

# Reliability stress screening —

## Part 2: Electronic components

ICS 31.020

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### Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the CEI IEC title page, page ii, pages 1 to 24 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

This British Standard, having been prepared under the direction of the Management Systems Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 February 1999

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ISBN 0 580 30923 1

### Amendments issued since publication

| Amd. No. | Date | Comments |
|----------|------|----------|
|          |      |          |
|          |      |          |
|          |      |          |
|          |      |          |
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**NORME  
INTERNATIONALE  
INTERNATIONAL  
STANDARD**

**CEI  
IEC**

**61163-2**

Première édition  
First edition  
1998-11

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**Déverminage sous contraintes –**

**Partie 2:  
Composants électroniques**

**Reliability stress screening –**

**Part 2:  
Electronic components**



Numéro de référence  
Reference number  
CEI/IEC 61163-2:1998

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## Introduction

Although first developed as a tool for designing reliability into systems that operate in harsh environmental conditions, reliability stress screening has emerged as a technique in the electrotechnical manufacturing community that is useful if the drive toward zero defect levels in new products is to continue.

Reliability stress screening has proved to be an effective tool in

- a) identifying and removing flaws due to poor component design and manufacturing deficiencies,
- b) screening parts to a tighter specification than those published,
- c) providing feedback to enable the streamlining of processes to achieve very tight limits in order to minimize parameter variability.

Reliability stress screening should not be considered as a normal procedure to be used in assuring the reliability of electronic components because reliability stress screening cannot improve the reliability of an individual component. Reliability stress screening can, however, improve the actual reliability of a system. The cost and risks generally outweigh the potential benefits since any applied stress may have detrimental effects on the lifetime of the components. Greater benefits may be obtainable by tighter manufacturing process control. However, in some cases, this may not be practical, for example with existing components with less than acceptable reliability. Using reliability stress screening to upgrade component specifications can also lead to a logistical problem, when similarly screened components are not available at a later date.

When performing reliability stress screening on components for use in a particular system, either enough components needed for the repair of the system over its entire service life need to be screened initially or the user needs to ensure that system documentation be sufficient to control component procurement so that all replacement components be similarly screened.

## 1 Scope

This part of IEC 61163 provides guidance on reliability stress screening techniques and procedures for electronic components. This standard is not, and cannot be, exhaustive due to the rapid rate of developments in the electronics industry.

This standard is intended for the use of

- a) component manufacturers as a guideline,
- b) component users as a guideline to negotiate with component manufacturers on stress screening requirements or plan a stress screening process in house due to reliability requirements,
- c) subcontractors who provide stress screening as a service.

This standard is not intended to provide test plans for specific electronic components or for delivery of certificates of conformance for batches of components.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61163. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 61163 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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

IEC 60300-1:1993, *Dependability management — Part 1: Dependability programme management*.

IEC 60300-2:1995, *Dependability management Part 2: Dependability programme elements and tasks*.

IEC 60300-3-7: —, *Dependability management — Part 3-7: Application guide — Reliability stress screening of electronic hardware*<sup>1)</sup>.

IEC 61163-1:1995, *Reliability stress screening — Part 1: Repairable items manufactured in lots*.

IEC 61709:1996, *Electronic components — Reliability — Reference conditions for failure rates and stress models for conversion*.

<sup>1)</sup> To be published.

### 3 Definitions

For the purpose of this part of IEC 61163, the following definitions as well as those given in IEC 60050(191) and IEC 60300-3-7 apply:

#### 3.1 reliability screening (process)

a process of detection of flaws and removal and repair of weak items for the purpose of reaching as rapidly as possible the reliability level expected during the useful life

NOTE 1 IEC 60050(191) defines in 191-17-02, the term “burn-in”. This term, however, is used by many manufacturers to describe a so-called “soak-test”, which is only one of many possible ways of screening. Furthermore “burn-in” may include ageing, the purpose of which is to stabilize parameters, and where in many cases no failures occur.

NOTE 2 IEC 60050(191) defines, in 191-14-09, the term “screening test”. This term, however, is defined too broadly to be applicable in the present context because it encompasses screening of any types of non-conformities. Furthermore, reliability screening is a process, not a test.

NOTE 3 Repair is not applicable in the case of electronic components.

#### 3.2 reliability stress screening (process)

a process using environmental and/or operational stress as a means of detecting flaws by precipitating them as detectable failures

NOTE Reliability screening is designed with the intention of precipitating flaws into detectable failures. An ageing process designed specifically with the intention of stabilizing parameters is not a reliability stress screening process and is therefore outside the scope of this standard.

#### 3.3 weak item

an item which has a high probability of failure in the early failure period due to a flaw (see also 3.8: early failure period)

#### 3.4 weakness

any imperfection (known or unknown) in an item, capable of causing one or more weakness failures

NOTE 1 Each type of weakness is assumed to be statistically independent of all other such types.

NOTE 2 A weakness may be either inherent or induced.

#### 3.5 weakness failure

a failure due to a weakness in the item itself when subjected to stresses within the stated capabilities of the item [IEV 191-04-06]

#### 3.6 flaw

a weakness in an item which gives rise to early weakness failures

#### 3.7 inherent flaw

a flaw in an item related to its technology and manufacturing process

#### 3.8 early failure period

that early period, if any, in the lifetime of an item, beginning at a given instant of time and during which the instantaneous failure intensity for a repaired item or the instantaneous failure rate for a non-repaired item is considerably higher than that of the subsequent period [IEV 191-10-07]

NOTE The early failure period is the period where the weak items fail.

### 4 Procedure

#### 4.1 General

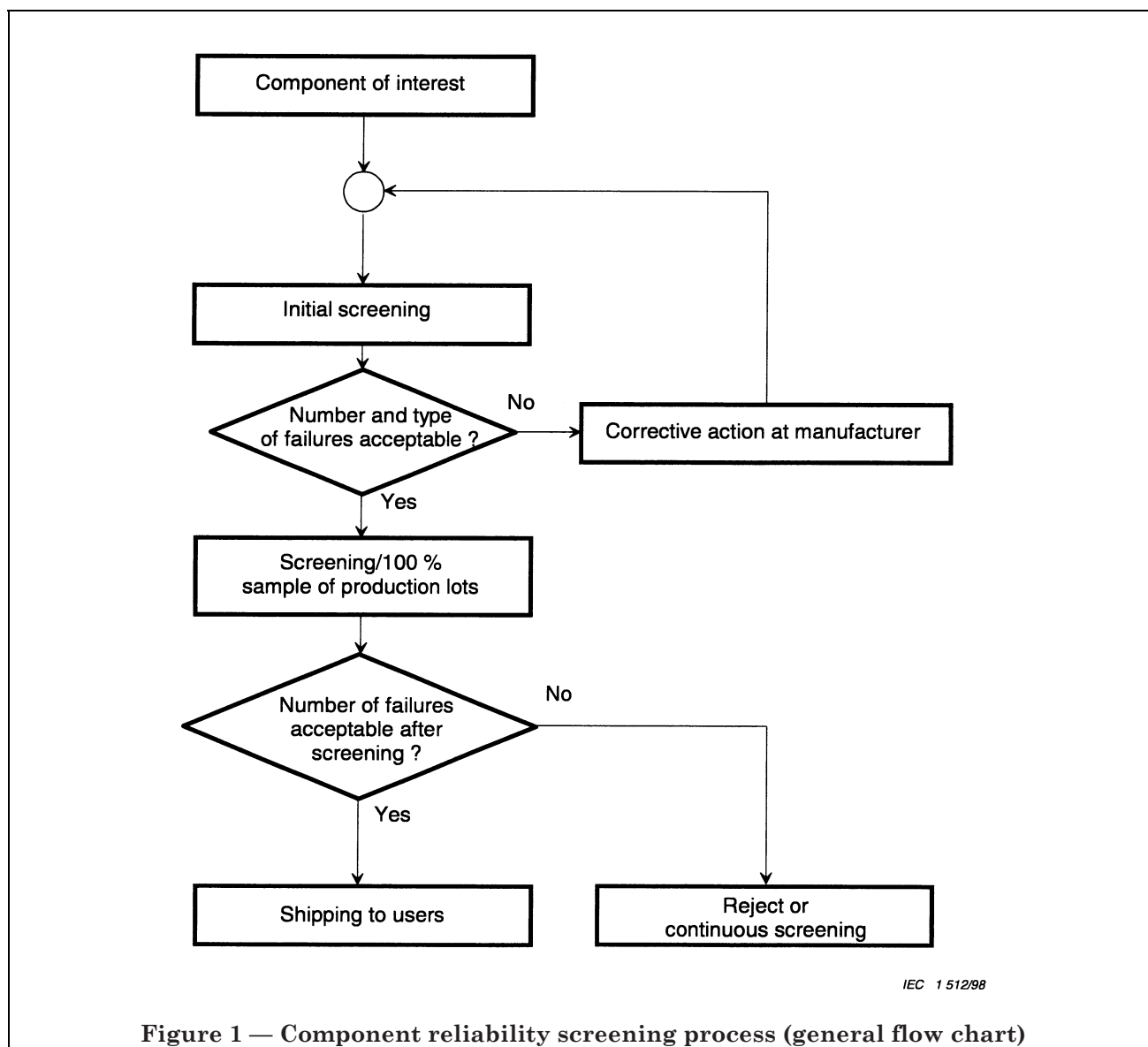
In designing a stress programme, it is important to understand the purpose of the programme as to whether it is:

- a) to improve the process capability by understanding and eliminating causes of failures;
- b) to achieve tighter performance on screened devices compared to published specifications;
- c) to understand and improve reliability of new device technologies;
- d) to remove weak devices which may fail early.

It is important to note that there are two types of failures:

- time-dependent failures; the mechanisms that cause these failures are stress-dependent and will cause degradation of the device given sufficient time. The techniques used to accelerate these failure mechanisms should not affect good devices;
- time-independent failures; these failure mechanisms are due to latent flaws that do not affect devices in normal operation unless induced by some external events. Care should be taken when choosing the techniques used to accelerate these failures since damage to good components is possible if the screen is too harsh.

In all the above cases, the screening will start at 100 %, gradually reduce and finally be eliminated after analysis of failures is made and follow-up actions are taken.



It is important that the aim for a reliability stress screening be carefully considered. No reliability stress screening procedure should be used routinely. There is to be a clear reason why reliability stress screening is chosen (for example economic reasons). In order to get the best possible results from a stress screen, it is necessary to fully understand the failure mechanisms of the components to be screened and how the application of any particular screen will affect these mechanisms. Care should be taken so that only the failure mechanisms likely to occur while the component is operating in the field are accelerated by the screen, since it is relatively easy to induce unlikely failure mechanisms by misapplication of screening stress.

Before and after any screen is applied, functional testing of each part to be screened should be performed. Firstly, this testing is done so that only those parts that fail as a result of the stress screen should be recorded as failing for that reason. Secondly, the stress screen is applied to every component for the specified period of time and under the specified conditions. Thirdly, every component is tested functionally again, in order to remove any failed parts from the good product population. Functional testing may not be sufficient for components which are particularly delicate or costly, such as lasers. In these cases, a parametric test may be necessary.

The reliability stress screening performed in this manner can be used to determine the yield of the screen for the lot of components screened. This screen yield data may be compared to data for yield without screen application and both these types of data may be compared in turn to system yield data, and ultimately to system field return data, all in order that the effectiveness of the screen may be monitored.

In order to use reliability stress screening of electronic components effectively, the type of failure(s) expected should be understood. Then the details of the stress screen programme, including stress levels and screen durations, should be planned.

The reliability stress screening methodology cannot be described in detail since there are many different component types. Therefore, it is not advisable to comprehensively list reliability screening procedures for particular component types. A general procedure, however, can be recommended for designing a specific reliability stress screening plan (see 4.2). It is important to note that all the steps of such a procedure need not be used in designing every reliability stress screening plan.

#### 4.2 Programme definition

The following procedure for setting up and running a reliability stress screening process is recommended:

- establish contact between the two parties involved
- identify the possible flaws and failure modes for each component
- select stress types, stress levels and stress sequence to be used in order to precipitate failures
- determine the duration of the reliability stress screening process
- mathematically analyze initial test results
- perform failure analysis
- perform stress sequence on the components
- determine approval or rejection criteria
- develop closed-loop corrective action process
- provide feedback to the component manufacturers
- discontinue the reliability stress screening process

In the following subclauses, each step is discussed. Annex C gives examples of how a reliability stress screening process could be designed for different component types. These examples should not be used uncritically for reliability stress screening of components of the same family, but only regarded as illustrations, of the step-by-step method described in the following subclauses.

#### 4.3 Establish contact between the two parties involved

Before performing a reliability stress screening process, it is necessary to gather as much information about the component to be screened as possible. This can best be achieved by contacting the component manufacturer. The manufacturer will be aware of all the processes used in the production of the component and how they affect the end product. He will be able to provide insight into the failure modes and mechanisms that may be expected from good components as well as from less robust components. Information on methods of diagnosing flaws without having to perform a stress test may also be available.

In some cases, it may prove more economical to allow the component manufacturer to perform the stress test, as he will inevitably be performing such tests already. If stress testing by the component manufacturer is unavailable for some reason, then useful information about the design and operation of a stress test may be obtained from him.

#### 4.4 Identify the possible flaws and failure modes for each component

After contact with the manufacturer, a list of the potential flaws in the component should be developed. Table A.1 shows potential flaws for different generic component types and technologies. If experience from failure analysis of failed components exists, this will give important information about possible flaws. After the potential flaws have been listed, each should be evaluated to determine if the flaw will develop into a failure in the environment of the finished product. Further, the aim of the reliability stress screening process should be taken into account. This evaluation results in a list of potential flaws with their probability of occurrence.