

# INTERNATIONAL STANDARD

**IEC**  
**61811-10**

QC 160100

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## **Electromechanical elementary relays of assessed quality –**

### **Part 10: Sectional specification – Relays for industrial application**

*Relais élémentaires électromécaniques  
soumis au régime d'assurance de la qualité –*

*Partie 10:  
Spécification intermédiaire –  
Relais pour applications industrielles*



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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## ELECTROMECHANICAL ELEMENTARY RELAYS OF ASSESSED QUALITY –

### Part 10: Sectional specification – Relays for industrial application

#### FOREWORD

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International Standard IEC 61811-10 has been prepared by IEC technical committee 94: All-or-nothing electrical relays.

This standard cancels and replaces IEC 60255-19 (1983) and constitutes a technical revision.

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

FDIS	Report on voting
94/168/FDIS	94/172/RVD

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

The QC number that appears on the front cover of this publication is the specification number in the IEC Quality Assessment System for Electronic Components (IECQ).

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

The committee has decided that the contents of this publication will remain unchanged until 2006. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

## ELECTROMECHANICAL ELEMENTARY RELAYS OF ASSESSED QUALITY –

### Part 10: Sectional specification – Relays for industrial application

#### 1 General

##### 1.1 Scope

This part of IEC 61811 is a sectional specification applicable to electromechanical elementary (non-specified time all-or-nothing) relays of assessed quality for industrial application.

NOTE Electromechanical all-or-nothing telecom relays of assessed quality are covered by IEC 61811-50.

It is based on the basic relay standard IEC 61810-1 as well as on the generic specification IEC 61811-1 and selects from IEC 61810-7 the appropriate test and measurement procedures to be used in detail specifications derived from this specification. Moreover it contains a basic test schedule to be used in the preparation of such specifications. Detailed test schedules are given in the blank detail specifications supplementary to this sectional specification.

For the purpose of this standard, only fundamental tests have been compiled. Depending on the field of application, further tests should be selected as appropriate, preferably in accordance with the test and measurement procedures of IEC 61810-7.

##### 1.2 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 60062:1992, *Marking codes for resistors and capacitors*

IEC 60255-23:1994, *Electrical relays – Part 23: Contact performance*

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

IEC 61709:1996, *Electronic components – Reliability – Reference conditions for failure rates and stress models for conversion*

IEC 61810-1:1998, *Electromechanical non-specified time all-or-nothing relays – Part 1: General requirements*

IEC 61810-5:1998, *Electromechanical non-specified time all-or-nothing relays – Part 5: Insulation coordination*

IEC 61810-7:1997, *Electromechanical all-or-nothing relays – Part 7: Test and measurement procedures*

IEC 61811-1:1999, *Electromechanical non-specified time all-or-nothing relays of assessed quality – Part 1: Generic specification*

IEC QC 001002-3, *IEC Quality Assessment System for Electronic Components (IECQ) – Rules of Procedure – Part 3: Approval procedures*

### 1.3 Marking

Relays and their package supplied in accordance with detail specifications covered by this sectional specification, shall as a minimum be marked as follows:

#### 1.3.1 Relay

- Trade mark or manufacturer's name
- Relay type and variant code
- Date of manufacture, year/week, coded in accordance with IEC 60062
- IECQ mark

Where space permits, a circuit diagram or terminal identification should be given.

#### 1.3.2 Package

- Trade mark or manufacturer's name
- Detail specification reference if not marked on the relay
- Quantity
- Relay type and variant code
- Manufacturer's batch identification code

### 1.4 Ordering information

The ordering information shall be coded and shall contain the following details:

- IECQ detail specification number
- Coded coil voltage
- Terminal code
- Coded mounting arrangement
- Specials code

## 2 Quality assessment procedures

### 2.1 Primary stage of manufacture

The primary stage of manufacture is the first process subsequent to the manufacture of finished parts and subassemblies of the relay.

NOTE 1 A subassembly is understood to mean here the permanent assembly of two or more piece parts.

NOTE 2 Important manufacturing steps are as follows:

- a) fabrication, heat treatment and plating of the component parts of the relay;
- b) coil winding;
- c) assembling of the electrical and electromechanical parts;
- d) adjustment of the relay contacts, if applicable;
- e) high-temperature drying, gas backfilling and sealing of the relay, if applicable;
- f) final measurements and periodic inspection of test groups A to D.

### 2.2 Structurally similar relays

Relays are considered structurally similar if having no differences in design other than in:

- a) coil wire diameter, number of windings and the coil transient suppression device;
- b) types, numbers and material of contacts;
- c) rated coil and/or contact voltage(s);
- d) mounting and terminal variants within the limits prescribed in the detail specification.

## **2.3 Subcontracting**

Subcontracting the primary stage of manufacture (see 2.1) and/or subsequent stages to an unapproved manufacturer is forbidden. Subcontracting is permitted for any stages preceding the primary stage of manufacture and shall be in accordance with the requirements of (normative) Annex B to Clause 2 of IEC QC 001002-3.

## **2.4 Qualification approval procedures**

The manufacturer shall comply with the general requirements of the basic rules governing qualification approval defined in Clause 3 of IEC QC 001002-3 and the provisions given in 2.2 of IEC 61811-1.

The requirements contained in 4.2 of IEC 61810-1 shall be met.

Qualification approval tests shall include all the tests prescribed in the detail specification, and shall be performed by a schedule specifically prescribed in the detail specification.

Sampling shall be carried out in accordance with the sampling plans and procedures specified in IEC 60410. The number of specimens for each subgroup is specified in the blank detail specification. As a general rule, a minimum of five specimens are required for each group of tests. The qualification tests schedule may specify destructive and cumulative non-destructive tests.

## **2.5 Quality conformance inspection requirements**

### **2.5.1 General requirements**

Quality conformance inspection shall be carried out in accordance with the requirements of Clause 3 of IEC QC 001002-3 and 2.3 of IEC 61811-1.

### **2.5.2 Formation of inspection lots**

Inspection lots to be submitted to group A and B acceptance tests shall be formed in accordance with 3.2.3 and 3.3.1 of IEC QC 001002-3 and with the sampling plans and procedures given in IEC 60410, except where production is too infrequent or too small for sampling plans to apply; in these cases inspection shall be 100 %.

When sampling is carried out in accordance with IEC 60410, the percent defective concept only shall be used. Stratified or representative sampling shall always be used to include all production lines and structurally similar relays in proportion to their respective quantities in the lot. Exceptions from proportionality may become necessary and shall be stated in the detail specification or agreed between the manufacturer and the National Supervising Inspectorate (NSI). Specimens shall be as representative as possible of the production.

### **2.5.3 Periodic inspection**

Fixed samples for group C and D inspection shall be taken from a lot (or lots) which has passed group A and B inspection during, or at the end, of the specified reference period. In both cases the inspection lot (or lots) shall not be less than the average of production lots during the reference period for each group.

## **2.6 Test schedule**

### **2.6.1 Test sequence**

A test sequence shall consist of all tests listed in the (blank) detail specification.

The reference numbers of the tests are those of IEC 61810-7, with the exception of additional test(s) described in the sectional, the blank detail or the detail specification.

## 2.6.2 Groups A and B

The IL (inspection level) notation applies for all tests in one subgroup. A corresponding range of values for AQL (acceptable quality level) shall be given in the blank detail specification, and the authority preparing detail specifications shall choose the appropriate value which then applies to all tests in one subgroup.

## 2.6.3 Groups C and D

The blank detail specification shall prescribe for each subgroup:

- a) Periodicity of this subgroup. If the same periodicity is applicable to all subgroups, it shall be given at the beginning of the group test details.
- b) The minimum sample size for each test (or group of tests) performed with the same relays, the number of test specimens and the permitted number of defectives shall be specified.

## 2.7 Order of tests

Quality conformance inspection is divided into two parts: that carried out lot-by-lot, on which the release of the individual lots is based, and that carried out on a periodic basis which contains the time-consuming and more expensive tests.

Following 2.3 of IEC 61811-1, groups A and B contain lot-by-lot tests, while periodic tests required for the maintenance of qualification approval are contained in groups C and D.

When several tests are subsequently to be carried out on any one specimen or number of specimens, the following order shall apply unless otherwise prescribed in the blank detail specification:

- Screening or sorting tests (if applicable) and subgroup A1 shall always precede any other non-destructive (ND) or destructive (D) tests.
- The remaining tests shall be conducted as given in the blank detail specification. The order of tests within subgroups is mandatory.
- Destructive tests may be preceded by one or more non-destructive or destructive tests, provided that the effects of the preceding tests are not considered liable to invalidate the results of the later tests.

## 3 Preparation of blank detail and detail specifications

### 3.1 Contents of blank detail and detail specifications

Blank detail specifications shall conform with the test schedule given in Table 1 of this specification and the related explanations.

Tests marked M are mandatory. If tests are marked R (recommended) they may be included in the blank detail specification; they then become mandatory for the detail specification.

Blank detail specifications shall give the following information or call for inclusion into the detail specification:

- a) Identification of the detail specification.
- b) Identification of the relay and information on its applications. Identification shall be provided by such properties as rated power, dimensions, sealing, whether monostable or bistable, polarised or not, or otherwise required for identification.
- c) Outline drawings of the relay and key dimensions. Variants, such as for terminals, may be given in an annex to the detail specification.

- d) Reference data of the relay. A limited number of values is required on the front page, so as to describe the overall performance of the relay. Full information in conformance with IEC 61810-1 shall be added on one of the subsequent pages. Rated values should preferably be those listed therein. Where tests are referred to rated values, they shall be indicated with each test. Where tests are to be performed at other than rated values, the test values shall be indicated and clearly distinguished from the rated values.
- e) Related documents. Reference shall be made to IEC 61811-1 and this sectional specification. When reference to further documents is necessary, such documents shall be listed with their full title, year of edition and, unless common knowledge, the source from which they can be obtained.
- f) Periodicity of tests.
- g) Formation of inspection lots, if predictable in the sense of 2.5.
- h) Order of the tests.
- i) General test conditions, if deviating from 3.5 of IEC 61810-7.
- j) Qualification approval test schedule.
- k) Quality conformance test schedule.
- l) Specification of IL numbers (groups A and B) and sample sizes (groups C and D).
- m) Specification of AQL numbers (groups A and B) and permitted number of defectives (groups C and D).
- n) Marking of package and/or relays, ordering information beyond that listed in this specification, if necessary.
- o) Coded ordering information.

Additional information such as curves and drawings may be given in an annex of the detail specification.

When preparing blank detail specifications, the following steps are to be taken:

- include in the blank detail specification all the mandatory tests of Table 1, together with those recommended tests considered appropriate for the intended use;
- if necessary, add any other tests required either from or beyond IEC 61810-7.

### **3.2 Basic test schedule**

The basic test schedule is given in Table 1.

#### **3.2.1 Order of tests**

The order within subgroups shall be defined in the blank detail specification.

#### **3.2.2 Sampling values**

IL and AQL values, sample size and allowed defectives shall be chosen from IEC 60410 and by using Annex A, and shall be stated in the blank detail specification.

#### **3.2.3 Abbreviations**

Options:

Tests marked with M are mandatory for inclusion in the (blank) detail specification.

Tests marked with R are recommended for inclusion in the (blank) detail specification.

Types of relays:

- RT 0 Unenclosed relay
- RT I Dust protected relay
- RT II Flux proof relay
- RT III Wash tight relay
- RT IV Sealed relay
- RT V Hermetically sealed relay

The respective definitions are given in 2.2 of IEC 61810-7.

### 3.3 Test schedule for blank detail specifications

The mandatory and recommended tests for quality conformance inspection to be used for the establishment of a test schedule in a blank detail specification are given in Table 1 below.

**Table 1 – Tests for quality conformance inspection**

#### Group A

Conducted on a sampling basis, lot by lot.

#### Subgroup A1

For all tests in this subgroup IL: ...  
AQL: ...

Test from IEC 61810-7 and respective subclause number	Options and particular requirements
Visual inspection – relay marking (ND) 3.6.4 items a) and b)	M
Coil resistance (ND) 3.8.1	M
Dielectric test (ND) 3.9	M In accordance with Clauses 3 and 4 of IEC 61810-5
Contact-circuit resistance, static (ND) 3.12	M Test voltage and current according to CA category/ies specified for the relay
Functional tests (ND) 3.13	M Operate and release value shall be checked as a minimum. In accordance with 4.1.2 of IEC 61810-1
Timing tests (ND) 3.14.2	R

**Group B**

Conducted on a sampling basis, lot by lot.

**Subgroup B2**

For all tests in this subgroup IL: ...

AQL: ...

Test from IEC 61810-7 and respective subclause number	Options and particular requirements	
Visual inspection other than marking (ND) 3.6.4 items c) and d)	M R	For the relay For accessories and packaging, as applicable
Check of dimensions (ND) 3.6.1	M R	For key dimensions For all other dimensions, including clearances and creepage distances

**Group C**

Periodic tests with fixed sample size

**Subgroup C1**

Periodicity: ... months

Sample size: ... specimens

Test from IEC 61810-7 and respective subclause number	Options and particular requirements	
Heating (ND) 3.18	M	In accordance with 4.1.6 of IEC 61810-1
Dielectric test (ND) 3.9	M	In accordance with Clauses 3 and 4 of IEC 61810-5
Impulse voltage test (ND) 3.10	M	In accordance with Clause 4 of IEC 61810-5
Insulation resistance (ND) 3.11	M	
Enclosure (ND) 3.20	R	

**Subgroup C2**

Periodicity: ... months

Sample size: ... specimens

Test from IEC 61810-7 and respective subclause number	Options and particular requirements	
Electrical endurance (D) 3.30	M	In accordance with the provisions of IEC 60255-23 and 4.1.5 of IEC 61810-1

### Subgroup C3

Periodicity: ... months  
Sample size: ... specimens

Test from IEC 61810-7 and respective subclause number	Options and particular requirements
Timing tests (ND) 3.14	M Only if not tested in subgroup A1
Coil transient suppression (ND) 3.8.4	R For relays with transient suppression device only
Weighing (ND) 3.7.2	R
Check of dimensions (ND)/(D) 3.6.1	M For all dimensions including clearances and creepage distances, if not tested in subgroup B2

### Subgroup C5

Periodicity: ... months  
Sample size: ... specimens

Test from IEC 61810-7 and respective subclause number	Options and particular requirements
Rapid change of temperature (D) 3.19	R Sealed relays (RT IV and RT V) only
Resistance to soldering heat (D) 3.25	M For relays with solder terminals only
Climatic sequence (D) 3.15	R
Damp heat, steady state (D) 3.16	R
Robustness of terminals (D) 3.24	R For QC (quick-connect) terminals only: according to 4.1.9 of IEC 61810-1.
Shock (D) 3.26	R
Bump (D) 3.27	R
Vibration (D) 3.28	R
Mechanical endurance (D) 3.31	R In accordance with 4.1.4 of IEC 61810-1
Thermal endurance (D) 3.32	R
Fire hazard (D) 3.48	M In accordance with 4.1.7 of IEC 61810-1

**Subgroup C6**

Periodicity: ... months  
 Sample size: ... specimens

Test from IEC 61810-7 and respective subclause number	Options and particular requirements
Resistance to cleaning solvents (ND) 3.47.2	R
Electrical contact noise (ND) 3.39	R Only if required
Mould growth (D) 3.23	R Only if required
Corrosive atmospheres (D) 3.22	R Only if required

**Group D**

Periodicity: ... months  
 Sample size: ... specimens

Test from IEC 61810-7 and respective subclause number	Options and particular requirements
Coil impedance (ND) 3.8.3	R For a.c. relays only
Internal moisture (ND) 3.21	R Only if applicable
Solderability (D) 3.25	M For relays with solder terminals only

**4 Relay reliability – failure rate data**

The evaluation and indication of reliability data is not mandatory.

However, if required in a detail specification, the failure rate data for the reliability prediction of relays in electronic equipment shall be stated in an appropriate way. It is strongly recommended to give such data in accordance with IEC 61709. Therefore, the preferred (blank) data base for failure rates, the stress model and the particular stress factors for conversion of the failure rate data at reference conditions to the actual operating conditions are given in informative Annex B. In the relevant detail specification, reference shall be made to this Annex B and further details be given.

The reference failure rate shall be determined by the manufacturer for his particular relay type. The relay manufacturer is required to log cumulatively all endurance test data and all other relevant data including those derived from field experience, which would demonstrate/indicate achieved reliability. The endurance tests specified in the detail specification are intended, amongst other things, to provide a measure of the failure rate under prescribed conditions.

If another stress model, or other stress factors respectively, are known to be more suitable for a particular relay type, such deviations shall be clearly described in an Annex of the relevant detail specification and used instead (all necessary details which allow the conversion of the failure rate data to the actual operating conditions and the source(s) of these data shall be described). However, the statements in B.8 shall be kept in this case.

All the activities listed above shall be performed under the supervision of the National Supervising Inspectorate (NSI).

NOTE Relay manufacturers are not required to demonstrate the achievement of the failure rate data before delivery of a specific lot.

## Annex A (informative)

### Explanations and examples regarding IL and AQL values

#### A.1 Introduction

This sectional specification refers to, and detail specifications derived from it will generally use, the concept of IEC 60410 which is based on notations called IL and AQL values.

This informative annex explains in a rather simple form the meaning of inspection level (IL) and acceptable quality level (AQL) while showing by some examples the consequences from choosing IL and AQL values.

It is not intended to replace or supersede the far more detailed terminology and specifications contained in IEC 60410.

#### A.2 Inspection level (IL)

The inspection level determines the relationship between the lot or batch size and the sample size. This relationship is established by means of a table in IEC 60410 which contains lines for various lot or batch sizes, from 2 to more than 50 000, and contains columns for seven different inspection levels. These levels are divided into two groups.

The general inspection levels are I, II and III from which IL II is normally used, while IL I results in a smaller, and IL III in a larger number of test specimens.

The special inspection levels are S-1 to S-4 and result in far smaller sample sizes. They are to be used for expensive tests, for example destructive tests or tests of long duration. IL S-1 results in the smallest, and IL S-4 results in the largest sample size among the special inspection levels.

#### A.3 Sample sizes versus IL values

If single sampling and normal inspection (see IEC 60410 for the explanations of these terms) are used, the following examples of relationship between lot or batch size and sample size apply.

Lot or batch size	Sample size for IL						
	S-1	S-2	S-3	S-4	I	II	III
91 to 150	3	3	5	8	8	20	32
501 to 1 200	5	5	13	20	32	80	125
10 001 to 35 000	5	8	20	50	125	315	500

#### A.4 Acceptable quality level (AQL)

The acceptable quality level is – simply explained – the percentage of defectives within a lot which a buyer is willing to admit, and which is ensured to him, by means of sampling inspection, at given probability. This probability is of the order of 90 % but varies with the chosen IL and AQL.

The AQL is the index of tables in IEC 60410 which relate two figures to a given AQL and the sample sizes determined as above: the figure Ac (accepted) is the maximum of defectives up to which the lot or batch is accepted. The figure Re (rejected) is the number of defectives above which the lot or batch is rejected.

#### A.5 Admitted defectives versus AQL

If single sampling, normal inspection and IL II are used, the following examples of relationship between sample size and number of allowed defectives apply.

It is to be noted that some AQL values may require a larger or smaller sample size than determined in accordance with the IL value. This is indicated by arrows in the following table:

Lot size	Sample size	Number of allowed defectives (Ac) at IL II and AQL					
		0,25	0,40	0,65	1,0	1,5	2,5
91-150	20				0		
					↑↑		
		use 50 specimens	use 32 specimens	0	use 13 specimens	use 32 specimens	1
501-1 200	80	↓	↓			↓	
		0	0			1	
		↑↑					
10 001-35 000	315	use 50 specimens	use 125 specimens	1	2	3	5
			↓				
			1				
		2	3	5	7	10	14

## **Annex B** (informative)

### **Data base for failure rates**

#### **B.1 Scope**

This annex details the data base for failure rates of relays based on IEC 61709. If required in the relevant (blank) detail specification, the information given below and any further details necessary should be given in a respective annex in that specification.

#### **B.2 Description of the relay**

##### **B.2.1 Identification**

The XY relay is [details to be given in the detail specification]. For further details, see boxes (5) and (6) under 1.3 of the relevant (blank) detail specification.

NOTE Numbering of the boxes in brackets in this annex corresponds to the front page layout given under 1.3 of the relevant (blank) detail specification.

##### **B.2.2 Ratings**

Coil data and contact data, see boxes (9), (10) and (11) under 1.3 of the relevant (blank) detail specification.

#### **B.3 Quality level**

##### **B.3.1 Form of qualification:**

IECQ qualification approval and quality conformance inspections according to Clauses 3 and 4 of the relevant (blank) detail specification.

#### **B.4 Fault and failure data**

##### **B.4.1 Fault definition**

According to 2.25, 2.26 and 2.28 of IEC 60255-23 – see also B.4.3.

##### **B.4.2 Fault application**

Useful life time period. Beginning of useful life time: relay in new condition; end of useful life time: number of switching cycles stated in the relevant (blank) detail specification.

##### **B.4.3 Failure definition**

According to 2.27, 2.28, 2.29 and 2.30 of IEC 60255-23.

##### **B.4.4 Failure application**

Wear-out failure time period.

NOTE For conversion of the cycle-related to the time-related failure rate, see E.2.4 of IEC 60255-23.

## B.5 Source of data

### B.5.1 Failure rate under reference conditions, $\lambda_{\text{ref}}$ specified in B.7

Manufacturer's laboratory tests in accordance with 5.2.1.2 of IEC 60255-23.

### B.5.2 Stress factors $\pi_{\text{ES}}$ , $\pi_{\text{S}}$ and $\pi_{\text{T}}$

According to 7.7 of IEC 61709 – see B.10.

### B.5.3 Data level

Single relay.

## B.6 Conditions for which failure rates apply

The application of the failure rates described in this annex is limited by the following values stated in the relevant (blank) detail specification:

- ratings – see boxes (9) and (10) under 1.3
- component climatic category according to IEC 60068 – see box (11) under 1.3
- operating range – see box (11) under 1.3
- environmental data – see 2.7.

## B.7 Reference failure rate $\lambda_{\text{ref}}$

**B.7.1** The failure rate under reference conditions specified in B.7.2 to B.7.7:

$$\lambda_{\text{ref}} = \dots \text{ per operating cycle}$$

### B.7.2 Factors for failure rate under reference conditions

#### B.7.2.1 Time period

Mean failure rate related to wear-out time period according to C.3 of IEC 60255-23 ( $\mu$  value) with confidence level of 90 %.

#### B.7.2.2 Failure criterion

Fault and failure definitions according to B.4.

#### B.7.2.3 Operating mode

Accelerated conditions in accordance with E.1 of IEC 60255-23 simulating one operating cycle per hour.

#### B.7.2.4 Climatic and mechanical stresses

Ambient temperature: 40 °C

Climatic conditions: 3K3 of IEC 60721-3-3

Mechanical stresses: 3K3 of IEC 60721-3-3

#### B.7.2.5 Electrical stresses

Stress region 2 according to Figure 9 of IEC 61709:  $0,5 \text{ V} < U \leq U_{\text{rat}}$ ,  $0 \text{ A} < I \leq 0,1 \text{ A}$ .

### B.7.2.6 Supplementary statements

No supplementary statements required.

## B.8 Methods for combining and adding new data

The relay manufacturer should log cumulatively all endurance test data and all other relevant data including that ones derived from field experience which would demonstrate / indicate achieved reliability. All endurance tests specified in the relevant (blank) detail specification are intended, amongst other things, to provide a measure of the failure rate under prescribed conditions.

The relay manufacturer should check systematically the validity of the failure rate data by a particular communication/co-operation with the relevant relay user(s). The relay manufacturer should keep the necessary records on this matter and suggest amendments (particularly of Clause B.10) if necessary.

All these activities should be performed under the supervision of the National Supervising Inspectorate (NSI).

## B.9 Stress model

The following stress model and stress factors should be used for conversion of the failure rate at reference conditions ( $\lambda_{\text{ref}}$ ) to the failure rate under actual operating conditions ( $\lambda$ ). This conversion is only permissible within the functional limits specified in the relevant (blank) detail specification and in connection with the statements in IEC 61709.

The failure rate under operating conditions is calculated as follows:

$$\lambda = \lambda_{\text{ref}} \times \pi_{\text{ES}} \times \pi_{\text{S}} \times \pi_{\text{T}}$$

where

$\lambda$  failure rate under operating conditions

$\lambda_{\text{ref}}$  failure rate under reference conditions – see B.7

$\pi_{\text{ES}}$  electrical stress dependence factor – see Table B.1

$\pi_{\text{S}}$  switching rate dependence factor – see B.10.2

$\pi_{\text{T}}$  temperature dependence factor – see B.10.3

Relay manufacturers are not required to demonstrate the achievement of the failure rate data before delivery of a specific lot.

## B.10 Stress factors

### B.10.1 Electrical stress dependence factor $\pi_{\text{ES}}$

See Table B.1.

**Table B.1 – Factor  $\pi_{ES}$**

Stress region See Figure 9 of IEC 61709	Factor $\pi_{ES}$ for		
	Resistive load	Capacitive <sup>a</sup> and incandescent lamp load	Inductive load
1	2	2	–
2	1	8	8
3	2	20	40
4	8	40	–

<sup>a</sup> Maximum current peak stated in the relevant detail specification not to be exceeded.

**B.10.2 Switching rate dependence factor  $\pi_S$**

This factor considers the number of operating cycles per hour ( $S$ ).

a)  $\pi_S = 1$  for  $0,01 < S \leq 1$

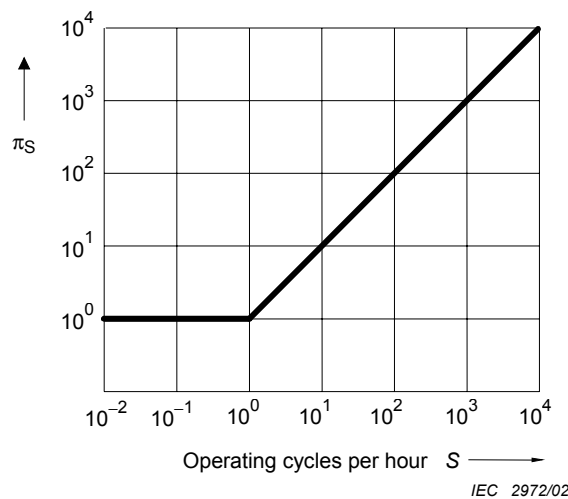
b)  $\pi_S = S / S_{ref}$  for  $S > 1$

where

$S$  is the number of operating cycles per hour;

$S_{ref}$  is the reference operating cycles per hour, where  $S_{ref} = 1$ .

The factor  $\pi_S$  is shown in Figure B.1.



**Figure B.1 – Factor  $\pi_S$  depending on the operating cycles**

**B.10.3 Temperature dependence factor,  $\pi_T$**

See Table B.2.

**Table B.2 – Factor  $\pi_T$**

Factor for the average ambient temperature		
$\theta_{amb}^a$		
$\leq 40\text{ °C}$	$70\text{ °C}$	$85\text{ °C}$
1	1,8	2,3
<sup>a</sup> Valid only up to the maximum permissible ambient temperature according to box (11) under 1.3 of the relevant (blank) detail specification.		

**B.11 Example for calculation of the failure rate under actual operating conditions**

A relay certified according to a detail specification switches a resistive contact load of stress region 1 (see Table B.1, and Figure 9 of IEC 61709) at an ambient temperature of 70 °C:

$\lambda = 10^{-7}$ ;  $U \leq 0,5\text{ V}$ ;  $I \leq 0,1\text{ A}$ ; ambient temperature  $\theta_{amb} = 70\text{ °C}$

What is the value of the failure rate under those conditions?

step (1): from equation under B.9:  $\lambda = \lambda_{ref} \times \pi_{ES} \times \pi_S \times \pi_T$

step (2): from B.10.1, Table B.1, stress region 1:  $\pi_{ES} = 2$

step (3): from B.10.2, Figure B.1, one cycle per hour:  $\pi_S = 1$

step (4): from B.10.3, Table B.2,  $\theta_{amb} = 70\text{ °C}$ :  $\pi_T = 1,8$

step (5): perform the calculation; thus the failure rate, under the conditions stated above, is obtained as:

$\lambda = \lambda_{ref} \times \pi_{ES} \times \pi_S \times \pi_T = 10^{-7} \times 2 \times 1 \times 1,8 =$   
 $= 3,6 \cdot 10^{-7}$  per operating cycle = 360 fit

step (6): perform the calculation according to E.2.4 of IEC 60255-23:

$MTBF = \frac{1}{\lambda} = \frac{1}{3,6 \times 10^{-7}} = 2,8 \cdot 10^6$  hours = 317 years

The same procedure applies to the cycle-related mean time between failures ( $MTBF_c$ ). Details and more information are given in E.2.1 to E.2.3 of normative Annex E of IEC 60255-23.





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