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Long duration storage of electronic components - Specification for implementation



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# Long duration storage of electronic components – Specification for implementation

Stockage longue durée des composants électroniques –
Guide de mise en oeuvre

Langzeitlagerung von elektronischen Bauelementen –
Spezifikation für die Ausführung



This Technical Specification was approved by CENELEC on 2005-12-03.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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## Foreword

This Technical Specification was prepared by the Technical Committee CENELEC TC 107X, Process management for avionics.

The text of the draft was submitted to the formal vote and was approved by CENELEC as CLC/TS 50466 on 2005-12-03.

The following date was fixed:

| | | |
|---|---|---|
| – latest date by which the existence of the CLC/TS has to be announced at national level | (doa) | 2006-06-03 |

This document, which is in line with IEC/PAS 62435 relating to the management of obsolescence of electronic components, is first of all a practical guide to methods of long duration storage (more than 5 years) which summarizes the existing practices in the industry.

The application of the approach proposed in this guide in no way guarantees that the stored components are in perfect operating condition at the end of this storage. It only comprises a means of minimizing potential and probable degradation factors.

Unless otherwise specified, the approach, as well as the methods presented apply to all families of electronic components:



– passive components, including quartz crystals, connectors and relays. However, components with "manufacturer's" specifications showing an expiry date, or specific storage conditions, are excluded from this guide (e.g. primary cells, storage cells, etc...),

– encapsulated or non-encapsulated active components of a silicon [Si] or gallium arsenide [GaAs] technology,



– micro-electronic assemblies.

## Contents

## 1 General

Although it has always existed to some extent, obsolescence of electronic components, and particularly integrated circuits, has become increasingly intense over the last few years.

Indeed, with the existing technological boom, the commercial life of a component has become very short compared with the life of industrial equipment such as those encountered in the aeronautical field, the railway industry or the energy sector.

The many solutions enabling obsolescence to be resolved are now identified. However, selecting one of these solutions must be preceded by a case by case technical and economic feasibility study, depending on whether storage is envisaged for field service or production.

Remedial storage as soon as components are no longer marketed.

Preventive storage anticipating declaration of obsolescence.

Taking into account the expected life of some installations, sometimes covering several decades, the qualification times, and the unavailability costs, which can also be very high, the solution to be adopted to resolve obsolescence must often be rapidly implemented. This is why the solution retained in most cases consists in systematically storing components which are in the process of becoming obsolescent.

The technical risks of this solution are, a priori, fairly low. However, it requires the perfect mastery of the implemented process, and especially of the storage environment, although this mastery becomes critical when it comes to long term storage.



All handling, protection, storage and test operations should be performed in accordance with the technology requirements of the component.



## 2 Normative references

The following referenced documents are indispensable for the application 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.

EN 190000:1995, *Generic specification: Integrated monolithic circuits*

EN 60068-2-17:1994, Environmental testing - Part 2: Tests - Test Q: Sealing (IEC 60068-2-17:1994)

HD 323.2.20 S3:1988, *Basic environmental testing procedures - Part 2: Tests - Test T: Soldering* (IEC 60068-2-20:1979 + A2:1987)

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

## 3 Storage decision criteria

Before taking the decision to store electronic components the following should be reviewed.

– On the one hand, after having compared with the following additional solutions:
  - modification to the printed board by adding a "backpack" macro-component,
  - development of a specific ASIC,
  - production re-launched at a manufacturer specialized in the resumption of obsolete technological processes and components,
  - complete revision of the board or the equipment.

– On the other hand, by taking into account the following aspects:

### 3.1 Advantages of storage

#### 3.1.1 Technical simplicity – Rapidity

When the various steps of the storage process are finalized and validated, the creation of a stock is a simpler, faster and technically less hazardous solution than developing or modifying electronic boards.

Storage can also be a temporary solution enabling equipment maintenance and production continuity during modification or development of superseding electronic boards.



#### 3.1.2 Solution durability

Any equipment changes based on the use of new electronic components will be faced, eventually, with the obsolescence of these new components. Storage can resolve obsolescence problems until the end of the operating life of the equipment.



#### 3.1.3 Preventive storage

Preventive storage (i.e. before the component becomes obsolete) presents several additional advantages compared with remedial storage (i.e. when the component has already become obsolete):

– the component price has not become prohibitive as in the case of specific obsolete components which have become very rare;
– the quality level is ensured if the component can be directly purchased from the manufacturers' or at approved distributors'. When a component has been obsolete for a long time, it can only be found at specialists' in purchasing, storage and resale of obsolete components ("brokers"). In this case, no component reliability guarantee will apply. These components must have traceability back to the original manufacturer.

### 3.2 Hazards – Drawbacks

#### 3.2.1 Generic aging hazard

Stock dimensioning is based on the assumption of a constant component failure rate. The problem of generic aging of the components ("bath tub curve") cannot be easily taken into account and quantified. However, the current electronic components seem to have extremely long lives provided that they have been manufactured with their quality assurance guaranteed, and that they are used in accordance with their specifications.

### 3.2.2 Poor stock dimensioning

The calculation of the number of components to be stored may be based on feedback (operational failure rate) and/or on theoretical models (predictive failure rate). Calculation using feedback is only valid if the sample is big enough (significant population of components installed, operation for several years, high number of failures evidenced). Predictive calculations do not generally take into account the extrinsic parameters of the components (defects caused by printed board handling and repair, systematic replacement of the components (including functional components) during repairs, improper use of the components, etc.). Therefore the stock volume may be improperly assessed.
Underestimating the stock may lead to a lack of components to repair printed boards, which will ruin the stock strategy. Overestimating it will lead to the purchasing and conditioning of components which will not be used, including to significant additional costs.

### 3.2.3 Incorrect control of reliability during storage

Storage conditions must be precisely defined and controlled, in order to guarantee the reliability of the components stored (refer to Clause 5). In addition, it is important to check the quality of the components to be stored (refer to Clause 4). This may lead to the setting up of fairly heavy and costly infrastructure and procedures.
Checking component quality may be an efficient means of reducing the risk of improper reliability control during storage. This can be done either by performing periodic sampling in order to carry out tests on the components (refer to Clause 6) or by checking that the components taken from the stock and used on the electronic boards operate correctly (provided that the consumption of the components in stock is sufficiently regular).



### 3.2.4 Freezing equipment functionalities



Storing components to ensure equipment maintenance over a long time implies that the equipment functionalities be frozen. A long-duration storage solution is therefore not very compatible with the wish to upgrade equipment and functionalities.

## 3.3 Storage cost (Annex C)

In order to assess the cost of a storage solution, various items should be taken into account, such as:

- component purchasing;
- validation / test of purchased component batches;
- conditioning and deconditioning;
- test equipment for periodic sampling will have to be maintained;
- stock management;
- maintenance of installations dedicated to storage by means of manufacturing tests and/or repair;
- staff ensuring storage, maintenance operations, etc.;
- financial cost of tied up stocks.

## 3.4 Decision criteria

- planned storage time
- stock dimensioning
- dimensioning reliability index
- life of test means

– life of manufacturing means and/or printed boards
– competence traceability and related documentation
– industrial consequences of underdimensioning or a component failure at the end of storage
– confidence level in the knowledge of potential component failure mechanisms
– cost compared with other solutions

# 4 Purchasing procurement

## 4.1 List of components

A detailed list of the components used should be established. It should include the designations, specifications, manufacturers and the corresponding trade references.
This list must be related to the various lists of electronic boards (by means of either a procurement code, or a generic designation).

The purpose of this list is to:
– define all components of a market or a series of equipment;
– allow component approval at the beginning of their design stage;
– allow field service procurement.

An example of this list is appended (see Annex A).
An example of an individual component format is given (see Annex A).
These records shall, as far as possible, indicate the probable life cycle of each component over a 10-year period.



## 4.2 Quantity of components to be stored

There are two types of requirements:
– production stock
– field service stock

Special attention will be paid to:
– components with specific requirements,
– single-source components,
– components becoming obsolete before end of equipment production.

Care will also need to be taken to make sure that the stored quantities take into account parts used for tests considered as destructive.

### 4.2.1 Production stock

This stock shall guarantee current production in progress and any future production. (if there is a future production requirement).

### 4.2.2 Field service stock

This stock shall enable components to be kept operational during the whole life of the equipment and systems (e.g. 25, 30, even 40 years for military, railroad or nuclear power plant equipment).

A stock of the various component types must be made up from the parts lists, the bills of material and feedback (including observed failure rate).

ASSESSMENT EXAMPLE:
These batches of parts, calculated as per the following formula, should not be less than 3 % of the total number of components installed (the higher of the two values) on the relevant equipment:

$$N_o = N * h * \lambda * A$$

$N_o$ : stock quantity.
N : number of components in service.
h : number of operating hours per year.
A : number of years during which the requirement for these components must be guaranteed.
$\lambda$ : operational failure rate of the component, if known. Otherwise, the predictive failure rate is used. It is given either in a reliability data handbook (IEC/TR 62380), or by the manufacturer.

### 4.3 When is it worth keeping in stock?

Depending on the component type:

The procurement of specific components should be launched at the latest at the same time as the last component production batch.



If it is a single source component, the order shall be launched in the time prescribed by the manufacturer.



### 4.4 Procurement recommendations

Every component batch should be clearly identified.

No batch should have date-codes older than 2 years at time of delivery.

All batches will be accompanied by all necessary documents (certificate of compliance, electrical test results etc.) to ensure traceability of the components.

Components will be delivered, if required, in packages guaranteeing ESD protection and protection against humidity.

Packages will be correctly identified (date-code, manufacturer, component reference).

## 5 Technical validation of the components

### 5.1 Purpose

The purpose of the technical validation of the components with a view to their storage is to detect a priori the batches which do not offer proper reliability and life guarantees.

### 5.2 Relevant field

All electronic components (passive as well as active) are relevant.

However, active semiconductor components are the most affected by the obsolescence issue. This is why, in the following paragraphs of this chapter, we will only deal with active component validation methods.

The methods to be applied for passive components, save a few adaptations specific to their technologies, are directly applicable.

### 5.3 Test selection criteria

The first thing to be taken into account is selection of the tests to be implemented before storing components and to have these components qualified initially, dependant on the profile of their expected mission.

In addition, in the case of multiple-source components, the selection of the sources must have been validated by a method capable of detecting "false" second sources.

The selection of the required tests and measurements will depend on the storage strategy adopted. It can cover a range from a minimal utilization with no tests to a maximal utilization, where all tests described in this chapter would be performed.

As a whole, the technical validation of the components requires the following items to be checked:

a) compliance with the visual inspection criteria,
b) solderability checking,
c) sealing/hermeticity checking (for components with hermetic packages),
d) compliance with the electrical specifications in the temperature range,
e) checking of manufacturing control (technological analysis),
f) checking of the supplied batch reliability.



The criteria for sanctions and the number of tested components may vary depending on the requirements and level of reliability, as well as the data collected from the manufacturer. At the end of the technical validation, a status is established for this batch in order to decide on its storage capability.

### 5.4 Measurements and tests

#### 5.4.1 Sampling

Generally measurements of the component electrical parameters are performed on 100 % of the batch. However, if a batch is too large and depending on the storage strategy adopted, the measurements can be made by sampling.

The sampling plan shall, in this case, adhere to the rules defined in the standards (for example: IEC 60410).

Visual inspection is normally non destructive but solderability testing may be considered destructive.

The technological analysis is destructive and must be made on a sufficient number of components in order to check compliance with the characteristics required. Generally, 3 to 10 components are submitted to the analysis.

For reliability tests, except for the package sealing test, all other tests are destructive tests.