IEC 62435-6

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electronic components – Long-term storage of electronic semiconductor devices –
Part 6: Packaged or finished devices

Composants électroniques – Stockage de longue durée des dispositifs électroniques à semiconducteurs –
Partie 6: Dispositifs encapsulés ou finis

IEC 62435-6:2018-08(en-fr)

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INTERNATIONAL
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ELECTRONIC COMPONENTS – LONG-TERM STORAGE OF ELECTRONIC SEMICONDUCTOR DEVICES –

Part 6: Packaged or finished devices

FOREWORD

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International Standard IEC 62435-6 has been prepared by IEC technical committee 47: Semiconductor devices.

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

FDIS	Report on voting
47/2482/FDIS	47/2495/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62435 series, published under the general title *Electronic components – Long-term storage of electronic semiconductor devices*, 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 "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This document applies to the long-term storage of electronic components.

This is a standard for long-term storage (LTS) of electronic devices drawing on the best long-term storage practices currently known. For the purposes of this standard, LTS is defined as any device storage whose duration can be more than 12 months for product scheduled for long duration storage. While intended to address the storage of unpackaged semiconductors and packaged electronic devices, nothing in this document precludes the storage of other items under the storage levels defined herein.

Although it has always existed to some extent, obsolescence of electronic components and particularly of 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 that 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 should be preceded by a case-by-case technical and economic feasibility study, depending on whether storage is envisaged for field service or production, for example:

- 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 should 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 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 are recommended to be performed according to the state of the art.

The application of the approach proposed in this document 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.

Some electronic device users have the need to store electronic devices for long periods of time. Lifetime buys are commonly made to support production runs of assemblies that well exceed the production timeframe of its individual parts. This puts the user in a situation requiring careful and adequate storage of such parts to maintain the as-received solderability and minimize any degradation effects to the part over time. Major degradation concerns are moisture, electrostatic fields, ultraviolet light, large variations in temperature, air-borne contaminants, and outgassing.

Warranties and sparing also present a challenge for the user or repair agency as some systems have been designated to be used for long periods of time, in some cases for up to 40 years or more. Some of the devices needed for repair of these systems will not be available from the original component manufacturer for the lifetime of the system or the spare assembly can be built with the original production run but then requires long-term storage. This document was developed to provide a standard for storing electronic devices for long periods of time. For storage of devices that are moisture sensitive but that do not need to be stored for long periods of time, IEC TR 62258-3 can be consulted.

Long-term storage assumes that the device is going to be placed in uninterrupted storage for a number of years. It is essential that it is useable after storage. Particular attention should be paid to storage media surrounding the devices together with the local environment.

These guidelines do not imply any warranty of product or guarantee of operation beyond the storage time given by the original component manufacturer.

The IEC 62435 series is intended to ensure that adequate reliability is achieved for devices in user applications after long-term storage. Users are encouraged to request data from suppliers to applicable specifications to demonstrate a successful storage life as requested by the user. These standards are not intended to address built-in failure mechanisms that would take place regardless of storage conditions.

These standards are intended to give practical guide to methods of long-duration storage of electronic components where this is intentional or planned storage of product for a number of years. Storage regimes for work-in-progress production are managed according to company internal process requirements and are not detailed in this series of standards.

The overall standard is split into a number of parts. Parts 1 to 4 apply to any long-term storage and contain general requirements and guidance, whereas Parts 5 to 9 specific to the type of product being stored. It is intended that the product specific part should be read alongside the general requirements of Parts 1 to 4.

Electronic components requiring different storage conditions are planned to be covered separately starting with Part 5.

The structure of the IEC 62435 series as currently conceived is as follows:

– Part 1 – General
– Part 2 – Deterioration mechanisms
– Part 3 – Data
– Part 4 – Storage
– Part 5 – Die and wafer devices
– Part 6 – Packaged or finished devices
– Part 7 – MEMS
– Part 8 – Passive electronic devices
– Part 9 – Special cases

ELECTRONIC COMPONENTS – LONG-TERM STORAGE OF ELECTRONIC SEMICONDUCTOR DEVICES –

Part 6: Packaged or finished devices

1 Scope

This part of IEC 62435 on long-term storage applies to packaged or finished devices in long-term storage that can be used as part of obsolescence mitigation strategy. Long-term storage refers to a duration that can be more than 12 months for product scheduled for storage. Philosophy, good working practice, and general means to facilitate the successful long-term storage of electronic components are also addressed.

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 60749-20, *Semiconductor devices – Mechanical and climatic test methods – Part 20: Resistance of plastic encapsulated SMDs to the combined effect of moisture and soldering heat*

IEC 60749-20-1, *Semiconductor devices – Mechanical and climatic test methods – Part 20-1: Handling, packing, labelling and shipping of surface-mount devices sensitive to the combined effect of moisture and soldering heat*

JEDEC J-STD-020, *Moisture/reflow classification for nonhermetic solid state surface mount devices*

JEDEC J-STD-075, *Classification of non-IC electronic components for assembly processes*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1
storage environment
specially controlled storage area, with particular control of temperature, humidity, atmosphere and any other conditions depending on the product requirements

3.2
critical moisture limit
maximum safe equilibrium moisture content for a specific encapsulated device at reflow assembly or rework

3.3
long-term storage
LTS
planned storage of components to extend the life-cycle for a duration with the intention of supporting future use

Note 1 to entry: Allowable storage durations will vary by form factor (for example; packing materials, shape) and storage conditions. In general, long-term storage is longer than 12 months.

3.4
LTS storeroom
area containing components that have additional packaging for storage to protect from moisture or from mechanical impact or for ease of identification or handling

3.5
moisture-sensitive device
MSD
device that has moisture absorption or moisture retention and whose quality or reliability is affected by moisture

3.6
electronic device
packaged electrical, electronic, electro-mechanical (EEE) item, or assemblies using such items

3.7
desiccant
hygroscopic substance used to remove moisture from an atmosphere

3.8
moisture barrier bag
MBB
storage bag manufactured with a flexible laminated vapour barrier film that restricts the transmission of water vapour

Note 1 to entry: Refer to IEC 60749-20-1 for packaging of moisture sensitive products.

3.9
humidity indicator card
HIC
card printed with a moisture sensitive chemical that changes, typically, from blue to pink in the presence of water vapour

3.10
water vapour transmission rate
WVTR
measure of permeability of MBBs to water vapour

3.11
dunnage
all the matter stored in a moisture barrier bag that is additional to the packaged electronic component

3.12
electrostatic discharge
ESD
transfer of electric charge between bodies of different electrostatic potentials in proximity or through direct contact

[SOURCE: IEC 60050-561:2014, 561-03-06]

4 Storage considerations

4.1 Failure mechanisms

4.1.1 Occurrence of failure and driving force

Failures during long-term storage may be mitigated by control of the stimuli and driving forces likely to initiate given failure modes of interest as defined by a Failure Modes and Effects Analysis (FMEA). Storage related failures are often detected as modes of non-operation, visual quality or other non-conformance. The modes of failure during storage are typically related to a failure mechanism that is driven by a physical stimuli or condition. Successful long-term storage is accomplished by controlling the failure mechanism stimuli as identified using a failure modes and effect analysis based on information from technology development and testing. Table 1 provides examples of failure stimuli. Additional examples of deterioration mechanisms are found in IEC 62435-2. Successful long-term storage is accomplished by mitigating failures through control of the stimuli or driving force.

Table 1 – Example failure mechanisms in storage and stimuli to mitigate during storage

Failure mechanism	Failure mechanism detail	Failure mode	Mechanism stimuli
Popcorn effect	High rate vapour expansion within a package during surface mounting	Open circuit, blistering, package cracks	Temperature increase leading to moisture vapour
Handling damage	Cracking	Open, short, visible crack	Application of force
	Visible scratch/smudge	Open, short, surface mark	Mechanical abrasion
Device data loss/damage	Electro-magnetic current field induced short/open/error	Open, short, data corruption	Electro-magnetic field
	High ionizing radiation induced open, short or error	Open, short, data corruption	High-energy radiation, x-ray
	Soft error resulting from device damage	Open, short or data corruption	Neutron particle hit Alpha particle emission hit
Staining residue	Change in surface appearance and specification resulting from unplanned exposure to oxidizing contents	Visible defect, non-conforming appearance and potential of misprocessing	Exposure resulting in aging, oxidation or hardening of residue
Polymer material aging	Polymer embrittlement	Visible cracking, open or shorting	Temperature exposure, residual mechanical stress and bright light
Storage media issues	Tape on reel, tube embrittlement/aging	Misalignment during processing	Temperature exposure, mechanical stressing and bright light
	Tray and tube aging embrittlement	Dropped parts from broken tray media or parts out of formed pocket	Temperature, handling and bright light
	Box aging embrittlement	Dropped parts Opens or shorts from ESD Foreign material	Temperature and bright light
	ESD coating degradations	Opens or shorts from ESD	Triboelectric charging or charge potential difference
	Label aging	Illegible mark	Bright light, temperature
		Missing label	Temperature and bright light
		Brittle flaking – partial label	Temperature and bright light

Failure mechanism	Failure mechanism detail	Failure mode	Mechanism stimuli
Indirect material issues	Moisture barrier bag leak	Humidity indicator card trigger, visual non-conformance	Handling abrasion, bending and shock events
	Humidity Indicator Card In-activated	Incorrect colour or no moisture exposure indicated	Temperature, humidity Exposure before use
	Label aging	Illegible mark	Bright light, temperature
		Missing label	Temperature and bright light
		Brittle flaking – partial label	Temperature and bright light
Solderability	Inability to form a good solder joint	Post surface mount electrical open	Temperature, humidity Exposure
Corrosion	Electro-chemical reaction leading failure	Open, short, visual non-conformance	Temperature, galvanic cell, chemical residue
Tin whiskers	Whisker filament formed by dislocations in metal films with a gradient in surface mechanical stress.	Visual whiskers, short	Bright tin(Sn) surface finish (un-alloyed) crystal dislocation growth (in un-mitigated parts) Sulphur gas catalysed reaction
Wettability	Passivation surface change	Flux or adhesion change	Surface energy change

4.1.2 Storage environment and mitigation for stimuli to prevent failure

Mitigation of failures during and after long-term storage occurs by directly controlling or limiting the stimulus for failure by a number of means. Common requirements for sustained long-term storage are given in Table 2. Knowledge and control of the storage environment is of primary importance to identify the risk of failure occurrence and to control or eliminate failure stimuli during storage. Examples of the storage environment are contained in IEC 62435-4. Other storage environment parameters related to long-term storage that may be important for products or devices with certain sensitivities are presented in Annex A. It is the responsibility of the end customer to maintain the storage environment as well as to ensure that terms and conditions are in place for successful long-term storage at the time of product purchase and at storage from a storage service provided, if used.

The full component thermal and environmental chain should be considered in planning the reliability characterization evaluation, for estimation of the reliability after storage which is added to the use reliability estimates.

If components storage is entrusted to a storage service provider, the customer shall define the storage environment conditions according to the components sensitivity (see Table 2 and Table A.1) unless the service provider has the competence to do this.

Table 2 – Long-term environment – Sustained condition requirements

Storage Environment	Range (terrestrial storage)	Failure Mitigation
Temperature [a, b]	low/high: + 5 °C / + 40 °C	Temperature controls or geographical placement
Relative Humidity (RH) non-condensing [c]	low/high: 10 %/85 % RH	Dry pack

[a] IEC 60721-3-1 storage classification 1K21

[b] ASHRAE – climate control class A3 and class C for temperature

[c] RH greater control > 7% is required for ESD control.