JEITA

Standard of Japan Electronics and Information Technology Industries Association

EIAJ ED-4701/200

Environmental and endurance test methods for semiconductor devices
(Life test II)

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CONTENTS

Standard of Japan Electronics and Information Technology Industries Association

Environmental and endurance test methods for semiconductor devices (Life test II)

1. SCOPE

These standards provide for environmental test methods and endurance test methods (especially life tests) aimed at evaluating the resistance and the endurance of discrete semiconductor devices and integrated circuits (hereinafter generically called semiconductor devices) used in electronic equipment mainly for general industrial applications and consumer applications, under the various environmental conditions of various kinds that occur during their use, storage and transportation.

2. DEFINITION OF TERMS

The definitions of the technical terms used in these standards and in the relevant specifications are given in **EIAJ ED-4701/001** "Environmental and endurance test methods for semiconductor devices (General)."

3. PRECAUTIONS

The precautions used in these standards and in the relevant specifications are given in **EIAJ ED-4701/001** "Environmental and endurance test methods for semiconductor devices (General)."

4. TEST METHODS

Refer to the Appendix for the test methods.

Remarks:

The various test methods are arranged independently for the sake of more convenient use of these standards.

COMMENTS

1. PURPOSE OF ESTABLISHMENT OF THESE STANDARDS

Before the establishment of these standards, the standardization referring to **EIAJ ED-4701** "Environmental and endurance test methods for semiconductor devices" established on Feb., 1992, and EIAJ has issued amendments, whenever the revision and also new test method establish. However, it is recondite where the latest test methods are entered, it was resulting the confusion of users. So establishment of new numbering system that is easy to use both users and manufacturers was decided, and reached to the issuance in this time.

Electronic Industries Association of Japan (EIAJ) and The Japan Electronic Industry Development Association (JEIDA) have merged effective November 1,2000, the Japan Electronics and Information Technology Industries Association (JEITA).

2. EVOLUTION OF THE DELIBERATIONS

The revision of the standards and new numbering system have been deliberated by "Sub-Committee on Semiconductor Devices Reliability" of the Technical Standardization Committee on Semiconductor Devices/Semiconductor Devices Reliability Group from Apr., 2000. Though to issue as a separate standard every each test method was considered, it made to issue with the system like the following.

- **(a) EIAJ ED-4701/001** Environmental and endurance test methods for semiconductor devices (General)
- **(b) EIAJ ED-4701/100** Environmental and endurance test methods for semiconductor devices (Life test I)
  - **101** Steady state operating life
  - **102** Temperature humidity bias (THB)
  - **103** Temperature humidity storage
  - **104** Moisture soaking and soldering heat stress series test
  - **105** Temperature cycle
  - **106** Intermittent operating life
- **(c) EIAJ ED-4701/200** Environmental and endurance test methods for semiconductor devices (Life test II)
  - **201** High temperature storage
  - **202** Low temperature storage
  - **203** Moisture resistance (Cyclic)
  - **204** Salt mist
- **(d) EIAJ ED-4701/300** Environmental and endurance test methods for semiconductor devices (Stress test I)
  - **301** Resistance to soldering heat for surface mounting devices (SMD)
  - **302** Resistance to soldering heat (Excluding surface mounting devices)
  - **303** Solderability
  - **304** Human body model electrostatic discharge (HBM/ESD)

305 Charged device model electrostatic discharge (CDM/ESD)
306 Latch-up
307 Thermal shock

(e) EIAJ ED-4701/400 Environmental and endurance test methods for semiconductor devices (Stress test II)

401 Terminal strength
402 Mounting strength
403 Vibration (Sinusoidal)
404 Shock
405 Acceleration (Steady state)

(f) EIAJ ED-4701/500 Environmental and endurance test methods for semiconductor devices (Miscellaneous)

501 Permanence of marking
502 Flammability tests of plastic-encapsulated devices (Externally induced)
503 Seal
504 Low air pressure

Both life and stress tests are divided into two standards as "I" and "II". "I" is including test method that is thought that revision occurs comparatively from now on.

3. DELIBERATING MEMBERS

Deliberation of this standard has been made by "Sub-Committee on Semiconductor Devices Reliability" of the Technical Standardization Committee on Semiconductor Devices/Semiconductor Devices Reliability Group.

Below are listed the members of deliberation of this standard.

<Technical Standardization Committee on Semiconductor Devices/Semiconductor Devices Reliability Group>

Chairman	Mitsutoshi Ito	NEC Corp.

<Semiconductor Devices Reliability Group>

Chairman	Kazutoshi Miyamoto	Mitsubishi Electric Corp.

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	Takahiro Ito	Rohm Co., Ltd.
Special Members	Yasuhiro Fukuda	Oki Electric Industry Co., Ltd.
	Kouji Obinata	Sony Corp.
	Takeshi Watanabe	NEC Corp.

APPENDIX

TEST METHOD 201
HIGH TEMPERATURE STORAGE

1. SCOPE

This standard provides for the methods to evaluate the endurance of semiconductor devices when stored under high temperature for long time.

2. TEST EQUIPMENT

The chamber to be used in this test should be capable to keep the test temperature at the value specified in section **3.2** and within the tolerances. In this case, the chamber should have such a construction that at all places where the specimen are placed it is not exposed to direct radiation from the heat source.

3. PROCEDURE

3.1 Initial measurement

The initial measurements should be carried out in conformity with the items and conditions specified in the relevant specifications.

3.2 Test

Store the specimen in the thermostatic chamber preset at the specified temperature (high temperature), during the specified time. The storage temperature should be the maximum rated storage temperature ($T_{stg\ max}$), unless otherwise specified.

The permissible difference of storage temperature should be +5°C, -3°C at under 125°C, and ±5°C at 125°C or more.

The test time should be 1 000 hours, unless otherwise specified.

Reference:

In **IEC 60749**, test time and intermediate measure intervals should be selected following; 168 hours, 336 hours, 672 hours, 1 000 hours, 2 000 hours, 5 000 hours, 10 000 hours.

3.3 Post treatment

After finishing the test, take the specimen out of the thermostatic chamber, and leave it standing under standard conditions for 2 hours to 24 hours.

3.4 End-point measurement

Carry out the end-point measurements in conformity with the items and conditions specified in the relevant specifications.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATIONS

(1) Items and conditions of the initial measurements [Refer to **3.1**]

(2) Storage temperature (When the storage temperature is other than $T_{stg\ max}$) [Refer to **3.2**]

(3) Test duration (When the test duration is other than 1 000 hours) [Refer to **3.2**]

(4) Post treatment (When the post treatment condition is other than the specified ones) [Refer to **3.3**]

(5) Items and conditions of the end-point measurements [Refer to **3.4**]

TEST METHOD 202
LOW TEMPERATURE STORAGE

1. SCOPE

This standard provides for the methods to evaluate the endurance of semiconductor devices when stored under low temperature for long time.

Reference:

In **IEC 60749,** the standard of Low temperature storage test does not exist.

2. TEST EQUIPMENT

The chamber to be used in this test should be capable to keep the test temperature at the value specified in section **3.2** and within the tolerances. In this case, the chamber should have such a construction that at all places where the specimen are placed it is not exposed to direct radiation from the cold source.

3. PROCEDURE

3.1 Initial measurement

The initial measurements should be carried out in conformity with the items and conditions specified in relevant specifications.

3.2 Test

Store the specimen in the thermostatic chamber preset at the specified temperature (Low temperature), during the specified time. The storage temperature should be the minimum rated storage temperature ($T_{stg\ min}$), unless otherwise specified.

The permissible difference of storage temperature should be ±5°C at under -25°C, and +3°C, -5°C at -25°C or more.

The test time should be 1 000 hours, unless otherwise specified.

3.3 Post treatment

After finishing the test, take the specimen out of the thermostatic chamber, and leave it standing under standard conditions for 2 hours to 24 hours.

When there is frost or water drop stuck on the specimen, remove them beforehand.

3.4 End-point measurement

Carry out the end-point measurements in conformity with the items and conditions specified in the relevant specifications.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATIONS

(1) Items and conditions of the initial measurements [Refer to **3.1**]

(2) Storage temperature (When the storage temperature is other than $T_{stg\ min}$) [Refer to **3.2**]

(3) Test duration (When the test duration is other than 1 000 hours) [Refer to **3.2**]

(4) Post treatment (When the post treatment condition is other than the specified ones) [Refer to **3.3**]

(5) Items and conditions of the end-point measurements [Refer to **3.4**]

TEST METHOD 203
MOISTURE RESISTANCE (CYCLIC)

1. SCOPE

This standard provides for the method to evaluate the endurance of semiconductor devices when they are exposed to temperature changes under high humidity conditions.

Remarks:

These tests have been designed by assuming the acceleration of crack-growth due to the respiration effect mainly caused by the thermal cycle and the acceleration of the corrosion due to the electrolytic effect.

2. TEST EQUIPMENT

2.1 Capacity of the equipment

Chambers to be used in these tests should be capable to maintain the cycles and the conditions shown in **Figure 1** and **Table 1**.

2.2 Materials and structure of the temperature-humidity test chamber

The materials of the chamber should not react under high humidity conditions. Moreover, water condensed on the ceiling of the chamber should not drop on the specimen.

2.3 Water to be used in the test

Water to be used in the tests should be distilled water or deionized water, with pH from 6.0 to 7.2, and resistivity of 500 Ωm or more at 23°C temperature.

3. PROCEDURE

When the specimen is plastic-moulded SMD, carry out the moisture soaking and soldering heat stress treatment specified in the TEST METHOD **104** (Moisture soaking and soldering heat stress) prior to this test.

3.1 Preliminary treatment

When specified in the relevant specifications, submit the specimen to lead bending stress. In this case, refer to TEST METHOD **401** (Terminal strength).

3.2 Initial measurement

Carry out the initial measurements in conformity with the items and conditions specified in the relevant specifications.

3.3 Tests

The 24-hour period from step a to step i of **Figure 1** should be regarded as one cycle, and 10 cycles should be repeated, unless otherwise specified. The door of the chamber should not be opened during humidification and/or dehumidification.

(1) Sub-cycle

The low-temperature sub-cycle of **Figure 1** should be executed in any of the 9 initial cycles, and should be carried out at least 5 cycles. In the cycle in which the low-temperature sub-cycle is not applied, the period g should be extended to the end of 1 cycle after finishing the period f. When carrying out the change from the normal-temperature high-humidity to the low temperature using 2 chambers, the specimen should be taken out of the chamber within 1 hour to 4 hours after starting the

sub-cycle, and should be placed in the low-temperature chamber within 5 minutes by taking into consideration the effect of the thermal shock. In changing the state from the low-temperature state to the normal-temperature high-humidity state, it should be returned within 10 minutes to 15 minutes.

When carrying out the said change with only one chamber, preset the chamber in such a way that the low-temperature state is reached within 30 minutes, and the normal-temperature high-humidity state is reached within 1.5 hours. At the low-temperature state the chamber should keep -10°C+3°C, -5°C for 3 hours, and the humidity should not be adjusted in the meantime.

When the specimen reaches 25°C±2°C temperature and 90% - 96% relative humidity, it should be kept at that state until the start of the next cycle.

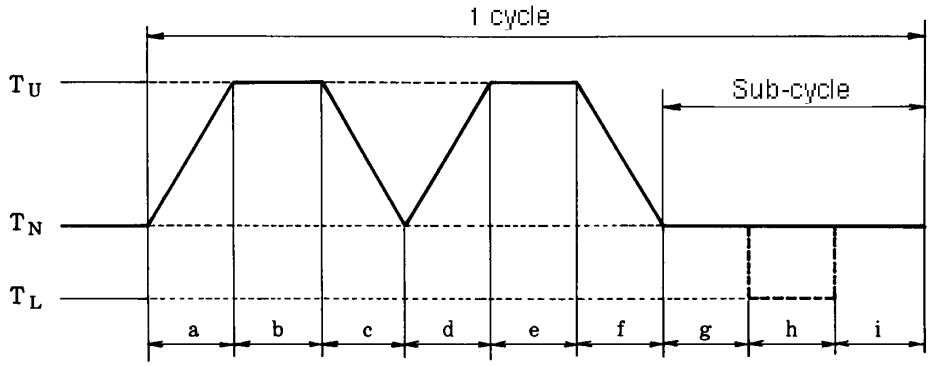
(2) Voltage application

When the conditions are specified in the relevant specifications, voltage should be applied in conformity with the specified conditions.

Remarks:

1. When applying voltage, it should be in conformity with the condition of the relevant specifications, and moreover it is recommendable to restrict the internal heat generation by minimizing power dissipation.
2. When mounting the SMD on the jig for evaluation, the relevant conditions (substrate material, size of the land, soldering method, flux cleaning method, etc.) should be specified in the relevant specifications.

Figure 1 COMPOSITION OF ONE CYCLE



T_U, T_N, and T_L indicate the various temperatures.

Table 1 TEMPERATURE AND HUMIDITY CYCLE CONDITIONS

Conditions / Step	Time (h)	Temperature (°C)	Relative humidity (%)
a	2.5	-	90 ~ 96
b	3.0	65±2	90 ~ 96
c	2.5	-	80 ~ 96
d	2.5	-	90 ~ 96
e	3.0	65±2	90 ~ 96
f	2.5	-	80 ~ 96
g	1 ~ 4	25±2	90 ~ 96
h	3.0	-10^{+3}_{-5}	Arbitrary
i	1 ~ 4	25±2	90 ~ 96
1 cycle	24	-	-

3.4 Post treatment

After finishing the step i, which is the last step of the cycle, leave the specimen standing under standard conditions from 2 hours to 24 hours.

Remarks:

The MIL standards specify the ending point of either step g or step i of the last cycle as the starting point as the starting point of the post treatment, but in this test the post treatment should be started at the ending point of the step i.

3.5 End-point measurement

The end-point measurements should be carried out in conformity with the items and conditions specified in the relevant specifications.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATIONS

(1) Preliminary treatment (Whenever required) [Refer to **3.1**]

(2) Items and conditions of the initial measurements [Refer to **3.2**]

(3) Number of repetition cycles (When the number of repetition cycles is other than 10) [Refer to **3.3**]

(4) Voltage application method and the specimen mounting method to be adopted at that time (When required) [Refer to **3.3(2)**]

(5) Post treatment (When the post treatment condition is other than the specified ones) [Refer to **3.4**]

(6) Items and conditions of the end-point measurements [Refer to **3.5**]

TEST METHOD 204
SALT MIST

1. SCOPE

This standard provides for the method to evaluate the endurance of semiconductor devices against salt mist.

2. TEST EQUIPMENT

Equipment to be used in this test should consist of the test equipment which has the function of exposing the specimen to salt mist and the salt water tank which has function of feeding salt water to the test chamber, and should meet the test conditions specified in section **4.3** as well as the following matters.

(1) Water condensed on the ceiling and on the door of the test chamber should not drop on the specimen.

(2) Drops falling form the specimen should not return to the salt water tank, and should not be used again in the test.

(3) The materials and the equipment should not exert a bad effect on the corrosion of specimen.

3. MATERIALS

3.1 Salt water

The aqueous salt solution, used to make salt mist, should be made by dissolving sodium chloride of good quality [**JIS K8150** (REAGENTS)]in distilled water or water with less than 200ppm of overall content of solids, and the salt concentration should be adjusted to 5% ±1% (mass ratio).

The solution sprayed at 35°C should be pH of 6.5 to 7.2. Prior spraying the solution, make sure that it contains no pollutants. The solution should have the same temperature inside of the chamber, and the sprayed solution should not be reused.

3.2 Supply air

Compressed air using to make salt mist should be free of impurities having influence on the test results, and the temperature of the compressed air should be the same as the temperature inside the test chamber.

4. PROCEDURE

4.1 Preliminary treatment

(1) When specified in the relevant specifications, carry out both of the bending test and twisting test for the terminal strength before this test (when the execution of both tests is impossible, carry out the one regarded as practicable) strength. In this case, refer to the Test Method **401**.

(2) Wash the metallic surfaces of the specimen, and remove oil, spots, silicone grease, etc. When washing, do not use the washing solution containing abrasive and having possibility of forming protective film on the surface of the specimen.

4.2 Initial measurement

Inspect the outer view of the specimen with an optical apparatus with magnification power of 3 to 10, and moreover carry out the initial measurements in conformity with the items and conditions specified in the relevant specifications.

4.3 Tests

4.3.1 Spraying method

Place the specimen in the test chamber, and circulate salt water at 35°C ±2°C during the specified time. Adjust the concentration and speed of the salt mist so as to obtain salt deposition rate of 10 g/m^2 to 50 g/m^2 per day in the test area.

Remarks:

When placing the specimen in the test chamber, take care to obtain uniform salt mist spraying conditions, because depending on the shape of the specimen different test results may be obtained according to the position where it is placed.

Reference:

In **IEC 60749**, the spraying conditions should be kept so as to obtain average salt solution of 1.0 ml/h to 2.0 ml/h while the test has been continued over 16 hours, using clear plate (80 cm^2) at every space in the chamber.

4.3.2 Test duration

Select the test duration out of the values shown in **Table 1**, and adopt the Condition B unless otherwise specified.

Table 1 TEST TIME OF THE SALT MIST TEST

Test condition code	Test time (h)
A	16±1
B	24±2
C	48±4
D	96±4

4.4 Post treatment

After finishing the test, brush the specimen gently in running water during 5 minutes, rinse it with distilled water or water with overall solid content below 200ppm, remove water drops stuck on the specimen by shaking it with the hand, and then leave it standing under normal conditions during 2 hours to 24 hours.

4.5 End - point measurement

Inspect the outer view of the specimen with an optical apparatus with magnification power of 3 to 10. The specimen should be rejected when it has illegible markings, and the surface present such obvious defects as peeling depression, corrosion, etc., that could obstruct its use.

Moreover, the end – point measurements should be carried out in conformity with the items and conditions specified in the relevant specifications.

5. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATIONS

(1) Preliminary treatment (When required) [Refer to **4.1**]

(2) Items and conditions of the initial measurements [Refer to **4.2**]

(3) Test conditions (When the test condition is other than Condition B) [Refer to **4.3.2**]

(4) Post treatment (When the post treatment condition is other than the specified ones) [Refer to **4.4**]

(5) Items and conditions of the end - point measurements [Refer to **4.5**]