Moisture Sensitivity

Introduction

Microsemi tests and classifies all semiconductor devices for moisture sensitivity to ensure long-term reliability. This document briefly describes moisture-related failure modes, preventative test procedures, and moisture sensitivity of Microsemi FPGAs. Microsemi tests all of its packaged devices in accordance with the procedures outlined by JEDEC (IPC/JEDEC JSTD- 020 and JESD22-A113).

Moisture-Induced Manufacturing Failures

Improper storage, handling, or packaging of plastic encapsulated semiconductor devices can allow the introduction of moisture. Moisture trapped inside plastic encapsulated packages can damage them during soldering, as the moisture vaporizes and tries to expand. This internal vapor pressure can cause separation of the plastic package from the semiconductor chip or lead frame, internal or external cracks, and damage to thin films and wirebonds. In severe cases, soldering may even cause an integrated circuit to bulge and/or explode.

It is important to handle dry pack bags very carefully to prevent plastic packages from absorbing moisture. Microsemi strongly recommends adhering to the following guidelines when handling these devices (refer to IPC/JEDEC STD-033 for more information):

1. Moisture barrier bags are sealed at Microsemi. These bags must be handled with care to avoid puncture or tearing of the bag's material.
2. Upon receipt, moisture barrier bags should be inspected for punctures or holes of any kind. If openings in the bag are found and the maximum humidity indicator has been exceeded, Microsemi recommends baking the parts according to the conditions specified in Table 1 on page 2.
3. Bags should remain sealed until parts are ready to be used.
4. Inspect the humidity indicator card (HIC) immediately after opening the package and evaluate the colors of the dots. The HIC card color should be blue (dry).
5. Proper handling of storage, board mounting assembly and rework is critical to avoid over-exposure of the package to moisture.

Moisture Sensitivity Ranges

JEDEC has defined a moisture sensitivity classification that is universally regarded as the standard for definitions in this area. The purpose of this standard is to identify the moisture sensitivity level at a fixed reflow temperature (shown in Table 1 on page 2), so that the user can properly store and handle the devices and to avoid subsequent thermal/mechanical damage during the assembly reflow attachment and/or repair operations.

The present moisture sensitivity standard contains seven levels. The lower the level, the longer a device’s floor life. The goal of all package manufacturers is to have their packages reach level 1, which would be an unlimited floor life.

Table 1: **JEDEC Standard Qualification Levels**

Level	Description	Preconditioning Followed by Three Cycles of VPR or IR Solder Shock	Expected Floor Life (at 30°C / 60% RH)
1	Not moisture sensitive	168 hours at 85°C/85% RH	Unlimited
2	Limited moisture sensitive	168 hours at 85°C/60% RH	One year
3	Moisture sensitive	192 hours at 30°C/60% RH	Seven days
4	Moisture sensitive	84 hours at 30°C/60% RH	Three days
5	Highly moisture sensitive	168 hours at 85°C/85% RH	One day
6	Extremely moisture sensitive	168 hours at 85°C/85% RH	Six hours

Typically, most packaged ICs are certified at level 3. This means they have a floor life of 168 hours before they need to be rebaked.

Moisture Test Method

Consistent with JEDEC recommendations, Microsemi's tests follow the latest revision of IPC/JEDEC J-STD-020 (consult JEDEC for the full profile).

Table 2: **Moisture Sensitivity Levels for Microsemi Packages**

Package Type	Maximum Exposure Time to Ambient Condition Prior to Surface	Bake Time at 125°C	Moisture Level
BG/BGG 272/329/456/729	168 hours	8 hours	Level 3
FG/FGG 144/256/324/484/676/896/1152	168 hours	8 hours	Level 3
VF 49/128/180/289	168 hours	8 hours	Level 3
CSG 81/196/201/281	168 hours	8 hours	Level 3
uCG 81	168 hours	8 hours	Level 3
QNG 108/132/180	1 year	8 hours	Level 2
QNG 68	168 hours	8 hours	Level 3
RQ 208/240	72 hours	8 hours	Level 4
PQ/PQG 100/144/160/208/240	168 hours	8 hours	Level 3
TQ/TQG 64/100/144/176	168 hours	5 hours	Level 3
VQ/VQG 80/100	168 hours	5 hours	Level 3
PL/PLG 44/68/84	168 hours	8 hours	Level 3

A device is considered a JEDEC failure if it exhibits any of the following:

1. External crack visible under 40X optical microscope
2. Any internal crack that extends more than two-thirds of the distance from the crack initiation to bonding fingers or package surface
3. Electrical room temperature DC or functional failure. If failure analysis can show that the electrical failure is not due to moisture-stress sensitivity (for example, electrical overstress), then that failure may be disallowed. If more than one failure is disallowed, that subgroup must be rerun.
4. Complete delamination on top of a die is verified by a scanning acoustic microscope.

Conclusion

Moisture trapped inside plastic packages can damage them during soldering. Microsemi tests all plastic packaged FPGAs for moisture sensitivity according to the procedures outlined by JEDEC. Most of Microsemi's plastic packages are rated at a moisture sensitivity level (MSL) of 3. Microsemi's eX FPGAs, offered in 0.8 mm chip-scale (CS) plastic packages, are rated at an MSL of 2, which means they can be stored at room temperature and 85% relative humidity for up to one year. If a user has stored any device beyond the floor life at or above recommended temperature relative humidity, Microsemi recommends the user adhere to JEDEC guidelines and perform a bake-out before reflow soldering (Table 1 on page 2).

List of Changes

The following table lists critical changes that were made in each revision of the document.

Revision	Change	Page
51700045-4/3.11	Table 2: Moisture Sensitivity Levels for Microsemi Packages was revised to change the CSG 49/128/180 package type row to VF 49/128/180/289. The CSG 81/196/201/281/289 package type row was changed to CSG 81/196/201/281. The moisture level was changed from 2 to 3 for VF 49/128/180/289, CSG 81/196/201, and uCG81. The maximum exposure time was changed from 1 year to 168 hours for VF 49/128/180/289, CSG 81/196/201, and uCG81.	2
51700045-3/1.09	CS289 and QN68 data were added to Table 2: Moisture Sensitivity Levels for Microsemi Packages.	2
51700045-2/11.08	CSG 281 level 2 was removed from Table 2: Moisture Sensitivity Levels for Microsemi Packages.	2
51700045-1/6.08	In the "Introduction" section, IPC/JEDEC JSTD-020B and JESD22-A113-B were changed to IPC/JEDEC JSTD- 020 and JESD22-A113.	1
	The "Moisture Test Method" section was significantly updated.	2
	Table 2: Moisture Sensitivity Levels for Microsemi Packages was updated to include the following packages: CS 81/196/201/281/289 uC 81 QN 68/108/132/180 The pin names in the Package Type column were updated to include G. For example, BG became BGG.	2

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