

# UM10569

## Store and transport requirements

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User manual

### Document information

Info	Content
<b>Keywords</b>	Storage, transport, shelf life, dry-baking, drying, dry-packing
<b>Abstract</b>	This document describes the store and transport requirements of final commercial and semi-finished products of NXP Semiconductors



## Revision history

Rev	Date	Description
v.3	20150309	third, enhanced revision
v.2	20140124	second revision
v.1	20120625	new user manual, first revision

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## 1. Introduction

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This specification describes the technical conditions of shelf life and transport of final commercial and semi-finished products of NXP Semiconductors. Other aspects like sales, warranty, legal and commercial issues are regulated by NXP's "Terms and Conditions of commercial Sale", see [Ref. 7 on page 13](#).

## 2. Objectives

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It is essential that the quality of products entering store areas is maintained and that the products are easily identified. The quality of stored products must not deteriorate by additional handling while in store.

Transport conditions must be such that the quality and reliability of the product and its packing shall not be harmed in any way.

## 3. Definitions

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**Bake to seal time** — The maximum time after bake that components may be exposed to ambient conditions prior to being sealed in MBBs.

**Desiccant** — An absorbent material used to maintain a low relative humidity.

**ESD** — ElectroStatic Discharge

**FFC** — Film Frame Carrier

**Floor life** — The permissible time period between removing the MBB and soldering.

**HIC** — Humidity Indicator Card.

**IC** — Integrated Circuit

**MBB** — Moisture Barrier Bag.

**MSL** — Moisture Sensitivity Level

**PQ-box** — The box for containing and protecting the prescribed Packing Quantity of final product (also called Inner Box).

**RH** — Relative Humidity

**Shelf life** — The possible storage life before the product is used.

**SMD** — Surface-Mount Device

**Transport** — In this standard, transport includes the whole path and temporary storage from the sending warehouse to the receiving point, which can be a warehouse or the customer.

## 4. General conditions

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Products have to be packed in a way that ensures protection against mechanical, environmental and electrical influences during transport and storage.

Store and transport conditions should be such that the integrity of the product and its packing are not harmed in any way.

## 5. Receiving inspection

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Dry-packed packages should be inspected for a bag seal date on the caution or bar code label to determine remaining shelf life. The bags should be inspected to verify that there are no holes, gouges, tears, punctures, or openings of any kind that would expose either the contents or an inner layer of a multilayer bag. If openings are found and the humidity indicator card (HIC) indicates that the maximum humidity has been exceeded, then the parts should be baked using the bake times of [Table 3](#) or [Table 4](#). This resets the floor life of the parts to be used and shelf life if the parts are to be dry-packed.

## 6. Store conditions

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Secure and clean store areas shall be provided to isolate and protect the products.

Conditions in the store areas shall be such that the quality of the products does not deteriorate due to, among others, harmful gasses or electrical fields.

The following conditions have to be taken into account:

- Temperature
  - Min. +8 °C
  - Max. +45 °C
- Humidity
  - Min. 25 %
  - Max 75 %
  - No condensation under any condition is allowed.
- Light intensity
  - No direct sun light

## 7. Transport conditions

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In the case of transporting, the following conditions have to be observed.

### 7.1 General transport conditions

During transport the packing and the products should be protected against extreme temperatures, humidity and mechanical forces.

The following conditions have to be taken into account:

- Temperature
  - Min. +8 °C
  - Max. +60 °C
  - (Higher temperature causes a serious risk of deformation of the packing material and lower temperature the risk of condensation within the package).
  - In tropical conditions, the packing shall not be placed in direct sunlight.
- Humidity

- Direct contact of packing boxes with water is prohibited.
- Mechanical forces
  - Transport must be done in such a way that the PQ-boxes are not deformed and forces are not directly passed on to PQ-boxes.
- Time
  - The total transport time should be as short as possible. When transport time exceeds 5 days the transport conditions shall be the same as store conditions, or the products have to be sealed with inclusion of a dry-agent.

## 7.2 Conditioned air transport

Air transport is possible with conditioned cargo rooms. This conditional air transport is advised for all products, but mandatory for air transport of products in sealed bags, like dry pack.

- Temperature
  - Min. +8 °C
  - Max. +45 °C
- Humidity
  - Avg. 16 %
- Air pressure
  - Min. 700 mbar
  - Max. 1060 mbar

## 8. Shelf life conditions

### 8.1 Packed end products

The shelf life for packed end products is 4 years after the date code. This includes encapsulated products in standard packing, encapsulated products in dry pack.

For products in dry pack, the dry conditions are guaranteed for one year (this is not shelf life, see above). When the HIC shows a relative humidity of higher than 10 %, the products have to be baked before use (see [Section 10](#)).

### 8.2 Wafers and bare die

Wafers and bare die have to be packed in dry pack, or stored under the following conditions:

- Inert gas
- Dry air or dry nitrogen
- No sources of corrosive material such as halogenic contamination
- Temperature 18 °C to 24 °C

The shelf life for wafers or bare die is 3 years (excluding wafers with Au/Ge backside and assuming condition of <60 % relative humidity) after diffusion process end (Fab. date code).

The shelf life for products on FFC (Film Frame Carrier) is 6 months due to the FFC material.

### 8.2.1 Maximum shelf life versus humidity

Parts of bare wafers and bare die products that are sensitive for aging are aluminum and backside metal surfaces (e.g. Ti, Ni, Ag or AuGe). Shelf life of wafers and bare die with a combination of given bond and back side material at different humidity levels are given in [Table 1](#).

**Table 1. Shelf life of wafers and bare die**

*The indicated humidity levels in the table should not be exceeded.*

Relative humidity <sup>[1]</sup>	Bond pad material	Back side	Technical shelf life
< 10 %	all types	all types	> 15 years <sup>[2]</sup>
< 30 %	all types	all types	6 years
< 50 %	Al	all types (not AuGe)	4 years
< 50 %	all types	AuGe	1 year
< 60 %	Al	all types (not AuGe)	3 years
< 60 %	Ag	Ag	4 years
< 60 %	Au	AuAs	> 15 years <sup>[2]</sup>
< 80 %	Al	all types	0.1 years

[1] RH % should be monitored or evidence (humidity indicator card) should be available that RH % requirement was really met during the storage period.

[2] The life time at such low humidity is limited only by the amount of desiccant added and the integrity of the MBB over time.

The shelf life time of bare wafer and bare die products is determined by the halogen (F, Cl, Br) contamination level in the product environment and the humidity which affect the degradation of aluminum bond pads. At low humidity, the halogen contamination has no aging effect, but at higher humidity, the halogens become volatile.

Humidity is the most important aging factor in the aging of wafers with backside metal. Additionally, gold contamination on Ti/Ni/Ag backside metal surface accelerates the aging process.

Silver surfaces are very sensitive for sulphur contamination. MBB will be a barrier for airborne sulphur contamination and therefore wafers packed in a sealed MBB are safe.

## 9. Floor life and bake to seal time

The floor life starts with opening the MBB. The floor life and the bake to seal time of IC products are dependent on the MSL (see [Table 2](#)). If the bake to seal time is exceeded, the products must be baked again.

**Table 2. Moisture Classification Level, floor life, and bake to seal time**

Moisture Sensitivity Level (MSL)	Ambient conditions		Floor life (out of bag time)	Bake to seal time
	Temperature	RH		
1 <a href="#">[1][2]</a>	30 °C	≤ 90 %	no limit	no limit
2 <a href="#">[3]</a>		≤ 60 %	1 year	7 days
2a <a href="#">[3]</a>			4 weeks	
3 <a href="#">[3]</a>		168 hours	24 hours	
4 <a href="#">[3]</a>				
5 <a href="#">[3]</a>				
5a <a href="#">[3]</a>				
6 <a href="#">[4]</a>		6 hours	no limit	

[1] Products with MSL1 are not dry packed.

[2] Wafers and bare die are rated as MSL 1. They do not require baking but require dry packing to avoid oxidation.

[3] Products that are moisture sensitive (MSL 2 through MSL 6) shall be baked prior dry-packed.

[4] Products of MSL 6 must be baked before use within 6 hours at the customer.

If partial lots are used, the remaining products must be resealed or placed in safe storage within 1 hour of bag opening. If the bag opening time or the floor life has expired or an excess moisture exposure happened, the products have to be backed prior dry-packing.

For information about storing in a dry atmosphere cabinet or a dry cabinet, see [Ref. 4 "IPC/JEDEC J-STD-033C"](#).

## 10. Dry-baking and drying

Before sealing product devices in MBBs, the products must be dry. This can be done by dry-baking or drying.

### 10.1 Dry-baking

Dry-bake conditions are:

- Bake temperature: +125 °C + 0 °C/– 5 °C
- Bake time, see [Table 3](#)
  - Packages, not mentioned in this table, are baked 5 times the package thickness (in mm), see [Table 4](#) and [Ref. 4 "IPC/JEDEC J-STD-033C"](#)
  - The x's in a package name in [Table 3](#) cover all versions except specifically mentioned versions

**Table 3. Dry-bake time per package type**  
*Bake temperature +125 °C + 0 °C/– 5 °C.*

Package family	Dry-bake time in hours
SO	8
SSOP, HSOP, VSO	10
TSSOP, HTSSOP	5
HBCC	5
xxQFP packages	12
LQFP, HLQFP, TQFP, HTQFP	8
PLCC, HSSON	12
xxBGA packages, <math>40 \times 40 \text{ mm}^2</math>	10
xxBGA packages, $\geq 40 \times 40 \text{ mm}^2$	15
TFBGA, LBGA, LFBGA	5
HVQFN, HVSON	5
SOJ	24

**Remark:** Baking deteriorates the solderability; do not bake for longer and not more often than required.



## 10.2 Drying

Products, packed in tubes or tapes cannot be baked at 125 °C and therefore must be dried at lower temperatures, see [Ref. 4 “IPC/JEDEC J-STD-033C”](#).

Table 4. Reference conditions for drying mounted or unmounted SMD packages according to [Ref. 4 “IPC/JEDEC J-STD-033C”](#)

Package body	MSL	Bake at					
		+125 °C + 10 °C/– 0 °C		+90 °C + 8 °C/– 0 °C ≤5 % RH		+40 °C + 5 °C/– 0 °C ≤5 % RH	
		Exceeding floor life by					
		>72 hours	≤72 hours	>72 hours	≤72 hours	>72 hours	≤72 hours
Thickness ≤1.4 mm	2	5 hours	3 hours	17 hours	11 hours	8 days	5 days
	2a	7 hours	5 hours	23 hours	13 hours	9 days	7 days
	3	9 hours	7 hours	33 hours	23 hours	13 days	9 days
	4	11 hours	7 hours	37 hours	23 hours	15 days	9 days
	5	12 hours	7 hours	41 hours	24 hours	17 days	10 days
	5a	16 hours	10 hours	54 hours	24 hours	22 days	10 days
Thickness >1.4 mm ≤2.0 mm	2	18 hours	15 hours	63 hours	2 days	25 days	20 days
	2a	21 hours	16 hours	3 days	2 days	29 days	22 days
	3	27 hours	17 hours	4 days	2 days	37 days	23 days
	4	34 hours	20 hours	5 days	3 days	47 days	28 days
	5	40 hours	25 hours	6 days	4 days	57 days	35 days
	5a	2 days	40 hours	8 days	6 days	79 days	56 days
Thickness >2.0 mm ≤4.5 mm	2	2 days	2 days	10 days	7 days	79 days	67 days
	2a	2 days	2 days	10 days	7 days	79 days	67 days
	3	2 days	2 days	10 days	8 days	79 days	67 days
	4	2 days	2 days	10 days	10 days	79 days	67 days
	5	2 days	2 days	10 days	10 days	79 days	67 days
	5a	2 days	2 days	10 days	10 days	79 days	67 days
BGA package >17 mm × 17 mm or any stacked die package	2 to 5a	96 hours	as above per package thickness and moisture level	not applicable	as above per package thickness and moisture level	not applicable	as above per package thickness and moisture level

## 11. Dry-packing

### 11.1 Material requirements

Moisture absorbing packing materials that are used in the MBB (e.g. the cardboard guard band for reels and the Humidity Indicator or HIC), shall be dry, before packing in the moisture barrier bag. Moisture absorbing packing material should therefore be kept dry in a drying box or an oven, with sufficient capacity to store (and dry) the required packing material for at least 24 hours, before use.

**Remark:** Exposure of the desiccant, HIC and paper guard band to the environment shall be for no more than 5 minutes, before packing and sealing the MBB.

#### 11.1.1 Desiccant requirements

- The desiccant must meet [Ref. 5 “MIL-D-3464E”](#), Type II. The desiccant shall be dustless, noncorrosive, and absorbent to the amounts specified in the standard.
- The desiccant capacity at 10 % RH and 25 °C per unit shall be  $\geq 2.5$  grams. The desiccant capacity at 10 % RH and 25 °C per unit shall be provided by desiccant supplier.
- If desiccant capacity is  $< 2.5$  grams, then desiccant amounts shown in [Table 5](#) and [Table 6](#) must be recalculated, see [Ref. 4 “IPC/JEDEC J-STD-033C”](#).
- The desiccant type shall be bentonite clay.
- The desiccant bag shall be moisture permeable Tyvek.
- Desiccant is typically supplied in packs containing two units but this is not a requirement and different size desiccant packs can be used.

The desiccant shall be stored in closed containers as received. After taking out the required quantity of desiccant, the container shall be closed immediately. A humidity indicator with a 5 % RH measuring spot shall be used in the desiccant container to check the humidity. Once this spot is showing another color than is specified for “dry”, the desiccant shall be reactivated (baked) first, in an oven according to suppliers recommendation before using. Desiccants made of so-called Molecular Sieve, cannot be reactivated.

**Table 5. Desiccant requirement for wafer pack**

MBB size (cm)		Typical wafer size (mm)	Total units of desiccant required
30	37	10	5
36	38	125	5
40	48.3	125; 150	7
50.5	77.5	200	12
76	82	300	19

Table 6. Desiccant requirement for finished products

MBB size (cm)		Pack type	Total units of desiccant required
20.5	47.5	5 tray	4
17	43	1 tray	4
22.5	30	reel, 180 × 12/16/24	4
38.1	45.7	reel, 330 × 12/16/24	6
40	48.3	reel, 330 × 32/44	6
9	61	SO-S tube	4
13.5	65	SO-L tube	4
20	67	PLCC tube	5
20	75	SMS tube	6
11	61	HSOP20 tube	4

### 11.1.2 Humidity Indicator Card (HIC) requirements

- The HIC shall have three color spots with sensitivity values of 5 %, 10 % and 60 % RH.
- The HIC shall comply with [Ref. 4 “IPC/JEDEC J-STD-033C”](#) and be Cobalt free version.

### 11.1.3 Moisture Barrier Bag (MBB) requirements

The moisture barrier bag shall meet [Ref. 6 “MIL-PRF-81705E \(W/AMENDMENT 1\)”](#), Type I requirements for flexibility, ESD protection, mechanical strength, and puncture resistance. The bags shall be heat sealable. The Water Vapor Transmission Rate (WVTR) shall be  $\leq 0.0310 \text{ g/m}^2$  ( $0.002 \text{ g/100 in}^2$ ) in 24 hours at 40 °C after flex testing per condition “E” [Ref. 1 “ASTM F392 / F392M-11”](#). The WVTR is measured using [Ref. 2 “ASTM F1249-13”](#).

### 11.1.4 Requirements for a material drying oven

- Temperature: +55 °C + 0 °C/– 5 °C.
- A dry air inlet, producing 10 liters of dry air per minute per 1 m<sup>3</sup> cabinet space. Dry air can be obtained from e.g. the standard high pressure (>4 ATO) air supply, the use of a dust and oil filter is obligatory.
- The heating system is in the bottom part of the oven. This results in an RH of 1/4th of the original RH from the air inlet, or 1/5th at  $T_{\text{amb}} = 20 \text{ °C}$ .
- Sufficient ventilation by openings in bottom and top, total 50 cm<sup>2</sup>.
- Use a humidity indicator to check the RH in the cabinet.

## 11.2 Dry-pack process requirements

In the dry-pack process, the carriers (trays, tubes, and reels) are placed in a qualified moisture barrier bag, with desiccants and a humidity indicator (HIC). The bag is pre-printed (if not: labeled) with a moisture caution label and the packing (PQ) box is identified (pre-printed) with a moisture warning sticker/printed logo.

**Remark:** The Moisture Barrier Bag must not be folded or creased. Do not use any MBB that has been creased or crumpled.

**Remark:** When, at repacking, a new bag and new desiccant is packed, the Bag Seal Date line on the moisture caution label must be filled in.

### 11.3 Sealing requirements

- Seal the MBB using “light vacuum” to reduce packing bulk, refer to [Ref. 4](#) “IPC/JEDEC J-STD-033C”. The sealing condition should be adjusted for proper sealing quality, based on visual inspection.
  - The minimum vacuum condition is when the MBB is pulled closely around the wafer box, trays, tubes, or reels with no air pockets between that MBB and the wafer box, trays, tubes, or reels.
  - The vacuum condition is too severe if the MBB is damaged or the wafer box, tubes, or reels are deformed.
  - For Wafer packs, the vacuum condition is too severe if the wafers show increased breakage rates during handling.
- The sealed packs need a consistent and uniform appearance.
- Wafer packs should have the excess MBB folded and taped around the wafer box.
- The bag shall be sealed at 7 mm to 10 mm from the open edge to allow an additional 3 seal operation of this bag.
- Use heat sealing conditions recommend by MBB supplier.
- Establish and routinely run seal quality monitor on the MBB seal operation.
- To enable a visual check on the presence of a HIC, the HIC can be placed on top of the desiccant bag that in turn is placed on top of the wafer box.
- For partial packing in tape and reel, recommend inserting the additional guard band at the outer layer nearby the edge of reel (especially for lightweight reel) before dry packing to minimize the possibility of reel flank bent.

## 12. References

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- [1] **ASTM F392 / F392M-11** — Standard Practice for Conditioning Flexible Barrier Materials for Flex Durability
- [2] **ASTM F1249-13** — Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor
- [3] **IPC/JEDEC J-STD-020** — Moisture/Reflow sensitivity classification for Non hermetic solid state Surface Mount Devices
- [4] **IPC/JEDEC J-STD-033C** — Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices
- [5] **MIL-D-3464E** — MILITARY SPECIFICATION: DESICCANTS, ACTIVATED, BAGGED, PACKAGING USE AND STATIC DEHUMIDIFICATION
- [6] **MIL-PRF-81705E (W/AMENDMENT 1)** — PERFORMANCE SPECIFICATION: BARRIER MATERIALS, FLEXIBLE, ELECTROSTATIC PROTECTIVE, HEAT-SEALABLE
- [7] **Terms and conditions of commercial sale** — <http://www.nxp.com/about/sales-offices-distributors/general-terms-and-conditions-of-commercial-sale.html>

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