periodic tests at least once a year. This PAS 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).

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

NOTE Requirements for such relays are given in EN 50205.

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ELECTROMECHANICAL ELEMENTARY RELAYS –

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

1 Scope

This PAS 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 PAS.

This specification is only intended to be used in conjunction with IEC 61810-2.

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.

IEC 61810-1:2003, *Electromechanical elementary relays – Part 1: General and safety requirements*

IEC 61810-2:2005, *Electromechanical elementary relays – Part 2: Reliability*

IEC 62061:2005, *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*

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

3 Terms and definitions

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

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

[3.1.5 of ISO 13849-1]

3.2

conformity test

test of a sample of relays made to a given design to verify that these relays comply with the specified requirements

3.3

periodic test

test carried out periodically on a sample of relays drawn from running production

NOTE The results from periodic tests are used to verify that the level of technical performance is maintained.

4 Verification of B_{10}

4.1 General

This clause 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 changeover contact;
- insulation failure of the relay.

NOTE 3 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).

From a conformity 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 4 With the knowledge of the frequency of operation (cycling rate) of the relay within a specific application it is possible to calculate an effective MTTF (Mean time to failure) value for the relay in that application.

Verification that this B_{10} value is applicable to relays from the series production shall be carried out by periodic 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 with 10 relays in accordance with IEC 61810-2.

4.2.2 Test circuit

The appropriate test circuit shall be given by the manufacturer. When feasible, one of the circuits in accordance with Annex A of IEC 61810-2 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 5.7 of IEC 61810-1.

4.2.4 Environmental conditions

The conditions of Table 1 of IEC 61810-1 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 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).

For the assessment of recorded malfunctions Severity B according to Clause 6 of IEC 61810-2 applies.

The verification of insulation requirements according to Clause 14 of IEC 61810-1 (with 75 % of the initial voltage for the dielectric test) 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.

4.3 Performance of the tests

4.3.1 Conformity test

The conformity 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.

After completion of a conformity test the first periodic test shall be initiated for verification.

4.3.2 Periodic test

The periodic test shall be performed in regular intervals as specified.

For each periodic test the evaluated B_{10} value shall be at least 80 % of the B_{10} value obtained from the conformity test.

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

In case these requirements are not met, suitable corrective actions have to be taken to remove the failure causes. The complete conformity test shall be repeated with appropriately modified test specimens or adapted contact loads (e.g. reduced switching current).

5 Evaluation and verification of B_{10d}

5.1 General

This clause specifies requirements for relays intended to be used in safety-related control systems of machinery in accordance with IEC 62061 and ISO 13849-1.

This procedure is applicable to relays where wearout mechanisms prevail.

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 changeover 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).

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).

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).

Simultaneous closing of make contact(s) and break contact(s) is excluded if forcibly guided (mechanically linked) contacts are used. Such relays are specified in EN 50205.

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

NOTE 4 With the knowledge of the frequency of operation (cycling rate) of the relay within a specific application, it is possible to calculate an effective $MTTF_d$ value for the relay in that application.

Verification that these B_{10d} values are applicable to relays from the series production shall be carried out by periodic 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 with 10 relays for each contact load rating in accordance with IEC 61810-2. In 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 appropriate test circuit shall be given by the manufacturer. When feasible, one of the circuits in accordance with Annex A of IEC 61810-2 is to be used.

5.2.3 Contact loads

The contact loads shall be specified by the manufacturer and indicated in the test report. It is recommended to select load types according to Annex K (endurance test) of IEC 61810-1.

Unless otherwise specified, the conformity test shall be carried out for AC-15 with 230 V and for DC-13 with 24 V, respectively, with the following load currents:

- I_e
- $I_e/2$
- $I_e/4$

with I_e = rated operating current.

NOTE In general, the periodic test is made with I_e only (see 5.3.2).

5.2.4 Environmental conditions

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

5.2.5 Operating conditions

The provisions of 5.3 of IEC 61810-2 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.

5.2.6 Failure criteria

The test shall be continued until all test specimens have failed.

For the assessment of recorded malfunctions in accordance with Clause 6 of IEC 61810-2, the following applies:

- for malfunctions related to a dangerous failure mode: Severity A;
- for other malfunctions: Severity B.

The verification of insulation requirements according to Clause 14 of IEC 61810-1 (with 75 % of the initial voltage for the dielectric test) shall be performed when a relay under test fails due to a functional contact failure (see 5.1). If the relay does not comply with the dielectric test, the whole test is not passed.

5.3 Performance of the tests

5.3.1 Conformity test

The conformity test is carried out with a sample of 10 relays for each contact load rating. Each failure shall be recorded. The dangerous failures are registered separately.

In the first step, the B_{10} value is evaluated based on the procedure given in IEC 61810-2 taking into account all registered failures.

The B_{10d} value is derived as follows:

$$B_{10d} = B_{10} \times 10/N_d$$

with

10 is the number of tested relays;

N_d is the number of registered dangerous failures.

NOTE When no dangerous failure has been registered, $N_d = 1$ is assumed.

After completion of a conformity test the first periodic test shall be initiated for verification.

5.3.2 Periodic test

The periodic test shall be performed in regular intervals as specified, as a minimum with the rated operating current I_e only.

NOTE 1 It is recommended to perform the periodic test once a year.

The total number of dangerous failures during the periodic test shall not exceed the value N_d registered during the conformity test by more than two failures.

For each periodic test, the evaluated B_{10} value shall be at least 80 % of the B_{10} value obtained from the conformity test.

NOTE 2 This requirement is intended to take into account possible variations for the periodic tests.

In the case where these requirements are not met, suitable corrective actions have to be taken to remove the failure causes. The complete conformity test shall be repeated with appropriately modified test specimens or adapted contact loads (e.g. reduced value for I_e).

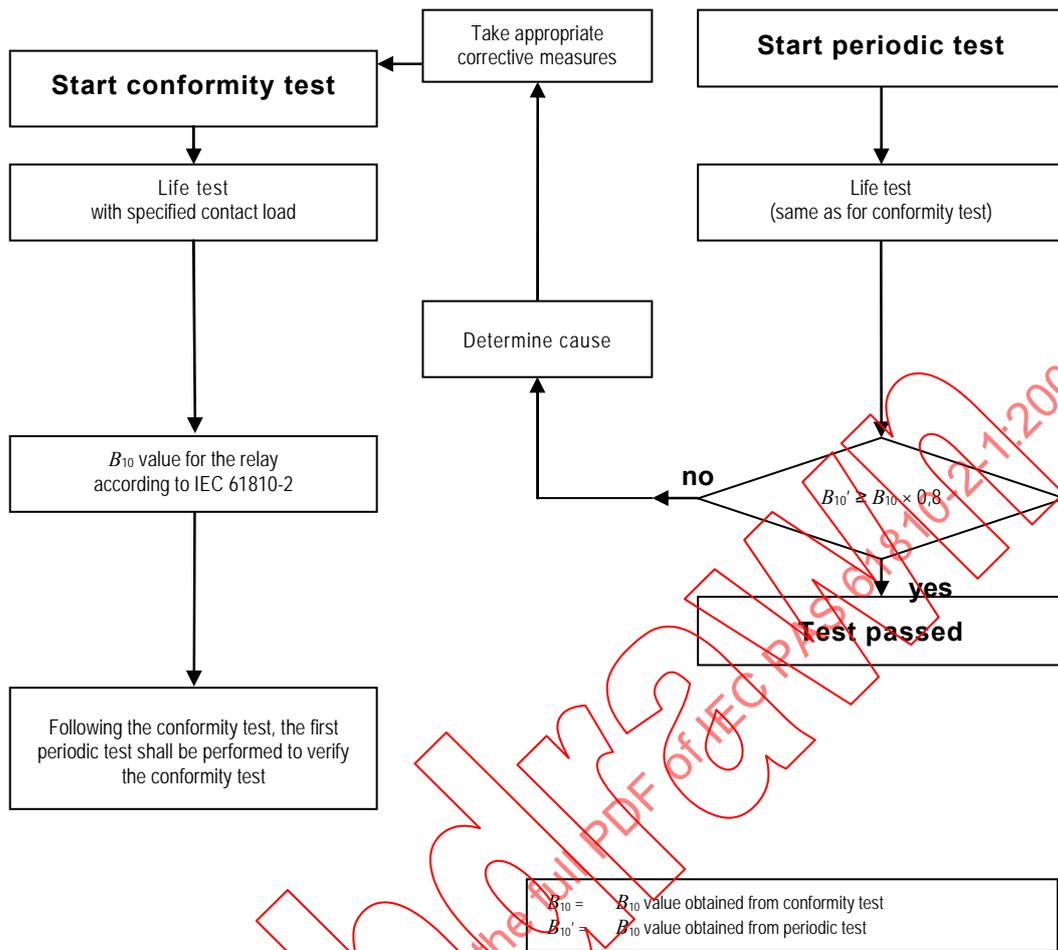


Figure 1 – Schematic flowchart