



SLOVENSKI STANDARD
SIST EN 61164:2004

01-september-2004

Rast zanesljivosti – Statistične preskusne in ocenjevalne metode

Reliability growth - Statistical test and estimation methods

Zuverlässigkeitswachstum - Statistische Prüf- und Schätzverfahren

Croissance de la fiabilité - Tests et méthodes d'estimation statistiques

Ta slovenski standard je istoveten z: EN 61164:2004

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ICS:

03.120.01	Kakovost na splošno	Quality in general
21.020	Značilnosti in načrtovanje strojev, aparatov, opreme	Characteristics and design of machines, apparatus, equipment

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en

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EUROPEAN STANDARD

EN 61164

NORME EUROPÉENNE

EUROPÄISCHE NORM

April 2004

ICS 03.120.01; 03.120.30

English version

**Reliability growth -
Statistical test and estimation methods
(IEC 61164:2004)**

Croissance de la fiabilité -
Tests et méthodes
d'estimation statistiques
(CEI 61164:2004)

Zuverlässigkeitswachstum -
Statistische Prüf- und Schätzverfahren
(IEC 61164:2004)

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This European Standard was approved by CENELEC on 2004-04-01. 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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

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

CENELEC

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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 56/920/FDIS, future edition 2 of IEC 61164, prepared by IEC TC 56, Dependability, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61164 on 2004-04-01.

This European Standard should be used in conjunction with EN 61014:2003.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2005-01-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2007-04-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61164:2004 was approved by CENELEC as a European Standard without any modification.

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Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

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

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-191	1990	International Electrotechnical Vocabulary (IEV) Chapter 191: Dependability and quality of service	-	-
IEC 60300-3-5	2001	Dependability management Part 3-5: Application guide - Reliability test conditions and statistical test principles	-	-
IEC 60605-4	- ¹⁾	Equipment reliability testing Part 4: Statistical procedures for exponential distribution - Point estimates, confidence intervals, prediction intervals and tolerance intervals https://standards.iteh.ai/catalog/standards/sist/ad3673b1-8629-4d05-8c7e-45d04d7716d8/sist-en-61164-2004	-	-
IEC 60605-6	- ¹⁾	Part 6: Tests for the validity of the constant failure rate or constant failure intensity assumptions	-	-
IEC 61014	2003	Programmes for reliability growth	EN 61014	2003

¹⁾ Undated reference.

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INTERNATIONAL STANDARD

IEC 61164

Second edition
2004-03

Reliability growth – Statistical test and estimation methods

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Международная Электротехническая Комиссия

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RELIABILITY GROWTH –
STATISTICAL TEST AND ESTIMATION METHODS**

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.
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- 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 61164 has been prepared by IEC technical committee 56: Dependability.

This second edition cancels and replaces the first edition, published in 1995, and constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

- addition of two statistical models for reliability growth planning and tracking in the product design phase;
- statistical methods for the reliability growth programme in the design phase of IEC 61014;
- addition of the discrete reliability growth model for the test phase;
- addition of the fixed number of faults model for the test phase;
- clarification of the symbols used for various models;
- addition of real life examples for most of the statistical models;
- numerical correction of tables in the reliability growth test example.

This standard should be used in conjunction with IEC 61014.

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

FDIS	Report on voting
56/920/FDIS	56/939/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.

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 2011. At this date, the publication will be

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

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INTRODUCTION

This International Standard describes the power law reliability growth model and related projection model and gives step-by-step directions for their use. There are several reliability growth models available, the power law model being one of the most widely used. This standard provides procedures to estimate some or all of the quantities listed in Clauses 4, 6 and 7 of IEC 61014.

Two types of input are required. The first one is for reliability growth planning through analysis and design improvements in the design phase in terms of the design phase duration, initial reliability, reliability goal, and planned design improvements, along with their expected magnitude. The second input, for reliability growth in the project validation phase, is for a data set of accumulated test times at which relevant failures occurred, or were observed, for a single system, and the time of termination of the test, if different from the time of the final failure. It is assumed that the collection of data as input for the model begins after the completion of any preliminary tests, such as environmental stress screening, intended to stabilize the product's initial failure intensity.

Model parameters estimated from previous test results may be used to plan and predict the course of future reliability growth programmes, provided the conditions are similar.

Some of the procedures may require computer programs, but these are not unduly complex. This standard presents algorithms for which computer programs should be easy to construct.

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RELIABILITY GROWTH – STATISTICAL TEST AND ESTIMATION METHODS

1 Scope

This International Standard gives models and numerical methods for reliability growth assessments based on failure data, which were generated in a reliability improvement programme. These procedures deal with growth, estimation, confidence intervals for product reliability and goodness-of-fit tests.

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 60050(191):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 191: Dependability and quality of service*

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

IEC 60605-4, *Equipment reliability testing – Part 4: Statistical procedures for exponential distribution – Point estimates, confidence intervals, prediction intervals and tolerance intervals*

IEC 60605-6, *Equipment reliability testing – Part 6: Tests for the validity of the constant failure rate or constant failure intensity assumptions*

IEC 61014:2003, *Programmes for reliability growth*

3 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 60050(191) and IEC 61014, together with the following terms and definitions, apply.

3.1

reliability goal

desired level of reliability that the product should have at the end of the reliability growth programme

3.2

initial reliability

reliability that is estimated for the product in earlier design stages before any potential failure modes or their causes have been mitigated by the design improvement

3.3

reliability growth model for the design phase

mathematical model that takes into consideration potential design improvements, and their magnitude to express mathematically reliability growth from start to finish during the design period

3.4**average product failure rate**

average product failure rate calculated from its reliability as estimated for a predetermined time period

NOTE The change in this failure rate as a function of time is a result of the modifications of the product design.

3.5**delayed modification**

corrective modification, which is incorporated into the product at the end of a test

NOTE A delayed modification is not incorporated during the test.

3.6**improvement effectiveness factor**

fraction by which the intensity of a systematic failure is reduced by means of corrective modification

3.7**type I test**

time-terminated test

reliability growth test which is terminated at a predetermined time, or test with data available through a time which does not correspond to a failure

3.8**type II test**

failure-terminated test

reliability growth test which is terminated upon the accumulation of a specified number of failures, or test with data available through a time which corresponds to a failure

4 Symbols

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For the purposes of this standard, the following symbols apply.

a) For 6.1, clauses A.1 and B.3:

T	product lifetime such as mission, warranty period or operational time
$R_0(T)$	initial product reliability
λ_{a0}	initial average failure rate of product in design period
$d(t)$	number of design modifications at any time during the design period
α_D	reliability growth rate resultant from fault mitigation
D	total number of implemented design improvements
t_D	total duration of the design period available for the design improvements
t	time variable during the design period from 0 to t_D
$\lambda_a(t)$	average failure rate of product as a function of time during the design period
$\lambda_{aG}(t_D)$	goal average failure rate at the end of the design period t_D

$R_G(T)$	reliability goal of the product to be attained during design period
$R(t,T)$	reliability of product as a function of time and design improvements

b) For 6.2, clauses A.2 and B.4:

$R_G(T)$	reliability goal of the product to be attained during design period
t_D	total duration of the design period
α_D	reliability growth rate during design period
λ_{NS}	rate of non-systematic (or residual) failures
D	total number of predicted or implemented design improvements within design period to address weaknesses
K	total number of distinct classes of fault
j,k,i	general purpose indicators
P_{kj}	probability of j -th design weakness in fault class k resulting in failure during the specified life of the product
η_k	expected number of design weaknesses in fault class k resulting in failure during the specified life of the product
D_k	total number of predicted or implemented design improvements within design period to address faults in fault class k
λ_k	failure rate of design weaknesses categorized in fault class k
$R_1(T)$	initial reliability at time T
$R(T)$	reliability of product as a function of T
t_G	expected time to reach reliability goal

c) For 7.1.1, 7.1.2, Clauses 9, A.4, B.1, and B.2:

D	total number of design modifications carried out during product design period to mitigate identified faults
t_D	total duration of the design period available for potential design modifications
t	time variable (during design period $0 \leq t \leq t_D$)
$d(t)$	number of design modifications at any given time t during design period from 0 to t_D
α_D	reliability growth rate during the design period
λ_{a0}	initial average failure rate of a product in design