

INTERNATIONAL STANDARD

**Semiconductor devices - Guidelines for reliability qualification plans -
Part 4: Early failure assessment**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Semiconductor devices -
Guidelines for reliability qualification plans -
Part 4: Early failure assessment**

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The text of this International Standard is based on the following documents:

Draft	Report on voting
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Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

This International Standard is to be read in conjunction with IEC 63287-1.

A list of all parts in the IEC 63287 series, published under the general title *Semiconductor devices - Guidelines for reliability qualification plans*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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1 Scope

This part of IEC 63287 gives guidelines for the development of reliability qualification plans using the early failure assessment, based on the environmental conditioning and proposed usage of the product. This document is not intended for military- and space-related applications.

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 63287-1, *Semiconductor devices - Generic semiconductor qualification guidelines - Part 1: Guidelines for IC reliability qualification*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

4 Early failure assessment

4.1 General

This is estimate of the confidence interval of the early failure assessment.

4.2 Early failure assessment for zero failure case

4.2.1 General

If failure does not occur in the fixed-time type reliability test for confirmation of convergence in screening, etc., it means that if zero failure cannot be obtained as a result, $\hat{F}(t_b) = 0$ is assumed in point estimation. Hence, $\hat{\eta}$ cannot be obtained with Formula (2) in accordance with IEC 63287-1. For this reason, the method employing the upper limit of the estimate of the confidence interval $F_c(t_b)$ of the cumulative failure probability obtained with one-sided confidence early failure assessment of $F(t_b)$ is used. $\hat{F}_c(t_b)$ is obtained with, for instance, parametric methods that assume a defined distribution for device lifetime distribution and nonparametric methods that do not assume any defined distribution for lifetime distribution and consider the cumulative failure probability only. An example of the former is Method A in Table 1 and Table 2, the method that makes use of $2T/MTTF$ forming χ^2 distribution with degree of freedom $= 2n$, when lifetime distribution can be assumed to be exponential distribution. Although this method is used widely, the sample size n shall be large for the failure rate to be set constant, when estimating early failure rate. Another method (Method B in Table 1 and Table 2) assumes the lifetime distribution to be Weibull distribution and extends Method A by means of time measurement conversion. This method requires value of the shape parameter m to be established in advance, based on information on similar products in the past. A nonparametric method (Method C in Table 1 and Table 2) uses $F_c(t_b)$ as failure probability in binomial distribution. Annex A gives an example of an early failure assessment for zero failure case. When sample size n is large, these methods arrive at the same estimate of the cumulative failure probability at the point when failure is confirmed to be 0 at time point t_b . Further details on Method A and Method B will be found in 4.2.2 and 4.2.3, respectively. Also, the estimation results of methods A, B and C as shown in the table below. Table 1 shows that the upper limit of the confidence early failure assessment for cumulative failure probability differs when the sample size n is small. Conversely, when the sample size n is large ($n = 1\,000$ or more), the estimate obtained with Method A that assumes the failure rate to be constant will match the results of Methods B and C.

Table 1 – Confidence level (C.L.) 60 % ($\alpha = 0,4$) Upper limit of one-sided early failure assessment of cumulative failure probability

Sample size (n)	Method A	Method B	Method C
1	0,916 29	0,600 00	0,600 00
10	0,091 63	0,087 56	0,087 56
22	0,041 65	0,040 79	0,040 79
45	0,020 36	0,020 16	0,020 16
77	0,011 90	0,011 83	0,011 83
100	0,009 16	0,009 12	0,009 12
231	0,003 97	0,003 96	0,003 96
500	0,001 83	0,001 83	0,001 83
1 000	0,000 92	0,000 92	0,000 92