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Reliability aspects for electronic components

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à la fiabilité des composants
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Anwendung von "EN ISO 9000:1994"
Kriterien für die Zuverlässigkeit von
elektronischen Bauelementen



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CENELEC

European Committee for Electrotechnical Standardization
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FOREWORD

This CECC Guidance Document was prepared by CLC/TC CECC WG Reliability.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as CECC 00 804 on 1995-11-28.

This document is a revision of CECC 00 804:1994. This second issue is now consistent with EN ISO 9000:1994. The title has been modified to reflect this. Amendments have been made to the text to enhance clarity.

The following dates were fixed:

- latest date by which this document has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 1996-06-01
- latest date by which the national standards conflicting
with this document have to be withdrawn (dow) 1996-06-01

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SECTION A - GUIDE

INTRODUCTION

0.1 General introduction to CECC 00 804

EN 100114-1 provides the basis for all CECC approvals. It incorporates the requirements of EN ISO 9000:1994 which is widely acknowledged as setting the ground rules for an organisation's quality system. It may also be used as the basis for defining policy and procedures relating to product reliability.

Many components fail (i.e. exhibit inadequate reliability) due to inadequate procedures in design, test, customer interface, etc. This guide assists in identifying such procedural deficiencies and provides guidance on the reliability aspects of EN ISO 9000. General guidance in applying EN ISO 9000 to the electronics components industry is under consideration. Process assessment schedules in the CECC 200 000 series give additional guidance for specialist processes and services.

Attention is also drawn to CECC 00 809: GUIDANCE DOCUMENT, QUESTIONNAIRE FOR AUDITING IC AND ASIC MANUFACTURING LINE (based on EN 190 000).

CECC 00 804 is intended as guidance material for use by engineers, technicians and managers throughout the industry. It is issued as a single document containing the following sections:

Section A - Guide: This section helps organisations to prepare for assessment against the Section B Check List by posing secondary questions and identifying possible acceptable answers. The application of the Check List and Guide by different organisations is described in clauses 0.2 to 0.4 below.

Section B - Check List: This section provides a set of questions to be used in assessing an organisation's competence in reliability matters.

CECC 00 804 is supported by CECC 00 805: General Guide to Component Reliability, which describes the principles and concepts behind this guide and explains relevant terminology, objectives and 'best practices' associated with component reliability.

This Issue 2 is now consistent with EN ISO 9000, and the title has been modified to reflect this. Amendments have been made to the text to enhance clarity.

0.2 Application of CECC 00 804 by component manufacturers and specialist contractors

By applying this guidance information whilst developing and documenting those procedures necessary to gain CECC approval, component manufacturers and specialist contractors can do much to ensure the reliability of their product or service. The questions are designed to focus the mind of personnel in all parts of the organisation so that appropriate reliability issues are continually considered as objectives of their activity.

The check list is thus best used for internal audit purposes to assess the current level of competence and to indicate areas for improvement.

0.3 Application of CECC 00 804 by other organisations

Whilst the prime use of this guide is likely to be in the assessment of component suppliers or of potential suppliers, much of the guidance given can also be used by other organisations.

Attention is drawn to IEC 300-1 / ISO 9000-4 "Application (of ISO 9000) for Dependability Management", which states:

"It (dependability assurance) is a responsibility to be shared by the supplier and customer."

The adoption of similar approaches and close liaison between component manufacturer and customer will do much to reduce the confusions which often lead to unreliability.

0.4 Application of CECC 00 804 by auditing bodies

When used by auditing bodies, whether second or third party, this guide helps to maintain consistency between auditors.

GUIDANCE**1 Management responsibility****1.1 Does the company have a reliability policy?**

Has the company consciously addressed reliability? Ideally, there should be a policy statement, signed by a senior executive.

1.2 Who has overall responsibility for implementation of this policy?

Who has responsibility is not as important as the fact that a responsible person with sufficient authority has been identified and made known. This responsibility may change through the life cycle of the product, e.g. from design to production manager.

1.3 Can suspect reliability be used as a justification for stopping of production?

Can production be stopped or other action taken to prevent suspect items from being released to the customer? Ideally continuous monitoring of reliability should prevent the need for such action, but there is a need for a staff member of sufficient authority to warn of the risks of releasing items where reliability may not satisfy customer expectations.

1.4 Is the reliability organisational structure clearly defined?

Again, the issue is not so much what the structure is, but whether that structure is defined and known to all involved. Organisational charts should clearly indicate the division of responsibilities.

1.5 Who has responsibilities for liaison with customers on reliability issues?

It is important that all customer needs are understood and communicated to the design and production teams. There is a particular difficulty with reliability since each market tends to have very specific requirements. The reliability of components supplied to a given customer depends not just upon the system's electrical and mechanical design, but also upon the environment in which it will work.

The relevant experience necessary to perform this function includes:

- a) An understanding of the product, processes and typical failure mechanisms.
- b) An understanding of typical customer requirements and field conditions.

1.6 How are the reliability functions integrated?

It is vital that reliability functions are an integral activity with all design and manufacturing processes. This is particularly important where a separate group exists which provides the reliability expertise because only by good engineering will high reliability be achieved. Similarly, there is a close relationship between quality and reliability and it may be beneficial in some cases for quality and reliability plans to be combined so that possible duplications and/or confusions are avoided.

1.7 Who has responsibility for reliability verification?

Within the organisation consideration should be given to the verification tasks which have to be undertaken to ensure that the delivered products will satisfy its reliability objectives.

2 Quality system (Not applicable)**3 Contract review**

NOTE: This section only applies to contracts for component development and to production contracts in which the customer has included reliability requirements.

3.1 Are contracts vetted for acceptable reliability clauses?

As stated in 1.5, the first and most significant stage in satisfying a reliability requirement is to understand what those requirements are. At the electronic system level, it is becoming increasingly common for contracts relating to major development projects to include penalty or bonus clauses related to reliability.

Definition of reliability / performance according to the "IEC 191-02-06, Dependability Terms": "The ability of an item to perform a required function under given conditions for a given time interval". - By considering this definition it can be clearly seen that a contract must define:

- a) A value of intrinsic reliability usually expressed as a failure rate based on an assessment of components.

- b) The functions that are to be performed by the device
- c) The environment to which the product is subjected. This includes the electrical and mechanical environment as well as temperature, vibration, and humidity aspects.
- d) The time interval for which a) above is applicable. In some cases there may be different reliability values for different time intervals. In particular, a shelf life, if applicable, needs to be clearly specified.

It can be very useful, particularly for complex devices, to also define the functions and environments in which the device will not function, i.e. the definition of the term 'failure'.

For high reliability components it may be more realistic to define the reliability activities which will be performed, rather than failure rate/probability requirements. Whatever clauses the customer inserts, however, it is vital that the contractor understands what is expected of him before the contract is accepted. Guidance on the specification of component reliability is given in CECC 00 805.

The person vetting such contracts should have sufficient understanding of reliability to highlight any subsequent implications. For example, reliability demonstrations arising out of customer requirements are often extremely costly and time consuming. All assumptions made (e.g. number of samples, temperatures and durations of tests, etc) should be clearly stated and agreed if extra costs are not to be incurred. Further guidance on the definition and execution of reliability demonstration programmes are given in CECC 00 805.

3.2 Are contract negotiations used as a means of:

- a) Improving vendor/customer liaison?
- b) Clarifying conditions of use of product and identifying key customer hazards?
- c) Clarifying and specifying reliability requirements?

Overly simplistic or complex reliability targets should be avoided. A component manufacturer will typically have defined his design rules to meet in-house reliability targets. Procedures should ensure that all relevant figures are consistent. You cannot, for example, compare a 'time to 2% failures' with a FIT rate (failure in 10^9 hours) unless an assumed failure distribution is stated. Further guidance on the specification of reliability targets is given in CECC 00 805.

- d) Emphasizing the need for feedback?

In addition to understanding customer requirements and agreeing to assumptions on demonstration testing, etc., contract negotiations may be used as an opportunity to encourage the feedback of reliability data. Often the only true measure of component reliability is how well it performs in actual use. This information is only available from the customer. It is thus perfectly reasonable for a component manufacturer to negotiate, as part of his commitment to achieving reliability goals, on the feedback of reliability data.

Usage quality and reliability improvement is possible when the manufacturer knows what is failing and how. The return of failed devices with supporting information is one way in which a customer can demonstrate his commitment to joint action on reliability.

3.3 Is there any specific documentation defining project related reliability activities?

An integrated reliability programme, tailored to the needs of the product, should be included as described in IEC 300-1 and IEC 300-2. Procedures should be available which require the definition of reliability tasks on every development programme. This may be covered by project milestone definitions or by including reliability activities in quality plans. Activities required might be risk analysis, FMECA, FTA, etc; further guidance and references to other international specifications are given in CECC 00 805. Separate tasks by independent reliability experts is only one means of satisfying this clause. Integrating of reliability activities into other tasks may be more effective. Design reviews may, for example, ask all relevant questions.

4 Design control**4.1 Is reliability fully integrated into the design process?**

Is reliability a discipline addressed at design conception as opposed to being introduced as the design approaches completion? Are trade-off studies conducted where performance, cost and reliability are given equal merit? For designs being developed at the boundaries of existing design rules (or where design rules have yet to be established), it is important that reliability verification is thoroughly undertaken. Similarly, models such as ones which deduce the AC hot-carrier degradation lifetime, need to be treated with caution until fully verified by reliability testing. Note that reliability testing involves defining the functions and environments as well as failure rates and time scales.

4.2 Are known failure mechanisms:**a) included in design rules?**

What design/layout rules for processes and components are used and how are they established? In that early life (reliability) failures and process failures are often due to the same mechanisms, reliability design rules and those related to process limits and spreads are closely associated. In addition, design rules aimed at avoiding specific reliability hazards may be necessary, e.g. use of a standard static protection circuit.

b) categorized in order of predominance?

Examples might be dielectric breakdown, electromigration, etc. Whether these failures relate to early-life, useful life or the wearout period of a component should be understood.

c) modelled and/or simulated?

Does the manufacturer understand those degradation mechanisms that most affect his product or process? Does he have a documented physical and/or mathematical model for each mechanism. Where a recognized model exists, has this been incorporated into circuit level simulator? Realistically, computer aided reliability simulation is unlikely for most mechanisms, but procedures should exist that ensure that designs are such that predominant failure mechanisms will not occur.

4.3 Do models and design rules adequately reflect real products in real applications?

Testing to confirm a particular model or design rule usually considers the effect of varying only a small number of parameters, such as stresses. However, in practice, many parameters are involved and in some cases the interaction between these parameters may be of greater significance. Hence real time testing of real products in real applications are necessary to corroborate the design rules/models. Normal CECC qualification and Capability Approval Testing may help to provide this evidence. Testing may be of CQC's (Capability Qualifying Components), product or other test structure. It should be noted