IEC TS 61586

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TECHNICAL SPECIFICATION

SPECIFICATION TECHNIQUE

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Estimation of the reliability of electrical connectors

Estimation de la fiabilité des connecteurs électriques

IEC TS 61586:2017-01(en-fr)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ESTIMATION OF THE RELIABILITY OF ELECTRICAL CONNECTORS

FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 61586, which is a technical specification, has been prepared by IEC technical committee 48: Electrical connectors and mechanical structures for electrical and electronic equipment.

This second edition cancels and replaces the first edition published in 1997. This edition constitutes a technical revision.

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The main technical changes with regard to the previous edition are as follows:

- A specific “basic” testing protocol is defined which utilizes a single test group subjecting connectors to multiple stresses.
- Additional information is provided concerning test acceleration factors.
- A discussion of the limitations of providing MTTF/MTBF estimates for connectors has been added.
- The bibliography has been expanded.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
48/563/DTS	48/568/RVC

Full information on the voting for the approval of this technical specification 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 publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

The reliability of electronic assemblies depends on the reliability of the passive electrical connections between the active components, as well as on the reliability of the components themselves. There is a common perception that interconnections, specifically connectors, are a major source of failures, often of the "no fault found" variety, in electronic assemblies. Whether this perception is true is not the subject of this technical document, but connector reliability is a concern. Much of the increasing attention being given to reliability of electrical connectors focuses on the basic question of how the reliability of electrical contacts and connectors can be meaningfully determined.

The definition of reliability which will be assumed in this document is the following:

> The probability of a product performing a specific function under defined operating conditions for a specified period of time.

Reliability is therefore a function of:

a) The expected lifetime of the part.

b) The application stresses (electrical, thermal, mechanical, chemical, etc.) the part will be subjected to during its life.

c) The specified failure criteria.

Since these factors will be different for every application in which the connector may be used, a given connector will have a different reliability for every application in which it may be used. Therefore, a connector manufacturer cannot provide a reliability estimate for a contact or connector until the customer has provided a detailed description of the factors listed above for the application in which the connector will be used. To provide a numerical estimate of connector reliability, the manufacturer will then need to use the information provided by the customer to design a test program to simulate the application intended.

Some factors which are to be taken into account in addressing this definition are the subject of this document. The reliability assessment methodology to be discussed centres on appropriate statistical analysis of test data, based on proper consideration of the following issues.

d) The active degradation mechanisms are to be identified and categorized by their importance for the application.

e) Appropriate environmental tests, with corresponding acceleration factors, where practical and appropriate, and exposures, are to be determined for these degradation mechanisms.

f) Use of a test sequence which provides an opportunity for the interaction of the potential degradation mechanisms as is necessary to realistically simulate the effects of the expected application.

g) The statistical approach to estimating reliability from the test data is to be agreed upon.

h) An acceptance criterion appropriate for the application of interest is to be established.

Items d), e and f) relate to the ability of the product to continue to perform its designated function under the degradation mechanisms it is subjected to in its operating environment. In addition, the need for an acceleration factor is fundamental to assessing the operating life of the product.

Item g) is necessary, since the reliability definition is based on probability which requires statistical treatment of appropriate data.

Finally, item h) is a result of the fact that the reliability to be assessed is based on the product performing a defined function.

The level of knowledge and understanding available to address these issues varies appreciably. Each topic is considered in a separate subclause.

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It is to be noted that there are a number of other factors which have an effect on connector reliability. Among these are:

i) the connector manufacturing process;

j) assembly/application procedures of the equipment manufacturer;

k) abuse/misuse of the equipment by the end user.

The importance of these application or extrinsic factors cannot be denied and may well be the final determinants of connector reliability. However, extrinsic factors are highly variable and, therefore, difficult to account for in any estimation of reliability. For these reasons, this document will focus on intrinsic connector reliability, i.e. the reliability of the design/materials of the connector itself as evaluated by the procedures listed previously. This intrinsic reliability represents the greatest reliability which the connector can achieve. The extrinsic factors will result in a reduction in reliability.

It is also to be noted that the approach to reliability estimation in this document differs significantly from that based on a base failure rate which is modified by application-specific factors as, for example, in IEC 60863 or MIL Handbook 217.

The two approaches are related in that the base failure rate could be determined by a different statistical treatment from the same data which are used in assessing reliability by the method to be discussed. The test environments and exposures would determine the standard conditions which are defined for the base failure rate. In addition, the derating factors used in the failure rate approach can, in principle, be derived from the same data used to determine acceleration factors in the proposed statistical method.

The advantage of the approach recommended in this document is that the standard conditions, acceptance criteria, and statistical treatment are specifically defined for the application under consideration. This is in contrast to a base failure rate starting point which is frequently poorly defined and documented.

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ESTIMATION OF THE RELIABILITY OF ELECTRICAL CONNECTORS

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1 Scope

This technical specification deals with the estimation of the inherent design reliability of electrical connectors through the definition and development of an appropriate accelerated testing programme. The basic intrinsic degradation mechanisms of connectors, which are those mechanisms which exist as a result of the materials and geometries chosen for the connector design, are reviewed to provide a context for the development of the desired test programme. While extrinsic degradation mechanisms may also significantly affect the performance of connectors, they vary widely by application and thus are not addressed in this document.

2 Normative references

There are no normative references in this document

3 Terms and definitions

No terms and definitions are listed in this document.

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

4 General considerations

4.1 General

Degradation leading to failure of a contact or connector can occur in many ways. For our purpose, it is convenient to divide the mechanisms into two categories, intrinsic and extrinsic.

4.2 Intrinsic degradation mechanisms

As mentioned in the introduction, intrinsic degradation mechanisms are those related to the design and materials of manufacture of the contact or connector. Examples are corrosion, loss of normal force through stress relaxation, and excessive Joule heating leading to temperature-related degradation.

4.3 Extrinsic degradation mechanisms

Extrinsic degradation mechanisms are related to the application of the contact or connector. Examples are inadequate controls during manufacture of the connector, improper assembly processes during equipment manufacture, contamination during application, degradation caused by use of the connector outside its rated temperature range (both ambient and enclosure-related) or by application of currents exceeding the product specification (in both single and distributed modes), and contact abuse resulting from improper mating practices (mating at excessive angles, pulling on cables, etc.) by the end user.