IEC 61123

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Reliability testing – Compliance test plans for success ratio

Essais de fiabilité – Plans d'essai de conformité pour une proportion de succès

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Reliability testing – Compliance test plans for success ratio

Essais de fiabilité – Plans d'essai de conformité pour une proportion de succès

INTERNATIONAL
ELECTROTECHNICAL
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COMMISSION
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RELIABILITY TESTING – COMPLIANCE TEST PLANS FOR SUCCESS RATIO

FOREWORD

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International Standard IEC 61123 has been prepared by IEC technical committee 56, Dependability.

This second edition cancels and replaces the first edition published in 1991. This edition constitutes a technical revision.

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

a) The sequential probability ratio test (SPRT) [1, 2][1] has been significantly developed in recent years [3, 4, 5]. This edition contains shorter and accurate tests, a wide range of test plans, and significant additional characteristic data, as follows:
   – the tests are significantly truncated (the maximum trial numbers are low) without substantially increasing the expected number of trials to decision (ENT);
   – the true producer's and consumer's risks (α', β') are given and very close to the nominal (α, β);

[1] Numbers in square brackets refer to the bibliography.

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- the range of the test parameters is wide (failure ratio, risks and discrimination ratio);
- the test plans include various risk ratios (not restricted to equal risks only);
- the values of ENT are accurate and given in the relevant region (for practical use);
- guidelines for extension of the test sets (interpolation and extrapolation) are included.

b) In Annex C, the use of the cumulative binomial distribution function of Excel that simplifies the procedure of designing has been added (Clause C.3).

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

FDIS	Report on voting
56/1852/FDIS	56/1873/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.

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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- withdrawn,
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INTRODUCTION

A compliance test is an essential part of the reliability assurance system. Reliability is affected by many random factors, so its prediction is not accurate. The direct way to check if the item/system meets its reliability specifications is to perform a compliance test.

The test serves to verify the compliance with the specified probability that an item will perform as required. The outcome of each trial of the test is either success or failure.

The probability of making the correct decision in the test depends on the sample size (number of trials). The tests require a large sample size and, accordingly, a large consumption of funds and time. The consumptions are especially high for reliability testing. For this reason, sampling plans of the tests must be carefully planned in order to reduce the sample size.

This document is dedicated to sampling plans for the tests.

The procedures are based on the assumption that trials of the test are statistically independent and the probability of success, q in them is constant. This document also applies the probability of failure $p = 1 - q$.

The tests are characterized by operating characteristic (OC) and number of trials to decision.

OC is the probability of accepting an item as meeting the requirements. In this document, the OC is represented by the coordinates of its two points (see ISO 3534-2):

– $(p_0, 1 - \alpha)$ are the coordinates of the producer's risk point (PRP);

– (p_1, β) are the coordinates of the consumer's risk point (CRP).

The number of trials to reaching a decision regarding the test is a random value and in this document is usually characterized by its expected (ENT) and maximum (MaxNT) values.

This document contains two types of tests:

– truncated sequential probability ratio test (SPRT);

– fixed trial/failure terminated test (FTFT).

The FTFT is characterized by decision rules for accepting or rejecting compliance when the termination trials number n_f (MaxNT) has been reached, or the acceptable number of failures c has been exceeded. This test has the smallest n_f among all tests with specified PRP and CRP. When testing objects with $p \leq p_0$, ENT is close to n_f, and for $p > p_0$, ENT decreases significantly. Another advantage of the FTFT is the ability to conduct all trials simultaneously, but ENT increases and becomes equal to n_f.

In the SPRT, the decision is made after each trial: accept or reject compliance, or continue testing. This document contains a truncated SPRT with MaxNT = n_t. This n_t is 1,1 to 1,2 times greater than n_f of the FTFT with the same PRP and CRP. However, the ENT of the SPRT is significantly smaller than that of the corresponding FTFT, and for $p \leq p_0$ it can be 1,4 to 1,8 times smaller. This is a great advantage of the SPRT. If it is necessary to shorten the calendar time of the SPRT, it is possible to run the trials by small portions of n_t, while the OC and ENT will not change significantly.

The planning of the SPRT is quite complicated so this document contains extensive tables with ready-to-use test plans and their characteristics. Tests are listed for $\alpha = \beta$ as well as for $\alpha \neq \beta$. The tables also allow the design of additional tests by simple interpolation and, for small p_0, by extrapolation.

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Some of the tests have a very large sample size, which will probably be used rarely. However, the data allow the user of this document to assess the economic benefit of the OC test requirements and, in general, to assess the advisability of performing the test.

The test is used for reliability testing; for example, to check compliance of the reliability of a non-repairable item for a given time interval (warranty period or designed lifetime). The test makes no assumption on whether the failure rate is constant or non-constant. IEC 61124 assumes a constant failure rate and is more statistically efficient since it takes the accumulated operating time into account.

Clause 4 presents the types of tests and recommendations for their selection. It also discusses the ability to reuse items during the test. Clause 5 explains the parameters of the stopping boundaries and the characteristics of the SPRT (their values are given in Annex D). Clause 6 is devoted to the FTFT, a table with parameters of stopping boundaries and characteristics is given. Annex A is devoted to the SPRT and provides examples of choosing a test by cost-benefit considerations, extension of the test set of Clause 5 by extra- and interpolation.

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RELIABILITY TESTING – COMPLIANCE TEST PLANS FOR SUCCESS RATIO

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1 Scope

This international standard is intended to define a procedure to verify if a reliability of an item/system complies with the stated requirements. The requirement is assumed to be specified as the percentage of success (success ratio) or the percentage of failures (failure ratio).

This document can be used where a number of items are tested (number of trials performed) and classified as passed or failed. It can also be used where one or a number of items are tested repeatedly. The procedures are based on the assumption that the probability of success or failure is the same from trial to trial (statistically independent events). Plans for fixed trial/failure terminated tests as well as truncated sequential probability ratio tests (SPRTs) are included. This document contains extensive tables with ready-to-use SPRT plans and their characteristics for equal and non-equal risks for supplier and customer.

In the case of the reliability compliance tests for constant failure rate/intensity, IEC 61124 applies.

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 60050-192:2015, *International Electrotechnical Vocabulary – Part 192: Dependability* (available at http://www.electropedia.org)

IEC 60300-3-5:2001, *Dependability management – Part 3-5: Application guide – Reliability test conditions and statistical test principles*

3 Terms, definitions, abbreviated terms and symbols

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions 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

3.1.1
success ratio
probability that an item will perform as required or that a trial will be successful under stated conditions

Note 1 to entry: An observed success ratio is the ratio of the number of non-faulty items or of successful trials at the completion of testing, to the total number of test items or number of trials.