JEITA

Standard of Japan Electronics and Information Technology Industries Association

EIAJ ED-4701/100

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

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Standard of Japan Electronics and Information Technology Industries Association

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

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.

<Sub-Committee on Semiconductor Devices Reliability>

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

APPENDIX

TEST METHOD 101
STEADY STATE OPERATING LIFE

1. SCOPE

This standard provides for the method to evaluate the endurance of semiconductor devices when they are submitted to electric stress and thermal stress of long duration.

Remarks:

Care must be taken when executing this test, because the device temperature may exceed the ambient preset temperature and rise conspicuously due to internally dissipated heat from the device.

2. TEST EQUIPMENT

Equipment to be used in this test should consist of a chamber capable to keep the specified test temperature within the specified tolerance, the power supply capable to generate the specified AC or DC voltages, and the board to make electrical contact to the terminals of devices under test with socket or other mounting method, having heat.

2.1 Circuitry

The biasing and operating schemes shall consider the limitations of the device. Device thermal characterization shall be considered to ensure that the temperature of "Hot Spots" on the die does not exceed maximum rated junction temperature (Tjmax).

2.2 Device mounting

Device mounting shall consider the thermal capacity to minimize adverse effects during test.

Remarks:

When he SMD is mounted on the test board for evaluation, the relevant conditions (substrate material, land size, soldering method, flux cleaning, etc.) should be specified in the relevant specifications.

2.3 Environmental chamber

The environmental chamber shall be capable of maintaining the specified ambient temperature within a tolerance of ±5°C throughout the chamber while a test is being conducted.

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 Operating mode and test circuit

Operating mode and test circuit should be in conformity with the stipulations of the relevant specifications.

(1) High-Temperature Operating Life (HTOL)

The HTOL test is configured to exercise the maximum number of nodes feasible. The supply voltages and clock frequency should be in conformity with the stipulations of the relevant specifications.

(2) High-Temperature Reverse-Bias (HTRB)

The HTRB test is configured to apply the maximum rated DC reverse voltage (V_{RMAX}) to the devices that remain in a static mode of operation for the duration of the test. The supply voltage

should be in conformity with the stipulations of the relevant specifications.

(3) High-Temperature Forward-Bias (HTFB)

The HTFB test is configured to apply power to the device samples so as to forward bias major power-handling junctions. The devices are operated in either a static or pulsed operating mode. Operating condition should be conformity with the stipulations of the relevant specifications. The HTFB test is typically used for diodes, transistors or power driver integrated circuits.

3.3 Ambient temperature

The ambient temperature should be 125°C±5°C, unless otherwise exceeded the maximum rated junction temperature (T_{jmax}).

Remarks:

Care must be taken because the maximum rated junction temperature (T_{jmax}) may be exceeded due to internally dissipated heat from the specimen.

3.4 Test duration

The test duration should be 1000 hours (+168 hours, -0 hours), unless otherwise specified. If interim measurements are deemed necessary, they may be chosen from the following standard time intervals, as time to perform such measurements.

24 hours	(+ 8 hours, - 0 hours)
48 hours	(+ 8 hours, -0 hours)
96 hours	(+24 hours, -0 hours)
168 hours	(+72 hours, -0 hours)
504 hours	(+168 hours,-0 hours)

Remarks:

The time spent reducing chamber conditions to room ambient and conducting the interim measurements shall not be considered a portion of the total specified test duration.

3.5 Post treatment

At the end of the test period, the specimen should be stored under normal conditions from 2 hours to 24 hours.

3.6 End-point measurement

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

Remarks:

Electrical end-point testing shall be completed within 48 hours of removal of bias from devices.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATIONS

(1) Specimen mounting method (When required) [Refer to **2.2**]

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

(3) Operating mode and test circuit [Refer to **3.2**]

(4) Ambient temperature (When using temperatures other than 125°C) [Refer to **3.3**]

(5) Test duration (When using test duration other than 1000 hours) [Refer to **3.4**]

(6) Post treatment (When executing post treatment other than the specified ones) [Refer to **3.5**]

(7) Items and conditions of the end-point measurements. [Refer to **3.6**]

TEST METHOD 102
TEMPERATURE HUMIDITY BIAS (THB)

1. SCOPE

This standard provides for the methods to evaluate the endurance of semiconductor devices when used in high temperature and high humidity ambient.

Remarks

1. At the beginning, this test was designed by assuming the evaluation of the endurance of semiconductor devices contained mainly in resin sealed packages, against the corrosion phenomenon of metallic wiring on the chip.
   Recently, however, this test is being used to accelerate the leak phenomenon due to infiltration of moisture through the passivation film and as a part of various kinds of series tests, but care must be taken because accelerability data are not necessarily well known, and it may bring about failure modes that do not occur in the field.
2. Care must be taken because failure modes consisting of short-circuit (leak) between external leads by plating metal, that do not occur in the field, may occur under condition C (temperature 85°C, humidity 85%), and Unsaturated Pressurized Vapor Test

2. TEST EQUIPMENT

2.1 Capacity of the test equipment

Equipment to be used in this test should be provided with a chamber capable to keep the test temperature and humidity specified in section **3.2.2(3)** for long time, a power supply, and whenever required a timer to turn the power supply ON and OFF during the specified time, when required.

2.2 Material and construction of the chamber

The chamber should be made of material that does 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 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 Ohm-m or more at 23°C.

3. PROCEDURE

When the specimen is a plastic-molded SMD, carry out the moisture soaking and soldering heat stress treatment specified in test method **104** (moisture soaking and soldering heat stress series tests)before executing this test.

3.1 Initial measurement

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

3.2 Tests

Apply the specified voltage on the specimen in the test chamber kept at high temperature and high humidity conditions. When required turn the power ON and OFF cyclically. When putting the specimen in and out of the chamber, make sure that water drops are not stuck to the specimen and do not dip it in water.

Remarks:

When the SMD is to be mounted on a jig for evaluation, the relevant conditions (substrate material, size of the land, soldering method. flux cleaning. etc.) should be specified in the relevant specifications.

3.2.1 Test circuit

The test circuit should be in conformity with the relevant specifications.

3.2.2 Test conditions

(1) Voltage application

Apply voltage continuously in conformity with the conditions specified in the relevant specifications. Apply the voltage intermittently when the power dissipation is large, however, and turn the power supply ON and OFF in conformity with the time specified in the relevant specifications.

Remarks:

1. The applied voltage should be in conformity with the stipulations of the relevant specifications, and it is desirable to restrict the internal heat generation so as to minimize power dissipation.
2. The relative humidity of the chip surface in the package decreases due to heat generation of the chip when the device has large power dissipation, and corrosion becomes less probable. In this case, it is recommendable to turn the power ON and OFF in order to attain more effective results related to corrosion. In general, continuous power application is desirable when the power dissipation is smaller than 100mW, and intermittent power application consisting of 1-hour ON and 3-hour OFF is recommended when the power dissipation exceeds 100mW.

(2) Tolerance of the applied voltage

The tolerance of the applied voltage should be within ±5% of the preset value.

(3) High temperature and high humidity conditions

Select the temperature and humidity conditions out of those ones of **Table 1**, and apply the Conditions C unless otherwise specified. Under condition D, E, and F (Unsaturated Pressurized Vapor Test), the temperature and the humidity from the start to the end of the test should be controlled in conformity with the profile of **Figure 1**, unless otherwise specified.

The relative humidity in the chamber during the heating and humidification phase as well as in the cooling and dehumidification phase should be kept from 50% to 85%.

(4) Test duration

Test duration should be refered to **Table 1**, except when otherwise specified. Under condition D, E, and F (Unsaturated Pressurized Vapor Test), the time count should be started when the vapor pressure and temperature reach stable state as shown in **Figure 1**.

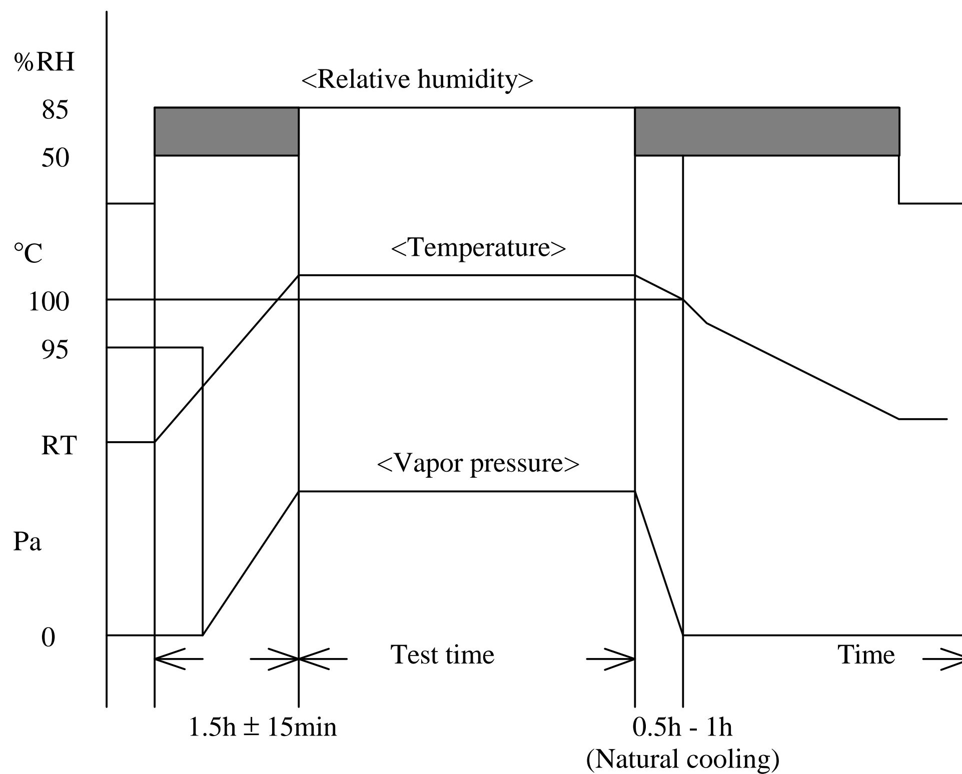
Table 1 TEMPERATURE HUMIDITY STORAGE TEST CONDITIONSTest code

Test code	Temperature °C	Humidity %	Test duration h	Vapor pressure(1) Pa
A	40±2	90±5	1000+168/-24	-
B	60±2	90±5	1000+168/-24	-
C	85±2	85±5	1000+168/-24	-
D	110±2	85±5	――――	1.2×10^5
E	120±2	85±5	――――	1.7×10^5
F	130±2	85±5	――――	2.3×10^5

Note(1) Reference value

Condition D, E, and F is called Unsaturated Pressurized Vapor Test.

Figure 1 UNSATURATED PRESSURIZED VAPOR TEST CONDITIONS FROFILE



3.3 Post treatment

After finishing the tests, leave the specimen standing under normal conditions, from 2 hours to 24 hours.

Remarks:

Under condition D, E, and F (Unsaturated Pressurized Vapor Test), special care should be taken when handling the specimen after finishing the test,because failure modes differnt from those ones of the tests may occur due to condensation, sudden changes in the temperature and pressure, and other relevant factors. After finishing the test, remove the specimen from the chamber after confirming that the interior of the chamber has returned approximately to the normal condition in conformity with the specified temperature and humidity profile, and then leave the specimen in room temperature.

3.4 End-point measurement

Carry out the end-point measurements in conformity with the items and conditions specified in the relevant specifications. These measurements should be carried out within 48 hours under normal conditions after the completion of the tests, except when other specified.

Remarks:

In case of expending more completion time of the measurements than 48 hours, the specimen should be storaged in suitable storage conditions such as no influence of test results.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATIONS

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

(2) Specimen mounting method (When required) [Refer to **3.2**]

(3) Test circuit [Refer to **3.2.1**]

(4) Voltage application conditions and power ON/OFF cycle
(When using conditions and cycles other than the specified ones) [Refer to **3.2.2(1)**]

(5) High temperature and high humidity conditions
(When using conditions other than the specified ones) [Refer to **3.2.2(3)**]

(6) Test duration (When using duration other than 1000 hours) [Refer to **3.2.2(4)**]

(7) Post treatment (When executing post treatment other than the specified ones)
[Refer to **3.3**]

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

(9) Storage conditions to the measurements
(When using storage conditions than the specified ones) [Refer to **3.4**]

TEST METHOD 103
TEMPERATURE HUMIDITY STORAGE

1. SCOPE

This standard dprovides for the methods to evalute the endurance of plastic moulded package semiconductor devices when they are used in high temperature and high humidity ambient.

Remarks:

1. This test have been designed with the object of evaluating the endurance, against corrosion, of metallic wiring of chips of semiconductor devices contained mainly in plastic molded packages. Recently it is also being used as a means to accelerate the leak phenomenon due to the moisture penetration through the passivation film and as a pre-conditioning for various kinds of tests, but care must be taken because data related to accelerability are not clearly known yet.
2. Care must be taken because failure modes consisting of short-circuit (leak) between external leads by plating metal, that do not occur in the field, may occur under condition C (temperature 85°C,humidity 85%), and Unsaturated Pressurized Vapor Test (condition D, E, and F).

2. TEST EQUIPMENT

2.1 Capacity of the equipment

Chamber to be used in this test should be capable to keep the test temperature and humidity conditions specified in section **3.2** for long time.

2.2 Materials and construction of the thermostatic/humidistatic chamber

The chamber should be made of material that does 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 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 Ohm-m or more at 23°C temperature.

3. PROCEDURE

When the specimen is plastic-molded SMD, carry out the moisture soaking and soldering heat stress treatment specified in the test method **104** (Moisture soaking and soldering heat stress test series) before executing this test.

3.1 Initial measurement

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

3.2 Tests

Place the specimen in the chamber kept at high temperature and high humidity conditions. When putting the specimen in and out of the chamber, make sure that water drops not to be stuck to the specimen and not to dip it in water.

Remarks:

When the SMD is to be mounted on the jig for evaluation, the relevant conditions (board materials, size of the land, soldering method, flux cleaning, etc.) should be specified in the relevant specifications.

(1) Test conditions

Select the temperature and humidity conditions out of those ones of **Table 1**, and apply the Conditions C unless otherwise specified. Under condition D, E, and F (Unsaturated Pressurized Vapor Test), the temperature and the humidity from the start to the end of the test should be controlled in conformity with the profile of **Figure 1**, unless otherwise specified.

The relative humidity in the chamber during the heating and humidification phase as well as in the cooling and dehumidification phase should be kept from 50% to 85%.

(2) Test duration

Test duration should be refered to **Table 1**, except when otherwise specified. Under condition D, E, and F (Unsaturated Pressurized Vapor Test), the time count should be started when the vapor pressure and temperature reach stable state as shown in **Figure 1**.

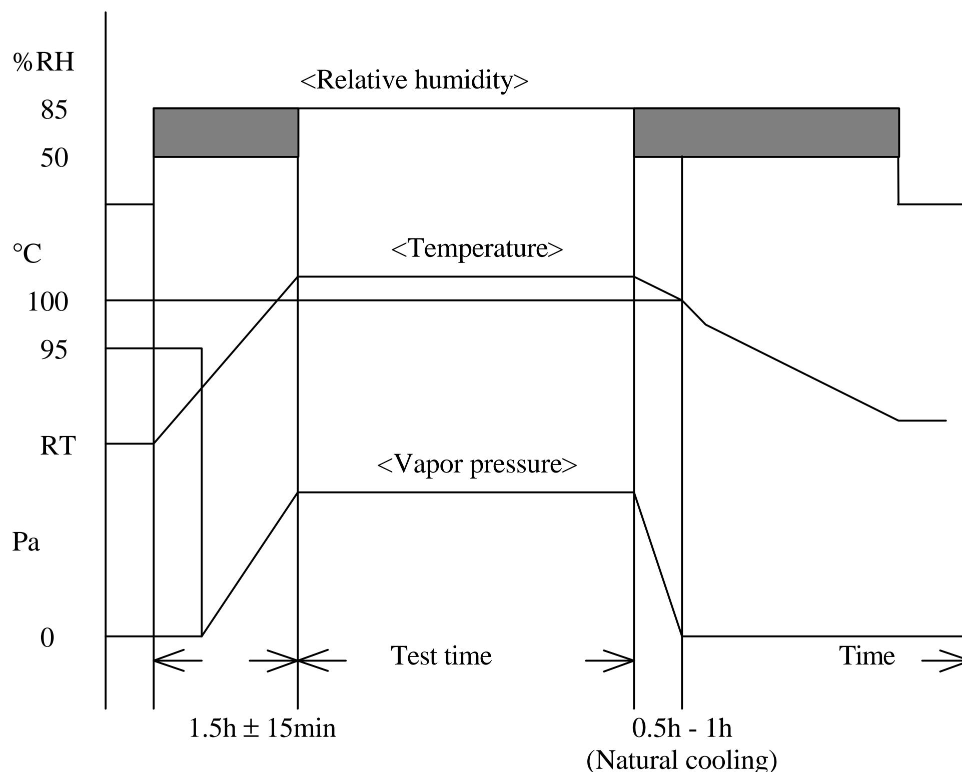
TABLE 1 TEMPERATURE HUMIDITY STORAGE TEST CONDITIONSTest code

Test code	Temperature °C	Humidity %	Test duration h	Vapor pressure[1] Pa
A	40±2	90±5	1000+168/-24	-
B	60±2	90±5	1000+168/-24	-
C	85±2	85±5	1000+168/-24	-
D	110±2	85±5	192+8/-0	1.2×10^5
E	120±2	85±5	96+4/-0	1.7×10^5
F	130±2	85±5	48+2/-0	2.3×10^5

Note([1]) Reference value

Condition D, E, and F is called Unsaturated Pressurized Vapor Test.

Figure 1 UNSATURATED PRESSURIZED VAPOR TEST CONDITIONS FROFILE



3.3 Post treatment

After finishing the tests, leave the specimen standing under normal conditions, from 2 hours to 24 hours.

Remarks:

Under condition D, E, and F (Unsaturated Pressurized Vapor Test), special care should be taken when handling the specimen after finishing the test,because failure modes differnt from those ones of the tests may occur due to condensation, sudden changes in the temperature and pressure, and other relevant factors. After finishing the test, remove the specimen from the chamber after confirming that the interior of the chamber has returned approximately to the normal condition in conformity with the specified temperature and humidity profile, and then leave the specimen in room temperature.

3.4 End-point measurement

Carry out the end-point measurements in conformity with the items and conditions specified in the relevant specifications. These measurements should be carried out within 48 hours under normal conditions after the completion of the tests, except when other specified.

Remarks:

In case of expending more completion time of the measurements than 48 hours, the specimen should be storaged in suitable storage conditions such as no influence of test results.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATIONS

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

(2) Test condition (cases other than the specified ones) [Refer to **3.2.(1)**]

(3) Test duration (cases other than the specified ones) [Refer to **3.2.(2)**]

(4) Post treatment (cases other than the specified ones) [Refer to **3.3**]

(5) Items and conditions of the end-point measurements (cases other than the specified ones) [Refer to **3.4**]

(6) Storage conditions to the measurements
(When using storage conditions than the specified ones) [Refer to **3.4**]

TEST METHOD 104
MOISTURE SOAKING AND SOLDERING HEAT STRESS SERIES TEST

1. SCOPE

This standard provides for the methods to evaluate the resistance and the endurance of plastic molded SMD after moisture absorption during storage and after submitted to soldering heat stress when mounted on the Printed circuit board.

Remarks:

These are the series tests that must be carried out with plastic molded SMDs before the various test items shown In Sub-clause **2.**

Test methods and reference standards are referred to the latest revision.

2. TEST ITEMS THAT REQUIRE THE MOISTURE SOAKING AND SOLDERING HEAT STRESS SERIES TESTS

These series test must be carried out in the first place, when executing the following tests.

(1) Test Method **102** Temperature humidity bias.
(2) Test Method **103** Temperature humidity storage.
(3) Test Method **105** Temperature cycle.
(4) Test Method **307** Thermal shock
(5) Test Method **203** Moisture resistance cycle.

3. TEST EQUIPMENT

Test equipments are specified in the test method **301** (Resistance to soldering heat for SMDs).

4. MATERIAL

Materials are specified in the test method **301** (Resistance to soldering heat for SMDs).

5. PROCEDURE

5.1 Initial measurement

Initial measurements are specified in the test method **301** (Resistance to soldering heat for SMDs).

SAT inspection for initial measurements shall be carried out only when specified in the Relevant specifications.

5.2 Baking before humidification treatment

Baking before humidification treatment is specified in the test method **301** (Resistance to soldering heat for SMDs).

5.3 Humidification treatment

Humidification treatment is specified in the test method **301** (Resistance to soldering heat for SMDs).

5.4 Heat treatment for soldering

Heat treatment for soldering is specified in the test method **301** (Resistance to soldering heat for SMDs).

5.5 Treatment after the series tests

If necessary, leave the specimen standing under the normal condition during the time specified in the

relevant Specification.

5.6 Measurements after finishing the series tests

Measurements after finishing the series tests is specified in the test method **301** (Resistance to soldering heat for SMDs).

5.7 Main test

After finishing these series tests, carry out the tests mentioned in Sub-clause 2 above.

6. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATIONS

(1) SAT inspection (When required) [Refer to **5.1**, **5.6**]

TEST METHOD 105
TEMPERATURE CYCLE (1)

1. SCOPE

This standard provides for the methods to evaluate the endurance of semiconductor devices when they are exposed to repeated temperature variation cycles between high temperature and low temperature.

Remarks;

Care should be taken when carrying out screening consisting of 10 or more temperature cycles with plastic-molded semiconductor device packages, because it may result into impaired reliability in the field due to crack on the passivation film on the chip, delamination between plastic and die, and other relevant factors.

2. TEST EQUIPMENT

Two chambers should be used. One chamber should be preset at the minimum storage temperature, and the other should be preset at the maximum storage temperature. These chambers should keep their internal temperature at the preset values by circulating air therein, and the tolerances in their storage temperatures should be in conformity with **Table 1**. The thermostatic chambers should have thermal capacity sufficient to reach the preset temperature in principle within 5 minutes after loading the specimen or within the longer one out of 10% of step a or step c of **Table 3**.

TABLE 1 TOLERANCE OF THE TEST CONDITIONS

Temperature		Tolerance
High temperature side	125°C or more	±5°C
	Below 125°C	+5°C - 3°C
Low temperature side	-25°C or more	+3°C - 5°C
	Below -25°C	±5°C

3. PROCEDURE

When the specimen is plastic-molded SMD, carry out the specified moisture soaking and soldering heat stress treatments of TEST METHOD **104** (Moisture soaking and soldering heat stress series tests) prior to executing this test.

3.1 Initial measurement

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

3.2 Test

3.2.1 Test Condition

Step a to step d of **Figure 1** should be regarded as 1 cycle, and the specimen should be tested in conformity with **Table 2**, starting from Step a. When evaluating the structural endurance, carry out 10 cycles, unless otherwise specified. For all other cases the test conditions should be specified in the relevant specifications.

Note (1)

Reference :

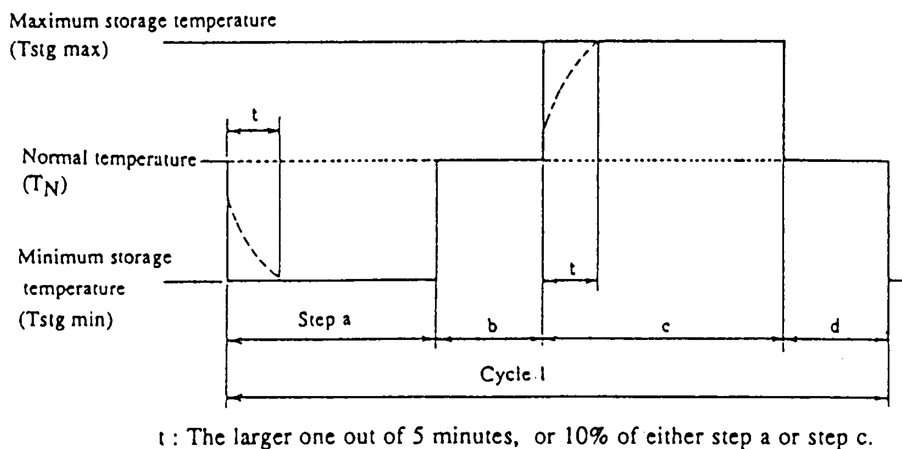
Regarding the testing cycle, **IEC 60749** specifies 5 cycles.

3.2.2 Test Methods

When loading the specimen in the thermostatic chamber, put it at such a place where there is circulation of air around the specimen.

When the specimen is to be placed in an unusual way, the matter should be specified in the relevant specifications. In order to avoid thermal shock when it is transferred from one chamber to other, direct transmission of heat to the specimen should be as small as possible.

Figure 1 COMPOSITION OF THE TEMPERATURE CYCLE



t : The larger one out of 5 minutes, or 10% of either step a or step c.

Table 2 TEST CONDITIONS

Step	Temperature	Time
a	Minimum storage temperature ($T_{stg\ min}$)	Select one condition from **Table 3**
b	Normal temperature 5°C-35°C (T_N)	Select one condition from **Table 3**
c	Maximum storage temperature ($T_{stg\ max}$)	Select one condition from **Table 3**
d	Normal temperature 5°C-35°C (T_N)	Select one condition from **Table 3**

Table 3 DWELL TIME OF THE TEMPERATURE CYCLE

Mass (m) of the specimen (g)	Step b Step d	Step a Step c
$M \leqq 15$	Within 5 min	10 min or more
$15 < m \leqq 150$	Within 15 min	30 min or more
$150 < m \leqq 1500$	Within 30 min	60 min or more
$1500 < m$	Specified in the relevant specifications	

Remarks :

As for the dwell times at low temperature and high temperature, the time counted from the instant when the specimen reaches thermal balance should be regarded as the steps a and c when the specimen does not reach the storage temperature within the specified time.

Note (1)

In the IEC standards, this method corresponds to Rapid Change of Temperature: two Chamber Method.

Reference :

Regarding the retention time of the temperature cycle, **IEC 60749** specifies the time counted just after the sample has reached the balanced condition of the test temperature.

3.3 Post treatment

After finishing the test, the specimen should be left standing under normal conditions, from 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) Method to place the specimen (When the specimen is placed in a special way) [Refer to **3.2**]

(3) Dwell time under low temperature conditions, high temperature conditions and normal temperature conditions [Refer to **3.2**]

(4) Number of repetition cycles (When adopting number of cycles other than 10) [Refer to **3.2**]

(5) Post treatment (When executing post treatment other than the specified ones) [Refer to **3.3**]

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

REFERENCE 1 SUPPLEMENTARY INFORMATION ON THE TEST METHOD

1. Discussion contents about the revision and carried over problems.

In discussing the revision based on the compatibility with IEC, questionnaires were sent to the committee of each company for the review about the necessity of the revision of temperature cycle test, test condition, and purposes of the test(presumable environments and failure modes),and the following results were obtained.

(1) Necessity of the revision of temperature cycle test.

A half of the committee (9 out of 17 companies) were of the opinion that the revision is not necessary, in particular. The opinions referring to the revision comprise the necessity of defining the purposes of the test and recheck and review of the required number of test cycles.

(2) Test conditions.

(a) The test temperature conditions were divided roughly in to the three conditions shown below.

-65 ←→ +150°C, -55 ←→ +150°C, Tstg.min ←→ Tstg.max.

(b) Regarding the number of test cycles, the committee of companies were of the following opinion.

10 ~ 1000cycles, number of cycles demanded by customers.

- Since the execution purposes of this test were not defined yet,the number of test cycles was noticeably dispersed among these companies as a result, because of the mixture of the number of test cycles for the product development processes, customers, demands, and other factors.
- It doesn't always become clear but it is the present situation that is implementing the technical opinion of the customer number of the request cycles at the number of the customer request cycles.

(3) The purposes of test (presumable environments and failure modes) and others.

There was a following opinion from the member of the committee.

(a) Definition of the number of test cycles including the possibilities of the acceleration according to the actual working purposes.

(b) Definition of the basis of the temperature chage conditions in the fields and required number of resisting cycles.

(c) Definition of the presumable failure modes of wire bonding open, Aluminum metallization line slide, etc. and the required number of cycles.

(d) Definition of the basis of the holding time specified by the unitary mass of samples.

2. Conclusion

Regarding the recheck and revision of the temperature cycle testing method, the committee of the companies were of the same opinion the required number of cycles should be specified by defining the purposes of the test (presumable environments, failure modes, etc.)

According to the results in paragraph 1,more than a half of the committee were of the opinion that the revision is not necessary, in particular. Since data and materials were insufficient for discussing and reviewing the revision due to the noticeable dispersion about the number of test cycles, indefinite purposes of the test, indefinite basis of the number of cycles, etc., the substantial revision was difficult ,and the revision was limited to the substantial comments only at this time. The required number of test cycles, etc. were carried over as the problems to be reviewed in the future.

TEST METHOD 106
INTERMITTENT OPERATING LIFE

1. SCOPE

This standard provides for the method to evaluate the endurance of semiconductor devices when they are submitted to variable electrical and thermal stresses that occur when electrical stress is applied cyclically in ON and OFF states.

Remarks:

Care must be taken when executing this test, because the device temperature may exceed the ambient preset temperature and rise conspicuously due to internally dissipated heat from the device.

2. TEST EQUIPMENT

Equipment to be used in this test should consist of a chamber capable to keep the specified test temperature within the specified tolerance, the power supply capable to generate intermittently the specified AC or DC voltages, and the board to make electrical contact to the terminals of devices under test with socket or other mounting method, having heat..

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 Tests

The test should be carried out by turning the totality or part of the input and the power supply cyclically ON and OFF according to the same operating condition as the test method **101** STEADY STATE OPERATING LIFE. The test procedure should be the same as in the steady state operating life test, except the electrical stress application method.

(1) Test circuit

The test circuit should be in conformity with the stipulations of the relevant specifications.

(2) Ambient temperature

Unless otherwise specified, the ambient temperature should be operating temperature (T_{opr}) specified in the relevant specifications.

Remarks:

Care must be taken because the maximum rated junction temperature (T_{jmax}) may be exceeded due to internally dissipated heat from the specimen.

(3) Method and time to turn the power ON/OFF

Unless otherwise specified, the method and time to turn the power ON/OFF should be condition specified in the relevant specifications.

(4) Number of repetition cycles

Unless otherwise specified, the number of repetition cycles should be condition specified in the relevant specifications.

(5) Specimen mounting method

When required, the specimen should be mounted in conformity with the method specified in the

relevant specifications.

Remarks:

When he SMD is mounted on the test board for evaluation, the relevant conditions (substrate material, land size, soldering method, flux cleaning, etc.) should be specified in the relevant specifications.

3.3 Post treatment

At the end of the test period, the specimen should be stored under normal conditions from 2 hours to 24 hours.

3.4 End-point measurement

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

Remarks:

Electrical end-point testing shall be completed within 48 hours of removal of bias from devices.

4. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATIONS

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

(2) Test circuit (Circuit, applied voltage, etc.) [Refer to **3.2(1)**]

(3) Ambient temperature [Refer to **3.2(2)**]

(4) Method and time to turn the power ON/OFF [Refer to **3.2(3)**]

(5) Number of repetition cycles [Refer to **3.2(4)**]

(6) Mounting method of the specimen (When required) [Refer to **3.2(5)**]

(7) Post treatment (When executing post treatment other than the specified ones) [Refer to **3.3**]

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