



Standard of Electronic Industries Association of Japan

EIAJ ED-4702

**Mechanical stress test methods
for semiconductor surface mounting devices**

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STANDARD OF ELECTRONIC INDUSTRIES ASSOCIATION OF JAPAN**MECHANICAL STRESS TEST METHODS FOR SEMICONDUCTOR
SURFACE MOUNTING DEVICES****1. SCOPE**

This standard specifies the methods for evaluating resistance to mechanical stress and thermal stress applied to surface mounting devices (SMDs) used in industrial or consumer electronic equipment while or after SMDs are mounted on printed circuit boards.

Note 1: The tests specified in this standard are comprehensive tests applicable to mounting methods, mounting conditions, printed circuit boards and soldering materials as well as SMDs alone. These tests are intended for comprehensive evaluation of SMDs including their mounting statuses rather than resistance of a single SMD to mechanical stress and thermal stress. Tests shall be conducted to be equivalent to the environmental condition where boards including SMDs are actually used.

Note 2: If mechanical stress in each test is not applied in actual use or in handling after the SMD is mounted on boards, the tests do not need to be conducted.

2. TERMINOLOGY

The terms used in this standard or the related detail specification are defined as follows:

- (1) Sample: Mounted SMD used in tests
- (2) Sample SMD: Single SMD used in tests
- (3) SMD: Surface mounting device which is a semiconductor device designed to be mounted on the surface of a printed circuit board
- (4) Surface mounting: Mounting or jointing devices on the surfaces of printed circuit boards
- (5) Equipment: Equipment used to test
- (6) Material: Materials used to test
- (7) Procedure: A sequence of treatment, measurement, setting of conditions, inspection, and other steps to test
- (8) Pre-treatment: Treatment performed before initial measurement or test
- (9) Test: Checking the samples under the specified conditions
- (10) Mounting: Installing the samples on a printed circuit board to test them
- (11) Post-treatment: Treatment performed for samples before final measurement in order to remove the effects other than those imposed in the test
- (12) Final measurement: Check of the appearance of samples and measurement of electrical characteristics
- (13) Ambient temperature
 - (a) For a sample not dissipating electric power: Temperature of the air surrounding the sample
 - (b) For a sample dissipating electric power: When the sample is cooled through natural convection, the ambient temperature is the air temperature measured at a distance from the sample where the effect of heat dissipation is negligible. When the sample

is cooled through forced convection, the ambient temperature shall be measured as specified in the detail specification.

- (14) Storage temperature: Ambient temperature when samples in no operation are stored
- (15) Operating temperature: Ambient temperature when samples are operating
- (16) Printed circuit board: Board on which samples are mounted
- (17) Mounting method: Method for mounting a sample SMD on a printed circuit board. Mounting methods include infrared reflow soldering, vapor phase soldering (VPS) and flow soldering.

3. GENERAL

If a sample SMD needs to be mounted on a printed circuit board for test, preparation shall be done as specified below.

3.1 PREPARATION FOR TEST

(1) Printed circuit board

According to the structure of the SMD, a proper printed circuit board shall be used as specified in the detail specification. Figure 1 shows a printed circuit board made of glass-based epoxy resin which is metallized with copper. The thickness of the board is $1.6 \text{ mm} \pm 0.2 \text{ mm}$. The thickness of the copper metallization is $0.04 \text{ mm} \pm 0.01 \text{ mm}$. Lands are made on the board for mounting SMDs.

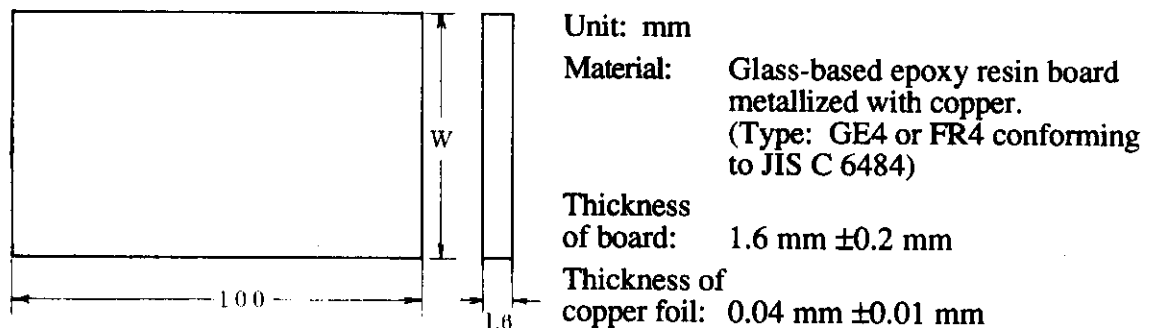


Figure 1 Board on which a sample is mounted

(2) Equipment for mounting

A reflow soldering equipment, such as a vapor phase reflow furnace, infrared reflow furnace or hot air furnace, a flow soldering unit, or solder bath is used for mounting.

(3) Pre-treatment

The sample SMD shall be subject to pre-treatment if it is specified in the detail specification.

(4) Mounting method

The sample SMD shall be mounted on the printed circuit board as specified in the detail specification. If a mounting method is not specified, the sample SMD shall be mounted using methods I to III. In this case, if the surface of sample SMD being heated is limited in temperature, the temperature shall be checked to be below the limit by measuring with the method in Figure 2.

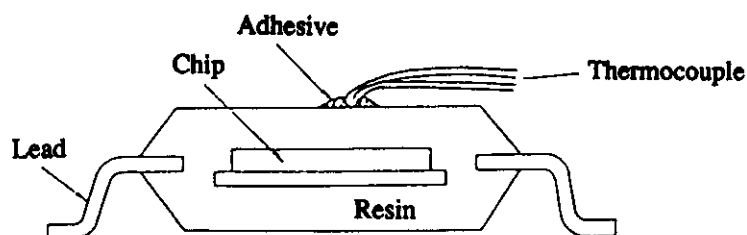


Figure 2 Measurement of the surface temperature of a sample SMD

Method I (Infrared reflow soldering)

When mounting a sample SMD with an infrared reflow furnace, follow the procedure specified below.

- (a) Preparation 1: Apply cream solder to the mounting area on the printed circuit board by a thickness of $150\ \mu\text{m} \pm 50\ \mu\text{m}$. If a solder bridge is formed after soldering, change cream solder thickness, without having to be restricted to the above thickness.
- (b) Preparation 2: Mount a sample SMD on a printed circuit board.
- (c) Put the printed circuit board with the sample SMD in the preheated reflow furnace, and keep the temperature of the printed circuit board at $150^\circ\text{C} \pm 10^\circ\text{C}$ for 90 sec. ± 30 sec. (see Figure 3).
- (d) Heating: After completion of pre-heating, keep the sample SMD again in the condition shown in Figure 3.
- (e) Removing flux: Remove the flux from the sample by cleaning.

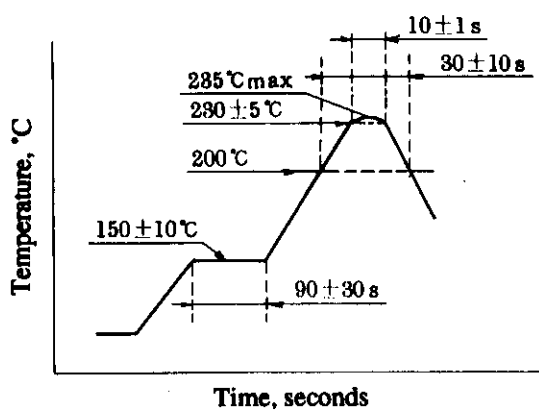


Figure 3 Heating conditions in infrared reflow

Method II (Vapor phase reflow soldering)

When mounting a sample SMD with a vapor phase reflow furnace, follow the procedure specified below.

- (a) Preparation 1: Apply cream solder to the mounting area on the printed circuit board by a thickness of $150\ \mu\text{m} \pm 50\ \mu\text{m}$. If a solder bridge is formed after soldering, change cream solder thickness, without having to be restricted to the above thickness.
- (b) Preparation 2: Mount a sample SMD on a printed circuit board.

- (c) Put the printed circuit board with the sample SMD in the pre-heated reflow furnace. Keep the printed circuit board at $150^{\circ}\text{C} \pm 10^{\circ}\text{C}$ for $90 \text{ sec.} \pm 30 \text{ sec.}$ (see Figure 4).
- (d) Heating: After completion of pre-heating, keep the condition of the sample SMD again in Figure 4.
- (e) Removing flux: Remove the flux from the sample by cleaning.

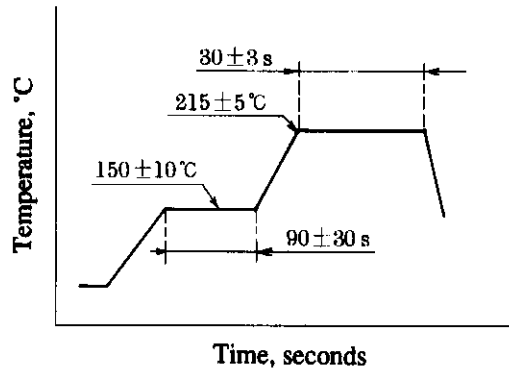


Figure 4 Heating conditions in vapor phase reflow

Method III (Flow soldering)

When mounting a sample SMD by flow soldering or solder dipping, follow the procedure specified below.

- (a) Preparation: Bond a sample SMD with adhesive to a printed circuit board.
- (b) Flux dipping: Apply flux to the leads of the sample SMD.
- (c) Cleaning the solder surface: When mounting the sample SMD by solder dipping, clean the solder bath surface with a stainless spatula or another similar tool.
- (d) Heating: Select either heating condition from Table 1. Take care so that the surface temperature of the sample SMD does not exceed the specified temperature during mounting.
- (e) Removing flux: Remove the flux from the sample by cleaning.

Table 1 Heating conditions in flow soldering or solder dipping

Solder temperature	Dipping time
$240 \pm 5^{\circ}\text{C}$	$5 \pm 1 \text{ sec.}$
$260 \pm 5^{\circ}\text{C}$	$5 \pm 1 \text{ sec.}$

3.2 MATERIALS

Materials used to mount a sample SMD on a printed circuit board is specified in the detail specification. If not specified, the following description shall be applied.

- (1) Solder: Solder shall be the one specified in H63A, H60A and H60S in JIS C 3282 (solder) or appendix B of IEC publ. 68-2-20 or an equivalent.
- (2) Flux: Flux shall be 2-propanol (isopropyl alcohol in JIS K 8839, JIS K 1152, or appendix C of IEC publ. 68-2-20) solution of rosin (in JIS K 5902 or Appendix C of IEC publ. 68-2-20) or an equivalent. The concentration of the rosin shall be 10% to 35% by weight. Unless otherwise specified, the concentration shall be 25%.

- (3) Cream solder: The solder grain size shall be 200 meshes or less. The material shall be as specified in (1) above, or shall provide a higher quality. Flux shall be as specified in (2) above, or shall be less active rosin (RMA specified in Federal standard QQ-S-571 or an equivalent).
- (4) Perphloro carbon: Perphloro carbon (perphloro isobutylene) shall be used for the vapor phase reflow furnace.
- (5) Cleaning liquid: Cleaning liquid shall be 2-propanol (isopropyl alcohol) specified in JIS K 8839 or ethanol (ethyl alcohol) specified in JIS K 8101.

3.3 ORIENTATION OF THE SAMPLE

The sample shall be oriented as specified in EIAJ ED-4701. For the shapes not specified in EIAJ ED-4701, their orientations are specified in the detail specification.

3.4 ENVIRONMENTAL CONDITIONS

- (1) Standard condition: Environmental condition required for pre-treatment, post-treatment and test is 15°C to 35°C of temperature, 45% to 75% of relative humidity and 86 kPa to 106 kPa of atmospheric pressure.
- (2) Decision condition: Environmental condition required for initial and final measurements is 25°C $\pm$ 3°C of ambient temperature 45% to 75% of relative humidity, and 86 kPa to 106 kPa of atmospheric pressure.

3.5 VISUAL INSPECTION OF SOLDERED PORTIONS: The portions to be evaluated visually in initial measurement after mounting, intermediate measurement during test, or measurement after test are specified in the detail specification. If these portions are not specified, they shall be evaluated as specified in EIAJ ED-4701 (Test method A-131 Solderability test).

4. GENERAL NOTES

- (1) The main purpose of the after-mounting test in this standard is to test the solder joints of the external leads of the mounted SMD. The strength largely depends on the mounting method, mounting conditions, materials, printed circuit board, and other factors. If the expected strength is not obtained, the faulty portions shall be carefully analyzed to check whether the cause is attributed to the SMD itself. If the SMD has no problem, the mounting method, mounting conditions, materials, printed circuit board, and other factors shall be reviewed, and then the test shall be conducted again.
- (2) The mechanical stress resistance and thermal stress resistance obtained in this test for the mounted SMD shall be carefully considered on the relation to the actual use conditions. The requirements in the detail specification shall be particularly observed.
- (3) This standard does not cover the device with the tape carrier packages (TCPs) and other devices having a lead strength and a lead pitch significantly different from that for standard SMDs. Because of the difference in handling and mounting, the method and criteria of handling these packages must be specified in a detail specification.
- (4) On the application of temperature cycles: When temperature cycle test or another environmental test is performed after mounting, test conditions applied to single SMDs shall not be used without alteration. Since the test is comprehensive test covering the mounting method, conditions, printed circuit board, and solder material, test conditions shall conform to evaluation test for the assembled system.

5. TEST PROCEDURES

5.1 STRENGTH OF THE BODY OF SMDS

5.1.1 Scope

This test shall specify a procedure for evaluating the resistance to an external force applied to the SMD through the package surface.

Note 1: This test shall be conducted when a static load is applied during measurement of alignment of chips to be mounted on a printed circuit board with an in-circuit tester.

Note 2: Resistance to the dynamic load applied by the automatic mounting machine during mounting shall be tested in the test of resistance to impact. Resistance to warp, deflection, or another external force shall be tested in the board bending test. These loads shall be distinctly distinguished.

5.1.2 Test equipments, tools and jigs

The equipment and tools used in this test shall conform to 5.1.3 (3).

5.1.3 Test procedure

- (1) Pre-treatment: Perform pre-treatment for the sample SMD as specified in the detail specifications, if necessary.
- (2) Initial measurement: Check the appearance of the sample SMD using a magnifier having a magnification power of 10X. Check the electrical and/or mechanical characteristics, when these are specified in the detail specification.
- (3) Placement: Place the sample SMD in such a way that both ends of the sample SMD are evenly placed on the support board shown in Figure 5, unless otherwise specified in the detail specification. Place the support board on a flat and rigid test table so that test is not affected when a pressure is applied.

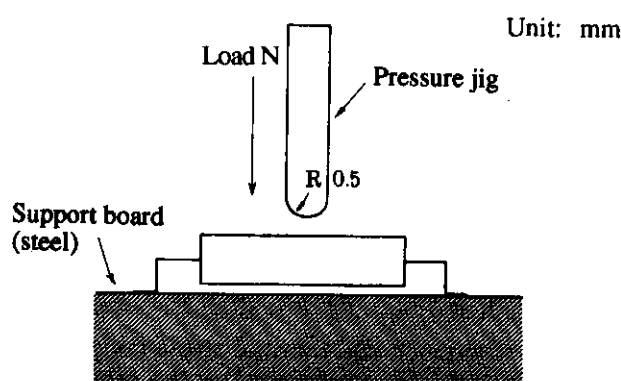


Figure 5 Placement

- (4) Pressuring: Apply a pressure at the center of the sample SMD for 10 sec. ± 1 sec. with the pressure jig shown in Figure 6. The load is specified in the detail specification. If a load is not specified, apply a load of $10\text{ N} \pm 1\text{ N}$ ($1.02\text{ kgf} \pm 0.10\text{ kgf}$). The direction of the load is also specified in the detail specification.
- (5) Post-treatment: Perform post-treatment for the sample SMD as specified in the detail specification, if necessary.

- (6) **Final measurement:** Check the appearance of the SMD for cracks and other faults using a magnifier having a magnification power of 10X. Then check its electrical and/or mechanical characteristics as specified in the detail specification.

Unit: mm

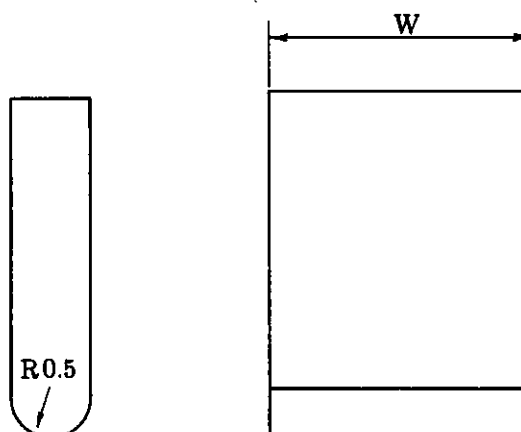


Figure 6 Pressure jig

Note 1: W shall be longer than the width of the part.

Note 2: The tool shall be made of hardened steel or hard metal.

5.1.4 Information to be given in the detail specifications

- | | |
|---|-----------------|
| (1) Pre-treatment (if necessary) | (See 5.1.3 (1)) |
| (2) Items and conditions in initial measurements | (See 5.1.3 (2)) |
| (3) Load to be applied (when not conforming to the specification) | (See 5.1.3 (4)) |
| (4) Direction of applied load | (See 5.1.3 (4)) |
| (5) Post-treatment (if necessary) | (See 5.1.3 (5)) |
| (6) Items and conditions in final measurements | (See 5.1.3 (6)) |
| (7) Other required items | |

5.1.5 Reference

- (1) While a pressure is being applied, electrical parameters may be measured with an in-circuit tester. In this method, this measurement is excluded, assuming that there is no continuity under a pressure in a normal use condition.
- (2) The surface of support board is flat, assuming that it is usually flat. If necessary, grooves may be made on the support table.

5.2 RESISTANCE TO PEELING

5.2.1 Scope

This test shall specify a procedure for evaluating the resistance to the force by which an SMD is removed from the printed circuit board by an external force to be applied perpendicularly to the SMD after mounting on the printed circuit board or during use of the SMD. Whether to conduct this test shall be specified in the detail specification.

Note: This test shall be conducted when:

- (1) Tape is peeled off from the surface of the device.

- (2) SMDs have the structure which is assumed to receive an external force, like as surface mounting connectors or another components.
- (3) The high SMDs with heat sink are applied external forces while a printed circuit board mounted SMDs is handled.

5.2.2 Test equipments

The equipments and tools used in this test shall conform to 5.2.4 (3).

5.2.3 Preparation of a sample

Solder an SMD on a printed circuit board as specified in the detail specification. Unless otherwise specified, solder an SMD as specified in "3. General."

5.2.4 Test procedure

- (1) Pre-treatment: Perform pre-treatment for the sample SMD as specified in the detail specification, if necessary.
- (2) Initial measurement: Check the appearance of the mounted sample SMD and the solder joints using a magnifier having a magnification power of 10X. Check the electrical and/or mechanical characteristics when these are specified in the detail specification.
- (3) Test: Apply a peeling load as follows. Secure a printed circuit board for test. Hold the body of sample SMD or bond a peeling tool at the center of the surface of the sample SMD, as shown in Figure 7. When a sample SMD has a heat sink, hold the heat sink. Unless otherwise specified, apply a load of 5 N (0.51 kgf) for 10 sec. ± 1 sec. Make sure that the direction of the load is within 5° with respect to the vertical line.
- (4) Post-treatment: Perform post-treatment for the sample SMD as specified in the detail specification, if necessary.
- (5) Final measurement: Upon completion of test, check the appearance of the SMD for cracks and other faults on the soldered joints using a magnifier having a magnification power of 10X. Then check the electrical characteristics of the soldered joints as specified in the detail specification.

In this test, the printed circuit board, solderability, and the SMD may cause complex effects. If a failure occurs, check whether it is caused by the SMD itself and take appropriate action.

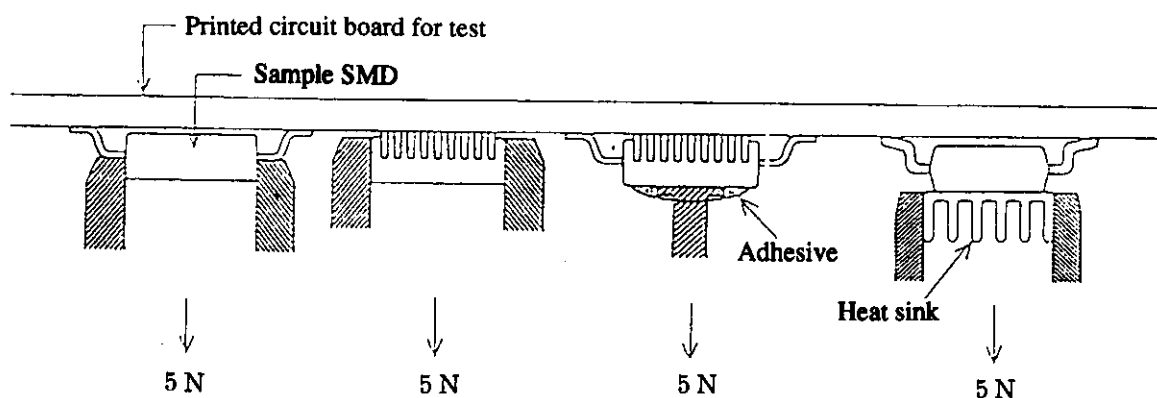


Figure 7 Peeling load

5.2.5 Information to be given in the detail specifications

- | | |
|---|-----------------|
| (1) Decision as to whether to test | (See 5.2.1) |
| (2) Printed circuit board for mounting SMDs
(when not conforming to the specification) | (See 5.2.3) |
| (3) Solder (when not conforming to the specification) | (See 5.2.3) |
| (4) Flux (when not conforming to the specification) | (See 5.2.3) |
| (5) Soldering conditions | (See 5.2.3) |
| (6) Cleaning | (See 5.2.3) |
| (7) Pre-treatment (if necessary) | (See 5.2.4 (1)) |
| (8) Items and conditions in initial measurements | (See 5.2.4 (2)) |
| (9) Load conditions (when not conforming to the specification) | (See 5.2.4 (3)) |
| (10) Post-treatment (if necessary) | (See 5.2.4 (4)) |
| (11) Items and conditions in final measurements | (See 5.2.4 (5)) |
| (12) Other required items | |

5.2.6 Reference

This test should be conducted under actual use conditions. Therefore, it was presented as an alternate method simulating actual surface mounting status as much as possible.

In leadless component test, a load can be applied from the back of a printed circuit board through a hole on it. But, this method was not adopted for SMDs, because this method is not practical, and a exclusive printed circuit board is required according to the external shape of the SMD.

In the test of resistance to peeling of a leaded SMD, the leads on one side are cut with a diamond cutter and the remaining leads can be deformed and mounted SMD is placed perpendicular to the printed circuit board. This method was not adopted, because this is not so practical.

5.3 RESISTANCE TO A BENT PRINTED CIRCUIT BOARD

5.3.1 Scope

This test shall specify a procedure for evaluating the resistance of the SMD and soldered joints to the stress caused by a bent printed circuit board mounted SMDs.

Note: This test is specified, assuming that a printed circuit board causes warp, deflection, or another temporary deformation after an SMD is mounted on the printed circuit board or while the board is being used. The test shall be applicable when specified in a detail specification, and shall not be adopted for the SMD mounted on a flexible printed circuit board or alumina ceramics printed circuit board.

5.3.2 Test equipments

The equipments and tools used in this test shall conform to 5.3.4 (3).

5.3.3 Preparation of a sample

Solder an SMD on a printed circuit board as specified in the detail specification. If this soldering is not specified in the detail specification, solder an SMD as specified in "3. General."

5.3.4 Test procedure

- (1) **Pre-treatment:** Perform pre-treatment for the sample SMD as specified in the detail specification, if necessary.
- (2) **Initial measurement:** Check the appearance of the sample SMD using a magnifier having a magnification power of 10X. Check the electrical and/or mechanical characteristics when these are specified in the detail specification, check them.
- (3) **Placement:** Place the printed circuit board mounted a sample SMD on a support as shown in Figure 8. The support must be on a flat and rigid test table so that test is not affected by an applied pressure.

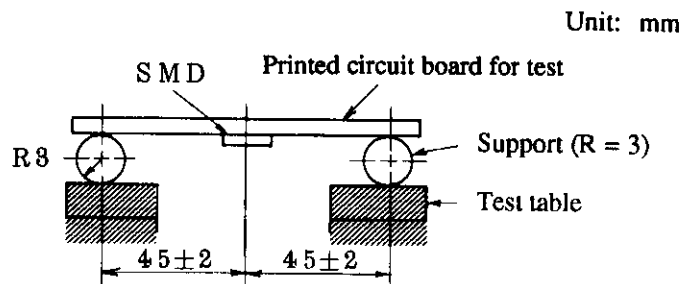
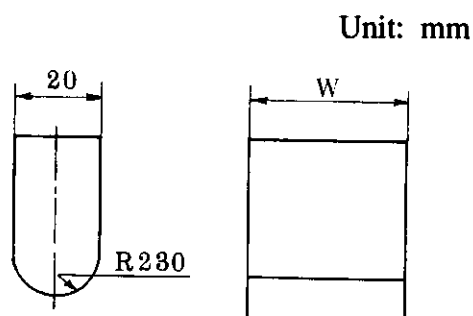


Figure 8 Placement

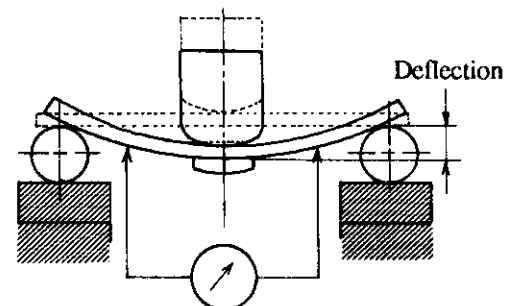
- (4) **Test:** Using the tool shown in Figure 9, apply the load to the printed circuit board mounted the sample SMD by the method shown in Figure 10. The material of the support must have no deformation under pressure. The amount of deflection is 1, 2, 3 or 4 mm with its tolerance of ± 0.5 mm, and is specified in the detail specification. If not specified, apply a deflection of 3 mm. Press the tool with the deflection speed of 1mm/sec, until the specified deflection is reached. Unless otherwise specified, hold the specified deflection for 5 sec. ± 1 sec. Unless otherwise specified, perform this test only once.

For QFPs, PLCCs, and other packages having leads on four sides, perform this test for both X and Z directions.



Material: Hardened steel or hard metal
W: The tool shall be at least 5 mm wider than the printed circuit board at both sides.

Figure 9 Tool



The amount of deflection can be measured as a displacement of the tool or another measuring point that provides a deflection.

Figure 10 Pressuring

- (5) Post-treatment: Perform post-treatment for the sample SMD as specified in the detail specification, if necessary.
- (6) Final measurement: After completion of test, check the appearance of the SMD for cracks and other faults on the sample SMD and soldered joints using the magnifier having a magnification power of 10X. Then check the electrical and/or mechanical characteristics of the soldered joints as specified in the detail specification. If a failure occurs, check whether it is caused by the SMD itself and deal with appropriate action.

5.3.5 Information to be given in the detail specifications

- | | |
|--|-----------------|
| (1) Printed circuit board for mounting SMD
(when not conforming to the specification) | (See 5.3.3) |
| (2) Cream solder (when not conforming to the specification) | (See 5.3.3) |
| (3) Solder (when not conforming to the specification) | (See 5.3.3) |
| (4) Flux (when not conforming to the specification) | (See 5.3.3) |
| (5) Soldering conditions | (See 5.3.3) |
| (6) Cleaning | (See 5.3.3) |
| (7) Pre-treatment (if necessary) | (See 5.3.4 (1)) |
| (8) Items and conditions in initial measurements | (See 5.3.4 (2)) |
| (9) Amount of deflection | (See 5.3.4 (4)) |
| (10) Post-treatment (if necessary) | (See 5.3.4 (5)) |
| (11) Items and conditions in final measurements | (See 5.3.4 (6)) |
| (12) Other required items | |

5.3.6 Reference

When a printed circuit board mounted a too large SMD is bent, the surface of the printed circuit board presses the back side of the SMD as shown in Figure 11. In this case, an excessive force is applied to the SMD, as a result, disconnecting of soldered portions, deforming or cutting of leads happens. This status never occurs in actual use. Take care when setting an amount of deflection.

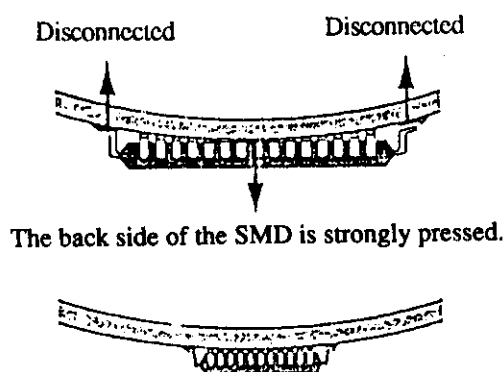


Figure 11 Large SMD and small SMD

5.4 STICK

5.4.1 Scope

This test shall specify a procedure for evaluating the strength of stick of an SMD to the printed circuit board when an external force is applied horizontally to the SMD, after it is mounted on the printed circuit board, or during the printed circuit board mounted SMDs is used. Whether to conduct this test shall be specified in the detail specification.

Note: This test shall be conducted when:

- (1) The SMDs have the structure which is assumed to receive an external force, like as surface mounting connector or another component.
- (2) The high SMD with heat sink are applied external force while a printed circuit board mounted SMDs is handled.

5.4.2 Test equipment

The equipment and tools used in this test shall conform to 5.4.4 (3).

5.4.3 Preparation of a sample

Solder an SMD on a printed circuit board as specified in the detail specification. Unless otherwise specified, solder an SMD as specified in "3. General."

5.4.4 Test procedure

- (1) Pre-treatment: Perform pre-treatment for the sample SMD as specified in the detail specification, if necessary.
- (2) Initial measurement: Check the appearance of the mounted sample SMD and the solder joints using a magnifier having a magnification power of 10X. Check the electrical and/or mechanical characteristics of the soldered joints, when these are specified in the detail specification.
- (3) Test: Secure the printed circuit board mounted SMDs, and then gradually apply a pressure to the top of the sample SMD with the pressuring tool in the horizontal direction of the printed circuit board, as shown in Figure 12. Unless otherwise specified, apply a load of 5 N (0.5 kgf) for 10 sec. ± 1 sec. For SOPs or other packages having leads on two side, apply a pressure to the center of a side having no leads. For QFPs or other packages having leads on the four sides, apply pressures to the centers of two sides which are perpendicular to each other (see Figure 13.).

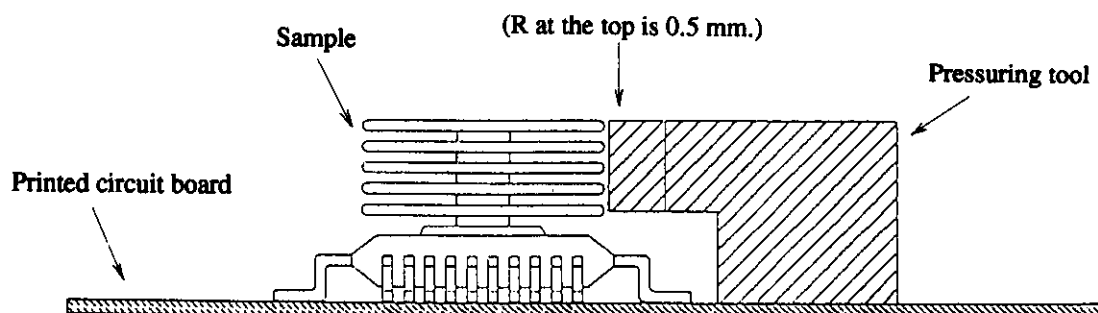


Figure 12 Direction of pressure

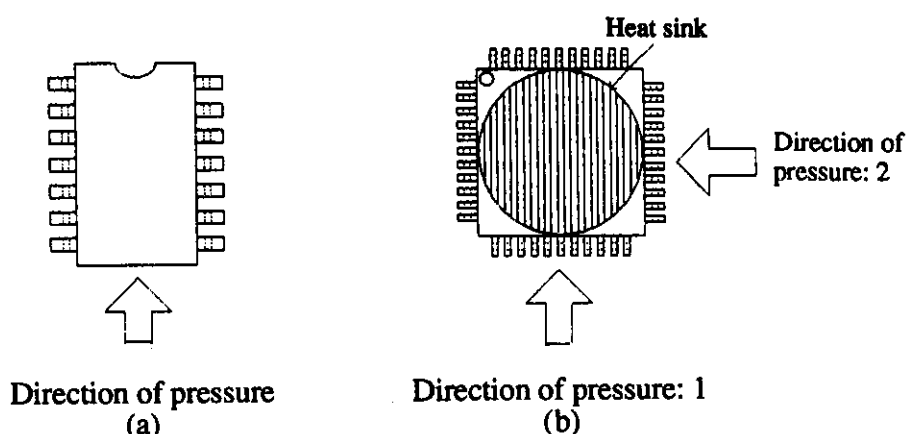


Figure 13 Direction of pressure

- (4) Post-treatment: Perform post-treatment for the sample SMD as specified in the detail specification, if necessary.
- (5) Final measurement: Upon completion of test, check the appearance of the SMD for cracks and other faults on the soldered joints using a magnifier having a magnification power of 10X. Then check the electrical characteristics of the soldered joints as specified in the detail specification.

In this test, the printed circuit board, solderability, and the SMD may cause complex effects. If a failure occurs, check whether it is caused by the SMD itself and take appropriate action.

5.4.5 Information to be given in the detail specifications

- | | |
|--|-----------------|
| (1) Decision as to whether to test | (See 5.4.1) |
| (2) Printed circuit board for mounting SMD
(when not conforming to the specification) | (See 5.4.3) |
| (3) Solder (when not conforming to the specification) | (See 5.4.3) |
| (4) Flux (when not conforming to the specification) | (See 5.4.3) |
| (5) Soldering conditions | (See 5.4.3) |
| (6) Cleaning | (See 5.4.3) |
| (7) Pre-treatment (if necessary) | (See 5.4.4 (1)) |
| (8) Items and conditions in initial measurements | (See 5.4.4 (2)) |
| (9) Pressure conditions (when not conforming to the specification) | (See 5.4.4 (3)) |
| (10) Shape of the pressuring tool (when not conforming
to the specification) | (See 5.4.4 (3)) |
| (11) Post-treatment (if necessary) | (See 5.4.3 (4)) |
| (12) Items and conditions in final measurements | (See 5.4.4 (5)) |
| (13) Other required items | |

5.5 TEMPERATURE CYCLE AFTER MOUNTING

5.5.1 Scope

This test shall specify a procedure for evaluating the structural resistance of soldered joints of an SMD mounted on a printed circuit board when the SMD is exposed to extremely high and low temperatures, and for evaluating the endurance of soldered joint when the SMD is subject to temperature cycles between extremely high and low temperatures.

5.5.2 Test equipment

The test equipment shall conform to EIAJ ED-4701 (B-131).

5.5.3 Preparation of a sample

Solder an SMD on a printed circuit board as specified in the detail specification. Unless otherwise specified, solder an SMD as specified in "3. General."

5.5.4 Test procedure

- (1) Pre-treatment: Perform pre-treatment for the sample SMD as specified in the detail specification, if necessary.
- (2) Initial measurement: Check the appearance of the sample and the soldered joints for cracks and other faults using a magnifier having a magnification power of 10X. Then check the electrical characteristics of the soldered joints as specified in the detail specification.
- (3) Test: Test shall be conducted under the conditions specified in the detail specification. Unless otherwise specified, test shall be conducted at the temperatures listed in Table 2. When the endurance of soldered joints is evaluated, however, conditions A to C are not preferable. When the endurance is evaluated with no condition specified, repeat the cycle consisting of steps 1 to 4 in Table 2 of five cycles.

Note 1: When the endurance of soldered joints is evaluated, their life must be evaluated in an actual use environment. Therefore, this test shall be conducted at temperatures simulating an actual use environment.

Note 2: When an SMD is mounted on a high-density printed circuit board, low melting point solder may be used. In this case, when the test temperature reaches near the solid phase point, the mechanical strength of the solder may be lowered.

- (4) Post-treatment: Post-treatment shall be conducted as specified in EIAJ ED-4701 (B-131).
- (5) Final measurement: After completion of test, check the soldered joints for cracks and other faults with a 10X magnifying glass. Then check the electrical characteristics of the soldered joints as specified in the detail specification. Also check their mechanical characteristics if specified in the detail specification.

Note: In this test, the printed circuit board, solderability, and the SMD may cause complex effects. If a failure occurs, check whether it is caused by the SMD itself and take appropriate action.

5.5.5 Information to be given in the detail specifications

- | | |
|--|-----------------|
| (1) Printed circuit board for mounting SMD
(when not conforming to the specification) | (See 5.5.3) |
| (2) Solder (when not conforming to the specification) | (See 5.5.3) |
| (3) Flux (when not conforming to the specification) | (See 5.5.3) |
| (4) Soldering conditions | (See 5.5.3) |
| (5) Cleaning | (See 5.5.3) |
| (6) Pre-treatment (if necessary) | (See 5.5.4 (1)) |

- (7) Items and conditions in initial measurements (See 5.5.4 (2))
- (8) Temperature cycle conditions (See 5.5.4 (3))
- (9) Number of cycles repeated (when the number of cycles repeated is not 5) (See 5.5.4 (3))
- (10) Post-treatment (when not conforming to the specification) (See 5.5.4 (4))
- (11) Items and conditions in final measurements (See 5.5.4 (5))
- (12) Other required items

Table 2 Temperature cycle conditions

Condition		A		B		C		D	
Step		Temperature (°C)	Time (minutes)	Temperature (°C)	Time (minutes)	Temperature (°C)	Time (minutes)	Temperature (°C)	Time (minutes)
1 cycle	1	-65 ± 3	30	-65 ± 3	30	-55 ± 3	30	Top min ± 3	30
	2	20 ± 15	10 to 15	20 ± 15	10 to 15	20 ± 15	10 to 15	20 ± 15	10 to 15
	3	125 ± 3	30	100 ± 3	30	100 ± 3	30	Top max ± 3	30
	4	20 ± 15	10 to 15	20 ± 15	10 to 15	20 ± 15	10 to 15	20 ± 15	10 to 15

Top: Operating temperature of the mounting printed circuit board

Note: Test conditions A to C are specified in JIS C 5012 (Procedures for testing printed circuit boards).

REFERENCE: IMPACT-RESISTANCE

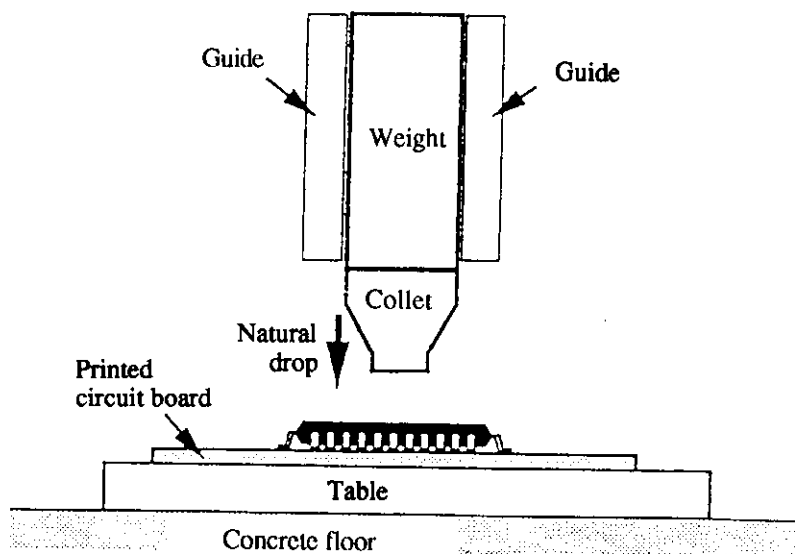
1. SCOPE

This reference test shall apply to SMDs mounted on printed circuit boards. In this test, the resistance of SMDs to the impact produced by mounting a device is evaluated.

2. TEST EQUIPMENT

2.1 TEST EQUIPMENT

The test equipment used shall be able to provide an impact specified in 2.2 as shown in Reference Figure 1. The collet and weight must be dropped without a friction. The table shall be made of metal. It shall have an area wider than the sample SMD. The thickness of the table shall be 1 cm or more. The weight of the table shall be 2 kg or more. The table shall be placed on a concrete floor or an equivalent. It must not be placed on rubber or another shock-absorbing material.



Reference Figure 1 Test equipment and test method

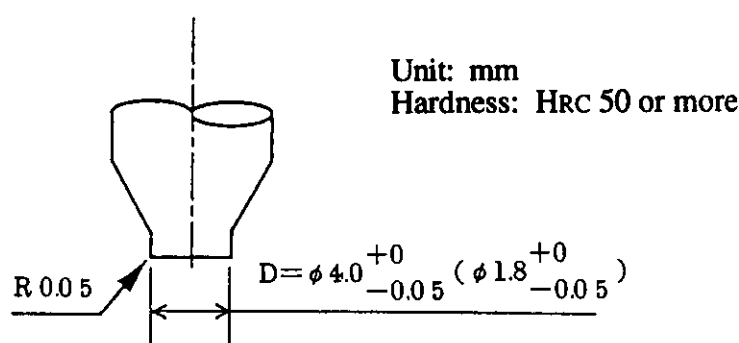
2.2 COLLET AND WEIGHT

The top of the collet shall be a cylinder as shown in Reference Figure 2. When the width and length of the SMD to which to apply an impact is 4 mm or more, the diameter of the cylinder shall be $4.0 +0/-0.05$ mm. When the SMD size is less than 4.0 mm, the diameter shall be $1.8 +0/-0.05$ mm.

The hardness of the collet and weight shall be HRC 50 or more. The collet and weight shall be joined with a sufficient strength. There shall be no shock-absorbing material between them. (One-piece collet and weight is preferable.)

2.3 PRINTED CIRCUIT BOARD

The material and size of the printed circuit board on which to mount an SMD shall be as specified in the detail specification.



Reference Figure 2 Top of the collet

3. TEST PROCEDURE

3.1 INITIAL MEASUREMENT

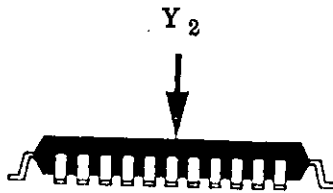
Unless otherwise specified, measure the electrical characteristics of the sample SMD as specified in the detail specification. Check the appearance of the sample SMD for cracks and chip traces using a magnifier having a magnification power of 10X.

3.2 PLACEMENT

Place the sample SMD on the printed circuit board as shown in Reference Figure 1 so that an impact specified in 3.3 can be applied.

3.3 TEST

Naturally drop the collet and weight specified in the detail specification from the specified height in order to apply an impact to the center of the top of the sample SMD. Unless otherwise specified, apply an impact once in the Y2 direction of the sample SMD as shown in Reference Figure 3.



Reference Figure 3 Direction of an Impact (for a QFP)

4. FINAL MEASUREMENT

Unless otherwise specified, check the electrical characteristics of the sample SMD as specified in the detail specification. Check the appearance of the sample SMD for cracks and chip traces using a magnifier having a magnification power of 10X.

5. INFORMATION TO BE GIVEN IN THE DETAIL SPECIFICATIONS

- (1) Decision as to whether to test
- (2) Material and size of the printed circuit board (See 2.3)
- (3) Items and conditions in initial measurements (See 3.1)
- (4) Weights of the collet and weight (See 3.3)
- (5) Heights of the collet and weight (See 3.3)
- (6) Direction of an impact and the number of times (when not conforming to the specification) (See 3.3)
- (7) Items and conditions in final measurements (See 4)
- (8) Other required items

6. REFERENCE

This test method is specified to evaluate the resistance to an impact applied to SMD mounted on printed circuit board. Due to the following problems, however, the test method has been just suggested as a reference test method rather than a standard.

- (1) The resistance to an impact essentially depends on the basic structure of the SMD, and setting condition for this test depends on SMD's structures so that leads are not deformed. For these reasons, it is difficult to standardize this test method with the constant conditions.
- (2) The magnitudes of actual mounting impacts applied to mounted SMDs are not clear. Appropriate methods for measuring the magnitude of impacts are not available. For these reasons, it is difficult to set test conditions.

DESCRIPTION

1. PURPOSE OF THIS STANDARD

This standard was being established at IEC. Mechanical stress test methods for mounted SMDs are already specified in standards EIAJ RCX-0102 to RCX-0105 established by Electronic Industries Association of Japan (EIAJ). This standard covers the resistances to items in these standards as the minimum requirement when semiconductor SMDs are mounted.

2. HISTORY OF DELIBERATION

October 1991

EIAJ ED-4701 including methods of testing SMDs was completed. Test items which are not included in EIAJ ED-4701, but should be standardized, were investigated. The committee decided to deliberate the items not yet standardized as semiconductor SMDs in the following three categories. For items which are difficult to standardize, the committee also decided to study their guidelines.

In addition, the Semiconductor Devices Reliability Subcommittee decided to address questionnaires to ask whether items (1) and (2) below should be standardized.

- (1) Items which are specified in EIAJ standards RCX-xxxx for general SMDs, but should be studied on the semiconductor devices.
 - (a) Stick
 - (b) Resistance to a bent printed circuit board
 - (c) Resistance to peeling
 - (d) Strength of the body
 - (e) Mechanical stress at mounting (impact test)
- (2) Items which are not specified in RCX-xxxx but considered to be important for semiconductors
 - (a) Temperature cycle after mounting
 - (b) Life for repetitive board bending after mounting (vibration)
- (3) Other items
 - (a) Resistance to ultrasonic cleaning
 - (b) Temporary mounting

December 1991

Table 1 summarizes the result of the questionnaires concerning the necessity of standardization. Detailed analysis of the result indicates that users need standardization and many manufacturers do not yet need standardization.

Table 1 Answers In response to questionnaires addressed by the Semiconductor Devices Reliability Subcommittee

Test	Stick, peeling, and bent board	Strength of the body	Resistance to impact	Temperature cycle after mounting	Board bending after mounting
Standardization	Not required: 10 Required: 1	9 2	8 3	9 2	9 2
Experiences	No: 10 Yes: 1	11 0	10 1	8 3	9 2
Inquiry from users	No: 7 Yes: 4	10 1	10 1	9 2	10 1
Submission of test data	No: 10 Yes: 1 Not possible: 1	11 0 0	11 0 0	8 3 3	10 1 1

During discussion of the result, the following problems were revealed:

- (1) Many responders do not require standardization. Which of the following reasons is true is not clear.
 - (a) Test does not need to be conducted about the items to be standardized:
 - (b) Test must not be conducted.
- (2) The following problems occurred about the items to be standardized:
 - (a) Whether to include all the items which may be necessary
 - (b) Whether to include only the minimum necessary items
- (3) There are significant differences in handling, shapes and strengths between integrated circuits (ICs) and discrete devices (passive parts). Does it need to make new standards for semiconductor integrated circuits required to distinct clearly between their conditions?
- (4) If it is difficult to standardize conditions and materials in a uniform manner, should only test methods be standardized?

January 1992

- (1) The committee decided to standardize minimum necessary evaluation tests after mounting as EIAJ standard for a semiconductor SMD in EIAJ ED-4702. Below are reasons.
 - (a) IEC and CECC are standardizing evaluation tests after mounting.
 - (b) Evaluation tests have been standardized in RCX-xxxx.
 - (c) Semiconductors differ from passive parts in many aspects. If there is no standard for semiconductors, the application of common standard to semiconductor SMDs, causes problems.
 - (d) If there is no Japanese standard for semiconductors, Japan cannot express opinion to other countries.
 - (e) If a problem occurs during use, it is difficult to assume the responsibility of either the user or manufacturer.
 - (f) IEC proposed TC47 (S) 1228 as a standard to perform temperature cycle test for mounted semiconductor SMDs after printed circuit board bending test. In addition to mechanical stress, foreign countries appear to pay attention to thermal stress. To respond to this, temperature cycle test after mounting will be standardized.

- (2) The committee decided to make the following clear before standardization:
- (a) Purpose of test
 - (b) Mechanisms of failures which may occur during actual use
 - (c) Failures are not caused by SMDs alone.
 - (d) If failures are expected not to occur during actual use, test does not need to be conducted.
 - (e) Test must not be conducted under stress which is never applied in actual use.
 - (f) The mounting method and conditions are specified in a detail specification.
 - (g) The visual inspection is used for the method to judge whether the sample is good or bad. Additional tests are specified in a detail specification.

February 1992

- (1) The committee decided to establish a standard organized as follows:
- (a) General
 - (b) Stick
 - (c) Resistance to peeling
 - (d) Resistance to a bent printed circuit board
 - (e) Strength of the body
 - (f) Mechanical stress at mounting
 - (g) Thermal cycle after mounting
- (2) For temporary mounting, it is difficult to specify materials of adhesive. Ultrasonic cleaning is not specific to SMDs. Life for repetitive board bending (vibration) after mounting is not a practical problem. The committee decided to exclude tests for these from this standard.

March to July 1992

The committee studied each draft of standard. For mechanical stress test at mounting, the committee decided to describe a test method as a reference test. This is because the test is difficult to specify in a uniform manner due to the following reasons: a specific impact is difficult to determine and even devices susceptible to an impact are mounted according to actual usage.

August 1992

The committee named mechanical stress test at mounting as "impact test."

3. COMMITTEE MEMBERS

This standard was discussed mainly by the Semiconductor Devices Reliability Subcommittee of the Special Technical Committee on Semiconductor Devices Quality and Reliability. The members of the special technical committee and subcommittee are listed below.

<Special Technical Committee on Semiconductor Devices Quality and Reliability>

Chairman:	Yoichi Kubo	Hitachi, Limited
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<Sub-Committee on Semiconductor Devices Reliability>

Chief examiner:	Ryusuke Kawanaka	Sony Corporation
Deputy chief examiner:	Kazutoshi Miyamoto	Mitsubishi Electric Corporation
Member:	Sinya Tanaka	NMB Semiconductor
Member:	Masayuki Kubota	Oki Electric Industry., Ltd.
Member:	Kenji Hamagishi	Kawasaki Steel Corporation
Member:	Yasuo Imai	Sanken Electric Co., Ltd.
Member:	Kazuaki Sakane	Sansha Electric Manufacturing
Member:	Kazutoshi Kitazume	Sanyo Electric Co., Ltd.
Member:	Nobuyuki Kawayoshi	Sharp Corporation
Member:	Tadashi Hagino	Shindengen Electric Mfg. Co., Ltd.
Member:	Tadatoshi Okabe	New Japan Radio Co., Ltd.
Member:	Hiroyoshi Ohdaira	Seiko Epson Corporation
Member:	Mikio Numakawa	Toshiba Corporation
Member:	Makoto Nogawa	Nihon Inter Electronics Corporation
Member:	Yasuo Tuchida	Nihon Semiconductor Inc.
Member:	Ikuo Shito	Texas Instruments Japan Ltd.
Member:	Kunimitsu Fujiki	NEC Corporation
Member:	Ryoichi Asai	Nippon Denso Co., Ltd.
Member:	Nobuhiko Kamochi	Philips Japan Ltd.
Member:	Satoshi Yuki	Nippon Motorola Ltd.
Member:	Masaki Tanaka	Hitachi, Limited
Member:	Yuzuru Matsuno	Fujitsu, Limited
Member:	Toshiharu Kurihara	Fuji Electric Co., Ltd.
Member:	Hiroshi Higuchi	Matsushita Electronics Corporation
Member:	Hiroshi Yoshiyama	Mitsumi Electric Co., Ltd.
Member:	Kunitaro Yoshida	Richoh Co., Ltd.
Special Member:	Itsuya Nishimae	Hitachi Limited
Guest Member:	Shuji Sasaki	Reliability Center for Electronic Components of Japan