

# Dependability management —

## Part 3-7: Application guide — Reliability stress screening of electronic hardware

ICS 03.120.01; 31.020

# National foreword

This British Standard reproduces verbatim IEC 60300-3-7:1999 and implements it as the UK national standard.

The UK participation in its preparation was entrusted by Technical Committee DS/1, Dependability and terotechnology, to Subcommittee DS/1/1, Dependability, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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## Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

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## Summary of pages

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**Dependability management –**

**Part 3-7:  
Application guide –  
Reliability stress screening of  
electronic hardware**



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## CONTENTS

|                                                                                             | <b>Page</b> |
|---------------------------------------------------------------------------------------------|-------------|
| <b>FOREWORD</b> .....                                                                       | <b>3</b>    |
| <b>INTRODUCTION</b> .....                                                                   | <b>4</b>    |
| <b>Clause</b>                                                                               |             |
| <b>1 Scope</b> .....                                                                        | <b>5</b>    |
| <b>2 Normative references</b> .....                                                         | <b>5</b>    |
| <b>3 Definitions</b> .....                                                                  | <b>6</b>    |
| <b>4 Acronyms</b> .....                                                                     | <b>8</b>    |
| <b>5 General considerations for a reliability stress screening programme</b> .....          | <b>9</b>    |
| <b>6 General information about the reliability stress screening process</b> .....           | <b>9</b>    |
| <b>7 Analysis of the benefits of the reliability stress screening process</b> .....         | <b>10</b>   |
| <b>8 Characteristics of a successful reliability stress screening programme</b> .....       | <b>10</b>   |
| <b>9 Screening types</b> .....                                                              | <b>11</b>   |
| <b>10 Screening levels</b> .....                                                            | <b>13</b>   |
| <b>11 Screening strength</b> .....                                                          | <b>14</b>   |
| <b>12 Selection of screens</b> .....                                                        | <b>14</b>   |
| <b>13 Flaws detected by a reliability stress screening process</b> .....                    | <b>14</b>   |
| <b>14 Pre-production screening process</b> .....                                            | <b>15</b>   |
| <b>15 Planning, performing and eliminating a reliability stress screening process</b> ..... | <b>15</b>   |
| 15.1 General .....                                                                          | 15          |
| 15.2 Step 1 – Identification of objectives and goals .....                                  | 15          |
| 15.3 Step 2 – Screening process design and application .....                                | 17          |
| 15.4 Step 3 – Cost-benefit analysis .....                                                   | 21          |
| 15.5 Step 4 – Preparation of a screening plan .....                                         | 23          |
| 15.6 Step 5 – Screening process data collection, analysis and corrective actions .....      | 24          |
| <b>Figures</b>                                                                              |             |
| <b>1 Levels where reliability stress screening can be performed</b> .....                   | <b>12</b>   |
| <b>2 Reliability stress screening of repairable items</b> .....                             | <b>22</b>   |
| <b>3 Flow chart for control of a reliability stress screening process</b> .....             | <b>25</b>   |
| <b>A.1 Level chosen for the RSS process</b> .....                                           | <b>31</b>   |
| <b>Table A.1 – Relation between the sensitivity of flaws and stresses</b> .....             | <b>32</b>   |
| <b>Annex A (informative) RSS of repairable items produced in lots</b> .....                 | <b>28</b>   |
| <b>Annex B (informative) RSS of electronic components</b> .....                             | <b>33</b>   |

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## DEPENDABILITY MANAGEMENT –

**Part 3-7: Application guide –  
Reliability stress screening of electronic hardware**

## FOREWORD

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International Standard IEC 60300-3-7 has been prepared by IEC technical committee 56: Dependability.

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

| FDIS        | Report on voting |
|-------------|------------------|
| 56/654/FDIS | 56/660/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.

Annexes A and B are for information only.

## INTRODUCTION

With the continuous advancement in electronics technology, especially the usage of new materials and the introduction of new and immature manufacturing processes, stress and time dependent types of physical, chemical and mechanical imperfections are introduced to the electronic hardware. These types of imperfections are called flaws. Based on the operational and environmental stress profiles of electronic hardware, these flaws could manifest as failures during the hardware useful life.

A reliability stress screening process (RSS) is a process which involves the application of operational and/or environmental stress to electronic hardware on a 100 % basis, for the purpose of precipitating inherent, as well as process-induced, flaws while neither destroying nor degrading in a significant way the hardware being stressed. Screening can also be made without increased stress. This screening is based on measurements on primary functional parameters or secondary parameters. Such a screening process is called an indicator screening. A standard on indicator screening is planned.

It is important to emphasize that flaws which can be revealed by functional tests, visual inspection, or other types of conventional quality control procedures, should not be the target of the screening process. The objective of a stress screening process is to focus on flaws which are not revealed by normal methods, and manifest these as failures in the factory rather than in the field. However, the RSS process should not create failure modes other than those normally expected during the operational life of the item.

It is important to point out the difference in interpretation and purpose between a screening process and testing. In spite of the fact that an analysis of screening process data may reveal the weakness of a certain manufacturing process, or a common part failure pattern, the purpose of an RSS process should not be confused with that of environmental qualification tests, reliability tests, factory acceptance tests or any other type of tests. The purpose of these other tests is to demonstrate the conformance of the hardware to design and reliability/quality requirements. In addition, the environments used in the screening process are tailored to precipitate specific flaws and may have no relation to the hardware life cycle environmental profile. In other words, the RSS process is a stimulation process and not a simulation test. However, data from a component RSS process may be used to accept or reject a lot of equipment or components.

## DEPENDABILITY MANAGEMENT –

### Part 3-7: Application guide – Reliability stress screening of electronic hardware

#### 1 Scope

This part of IEC 60300 serves as an application guide to a reliability stress screening process for electronic hardware. The concept, purpose and justification of the screening process are explained. The main elements of a screening programme are stated, together with the general planning procedure. This standard is intended as a guide and should be used in conjunction with one of the IEC reliability stress screening standards, ("tools" in the toolbox concept), referenced in clause 15, based on the screening process application level.

This standard gives guidance in cases where it is essential that early failures be removed from the items manufactured in order to deliver them to the customer when the problems causing the early failures are solved. The standard also gives guidance on where the reliability stress screening should be carried out, i.e. component level, subsystem level, or system level (see figure 1), and can also be used where steps to reduce the risk of early failures are included in a contract.

This standard is aimed at personnel in the contract department, project management, product development, process management, production, quality control and purchasing.

#### 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. 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 60068-2 (all parts), *Environmental testing – Part 2: Tests*

IEC 60747 (all parts), *Semiconductor devices – Discrete devices*

IEC 60748 (all parts), *Semiconductor devices – Integrated circuits*

IEC 60749:1996, *Semiconductor devices – Mechanical and climatic test methods*

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

IEC 61163-2:1998, *Reliability stress screening – Part 2: Electronic components*

ISO 8258:1991, *Shewhart control charts*

MIL STD 750, 2052 *Test methods for semiconductor devices, 2000 series test methods*

MIL STD 883, 2020 *Test methods for microelectronics, 2000 series test methods*

### 3 Definitions

For the purpose of this part of IEC 60300 the following definitions, as well as those given in IEC 60050(191), apply.

NOTE – Terms of particular importance for reliability stress screening of repairable items are quoted with the IEC 60050(191) reference number stated in square brackets. The quotation includes all notes, whether they are relevant to this standard or not. Additional comments to an IEC term, relevant to RSS, are stated as "remark".

#### 3.1

##### **reliability improvement**

a process undertaken with the deliberate intention of improving the reliability performance by eliminating causes of systematic failures and/or by reducing the probability of occurrence of other failures [IEV 191-17-05]

Remark – Reliability stress screening reduces the probability of occurrence of other failures. The systematic failures are principally catered for by a reliability growth programme, but some may appear during the RSS process.

#### 3.2

##### **systematic failure**

a failure related in a deterministic way to a certain cause, which can only be eliminated by a modification of the design or of the manufacturing process, operational procedures, documentation or other relevant factors

NOTE 1 – Corrective maintenance without modification will usually not eliminate the failure cause.

NOTE 2 – A systematic failure can be induced at will by simulating the failure cause. [IEV 191-04-19]

NOTE 3 – Design, in this case, includes hardware and/or software as appropriate.

#### 3.3

##### **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 191-17-02 defines 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 191-14-09 defines the term "screening test". This term, however, is defined too broadly to be applicable in the present context because it encompasses screening for all types of non-conformities. Furthermore, reliability screening is a process, not a test.

NOTE 3 – Environmental test levels, e.g. IEC 60068-2, are often used in the stress screening process in order to use standard test equipment and standard control programmes for the equipment.

#### 3.4

##### **useful life**

under given conditions, the time interval beginning at a given instant of time, and ending when the failure intensity becomes unacceptable or when the item is considered unrepairable as a result of a fault

NOTE – In French the term "durée de vie utile" is the duration of this time interval.  
[IEV 191-10-06]

#### 3.5

##### **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 – The RSS process is designed with the intention of precipitating flaws as detectable failures. An ageing process designed solely with the intention of stabilizing parameters is not a RSS process and therefore outside the scope of this standard.

**3.6****item**

any part, component, device, subsystem, functional unit, equipment or system that can be individually considered

NOTE 1 – An item may consist of hardware, software or both, and may also in particular cases include people.

NOTE 2 – In French the term "entité" is preferred to the term "dispositif" due to its more general meaning. The term "dispositif" is also the common equivalent for the English term "device".

NOTE 3 – In French the term "individu" is used mainly in statistics.

NOTE 4 – A number of items, e.g. a population of items or a sample, may itself be considered an "item".

[IEV 191-01-01]

NOTE – In the context of a reliability screening process, only the hardware part of an item is relevant. Current examples are electronic components, assemblies, equipment and hardware parts of systems.

**3.7****weak item**

an item which has a high probability of failure in the early failure period due to a flaw (see also 3.15, early failure period)

**3.8****component**

a single item which is not intended to be repaired

**3.9****weakness**

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

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

**3.10****weakness failure**

a failure due to weakness in the item itself when subjected to stress within the stated capabilities of the item

NOTE – A weakness may be either inherent or induced.

[IEV 191-04-06]

**3.11****flaw**

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

NOTE 1 – A flaw is localized in a component or caused by interaction between components with characteristics close to the margins of the design requirements.

NOTE 2 – An interaction between components can for example be caused by tolerances in the parameters of the components (e.g. resistance, capacitance or time delay). This interaction will have to be corrected by a design change. The RSS process will however be able to screen away the items where the combinations of the tolerance values cause failures. Interconnections, such as connectors and sockets, are defined as components. Solderings are considered a part of the component when it is mounted in an assembly.

**3.12****inherent flaw**

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

**3.13**

**induced flaw**

a flaw in an item related to assembling, testing, handling or other manipulations of the item after it has been manufactured

NOTE – The induction may for example take place at the component manufacturer's plant, during transportation or at the system manufacturer's plant.

**3.14**

**flaw density**

the average number of flaws in a population of items (component, assembly, subsystem or system), under consideration

**3.15**

**early failure period**

that early period, if any, in the life 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 when the weak items fail.

**3.16**

**screening strength**

a measure of the capability of a screening process designed with specified parameters, to precipitate flaws into failures

NOTE – The screening strength is a function of the type of screening as well as the screening parameters.

**3.17**

**screening relevant failure**

a failure brought about by the screening process as a result of one or more flaws

**4 Acronyms**

- 4.1 ATE: automatic test equipment
- 4.2 BITE: built-in test equipment
- 4.3 ESD: electrostatic discharge
- 4.4 HASS: highly accelerated stress screen
- 4.5 MOSS: multi-operational stress screening
- 4.6 PCB: printed circuit board
- 4.7 PIND: particle impact noise detection
- 4.8 PWA: printed wiring assembly
- 4.9 RSS: reliability stress screening
- 4.10 SMT: surface mount technology

## 5 General considerations for a reliability stress screening programme

An RSS programme should not be required in a contract unless it is a necessity to achieve the required reliability level concerning early failures. One or more of the analyses described in clause 7 combined with a specified maximum level of early failures should be stated instead.

If a conflict should arise between this International Standard and the relevant contract or specification(s), the latter should apply.

Since this standard requires the stress screening programme to be tailored to a specific item, several issues have to be agreed upon between the customer, the manufacturer, and an independent reliability screening laboratory (if any). All contracts or RSS plans should refer to this International Standard and any other International Standard on the subject of the RSS to be employed.

In addition, the party given the discretion and the areas in which discretion is to be exercised should specifically be mentioned in the contract or RSS plan in the following cases:

- when selecting, modifying or deleting a specific RSS process;
- when optimizing the duration of the stress screening process;
- when changing the screening process to a sample;
- when accepting or rejecting a lot on the basis of the screening process.

Furthermore, the following recommendations apply:

- where specific reliability stress screening processes or special control and optimization procedures have to be agreed to, the agreements should be stated in an annex to the contract or RSS plan;
- where any matter requiring agreement has not been resolved, it should be specifically identified in the contract or RSS plan, and suitable provisions, including deadlines for agreement and dispute resolution procedures, should be stated.

In all instances, the applicable contract or subcontract should identify the party responsible for performing the RSS, the party liable for the consequences of failing to perform the RSS appropriately or the consequences of the system failing to comply with the specifications, the scope or limitations of such liability, and the nature of, or limitations on, remedies available to the damaged party.

## 6 General information about the reliability stress screening process

As a result of the reliability growth process, hardware will normally mature to its predicted, or inherent, design reliability level by the end of the development cycle. However, this inherent reliability level is very difficult to maintain because it is often degraded by the introduction of different manufacturing processes. A well designed stress screening programme will help to preserve this inherent reliability level.

Forcing flaws to manifest themselves as failures in the factory rather than in the field will increase productivity, reduce warranty cost, and improve customer satisfaction. This will enhance the manufacturer's reputation in the eyes of the user and improve the overall life cycle cost of the product.

The data generated by the screening process may also be used to improve the product. RSS failure information can highlight workmanship problems or identify unqualified parts/material suppliers. By addressing these deficiencies, product quality will be enhanced and screening process costs may be reduced and/or the screening process eliminated.

The RSS process should always be regarded as a temporary measure that allows the manufacturer to deliver items with an acceptable quality to the customer, while at the same time solving the problems in design, raw materials, components and processes that cause early failures in the finished item. The aim should always be to eliminate the RSS process or reduce it to a sample of the finished items.

When performing an RSS process on a sample of the items, it can be regarded as a screening process of production lots, since the purpose of the RSS process on a sample is to identify production lots with too high a percentage of early failures. The RSS process may then be reintroduced on a 100 % basis to the identified lots and to the following lots in the production. In case the production is not divided into lots, a fictive lot may be identified, as for example a week or a day's production. For an RSS process of single items, each individual item should be considered separately.

## **7 Analysis of the benefits of the reliability stress screening process**

As with any other manufacturing process, the reliability stress screening process costs money, and is considered a separate activity, with time and milestones allocated in the schedule.

Accordingly, at least one of the following analyses should be performed to ensure cost effectiveness before a decision is made to implement an RSS programme:

- a) an analysis which indicates that the reliability contract requirements will not be achieved unless a stress screening programme is implemented;
- b) a cost-benefit analysis which clearly indicates the advantage of the stress screening process over any other alternative;
- c) a field data analysis, when available, that reveals an unacceptable level of early failures causing high warranty cost and/or customer dissatisfaction.

## **8 Characteristics of a successful reliability stress screening programme**

Once it has been determined that an RSS screening process is appropriate (see clause 7), the following elements should be addressed to ensure that an effective RSS programme is implemented:

- a) the screening process should be tailored, based on the type of hardware and the applicable manufacturing processes. Accordingly, a thorough knowledge of the materials/parts involved, their properties, failure mechanisms and manufacturing processes is essential;
- b) quantitative goals should be set for the screening process;
- c) the screening programme should be dynamic. This means that the process should be continuously monitored and changes made, if necessary, based on the analysis of the data resulting from the screening process. Without such dynamism, the screening process may not be cost effective, and the screening process goals may not be achieved;