APPLICATION NOTE

Guidelines for storage and handling of plastic encapsulated ICs (v1.0)

April 2020

Quality
&
Advanced Customer Solutions

Guidelines for storage and handling of plastic encapsulated ICs

1. Scope
2. Risks of storage and handling
3. Product labelling and packing
4. Shelf life control and reaction
5. Floor life and handling

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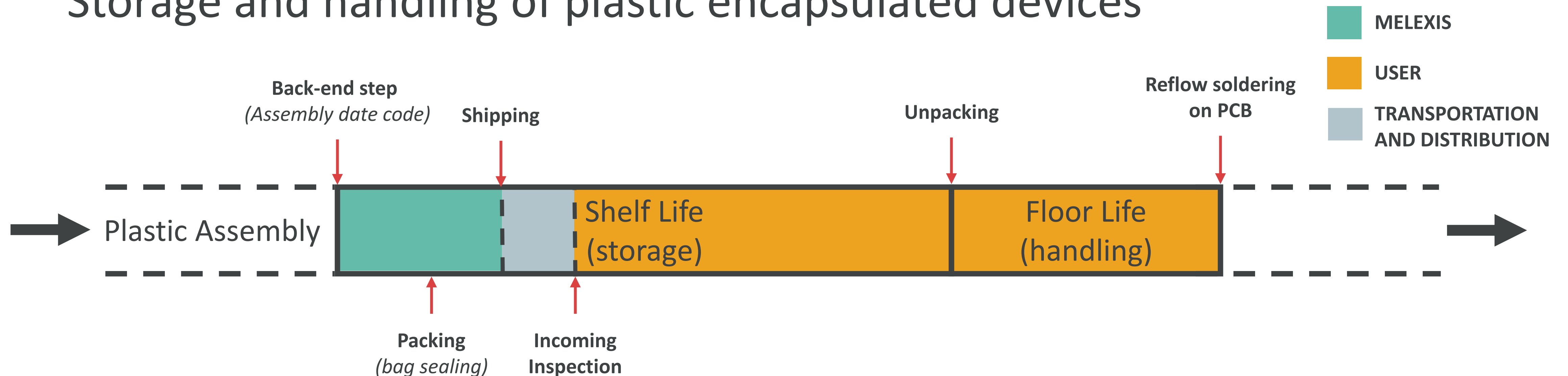
1. Scope

Storage and handling of plastic encapsulated devices



After plastic assembly of a plastic encapsulated device, exposure to the environment might degrade the materials of the package. Proper storage conditions ought to be foreseen to mitigate the problems associated with degradation mechanisms. There are two main timeframes to consider:

- **Shelf life**: Shelf life is the maximum time of storage at normal conditions that will not cause risks for product assembly quality, performance or reliability degradation. It usually starts at the assembly date code (assy DC). Some of the shelf life will be consumed at Melexis before shipping to the user (time-controlled by supply chain), during transportation and during storage at distributors (if any).
- **Floor life**: Floor life means time of exposure of unpacked products at the end customer before soldering on PCB.

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1. Scope

Applicable JEDEC standards for storage and handling

J-STD-033:

Handling, Packing, Shipping and Use of Moisture, Reflow, and Process Sensitive Devices

JEP-160:

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

Under normal conditions, it is expected that Melexis products are assembled by the user within maximum one year after the shipping date. During this time, J-STD-033 provisions for storage and handling are applicable, with factory environment conditions typically at <30C and <60% RH for proper storage and handling of the devices on the shop floor.

In the event that more than one year from shipping date to PCB assembly happens (for instance, when having a distributor warehouse time in between), then JEP-160 recommendations are applicable, with warehouse environment kept at <40C and <90% RH for proper storage conditions

Guidelines for storage and handling of plastic encapsulated ICs

1. Scope
2. Risks of storage and handling
3. Product labelling and packing
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2. Risks of storage and handling

Main risks during storage and handling of plastic encapsulated devices

Risk 1:
Solderability degradation of leads

Mainly during storage. Defines the shelf life

Risk 2:
Moisture absorption in plastic mold

Both during storage and handling on the shop floor. Defines the floor life

Risk 3:
ESD

During unpacking and handling on the shop floor.

2. Risks of storage and handling

Risk 1: Solderability degradation of leads

There are several mechanisms that might impact the solderability of the devices, leading to improper wetting of the leads during soldering. The resulting poor solder joint might further degrade to open circuit and cause a field failure. These degradation mechanisms are highly dependent on the metallurgical characteristics and surface treatment of the leads. At the present moment, Melexis offers two different lead finishes: tin plating (Sn) and Nickel-Palladium-Gold plating (NiPdAu).

To mitigate above, a shelf life for each of them has been defined: within this timespan, the solderability is guaranteed. The shelf life as defined by Melexis is a conservative estimate that takes into consideration not only the solderability of the lead finish, but also the unknown environmental conditions during both shipping and storage.

Lead finishes at Melexis and their shelf life	
Sn plating	NiPdAu plating
4 years (from Assy DC)	4 years (from Assy DC)

Refer to the Shelf Life statement (https://www.melexis.com/en/quality-environment/shelf-life) for more information

2. Risks of storage and handling

Risk 2: Moisture absorption in plastic mold

Water molecules in the environment might get trapped inside the structure of the mold package, which is non-hermetic. During reflow soldering the package is subjected to a high temperature, the moisture evaporates and may build-up enough pressure inside the plastic mold to cause delamination or mold crack (pop-corn effect). Under thermomechanical stresses in the application, it may further develop to wire bond or die damage and eventual field failure.

To mitigate above, products that by categorization (Moisture Sensitivity Level, MSL) are sensitive to moisture absorption are dried before packing, and then stored in a dry pack made of desiccant material and a Humidity Indicator Card (HIC) sealed in a Moisture Barrier Bag (MBB) along the devices. MSL categorization is a part of the Melexis product qualification procedure and can be found in the PQR (usually released along the PPAP). Melexis products are either MSL1 or MSL3:

MSL 1

- Devices are insensitive to moisture absorption

MSL 3

- Devices are sensitive to moisture absorption
- ‘Dry pack’ is a must
- Handling must follow J-STD-033 to meet the floor life requirements

MSL categorization according to J-STD-020

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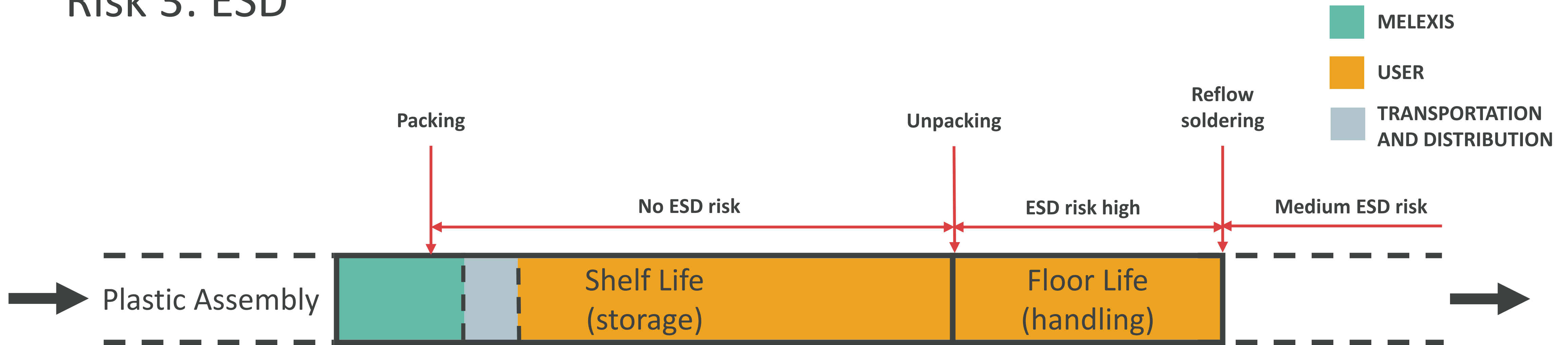
2. Risks of storage and handling

Risk 3: ESD



ESD events might vary according to the mechanism of the discharge. The damage sustained by the IC structures by excessive heating of the silicon structure during the discharge might lead to outright failure or to a latent failure that will further develop and eventually fail in the field.

To mitigate above, Melexis packing is designed to be ESD safe: the parts are shielded and eliminating the chance of an ESD event. However, once the packing is opened, the user is responsible to guarantee proper protection mechanisms for the mitigation of ESD risks. Hence, the assembly into systems shall be carried out in EPA areas according to ANSI/ESD S20.20. Although not requested by standard, Melexis also recommends to maintain active environmental control with relative humidity of 40% RH minimum to avoid charge build-up on the devices and decrease the chance of ESD events.

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Guidelines for storage and handling of plastic encapsulated ICs

1. Scope

2. Risks of storage and handling

3. Product labelling and packing

4. Shelf life control and reaction

5. Floor life and handling

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3. Product labelling and packing

Labelling for Melexis products

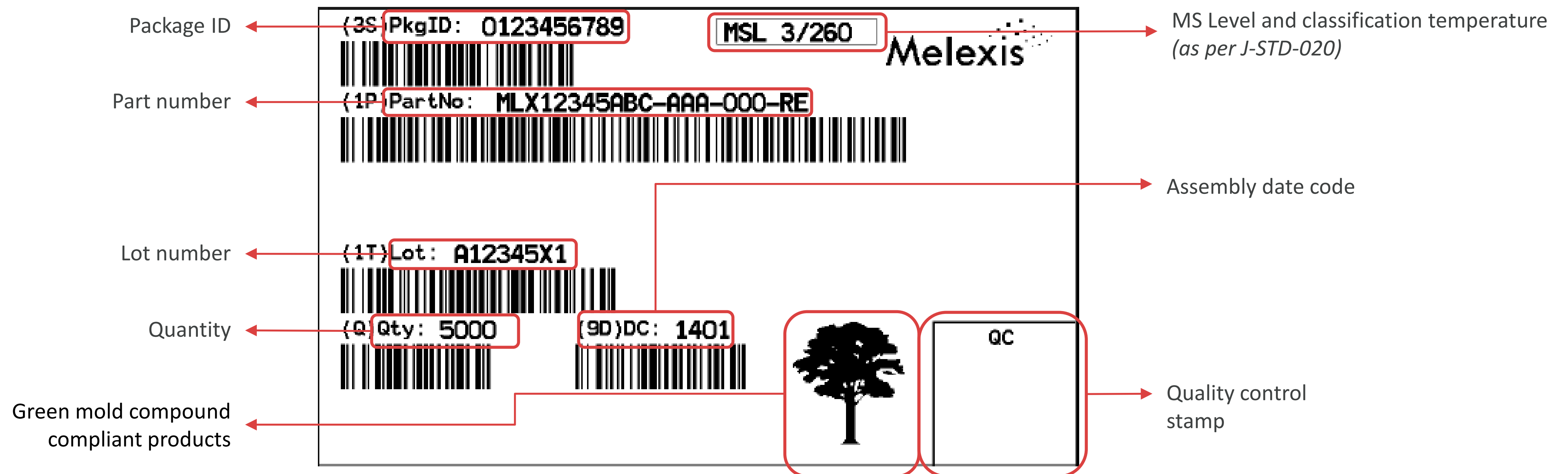
Reel in MBB bag

Packing and labeling is done by MS level according to the requirements of J-STD-033.

- **Product ID label:** It contains product name, production lot number and plastic assembly date code (DC) in format WWYY (week of the year) among others.
- **MSL caution label:** It contains information for proper storage and handling: date of dry pack sealing, MS level and storage conditions among others.

3. Product labelling and packing

Product ID label



Label size is 100x60mm, black ink on white background. This is a reference since there might variations on the information displayed on the label depending on the product inside and QC stamp might not be present. Every Melexis product has an ID label on the packing, no matter its MSL categorization. Label picture is not contractual

3. Product labelling and packing

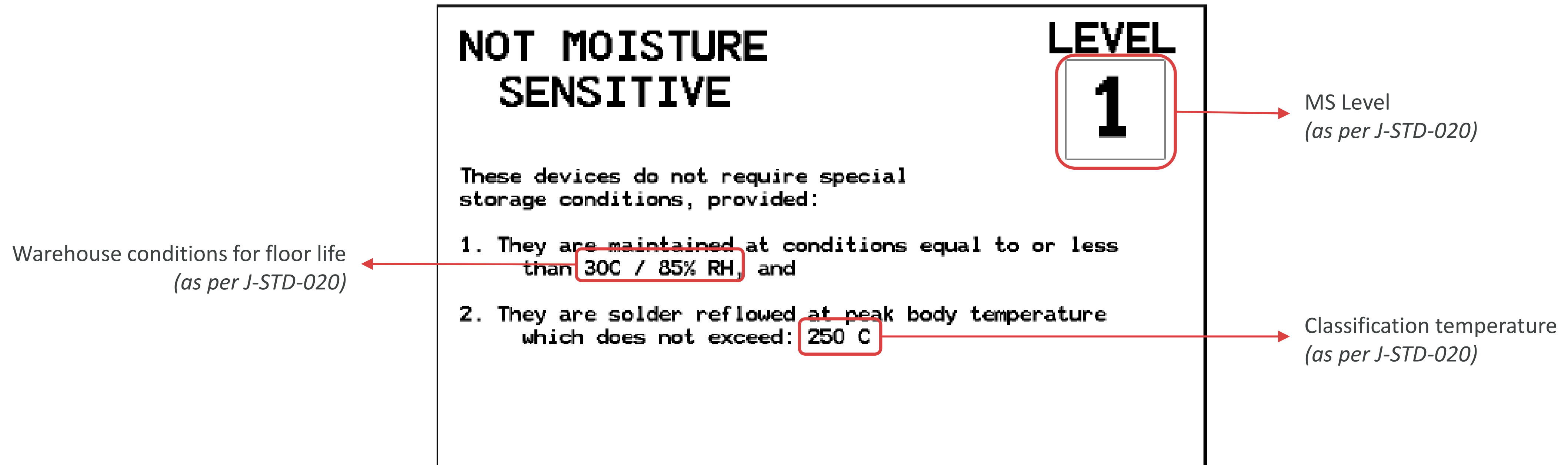
Product packing according to MSL

MSL 1					MSL 3	
Bulk packaging	Radial Tape on ammopack *(IEC 60286-2)*	Radial tape on reel *(IEC 60286-2)*	Embossed Tape on 7" Reel *(IEC 60286-3)*	Embossed Tape on 13" Reel *(IEC 60286-3)*	Embossed Tape on 13" Reel in MBB *(IEC 60286-3)*	JEDEC Tray *(IEC 60286-5)*

Contact Melexis at rma@melexis.com for the detailed specification of each packing method

3. Product labelling and packing

MSL caution label for MSL 1 products



Label size is 100x60mm, black ink on white background. Every Melexis product categorized as MSL1 has this label attached to the ESD safe packing. Label picture is not contractual

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3. Product labelling and packing

MSL1: Bulk packaging

Back view

Front view

Bulk packaging is a MSL 1 packing method used for Single-in-Line packages (SIP). The devices are stored in a ESD safe bag. Since floor life is unlimited for MSL1 products, hermetic sealing is not required.

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3. Product labelling and packing

MSL1: Radial tape on ammopack

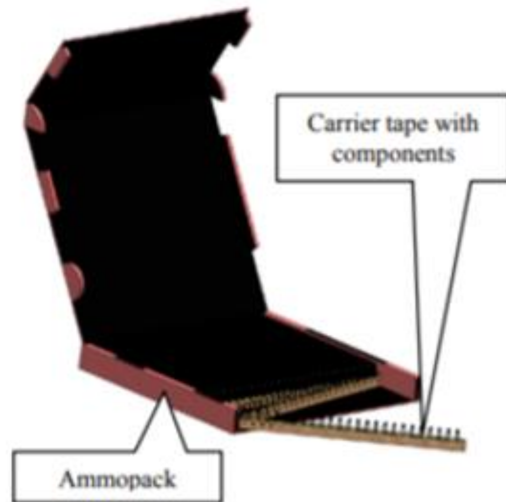

Diagram of radial tape on ammopack

Closed cartoon box

Top view of the cartoon box

Radial tape on cartoon ammopack (also known as pizza box) is a MSL 1 packing method used for Single-in-Line packages (SIP) in zig-zag radial tape. The carton is impregnated with (black) conductive ESD shielding paint, so there is no need of ESD safe plastic bag. Since floor life is unlimited for MSL1 products, sealing is not needed.

3. Product labelling and packing

MSL1: Radial tape

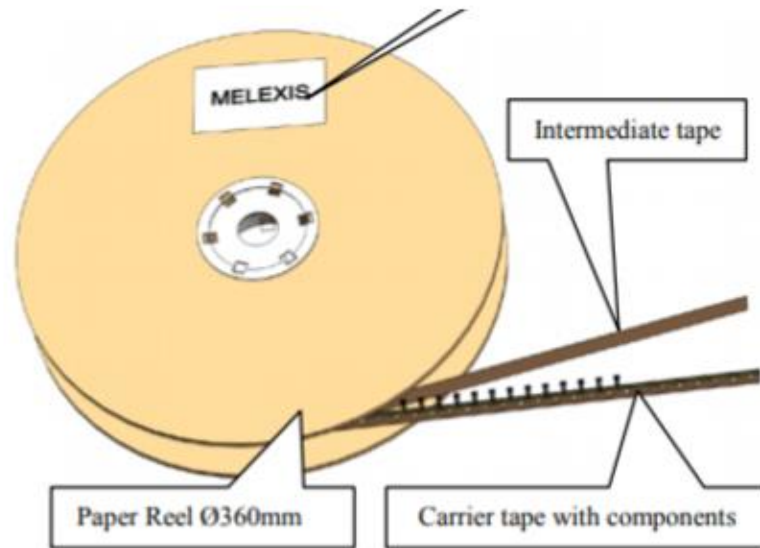

Diagram of radial tape on reel

Reel in ESD bag

Reel in ESD bag and bubble bag

Radial tape on reel is a MSL 1 packing method used for Single-in-Line packages (SIP). The devices are stored in a reel, and the reel is introduced in an ESD bag and thereafter in a bubble bag. Since floor life is unlimited for MSL1 products, sealing is not needed.

3. Product labelling and packing

MSL1: Embossed Tape on 7” Reel

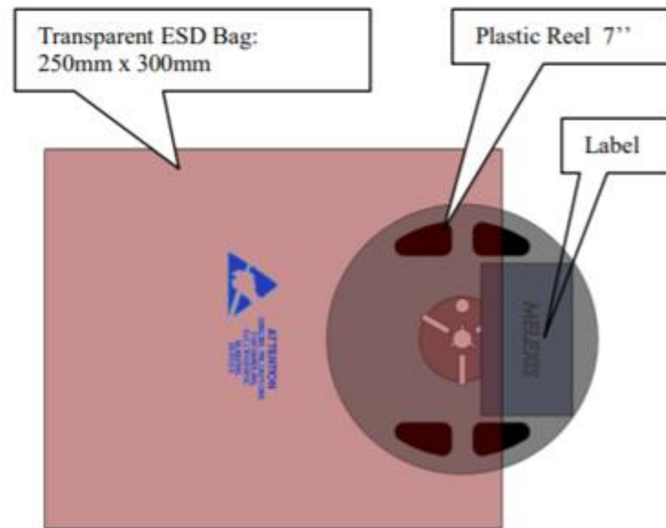

Diagram of embossed tape on 7’’ reel

Reel

Reel in ESD bag

Embossed tape on 7’’ reel is a MSL 1 packing method used for SOT23 devices. The devices are taped in an embossed reel, and the reel is introduced in an ESD bag. Since floor life is unlimited for MSL1 products, sealing is not needed.

3. Product labelling and packing

MSL1: Embossed Tape on 13” Reel

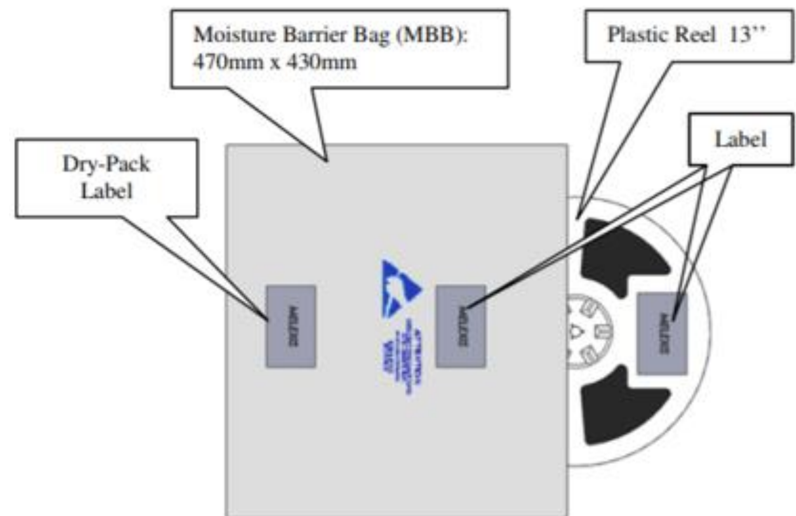

Diagram of embossed tape on 7’’ reel

Reel

Reel in MBB bag

Embossed tape on 13’’ reel is a MSL 1 packing method used for leaded and non-leaded devices. The devices are taped in an embossed reel, and the reel is placed in a moisture barrier bag (although it is not required for MSL1) without HIC nor silica-desiccant inside: it is not considered a dry pack and parts are not dried before they are placed on tape.

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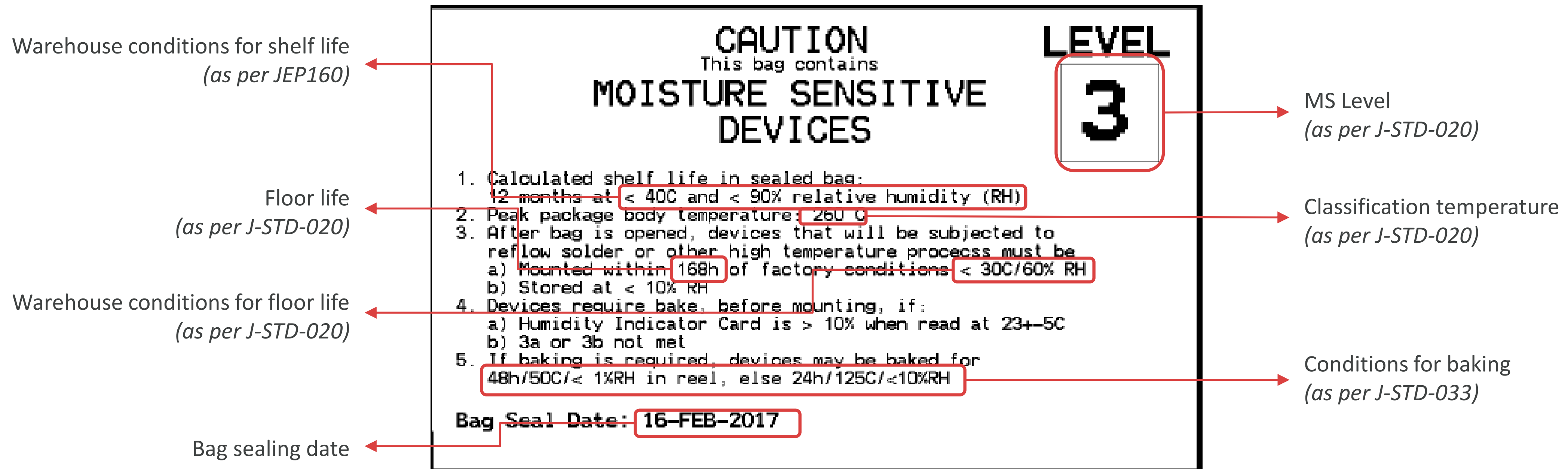
3. Product labelling and packing

MSL caution label for MSL 3 products



Label size is 100x60mm, black ink on white background. Every Melexis product categorized as MSL3 will have this label attached to the protective packing. Label picture is not contractual

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3. Product labelling and packing

MSL3: Embossed Tape on 13” Reel (dry pack)

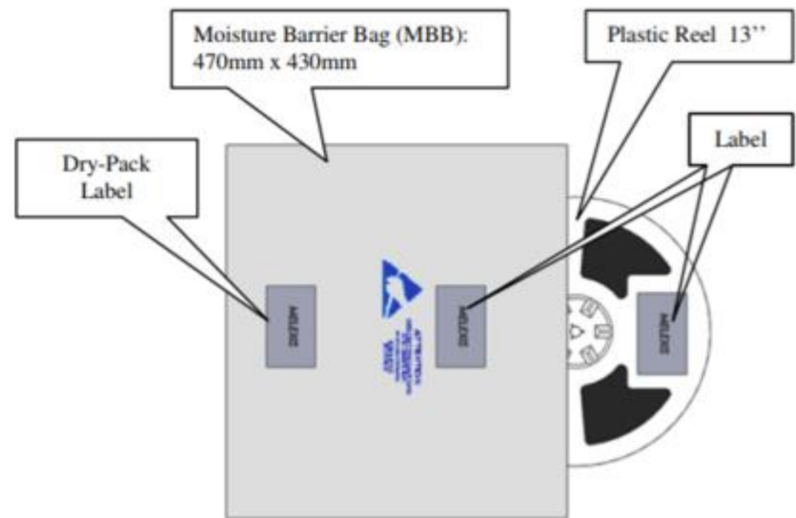

Diagram of embossed tape on 7’’ reel

Reel with HIC

Reel in MBB bag

Embossed tape on 13’’ reel is a MSL 3 packing method used for leaded and non-leaded devices. To avoid moisture absorption, devices need to be packed in a dry pack consisting of a moisture barrier bag (MBB) to avoid moisture from reaching the devices; a Humidity Indicator Card (HIC) next to the devices, to monitor the amount of humidity inside the bag; and silica-dessicant to absorb any humidity left during packing. If backing to dry the devices is required, it must be done according to the MSL 3 label in a low humidity environment.

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3. Product labelling and packing

MSL3: JEDEC Tray

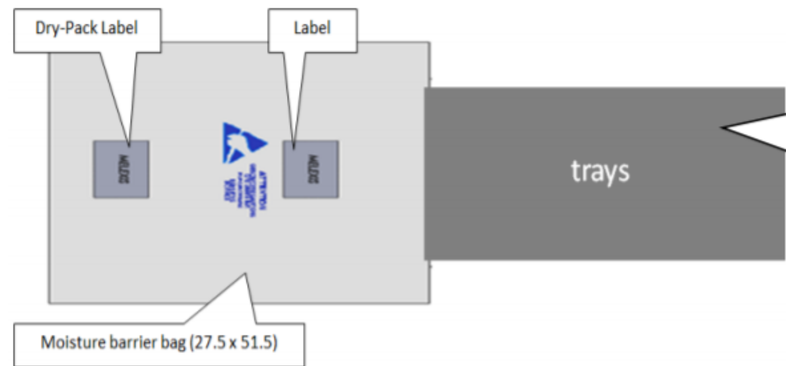

Diagram of JEDEC tray

JEDEC tray with HIC and silica dessicant

JEDEC tray in MBB

JEDEC tray is a MSL 3 packing method used for QFN devices. To avoid moisture absorption, devices need to be packed in a dry pack consisting of a Moisture Barrier Bag (MBB) to avoid moisture from reaching the devices; a Humidity Indicator Card (HIC) next to the devices, to monitor the amount of humidity inside the bag; and silica-dessicant to absorb any humidity left during packing. The maximum baking temperature is stamped onto the trays. If backing to dry the devices is required, the stated maximum baking temperature must be respected; otherwise it will cause the dimensions of the tray to alter, potentially damaging the contents.

Guidelines for storage and handling of plastic encapsulated ICs

1. Scope

2. Risks of storage and handling

3. Product labelling and packing

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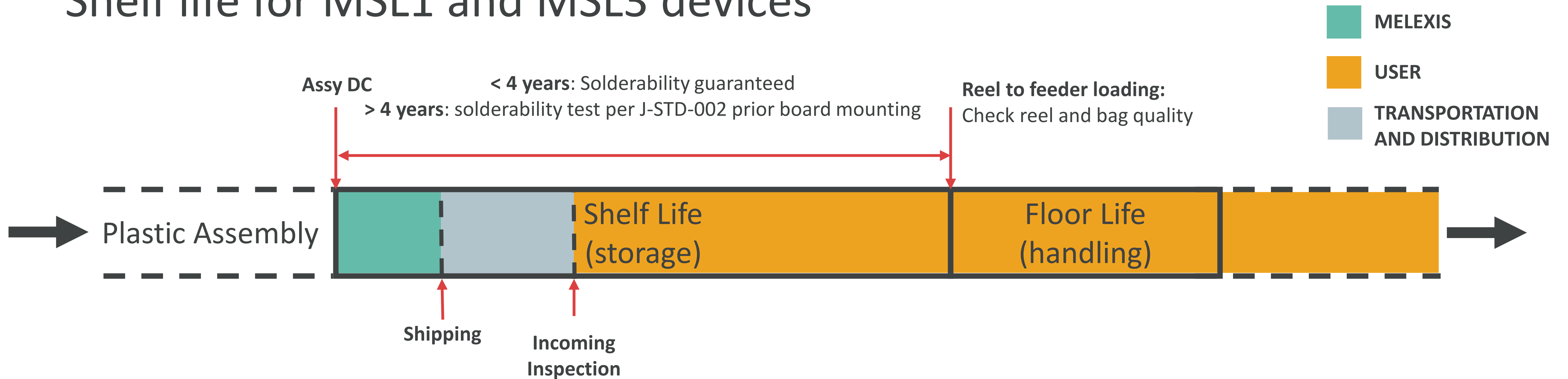
4. Shelf life control and reaction

Shelf life for MSL1 and MSL3 devices



Shelf life starts at plastic assembly and ends at PCB assembly. The main concern during this timeframe is the potential degradation of the solderability of the devices. It is *recommended* to follow JEP-160 with warehouse environment kept at <40C and <90% RH.

Solderability is independent of MSL categorization. Melexis guarantees 4 years versus the assembly date code found on the ID label. If the shelf life has expired at the time of board assembly, a solderability test shall be conducted per J-STD-002 on samples from an assembly batch (considered as one wafer lot and one date code) at the time of unpacking. If the test passes, the parts can be assembled normally.

For MSL3 devices, it is also required to check the moisture inside the dry pack upon opening the MBB. If the HIC is blue (moisture inside the bag <10% RH), assembly can proceed normally. If it is pink (moisture inside the bag >10% RH), drying shall be done prior assembly. The conditions for this baking step can be found on the MSL label and are different for MSL 3 devices delivered on JEDEC tray and devices delivered on embossed tape.

4. Shelf life control and reaction

Acceptance criteria

MSL 1 product acceptance criteria

- Not damaged Reel
- Not damaged Tape
- No Heavily cut outer bag indicating mechanical overstress
- Readable labelling

MSL 3 product acceptance criteria

- Not damaged Reel
- Not damaged Tape
- No Heavily cut outer bag indicating mechanical overstress
- Readable labelling
- HIC indicating < 10% RH
- HIC is not missing
- Silica desiccant is not missing

Contact rma@melexis.com in case any of the above criteria is not met

4. Shelf life control and reaction

Drying of MSL 3 devices when HIC is indicating > 10% RH

CAUTION
This bag contains
MOISTURE SENSITIVE
DEVICES

LEVEL
3

1. Calculated shelf life in sealed bag:
   12 months at < 40C and < 90% relative humidity (RH)
2. Peak package body temperature: 260 C
3. After bag is opened, devices that will be subjected to reflow solder or other high temperature proceess must be
   a) Mounted within 168h of factory conditions < 30C/60% RH
   b) Stored at < 10% RH
4. Devices require bake, before mounting, if:
   a) Humidity Indicator Card is > 10% when read at 23+-5C
   b) 3a or 3b not met
5. If baking is required, devices may be baked for
   48h/50C/< 1%RH in reel, else 24h/125C/<10%RH

Bag Seal Date: 16-FEB-2017

Conditions for baking for **tape on reel**

Conditions for baking for **JEDEC tray** or after removal from tape on reel

If the HIC indicates > 10% RH, moisture could have been absorbed by the mold package with its inherent impact during reflow soldering on PCB. It is then necessary to dry the parts by baking the devices according to the MSL 3 label. Two different conditions are given: one for tape on reel and one for any other case (either JEDEC tray or customer carriers). In either case, the user takes full responsibility during handling of the devices.

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4. Shelf life control and reaction

Baking tape on reel products

Reels on super dry oven (50C, <1% RH)

Reels on tray

Melexis reels can be dried at maximum temperature of 50C in a low humidity environment <1% RH for 48 hours, as stated in the MSL label. This is only applicable to MSL 3 products. Exceeding 50C baking temperature might lead to damage to the reel, carrier tape and the devices contained within. If 125C baking is foreseen, the products shall be removed from the tape and placed in an appropriate high temperature carrier.

Guidelines for storage and handling of plastic encapsulated ICs

1. Scope

2. Risks of storage and handling

3. Product labelling and packing

4. Shelf life control and reaction

5. Floor life and handling

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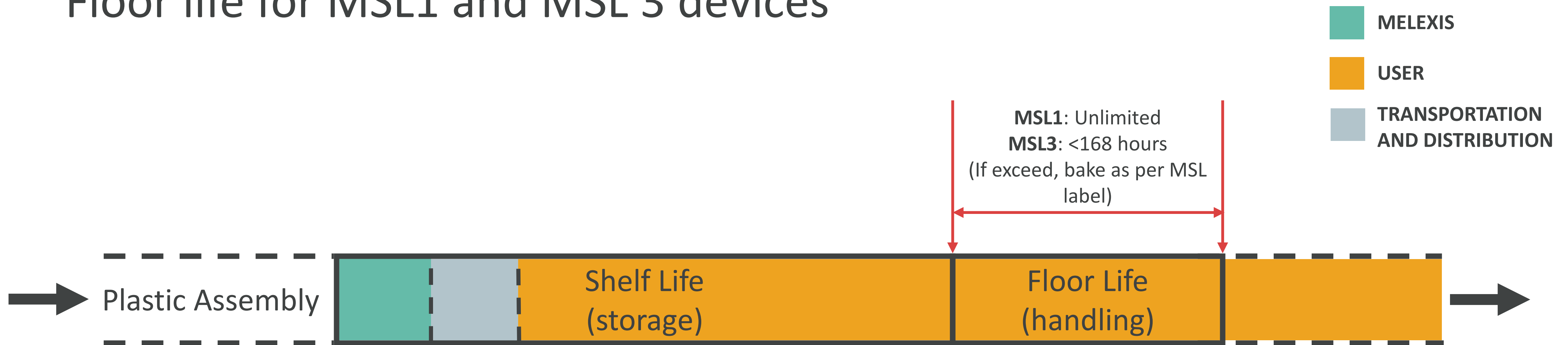
5. Floor life and handling

Floor life for MSL1 and MSL 3 devices



Floor life is the time of exposure of unpacked products at end customer before soldering on PCB. It is *required* to follow J-STD-033 for proper handling of the devices on the shop floor. The floor life depends on the environmental conditions of the factory and on the MSL categorization of the devices:

- MSL 1: floor life is unlimited at ≤ 30 ºC/85% RH
- MSL 3: floor life is limited to 168 hours at ≤ 30 ºC/60% RH

If floor life requirements cannot be met for MSL 3 devices, either because the batch produced does not consume all the devices in the reel or due to other factors, the floor life can be stopped by following 'safe storage' conditions: either in in a dry pack or a dry cabinet with humidity control. In case the maximum floor life is reached for MSL 3, it can be reset by baking the parts post exposure to factory ambient as described in the MSL label.

5. Floor life and handling

Derating due to factory ambient conditions

	<40% RH	50% RH	60% RH	70% RH	80% RH	90% RH
35C	∞	8	5	1	0.5	0.5
30C	∞	11	7	1	1	1
25C	∞	14	10	2	1	1
20C	∞	20	13	2	2	1

Equivalent factory floor life in days for MSL 3 devices with body thickness <2.1 mm

If the factory conditions are different from the ones specified in the MSL label, a derating of the floor life has been foreseen in J-STD-033 Table 7-1. This derating depends on the body thickness of the devices, which mostly falls below 2.1 mm for Melexis products. This derating only applies to products categorized as MSL 3 since MSL 1 has an unlimited floor life by default. The conditions assumed in the MSL label is highlighted in green.

Note that even though an environment with <40% RH means unlimited floor life for products categorized as MSL 3, such low humidity increases the chance of ESD events and hence it is not recommended by Melexis.

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Appendix I: Standards addressed in the document

JEP 160

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

J-STD-020

Moisture/Reflow Sensitivity Classification for Nonhermetic Surface Mount Devices

J-STD-033

Handling, Packing, Shipping and Use of Moisture, Reflow, and Process Sensitive Devices

IEC 60286-2

Packaging of Components for Automatic Handling - Part 2: Packaging of Components with Unidirectional Leads on Continuous Tapes

IEC 60286-3

Packaging of Components for Automatic Handling - Part 3: Packaging of Surface Mount Components on Continuous Tapes

IEC 60286-5

Packaging of Components for Automatic Handling - Part 5: Matrix trays

ANSI/ESD S20.20

Protection Of Electrical And Electronic Parts, Assemblies And Equipment

Appendix II: Acronyms used in the document

Assy DC: Assembly Date Code

EPA: ESD Protected Area

ESD: Electrostatic Discharge

HIC: Humidity Indicator Card

IC: Integrated Circuit

ID: Identity Document

MBB: Moisture Barrier Bag

MS: Moisture Sensitivity

NiPdAu: Nickel-Palladium-Gold

PCB: Printed Circuit Board

PPAP: Production Part Approval Process

PQR: Product Qualification Report

RH: Ambient Air Relative Humidity

SIP: Single In-line Package

Sn: Tin

SOT: Small Outline Transistor

WWYY: Week-Year

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3. defense related products, or other material for military use or for law enforcement;
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