



TECHNICAL REPORT

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Long-Term Storage (LTS) of Electronic Devices

RATIONALE

Update the document to show current practices.

FOREWORD

Some electronic device users need to store their devices for long periods of time. Lifetime buys are commonly made to support assemblies' production runs that well exceed the production time frame of their individual parts. This puts the user in a situation requiring appropriate storage of such parts to maintain the as-received solderability and minimize degradation of the parts over time. Major degradation concerns are moisture, electrostatic fields, ultraviolet light, large temperature variations, airborne 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 - in some cases, 40 years or more. Some of the devices needed for the repair of these systems will not be available from the original supplier for the lifetime of the system, or the spare assembly may be built with the original production run and require long-term storage. This document provides guidelines for storing electronic devices for long periods. It utilizes consistent language to avoid conflicts with other industry documents (e.g., JEP160) and international documents (IEC 62435-1). Refer to IPC/JEDEC J-STD-033 for storage of devices that are moisture-sensitive but do not need to be stored for long periods.

INTRODUCTION

The long-term storage (LTS) of electronic devices is achieved by preventing moisture, oxygen, and any potentially corrosive outgassing from the packaging. Four basic methods are used to minimize chemical interaction for as long as possible while electronic devices are stored: 1) a barrier bag (BB) to prevent oxygen and moisture intrusion, 2) BBs sealed with a purged inert environment or keeping the electronic devices in dry nitrogen (N₂) cabinets, 3) an oxygen absorbing desiccant (OAD) to absorb oxygen and moisture and minimize any outgassing from packing materials within the BB, and 4) humidity indicator cards (HICs) to identify any compromised BBs.

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1. SCOPE

1.1 Purpose

This document provides guidelines for the long-term storage (LTS) of electronic devices (dice, wafers, packaged parts, and electronic assemblies). The guidelines identify the protective storage conditions to retain the functionality of electronic devices as received from device manufacturers, distributors, or other facilities.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

MIL-PRF-27401 Propellant Pressurizing Agent, Nitrogen

MIL-PRF-81705 Barrier Materials, Flexible, Electrostatic Protective, Heat-Sealable

2.1.2 JEDEC Publications

Copies of these documents are available online at <https://www.jedec.org/>.

IPC/JEDEC J-STD-033 Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices (SMO)

JEP160 Long-Term Storage for Electronic Solid-State Wafers, Dice, and Devices

JESD88 Dictionary of Terms for Solid-State Technology

JESD625 Requirements for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices

2.1.3 ANSI Publications

Copies of these documents are available online at <https://webstore.ansi.org>.

ANSI/ESD S20.20 Protection of Electrical and Electronic Parts, Assemblies, and Equipment

2.1.4 IEC Publications

Available from IEC Secretariat, 3 rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 0211, www.iec.ch.

IEC 62435-1 Components - Long-Term Storage of Electronic Semiconductor Devices, Part 5 - Die and Wafer Storage

2.1.5 ASTM International

Available from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9500, www.astm.org.

ASTM D3985 Testing Method to Measure Oxygen Transmission Rates Through Plastic Films and Sheeting

ASTM F1249 Testing Method to Measure Water Vapor Transmission Rate

2.2 Definitions

Subsections 2.2.1 through 2.2.11 provide definitions of specific terms used in this document. These terms, plus any others used in the document, follow the definitions provided in JESD88.

2.2.1 PACKAGED ELECTRONIC DEVICES

Electronic devices are defined as any packaged electrical, electronic, or electromechanical (EEE) item or assemblies using such items.

2.2.2 UNPACKAGED MICROELECTRONICS

Unpackaged microelectronics in the form of a wafer or bare die.

2.2.3 USER

The user of this document may be any organization or entity that would store electronic devices or unpackaged microelectronics.

2.2.4 SUPPLIER

The device manufacturer, distributor, organization, or entity who provided the part to be stored.

2.2.5 DRY N₂ ATMOSPHERE

A dry N₂ environment is that which is in accordance with MIL-PRF-27401, Type 1 Gas, and Grade C (99.995%).

2.2.6 DRY CABINET

A dry cabinet at 5% relative humidity (RH) or less.

2.2.7 CONTAINER

A portable or fixed enclosure for electronic devices, depending on the type specified.

2.2.8 HUMIDITY INDICATOR CARD

As defined in IPC/JEDEC J-STD-033 for Type 1 HIC (reversible) and Type 2 HIC (nonreversible) with some exceptions for LTS considerations.

The HIC is packaged inside the BB, along with an OAD, to aid in determining the level of moisture to which the moisture-sensitive device has been subjected. HICs that have been exposed to 60% or greater RH will no longer be considered accurate.

2.2.9 FRESHNESS DETERMINATION

Freshness determination aims to establish the suitability of items (whether they have retained their original qualities) after they are removed from LTS, usually by performing tests.

2.2.10 FUNCTIONAL FAILURE

The failure of a device to deliver correct output data or signals during operation (e.g., stuck-high or stuck-low output, open input or output, logic error).

2.2.11 PARAMETRIC FAILURE

An out-of-tolerance current or voltage level at an input, output, or power supply terminal of a component. Parametric failures are usually detected during input-leakage, output-voltage, power-supply-current, timing/switching, and capacitance tests.

2.3 Acronyms and Abbreviations

BB	barrier bag
°C	degrees Celsius
CCA	circuit card assembly
C of C	certificate of conformance
CF	constant flow
CP	constant pressure
Dry N ₂	dry nitrogen
EEE	electrical, electronic, electromechanical
ESD	electrostatic discharge
ESDS	electrostatic discharge sensitive
g	grams
HIC	humidity indicator card
LTS	long-term storage
MSL	moisture sensitivity level
MVTR	moisture vapor transmission rate
OAD	oxygen absorbing desiccant
OEM	original equipment manufacturer
OTR	oxygen transfer rate
PEM	plastic encapsulated microcircuit
QMS	quality management system
RH	relative humidity
SMD	surface mount devices
WVTR	water vapor transfer rate

3. GUIDELINES

3.1 Storage Conditions

This document establishes the recommended minimum guidelines for the storage of electronic devices. The storage environment should include the protections identified in Table 1. These guidelines provide for Condition 1, Condition 2-1, Condition 2-2, and Condition 3 to address the specific storage environments. Those conditions will be coordinated between the storage facility and the customer. Factors used in this coordination include the type of electronic devices (die, wafer, integrated circuit, higher level assembly, etc.), economic value of the product, replaceability/irreplaceability of the product, moisture sensitivity, or other special circumstances regarding the particular electronic devices to be stored.



The storage environment should have appropriate controls for electrostatic discharge sensitive (ESDS), temperature, radiation environments, chemical contamination, humidity, and minimizing shock and vibration. All electronic devices should be stored in a heat-sealed BB or container unless special circumstances need to be considered.

As for usage of dry N₂ storage, some of the recommended storage conditions include storage in dry N₂. The atmosphere guidelines for dry N₂ are identified in 3.4.4. The dry N₂ atmosphere can be applied inside a BB or a dry N₂ cabinet, which can be either a constant flow (CF) or a constant pressure (CP) dry N₂ cabinet. The choice of either cabinet will be made based on different factors and decisions of the storage facility. Some factors to be considered in the choice of a dry N₂ cabinet are:

- A facility that needs to frequently access a product could be better served by a CF dry N₂ cabinet. Access time would be minimized.
- A facility that only needs infrequent access to a product could be better served by a CP dry N₂ cabinet. This would minimize the use of dry N₂, which could provide significant economic advantages.

As for the above identified storage environments, this document establishes storage condition recommendations for specific products and situations. These conditions are outlined in Table 1.

Guidelines for storage condition selection include:

- Die and wafer storage should utilize Condition 2-1a or 2-2a (see Table 1). Many storage facilities may not have proper clean room capability and thus may not have the ability to place an OAD inside the BB. They would rely on how the die or wafer was received by the storage facility.
- Moisture-sensitive devices are best addressed using N₂ cabinets. If the storage facility does not need to compromise the moisture-sensitive BB as received, then Condition 2-1a or 2-2a would apply. If there is a need to compromise the moisture-sensitive BB, then Conditions 2-1b through 2-1c or Conditions 2-2b through 2-2d would apply.
- Most other finished products can utilize any of Conditions 2-1 or 2-2. The choice of additional protection will depend on coordination between the customer and the storage facility and will incorporate factors such as the economic value and replaceability/irreplaceability of the product.
- Occasionally, products may have special circumstances, such as extra outgassing of corrosive items, or the size of the product may prohibit the use of available BBs. In these circumstances, Condition 3 would apply.

Many known and unknown degradation factors can occur during LTS of electronic products. Some of these can be mitigated by the guidelines in this document. The guidelines in Appendix B shall be updated when any of these factors are further identified and clarified regarding their effect on the guidelines in this document. Those factors that cannot be controlled by the guidelines in this document will be separated, and information will be provided to users of items in LTS.