IEC 62435-4

Edition 1.0 2018-06

INTERNATIONAL STANDARD

Electronic components – Long-term storage of electronic semiconductor devices –
Part 4: Storage

IEC 62435-4:2018-06(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC 62435-4

Edition 1.0 2018-06

INTERNATIONAL STANDARD

Electronic components – Long-term storage of electronic semiconductor devices –
Part 4: Storage

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.020

ISBN 978-2-8322-5768-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

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

Part 4: Storage

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62435-4 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
47/2469/FDIS	47/2486/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.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

This standard 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 document, LTS is defined as any device storage whose duration may be more than 12 months for products 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, selection of 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;
- preventative 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 their individual parts. This puts the user in a situation requiring careful and adequate storage of such parts to maintain the as-received solderability and to minimize any degradation effects to the part over time. Major degradation concerns are moisture, electrostatic fields, ultra-violet 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 supplier for the lifetime of the system, or the spare assembly can be built with the original production run but then require long-term storage. This document was developed to provide a standard for storing electronic devices for long periods of time.

The storage of devices that are moisture sensitive but that do not need to be stored for long periods of time is dealt with in IEC TR 62258-3.

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 be useable after storage. It is important that storage media and the local environment are considered together.

These guidelines do not imply any warranty of product or guarantee of operation beyond the storage time given by the 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 guidance on methods of long-duration storage of electronic components, where this is intentional or involves planned storage of a 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 series 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 are specific to the type of product being stored.

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

The structure of the IEC 62435 series as currently planned consists of the following:

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 4: Storage

1 Scope

This part of IEC 62435 specifies long-term storage methods and recommended conditions for long-term storage of electronic components including logistics, controls and security related to the storage facility. Long-term storage refers to a duration that may be more than 12 months for products scheduled for long duration storage. The philosophy of such storage, good working practices 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 60749-20-1, *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*

IEC TR 62258-3, *Semiconductor die products – Part 3: Recommendations for good practice in handling, packing and storage*

IEC 61340-5-2, *Electrostatics – Part 5-2: Protection of electronic devices from electrostatic phenomena – User guide*

JEDEC J-STD-033, *Standard for handling, packing, shipping, and use of moisture/reflow sensitive surface mount devices*

MIL-PRF-27401, *Propellant pressurizing agent nitrogen*

MIL-PRF-81705, *ESD Materials, Bags and Performance Specification*

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
moisture sensitivity level
MSL
rated and verified moisture sensitivity level assigned to a component that defines the maximum safe equilibrium moisture exposure for a specific encapsulated device prior to 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

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

[SOURCE: IEC 60050-551:1998, 551-14-01, modified]

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 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
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 Purpose of storage (facility)

4.1 General

Successful long-term storage is dependent upon sustained control of the environment and its physical and data security. Costs associated with handling, maintaining traceability, physical accounting and environmental conditions should be accounted for from the outset of long-term storage.

4.2 Cost of ownership

Cost will be determined by type of storage facility, cabinet, continuous nitrogen flow or inert gas flow and periodical examination on a representative sample.

4.3 Security

Access to controlled areas should be limited to a small number of persons to ensure adequate security. Controlled areas shall be secure from theft, tampering and environmental disturbances.

4.4 Location and ambient environment

The LTS storeroom should be located away from any vibration, electromagnetic fields, ultraviolet rays and other strong light. Consideration should be given to any catastrophic events likely to occur near or at the physical locale of the storage facility. For example, seismically active locations may have building safety and control mitigation measures in place.

4.5 Incorrect control of reliability during storage

Storage conditions should be precisely defined and controlled, to ensure the reliability of the components (see Clause 5).

Component integrity may be reduced by improper storage conditions. Potential causes of storage risk are related to poor control of environmental conditions. Proper control should consider temperature, humidity, moisture, pressure, atmospheric gases, electrostatic field charge, applied physical forces, handling (shock, vibration, impacts, etc.), contamination or other applied stress factors. Degradation mechanisms that are induced with moisture may occur if the integrity of the dry storage (cabinet or MBB) is violated. Verification of moisture exposure includes, but is not limited to, examination of the HIC for any change in colour, chamber humidity monitoring and the use of recording devices that indicate moisture exposure. Different materials can absorb moisture at different rates and should be evaluated based upon exposure time. For other degradation mechanisms that require oxygen, radiation, electrical exposure or mechanical impact, the LTS environment should be evaluated to prevent contributing to failure concerns.

Packing materials used in LTS should be evaluated for moisture absorption and release. The packing requirements of IEC 60749-20-1 or J-STD-033 should be followed for LTS unless otherwise indicated in this publication.

5 Storage

5.1 General

The following 5.2 to 5.6 describe storage environments and practices within the storage facility.

5.2 Type of environment

Various types of storage environments exist, such as:

- air without any monitoring;
- “dry”-air (relative humidity lower than 7 % – 25 %), with or without active desiccant, which may be in a sealed moisture barrier bag;
- low-oxygen; typically nitrogen (racks, bags, tubes, etc.) where a nitrogen or oxygen detector is recommended;
- vacuum in fully evacuated chamber (with precautions to prevent part-crushing damage or bag foil damage if used).

The selection of a solution shall be made on the basis of the intended storage time, the application of the technology and the accepted risks. For long-term storage, a dry-air, nitrogen or vacuum solution is recommended.

5.3 Storage identification – traceability

Storage of part manufacturing data, unit level traceability and various other data that is recorded during storage should be maintained and archived. Data storage practices and requirements are planned to be addressed in IEC 62435-3[1]. Data to be stored coincident with the environment should include:

- the component manufacturer's name and part number;
- the procurement source;
- the date-code;
- the storage history;
- the validation test identification or program version performed.

The purpose of this data is to accurately identify the components stored, to ensure the traceability and enable tracking of components.

When there are periodic checks, the following data should be recorded and compared to the previous checks: date, nature of the checks, components tested, results.

5.4 Initial packaging

Initial packaging may not be suitable for long-term storage, and consideration should be made as to the method of packing for storage, in particular, re-packing devices in special protective material that will not degrade or out-gas during storage. ESD controls and protection guidelines are found in IEC TR 61340-5-2 and recommendations for ESD protective materials are found in IEC 61340-5-3.

If packaging fails, the components should be assessed for further handling and additional storage, and if necessary the components should be repackaged. This type of operation can only be performed in exceptional circumstances during storage because the components could be degraded or damaged.

Re-package all devices in accordance with the specified storage environment. Parts should be exposed to ambient air for as limited a time as possible. If re-packing is required it should be completed within 8 h or less. Care should be taken to avoid part contamination through foreign material by segregating component bag opening and storage preparation areas. Containers may be reused, as long as they are visibly inspected and show no damage. Where desiccant is required, fresh or refreshed desiccant should be used for initial storage and for every subsequent re-packaging.

1 Under preparation. Stage at the time of publication: IEC/PCC 62435-3:2018.

5.5 Storage conditions

5.5.1 General

To ensure the integrity of the components during LTS, the conditions of the storage environment should be maintained.

5.5.2 Storage area

5.5.2.1 General

The stock shall be stored in clean premises or LTS storeroom, in compliance with the requirements of 5.5.2.2 to 5.5.2.9.

5.5.2.2 Temperature

Many aging mechanisms are accelerated by temperature. The temperature should be maintained between 5 °C and 40 °C condition, environment description 1K21, as prescribed by IEC 61760-2, IEC 60721-3-1 and JEDEC JEP-160.

5.5.2.3 Temperature variations

Generally, temperature variations provoke the premature aging of assemblies made of different materials. The temperature ranges given in 5.5.2.2 describe only the minimum and maximum possible over a given year and not the daily temperature or seasonal temperature variation.

5.5.2.4 Relative humidity – chemical attacks – contamination

In addition to "popcorning" of MSDs during surface mount, humidity, as well as any form of chemical attack or contamination, creates a corrosion hazard for electronic components.

By reducing all contamination sources and by maintaining a relative humidity lower than 50 %, these risks are significantly reduced. It is worth pointing out, however, that a relative humidity lower than 20 % will favour the development of electrostatic discharges.

Dry nitrogen storage practically eliminates all corrosion and contamination problems.

5.5.2.5 Pressure

The possible pressure variation between the storage environment and the outside atmosphere should be taken into account.

5.5.2.6 Electrostatic discharges

Electrostatic discharges (ESDs) are an important cause of failure in electronic components. Specific measures to reduce failures to a minimum shall be taken (see IEC 61340-5-2), for instance:

– component storage in anti-static protections (bags, strips, conductive foams);
– metallic racks connected to earth;
– component storage in antistatic containers;
– protection of the work stations (straps, working surfaces, dissipaters, etc.);
– raising awareness of ESD problems to the operators and managers responsible for storage of the components; maintenance of relative humidity at greater than 7 % to avoid charge build-up and discharge;
– use of air ionizers.

Antistatic protection equipment (bags, strips) generally have a limited useable life-time, either because of surface treatment abrasion phenomena or under the impact of ultraviolet rays.

5.5.2.7 Vibration – mechanical impacts

Stored components should be kept away from any constant vibration source. The maintenance and destocking operations concerning components and other elements should be performed in such a way as to keep to a minimum the risks of mechanical damage to the stock.

Effectiveness of antistatic protection of strips should be maximized by careful surface treatment (except for carbon-charged strips). This treatment can be highly damaged by abrasion due to friction of the component leads in the strip. Components should, therefore, be blocked in the strips. Stored component handling should be kept to a minimum, in order to avoid the premature aging of the strips.

5.5.2.8 Electromagnetic field – radiations

Stored components should be kept away from any high intensity or constant exposure to greater than supplier-specified radiation and electromagnetic fields.

5.5.2.9 Light

Light, especially ultraviolet rays, can lead to a degradation of organic materials (packing bags, antistatic strips, etc.). The components should be stored away from light.

5.6 Maintaining storage conditions

The role of the equipment is to ensure that storage conditions are maintained within the limits defined to ensure the best integrity of the component properties. Equipment should be regularly checked and adjusted or repaired if required: heating, air conditioning, temperature and relative humidity measurement systems, ionizers, protections against ESDs (see IEC 61340-5-1), etc.

Checking and maintenance operations are recorded.

6 Periodic check of the components

6.1 Objectives

The most important stresses electronic components may suffer during storage are of the mechanical, thermal and chemical types. These stresses may be internal or external to the component.

The risks to quality and reliability justify

– an environmental check;
– a periodic component conformity check;
– a component check during de-stocking.

Depending on the risk versus cost compromise decision, the periodic check may be replaced by a check during de-stocking.

6.2 Periodicity

If the stock is not used regularly, it is necessary to carry out a check, the periodicity of which depends on:

– the level of risk envisaged;
– the findings of the initial evaluation tests;
– the findings of previous periodic checks.

6.3 Tests during periodic check

Generally, the tests or measurements will be made

– on a representative sample of the components stored;
– on the same samples, in order to avoid stresses caused by handling and test operations;
– in compliance with the specifications and quality levels used during procurement;
– following the electrical parameters identified as critical;
– following the expected risk versus cost compromise parameters.

7 Removal from storage

7.1 Precautions

It is important not to interrupt the chain of precautions taken against certain effects of storage, such as temperature variations, relative humidity, aggression, contaminations, electrostatic discharges, radiation and light.

Any component removed from storage can only be stored again if the storage rules provided for this type of component are adhered to again. However, the initial storage period shall be taken into account and any required pre-storage routines should be adhered to.

If any packaged electronic device (part) or unpackaged semiconductor is removed from storage (exposed), it shall be handled in accordance with the manufacturer's recommendations for ESD and (if moisture sensitive) moisture control. Unless otherwise allowed by the device's storage temperature, the temperature shall be maintained between 5 °C and 40 °C. Unpackaged semiconductors shall not be removed from their sealed packaging unless the facility has cleanliness, environmental controls and properly documented processes to assure that, when exposed, the unpackaged semiconductors will not be degraded due to contamination. Unpackaged semiconductors shall be kept in the original sealed packaging to the maximum extent practical.

Stock should be controlled by a first-in/first-out distribution industrial practice to avoid accumulation of vintage components.

7.2 Electrostatic discharges

It is mandatory to perform destocking maintaining the continuity of the conditions. See IEC 61340-5-2.

8 Materials used in storage regimes

8.1 General

Packing materials that deteriorate with age should not be used, since outgassing of chemicals and decomposition products could contaminate the product. Use of specific materials for LTS should be identified and utilized (e.g., closed-cell foams with nitrogen filling).

8.2 Moisture barrier bags (MBB)

Utilization of MBBs with desiccant and HICs for LTS is not limited to MSD hardware. The use of MBBs is good practice for device protection during LTS. Dry packing has a finite effective life for moisture protection due to the limited absorption capability of the desiccant and moisture penetration through the packing material and the moisture barrier bag. Humidity indicator cards may not be required for non-MSD hardware.

The moisture barrier bag shall be in accordance with MILPRF-81705, TYPE I. Dry pack for moisture sensitive devices (MSDs) is required in accordance with IEC 60749-20-1 and J-STD-033.

8.3 Desiccant

The desiccant material shall be capable of removing sources of corrosion and deterioration of product caused by oxidation, sulfurization, and other processes. The required levels of control are as follows:

a) Oxygen: < 0,1%
b) Hydrogen sulphide: < 10^{-6}
c) Sulphur dioxide: < 10^{-6}
d) Hydrogen chloride: < 10^{-6}
e) Ammonia: < 10^{-6}

The desiccant shall be packaged in moisture permeable bags or pouches as determined using the procedure detailed in IEC 60749-20-1. The MBB rated water vapour transmission rate (WVTR), bag size and moisture level of non-components that are placed into the MBB are required for successful calculation of the desiccant required.

8.4 Humidity indicator card (HIC)

Assurance should be made by periodical check of HIC or continuous humidity sensors during LTS to avoid degradation of components. At the time of this publication JEDEC has determined that certain bromine-free HICs are useable just over five years. HIC suppliers should be able to specify the useable life-time. Refer to IEC 60749-20-1 for guidance on the use of the HIC for storage.

8.5 Dry nitrogen atmosphere

Nitrogen environments of 5 % RH or less shall be in accordance with MIL-PRF-27401, Type 1 Gas, Grade C (99,995 %) and IEC 62258-3. The use of other atmospheric conditions should be evaluated to ensure performance to LTS requirements.

Nitrogen gas environments shall be in accordance with MIL-PRF-27401, Type 1 Gas, Grade C (99,995 %).

NOTE Other sources of dry nitrogen are not sufficiently contaminant-free to provide reliable storage.

8.6 High purity dry air atmosphere

Wafer and die may be stored at lower relative humidity while packaged products may be stored at a minimum relative humidity of greater than 7 % to protect against charge build up and ESD events.

For wafer and die, dry air meeting the following parameters can be used: 5 % RH 0,04 % CO2, 0,001 % Cl2, 0,001 % S, 0,001 % P. The use of other atmospheric conditions should be evaluated to ensure performance to LTS requirements.

Dry cabinet storage at 5 % – 10 % RH nominal in dry cabinets may be considered equivalent to storage in a MBB. Note that open and closing operations result in transient temperature and humidity excursion that have an associated recovery time to re-establish equilibrium. Care should be taken to segregate long term storage areas from short term storage areas to avoid excessive transient humidity exposure that may go as high as 25 %. Finished components should be stored at greater than 7 % RH to avoid static charge build-up.

8.7 Storage containers

Packaging materials used and in contact with or in close proximity to the device surface shall preserve product integrity. The container should provide protection from contamination, abrasion, and outgassing. When ESD concerns are warranted, proper materials and procedures should be used.

8.8 Foams, packing material and protective cushioning

If used, material for LTS should not contaminate contents. Nitrogen-filled, closed cell foam is an example of a suitable material for LTS. If using a carbon-filled variant of this type of foam, take care to ensure that the carbon is fixed in the material and cannot shed particles during LTS. The packing material should be able to meet the LTS life. In particular, any packing item that could give rise to chemical or particulate contamination by long-term degradation should be avoided. Paper used to separate products such as lint-free sheet should be contaminant-free and meet application ESD requirements. Materials coated with films to reduce static charge (i.e. ESD-coated) should be evaluated for outgassing concerns. Barrier materials as defined by MIL-PRF-131 should be tested to confirm LTS performance is acceptable.

9 General storage environment

The storage environment for LTS packaged products should be controlled to minimize vibrations and product handling. Temperature control is important to provide protection from material decomposition and warpage mechanisms. It is important to prevent rapid temperature changes that cause moisture condensation based upon the saturated vapour pressure of water in the container or thermal shock failure mechanisms. Temperature ramp rates should be controlled so that the product maintains a thermal equilibrium to prevent thermal shock or moisture condensation. Humidity control is important as MBB integrity is directly related to the humidity exposure. Maximum storage time depending upon HIC response can be calculated using the water vapour transmission rate (WVTR) as defined in IEC 60749-20-1 and J-STD-020.

General warehouse temperature and humidity storage environments should be evaluated for component LTS concerns. Typical warehouse temperatures are less than 40 °C. Typical warehouse humidity is less than 90 % RH. Consideration should be made with the storage materials to reduce the likelihood of outgassing. Outgassing can be related to temperature exposure of the LTS material (including foams, trays, gaskets, insulators, topical antistats, etc.), thus evaluation of maximum storage temperatures should be performed. Product exposed to the environment outside of LTS packaging should follow IEC 60749-20-1 and J-STD-033 for storage. Any temperature or humidity excursion outside these limits should be recorded and logged. Non-conforming conditions should be identified, evaluated, and modified by appropriate corrective actions.

During storage, sufficient protection should be provided to guard against damaging movements or vibrations. Orientation may be important for both product usage as well as limiting mechanical damage from shock and vibration. Containers and shelving may require anti-vibration, anti-resonance mounting and earthquake impact mitigation. Packing material should be designed to offer some degree of protection against handling damage.

10 LTS methods

10.1 General

LTS is designed to prevent product degradation due to oxygen, moisture and/or outgassing mechanisms. The LTS protection method employed depends upon the mechanism of concern. When considering multiple mechanisms, a combination of prevention methods may be needed.

10.2 Dry cabinet storage

10.2.1 General

Product stored in a dry cabinet should be maintained at 7 % – 10 % RH for MSL 2 or 3 and maximum 5 % RH for MSL 4 to 6 unless device application requirements or other specifications indicate a different minimum RH value. Refer to IEC 60749-20-1, IEC 60749-30 and J-STD-020 for moisture classification levels, floor life requirements, and reflow limitations prior to use. Atmosphere should be high purity dry air, dry nitrogen or any other dry inert gas atmosphere as required by the supplier. The pressure should be sufficiently high to prevent the ingress of external atmosphere contaminates.

10.2.2 Humidity controlled storage

The cabinets should be capable of recovering to their stated humidity rating within one hour from routine excursions such as a door being opened and closed. To limit possible moisture exposure from ambient atmosphere, the suggested time limit for dry cabinet open door is 10 min cumulative per 8 h for a total of 30 min cumulative per 24 hour period.

10.2.3 Oxygen (O_2)-controlled storage

The recommended atmosphere is dry nitrogen or any other dry inert gas atmosphere. The pressure should be sufficiently high to prevent the ingress of external atmosphere contaminants. For oxygen exposure, an inline monitor or other detection methods should be employed.

10.2.4 Outgassing-controlled storage

Atmosphere shall be high purity dry air, dry nitrogen, or any other dry inert gas atmosphere as required by the supplier. The pressure should be sufficiently high to prevent the ingress of external atmosphere contaminants. The cabinet should have an atmospheric exchange rate sufficient to prevent internal atmospheric contamination.

10.3 MBB storage

10.3.1 General

The MBB is commonly used for shipping and storing wafers, die, and devices. The use of a MBB for LTS requires confirmation that the product is maintained at an acceptable moisture level. The most common method to identify moisture exposure in the MBB is to include a HIC. The use of HICs in MBBs for wafers and/or dice storage is optional due to potential contamination concerns. Users should determine if HIC use with wafers and/or dice are acceptable.

Care should be exercised on the force of vacuum applied to ensure product and package integrity. Air evacuation can create damage to packing materials and product and; as such, the appropriate vacuum pressure should be identified and applied. A visual check should be performed to verify the MBB sealed conditions.

10.3.2 Humidity-controlled storage

The use of MBBs with desiccant for LTS requires the presence of a HIC and confirmation that it displays acceptable moisture level exposure prior to using contents. Periodic inventory and HIC checks should give consideration to the HIC lifetime.

10.3.3 Oxygen (O_2)-voided storage

Flush the MBB with dry nitrogen or any other dry inert gas to ensure ambient atmosphere is totally removed. Vacuum is applied immediately after the flush. An oxygen sensor or other detection methods should be employed to ensure compliance is met.