JEDEC STANDARD

Steady-State Temperature-Humidity Bias Life Test

JESD22-A101D

(Revision of JESD22-A101C, March 2009)

JULY 2015

JEDEC SOLID STATE TECHNOLOGY ASSOCIATION

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Published by
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TEST METHOD A101D

STEADY-STATE TEMPERATURE-HUMIDITY BIAS LIFE TEST

(From JEDEC Board Ballots JCB-96-64, JCB-09-10, and JCB-15-28, formulated under the cognizance of JC-14.1 Committee on Reliability Test Methods for Packaged Devices.)

1 Scope

The Steady-State Temperature-Humidity Bias Life Test is performed to evaluate the reliability of non-hermetic packaged IC devices in humid environments. Temperature, humidity, and bias conditions are applied to accelerate the penetration of moisture through the external protective material (encapsulant or seal) or along the interface between the external protective material and the metallic conductors which pass through it.

2 Apparatus

The test requires a temperature-humidity test chamber capable of maintaining a specified temperature and relative humidity continuously, while providing electrical connections to the devices under test in a specified biasing configuration.

2.1 Temperature and relative humidity

The chamber must be capable of providing controlled conditions of temperature and relative humidity during ramp-up to, and ramp-down from, the specified test conditions.

NOTE Care should be taken to ensure the test chamber (dry-bulb) temperature exceeds the wet-bulb temperature at all times.

2.2 Devices under stress

Devices under stress must be physically located to minimize temperature gradients.

NOTE Care should be taken to minimize relative humidity gradients and maximize air flow between devices.

2.3 Minimize release of contamination

Care must be exercised in the choice of board and socket materials to minimize release of contamination, and to minimize degradation due to corrosion and other mechanisms.

2.4 Ionic contamination

Ionic contamination from the test apparatus (e.g., card cage, test boards, sockets, wiring, storage containers, etc.) shall be controlled to avoid test artifacts.

2.5 Deionized water

Deionized water with a minimum resistivity of 1 MΩ-cm at room temperature shall be used.

3 Test Conditions

Test conditions consist of a temperature, relative humidity, and duration used in conjunction with an electrical bias configuration specific to the device.

3.1 Temperature, Relative Humidity and Duration

Temperature[1] [dry-bulb °C]	Relative Humidity[1] [%]	Temperature[2] [wet-bulb, °C]	Vapor Pressure[2] [kPa (psia)]	Duration[3] [hours]
85 ± 2	85 ± 5	81.0	49.1 (7.12)	Typ. 1000 +168/-24

NOTE 1 Tolerances apply to the entire useable test area.

NOTE 2 For information only.

NOTE 3 The test conditions are to be applied continuously except during any interim readouts. For interim readouts, devices should be returned to stress within the time specified in 4.5.

3.2 Biasing guidelines

Apply either of the two methods ofbias according to the following guidelines:

a) Minimize power dissipation.

b) Alternate pin bias as much as possible.

c) Distribute potential differences across chip metallization as much as possible.

d) Maximize voltage within operating range.

NOTE The priority of the above guidelines depends on mechanism and specific device characteristics.

e) Either of two methods of bias can be used to satisfy these guidelines, whichever is more severe:

1) Continuous bias: The dc bias shall be applied continuously. Continuous bias is more severe than cycled bias when the die temperature is ≤ 10 °C higher than the chamber ambient temperature. If the die temperature is not known, when the heat dissipation of the device under test (DUT) is less than 200 mW. If the heat dissipation of the DUT exceeds 200 mW, then the die temperature should be calculated. If the die temperature exceeds the chamber ambient temperature by more than 5 °C then the die temperature rise above the chamber ambient should be included in reports of test results since acceleration of failure mechanisms will be affected.

3.2 Biasing guidelines (cont'd)

2) Cycled bias: The dc voltage applied to the devices under test shall be periodically interrupted with an appropriate frequency and duty cycle. If the biasing configuration results in a temperature rise above the chamber ambient, ΔT_{ja}, exceeding 10 °C, then cycled bias, when optimized for a specific device type, will be more severe than continuous bias. Heating as a result of power dissipation tends to drive moisture away from the die and thereby hinders moisture-related failure mechanisms. Cycled bias permits moisture collection on the die during the off periods when device power dissipation does not occur. Cycling the DUT bias with one hour on and one hour off is optimal for most plastic-encapsulated microcircuits. The die temperature, as calculated on the basis of the known thermal impedance and dissipation, should be quoted with the results whenever it exceeds the chamber ambient by 5 °C or more.

3.2.1 Choosing and reporting

Criteria for choosing continuous or cyclical bias, and whether or not to report the amount by which the die temperature exceeds the chamber ambient temperature, are summarized in the table:

ΔT_{ja}	Cyclical Bias?	Report ΔT_{ja}?
$\Delta T_{ja} < 5$ °C, or Power per DUT < 200 mW	No	No
($\Delta T_{ja} \geq 5$ °C or Power per DUT ≥ 200 mW), and $\Delta T_{ja} < 10$ °C	No	Yes
$\Delta T_{ja} \geq 10$ °C	Yes[1]	Yes
[1] Cycling the DUT bias with one hour on and one hour off is optimal for most plastic-encapsulated microcircuits		

4 Procedures

The test devices shall be mounted in a manner that exposes them to a specified condition of temperature and humidity with a specified electrical biasing condition. Exposure of devices to excessively hot, dry ambient or conditions that result in condensation on devices and electrical fixtures shall be avoided, particularly during ramp-up and ramp-down. Appropriate attention should also be made to avoid any water dripping on the devices under stress.

4.1 Ramp-up

The time to reach stable temperature and relative humidity conditions should be less than 3 hours.

Condensation on the devices under stress and/or fixtures/hardware shall be avoided at all times by ensuring that their temperature is always higher than the dew point temperature.

4.2 Ramp-down

Ramp-down should be less than 3 hours.

Condensation shall be avoided by ensuring that the test chamber (dry-bulb) temperature exceeds the wet-bulb temperature at all times during ramp-down.

NOTE For a DUT with a cavitiy in the package, condensation on the internal surface may occur due to length of ramp-down time.

4.3 Test Clock

The test clock starts when the temperature and relative humidity reach the setpoints, and stops at the beginning of ramp-down.

4.4 Bias

Bias application during ramp-up and ramp-down is optional. Bias should be verified after devices are loaded, prior to the start of the test clock. Bias should also be verified after the test clock stops, but before devices are removed from the chamber.

4.5 Readout

Electrical test shall be performed not later than 48 hours after the end of ramp-down. For intermediate readouts, devices shall be returned to stress within 96 hours of the end of ramp-down. The rate of moisture loss from devices after removal from the chamber can be reduced by placing the devices in sealed moisture barrier bags (without desiccant). When devices are placed in sealed bags, the "test window clock" runs at 1/3 of the rate of devices exposed to the laboratory ambient. Thus the test window can be extended to as much as 144 hours, and the time to return to stress to as much as 288 hours by enclosing the devices in moisture-proof bags.

NOTE 1 The electrical test parameters should be chosen to preserve any defect (i.e., by limiting the applied test current).

NOTE 2 Additional time-to-test delay or return-to-stress delay time may be allowed if justified by technical data

4.6 Handling

Suitable hand-covering shall be used to handle devices, boards and fixtures. Contamination control is important in any accelerated moisture stress test.

5 Failure Criteria

A device will be considered to have failed the Steady-State Temperature-Humidity Bias Life Test if parametric limits are exceeded, or if functionality cannot be demonstrated under nominal and worst-case conditions. Specific failure criteria may be found in other applicable document or data sheet.

6 Safety

Follow equipment manufacturer's recommendations and local safety regulations.

7 Summary

The following details shall be specified in the applicable procurement document:

a) Test duration, if other than as specified in 3.1.

b) Measurements after test.

c) Biasing configuration.

d) Temperature of die during test if it is ≥ 5 °C above the chamber ambient.

e) Frequency and duty cycle of bias if cycled bias is to be used.

Annex A (informative) Differences between JESD22-A101D and its predesessors

These tables briefly describe most of the non-editorial changes made to entries that appear in this standard, JESD22-A101D, compared to its predecessors, JESD22-A101C (March 2009) and JESD22-A101-B (April 1997).

A.1 Differences between JESD22-A101D and JESD22-A101C

Clause	Description of change
3.1	Changed “psia/kPa” to “kPa (psia)”. This corrects an error made in JESD22-A101C when the order of the numbers was reversed, but the order of the units in the heading was not.
3.1	In table, last column: replaced “Note 4” with context of NOTE 4.
3.1	Removed NOTE 4.
4.1	Changed the phrase “shall be less than 3 hours” to “should be less than 3 hours”.
4.2	Changed the phrase “shall not exceed 3 hours” to “should be less than 3 hours”.

A.2 Differences between JESD22-A101C and JESD22-A101-B (April 1997)

Clause	Description of change
1	deleted “for the purpose of evaluating” replaced with “to evaluate”.
1	deleted “solid-state” replaced with “IC”.
1	deleted “It employs conditions of” replaced with “.”.
1	deleted “which” replaced with “conditions are applied to”.
1	deleted “encapsulant” replaced with “encapsulate”.
2.1	Added note.
2.2	Added note.
2.4	deleted “of” replaced with “from”
3.1	Under duation hours, changed from “1000(-24,+168)” to “Note 4”
3.1	Added Note 4.
3.2	Added “either of the two methods of”.
3.2e	deleted ‘kinds” replaced with “methods”.
3.2.1	In table replaced “D” with “Δ” in 3 places.
3.2.1	Added reference 1.
4	Add last sentence to paragraph beginning “Appropriate attention…”.
4.1	Reworded second paragraph.
4.2	Added “during ramp-down” at end of first paragraph.
4.2	Added note.
4.5	Added note.
5	Reworded paragraph.

Standard Improvement Form

JEDEC JESD22-A101D

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1. I recommend changes to the following:

☐ Requirement, clause number _____

☐ Test method number _____ Clause number _____

The referenced clause number has proven to be:

☐ Unclear ☐ Too Rigid ☐ In Error

☐ Other _____

2. Recommendations for correction:

3. Other suggestions for document improvement:

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