

STN	Skúšky spoľahlivosti Plány skúšok zhody pre pomer úspešnosti	STN EN IEC 61123 01 0644
------------	---	--

Reliability testing - Compliance test plans for success ratio

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 06/20

Obsahuje: EN IEC 61123:2020, IEC 61123:2019

Oznámením tejto normy sa od 27.12.2022 ruší
STN IEC 61123 (01 0644) z júla 1999

130879

EUROPEAN STANDARD

EN IEC 61123

NORME EUROPÉENNE

EUROPÄISCHE NORM

February 2020

ICS 03.120.01; 03.120.30; 21.020

English Version

**Reliability testing - Compliance test plans for success ratio
(IEC 61123:2019)**

Essais de fiabilité - Plans d'essai de conformité pour une
proportion de succès
(IEC 61123:2019)

Prüfung der Zuverlässigkeit - Konformitätsprüfpläne für den
Erfolgsquotienten
(IEC 61123:2019)

This European Standard was approved by CENELEC on 2019-12-27. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

EN IEC 61123:2020 (E)**European foreword**

The text of document 56/1852/FDIS, future edition 2 of IEC 61123, prepared by IEC/TC 56 "Dependability" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61123:2020.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-09-27
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-12-27

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61123:2019 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 61124 NOTE Harmonized as EN 61124

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-192	2015	International electrotechnical vocabulary - Part 192: Dependability	-	-
IEC 60300-3-5	2001	Dependability management - Part 3-5: Application guide - Reliability test conditions and statistical test principles	-	-



IEC 61123

Edition 2.0 2019-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Reliability testing – Compliance test plans for success ratio

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



**THIS PUBLICATION IS COPYRIGHT PROTECTED****Copyright © 2019 IEC, Geneva, Switzerland**

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -**webstore.iec.ch/advsearchform**

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.



IEC 61123

Edition 2.0 2019-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Reliability testing – Compliance test plans for success ratio

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 03.120.01; 03.120.30; 21.020

ISBN 978-2-8322-7647-1

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	8
2 Normative references	8
3 Terms, definitions, abbreviated terms and symbols.....	8
3.1 Terms and definitions.....	8
3.2 Abbreviated terms and symbols	9
3.2.1 Abbreviated terms	9
3.2.2 Symbols	9
4 General requirements and area of application.....	10
4.1 Reliability requirement	10
4.2 Repair and replacement.....	10
4.3 Types of test plans.....	10
4.3.1 General	10
4.3.2 Features of the test plan types.....	10
4.4 General test procedure	11
4.5 General decision criteria	11
5 Truncated sequential probability ratio test plans (SPRT).....	13
5.1 Characteristics	13
5.2 Decision criteria	13
5.3 Operating characteristic curve (OC).....	14
5.4 Expected number of trials to decision (ENT)	15
6 Fixed trial/failure terminated test plans (FTFT)	16
6.1 Characteristics	16
6.2 Decision criteria	16
7 Design of fixed trial/failure terminated test plans	17
7.1 Characteristics	17
7.2 Approach	17
7.3 Common case.....	18
7.4 Other cases	18
7.5 Example of application.....	18
7.6 Procedure to determine D and c or n and c	18
7.6.1 Figure and table readings	18
7.6.2 Use of figures and tables	19
7.7 Decision criteria	19
Annex A (informative) Additional information on sequential test plans.....	20
A.1 Example.....	20
A.2 Extension of the test set (through interpolation and extrapolation)	21
A.2.1 General	21
A.2.2 Extrapolation for $p_0 < 0,001$	21
A.2.3 Interpolation	21
Annex B (informative) Design of fixed trial/failure terminated test plans – Examples	24
B.1 Use of figures and tables	24
B.2 Case where number of events, n , is not known, but is predictable	24
Annex C (informative) Design of fixed trial/failure terminated test plans – Mathematical procedures and formulas	26

C.1	General.....	26
C.2	Symbols.....	26
C.3	Computation	26
C.3.1	Determination of D versus n	26
C.3.2	Determination of n and c versus p_0, D, α, β	27
C.3.3	Test without failures – Determination of n and D versus p_0, α, β	27
C.3.4	Determination of OC curves.....	28
C.3.5	Determination of inverse OC curves	28
C.4	Accuracy.....	29
C.5	Tables of cumulative normal distribution and its Inverse.....	29
Annex D	(normative) Truncated sequential test plans	31
Annex E	(informative) Design of fixed trial/failure terminated test plans – Figures and tables to determine D and c or n and c	40
Bibliography	49
Figure 1	– Expected and maximal number of trials for SPRT and FTFT with the same risks ..	11
Figure 2	– SPRT diagram.....	14
Figure 3	– OC curve.....	15
Figure 4	– SPRT – Curve of expected number of trials to decision (ENT).....	15
Figure 5	– Principal layout of Tables E.1 to E.3.....	19
Figure A.1	– Example of a truncated sequential test	20
Figure E.1	– Discrimination ratio, D , versus number of events, n for $p_0 = 0,05$	40
Figure E.2	– Discrimination ratio, D , versus number of events, n for $p_0 = 0,10$	41
Figure E.3	– Discrimination ratio, D , versus number of events, n for $p_0 = 0,15$	42
Table 1	– Overview – Maximal number of trials and expected number of trials at p_0 for SPRT and FTFT.....	12
Table 2	– Range of the test parameters	13
Table 3	– OC curve.....	14
Table 4	– ENT (n_e) versus true failure ratio (p).....	15
Table 5	– Fixed trial/failure terminated test plans	16
Table A.1	– Example for interpolation by α and β	23
Table C.1	– Cumulative normal distribution for fixed u_γ values	29
Table C.2	– Inverse cumulative normal distribution for fixed $1 - \gamma$ values	30
Table D.1	– Truncated sequential test plans	31
Table E.1	– Acceptable number of failures, c , versus number of events, n for $p_0 = 0,05$	43
Table E.2	– Acceptable number of failures, c , versus number of events, n for $p_0 = 0,10$	45
Table E.3	– Acceptable number of failures, c , versus number of events, n for $p_0 = 0,15$	47

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RELIABILITY TESTING –
COMPLIANCE TEST PLANS FOR SUCCESS RATIO****FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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.

- 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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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 $\text{MaxNT} = n_t$. 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.

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.

RELIABILITY TESTING – COMPLIANCE TEST PLANS FOR SUCCESS RATIO

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*

koniec náhľadu – text ďalej pokračuje v platenej verzii STN