

This is a preview - click here to buy the full publication

INTERNATIONAL STANDARD

IEC 61164

Second edition
2004-03

Reliability growth – Statistical test and estimation methods

© IEC 2004 — Copyright - all rights reserved

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 the publisher.

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE

XA

For price, see current catalogue

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	7
4 Symbols	8
5 Reliability growth models in design and test	12
6 Reliability growth models used for systems/products in design phase.....	13
6.1 Modified power law model for planning of reliability growth in product design phase.....	13
6.2 Modified Bayesian IBM-Rosner model for planning reliability growth in design phase.....	16
7 Reliability growth planning a tracking in the product reliability growth testing.....	18
7.1 Continuous reliability growth models	18
7.2 Discrete reliability growth model.....	20
8 Use of the power law model in planning reliability improvement test programmes.....	23
9 Statistical test and estimation procedures for continuous power law model.....	23
9.1 Overview	23
9.2 Growth tests and parameter estimation	23
9.3 Goodness-of-fit tests	27
9.4 Confidence intervals on the shape parameter.....	29
9.5 Confidence intervals on current MTBF	31
9.6 Projection technique.....	33
Annex A (informative) Examples for planning and analytical models used in design and test phase of product development.....	37
Annex B (informative) The power law reliability growth model – Background information.....	50
Bibliography.....	55
Figure 1 – Planned improvement of the average failure rate or reliability	12
Figure A.1 – Planned and achieved reliability growth – Example	40
Figure A.2 – Planned reliability growth using Bayesian reliability growth model.....	41
Figure A.3 – Scatter diagram of expected and observed test times at failure based on data of Table A.2 with power law model.....	48
Figure A.4 – Observed and estimated accumulated failures/accumulated test time based on data of Table A.2 with power law model.....	49
Table 1 – Categories of reliability growth models with clause references	13
Table 2 – Critical values for Cramér-von Mises goodness-of-fit test at 10 % level of significance.....	34
Table 3 – Two-sided 90 % confidence intervals for MTBF from Type I testing	35

Table 4 – Two-sided 90 % confidence intervals for MTBF from Type II testing	36
Table A.1 – Calculation of the planning model for reliability growth in design phase	39
Table A.2 – Complete data – All relevant failures and accumulated test times for Type I test	46
Table A.3 – Grouped data for Example 3 derived from Table A.2	46
Table A.4 – Complete data for projected estimates in Example 4 – All relevant failures and accumulated test times	47
Table A.5 – Distinct types of Category B failures, from Table A.4, with failure times, time of first occurrence, number observed and effectiveness factors.....	47

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.
- 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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 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 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.

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.

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*