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Electric components – Reliability – Reference conditions for failure rates and stress models for conversion

Composants électriques – Fiabilité – Conditions de référence pour les taux de défaillance et modèles de contraintes pour la conversion

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This third edition cancels and replaces the second edition, published in 2011. This edition constitutes a technical revision. This third edition is a merger of IEC 61709:2011 and IEC TR 62380:2004.

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

a) addition of 4.5 Components choice, 4.6 Reliability growth during the deployment phase of new equipment, 4.7 How to use this document, and of Clause 19 Printed circuit boards (PCB) and Clause 20 Hybrid circuits with respect to IEC TR 62380;
b) addition of failure modes of components in Annex A;

c) modification of Annex B, Thermal model for semiconductors, adopted and revised from IEC TR 62380;

d) modification of Annex D, Considerations on mission profile;

e) modification of Annex E, Useful life models, adopted and revised from IEC TR 62380;

f) revision of Annex F (former B.2.6.4), Physics of failure;

g) addition of Annex G (former Annex C), Considerations for the design of a data base on failure rates, complemented with parts of IEC 60319;

h) addition of Annex H, Potential sources of failure rate data and methods of selection;

i) addition of Annex J, Presentation of component reliability data, based on IEC 60319.

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

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The contents of the corrigendum of October 2019 have been included in this copy.

INTRODUCTION

This document is intended for the reliability prediction of electric components as used in equipment and is aimed at organizations that have their own data and describes how to state and use that data in order to perform reliability predictions.

It can also be used to allow an organization to set up a failure rate database and describes the reference conditions for which field failure rates should be stated. The reference conditions adopted in this document are typical of the majority of applications of components in equipment however when components operate under other conditions the users may consider stating these conditions as their reference conditions.

Using the presented stress models allows extrapolation of failure rates from reference conditions to other operating conditions which in turn permits the prediction of failure rates at assembly level. This allows estimation of the effect of design changes or changes in the environmental conditions on component reliability. Reliability prediction is most useful in the early design phase of equipment. It can be used, for example, to identify potential reliability problems, the planning of logistic support strategies and the evaluation of designs.

The stress models contained herein are generic and are as simple as possible while still being comparable with more complex equations contained in other models. The predictions generated using this document have a wide range of prediction accuracy.

This document does not contain failure rates, but it describes how they can be stated and used. This approach allows a user to select the most relevant and up to date failure rates for the prediction from a source that they select. This document also contains information on how to select the data that can be used in the presented models.

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The failure rates considered in this document are assumed to be constant, either for an unlimited period of operation (general case) or for limited periods. The limitation of life is called useful life and applies only for some few component families, reaching the wear-out failure period (during which the failure rate is increasing) within the normal period of use. It is hence assumed that during useful life, the failure rate can be considered constant for any practical use.

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For the purposes of this document the term electric component includes the commonly used terms “electronic component”, “electrical component” and “electro-mechanical component”.

ELECTRIC COMPONENTS – RELIABILITY – REFERENCE CONDITIONS FOR FAILURE RATES AND STRESS MODELS FOR CONVERSION

1 Scope

This document gives guidance on the use of failure rate data for reliability prediction of electric components used in equipment.

The method presented in this document uses the concept of reference conditions which are the typical values of stresses that are observed by components in the majority of applications.

Reference conditions are useful since they provide a known standard basis from which failure rates can be modified to account for differences in environment from the environments taken as reference conditions. Each user can use the reference conditions defined in this document or use their own. When failure rates stated at reference conditions are used it allows realistic reliability predictions to be made in the early design phase.

The stress models described herein are generic and can be used as a basis for conversion of failure rate data given at these reference conditions to actual operating conditions when needed and this simplifies the prediction approach. Conversion of failure rate data is only possible within the specified functional limits of the components.

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This document also gives guidance on how a database of component failure data can be constructed to provide failure rates that can be used with the included stress models. Reference conditions for failure rate data are specified, so that data from different sources can be compared on a uniform basis. If failure rate data are given in accordance with this document then additional information on the specified conditions can be dispensed with.

https://standards.iteh.ai/catalog/standards/sist/[illegible] IEC 61709:2017

This document does not provide base failure rates for components – rather it provides models that allow failure rates obtained by other means to be converted from one operating condition to another operating condition.

The prediction methodology described in this document assumes that the parts are being used within its useful life. The methods in this document have a general application but are specifically applied to a selection of component types as defined in Clauses 6 to 20 and I.2.

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*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-192 and the following 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
electric component
component with conductive terminals through which voltages or currents may be applied or delivered

Note 1 to entry: The term electric component includes the commonly used terms “electronic component”, “electrical component” and “electro-mechanical component”.

[SOURCE: IEC 61360-1:2009, 2.18, modified — Existing note deleted and Note 1 to entry added]

3.1.2
Failure <of an item>
loss of ability to perform as required

Note 1 to entry: A failure of an item is an event that results in a fault of that item: see fault (IEC 60050-192:2015, 192-04-01).

Note 2 to entry: Qualifiers, such as catastrophic, critical, major, minor, marginal and insignificant, may be used to categorize failures according to the severity of consequences, the choice and definitions of severity criteria depending upon the field of application.

Note 3 to entry: Qualifiers, such as misuse, mishandling and weakness, may be used to categorize failures according to the cause of failure.

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[SOURCE: IEC 60050-192:2015, 192-03-01]

3.1.3
failure mode
IEC 61709:2017
https://ecommerce.sist.si/catalog/standards/sist/42393689-38ca-4537-90a4-5bc80655a7dc/iec-61709-2017
manner in which failure occurs

Note 1 to entry: A failure mode may be defined by the function lost or the state transition that occurred.

[SOURCE: IEC 60050-192:2015, 192-03-17]

3.1.4
instantaneous failure rate
failure rate
limit, if it exists, of the quotient of the conditional probability that the failure of a non-repairable item occurs within time interval $(t,\ t + \Delta t)$, by Δt, when Δt tends to zero, given that failure has not occurred within time interval $(0,\ t)$

$$\lambda(t) = \lim_{\Delta t \to 0} \frac{1}{\Delta t} \frac{F(t + \Delta t) - F(t)}{R(t)} = \frac{f(t)}{R(t)}$$

where $F(t)$ and $f(t)$ are, respectively, the distribution function and the probability density at the failure instant, and where $R(t)$ is the reliability function, related to the reliability $R(t_1,\ t_2)$ by $R(t) = R(0,\ t)$.

Note 1 to entry: See IEC 61703, *Mathematical expressions for reliability, availability, maintainability and maintenance support terms*, for more detail.

Note 2 to entry: Other terms used for instantaneous failure rate are: “hazard function”; “hazard rate”; and “force of mortality” (abbreviation FOM).

Note 3 to entry: $\lambda(t)$ in this document is assumed to be constant over time unless explicitly stated otherwise.

[SOURCE: IEC 60050-192:2015, 192-05-06, modified — Note 3 to entry added]