

Product Handling, Safe Storage, Shelf Life Application Note

GSN-APP-710.V01

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1. Purpose

Gallium Semiconductor products uses JEDEC industry standard for ESD sensitive integrated circuit and MSD to prepare semiconductor devices to end-user. End-users are to observe the sensitivity in the process of application.

2. Scope

This specification provide an application note with ESD, EOS, HBM, CDM charge model for proper products handling and the process of application for end-user to review, and the recommended safe storage and products shelf life applies to all Gallium Semiconductor RF products.

3. Reference Documents

J-STD-020	Moisture/Reflow Sensitivity Classification for SMDs
J-STD-033	Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices
JS-001-2023	Joint JEDEC/ESDA Standard for Electrostatic Discharge Sensitivity Test (Component Level)
JEP174	Electrical Overstress (EOS)
JESD625	Requirements for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices
EIA-541	Packaging Material Standards for ESD Sensitive Items
EIA-583	Packaging Material Standards for Moisture Sensitive Item

4. Abbreviation, Acronym, Definition

JEDEC	Joint Industry Standard
IC	Integrated Circuits
MSD	Moisture Sensitive Devices (Non MSL Level1)
MSL	Moisture Sensitive Level
ESDS	Electrostatic-Discharge-Sensitive
ESD	Electrostatic Discharge
EOS	Electrostatic Overstress
HBM	ESD Human-Body Model
CDM	ESD Charged-Device Model
HIC	Humidity Indicator Card
MET	Manufacturer's (end user) Exposure Time

5. ESD and EOS Cautionary for End-User

ESD-induced failures in semiconductor IC can be seen in the form of leakage, short, burnout, contact damage, gate oxide rupture, resistor-metal interface damage, etc. EOS is a failure state wherein the device is subjected to undesirable voltage, current, or power with excessive heat generated. An EOS event can degrade the IC or cause permanent functional failure. ESD is a subset of EOS.

6. ESD Model for End-User

Gallium Semiconductor recommend the use of HBM and CDM models for end-user application. The different models simulate the different environments which may be encountered by the component during the process of application. The models differ in that the HBM simulate the electrostatic discharge from a person to a device, whereas the CDM simulates the electrostatic discharge to and

from a device due to induced or triboelectric charging. The ESD models allow end-users to identify and mitigate ESD related risks. Please refer to Gallium Semiconductor data sheet for more information at www.galliumsemi.com

7. ESD Sensitive Devices Protection Requirements

Gallium Semiconductor emphasize end-users to ensure the proper ESDS or ESD sensitive devices handling protection shall be observed, and ESD grounding of personnel, tools and automatic equipment to a device and ionizer in the device chamber, DUT area, workspace or process zone during the application of the IC. This is particularly critical if ESD sensitive products are handled under low humidity conditions.

The transportation or transfer materials (IC unit carrier) used shall comply to the requirements for Handling of Electrostatic-Discharge-Sensitive Devices and Packaging Material Standards for ESD Sensitive Devices, such as static dissipative material: A material having a surface resistance or any ESD safe coated materials.

8. Bare Die Handling Requirements

End-user is responsible and must aware given the sensitivity of bare die, EXTREME CARE should be taken to avoid damaging the bare die. This document is aimed to rise the sensitivity and awareness of physical effects which could harm the quality, reliability, and yield. It is necessary to handle bare die in ESD protected environment and in clean room environment.

Mechanical influences shall be avoided in the application. And to protects the circuits against certain mechanical damages, applying of mechanical forces must be avoided or limited. Uneven forces to the die can bend it and generate damages to the integrated circuits surface and generating cracks, indents, scratches, etc. Therefore, it is necessary to use the appropriate tools to handle bare die to avoiding damages by end-user.

End-user is recommended for bare die handling must always be handled in a clean room environment of at least class 10K or better. To avoid contaminations and damages:

- Die must never be handled by bare fingers
- Active side of a die should never be touched without appropriate tool determined by end-user
- Vacuum pick-up tool is recommended to use to move die from the packaging unit carrier without causing damages
- Mechanical pressure has to be avoided or limited
- Work only in ESD safe and clean room environments

9. Erasure Risk

End-users are responsible to determine any exposure of erasure risk with X-Ray equipment used to inspect modules and/or demo boards (EVB) during application.

10. Product Safe Storage Requirements

End-users shall conform to meet JEDEC specified safe storage requirements to ensure product shelf life is applicable for all Gallium Semiconductor products as follows:

a) IC Package Product

With MSL Level-1 of unlimited floor life at $\leq 30^{\circ}\text{C}/85\% \text{RH}$, and MSD (Non MSL Level-1) at ambient conditions $< 30^{\circ}\text{C}/60\% \text{RH}$, all products should store at

- Minimum Gallium Semiconductor specified dry packing standard, or
- In dry atmosphere cabinet with dry air Nitrogen at $25 \pm 5^{\circ}\text{C}$, or
- Dry cabinet at 5% RH

b) Integrated Circuit Dies, or Bare Dies

All bare dies should store in

- Minimum Gallium Semiconductor specified dry packing standard in gel-box, or
- In dry atmosphere cabinet with dry air Nitrogen at $25 \pm 5^{\circ}\text{C}$, or
- Dry cabinet at 5% RH

c) Demo Boards (EVB)

Recommend at ambient conditions $< 30^{\circ}\text{C}/60\% \text{RH}$.

11. Moisture Induced Soldering Stress

Moisture inside MSD plastic package turns to vapor and tries to expand when the package is exposed to rapid high temperatures during soldering. The internal vapor pressure can cause separation of the plastic encapsulation from the semiconductor IC or lead frame, internal and external cracks, and damage to wire bonds from 'pop-corn' effect that can take place in severe case. This is distinctly for thinner plastic packages that come into more contact with high temperatures. To reduce the effects of moisture-induced stress during soldering, Gallium Semiconductor recommends dry bake of its MSD (moisture sensitive devices) before reflow soldering according to standard industry procedures.

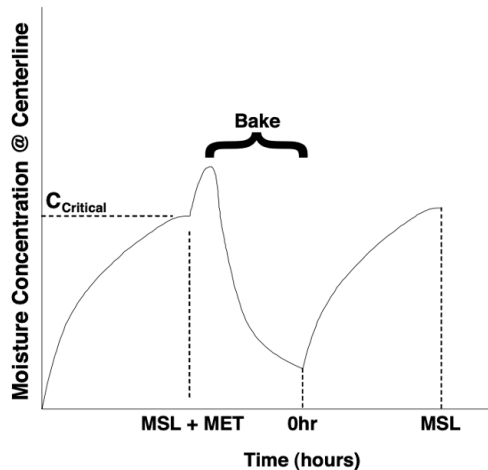
12. Product Shelf Life and Dry Bake for End-User

The minimum shelf life is 12 months from the dry bag seal date, or assembly date code as specified by Gallium Semiconductor in below table. The shelf life are determined based on Gallium Semiconductor knowledge, experience and industry standards. Shelf life is the length of time during which products and MSD can be stored in sealed MBB dry pack or safe storage condition.

It is mandatory a MSD packaged products to dry bake at end-user site before surface mounting with reflow soldering by end-user and critically important if MSD products are exposed at ambient conditions $< 30^{\circ}\text{C}/60\% \text{RH}$. End-user to adhere in addition to the following conditions if is true,

- MSD packaged products stored at $> 20\% \text{RH}$
- Humidity indicator card $> 10\% \text{RH}$ at $23 \pm 5^{\circ}\text{C}$ (MSD)
- MSD product floor life has expired (J-STD-033), where floor life refers to the maximum allowable time period after removal from a moisture barrier bag, dry storage, or dry bake and before the solder reflow process

Gallium Semiconductor recommend dry bake temperature at $125^{\circ}\text{C} + 10/-0^{\circ}\text{C}$, $< 5\% \text{RH}$. The oven used for dry baking shall be vented and capable of maintaining the required temperatures at $< 5\% \text{RH}$. End-user shall use J-STD-033 to determine bake temperature and bake time appropriately for MSD products.

Derivation of Bake Table


Product Type	Shelf Life	MSL Level	Start Date	Safe Storage Condition	Exceed Shelf Life and Re-Certification
Integrated Circuit Package	2 years	1	Assembly YYWW	MBB Dry Pack / Dry Atmosphere Cabinet with dry air nitrogen at 25 ± 5°C / Dry Cabinet at 5% RH	<ul style="list-style-type: none"> > 2 Years, solderability test
Integrated Circuit Package	2 years	3	Assembly YYWW	MBB Dry Pack / Dry Atmosphere Cabinet with dry air nitrogen at 25 ± 5°C / Dry Cabinet at 5% RH	<ul style="list-style-type: none"> > 2 Years or HIC indicator, dry-bake per J-STD-033 and solderability test
Bare Die	1 year	N.A	After Dry Pack	MBB Dry Pack / Dry Atmosphere Cabinet with dry air nitrogen at 25 ± 5°C / Dry Cabinet at 5% RH Maximum 16 hours (Au bonding) out of N2 storage / safe storage before wire bonding	<ul style="list-style-type: none"> Exceed shelf life, bondability test
Demo Boards (EVB)	No Limit	N.A	N.A	Ambient conditions < 30°C/60% RH	N.A

HIC Indication Guide:

- If the 10% and 60% RH spots indicate dry, then MSD products are still adequately dry.
- If the 5% RH spot indicates wet and the 10% RH spot does not indicate dry, and the 60% spot indicates dry, the MSD products have been exposed to an excessive level of moisture, and drying shall be done.

13. End-User MET Requirements

MET is the maximum CUMULATIVE TIME allowed after dry bake that products or devices may be exposed to ambient conditions < 30°C/60% RH. It also apply to end-user application process stipulates the longest exposure time from baking completion to sealing of MBB dry pack or safe storage in dry cabinet, which accounts for MET. This term also applies to the MSD exposure time from the opening of vacuum MBB dry pack to resealing. End-user to use JEDEC MET dry bake parameters before to dry pack.

End-user is to use 24 hours as MET default time value. And end-user is responsible to keep MET record within its process of MSD exposure time in cumulative value to ensure MSD is in its applicable dry state level for safe reflow soldering process. If MET ≥ 24 hours, end-user shall dry bake MSD to reset MET time before returning MSD to dry cabinet or resealing MBB dry pack.

Repacking by distributors are to ensure acceptable HIC indicator (not > 10% at 23 ± 5°C), MBB and active desiccant present. New fresh set of HIC and desiccant shall be use upon repack. The period between drying and sealing must not exceed the MET time of 24 hours to open the MBB bags and repack if necessary at distributor site.

14. Appendix A - Disclaimer Advice

The information in this application note is provided as a guideline for using the product. It shall under no circumstances to be construed as a description or warranty of the product functionality or quality. The recipient of this application note must verify any functions and other technical details in the actual application before implementing the product.

With regards to all the information provided in this application note, Gallium Semiconductor hereby disclaims any, and all warranties and liabilities of any kind, including without limitation warranties of non-infringement on any third-party intellectual property rights.

It is the responsibility of customer to evaluate the suitability of the product for the intended application and the completeness with respect to such application.

Further details on End-User Term of Use can be found in the following URL address:

www.galliumsemi.com/sales-terms-conditions

Document Revision History

Rev	Date	Initiator	Description of Changes
01	31-July-2023	Henk T., EW Quek	Initial Release